

# Technical Information

## Waterpilot FMX11

Hydrostatic level measurement

### Compact transmitter for level measurement

#### Application

The Waterpilot FMX11 is a pressure sensor for hydrostatic level measurement in fresh water applications. Typical applications include:

- Level measurement in groundwater wells; suitable for narrow 1" pipes
- Surface water monitoring in rivers and lakes
- Level monitoring in the extraction of drinking water, e.g., in water towers

#### Your benefits

- Easy and quick to install and commission
- Flexible uses in fresh water applications thanks to the very compact design and materials that are suitable for drinking water



## Table of contents

<b>About this document</b> .....	<b>3</b>	<b>Human interface</b> .....	<b>17</b>
Document function .....	3	<b>Certificates and approvals</b> .....	<b>18</b>
Symbols .....	3	CE mark .....	18
List of abbreviations .....	4	cUL <sub>US</sub> listing .....	18
<b>Function and system design</b> .....	<b>5</b>	Drinking water approval .....	18
Measuring principle .....	5	Pressure Equipment Directive .....	18
Measuring system .....	5	Additional certification .....	18
<b>Input</b> .....	<b>6</b>	Other standards and guidelines .....	18
Measured variable .....	6	<b>Ordering information</b> .....	<b>20</b>
Measuring range .....	6	Scope of delivery .....	20
Input signal .....	6	<b>Accessories</b> .....	<b>21</b>
<b>Output</b> .....	<b>7</b>	Device-specific accessories .....	21
Output signal .....	7	<b>Supplementary documentation</b> .....	<b>21</b>
Signal range .....	7		
Maximum load .....	7		
<b>Power supply</b> .....	<b>8</b>		
Supply voltage .....	8		
Power consumption .....	8		
Current consumption .....	8		
Electrical connection .....	8		
Terminals in the terminal box .....	8		
Cable specification .....	8		
Residual ripple .....	9		
Overvoltage protection .....	9		
<b>Performance characteristics</b> .....	<b>10</b>		
Reference operating conditions .....	10		
Reference accuracy .....	10		
Long-term stability .....	10		
Influence of medium temperature .....	10		
Warm-up period .....	10		
Response time .....	10		
<b>Installation</b> .....	<b>10</b>		
Installation instructions .....	10		
<b>Environment</b> .....	<b>13</b>		
Ambient temperature range .....	13		
Storage temperature range .....	13		
Degree of protection .....	13		
Electromagnetic compatibility (EMC) .....	13		
<b>Process</b> .....	<b>14</b>		
Medium temperature range .....	14		
Medium temperature limit .....	14		
Process pressure range .....	14		
<b>Mechanical construction</b> .....	<b>15</b>		
Dimensions .....	15		
Weight .....	16		
Materials .....	16		

---

## About this document

---

### Document function

The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device

---

### Symbols

#### Safety symbols

** DANGER**

This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

** WARNING**

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

** CAUTION**

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

**NOTICE**

This symbol contains information on procedures and other facts which do not result in personal injury.

#### Electrical symbols


*Ground connection:* 

A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.


#### Symbols for certain types of information

*Permitted:* 


Procedures, processes or actions that are permitted.

*Forbidden:* 

Procedures, processes or actions that are forbidden.

*Additional information:* 

*Series of steps:* 

*Result of an individual step:* 

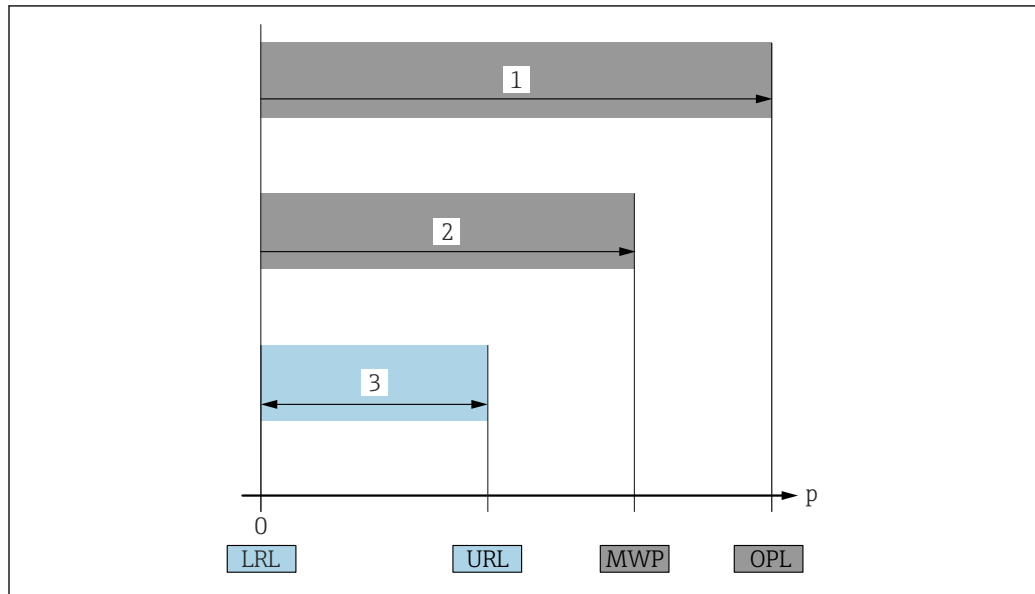
#### Symbols in graphics

*Item numbers:* 1, 2, 3 ...

*Series of steps:* 

*Views:* A, B, C, ...

List of abbreviations



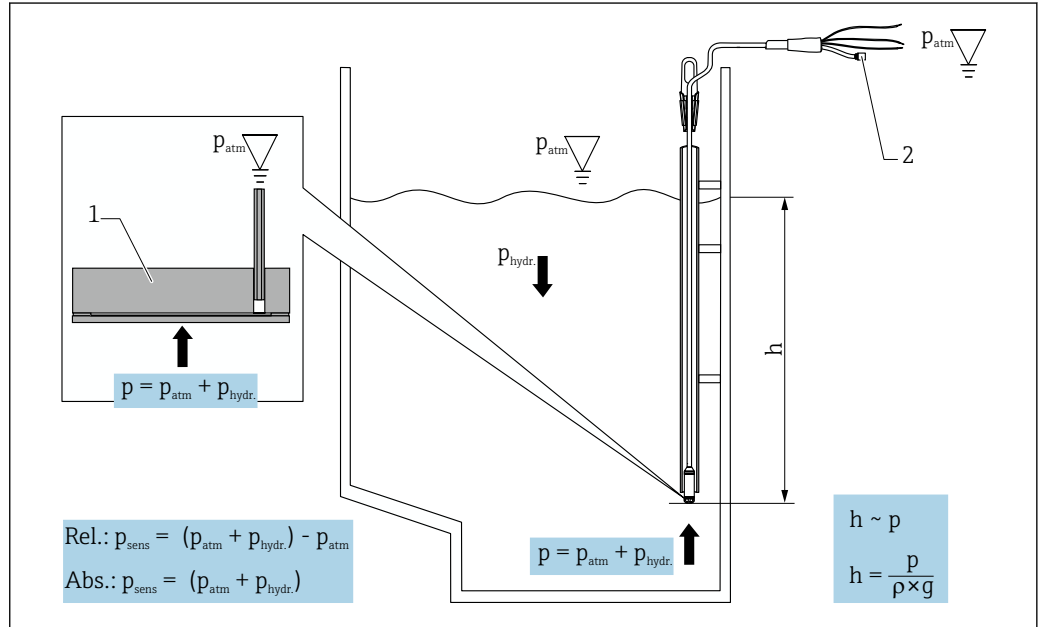
A0042446

Item	Term/abbreviation	Explanation
1	OPL	The OPL (over pressure limit = sensor overload limit) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency. The OPL may only be applied for a limited period of time.
2	MWP	The MWP (maximum working pressure) for the sensors depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency. The MWP may be applied at the device for an unlimited period.
3	Maximum sensor measuring range/ calibrated span	Span between LRL and URL This sensor measuring range is equivalent to the maximum calibratable/adjustable span.
p	-	Pressure
-	LRL	Lower range limit
-	URL	Upper range limit

## Function and system design

### Measuring principle

The process pressure causes the metal process isolating diaphragm of the sensor to deflect. A filling oil transfers the pressure to a Wheatstone bridge (semiconductor technology). The pressure-dependent change in the bridge output voltage is measured and evaluated.



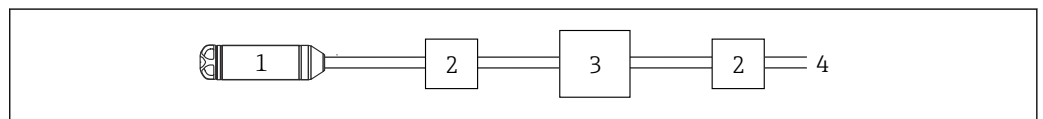
A0019140

- 1 Metal measuring cell
- 2 Pressure compensation tube
- h Level height
- p Total pressure = atmospheric pressure + hydrostatic pressure
- $\rho$  Density of the medium
- g Gravitational acceleration
- $p_{hydr.}$  Hydrostatic pressure
- $p_{atm}$  Atmospheric pressure
- $p_{sens}$  Pressure displayed on the sensor

### Measuring system

#### Application examples

The complete measuring system comprises a Waterpilot FMX11 and a transmitter power supply unit with a supply voltage of 8 to 28 V<sub>DC</sub> as standard.



A0040871

- 1 Waterpilot FMX11
- 2 Overvoltage protection (OVP), e.g., HAW from Endress+Hauser
- 3 Power supply, display and evaluation unit with one input for 4 to 20 mA
- 4 Power supply

## Input

**Measured variable** Hydrostatic pressure of a liquid

**Measuring range** Customer-specific measuring ranges or calibration that has been preset in the factory.

Input variable absolute pressure					
Relative nominal pressure [bar (abs.)]	0.2 (3)	0.4 (6)	0.6 (9)	1.0 (14.5)	2.0 (29)
Level [mH <sub>2</sub> O]	2	4	6	10	20
Overload OPL [bar (abs.)]	1 (14.5)	2 (29)	5 (72.5)	5 (72.5)	10 (145)
Burst pressure ≥ [bar (abs.)]	1.5 (22)	3 (43.5)	7.5 (109)	7.5 (109)	10 (145)
Negative pressure [bar (abs.)]	-0.7 (-11)	-1 (-14.5) (unrestricted vacuum-resistance)			

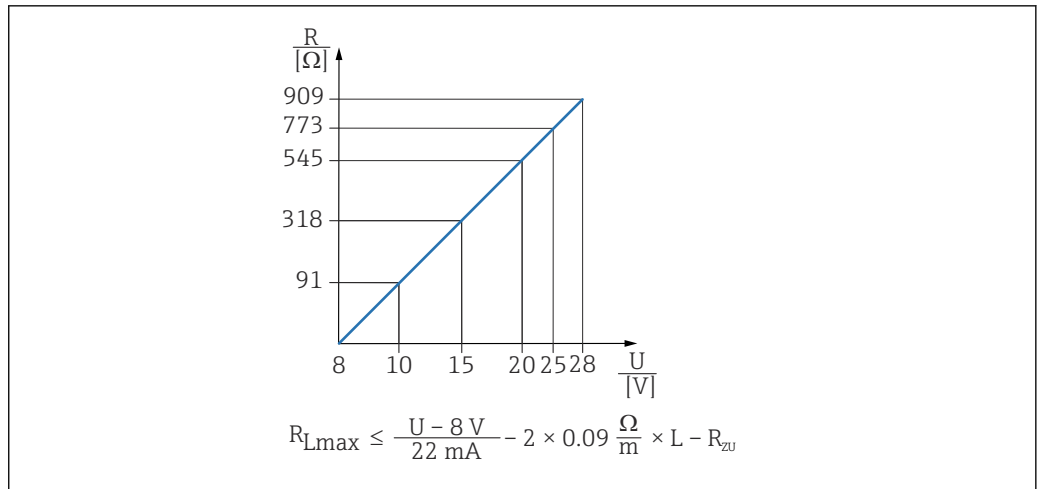
**Input signal** Change in capacitance

## Output

**Output signal** 4 to 20 mA analog, 2-wire for hydrostatic pressure measured value.

**Signal range** 2 to 22 mA

**Maximum load** The maximum load resistance depends on the supply voltage (U) and must be determined individually for each current loop, see formula and diagram. The total resistance resulting from the resistances of the connected devices, the connecting cable and, where applicable, the resistance of the extension cable may not exceed the load resistance value. Load diagram for an approximate calculation of the load resistance. Additional resistances, such as the resistance of the extension cable (per wire  $\leq 0.09 \Omega/m$ ), have to be subtracted from the value calculated as shown in the equation.



A0043461

$R_{Lmax}$  Max. load resistance [ $\Omega$ ]

$R_{add}$  Additional resistances such as resistance of evaluating device and/or display unit, cable resistance [ $\Omega$ ]

$U$  Supply voltage [V]

$L$  Basic length, extension cable [m]

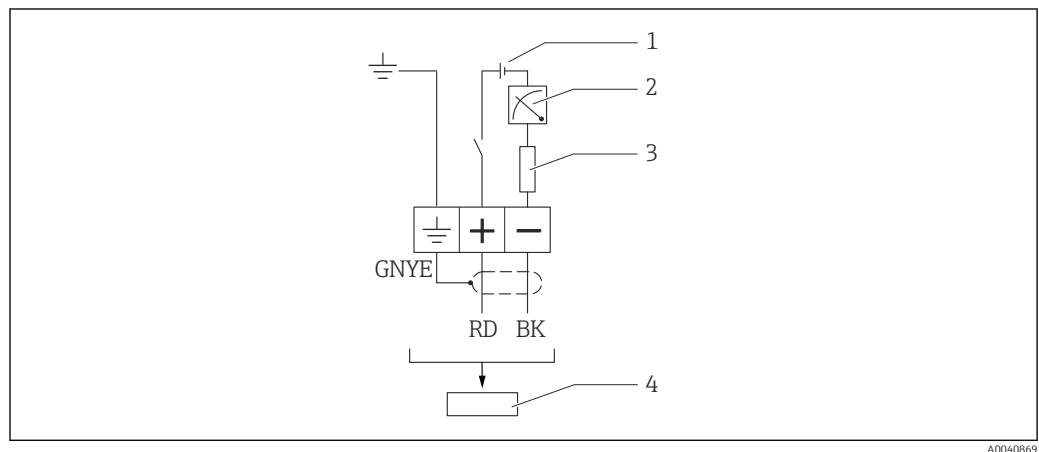
## Power supply

<b>Supply voltage</b>	8 to 28 V <sub>DC</sub>
<b>Power consumption</b>	≤ 0.62 W at 28 V <sub>DC</sub>
<b>Current consumption</b>	Max. current consumption: ≤ 22 mA Min. current consumption: ≥ 2 mA

### Electrical connection

- The supply voltage must match the supply voltage specified on the nameplate.
- The cable must end in a dry room or a suitable terminal box. The terminal box (IP66/IP67) with GORE-TEX® filter from Endress+Hauser is suitable for outdoor installation. The terminal box can be ordered separately as an accessory (order number: 52006152).
- Connect the device in accordance with the following diagrams. Reverse polarity protection is integrated in the Waterpilot FMX11. Changing the polarities will not result in damage to the device. The device is not operational.
- A suitable circuit breaker should be provided for the device in accordance with IEC/EN 61010.

The electrical connection is established with the corresponding wires of the extension cable and with the optional use of the terminal box and a power supply (e.g. RN221N active barrier).



- 1 8 to 28 V<sub>DC</sub>
- 2 4 to 20 mA
- 3 Resistance (R<sub>L</sub>)
- 4 Waterpilot FMX11

### Wire colors

- RD = red
- BK = black
- GNYE = green/yellow

### Connection values

Connection classification as per IEC 61010-1:

- Overvoltage category 1
- Pollution level 1


<b>Terminals in the terminal box</b>	Three terminals as standard in terminal box (terminal box can be ordered separately as an option, order number: 52006152).
--------------------------------------	--

<b>Cable specification</b>	<b>Connecting cable</b> Endress+Hauser recommends using shielded, twisted-pair two-wire cables. <ul style="list-style-type: none"> <li>▪ Commercially available instrument cable</li> <li>▪ Terminals, terminal box: 0.08 to 2.5 mm<sup>2</sup> (28 to 14 AWG)</li> </ul>
----------------------------	--



**Extension cable**

- Total outer diameter: 6 mm (0.24 in) ±0.2 mm (0.01 in)
- PA pressure compensation tube:
  - Outer diameter 2.5 mm (0.1 in)
  - Internal diameter 1.5 mm (0.06 in)
  - Pressure compensation element outer diameter 6 mm (0.24 in)

 The extension cables are shielded.

*Cross-section*

2 x 0.22 mm<sup>2</sup> + pressure compensation tube

*Cable resistance*

Per wire: ≤0.09 Ω/m

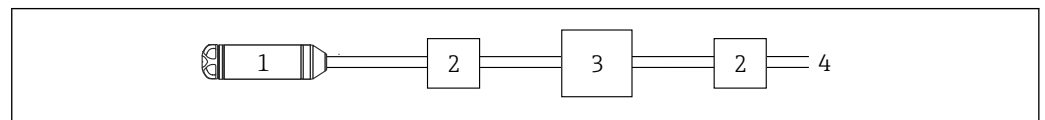
---

**Residual ripple** No impact on the 4 to 20 mA signal to ±5 % residual ripple within the permitted voltage range.

---

**Overvoltage protection** To protect the Waterpilot from large interference voltage peaks, Endress+Hauser recommends installing overvoltage protection upstream and downstream of the display and/or evaluation unit.

- Integrated overvoltage protection to EN 61000-4-5 (2 kV asymmetrical)
- Install overvoltage protection ≥ 1.0 kV, external if necessary



A0040871

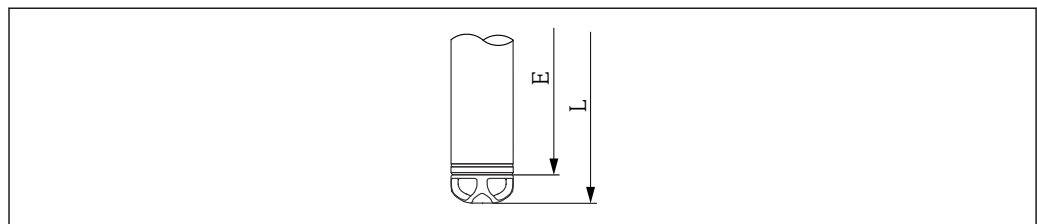
- 1 Waterpilot FMX11
- 2 Overvoltage protection (OVP), e.g., HAW from Endress+Hauser
- 3 Power supply, display and evaluation unit with one input for 4 to 20 mA
- 4 Power supply

## Performance characteristics

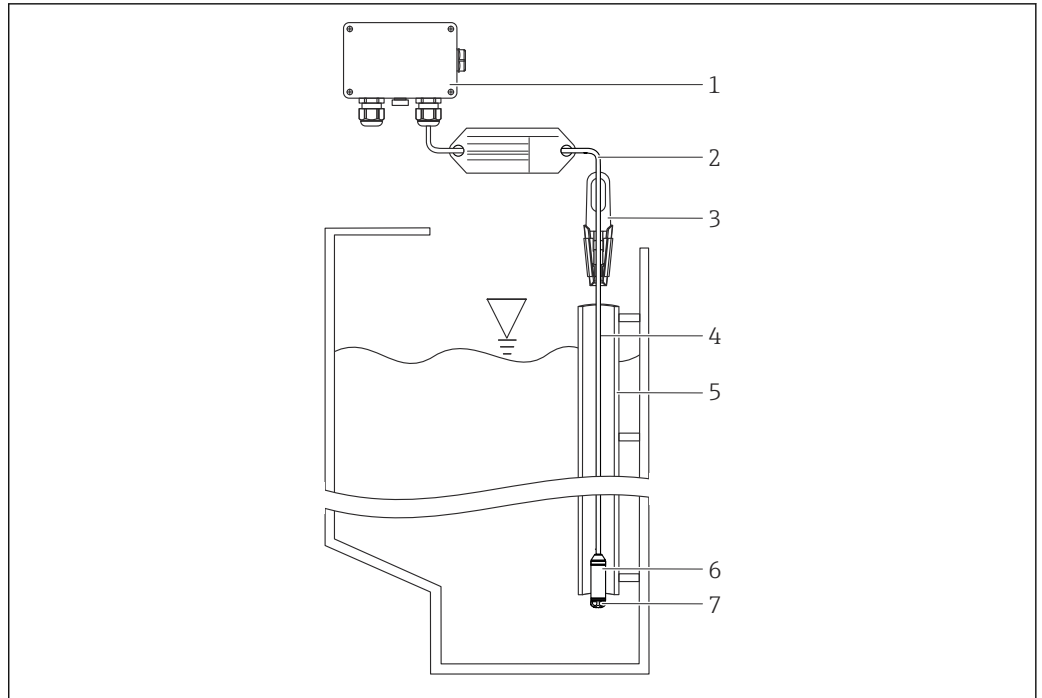
<b>Reference operating conditions</b>	<ul style="list-style-type: none"> <li>▪ As per IEC 60770</li> <li>▪ Ambient temperature <math>T_U</math> = constant, in the range: +21 to +27 °C (+70 to +81 °F)</li> <li>▪ Humidity <math>\varphi</math> = constant, in the range of 20 to 80 % rH</li> <li>▪ Ambient pressure <math>p_U</math> = constant, in the range: 860 to 1 060 mbar (12.47 to 15.37 psi)</li> <li>▪ Position of measuring cell constant, vertical in the range of <math>\pm 1^\circ</math></li> <li>▪ Supply voltage constant: 21 V DC to 27 V DC</li> </ul>
<b>Reference accuracy</b>	<p>The reference accuracy comprises the non-linearity after limit point configuration, hysteresis and non-reproducibility in accordance IEC 60770.</p> <ul style="list-style-type: none"> <li>▪ Sensor measuring range <math>\geq 400</math> mbar: <math>\leq \pm 0.35</math> %</li> <li>▪ Sensor measuring range <math>&lt; 400</math> mbar: <math>\leq \pm 0.50</math> %</li> </ul>
<b>Long-term stability</b>	$\leq \pm 0.1$ % of URL/year at reference operating conditions
<b>Influence of medium temperature</b>	<ul style="list-style-type: none"> <li>▪ Thermal change in the zero output and the output span: -10 to +70 °C (+14 to 158 °F): <math>&lt; (0.4 + 0.4 \times TD)\%</math> of set span</li> <li>▪ Temperature coefficient (<math>T_K</math>) of the zero output and the output span 0 to +70 °C (32 to 158 °F): 0.15 %/10 K of URL</li> </ul>
<b>Warm-up period</b>	$\leq 10$ s
<b>Response time</b>	<ul style="list-style-type: none"> <li>▪ T90 time: <math>\leq 15</math> ms</li> <li>▪ T99 time: <math>\leq 45</math> ms</li> </ul>

## Installation

<b>Installation instructions</b>	<ul style="list-style-type: none"> <li>▪ Cable length <ul style="list-style-type: none"> <li>▪ See → 11</li> <li>▪ Limited cable length when performing installation with freely suspended device with suspension clamp: max. 300 m (984 ft).</li> </ul> </li> <li>▪ Sideways movement of the level probe can result in measuring errors. Install the probe at a point free from flow and turbulence or use a guiding tube. The internal diameter of the guiding tube should be at least 1 mm (0.04 in) greater than the outer diameter of the FMX11.</li> <li>▪ To avoid mechanical damage to the measuring cell, the device is equipped with a protection cap.</li> <li>▪ The cable must end in a dry room or a suitable terminal box. The terminal box from Endress+Hauser provides humidity and climatic protection and is suitable for installation outdoors.</li> <li>▪ Cable length tolerance: <math>\pm &lt; 50</math> mm (1.97 in)</li> <li>▪ Endress+Hauser recommends using twisted, shielded cable.</li> <li>▪ The length of the extension cable depends on the intended level zero point. The height of the protective cap must be taken into consideration when designing the layout of the measuring point. The level zero point (E) corresponds to the position of the process isolating diaphragm. Level zero point = E; tip of probe = L (see the following diagram).</li> </ul>
----------------------------------	--



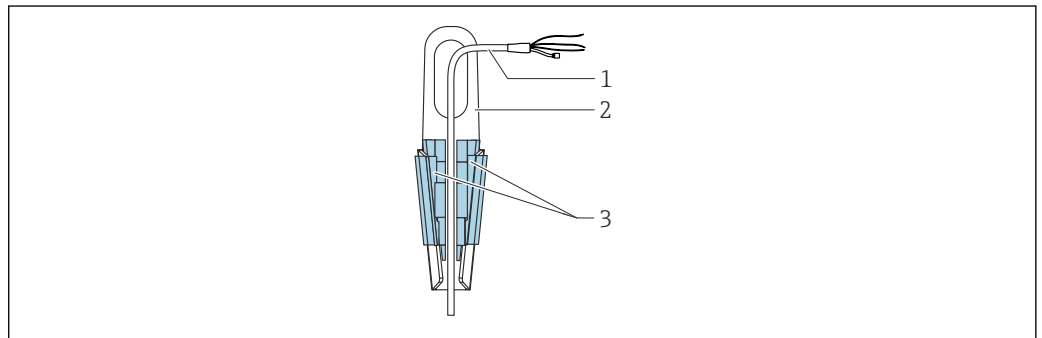
A0043690



A0040853

- 1 Terminal box can be ordered separately
- 2 Bending radius of extension cable
- 3 Suspension clamp can be ordered as an accessory
- 4 Extension cable, cable length
- 5 Guiding tube
- 6 Waterpilot FMX11
- 7 Protection cap

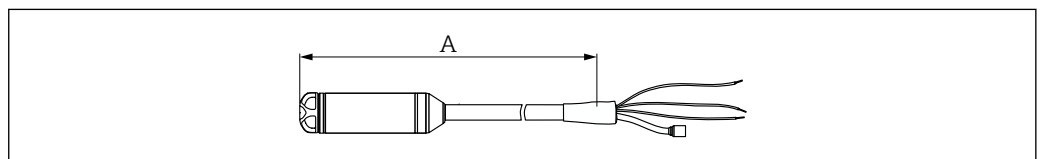
**Mounting the Waterpilot with a mounting clamp**



A0040921

- 1 Extension cable
- 2 Suspension clamp
- 3 Clamping jaws

**Cable length**



A0043689

- A Length of extension cable

 Pay attention to the "Load"

Cable lengths available for order

- 6 m (20 ft) cable, can be shortened, PE
- 10 m (33 ft) cable, can be shortened, PE
- 20 m (66 ft) cable, can be shortened, PE
- 30 m (98 ft) cable, can be shortened, PE
- Limited cable length when performing installation with freely suspended device with suspension clamp: max. 300 m (984 ft).

**Technical data for cable**

- Minimum bending radius:
  - ≥ 70 mm (2.76 in) (static)
- Tensile strength: 500 N (112.4 lbf)
- Cable extraction force (= tensile force required to extract the cable from the probe):
  - ≥ 400 N (89.92 lbf)
- UV-resistant (UV = ultraviolet)
- TPE: Use in water and drinking water

## Environment

---

<b>Ambient temperature range</b>	<b>FMX11</b> -10 to +70 °C (+14 to +158 °F) (= medium temperature)  <b>Terminal box</b> -40 to +80 °C (-40 to +176 °F)
<b>Storage temperature range</b>	<b>FMX11</b> -10 to +70 °C (+14 to +158 °F)  <b>Terminal box</b> -40 to +80 °C (-40 to +176 °F)
<b>Degree of protection</b>	<b>FMX11</b> IP68, permanently hermetically sealed at 10 bar (145 psi)  <b>Terminal box (optional)</b> IP66, IP67
<b>Electromagnetic compatibility (EMC)</b>	<ul style="list-style-type: none"><li>■ EMC in accordance with all relevant requirements of EN 61326 series. For details, refer to the Declaration of Conformity.</li><li>■ Maximum deviation: &lt; 0.5 % of span.</li></ul>

---

## Process

---

**Medium temperature range** 0 to +70 °C (+32 to +158 °F)

---

**Medium temperature limit** -10 to +70 °C (+14 to +158 °F)



The FMX11 may be operated in this temperature range. The specification values, such as accuracy, may be exceeded.

---

**Process pressure range**



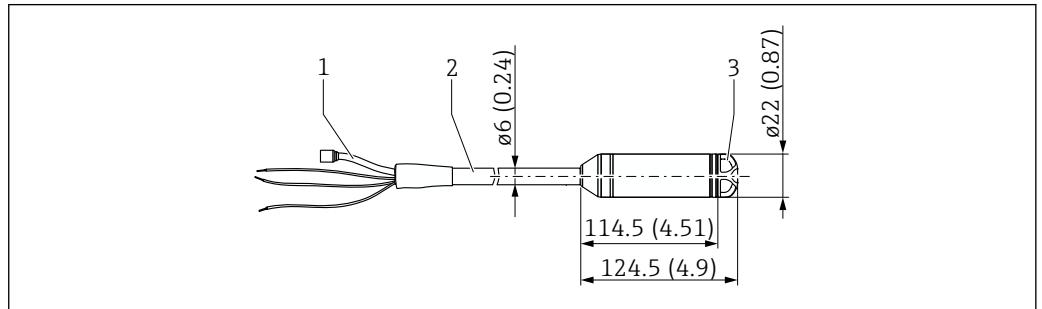
**The maximum pressure for the measuring device depends on the lowest-rated element with regard to pressure.**

- ▶ The measuring device must be operated only within the specified limits!
- ▶ The Pressure Equipment Directive (2014/68/EU) uses the abbreviation "PS". The abbreviation "PS" corresponds to the MWP (maximum working pressure) of the measuring device.
- ▶ OPL (Over Pressure Limit = sensor overload limit): The test pressure corresponds to the over pressure limit of the sensor and may only be applied for a limited time period so that no permanent damage develops.

## Mechanical construction

### Dimensions

#### Level probe

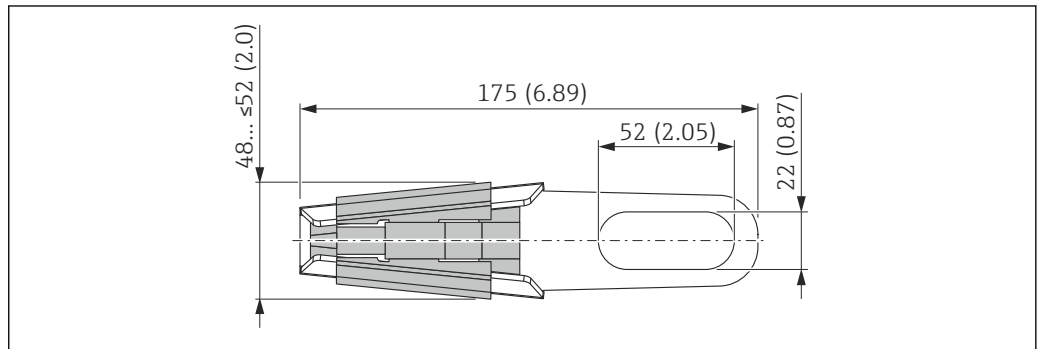


A0040874

Unit of measurement mm (in)

- 1 Pressure compensation tube
- 2 Extension cable
- 3 Protection cap

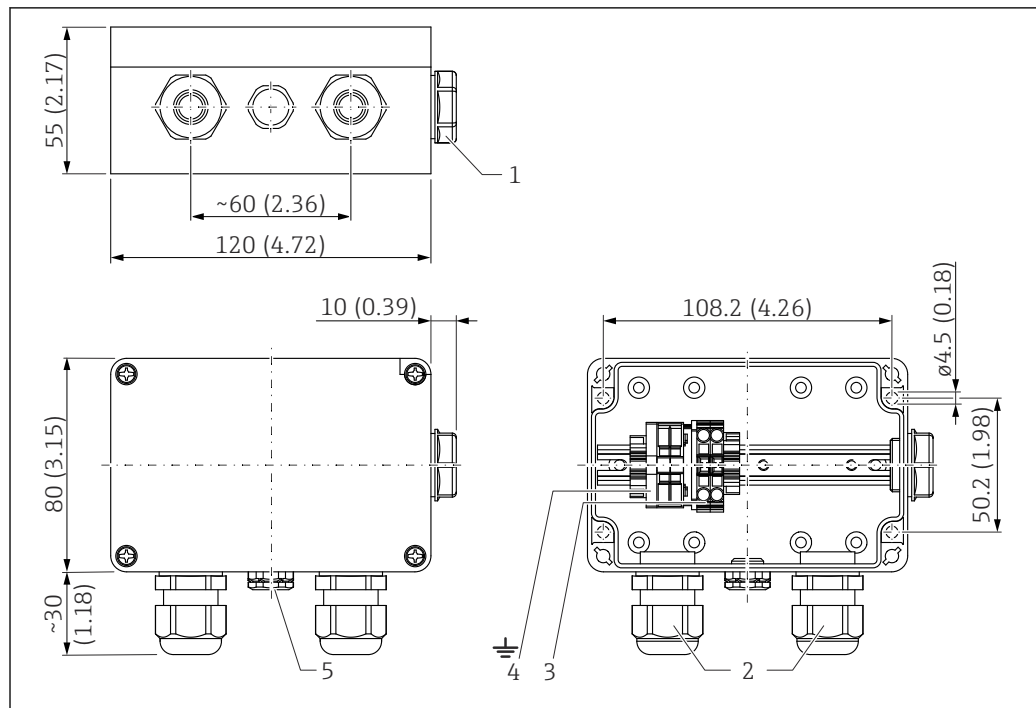
#### Suspension clamp



A0018659

Unit of measurement mm (in)

## Terminal box IP66, IP67 with filter



A0018772

Unit of measurement mm (in)

- 1 Dummy plug M20x1.5
- 2 Cable gland M20x1.5
- 3 4 to 20 mA; terminals for 0.08 to 2.5 mm<sup>2</sup> (28 to 14 AWG) 0.08 to 2.5 mm<sup>2</sup>
- 4 Ground connection; terminals for 0.08 to 2.5 mm<sup>2</sup> (28 to 14 AWG) 0.08 to 2.5 mm<sup>2</sup>
- 5 GORE-TEX® filter

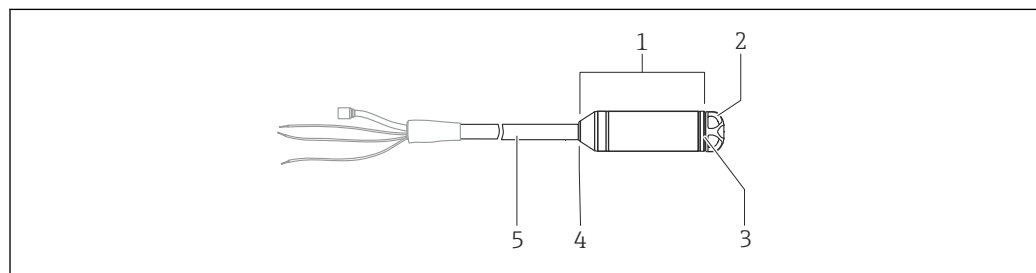
Terminal box IP66/IP67 with GORE-TEX® filter incl. 3 integrated terminals.

## Weight

- Level probe: 165 g (5.82 oz)
- Extension cable: 32 g/m (1.129 oz/ft)
- Suspension clamp: 170 g (5.996 oz)
- Terminal box: 235 g (8.288 oz)

## Materials

## Materials in contact with process



A0040876

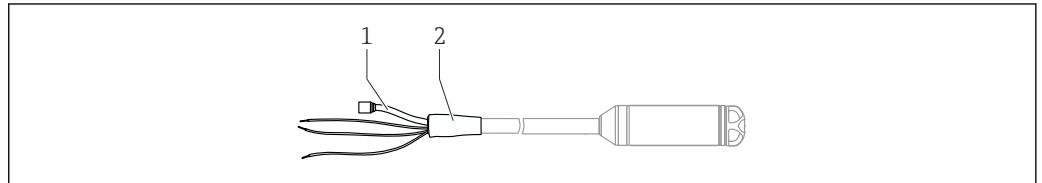
- 1 Level probe: 316L (1.4404/1.4435)
- 2 Protection cap (order number: 52008999): POM
- 3 Process isolating diaphragm: 316L
- 4 Seal: EPDM
- 5 Extension cable insulation: TPE



*Extension cable*

- Abrasion-resistant extension cable with strain-relief members made of high-strength PE fibers
- Shielded (aluminum)
- Insulated with TPE
- Copper wires, twisted
- Pressure compensation tube with Teflon filter

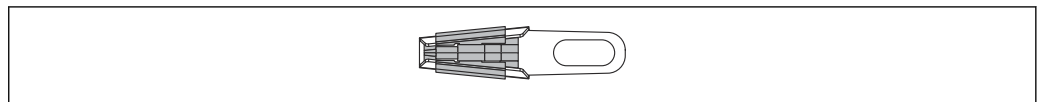
**Materials not in contact with process**



A0040878

- 1 Pressure compensation tube: PA
- 2 Heat shrink tube: polyolefin

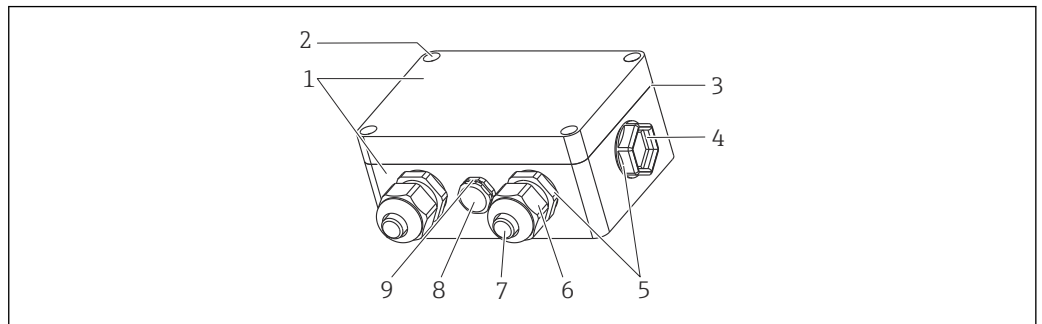
*Suspension clamp*



A0030950

Material: 3 16L (1.4404) and fiber-glass reinforced PA (polyamide)

*Terminal box*



A0018917

- 1 Housing: PC
- 2 Mounting screws (4 x): A2
- 3 Seal: CR (chloroprene rubber)
- 4 Dummy plug M20x1.5: PBT-GF30
- 5 Cable gland M20x1.5: PE-HD
- 6 Cable gland M20x1.5: PA6
- 7 Cable gland M20x1.5: PA6-GF30
- 8 Pressure compensation filter: PA6-GF10, ePTFE
- 9 Pressure compensation filter O-ring: silicone (VMQ)

## Human interface

No display or other operation facility is required to operate the device. However, the measured values can be read out with optional evaluation units.

## Certificates and approvals

<b>CE mark</b>	The device meets the legal requirements of the relevant EC directives. Endress+Hauser confirms that the device has been successfully tested by applying the CE mark.
<b>cUL<sub>US</sub> listing</b>	The measuring device is UL-listed.
<b>Drinking water approval</b>	KTW, NSF61, ACS, DVGW
<b>Pressure Equipment Directive</b>	<p><b>Pressure Equipment Directive 2014/68/EU (PED)</b></p> <p><i>Pressure equipment with allowable pressure <math>\leq 200</math> bar (2 900 psi)</i></p> <p>Pressure equipment (with a maximum allowable pressure <math>PS \leq 200</math> bar (2 900 psi)) can be classified as pressure accessories in accordance with Pressure Equipment Directive 2014/68/EU. If the maximum allowable pressure is <math>\leq 200</math> bar (2 900 psi) and the pressurized volume of the pressure equipment is <math>\leq 0.1</math> l, the pressure equipment is subject to the Pressure Equipment Directive (cf. Pressure Equipment Directive 2014/68/EU, Article 4, point 3). The Pressure Equipment Directive only requires that the pressure equipment shall be designed and manufactured in accordance with the "sound engineering practice of a Member State".</p> <p><i>Reasons:</i></p> <ul style="list-style-type: none"> <li>▪ Pressure Equipment Directive (PED) 2014/68/EU Article 4, point 3</li> <li>▪ Pressure Equipment Directive 2014/68/EU, Commission's Working Group "Pressure", Guideline A-05 + A-06</li> </ul> <p><i>Note:</i></p> <p>A partial examination shall be performed for pressure instruments that are part of safety equipment for the protection of a pipe or vessel from exceeding allowable limits (safety accessory in accordance with Pressure Equipment Directive 2014/68/EU, Article 2, point 4).</p>
<b>Additional certification</b>	<p><b>Calibration unit</b></p> <ul style="list-style-type: none"> <li>▪ Sensor range; mbar/bar</li> <li>▪ Sensor range; mm/m H<sub>2</sub>O</li> <li>▪ Sensor range; in H<sub>2</sub>O/ft H<sub>2</sub>O</li> </ul> <p><b>Calibration</b></p> <p>Factory calibration certificate, 3-point</p>
<b>Other standards and guidelines</b>	<p>The applicable European guidelines and standards can be found in the relevant EU Declarations of Conformity. The following standards were also applied:</p> <p><b>DIN EN 60770 (IEC 60770):</b></p> <p>Transmitters for use in industrial process control systems Part 1: Methods for performance evaluation</p> <p>Methods for evaluating the performance of transmitters for control and regulation in industrial process control systems.</p> <p><b>DIN 16086:</b></p> <p>Electrical pressure measuring instruments, pressure sensors, pressure transmitters, pressure measuring instruments, concepts, specifications on data sheets</p> <p>Procedure for writing specifications in data sheets for electrical pressure measuring instruments, pressure sensors and pressure transmitters.</p> <p><b>EN 61326:</b></p> <p>Electrical equipment for measurement, control and laboratory use – EMC requirements</p>

**EN 61010-1 (IEC 61010-1):**

Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures

**EN 60529:**

Degrees of protection provided by enclosures (IP code)

---

## Ordering information

Detailed ordering information is available from the following sources:

- In the Product Configurator on the Endress+Hauser website: [www.endress.com](http://www.endress.com) -> Click "Corporate" -> Select your country -> Click "Products" -> Select the product using the filters and search field -> Open product page -> The "Configure" button to the right of the product image opens the Product Configurator.
- Your Endress+Hauser sales center: [www.addresses.endress.com](http://www.addresses.endress.com)



### **Product Configurator - the tool for individual product configuration**

- Up-to-the-minute configuration data
- Depending on the device: Direct input of measuring point-specific information such as measuring range or operating language
- Automatic verification of exclusion criteria
- Automatic creation of the order code and its breakdown in PDF or Excel output format
- Ability to order directly in the Endress+Hauser Online Shop

---

### Scope of delivery

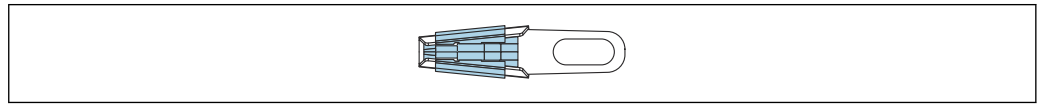
- Measuring device
- Certificates
- Optional accessories

## Accessories

---

### Device-specific accessories

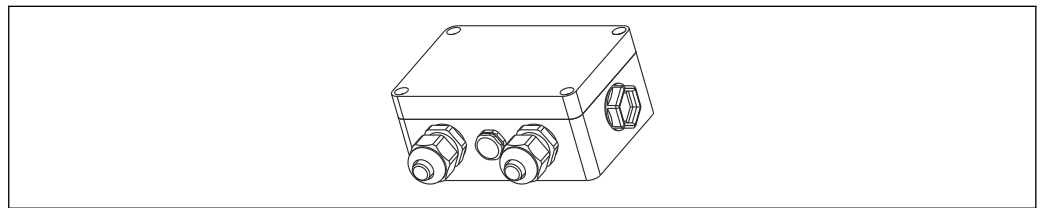
#### Suspension clamp



A0030950

Order number: 52006151

#### Terminal box



A0030967

Order number: 52006152

## Supplementary documentation



For an overview of the scope of the associated Technical Documentation, refer to the following:

- *W@M Device Viewer* ([www.endress.com/deviceviewer](http://www.endress.com/deviceviewer)): Enter the serial number from nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the 2D matrix code (QR code) on the nameplate



---



[www.addresses.endress.com](http://www.addresses.endress.com)

---