Operating Instructions
Waterpilot FMX21

Hydrostatic level measurement
4 to 20 mA Analog

Endress+Hauser

People for Process Automation

Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXX
Ext. ord. cd.: XXX.XXXX.XX

Endress+Hauser

Serial number

1.

2. www.endress.com/deviceviewer
Endress+Hauser Operations App

Download on the App Store
ANDROID APP ON Google Play

3.
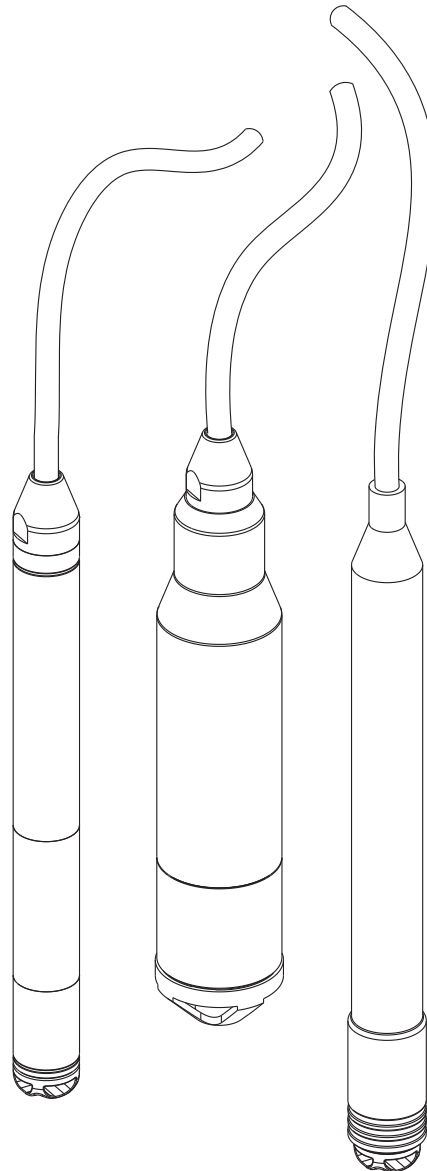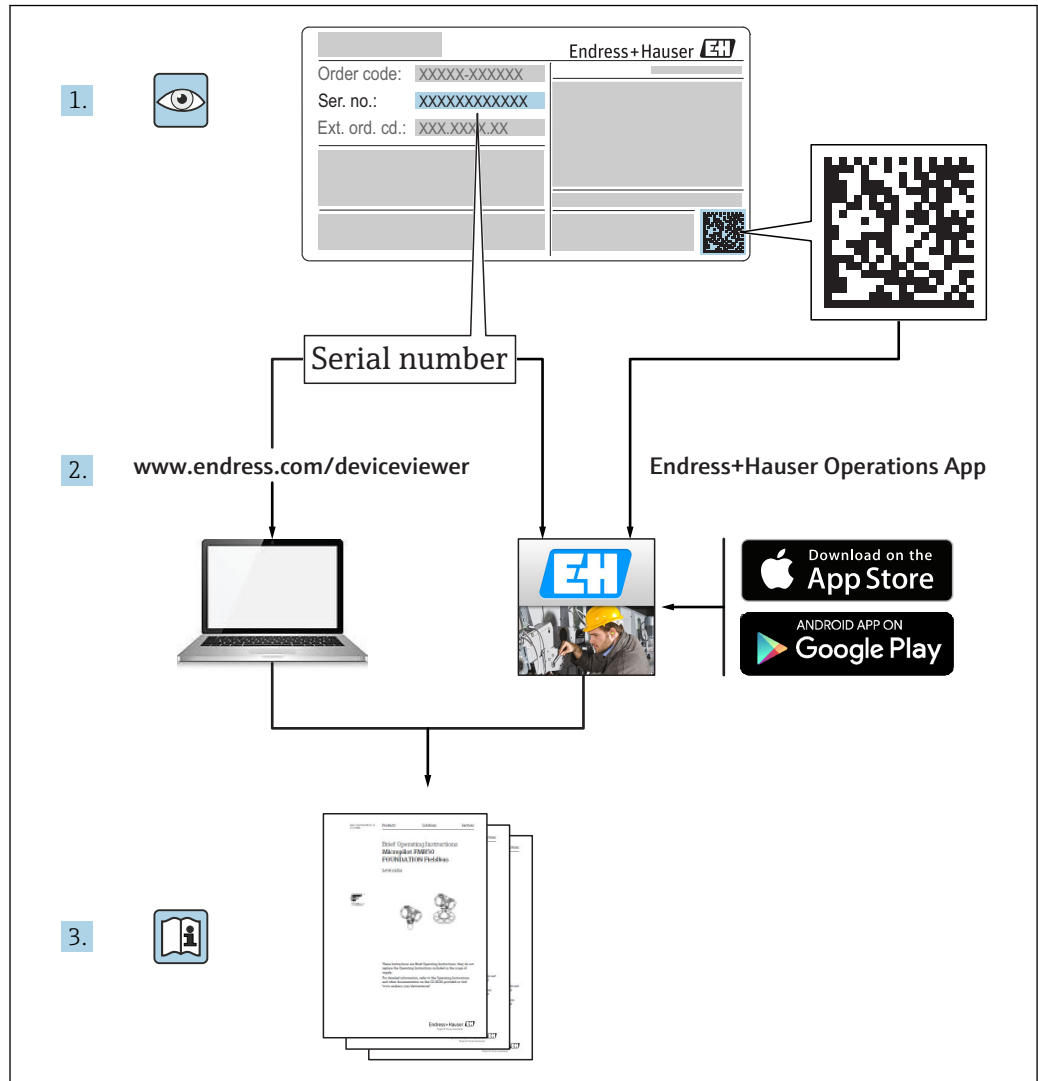
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- Make sure the document is stored in a safe place such that it is always available when working on or with the device.
- To avoid danger to individuals or the facility, read the "Basic safety instructions" section carefully, as well as all other safety instructions in the document that are specific to working procedures.
- The manufacturer reserves the right to modify technical data without prior notice. Your Endress+Hauser distributor will supply you with current information and updates to these Instructions.

Table of contents

1   Document information

1.1   Document function

These Operating Instructions contain all the information that is required in various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.

1.2   Symbols used

1.2.1   Safety symbols
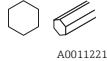
Symbol	Meaning
⚠ DANGER	**DANGER!** This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.
⚠ WARNING	**WARNING!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
⚠ CAUTION	**CAUTION!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.
NOTICE	**NOTE!** This symbol contains information on procedures and other facts which do not result in personal injury.

1.2.2   Electrical symbols

Symbol	Meaning	Symbol	Meaning
⎓	Direct current	∼	Alternating current
⩪	Direct current and alternating current	⏚	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
⏚	**Protective ground connection** A terminal which must be connected to ground prior to establishing any other connections.	▽	**Equipotential connection** A connection that has to be connected to the plant grounding system: This may be a potential equalization line or a star grounding system depending on national or company codes of practice.

1.2.3   Tool symbols

Symbol	Meaning
A0011220	Flat blade screwdriver
A0011219	Phillips screwdriver

Symbol	Meaning
A0011221	Allen key
A0011222	Open-ended wrench

1.2.4 Symbols for certain types of information

Symbol	Meaning
	Permitted Procedures, processes or actions that are permitted.
	Preferred Procedures, processes or actions that are preferred.
	Forbidden Procedures, processes or actions that are forbidden.
	Tip Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
1., 2., 3. ...	Series of steps
	Result of a step
	Help in the event of a problem
	Visual inspection

1.2.5 Symbols in graphics

Symbol	Meaning
1, 2, 3 ...	Item numbers
1., 2., 3. ...	Series of steps
A, B, C, ...	Views
A-A, B-B, C-C, ...	Sections

1.3 Documentation

The document types listed are available:
In the Downloads area of the Endress+Hauser website: www.endress.com →
Downloads

1.3.1 Technical Information (TI): planning aid for your device

TI00431P:

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.

1.3.2 Brief Operating Instructions (KA): getting the 1st measured value quickly

FMX21 4 to 20 mA Analog - KA01244P:

The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.

1.3.3 Safety Instructions (XA)

Depending on the approval, the following Safety Instructions (XA) are supplied with the device. They are an integral part of the Operating Instructions.

Directive	Type of protection	Category	Documentation	Option [1]
ATEX	Ex ia IIC	II 2 G	XA00454P	BD
ATEX	Ex nA IIC	II 3 G	XA00485P	BE
IECEx	Ex ia IIC	n/a	XA00455P	IC
CSA C/US	Ex ia IIC	n/a	ZD00232P (960008976)	CE
FM	AEx ia IIC	n/a	ZD00231P (960008975)	FE
NEPSI	Ex ia IIC	n/a	XA00456P	NA
INMETRO	Ex ia IIC	n/a	XA01066P	MA

1) Product Configurator order code for "Approval"

The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

1.4 Terms and abbreviations
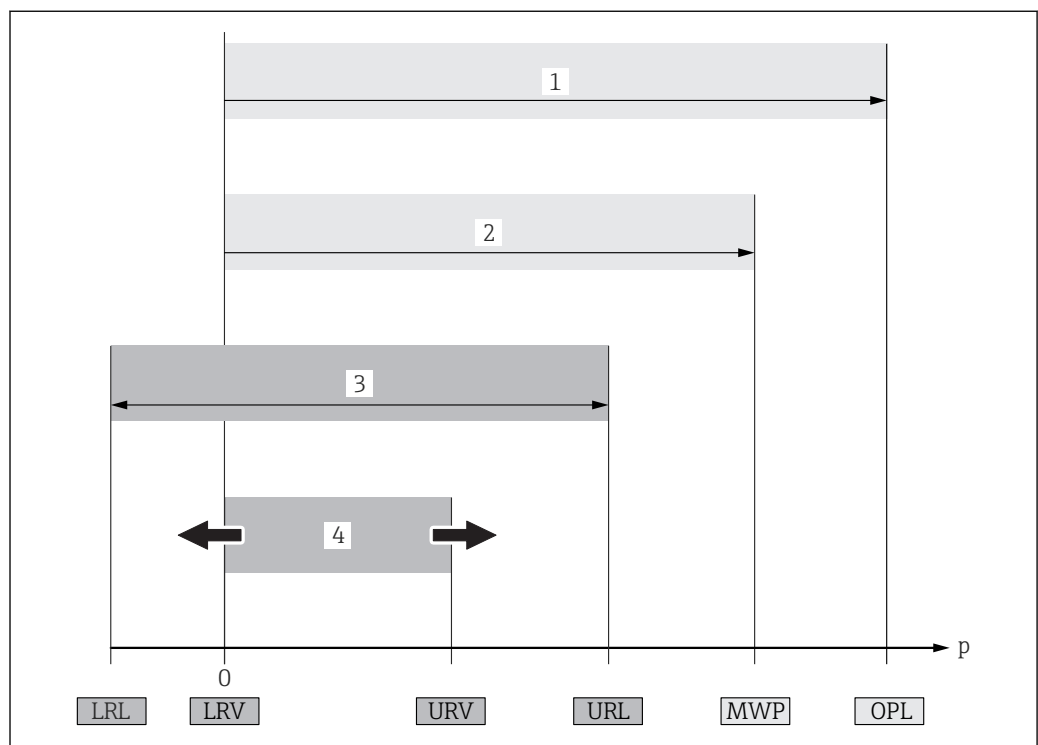
Item	Term/abbreviation	Explanation
1	OPL	The OPL (over pressure limit = sensor overload limit) for the measuring device depends on the lowest-rated element, with regard to pressure, of the selected components, i.e. the process connection has to be taken into consideration in addition to the measuring cell. Also observe pressure-temperature dependency. For the relevant standards and additional notes, see the "Pressure specifications" section . 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. For the relevant standards and additional notes, see the "Pressure specifications" section . The MWP may be applied at the device for an unlimited period. The MWP can also be found on the nameplate.
3	Maximum sensor measuring range	Span between LRL and URL This sensor measuring range is equivalent to the maximum calibratable/adjustable span.
4	Calibrated/adjusted span	Span between LRV and URV Factory setting: 0 to URL Other calibrated spans can be ordered as customized spans.
p	-	Pressure
-	LRL	Lower range limit
-	URL	Upper range limit
-	LRV	Lower range value
-	URV	Upper range value
-	TD (turn down)	Turn down Example - see the following section.
-	PE	Polyethylene
-	FEP	Fluorinated ethylene propylene
-	PUR	Polyurethane

1.5 Turn down calculation
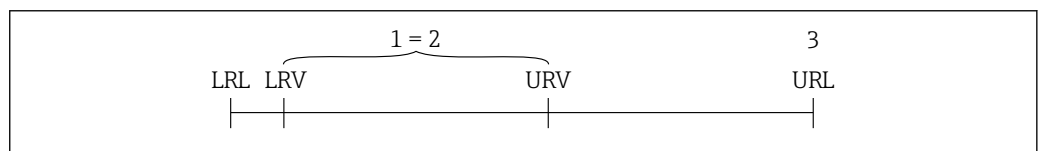
1 Calibrated/adjusted span
2 Zero point-based span (4 to 20 mA Analog: customer-specific span can only be set at the factory when ordered)
3 URL sensor

Example
• Sensor:10 bar (150 psi)   • Calibrated/adjusted span: 0 to 5 bar (0 to 75 psi)   • Upper range value (URL) = 10 bar (150 psi)   • Lower range value (LRV) = 0 bar (0 psi)   • Upper range value (URV) = 5 bar (75 psi)   Turn down (TD): $$TD = \frac{URL}{|URV - LRV|}$$ $$TD = \frac{10 \text{ bar (150 psi)}}{|5 \text{ bar (75 psi)} - 0 \text{ bar (0 psi)}|} = 2$$ In this example, the TD is 2:1.   This span is based on the zero point.

2   Basic safety instructions

2.1   Requirements concerning the staff

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:
▶ Trained, qualified specialists: must have a relevant qualification for this specific function and task
▶ Are authorized by the plant owner/operator
▶ Are familiar with federal/national regulations
▶ Before beginning work, the specialist staff must have read and understood the instructions in the Operating Instructions and supplementary documentation as well as in the certificates (depending on the application)
▶ Following instructions and basic conditions

The operating personnel must fulfill the following requirements:
▶ Being instructed and authorized according to the requirements of the task by the facility's owner-operator
▶ Following the instructions in these Operating Instructions

2.2   Designated use

2.2.1   Application and media

The Waterpilot FMX21 is a hydrostatic pressure sensor for measuring the level of fresh water, wastewater and salt water. The temperature is measured simultaneously in the case of sensor versions with a Pt100 resistance thermometer.

An optional temperature head transmitter converts the Pt100 signal into a 4 to 20 mA signal.

2.2.2   Incorrect use

The manufacturer is not liable for damage caused by improper or non-designated use.

Verification for borderline cases:
▶ For special fluids and fluids for cleaning, Endress+Hauser is glad to provide assistance in verifying the corrosion resistance of fluid-wetted materials, but does not accept any warranty or liability.

2.3   Workplace safety

For work on and with the device:
▶ Wear the required personal protective equipment according to federal/national regulations.
▶ Switch off the supply voltage before connecting the device.

2.4   Operational safety

Risk of injury!
▶ Operate the device in proper technical condition and fail-safe condition only.
▶ The operator is responsible for interference-free operation of the device.

Modifications to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers.
▸ If, despite this, modifications are required, consult with Endress+Hauser.

Repairs

To ensure continued operational safety and reliability,
▸ Carry out repairs on the device only if they are expressly permitted.
▸ Observe federal/national regulations pertaining to repair of an electrical device.
▸ Use original spare parts and accessories from Endress+Hauser only.

Hazardous area

To eliminate danger to persons or the facility when the device is used in the approval-related area (e.g. explosion protection, pressure vessel safety):
▸ Check the nameplate to verify if the device ordered can be put to its intended use in the approval-related area.
▸ Observe the specifications in the separate supplementary documentation that is an integral part of these Instructions.

2.5   Product safety

This measuring device is designed in accordance with good engineering practice to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate.

It meets general safety standards and legal requirements. It also complies with the EC directives listed in the device-specific EC Declaration of Conformity. Endress+Hauser confirms this by affixing the CE mark to the device.

3   Product description

3.1   Function

The ceramic measuring cell is a dry measuring cell i.e. the pressure acts directly on the robust, ceramic process isolating diaphragm of the Waterpilot FMX21. Changes in air pressure are guided via a pressure compensation tube through the extension cable to the rear of the ceramic process isolating diaphragm and are compensated for. A pressure-dependent change in capacitance, caused by the movement of the process isolating diaphragm, is measured at the electrodes of the ceramic carrier. The electronics unit then converts this to a signal that is proportional to the pressure and linear to the level.
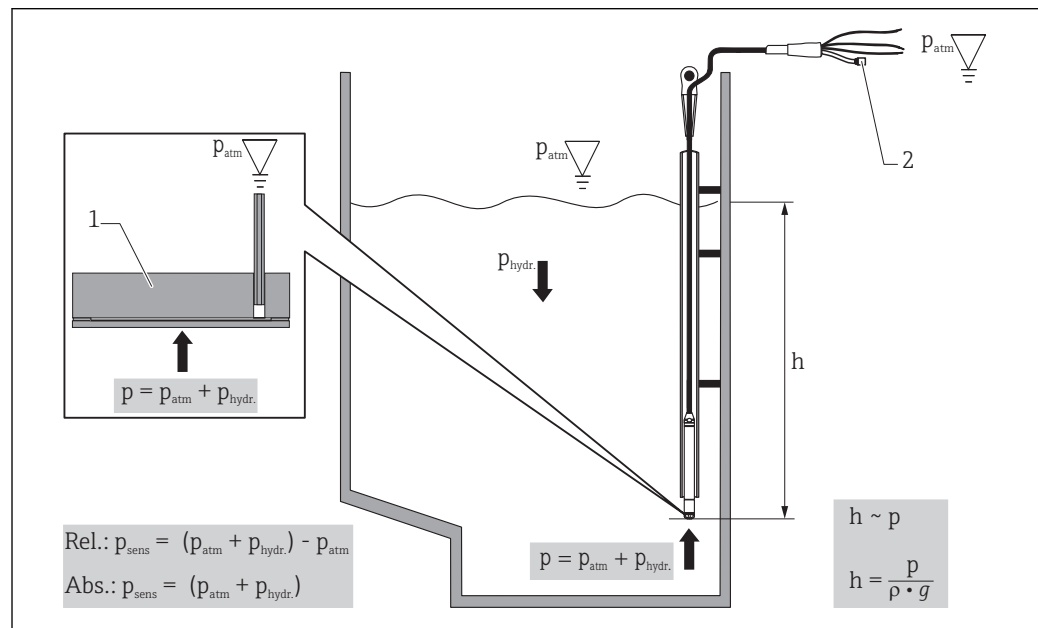
1   Ceramic measuring cell
2   Pressure compensation tube
h   Height level
p   Total pressure = atmospheric pressure + hydrostatic pressure
ρ   Density of the medium
g   Acceleration due to gravity
$P_{hydr.}$ Hydrostatic pressure
P_{atm} Atmospheric pressure
P_{sens} Pressure displayed on the sensor

4 Incoming acceptance and product identification

4.1 Incoming acceptance
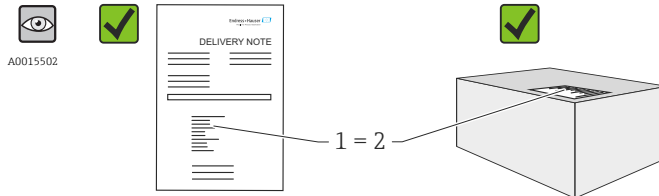
Is the order code on the delivery note (1) identical to the order code on the product sticker (2)?
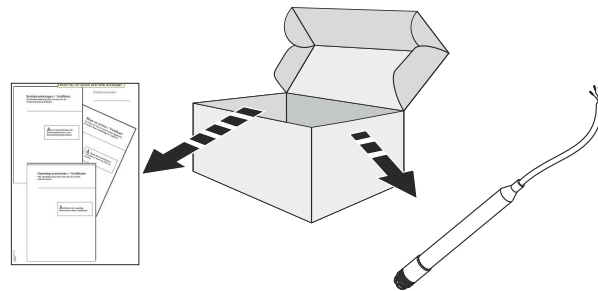
Are the goods undamaged?
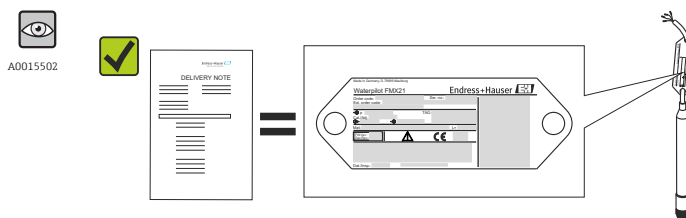
Do the data on the nameplate correspond to the order specifications and the delivery note?

A0015502
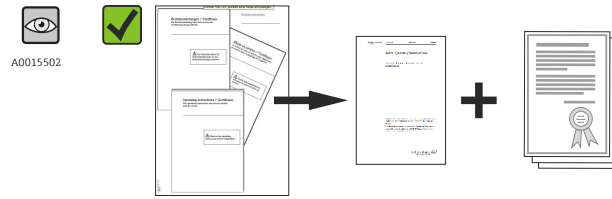
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Is the documentation available?
If required (see nameplate): Are the safety instructions (XA) present?

If one of these conditions does not apply, please contact your
Endress+Hauser sales office.

4.2   Product identification

The following options are available for identification of the measuring device:
- Nameplate specifications
- Order code with breakdown of the device features on the delivery note
- Enter serial numbers from nameplates in *W@M Device Viewer*
  (www.endress.com/deviceviewer): All information about the measuring device is
  displayed.

For an overview of the technical documentation provided, enter the serial number from
the nameplates in the *W@M Device Viewer* (www.endress.com/deviceviewer)

4.3   Nameplates

4.3.1   Nameplates on extension cable
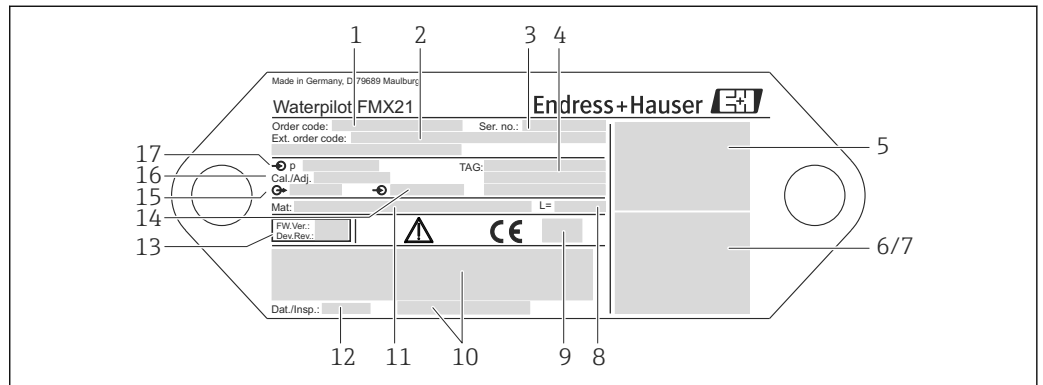
*1   Order code (shortened for reordering); The meaning of the individual letters and digits is explained in the
      order confirmation details.*
2   Extended order number (complete)
3   Serial number (for clear identification)
4   TAG (device tag)
5   FMX21 connection diagram
6   Pt100 connection diagram (optional)
7   Warning (hazardous area), (optional)
8   Length of extension cable
9   Approval symbol, e.g. CSA, FM, ATEX (optional)
10   Text for approval (optional)
11   Materials in contact with process
12   Test date (optional)
13   Software version/device version
14   Supply voltage
15   Output signal
16   Set measuring range
17   Nominal measuring range

Additional nameplate for devices with approvals
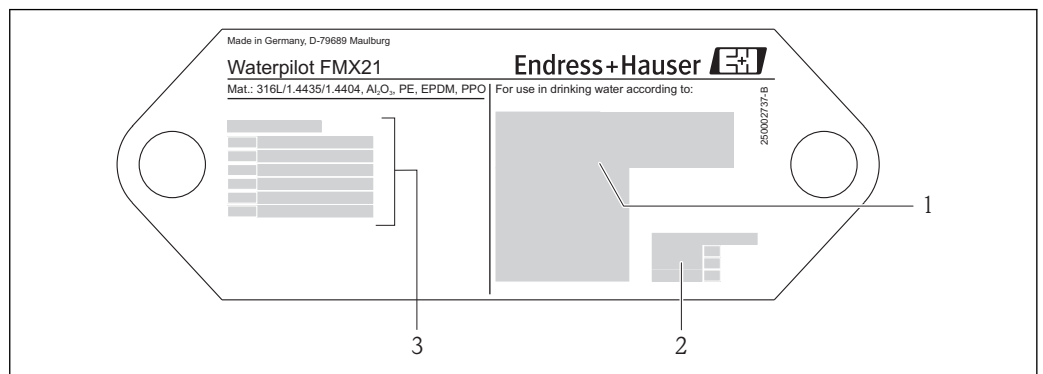
1   Approval symbol (drinking water approval)
2   Reference to associated documentation
3   Approval number (marine approval)

4.3.2 Additional nameplate for devices with external diameter 22 mm (0.87 in) and 42 mm (1.65 in)

A0018804
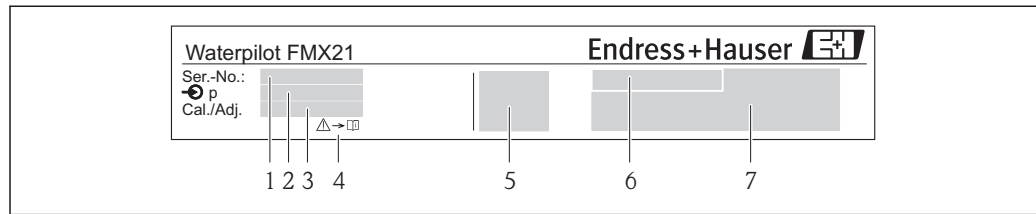
1   Serial number
2   Nominal measuring range
3   Set measuring range
4   CE mark or approval symbol
5   Certificate number (optional)
6   Text for approval (optional)
7   Reference to documentation

4.4   Storage and transport

4.4.1   Storage conditions

Use original packaging.

Store the measuring device in clean and dry conditions and protect from damage caused by shocks (EN 837-2).

Storage temperature range

FMX21 + Pt100 (optional)

–40 to +80 ℃ (–40 to +176 ℉)

Cable

(when mounted in a fixed position)
- With PE: –30 to +70 ℃ (–22 to +158 ℉)
- With FEP: –30 to +80 ℃ (–22 to +176 ℉)
- With PUR: –40 to +80 ℃ (–40 to +176 ℉)

Terminal box

–40 to +80 ℃ (–40 to +176 ℉)

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

–40 to +100 ℃ (–40 to +212 ℉)

4.4.2   Transporting the product to the measuring point

⚠ WARNING

Incorrect transport!
Device or cable may become damaged, and there is a risk of injury!
▶   Transport measuring device in the original packaging.
▶   Follow the safety instructions and transport conditions for devices weighing more than 18 kg (39.6 lbs).

4.5   Scope of delivery

The scope of delivery comprises:
- Waterpilot FMX21, optionally with integrated Pt100 resistance thermometer
- Optional accessories

Documentation supplied:
- The Operating Instructions BA01605P are available on the internet. → see: www.de.endress.com → Downloads.
- Brief Operating Instructions KA01244P
- Final inspection report
- Drinking water approvals (optional): SD00289P, SD00319P, SD00320P
- Devices that are suitable for use in hazardous areas: Additional documentation e.g. Safety instructions (XA, ZD)

5   Installation

5.1   Installation conditions
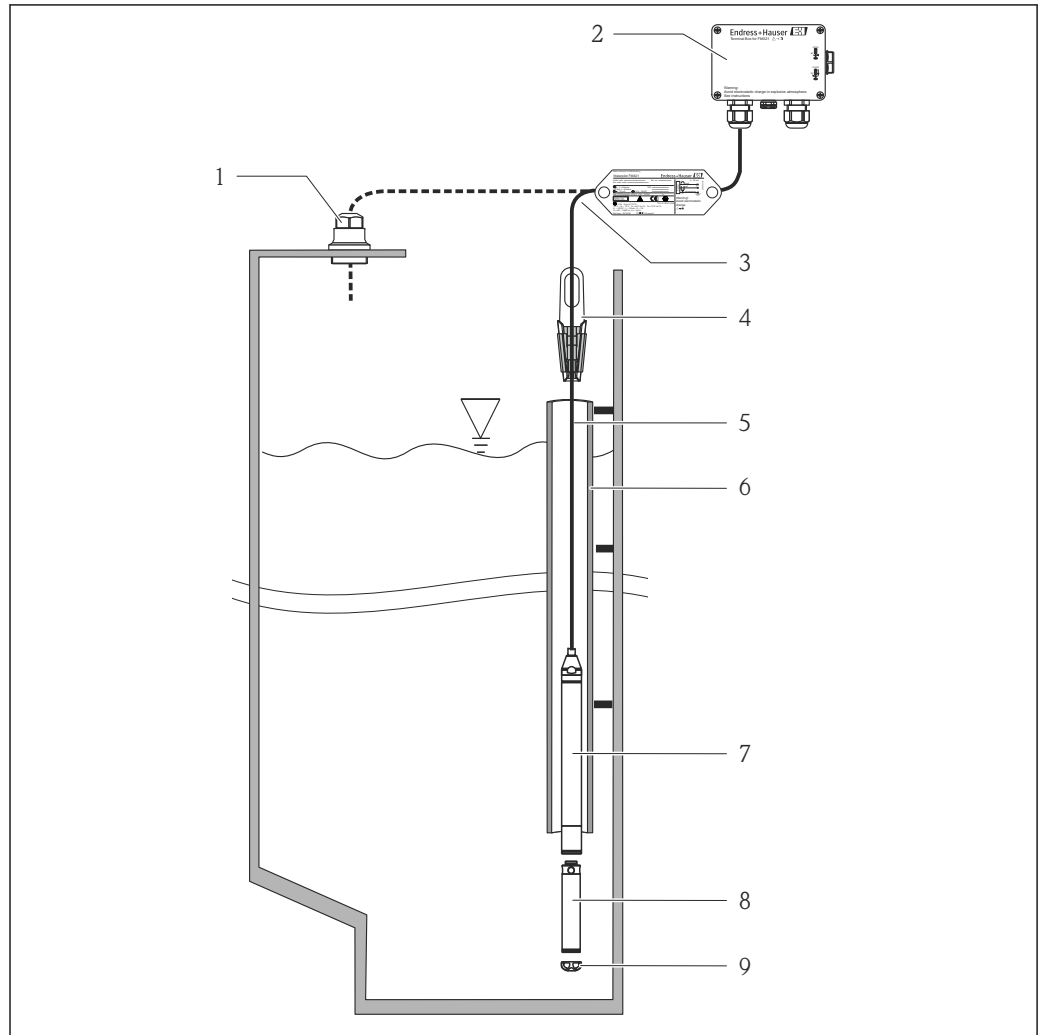
A0018770

1   Cable mounting screw (can be ordered as an accessory)
2   Terminal box (can be ordered as an accessory)
3   Bending radius of extension cable > 120 mm (4.72 in)
4   Mounting clamp (can be ordered as an accessory)
5   Extension cable
6   Guide tube
7   Waterpilot FMX21
8   Additional weight can be ordered as an accessory for the FMX21 with external diameter of 22 mm (0.87 in)
     and 29 mm (1.14 in)
9   Protection cap

5.2   Additional mounting instructions

- Cable length
  - Customer-specific in meters or feet.
  - Limited cable length when performing installation with freely suspended device with cable mounting screw or mounting clamp, as well as for FM/CSA approval: max. 300 m (984 ft).
- Sideways movement of the level probe can result in measuring errors. For this reason, install the probe at a point free from flow and turbulence, or use a guide tube. The internal diameter of the guide tube should be at least 1 mm (0.04 in) greater than the external diameter of the selected FMX21.
- To avoid mechanical damage to the measuring cell, the device is equipped with a protection cap.
- 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 → 🕮 34.
- Cable length tolerance: < 5 m (16 ft): ±17.5 mm (0.69 in); > 5 m (16 ft): ±0.2 %
- If the cable is shortened, the filter at the pressure compensation tube must be reattached. Endress+Hauser offers a cable shortening kit for this purpose → 🕮 34(documentation SD00552P/00/A6).
- Endress+Hauser recommends using twisted, shielded cable.
- In shipbuilding applications, measures are required to restrict the spread of fire along cable looms.
- The length of the extension cable depends on the intended level zero point. The height of the protection 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).
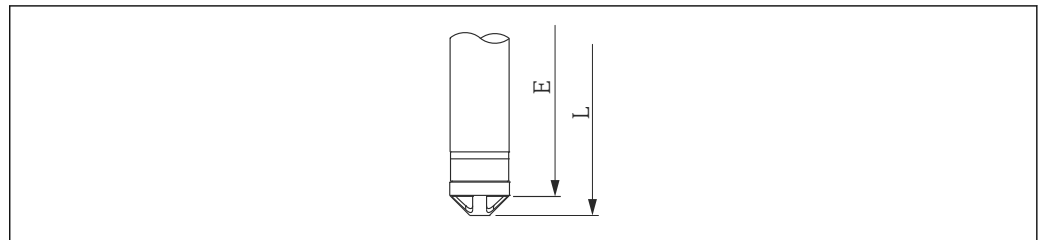
A0026013

5.3   Dimensions

For dimensions, please refer to the Technical Information TI00431P/00/EN, "Mechanical construction" section (see also: www.de.endress.com → Downloads → Media Type: Documentation).

5.4   Mounting the Waterpilot with a mounting clamp
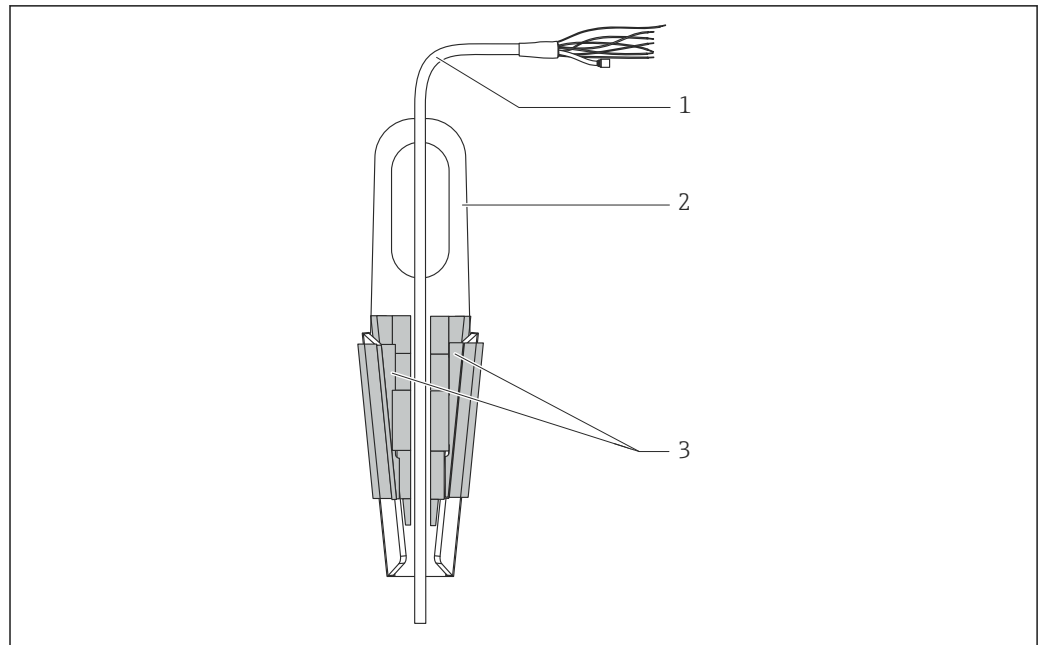
A0018793

1   Extension cable
2   Suspension clamp
3   Clamping jaws

5.4.1   Mounting the suspension clamp:

1. Mount the suspension clamp (item 2). Take the weight of the extension cable (item 1) and the device into account when selecting the fastening point.

2. Push up the clamping jaws (item 3). Place the extension cable (item 1) between the clamping jaws as shown in the graphic.

3. Hold the extension cable (item 1) in position and push the clamping jaws (item 3) back down. Tap the clamping jaws gently from above to fix them in place.

5.5　Mounting the Waterpilot with a cable mounting screw

1　Extension cable
2　Cover for cable mounting screw
3　Sealing ring
4　Clamping sleeves
5　Adapter for cable mounting screw
6　Top edge of clamping sleeve
7　Desired length of extension cable and Waterpilot probe prior to assembly
8　After assembly, item 7 is located next to the mounting screw with G 1½" thread: height of sealing surface of the adapter or NPT 1½" thread height of thread run-out of adapter

Engineering unit mm (in). Illustrated with G 1½" thread.

If you want to lower the level probe to a certain depth, position the top edge of the clamping sleeve 40 mm (4.57 in) higher than the required depth. Then push the extension cable and the clamping sleeve into the adapter as described in Step 6 in the following section.

5.5.1　Mounting the cable mounting screw with a G 1½" or NPT 1½" thread:

1. Mark the desired length of extension cable on the extension cable.

2. Insert the probe through the measuring aperture and carefully lower on the extension cable. Fix the extension cable to prevent it from slipping.

3. Slide the adapter (item 5) over the extension cable and screw it tightly into the measuring aperture.

4. Slide the sealing ring (item 3) and cover (item 2) onto the cable from above. Press the sealing ring into the cover.

5. Place the clamping sleeves (item 4) around the extension cable (item 1) at the marked point as illustrated in the graphic.

6. Slide the extension cable with the clamping sleeves (item 4) into the adapter (item 5)

7. Fit the cover (item 2) with the sealing ring (item 3) onto the adapter (item 5) and securely screw together with the adapter.

To remove the cable mounting screw, perform this sequence of steps in reverse.

⚠ CAUTION

Risk of injury!

▸ Use only in unpressurized vessels.

5.6   Mounting the terminal box

The optional terminal box is mounted using four screws (M4). For the dimensions of the terminal box, please see the Technical Information TI00431P/00/ EN, "Mechanical construction" section (see also: www.de.endress.com → Downloads → Media Type: Documentation).

5.7   Mounting the TMT181 temperature head transmitter with terminal box
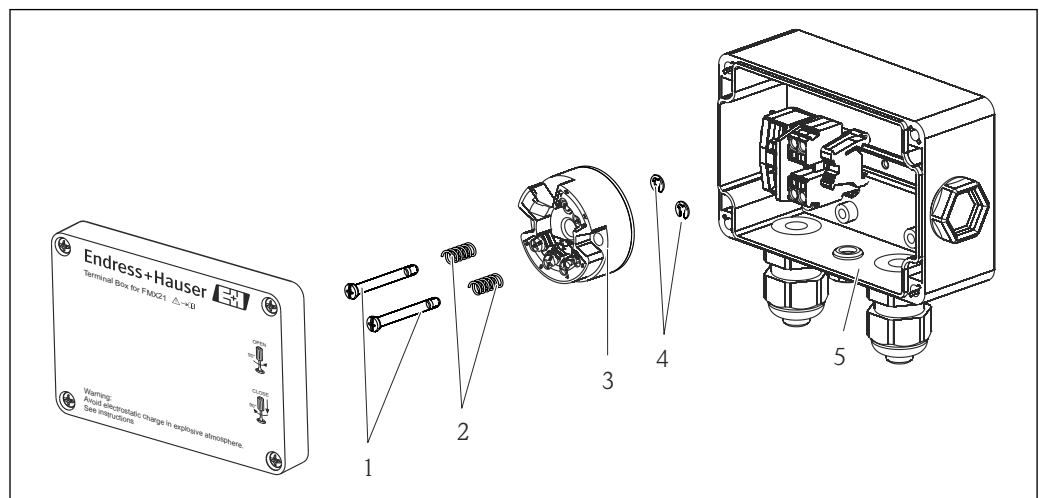
A0018813

1   Mounting screws
2   Mounting springs
3   TMT181 temperature head transmitter
4   Circlips
5   Terminal box

ℹ️ Only open the terminal box with a screwdriver.

⚠ WARNING

Risk of explosion!

▸ The TMT181 is not designed for use in hazardous areas.

5.7.1   Mounting the temperature head transmitter:

1. Guide the mounting screws (item 1) with the mounting springs (item 2) through the bore of the temperature head transmitter (item 3)

2. Secure the mounting screws with the circlips (item 4). Circlips, mounting screws and springs are included in the scope of delivery for the temperature head transmitter.

3. Screw the temperature head transmitter into the field housing tightly. (Width of screwdriver blade max. 6 mm (0.24 in))

NOTICE

Avoid damage to the temperature head transmitter.

▸ Do not overtighten the mounting screw too.

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1   Terminal box
2   Terminal strip
3   TMT181 temperature head transmitter

Engineering unit mm (in)
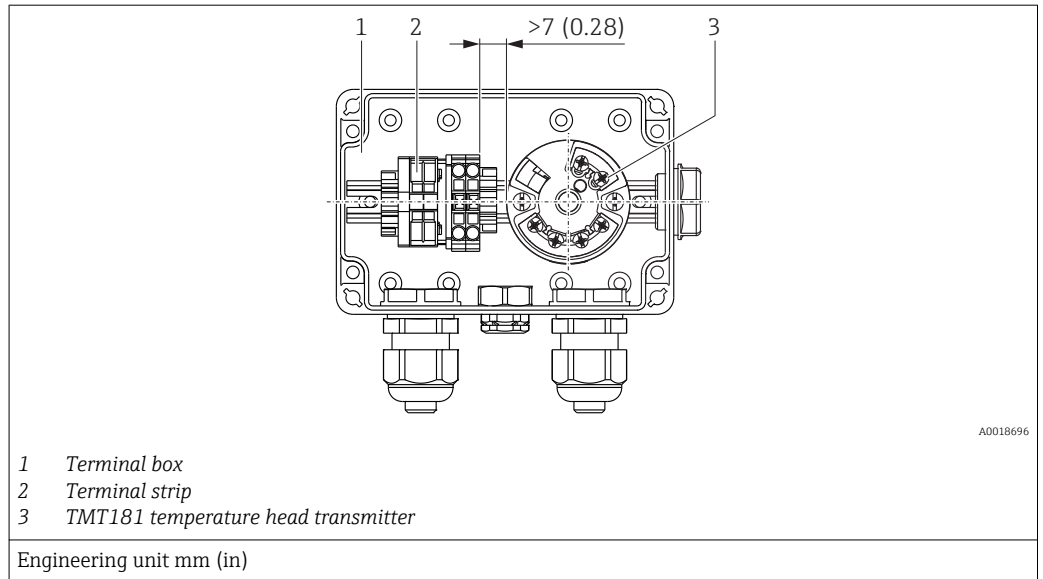
NOTICE

Incorrect mounting!

▶ A distance of >7 mm (> 0.28) must be maintained between the terminal strip and the TMT181 temperature head transmitter.

5.8   Mounting the terminal strip for the Pt100 passive (without TMT181)

If the FMX21 with optional Pt100 is supplied without the optional TMT181 temperature head transmitter, a terminal strip is provided with the terminal box for the purpose of wiring the Pt100.

⚠ WARNING

Risk of explosion!

▶ The Pt100, as well as the terminal strip, are not designed for use in hazardous areas.

A0018815
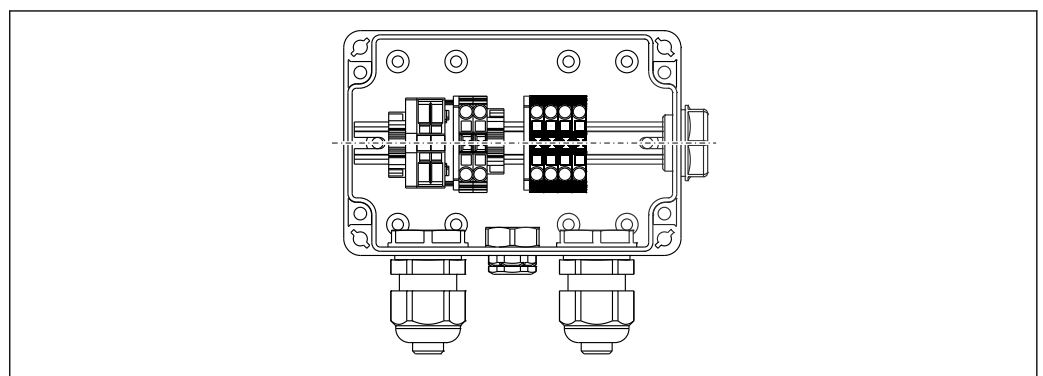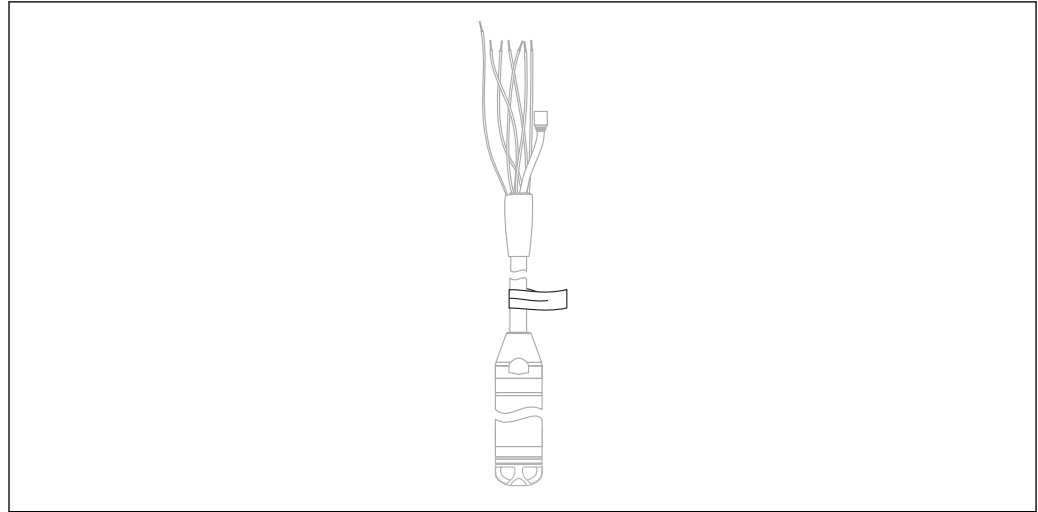
5.9   Cable marking

A0030955

- To make installation easier, Endress+Hauser marks the extension cable if a customer-specific length has been ordered.
  Ordering information: Product Configurator order code for "Service", option "IR" or "IS".
- Cable marking tolerance (distance to lower end of level probe):
  Cable length < 5 m (16 ft): ±17.5 mm (0.69 in)
  Cable length > 5 m (16 ft): ±0.2 %
- Material: PET, stick-on label: acrylic
- Immunity to temperature change: −30 to +100 ℃ (−22 to +212 ℉)

NOTICE

The marking is used exclusively for installation purposes.

▶ The mark must be thoroughly removed without trace in the case of devices with drinking water approval. The extension cable must not be damaged in the process.

Not for use of the FMX21 in hazardous areas.

5.10   Cable shortening kit
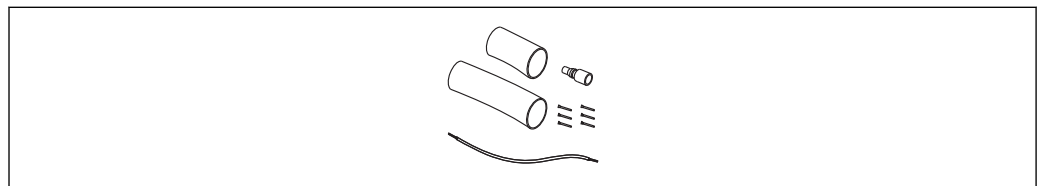
A0030948

The cable shortening kit is used to shorten a cable easily and professionally.

The cable shortening kit is not designed for the FMX21 with FM/CSA approval.

- Ordering information: Product Configurator order code for "Accessories enclosed", option "PW"
- Associated documentation SD00552P/00/A6.

5.11   Post-installation check

❑	Is the device undamaged (visual inspection)?
❑	Does the device conform to the measuring point specifications? For example: • Process temperature • Process pressure • Ambient temperature • Measuring range
❑	Are the measuring point identification and labeling correct (visual inspection)?
❑	Check that all screws are firmly seated.

6   Electrical connection

> ⚠ **WARNING**
>
> **Electrical safety is compromised by an incorrect connection!**
> ▶ When using the measuring device in a hazardous area, the relevant national standards and guidelines as well as the Safety Instructions (XAs) or installation or control drawings (ZDs) must be adhered to. All data relating to explosion protection can be found in separate documentation which is available on request. This documentation is supplied with the devices as standard → 📖 6

6.1   Connecting the device

> ⚠ **WARNING**
>
> **Electrical safety is compromised by an incorrect connection!**
> ▶ The supply voltage must match the supply voltage specified on the nameplate → 📖 13
> ▶ Switch off the supply voltage before connecting the device.
> ▶ The cable must end in a dry room or a suitable terminal box. The IP66/IP67 terminal box with GORE-TEX® filter from Endress+Hauser → 📖 20 is suitable for outdoor installation.
> ▶ Connect the device in accordance with the following diagrams. Reverse polarity protection is integrated into the Waterpilot FMX21 and the temperature head transmitter. Changing the polarities will not result in the destruction of the devices.
> ▶ A suitable circuit breaker should be provided for the device in accordance with IEC/EN 61010.

6.1.1   Waterpilot with Pt100
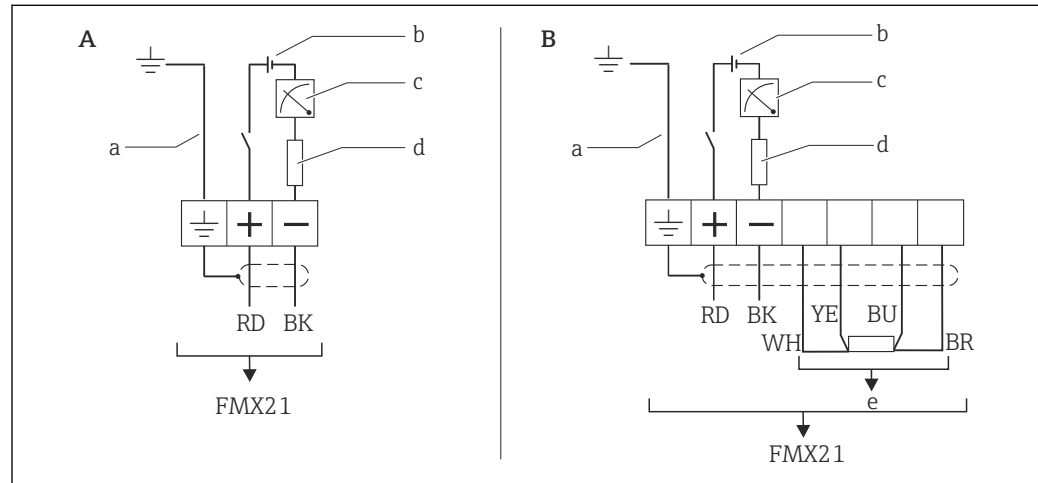
A0019441

A   Waterpilot FMX21
B   Waterpilot FMX21 with Pt100 (not for use in hazardous areas); option "NB", Product Configurator order code for "Accessories"
a   Not for the FMX21 with external diameter of 29 mm (1.14 in)
b   10.5 to 30 V DC (hazardous area), 10.5 to 35 V DC
c   4...20 mA
d   Resistance (R_L)
e   Pt100

6.1.2 Waterpilot with Pt100 and TMT181 temperature head transmitter for FMX21 4 to 20 mA Analog

A0030945
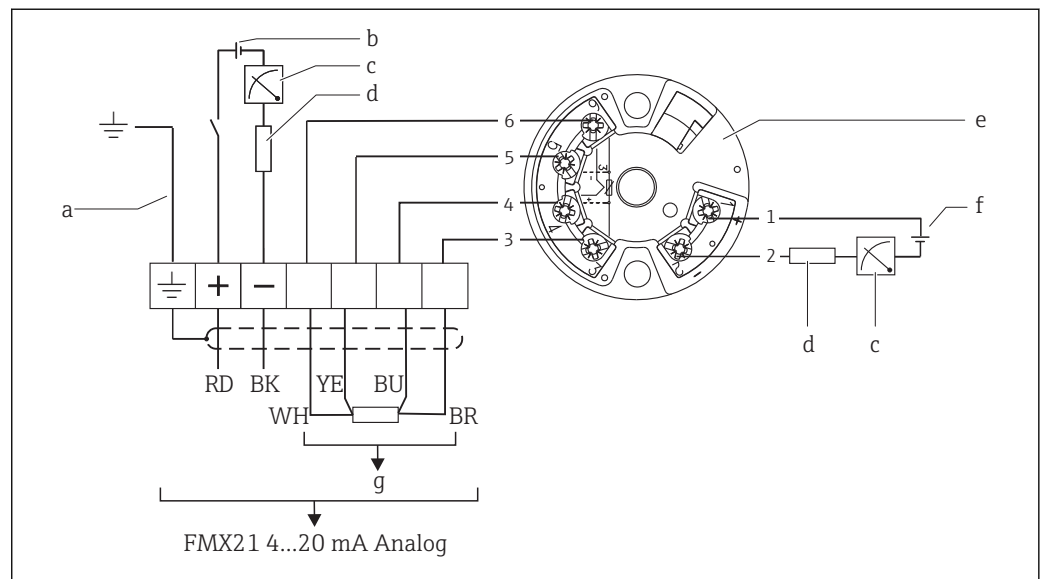
a   *Not for the FMX21 with external diameter of 29 mm (1.14 in)*
b   *10.5 to 35 V DC*
c   *4...20 mA*
d   *Resistance (R_L)*
e   *TMT181 temperature head transmitter (4 to 20 mA) (not for use in hazardous areas)*
f   *8 to 35 V DC*
g   *Pt100*
1...6 Pin assignment

Ordering information:

Pt100: Product Configurator order code for "Accessories mounted", option "NB"

TMT181: Product Configurator order code for "Accessories enclosed", option "PX"

6.1.3 Wire colors

RD = red, BK = black, WH = white, YE = yellow, BU = blue, BR = brown

6.1.4 Connection data

Connection classification as per IEC 61010-1:
• Overvoltage category 1
• Pollution level 1

Connection data in the hazardous area

See relevant XA.

6.2   Supply voltage

⚠ WARNING

Supply voltage might be connected!

Risk of electric shock and/or explosion!

▶ When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations as well as the Safety Instructions.

▶ All explosion protection data are given in separate documentation which is available upon request. The Ex documentation is supplied as standard with all devices approved for use in explosion hazardous areas.

6.2.1   FMX21 + Pt100 (optional)

• 10.5 to 35 V (not hazardous areas)
• 10.5 to 30 V (hazardous areas)

6.2.2   TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

8 to 35 V DC

6.3   Cable specifications

Endress+Hauser recommends using shielded, twisted-pair two-wire cables.

ℹ The probe cables are shielded for device versions with outer diameters of 22 mm (0.87 in) and 42 mm (1.65 in).

6.3.1   FMX21 + Pt100 (optional)

• Commercially available instrument cable
• Terminals, terminal box: 0.08 to 2.5 mm^2 (28 to 14 AWG)

6.3.2   TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

• Commercially available instrument cable
• Terminals, terminal box: 0.08 to 2.5 mm^2 (28 to 14 AWG)
• Transmitter connection: max. 1.75 mm^2 (15 AWG)

6.4   Power consumption

6.4.1   FMX21 + Pt100 (optional)

• ≤ 0.805 W at 35 V DC (non-hazardous area)
• ≤ 0.690 W at 30 V DC (hazardous area)

6.4.2   TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

≤ 0.875 W at 35 V DC

6.5   Current consumption

6.5.1   FMX21 + Pt100 (optional)

Max. current consumption: ≤ 23 mA
Min. current consumption: ≥ 3.6 mA
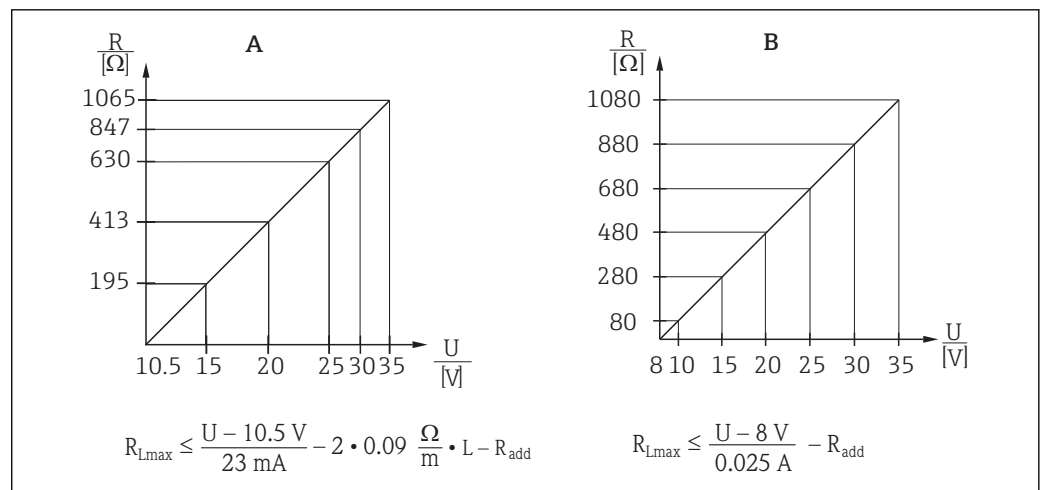
6.5.2   TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

- Max. current consumption: ≤ 25 mA
- Min. current consumption: ≥ 3.5 mA

6.6   Maximum load for FMX21 4 to 20 mA Analog

The maximum load resistance depends on the supply voltage (U) and must be determined individually for each current loop, see formula and diagrams for FMX21 and temperature head transmitter. 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.

$$R_{Lmax} \leq \frac{U - 10.5\ V}{23\ mA} - 2 \cdot 0.09\ \frac{\Omega}{m} \cdot L - R_{add} \qquad R_{Lmax} \leq \frac{U - 8\ V}{0.025\ A} - R_{add}$$

A0030561-EN

A   FMX21 4 to 20 mA Analog load chart for estimating the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the value calculated as shown in the equation.
B   Load diagram for TMT181 temperature head transmitter for estimating the load resistance. Additional resistances must be subtracted from the value calculated as shown in the equation
R_{Lmax} Max. load resistance [Ω]
R_{add} Additional resistances such as resistance of evaluating device and/or display unit, cable resistance [Ω]
*U   Supply voltage [V]*
L   Basic length of extension cable [m] (cable resistance per wire 0.09 Ω/m)

ℹ️   When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings (XA).

6.7 Connecting the measuring unit

6.7.1 Overvoltage protection

To protect the Waterpilot and the TMT181 temperature head transmitter from large interference voltage peaks, Endress+Hauser recommends installing overvoltage protection upstream and downstream of the display and/or evaluation unit as shown in the graphic.
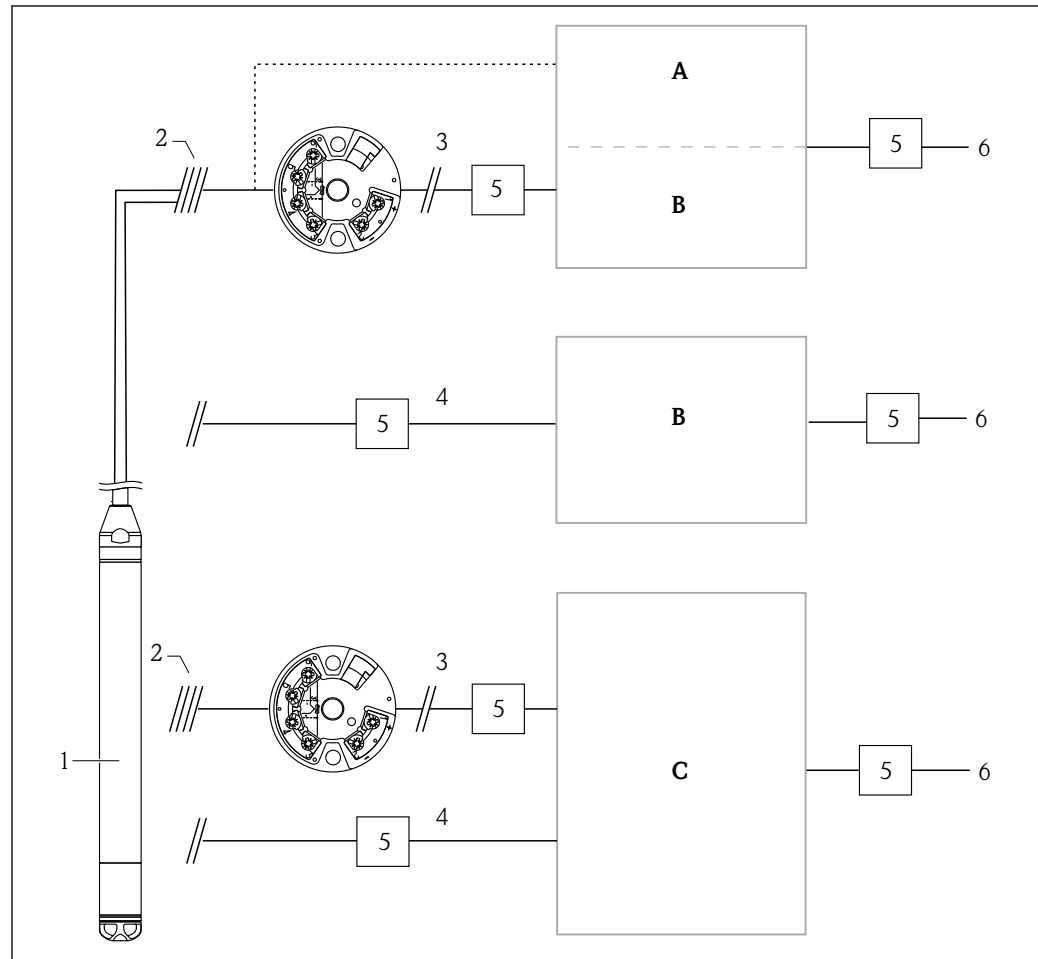
A Power supply, display and evaluation unit with one input for Pt100
B Power supply, display and evaluation unit with one input for 4 to 20 mA
C Power supply, display and evaluation unit with two inputs for 4 to 20 mA
1 Waterpilot FMX21
2 Connection for integrated Pt100 in the FMX21
3 4 to 20 mA (temperature)
4 4 to 20 mA (level)
5 Overvoltage protection, e.g. HAW from Endress+Hauser (not for use in hazardous areas.)
6 Power supply

6.8 Post-connection check

❑	Is the device or cable undamaged (visual check)?
❑	Do the cables comply with the requirements ?
❑	Do the cables have adequate strain relief?
❑	Are all cable glands installed, securely tightened and leak-tight?
❑	Does the supply voltage match the specifications on the nameplate?
❑	Is the terminal assignment correct ?

7   Operation options

Endress+Hauser offers comprehensive measuring point solutions with display and/or evaluation units for the Waterpilot FMX21 and TMT181 temperature head transmitter.

Your Endress+Hauser service organization would be glad to be of service if you have any other questions. Contact addresses can be found on the website at www.endress.com/worldwide

7.1   Overview of operating options

No display or other operation facility is required to operate the device.

8   Diagnostics and troubleshooting

8.1   Troubleshooting

General errors

Error	Possible cause	Solution
Device is not responding.	Supply voltage does not match the specification on the nameplate.	Apply correct voltage.
	Supply voltage has incorrect polarity.	Reverse polarity of supply voltage.
	Connecting cables are not in contact with the terminals.	Check the connection of the cables and correct if necessary.
Output current < 3.6 mA	Signal line is not wired correctly. Electronics unit is defective.	Check wiring.

8.2   Troubleshooting specific to Waterpilot FMX21 with optional Pt100

Error description	Reason	Corrective action
No measuring signal	4 to 20 mA cable not connected correctly	Connect device as per → 🗎 24.
	No power supplied via the 4 to 20 mA cable	Check current loop.
	Supply voltage too low (min. 10.5 V DC)	• Check supply voltage. • Overall resistance greater than max. load resistance
	Waterpilot defective	Replace the Waterpilot.
Temperature measured value is inaccurate/incorrect (only for Waterpilot FMX21 with Pt100)	Pt100 connected in 2-wire circuit, cable resistance was not compensated for	• Compensate the cable resistance. • Connect Pt100 as 3-wire or 4-wire circuit.

8.3   Troubleshooting specific to TMT181 temperature head transmitter

Error description	Reason	Corrective action
No measuring signal	4 to 20 mA cable not connected correctly	Connect device as per → 🗎 24.
	No power supplied via the 4 to 20 mA cable	Check current loop.
	Supply voltage too low (min. 8 V DC)	• Check supply voltage. • Overall resistance greater than max. load resistance
Error current ≤ 3.6 mA or ≥ 21 mA	Pt100 not connected correctly	Connect device as per → 🗎 24.
	4 to 20 mA cable not connected correctly	Connect device as per → 🗎 24.
	Pt100 resistance thermometer defective	Replace the Waterpilot.

Error description	Reason	Corrective action
	Temperature head transmitter defective	Replace the temperature head transmitter.
Measured value is inaccurate/ incorrect	Pt100 connected in 2-wire circuit, cable resistance was not compensated for	• Compensate the cable resistance. • Connect Pt100 as 3-wire or 4-wire circuit.

9   Maintenance

- Terminal box: Keep the GORE-TEX® filter free from contamination
- FMX21 extension cable: Keep the Teflon filter in the pressure compensation tube free from contamination
- Check the process isolating diaphragm for buildup at suitable intervals.

9.1   Exterior cleaning

Please note the following points when cleaning the device:
- The cleaning agents used should not corrode the surface and the seals.
- Mechanical damage to the process isolating diaphragm, e.g. due to sharp objects, must be avoided.
- Only clean the terminal box with water or with a cloth dampened with very diluted ethanol.

10   Repairs

10.1   General notes

10.1.1   Repair concept

Repairs are not possible.

10.2   Spare parts

All the spare parts for the measuring device along with the order code are listed In the *W@M Device Viewer* (www.endress.com/deviceviewer) and can be ordered. If available, users can also download the associated Installation Instructions.

Measuring device serial number:
Is located on the nameplate of the device.

10.3   Return

The measuring device must be returned if the wrong device has been ordered or delivered.

As an ISO-certified company and also due to legal regulations, Endress+Hauser is obliged to follow certain procedures when handling any returned products that have been in contact with medium. To ensure swift, safe and professional device returns, please read the return procedures and conditions on the Endress+Hauser website at www.services.endress.com/return-material

▸ Select country.
  ↳ The web site of the responsible sales office opens with all of the relevant information relating to returns.

1. If the desired country is not listed:
   Click on the "Choose your location" link.
     ↳ An overview of Endress+Hauser sales offices and representatives opens.
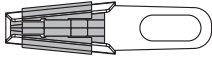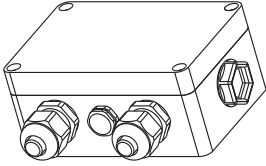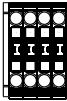2. Contact your Endress+Hauser sales office or representative.

10.4   Disposal
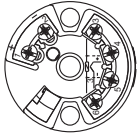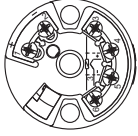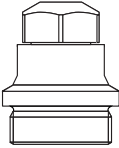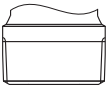
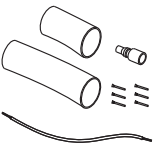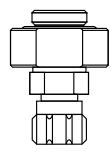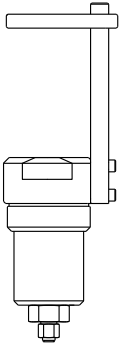When disposing, separate and recycle the device components based on the materials.

11   Accessories

⚠ CAUTION

Observe the additional information in the individual sections!

▸ For additional information, see the "Mechanical construction" section (in Technical Information TI00431P), "Environment", → 🕮 42, "Process" → 🕮 44 and "Installation" → 🕮 16.

Description	Diagram	Description	Order number / ordering information
Suspension clamp	A0030950	For easy installation of the FMX21, Endress+Hauser offers a mounting clamp .	• 52006151 • Product Configurator order code for "Accessory enclosed", option "PO"
Terminal box	A0030967	Terminal box for terminal strip, temperature head transmitter and Pt100.	• 52006152 • Product Configurator order code for "Accessories enclosed", option "PS"
4-terminal strip/terminals	A0030951	4-terminal strip for wiring	52008938
TMT181 temperature head transmitter for FMX21 4 to 20 mA Analog	A0030952	PC-programmable (PCP) temperature head transmitter for the conversion of various input signals	• 52008794 • Product Configurator order code for "Accessories enclosed", option "PX"
TMT182 temperature head transmitter for FMX21 4 to 20 mA HART	A0030952	PC-programmable (PCP) temperature head transmitter for the conversion of various input signals	• 51001023 • Product Configurator order code for "Accessories enclosed", option "PT"
Cable mounting screws	A B A0030953 A G 1½" A B NPT 1½"	Endress+Hauser offers a cable mounting screw for easy FMX21 mounting and to seal the measuring aperture.	• G 1½" A – 52008264 – Product Configurator order code for "Accessories enclosed", option "PQ" • NPT 1½" – 52009311 – Product Configurator order code for "Accessories enclosed", option "PR"
Additional weight for FMX21 with outer diameter 22 mm (0.87 in) or 29 mm (1.14 in)	A0030954	Endress+Hauser offers additional weights to prevent sideways movement that results in measuring errors, or to make it easier to lower the device in a guide tube.	• 52006153 • Product Configurator order code for "Accessories enclosed", option "PU"

Description	Diagram	Description	Order number / ordering information
Cable shortening kit	A0030948	The cable shortening kit is used to shorten a cable easily and professionally.	• 71222671 • Product Configurator order code for "Accessories enclosed", option "PW"
Testing adapter for FMX21 with outer diameter 22 mm (0.87 in) or 29 mm (1.14 in)	A0030956	Endress+Hauser offers a testing adapter to ease function-testing of the level probes.	• 52011868 • Product Configurator order code for "Accessories enclosed", option "PV"
Testing adapter for FMX21 with outer diameter 42 mm (1.65 in)	A0030957	Endress+Hauser offers a testing adapter to ease function-testing of the level probes. • Observe the maximum pressure for compressed air hose and maximum overload for level probe • Maximum pressure for the quick coupling piece provided: 10 bar (145 psi)	71110310

12   Technical data

12.1   Input

12.1.1   Measured variable

FMX21 + Pt100 (optional)

- Hydrostatic pressure of a liquid
- Pt100: Temperature

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

Temperature

12.1.2   Measuring range

- Customer-specific measuring ranges or calibration that has been preset in the factory
- Temperature measurement of −10 to +70 ℃ (+14 to +158 ℉) with Pt100 (optional)

Relative pressure

Sensor measuring range [bar (psi)]	Lowest calibratable span [1] [bar (psi)]	Vacuum resistance [bar_abs (psi_abs)]	Option [2]
0.1 (1.5)	0.01 (0.15)	0.3 (4.5)	1C
0.2 (3.0)	0.02 (0.3)	0.3 (4.5)	1D
0.4 (6.0)	0.04 (1.0)	0	1F
0.6 (9.0)	0.06 (1.0)	0	1G
1.0 (15.0)	0.1 (1.5)	0	1H
2.0 (30.0)	0.2 (3.0)	0	1K
4.0 (60.0)	0.4 (6.0)	0	1M
10.0 (150) [3]	1.0 (15)	0	1P
20.0 (300) [3]	2.0 (30)	0	1Q

1)   Largest turn down that can be configured at the factory: 10:1, higher turn down can be configured on request or in the device (for FMX21 4 to 20 mA HART).
2)   Product Configurator order code for "Sensor range"
3)   These measuring ranges are not available for the special version with plastic insulation, external diameter of 29 mm (1.14 in).

Absolute pressure

Sensor measuring range [bar (psi)]	Lowest calibratable span [1] [bar (psi)]	Vacuum resistance [bar_abs (psi_abs)]	Option [2]
2.0 (30.0)	0.2 (3.0)	0	2K
4.0 (60.0)	0.4 (6.0)	0	2M

Sensor measuring range [bar (psi)]	Lowest calibratable span [1] [bar (psi)]	Vacuum resistance [bar_{abs} (psi_{abs})]	Option [2]
10.0 (150) [3]	1.0 (15)	0	2P
20.0 (300) [3]	2.0 (30)	0	2Q

1) Largest turn down that can be configured at the factory: 10:1, higher turn down can be configured on request or in the device (for FMX21 4 to 20 mA HART).
2) Product Configurator order code for "Sensor range"
3) These measuring ranges are not available for the special version with plastic insulation, external diameter of 29 mm (1.14 in).

12.1.3 Input signal

FMX21 + Pt100 (optional)

- Change in capacitance
- Pt100: Change in resistance

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

Pt100 resistance signal, 4 wire

12.2   Output

12.2.1   Output signal

FMX21 + Pt100 (optional)

- 4 to 20 mA Analog, 2-wire for hydrostatic pressure measured value.
  Ordering information: Product Configurator order code for "Output", option "1"
- Pt100: temperature-dependent resistance value

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog
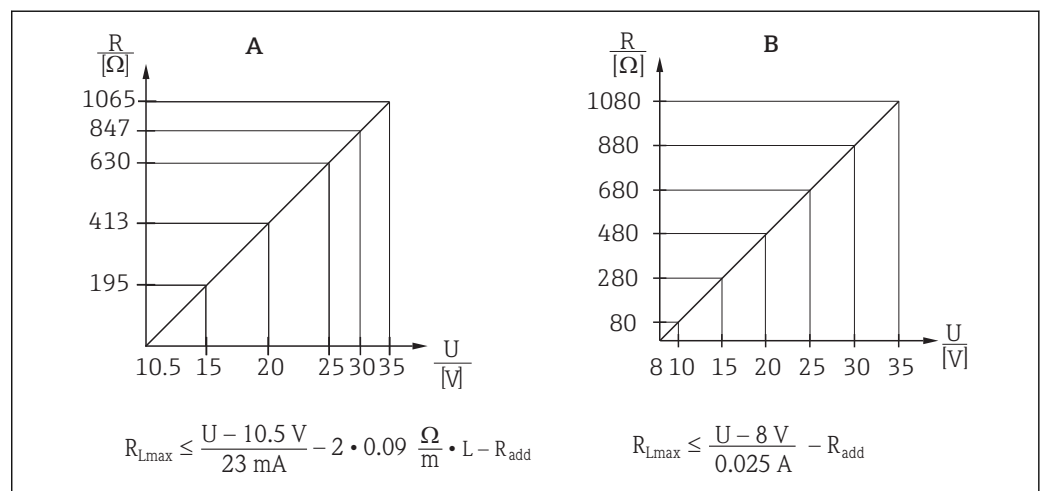
4 to 20 mA Analog for temperature measured value, 2-wire

12.2.2   Signal range

3.8 mA to 20.5 mA

12.2.3   Maximum load for FMX21 4 to 20 mA Analog

The maximum load resistance depends on the supply voltage (U) and must be determined individually for each current loop, see formula and diagrams for FMX21 and temperature head transmitter. 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.

$$R_{Lmax} \leq \frac{U - 10.5\,V}{23\,mA} - 2 \cdot 0.09\,\frac{\Omega}{m} \cdot L - R_{add}$$

$$R_{Lmax} \leq \frac{U - 8\,V}{0.025\,A} - R_{add}$$

A0030561-EN

A   FMX21 4 to 20 mA Analog load chart for estimating the load resistance. Additional resistances, such as the resistance of the extension cable, have to be subtracted from the value calculated as shown in the equation.
B   Load diagram for TMT181 temperature head transmitter for estimating the load resistance. Additional resistances must be subtracted from the value calculated as shown in the equation
R_{Lmax} Max. load resistance [Ω]
R_{add} Additional resistances such as resistance of evaluating device and/or display unit, cable resistance [Ω]
U   Supply voltage [V]
L   Basic length of extension cable [m] (cable resistance per wire 0.09 Ω/m)

ℹ️   When using the measuring device in hazardous areas, installation must comply with the corresponding national standards and regulations and the Safety Instructions or Installation or Control Drawings (XA).

12.3   Performance characteristics

12.3.1   Reference operating conditions

FMX21 + Pt100 (optional)

- As per IEC 60770
- Ambient temperature T_U = constant, in the range of +21 to +33 ℃ (+70 to +91 ℉)
- Humidity φ = constant, in the range of 20 to 80 % rH
- Ambient pressure p_U = constant, in the range of 860 to 1060 mbar (12.47 to 15.37 psi)
- Position of measuring cell constant, vertical in the range of ±1°
- Input of LOW SENSOR TRIM and HIGH SENSOR TRIM for lower range value and upper range value (only for HART)
- Supply voltage constant: 21 V DC to 27 V DC
- Pt100: DIN EN 60770, T_U = +25 ℃ (+77 ℉)

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

Calibration temperature +23 ℃ (+73 ℉) ±5 K

12.3.2   Reference accuracy

FMX21 + Pt100 (optional)

The reference accuracy comprises the non-linearity after limit point configuration, hysteresis and non-reproducibility in accordance IEC 60770.

Standard version [1]:
Setting ±0.2 %
– to TD 5:1: < 0.2 % of set span
– from TD 5:1 to TD 20:1 ±(0.02 x TD+0.1)

Platinum version [2]:
- Setting ±0.1 % (optional)
  – to TD 5:1: < 0.1 % of set span
  – from TD 5:1 to TD 20:1 ±(0.02 x TD)
- Class B as per DIN EN 60751
  Pt100: max. ±1 K

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

- ±0.2 K
- With Pt100: max. ±0.9 K

---

1)   Ordering information: Product Configurator order code for "Reference accuracy", option "G"
2)   Ordering information: Product Configurator order code for "Reference accuracy", option "D"

12.3.3   Long-term stability

FMX21 + Pt100 (optional)

- ≤ 0.1 % of URL/year
- ≤ 0.25 % of URL/5 years

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

≤ 0.1 K per year

12.3.4   Influence of medium temperature

- Thermal change in the zero output and the output span:
  0 to +30 °C (+32 to +86 °F): < (0.15 + 0.15 x TD)% of set span
  −10 to +70 °C (+14 to +158 °F): < (0.4 + 0.4 x TD)% of set span
- Temperature coefficient (T_K) of the zero output and the output span
  −10 to +70 °C (+14 to +158 °F): 0.1 % / 10 K of URL

12.3.5   Warm-up period

FMX21 + Pt100 (optional)

- FMX21: < 6 s
- Pt100: 20 m

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

4 s

12.3.6   Response time

FMX21 + Pt100 (optional)

- FMX21: 400 ms (T90 time), 500 ms (T99 time)
- Pt100: 160 s (T90 time), 300 s (T99 time)

12.4 Environment

12.4.1 Ambient temperature range

FMX21 + Pt100 (optional)

- With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
  −10 to +70 °C (+14 to +158 °F) (= medium temperature)
- With external diameter of 29 mm (1.14 in):
  0 to +50 °C (+32 to +122 °F) (= medium temperature)

Cable

(when mounted in a fixed position)
- With PE: −30 to +70 °C (−22 to +158 °F)
- With FEP: −40 to +70 °C (−40 to +158 °F)
- With PUR: −40 to +70 °C (−40 to +158 °F)

Terminal box

−40 to +80 °C (−40 to +176 °F)

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

−40 to +85 °C (−40 to +185 °F)

Temperature head transmitter 2-wire, configured for a measuring range of
−20 to +80 °C (−4 to +176 °F). This configuration offers a temperature range of 100 K
which can be easily mapped. Please note that the Pt100 resistance temperature detector is
suitable for a temperature range of −10 to +70 °C (14 to +158 °F)

ℹ The TMT181 temperature head transmitter is not designed for use in hazardous areas
incl. CSA GP.

12.4.2 Storage temperature range

FMX21 + Pt100 (optional)

−40 to +80 °C (−40 to +176 °F)

Cable

(when mounted in a fixed position)
- With PE: −30 to +70 °C (−22 to +158 °F)
- With FEP: −30 to +80 °C (−22 to +176 °F)
- With PUR: −40 to +80 °C (−40 to +176 °F)

Terminal box

−40 to +80 °C (−40 to +176 °F)

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

−40 to +100 °C (−40 to +212 °F)

12.4.3 Degree of protection

FMX21 + Pt100 (optional)

IP68, permanently hermetically sealed at 20 bar (290 psi) (~200 m H_2O)

Terminal box (optional)

IP66, IP67

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

IP00, condensation permitted

When installed in the optional terminal boxes: IP66/IP67

12.4.4 Electromagnetic compatibility (EMC)

FMX21 + Pt100 (optional)

• EMC in accordance with all relevant requirements of EN 61326 series. For details, refer to the Declaration of Conformity.
• Maximum deviation: < 0.5 % of span.

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

Interference emission to EN 61326 Class B equipment, interference immunity to EN 61326 Appendix A (Industrial). For details, refer to the Declaration of Conformity.

12.4.5 Overvoltage protection

FMX21 + Pt100 (optional)

• Integrated overvoltage protection as per EN 61000-4-5 (500 V symmetrical/1000 V asymmetrical)
• Overvoltage protection ≥ 1.0 kV, external if necessary

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

Provide overvoltage protection, externally if necessary .

12.5   Process

12.5.1   Medium temperature range

FMX21 + Pt100 (optional)

- With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
  −10 to +70 ℃ (+14 to +158 ℉)
- With external diameter of 29 mm (1.14 in):
  0 to +50 ℃ (+32 to +122 ℉)

TMT181 temperature head transmitter (optional) for FMX21 4 to 20 mA Analog

−40 to +85 ℃ (−40 to +185 ℉)

(= ambient temperature), install temperature head transmitter outside the medium.

Temperature head transmitter 2-wire, configured for a measuring range of
−20 to +80 ℃ (−4 to +176 ℉). This configuration offers a temperature range of 100 K
which can be easily mapped. Please note that the Pt100 resistance temperature detector is
suitable for a temperature range of −10 to +70 ℃ (14 to +158 ℉)

ℹ️ The TMT181 temperature head transmitter is not designed for use in hazardous areas
incl. CSA GP.

12.5.2   Medium temperature limit

FMX21 + Pt100 (optional)

With external diameter of 22 mm (0.87 in) and 42 mm (1.65 in):
−20 to +70 ℃ (−4 to +158 ℉)

ℹ️ In hazardous area incl. CSA GP, the medium temperature limit is
−10 to +70 ℃ (+14 to +158 ℉).

With external diameter of 29 mm (1.14 in): 0 to +50 ℃ (+32 to +122 ℉)

ℹ️ The FMX21 may be operated in this temperature range. The specification values, such
as accuracy, may be exceeded.

12.6   Additional technical data

See Technical Information TI00431P.

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