Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

Operating Instructions

iTEMP® TMT162

Temperature field transmitter with FOUNDATION Fieldbus™ protocol

BA224R/09/en/13.10
71123287
Device software
01.01

Endress+Hauser
People for Process Automation

Brief Overview

For quick and easy commissioning:

Safety instructions	→ page 4
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Installation	→ page 7
▼	
Wiring	→ page 10
▼	
Display and operating elements	→ page 18
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Commissioning	→ page 24
Device-specific parameters are configured and automation functions for FOUNDATION Fieldbus are specified using configuration programs of various manufacturers.	
▼	
Customer-specific configuration/ Description of device functions	→ page 50
Complex measurement tasks require the configuration of additional functions which you can individually select, set and adapt to your process conditions using the relevant device parameters. – Configuration via the configuration program (FF)	

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1 Safety instructions

1.1 Designated 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 unit is designed for mounting in the field.
- The user cannot be held responsible for damage caused by misuse of the unit. The device can, however, be a source of danger if used incorrectly or for anything other than the designated use.

1.2 Installation, commissioning and operation

Note the following points:

- The device may only be installed, connected, commissioned and maintained by properly qualified and authorized staff (e.g. electrical technicians)
  in strict compliance with these Operating Instructions, applicable standards, legal regulations and certificates (depending on the application).
- The specialist staff must have read and understood these Operating Instructions and must follow the instructions they contain.
- The device may only be modified and repaired if such work is specifically permitted in the Operating Instructions.
- Damaged devices which could constitute a source a danger must not be put into operation and must be clearly indicated as defective.
- Invariably, local regulations governing the opening and repair of electrical devices apply.

1.3 Operational safety

- The device is designed 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.
  Applicable regulations and European standards have been taken into consideration.
- Please pay particular attention to the technical data on the nameplate! The nameplate is located on the left-hand side of the housing.

Hazardous areas
When using in hazardous areas, the national safety requirements must be met. Separate Ex documentation is contained in these Operating Instructions for measurement systems that are to mounted in hazardous areas. Strict compliance with the installation instructions, ratings and safety instructions as listed in this supplementary documentation is mandatory.

Repairs
Repairs that are not described in the Operating Instructions may only be carried out directly at the manufacturer's site or by the Service team.

Electromagnetic compatibility
The device complies with the general safety requirements in accordance with EN 61010 and the EMC requirements of EN 61326 and NAMUR Recommendations NE 21, NE 43 and NE 89.

Caution!
Power must be supplied to the device from a 9 to 32 VDC power supply in accordance with NEC Class 02 (low voltage/current) with short-circuit power limitation to 8 A/150 VA.

1.4 Notes on safety conventions and icons

Always refer to the safety instructions in these Operating Instructions labeled with the following symbols:

Caution!
This symbol draws attention to activities or procedures that can lead to defective operation or to destruction of the unit if not carried out properly.

Warning!
This symbol draws attention to activities or procedures that can lead to injuries to persons, safety risks or the destruction of the unit if not carried out properly.

Note!
This symbol draws attention to activities or procedures that have an indirect effect on operation, or can trigger an unforeseen unit reaction if not carried out properly.

ESD – Electrostatic discharge
Protect the terminals against electrostatic discharge. Failure to comply with this instruction can result in the destruction of parts of the electronics.

2 Identification

2.1 Device designation

2.1.1 Nameplate

Compare the nameplate on the device with the following graphic:

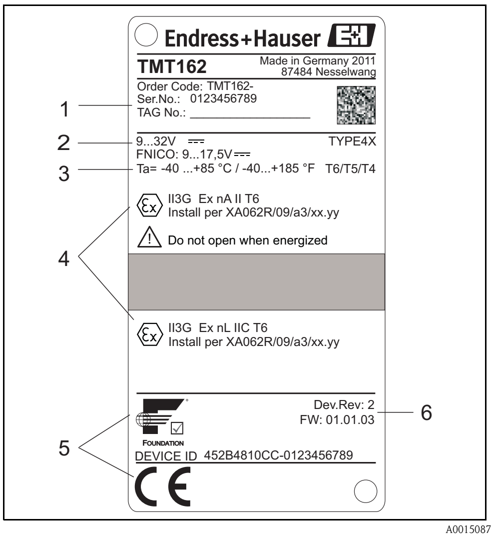

Fig. 1: Nameplate of the field transmitter (example, Ex version)

1 Order code, serial number and TAG of device
2 Power supply
3 Ambient temperature
4 Approval in hazardous area with numbers of the relevant Ex documentations (XA...)
5 Approvals with symbols
6 Device revision and firmware version

2.2 Scope of delivery

The scope of delivery comprises:

- Temperature field transmitter
- Dummy plugs
- Operating Instructions on CD-ROM
- Multi-language hard copy of Brief Operating Instructions
- Operating Instructions for use in hazardous areas (Ex approval)

2.3 Certificates and approvals

CE mark, declaration of conformity

The temperature field transmitter is designed 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. The device complies with the applicable standards and regulations in accordance with EN 61 010 “Protection Measures for Electrical Equipment for Measurement, Control, Regulation and Laboratory Procedures”.
The device described in these Operating Instructions is therefore in conformity with the statutory requirements of the EU Directives. The manufacturer confirms a positive completion of all tests by fitting the unit with a CE mark.

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 5.2.0
- Device certification number: IT070400
- The device meets all the specifications of FOUNDATION Fieldbus-H1 (www.fieldbus.org).
- The device may also be operated with certified devices from other manufacturers (interoperability).

An overview of other approvals and certificates can be found in chapter 10: "Technical data".

3 Installation

3.1 Quick installation guide

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 kits are available (see → fig. 4). The illuminated display can be mounted in four different positions (→ fig. 2):

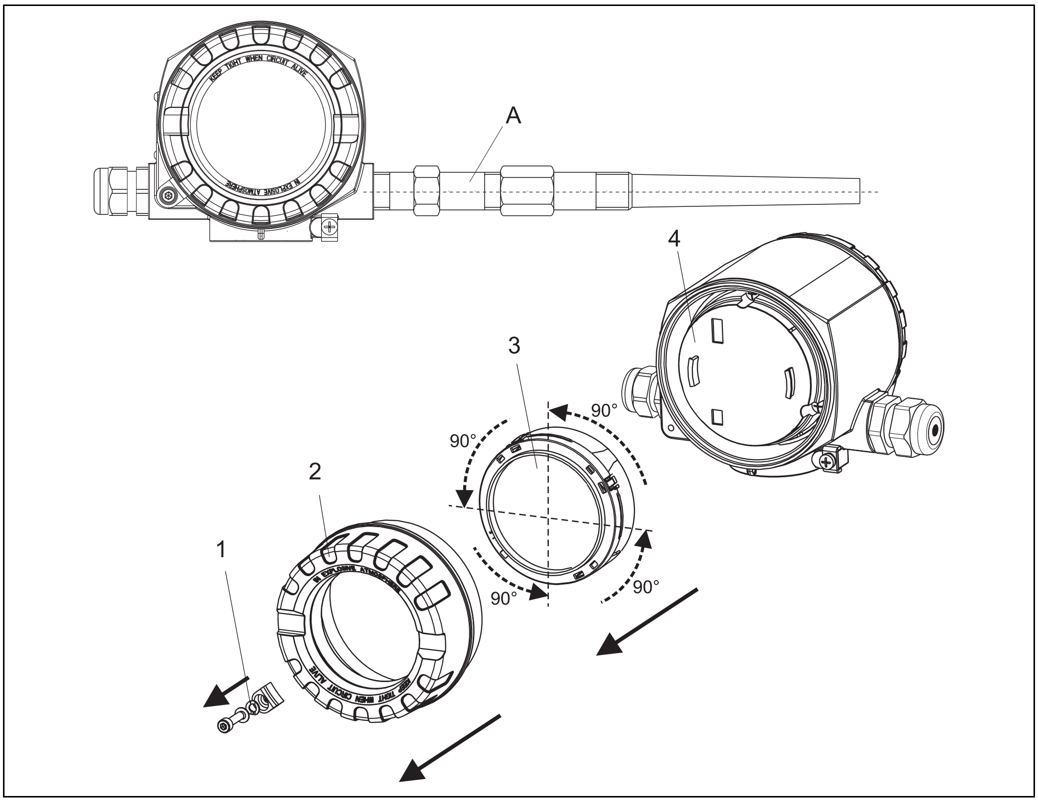

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Fig. 2: Temperature field transmitter with sensor, 4 display positions, can be plugged-in in 90° steps

A: Sensor
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 retainer and twist protection (3) from the electronics module (4). Adjust the display with retainer in 90°stages to the desired position and rearrange it on the particular slot on the electronics module.
4. Then screw on the housing cover together with the O-ring. Mount the cover clamp.

3.2 Installation conditions

3.2.1 Dimensions

The dimensions of the device can be found in chapter 10 "Technical data".

3.2.2 Installation point

Information on installation conditions, such as ambient temperature, protection classification, climatic class etc., can be found in chapter 10 "Technical data".

3.3 Installation instructions

3.3.1 Direct sensor mounting

If the sensor is permanently integrated in the process connection, the device can be installed directly on the sensor.

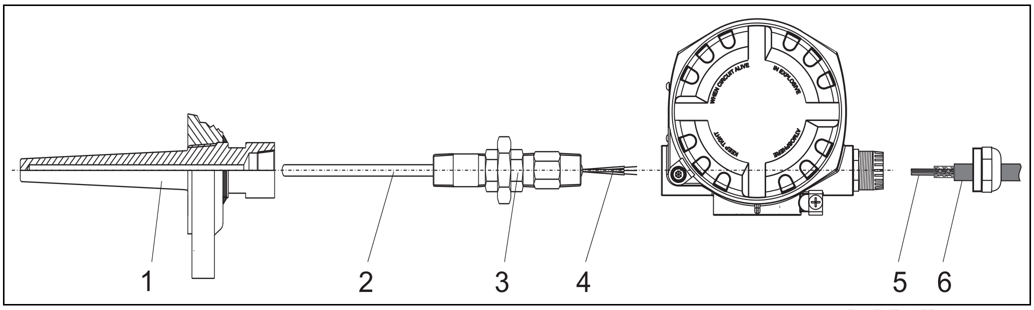

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Fig. 3: Direct field transmitter mounting on sensor

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

Proceed as follows to mount the field transmitter:

1. Mount the thermowell and screw down (1). Screw the gauge slide into the thermowell (2).
2. Fit the necessary neck tube nipples and adapter (3) on the thermowell. Seal the nipple and adapter thread with silicone tape.
3. Feed the sensor cables (4) through the neck tube, adapter and cable gland of the field transmitter housing.
4. Mount the fieldbus shielded cable or fieldbus connector (6) (see page 14 ff.) on the other cable gland.
5. Guide the fieldbus cables (5) through the cable gland of the fieldbus transmitter housing into the connection compartment.
6. Seal both cable glands leak-tight as described in → chap. 4.5. Both cable glands must meet explosion protection requirements.

3.3.2 Remote mounting

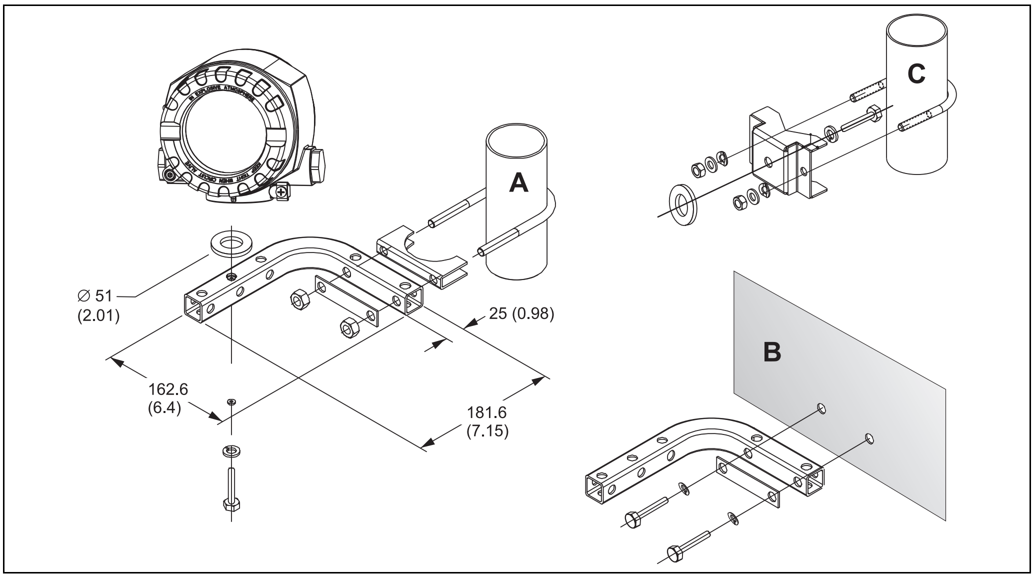

Fig. 4: Installation of the field transmitter using the mounting kit, see chapter 'Accessories'. Dimensions in mm (inch)

A, B Mounting with combined wall/pipe mounting kit
C Mounting with pipe mounting kit 2"/V4A

3.4 Post-installation check

After installing the device, always run the following final checks:

Device condition and specifications	Notes
Is the device visibly free of damage (visual check)?	-
Does the device comply to the measurement point specifications, such as ambient temperature, measurement range etc.?	See chapter 10 "Technical data"

4 Wiring

Caution!
- Switch off power supply before installing or connecting the device. Failure to observe this may result in destruction of parts of the electronics.
- When installing Ex-approved devices in a hazardous area please take special note of the instructions and connection schematics in the respective Ex documentation added to these Operating Instructions. The local Endress+Hauser representative is available for assistance if required.

For wiring the device proceed as follows:

1. Remove the cover clamp (→ fig. 2).
2. Unscrew the housing cover on the connection compartment together with the O-ring (→ fig. 2).
3. Open the cable glands of the device.
4. Feed the cables through the opening in the cable glands.
5. Connect the cables as shown in → fig. 5, → chap. 4.4.1 and → chap. 4.4.2.
6. On completion of the wiring, screw the screw terminals tight. Tighten the cable glands again. In doing so, also pay particular attention to → chap. 4.5. Screw the housing cover down again and refit the cover clamp.
7. In order to avoid connection errors always take note of the hints given in the section connection check!

4.1 Quick wiring guide

Terminal assignment

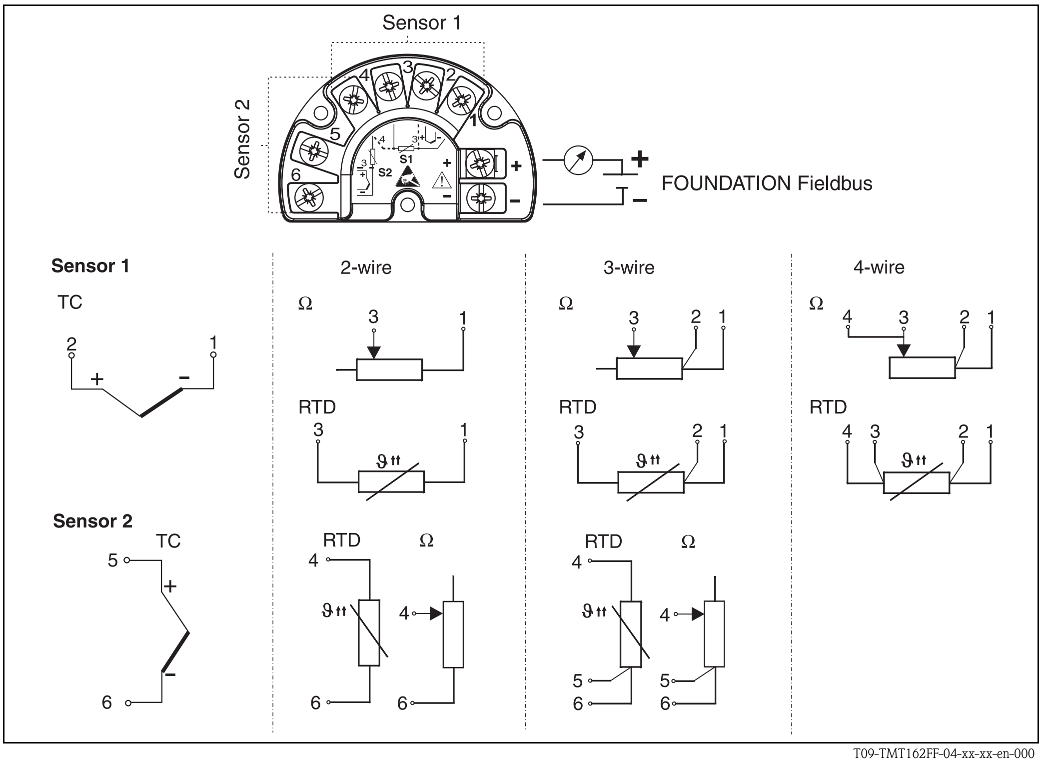

Fig. 5: Wiring the field transmitter

Caution!
Protect the terminals from electrostatic discharge. Failure to observe this may result in destruction of parts of the electronics.

4.2 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.

The electrical data of the fieldbus cable have not been specified but determine important characteristics of the design of the fieldbus, such as distances bridged, number of users, electromagnetic compatibility, etc.

	Type A	Type B
Cable structure	Twisted pair, shielded	One or more twisted pairs, fully shielded
Wire size	0.8 mm^2 (AWG 18)	0.32 mm^2 (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	*
Shield coverage	90%	*
Max. cable length (incl. spurs >1 m)	1900 m	1200 m
* 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 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 are permitted between user and master.

Maximum spur length

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

Number of spurs	1 to 12	13 to 14	15 to 18	19 to 24	25 to 32
Max. length per spur	120 m	90 m	60 m	30 m	1 m

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 a 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.

Caution!
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 are always to be terminated with 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. Note the following points in addition:

- 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, then the extension must also be terminated at both ends.

Further information

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

4.3 Connecting the sensor

Note!
Proceed as described on Page 10. The terminal assignment for the sensor terminals can be found in → fig. 5. The following connection options are possible for two sensor inputs:

	Sensor 1: RTD 2-wire	**Sensor 1: RTD 3-wire**	**Sensor 1: RTD 4-wire**	**Sensor 1: TC connection**
Sensor 2: RTD 2-wire	Yes	Yes	No	Yes
Sensor 2: RTD 3-wire	Yes	Yes	No	Yes
Sensor 2: RTD 4-wire	No	No	No	No
Sensor 2: TC connection	Yes	Yes	Yes	Yes

There are special cable entries available as accessories when connecting 2 sensors → chap. 8.

Caution!
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. In this situation, the sensors have to be galvanically isolated from one another by connecting each sensor separately to a field transmitter. The device provides sufficient galvanic isolation (> 2 kV AC) between the input and output.

4.4 Connecting the device

4.4.1 Cable glands or entries

Caution!
- Switch off power supply before installing or connecting the device. Failure to observe this may result in 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! Between the stripped fieldbus cable and the ground terminal, the cable shielding should be kept as short as possible.
- Risk of damaging the fieldbus cable!
  - If the shielding of the fieldbus cable is grounded at more than one point in systems without additional potential matching, power supply 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 only one side, 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.

Note!
- The terminals for the fieldbus connection have an integral polarity protection.
  – Cable cross-section: max. 2.5 mm^2
- A shielded cable must be used for the connection.

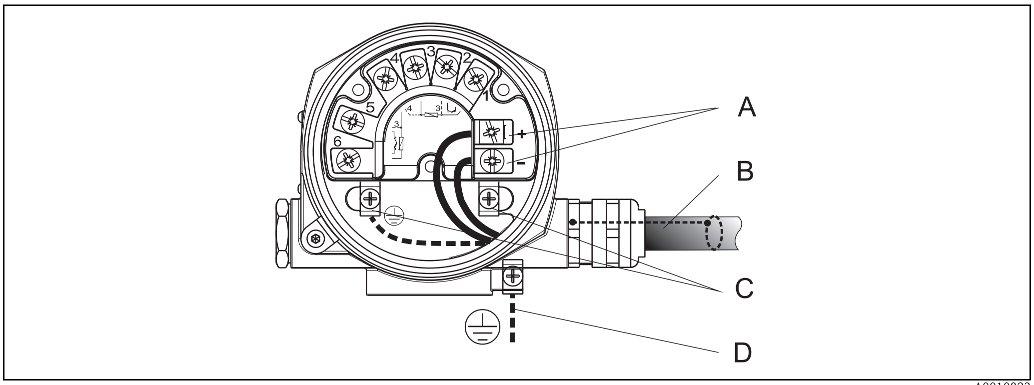

Fig. 6: Connecting the device to the FOUNDATION Fieldbus fieldbus cable

A FF terminals - fieldbus communication and power supply
B Fieldbus cable (FOUNDATION Fieldbus)
C Ground terminals
D Ground terminal (external, relevant for remote version)

4.4.2 Fieldbus connector

The connection technology of FOUNDATION Fieldbus allows devices to be connected to the fieldbus via uniform mechanical connections such as T-boxes, distribution modules, 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 field transmitter was ordered with fieldbus connector (order code → cable entry: position C and D) it is supplied with the fieldbus connector pre-assembled and wired ex works. Fieldbus connectors for retrofitting can be ordered from Endress+Hauser as an accessory (→ chap. 8).

Supply line/T-box shielding
Use cable glands with good EMC properties, if possible with all-round contact of the cable shielding (Iris spring). This requires small differences in potential, poss. potential matching.

- 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 for the shielding connection. The shielding is connected to the T-box housing by means of the Iris spring located inside the gland. The shielding braid is located beneath 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 connection box or a plug-in connection is to be seen as 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 instances, a metallic connector must be used where the cable shielding is positioned at the plug housing (e.g. prefabricated cables).

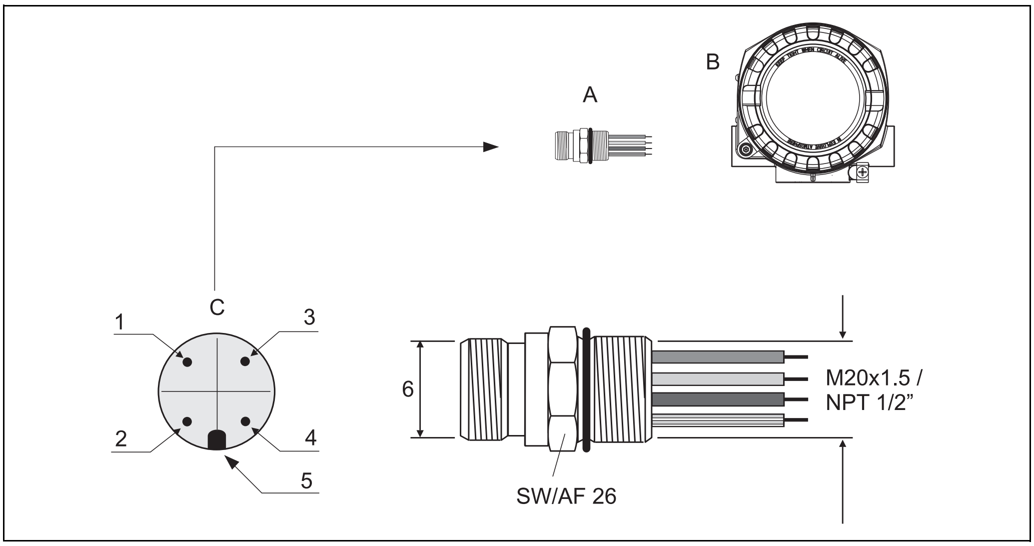

Fig. 7: Connectors for connecting to the FOUNDATION Fieldbus

A Fieldbus connector (pin assignment/color codes)
– 1 Blue wire: FF- (terminal 1)
– 2 Brown wire: FF– (terminal 2)
– 3 Grey wire: Shielding
– 4 Green-yellow wire: ground
– 5 Positioning tappet
– 6 7/8" UNC thread
B Field housing
C Connector at the housing (male)

Connector technical data:

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

4.5 Degree of protection

The device conforms to the requirements to IP 67 ingress protection. In order to fulfill an IP 67 degree of protection after installation or service, the following points must be taken into consideration:

- 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 cables used for connection must be of the correct specified outside diameter (e.g. M20 x 1.5, cable diameter from 8 to 12 mm; 0.315 to 0.47 in).
- Firmly tighten the cable gland (→ fig. 8).

- The cables must loop down before they enter the cable glands (“water trap”, → fig. 8). This means that any moisture that may form cannot enter the gland. Install the device so that the cable glands are not facing upwards.
- Cable glands not used are to be blanked off using the dummy plugs provided.
- Do not remove the grommet from the cable gland.

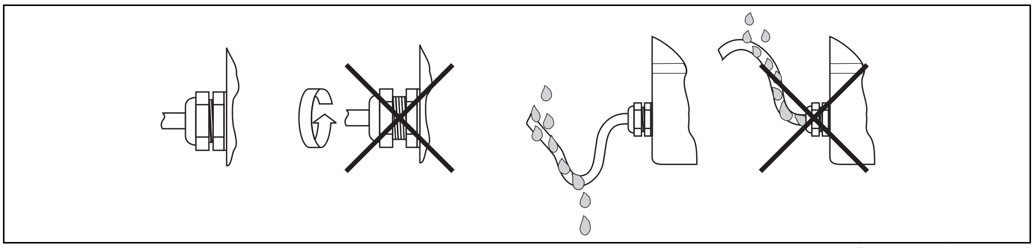
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Fig. 8: Connection hints to retain IP 67 protection

4.6 Post-connection check

After the electrical installation of the device, always perform the following final checks:

Device condition and specifications	Notes
Are the device or the cables damaged (visual check)?	-
Electrical connection	Notes
Does the supply voltage match the specifications on the nameplate?	9 to 32 V DC
Do the cables used comply with the specifications?	Fieldbus cable, → chap. 4.2 Sensor cable, → chap. 4.3
Do the cables have adequate strain relief?	-
Are the power supply and fieldbus cables correctly connected?	See the wiring diagram inside the cover of the terminal compartment
Are all terminals firmly tightened?	-
Are all the cable glands installed, tightened and sealed? Cable run with "water trap"?	See → chap. 4.5
Are all the housing covers installed and tightened?	-
Electrical connection of FOUNDATION Fieldbus	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?	-
Has the max. length of the fieldbus cable been observed in accordance with the FOUNDATION Fieldbus specifications?	→ chap. 4.2
Has the max. length of the spurs been observed in accordance with the FOUNDATION Fieldbus specifications?	
Is the fieldbus cable fully shielded and correctly grounded?	

5 Operation

5.1 Quick operation guide

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

1. Configuration programs → page 22
The configuration of FF functions and device-specific parameters is primarily done via the Fieldbus interface. You can obtain special configuration and operating programs from various manufacturers for these purposes.

2. Miniature switches (DIP switches) for diverse hardware settings → page 23 ff.
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

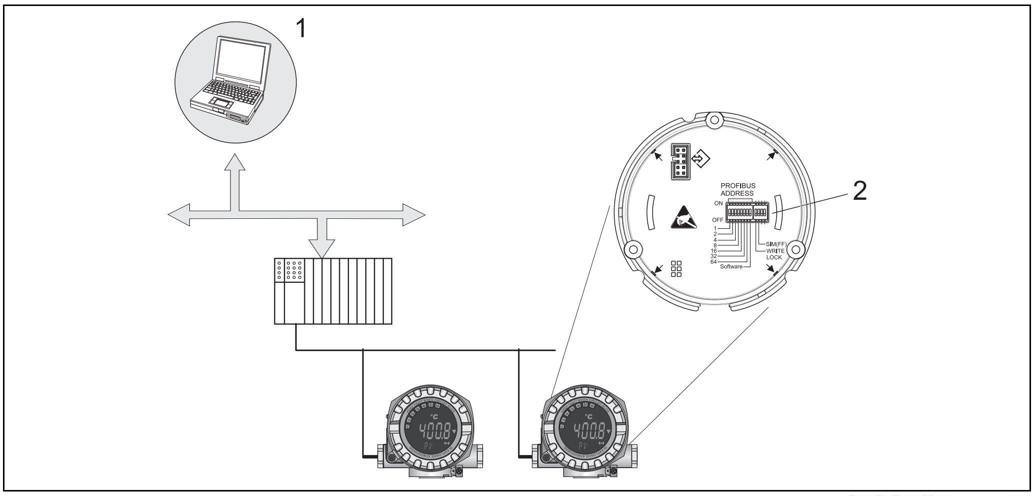

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Fig. 9: Device operating options via the FOUNDATION Fieldbus interface

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

5.2 Display and operating elements

5.2.1 Display

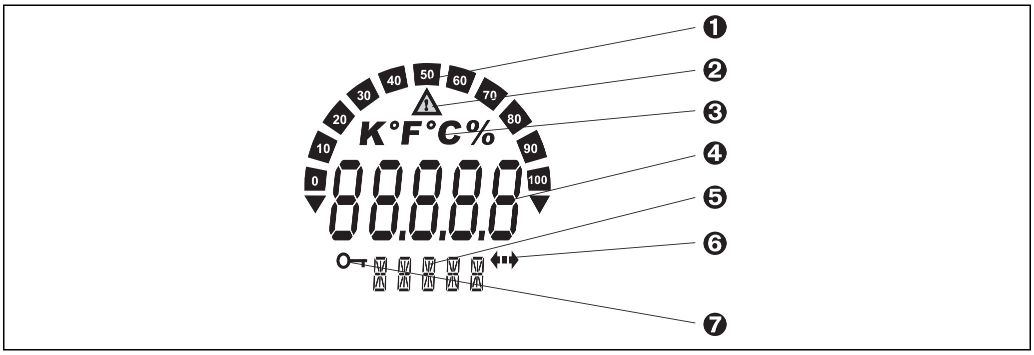

Fig. 10: LC display of the field transmitter (illuminated, can be plugged in in 90° steps)

5.2.2 Display symbols

Item No.	Function	Description
1	Bar graph display	In stages of 10% with markers for measuring range undershoot and overshoot. 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, °F, °C or %	Unit display for the internal measured value displayed
4	Measured value display (digit 20.5 mm high)	The measured value appears on the display. If a warning occurs, the display alternates between the measured value and the warning code. If an error occurs, the error code is displayed instead of the measured value.
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. SENS 1
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

5.3 FOUNDATION Fieldbus technology

The FOUNDATION Fieldbus (FF) is a purely digital, serial communication system that connects fieldbus devices (sensors, actors), 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 technology. The FF thus forms the basic network throughout the hierarchy of a communication system.

Please refer to Operating Instructions BA 013S/04/en “FOUNDATION Fieldbus Overview: Installation and Commissioning Guidelines” for configuration information.

5.3.1 System architecture

The following figure shows an example of a FOUNDATION Fieldbus network with the associated components.

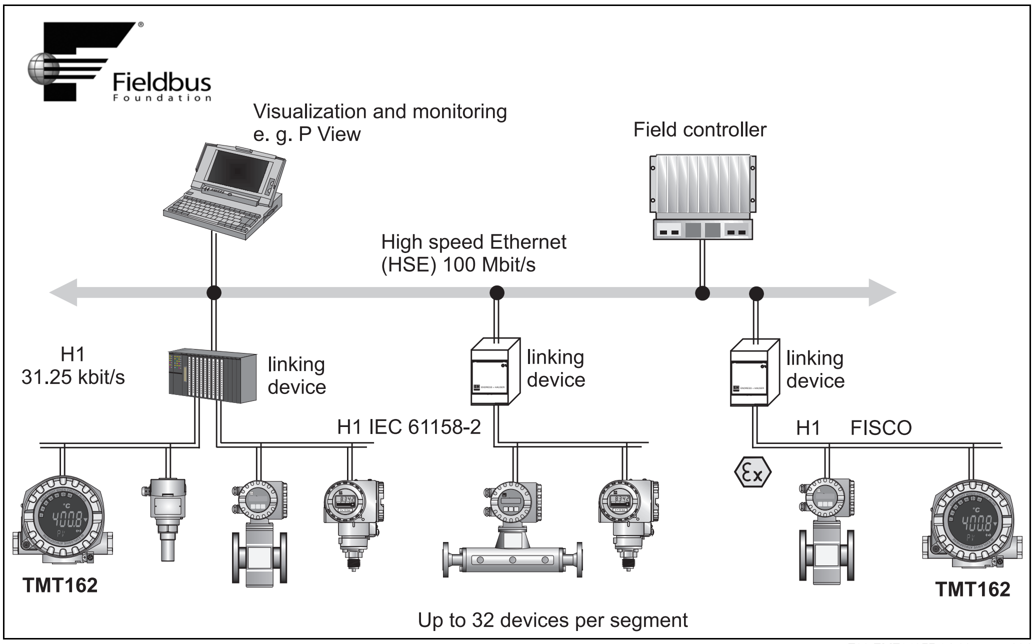

Fig. 11: FOUNDATION Fieldbus system architecture including associated components (line structure)

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 ranking fieldbus protocols (e.g. to the High Speed Ethernet - HSE) (Control Net)*
- *A H1 card is required for direct connection to a process control system.*
- *System inputs are available directly for H1 and H2 (HSE).*

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 allows simultaneous feed to the field devices and data transfer on the two-wire line.
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 is connected in parallel to the bus line. Devices requiring external power must use a separate power supply.
- One of the most common network structures is the line structure. 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 a 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, length of spur, cable types, current consumption of field devices etc. (see → page 11).
- If using fieldbus devices 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 realized 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.

5.3.2 Link Active Scheduler (LAS)

The FOUNDATION Fieldbus works according to the 'producer-consumer' relationship.
This provides various 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 this data. Publication of this data is carried out by a 'bus administrator' known as the 'Link Active Scheduler', which controls the sequence of bus communication centrally. The LAS organizes all the bus activities and sends appropriate commands to the individual field devices.

Other tasks of the LAS are:
- Recognition and reporting of newly connected devices.
- Reporting the removal of devices no longer communicating with the fieldbus.
- Keeping the 'Live List'. This list, in which all the fieldbus users are recorded, is checked by the LAS regularly. New or removed devices are immediately transferred to the Live List and sent to all the devices.
- Requesting process data from the field devices in accordance with a fixed schedule.
- Allocation of send rights (tokens) to devices between the untimed data transfer.

The LAS can be 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. Through precise timing of the bus communication via the LAS, the FF can run exact processes at regular intervals.

✎ Note!
Fieldbus devices such as the TMT162, which can take over the LAS function in the event of failure of the primary master, are called 'Link Masters'. In contrast, 'Basic Devices' can only receive signals and send them to the central process control system. At the delivery status the LAS functionality for the TMT162 is deactivated.

5.3.3 Data transfer

We distinguish between two types of data transfer:
- **Scheduled data transfer (cyclic):** all time-critical process data (i.e. continuous measurement or actuating signals) are transferred and processed in accordance with a fixed schedule.
- **Unscheduled data transfer (acyclic):** device parameters that are not time-critical for the process and diagnosis information are only transferred to the fieldbus when needed. This data transfer is always carried out in the intervals between timed communication.

5.3.4 Device ID, addressing

Within the FF network, each fieldbus device is identified by a unique device ID (DEVICE_ID).
The fieldbus host system (LAS) automatically gives the network address for this to the field device.
The network address is the address that the fieldbus currently uses.

The FOUNDATION Fieldbus™ uses addresses between 0 and 255:
- **0 to 15** are reserved.
- **16 to 247** are available for permanent devices. Some host systems may further subdivide this range. This range is typically shortened for efficiency.
- **248 to 251** are available for devices with no permanent address such as new devices or decommissioned devices.
- **252 to 255** are available for temporary devices, such as handhelds.

The field device tag name (PD_TAG) is given to the device in question during commissioning (→ page 24). It remains stored in the device even during a supply voltage failure.

5.3.5 Function blocks

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 which a device can accept in the whole of the 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 function blocks:
- 'Analog Output' or
- 'Discrete Output' (digital output)

For control tasks there are the blocks:
- PD controller or
- PID controller

✎ Note!
More information on this can be found on → page 50 onwards.

5.3.6 Fieldbus based process control

With the FOUNDATION Fieldbus field devices can carry out simple process control functions themselves, thereby relieving pressure on the superior process control system. Here the Link Active Scheduler (LAS) coordinates data exchange between the sensor and controller and makes sure that two field devices cannot access the bus at the same time. To do this, configuration software such as the NI-FBUS Configurator from National Instruments is used to connect the various function blocks to the desired control strategy – generally graphically (→ page 29).

5.3.7 Device description

For commissioning, diagnosis, configuration etc. make sure that process control systems or superior configuration systems can access all device data and that the operating structure is uniform.
The device-specific information required for this is stored as so-called device description data in special files (the 'Device Description'- DD). This enables the device data to be interpreted and shown via the configuration program. The DD is thus a kind of 'device driver'.
On the other hand, a CFF file (CFF = Common File Format) is required for the network configuration in the OFF-line mode.

These files are on the CD-ROM supplied and or can be acquired as follows:
– Free of charge via the Internet: www.endress.com
– Via the Fieldbus Foundation Organization: www.fieldbus.org

5.3.8 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 (→ chap. 11.3.9). 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.

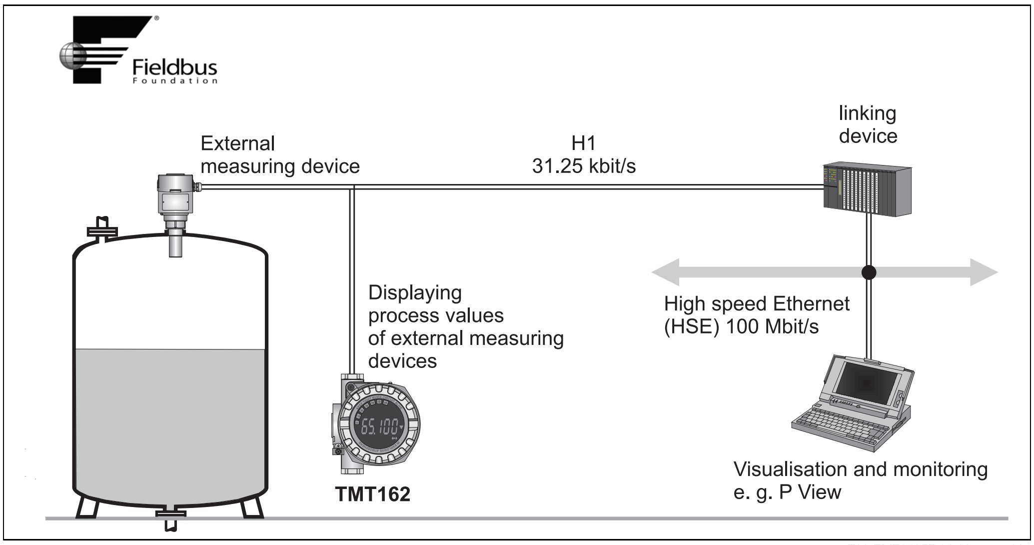

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Fig. 12: Displaying process values of external devices

5.4 Configuration of the field transmitter and FF functions

The FF communication system will only function properly if correctly configured. You can obtain special configuration and operating programs from various manufacturers for the configuration.

Process control systems	Asset management systems
Endress+Hauser Controlcare ≥ 2.01	National Configurator (≥ 3.1.1) AMS (≥ 7.0) FC375/475 (handheld) Fieldcare Yokogawa PRM incl. Device Viewer
Emerson DeltaV (≥ 7.3)	
Yokogawa: ▪ Centum CS3000 ▪ Centum VP	
ABB: ▪ AC800 XA (4.)1 ▪ AC800 M (7.2) ▪ Freelance2000 (7.2)	
Honeywell: ▪ PKS Experion (2.10)	
Foxboro Invensys I/A Series	

These can be used for configuring both the FF functions and all of the device-specific parameters. The predefined function blocks allow uniform access to all the network and fieldbus device data.

✎ Note!
A detailed step-by-step description of the procedure for commissioning the FF functions is given on → page 26 together with information on configuring device-specific parameters.

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)

These files can be acquired as follows:
– Free of charge via the Internet: www.endress.com
– Via the Fieldbus Foundation Organization: www.fieldbus.org

5.5 Hardware settings

5.5.1 Switching write protection on/off

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. The current write protection status is displayed in the WRITE_LOCK parameter (Resource Block → page 51).

Caution!
Protect the terminals from electrostatic discharge. Failure to observe this may result in destruction of parts of the electronics.

Note!
The simulation mode via the hardware setting has priority over the software setting.

1. Remove the cover clamp (see fig. 2, Pos. 1).
2. Unscrew the housing cover together with the O-ring (see fig. 2, Pos. 2).
3. Where necessary, remove the display with retainer (see fig. 2, Pos. 3) from the electronics module (see fig. 2, Pos. 4). Configure the hardware write protection and simulation mode accordingly with the aid of the DIP switches.
4. Installation is the reverse of the removal procedure.

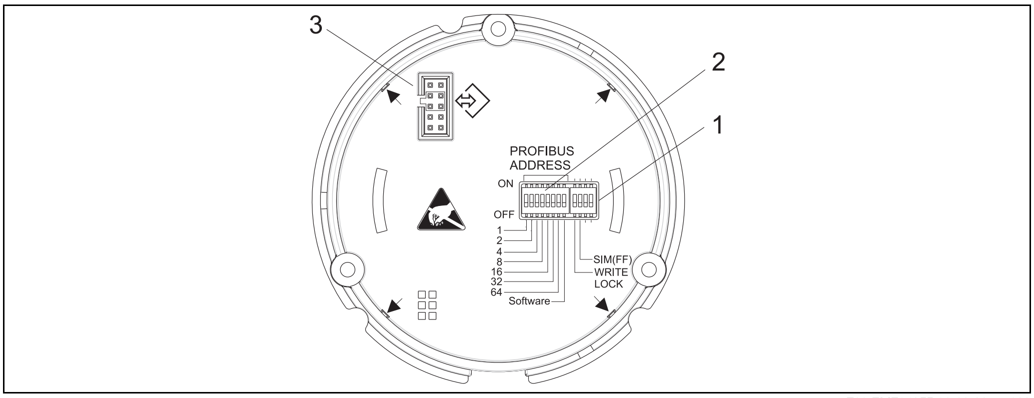

Fig. 13: Hardware settings on the electronics module

1 *DIP switch 2 - write protection; simulation mode (prerequisite for the FOUNDATION Fieldbus™ simulation mode)*
2 *DIP switch for PROFIBUS® device address (for the FOUNDATION™ Fieldbus communication without function)*
3 *Display and service interface connection (CDI)*

6 Commissioning

6.1 Function check

Before commissioning the measurement point make sure that all final checks have been carried out:
- Checklist “Post-installation check”→ page 9
- Checklist “Post-connection check”→ page 16

✎ Note!
- The FOUNDATION Fieldbus interface's technical data must be maintained in accordance with IEC 61158-2 (MBP).
- The bus voltage of 9 to 32 V and the current consumption of 11 mA at the device can be checked using a normal multimeter.

6.1.1 Switching on the device

Once the final checks have been successfully completed, it is time to switch on the supply voltage. The device is ready for operation after approx. 20 seconds!

The device 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	E+H appears on the display TMT162 appears on the display
4	The current firmware version appears on the display
5	The current device revision appears on the display
6a	The current measured value appears on the display. Bar graph displays the % value within the set bar graph range
6b	The current status message appears on the display. ✎ Note! If the switch-on procedure fails, the appropriate status message is displayed, depending on the cause.

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

6.2 Commissioning

Note the following points:

- The files required for commissioning and network configuration can be obtained as described on page 22.
- 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)
- For quick and reliable field transmitter configuration, a wide range of configuration wizards are available to guide the user through the configuration of the most important parameters of the Transducer Blocks. Please refer to the Operating Instructions of your operating and configuration software.

The following wizards are available:

Configuration wizards		
Name	Block	Description
Quick Setup	Sensor Transducer	Configuration of the sensor input with sensor-relevant data.
Quick Setup	Display Transducer	Menu-guided configuration of the display unit.
Set to OOS mode	Resource, Sensor Transducer, Display Transducer, AdvDiagnostic Transducer, AI, PID and ISEL	Setup to mode 'Out Of Service'
Set to Auto mode	Resource, Sensor Transducer, Display Transducer, AdvDiagnostic Transducer, AI, PID and ISEL	Setup to mode 'Auto'
Restart	Resource	Device restart with various options as to which parameters are to be reset to default values.
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 two-wire compensation.
Calibration wizards		
User Sensor Trim Configuration	Sensor Transducer	Menu guidance for linear scaling (offset + slope) to adapt the measuring point to the process (see Section 11).
Factory Trim settings	Sensor Transducer	Reset scaling to the "Factory Standard Trim" (see Section 11).
RTD-Platin Configuration Call.-Van Dusen	Sensor Transducer	Entry of Callendar-Van-Dusen coefficients.
RTD-Copper Configuration	Sensor Transducer	Entry of coefficients for polynomial nickel.
RTD-Nickel Configuration	Sensor Transducer	Entry of coefficients for polynomial copper.

6.2.1 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 the device on.
2. Note the DEVICE_ID on the device nameplate (→ page 5).
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 (→ chap. 5.4). 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”
TB_ADVDIAG_xxxxxxxxxxx	800	Transducer Block “Advanced Diagnostic”
AI1_ xxxxxxxxxxx	900	Analog Input function block 1
AI2_ xxxxxxxxxxx	1000	Analog Input function block 2
AI3_ xxxxxxxxxxx	1100	Analog Input function block 3
PID_ xxxxxxxxxxx	1200	PID function block
ISB_xxxxxxxxxxx	1300	Input Selector function block

✎ Note!
The device is delivered from the factory with the bus address “247” and is thus in the address range between 232 and 247 reserved for reserve devices. A lower bus address should be assigned to the device for commissioning.

5. 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).

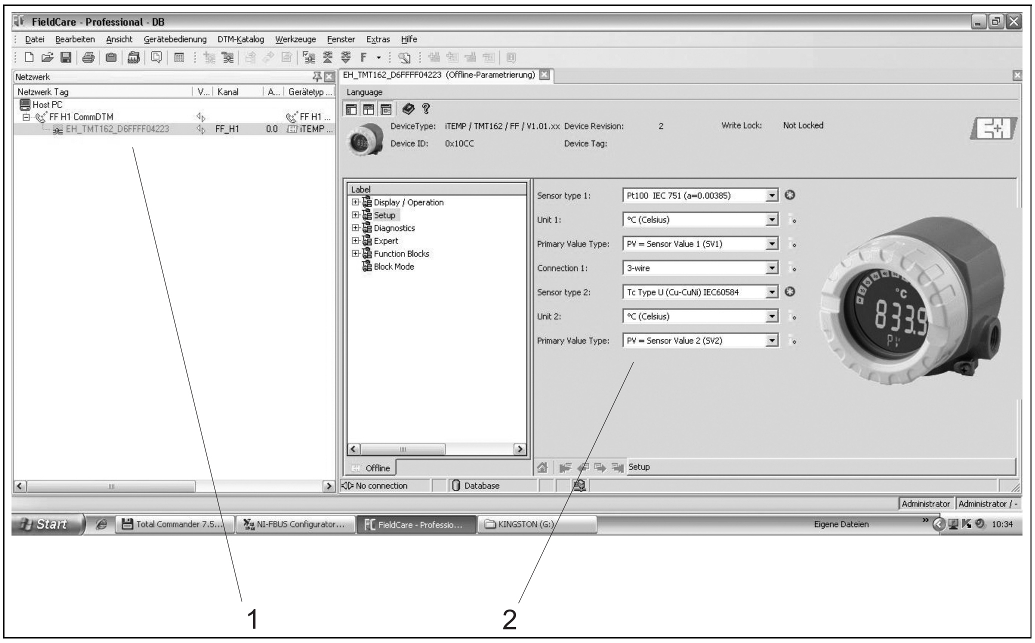

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Fig. 14: Screen display of the asset management system FieldCare by Endress+Hauser

1 Device designation (EH_TMT162_xxxxxxxxxxx = factory setting for tag name PD_TAG)
2 Parameterization

Configuring the "Resource Block" (base index 400)

6. Open the Resource Block.
7. 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

   Disable the write protection if necessary → page 23.

8. 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_ADV_DIAG_xxxxxxxxxx" (base index: 800)

9. 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).

10. Enter the required name for the Analog Input function block (optional).
    Factory setting: AI1_ xxxxxxxxxxx
11. Open Analog Input function block 1.
12. Set the operating mode in the MODE_BLK parameter group (TARGET parameter) to OOS, i.e. the block is out of service.
13. 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
	RJ Value 1
	RJ Value 2

14. 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.

    Caution!
    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.

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

    Caution!
    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.

16. 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

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

17. 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_PRI, LO_LO_PRI parameters). Reporting to the fieldbus host system only occurs if the alarm priority is greater than 2.

System configuration / connecting function blocks (see fig. 15):

18. 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 ControlCare, 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.

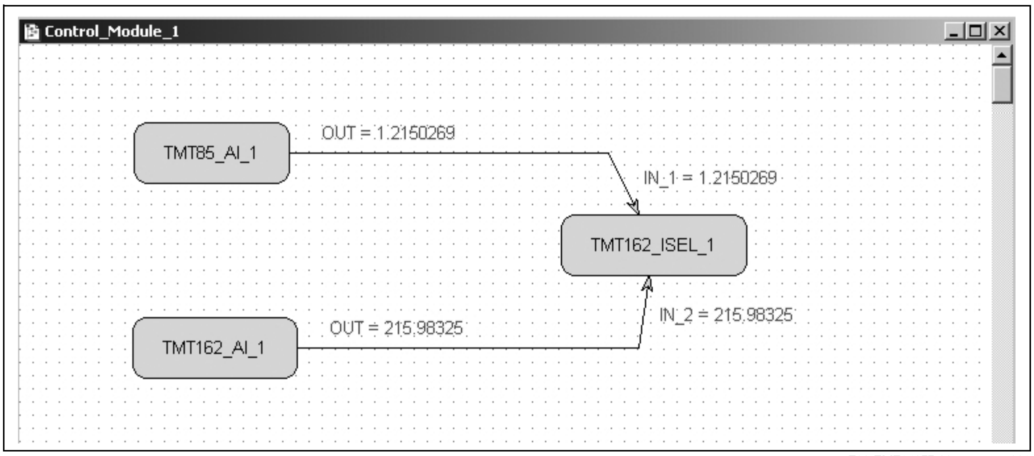

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Fig. 15: Connecting function blocks with the aid of ControlCare. Example: Averaging (output OUT in the Input Selector Block) of two temperature inputs (OUT in the Analog Input Blocks 1 and 2).

19. Once you have specified the active LAS, download all the data and parameters to the field device.
20. Set the operating mode in the MODE_BLK parameter group (TARGET parameter) to AUTO. This is only possible, however, under two conditions:
    – The function blocks are correctly connected to one another.
    – The Resource Block is in the AUTO operating mode.

7 Maintenance

In general, no specific maintenance is required for this device.

8 Accessories

Various accessories, which can be ordered separately from Endress+Hauser, are available for the field transmitter. The Endress+Hauser service organisation can provide detailed information on the order code of your choice.
If ordering accessories, please specify the serial number of the unit!

Type	Description	Order number (international)	Order code (North American region)
Cable glands for connecting 2 sensors	▪ NPT ½" cable gland 2 x D0.5 cable for 2 sensors ▪ M20x1.5 cable gland 2 x D0.5 cable for 2 sensors ▪ Screwed cable gland M20x1.5 / PG11 brass	▪ 51004654 ▪ 51004653 ▪ 51007474	▪ TMT162A-MB ▪ - ▪ -
Wall and stand pipe mounting kit	▪ Stainless steel wall/2" pipe mounting kit ▪ Mounting bracket 2" tube V4A	▪ 51004823 ▪ 51006412	▪ TMT162A-MA ▪ TM162A-MD
Fieldbus Connector (FF)	▪ NPT½" → 7/8" ▪ M20 → 7/8"	▪ 71005803 ▪ 71005804	

9 Troubleshooting

9.1 Troubleshooting instructions

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

✎ Note!
In the event of a serious fault, a device might have to be returned to the manufacturer for repair. Follow the instructions in → chap. 9.5 before returning the device to Endress+Hauser.

Check display (local display)	
No display visible - No connection to the FF host system.	1. Check the supply voltage → Terminals + and - 2. Electronics defective → Order spare part → chap. 9.4
No display visible - However, connection has been established to the FF host system.	1. Check whether the retainers of the display module are correctly seated on the electronics module → chap. 3.1 2. Display module defective → Order spare part → chap. 9.4 3. Electronics defective → Order spare part → chap. 9.4

↓

Local error messages on the display
→ chap. 9.2

↓

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 → chap. 4.4.2
Fieldbus voltage	Check that 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 length and number of spurs → chap. 4.2
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	Check the current consumption of the bus segment: The current consumption of the bus segment in question (= total of basic currents of all bus users) must not exceed the max. permissible feed current of the bus power supply unit.

↓

Error messages in the FF configuration program
→ chap. 9.2

↓

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. Caution! 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: 1. 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. 2. Check the parameter BLOCK_ERR for a configuration error. In this case read the parameter BLOCK_ERR_DESC_1 where the reason of the configuration error is written. 3. Make sure that the CHANNEL parameter (select process variable) has already been configured in the Analog Input function block (see page 28). The option CHANNEL = 0 (uninitialized) is not valid. 4. Make sure that the XD_SCALE parameter group (input range, unit) has already been configured in the Analog Input function block (see page 28). 5. Make sure that the L_TYPE parameter (linearization type) has already been configured in the Analog Input function block (see page 28). 6. Check whether the operating mode of the Resource Block is set to AUTO. MODE_BLK parameter group / TARGET parameter 7. Make sure that the function blocks are correctly connected together and that this system configuration has been sent to the fieldbus users (see page 29)
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. Error messages → page 33

▪ Parameters cannot be changed or ▪ No write access to parameters	1. Parameters that only show values or settings cannot be changed (so-called Read-only-parameter)! 2. The hardware write protection is enabled. Disable the write protection → page 23 ✎ Note! You can check whether the hardware write protection is enabled or disabled via the WRITE_LOCK parameter in the Resource Block: LOCKED = write protection enabled UNLOCKED = write protection disabled 3. The block operating mode is set to the wrong mode. Certain parameters can only be changed in the OOS (out of service) mode or the MAN (manual) mode → Set the operating mode of the block to the desired mode → MODE_BLK parameter group. 4. The value entered is outside the specified input range for the parameter in question: → Enter a suitable value → Increase input range if necessary
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. For information on where to obtain the DD see page 23 ✎ Note! Make sure you are using the correct system files for integrating field devices into the host system. Relevant version information can be queried with TMT162 by means of the following functions/parameters: FOUNDATION Fieldbus interface: – Resource Block → DD_REV parameter Example: Display in DEV_REV parameter → 01 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.

9.2 Status messages

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 category	Description	Error category
F	Fault detected ('Failure')	ALARM
M	Maintenance necessary	WARNING
C	Device is in the service mode (check)	
S	Specifications not observed ('Out of specification')	

WARNING error category:
With "M", "C" and "S" status messages, the device tries to continue measuring (uncertain measurement!). Alternating with the main measured value, the status is displayed onsite in the form of the letter in question plus the defined error number (7-segment display). The '⚠' symbol is also displayed (→ chap. 5.2.2).

ALARM error category:
The device does not continue measuring when the status message is "F". The display alternates between "-----" and the error message. Via the fieldbus the last measured value with the measured value status 'BAD' will be transmitted. The fault condition is indicated on the display in the form of the letter "F" plus a defined number
(7-segment display). The '⚠' symbol is also displayed (→ chap. 5.2.2).

✎ Note!
In both instances, the 14-segment display outputs the sensor that generates the status, e.g. 'SENS1', 'SENS2'. If nothing is displayed on the 14-segment display, the status message does not refer to a sensor but refers to the device itself.

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	Cause of error / remedy	Output variables affected
F	041	*Device status message (FF):* Sensor break F041 *Local display:* ⚠ F041 ↔ "-----" SENS 1 or SENS2	BLOCK_ERR = Other | Input failure | Device needs maintenance now	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		

Cate-gory	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	Cause of error / remedy	Output variables affected
F	042	*Device status message (FF):* Sensor corrosion F042 *Local display:* ⚠ F042 ↔ "-----" SENS 1 or SENS2	BLOCK_ERR = Other | Input failure | Device needs maintenance now	QUALITY = BAD	*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 = Mechanical failure	SUBSTATUS = Sensor failure		
M	042	*Device status message (FF):* Sensor corrosion M042 *Local display:* ⚠ M042 ↔ Measured value SENS 1 or SENS2	BLOCK_ERR = Device needs maintenance now	QUALITY = UNCERTAIN	*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 shortcut F043 *Local display:* ⚠ F043 ↔ "-----" SENS 1 or SENS2	BLOCK_ERR = Other | Input failure | Device needs maintenance now	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		
F	101	*Device status message (FF):* Under-usage of sensor range F101 *Local display:* ⚠ F101 ↔ "-----" SENS 1 or SENS2	BLOCK_ERR = Other | Input failure | Device needs maintenance now	QUALITY = BAD	*Cause of error:* Physical measuring range undershot *Remedy:* Select suitable sensor type	SV1, SV2 Also PV1, PV2 depending on the configuration
			Transducer_Error = General error	SUBSTATUS = Sensor failure		
M	101	*Device status message (FF):* Under-usage of sensor range M101 *Local display:* ⚠ M101 ↔ Measured value SENS 1 or SENS2	BLOCK_ERR = Device needs maintenance now	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		
F	102	*Device status message (FF):* Exceeded sensor range F102 *Local display:* ⚠ F102 ↔ "-----" SENS 1 or SENS2	BLOCK_ERR = Other | Input failure | Device needs maintenance now	QUALITY = BAD	*Cause of error:* Physical measuring range overshot *Remedy:* Select suitable sensor type	SV1, SV2 Also PV1, PV2 depending on the configuration
			Transducer_Error = General error	SUBSTATUS = Sensor failure		

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	Cause of error / remedy	Output variables affected
M	102	*Device status message (FF):* Exceedence of sensor range M102 *Local display:* ⚠ M102 ↔ Measured value SENS1 or SENS2	BLOCK_ERR = Device needs maintenance now Transducer_Error = No error	QUALITY = UNCERTAIN SUBSTATUS = Sensor conversion not accurate	*Cause of error:* Physical measuring range overshot *Remedy:* Select suitable sensor type	SV1, SV2 Also PV1, PV2 depending on the configuration
F	103	*Device status message (FF):* Sensor drift detected F103 *Local display:* ⚠ F103 ↔ "-----"	BLOCK_ERR = Other | Input failure | Device needs maintenance now Transducer_Error = General error	QUALITY = BAD SUBSTATUS = Sensor failure	*Cause of error:* Sensor drift has been detected (in accordance with the settings in the Advanced Diagnostic Block) *Remedy:* Check the sensors depending on the application	PV1, PV2 SV1, SV2
M	103	*Device status message (FF):* Sensor drift detected M103 *Local display:* ⚠ M103 ↔ Measured value	BLOCK_ERR = Device needs maintenance now Transducer_Error = No error	QUALITY = UNCERTAIN SUBSTATUS = Non-specific	*Cause of error:* Sensor drift has been detected (in accordance with the settings in the Advanced Diagnostic Block) *Remedy:* Check the sensors depending on the application	PV1, PV2 SV1, SV2
M	104	*Device status message (FF):* Backup active M104 *Local display:* ⚠ M104 ↔ Measured value	BLOCK_ERR = Device needs maintenance now Transducer_Error = No error	QUALITY = GOOD / BAD SUBSTATUS = Ok / sensor failure	*Cause of error:* Backup function activated and an error was detected at one sensor *Remedy:* Rectify sensor error	SV1, SV2 PV1, PV2 depending on the configuration
F	221	*Device status message (FF):* RJ Error F221 *Local display:* ⚠ F221 ↔ "-----"	BLOCK_ERR = Device needs maintenance now Transducer_Error = General error	QUALITY = BAD SUBSTATUS = Device failure	*Cause of error:* Internal reference junction defective *Remedy:* Device defective. Send to manufacturer for repair	SV1, SV2, PV1, PV2, RJ1, RJ2
F	261	*Device status message (FF):* Electronics board defective F261 *Local display:* ⚠ F261 ↔ "-----"	BLOCK_ERR = Other | Transducer_Error = Electronic failure	QUALITY = BAD SUBSTATUS = Device failure	*Cause of error:* Error in the electronics *Remedy:* Replace electronics module, → chap. 9.4	SV1, SV2, PV1, PV2, RJ1, RJ2

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	Cause of error / remedy	Output variables affected
F	283	*Device status message (FF):* Memory error F283 *Local display:* ⚠ F283 ↔ "-----"	BLOCK_ERR = Other | Lost static data Transducer_Error = Data integrity error	QUALITY = BAD SUBSTATUS = Device failure	*Cause of error:* Error in memory *Remedy:* Replace electronics module, → chap. 9.4	SV1, SV2, PV1, PV2, RJ1, RJ2
C	402	*Device status message (FF):* Startup of device C402 *Local display:* ⚠ C402 ↔ Measured value	BLOCK_ERR = Power up Transducer_Error = No error	QUALITY = UNCERTAIN SUBSTATUS = Non-specific	*Cause of error:* Device starting/initializing *Remedy:* Message is only displayed during power-up	SV1, SV2, PV1, PV2, RJ1, RJ2
F	431	*Device status message (FF):* No calibration F431 *Local display:* ⚠ F431 ↔ "-----"	BLOCK_ERR = Other Transducer_Error = Calibration error	QUALITY = BAD SUBSTATUS = Device failure	*Cause of error:* Error in calibration parameters *Remedy:* Replace electronics module, → chap. 9.4	SV1, SV2, PV1, PV2, RJ1, RJ2
F	437	*Device status message (FF):* Configuration Error F437 *Local display:* ⚠ F437 ↔ "-----"	BLOCK_ERR = Other | Block Configuration Error Transducer_Error = Calibration error	QUALITY = BAD SUBSTATUS = Device failure	*Cause of error:* Wrong configuration within sensor transducer block "Sensor 1 and 2" *Remedy:* Check configuration of used units, settings of PV1 and/or PV2 and used sensor types.	SV1, SV2, PV1, PV2, RJ1, RJ2
C	482	*Device status message (FF):* Simulation Mode Active C482 *Local display:* ⚠ C482 ↔ Measured value	BLOCK_ERR = Simulate active Transducer_Error = No error	QUALITY = UNCERTAIN SUBSTATUS = Substitute	*Cause of error:* Simulation is active *Remedy:* -	
C	501	*Device status message (FF):* Device preset C501 *Local display:* ⚠ C501 ↔ Measured value	BLOCK_ERR = Transducer_Error = No error	QUALITY = UNCERTAIN/GOOD SUBSTATUS = Non-specific/update event	*Cause of error:* Device reset is performed *Remedy:* Message is only displayed during reset	SV1, SV2, PV1, PV2, RJ1, RJ2
S	502	*Device status message (FF):* Linearization S502 *Local display:* ⚠ S502 ↔ Measured value	BLOCK_ERR = Other | Block configuration error Transducer_Error = Configuration error	QUALITY = BAD SUBSTATUS = Configuration error	*Cause of error:* Error in linearization *Remedy:* Select valid type of linearization (sensor type)	SV1, SV2, PV1, PV2, RJ1, RJ2

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	Cause of error / remedy	Output variables affected
S	901	*Device status message (FF):* Ambient temperature too low S901 *Local display:* ⚠ S901 ↔ Measured value	BLOCK_ERR = Transducer_Error = No error	QUALITY = UNCERTAIN SUBSTATUS = Non-specific	*Cause of error:* Reference junction temperature < -40 °C (-40 °F); parameter **Alarm_Ambient_ Temp = OFF** *Remedy:* Observe ambient temperature as per specification	SV1, SV2, PV1, PV2, RJ1, RJ2
F	901	*Device status message (FF):* Ambient temperature too low F901 *Local display:* ⚠ F901 ↔ "-----"	BLOCK_ERR = Device needs maintenance now Transducer_Error = General error	QUALITY = BAD SUBSTATUS = Device failure	*Cause of error:* Reference junction temperature < -40 °C (-40 °F); parameter **Alarm_Ambient_ Temp = ON** *Remedy:* Observe ambient temperature as per specification	SV1, SV2, PV1, PV2, RJ1, RJ2
S	902	*Device status message (FF):* Ambient temperature too high S902 *Local display:* ⚠ S902 ↔ Measured value	BLOCK_ERR = Transducer_Error = No error	QUALITY = UNCERTAIN SUBSTATUS = Non-specific	*Cause of error:* Reference junction temperature > +85 °C (+185 °F); parameter **Alarm_Ambient_ Temp = OFF** *Remedy:* Observe ambient temperature as per specification	SV1, SV2, PV1, PV2, RJ1, RJ2
F	902	*Device status message (FF):* Ambient temperature too high F902 *Local display:* ⚠ F902 ↔ "-----"	BLOCK_ERR = Device needs maintenance now Transducer_Error = General error	QUALITY = BAD SUBSTATUS = Device failure	*Cause of error:* Reference junction temperature > +85 °C (+185 °F); parameter **Alarm_Ambient_ Temp = ON** *Remedy:* Observe ambient temperature as per specification	SV1, SV2, PV1, PV2, RJ1, RJ2

9.2.1 Corrosion detection

Sensor connection cable corrosion can lead to false measured value readings. Therefore our unit offers the possibility to recognize any corrosion before the measured values are affected.

2 different stages can be selected in the CORROSION_DETECTION parameter (→ page 69) depending on the application requirements:

- Off (no corrosion detection)
- On (warning output just before reaching the alarm set point. This allows for preventative maintenance/troubleshooting to be done.) An alarm message is output as of the alarm set point)

The following table describes how the device behaves when the resistance in a sensor connection cable changes depending on whether the on or off option has been selected.

✎ Note!
Corrosion detection only for RTD with 4-wire connection

RTD [a]	**< ≈ 2 kΩ**	**2 kΩ ≈ < x< ≈ 3 kΩ**	**> ≈ 3 kΩ**
off	—	No alarm	No alarm
on	—	WARNING (M042)	ALARM (F042)

a. Pt100 = 100 Ω at 0°C / Pt1000 = 1000 Ω at 0°C

TC	**< ≈ 10 kΩ**	**10 kΩ ≈ < x< ≈ 15 kΩ**	**> ≈ 15 kΩ**
off	—	No alarm	No alarm
on	—	WARNING (M042)	ALARM (F042)

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.

9.3 Application errors without messages

9.3.1 Application errors for RTD connection

Pt100/Pt500/Pt1000/Ni100

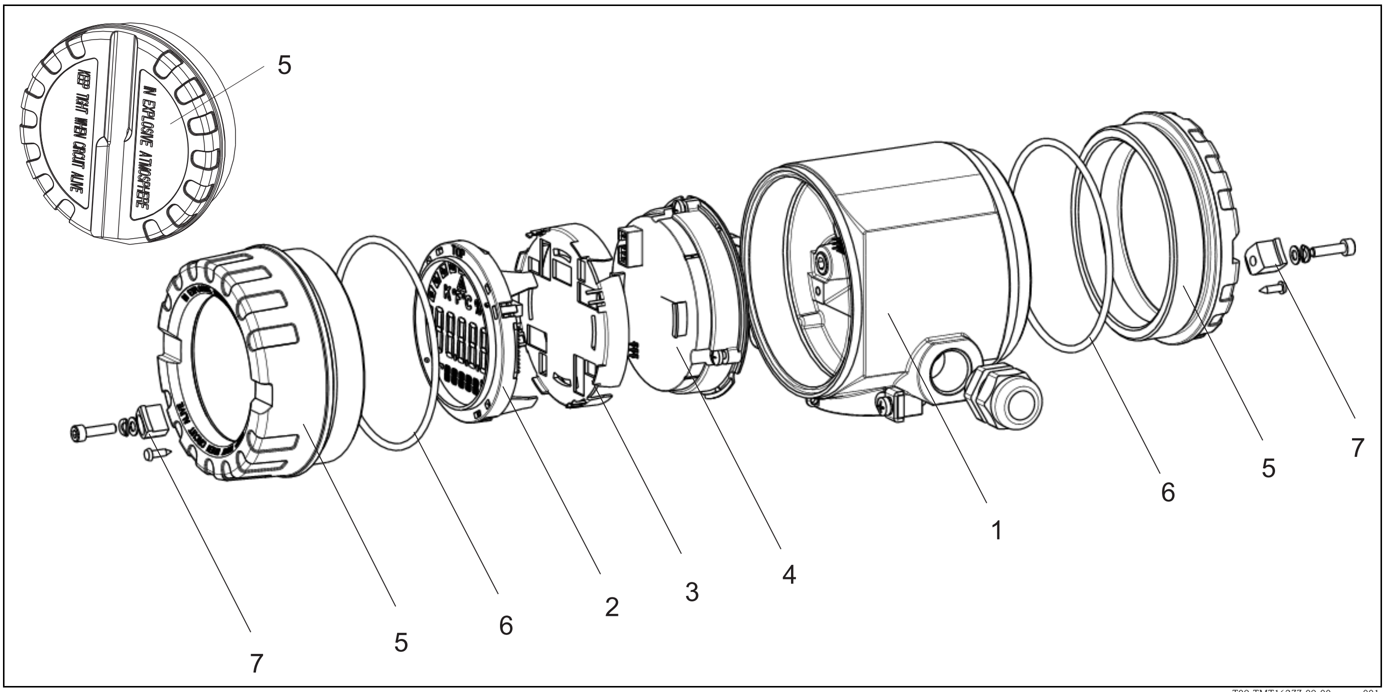
Symptoms	**Cause**	**Action/cure**
Measured value is incorrect/inaccurate	Incorrect sensor orientation	Install the sensor correctly
	Heat conducted by sensor	Observe the face-to-face length of the sensor
	Device programming is incorrect (number of wires)	Change the SENSOR_CONNECTION device function
	Device programming is incorrect (scaling)	Change scaling
	Incorrect RTD configured	Change SENSOR_TYPE device function
	Sensor connection (two-wire)	Check the sensor connection
	The cable resistance of the sensor (two-wire) was not compensated	Compensate the cable resistance
	Offset incorrectly set	Check offset
	Sensor defective	Check sensor
	RTD connection incorrect	Connect the connecting cables correctly (terminal diagram)
	Programming	Incorrect sensor type set in the SENSOR_TYPE device function; change to the correct sensor type
	Device defective	Replace device

9.3.2 Application errors for TC connection

Symptoms	Cause	Action/cure
Measured value is incorrect/inaccurate	Incorrect sensor orientation	Install the sensor correctly
	Heat conducted by sensor	Observe the face-to-face length of the sensor
	Device programming is incorrect (scaling)	Change scaling
	Incorrect thermocouple type (TC) configured	Change SENSOR_TYPE device function
	Incorrect comparison measurement point set	See 'Description of Device Functions' chapter
	Offset incorrectly set	Check offset
	Interference via the thermocouple wire welded in the thermowell (interference voltage coupling)	Use a sensor where the thermocouple wire is not welded
	Sensor incorrectly connected	Connect the sensor as per the terminal diagram (polarity)
	Sensor defective	Check sensor
	Programming	Incorrect sensor type set in the SENSOR_TYPE device function; set the correct thermocouple
	Device defective	Replace device

9.4 Spare parts

If ordering spare parts, please specify the serial number of the unit!



T09-TMT162ZZ-09-00-xx-xx-001

Housing					
	Certification:				
	A	Non hazardous areas + ATEX Ex ia			
	B	ATEX Ex d			
		Material:			
		A	Aluminum, HART		
		B	Stainless steel 316L, HART		
		C	T17, HART		
		F	Aluminum, FF		
		G	Stainless steel 316L, FF		
		H	T17, FF		
			Cable entry:		
			1	2 x thread NPT ½" + terminal block + 1 blanking plug	
			2	2 x thread M20x1.5 + terminal block + 1 blanking plug	
			4	2 x thread G½" + terminal block + 1 blanking plug	
				Model:	
				A	Standard
TMT162G-				**A**	⇐ **Order code**

Electronics				
	Certification:			
	A	Non hazardous areas		
	B	ATEX Ex ia, FM IS, CSA IS		
		Sensor input; communication:		
		A	1x; HART	
		B	2x; config. output sensor 1; HART	
		C	2x; FF	
		D	2x; PA	
			Configuration:	
			A	50 Hz line voltage filter
			B	According to original order (specify serial no.) 50 Hz mains filter
			K	60 Hz line voltage filter
			L	According to original order (specify serial no.) 60 Hz mains filter
TMT162E-				⇐ **Order code**

Pos. no.	Order code	Spare part
2, 3	TMT162X-DA	Display HART + fitting kit + twist protection
2, 3	TMT162X-DB	Display PA/FF + fitting kit + twist protection
2, 3	TMT162X-DC	Display fitting kit + twist protection
5	TMT162X-HH	Housing cover blind, Alu Ex d, FM XP with O-ring, CSA XP only as cover of terminal part
5	TMT162X-HI	Housing cover blind, alu + O-ring
5	TMT162X-HK	Housing cover cpl.display, Alu Ex d + O-ring
5	TMT162X-HL	Housing cover cpl. display, alu + O-ring
5	TMT162X-HA	Housing cover blind stainl. st. 316L Ex d, ATEX Ex d, FM XP with O-ring, CSA XP only as cover of terminal part
5	TMT162X-HB	Housing cover blind stainl. st. 316L, with O-ring
5	TMT162X-HC	Housing cover cpl. display, Ex d, stainl. st. 316L, ATEX Ex d, FM XP, CSA XP, with O-ring
5	TMT162X-HD	Housing cover cpl. display, stainl. st. 316L with O-Ring
5	TMT162X-HE	Housing cover blind, T17 316L
5	TMT162X-HF	Housing cover cpl. display, polycarbonate T17, 316L
5	TMT162X-HG	Housing cover cpl. display, glass T17 316L
6	51004555	O-ring 88x3 NBR70 PTFE coated
7	51004948	Cover latch spares kit field housing screw, washer, spring washer

9.5 Returns

The device should be well packed, preferably in the original packaging when storing for further use or returning it for repair. Repairs must only be done by the service organization of your supplier or by trained skilled personnel.

When returning the device for repair, please add a desription of both the fault and the application and additional enclose a fully completed “Declaration of Contamination” form with the device. A copy of that can be found as pdf file on the CD-ROM. For USA and Canada please follow the Return Authorization Policy which is attached.

9.6 Disposal

The device contains electronic components and when being disposed of should be placed in the electronic waste. Please take note of any local waste disposal legislation when disposing of the device.

9.7 Software history and overview of compatibility

Release

The release number on the title page in the Operating Instructions indicates the device release history: XX.YY.ZZ (example 01.02.01).

XX Change in the main version.
No longer compatible. Changes to device and Operating Instructions.

YY Change in the functionality and operation.
Compatible. Changes to Operating Instructions.

ZZ Debugging and internal modifications.
No changes to Operating Instructions.

Date	Firmware version	Modifications	Documentation
01/2006	1.00.00	Original Firmware	BA224R/09/en/11.06 71009687
08/2010	1.01.00	New device revision 2	BA224R/09/en/13.10 71123287

10 Technical data

10.1 Input

Measured variable

Temperature (temperature linear transmission behaviour), resistance and voltage.

Input

Input	Designation	Measuring range limits
Resistance thermometer (RTD) to IEC 60751 (α = 0.00385)	Pt100 Pt200 Pt500 Pt1000	-200 to 850 °C (-328 to 1562 °F) -200 to 850 °C (-328 to 1562 °F) -200 to 250 °C (-328 to 482 °F) -200 to 250 °C (-238 to 482 °F)
to JIS C1604-81 (α = 0.003916)	Pt100	-200 to 649 °C (-328 to 1200 °F)
to DIN 43760 (α = 0.006180)	Ni100 Ni1000	-60 to 250 °C (-76 to 482 °F) -60 to 150 °C (-76 to 302 °F)
to Edison Copper Winding No.15 (α = 0.004274)	Cu10	-100 to 260 °C (-148 to 500 °F)
to SAMA (α = 0.003923)	Pt100	-100 to 700 °C (-148 to 1292 °F)
to Edison Curve (α = 0.006720)	Ni120	-70 to 270 °C (-94 to 518 °F)
to GOST (α = 0.003911)	Pt50 Pt100	-200 to 1100 °C (-328 to 2012 °F) -200 to 850 °C (-328 to 1562 °F)
to GOST (α = 0.004278)	Cu50, Cu100	-200 to 200 °C (-328 to 392 °F)
	Pt100 (Callendar - van Dusen)	10 to 400 Ω
	Nickel or copper polynomial	10 to 400 Ω 10 to 2000 Ω

Input	Designation	Measuring range limits
	▪ 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 to max. 50 Ω per wire	
Resistance transmitter	Resistance Ω	10 to 400 Ω 10 to 2000 Ω
Thermocouples (TC) to IEC 584 part 1	Type B (PtRh30-PtRh6)[a b] 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)	40 to +1820 °C (104 to 3308 °F) -270 to +1000 °C (-454 to 1832 °F) -210 to +1200 °C (-346 to 2192 °F) -270 to +1372 °C (-454 to 2501 °F) -270 to +1300 °C (-454 to 2372 °F) -50 to +1768 °C (-58 to 3214 °F) -50 to +1768 °C (-58 to 3214 °F) -270 to +400 °C (-454 to 752 °F)
to ASTM E988	Type C (W5Re-W26Re) Type D (W3Re-W25Re)	0 to +2315 °C (32 to 4199 °F) 0 to +2315 °C (32 to 4199 °F)
to DIN 43710	Type L (Fe-CuNi) Type U (Cu-CuNi)	-200 to +900 °C (-328 to 1652 °F) -200 to +600 °C (-328 to 1112 °F)
	▪ Cold junction: internal (Pt100) or external, value can be adjusted from -40 to +85 °C (-40 to +185 °F) ▪ Accuracy of cold junction: ± 1 °C (± 1.8 °F) ▪ Max. sensor resistance 10 kΩ (if sensor resistance is greater than 10 kΩ, error message as per NAMUR NE89)[c]	
Voltage transmitter (mV)	Millivolt transmitter (mV)	-20 to 100 mV

a. Significant measuring inaccuracy for temperatures lower than 300 °C (572 °F).
b. When operating conditions are based over a large temperature range, the TMT162 offers you the ability to do a split range. For example a Type S or R thermocouple can be used for the low range and a Type B can be used for the upper range. The TMT162 is then programmed by the end user to switch at a predetermined temperature. This allows for utilization of the best performance from each individual thermocouple and provides 1 output that represents the process temperature.
c. Basic requirements NE89:
Detection of increased wire resistance (e.g. corrosion of contacts or wires) of TC or RTD/4-wire. Warning - exceeding ambient temperature.

10.2 Output

Output signal

FOUNDATION Fieldbus™ interface

- FOUNDATION Fieldbus™ H1, IEC 61158-2, galvanically isolated
- Current consumption ≤ 11 mA
- FDE (Fault Disconnection Electronic) = 0 mA
- Data transmission rate: supported baudrate = 31.25 kBit/s
- Signal encoding = Manchester II
- Function blocks: Resource Block, 2 x Sensor Transducer, Display Transducer, adv. Diagnostics Transducer, 3 x Analog Input (execution time 35 ms), PID (50 ms), Input Selector (30 ms)
- ITK 5.2.0 conformity
- Output data: Available values via AI-blocks: Temperature (PV), temp. sensor 1, temp. sensor 2, terminal temperature
- Link Master (LM) functionality is supported
- According to IEC 60079-27, FISCO/FNICO

Breakdown information

Status message according to FOUNDATION Fieldbus™.

Linearization/transmission behavior

Temperature linear, resistance linear, voltage linear

Filter

1st order digital filter: 0 to 60 s

Galvanic isolation	U = 2 kV AC (input/output)
Current consumption	≤ 11 mA
Switch-on delay	8 s

10.3 Power supply

Note!
The sensitive electronics of this apparatus can be impaired or damaged by electrostatic discharge (ESD).

Supply voltage	U_b= 9 to 32 V, polarity-independent (reverse polarity protection for T17 housing), max. voltage U_b = 35 V
Cable entry	Overview see → Chap. 'Accessories'

10.4 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 °C ± 5 K (77 °F ± 9 °F)

Maximum measured error

✎ Note!
The accuracy data are typical values and correspond to a standard deviation of ± 3σ (normal distribution), i.e. 99.8% of all the measured values achieve the given values or better values.

	Designation	**Accuracy (digital)**
Resistance thermometer (RTD)	Cu100, Pt100, Ni100, Ni120 Pt500 Cu50, Pt50, Pt1000, Ni1000 Cu10, Pt200	0.1 °C (0.18 °F) 0.3 °C (0.54 °F) 0.2 °C (0.36 °F) 1 °C (1.8 °F)
Thermocouples (TC)	K, J, T, E, L, U N, C, D S, B, R	typ. 0.25 °C (0.45 °F) typ. 0.5 °C (0.9 °F) typ. 1.0 °C (1.8 °F)
	Measuring range	**Accuracy (digital)**
Resistance transmitter (Ω)	10 to 400 Ω 10 to 2000 Ω	± 0.04 Ω ± 0.8 Ω
Voltage transmitter (mV)	-20 to 100 mV	± 10 µV

Physical input range of the sensors	
10 to 400 Ω	Cu10, Cu50, Cu100, Polynom RTD, Pt50, Pt100, Ni100, Ni120
10 to 2000 Ω	Pt200, Pt500, Pt1000, Ni1000
-20 to 100 mV	Thermocouple type: C, D, E, J, K, L, N, U
-5 to 30 mV	Thermocouple type: B, R, S, T

Sensor transmitter matching

RTD sensors are one of the most linear temperature elements for measurement. However, the output still needs to be linearized. To significantly improve temperature measurement accuracy, the TMT162 allows you to utilize two methods to achieve that:

- Customer specific linearization

Using PC configuration software the TMT162 can be programmed with sensor specific curve data. Once the sensor-specific data has been entered, the TMT162 utilizes this to generate a custom curve. Endress+Hauser Readwin® 2000 software supports by calculating sensor specific curves.

- 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 constants, commonly referred to 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 to each RTD sensor.
The process involves programming the TMT162 with curve data for a specific RTD, instead of using the standard curve.
Sensor transmitter matching using any of the above methods substantially improves the temperature measurement accuracy of the entire system. This is as a result of the transmitter using the sensor's actual resistance vs. temperature curve data instead of the ideal curve data.

Repeatability

0.0015% of the physical input range (16 Bit)
Resolution A/D conversion: 18 Bit

Long-term stability

≤ 0.1 °C/year (≤ 0.18 °F/year) or ≤ 0.05%/year
Data under reference conditions. % relates to the set span. The larger value applies.

Influence of ambient temperature (temperature drift)

Total temperature drift = input temperature drift + output temperature drift (see example below)

Effect on the accuracy when ambient temperature changes by 1 °C (1.8 °F):	
Input 10 to 400 Ω	typ. 0.001% of measured value (min. 100 Ω)
Input 10 to 2000 Ω	typ. 0.001% of measured value (min. 1000 Ω)
Input -20 to 100 mV	typ. 0.001% of measured value (maximum value = 1.5 x typ., min. 20 mV)
Input -5 to 30 mV	typ. 0.001% of measured value (maximum value = 1.5 x typ., min. 10 mV)
Output 4 to 20 mA	typ. 0.001% of measured value (maximum value = 1.5 x typ.)

Typical sensor resistance change when process temperature changes by 1 °C (1.8 °F):				
Cu10: 0.04 Ω	Pt200: 0.8 Ω	Ni120: 0.7 Ω	Cu50: 0.2 Ω	Pt50: 0.2 Ω
Cu100, Pt100: 0.4 Ω	Pt500: 2 Ω	Pt1000: 4 Ω	Ni100: 0.6 Ω	Ni1000: 6 Ω

Typical change in thermoelectric voltage when process temperature changes by 1 °C (1.8 °F):					
B: 10 V	C: 20 V	D: 20 V	E: 75 V	J: 55 V	K: 40 V
L: 55 V	N: 35 V	R: 12 V	S: 12 V	T: 50 V	U: 60 V

Examples for calculation of accuracy:

Example 1:

Input temperature drift $\Delta\vartheta$ = 10 °C (18 °F), Pt100, span 0 to 100 °C (32 to 212 °F)
Maximum process value: 100 °C (212 °F)
Measured resistance value: 138.5 Ω (s. IEC 60751)

Typ. influence in Ω: (0.001% of 138.5 Ω) * 10 = 0.01385 Ω
Conversion Ω to K: 0.01385 Ω / 0.4 Ω/°C = 0.03 °C (0.054 °F)

Example 2:
Input temperature drift Δϑ = 10 °C (18 °F),
thermocouple type K with span 0 to 600 °C (32 to 1112 °F)
Maximum process value: 600 °C (1112 °F)
Measured thermoelectric voltage: 24905 µV (s. IEC584)
Typ. influence in µV: (0.001% of 24905 µV) * 10 = 2.5 µV
Conversion Ω to K: 2.5 µV / 40 µV/K = 0.06 °C (0.11 °F)
Example 3:
max. possible measured error Δϑ = 10 °C (18 °F), Pt100,
measuring range 0 to 100 °C (32 to 212 °F)
Measured error Pt100: 0.1 °C (0.18 °F)
Output measured error: 0.02 °C (0.04 °F) = 0.02% of 100 °C
Input temperature drift: 0.03 °C (0.054 °F)
Output temperature drift: 0.01 °C * 1.5 = 0.015 °C (0.03 °F)
Max. possible error (total of errors): 0.165 °C (0.3 °F)

Δϑ = deviation of ambient temperature from the reference operating condition.

Total measuring point error = max. possible measured error + temperature sensor error.

Influence of reference junction (internal cold junction)

Pt100 DIN IEC 60751 Cl. B (internal cold junction with thermocouples TC)

10.5 Environment conditions

Ambient temperature limits

- Without display: -40 to +85 °C (-40 to +185 °F)
- With display: -40 to +80 °C (-40 to +176 °F)

For use in Ex area, see Ex certificate

✎ Note!
At temperatures < -20 °C (-4 °F) the display may react slowly. 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)

Altitude

Up to 2000 m (6560 ft) above sea level according to IEC 61010-1, CSA 1010.1-92

Climate class

As per IEC 60654-1, Class C

Degree of protection

- Aluminum die-cast or stainless steel housing: IP67, NEMA 4x
- Stainless steel housing for hygienic applications (T17 housing): IP66/IP68 (1,83 m H_2O for 24 h), NEMA 4x, NEMA 6P

Shock and vibration resistance

3g / 2 to 150 Hz as per IEC 60 068-2-6

✎ Note!
Attention should be taken when considering the use of the L-form bracket (see wall/tube 2" brackets in chapter 'Accessories') since this can cause resonance. As resonances can also be caused by pipes, brackets or any sensor lagging extensions. They need to be given due consideration to ensure that any vibrations directly at the transmitter do not exceed the specification.

Electromagnetic compatibility (EMC)

CE Electromagnetic Compatibility Compliance
The device meets all requirements listed under IEC 61326 Amendment 1, 1998 and NAMUR NE21. This recommendation is a uniform and practical way of determining whether the devices used in laboratories and process control are immune to interference with an objective to increase its functional safety.

ESD (Electrostatic discharge)	IEC 61000-4-2	6 kV cont., 8 kV air	
Electromagnetic fields	IEC 61000-4-3	0.08 to 4 GHz	10 V/m
Burst (fast transient)	IEC 61000-4-4	1 kV	
Surge	IEC 61000-4-5	1 kV asym.	
Conducted RF	IEC 61000-4-6	0.01 to 80 MHz	10 V

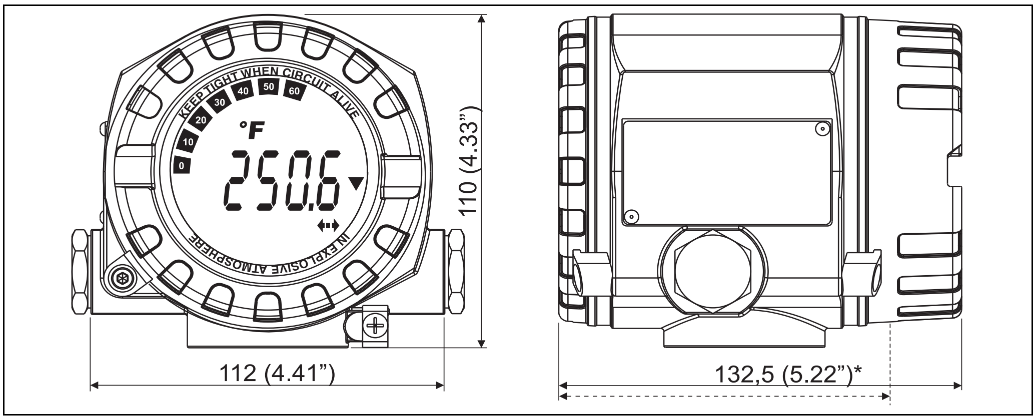
Condensation Permitted

Installation category 1 to IEC 61010

Pollution degree 2 to IEC 61010

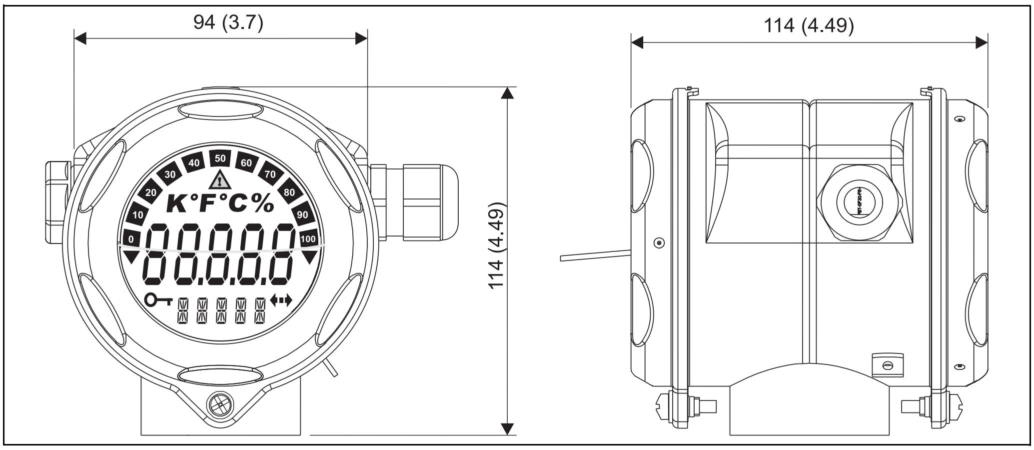
10.6 Mechanical construction

Design, dimensions



T09-TMT162ZZ-06-00-xx-xx-001

Data in mm (inch)
Die-cast aluminum housing for general purpose or as option stainless steel housing
** dimensions without display = 112 mm (4.41")*



T09-TMT162ZZ-06-00-xx-en-003

Data in mm (inch)
Optional T17 stainless steel housing for hygienic applications

- Separate electronics compartment and connection compartment
- Display pluggable in 90° stages

Weight

- Approx. 1.4 kg (3 lbs), with display, aluminum housing
- Approx. 4.2 kg (9.3 lbs), with display, stainless steel housing
- Approx. 1.25 kg (2.76 lbs), with display, T17 housing

Material

Housing	Nameplate
Die-cast aluminum housing AlSi10Mg with powder coating on polyester basis	Aluminum AlMgl, anodized in black
Stainless steel 1.4435 (AISI 316L)	1.4301 (AISI 304)
Stainless steel 1.4435 (AISI 316L) for hygienic applications (T17 housing)	-

Terminals

2.5 mm^2 (12 AWG) plus wire end ferrules

10.7 Certificates and approvals

CE-Mark

The measurement system fulfils the requirements demanded by the EU regulations. Endress+Hauser acknowledges successful unit testing by adding the CE mark.

MTBF

126 a, according to Siemens Standard SN29500

Hazardous area approvals

- FM IS, NI Class I, Div. 1+2, Group A, B, C, D
  Depending on location install per National Electrical Code (NEC) using wiring methods described in article 500 through article 510. For Nonincendive installation an intrinsic safety barrier is not required.
  CSA IS, NI Class I, Div. 1+2, Group A, B, C, D
  ATEX II1G EEx ia IIC T4/T5/T6

- FM XP, DIP, NI Class I, II, III, Div. 1+2, Group A, B, C, D, E, F, G
  CSA XP, DIP, NI Class I,II,III, Div. 1+2, Group A, B, C, D, E, F, G
  ATEX II2G EEx d IIC T6

- FM XP, DIP, NI Class I, II, III, Div. 1+2, Group A, B, C, D, E, F, G
  CSA XP, DIP, NI Class I, II, III, Div. 1+2, Group A, B, C, D, E, F, G
  ATEX EEx d, EEx ia

- FM+CSA XP, DIP, IS, NI Class I,II,III, Div. 1+2, Group A, B, C, D, E, F, G
  ATEX II3G EEx nA IIC T4/T5/T6

- ATEX II1/2D

- CSA General purpose

Other standards and guidelines

- IEC 60529:
  Degrees of protection by housing (IP-Code)
- IEC 61010:
  Safety requirements for electrical measurement, control and laboratory instrumentation
- IEC 61326:
  Electromagnetic compatibility (EMC requirements)
- NAMUR
  Standardization association for measurement and control in chemical and pharmaceutical industries. (www.namur.de)
- NEMA
  Standardization association for the electrical industry

Certification FOUNDATION Fieldbus™

The temperature transmitter has successfully passed all test procedures and is certified and registered by the Fieldbus Foundation. The device thus meets all the requirements of the specifications following:

- Certified according to FOUNDATION Fieldbus™ Specification
- The device meets all the specifications of the FOUNDATION Fieldbus™-H1
- Interoperability Test Kit (ITK), revision status 5.2.0 (device certification no. available on request): The device can also be operated with certified devices of other manufacturers
- Physical Layer Conformance Test of the FOUNDATION Fieldbus™

10.8 Documentation

- Instruction manual FOUNDATION Fieldbus Overview - Installation and Commissioning Guidelines (BA013S/04/en)
- Instruction manual ControlCare - Function Blocks (BA022S/04/en)
- FOUNDATION Fieldbus™ Function Blocks manual (BA062S/04)
- Hazardous area safety instructions:
  ATEX II2G, EEx d: XA058R/09/a3
  ATEX II1/2D: XA059R/09/a3
  ATEX II1G: XA060R/09/a3
  ATEX EEx ia + EEx d: XA061R/09/a3
- Technical information Omnigrad S TMT162R and TMT162C
  (TI266T/02/en and TI267T/02/en)

11 Operation via FOUNDATION Fieldbus

11.1 Block model

In the FOUNDATION Fieldbus 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.

TMT162 FF has the following blocks:

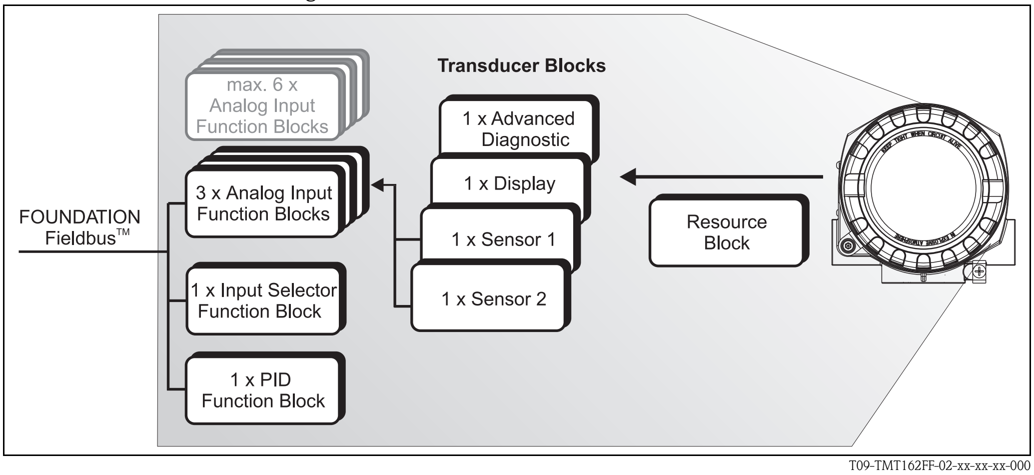


Fig. 16: Block model TMT162 FF

11.2 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 revision, software revision, device release 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.

11.2.1 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)

✎ Note!
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.

11.2.2 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.

11.2.3 Write protection and simulation

DIP switches in the electronics compartment allow device parameter write protection and simulation in the Analog Input function block to be disabled or enabled → page 23.

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.

11.2.4 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 (see page 23), 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 if an active write protection alarm WRITE_ALM.

✎ Note!
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.

11.2.5 Resource Block FF parameters

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

Resource Block			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
38	**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.**
37	**ALARM_SUM**	**AUTO - OOS**	Displays the current status of the process alarms in the Resource Block. Note! In addition the process alarms can also be disabled in this parameter group.
4	**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**
36	**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 Note! If the option of the alarm has **not** been enabled in the ACK_OPTION parameter, the alarm can only be acknowledged via this parameter.
6	**BLOCK_ERR**	**Read only**	The active block errors appear on the display. Display: SIMULATE ACTIVE Simulation is possible in the Analog Input function block via the SIMULATE parameter (refer also to Hardware Write Protection Configuration on page 23). OUT OF SERVICE The block is in the "out of service" mode.
30	**CLR_FSTATE**	**AUTO - OOS**	This parameter can be used to manually disable the security behavior of the Analog Output and Discrete Output function blocks.
33	**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:** **640000 $^{1}/_{32}$ ms**
20	**CYCLE_SEL**	**AUTO - OOS**	Displays the block execution method used by the fieldbus host system. Note! The block execution method is selected by the fieldbus host system.

Resource Block			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
19	**CYCLE_TYPE**	**Read only**	Displays the block execution method supported by the device. Display: SCHEDULED timed block execution method BLOCK EXECUTION sequential block execution method MANUF SPECIFIC manufacturer specified
9	**DD_ RESOURCE**	**Read only**	Displays the reference source for the device description in the device. Display: (NULL)
13	**DD_REV**	**Read only**	Displays the revision number of the device description.
12	**DEV_REV**	**Read only**	Displays the revision number of the device
11	**DEV_TYPE**	**Read only**	Displays the device type in decimal numeric format. Display: 0 x 10CC hex for TMT162 FF
28	**FAULT_STATE**	**Read only**	Current status display of the security behavior of the Analog Output and Discrete Output function blocks.
17	**FEATURES**	**Read only**	Displays the additional options supported by the device. Display: REPORTS FAULTSTATE SOFT W LOCK
19	**FEATURES_SEL**	**AUTO - OOS**	For selecting the additional functions supported by the device.
25	**FREE_TIME**	**Read only**	Displays the free system time (in percent) available for execution of further function blocks. ✎ Note! Since the function blocks of the device are preconfigured, this parameter always displays the value 0.
24	**FREE_SPACE**	**Read only**	Displays the free system memory (in percent) available for execution of further function blocks. ✎ Note! Since the function blocks of the device are preconfigured, this parameter always displays the value 0.
14	**GRANT_DENY**	**AUTO - OOS**	Enables or restricts the access authorization of a fieldbus host system to the field device.
15	**HARD_TYPES**	**Read only**	Displays the input signal type for the Analog Input function block.
32	**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**
10	**MANUFAC_ID**	**Read only**	Displays the manufacturer's ID number. Display: 0 x 452B48 = Endress+Hauser

Resource Block			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
31	**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
22	**MEMORY_SIZE**	**Read only**	Displays the available configuration memory in kilobytes. ✎ Note! This parameter is not supported.
21	**MIN_CYCLE_T**	**Read only**	Displays the minimum execution time
5	**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 ✎ Note! 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. ✎ Note! The current operating status of the Resource Block is also shown via the RS_STATE parameter.
23	**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 **Factory default: 19.200.000 $^1/_{32}$ ms** ✎ Note! The device saves dynamic NV parameters in non volatile memory every 10 minutes. Therefore the value of this parameter is 19.200.000 1/32 ms.
16	**RESTART**	**AUTO - OOS**	This parameter is used to reset the device in various ways. Options: ▪ Restart UNINITIALIZED ▪ RUN ▪ Restart RESOURCE ▪ Restart with DEFAULTS ▪ Restart PROCESSOR ▪ Restart PRODUCT DEFAULT (all the parameters are reset to the factory setting) ▪ Restart ORDER CONFIGURATION (all the parameters are reset to the ordered pre-configuration)

Resource Block			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
7	**RS_STATE**	**Read only**	Displays the current operating status of the Resource Blocks. Display: 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.
29	**SET_FSTATE**	**AUTO - OOS**	This parameter can be used to manually enable the security behavior of the device.
26	**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: 640000 $^1/_{32}$ ms**
27	**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. **Factory default: 640000 $^1/_{32}$ ms**
3	**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** ✎ Note! This data is neither checked nor processed by the Resource Block.
1	**ST_REV**	**Read only**	The revision status of the static data appears on the display. ✎ Note! The revision status is incremented on each modification of static data.
2	**TAG_DESC**	**AUTO - OOS**	Entry of a user specific text for unique identification and assignment of the block.
8	**TEST_RW**	**AUTO - OOS**	✎ Note! This parameter is required only for interoperability tests and has no meaning in normal operation.
35	**UPDATE_EVT**	**Read only**	Indicates whether static block data have been altered, including date and time.
40	**WRITE_ALM**	**AUTO - OOS**	Displays the status of the write protected alarm. ✎ Note! The alarm is triggered if the write protection is disabled.
34	**WRITE_LOCK**	**Read only**	Able and disable write protection Display: LOCKED Device data cannot be modified NOT LOCKED Device data can be modified UNINITIALIZED

Resource Block			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
39	**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. 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**
41	**ITK_VER**	**Read only**	Displays the main ITK version the device was certified with. Display: 5
42	**CAPABILITY_LEV**	**Read only**	Displays the capability level which the device supports. Display: 1
43	**COMPATIBILITY _LEV**	**Read only**	Indicates until which previous device revision the device is compatible. Display: 2

11.2.6 Resource Block Endress+Hauser parameters

The following table shows the Endress+Hauser-specific parameters of the Resource Block.

Resource Block		
Parameter	**Write access with operating mode**	**Description**
HARDWARE_VERSION	**Read only**	Hardware version of the device
FIRMWARE_VERSION	**Read only**	Software version of the device
DEVICE_TAG	**Read only**	Actual TAG of the device
FF_COMM_VERSION	**Read only**	FF communication version
ENP_VERSION	**Read only**	Version of used electronic name plate
SERIAL_NUMBER	**Read only**	Serial number of the electronics. Is used to create the Device ID.
ORDER_CODE	**Read only**	Order code of the device

11.3 Transducer Blocks

The Transducer Blocks of the TMT162 FF contain all the measuring and device-specific parameters of the device. 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.

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 TMT162 FF are split into several Transducer Blocks, each covering different task areas (→ fig. 16).

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.

11.3.1 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 no.
Transducer Block “Sensor 1”	Primary Value	Primary Value 1	1
	Sensor Value	Sensor Value 1	3
	RJ Value	RJ Value 1	5
Transducer Block “Sensor 2”	Primary Value	Primary Value 2	2
	Sensor Value	Sensor Value 2	4
	RJ Value	RJ Value 2	6

11.3.2 Selecting the operating mode

The operating mode is set by means of the MODE_BLK parameter group (see page 60). The Transducer Block supports the following operating modes:
- AUTO (automatic mode)
- OOS (out of service)

✎ Note!
The OOS block status is also displayed by means of the BLOCK_ERR parameter (see page 60).

11.3.3 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 (→ page 60) 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.

11.3.4 Accessing the manufacturer-specific parameters

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

11.3.5 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 the view in the respective configuration program.

11.3.6 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 page 64 ff..

Transducer Block (FF parameters)			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
1	**Static revision (STAT_REV)**	**Read only**	The revision status of the static data appears on the display. Note! The revision status parameter is incremented on each modification of static data. When a factory reset is done this parameter will be reset to 0 in all blocks.
2	**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
3	**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 setting:** 0 Note! These data are neither checked nor processed by the Transducer Blocks.

Transducer Block (FF parameters)			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
4	**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
5	**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 Note! 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
6	**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: ▪ INPUT FAILURE Failure at one or both sensor inputs ▪ MAINTENANCE NEEDED The device must be checked since an active device error is pending. The detailed cause of the error can be called up in the "Advanced Diagnostic" Transducer Block by means of the "ACTUAL_STATUS_CATEGORY" and "ACTUAL_STATUS_NUMBER" parameters. ▪ LOST STATIC DATA / LOST_NV_DATA The memory is inconsistent. ▪ Power-UP: Status message during initialization. ▪ SIMULATE ACTIVE: DIP switch for simulation is active. ▪ BLOCK CONFIGURATION ERROR: Block has been configured wrong. ▪ 0x0000: No active block error present. An exact error description as well as information on rectifying faults can be found on → page 30.
7	**Update Event (UPDATE_EVT)**	**AUTO - OOS**	Indicates whether static block data have been altered, including date and time.
8	**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. Note! ▪ 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 Block (FF parameters)			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
9	**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
10	**Transducer Error (XD_ERROR)**	**Read only**	The active device error appears on the display. **Possible display:** ■ No Error (normal status) ■ Electronics failure ■ Data Integrity Error ■ Mechanical failure ■ Configuration Error ■ Calibration error ■ General Error Note! ■ 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. ■ An exact error description as well as information on rectifying errors can be found on page 33 ff..

11.3.7 Transducer Blocks "Sensor 1 and 2"

The "Sensor 1 and 2" Transducer Blocks analyze the signals of both sensors from a metrological perspective and display them as a physical variable (value 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 (RJ_VALUE) and its unit (RJ_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 threshold function, backup function or sensor drift detection.
- Threshold function:
  This function enables a measurement over a wide temperature range. Channel 1 can be connected with a sensor usable for the lower temperature range and channel 2 can be connected with a sensor usable for the higher temperature range. Set the temperature in the parameter THRESHOLD_VALUE in the transducer block for switching from channel 1 to channel 2 in the PRIMARY_VALUE. PRIMARY_VALUE_TYPE has to be set to "PV = SV_1 (OR SV_2 if SV_1>T)".
- Backup function:
  If a sensor fails, the system automatically switches to the remaining sensor and a warning message is sent to the distributed control system. The backup function ensures that the process is not inter-

rupted 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, a warning/alarm is sent to the distributed control system. 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", → chap. 11.3.8.

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 length: 100 m
- Conductor cross-section: 0.5 mm^2
- Conductor material: copper
- Resistivity of Cu: 0.0178 mm^2/m

$R = 0.0178\ mm^2/m * (2 * 100\ m)/0.5\ mm^2 = 7.12\ Ohm$

Resulting measured error = 7.12 Ohm / 0.385 Ohm/K = **18.5 K**

✎ Note!
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.

✎ Note!
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.

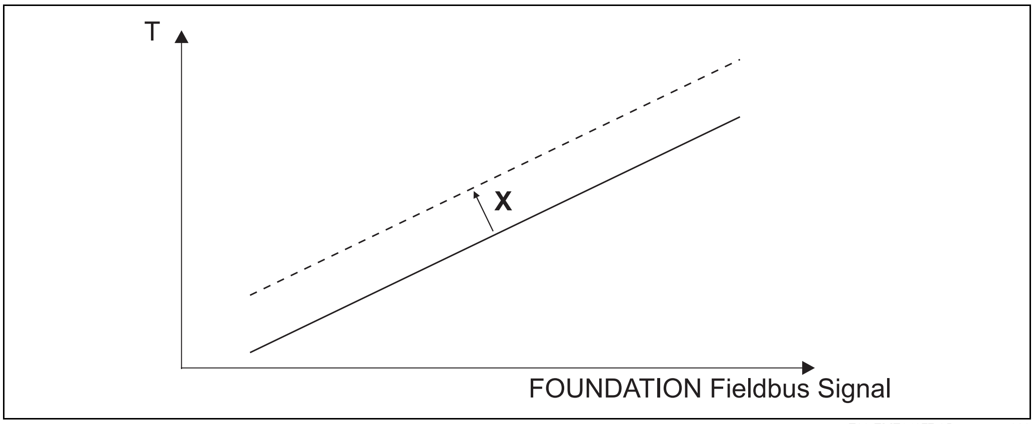


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Fig. 17: Sensor offset

- *X = Offset*
- *———— = standard sensor characteristic*
- *- - - - - - - - = sensor characteristic with offset setting*

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:

- **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 °C) 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 °C), 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**".

✎ Note!
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.

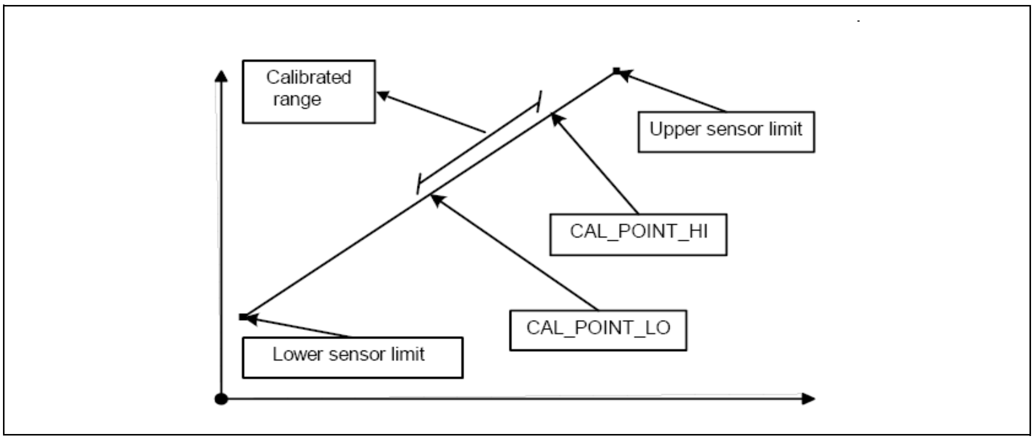

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Fig. 18: Linear scaling of temperature-linear curve.

- **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.

✎ Note!
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.

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

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.

The following table shows all the Endress+Hauser-device-specific parameters of the Sensor Transducer Blocks:

Transducer Block "Sensor 1 and 2" (Endress+Hauser parameters)

Parameter Index	Parameter	Write access with operating mode (MODE_BLK)	Description
13	**Primary value (PRIMARY_VALUE)**	**Dynamic / read only**	Result of link PRIMARY_VALUE_TYPE: ▪ VALUE ▪ STATUS ✎ Note! The PRIMARY_VALUE can be made available to the AI Block for further processing. The assigned unit is the PRIMARY_VALUE_UNIT.

Transducer Block "Sensor 1 and 2" (Endress+Hauser parameters)			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
14	**Primary value unit (PRIMARY_VALUE_UNIT)**	**AUTO - OOS**	Configuring the unit of the PRIMARY_VALUE ✎ Note! 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.
12	**Primary value type (PRIMARY_VALUE_TYPE)**	**AUTO - OOS**	The calculation process for the PRIMARY_VALUE appears on the display. Display: Sensor Transducer 1: ■ PV = SV_1: Secondary 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 Secondary Value 1 or Secondary 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: Secondary 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 Secondary Value 1 or Secondary 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)
15	**Threshold value (THRESHOLD_VALUE)**	**AUTO - OOS**	Value for switching in the threshold PV mode. Entry in the range from –270°C to 2450°C (–454°F to 4442°F)
16	**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 by writing any value to this parameter.
17	**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 by writing any value to this parameter.
18	**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
19	**Sensor type (SENSOR_TYPE)**	**AUTO - OOS**	Configuration of the sensor type. Sensor Transducer 1: Settings for sensor input 1 Sensor Transducer 2: Settings for sensor input 2 ✎ Note! Please observe the wiring diagram in Section 4.1 when connecting the individual sensors. In the case of 2-channel operation, the possible connection options in Section 4.2 also have to be observed.

Transducer Block "Sensor 1 and 2" (Endress+Hauser parameters)			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
20	**Sensor connection (SENSOR_CONNECTION)**	**AUTO - OOS**	Sensor connection mode: Sensor Transducer 1: ▪ 2-wire ▪ 3-wire ▪ 4-wire Sensor Transducer 2: ▪ 2-wire ▪ 3-wire
21	**Sensor range (SENSOR_RANGE)**	**AUTO - OOS**	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.)
22	**Sensor offset (SENSOR_OFFSET)**	**AUTO - 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
23	**2-wire compensation (TWO_WIRE_ COMPENSATION)**	**AUTO - OOS**	Two-wire compensation The following values are permitted: 0 to 30 Ohm
24	**Sensor serial number (SENSOR_SN)**	**AUTO - OOS**	Serial number of the sensor
25	**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 by writing any value to this parameter.
26	**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 by writing any value to this parameter.
27	**Mains filter (MAINS_FILTER)**	**AUTO - OOS**	Mains filter for the A/D converter
28	**Calibration highest point (CAL_POINT_HI)**	**AUTO - OOS**	Upper point for linear characteristic calibration (this affects offset and slope). Note! To write to this parameter, SENSOR_CAL_METHOD must be set to "User Trim Standard Calibration".
29	**Calibration lowest point (CAL_POINT_LO)**	**AUTO - OOS**	Lower point for linear characteristic calibration (this affects offset and slope). Note! To write to this parameter, SENSOR_CAL_METHOD must be set to "User Trim Standard Calibration".
30	**Calibration minimum span (CAL_MIN_SPAN)**	**AUTO - OOS**	Span of the measuring range, depending on the sensor type set.
31	**Calibration unit (CAL_UNIT)**	**Read only**	Unit for sensor calibration.

Transducer Block "Sensor 1 and 2" (Endress+Hauser parameters)			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
32	**Sensor calibration method (SENSOR_CAL_ METHOD)**	**AUTO - 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 Note! 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).
33	**Sensor calibration location (SENSOR_CAL_ LOC)**	**AUTO - OOS**	Name of the location where the sensor calibration was carried out.
34	**Sensor calibration date (SENSOR_CAL_ DATE)**	**AUTO - OOS**	Date and time of the calibration.
35	**Sensor calibration who (SENSOR_CAL_ WHO)**	**AUTO - OOS**	Name of the person responsible for the calibration.
36	**Callendar Van Dusen A (CVD_COEFF_A)**	**AUTO - OOS**	Sensor linearization based on the Callendar Van Dusen method. Note! 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".
37	**Callendar Van Dusen B (CVD_COEFF_B)**	**AUTO - OOS**	
38	**Callendar Van Dusen C (CVD_COEFF_C)**	**AUTO - OOS**	
39	**Callendar Van Dusen R0 (CVD_COEFF_R0)**	**AUTO - OOS**	
40	**Callendar Van Dusen Measuring Range Maximum (CVD_COEFF_MAX)**	**AUTO - OOS**	Upper calculation limit for Callendar Van Dusen linearization.
41	**Callendar Van Dusen Measuring Range Minimum (CVD_COEFF_MIN)**	**AUTO - OOS**	Lower calculation limit for Callendar Van Dusen linearization.
42	**Polynom Coeff. A (POLY_COEFF_A)**	**AUTO - OOS**	Sensor linearization of copper/nickel resistance thermometers (RTD). Note! 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".
43	**Polynom Coeff. B (POLY_COEFF_B)**	**AUTO - OOS**	
44	**Polynom Coeff. C (POLY_COEFF_C)**	**AUTO - OOS**	
45	**Polynom Coeff. R0 (POLY_COEFF_R0)**	**AUTO - OOS**	
46	**Polynom (Nickel/ Copper) Measuring Range Maximum (POLY_COEFF_MAX)**	**AUTO - OOS**	Upper calculation limit for the RTD polynom (nickel/copper) linearization.

Transducer Block "Sensor 1 and 2" (Endress+Hauser parameters)			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
47	**Polynom (Nickel/ Copper) Measuring Range Minimum (POLY_COEFF_MIN)**	**AUTO - OOS**	Lower calculation limit for the RTD polynom (nickel/copper) linearization.
48	**Reference junction (RJ_VALUE)**	**Dynamic / read only**	Internal reference temperature measurement: ▪ VALUE ▪ STATUS
49	**Reference junction type (RJ_TYPE)**	**AUTO - 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.
50	**Reference junction value unit (RJ_UNIT)**	**Read only**	Unit of the internal reference temperature. This always corresponds to the unit set in SENSOR_RANGE —> UNITS_INDEX.
51	**Reference junction external value (RJ_EXTERNAL_VALUE)**	**AUTO - OOS**	Value for temperature compensation (see RJ_TYPE parameter).
52	**Reference junction max. indicator (RJ_MAX_INDICATOR)**	**AUTO - OOS**	Max. indicator of the internal reference temperature is stored in the nonvolatile memory in intervals of 10 minutes.
53	**Reference junction min. indicator (RJ_MIN_INDICATOR)**	**AUTO - OOS**	Min. indicator of the internal reference temperature is stored in the nonvolatile memory in intervals of 10 minutes.

11.3.8 Transducer Block "Advanced Diagnostic"

The Transducer Block "Advanced Diagnostic" is used to configure all the diagnostic functions of the transmitter.

Functions such as
– Corrosion detection
– Drift detection
– Ambient temperature monitoring
can be configured here.

Corrosion monitoring
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 RTDs with a 4-wire connection and thermocouples (see also Section 9.2.1).

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.

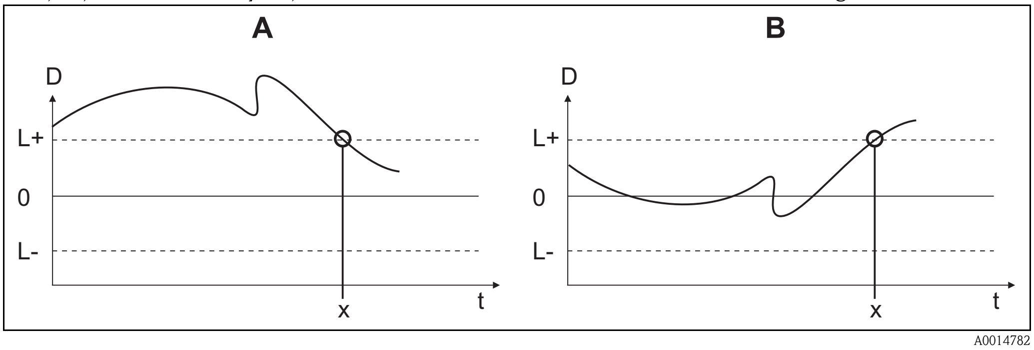

Fig. 19: Drift detection

- *A = 'Undershooting' mode*
- *B = 'Overshooting' mode*
- *D = Drift*
- *L+, L- = Upper (+) or lower (-) limit value*
- *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.

Transducer Block "ADVANCED DIAGNOSTIC" (Endress+Hauser parameters)			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
11	**Corrosion detection (CORROSION_ DETECTION)**	**AUTO - OOS**	▪ OFF: Corrosion detection off ▪ ON: Corrosion detection on ✎ Note! Only possible for RTD 4-wire connection and thermocouples (TC).

Transducer Block "ADVANCED DIAGNOSTIC" (Endress+Hauser parameters)			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
12	**Sensor drift monitoring (SENSOR_DRIFT_MONITORING)**	**AUTO - OOS**	Deviation between SV1 and SV2 as error (Failure) or as need for maintenance (Maintenance): ■ OFF: Sensor deviation monitoring off ■ FAILURE: (sensor deviation > SENSOR_DRIFT_ALERT_VALUE) => Failure ■ MAINTENANCE: (sensor deviation > SENSOR_DRIFT_ALERT_VALUE) => Maintenance
13	**Sensor drift mode (SENSOR_DRIFT_MODE)**	**AUTO - OOS**	Select whether a status is generated if the value set in the SENSOR_DRIFT_ALERT_VALUE parameter is undershot (Undershooting) or overshot (Overshooting). ✎ Note! If "Overshooting" is selected, the corresponding status is generated if the limit value is overshot (SENSOR_DRIFT_ALERT_VALUE). In the case of "Undershooting", the status is output if the limit value is undershot.
14	**Sensor Drift alert value (SENSOR_DRIFT_ALERT_VALUE)**	**AUTO - OOS**	Limit value of the permitted deviation from 1 to 999.99.
15	**System alarm delay (SYSTEM_ALARM_DELAY)**	**AUTO - OOS**	Time until a device status (failure or maintenance) and a measured value status (bad or uncertain) is transmitted. This parameter has no influence on the local display. Can be configured between 0 and 10 seconds
16	**Ambient temp. alarm (AMBIENT_ALARM)**	**AUTO - OOS**	Maintenance or Failure in the event of the operating temperature of the transmitter being undershot or overshot (< -40 °C (-40 °F) or > +85 °C (185 °F)): ■ Maintenance: Int. temperature overshoot/undershoot results in message. ■ Failure: Int. temperature overshoot/undershoot results in 'Failure' device status.
19	**Actual status category / last status category (ACTUAL_STATUS_CATE GORY / LAST_STATUS_CATEGORY)**	**Read only / AUTO - OOS**	Current/last status category ■ Good: No errors detected ■ F: Failure: Error detected ■ M: Maintenance required: Maintenance necessary ■ C: Function check: Device is in the service mode ■ S: Out of Spec.: Device is being operated outside the specifications

Transducer Block “ADVANCED DIAGNOSTIC” (Endress+Hauser parameters)			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
17	**Actual status number / last status number (ACTUAL_ STATUS_ NUMBER / LAST_STATUS_ NUMBER)**	**Read only / AUTO - OOS**	Current/past 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 **411 UP-/DOWNLOAD:** Uploading/downloading **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; RJ_Value < -40 °C (-40 °F) **902 AMBIENT TEMPERATURE HIGH:** Ambient temperature too high; RJ_Value > 85 °C (185 °F) **261 ELECTRONICBOARD:** Electronics module/hardware faulty 437 **CONFIGURATION ERROR**: A wrong configuration set in the device **431 NO CALIBRATION:** Calibration values lost/modified **283 MEMORY ERROR:** Contents of memory inconsistent **221 RJ ERROR:** Error in reference junction measurement/internal temperature measurement
20	**Actual status channel/last status channel (ACTUAL/LAST_ STATUS_ CHANNEL)**	**Read only / AUTO - OOS**	ACTUAL_STATUS_CHANNEL displays the channel that currently has the error with the highest value. LAST_STATUS_CHANNEL indicates the channel where an error last occurred.
23	**Actual Status Description / Last Status Description (ACTUAL/LAST_ STATUS_DESC)**	**Read only / AUTO - OOS**	Displays the descriptions of the current and last error status. ✎ Note! The descriptions can be taken from the description for the Actual Status Number/ Last Status Number parameter.
21	**Actual status count (ACTUAL_ STATUS_ COUNT)**	**Read only / AUTO - OOS**	The number of status messages currently pending in the device.
26	**Primary Value 1 Max. Indicator PV1_MAX_ INDICATOR**	**AUTO - OOS**	Maximum indicator for the maximum value to occur for PV1, can be reset by writing any value to this parameter.
27	**Primary Value 1 Min. Indicator PV1_MIN_ INDICATOR**	**AUTO - OOS**	Maximum indicator for the minimum value to occur for PV1, can be reset by writing any value to this parameter.
28	**Primary Value 2 Max. Indicator PV2_MAX_ INDICATOR**	**AUTO - OOS**	Maximum indicator for the maximum value to occur for PV2, can be reset by writing any value to this parameter.

Transducer Block "ADVANCED DIAGNOSTIC" (Endress+Hauser parameters)			
Parameter Index	**Parameter**	**Write access with operating mode (MODE_BLK)**	**Description**
29	**Primary Value 2 Min. Indicator PV2_MIN_ INDICATOR**	**AUTO - OOS**	Maximum indicator for the minimum value to occur for PV2, can be reset by writing any value to this parameter.
30	**Sensor 1 Max. Indicator SV1_MAX_ INDICATOR**	**AUTO - OOS**	Maximum indicator for the maximum value to occur at sensor 1, can be reset by writing any value to this parameter.
31	**Sensor 1 Min. Indicator SV1_MIN_ INDICATOR**	**AUTO - OOS**	Maximum indicator for the minimum value to occur at sensor 1, can be reset by writing any value to this parameter.
32	**Sensor 2 Max. Indicator SV2_MAX_ INDICATOR**	**AUTO - OOS**	Maximum indicator for the maximum value to occur at sensor 2, can be reset by writing any value to this parameter.
33	**Sensor 2 Min. Indicator SV2_MIN_ INDICATOR**	**AUTO - OOS**	Maximum indicator for the minimum value to occur at sensor 2, can be reset by writing any value to this parameter.
34	**RJ Max. Indicator RJ_MAX_ INDICATOR**	**AUTO - OOS**	Maximum indicator for the maximum value to occur at the internal reference temperature measuring point
35	**RJ Min. Indicator RJ_MIN_ INDICATOR**	**AUTO - OOS**	Maximum indicator for the minimum value to occur at the internal reference temperature measuring point

11.3.9 Transducer Block "Display"

The settings in the "Display" Transducer Block make it possible to display measured values from the two Transducer Blocks "Sensor 1 + 2" on the onsite display. Similarly, measured values from other FOUNDATION Fieldbus devices can also be displayed.
The selection is made by means of the DISPLAY_SOURCE_X[a] 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 °C, K, F and %. These units are displayed automatically when the measured value is selected. Other units can be entered as additional text and displayed.
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 4 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.

Transducer Block “DISPLAY” (Endress+Hauser parameters)		
Parameter	**Write access with operating mode (MODE_BLK)**	**Description**
Altenating time **ALTERNATING_TIME**	**AUTO - OOS**	Entry (in s) as to how long a value should be shown on the display. Setting from 4 to 20 s.
Display value x **DISP_VALUE_X**	**Read only**	Selected measured value: ■ Status ■ Value
Display source x **DISP_SOURCE_X**[a]	**AUTO - OOS**	For selecting the value to be displayed. Possible settings: ■ Off ■ Primary Value 1 ■ Sensor Value 1 ■ RJ Value 1 ■ Primary Value 2 ■ Sensor Value 2 ■ RJ Value 2 ■ ISEL In 1 ■ ISEL In 2 ■ ISEL In 3 ■ ISEL In 4 ■ PID In 1 ✎ Note! If all 6 display channels are switched to 'Off', the display will show "——".
Display text x **DISP_VALUE_X_TEXT**	**AUTO - OOS**	Text to be displayed on the selected value. ✎ Note! Maximum 16 letters. Certain lower-case letters or special characters can be displayed on the 16-segment-display.
Decimal places x **DISP_VALUE_X_FORMAT**	**AUTO - OOS**	For selecting the number of places displayed after the decimal point. Configuration option 0-3.
Bargraph max. x **DISP_VALUE_X_BGMAX**	**AUTO - OOS**	Scaling for the bar graph display. Specify the maximum value (100%) here.
Bargraph min. x **DISP_VALUE_X_BGMIN**	**AUTO - OOS**	Scaling for the bar graph display. Specify the minimum value (0%) here.

a. X = Number of the display channel in question (1 to 6)

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
Text to be displayed:	TEMP PIPE 11
Decimal places:	2
Maximum temperature:	250 °C
Minimum temperature:	50 °C

- 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 °C
Minimum temperature:	40 °C

- 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

11.4 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 on the supplied CD-ROM (BA062S/04).

11.5 PID function block (PID controller)

A PID function block contains the input channel processing, the proportional integral-differential 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 on the supplied CD-ROM (BA062S/04).

11.6 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 on the supplied CD-ROM (BA062S/04).

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