

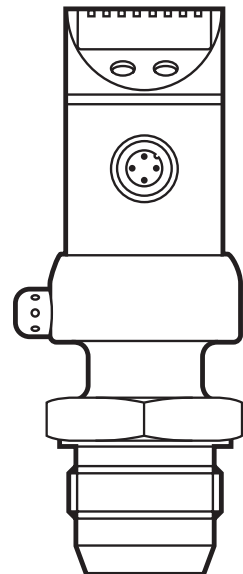


Operating instructions  
Electronic pressure sensor

UK

**PI16xx**

704639 / 00 06 / 2009



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# 1 Preliminary note

## 1.1 Symbols used

- ▶ Instruction
- > Reaction, result
- [...] Designation of buttons, switches or indications
- Cross-reference



Important note

Non-compliance can result in malfunctions or interference.

## 2 Safety instructions

- Read this document before installing the unit. Ensure that the product is suitable for your application without any restrictions.
- Non-adherence to the operating instructions or technical data can lead to personal injury and/or damage to property.
- In all applications check compliance of the product materials (→ chapter 12 Technical data) with the media to be measured.
- For units with cULus approval and the scope of validity cULus → chapter 6 Electrical connection.

## 3 Functions and features

The pressure sensor detects the system pressure of machines and installations.

### 3.1 Applications

Type of pressure: relative pressure

Order no.	Measuring range		Permissible overload pressure		Bursting pressure	
	bar	PSI	bar	PSI	bar	PSI
PI1693	-1...25	-14.4...362.7	100	1 450	350	5 070
PI1694	-1...10	-14.5...145	50	725	150	2 175
PI1695	-1...4	-14.5...58	30	435	100	1 450
PI1696	-0.124...2.5	-1.8...36.24	20	290	50	725
	mbar	PSI	bar	PSI	bar	PSI
PI1689	5...100	-0.073...1.45	4	58	30	435
PI1697	-50...1 000	-0.73...14.5	10	145	30	435
PI1698	-12.4...250	-0.18...3.62	10	145	30	435
PI1699	-1 000...1 000	-14.5...14.5	10	145	30	435

$$\text{MPa} = \text{bar} \div 10 \quad / \quad \text{kPa} = \text{bar} \times 100$$



Static and dynamic overpressures exceeding the indicated overload pressure are to be avoided by taking appropriate measures.

The indicated bursting pressure must not be exceeded. Even if the bursting pressure is exceeded only for a short time, the unit can be destroyed.

NOTE: Risk of injury!

## 4 Function

### 4.1 Processing of the measured signals

- The unit displays the current system pressure.
- It generates 1 output signal according to the parameter setting.

<b>OUT</b>	analogue signal 4...20 mA (20...4 mA)
------------	---------------------------------------

### 4.2 Pressure monitoring/ analogue function

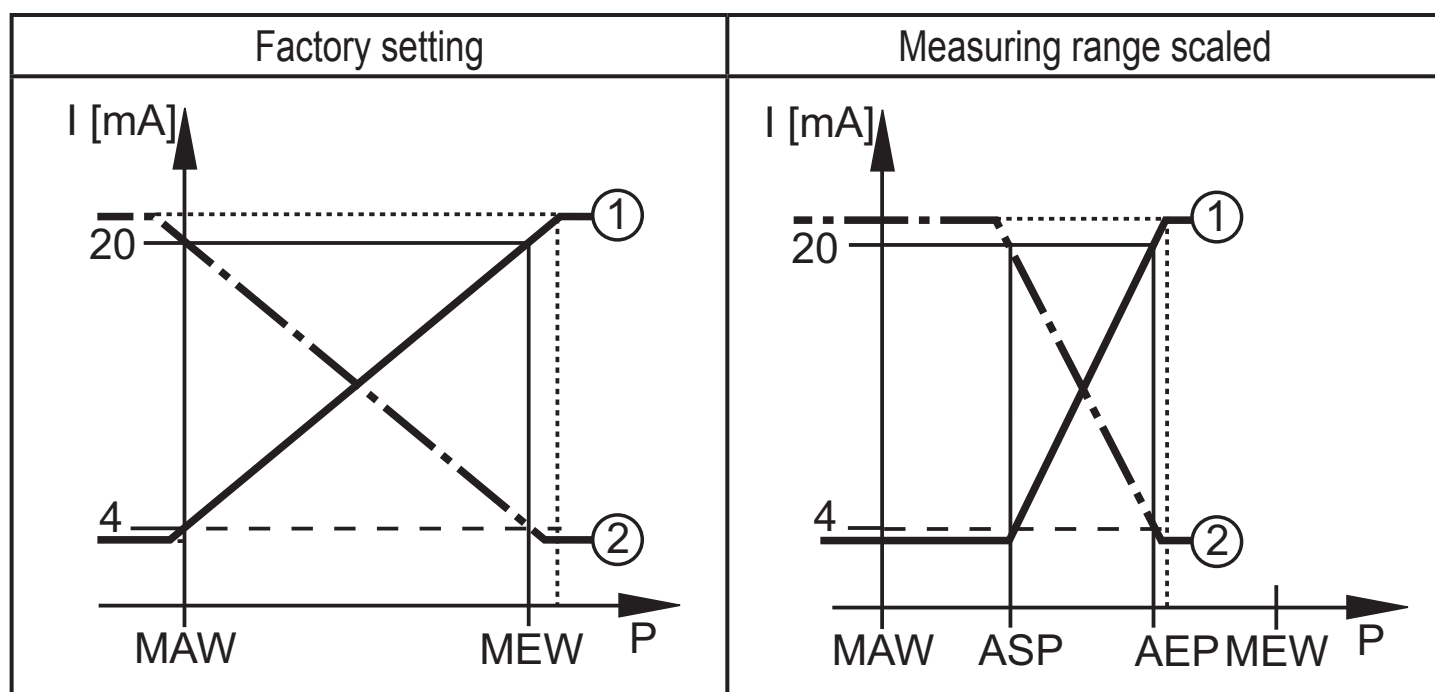
The analogue signal can be set.

- [OU2] defines whether the set measuring range is provided as a 4...20 mA signal ([OU2] = [I]) or a 20...4 mA signal ([OU2] = [InEG]).

Scaling can also be set by means of the teaching process or by entering a value for the ASP and AEP parameters.

- By teaching the analogue start point (tASP) or setting the parameter ASP you define the measured value at which the output signal is 4 mA (20 mA at [InEG]).
- By teaching the analogue end point (tAEP) or setting the parameter AEP you define the measured value at which the output signal is 20 mA (4 mA at [InEG]).

Minimum distance between [ASP] and [AEP] = 25 % of the final value of the measuring range (turn down 1:4).



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P = system pressure, MAW = initial value of the measuring range, MEW = final value of the measuring range

①: [OU2] = [I]; ②: [OU2] = [InEG]

The output signal is between 4 and 20 mA ([OU2] = [I]) or between 20 and 4 mA ([OU2] = [InEG]). It is also indicated:

- System pressure above the measuring range:
  - output signal > 20 mA if [OU2] = [I].
  - output signal between 4 and 3.8 mA if [OU2] = [InEG].
- System pressure below the measuring range:
  - output signal between 4 and 3.8 mA if [OU2] = [I].
  - output signal > 20 mA if [OU2] = [InEG].

## 5 Installation

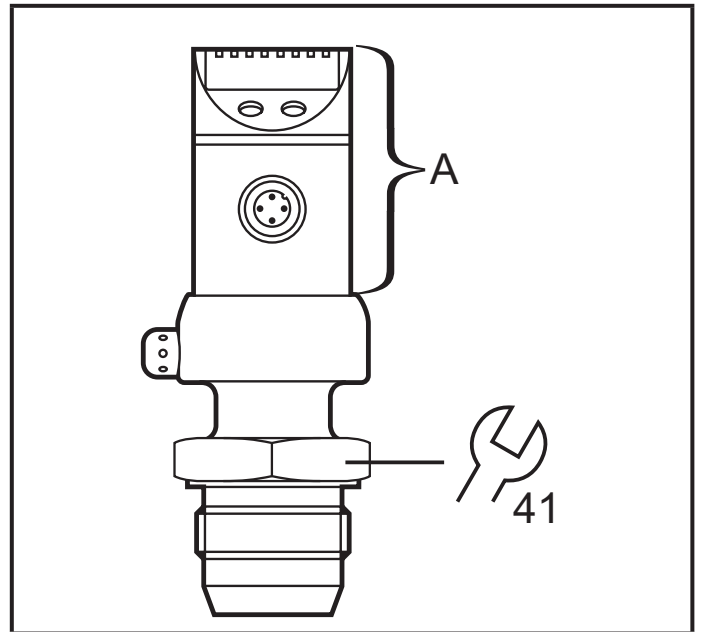
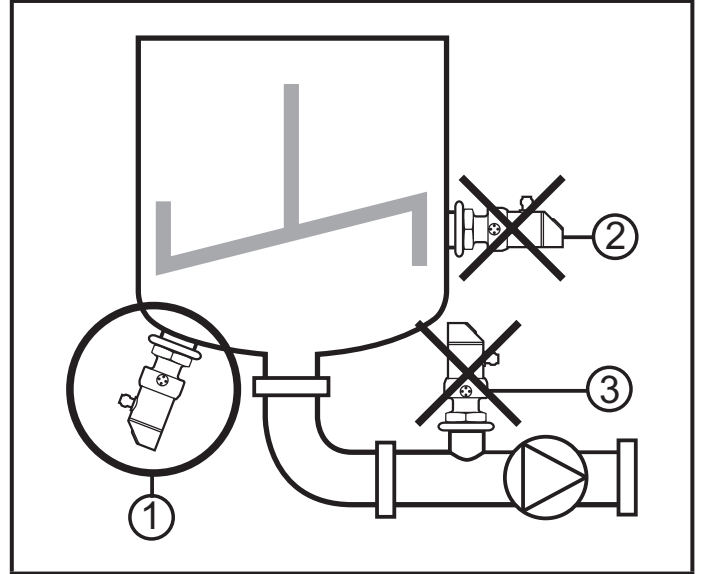


Ensure that no pressure is applied to the installation while mounting or removing the sensor. Please note: Display „0%“ does not mean that the system is free of pressure!

Horizontal mounting recommended for high medium temperatures.

To monitor a tank:

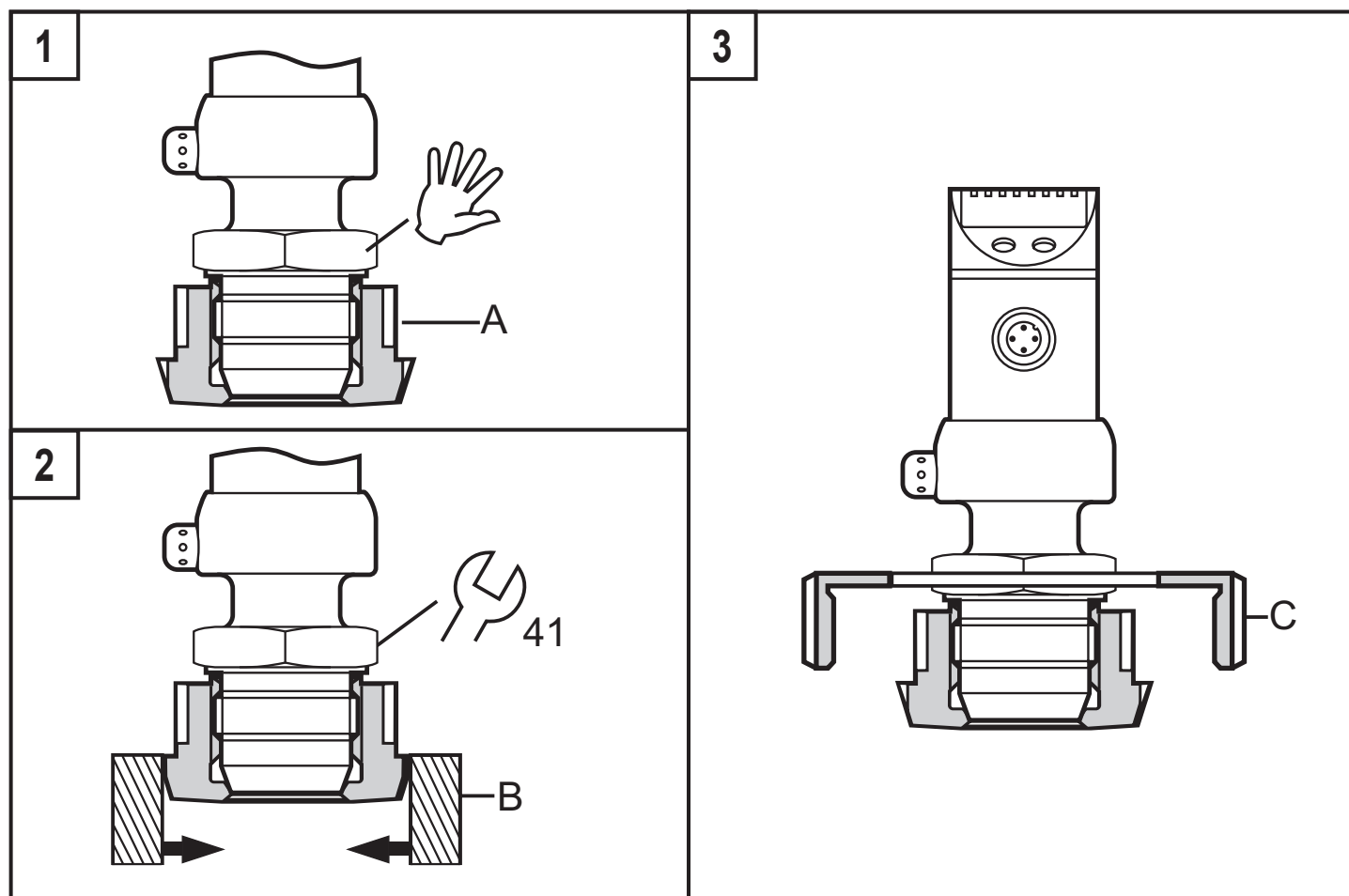
- ▶ If possible, mount the sensor at the bottom of the tank (1). Do not mount near an agitator (2), a pump (3) or in the spout of the tank (3).
- ▶ Screw the sensor into a G 1 process fitting.
- ▶ Tighten the sensor with a spanner. Tightening torque: 20 Nm..



A = freely rotatable housing

The unit is adaptable for various G 1 process fittings. G 1 process adapters to be ordered separately as accessories.

## Mounting



- ▶ Screw the unit into the adapter (A) until it is hand-tight (fig. 1). Do not damage the sealing chamfers.
- ▶ Clamp sensor and adapter into a clamping device (B); (fig. 2). Tighten the clamping device only slightly so that the adapter does not warp.
- ▶ Tighten the sensor using a spanner .  
Tightening torque: 20 Nm.
- ▶ Fix the unit + adapter to the process connection by means of a coupling nut, a clamp flange or the like (C); (fig 3).

NOTE: A guarantee for a long-term stable sealing of the metal seal is only valid for once-only mounting.

## Welding adapter

- ▶ First weld the adapter, then mount the sensor. Follow the instructions included with the adapter.

## 6 Electrical connection



The unit must be connected by a qualified electrician.

The national and international regulations for the installation of electrical equipment must be adhered to.

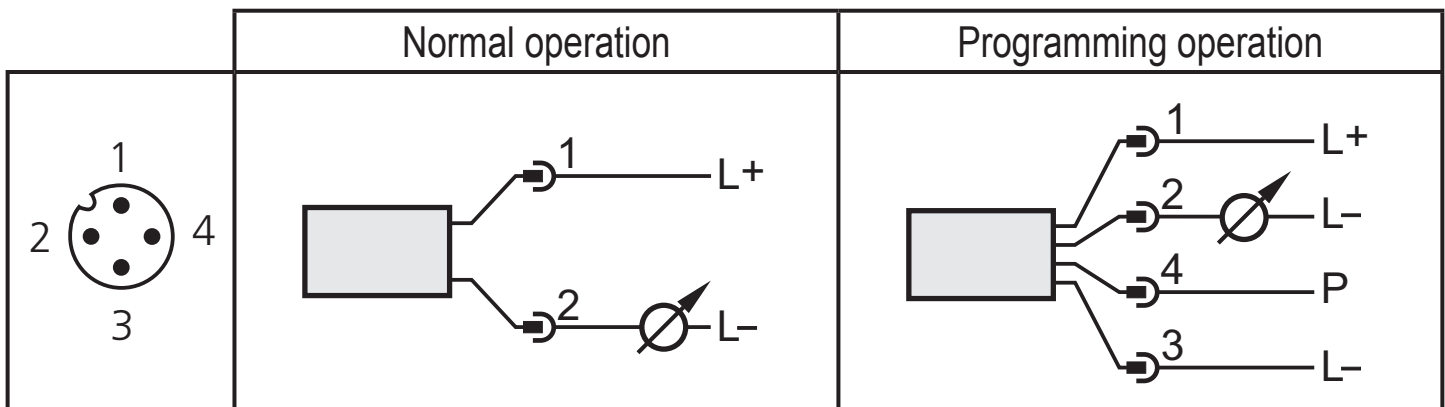
Voltage supply to EN50178, SELV, PELV.

For units with cULus approval and the scope of validity cULus: The device shall be supplied from an isolating transformer having a secondary Listed fuse rated as noted in the following table.

Overcurrent protection		
Control-circuit wire size		Maximum protective device rating [A]
AWG	[mm <sup>2</sup> ]	
22	0.32	3
20	0.52	5
18	0.82	7
16	1.3	10
14	2.1	20
12	3.3	25

► Disconnect power.

► Connect the unit as follows:

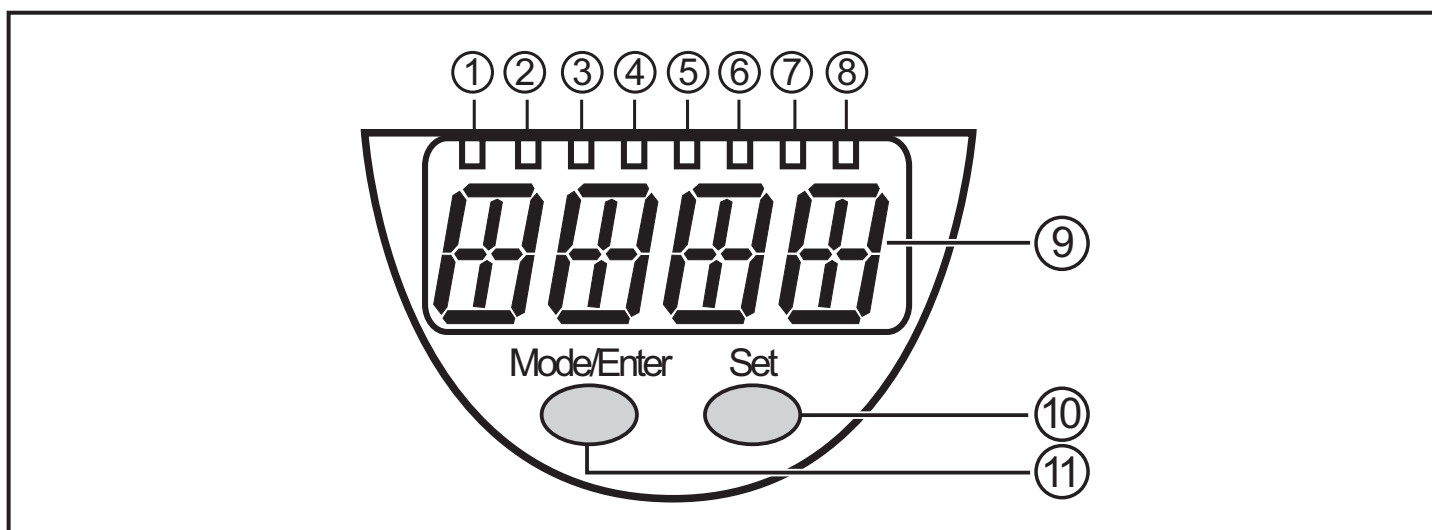


<b>Pin 1</b>	Ub+
<b>Pin 3</b>	Ub-
<b>Pin 4 (P)</b>	P = communication via EPS / FDT interface
<b>Pin 2 (OUT2)</b>	analogue output for system pressure

Core colours of ifm sockets:

1 = BN (brown), 2 = WH (white), 3 = BU (blue), 4 = BK (black)

## 7 Operating and display elements



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### 1 to 8: Indicator LEDs

- LED 1 to LED 6 = system pressure in unit of measurement as indicated on the label. LEDs 5 to 6 not used for units with 3 adjustable units of measurement.
- LED 7 not used.
- LED 8 not used.

### 9: Alphanumeric display, 4 digits

- Indication of the current system pressure.
- Indication of the parameters and parameter values.

### 10: Set pushbutton

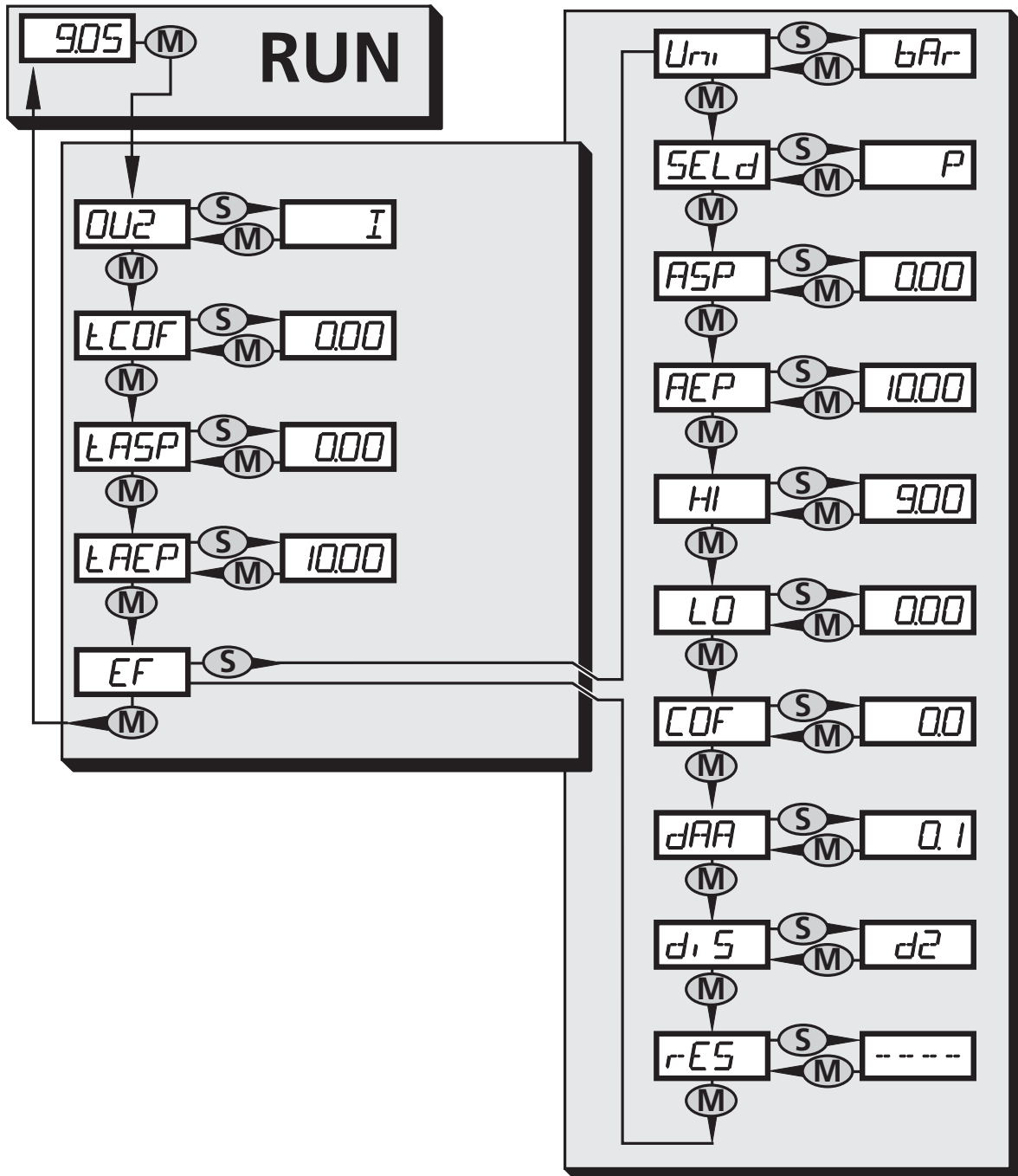
- Setting of the parameter values (scrolling by holding pressed, incremental by pressing briefly).

### 11: Mode/Enter pushbutton

- Selection of the parameters and acknowledgement of the parameter values.

# 8 Menu

## 8.1 Menu structure



## 8.2 Menu explanation

OU2	Output function for OUT2: <ul style="list-style-type: none"> <li>Analogue signal for the current system pressure: 4...20 mA [I] or 20...4 mA [InEG].</li> </ul>
tCOF	Teaching zero-point calibration.
tASP	Teaching analogue start point for the system pressure: set value at which 4 mA are output (20 mA on [OU2] = [InEG]).
tAEP	Teaching analogue end point for the system pressure: set value at which 20 mA are output (4 mA on [OU2] = [InEG]).
EF	Extended functions / Opening menu level 2.
Uni	Standard unit of measurement for the system pressure.
SELd	Display mode: <ul style="list-style-type: none"> <li>Pressure in the unit set in [Uni].</li> <li>Pressure in % of the set scaling of the analogue output.</li> </ul>
ASP	Analogue start point for the system pressure: measured value at which 4 mA are output (20 mA on [OU2] = [InEG]).
AEP	Analogue end point for the system pressure: measured value at which 20 mA are output (4 mA on [OU2] = [InEG]).
HI	Maximum value memory for the system pressure.
LO	Minimum value memory for the system pressure.
COF	Zero point calibration.
dAA	Damping for the analogue output.
diS	Update rate and orientation of the display.
rES	Restore the factory setting.

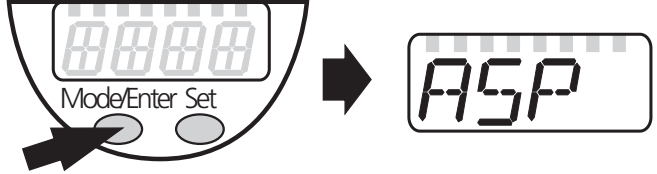
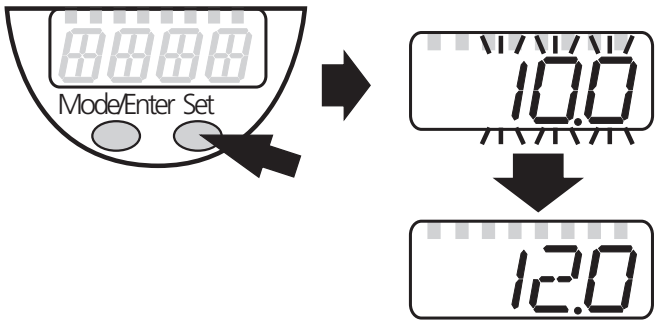

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# 9 Parameter setting

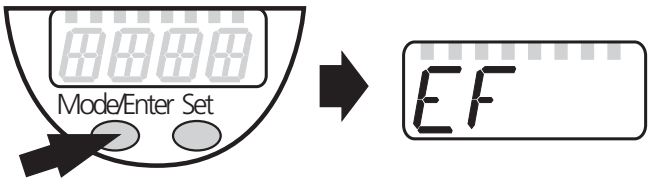
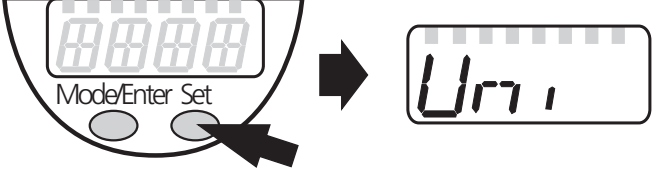
During the parameter setting process the unit remains in the operating mode. It continues its monitoring function with the existing parameters until parameter setting has been terminated.

## 9.1 Parameter setting general

Each parameter setting requires 3 steps:

<p><b>1</b></p>	<p><b>Selecting parameter</b></p> <ul style="list-style-type: none"> <li>▶ Press [Mode/Enter] until the requested parameter is displayed.</li> </ul>	
<p><b>2</b></p>	<p><b>Setting the parameter value</b></p> <ul style="list-style-type: none"> <li>▶ Press [Set] and keep the button pressed.</li> <li>&gt; Current setting value of the parameter bit flashes for 5 s.</li> <li>&gt; After 5 s: Setting value is changed: incremental by pressing briefly or scrolling by holding pressed.</li> </ul>	
<p>The numerical values are incremented continuously. If the value is to be reduced: Let the display move to the maximum setting value. Then the cycle starts again at the minimum setting value.</p>		
<p><b>3</b></p>	<p><b>Acknowledge parameter value</b></p> <ul style="list-style-type: none"> <li>▶ Press [Mode/Enter] briefly.</li> <li>&gt; The parameter is displayed again. The new setting value is stored.</li> </ul>	
<p><b>Set more parameters</b></p> <ul style="list-style-type: none"> <li>▶ Start again with step 1.</li> </ul>		
<p><b>Finishing parameter setting</b></p> <ul style="list-style-type: none"> <li>▶ Press [Mode/Enter] several times until the current measured value is displayed or wait for 15 s.</li> <li>&gt; The unit returns to the operating mode.</li> </ul>		

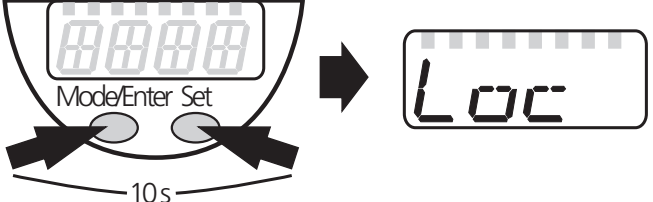
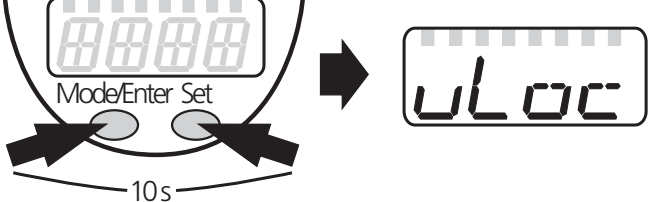
- Changing from menu level 1 to menu level 2:

<ul style="list-style-type: none"> <li>▶ Press [Mode/Enter] until [EF] is displayed.</li> </ul>	
<ul style="list-style-type: none"> <li>▶ Press [Set] briefly.</li> <li>&gt; The first parameter of the submenu is displayed (here: [Uni]).</li> </ul> <p>If menu level 2 is protected by an access code, „Cod1“ flashes in the display.</p> <ul style="list-style-type: none"> <li>▶ Press [Set] and keep it pressed until the valid code no. is displayed.</li> <li>▶ Press [Mode/Enter] briefly.</li> </ul> <p>Delivery by ifm electronic: no access restriction.</p>	

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- Locking / unlocking

The unit can be locked electronically to prevent unintentional wrong settings.

<ul style="list-style-type: none"> <li>▶ Ensure that the unit is in the normal operating mode.</li> <li>▶ Press [Mode/Enter] + [Set] for 10 s.</li> <li>&gt; [Loc] is displayed.</li> </ul>	
<p>During operation: [Loc] is displayed briefly when you try to change parameter values.</p>	
<p>For unlocking:</p> <ul style="list-style-type: none"> <li>▶ Press [Mode/Enter] + [Set] for 10 s.</li> <li>&gt; [uLoc] is displayed.</li> </ul>	

On delivery: Unlocked.

- Timeout:

If no button is pressed for 15 s while the parameters are being set, the unit returns to the operating mode with unchanged values.

## 9.2 Configuring the display (optional)




<p>▶ Select [Uni] and set the unit of measurement:</p> <ul style="list-style-type: none"> <li>- [bAr], [mbAr],</li> <li>- [MPa], [kPa],</li> <li>- [PSI],</li> <li>- [InHO] (only PI1689, PI1696, PI1697, PI1698, PI1699),</li> <li>- [mWS] (only PI1696, PI1697, PI1699),</li> <li>- [mmWS] (only PI1689 and PI1698).</li> </ul>	
<p>▶ Select [SELD] and set the display mode:</p> <ul style="list-style-type: none"> <li>- [P]: Pressure in the unit set in Uni.</li> <li>- [P%]: percentage value (pressure in % of the set scaling of the analogue output. The following applies: 0% = ASP value; 100% = AEP value).</li> </ul> <p>NOTE: Display „0%“ does not mean that the system is free of pressure.</p>	
<p>▶ Select [diS] and set update rate and orientation of the display:</p> <ul style="list-style-type: none"> <li>- [d1]: Update of the measured value every 50 ms.</li> <li>- [d2]: Update of the measured value every 200 ms.</li> <li>- [d3]: Update of the measured value every 600 ms.</li> <li>- [rd1], [rd2], [rd3]: Display like d1, d2, d3; rotated by 180°.</li> <li>- [OFF]: The display is deactivated in the operating mode. If one of the buttons is pressed, the current measured value is displayed for 15 s. Another press of the Mode/Enter button opens the Display mode. The LEDs remain active even if the display is deactivated.</li> </ul>	

## 9.3 Setting the output signal

### 9.3.1 Setting the output function

<p>▶ Select [OU2] and set the analogue function:</p> <ul style="list-style-type: none"> <li>- [I] = current signal proportional to the pressure 4...20 mA,</li> <li>- [InEG] = current signal proportional to the pressure 20...4 mA.</li> </ul>	
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### 9.3.2 Scaling the analogue value

<ul style="list-style-type: none"> <li>▶ Set the requested minimum pressure in the system.</li> <li>▶ Press [Mode/Enter] until [tASP] is displayed.</li> <li>▶ Press [Set] and keep the buton pressed.</li> <li>&gt; The currently set value flashes.</li> <li>▶ Release [Set] when the display stops flashing.</li> <li>&gt; The new set value is displayed.</li> <li>▶ Press [Mode/Enter] briefly.</li> <li>&gt; The current system pressure is defined to be the start value for the analogue signal.</li> </ul>	
<ul style="list-style-type: none"> <li>▶ Set the requested maximum pressure in the system.</li> <li>▶ Press [Mode/Enter] until [tAEP] is displayed.</li> <li>▶ Press [Set] and keep the buton pressed.</li> <li>&gt; The currently set value flashes.</li> <li>▶ Release [Set] when the display stops flashing.</li> <li>&gt; The new set value is displayed.</li> <li>▶ Press [Mode/Enter] briefly.</li> <li>&gt; The current system pressure is defined to be the end value for the analogue signal.</li> </ul>	
<p>ASP / AEP can only be taught within defined limits (→ 12.1 setting ranges). If the teaching process is carried out at an invalid pressure, [UL] or [OL] is displayed. After acknowledgement by [Mode/Enter], [Err] flashes, the ASP value / AEP value is not changed.</p>	
<p>As an alternative:</p> <ul style="list-style-type: none"> <li>▶ Select [ASP] and set measured value at which 4 mA are output (20 mA at [OU2] = [InEG]).</li> <li>▶ Select [AEP] and set measured value at which 20 mA are output (4 mA at [OU2] = [InEG]).</li> </ul> <p>Minimum distance between ASP and AEP = 25 % of the final value of the measuring range (scaling factor 1:4).</p>	

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## 9.4 User settings (optional)

### 9.4.1 Zero-point calibration

<ul style="list-style-type: none"><li>▶ Select [COF] and set a value between -5% and 5% of the final value of the measuring range. The internal measured value "0" is shifted by this amount.</li></ul>	<i>COF</i>
<p>As an alternative: Automatic adaptation offset (setting range 0 bar <math>\pm</math>5%); e.g. in the event of a deviation of the mounting location of the sensor and the zero point level for level measurement.</p> <ul style="list-style-type: none"><li>▶ Make sure that no pressure is applied to the system.</li><li>▶ Press [Mode/Enter] until [tCOF] is displayed.</li><li>▶ Press [Set] and keep the button pressed.</li><li>&gt; The current offset value (in %) briefly flashes, then the current system pressure (in the selected display unit) is displayed.</li><li>▶ Release [Set].</li><li>▶ Press [Mode/Enter] briefly to confirm the new offset value.</li></ul>	<i>tCOF</i>

### 9.4.2 Setting the damping for the analogue signal

<ul style="list-style-type: none"><li>▶ Select [dAA] and set value between 0.1 and 100.0 s (at 0.0 = [dAA] is not active).</li></ul> <p>dAA value = response time between pressure change and change of the analogue signal in seconds.</p>	<i>dAA</i>
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## 9.5 Service functions

### 9.5.1 Reading the min./max. values for the system pressure

<ul style="list-style-type: none"><li>▶ Select [HI] or [LO], press [Set] briefly. [HI] = maximum value, [LO] = minimum value.</li></ul> <p>Delete memory:</p> <ul style="list-style-type: none"><li>▶ Select [HI] or [LO].</li><li>▶ Press [SET] until [----] is displayed.</li><li>▶ Press [MODE/ENTER] briefly.</li></ul>	<i>HI</i> <i>LO</i>
---	------------------------

### 9.5.2 Reset all parameters to the factory setting

<ul style="list-style-type: none"><li>▶ Select [rES]</li><li>▶ Press [SET] until [----] is displayed.</li><li>▶ Press [MODE/ENTER] briefly.</li></ul> <p>It makes sense to note down your own settings before executing the function (→ 13 Factory preset).</p>	<i>rES</i>
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## 10 Operation

After power on of the supply voltage the unit is in the Run mode (= normal operation). It carries out its measurement and evaluation functions and generates output signals according to the set parameters.

Operation indicatin → chapter 7 Operating and display elements.

### 10.1 Read the set parameter values

- ▶ Press [Mode/Enter] until the requested parameter is displayed.
- ▶ Press [Set] briefly.
- > The unit displays the corresponding parameter value for about 15 s. After another 15 s the unit returns to the Run mode.

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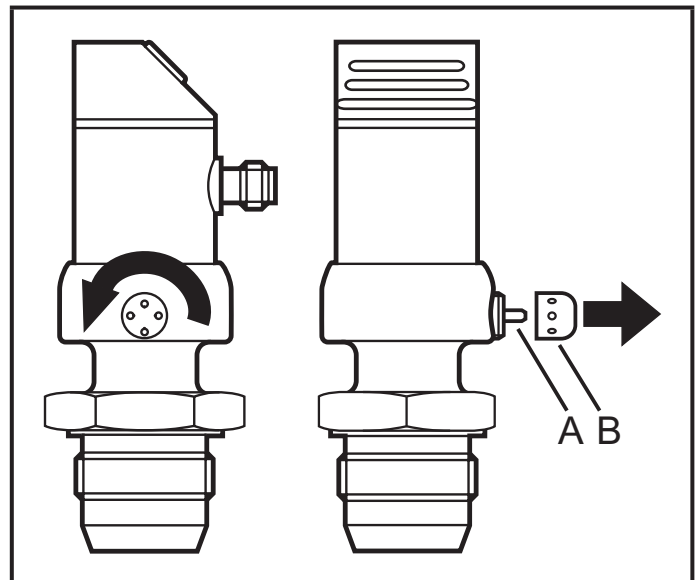
### 10.2 Fault indication

[OL]	Overload pressure (measuring range exceeded).
[UL]	Underpressure range (measuring range below the minimum value).
[Err]	Internal fault, invalid input (indicated even if the display is deactivated).

### 10.3 Cleaning of the filter cover

If viscous and residues producing media clog the filter cover of the sensor (and thus reduce the measuring accuracy slightly), you can clean it.

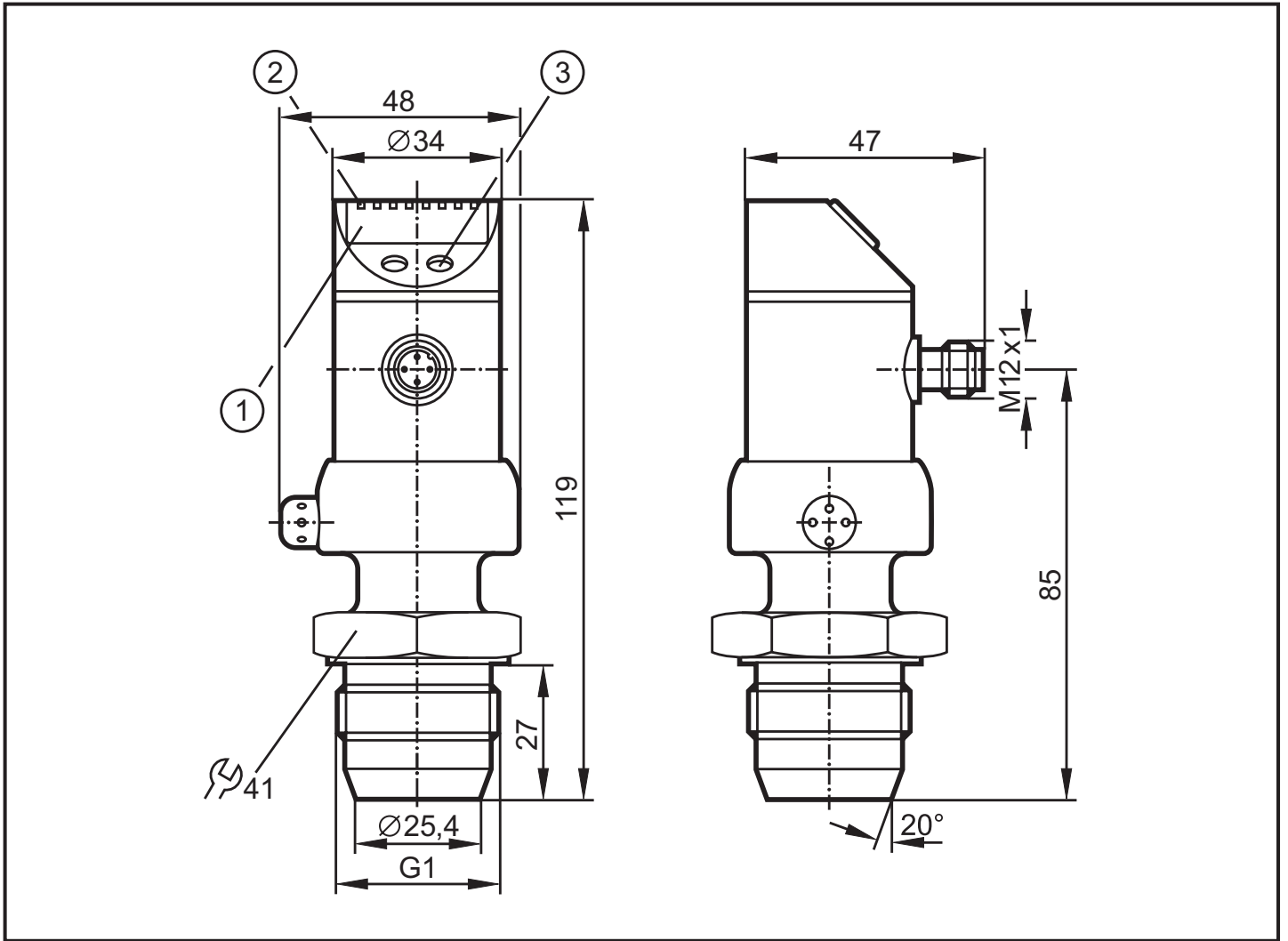
- ▶ Unscrew the filter cover (B) (use a pair of pliers with plastic-covered jaws for this).
- ▶ Clean the cover thoroughly.



The vent (A) should only be cleaned by skilled personnel and with utmost care. Possible medium residues must not be compressed and pressed into the vent. This could clog the filter system and reduce the measuring accuracy of the sensor.

- ▶ Screw the filter cover again tightly.

# 11 Scale drawing



Dimensions are in millimeters

1: display

2: LED's

3: programming button

# 12 Technical data

Operating voltage [V].....	20...32 DC
Reverse polarity / overload protection, integrated watchdog	
Power-on delay time [s].....	0.5
Analogue output .....	4...20 mA / 20...4 mA
Max. load current output [ $\Omega$ ] .....	300
Switch-on peak current.....	60 mA (30 ms)
Step response time analogue output [ms] .....	40

Accuracy / deviation (in % of the span)<sup>1)</sup>

	PI169x	PI1689
Characteristics deviation (linearity. incl. hysteresis and repeatability) <sup>2)</sup>	< ± 0.2	< ± 0.5
Linearity	< ± 0.15	< ± 0.15
Hysteresis	< ± 0.15	< ± 0.15
Repeatability (with temperature fluctuations < 10 K)	< ± 0.1	< ± 0.1
Long-term stability (in % of the span per year)	< ± 0.1	< ± 0.1

- Temperature coefficient (TC) in the compensated temperature range 0 ... 70°C (in % of the span per 10 K)

	PI169x	PI1689
Greatest TC of the zero point	< ± 0.05	< ± 0.1
Greatest TC of the span	< ± 0.15	< ± 0.2

Material (wetted parts)

..... stainless steel 316L / 1.4435, surface characteristics: Ra 0.4 / Rz 4  
ceramics (99.9 % Al<sub>2</sub> O<sub>3</sub>); PTFE;

Housing materials

..... stainless steel 316L / 1.4404; PC (Makrolon); PBT (Pocan); PEI; FPM (Viton); PTFE

Protection ..... IP 67 / IP 69K

Protection class ..... III

Insulation resistance [MΩ] ..... > 100 (500 V DC)

Shock resistance [g] ..... 50 (DIN / IEC 68-2-27, 11ms)

Vibration resistance [g] ..... 20 (DIN / IEC 68-2-6, 10 - 2000 Hz)

Switching cycles min. .... 100 million

Operating temperature [°C] ..... -25 ... +80

Medium temperature [°C] ..... -25... 125 (145 max. 1h)

Storage temperature [°C]..... -40...+100

EMC EN 61000-4-2 ESD: ..... 4 / 8 KV

EN 61000-4-3 HF radiated: ..... 10 V/m

EN 61000-4-4 Burst: ..... 2 KV

EN 61000-4-5 Surge: ..... 0.5 / 1 KV

EN 61000-4-6 HF conducted: ..... 10 V

<sup>1)</sup> all indications are referred to a turn down of 1:1

<sup>2)</sup> limit value setting to DIN 16086

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## 12.1 Setting ranges

		ASP		AEP		$\Delta P$
		min	max	min	max	
<b>PI1689</b>	mbar	5.0	75.0	20.0	100.0	0.1
	kPa	-0.50	7.50	2.00	10.00	0.01
	inH <sub>2</sub> O	-2.00	30.12	8.04	40.16	0.04
	mmWS	-51	765	204	1020	1
<b>PI1693</b>	bar	-1.00	18.74	5.24	25.00	0.02
	PSI	-14.4	271.8	76.2	362.7	0.3
	MPa	-0.100	1.874	0.524	2.500	0.002
<b>PI1694</b>	bar	-1.00	7.50	1.50	10.00	0.01
	PSI	-14.5	108.7	21.8	145.0	0.1
	MPa	-0.100	0.750	0.150	1.000	0.001
<b>PI1695</b>	bar	-1.000	3.000	0.000	4.000	0.005
	PSI	-14.50	43.50	0.00	58.00	0.05
	kPa	-100.0	300.0	0.0	400.0	0.5
<b>PI1696</b>	bar	-0.124	1.880	0.500	2.500	0.002
	PSI	-1.80	27.27	7.26	36.27	0.03
	kPa	-12.4	188.0	50.0	250.0	0.2
	inH <sub>2</sub> O	-50	755	201	1004	1
	mWS	-1.26	19.17	5.10	25.49	0.01
<b>PI1697</b>	mbar	-50	750	200	1000	1
	PSI	-0.73	10.88	2.90	14.50	0.01
	kPa	-5.0	75.0	20.0	100.0	0.1
	inH <sub>2</sub> O	-20.0	301.2	80.4	401.6	0.4
	mWS	-0.51	7.65	2.04	10.20	0.01
<b>PI1698</b>	mbar	-12.4	187.4	50.0	250.0	0.2
	kPa	-1.24	18.74	5.00	25.0	0.02
	inH <sub>2</sub> O	-5.0	75.3	20.1	100.4	0.1
	mmWS	-126	1912	510	2250	2

$\Delta P$  = increments

		ASP		AEP		$\Delta P$
		min	max	min	max	
<b>PI1699</b>	mbar	-1000	500	-500	1000	1
	PSI	-14.50	7.25	-7.25	14.50	0.05
	kPa	-100.0	50.0	-50.0	100.0	0.1
	inH <sub>2</sub> O	-401	201	-201	401	1
	mWS	-10.20	5.10	-5.10	10.20	0.01

$\Delta P$  = increments

## 13 Factory setting

UK

	Factory setting	User setting
<b>OU2</b>	<b>I</b>	
<b>ASP / tASP</b>	<b>0% VMR*</b>	
<b>AEP / tAEP</b>	<b>100% VMR*</b>	
<b>COF / tCOF</b>	<b>0.0</b>	
<b>dAA</b>	<b>0.1</b>	
<b>Uni</b>	<b>bAr / mbAr</b>	
<b>SELd</b>	<b>P</b>	
<b>dis</b>	<b>d2</b>	

\* = the indicated percentage of the final value of the measuring range (VMR) of the corresponding sensor in bar / mbar is set.

Technical data and further information at  
[www.ifm.com](http://www.ifm.com) → Select your country → Data sheet direct: