Operating Instructions
iTEMP TMT162

Dual-input temperature field transmitter with
FOUNDATION Fieldbus™ protocol

Endress+Hauser

People for Process Automation

Table of contents

1 About this document

1.1 Function of document and how to use

1.1.1 Document function

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

1.1.2 Safety Instructions (XA)

When using in hazardous areas, the relevant national standards must be observed. Separate Ex-specific documentation is provided for measuring systems that are used in hazardous areas. This documentation is an integral part of these Operating Instructions. The installation specifications, connection data and safety instructions contained therein must be strictly observed! Make sure that you use the right Ex-specific documentation for the right device with approval for use in hazardous areas! The number of the specific Ex documentation (XA...) is provided on the nameplate. If the two numbers (on the Ex documentation and the nameplate) are identical, then you may use this Ex-specific documentation.

1.2 Symbols

1.2.1 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.

1.2.2 Electrical symbols

Symbol	Meaning
⎓	Direct current
∼	Alternating current
≂	Direct current and alternating current

Symbol	Meaning
⏚	**Ground connection** A grounded terminal which, as far as the operator is concerned, is grounded via a grounding system.
⏛	**Potential equalization connection (PE: protective earth)** Ground terminals that must be connected to ground prior to establishing any other connections. The ground terminals are located on the interior and exterior of the device: • Interior ground terminal: potential equalization is connected to the supply network. • Exterior ground terminal: device is connected to the plant grounding system.

1.2.3 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

1.2.4 Tool symbols

Symbol	Meaning
A0011220	Flat-blade screwdriver
A0011219	Phillips screwdriver
A0011221	Allen key
A0011222	Open-ended wrench
A0013442	Torx screwdriver

1.3   Documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

1.3.1   Document function

The following documentation may be available depending on the version ordered:

Document type	Purpose and content of the document
Technical Information (TI)	**Planning aid for your device** 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.
Brief Operating Instructions (KA)	**Guide that takes you quickly to the 1st measured value** The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.
Operating Instructions (BA)	**Your reference document** The Operating Instructions contain all the information that is required in the 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.
Description of Device Parameters (GP)	**Reference for your parameters** The document provides a detailed explanation of each individual parameter. The description is aimed at those who work with the device over the entire life cycle and perform specific configurations.
Safety Instructions (XA)	Depending on the approval, safety instructions for electrical equipment in hazardous areas are also supplied with the device. The Safety Instructions are an integral part of the Operating Instructions. Information on the Safety Instructions (XA) relevant to the device is provided on the nameplate.
Supplementary device-dependent documentation (SD/FY)	Always comply strictly with the instructions in the relevant supplementary documentation. The supplementary documentation is an integral part of the device documentation.

1.4   Registered trademarks

FOUNDATION™ Fieldbus
Registered trademark of the Fieldbus Foundation, Austin Texas, USA

2   Safety instructions

2.1   Requirements for the personnel

NOTICE

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 manuals and supplementary documentation as well as in the certificates (depending on the application)
▶ Follow instructions and comply with basic conditions

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

2.2   Intended use

The device is a universal and configurable temperature field transmitter with either one or two temperature sensor inputs for resistance thermometers (RTD), thermocouples (TC) and resistance and voltage transmitters. The device is designed for mounting in the field.

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

2.3   Workplace safety

When working on and with the device:
▶ Wear the required personal protective equipment as per national regulations.

2.4   Operational safety

• Operate the device only if it is in proper technical condition, free from errors and faults.
• The operator is responsible for the interference-free operation of the device.

Power supply
▶ The device must only be powered by a 11.5 to 42 V_{DC} voltage supply according to NEC class 02 (low voltage/current) with short circuit power limitation to 8 A/150 VA.

Modifications to the device

Unauthorized modifications to the device are not permitted and can lead to unforeseeable dangers:
▶ If modifications are nevertheless required, consult with Endress+Hauser.

Repair

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

Hazardous area

To eliminate a danger for persons or for the facility when the device is used in the hazardous area (e.g. explosion protection or safety equipment):
▶ Based on the technical data on the nameplate, check whether the ordered device is permitted for the intended use in the hazardous area. The nameplate can be found on the side of the transmitter housing.
▶ Observe the specifications in the separate supplementary documentation included as an integral part of these instructions.

Electromagnetic compatibility

The measuring system complies with the general safety requirements as per EN 61010-1, the EMC requirements as per the IEC/EN 61326 series and the NAMUR recommendations NE 21 and NE 89.

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 EU directives listed in the device-specific EU Declaration of Conformity. The manufacturer confirms this by affixing the CE mark to the device.

2.6 IT security

Our warranty is valid only if the product is installed and used as described in the Operating Instructions. The product is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the product and associated data transfer, must be implemented by the operators themselves in line with their security standards.

3 Incoming acceptance and product identification

3.1 Incoming acceptance

Proceed as follows on receipt of the device:

1. Check whether the packaging is intact.

2. If damage is discovered:
   Report all damage immediately to the manufacturer.

3. Do not install damaged components, as the manufacturer cannot otherwise guarantee the material resistance or compliance with the original safety requirements, and can also not be held responsible for the consequences that may result.

4. Compare the scope of delivery against the contents of your order.

5. Remove all the packaging material used for transportation.

6. Do the data on the nameplate match the ordering information on the delivery note?

        Endress+Hauser

7. Are the technical documentation and all other necessary documents provided, e.g. certificates?

🛈 If one of the conditions is not satisfied, contact your Sales Center.

3.2 Product identification

The device can be identified in the following ways:
- Nameplate specifications
- Enter the serial number from the nameplate in the *Device Viewer* (www.endress.com/deviceviewer): all data relating to the device and an overview of the Technical Documentation supplied with the device are displayed.
- Enter the serial number on the nameplate into the *Endress+Hauser Operations App* or scan the 2-D matrix code (QR code) on the nameplate with the *Endress+Hauser Operations App*: all the information about the device and the technical documentation pertaining to the device is displayed.

3.2.1 Nameplate

The right device?

The nameplate provides you with the following information on the device:
- Manufacturer identification, device designation
- Order code
- Extended order code
- Serial number
- Tag name (TAG)
- Technical values: supply voltage, current consumption, ambient temperature, communication-specific data (optional)
- Degree of protection
- Approvals with symbols

▶ Compare the information on the nameplate with the order.

3.2.2 Name and address of manufacturer

Name of manufacturer:	Endress+Hauser Wetzer GmbH + Co. KG
Address of manufacturer:	Obere Wank 1, D-87484 Nesselwang or www.endress.com

3.3 Certificates and approvals

🛈 For certificates and approvals valid for the device: see the data on the nameplate

🛈 Approval-related data and documents: www.endress.com/deviceviewer → (enter the serial number)

3.3.1 Device certification FOUNDATION Fieldbus

The temperature field transmitter has successfully passed all the test procedures implemented and has been certified and registered by the Fieldbus FOUNDATION. The device thus meets all the requirements of the following specifications:
- Certified to fieldbus specification, revision status 6.1.2
- Device certification number: IT099000
- The device meets all the specifications of FOUNDATION Fieldbus-H1 (www.fieldbus.org)
- The device can also be operated with certified devices of other manufacturers (interoperability)

3.4 Storage and transport

Storage temperature	Without display –40 to +100 ℃ (–40 to +212 ℉)
	With display –40 to +80 ℃ (–40 to +176 ℉)

Maximum relative humidity: < 95 % as per IEC 60068-2-30

ℹ️ Pack the device for storage and transportation in such a way that it is reliably protected against impact and external influences. The original packaging provides the best protection.

Avoid the following environmental influences during storage:
• Direct sunlight
• Proximity to hot objects
• Mechanical vibration
• Aggressive media

4   Mounting

If stable sensors are used, the device can be fitted directly to the sensor. For remote mounting to a wall or stand pipe, two mounting brackets are available. The illuminated display can be mounted in four different positions.

4.1   Mounting requirements

4.1.1   Dimensions

The dimensions of the device are provided in the "Technical data" section.

4.1.2   Installation point

Information about the conditions (such as the ambient temperature, degree of protection, climate class etc.) that must be present at the installation point so that the device can be mounted correctly is provided in the "Technical data" section .

For use in hazardous areas, the limit values specified on the certificates and approvals must be observed (see Ex Safety Instructions).

4.2   Mounting the transmitter

NOTICE

Do not over-tighten the mounting screws, as this could damage the field transmitter.
▶   Maximum torque = 6 Nm (4.43 lbf ft)

4.2.1   Direct sensor mounting

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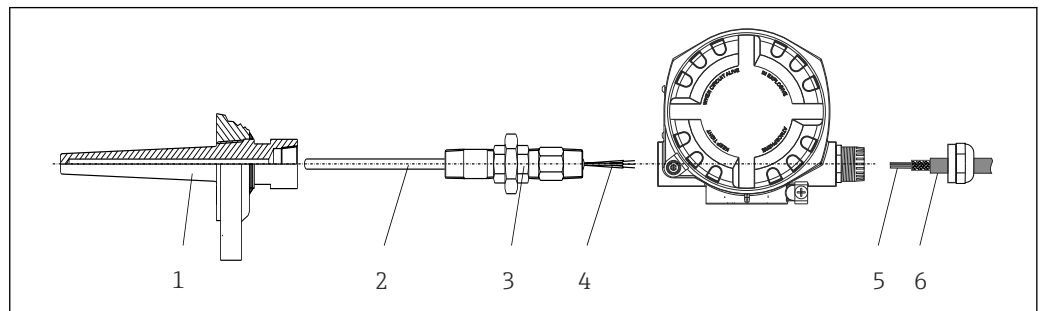
🖾 *1   Direct field transmitter mounting on sensor*

1   Thermowell
2   Insert
3   Neck tube nipple and adapter
4   Sensor cables
5   Fieldbus cables
6   Fieldbus shielded cable

1. Mount the thermowell and screw down (1).

2. Screw the insert with the neck tube nipple and adapter into the transmitter (2). Seal the nipple and adapter thread with silicone tape.

3. Connect the sensor cables (4) to the terminals for the sensors, see the terminal assignment.

4. Fit the field transmitter with the insert on the thermowell (1).

5. Mount the fieldbus shielded cable or fieldbus connector (6) on the other cable gland.

6. Guide the fieldbus cables (5) through the cable gland of the fieldbus transmitter housing into the connection compartment.

7. Screw the cable gland tight as described in the *Ensuring the degree of protection* section→ 🖹 20. The cable gland must meet explosion protection requirements.

4.2.2 Remote mounting
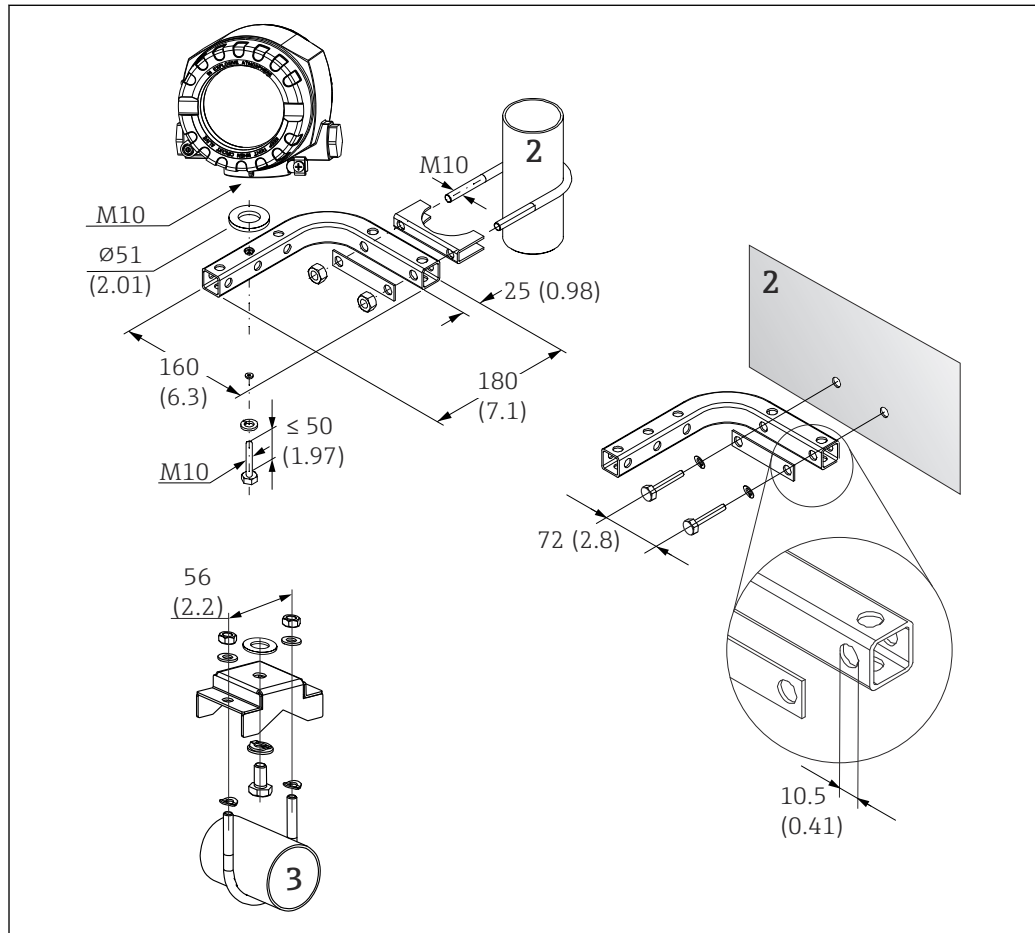
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🖼 *2   Installation of the field transmitter using the mounting bracket, see 'Accessories' section. Dimensions in mm (in)*

2   Combined wall/pipe mounting bracket 2", L-shaped, material 304
3   Pipe mounting bracket 2", U-shaped, material 316L

4.3   Display mounting

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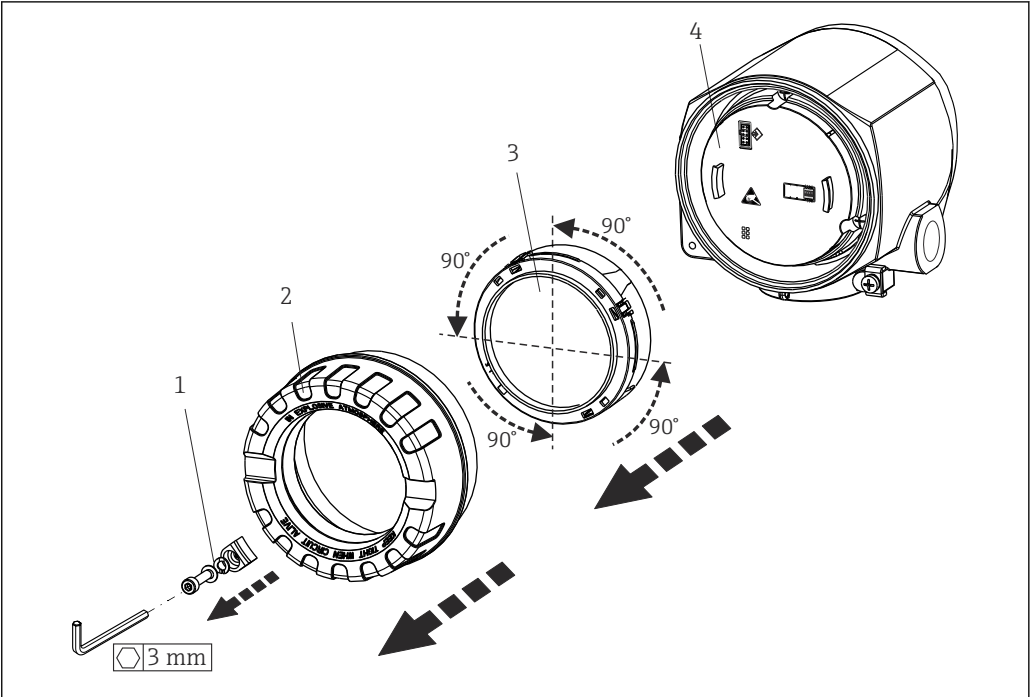
⊞ 3   *4 display installation positions, attachable in 90° stages*

1   Cover clamp
2   Housing cover with O-ring
3   Display with retainer and twist protection
4   Electronics module

1.   Remove the cover clamp (1).

2.   Unscrew the housing cover together with the O-ring (2).

3.   Remove the display with twist protection (3) from the electronics module (4). Fit the display with retainer in the desired position in 90° stages and plug it into the correct slot on the electronics module.

4.   Clean the thread in the housing cover and housing base and lubricate if necessary. (Recommended lubricant: Klüber Syntheso Glep 1)

5.   Then screw the housing cover together with the O-ring.

6.   Fit the cover clamp (1) back on.

4.4   Post-mounting check

After installing the device, always perform the following checks:

Device condition and specifications	Notes
Is the device undamaged (visual inspection)?	-
Do the ambient conditions match the device specification (e.g. ambient temperature, measuring range, etc.)?	

5 Electrical connection

5.1 Connecting requirements

⚠ CAUTION

The electronics could be destroyed

▶ Switch off power supply before installing or connecting the device. Failure to observe this may result in the destruction of parts of the electronics.

▶ When connecting Ex-certified devices, please take special note of the instructions and connection schematics in the Ex-specific supplement to these Operating Instructions. Contact the supplier if you have any questions.

A Phillips head screwdriver is required to wire the field transmitter at the terminals.

NOTICE

Do not over-tighten the screw terminals, as this could damage the transmitter.

▶ Maximum torque = 1 Nm ($\frac{3}{4}$ lbf ft).

Proceed as follows to wire the device:

1. Remove the cover clamp. → ☒ 3, 🕮 13

2. Unscrew the housing cover on the connection compartment together with the O-ring → ☒ 3, 🕮 13. The connection compartment is opposite the electronics module.

3. Open the cable glands of the device.

4. Route the appropriate connecting cables through the openings of the cable glands.

5. Wire the cables in accordance with → ☒ 4, 🕮 16 and as described in the sections: "Connecting the sensor" → 🕮 16 and "Connecting the measuring device" → 🕮 18.

6. On completion of the wiring, screw the screw terminals tight. Tighten the cable glands again. Refer to the information provided in the 'Ensuring the degree of protection' section.

7. Clean the thread in the housing cover and housing base and lubricate if necessary. (Recommended lubricant: Klüber Syntheso Glep 1)

8. Screw the housing cover tight again and fit the cover clamp back on. → 🕮 13

In order to avoid connection errors always follow the instructions in the post-connection check section before commissioning!

5.1.1 Fieldbus cable specifications

Cable type

Twin-core cables are required for connecting the device to the FOUNDATION Fieldbus H1. Following IEC 61158-2 (MBP), four different cable types (A, B, C, D) can be used with the FOUNDATION Fieldbus, only two of which (cable types A and B) are shielded.

- Cable types A or B are particularly preferable for new installations. Only these types have cable shielding that guarantees adequate protection from electromagnetic interference and thus the most reliable data transfer. In the case of cable type B, several fieldbuses (same degree of protection) may be operated in one cable. No other circuits are permissible in the same cable.
- Practical experience has shown that cable types C and D should not be used due to the lack of shielding, since the freedom from interference generally does not meet the requirements described in the standard.

	Type A	Type B
Cable structure	Twisted pair, shielded	One or more twisted pairs, fully shielded
Wire cross-section	0.8 mm² (AWG 18)	0.32 mm² (AWG 22)
Loop-resistance (direct current)	44 Ω/km	112 Ω/km
Characteristic impedance at 31.25 kHz	100 Ω ± 20%	100 Ω ± 30%
Attenuation constant at 39 kHz	3 dB/km	5 dB/km
Capacitive asymmetry	2 nF/km	2 nF/km
Envelope delay distortion (7.9 to 39 kHz)	1.7 ms/km	[1]
Shield coverage	90%	[1]
Max. cable length (incl. APL spurs >1 m)	1900 m	1200 m

1)   Not specified

Suitable fieldbus cables (type A) from various manufacturers for non-hazardous areas are listed below:
- Siemens: 6XV1 830-5BH10
- Belden: 3076F
- Kerpen: CeL-PE/OSCR/PVC/FRLA FB-02YS(ST)YFL

Maximum overall cable length

The maximum network expansion depends on the type of protection and the cable specifications. The overall cable length combines the length of the main cable and the length of all APL spurs (>1 m). Note the following points:
- The maximum permissible overall cable length depends on the cable type used.
- If repeaters are used, the maximum permissible cable length is doubled.

A maximum of three repeaters is permitted between the user and the master.

Maximum APL spur length

The line between the distribution box and field device is described as an APL spur. In the case of non-Ex applications, the max. length of an APL spur depends on the number of APL spurs (>1 m):

Number of APL spurs	1 to 12	13 to 14	15 to 18	19 to 24	25 to 32
Max. length per APL spur	120 m (394 ft)	90 m (295 ft)	60 m (197 ft)	30 m (98 ft)	1 m (3.28 ft)

Number of field devices

In accordance with IEC 61158-2 (MBP), a maximum of 32 field devices can be connected per fieldbus segment. However, this number is restricted under certain conditions (explosion protection, bus power option, field device current consumption). A maximum of four field devices can be connected to an APL spur.

Shielding and grounding

Optimum electromagnetic compatibility of the fieldbus system can only be guaranteed if the system components and, in particular, the lines are shielded and the shield forms as complete a cover as possible. A shield coverage of 90% is ideal. To ensure an optimum shield effect, connect the shield as often as possible to the reference ground. Where applicable, national installation regulations and guidelines must be observed! Where there are large differences in potential between the individual grounding points, only one point of the shielding is connected directly with the reference ground. In systems without potential equalization, therefore, cable shielding of fieldbus systems should only be grounded on one side, for example at the fieldbus supply unit or at safety barriers.

NOTICE

Damage to the fieldbus cable or fieldbus shield

▸ If the shielding of the cable is grounded at more than one point in systems without potential matching, power supply frequency equalizing currents can occur that damage the bus cable or shielding or have a serious effect on signal transmission.

Bus termination

The start and end of each fieldbus segment must always be terminated by a bus terminator. With various junction boxes (non-Ex), the bus termination can be activated via a switch. If this is not the case, a separate bus terminator must be installed.

Please note the following:
- In the case of a branched bus segment, the device furthest from the segment coupler represents the end of the bus.
- If the fieldbus is extended with a repeater, the extension must also be terminated at both ends.

🛈 Further information

General information and further information on wiring can be found on the website (www.fieldbus.org) of the Fieldbus Foundation.

5.2   Connecting the sensor

NOTICE

▸ ⚠ ESD - Electrostatic discharge. Protect the terminals from electrostatic discharge. Failure to observe this may result in the destruction or malfunction of parts of the electronics.

Terminal assignment

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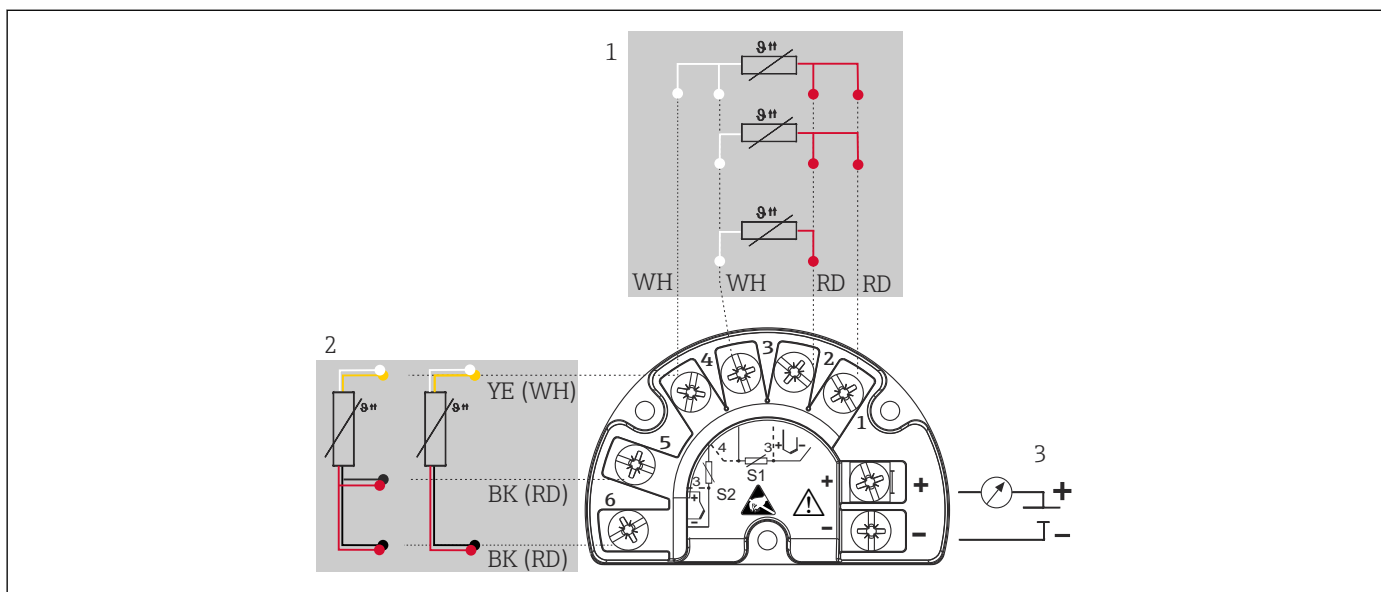
🔲 4   *Wiring of the field transmitter, RTD, dual sensor input*

1   Sensor input 1, RTD, : 2-, 3- and 4-wire
2   Sensor input 2, RTD: 2-, 3-wire
3   Field transmitter power supply and analog output 4 to 20 mA or fieldbus connection

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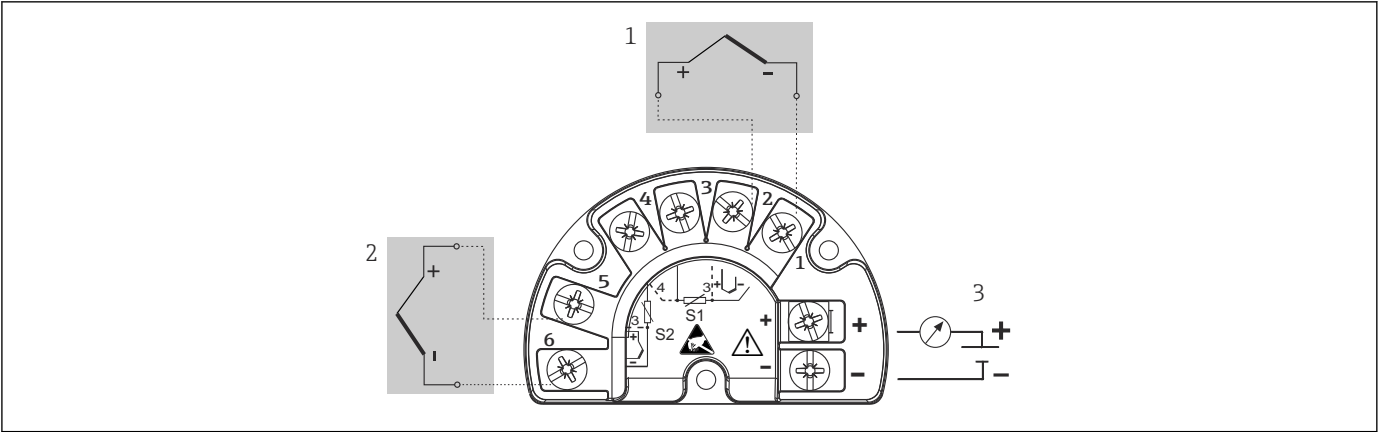
🖼 5   *Wiring of the field transmitter, TC, dual sensor input*

1   Sensor input 1, TC
2   Sensor input 2, TC
3   Field transmitter power supply and analog output 4 to 20 mA or fieldbus connection

> **NOTICE**
>
> **When connecting 2 sensors ensure that there is no galvanic connection between the sensors (e.g. caused by sensor elements that are not isolated from the thermowell). The resulting equalizing currents distort the measurements considerably.**
>
> ▶ The sensors must remain galvanically isolated from one another by connecting each sensor separately to a transmitter. The transmitter provides sufficient galvanic isolation (> 2 kV AC) between the input and output.

The following connection combinations are possible when both sensor inputs are assigned:

		Sensor input 1			
		RTD or resistance transmitter, 2-wire	RTD or resistance transmitter, 3-wire	RTD or resistance transmitter, 4-wire	Thermocouple (TC), voltage transmitter
Sensor input 2	RTD or resistance transmitter, 2-wire	☐	☐	-	☐
	RTD or resistance transmitter, 3-wire	☐	☐	-	☐
	RTD or resistance transmitter, 4-wire	-	-	-	-
	Thermocouple (TC), voltage transmitter	☐	☐	☐	☐

5.3   Connecting the measuring device

5.3.1   Cable gland or cable entry

⚠ **CAUTION**

Risk of damage

▸ Switch off power supply before installing or connecting the device. Failure to observe this may result in the destruction of parts of the electronics.

▸ If the device has not been grounded as a result of the housing being installed, we recommended grounding it via one of the ground screws. Observe the grounding concept of the plant! Keep the cable shield between the stripped fieldbus cable and the ground terminal as short as possible! Connection of the functional grounding may be needed for functional purposes. Compliance with the electrical codes of individual countries is mandatory.

▸ If the shielding of the fieldbus cable is grounded at more than one point in systems without additional potential matching, mains frequency equalizing currents can occur that damage the cable or the shielding. In such cases, the shielding of the fieldbus cable is to be grounded on one side only, i.e. it must not be connected to the ground terminal of the housing. The shield that is not connected should be insulated!

▸ We recommend that the fieldbus not be looped using conventional cable glands. If you later replace even just one device, the bus communication will have to be interrupted.

🛈 • The terminals for the fieldbus connection have integrated reverse polarity protection.
   • Cable cross-section: max. 2.5 mm²
   • A shielded cable must be used for the connection.

Follow the general procedure. → 🔖 14.
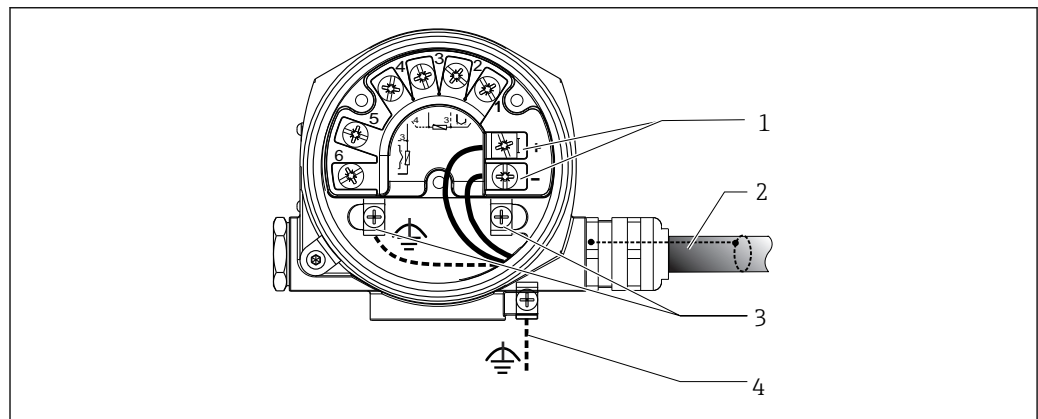
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🖼 *6*   *Connecting the device to the fieldbus cable*

1   Fieldbus terminals - fieldbus communication and power supply
2   Shielded fieldbus cable
3   Ground terminals, internal
4   Ground terminal (external, relevant for remote version)

5.3.2   Fieldbus connector

The connection technology of FOUNDATION Fieldbus allows devices to be connected to the fieldbus via uniform mechanical connections such as T-boxes, junction boxes etc. This

connection technology using prefabricated distribution modules and plug-in connectors offers substantial advantages over conventional wiring:

- Field devices can be removed, replaced or added at any time during normal operation. Communication is not interrupted.
- Installation and maintenance are significantly easier.
- Existing cable infrastructures can be used and expanded instantly, e.g. when constructing new star distributors using 4-channel or 8-channel distribution modules.

The device can therefore be supplied with the option of a fieldbus connector. If the transmitter has been ordered with the option of a fieldbus connector (order code → cable entry: position C and D), the fieldbus connector is ready mounted and wired upon delivery. Fieldbus connectors for retrofitting can be ordered from Endress+Hauser as an accessory.

Supply line/T-box shielding

Always use cable glands with good EMC properties, if possible with all-round contact of the cable shielding (Iris spring). This requires minimum differences in potential, and possibly potential equalization.

- The fieldbus cable shielding must be intact.
- The shielding connection must always be kept as short as possible.

Ideally, cable glands with Iris springs should be used to connect the shielding. The shielding is connected to the T-box housing by means of the Iris spring located inside the gland. The shielding braid is located under the Iris spring. When the armored thread is tightened, the Iris spring is pressed against the shielding, thereby creating a conductive connection between the shielding and the metal housing.

A terminal box or a plug-in connection must be considered part of the shielding (Faraday shield). This applies, in particular, to remote boxes if these are connected to a FOUNDATION Fieldbus device by means of a pluggable cable. In such a case, a metal connector must be used whereby the cable shielding is positioned at the connector housing (e.g. prefabricated cables).

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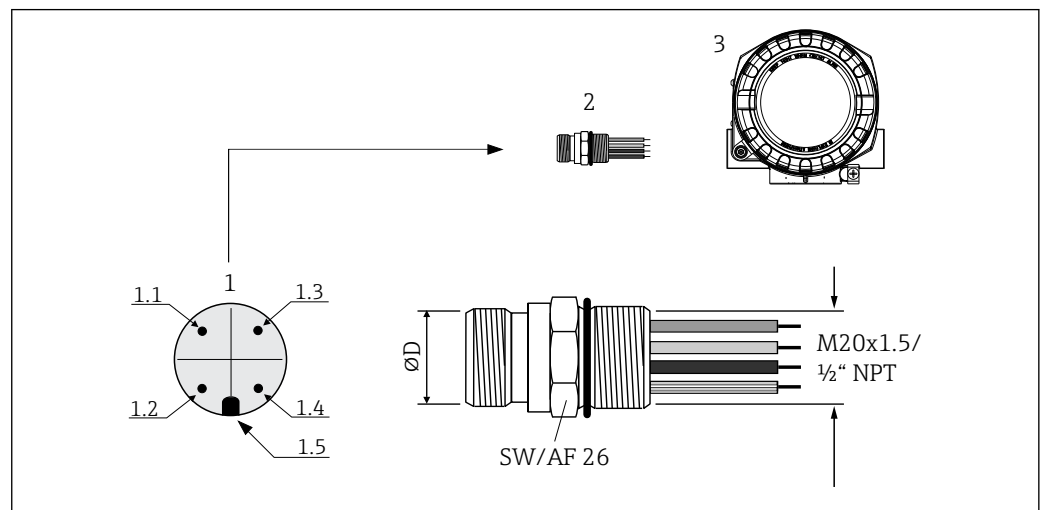
🖾 7   Connectors for connecting to the FOUNDATION Fieldbus

1   Connector on housing (male - pin assignment/color codes):
1.1   Blue wire: FF- (terminal 2)
1.2   Brown wire FF+ (terminal 2)
1.3   Gray wire: shield
1.4   Green-yellow wire: ground
1.5   Positioning key
2   7/8" UNC thread
3   Fieldbus connector
4   Field housing

Connector technical data:

Wire cross-section	4 x 0.8 mm²
Connection thread	M20 x 1.5 / ½" NPT
Degree of protection	IP 67 according to DIN 40 050 IEC 529
Contact plating	CuZn, gold-plated
Housing material	1.4401 (316)
Flammability	V - 2 according to UL - 94
Ambient temperature	−40 to +105 ℃ (−40 to +221 ℉)
Current carrying capacity	9 A
Rated voltage	Max. 600 V
Contact resistance	≤ 5 mΩ
Insulation resistance	≥ 10^9 Ω

5.4 Ensuring the degree of protection

The device meets all the requirements of IP66/IP67 protection. Compliance with the following points is mandatory following installation in the field or servicing in order to ensure that IP66/IP67 protection is maintained:

- The housing seals must be clean and undamaged when inserted into their grooves. The seals must be dried, cleaned or replaced if necessary.
- All housing screws and screw caps must be firmly tightened.
- The connecting cables used must have the specified external diameter (e.g. M20x1.5, cable diameter 8 to 12 mm).
- Firmly tighten the cable gland. → ▣ 8, 🕮 20
- The cables must loop down before they enter the cable glands ("water trap"). This means that any moisture that may form cannot enter the gland. Install the device so that the cable glands are not facing upwards. → ▣ 8, 🕮 20
- Replace unused cable glands with dummy plugs.
- Do not remove the grommet from the cable gland.
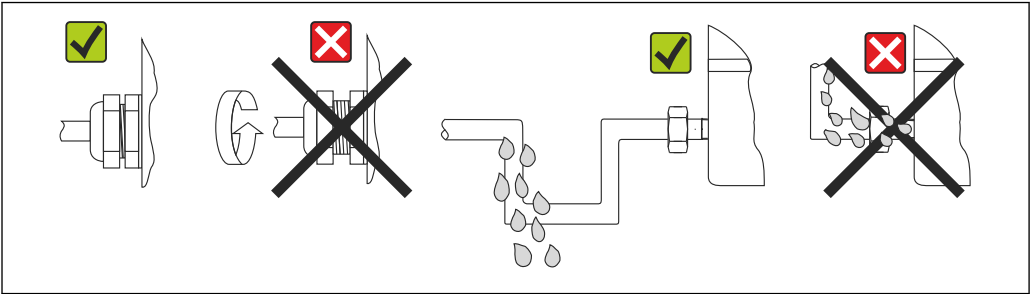
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▣ *8   Connection tips to retain IP66/IP67 protection*

5.5 Post-connection check

Device condition and specifications	Notes
Are the device and cables undamaged (visual check)?	--
Electrical connection	**Notes**
Does the supply voltage match the information on the nameplate?	9 to 32 V_{DC}
Do the cables used meet the necessary specifications?	Fieldbus cable → 🕮 16 Sensor cables → 🕮 16

Device condition and specifications	Notes
Are the mounted cables relieved of tension?	--
Are the power supply and fieldbus cables correctly connected?	See the wiring diagram inside the cover of the terminal compartment
Are all screw terminals well tightened?	--
Are all cable glands installed, securely tightened and leak-tight? Cable run with "water trap"?	→ 🖹 20
Are all housing covers installed and securely tightened?	--
Electrical connection of the fieldbus system	**Notes**
Are all the connecting components (T-boxes, junction boxes, connectors, etc.) connected with each other correctly?	--
Has each fieldbus segment been terminated at both ends with a bus terminator?	--
Does the max. length of the fieldbus cable comply with the fieldbus specifications?	Fieldbus cable, see specification
Has the max. length of the spurs been observed in accordance with the fieldbus specifications?	
Is the fieldbus cable fully shielded and correctly grounded?	

6   Operation options

6.1   Overview of operation options

Operators have a number of options for configuring and commissioning the device:

- **Configuration programs** → 🖺 24
  The configuration of FF functions and device-specific parameters is primarily done via the Fieldbus interface. Special configuration and operating programs are available from various manufacturers for this purpose.
- **Miniature switches (DIP switches) for various hardware settings** → 🖺 23
  You can make the following hardware settings for the FOUNDATION Fieldbus interface using miniature switches (DIP switches) on the electronics module:
  - Enabling/disabling the simulation mode in the Analog Input function block
  - Switching the hardware write protection on/off

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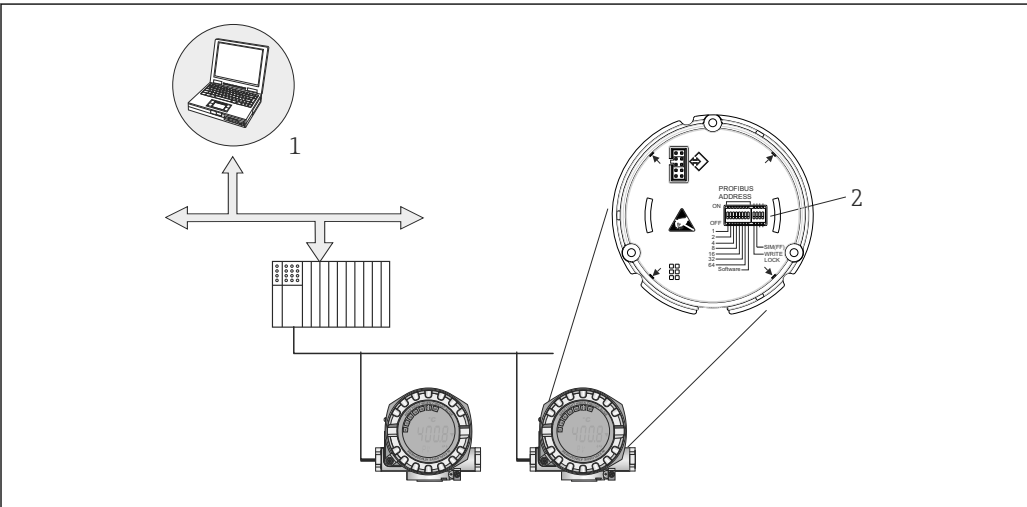
☒ *9   Device operating options via the FOUNDATION Fieldbus™ interface*

1   Configuration/operating programs for operation via FOUNDATION Fieldbus™ (Foundation Fieldbus functions, device parameter)
2   DIP switches for hardware settings (write protection, simulation mode)

6.1.1   Measured value display and operating elements

Display elements

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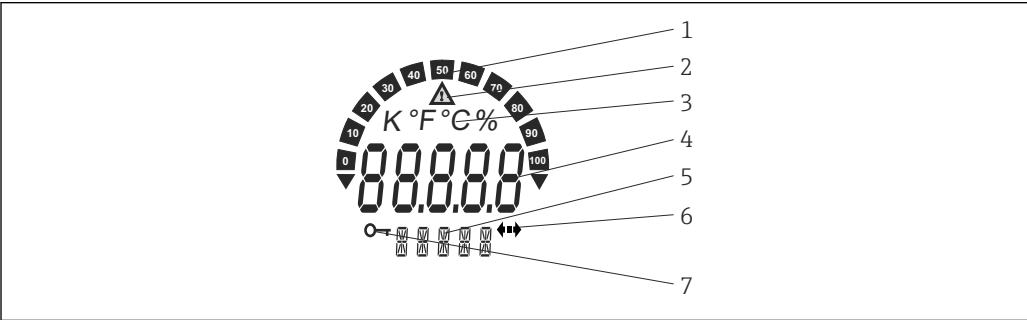
☒ *10   LC display of the field transmitter (illuminated, pluggable in 90° stages)*

Item no.	Function	Description
1	Bar graph display	In increments of 10% with indicators for underranging and overranging. The bar graph display flashes when an error occurs.
2	'Caution' symbol	This is displayed when an error or warning occurs.
3	Unit display K, ℉, ℃ or %	Unit display for the internal measured value displayed.
4	Measured value display, digit height 20.5 mm	Displays the current measured value. In the event of an error or warning, the corresponding diagnostics information is displayed. → 🖺 39
5	Status and information display	Indicates which value is currently shown on the display. Text can be entered for every value. In the event of an error or a warning, the sensor input that triggered the error/warning is also displayed where applicable, e.g. **SENS1**
6	'Communication' symbol	The communication symbol appears when bus communication is active.
7	'Configuration locked' symbol	The 'configuration locked' symbol appears when configuration is locked via the hardware

Local operation

NOTICE

▸ ⚠ ESD - Electrostatic discharge. Protect the terminals from electrostatic discharge. Failure to observe this may result in the destruction or malfunction of parts of the electronics.

Hardware write protection and the simulation mode (for Analog Input, Input Selector and PID function block) can be enabled or disabled by means of DIP switches on the electronics module. When write protection is active, parameters cannot be modified. A key symbol on the display indicates that the write protection is on. Write protection prevents any write access to the parameters. The current write protection status is displayed in the WRITE_LOCK parameter (Resource Block). → 🖺 60

1:	DIP switch 2 - write protection; simulation mode (prerequisite for the FOUNDATION Fieldbus™ simulation mode)
2:	No function for FOUNDATION™ Fieldbus communication (DIP switch for PROFIBUS® - device address)
3:	Display connection

🖳 11 *Hardware settings via DIP switches*
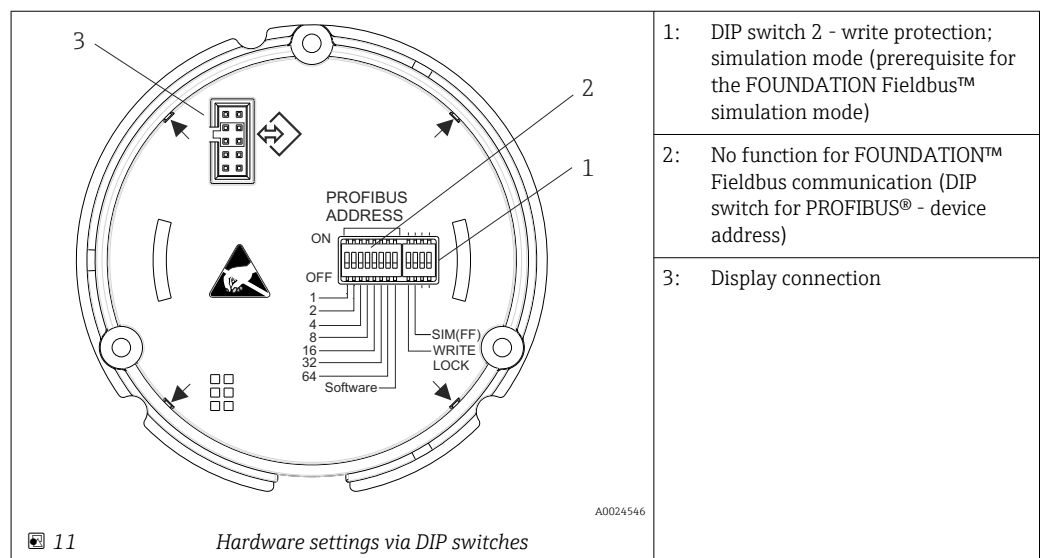
ℹ The simulation mode via the hardware setting has priority over the software setting.

Procedure for setting the DIP switch:

1. Remove the cover clamp.
2. Unscrew the housing cover together with the O-ring.

3. If necessary, remove the display with retainer from the electronics module.

4. Configure the hardware write protection **WRITE LOCK** and simulation mode **SIM(FF)** accordingly with the aid of the DIP switches. In general, the following applies: switch to ON = function enabled, switch to OFF = function disabled.

5. Reassembly is carried out in reverse order.

6.2 Access to the operating menu via the operating tool

System files
You require the following files for commissioning and configuring the network:
- Commissioning → DD (Device Description: *.sym, *.ffo, *sy5, *ff5)
- Network configuration → CFF file (Common File Format)

6.2.1 FieldCare

Range of functions

FDT/DTM-based plant asset management tool from Endress+Hauser. It can configure all smart field units in a system and helps you manage them. By using the status information, it is also a simple but effective way of checking their status and condition. Access is via the FOUNDATION Fieldbus™ protocol or CDI (= Endress+Hauser Common Data Interface).

Typical functions:
- Parameter configuration of transmitters
- Loading and saving of device data (upload/download)
- Documentation of the measuring point
- Visualization of the measured value memory (line recorder) and event logbook

For details, see Operating Instructions BA027S and BA059AS

Source for device description files

See information → 📖 26

User interface
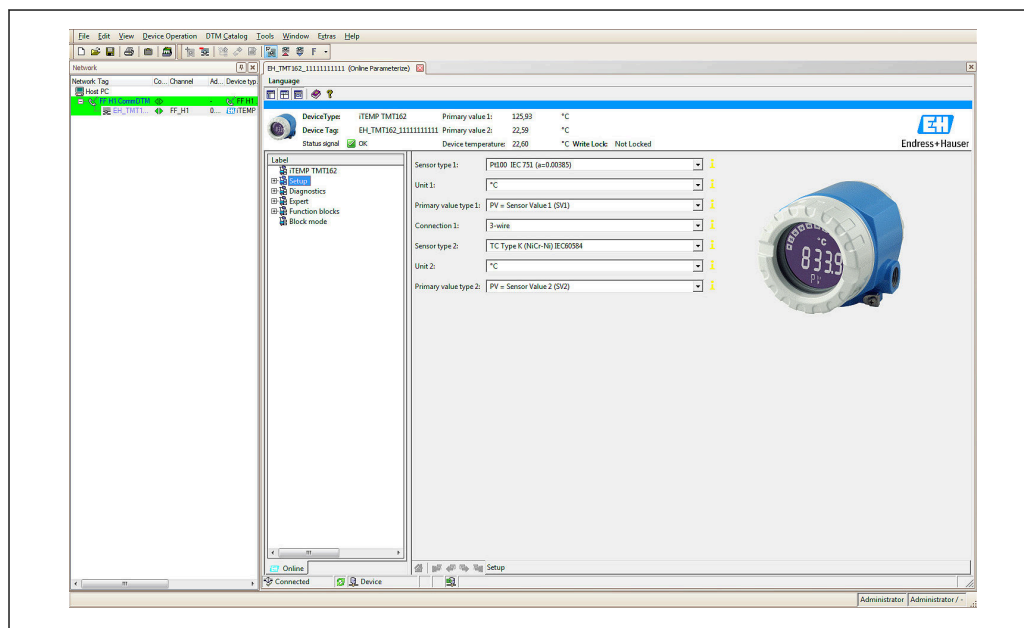
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6.2.2 DeviceCare

Range of functions

The fastest way to configure Endress+Hauser field devices is with the dedicated DeviceCare tool. DeviceCare's user-friendly design enables transparent and intuitive device connection and configuration. Intuitive menus and step-by-step instructions with status information ensure optimum transparency.

Quick and easy to install, connects devices in a single click (one-click connection). Automatic hardware identification and driver catalog update. The devices are configured using DTMs (Device Type Manager). Multilingual support, the tool is touch-enabled for tablet use. Hardware interfaces for modems : (USB/RS232), TCP/IP, USB and PCMCIA.

6.2.3 Field Xpert

Range of functions

Field Xpert is an industrial PDA with integrated touchscreen for commissioning and maintaining field devices in explosion hazardous and safe areas. It enables efficient configuration of FOUNDATION fieldbus, HART and WirelessHART devices. Communication is wireless via Bluetooth or WiFi interfaces.

6.2.4 Source for device description files

See information → 🖺 26.

7 System integration

Version data for the device

Firmware version	02.00.zz	• On the title page of the Operating Instructions • On the nameplate • **FIRMWARE_VERSION** parameter in the resource block.
Manufacturer ID	0x452B48	Manufacturer ID **(MANUFAC_ID)** parameter in the resource block.
Device type ID	0x10CC	Device type **(DEV_TYPE)** parameter in the resource block.
Interoperability Test Kit (ITK)	Revision status 6.1.2	---
Device revision	3	• On the transmitter nameplate • Device revision **(DEV_REV)** parameter in the resource block.

The suitable device description file for the individual operating tools is listed in the table below, along with information on where the file can be acquired.

Operating tools

Operating tool via FOUNDATION Fieldbus	Sources for obtaining device descriptions (DD/DTM)
FieldCare, DeviceCare, FieldXpert SMT70 (Endress+Hauser)	www.de.endress.com→ Downloads → Device driver: Enter type, product root and process communication
Control Builder, Field Device Manager (Honeywell)	www.de.endress.com→ Downloads → Device driver: Enter type, product root and process communication
Archestra (Schneider Invensys/Foxboro)	www.de.endress.com→ Downloads → Device driver: Enter type, product root and process communication

7.1 Overview of device description files

For commissioning, diagnostics, parameter configuration etc., it is important to ensure that process control systems or superior configuration systems can access all device data and have a uniform operating structure. The device-specific information required for this is stored as so-called device description data in special files (the 'Device Description'- DD). This makes it possible to interpret the device data and display the data via the configuration program. The DD is therefore a kind of "device driver". On the other hand, a CFF file (CFF = Common File Format) is required for network configuration in offline mode.

These files can be acquired as follows:
• Free via the Internet: www.endress.com
• Via the Fieldbus FOUNDATION organization: www.fieldbus.org

7.2 Integrating the measuring device in the system

7.2.1 FOUNDATION Fieldbus technology

The FOUNDATION Fieldbus™ (FF) is a purely digital, serial communication system that connects fieldbus devices (sensors, actuators), automation and process control systems with each other. As a local communications network (LAN) for field devices, the FF was

primarily designed for the requirements of process engineering. The FF is therefore the basic network in the overall hierarchy of a communication system.

For configuration information on the fieldbus, please refer to Operating Instructions BA 013S "FOUNDATION Fieldbus Overview: Installation and Commissioning Guidelines".

System architecture

The following graphic shows an example of a FOUNDATION Fieldbus™ network with the associated components.
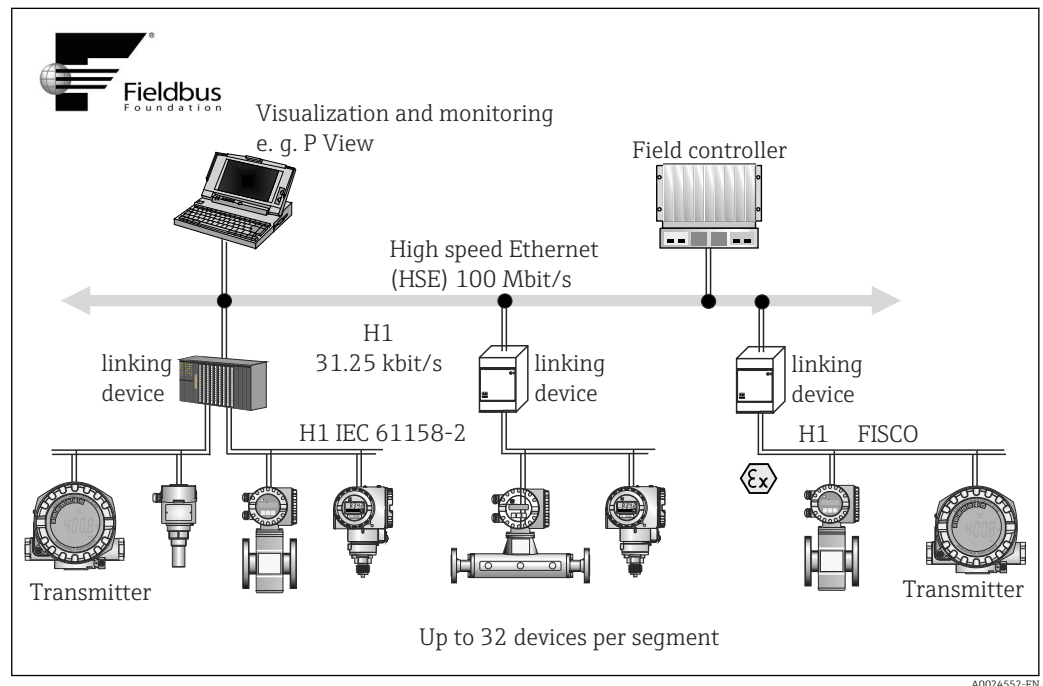
 12   *FOUNDATION Fieldbus™ system architecture with associated components (line structure)*

HSE   High Speed Ethernet
H1   FOUNDATION Fieldbus-H1

The following system connection options are possible:
- A linking device can be used to connect to higher-level fieldbus protocols (e.g. to the High Speed Ethernet - HSE).
- System inputs are directly available for H1 and H2 (HSE).
- A H1 connecting card is required for direct connection to a process control system.

The system architecture of the FOUNDATION Fieldbus™ can be divided into two subnetworks:

H1 bus system:

In the field, fieldbus devices are connected only via the slower H1 bus system that is specified following IEC 61158-2. The H1 bus system enables simultaneous power supply to the field devices and data transfer on the two-wire cable. The following points describe some important characteristics of the H1 bus system:
- All fieldbus devices are powered via the H1 bus. Like the fieldbus devices, the power supply unit is connected in parallel to the bus line. Devices requiring external power must use a separate power supply.
- The line structure is one of the most common network structures. Star, tree or mixed network structures are also possible using connecting components (junction boxes).
- The bus connection to the individual fieldbus devices is achieved by means of a T-connector or via an APL spur. This has the advantage that individual fieldbus devices can be connected or disconnected without interrupting the bus or the bus communication.

- The number of connected fieldbus devices depends on various factors, such as use in hazardous areas, the length of the spur, cable types, current consumption of the field devices, etc. → 🕮 14
- When fieldbus devices are used in a hazardous area, the H1 bus must be equipped with an intrinsically safe barrier before the transition to the hazardous area.
- A bus terminator is required at each end of the bus segment.

High Speed Ethernet (HSE):

The superior H2 bus system is implemented via the High Speed Ethernet (HSE) with a transmission rate of max. 100 MBit/s. This serves as the 'backbone' (basic network) between various local sub-networks and/or where there is a large number of network users.

Link Active Scheduler (LAS)

The FOUNDATION Fieldbus™ works according to the 'producer-consumer' relationship. This offers many advantages. Data can be directly exchanged between field devices, e.g. a sensor and an actuating valve. Each bus user "publishes" its data on the bus and all the bus users configured accordingly obtain these data. The publication of these data is controlled by a "bus administrator", known as the "Link Active Scheduler", which centrally controls the time sequence of the bus communication process. The LAS organizes all the bus activities and sends corresponding commands to the individual field devices.

Other tasks of the LAS include:
- Recognizing and reporting newly connected devices.
- Logging out devices that are no longer communicating with the fieldbus.
- Maintaining the "Live List". This list contains a record of all the fieldbus users and is checked regularly by the LAS. If devices are logged on or logged off, the "Live List" is updated and sent immediately to all the devices.
- Requesting process data from the field devices according to a fixed schedule.
- Allocating send rights (tokens) to devices between unscheduled data transfer.

The LAS can run redundantly, i.e. it exists both in the process control system and in the field device. If one LAS fails, the other LAS can accurately take over communication. Thanks to the precise timing of bus communication via the LAS, the FF can run exact processes at regular, equidistant intervals.

ℹ️ Fieldbus devices, such as this transmitter, which can take over the LAS function if the primary master fails, are called "Link masters". In contrast, 'Basic devices' can only receive signals and send them to the central process control system. The LAS functionality is deactivated in this device when the unit is delivered.

Data transfer

A distinction is made between two types of data transfer:
- **Scheduled data transfer (cyclic):** All time-critical data, i.e. continuous measurement or actuating signals, are transmitted and processed according to a fixed schedule.
- **Unscheduled data transfer (acyclic):** Device parameters and diagnostic information that are not time-critical for the process are only transmitted over the fieldbus when required. Data transmission only takes place in the intervals between cyclic (scheduled) communication.

Device ID, addressing

Each fieldbus device in the FF network is identified by a unique device ID (DEVICE_ID). The fieldbus host system (LAS) automatically gives the network address to the field device. The network address is the address that the fieldbus currently uses.

The FOUNDATION Fieldbus™ uses addresses between 0 and 255:
- Groups/DLL: 0 to 15
- Devices in operation: 20 to 35
- Reserve devices: 232 to 247
- Offline/substitute devices: 248 to 251

The tag name (PD_TAG) is assigned to the device during commissioning. The tag name remains stored in the device even in the event of a supply voltage failure.

Function blocks → ⮧ 79

The FOUNDATION Fieldbus™ uses predefined function blocks to describe the functions of a device and to specify uniform data access. The function blocks implemented in each fieldbus device provide information on the tasks that a device can perform in the overall automation strategy.

In the case of sensors, these are typically the following blocks:
• 'Analog Input' or
• 'Discrete Input' (digital input)

Actuating valves normally have the following function blocks:
• 'Analog Output' or
• 'Discrete Output' (digital output)

The following blocks are available for control tasks:
• PD controller or
• PID controller

Fieldbus-based process control

With FOUNDATION Fieldbus™, field devices can perform simple process control functions themselves and thereby reduce the workload on the superior process control system. Here, the Link Active Scheduler (LAS) coordinates data exchange between the sensor and controller and ensures that two field devices cannot access the bus simultaneously. For this purpose, configuration software, e.g. NI-FBUS Configurator from National Instruments, is used to connect the various function blocks to the desired control strategy (generally graphically).

Use as display unit in FOUNDATION Fieldbus™

With the aid of the 'Display' Transducer Block, the LC display of the device can be configured variably → ⮧ 77. In addition to the possibility of displaying measured values from the "Sensor 1 and 2" Transducer Blocks, process values of external devices that are integrated in the fieldbus can also be displayed (e.g. pressure, level and flow measuring devices). This functionality is of particular interest to devices that are mounted at points in the process that are difficult to access but whose measured values should still be displayed in the field.
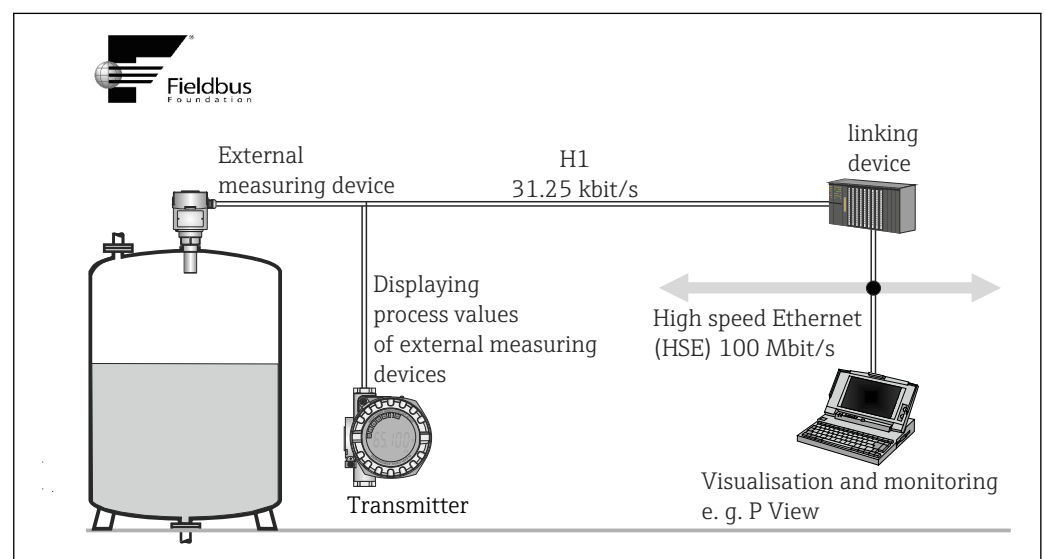
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⊞ 13   Displaying process values of external devices.

8   Commissioning

8.1   Function check

Before commissioning the measuring point, make sure that all final checks have been carried out:
- "Post-mounting check" checklist, → 🗎 13
- "Post-connection check" checklist, → 🗎 20

8.2   Switching on the device

Switch on the supply voltage after completing the final checks. The device is ready for operation after approx. 20 seconds! The transmitter performs a number of internal test functions after power-up. As this procedure progresses, the following sequence of messages appears on the local display:

Step	Display
1	All segments on
2	All segments off
3	Manufacturer data and device name are displayed
4	Current firmware version is displayed
5	Current device revision is displayed
6a	The current measured value is displayed. Bar graph displays the % value within the set bar graph range
6b	The current status message is displayed. If the switch-on procedure fails, the appropriate status message is displayed, depending on the cause. ℹ️ If the switch-on procedure is not successful, the relevant diagnostic event is displayed, depending on the cause. A detailed list of diagnostic events and the corresponding troubleshooting instructions can be found in the "Diagnostics and troubleshooting" section .

Normal measuring mode commences as soon as the switch-on procedure is completed. Various measured value and/or status variables appear on the display.

8.3   Commissioning

Note the following points:
- The files required for commissioning and network configuration can be obtained as described in the 'System integration' section. → 🗎 26
- In the case of the FOUNDATION™ Fieldbus, the device is identified in the host or configuration system by means of the device ID (DEVICE_ID). The DEVICE_ID is a combination of the manufacturer ID, device type and device serial number. It is unique and can never be assigned twice. The DEVICE_ID of the device is composed as follows: DEVICE_ID = 452B4810CC-XXXXXXXXXXX 452B48 = Endress+Hauser 10CC = TMT162 XXXXXXXXXXX = device serial number (11-digit)
- If you wish to configure the transmitter quickly but safely, configuration wizards can guide you through the menus and help you configure the most important parameters in the Transducer Blocks. For this, refer to the operating manual of your operating and configuration software.

Configuration wizards

Name	Block	Description
Quick Setup	Sensor Transducer	Configuration of the sensor input with the data relevant to the sensor.
	Display Transducer	Menu-guided configuration of the display unit.
Set to OOS mode	Resource, Sensor Transducer, Display Transducer, AdvDiagnostic Transducer, AI, PID and ISEL	Sets the block to the "**O**ut **O**f **S**ervice" mode.
Set to Auto mode	Resource, Sensor Transducer, Display Transducer, AdvDiagnostic Transducer, AI, PID and ISEL	Sets the block to the "Auto" mode.
Restart	Resource	Restarts the device with different options as to which particular parameters should be reset to the factory settings.
Sensor Drift Monitoring Configuration	AdvDiagnostic Transducer	Settings for drift or differential monitoring with 2 connected sensors.
Calc.wizard for 2-wire compensation value	Sensor Transducer	Calculation of the conductor resistance for 2-wire compensation.

Calibration wizards

Name	Block	Description
User Sensor Trim Configuration	Sensor Transducer	Menu guidance for linear scaling (offset + slope) for adapting the measuring point to the process. → ▤ 70
Factory Trim settings	Sensor Transducer	Resets scaling to the "Factory standard trim". → ▤ 72
RTD Platinum Configuration Call.-Van Dusen	Sensor Transducer	Entry of Callendar-Van-Dusen coefficients.
RTD Copper Configuration	Sensor Transducer	Entry of coefficients for nickel polynomial.
RTD Nickel Configuration	Sensor Transducer	Entry of coefficients for copper polynomial.

Initial commissioning

The following description takes you step-by-step through commissioning the device and all the necessary configurations for the FOUNDATION Fieldbus:

1. Switch on the device

2. Note the DEVICE_ID on the device nameplate

3. Open the configuration program

4. Load the device description files or the CFF file into the host system or the configuration program. Make sure you are using the right system files. → ▤ 26
   ↳ The first time you establish a connection, the device reacts as follows:
      EH_TMT162_ xxxxxxxxxxx (tag name PD-TAG)
      452B4810CC- xxxxxxxxxxx (DEVICE_ID)

Block structure:

Display text (xxx... = serial number)	Base index	Description
RS_xxxxxxxxxxx	400	Resource Block
TB_S1_xxxxxxxxxxx	500	Transducer Block temperature sensor 1
TB_S2_xxxxxxxxxxx	600	Transducer Block temperature sensor 2
TB_DISP_xxxxxxxxxxx	700	Transducer Block "Display" (local display)
TB_ADVDIAG_xxxxxxxxxxx	800	Transducer Block "Advanced Diagnostic"
AI_1_ xxxxxxxxxxx	900	Analog Input function block 1
AI_2_ xxxxxxxxxxx	1000	Analog Input function block 2
AI_3_ xxxxxxxxxxx	1100	Analog Input function block 3
PID_ xxxxxxxxxxx	1200	PID function block
ISEL_xxxxxxxxxxx	1300	Input Selector function block

The device is delivered from the factory with the bus address "247" and is therefore in the 232-247 address range which is reserved for reserve devices. A lower bus address should be assigned to the device for commissioning.

▶ Using the DEVICE_ID noted, identify the field device and assign the desired tag name (PD_TAG) to the fieldbus device in question. Factory setting: EH_TMT162_xxxxxxxxxxx (xxx... = serial number).

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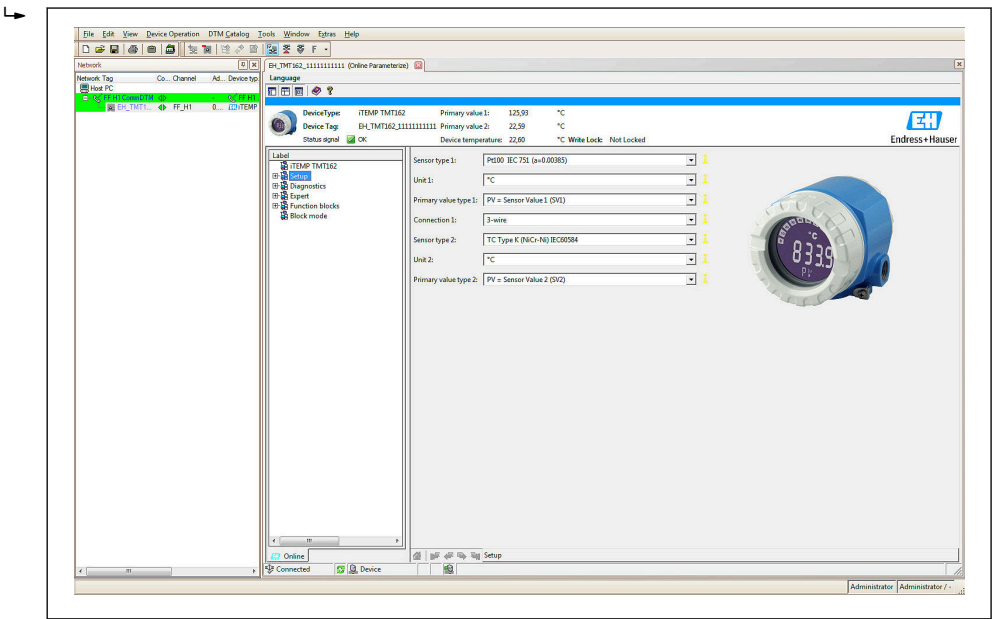
🖻 *14   Screen display in Endress+Hauser's FieldCare asset management system*

Configuring the "Resource Block" (base index 400)

1. Open the Resource Block.

2. When the device is delivered, the hardware write protection is disabled so the write parameters can be accessed via the FF. Check the status via the WRITE_LOCK parameter:
   ↳ – Write protection enabled = LOCKED
   – Write protection disabled = NOT LOCKED

3. Disable the write protection if necessary. → 🗏 23

4. Enter the desired name for the block (optional). Factory setting: RS_ xxxxxxxxxxx. Set the operating mode in the MODE_BLK parameter group (TARGET parameter) to AUTO.

Configuring the "Transducer Blocks"

The individual Transducer Blocks comprise various parameter groups arranged by device-specific functions:
- Temperature sensor 1 → Transducer Block "TB_S1_xxxxxxxxxxx" (base index: 500)
- Temperature sensor 2 → Transducer Block "TB_S2_xxxxxxxxxxx" (base index: 600)
- Local display functions → Transducer Block "TB_DISP_xxxxxxxxxxx" (base index: 700)
- Advanced diagnostics → Transducer Block "TB_ADVDIAG_xxxxxxxxxx" (base index: 800)

▸ Enter the desired name for the block (optional). For factory settings, see the table above. Set the operating mode in the MODE_BLK parameter group (TARGET parameter) to AUTO.

Configuring the "Analog Input function blocks"

The device has 2 x three Analog Input function blocks which can be assigned to the different process variables as desired. The following section describes an example for the Analog Input function block 1 (base index 900).

1. Enter the required name for the Analog Input function block (optional). Factory setting: AI_1_ xxxxxxxxxxx

2. Open Analog Input function block 1.

3. Set the operating mode in the MODE_BLK parameter group (TARGET parameter) to OOS, i.e. the block is out of service.

4. Use the CHANNEL parameter to select the process variable which should be used as the input value for the function block algorithm (scaling and limit value monitoring functions).
   ↳ The following settings are possible:
     CHANNEL → Uninitialized/Primary Value 1/Primary Value 2/Sensor Value 1/ Sensor Value 2/Device temperature

5. In the XD_SCALE parameter group, select the desired engineering unit which should be transmitted by means of the FOUNDATION Fieldbus interface, as well as the block input range for the process variable in question.

🛈 Make sure that the engineering unit selected suits the measured variable of the process variable chosen. Otherwise, the BLOCK_ERROR parameter displays the "Block Configuration Error" error message and the operating mode of the block cannot be set to AUTO.

▸ In the L_TYPE parameter, select the type of linearization for the input variable (direct, indirect, indirect sq. root).

🛈 Please note that if the "Direct" linearization type is selected, the settings in the OUT_SCALE parameter group are not taken into account. The engineering units selected in the XD_SCALE parameter group are decisive.

Use the following parameters to define the limit values for the alarm and warning messages:
- HI_HI_LIM → Limit value for the upper alarm
- HI_LIM → Limit value for the upper warning
- LO_LIM → Limit value for the lower warning
- LO_LO_LIM → Limit value for the lower alarm

1. The limit values entered must be within the value range specified in the OUT_SCALE parameter group.

2. In addition to the actual limit values, the behavior in the event of limit value overshoot must be specified by "alarm priorities" (HI_HI_PRI, HI_PRI, LO_PR, LO_LO_PRI parameters). → 🖹 75 Reporting to the fieldbus host system only occurs if the alarm priority is greater than 2. In addition to the settings for the alarm priorities, digital outputs can be defined for limit value monitoring. These outputs (HIHI_ALM_OUT_D, HI_ALM_OUT_D, LOLO_ALM_OUT_D, LO_ALM_OUT_D parameters) then switch from 0 to 1 when the specific limit value is exceeded. The general alarm output (ALM_OUT_D parameter) in which different alarms can be grouped must be configured appropriately via the ALM_OUT_D_MODE parameter. The behavior of the output in the event of an error must be configured in the parameter Fail Safe Type (FSAFE_TYPE) and if FSAFE_TYPE = "Fail Safe Value" is selected, the value to be output must be defined in the parameter Fail Safe Value (FSAFE_VALUE).

Alarm limit value:	HIHI_ALM_OUT_D	HI_ALM_OUT_D	LOLO_ALM_OUT_D	LO_ALM_OUT_D
PV ≥ HI_HI_LIM	1	x	x	x
PV < HI_HI_LIM	0	x	x	x
PV ≥ HI_LIM	x	1	x	x
PV < HI_LIM	x	0	x	x
PV > LO_LIM	x	x	0	x
PV ≤ LO_LIM	x	x	1	x
PV > LO_LO_LIM	x	x	x	0
PV ≤ LO_LO_LIM	x	x	x	1

System configuration/connecting function blocks

A final "overall system configuration" is necessary so that the operating mode of the Analog Input function block can be set to AUTO and the field device is integrated in the system application. For this purpose, configuration software, e.g. Endress+Hauser NI-FBUS Configurator from National Instruments, is used to connect the function blocks to the desired control strategy (mostly using graphic display) and then the time for processing the individual process control functions is specified.
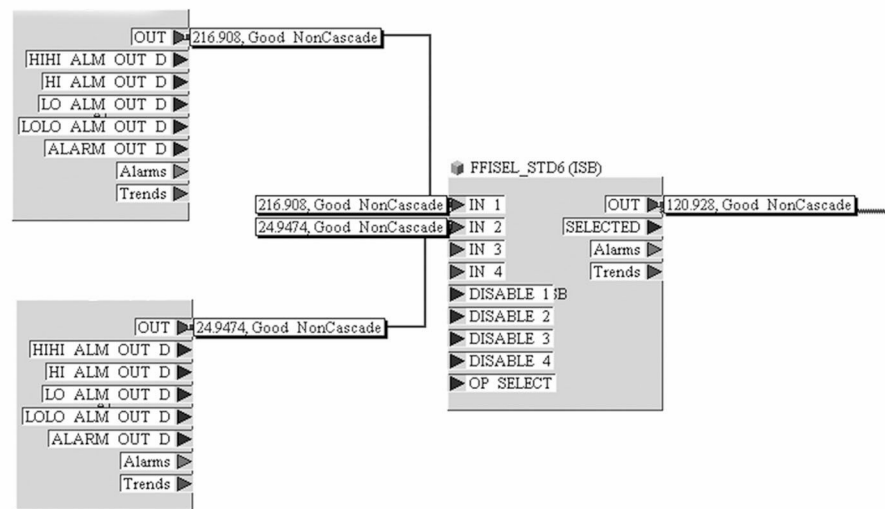
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⊠ *15   Connecting function blocks with the aid of the "NI-FBUS Configurator". Example: Averaging (output OUT in the Input Selector Block) of two temperature inputs (OUT in the Analog Input Blocks 1 and 2).*

1. Once you have specified the active LAS, download all the data and parameters to the field device.

2. – The function blocks are correctly connected to one another. The Resource Block is in the AUTO operating mode.

   Set the operating mode in the MODE_BLK parameter group (TARGET parameter) to AUTO.

8.4   Protecting settings from unauthorized access

If the device is locked against configuration, it must first be enabled via the hardware lock. The device is write-protected if the lock symbol is shown on the display.

To unlock, switch the write protection switch located on the electronics module to the "OFF" position (hardware write protection).

🛈 When hardware write protection is active (write protection switch set to the "ON" position), write protection cannot be disabled via the operating tool.

9   Diagnostics and troubleshooting

9.1   General troubleshooting

9.1.1   Troubleshooting instructions

Always start troubleshooting with the checklists below if faults occur after start up or during operation. The checklists take you directly (via various queries) to the cause of the problem and the appropriate remedial measures.

ℹ️ In the event of a serious fault, a device might have to be returned to the manufacturer for repair. Refer to the "Return" section before returning the device to Endress+Hauser. → 🖺 46

Check display (local display)	
No display visible - No connection to the FF host system.	1. Check the supply voltage → terminals + and - 2. Measuring electronics defective → order spare part, → 🖺 44
No display visible - However, connection has been established to the FF host system.	1. Check whether the display module retainers are correctly seated on the electronics module → 🖺 13 2. Display module defective → order spare part, → 🖺 44 3. Measuring electronics defective → order spare part, → 🖺 44

⊞

Local error messages on the display
→ 🖺 39

⊞

Faulty connection to the fieldbus host system	
No connection can be made between the fieldbus host system and the device. Check the following points:	
Fieldbus connection	Check data lines
Fieldbus connector (optional)	Check pin assignment/wiring. → 🖺 18
Fieldbus voltage	Check whether a min. bus voltage of 9 V DC is present at the +/- terminals. Permissible range: 9 to 32 V DC
Network structure	Check permissible fieldbus cable length and number of spurs. → 🖺 14
Basic current	Is there a basic current of min. 11 mA?
Terminating resistors	Has the FOUNDATION Fieldbus network been terminated correctly? Each bus segment must always be terminated with a bus terminator at both ends (start and finish). Otherwise there may be interference in communication.
Current consumption, permissible feed current	Has the FOUNDATION Fieldbus network been terminated correctly? Each bus segment must always be terminated with a bus terminator at both ends (start and finish). Otherwise there may be interference in communication.

⊞

Error messages in the FOUNDATION™ Fieldbus configuration program
→ 🖺 40

Problems when configuring function blocks	
Transducer Blocks: The operating mode cannot be set to AUTO.	Check whether the operating mode of the Resource Block is set to AUTO. → MODE_BLK parameter group/TARGET parameter. ℹ Make sure that the unit selected suits the process variable chosen in the SENSOR_TYPE parameter. Otherwise the BLOCK_ERROR parameter displays the "Block Configuration Error" error message. In this state, the operating mode cannot be set to AUTO.
Analog Input function block: The operating mode cannot be set to AUTO.	There can be several reasons for this. Check the following points one after another: • Check whether the operating mode of the Analog Input function block is set to AUTO: MODE_BLK parameter group/TARGET parameter. If not and the mode cannot be changed to AUTO, first check the following points. • Check the BLOCK_ERR parameter for a configuration error. In this case, read the BLOCK_ERR_DESC_1 parameter which contains the reason for the configuration error. • Make sure that the CHANNEL parameter (select process variable) has already been configured in the Analog Input function block. The option CHANNEL = 0 (uninitialized) is not valid. • Make sure that the XD_SCALE parameter group (input range, unit) has already been configured in the Analog Input function block. • Make sure that the L_TYPE parameter (linearization type) has already been configured in the Analog Input function block. • Check whether the operating mode of the Resource Block is set to AUTO. MODE_BLK parameter group/TARGET parameter. • Make sure that the function blocks are correctly connected together and that this system configuration has been sent to the fieldbus users. 📖 A detailed description of the Analog Input (AI) function block can be found in the FOUNDATION Fieldbus™ Function Blocks manual (BA00062S/04).
Analog Input function block: Although the operating mode is set to AUTO, the status of the AI output value OUT is "BAD" or "UNCERTAIN".	Check whether an error is pending in the Transducer Block "Advanced Diagnostic" → Transducer Block "Adv. Diagnostic" → "Actual Status Category" and 'Actual Status Number' parameters.
• Parameters cannot be changed or • No write access to parameters	→ Parameters that only show values or settings cannot be changed (these are read-only parameters)! → The hardware write protection is enabled. Disable the write protection. → 🖹 23 ℹ Via the WRITE_LOCK parameter in the Resource Block, you can check whether hardware write protection is enabled or disabled: LOCKED = write protection on (enabled) UNLOCKED = no write protection (disabled) → The block operating mode is set to the wrong mode. Certain parameters can only be modified in the OOS (out of service) or MAN (manual) mode. Set the measuring mode of the block to the required mode → MODE_BLK parameter group. → The value entered is outside the specified input range for the parameter in question: Enter a suitable value, increase the input range if necessary

Problems when configuring function blocks	
Transducer Blocks: The manufacturer-specific parameters are not visible.	The device description file (Device Description, DD) has not yet been loaded to the host system or the configuration program? Download the file to the configuration system. → 🕮 24
	ⓘ Make sure you are using the correct system files for integrating field devices into the host system. You can access version information in the transmitter using the following functions/ parameters: FOUNDATION Fieldbus interface: – Resource Block → DD_REV parameter **Example:** Display in the DEV_REV → 01 parameter Display in the DD_REV parameter → 01 Device description file (DD) required → 0101.sym/0101.ffo
Analog Input function block: The output value OUT is not updated despite a valid "GOOD" status.	Simulation is active → Deactivate simulation by means of the SIMULATE parameter group.

9.1.2 Corrosion detection

ⓘ Corrosion monitoring is only possible for RTDs with a 4-wire connection and thermocouples.

Sensor connection cable corrosion can lead to false measured value readings. Therefore the unit offers the possibility of recognizing any corrosion before a measured value is affected.

The corrosion setting is configured in the CORROSION_DETECTION parameter:
• Off: diagnostic event 041 sensor failure (default category: F) is output when the alarm limit is reached.
• On: diagnostic event 042 sensor corrosion (default category: M) is output before the alarm limit is reached. This allows preventative maintenance/troubleshooting to be performed. An alarm message is output as of the alarm limit.

Corrosion detection is configured via the field diagnostic parameters in the Transducer Block → 🕮 75. Depending on the configuration of diagnostic event 042 - "sensor corrosion", you configure which category is output in the event of corrosion. If corrosion detection is disabled, an F-041 error is output only after the alarm limit is reached. The following table describes how the device behaves in the as-delivered state when the resistance in a sensor connection cable changes, depending on whether on or off is displayed in the parameter.

RTD [1]	≤ 2 kΩ	2 kΩ ≤ x ≤ 3 kΩ	≥ 3 kΩ
off	-	No alarm	No alarm
on	-	WARNING (M042)	ALARM (F041)

1)   Pt100 = 100 Ω at 0 ℃/Pt1000 = 1000 Ω at 0 ℃

TC	≤ 10 kΩ	10 kΩ ≤ x ≤ 15 kΩ	≥ 15 kΩ
off	-	No alarm	No alarm
on	-	WARNING (M042)	ALARM (F041)

The sensor resistance can affect the resistance data in the table. If all the sensor connection cable resistances are increased at the same time, the values given in the table are halved. The corrosion detection system presumes that this is a slow process with a continuous increase in the resistance.

9.1.3 Application errors without messages

Application errors without status messages for RTD sensor connection

Error	Possible cause	Remedy
Measured value is incorrect/ inaccurate	Incorrect sensor orientation.	Install the sensor correctly.
	Heat conducted by sensor.	Observe the installed length of the sensor.
	Device programming is incorrect (number of wires).	Change the **Connection type** device function.
	Device programming is incorrect (scaling).	Change scaling.
	Incorrect RTD configured.	Change the **Sensor type** device function.
	Sensor connection.	Check that the sensor is connected correctly.
	The cable resistance of the sensor (2-wire) was not compensated.	Compensate the cable resistance.
	Offset incorrectly set.	Check offset.
	Sensor defective.	Check the sensor.
	RTD connected incorrectly.	Install the connecting cables correctly (terminal diagram).
	Incorrect programming.	Incorrect sensor type set in the **SENSOR_TYPE** device function. Select the right sensor type.
	Device defective.	Replace device

Application errors without status messages for TC sensor connection

Error	Possible cause	Remedy
Measured value is incorrect/ inaccurate	Incorrect sensor orientation.	Install the sensor correctly.
	Heat conducted by sensor.	Observe the installed length of the sensor.
	Device programming is incorrect (scaling).	Change scaling.
	Incorrect thermocouple type (TC) configured.	Change the **SENSOR_TYPE** device function.
	Incorrect reference junction set.	Set the correct reference junction.→ 🗎 72
	Interference via the thermocouple wire welded in the thermowell (interference voltage coupling).	Use a sensor where the thermocouple wire is not welded.
	Sensor is connected incorrectly.	Connect the sensor correctly as per the terminal diagram (polarity).
	Sensor defective.	Check sensor
	Incorrect programming.	Incorrect sensor type set in the **SENSOR_TYPE** device function. Change to the right sensor type.
	Device defective.	Replace device.

9.2 Diagnostic information on local display

The device displays warnings or alarms as status messages. If errors occur during commissioning or measuring operation, these errors are displayed immediately. This takes

place on the local display by means of the error message saved in the device and in the configuration program by means of the parameter in the Adv. Diagnostic Block. A distinction is made here between the following 4 status categories:

Status signals

Symbol	Event category	Meaning
F	Operating error	An operating error has occurred. The measured value is no longer valid.
C	Service mode	The device is in the service mode (e.g. during a simulation).
S	Out of specification	The device is being operated outside its technical specifications (e.g. during startup or cleaning processes).
M	Maintenance required	Maintenance is required. The measured value remains valid.

Diagnostic behavior

Alarm	The device cannot continue measuring with the "F" status message unless a backup sensor is configured, which provides a valid value → 🖹 68. If there is no valid measured value, the display indicates "- - -- -". The last measured value with the status 'BAD' is transmitted over the fieldbus. Alternating with the selected measured values, the status message 'F' plus the defined error number is shown on the display (7-segment display). Furthermore, the '△' symbol is permanently displayed. → 🖹 22
Warning	With "M", "C" and "S" status messages, the device tries to continue measuring (uncertain measurement!). Alternating with the selected measured values, the status message 'F' plus the defined error number (7-segment display) is shown on the display. Furthermore, the '△' symbol is permanently displayed. → 🖹 22

🛈 In both cases, the sensor which generates the status, e.g. "SENS1", "SENS2", is output on the 14-segment display. If nothing is displayed on the 14-segment display, the status message does not refer to a sensor but refers to the device itself.

Diagnostic event and event text: The fault can be identified by means of the diagnostic event. The event text helps you by providing information about the fault.

Diagnostic event		
Status signal	Event number	Event text
↓	↓	↓
Example **F**	042	**Sensor corroded**
	3-digit number	
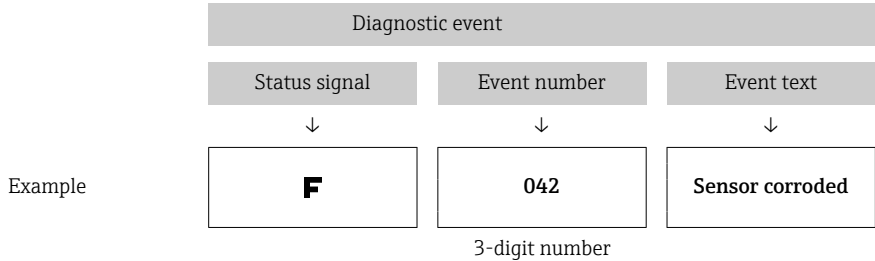
9.3 Overview of diagnostic information

Abbreviations for output variables:

SV1 = Sensor value 1

SV2 = Sensor value 2

PV1 = Primary value 1

PV2 = Primary value 2

DT = Device temperature

Default category	No.	Status messages – ACTUAL_STATUS_NUMBER in the 'Advanced Diagnostics' Transducer Block – Local display	Error messages in the Sensor Transducer Block in question	Sensor Transducer Block measured value status (default)	Cause of error / remedy	Output variables affected
F-	041	Device status message (FF): sensor cable open circuit F-041 Local display: F-041 ↔ measured value or '--------'	BLOCK_ERR = Other **I** Input Failure	QUALITY = BAD	Cause of error: 1. Electr. interruption of sensor or sensor wiring. 2. Incorrect setting for type of connection in the SENSOR_ CONNECTION parameter. Remedy: Re 1.) Reestablish electr. connection or replace sensor. Re 2.) Configure correct type of connection.	SV1, SV2, also PV1, PV2 depending on the configuration
			Transducer_Error = Mechanical failure	SUBSTATUS = Sensor failure		
M-	042	Device status message (FF): Sensor corrosion M-042 Local display: M-042 ↔ measured value	BLOCK_ERR = Other	QUALITY = UNCERTAIN (configurable)	Cause of error: Corrosion detected on the sensor terminals. Remedy: Check wiring and replace if necessary.	SV1, SV2, also PV1, PV2 depending on the configuration
			Transducer_Error = No error	SUBSTATUS = Sensor conversion not accurate		
F-	043	Device status message (FF): Sensor short-circuit F-043 Local display: F-043 ↔ measured value or '-------'	BLOCK_ERR = Other **I** Input Failure	QUALITY = BAD	Cause of error: Short circuit detected at the sensor terminals. Remedy: Check sensor and sensor wiring.	SV1, SV2, also PV1, PV2 depending on the configuration
			Transducer_Error = Mechanical failure	SUBSTATUS = Sensor failure		
M-	101	Device status message (FF): Sensor limit undershot M-101 Local display: M-101 ↔ measured value	BLOCK_ERR = Other	QUALITY = UNCERTAIN	Cause of error: Physical measuring range undershot. Remedy: Select suitable sensor type.	SV1, SV2, also PV1, PV2 depending on the configuration
			Transducer_Error = No error	SUBSTATUS = Sensor conversion not accurate		
M-	102	Device status message (FF): Sensor limit overshot M-102 Local display: M-102 ↔ measured value	BLOCK_ERR = Other	QUALITY = UNCERTAIN	Cause of error: Physical measuring range overshot. Remedy: Select suitable sensor type.	SV1, SV2, also PV1, PV2 depending on the configuration
			Transducer_Error = No error	SUBSTATUS = Sensor conversion not accurate		
M-	103	Device status message (FF): Sensor drift/difference M-103 Local display: M-103 ↔ measured value	BLOCK_ERR = Other	QUALITY = UNCERTAIN (configurable)	Cause of error: Sensor drift has been detected (in accordance with the settings in the Advanced Diagnostics Block). Remedy: Check the sensor, depending on the application.	PV1, PV2 SV1, SV2
			Transducer_Error = No error	SUBSTATUS = Non-specific		
M-	104	Device status message (FF): Backup active M-104 Local display: M-104 ↔ measured value	BLOCK_ERR = Other	QUALITY = GOOD / BAD	Cause of error: Backup function activated and an error was detected at one sensor. Remedy: Rectify the sensor error.	SV1, SV2, also PV1, PV2 depending on the configuration
			Transducer_Error = No error	SUBSTATUS = Non-specific		
F-	221	Device status message (FF): Reference measurement F-221 Local display: F-221 ↔ measured value or '------'	BLOCK_ERR = Other	QUALITY = BAD	Cause of error: Internal reference junction defective. Remedy: Device defective, replace.	SV1, SV2, PV1, PV2, DT
			Transducer_Error = General error	SUBSTATUS = Device failure		

Default category	No.	Status messages – ACTUAL_STATUS_NUMBER in the 'Advanced Diagnostics' Transducer Block – Local display	Error messages in the Sensor Transducer Block in question	Sensor Transducer Block measured value status (default)	Cause of error / remedy	Output variables affected
F-	261	Device status message (FF): Device electronics F-261 Local display: F-261 ↔ measured value or '------'	BLOCK_ERR = Other	QUALITY = BAD	**Cause of error:** Error in the electronics. **Remedy:** Device defective, replace	SV1, SV2, PV1, PV2, DT
			Transducer_Error = Electronic failure	SUBSTATUS = Device failure		
F-	283	Device status message (FF): Memory error F-283 Local display: F-283 ↔ measured value or '-------'	BLOCK_ERR = Other	QUALITY = BAD	**Cause of error:** Error in memory. **Remedy:** Device defective, replace.	SV1, SV2, PV1, PV2, DT
			Transducer_Error = Data integrity error	SUBSTATUS = Device failure		
C-	402	Device status message (FF): Device initialization C-402 Local display: Measured value	BLOCK_ERR = Power up	QUALITY = UNCERTAIN	**Cause of error:** Device starting/initializing. **Remedy:** Message is only displayed in the transducer block during power-up. [1]	SV1, SV2, PV1, PV2, DT
			Transducer_Error = Data integrity error	SUBSTATUS = Non-specific		
F-	431	Device status message (FF): Calibration values F-431 Local display: F-431 ↔ measured value or '------'	BLOCK_ERR = Other	QUALITY = BAD	**Cause of error:** Error in calibration parameters. **Remedy:** Device defective, replace.	SV1, SV2, PV1, PV2, DT
			Transducer_Error = Calibration error	SUBSTATUS = Device failure		
F-	437	Device status message (FF): Configuration error F-437 Local display: F-437 ↔ measured value or '------'	BLOCK_ERR = Other **I** Block configuration error	QUALITY = BAD	**Cause of error:** Incorrect configuration in the Transducer Blocks "Sensor 1 and 2". The reason for the configuration error is displayed in the "BLOCK_ERR_DESC1" parameter. **Remedy:** Check the configuration of the sensor types used, the units and the settings of PV1 and/or PV2.	SV1, SV2, PV1, PV2, DT
			Transducer_Error = Configuration error	SUBSTATUS = Device failure		
C-	482	Device status message (FF): Simulation active C-482 Local display: C-482 ↔ measured value	BLOCK_ERR = Other	QUALITY = UNCERTAIN	**Cause of error:** Simulation is active. **Remedy:** -	
			Transducer_Error = No error	SUBSTATUS = Substitute		
C-	501	Device status message (FF): Device reset C-501 Local display: C-501 ↔ measured value	BLOCK_ERR = Other	QUALITY = UNCERTAIN / GOOD	**Cause of error:** Device reset is performed. **Remedy:** Message is only displayed during reset.	SV1, SV2, PV1, PV2, DT
			Transducer_Error = No error	SUBSTATUS = Non-specific/ update event		
S-	502	Device status message (FF): Linearization S-502 Local display: S-502 ↔ measured value	BLOCK_ERR = Other **I** Block configuration error	QUALITY = BAD	**Cause of error:** Error in linearization. **Remedy:** Select valid type of linearization (sensor type).	SV1, SV2, PV1, PV2, DT
			Transducer_Error = Configuration error	SUBSTATUS = Configuration error		
S-	901	Device status message (FF): Ambient temperature range undershot S-901 Local display: S-901 ↔ measured value	BLOCK_ERR = Other	QUALITY = UNCERTAIN (configurable)	**Cause of error:** Device temperature < -40 °C (-40 °F) **Remedy:** Observe ambient temperature in accordance with specification.	SV1, SV2, PV1, PV2, DT
			Transducer_Error = No error	SUBSTATUS = Non-specific		

Default category	No.	Status messages – ACTUAL_STATUS_NUMBER in the 'Advanced Diagnostics' Transducer Block – Local display	Error messages in the Sensor Transducer Block in question	Sensor Transducer Block measured value status (default)	Cause of error / remedy	Output variables affected
S-	902	Device status message (FF): Ambient temperature range overshot S-902 Local display: S-902 ↔ measured value	BLOCK_ERR = Other	QUALITY = UNCERTAIN (configurable)	**Cause of error:** Device temperature > +85 ℃ (+185 ℉). **Remedy:**Observe ambient temperature in accordance with specification.	SV1, SV2, PV1, PV2, DT
			Transducer_Error = No error	SUBSTATUS = Non-specific		

1)   Status message is never displayed on local display.

9.4   Firmware history

Revision history

The firmware version (FW) on the nameplate and in the Operating Instructions indicates the device release: XX.YY.ZZ (example 01.02.01).

XX   Change to main version. No longer compatible. The device and Operating Instructions change.

YY   Change to functions and operation. Compatible. The Operating Instructions change.

ZZ   Fixes and internal changes. No changes to the Operating Instructions.

Date	Firmware version	Modifications	Documentation
01/2006	1.00.00	Original firmware	BA224R/09/en/11.06
08/2010	1.01.00	New device revision 2	BA224R/09/en/13.10
08/2010	1.01.00	-	BA224R/09/en/14.12
12/2014	2.00.00	New device revision 3	BA00224R/09/en/15.14
09/2023	2.00.00	-	BA00224R/09/en/16.23

10   Maintenance

No special maintenance work is required for the temperature transmitter.

10.1   Cleaning

A clean, dry cloth can be used to clean the device.

11 Repair

11.1 General notes

ℹ️ Repairs that are not described in these Operating Instructions must only be carried out directly by the manufacturer or by the service department.

11.2 Spare parts

Spare parts currently available for the product can be found online at: http://www.products.endress.com/spareparts_consumables. Always quote the serial number of the device when ordering spare parts!
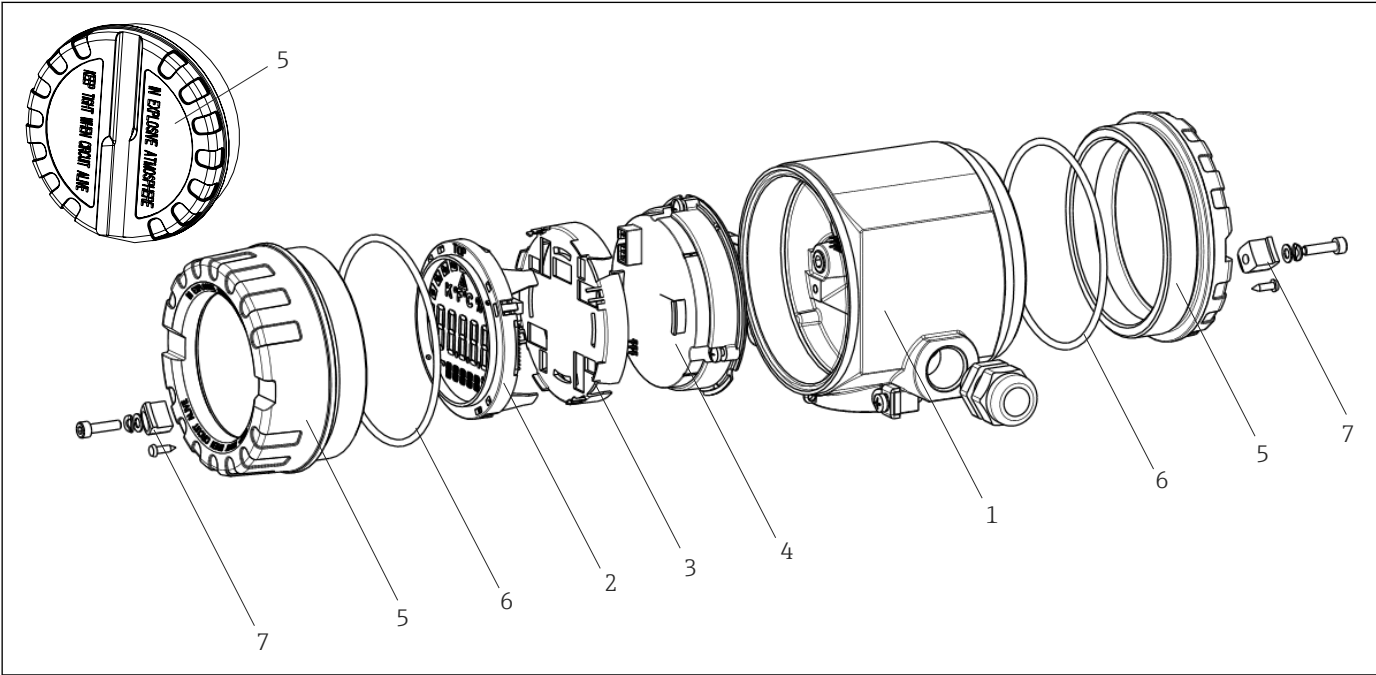
▣ 16   Field transmitter spare parts

Item no. 1	Housing	
	Certificates:	
	A	Non-hazardous area + Ex ia
	B	ATEX Ex d
	Material:	
	A	Aluminum, HART 5
	B	Stainless steel 316L, HART 5
	F	Aluminum, FF/PA
	G	Stainless steel 316L, FF/PA
	K	Aluminum, HART 7
	L	Stainless steel 316L, HART 7
	Cable entry:	
	1	2 x thread NPT ½" + terminal block + 1 dummy plug
	2	2 x thread M20x1.5 + terminal block + 1 dummy plug

Item no. 1	Housing			
			4	2 x thread G ½" + terminal block + 1 dummy plug
			Version:	
			A	Standard
TMT162G-			A	← order code

Item no. 4	Electronics module	
	Certificates:	
	A	Non-hazardous area
	B	ATEX Ex ia, FM IS, CSA IS
	Sensor input; communication:	
	A	1x; HART 5, FW 01.03.zz, DevRev02
	B	2x; HART 5, FW 01.03.zz, DevRev02, config. output sensor 1
	C	2x; FOUNDATION Fieldbus Device Revision 1
	D	2x; PROFIBUS PA, DevRev02
	E	2x; FOUNDATION Fieldbus FW 01.01.zz, Device Revision 2
	F	2x; FOUNDATION Fieldbus FW 02.00.zz, Device Revision 3
	G	1x; HART7, Fw 04.01.zz, DevRev04
	H	2x; HART7, Fw 04.01.zz, DevRev04, config. output sensor 1
	Configuration:	
	A	50 Hz mains filter
	B	Produced as per original order (quote serial number) 50 Hz mains filter
	K	60 Hz mains filter
	L	Produced as per original order (quote serial number) 60 Hz mains filter
TMT162E-		← order code

Item no.	Order code	Spare parts
2.3	TMT162X-DA	Display HART 5 + retainer + twist protection
2.3	TMT162X-DB	Display PA/FF + retainer + twist protection
2.3	TMT162X-DC	Display retainer + twist protection
2.3	TMT162X-DD	Display HART 7 + retainer + twist protection
5	TMT162X-HH	Housing cover blind, aluminum Ex d, FM XP with seal, CSA approval, only as cover of connection compartment
5	TMT162X-HI	Housing cover blind, aluminum + seal
5	TMT162X-HK	Housing cover cpl. display, aluminum Ex d with seal
5	TMT162X-HL	Housing cover cpl. display, aluminum with seal
5	TMT162X-HA	Housing cover blind, stainless steel 316L Ex d, ATEX Ex d, FM XP with seal, CSA approval, only as cover of connection compartment
5	TMT162X-HB	Housing cover blind, stainless steel 316L, with seal
5	TMT162X-HC	Housing cover cpl. display, Ex d, stainless steel 316L, ATEX Ex d, FM XP, CSA XP, with seal
5	TMT162X-HD	Housing cover cpl. display, stainless steel 316L, with seal
5	TMT162X-HF	Housing cover cpl. display, polycarbonate, 316L

Item no.	Order code	Spare parts
6	71439499	O-ring 88x3 HNBR 70˚ Shore PTFE coating
7	51004948	Cover clamp spare part set: screw, disk, spring washer

11.3   Return

The requirements for safe device return can vary depending on the device type and national legislation.

1. Refer to the website for more information:
   http://www.endress.com/support/return-material

2. Return the device if repairs or a factory calibration are required, or if the wrong device was ordered or delivered.

11.4   Disposal

If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

12   Accessories

Various accessories, which can be ordered with the device or subsequently from Endress +Hauser, are available for the device. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

Always quote the serial number of the device when ordering accessories!

12.1   Device-specific accessories

Accessories	Description	
Dummy plugs	- M20x1.5 EEx-d/XP - G ½" EEx-d/XP - NPT ½" ALU - NPT ½" V4A	
Cable glands	- M20x1.5 - NPT ½" D4-8.5, IP68 - NPT ½" cable gland 2 x D0.5 cable for 2 sensors - M20x1.5 cable gland 2 x D0.5 cable for 2 sensors	
Adapter for cable gland	M20x1.5 outside/M24x1.5 inside	
Wall and pipe mounting bracket	Stainless steel wall/2" pipe Stainless steel 2" pipe V4A	
Fieldbus device connector (FF)	**Threaded connection:**	**Cable connection thread:**
	M20	7/8"
	NPT ½"	7/8"

12.2   Service-specific accessories

Accessories	Description
Applicator	Software for selecting and sizing Endress+Hauser measuring devices: • Calculation of all the necessary data for identifying the optimum measuring device: e.g. pressure loss, accuracy or process connections. • Graphic illustration of the calculation results Administration, documentation and access to all project-related data and parameters over the entire life cycle of a project. Applicator is available: Via the Internet: https://portal.endress.com/webapp/applicator

Accessories	Description
Configurator	Product Configurator - the tool for individual product configuration • Up-to-the-minute configuration data • Depending on the device: direct input of information specific to the measuring point, such as the 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 The Product Configurator is available on the Endress+Hauser website: www.endress.com-> 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.
FieldCare SFE500	FDT-based plant asset management tool from Endress+Hauser. It can configure all smart field units in your system and helps you manage them. By using the status information, it is also a simple but effective way of checking their status and condition. For details, see Operating Instructions BA00027S and BA00065S
DeviceCare SFE100	Configuration tool for devices via fieldbus protocols and Endress+Hauser service protocols. DeviceCare is the tool developed by Endress+Hauser for the configuration of Endress+Hauser devices. All smart devices in a plant can be configured via a point-to-point or point-to-bus connection. The user-friendly menus enable transparent and intuitive access to the field devices. For details, see Operating Instructions BA00027S

12.3   System products

Accessories	Description
Graphic Data Manager Memograph M	The Advanced Data Manager Memograph M is a flexible and powerful system for organizing process values. The measured process values are clearly presented on the display and logged safely, monitored for limit values and analyzed. Via common communication protocols, the measured and calculated values can be easily communicated to higher-level systems or individual plant modules can be interconnected. For details, see Technical Information TI01180R/09
RN22	Single- or two-channel active barrier for safe separation of 0/4 to 20 mA standard signal circuits with bidirectional HART® transmission. In the signal duplicator option, the input signal is transmitted to two galvanically isolated outputs. The device has one active and one passive current input; the outputs can be operated actively or passively. The RN22 requires a supply voltage of 24 V_{DC}. For details, see Technical Information TI01515K

Accessories	Description
RN42	Single-channel active barrier for safe separation of 0/4 to 20 mA standard signal circuits with bidirectional HART® transmission. The device has one active and one passive current input; the outputs can be operated actively or passively. The RN42 can be powered with a wide range voltage of 24 to 230 $V_{AC/DC}$. ▯ For details, see Technical Information TI01584K
RID14/RID16	Field indicator with 8 input channels and FOUNDATION Fieldbus™ or PROFIBUS® PA protocol for displaying process values and calculated values. Onsite display of process parameters in fieldbus systems. ▯ For details: • Technical Information RID16: TI00146R • Technical Information RID14: TI00145R

13   Technical data

13.1   Input

Measured variable	Temperature (temperature-linear transmission behavior), resistance and voltage.

Measuring range

Resistance thermometer (RTD) as per standard	Designation	α	Measuring range limits	Min. span
IEC 60751:2008	Pt100 Pt200 Pt500 Pt1000	0.003851	−200 to +850 ℃ (−328 to +1 562 ℉) −200 to +850 ℃ (−328 to +1 562 ℉) −200 to +500 ℃ (−328 to +932 ℉) −200 to +250 ℃ (−328 to +482 ℉)	10 K (18 ℉)
JIS C1604:1984	Pt100	0.003916	−200 to +510 ℃ (−328 to +950 ℉)	10 K (18 ℉)
SAMA	Pt100	0.003923	−100 to +700 ℃ (−148 to +1 292 ℉)	10 K (18 ℉)
DIN 43760 IPTS-68	Ni100 Ni120 Ni1000	0.006180	−60 to +250 ℃ (−76 to +482 ℉) −60 to +250 ℃ (−76 to +482 ℉) −60 to +150 ℃ (−76 to +302 ℉)	10 K (18 ℉)
GOST 6651-94	Pt50 Pt100	0.003910	−185 to +1 100 ℃ (−301 to +2 012 ℉) −200 to +850 ℃ (−328 to +1 562 ℉)	10 K (18 ℉)
Edison Copper Winding No.15	Cu10		−100 to +260 ℃ (−148 to +500 ℉)	10 K (18 ℉)
OIML R84: 2003, GOST 6651-2009	Cu50 Cu100	0.004280	−175 to +200 ℃ (−283 to +392 ℉) −180 to +200 ℃ (−292 to +392 ℉)	10 K (18 ℉)
	Ni100 Ni120	0.006170	−60 to +180 ℃ (−76 to +356 ℉) −60 to +180 ℃ (−76 to +356 ℉)	10 K (18 ℉)
OIML R84: 2003, GOST 6651-94	Cu50	0.004260	−50 to +200 ℃ (−58 to +392 ℉)	10 K (18 ℉)
-	Pt100 (Callendar van Dusen) Nickel polynomial Copper polynomial	-	10 to 400 Ω 10 to 2 000 Ω	10 Ω 10 Ω
	• Type of connection: 2-wire, 3-wire or 4-wire connection, sensor current: ≤ 0.3 mA • With 2-wire circuit, compensation of wire resistance possible (0 to 30 Ω) • With 3-wire and 4-wire connection, sensor wire resistance up to max. 50 Ω per wire			
Resistance transmitter	Resistance Ω		10 to 400 Ω 10 to 2 000 Ω	10 Ω 10 Ω

Thermocouples [1] as per standard	Designation	Measuring range limits		Min. span
IEC 60584, Part 1	Type A (W5Re-W20Re) Type B (PtRh30-PtRh6) [2] Type E (NiCr-CuNi) Type J (Fe-CuNi) Type K (NiCr-Ni) Type N (NiCrSi-NiSi) Type R (PtRh13-Pt) Type S (PtRh10-Pt) Type T (Cu-CuNi)	0 to +2 500 ℃ (+32 to +4 532 ℉) +40 to +1 820 ℃ (+104 to +3 308 ℉) −270 to +1 000 ℃ (−454 to +1 832 ℉) −210 to +1 200 ℃ (−346 to +2 192 ℉) −270 to +1 372 ℃ (−454 to +2 501 ℉) −270 to +1 300 ℃ (−454 to +2 372 ℉) −50 to +1 768 ℃ (−58 to +3 214 ℉) −50 to +1 768 ℃ (−58 to +3 214 ℉) −270 to +400 ℃ (−454 to +752 ℉)	Recommended temperature range: 0 to +2 500 ℃ (+32 to +4 532 ℉) +100 to +1 500 ℃ (+212 to +2 732 ℉) 0 to +750 ℃ (+32 to +1 382 ℉) +20 to +700 ℃ (+68 to +1 292 ℉) 0 to +1 100 ℃ (+32 to +2 012 ℉) 0 to +1 100 ℃ (+32 to +2 012 ℉) 0 to +1 400 ℃ (+32 to +2 552 ℉) 0 to +1 400 ℃ (+32 to +2 552 ℉) −185 to +350 ℃ (−301 to +662 ℉)	50 K (90 ℉) 50 K (90 ℉) 50 K (90 ℉) 50 K (90 ℉) 50 K (90 ℉) 50 K (90 ℉) 50 K (90 ℉) 50 K (90 ℉) 50 K (90 ℉)
ASTM E988-96	Type C (W5Re-W26Re)	0 to +2 315 ℃ (+32 to +4 199 ℉)	0 to +2 000 ℃ (+32 to +3 632 ℉)	50 K (90 ℉)
	Type D (W3Re-W25Re)	0 to +2 315 ℃ (+32 to +4 199 ℉)	0 to +2 000 ℃ (+32 to +3 632 ℉)	50 K (90 ℉)

Thermocouples [1] as per standard	Designation	Measuring range limits		Min. span
DIN 43710	Type L (Fe-CuNi) Type U (Cu-CuNi)	−200 to +900 ℃ (−328 to +1652 ℉) −200 to +600 ℃ (−328 to +1112 ℉)	0 to +750 ℃ (+32 to +1382 ℉) −185 to +400 ℃ (−301 to +752 ℉)	50 K (90 ℉)
	• Internal cold junction (Pt100) • External cold junction: configurable value −40 to +85 ℃ (−40 to +185 ℉) • Maximum sensor wire resistance 10 kΩ (if the sensor wire resistance is greater than 10 kΩ, an error message as per NAMUR NE89 is output) [3]			
Voltage transmitter (mV)	Millivolt transmitter (mV)	−5 to 30 mV −20 to 100 mV		5 mV

1) When operating conditions are based on a large temperature range, the transmitter offers you the ability to split the range. For example, a Type S or R thermocouple can be used for the lower range and a Type B can be used for the upper range. The transmitter is then programmed by the end operator to switch at a predefined temperature. This allows for utilization of the best performance from each individual thermocouple and provides 1 output that represents the process temperature.
2) High measuring uncertainty for temperatures below 300 ℃ (572 ℉)
3) Basic requirement of NE89: detection of increased wire resistance (e.g. corrosion of contacts and wires) of TC or RTD/4-wire. Warning - exceeding ambient temperature.

Type of input

The following connection combinations are possible when both sensor inputs are assigned:

		Sensor input 1			
		RTD or resistance transmitter, two-wire	RTD or resistance transmitter, three-wire	RTD or resistance transmitter, four-wire	Thermocouple (TC), voltage transmitter
Sensor input 2	RTD or resistance transmitter, two-wire	☑	☑	-	☑
	RTD or resistance transmitter, three-wire	☑	☑	-	☑
	RTD or resistance transmitter, four-wire	-	-	-	-
	Thermocouple (TC), voltage transmitter	☑	☑	☑	☑

13.2 Output

Output signal

FOUNDATION Fieldbus™	
Signal encoding	FOUNDATION Fieldbus™ H1, IEC 61158-2, Manchester Bus Powered (MBP)
Data transmission rate	31.25 kBit/s, voltage mode
Galvanic isolation	U = 2 kV AC (input/output)

Failure information

FOUNDATION Fieldbus™
Status message in accordance with FOUNDATION Fieldbus™ specification

Linearization/transmission behavior

Temperature-linear, resistance-linear, voltage-linear

Filter

1st order digital filter: 0 to 60 s

Protocol-specific data

FOUNDATION Fieldbus™	
Supported functions	Instantiation of function blocks. The following methods are supported: • Quick Setup • User sensor trim • Factory trim settings • Callendar Van Dusen • Nickel/copper polynomial linearization • Sensor drift detection For detailed descriptions, see the specific Operating Instructions.
Basic data	
Manufacturer ID	452B48 (Endress+Hauser)
Device type	10CC (Hex)
Device or bus address	247 (default)
Device revision	03 (hex)
ITK Version	6.1.2
ITK Certification Driver No.	IT099000
Link Master capability (LAS)	Yes
Choice of Link Master / Basic Device	Yes; factory setting: **Basic Device**
Virtual Communication Relationship (VCRs)	
Number of VCRs	44
Number of link objects in VFD	50
Permanent entries	44
Client VCRs	0
Server VCRs	5
Source VCRs	8
Sink VCRs	0
Subscriber VCRs	12
Publisher VCRs	19
Link settings	
Slot time	4
Min. inter PDU delay	12
Max. response delay	40

Blocks		
Block description	Execution time (macro cycle ≤ 500 ms)	Block category
Resource Block	Permanent	Extended
Transducer Block Sensor 1	Pre-instantiatied	Manufacturer-specific
Transducer Block Sensor 2	Pre-instantiatied	Manufacturer-specific
Transducer Block Display	Pre-instantiatied	Manufacturer-specific
Transducer Block Adv. Diag.	Pre-instantiatied	Manufacturer-specific
Function Block AI1	35 ms (pre-instantiatied)	Extended
Function Block AI2	35 ms (pre-instantiatied)	Extended
Function Block AI3	35 ms (pre-instantiatied)	Extended
Function Block AI4	35 ms (not instantiated)	Extended
Function Block AI5	35 ms (not instantiated)	Extended
Function Block AI6	35 ms (not instantiated)	Extended
Function Block PID	30 ms	Standard
Function Block ISEL	30 ms	Standard

Brief block description	
Resource Block	The Resource Block contains all the data that clearly identify and characterize the device. It is an electronic version of a nameplate on the device. In addition to parameters that are needed to operate the device on the fieldbus, the Resource Block makes information such as the order code, device ID, hardware revision, software revision, device release etc. available.
Transducer Block "Sensor 1" and "Sensor 2"	The Transducer Blocks of the field transmitter contain all the measurement-specific and device-specific parameters which are relevant for the measurement of the input variables.
Display Transducer	The parameters of the "Display" Transducer Block enable the configuration of the display.
Advanced Diagnostic	All the parameters for self-monitoring and diagnostics are grouped in this Transducer Block.
Analog Input (AI)	In the AI Function Block, the process variables from the Transducer Blocks are prepared for subsequent automation functions in the control system (e.g. scaling, limit value processing).
PID	This function block contains input channel processing, proportional integral-differential control (PID) and analog output channel processing. The following can be realized: Basic controls, feedforward control, cascade control and cascade control with limiting.
Input Selector (ISEL)	The Input Selector Block enables the selection of up to four inputs and generates an output based on the configured action.

Switch-on delay   8 s

13.3   Power supply

Supply voltage U_b= 9 to 32 V, polarity-independent, maximum voltage U_b = 35 V. According to IEC 60079-27, FISCO/FNICO

ℹ️ The device may only be powered by a power unit with an energy-limited circuit in accordance with UL/EN/IEC 61010-1, Section 9.4 and the requirements of Table 18.

Current consumption

Current consumption (device basic current)	≤ 11 mA
Switch-on current (device inrush current) [1]	≤ 11 mA
Failure current FDE (Fault Disconnection Electronic)	0 mA

1)   Only FOUNDATION Fieldbus™

Terminals   2.5 mm² (12 AWG) plus ferrule

Cable entries

Version	Type
Thread	2x thread ½" NPT
	2x thread M20
	2x thread G½"
Cable gland	2x coupling M20

Connectors

Version	Type
Thread and fieldbus connector	2x thread ½" NPT 1x connector 7/8" FF
	2x thread M20x1.5 1x connector 7/8" FF

Cable specification → 🕮 18

13.4 Performance characteristics

Response time

Measured value update < 1 s per channel, depending on the type of sensor and connection method

Reference operating conditions

- Calibration temperature: +25 ℃ ±3 K (77 ℉ ±5.4 ℉)
- Supply voltage: 24 V DC
- 4-wire circuit for resistance adjustment

Maximum measured error

The data relating to the measured error are typical values and correspond to a standard deviation of ±3 σ (normal distribution), i.e. 99.8% of all measured values achieve the specified values or better values.

	Designation	Accuracy
Resistance thermometer (RTD)	Cu100, Pt100, Ni100, Ni120 Pt500 Cu50, Pt50, Pt1000, Ni1000 Cu10, Pt200	0.1 ℃ (0.18 ℉) 0.3 ℃ (0.54 ℉) 0.2 ℃ (0.36 ℉) 1 ℃ (1.8 ℉)
Thermocouples (TC)	Type: K, J, T, E, L, U Type: N, C, D Type: S, B, R	typ. 0.25 ℃ (0.45 ℉) typ. 0.5 ℃ (0.9 ℉) typ. 1.0 ℃ (1.8 ℉)
	Measuring range	**Accuracy**
Resistance transmitter (Ω)	10 to 400 Ω 10 to 2 000 Ω	±0.04 Ω ±0.08 Ω
Voltage transmitter (mV)	−20 to 100 mV	±10 µV

Physical input measuring range of sensors	
10 to 400 Ω	Cu10, Cu50, Cu100, polynomial RTD, Pt50, Pt100, Ni100, Ni120
10 to 2 000 Ω	Pt200, Pt500, Pt1000, Ni1000
−20 to 100 mV	Thermocouples type: C, D, E, J, K, L, N, U
−5 to 30 mV	Thermocouples type: B, R, S, T

Sensor adjustment

Sensor-transmitter-matching

RTD sensors are one of the most linear temperature measuring elements. Nevertheless, the output must be linearized. To significantly improve temperature measurement accuracy, the device allows the use of two methods:

- Customized linearization
  The transmitter can be programmed with sensor-specific curve data with the PC configuration software. As soon as the sensor-specific data have been entered, the transmitter uses these to create a customized curve.
- Callendar-Van-Dusen coefficients
  The Callendar-Van Dusen equation is described as:
  $R_T = R_0[1+AT+BT^2+C(T-100)T^3]$

  where A, B and C are constant. They are commonly referred as Callendar-Van-Dusen coefficients. The precise values of A, B and C are derived from the calibration data for the RTD and are specific for each RTD sensor. The process involves programming the transmitter with the curve data for a certain RTD instead of using a standardized curve. Sensor transmitter matching using one of the methods explained above significantly improves the temperature measurement accuracy of the entire system. This is a result of the transmitter using the sensor's actual resistance vs. temperature curve data instead of the ideal curve data.

Resolution	Resolution of A/D converter = 18 bit

Non-repeatability	*According to EN 61298-2*

Physical input measuring range of sensors		Non-repeatability
10 to 400 Ω	Cu10, Cu50, Cu100, polynomial RTD, Pt50, Pt100, Ni100, Ni120	15 mΩ
10 to 2 000 Ω	Pt200, Pt500, Pt1000, Ni1000	100 ppm x measured value
−20 to 100 mV	Thermocouples type: C, D, E, J, K, L, N, U	4 µV
−5 to 30 mV	Thermocouples type: B, R, S, T	3 µV

Long-term drift	≤ 0.1 ℃/year (≤ 0.18 ℉/year) under reference operating conditions or ≤ 0.05 %/year. Data under reference operating conditions. % refers to the set span. The larger value applies.

Influence of ambient temperature

Impact on accuracy when ambient temperature changes by 1 ℃ (1.8 ℉):	
Input 10 to 400 Ω	15 ppm of measured value, min. 1.5 mΩ
Input 10 to 2 000 Ω	15 ppm of measured value, min. 15 mΩ
Input −20 to 100 mV	30 ppm of measured value, min. 0.3 µV
Input −5 to 30 mV	30 ppm of measured value, min. 0.15 µV

Typical sensitivities of resistance thermometers		
Pt: 0.00385 * R_{nom}/K	Cu: 0.0043 * R_{nom}/K	Ni: 0.00617 * R_{nom}/K

Example of Pt100: 0.00385 x 100 Ω/K = 0.385 Ω/K

Typical sensitivities of thermocouples					
B: 10 µV/K at 1 000 ℃ (1 832 ℉)	C: 20 µV/K at 1 000 ℃ (1 832 ℉)	D: 20 µV/K at 1 000 ℃ (1 832 ℉)	E: 75 µV/K at 500 ℃ (932 ℉)	J: 55 µV/K at 500 ℃ (932 ℉)	K: 40 µV/K at 500 ℃ (932 ℉)
L: 55 µV/K at 500 ℃ (932 ℉)	N: 35 µV/K at 500 ℃ (932 ℉)	R: 12 µV/K at 1 000 ℃ (1 832 ℉)	S: 12 µV/K at 1 000 ℃ (1 832 ℉)	T: 50 µV/K at 1 000 ℃ (1 832 ℉)	U: 60 µV/K at 500 ℃ (932 ℉)

Examples of calculating the measured error with ambient temperature drift

Example 1:
Input temperature drift Δθ = 10 K (18 °F), Pt100, measuring range 0 to +100 °C (+32 to +212 °F)
Maximum process temperature: 100 °C (212 °F)
Measured resistance value: 138.5 Ω (IEC 60751) at maximum process temperature

Typical temperature drift in Ω: (0.0015% of 138.5 Ω) * 10 = 0.0208 Ω
Conversion to Kelvin: 0.0208 Ω/0.385 Ω/K = 0.05 K (0.09 °F)

Example 2:
Input temperature drift Δθ = 10 K (18 °F), thermocouple type K, measuring range 0 to +600 °C (+32 to +1 112 °F)
Maximum process temperature: 600 °C (1 112 °F)
Measured thermoelectric voltage: 24 905 V (see IEC 60584)

Typical temperature drift in μV: (0.001% of 24 095 μV) * 10 = 2.5 μV
Conversion to Kelvin: 2.5 μK/40 μV/K/K = 0.06 K (0.11 °F)

Total uncertainty of measurement of the measuring point

According to the Guide to the Expression of Uncertainty in Measurement (GUM), the uncertainty of measurement can be calculated as follows:

$$\text{Total measurement accuracy} = k\sqrt{\frac{(\text{Basic measured error transmitter})^2}{3} + \frac{(\text{Measured error ambient temperature})^2}{3} + \frac{(\text{Measured error sensor})^2}{3}}$$

<div align="right">A0024854-EN</div>

Example of calculating the total uncertainty of measurement of a thermometer:

Ambient temperature drift Δθ = 10 K (18 °F), Pt100 Class A, measuring range 0 to +100 °C (+32 to +212 °F), maximum process temperature: 100 °C (212 °F), k = 2

- Basic measured error: **0.1 K (0.18 °F)**
- Measured error caused by ambient temperature drift: **0.04 K (0.072 °F)**
- Measured error of the sensor: 0.15 K (0.27 °F) + 0.002 * 100 °C (212 °F) = **0.35 K (0.63 °F)**

$$\text{Total measurement accuracy} = 2\sqrt{\frac{(0.1\text{ K})^2}{3} + \frac{(0.04\text{ K})^2}{3} + \frac{(0.35\text{ K})^2}{3}} = 0.42\text{ K }(0.76\text{ °F})$$

<div align="right">A0024855-EN</div>

Influence of the reference junction	Pt100 DIN IEC 60751 Cl. B (internal reference junction with thermocouples TC)

13.5   Environment

Ambient temperature	• −40 to +85 °C (−40 to +185 °F), see Ex documentation for hazardous areas • Without display: −40 to +85 °C (−40 to +185 °F) • With display: −40 to +80 °C (−40 to +176 °F) ℹ The display may react slowly at temperatures < −20 °C (−4 °F). The readability of the display cannot be guaranteed at temperatures < −30 °C (−22 °F).
Storage temperature	• Without display: −40 to +100 °C (−40 to +212 °F) • With display: −40 to +80 °C (−40 to +176 °F)
Relative humidity	Permitted: 0 to 95 %

Altitude	Up to 2 000 m (6 560 ft) above mean sea level
Climate class	As per IEC 60654-1, Class C
Degree of protection	Die-cast aluminum or stainless steel housing: IP66/67, Type 4X
Shock and vibration resistance	Shock resistance as per KTA 3505 (section 5.8.4 Shock test)
	IEC 60068-2-6 test
	Fc: Vibration (sinusoidal)
	Vibration resistance according to DNV GL Guideline, Vibration: B
	ℹ The use of L-shaped mounting brackets can cause resonance (see wall/pipe 2" mounting bracket in the 'Accessories' section). Caution: vibrations at the transmitter may not exceed specifications.
Electromagnetic compatibility (EMC)	**CE conformity**
	Electromagnetic compatibility in accordance with all the relevant requirements of the IEC/EN 61326 series and NAMUR Recommendation EMC (NE21). For details, refer to the Declaration of Conformity.
	Maximum measured error <1% of measuring range.
	Interference immunity as per IEC/EN 61326 series, industrial requirements
	Interference emission as per IEC/EN 61326 series, Class B equipment
	ℹ A shielded cable that is grounded on both sides must be used for sensor cable lengths of 30 m (98.4 ft) and more. The use of shielded sensor cables is generally recommended.
	Connection of the functional grounding may be needed for functional purposes. Compliance with the electrical codes of individual countries is mandatory.
Overvoltage category	II
Pollution degree	2

13.6   Mechanical construction

Design, dimensions   Dimensions in mm (in)
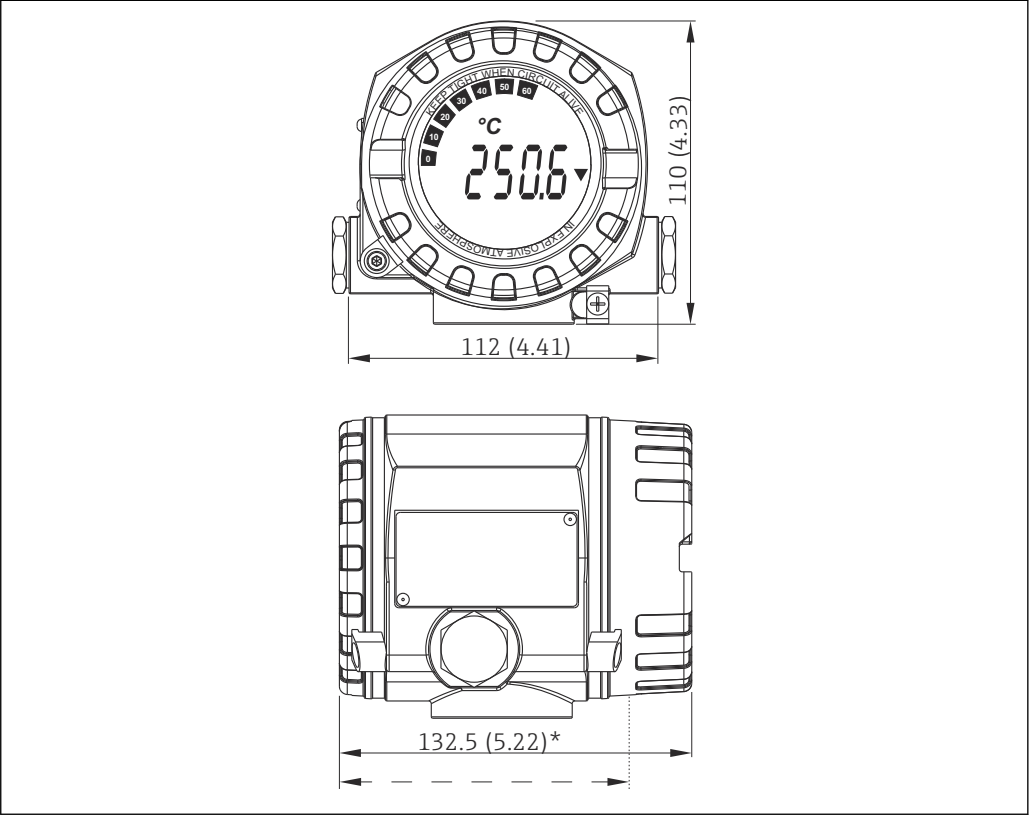
17   Die-cast aluminum housing for general applications, or optional stainless steel housing (316L)

* Dimensions without display = 112 mm (4.41")

- Separate electronics module and connection compartment
- Display attachable in 90° stages

Weight
- Aluminum housing approx. 1.4 kg (3 lb), with display
- Stainless steel housing approx. 4.2 kg (9.3 lb), with display

Materials

Housing	Sensor terminals	Nameplate
Die-cast aluminum housing AlSi10Mg/AlSi12 with powder coating on polyester base	Nickel-plated brass0.3 µm gold flashed/cpl., corrosion-free	Aluminum AlMgl, anodized in black
316L		1.4404 (AISI 316L)
		-
Display O-ring 88x3: HNBR 70° Shore PTFE coating	-	-

Cable entries

Version	Type
Thread	2x thread ½" NPT
	2x thread M20

Version	Type
	2x thread G½"
Cable gland	2x coupling M20

13.7   Certificates and approvals

Current certificates and approvals for the product are available at www.endress.com on the relevant product page:

1. Select the product using the filters and search field.

2. Open the product page.

3. Select **Downloads**.

MTTF	FOUNDATION Fieldbus™: **126 a**

|	
FOUNDATION Fieldbus certification	The temperature transmitter is certified and registered by the Fieldbus FOUNDATION. The measuring system meets all the requirements of the following specifications: • Certified in accordance with FOUNDATION Fieldbus™ specification • FOUNDATION Fieldbus™ H1 • Interoperability Test Kit (ITK), revision status 6.1.2, device certification number → 🖹 51: The device can also be operated with certified devices of other manufacturers. • Physical Layer Conformance Test of the Fieldbus FOUNDATION™ (FF-830 FS 1.0)

14   Operation via FOUNDATION Fieldbus™

14.1   Block model

In the FOUNDATION Fieldbus™ tasks all the device parameters are categorized according to their functional properties and task and are generally assigned to three different blocks. A block may be regarded as a container in which parameters and the associated functionalities are contained. A FOUNDATION Fieldbus™ device has the following block types:
- A Resource Block (device block):
  The Resource Block contains all the device-specific features of the unit.
- One or more Transducer Blocks:
  The Transducer Blocks contain the measuring and device-specific parameters of the device.
- One or more function blocks:
  The function blocks contain the device's automation functions. We distinguish between different function blocks, e.g. Analog Input function block, Analog Output function block. Each of these function blocks is used to execute different application functions.

Depending on how the individual function blocks are arranged and connected, various automation tasks can be realized. In addition to these blocks, a field device may have other blocks, e.g. several Analog Input function blocks if more than one process variable is available from the field device.
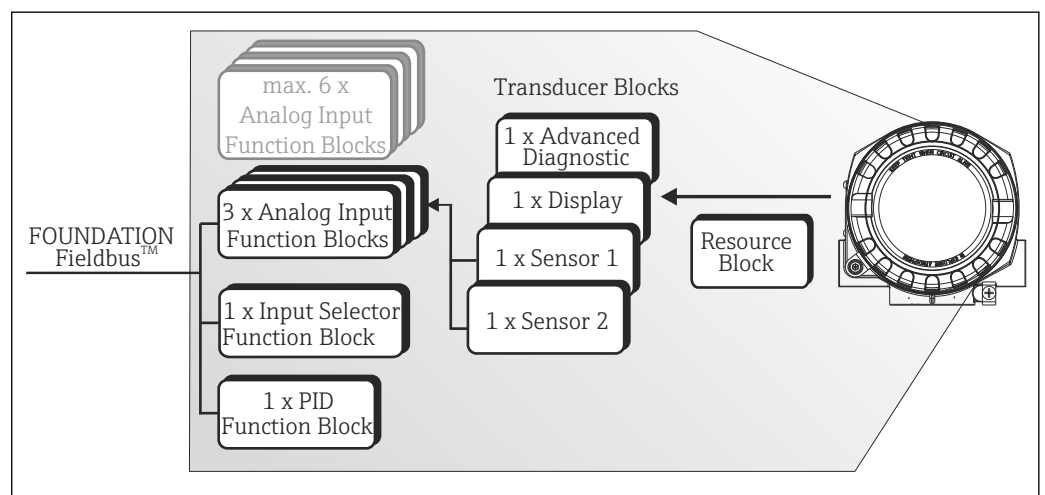
🖾 *18   Block model of the temperature field transmitter*

14.2   Resource Block (device block)

The Resource Block contains all the data that clearly identify and characterize the field device. It is an electronic version of a nameplate on the field device. In addition to parameters that are needed to operate the device on the fieldbus, the Resource Block makes information such as the order code, device ID, hardware version, firmware version, device revision etc. available.

A further task of the Resource Block is the management of overall parameters and functions that have an influence on the execution of the remaining function blocks in the field device. The Resource Block is thus a central unit that also checks the device status and thereby influences or controls the operability of the other function blocks and thus also of the device. As the Resource Block does not have any block input and block output data, it cannot be linked to other blocks.

The most important functions and parameters of the Resource Block are listed below.

14.2.1 Selecting the operating mode

The operating mode is set by means of the MODE_BLK parameter group. The Resource Block supports the following operating modes:

– AUTO (automatic mode)

– OOS (out of service)

– MAN (manual mode)

> The 'Out of Service' (OOS) operating mode is also displayed by means of the BLOCK_ERR parameter. In the OOS operating mode, all write parameters can be accessed without restriction if write protection has not been enabled.

14.2.2 Block status

The current operating status of the Resource Block is displayed in the RS_STATE parameter. The Resource Block can assume the following states:

– STANDBY	The Resource Block is in the OOS operating mode. It is not possible to execute the remaining function blocks.
– ONLINE LINKING	The configured connections between the function blocks have not yet been established.
– ONLINE	Normal operating status, the Resource Block is in the AUTO operating mode. The configured connections between the function blocks have been established.

14.2.3 Write protection and simulation

DIP switches on the optional display allow device parameter write protection and simulation in the Analog Input function block to be disabled or enabled.→ 🕮 22

The WRITE_LOCK parameter shows the status of the hardware write protection. The following statuses are possible:

– LOCKED	The device data cannot be altered via the FOUNDATION Fieldbus interface.
– NOT LOCKED	The device data can be altered via the FOUNDATION Fieldbus interface.

The BLOCK_ERR parameter indicates whether a simulation is possible in the Analog Input function block.

– Simulation Active	DIP switch for simulation mode active.

14.2.4 Alarm detection and processing

Process alarms provide information on certain block states and events. The status of the process alarms is communicated to the fieldbus host system by means of the BLOCK_ALM parameter. The ACK_OPTION parameter allows you to specify whether an alarm has to be acknowledged by means of the fieldbus host system.

The following process alarms are generated by the Resource Block:
- Block process alarms
  The following block process alarms of the Resource Block are displayed by means of the BLOCK_ALM parameter:
  – OUT OF SERVICE
  – SIMULATE ACTIVE
- Write protection process alarm
  If the write protection is disabled, the alarm priority specified in the WRITE_PRI parameter is checked before the status change is relayed to the fieldbus host system. The alarm priority specifies the behavior in the event of an active write protection alarm WRITE_ALM.

If the option of a process alarm was not activated in the ACK_OPTION parameter, this process alarm must only be acknowledged in the BLOCK_ALM parameter.

14.2.5 Resource Block FF parameters

The following table shows all the specified FOUNDATION™ Fieldbus parameters of the Resource Block.

Parameter	Write access with operating mode (MODE_BLK)	Description
Acknowledge Option (ACK_OPTION)	AUTO - OOS	This parameter is used to specify whether a process alarm must be acknowledged at the time of alarm recognition by the fieldbus host system. If this option is enabled, the process alarm is acknowledged automatically. **Factory default:** The option is not enabled for any alarm, the alarms must be acknowledged.
Alarm Summary (ALARM_SUM)	AUTO - OOS	Displays the current status of the process alarms in the Resource Block. In addition the process alarms can also be disabled in this parameter group.
Alert Key (ALERT_KEY)	AUTO - OOS	Use this function to enter the identification number of the plant unit. This information can be used by the fieldbus host system for sorting alarms and events. User input: 1 to 255 **Factory default:** 0
Block Alarm (BLOCK_ALM)	AUTO - OOS	The current block status appears on the display with information on pending configuration, hardware or system errors, including information on the alarm period (date, time) when the error occurred. The block alarm is triggered in the event of the following block errors: • SIMULATE ACTIVE • OUT OF SERVICE If the option of the alarm has **not** been enabled in the ACK_OPTION parameter, the alarm can only be acknowledged via this parameter.
Block Error (BLOCK_ERR)	Read only	The active block errors appear on the display. • **SIMULATE ACTIVE:** Simulation is possible in the Analog Input function block via the SIMULATE parameter. Refer also to hardware write protection configuration.→ 🖺 22 • **OUT OF SERVICE:** The block is in the "Out of Service" mode.
Block Error Description 1 (BLOCK_ERR_DESC_1)	Read only	Displays further information for solving block errors. • **Simulation permitted:** Simulation is allowed due to activated hardware simulation switch. • **Failsafe active:** Failsafe mechanism in an AI block is active.
Capability Level (CAPABILITY_LEVEL)	Read only	Indicates the capability level that the device supports.
Clear Fault State (CLR_FSTATE)	AUTO - OOS	This parameter can be used to manually disable the security behavior of the analog output and discrete output function blocks.
Compatibility Revision (COMPATIBILITY_REV)	Read only	This parameter indicates until which previous device revision the device is compatible.

Parameter	Write access with operating mode (MODE_BLK)	Description
Confirm Time (CONFIRM_TIME)	AUTO - OOS	Specifies the confirmation time for the event report. If the device does not receive confirmation within this time then the event report is sent to the fieldbus host system again. **Factory default:** 640 000 $\frac{1}{32}$ ms
Cycle Selection (CYCLE_SEL)	AUTO - OOS	Displays the block execution method used by the fieldbus host system. The block execution method is selected by the fieldbus host system.
Cycle Type (CYCLE_TYPE)	Read only	Displays the block execution method supported by the device. • **SCHEDULED:** Timed block execution method. • **BLOCK EXECUTION:** Sequential block execution method. • **MANUF SPECIFIC:** Manufacturer specified.
DD Resource (DD_RESOURCE)	Read only	Displays the reference source for the device description in the device.
DD Revision (DD_REV)	Read only	Displays the revision number of the ITK-tested device description.
Device Revision (DEV_REV)	Read only	Displays the revision number of the device.
Device Tag (ENP_DEVICE_TAG)	Read only	Tag name/device TAG.
Device type (DEV_TYPE)	Read only	Displays the device identification number in hexadecimal numerical format. Display: 0x10CC (hex) for TMT162 FF
Electronic Name Plate Version (ENP_VERSION)	Read only	Version of the ENP (electronic name plate).
Fault State (FAULT_STATE)	Read only	Current status display of the security behavior of the analog output and discrete output function blocks.
Check Active (FD_CHECK_ACTIVE)	Read only	Reflects the error conditions that are being detected as active as selected for this category.
Check Alarm (FD_CHECK_ALM)	AUTO - OOS	Are used primarily to broadcast a change in the associated active conditions.
Check Map (FD_CHECK_MAP)	AUTO - OOS	Enable or disable conditions to be detected as active for this alarm category.
Check Mask (FD_CHECK_MASK)	AUTO - OOS	Allow to suppress any single or multiple conditions.
Check Priority (FD_CHECK_PRI)	AUTO - OOS	Allow to specify the priority of this alarm category.
Fail Active (FD_FAIL_ACTIVE)	Read only	Reflect the error conditions that are being detected as active as selected for this category.
Fail Diagnostic Alarm (FD_FAIL_ALM)	AUTO - OOS	Are used primarily to broadcast a change in the associated active conditions.
Fail Map (FD_FAIL_MAP)	AUTO - OOS	Enable or disable conditions to be detected as active for this alarm category
Fail Mask (FD_FAIL_MASK)	AUTO - OOS	Allow to suppress any single or multiple conditions.
Fail Priority (FD_FAIL_PRI)	AUTO - OOS	Allow to specify the priority of this alarm category.
Maintenance Active (FD_MAINT_ACTIVE)	Read only	Reflect the error conditions that are being detected as active as selected for this category.
Maintenance Alarm (FD_MAINT_ALM)	AUTO - OOS	Are used primarily to broadcast a change in the associated active conditions.
Maintenance Map (FD_MAINT_MAP)	AUTO - OOS	Enable or disable conditions to be detected as active for this alarm category.
Maintenance Mask (FD_MAINT_MASK)	AUTO - OOS	Allow to suppress any single or multiple conditions.
Maintenance Priority (FD_MAINT_PRI)	AUTO - OOS	Allow to specify the priority of this alarm category.
Offspec Active (FD_OFFSPEC_ACTIVE)	Read only	Reflect the error conditions that are being detected as active as selected for this category.
Offspec Alarm (FD_OFFSPEC_ALM)	AUTO - OOS	Are used primarily to broadcast a change in the associated active conditions.

Parameter	Write access with operating mode (MODE_BLK)	Description
Offspec Map (FD_OFFSPEC_MAP)	AUTO - OOS	Enable or disable conditions to be detected as active for this alarm category.
Offspec Mask (FD_OFFSPEC_MASK)	AUTO - OOS	Allow to suppress any single or multiple conditions.
Offspec Priority (FD_OFFSPEC_PRI)	AUTO - OOS	Allow to specify the priority of this alarm category.
Recommended Action (FD_RECOMMEN_ACT)	Read only	A device enumerated summarization of the most severe condition or conditions detected.
Field Diagnostic Simulate (FD_SIMULATE)	AUTO - OOS	Used as the field diagnostic condition when the simulation is enabled.
Field device diagnostic version (FD_VER)	Read only	The major version of the field diagnostics specification used for the development of this device.
Features (FEATURES)	Read only	Displays the additional options supported by the device. Display: Reports | Faultstate | Hard W Lock | Change Bypass in Auto | MVC Report Distribution supported Multi-bit Alarm (Bit-Alarm) Support
Feature Selection (FEATURES_SEL)	AUTO - OOS	For selecting the additional functions supported by the device.
FF communication software version (FF_COMM_VERSION)	Read only	This parameter includes the version information of the communication stack software used in the device.
Firmware Version (FIRMWARE_ VERSION)	Read only	Displays the version of the device software.
Free Time (FREE_TIME)	Read only	Displays the free system time (in percent) available for execution of further function blocks. ⓘ Since the function blocks of the device are preconfigured, this parameter always displays the value 0.
Free Space (FREE_SPACE)	Read only	Displays the free system memory (in percent) available for execution of further function blocks. ⓘ Since the function blocks of the device are preconfigured, this parameter always displays the value 0.
Grant Deny (GRANT_DENY)	AUTO - OOS	Enables or restricts the access authorization of a fieldbus host system to the field device.
Hard Types (HARD_TYPES)	Read only	Displays the input signal type for the Analog Input function block.
Hardware Version (HARDWARE_ VERSION)	Read only	Displays the version of the device hardware.
ITK Version (ITK_VER)	Read only	Displays the version number of the supported ITK test.
Limit Notify (LIM_NOTIFY)	AUTO - OOS	This parameter is used to specify the number of event reports that can exist unconfirmed at the same time. Options: 0 to 3 **Factory default: 0**
Manufacturer ID (MANUFAC_ID)	Read only	Displays the manufacturer's ID number. Display: 0x452B48 (hex) = Endress+Hauser
Max Notify (MAX_NOTIFY)	Read only	Displays the maximum number of event reports supported by the device that can exist unconfirmed at the same time. Display: 3
Memory Size (MEMORY_SIZE)	Read only	Displays the available configuration memory in kilobytes. ⓘ This parameter is not supported.
Minimum Cycle Time (MIN_CYCLE_T)	Read only	Displays the minimum execution time.

Parameter	Write access with operating mode (MODE_BLK)	Description
Block Mode (MODE_BLK)	AUTO - OOS	Displays the current (Actual) and desired (Target) operating mode of the Resource Block, the permitted modes (Permitted) supported by the Resource Block and the normal operating mode (Normal). Display: AUTO - OOS The Resource Block supports the following operating modes: • AUTO (automatic operation) • In this mode the execution of the remaining blocks (ISEL, AI and PID function block) is permitted. • OOS (out of service) The block is in the "Out of Service" mode. In this mode execution of the remaining blocks (ISEL, AI and PID function block) is blocked. These blocks cannot be set to AUTO mode. ℹ The current operating status of the Resource Block is also shown via the RS_STATE parameter.
Resource Directory (RES_DIRECTORY)	Read only	Displays the resource directory for the electronic name plate (ENP).
Nonvolatile Cycle Time (NV_CYCLE_T)	Read only	Displays the time interval for which the dynamic device parameters are stored in the nonvolatile memory. The time interval displayed relates to storage of the following dynamic device parameters: • OUT • PV • FIELD_VAL • SP ℹ These values are stored in the nonvolatile memory every 11 minutes. Display: 21120000 ($\frac{1}{32}$ ms).
Order Code / Identification (ORDER_CODE)	Read only	Displays the order code for the device.
Extended order code (ORDER_CODE_EXT)	Read only	Displays the extended order code of the device.
Extended order code part2 (ORDER_CODE_EXT_PAR T2)	Read only	Displays the second part of the extended order code, always empty in this device (therefore sometimes not displayed in host systems.
Restart (RESTART)	AUTO - OOS	This parameter is used to reset the device in various ways.
Access code (RS_ACCESS_CODE)	AUTO - OOS	Enter access code. Use this function to enable the service parameters via the operating tool. ℹ This function allows service technicians to change ENP parameters (serial number, device tag, order code and extended order code). The access code is write only. Reading this parameter always returns to **0**. The service parameters should only be modified by the service organization.
Access level (RS_ACCESS_LEVEL)	Read only	Use this function to show access authorization to the parameters. Options • **Operator** • **Service** **Factory default:** Operator
Resource State (RS_STATE)	Read only	Displays the current operating status of the Resource Block. • **STANDBY:** The Resource Block is in the OOS operating mode. It is not possible to execute the remaining blocks. • **ONLINE LINKING:** The configured connections between the function blocks have not yet been made. • **ONLINE:** Normal operating status, the Resource Block is in the AUTO operating mode. The configured connections between the function blocks are established.
Serial Number (SERIAL_NUMBER)	Read only	Displays the device serial number.
Set Fault State (SET_FSTATE)	AUTO - OOS	This parameter can be used to manually enable the security behavior of the device.
Shed Remote Cascade (SHED_RCAS)	AUTO - OOS	Specifies the monitoring time for checking the connection between the fieldbus host system and a function block in the RCAS operating mode. When the monitoring time elapses, the function block changes from the RCAS operating mode to the operating mode selected in the SHED_OPT parameter. **Factory default:** 640 000 $\frac{1}{32}$ ms

Parameter	Write access with operating mode (MODE_BLK)	Description
Shed Remote Out (SHED_ROUT)	AUTO - OOS	Specifies the monitoring time for checking the connection between the fieldbus host system and the PID function block in the ROUT operating mode. When the monitoring time elapses, the PID function block changes from the ROUT operating mode to the operating mode selected in the SHED_OPT parameter. 📖 A detailed description of the PID function blocks can be found in the FOUNDATION Fieldbus™ Function Blocks manual (BA00062S/04). **Factory default:** 640 000 $\frac{1}{32}$ ms
Strategy (STRATEGY)	AUTO - OOS	Parameter for grouping and thus faster evaluation of blocks. Grouping is carried out by entering the same numerical value in the STRATEGY parameter of each individual block. **Factory default: 0** ℹ This data is neither checked nor processed by the Resource Block.
Static Revision (ST_REV)	Read only	The revision status of the static data appears on the display. ℹ The revision status is incremented on each modification of static data.
Tag Description (TAG_DESC)	AUTO - OOS	Entry of a user-specific text for unique identification and assignment of the block.
Test Read Write (TEST_RW)	AUTO - OOS	ℹ This parameter is required only for interoperability tests and has no meaning in normal operation.
Update Event (UPDATE_EVT)	Read only	Indicates whether static block data have been altered, including date and time.
Write Alarm (WRITE_ALM)	AUTO - OOS	Displays the status of the write protected alarm. ℹ The alarm is triggered if the write protection is disabled.
Write Lock (WRITE_LOCK)	Read only	Display of the current write protection (setting only via DIP switch on the display). Display: • **LOCKED:** Device data cannot be modified • **NOT LOCKED:** Device data can be modified • **UNINITIALIZED**
Write Priority (WRITE_PRI)	AUTO - OOS	Specifies the behavior of a write protected alarm ("WRITE_ALM" parameter). User input: • 0 = The write protection alarm is not evaluated. • 1 = No report to the fieldbus host system in the event of a write protection alarm. Device data can be modified. • 2 = Reserved for block alarms. • 3-7 = The write protection alarm is output with the appropriate priority (3 = low priority, 7 = high priority) to the fieldbus host system as a user notice. • 8-15 = The write protection alarm is output with the appropriate priority (8 = low priority, 15 = high priority) to the fieldbus host system as a critical alarm. **Factory default: 0**

14.3 Transducer Blocks

The Transducer Blocks of the field transmitter contain all the measuring and device-specific parameters. All the settings directly connected with the application (temperature measurement) are made here. They form the interface between sensor-specific measured value processing and the Analog Input function blocks required for automation. → 🖾 18, 🕮 59

A Transducer Block allows you to influence the input and output variables of a function block. The parameters of a Transducer Block include information on the sensor configuration, physical units, calibration, damping, error messages, etc. as well as the device-specific parameters.

The device-specific parameters and functions of the field transmitter are split into several Transducer Blocks, each covering different task areas.

- **Transducer Block "Sensor 1" / base index 500 or Transducer Block "Sensor 2" / base index 600:** This block contains all the parameters and functions that have to do with measuring the input variables (e.g. temperature).
- **Transducer Block "Display" / base index 700:** The parameters of this block allow the configuration of the display.
- **Transducer Block "Advanced Diagnostic" / base index 800:** This block comprises the parameters for automatic monitoring and diagnosis.

14.3.1   Block output variables

The following table shows which output variables (process variables) the Transducer Blocks make available. Transducer Blocks "Display" and "Advanced Diagnostic" do not have any output variables. The CHANNEL parameter in the Analog Input function block is used to assign which process variable is read in and processed in the downstream Analog Input function block.

Block	Process variable	Channel parameter (AI Block)	Channel
Transducer Block "Sensor 1"	Primary Value	Primary Value 1	1
	Sensor Value	Sensor Value 1	3
	Device temperature value	Device temperature	5
Transducer Block "Sensor 2"	Primary Value	Primary Value 2	2
	Sensor Value	Sensor Value 2	4
	Device temperature value	Device temperature	6

### 14.3.2   Selecting the operating mode

The operating mode is set by means of the MODE_BLK parameter group. The Transducer Block supports the following operating modes:
- AUTO (automatic mode)
- OOS (out of service)
- MAN (manual mode)

ℹ️ The OOS block status is also displayed by means of the BLOCK_ERR parameter. → 📖 67

14.3.3   Alarm detection and processing

The Transducer Block does not generate any process alarms. The status of the process variables is evaluated in the downstream Analog Input function blocks. If the Analog Input function block receives no input value that can be evaluated from the Transducer Block then a process alarm is generated. This process alarm is displayed in the BLOCK_ERR parameter of the Analog Input function block (BLOCK_ERR = Input Failure).

The BLOCK_ERR parameter of the Transducer Block displays the device error that produced the input value that could not be evaluated and thus triggered the process alarm in the Analog Input function block. → 📖 67

14.3.4   Accessing the manufacturer-specific parameters

To access the manufacturer-specific parameters, the hardware write protection must be deactivated. → 📖 23

14.3.5 Selecting the units

The system units selected in the Transducer Blocks do not have any effect on the desired units which should be transmitted by means of the FOUNDATION Fieldbus interface. This setting is made separately via the corresponding AI Block in the XD_SCALE parameter group. The unit selected in the Transducer Blocks is only used for the onsite display and for displaying the measured values within the Transducer Block in the configuration program in question.

A detailed description of the Analog Input (AI) function block can be found in the FOUNDATION Fieldbus™ Function Blocks manual (BA00062S/ 04).

14.3.6 Transducer Block FF parameters

The following table lists all the specified FOUNDATION Fieldbus parameters of the Transducer Blocks. The device-specific parameters are described as of table 'Transducer Block "Sensor 1 and 2"

Parameter	Write access with operating mode (MODE_BLK)	Description
Static revision (STAT_REV)	AUTO - OOS	The revision status of the static data appears on the display. The revision status parameter is incremented on each modification of static data. This parameter is reset to 0 in all blocks in the event of a factory reset.
Tag description (TAG_DESC)	AUTO - OOS	Use this function to enter a user-specific text of max. 32 characters for unique identification and assignment of the block. **Factory setting:** _____ (no text)
Strategy (STRATEGY)	Read only	Parameter for grouping and thus faster evaluation of blocks. Grouping is carried out by entering the same numerical value in the STRATEGY parameter of each individual block. **Factory setting:** 0 These data are neither checked nor processed by the Transducer Blocks.
Alert key (ALERT_KEY)	AUTO - OOS	Use this function to enter the identification number of the plant unit. This information can be used by the fieldbus host system for sorting alarms and events. **User input:** 1 to 255 **Factory setting:** 0

Block Mode (MODE_BLK)	AUTO - OOS	Displays the current (Actual) and desired (Target) operating mode of the corresponding Transducer Block, the permitted modes (Permitted) supported by the Resource Block and the normal operating mode (Normal).
		Display: AUTO; OOS; MAN
		
		The Transducer Block supports the following operating modes:
		• AUTO (automatic mode):
		  The block is executed.
		• OOS (out of service):
		  The block is in the "Out of Service" mode. The process variable is updated, but the status of the process variable changes to BAD.
		• MAN (manual mode):
		  The block is in the "manual mode". The process variable is updated. This status shows that the resource block is "Out of Service".

Block Error (BLOCK_ERR)	Read only	The active block errors appear on the display.
		Display: OUT OF SERVICE - The block is in the "out of service" operating mode.
		
		The following block errors are only shown in the Sensor Transducer Blocks:
		• OTHER
		  Further information is availabe in the Advanced Diagnostic Transducer
		• BLOCK CONFIGURATION ERROR
		  The block has been configured incorrectly. In the parameter BLOCK_ERR_DESC1 the cause of the configuration error is displayed
		• SENSOR FAILURE
		  Error at one or both sensor inputs

Update Event (UPDATE_EVT)	AUTO - OOS	Indicates whether static block data have been altered, including date and time.

Parameter	Write access with operating mode (MODE_BLK)	Description
Block Alarm (BLOCK_ALM)	AUTO - OOS	The current block status appears on the display with information on pending configuration, hardware or system errors, including information on the alarm period (date, time) when the error occurred. ℹ️ • In addition, the active block alarm can be acknowledged in this parameter group. • The device does not use this parameter to display a process alarm since this is generated in the BLOCK_ALM parameter of the Analog Input function block.
Transducer Type (TRANSDUCER_ TYPE)	Read only	The Transducer Block type appears on the display. **Display:** • Sensor Transducer Blocks: Custom Sensor Transducer • Display Transducer Block: Custom Display Transducer • Advanced Diagnostic Block: Custom Adv. Diag. Transducer
Transducer Type Version (TRANSDUCER_ TYPE_VER)	Read only	Display of the transducer block type version.
Collection Directory (COLLECTION_ DIR)	Read only	Display of the Collection Directory, always 0.
Transducer Error (XD_ERROR)	Read only	The active device error appears on the display. Exact error description as well as information on rectifying faults see section 'Diagnostics and troubleshooting'. → 🖺 36 **Possible display:** • No error (normal status) • Electronics failure • Data integrity error • Mechanical failure • Configuration error • Calibration error • General error ℹ️ Summarized device status/condition, more precise information on the pending error(s) is available by means of the manufacturer-specific error display. This can be read via the Transducer Block "Advanced Diagnostic" in the "ACTUAL_STATUS_CATEGORY" and "ACTUAL_STATUS_NUMBER" parameters.

14.3.7 Transducer Blocks 'Sensor 1 and 2'

The 'Sensor 1 and 2' Transducer Blocks analyze the signals of both sensors by way of technical measurement techniques and display them as a physical variable (value, measured value status and unit). Two physical measured values and an additional primary value which is mathematically calculated from the sensor values (the PRIMARY_VALUE) are available in each Sensor Transducer Block:

• The sensor value (SENSOR_VALUE) and its unit (SENSOR_RANGE -> UNITS_INDEX)
• The value of the internal temperature measurement of the device (DEVTEMP_VALUE) and its unit (RJ_VALUE_UNIT)
• The primary value (PRIMARY_VALUE -> VALUE) and its unit (PRIMARY_VALUE_UNIT)

The internal temperature measurement of the reference junction is analyzed in both Transducer Blocks but both values are identical. A third value in the block, the PRIMARY_VALUE, is formed from the sensor values.

The rule for forming the PRIMARY_VALUE can be selected in the PRIMARY_VALUE_TYPE parameter. The sensor value can be mapped unchanged in PRIMARY_VALUE but there is also the option of forming the differential value or mean value for both sensor values. In addition, various additional functions for connecting the two sensors are also available. These can help increase process safety, like the backup function or sensor drift detection.

- Backup function:
  If a sensor fails, the system automatically switches to the remaining sensor and a diagnostic message is generated in the device. The backup function ensures that the process is not interrupted by the failure of an individual sensor and that an extremely high degree of safety and availability is achieved.
- Sensor drift detection:
  If 2 sensors are connected and the measured values differ by a specified value, the device generates a diagnostic message. The drift detection function can be used to verify the correctness of the measured values and for mutual monitoring of the connected sensors. Sensor drift detection is configured in the Transducer Block 'Advanced Diagnostic'.
  → 🖹 75

The electronics can be configured for various sensors and measured variables by means of the SENSOR_TYPE parameter.

If resistance thermometers or resistance transmitters are connected, the type of connection can be selected by means of the SENSOR_CONNECTION parameter. If the "two-wire" type of connection is used, the TWO_WIRE_COMPENSATION parameter is available. This parameter is used to store the resistance value of the sensor connection cables.

The resistance value can be calculated as follows:
- Total cable:100 m
- Conductor cross-section: 0.5 mm^2
- Conductor material: copper
- Resistivity of Cu: 0.0178 Ω * mm^2/m

R = 0.0178 Ω * mm^2/m * (2 * 100 m)/0.5 mm^2 = 7.12 Ω. Resulting measured error = 7.12 Ω / 0.385 Ω/K = 18.5 K

ℹ️ The Transducer Blocks for sensor 1 and 2 have a wizard (configuration assistant) for calculating the resistance of sensor cables with different material properties, cross-sections and lengths.

When measuring temperature with thermocouples, the type of reference junction compensation is specified in the RJ_TYPE parameter. For the compensation, the internal terminal temperature measurement of the device (INTERNAL) can be used or a fixed value can be specified (EXTERNAL). This value has to be entered in the RJ_EXTERNAL_VALUE parameter.

The units displayed are selected with the PRIMARY_VALUE_UNIT and SENSOR_RANGE → UNITS_INDEX parameters. It must be ensured that the units selected physically suit the measured variables.

ℹ️ The Sensor 1 and 2 Transducer Blocks each make the "Quick Setup" wizard available to configure the measuring settings quickly and safely.

Sensor error adjustment can be performed with the sensor offset. Here, the difference between the reference temperature (target value) and the measured temperature (actual value) is determined and entered in the SENSOR_OFFSET parameter. This offsets the standard sensor characteristic in parallel and an adjustment between the target value and actual value is performed.
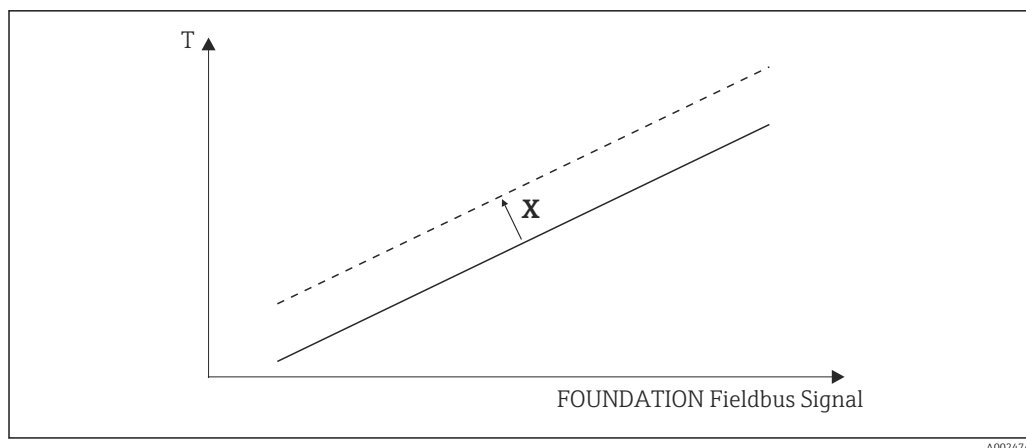
⊠ 19   Sensor offset

X   Offset
——   Standard sensor characteristic
*- - - Sensor characteristic with offset setting*

Linearization

The Sensor 1 and 2 Transducer Blocks also give users the option of linearizing any sensor type by entering polynom coefficients. The design provides for three types. Each of the values can be passed onto an AI function block or shown on the display. The AI and the Display Block make further options available for displaying and scaling measured values.

Linear scaling of temperature-linear curve

With the aid of linear scaling (offset and slope), the complete measuring point (measuring device + sensor) can be adapted to the desired process. Users must run through the following procedure for this purpose.

1. Switch the setting for the SENSOR_CAL_METHOD parameter to "user trim standard calibration". Then apply the lowest process value to be expected (e.g. −10 ℃) to the sensor of the device. This value is then entered in the CAL_POINT_LO parameter. Make sure that the status for SENSOR_VALUE is "Good".

2. Now expose the sensor to the highest process value to be expected (e.g. +120 ℃), again ensure the status is "Good" and enter the value in the CAL_POINT_HI parameter. The device now precisely shows the specified process value at the two calibrated points. The curve follows a straight line between the points.

3. The SENSOR_CAL_LOC, SENSOR_CAL_DATE and SENSOR_CAL_WHO parameters are available to track sensor calibration. The place, date and time of calibration can be entered here as well as the name of the person responsible for the calibration.

4. To undo sensor input calibration, the SENSOR_CAL_METHOD parameter is set to "Factory Trim Standard Calibration".

ℹ️ Menu guidance via the "User Sensor Trim" wizard is available for linear scaling. The "Factory Trim Settings" wizard can be used to reset the scaling.
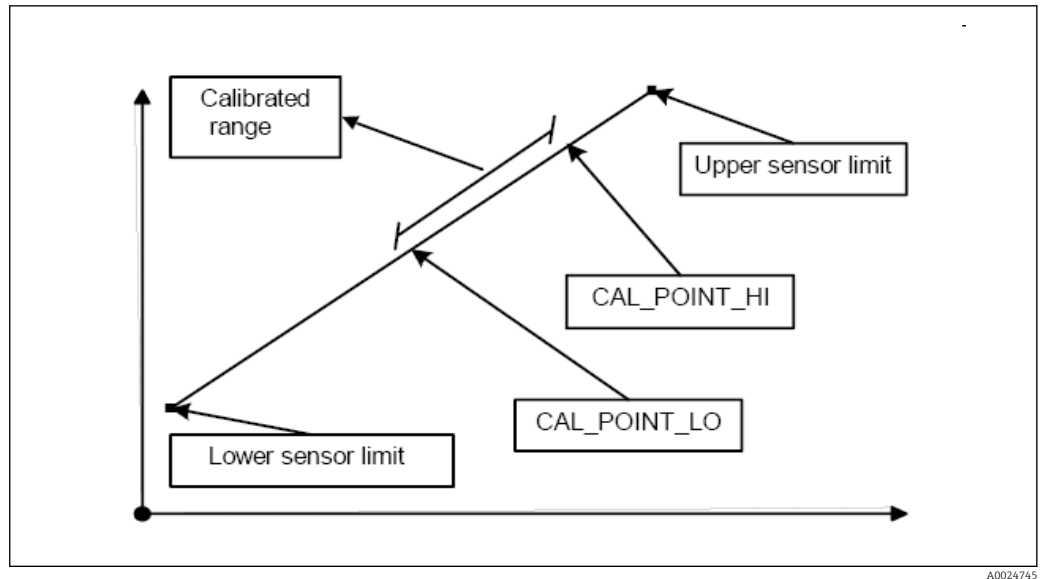
☒ *20   Linear scaling of temperature-linear curve*

Linearization of platinum resistance thermometers with the aid of Callendar-Van Dusen coefficients:

The coefficients R0, A, B, C can be specified in the CVD_COEFF_R0, CVD_COEFF_A, CVD_COEFF__B, CVD_COEFF_C parameters. To activate this linearization, select the "RTD Callendar Van Dusen" setting in the SENSOR_TYPE parameter. In addition, the upper and lower calculation limits have to be entered in the CVD_COEFF_MIN and CVD_COEFF_MAX parameters.

> The Callendar-Van Dusen coefficients can also be entered by means of the "Callendar Van Dusen" wizard.

Linearization of copper/nickel resistance thermometers (RTD)

The coefficients R0, A, B, C can be specified in the POLY_COEFF_R0, POLY_COEFF_A, POLY_COEFF_B, POLY_COEFF_C parameters. To activate this linearization, select the "RTD Polynom Nickel" or "RTD Polynom Copper" setting in the SENSOR_TYPE parameter. In addition, the upper and lower calculation limits have to be entered in the POLY_COEFF_MIN and POLY_COEFF_MAX parameters.

> The coefficients for nickel and copper polynoms can be entered with the aid of a wizard in the Transducer Blocks 'Sensor 1 and 2'.

Block configuration error

Due to an incorrect setting the device might display the event **437-configuration**. This means that the current transmitter configuration is not valid. The parameter BLOCK_ERR_DESC1 in the transducer blocks shows the cause of this configuration error.

Display	Description
Sensor 1 is 4-wire RTD and sensor 2 is RTD	If sensor 1 is configured as a 4-wire RTD, no RTD can be selected at sensor 2.
Sensor type 1 and sensor unit 1 do not match	The sensor type at channel 1 and the selected sensor unit do not match.
Sensor type 2 and sensor unit 2 do not match	The sensor type at channel 2 and the selected sensor unit do not match.
PV type calculation mode and "No Sensor " chosen	The PV is an interconnection of the two sensor inputs, however "No Sensor" is selected as sensor type.
PV type calculation mode, sensor 1 unit Ω and sensor 2 unit not Ω	The PV is an interconnection of the two sensor inputs, the sensor unit 1 is Ω, however sensor unit 2 is not.

Display	Description
PV type calculation mode, sensor 2 unit Ω and sensor 1 unit not Ω	The PV is an interconnection of the two sensor inputs, the sensor unit 2 is Ω, however sensor unit 1 is not.
PV type calculation mode, sensor 1 unit mV and sensor 2 unit not mV	The PV is an interconnection of the two sensor inputs, the sensor unit 1 is mV, however the sensor unit 2 is not.
PV type calculation mode, sensor 2 unit mV and sensor 1 unit not mV	The PV is an interconnection of the two sensor inputs, the sensor unit 2 is mV, however the sensor unit 1 is not.
Sensor 1 unit and PV unit do not match	The sensor unit 1 and the PV unit are not compatible.
Sensor 2 unit and PV unit do not match	The sensor unit 2 and the PV unit are not compatible.
Drift and "No Sensor" chosen	The sensor drift function has been activated however "No Sensor" was selected as sensor type.
Drift chosen and units do not match	The sensor drift function has been activated however the units of the two sensors are not compatible.

Device-specific parameters

The following table shows all the Endress+Hauser-device-specific parameters of the sensor Transducer Blocks 'Sensor 1 and 2'.

Parameter	Write access with operating mode (MODE_BLK)	Description
Primary value (PRIMARY_VALUE)	Dynamic / read only	Result of link PRIMARY_VALUE_TYPE: • VALUE • STATUS ℹ The PRIMARY_VALUE can be made available to the AI Block for further processing. The assigned unit is the PRIMARY_VALUE_UNIT.
Primary value unit (PRIMARY_VALUE_UNIT)	OOS	Configuring the unit of the PRIMARY_VALUE. ℹ The measurement range and engineering units are configured with an existing link in the relevant Analog Input function block using the XD_SCALE parameter group. A detailed description of the Analog Input (AI) function block can be found in the FOUNDATION Fieldbus™ Function Blocks manual (BA00062S/04).
Primary value type (PRIMARY_VALUE_TYPE)	OOS	The calculation process for the PRIMARY_VALUE appears on the display. Sensor Transducer 1: PV = SV_1: Sensor Value 1 PV = SV_1-SV_2: Difference PV = 0.5 x (SV_1+SV_2): Average PV = 0.5 x (SV_1+SV_2) redundancy: Average or Sensor Value 1 or Sensor Value 2 in the event of a sensor error in the other sensor. PV = SV_1 (OR SV_2): Backup function: If sensor 1 fails, the value of sensor 2 automatically becomes the Primary Value. PV = SV_1 (OR SV_2 if SV_1>T): PV changes from SV_1 to SV_2 if SV_1 > value T (THRESHOLD_VALUE parameter) Sensor Transducer 2: PV = SV_2: Sensor Value 2 PV = SV_2-SV_1: Difference PV = 0.5 x (SV_2+SV_1): Average PV = 0.5 x (SV_2+SV_1) redundancy: Average or Sensor Value 1 or Sensor Value 2 in the event of a sensor error in the other sensor. PV = SV_2 (OR SV_1): Backup function: If sensor 2 fails, the value of sensor 1 automatically becomes the Primary Value. PV = SV_2 (OR SV_1 if SV_2>T): PV changes from SV_2 to SV_1 if SV_2 > value T (THRESHOLD_VALUE parameter)
Threshold value (THRESHOLD_VALUE)	OOS	Value for switching in the threshold PV mode. Entry in the range from −270 to +2 450 ℃ (−454 to +4 442 ℉)
Primary value max. indicator (PV_MAX_INDICATOR)	AUTO - OOS	Max. indicator for PV is stored in the nonvolatile memory in intervals of 10 minutes. Can be reset.

Parameter	Write access with operating mode (MODE_BLK)	Description
Primary value min. indicator (PV_MIN_INDICATOR)	AUTO - OOS	Min. indicator for PV is stored in the nonvolatile memory in intervals of 10 minutes. Can be reset.
Sensor value (SENSOR_VALUE)	Dynamic / read only	Sensor Transducer 1: • VALUE = Value of the sensor connected to the S1 terminal group • STATUS = Status of this value Sensor Transducer 2: • VALUE = Value of the sensor connected to the S2 terminal group • STATUS = Status of this value
Sensor type (SENSOR_TYPE)	OOS	Configuration of the sensor type: • Sensor Transducer 1: Settings for sensor input 1 • Sensor Transducer 2: Settings for sensor input 2 ⓘ Please observe the wiring diagram when connecting the individual sensors. In the case of 2-channel operation, the possible connection options also have to be observed. → 🗏 16
Sensor connection (SENSOR_CONNECTION)	OOS	Sensor connection mode. Sensor Transducer 1: • 2-wire • 3-wire • 4-wire Sensor Transducer 2: • 2-wire • 3-wire
Sensor range (SENSOR_RANGE)	Read only (EU_100, EU_0) OOS (UNITS_INDEX, DECIMAL)	Physical measuring range of the sensor: • EU_100 (upper sensor range limit) • EU_0 (lower sensor range limit) • UNITS_INDEX (unit of the SENSOR_VALUE) • DECIMAL (places after the decimal point for the SENSOR_VALUE. This does not affect the measured value display.)
Sensor offset (SENSOR_OFFSET)	OOS	Offset of the SENSOR_VALUE. The following values are permitted: –10 to +10 for Celsius, Kelvin, mV and Ohm –18 to +18 for Fahrenheit, Rankine
2-wire compensation (TWO_WIRE_COMPENSATION)	OOS	Two-wire compensation with the following permitted values: 0 to 30 Ω
Sensor serial number (SENSOR_SN)	AUTO - OOS	Serial number of the sensor.
Sensor max. indicator (SENSOR_MAX_INDICATOR)	AUTO - OOS	Max. indicator of the SENSOR_VALUE - Is stored in the nonvolatile memory in intervals of 10 minutes. Can be reset.
Sensor min. indicator SENSOR_MIN_INDICATOR	AUTO - OOS	Min. indicator of the SENSOR_VALUE - Is stored in the nonvolatile memory in intervals of 10 minutes. Can be reset.
Mains filter (MAINS_FILTER)	OOS	Mains filter for the A/D converter.
Calibration highest point (CAL_POINT_HI)	OOS	Upper point for linear characteristic calibration (this affects offset and slope). ⓘ To write to this parameter, SENSOR_CAL_METHOD must be set to 'User Trim Standard Calibration'.
Calibration lowest point (CAL_POINT_LO)	OOS	Lower point for linear characteristic calibration (this affects offset and slope). ⓘ To write to this parameter, SENSOR_CAL_METHOD must be set to 'User Trim Standard Calibration'.
Calibration minimum span (CAL_MIN_SPAN)	OOS	Span of the measuring range, depending on the sensor type set.
Calibration unit (CAL_UNIT)	Read only	Unit for sensor calibration.

Parameter	Write access with operating mode (MODE_BLK)	Description
Sensor calibration method (SENSOR_CAL_ METHOD)	OOS	• Factory trim standard calibration: Sensor linearization with the factory calibration values • User trim standard calibration: Sensor linearization with the values CAL_POINT_HI and CAL_POINT_LO ℹ The original linearization can be established by resetting this parameter to 'Factory Trim Standard Calibration'. For linear characteristic calibration, the Transducer Block makes a wizard available (User Sensor Trim).
Sensor calibration location (SENSOR_CAL_ LOC)	OOS	Name of the location where the sensor calibration was carried out. ℹ To write to this parameter, SENSOR_CAL_METHOD must be set to 'User Trim Standard Calibration'.
Sensor calibration date (SENSOR_CAL_ DATE)	OOS	Date and time of the calibration. ℹ To write to this parameter, SENSOR_CAL_METHOD must be set to 'User Trim Standard Calibration'.
Sensor calibration who (SENSOR_CAL_ WHO)	OOS	Name of the person responsible for the calibration. ℹ To write to this parameter, SENSOR_CAL_METHOD must be set to 'User Trim Standard Calibration'.
Callendar Van Dusen A (CVD_COEFF_A)	OOS	Sensor linearization based on the Callendar Van Dusen method.
Callendar Van Dusen B (CVD_COEFF_B)	OOS	ℹ The CVD_COEFF_XX parameters are used for calculating the response curve if 'RTD Callendar Van Dusen' is set in the SENSOR_TYPE parameter. Both Transducer Blocks make a wizard available for configuring the parameters based on the 'Callendar Van Dusen method'.
Callendar Van Dusen C (CVD_COEFF_C)	OOS	
Callendar Van Dusen R0 (CVD_COEFF_R0)	OOS	
Callendar Van Dusen Measuring Range Maximum (CVD_COEFF_MAX)	OOS	Upper calculation limit for Callendar Van Dusen linearization.
Callendar Van Dusen Measuring Range Minimum (CVD_COEFF_MIN)	OOS	Lower calculation limit for Callendar Van Dusen linearization.
Polynom Coeff. A (POLY_COEFF_A)	OOS	Sensor linearization of copper/nickel resistance thermometers (RTD).
Polynom Coeff. B (POLY_COEFF_B)	OOS	ℹ The POLY_COEFF_XX parameters are used for calculating the response curve if 'RTD Polynom Nickel or RTD Polynom Copper' is set in the SENSOR_TYPE parameter. Both Transducer Blocks make a wizard (sensor polynom) available for configuring the parameters based on the 'Polynom method'.
Polynom Coeff. C (POLY_COEFF_C)	OOS	
Polynom Coeff. R0 (POLY_COEFF_R0)	OOS	
Polynom (Nickel/ Copper) Measuring Range Maximum (POLY_COEFF_MAX)	OOS	Upper calculation limit for the RTD polynom (nickel/copper) linearization.
Polynom (Nickel/ Copper) Measuring Range Minimum (POLY_COEFF_MIN)	OOS	Lower calculation limit for the RTD polynom (nickel/copper) linearization.
Device temperature (DEVTEMP_VALUE)	Dynamic / read only	Internal device temperature measurement: • VALUE • STATUS
Reference junction type (RJ_TYPE)	OOS	Configuration of reference junction measurement for temperature compensation: • NO_REFERENCE: No temperature compensation is used. • INTERNAL: Internal reference junction temperature is used for the temperature compensation. • EXTERNAL: RJ_EXTERNAL_VALUE is used for the temperature compensation.
Device temperature value unit (RJ_VALUE_UNIT)	Read only	Unit of the internal device temperature. This always corresponds to the unit set in SENSOR_RANGE → UNITS_INDEX.
Reference junction external value (RJ_EXTERNAL_VALUE)	OOS	Value for temperature compensation (see RJ_TYPE parameter).
Device temperature max. indicator (DEVTEMP_MAX_INDICA TOR)	AUTO - OOS	Max. indicator of the internal device temperature is stored in the nonvolatile memory in intervals of 10 minutes.
Device temperature min. indicator (DEVTEMP_MIN_INDICA TOR)	AUTO - OOS	Min. indicator of the internal device temperature is stored in the nonvolatile memory in intervals of 10 minutes.

14.3.8   Transducer Block 'Advanced Diagnostic'

The Transducer Block "Advanced Diagnostic" is used to configure and display all the diagnostic functions of the transmitter. Functions such as: corrosion detection, drift detection, ambient temperature monitoring are displayed here.

Corrosion detection

Sensor connection cable corrosion can lead to false measured value readings. Therefore the unit offers the possibility to recognize any corrosion before a measured value is affected. Corrosion monitoring is only possible for RTD with a 4-wire connection and thermocouples. → 🖺 38

Drift detection

Drift detection can be configured with the SENSOR_DRIFT_MONITORING parameter. Drift detection can be enabled or disabled.

If drift detection is enabled and a drift occurs, an error or maintenance prompt is output. A distinction is made between 2 different modes (SENSOR_DRIFT_MODE). In the 'Overshooting' mode, a status message is output if the limit value (SENSOR_DRIFT_ALERT_VALUE) for the drift is overshot, or, as the case may be, if the limit value is undershot in the 'Undershooting' mode.
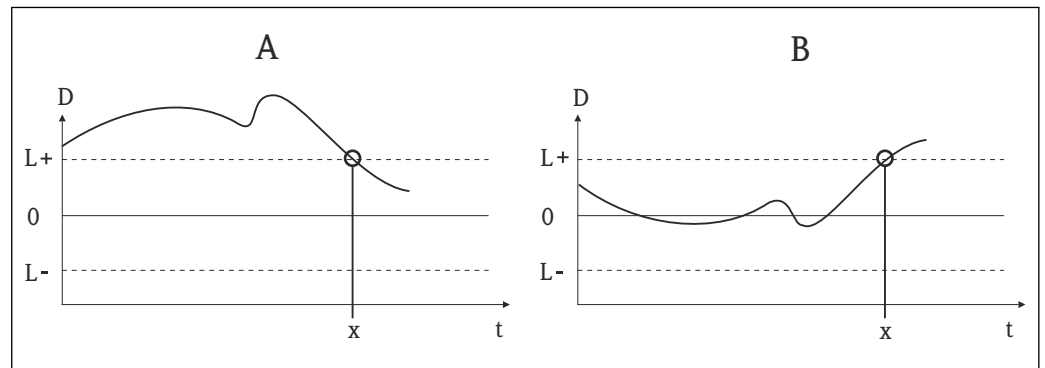
🖻 *21   Drift detection*

A   'Undershooting' mode
B   'Overshooting' mode
D   Drift
L+,   Upper (+) or lower (-) limit value
L-
t   Time
x   Error or prompt for maintenance, depending on the configuration

In addition, the entire status information of the device and the maximum indicators of the two sensor values and the internal temperature are available.

The following table shows all the Endress+Hauser parameters of the sensor Transducer Block 'Advanced Diagnostic'.

Parameter	Write access with operating mode (MODE_BLK)	Description
Corrosion detection (CORROSION_ DETECTION)	OOS	• OFF: Corrosion detection off • ON: Corrosion detection on ℹ️ Only possible for RTD 4-wire connection and thermocouples (TC).
Sensor Drift monitoring (SENSOR_DRIFT_ MONITORING)	OOS	Deviation between SV1 and SV2 will be displayed according to the Field Diagnostic configuration of the diagnostic event "103-Drift": • OFF: Sensor deviation monitoring off (diagnostic event 103 has been deactivated) • ON: Sensor deviation monitoring on (when occurring the diagnostic event 103 with the respectively configured category is displayed)

Parameter	Write access with operating mode (MODE_BLK)	Description
Sensor Drift mode (SENSOR_DRIFT_ MODE)	OOS	Select whether a status is generated if the value set in the SENSOR_DRIFT_LIMIT parameter is undershot (Undershooting) or overshot (Overshooting). **ℹ** If "Overshooting" is selected, the corresponding diagnostic event is generated if the limit value is overshot (SENSOR_DRIFT_LIMIT). In the case of "Undershooting", the diagnostic event is output if the limit value is undershot.
Sensor Drift alert value (SENSOR_DRIFT_ ALERT_VALUE)	OOS	Limit value of the permitted deviation from 1 to 999.99.
System Alarm delay (SYSTEM_ ALARM_DELAY)	OOS	Alarm hysteresis: Value as to the time a device status (Failure or Maintenance) and measured value status (Bad or Uncertain) is delayed until the status is output. Can be configured between 0 and 10 seconds. **ℹ** This setting does not affect the display.
Actual Status Category / Previous Status Category (ACTUAL_ STATUS_ CATE GORY / PREVIOUS_ STATUS_ CATEGORY)	Read only / AUTO - OOS	**Current/last status category** • Good: No errors detected • F: Failure: Error detected • C: Function check: Device is in the service mode • S: Out of Spec.: Device is being operated outside the specifications • M: Maintenance required: Maintenance necessary • Not categorized: No NAMUR category has been selected for the current diagnostic event
Actual Status Number / Previous Status Number (ACTUAL_ STATUS_ NUMBER / PREVIOUS_ STATUS_ NUMBER)	Read only / AUTO - OOS	**Current/last status number** • **000 NO_ERROR:** No error is present • **041 SENSOR_BREAK:** Sensor rupture • **043 SENSOR_SHORTCUT:** Sensor short circuit • **042 SENSOR_CORROSION:** Corrosion of connections or sensor cables • **101 SENSOR_UNDERUSAGE:** Measured value of the sensor is below the linearization range • **102 SENSOR_OVERUSAGE:** Measured value of the sensor is above the linearization range • **104 BACKUP_ACTIVATED:** Backup function activated due to sensor failure • **103 DEVIATION:** Sensor drift detected • **501 DEVICE_PRESET:** Reset routine in progress • **482 SIMULATION:** Device is in the simulation mode • **402 STARTUP:** Device is in the startup/initialization phase • **502 LINEARIZATION:** Linearization incorrectly selected or configured • **901 AMBIENT_TEMPERATURE_LOW:** Ambient temperature too low; DEVTEMP_VALUE < −40 ℃ (−40 ℉) • **902 AMBIENT_TEMPERATURE_HIGH:** Ambient temperature too high; DEVTEMP_VALUE > +85 ℃ (+185 ℉) • **261 ELECTRONICBOARD:** Electronics module/hardware faulty • **431 NO_CALIBRATION:** Calibration values lost/modified • **283 MEMORY_ERROR:** Contents of memory inconsisten • **221 RJ_ERROR:** Error in reference junction measurement/internal temperature measurement
Actual Status Channel/ Previous Status Channel (PREVIOUS/ ACTUAL_ STATUS_ CHANNEL)	Read only / AUTO - OOS	• ACTUAL_STATUS_CHANNEL displays the channel that currently has the error with the highest value. • PREVIOUS_STATUS_CHANNEL indicates the channel where an error last occurred.
Actual Status Description / Previous Status Description (PREVIOUS/ ACTUAL_ STATUS_DESC)	Read only / AUTO - OOS	Displays the descriptions of the current and previous error status. **ℹ** The descriptions can be taken from the description for the Actual Status Number/ Previous Status Number parameter.
Actual Status Count (ACTUAL_ STATUS_ COUNT)	Read only	The number of status messages currently pending in the device.
Primary Value 1 Max. Indicator (PV1_MAX_ INDICATOR)	AUTO - OOS	Indicator for the maximum value to occur for PV1, can be reset by writing an arbitrary value in this parameter
Primary Value 1 Min. Indicator (PV1_MIN_ INDICATOR)	AUTO - OOS	Indicator for the minimum value to occur for PV1, can be reset by writing an arbitrary value in this parameter.
Primary Value 2 Max. Indicator (PV2_MAX_ INDICATOR)	AUTO - OOS	Indicator for the maximum value to occur for PV2, can be reset by writing an arbitrary value in this parameter.

Parameter	Write access with operating mode (MODE_BLK)	Description
Primary Value 2 Min. Indicator (PV2_MIN_ INDICATOR)	AUTO - OOS	Indicator for the minimum value to occur for PV2, can be reset by writing an arbitrary value in this parameter.
Sensor 1 Max. Indicator (SV1_MAX_ INDICATOR)	AUTO - OOS	Indicator for the maximum value to occur at sensor 1, can be reset by writing an arbitrary value in this parameter.
Sensor 1 Min. Indicator (SV1_MIN_ INDICATOR)	AUTO - OOS	Indicator for the minimum value to occur at sensor 1, can be reset by writing an arbitrary value in this parameter.
Sensor 2 Max. Indicator (SV2_MAX_ INDICATOR)	AUTO - OOS	Indicator for the maximum value to occur at sensor 2, can be reset by writing an arbitrary value in this parameter.
Sensor 2 Min. Indicator (SV2_MIN_ INDICATOR)	AUTO - OOS	Indicator for the minimum value to occur at sensor 2, can be reset by writing an arbitrary value in this parameter.
Device temperature max. Indicator (DEVTEMP_MAX_ INDICATOR)	AUTO - OOS	Indicator for the maximum value to occur at the internal reference temperature measuring point, can be reset by writing an arbitrary value in this parameter.
Device temperature min. Indicator (DEVTEMP_MIN_ INDICATOR)	AUTO - OOS	Indicator for the minimum value to occur at the internal reference temperature measuring point, can be reset by writing an arbitrary value in this parameter.
CONFIG_AREA_1 ...CONFIG_AR EA _15	OOS	The configurable area of the FOUNDATION Fieldbus Field Diagnostics. One of the four diagnostic events: • 42 - Corrosion • 103 - Drift • 901 - Ambient temperature too low • 902 - Ambient temperature too high can be separated from the factory configured diagnostic group and can be categorized individually. By setting to one of the Field Diagnostic Bits 1-15 the category for this Bit can be configured to the categories F, C, S, M in the Resource Block. → 📄 83
STATUS_SELECT _42	OOS	The value status (BAD, UNCERTAIN, GOOD) for the respective diagnostic event can be configured.
STATUS_SELECT _103	OOS	
STATUS_SELECT _901	OOS	
STATUS_SELECT _902	OOS	
DIAGNOSIS_ SIMULATION_ ENABLE	OOS	Activating or deactivating of the simulation of an diagnostic event.
DIAGNOSIS_ SIMULATION_ NUMBER	AUTO - OOS	Selection of the diagnostic event to be simulated.

14.3.9 Transducer Block 'Display'

The settings in the 'Display' Transducer Block make it possible to display measured values from the two Transducer Blocks 'Sensor 1 and 2' on the display which can be purchased as an option. The selection is made by means of the DISPLAY_SOURCE_X1 parameter. The number of decimal places displayed can be configured independently for every channel using the DISP_VALUE_X_FORMAT parameter. Symbols are available for the units ℃, K, F, %, mV, R and Ω. These units are displayed automatically when the measured value is selected. Further units will be attached automatically to the additional text of the measured value.

This additional text is entered in the DISP_VALUE_X_TEXT parameter and has a maximum length of 16 characters. In addition, the display allows the user to display a scalable bar graph. The minimum and maximum values of the bar graph are specified by means of the DISP_VALUE_X_BGMIN and DISP_VALUE_X_BGMAX parameters. The "Display" Transducer Block can show up to 6 values alternately on the display, including the related text and bar graph. The system automatically switches between the values after a configurable time interval (between 2 and 20 seconds) which can be set in the ALTERNATING_TIME parameter.

The measured values of external devices are read into the device with the "Input Selector (ISEL)" or "PID" function block provided these values are available on the bus. Four values are available in the display from the Input Selector Block (ISEL) and one from the PID. The unit of the measured value is not displayed automatically for values from the Input Selector (ISEL) and PID Blocks. It is recommended to enter the unit as additional text here (DISP_VALUE_X_TEXT). The value displayed and its status are shown in the "DISPLAY_VALUE_X" parameter for every channel of the display.

The following table shows all the Endress+Hauser parameters of the sensor Transducer Block 'Display'.

Parameter	Write access with operating mode (MODE_BLK)	Description
Alternating time ALTERNATING_ TIME	AUTO - OOS	Entry (in s) as to how long a value should be shown on the display. Setting from 2 to 20 s.
Display value x DISP_VALUE_X [1]	Read only	Selected measured value: • Status • Value
Display source x DISP_SOURCE_X	AUTO - OOS	For selecting the value to be displayed. Possible settings: • Off • Primary Value 1 • Sensor Value 1 • Primary Value 2 • Sensor Value 2 • Device temperature ⓘ If all 6 display channels are switched off ('Off' option), the display will show "------".
Display value description x DISP_VALUE_X_ DESC	AUTO - OOS	Description of the display value displayed. ⓘ Maximum 12 letters. The value is not shown on the display.
Decimal places x DISP_VALUE_ X_FORMAT	AUTO - OOS	For selecting the number of places displayed after the decimal point. Configuration option from 0 to 4. The option 4 means 'AUTO'. The maximum number of decimal places possible always appears on the display. Possible settings: • Auto • xxxxx • xxxx.x • xxx.xx • xx.xxx

1) X = number of the display channel in question (1 to 3)

Configuration example. The following measured values should be shown on the display:

Value 1

Measured value to be displayed	Primary value of Sensor Transducer 1 (PV1)
Text to be displayed	TEMP PIPE 11
Decimal places	2
Maximum temperature	250 ℃
Minimum temperature	50 ℃

Value 2

Measured value to be displayed	RJ value of sensor transducer 2
Text to be displayed	INTERN TEMP
Decimal places	1
Maximum temperature	0 ℃
Minimum temperature	40 ℃

Value 3

Measured value to be displayed	Measured value of an external device read in by the bus with Input Selector (ISEL) channel 2
Text to be displayed	VALVE 3 POS
Decimal places	3
Maximum temperature	0 ℃
Minimum temperature	100 ℃

Every measured value should be visible on the display for 12 seconds.

For this purpose, the following settings should be made in the 'Display' Transducer Block:

Parameter	Value
DISP_SOURCE_1	'Primary Value 1'
DISP_VALUE_1_TEXT	TEMP PIPE 11
DISPLAY_VALUE_1_FORMAT	'xxx.xx'
DISP_VALUE_1_BGMAX	250
DISP_VALUE_1_BGMIN	50
DISP_SOURCE_2	'RJ VALUE 2'
DISP_VALUE_2_TEXT	INTERN TEMP
DISPLAY_VALUE_2_FORMAT	'xxxx.x'
DISP_VALUE_2_BGMAX	40
DISP_VALUE_2_BGMIN	0
DISP_SOURCE_3	'ISEL IN 2'
DISP_VALUE_3_TEXT	VALVE 3 POS
DISPLAY_VALUE_3_FORMAT	'xx.xxx'
DISP_VALUE_3_BGMAX	100
DISP_VALUE_3_BGMIN	0
ALTERNATING_TIME	12

14.4 Analog Input function block

In the Analog Input (AI) function block, the process variables of the Transducer Blocks are prepared for subsequent automation functions (e.g. linearization, scaling and limit value processing). The automation function is defined by connecting up the outputs.

A detailed description of the Analog Input (AI) function block can be found in the FOUNDATION Fieldbus™ Function Blocks manual (BA00062S/ 04).

14.5 PID function block (PID controller)

A PID function block contains the input channel processing, the proportional integraldifferential control (PID) and the analog output channel processing. The configuration of the PID function block depends on the automation task. The following can be realized: Basic controls, feedforward control, cascade control, cascade control with limiting.

A detailed description of the PID function block can be found in the FOUNDATION Fieldbus™ Function Blocks manual (BA00062S/04).

14.6   Input Selector function block

The signal selector block (Input Selector block = ISEL) provides selection of up to four inputs and generates an output based on the configured action.

A detailed description of the Input Selector function block can be found in the FOUNDATION Fieldbus™ Function Blocks manual (BA00062S/04).

14.7   Configuration of event behaviour according to FOUNDATION Fieldbus™ field diagnostics

The device supports the FOUNDATION Fieldbus Field Diagnostics configuration. Among other things this means:

- The diagnostic category according to NAMUR recommendation NE107 is transferred via the fieldbus in a manufacturer-independent form:
  - F: Failure
  - C: Function check
  - S: Out of specification
  - M: Maintenance required
- The diagnostic category of the predefined event groups can be adapted by the user according to the requirements of the respective application.
- Certain events can be separated from their group and can be treated separately:
  - 042: Sensor corrosion
  - 103: Drift
  - 901: Ambient temperature too low
  - 902: Ambient temperature too high
- Additional information and troubleshooting measures will be transferred with the event message via the fieldbus.

It has to be ensured that the option Multi-bit Alarm Support is activated in the parameter FEATURE_SEL from the Resource Block.

14.7.1   Event groups

The diagnostic events are divided into 16 default groups according to the source and the importance of the event. A default event category is assigned to each group ex works. One bit of the assignment parameters belongs to each event group. The following table defines default assignments of event messages to the respective group.

Event weighting	Default event category	Event source	Bit	Events of this group
Highest weighting	Failure (F)	Sensor	31	• F041: Sensor line break • F043: Sensor short circuit
		Electronics	30	• F221: Reference measurement • F261: Device electronics • F283: Memory error
		Configuration	29	• F431: Reference values • F437: Configuration error
		Process	28	Not used with this device

Event weighting	Default event category	Event source	Bit	Events of this group
High weighting	Function check (C)	Sensor	27	Not used with this device
		Electronics	26	Not used with this device

Event weighting	Default event category	Event source	Bit	Events of this group
		Configuration	25	• C402: Device initialization • C482: Simulation active • C501: Device reset
		Process	24	Not used with this device

Event weighting	Default event category	Event source	Bit	Events of this group
Low weighting	Out of specification (S)	Sensor	23	Not used with this device
		Electronics	22	Not used with this device
		Configuration	21	S502: Special linearization
		Process	20	• S901: Ambient temperature too low [1] • C902: Ambient temperature too high [1]

1)　　　This event can be removed from this group and treated separately; see section 'Configurable area'.

Event weighting	Default event category	Event source	Bit	Events of this group
Least weighting	Maintencance required (M)	Sensor	19	• M042: Ambient temperature too low • M101: Ambient temperature too high • M102: Sensor limit exceeded • M103: Sensor drift/difference • M104: Backup active
		Electronics	18	Not used with this device
		Configuration	17	Not used with this device
		Process	16	Not used with this device

14.7.2　Assignment parameters

The assignment of event categories to event groups is done via four assignment parameters. These are found in the block RESOURCE (RB2):
• FD_FAIL_MAP: for event category Failure (F)
• FD_CHECK_MAP: for event category Function check (C)
• FD_OFFSPEC_MAP: for event category Out of specification (S)
• FD_MAINT_MAP: for event category Maintenance required (M)

Each of these parameters consists of 32 bits with the following meaning:
• Bit 0: reserved by the Fieldbus Foundation ("check bit")
• Bits 1...15: Configurable area; certain diagnostic events can be assigned indepently from the event group they belong to. In this case they are removed from the event group and their behaviour can be configured individually. The following parameters can be assigned to the configurable area of this device:
  • 42: Sensor corrosion
  • 103: Drift
  • 901: Ambient temperature too low
  • 902: Ambient temperature too high
• Bits 16...31: Standard area; these bits are firmly assigned to event groups. If the bit is set to 1 this event group is assigned to the respective event category.

The following table indicates the default setting of the assignment parameters. The default setting has a clear assigment between the event weighting and the event category (i.e. the assignment parameter).

Default setting of assignment parameters

	Default range																Configurable area
Event weighting	Highest weighting				High weighting				Low weighting				Least weighting				
Event source [1]	S	E	C	P	S	E	C	P	S	E	C	P	S	E	C	P	
Bit	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15 to 1
FD_FAIL_MAP	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
FD_CHECK_MAP	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0
FD_OFFSPEC_MAP	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0
FD_MAINT_MAP	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0

1)   S: Sensor; E: Electronics; C: Configuration; P: Process

In order to change the diagnostic behaviour of an event group, proceed as follows:

1. Open assignment parameter to which the group is currently assigned to.
2. Change the bit of the event group from 1 to 0. In configuration systems this is done by deactivating the respective check box.
3. Open assignment parameter to which the group shall be assigned.
4. Change the bit of the event group from 0 to 1. In configuration systems this is done by activating the respective check box.

Example: The group 'Highest weighting/Configuration error' contains the events 431: 'Reference values' and 437: 'Configuration error'. These are to be categorized as Function check (C) and no longer as Failure (F).

1.
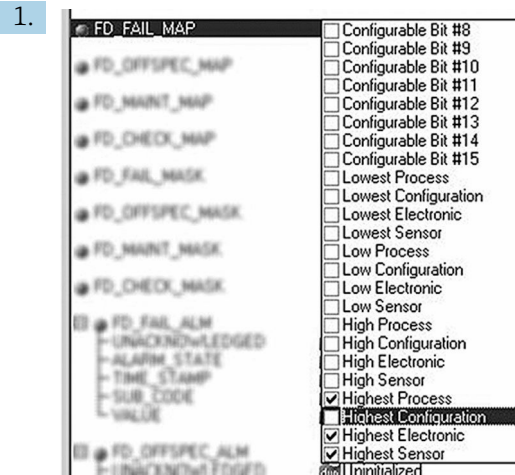
A0019661

Search for the group "Highest Configuration" in the Resource Block in the parameter FD_FAIL_MAP and deactivate the corresponding check box.

2.
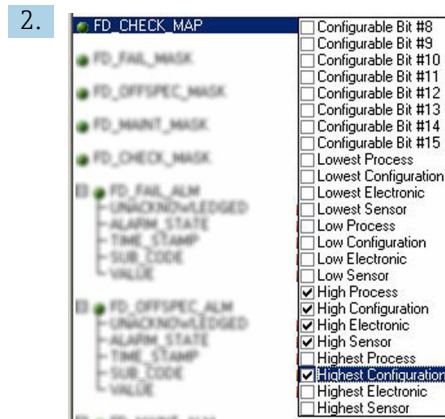
A0019663

Then search for the group "Highest Configuration" in the parameter FD_CHECK_MAP and activate the corresponding check box.

ℹ️ Care has to be taken that the corresponding bit is set in at least one of the assignment parameters for each event group. Otherwise no category will be transmitted with the event via the bus. Thus the control system will normally ignore the presence of the event.

The detection of diagnostic events is parameterized with the MAP parameters (F, C, S, M); however not the transfer of messages to the bus. The latter is done with the MASK parameters. The Resource Block has to be set in the Auto mode so that the status information is transmitted to the bus.

14.7.3 Configurable area

The event category can be individually defined for the following events - indepent of the event group they are assigned to in the default setting:
- 042: Sensor corrosion
- 103: Drift
- 901: Ambient temperature too low
- 902: Ambient temperature too high

First, in order to change the event category, the event has to be assigned to the bits 1 to 15. The parameters 'ConfigArea_1' to 'ConfigArea_15' in the block ADVANCED DIAGNOSTIC (ADVDIAG) are used for this. Then the corresponding bit can be set from 0 to 1 in the desired assignment parameter.

Example: The diagnostic event 103 'Drift' shall no longer be categorized as Mainenance required (M) but as Out of specification (S). Furthermore the status of the measurement value shall display BAD.

1. Navigate to the Advanced Diagnostic Transducer Block and the parameter CONFIGURABLE_AREA. In the default setting all bits have the value not assigned in the column Configurable Area Bits.

2.
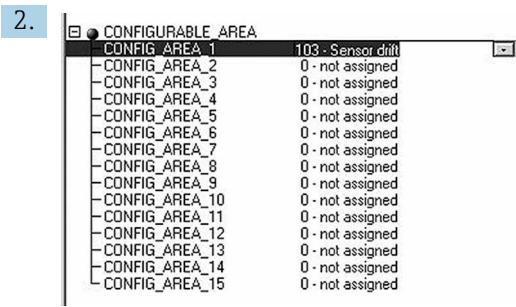
A0019664

Select one of these bits (here for example: Configurable Area Bit 1) and select the option 'Drift' from the corresponding selection list.

3. Confirm the selection with the button 'Enter'.

4.
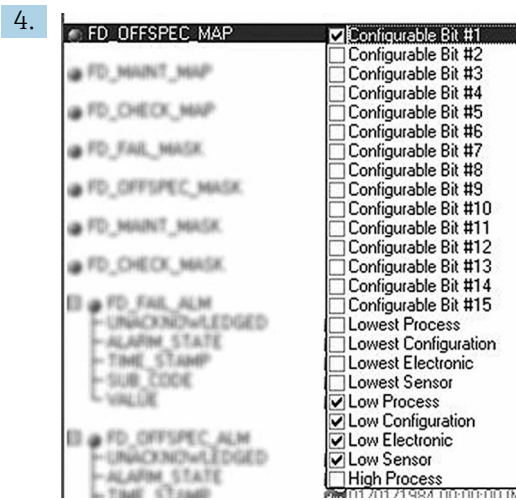
A0019665

Move to the Resource Block and activate the concerning bit (here: Configurable Area Bit 1) in the parameter FD_OFFSPEC_MAP.

↳ Now the measurement value can be additionally set for this event. With the parameter STATUS_SELECT_103 the measurement value BAD can be selected via the selection menu.

14.7.4 Cause and remedy of a diagnostic event

In the parameter FD_RECOMMEN_ACT in the Resource Block a description is displayed for the currently active diagnostic event with the highest priority.

This description has the following setup:

Diagnostic number:Diagnostic text with channel (ch x):troubleshooting recommendations separated with hyphens

Example for the diagnostic event sensor break:
41:Sensor break ch01:Check electrical connection - Replace sensor - Check configuration of the connection type

The value transmitted via the bus has the following setup: XXYYY

XX = channel number
YYY = diagnostic number

The value for the above mentioned example sensor break is 01041.

14.8   Transmission of event messages to the bus

The transmission of event messages must be supported by the respective control system used.

14.8.1   Event priority

Event messages are only transmitted to the bus if they have the priority 2 to 15. Events with priority 1 will be displayed but not transmitted to the bus. Events with priority 0 are ignored. In the factory setting the priority of all events is 0. The priority can be individually adapted for the four assignment parameters. Four PRI parameters (F, C, S, M) from the Resource Block are used for this.

14.8.2   Suppression of certain events

The transmission of certain events to the bus may be suppressed via a mask. In this case these events are displayed but not transmitted to the bus. This mask can be found in the MASK parameters (F, C, S, M). The mask serves as a negative mask, that means: if a field is marked the related events are not transmitted to the bus.

Index

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