Operating Instructions

42/11-51 EN

Temperature Transmitters TF02/TF02-Ex (head mounted) and TF202/TF202-Ex (field mounted)

FOUNDATION Fieldbus

Industrial IT enabled

FOUNDATION

ABB

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Operating Instructions

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Important information

Symbols

In order that you can make the best use of this document and to ensure safety during commissioning, operation and maintenance of the equipment, please note the following explanation of the symbols used.

Explanation of the symbols used.

Symbol	Signal Word	Definitions
	**DANGER**	DANGER indicates an **imminently hazardous** situation which, if not avoided, **will result** in death or serious injury. (High level of risk.)
	**WARNING**	WARNING indicates a **potentially hazardous** situation which, if not avoided, **could result** in death or serious injury. (Medium level of risk.)
	**CAUTION**	CAUTION indicates a **potentially hazardous** situation which, if not avoided, **could result** in minor or moderate injury. (Low level of risk.)
	**NOTICE**	NOTICE indicates a **potentially harmful** situation which, if not avoided, **may result** in damage of the product itself or of adjacent objects. (Damage to property)
	**IMPORTANT**	IMPORTANT indicates useful hints or other special information which, if not observed, could lead to a decline in operating convenience or affect the functionality. (Does not indicate a dangerous or harmful situation.)

As well as the instructions in this document, you must also follow the generally applicable accident prevention and safety regulations.

If the information in this document is insufficient in any situation, please contact our service department, who will be happy to help you.

Please read this document carefully before installation and commissioning.

CE MARKING

This product meets the requirements specified in EMC Directive 89/336/EEC and in Low Voltage Directive 73/23/EEC. Additional for the explosion proof versions TF02-Ex/TF202-Ex the protection regulations of the European Guidelines 94/9 EEC are fulfilled.

1 Introduction

1.1 Device features

The transmitter TF02 / TF02-Ex / TF202 / TF202-Ex is used to measure temperature and other process variables. It converts the input variable into digital values. These values are transmitting with field bus technology. The TF02 / TF202 are for connecting to field bus with design according to IEC 1158-2, 31,25 kbits/s. The supported field bus protocol is FOUNDATIONTM Fieldbus.

The TF02 / TF202 is available in Non Ex version (TF02 / TF202) and in Ex version (TF02-Ex / TF202-Ex).

The difference between TF02 and TF202 (including Ex versions) is only the housing.
TF02 / TF02-Ex: head mounted temperature transmitter
TF202 / TF202-Ex: field mounted temperature transmitter
(TF02 built in field mounted housing)

1.2 Using this manual

The four variants TF02 / TF02-Ex / TF202 / TF202-Ex are referred as TF02 in this manual.

1.3 General Safety Instructions!

Proper and safe operation of the TF02 / TF02-Ex / TF202 / TF202-Ex temperature transmitter requires proper transportation and storage, installation and commissioning by qualified personnel, correct operation according to the instructions, proper use and careful maintenance.

Only qualified personnel who are familiar with the installation, commissioning, operation and maintenance of this or similar devices are allowed to work on the device.

The unit TF02 / TF02-Ex / TF202 / TF202-Ex has been constructed and tested in accordance with IEC 1010-1 (corresponds to EN 61 010-1 corresponds to DIN VDE 0411 Part 1 "Safety requirements for electrical process, instrumentation and laboratory units"),
– possesses CE certification and
– has left the factory in a perfect technical and safe condition.

In order to retain this condition when dealing with the unit (transportation, storage, maintenance, commissioning, operation, servicing, switch off)
– contents of the Operation Manual and
– the ratings plates attached to the unit, inscriptions and safety instructions
must be observed.

Otherwise
– persons could be endangered and
– the unit itself, as well as other equipment could be damaged.

The safe separation of live currents can only be assured, if the connected apparatus meets the requirements of VDE 0106 T.101 (basic standards for electrical safety).

Before switching on the apparatus make sure that the ambient conditions stated in the Data Sheet and the Operation Instructions are met and also that the voltage of the power supply units is identical with the voltage of the unit TF02 / TF02-Ex / TF202 / TF202-Ex.

Whenever it can be assumed that harmless operation is no longer possible, the apparatus should be inoperative and secured against any unintended operation.

The directives, norms and guidelines mentioned in the Operation Manual are applicable in the Federal Republic of Germany. When using the unit in other countries, please observe the national regulations prevailing in the respective country.

Should the information provided in the Operation Manual prove to be insufficient, please do not hesitate to use the address list provided on the back of this manual to contact the manufacture.

1.4 Additional safety instructions for TF02-Ex and TF202-Ex!

During all work on TF02-Ex or TF202-Ex the EEC Certificate of Conformity DMT 02 ATEX E068 X must be observed.

TF02-Ex and TF202-Ex are certified for installation in Zone 0 and Zone 1 (according to ATEX) of hazardous locations. The measuring circuits as well as the fieldbus connection are in accordance to EEx ia. The required fieldbus power supply connection or conditioner for the supply of the transmitter (IEC 61158-2) must be selected according to the Ex classification.

The TF02-Ex shall be mounted in an enclosure, ensuring housing protection of IP20 according to EN 60529.

For grounding measures on the bus cable (e.g. shield) the guidelines given in IEC 60 079-14 or EN 60 079-14 must be followed.

If an apparatus with an intrinsically safe circuit is connected to the transmitter, proof of the intrinsic safety of the connection must be provided in accordance with DIN VDE 0165 / 08.98 (= EN 60 079-14 and IEC 60 079-14) respectively.

When working on an explosion-proof device, the standard EN 60 079-17 must be followed. Before commencing work, please ensure that safety measures regarding explosion protection have been taken!

DANGER
Only qualified personnel who are familiar with this product and its mounting, commissioning and operating procedures are allowed to mount, install, commission and operate the device. Qualified personnel, according to the understanding of this manual, are those people who were trained adequately, have the required experience, and know the relevant safety standards to be able to assess the tasks assigned to them and to recognize possible safety hazard. People working on explosion-proof devices for use in hazardous areas must prove that they have been trained adequately and are allowed to perform such work.The device must be transported and stored properly.

Each mine application (category IM 1) involving the temperature transmitter TF02-Ex and TF202-Ex must be verified by the local certifying body in regards to the interconnection of the devices within hazardous areas.

For mine applications the head mounted temperature transmitter TF02-Ex must be mounted in a housing certified for mine application category IM1.
Available ABB types are the stainless steel connection head types AGS, AGSH, AGSD

The TF202-Ex version certified for Mine applications (category IM 1) is only available in conjunction with the field housing ABB Types AGSF, AGSFH, AGSFD

1.5 Supplementary documentation!

For Ex-certified devices, the Certificate of Conformity must be read prior to the installation. In case you need supplement information, please feel free to contact us (see address on last page of this documentation) or download the information from our web page (ww.abb.com). A list of supplementary information is given below:

TF02 / TF02-Ex	Data Sheet 11/10-8.25 EC Type Examination Certificate DMT 02 ATEX E068 X
TF202 / TF202-Ex	Data Sheet 11/10-8.69 EC Type Examination Certificate DMT 02 ATEX E068 X

1.6 Declaration of Conformity

The protective regulations of the European guidelines 94/9/EG as well as the EN 50 014 and the EN 50 020 are fulfilled.

1.7 Maintenance

The device is maintenance-free.
Devices or components that are damaged or suspect to be damaged must not be used any longer.

1.8 Repair of explosion-proof devices

After repair, an expert in accordance with the explosion protection regulations must test the device before they can be used again. Successful passing of the test must be confirmed in writing or through a test mark. This test is not required, if the part is submitted to a routine check test by the manufacturer and successful passing of the test is indicated through a conformity mark attached to the device.

2 Device Specification

2.1 Communication Interface

2.1.1 Physical layer

The communication interface meets the rules for Foundation Fieldbus and PROFIBUS PA devices. The device fulfills both Intrinsically Safe (I.S.) and normal requirements on the physical layer. The specification FF-816 describes the Physical Layer. The baudrate of the fieldbus transmission is fixed to 31.25 kBit/s.

2.1.2 Protocol

– Foundation Fieldbus Specification 1.4
– Certified with Interoperability Test Kit 4
– IT Campain Number: IT015000

The TF02 fulfills all requirement regarding the FF-940 specification of a Group 3 / Class 31 compatible device.

3 Mounting

3.1 TF02 / TF202 installation sites

3.1.1 Mounting TF02 / TF02-Ex

Dimensional Drawing

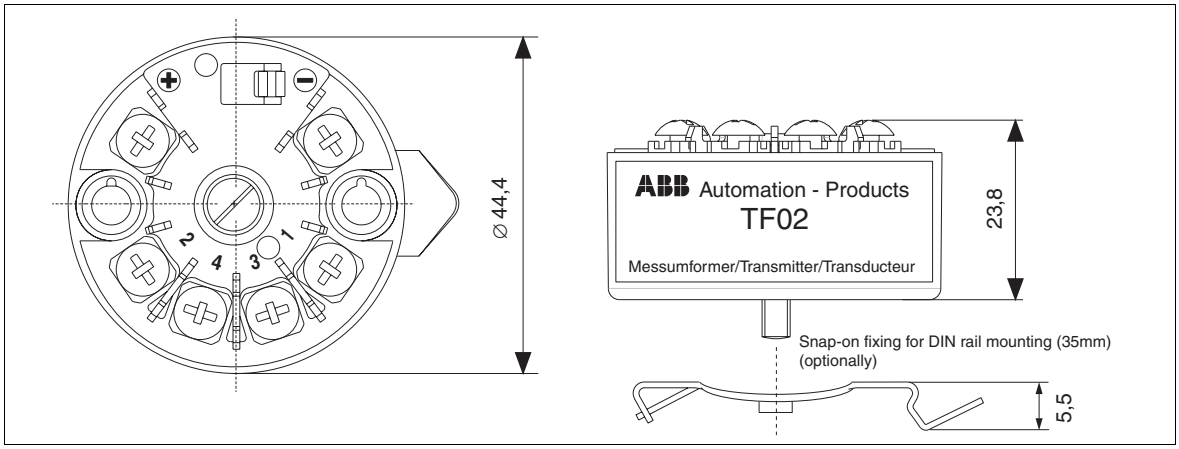


Fig. 3-1 TF02 / TF02-Ex dimensional drawing (all dimensions in mm)

Mounting possibilities

Version for mounting on measuring modules without riveted sleeves and springs.

Connection wires of measuring module approx. 50mm long and insulated.

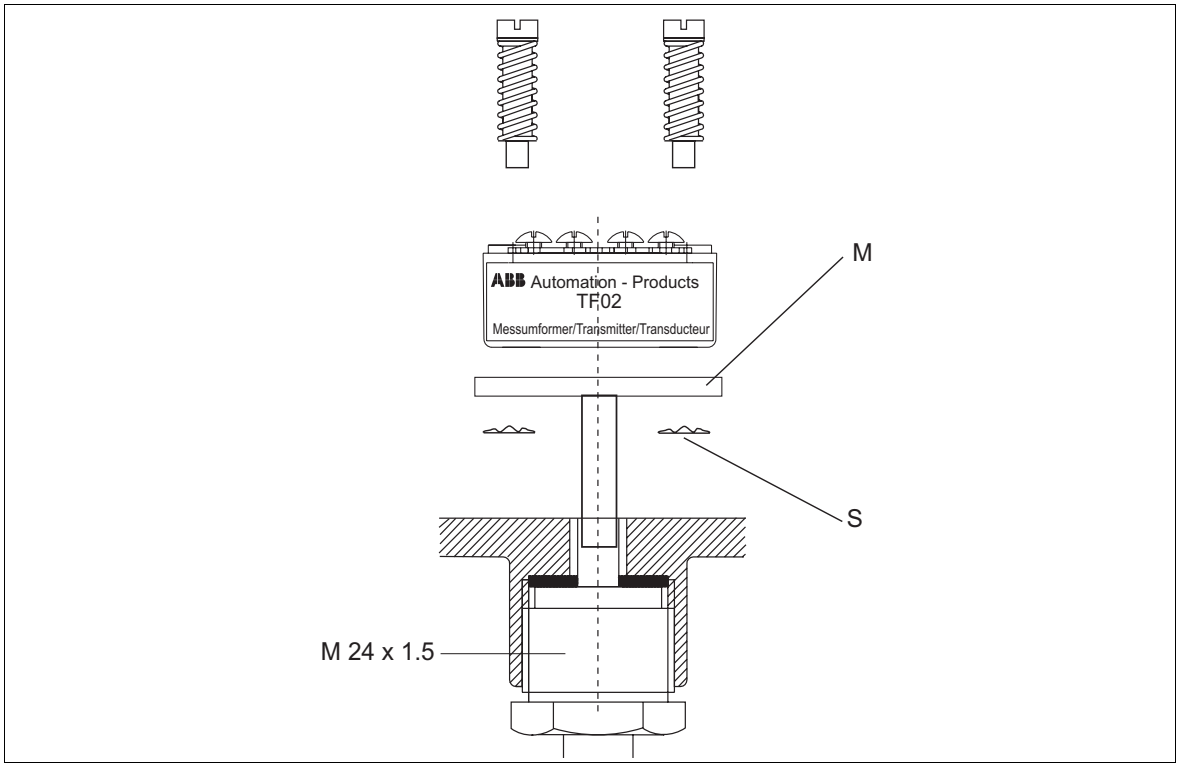


Fig. 3-2 Mounting on measuring module

WARNING

Insert the lock washers (S) with their convex edges pointing up. Then tighten up the mounting studs.

Pressing the washers (S) in-between the flange plate (M) of the measuring module and the bottom of the connection head produces a permanently solid link-up between the transmitter and the measuring module.

Mounting in the connection head type AGL or AGS

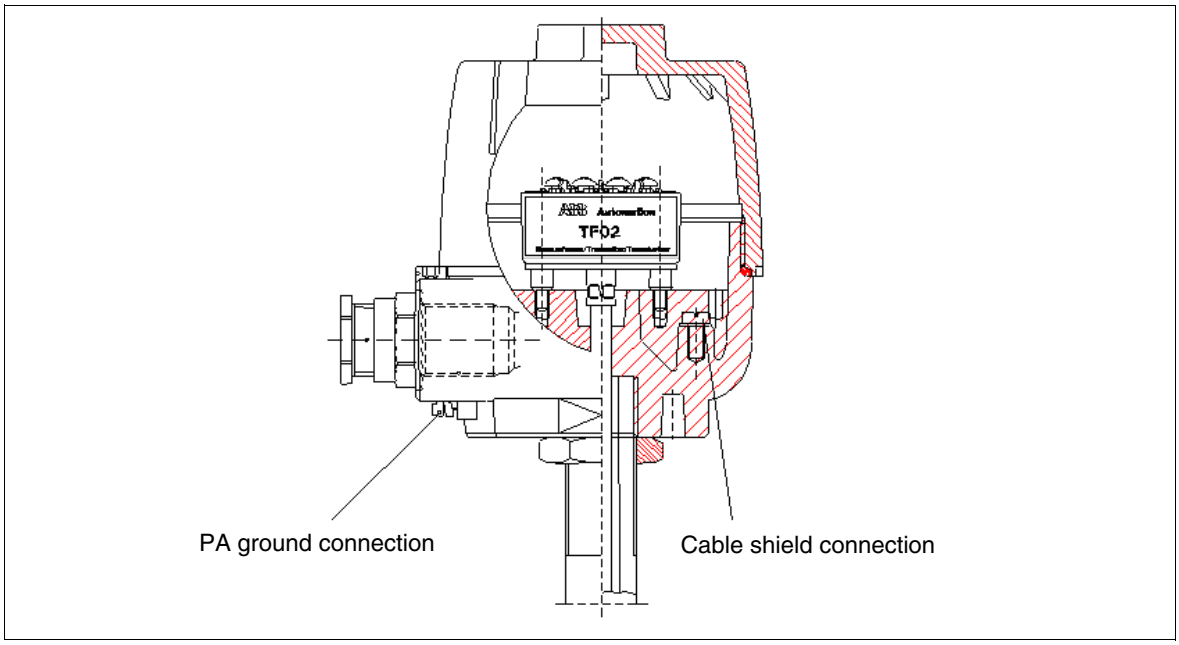


Fig. 3-3 Mounting TF02 in the connection head type AGL or AGS

PA ground connection:
To use for connecting the housing of the head type AGL or AGS to ground potential.

Cable shield connection:
To use for connecting the shield of the fieldbus and sensor cable.
For connecting the fieldbus wire and sensor wire see chapter 3.2.

3.1.2 Mounting TF202 / TF202-Ex

Dimensional Drawing

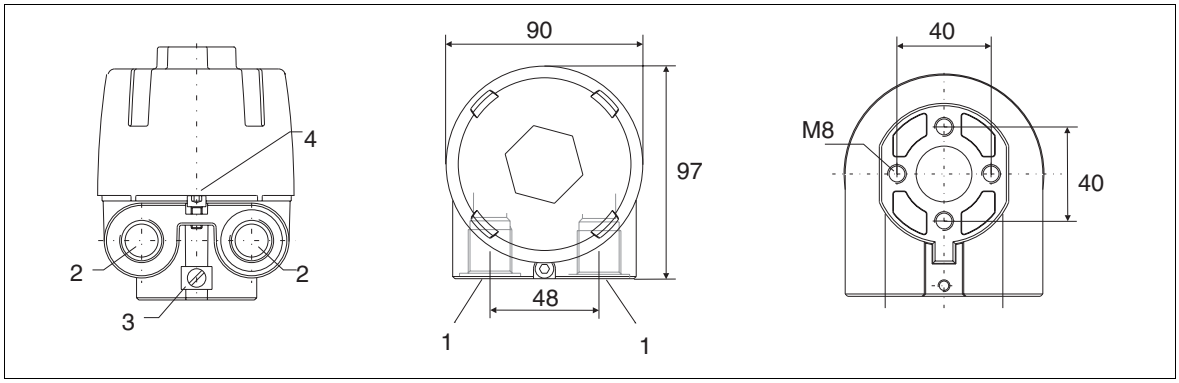


Fig. 3-4 TF202 / TF202-Ex Dimensional drawing (all dimensions in mm)
1 electrical connections
2 thread
3 equipotential bonding (connection point)
4 lock screw

Wall mounting and Pipe mounting TF202 / TF202-Ex

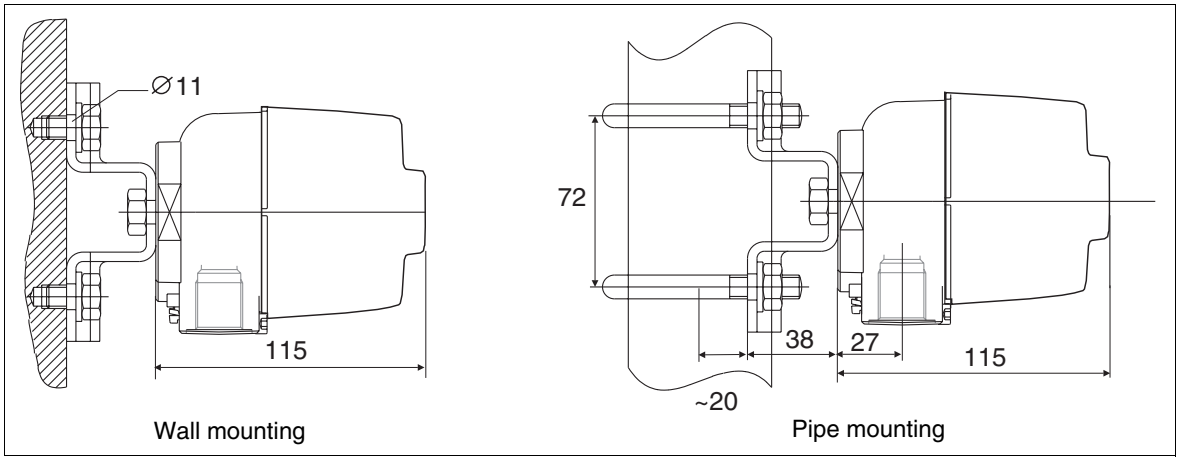


Fig. 3-5 Wall mounting and pipe mounting TF202 / TF202-Ex (all dimensions in mm)

Detail Drawing TF202 / TF202-Ex

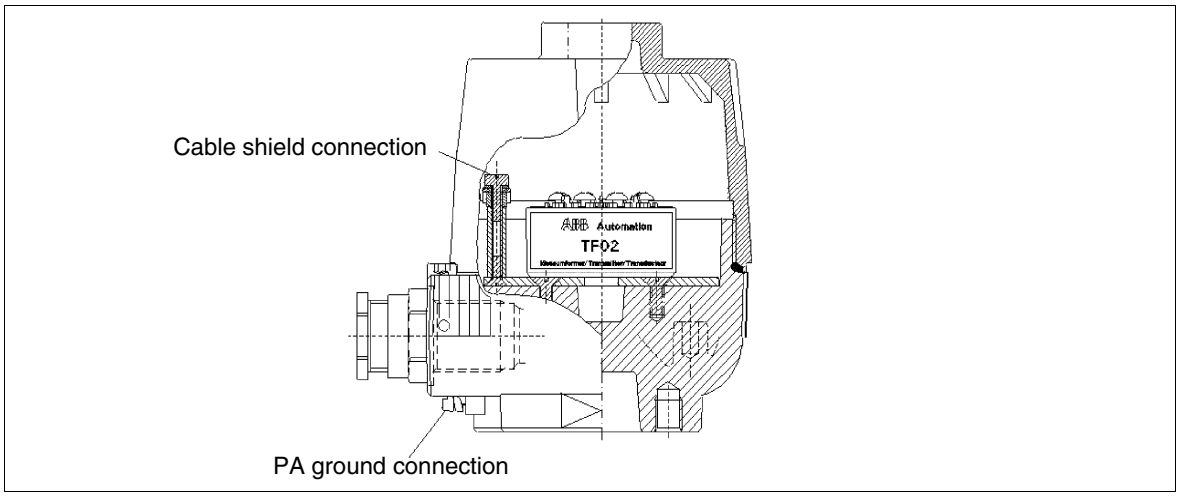


Fig. 3-6 Detail Drawing TF202 / TF202-Ex

PA ground connection: To use for connecting the field housing of the type AGLF or AGSF to ground potential.
Cable shield connection: To use for connecting the shield of the fieldbus and sensor cable.
For connecting the fieldbus wire and sensor wire see chapter 3.2.

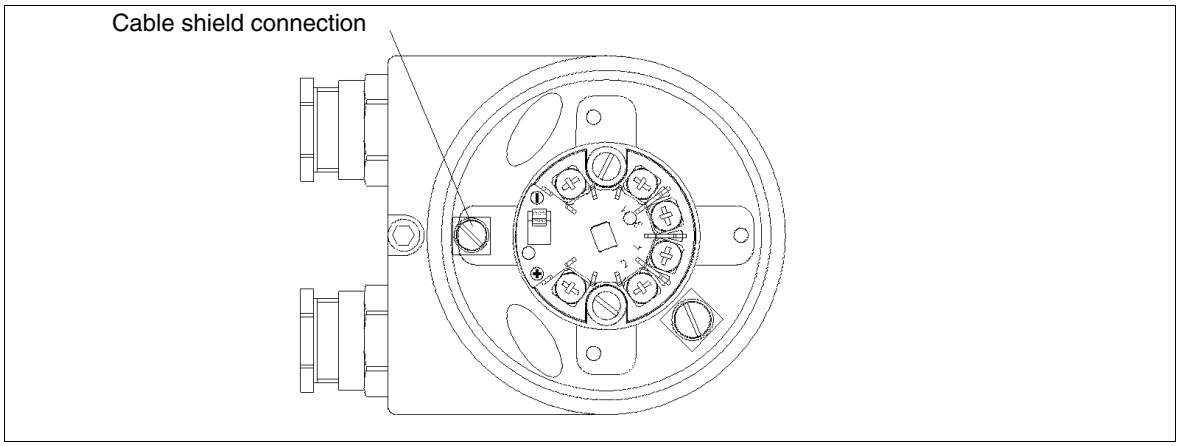


Fig. 3-7 Top view open field housing TF202 / TF202-Ex
Cable shield connection: To use for connecting the shield of the fieldbus and sensor cable.

3.1.3 Applications with hazardous areas

To meet the requirements of installations in hazardous areas an intrinsically safe fieldbus has to be installed. A host normally does not provide an Ex-i fieldbus port, so a special barrier is required to isolate the segments. ABB's MB204-Ex provides this isolation. See instruction manual for MB204 for further details. The fieldbus power can be supplied by the host or by a separate power conditioner as ABB's HPC-100. See instruction manual for HPC-100 for further details. Fig. 3-8 shows an installation example in hazardous areas using MB204-Ex and HPC-100 for fieldbus powering and Ex isolation.

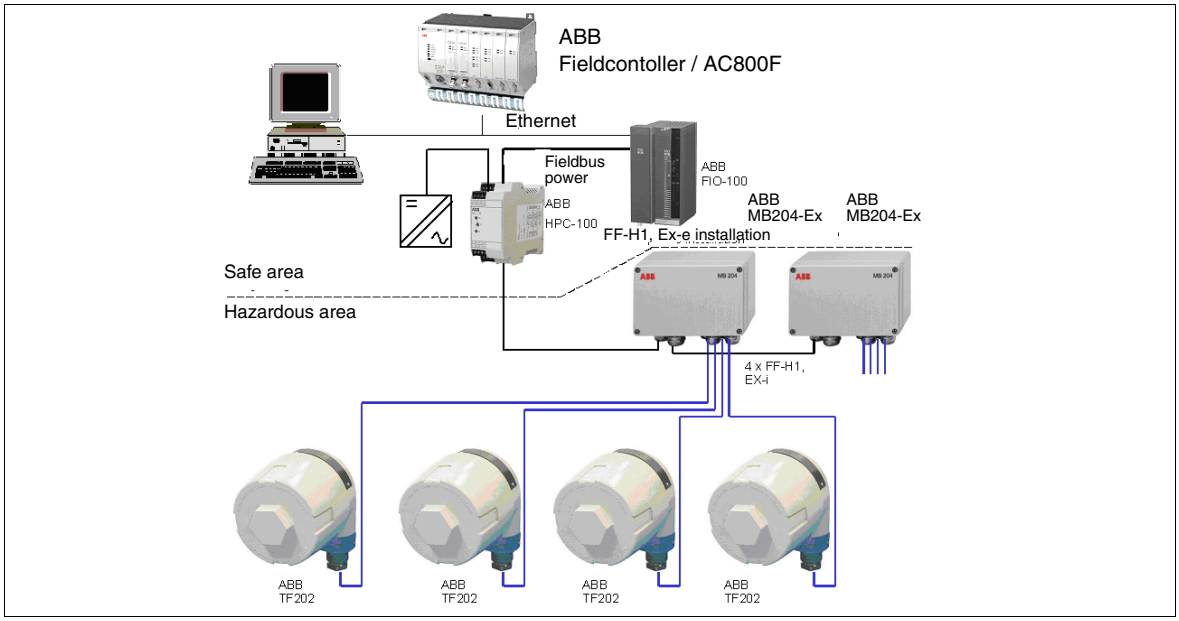


Fig. 3-8 TF202 installation example: Hazardous Area

3.1.4 Applications in safe areas

In safe area the host is able in most cases to provide power for the connected field devices. But this power is limited and allows only a connection of few field devices. Figure 3 9 shows an installation example using the optional fieldbus power capability of the FIO-100.

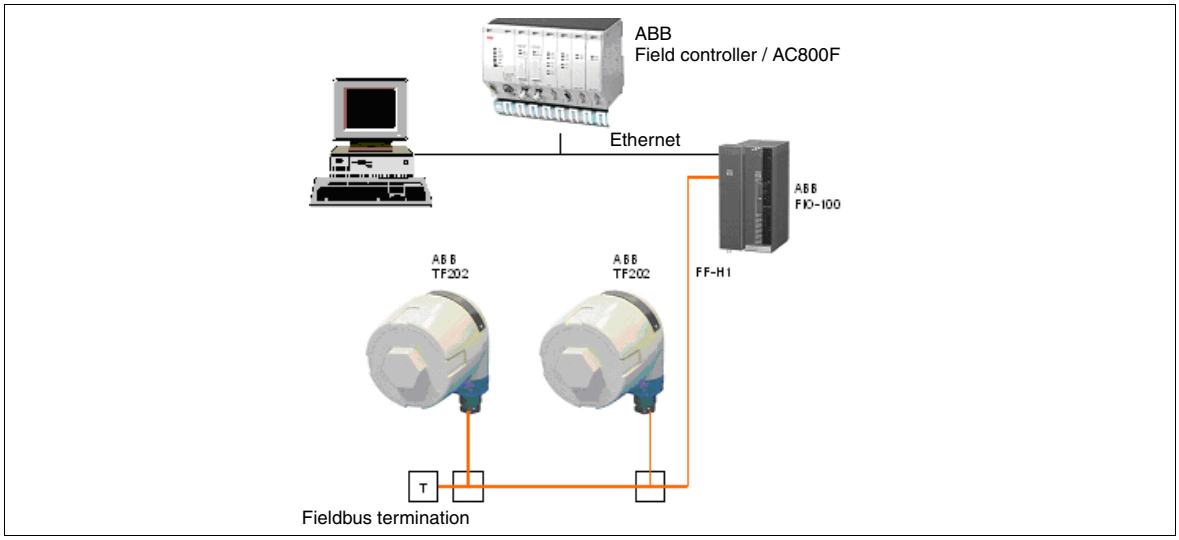


Fig. 3-9 TF202 installation example: safe area 1

The disadvantage of the shown solution is the fact, that a hardware failure on one field device could lead to power fail of the complete bus. This can be avoided by using the MB204 (non Ex version) as segment coupler. The bus power is provided by the HPC-100, the MB204 is used to decouple the field devices from the "main" bus. So a hardware failure of one field device does not lead to a power fail of the complete bus.

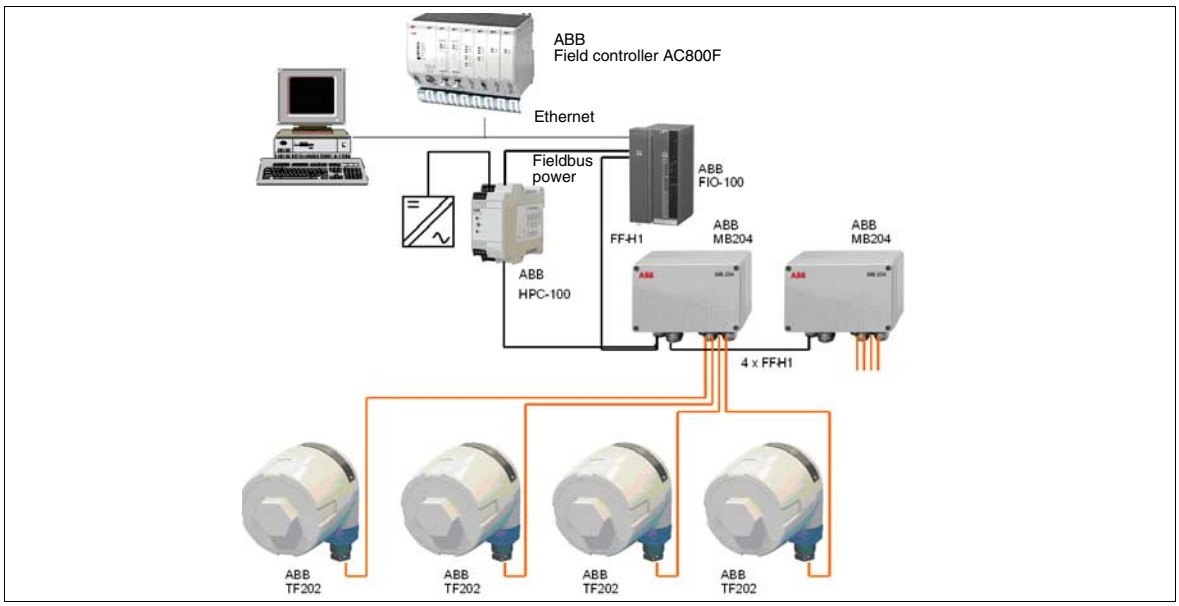


Fig. 3-10 TF202 installation example: Safe Area 2

3.1.5 Environment conditons

TF02/TF02-Ex; TF202/TF202-Ex (without display):

Ambient temperature range	-40…+ 85 °C
Transport and storage temperature	-40…+100 °C
Relative humidity	< 100% (100% humidity with isolated terminals only)
Condensation	permissible

For more detailed information, please refer to chapter 6, Technical Data.

3.2 Cabling / connecting the device

3.2.1 Fieldbus interface

Cable specifications

The Fieldbus Foundation recommends using the cable parameters specified as part of revision to the Physical Layer Standard for the Low Power Signaling Technique. The cable specifications in Subclause 22.7.2 are recommended in place of 11.7.2 for standard power devices as well as for low-power devices. Also Annex C was revised as part of the Low-Power Signaling specification. The Type "D" cable described in Annex B of IEC 1158-2 and Annex C of ISA S50.02 Part 2 should include an overall shield.

Basically only the cable type A or B with cable shielding are approved to use in combination with the TF02/TF202. The optimum electromagnetic compatibility and a reliable data transfer of the TF02/TF202 is only guaranteed with released shielded cable.

Connnection

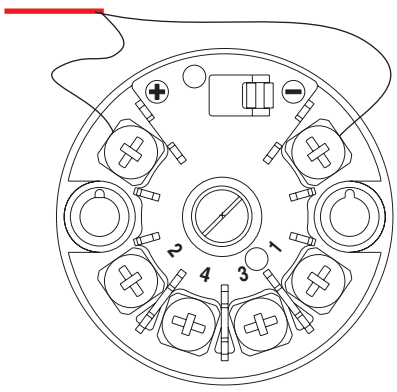


Fig. 3-11 Fieldbus wire connection

The connection of the fieldbus wires is polarity independent.

3.2.2 Sensor interface

Sensor conduits are connected to the screw terminals of the TF02 for pipe cross-sections of up to 2.5 mm² (with wire end ferrules).

DANGER

Use only the supplied threaded screws M3 × 6 mm. The use other, longer screws can lead to transmitter damage. In case of ex-proof transmitters, this would nullify the explosion protection.

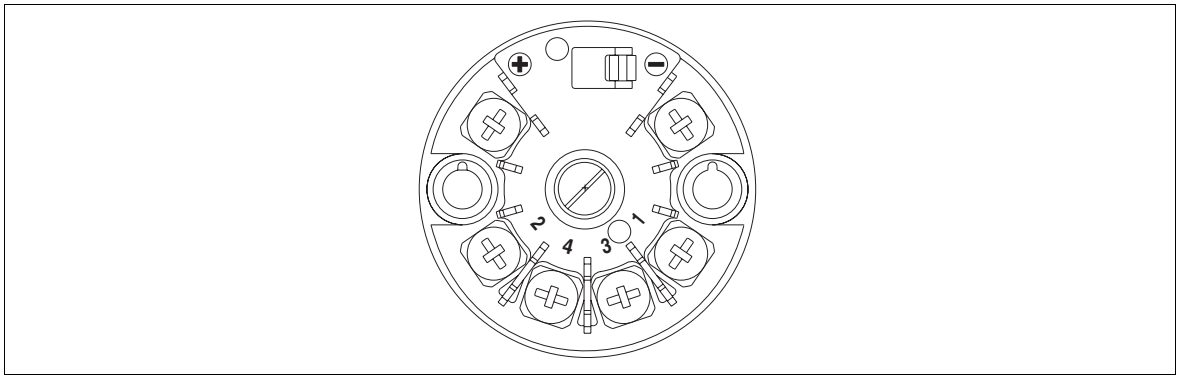


Fig. 3-12 Top view of the transmitter TF02

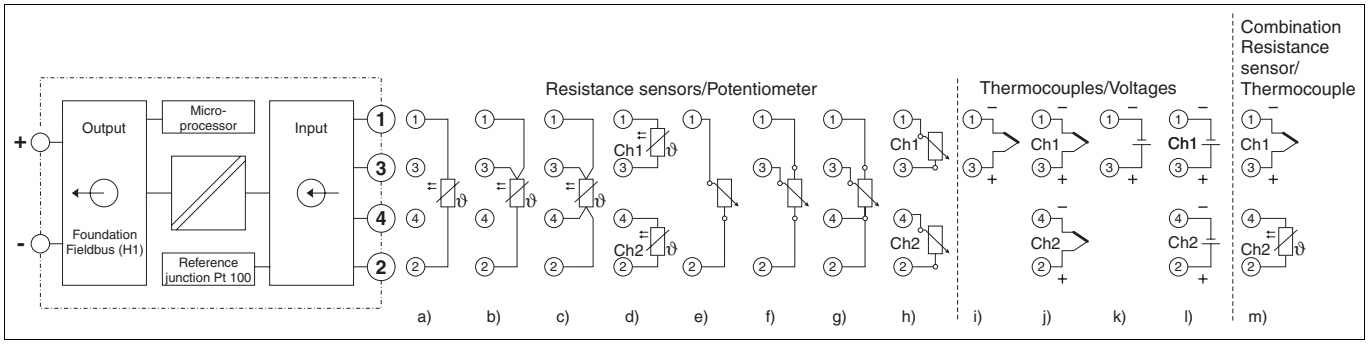


Fig. 3-13 Sensor connection TF02/ TF202

a) Resistance thermometer, 2-wire circuit
b) Resistance thermometer, 3-wire circuit
c) Resistance thermometer, 4-wire circuit
d) Double resistance thermometer, 2-wire circuit

Potentiometer: 0...500 Ω or 0...4000 Ω

e) Potentiometer, 2-wire circuit
f) Potentiometer, 3-wire circuit
g) Potentiometer, 4-wire circuit
h) 2 Potentiometer, 2-wire circuit
i) Thermocouple
j) Double thermocouple

Voltages: -75 mV...+75 mV or -120 mV...+1200 mV

k) Voltage measurement
i) 2-fold voltage measurement

m) Combination thermocouple and resistance thermometer

3.2.3 LCD indicator / HMI interface

The LCD indicator HMI-Ex type A serves for visualising current process values. Four keys enable local parameterisation. The electric connection of the LCD indicator HMI-Ex type A with transmitters for the most various measuring tasks such as temperature or pressure is by means of a 6-pin ribbon cable with plug-in connectors.

LCD indicator HMI-Ex type A

LCD indicator HMI-Ex type A with transmitter

Notes on explosion protection:

The connecting parts of the LCD indicator HMI-Ex type A must be installed so that protection class IP 20 according to IEC publication 60529:1989 is reached as a minimum. An additional mechanical protection is necessary for the ambient temperature range from -50 °C to -20 °C.

The allowed ambient temperature range as a function of the temperature class can be taken from the tables below for the respective unit categories:

Unit category 1 - Use:

Temperature class	T6	T5	T4, T3, T2, T1
Allowed ambient temperature range	-40 °C[1)]... +44 °C	-40 °C[1)]... +56 °C	-40 °C[1)]... +60 °C

[1)] -50°C available as an option

Unit category 2 - Use:

Temperature class	T6	T5	T4, T3, T2, T1
Allowed ambient temperature range	-40 °C[1)]... +56 °C	-40 °C[1)]... +71 °C	-40 °C[1)]... +85 °C

[1)] -50°C available as an option

Electrical data

Unit category 1 – Use

Display/service interface (connected by a plug)

- with type of protection "intrinsic safety" EEx ia IIB/IIC for connection to certified intrinsically safe circuits;
- maximum input values:
  Ui = 9 V, Ii = 65.2 mA, Pi = 101 mW, Ci ≈ 0, Li ≈ 0

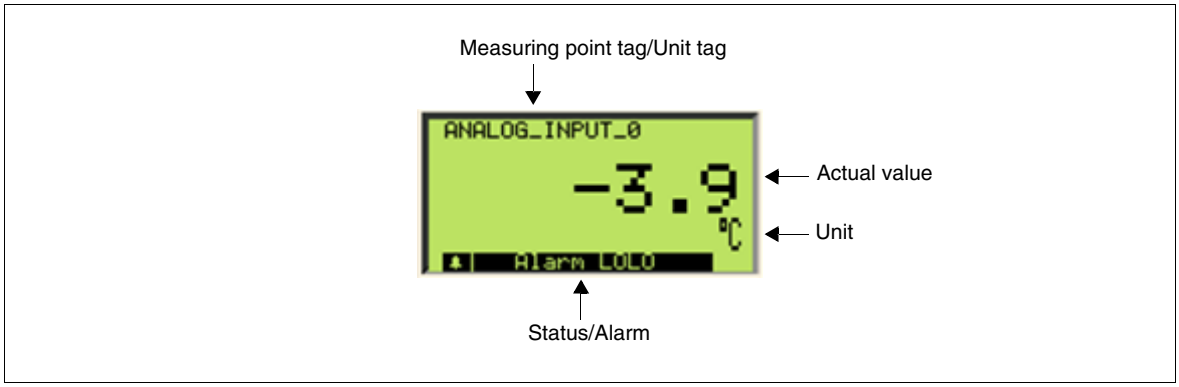
Unit category 2 – Use

Display/service interface (connected by a plug)

- with type of protection "intrinsic safety" EEx ia IIB / IIC or EEx ib IIB/IIC for connection to certified intrinsically safe circuits;
- maximum input values:
  Ui = 9 V, Ii = 65.2 mA, Pi = 101 mW, Ci ≈ 0, Li ≈ 0

The explosion protection data of the HMI interface on the transmitters given are always the same, i.e. plugging the LCD indicator into the transmitter will not change the electrical data of the transmitter.

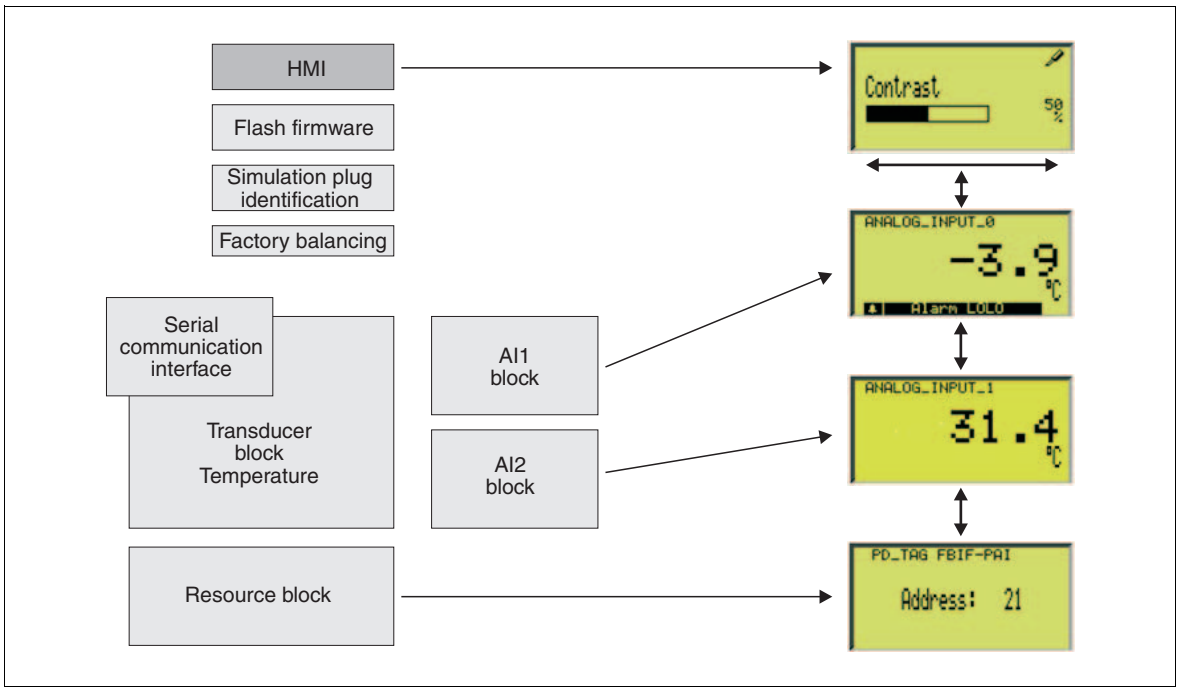
Menu structure/Operating notes:



The functions of the TF202 are structured into different blocks according to FF (FOUNDATION Fieldbus). The TF202 has a Resource block, a Transducer block and two Analog Input blocks.

Resource blocks such as AI blocks are standard blocks. In case of software changes in the standard blocks or in the Field bus communication stack, the unit must be newly certified by the FF.

The connection of the LCD indicator therefore is from the transducer block. Unless a modification of the firmware in the transducer block results in changes of the unit behaviour on the field bus, re-certification of the unit is not necessary.



3.3 Shielding, grounding, EMC

Shielding

Use only shielded bus cables to comply with the Foundation Fieldbus standards in accordance with IEC 61158-2. The shielded cable types A or B are approved to use in combination with TF02 / TF202.

The optimum electromagnetic compatibility of TF02 / TF202 is only guaranteed, if shielded cables are used for the wiring of the sensor connection.

The correct terminal for the cable shield connection is describe in the chapter 3.1 (TF02 / TF202 installation sites).

Grounding

The metallic connection head AGL / AGLF / AGS / AGSF, that are offered for the TF02 / TF202 have to connect directly to ground potential. Use for this connection Copper cable with a diameter at least of 4mm².

EMC

The optimum electromagnetic compatibility of systems is only guaranteed if system components and in particular lines are shielded and the shielding provides the most complete coverage possible.

3.4 Maintenance, repair, trouble-shooting

The TF02 / TF202 is fully operational immediately after switching on the fieldbus power supply.
The TF02 / TF202 is virtually maintenance-free.

Observe the warnings attached to the housing (externally and on the internal cover).

4 Fieldbus Communication

4.1 Block structure

A FF device consists of several function blocks. Most of these blocks are specified by the Fieldbus Foundation, as a Transducer Block or Resource Block for example. The TF02 consists of the following blocks:

- Resource Block
- Transducer Block
- AI Block I
- AI Block II

The Resource Block describes the device itself with all communication relevant data. The Transducer Block is the interface to the sensor and therefore its parameters control the measurement function of the TF02. The two AI Blocks scale the values in a proper way to provide them to function blocks as controllers of other FF devices like valve positioners.

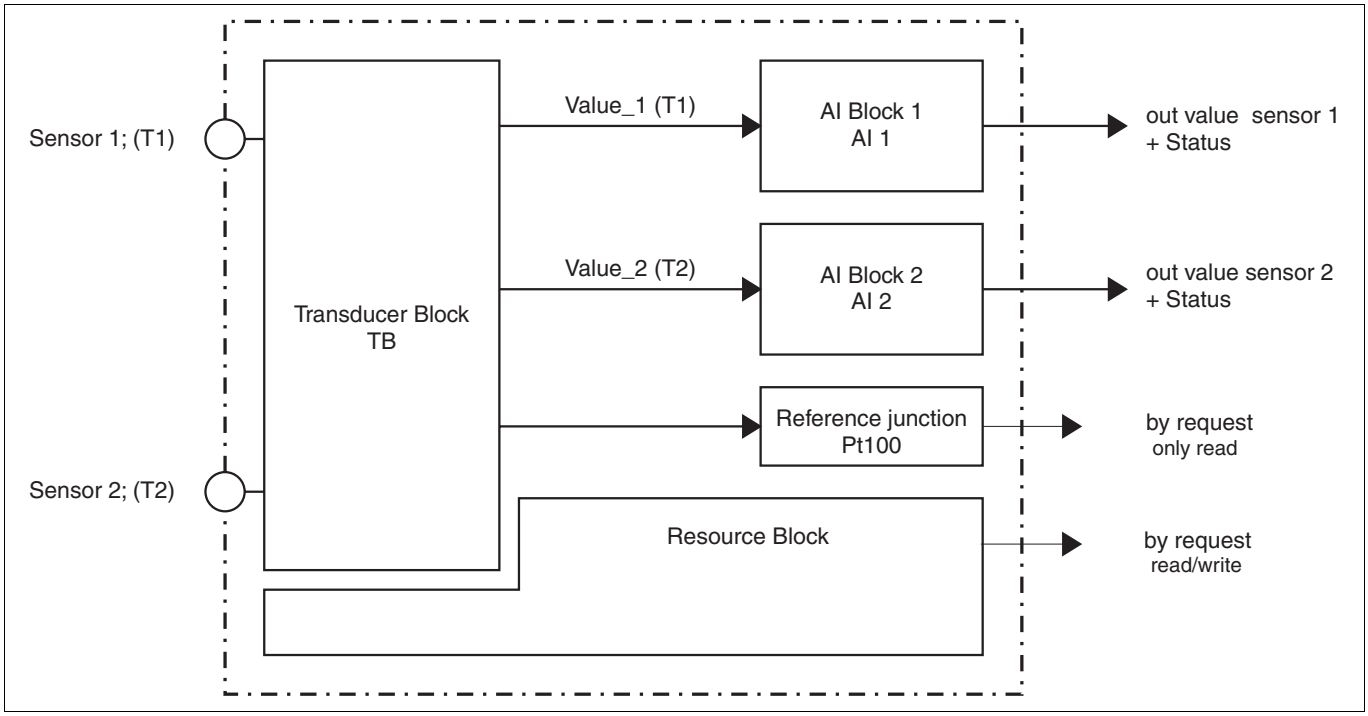


Fig. 4-1 Block structure of the TF02

4.2 Resource Block

4.2.1 Overview

This block contains data that is specific to the hardware that is associated with the resource. All data is modeled as Contained, so there are no links to this block. The data is not processed in the way that a function block processes data, so there is no function schematic. This parameter set is intended to be the minimum required for the Function Block Application associated with the resource in which it resides. Some parameters that could be in the set, like calibration data and ambient temperature, are more appropriately parts of their respective transducer blocks.

4.2.2 Description

The block data are classified into two groups. Operation data affect or reflect the operation of the Function Block Application within its resource. Other data does not. Each group is further divided into static and dynamic data. Normally the Engineering Tool would read or write parameters of the Resource Block automatically. Mostly the data is entered offline or is calculated by the environment. With the parameter TAG_DESC the device is referenced in the system.

Parameter (Access r = read/ w = write)	Description	
ST_REV r	Revision of static (NV) data. The revision counter is incremented at every write access to static data in this block.	
TAG_DESC r / w	A user defined text can be applied to this block for further referencing (TAG name).	
STRATEGY r / w	Allows grouping of several blocks by applying the same value for these blocks	
ALERT_KEY r / w	An identification number can be entered. With this value a host system is able to sort or group alarms or events.	
MODE_BLK r / w	Contains three sub collections with the same structure, "Actual" for actual state, "Permitted" for the allowed state for this block and "Normal“ for normal mode.	
	AUTO	The operation of the AI blocks is enabled
	O/S	The operation of the AI blocks is disabled
BLOCK_ERR r	SIMULATE_ACTIVE	Simulation enabled
	OUT_OF_SERVICE	Block mode is O/S (Out of Service)
	LOST_STATIC_DATA	Loss of data in NV memory
RS_STATE r	ONLINE	Normal operation mode. Block is in AUTO state
	STANDBY	Resource block is in O/S state
	ONLINE_LINKING	Connecting of communication links between the function blocks is in process
TEST_RW r/w	Only used for certification of FF devices, not used for normal operation.	
DD_RESOURCE r	Delivers information about the device description, used for configuration tools.	
MANUFAC_ID r	Manufacturer ID, ABB = 0x000320	
DEV_TYPE r	Device ID, TF02 = 30 (decimal)	
DEV_REV r	Revision number of the device	
DD_REV r	Revision number of the device description	
GRANT_DENY r	Used for access control (to field device by host)	
HARD_TYPES r	Indicates the types of hardware that are available to this resource. If an I/O block is configured that requires a type of hardware that is not available, the result will be a block alarm for a configuration error.	
RESTART r / w	RUN	Passive state (no change)
	RESOURCE	Clear up problems like garbage collection.
	DEFAULTS	Restart all configurable function block application objects to their initial value.
	PROCESSOR	Same as a hardware reset of the device. This value can not be read out.
FEATURES **r**	Displays the additional features supported by the device.	
FEATURES_SEL r / w	Selection of the additional features. Following features are supported: REPORTS: Enables alarms. Must be set for alarming at work. FAULTSTATE: not relevant OUT READBACK: not relevant	

Parameter (Access r = read/ w = write)	Description
CYCLE_TYPE r	Defines the type of cycles that this resource can do.
CYCLE_SEL r / w	Used to select the block execution method for this resource.
	SCHEDULED: Blocks are only executed based on the schedule in FB_START_LIST
	COMPLETION OF BLOCK EXECUTION: A block may be executed by linking to another blocks completion.
MIN_CYCLE_T r	The manufacturer specified minimum time to execute a cycle. It puts a lower limit on the scheduling of the resource.
MEMORY_SIZE r	Declares the size of the resource for configuration of function blocks, in kilobytes.
NV_CYCLE_T r	Allows the manufacturer to identify the minimum time interval between copies of NV class data to NV memory. NV memory is updated only if there has been a significant change in the dynamic value. The last value saved in NV memory will be available for the restart procedure. If the value is zero, it will never be automatically copied. Entries made by human interface devices to NV parameters must be copied to non-volatile memory at the time of entry.
FREE_SPACE r	Shows the percentage of configuration memory that is still available.
FREE_TIME r	Shows the approximate percentage of time that the resource has left for processing new function blocks, should they be configured.
SCHED_RCAS r / w	Watchdog for connection monitoring between host and device in RCAS state. After the specified time the AI block enters the state specified by the SCHED_OPT parameter.
SCHED_ROUT r/ w	Watchdog for connection monitoring between host and device in ROUT state. After the specified time the AI block enters the state specified by the SCHED_OPT parameter.
FAULT_STATE r / w	Cause all output function blocks in the resource to go immediately to the condition chosen by the Fault State Type I/O option. It may be set by a physical input to the device provided for that purpose, or by setting the SET_FSTATE parameter with a message over the bus. It may be cleared by setting the CLR_FSTATE parameter, if the physical input is reset. It will not clear by itself when the physical input resets. The set and clear parameters do not appear in a view because they are momentary.
SET_FSTATE r / w	Forces the device (block) to enter the fault state specified by the FAULT_STATE parameter.
CLR_FSTATE r / w	Forces the device (block) to leave the fault state.
MAX_NOTIFY r	Maximum number of alert reports that this resource can have sent without getting a confirmation, corresponding to the amount of buffer space available for alert messages.
LIM_NOTIFY r / w	A user can set the number lower than MAX_NOTIFY, to control alert flooding. If set to zero, no alerts are reported.
CONFIRM_TIME r / w	Time for the resource to wait for confirmation of receipt of a report before trying again.
WRITE_LOCK r / w	Prevent any external change to the static or non-volatile data base in the Function Block Application of the resource. Block connections and calculation results will proceed normally, but the configuration will be locked. Clearing WRITE_LOCK will generate the discrete alert WRITE_ALM, at the WRITE_PRI priority. Setting WRITE_LOCK will clear the alert, if it exists.
UPDATE_EVT r	TRUE if static (NV) block date was manipulated.
BLOCK_ALM r	Actual block alarm status.

Parameter (Access r = read/ w = write)	Description
ALARM_SUM r	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
ACK_OPTION r / w	Selection of whether alarms associated with the block will be automatically acknowledged.
WRITE_PRI r / w	Priority of the alarm generated by clearing the write lock.
WRITE_ALM r	This alert is generated if the write lock parameter is cleared.
ITK_VER r	Major revision number of the interoperability test case used in certifying this device as interoperable. The format and range of the version number is defined and controlled by the Fieldbus Foundation. Note: The value of this parameter will be zero (o) if the device has not been registered as interoperable by the FF.

Tab. 4-1 Parameters of the Resource Block

4.3 Transducer Block

4.3.1 Overview

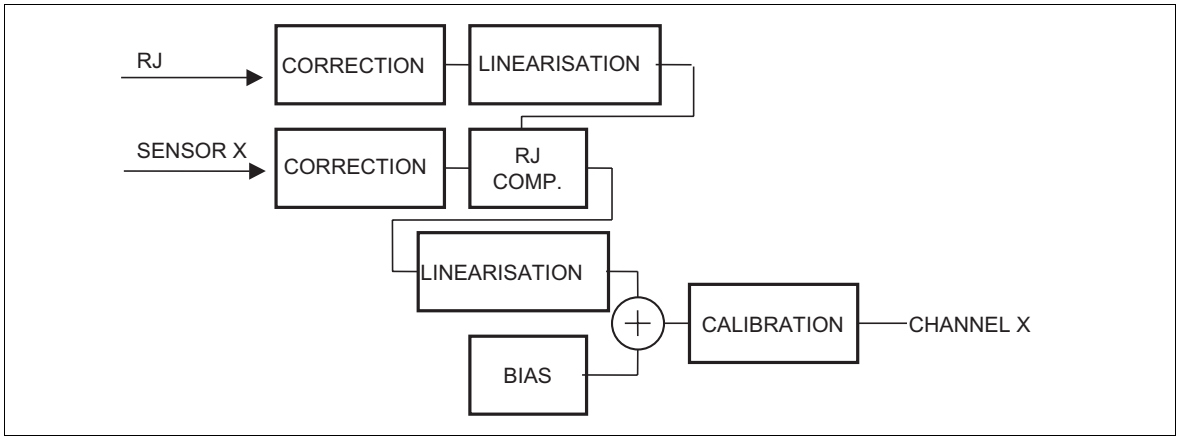


Fig. 4-2 Transducer Block structure

Transducer blocks insulate function blocks from the specifics of I/O devices, such as sensors, actuators, and switches. Transducer blocks control access to I/O devices through a device independent interface defined for use by function blocks. Transducer blocks also perform functions, such as calibration and linearization, on I/O data to convert it to a device independent representation. Their interface to function blocks is defined as one or more implementation independent I/O channels. Transducer blocks are defined to decouple function blocks from the local input/output functions required to read sensor hardware and command effector hardware. This permits the transducer block to execute as frequently as necessary to obtain good data from sensors without burdening the function blocks that use the data. It also insulates the function block from the manufacturer specific characteristics of an I/O device. Transducer classes may be defined as grouping of blocks having common parameters and behaviour. Three basic classes of transducer blocks are:

- Input Transducer Block - interfaces to physical measurements or inputs, processes these measurements and makes its results available to input function blocks through channel reference.
- Output Transducer Block - interfaces to output function blocks through channel reference and processes their target output to regulate physical actuators or physical outputs.
- Display Transducer Block - interfaces to local interface devices and allows the local interface access to function block parameters.

4.3.2 Description

The TF02 has got a Standard Temperature with Calibration two Sensor Device Access Transducer Block. This block is able to read two sensor values independently, if the sensors are connected with two wires.

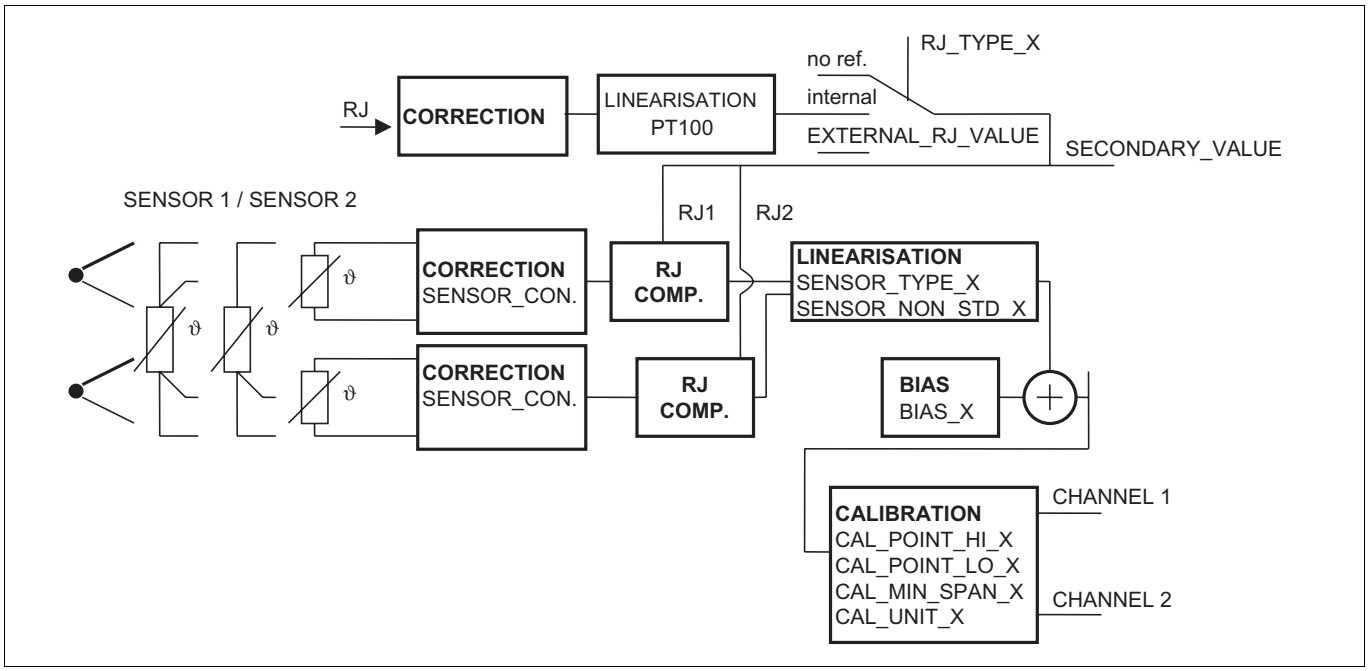


Fig. 4-3 Transducer Block structure, detailed

Sensor Connection

The TF02 has got two independent, but not galvanic isolated sensor inputs. These inputs can be either connected to two sensors (resistor or thermocouple) with two wires or the two inputs can be combined to connect one resistor with three or four wires. With the SENSOR_CONNECTION_X parameter the connection type is entered.

IMPORTANT

If channel 1 is connected to a sensor with three or four wires, the second channel does not deliver a valid value. A post connected AI Block would receive an invalid value.

Linearization / Sensor Type

The TF02 supports all sensors standardized by the Fieldbus Foundation. Additionally a lot of non standard sensors are supported. With the SENSOR_TYPE_X parameter the standard sensors can be selected. If the entry Non-standard is selected, the settings in SENSOR_NON_STANDARD_X becomes valid. Sensor types with a strong linear characteristic are selectable too. Non included sensors (user specific) can be connected with a user type linearization. To connect thermocouples a setting for CJC_TYPE_X is required. CJC is the Cold Junction compensation.

CJC for Thermocouples

Selectable settings are no reference, internal or external. Select "no reference" leads to no compensation and so to a measuring difference. The difference depends on the environmental temperature of the TF02 especially its sensor terminals.
Select "internal" to use the inbuilt PT100 inside the TF02. This PT100 is connected to one terminal block. Select "external" to use a external stabilized junction box. The stabilized temperature (by a thermostat) must be entered in EXTERNAL_CJC_VALUE_X.

User defined sensor characteristic

A non implemented sensor can be connected in two ways:

- By linear voltage or linear resistor type.
- By user defined sensor characteristic.

The linearization parameters are specified as coefficients of a polynomial 3rd degree:

$$y = A + Bx + Cx^2 + Dx^3$$

Where A is USER_TYPE_A_1
B is USER_TYPE_A_2
C is USER_TYPE_A_3
D is USER_TYPE_A4

Normally those linearizations are only defined in a specific area. An input value outside of the area bounds can not be calculated (= linearized) without a failure. So the area bounds are given with USER_TYPE_A_MIN and USER:TYPE_A_MAX. The TF02 allows three different linearization curves A, B and C with the same structure as describes above. The different curves can be connected to a super linearization. In this case the area that is described by one polynomial does not cover the desired range of the sensor. To enlarge the range a second and a third characteristic can be connected to the first one by selecting proper area bounds (USER_TYPE_A_MIN, USER_TYPE_A_MAX...).

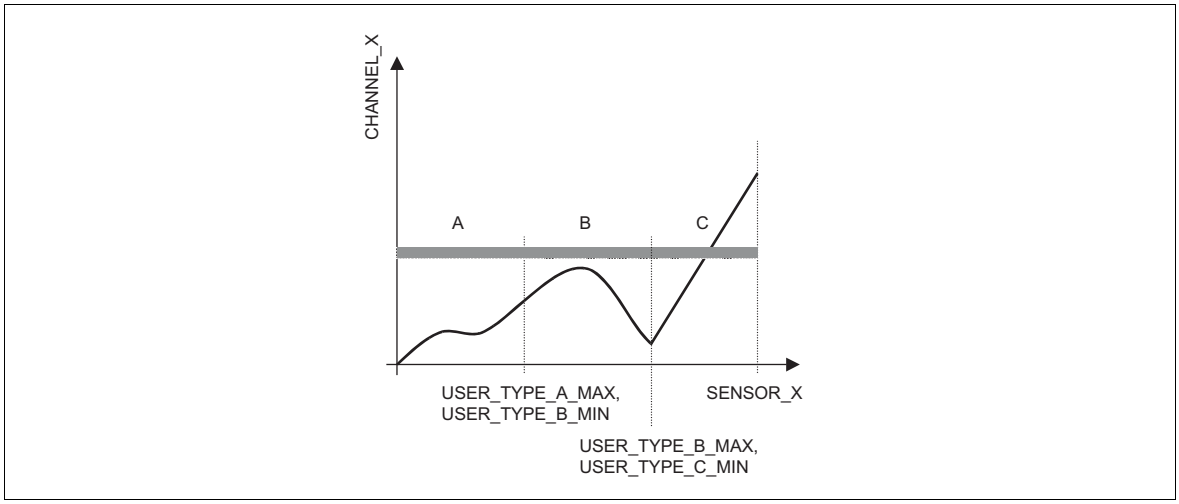


Fig. 4-4 Connecting three user characteristics A, B and C

The linearization characteristic is independent of the input signal, voltage or resistance. The decision is made with USER_SENSOR_UNIT_1 for the first channel and USER_SENSOR_UNIT_2 for the second channel. So one linearization curve can be used to calculate a voltage input on channel one and a resistance input on channel two also. This allows a high flexibility for non standard sensors. For each channel a predefined unit can be selected, because with user linearization characteristic not only temperature sensors can be connected. The TF02 is able to work as transmitter for any voltage or resistance value within a specified range.

Bias

BIAS_X is a constant offset (positive or negative) that is added to the calculated input value. The unit of the offset is the same as in PRIMARY_RANGE_X specified.

Calibration

The TF02 is factory trimmed during production. The accuracy is specified in the datasheet. To enhance the accuracy for special applications a user trimmed calibration of both sensor inputs is possible.

4.3.3 Objects / Parameters of the Transducer Block

Parameter (Access r = read/ w = write)	Description	
ST_REV r	Revision of static (NV) data. The revision counter is incremented at every write access to static data in this block.	
TAG_DESC r / w	A user defined text can be applied to this block for further referencing (TAG name).	
STRATEGY r / w	Allows grouping of several blocks by applying the same value for these blocks.	
ALERT_KEY r / w	An identification number can be entered. With this value a host system is able to sort or group alarms or events.	
MODE_BLK r / w	Contains three sub collections with the same structure, "Actual" for actual state, "Permitted" for the allowed state for this block and "Normal for normal mode.	
	AUTO	The operation of the AI blocks is enabled.
	O/S	The operation of the AI blocks is disabled.
BLOCK_ERR r	SIMULATE_ACTIVE	Simulation enabled
	OUT_OF_SERVICE	Block mode is O/S (Out of Service)
	LOST_STATIC_DATA	Loss of data in NV memory
UPDATE_EVT r	Delivers information about changed static block parameters.	
BLOCK_ALM r	Displays current block alarms with the possibility to acknowledge the active alarm.	
Transducer Directory Entry r	Directory that specifies the number and starting indices of the transducers in the transducer block	
Transducer Type r	Identifies the transducer that follows. For TF02: OTHER (The transducer block of the TF02 is corresponding to the standard FF temperature transducer block. Aditional it have more features)	
Transducer Error r	Shows the transducer block alarm subcode 0: no failure other values: failure	
Collection Directory r	A directory that specifies the number starting indices and DD Item ID's of the data collections in each transducer within a transducer block.	
primary_value_type_1 r	Depending of the sensor type the channel value can either be a process temperature or a non process temperature, e.g. a manual scaled value.	
primary_value_1 r	Actual value (and its status) of channel 1.	
primary_value_range_1 r	Shows the sensor dependent range of the channel value (output) for channel 1.	
cal_point_hi_1 r/w	The value of the Primary Value (channel 1) measurement used for the high calibration point.	
cal_point_lo_1 r/w	The value of the Primary Value (channel 1) measurement used for the low calibration point.	
cal_min_span_1 r	The minimum span that must be used between the high and low calibration points (sensor 1).	
cal_unit_1 r	The unit used for the calibration input.	
sensor_type_1 r/w	Choose the sensor type for channel 1. Can be either one of the FF standard types or a non standard type. In case of the "non standard" type is selected, the parameter sensor non standard 1 determines the type.	
sensor_range_1 r	Shows the sensor range (in Ohm or mV) of channel 1.	

Parameter (Access r = read/ w = write)	Description
sensor_sn_1 r	Serial number of the sensor 1.
sensor_cal_method_1 r/w	Either the factory trimmed calibration data or a user trimmed calibration data can be selected.
sensor_cal_loc_1 r/w	The last location of the sensor calibration (channel 1).
sensor_cal_date_1 r/w	Optional date of user trimmed calibration can be entered.
sensor_cal_who_1 r/w	Optional personal of user trimmed calibration can be entered.
sensor_connection_1 r/w	Any resistor type can be connected with 2, 3 or 4 wires. A connection with more than 2 wires disables channel 2 automatically.
primary_value_type_2 r	Shows the characteristic of the primary value 2 (channel 2). Can be a process / or noon process value. Is determined by the selected sensor type. Only the linear voltage or resistor types produce a non process value.
primary_value_2 r	Actual value (and its status) of channel 2
primary_value_range_2 r	Shows the sensor dependent range of the channel value (output) for channel 2.
cal_point_hi_2 r/w	The value of the Secondary Value (channel 2) measurement used for the high calibration point.
cal_point_lo_2 r/w	The value of the Secondary Value (channel 2) measurement used for the low calibration point.
cal_min_span_2 r	The minimum span that must be used between the high and low calibration points (sensor 2).
cal_unit_2 r	The unit used for the calibration input.
sensor_type_2 r/w	Choose the sensor type for channel 2. Can be either one of the FF standard types or a non standard type. In case of the "non standard" type is selected, the parameter sensor non standard 2 determines the type.
sensor_range_2 r	Shows the sensor range (in Ohm or mV) of channel 2.
sensor_sn_2 r	Serial number of the sensor 2
sensor_cal_method_2 r/w	Either the factory trimmed calibration data or a user trimmed calibration data can be selected.
sensor_cal_loc_2 r/w	The last location of the sensor calibration (channel 2).
sensor_cal_date_2 r/w	Optional date of user trimmed calibration can be entered.
sensor_cal_who_2 r/w	Optional personal of user trimmed calibration can be entered.
Secondary Value r	Shows the characteristic of the primary value 1 (channel 1). Can be a process / or noon process value. Is determined by the selected sensor type. Only the linear voltage or resistor types produce a non process value.
secondary value unit r/w	Determines the unit of the secondary value output of the Transducer Block. The value is the CJC.
Module Serial Number r	Serial number of the device

Parameter (Access r = read/ w = write)	Description
temperature unit 1 r/w	Unit of the channel 1 output
comp wire 1 r/w	Line resistance for 2 wire connection of resistors at channel 1.
RJ type 1 r/w	Type of CJC (Cold Junction Compensation) of channel 1 used for thermocouples.
external RJ-value 1 r	In case of an external stabilized CJC temperature this value has to be entered.
sensor non standard 1 r/w	Additional sensor types of the TF02. These types are not standardized by FF. This parameter is only relevant, if the parameter sensor_type_1 is adjusted to "non standard".
bias 1 r/w	A constant offset (positive or negative) can be added to the output value of channel 1.
temperature unit 2 r/w	Unit of the channel 2 output.
comp wire 2 r/w	Line resistance for 2 wire connection of resistors at channel 2.
RJ type 2 r/w	Type of CJC (Cold Junction Compensation) of channel 2 used for thermocouples.
sensor non standard 2 r/w	Additional sensor types of the TF02. These types are not standardized by FF. This parameter is only relevant, if the parameter sensor_type_1 is adjusted to "non standard".
bias 2 r/w	A constant offset (positive or negative) can be added to the output value of channel 1.
ADC control r/w	The internal filter can be set to 60 Hz, instead of the default 50 Hz to suppress the ripple produced by mains power lines.
sensor hard rev r	Hardware revision of the sensor interface circuit.
sensor soft rev r	Software revision of the sensor interface circuit.
user lin. -type A coefficient 1 r/w	Coefficient A of the polynom $y = A + Bx + Cx^2 + Dx^3$
user lin. -type A coefficient 2 r/w	Coefficient B of the polynom $y = A + Bx + Cx^2 + Dx^3$
user lin. -type A coefficient 3 r/w	Coefficient C of the polynom $y = A + Bx + Cx^2 + Dx^3$
user lin. -type A coefficient 4 r/w	Coefficient D of the polynom $y = A + Bx + Cx^2 + Dx^3$
user lin. -type B coefficient 1 r/w	Coefficient A of the polynom $y = A + Bx + Cx^2 + Dx^3$
user lin. -type B coefficient 2 r/w	Coefficient B of the polynom $y = A + Bx + Cx^2 + Dx^3$
user lin. -type B coefficient 3 r/w	Coefficient C of the polynom $y = A + Bx + Cx^2 + Dx^3$
user lin. -type B coefficient 4 r/w	Coefficient D of the polynom $y = A + Bx + Cx^2 + Dx^3$
user lin. -type C coefficient 1 r/w	Coefficient A of the polynom $y = A + Bx + Cx^2 + Dx^3$
user lin. -type C coefficient 2 r/w	Coefficient B of the polynom $y = A + Bx + Cx^2 + Dx^3$

Parameter (Access r = read/ w = write)	Description
user lin. -type C coefficient 3 r/w	Coefficient C of the polynom $y = A + Bx + Cx^2 + Dx^3$
user lin. -type C coefficient 4 r/w	Coefficient D of the polynom $y = A + Bx + Cx^2 + Dx^3$
user lin. -type A input min r/w	Lower range of the first user defined linearization curve
user lin. -type A input max r/w	Upper range of the first user defined linearization curve
user lin. -type B input min r/w	Lower range of user defined linearization curve B
user lin. -type B input max r/w	Upper range of user defined linearization curve B
user lin. -type C input min r/w	Lower range of user defined linearization curve C
user lin. -type C input max r/w	Upper range of user defined linearization curve V
user sensor unit 1 r/w	Resistor or voltage input for channel 1 (only relevant for user defined linearization curve).
user sensor unit 2 r/w	Resistor or voltage input for channel 2 (only relevant for user defined linearization curve).

Tab. 4-2 Parameters of the Transducer Block

4.4 AI Block

4.4.1 Overview

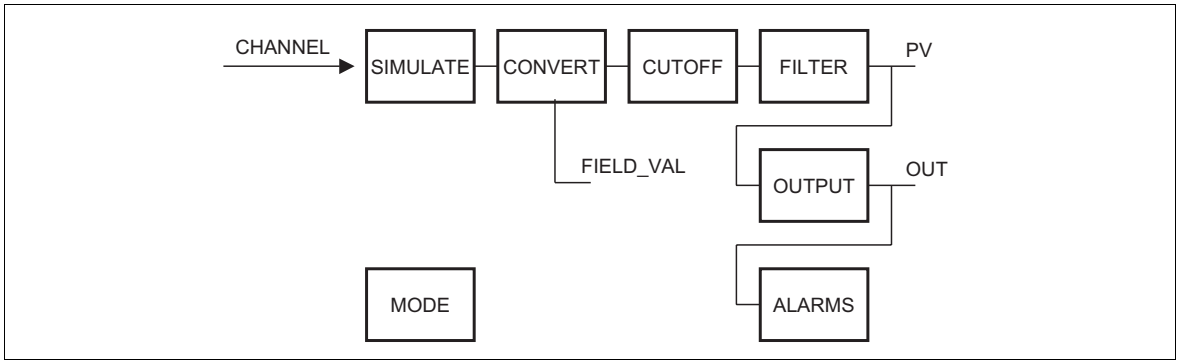


Fig. 4-5 Figure 4 5 AI Block structure

The function block is the primary means of defining monitoring and control in a function block application. Function blocks represent the basic automation functions performed by an application which is as independent as possible of the specifics of I/O devices and the network. Each function block processes input parameters and transducer block input according to a specified algorithm and an internal set of contained parameters. They produce output parameters and output to transducer blocks. Based on the processing algorithm, a desired monitoring, calculation or control function may be provided. The results from function block execution may be reflected in contained parameters for operation or diagnostic information. In addition, processing results may be reflected in the output to a transducer block or to one or more output parameters that may be linked to other function blocks. Based on common parameters and behaviour, the following classes of function blocks may be defined:

- Input Function Block - accesses physical measurements through channel reference to an input transducer block. After processing the transducer value, the results will be provided as an output for linking to other function blocks. Contains a simulate parameter by which the transducer value and status may be over-ridden for diagnostics and checkout.

- Output Function Block - acts upon input from other function blocks and passes its results to an output transducer block through channel reference. Also, the back-calculation output parameter is supported. Contains a simulate parameter by which the value and status passed from the transducer as a read back value may be over-ridden for diagnostics and checkout while the actual output value is held.
- Control Function Block - acts upon inputs from other function blocks to produce values that are passed to other control or output function blocks through output parameters. Contains logic and input parameters to use information from lower block to prevent windup and provide bump less transfer. Supports the back-calculation output parameter.
- Calculation Function Block - acts upon inputs from other function blocks to produce values that are passed to other function blocks through output parameters.

Function blocks may be characterized in the following manner:

- Each resource associated with a function block application may contain one or more function blocks.
- Function blocks are capable of processing information obtained through links with other function blocks inputs or outputs. Also, it may use or provide output to transducer block channels within the same resource.
- Function Block execution may be scheduled or invoked by completion of another function block. Execution may be defined to be manufacturer specific.

4.4.2 Description

The TF02 contains two Analog Input Function Blocks (AI). With an AI block the value delivered by a Transducer Block is scaled and applied with additional diagnostic information.

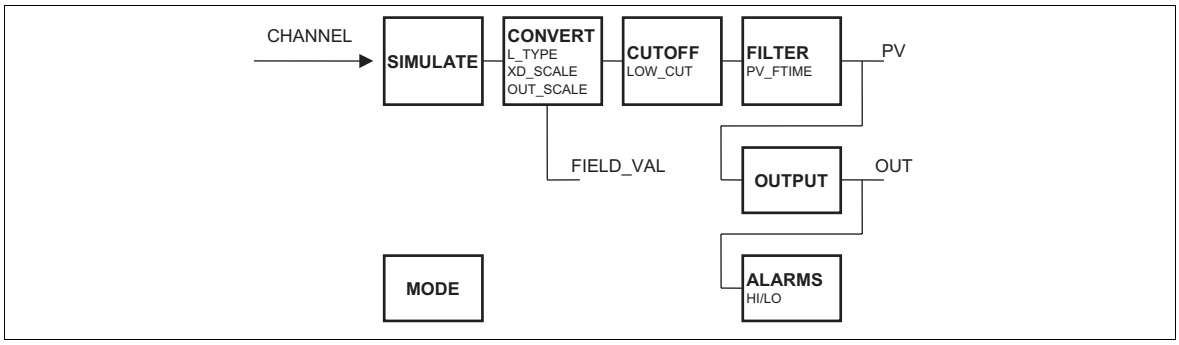


Fig. 4-6 AI Block structure, detailed

4.4.3 Scaling of the analog input value

XD_SCALE

Transducer scaling (XD_SCALE) is applied to the value from the channel to produce the FIELD_VAL in percent.

IMPORTANT

The XD_SCALE units code must match the channel units code (if one exists), or the block will remain in O/S mode after being configured. A block alarm for units mismatch will be generated.

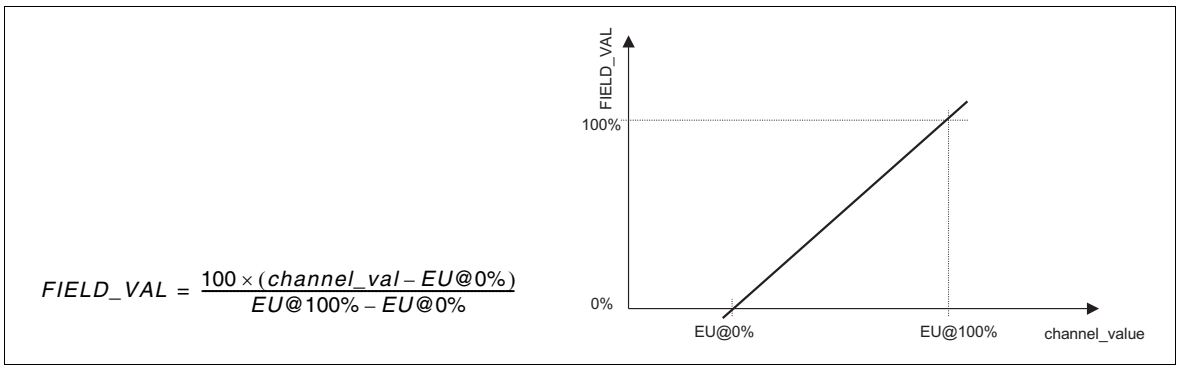


Fig. 4-7 XD_SCALE, relationship channel_value - FIELD_VAL

OUT_SCALE

With the OUT_SCALE setting the PV value is calculated. It can be the channel value direct without any scaling. Also a rescaling based on FIELD_VAL is possible, this is called indirect. The OUT_SCALE is normally the same as the transducer, but if L_TYPE is set to Indirect or Ind Sqr Root, OUT_SCALE determines the conversion from FIELD_VAL to the output. PV and OUT always have identical scaling. OUT_SCALE provides scaling for PV. The PV is always the value, that the block will place in OUT if the mode is Auto. If Man is allowed, someone may write a value to the output. The status will prevent any attempt at closed loop control using the Man value, by setting the Limit value to Constant. The LOW_CUT parameter has a corresponding "Low cut-off" option in the IO_OPTS bit string. If the option bit is true, any calculated output below the low cut-off value will be changed to zero. This is only useful for zero based measurement devices, such as flow. The PV filter, whose time constant is PV_FTIME, is applied to the PV, and not the FIELD_VAL.

Direct: $PV = channel\_value$

Indirect: $$PV = \frac{FIELD\_VAL}{100} \times (EU@100\% - EU@0\%) + EU@0\%$$

Ind Sqr Root: $$PV = \sqrt{\frac{FIELD\_VAL}{100}} \times (EU@100\% - EU@0\%) + EU@0\%$$

4.4.4 Alarms of the AI Block

The AI Block detects the following limit violations of its PV value:

- high high limit violation
- high limit violation
- low limit violation
- low low limit violation

An adjustable hysteresis is applied, if the value returns to its good state. A priority of each alarm message can be set separately. The following figure shows the meaning of the different limit settings.

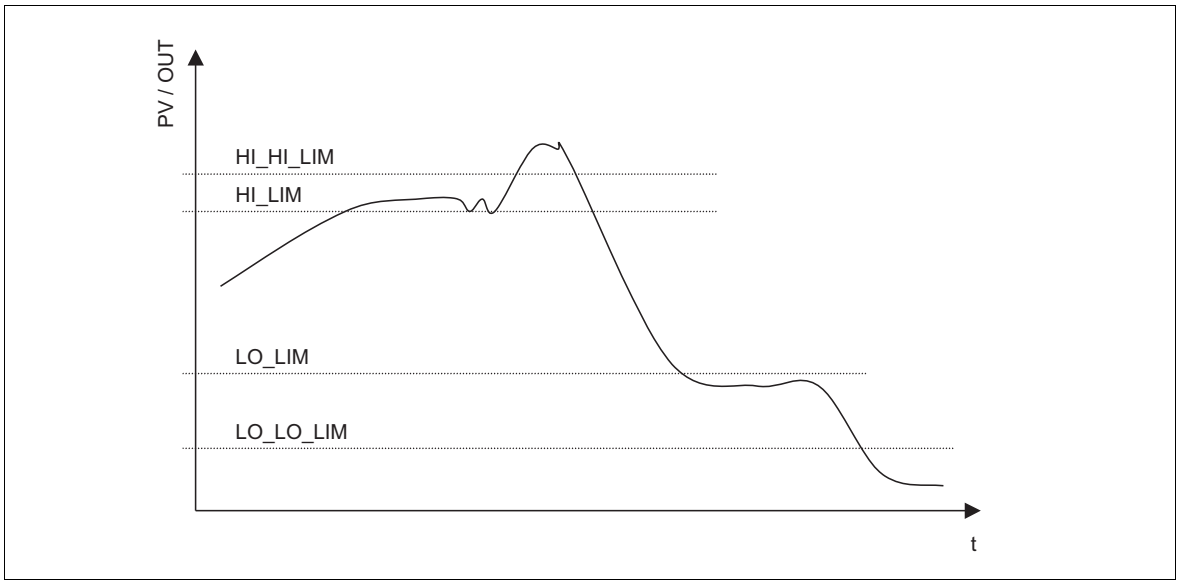


Fig. 4-8 Alarm types and limits

4.4.5 Simulation of the input value

The simulation function offers the possibility to simulate the AI block input value.

To use the simulation functionality , this function must be enabled with an hardware key, which is to plug into the TF02 / TF202 temperature transmitter. This simulation plug can be ordered with the order number 7957851.

The simulation plug is to put in the transmitter in the following described procedure:

1. Open the small cover on the top of the temperature transmitter.
   Then a six pin connection is to be seen.
2. For enabling the simulation function the hardware plug is to put into this connection.
3. After the simulation procedure the simulation plug is to be removed and the cover is to be closed.

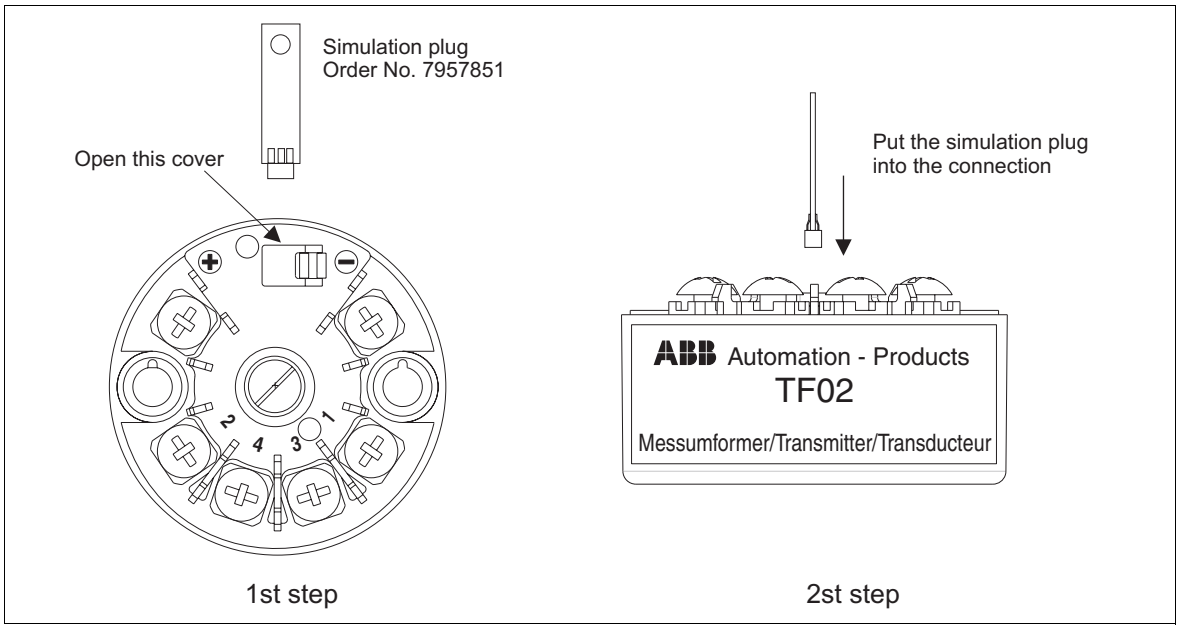


Fig. 4-9 Enable the simulation function with the simulation plug

4.4.6 Objects / Parameters of the AI Block

Parameter (Access r = read/ w = write)	**Description**	
ST_REV r	Revision of static (NV) data. The revision counter is incremented at every write access to static data in this block.	
TAG_DESC r / w	A user defined text can be applied to this block for further referencing (TAG name).	
STRATEGY r / w	Allows grouping of several blocks by applying the same value for these blocks.	
ALERT_KEY r / w	An identification number can be entered. With this value a host system is able to sort or group alarms or events.	
MODE_BLK r / w	Contains three sub collections with the same structure, "Actual" for actual state, "Permitted" for the allowed state for this block and "Normal for normal mode.	
	AUTO	The operation of the AI blocks is enabled.
	O/S	The operation of the AI blocks is disabled.
BLOCK_ERR r	SIMULATE_ACTIVE	Simulation enabled
	OUT_OF_SERVICE	Block mode is O/S (Out of Service)
	LOST_STATIC_DATA	Loss of data in NV memory

Parameter (Access r = read/ w = write)	Description
PV r	Delivers the process variable with its status information (see Figure 4 6)
OUT r	Delivers the OUT value with its status information. In mode AUTO this value is the same as PV, but in mode MAN this is a manually written value (e.g. by an operator during the replacement of a component).
SIMULATE r / w	Allows the transducer analog output to the block to be manually supplied when simulate is enabled. When simulation is disabled, the simulate value and status track the actual value and status.
XD_SCALE r / w	Transducer scaling is entered here. The channel value produced by the Transducer Block is scaled as percent of a given range. Detailed information can be read at the beginning of this chapter. $$FIELD\_VAL = \frac{100 \times (channel\_val - EU@0\%)}{EU@100\% - EU@0\%}$$
OUT_SCALE r / w	Scaling range is entered here. Detailed information can be read at the beginning of this chapter.
	Direct $PV = channel\_value$
	Indirect $$PV = \frac{FIELD\_VAL}{100} \times (EU@100\% - EU@0\%) + EU@0\%$$
	Ind.Sqr. Root $$PV = \sqrt{\frac{FIELD\_VAL}{100}} \times (EU@100\% - EU@0\%) + EU@0\%$$
GRANT_DENY r	Used for access control (to field device by host).
IO_OPTS	Allows the selection of input/output options used alter the PV.
STATUS_OPTS	Allows the user to select options for status handling and processing.
CHANNEL r / w	Channel of the connected Transducer Block is specified. The Transducer Block of the TF02 delivers two channel values. Channel = 1 connects the AI Block to sensor 1, channel = 2 connects the AI Block to sensor 2. The two AI Blocks of the TF02 can be connected to one channel (one sensor) too, e.g. for different scaling of one temperature value.
L_TYPE r / w	Determines if the values passed by the transducer block to the AI block may be used directly (Direct) or if the value is in different units and must be converted linearly (Indirect), or with square root (Ind Sqr Root), using the input range defined by the transducer and the associated output range.
LOW_CUT r / w	The LOW_CUT parameter has a corresponding "Low cut-off" option in the IO_OPTS bit string. If the option bit is true, any calculated output below the low cut-off value will be changed to zero.
PV_TIME r / w	The PV filter, whose time constant is PV_FTIME, is applied to the PV, and not the FIELD_VAL.
FIELD_VAL r	Channel value delivered by the connected Transducer Block after scaling but not filtered like PV or OUT value.
UPDATE_EVT r	This alert is generated by any change to the static data.
BLOCK_ALM r	Standard block alarm plus standard HI_HI, HI, LO, and LO_LO alarms applied to OUT.
ALARM_SUM r	The current alert status, unacknowledged states, unreported states, and disabled states of the alarms associated with the function block.
ACK_OPTION r / w	Selection of whether alarms associated with the block will be automatically acknowledged.

Parameter (Access r = read/ w = write)	Description
ALARM_HYS r / w	Amount the PV must return within the alarm limits before the alarm condition clears. Alarm Hysteresis is expressed as a percent of the PV span.
HI_HI_PRI r / w	Priority of the high high alarm.
HI_HI_LIM r / w	The setting for high high alarm in engineering units.
HI_PRI r / w	Priority of the high alarm.
HI_LIM r / w	The setting for high alarm in engineering units.
LO_PRI r / w	Priority of the low alarm.
LO_LIM r / w	The setting for low alarm in engineering units.
LO_LO_PRI r / w	Priority of the low low alarm.
LO_LO_LIM r / w	The setting for low low alarm in engineering units.
HI_HI_ALM r / w	Is set, if high high alarm is active. The acknowledge can be done in this group too.
HI_ALM r / w	Is set, if high alarm is active. The acknowledge can be done in this group too.
LO_ALM r / w	Is set, if low alarm is active. The acknowledge can be done in this group too.
LO_LO_ALM r / w	Is set, if low low alarm is active. The acknowledge can be done in this group too.

Fig. 4-10 Parameters of the AI Block

Value & Status Byte

Measurement values are transferred as data structure DS-65 - Value & Status in cyclic communication. This structure consists of a value as float number and a status information as byte. This status byte has the following 3 parts:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Quality		Quality Substatus				Limits	

Quality

0: Bad
1: Uncertain
2: Good (Not Cascade)
3: Good (Cascade)

Substatus BAD

0: Non-specific
1: Configuration Error
2: Not Connected
3: Device Failure
4: Sensor Failure
5: No Communication (last usable value)
6: No Communication (no usable value)
7: Out of Service

Substatus UNCERTAION

0: Non-specific
1: Last Usable Value
2: Substitute
3: Initial Value
4: Sensor Conversion not Accurate
5: Engineering Unit Range Violation
6: Sub-normal

Substatus GOOD (Non-Cascade)

0: Non-specific
1: Active Block Alarm
2: Active Advisory Alarm (priority < 8)
3: Active Critical Alarm (priority > 8)
4: Unacknowledged Block Alarm
5: Unacknowledged Advisory Alarm
6: Unacknowledged Critical Alarm

Substatus GOOD (Cascade)

0: Non-specific
1: Initialisation Acknowlegde
2: Initialisation Request
3: Not Invited
4: Not Selected
5: Local Override
6: -
7: Fault State Active
8: Initiate Fault State

Limits

0: Not limited
1: Low limited
2: High limited
3: Constant

TF02

AI BlockError and PV-Status on ResourceBlockError, TransducerBlockError and AIBlockError

Resource Block		Reason ->	Mode_BLK = OOS	Loss of data in EEPROM memory			
	BlockError		out of service	Lost static data			
		AI Block					
		BlockError	out of service	out of service			
		PV Status	Bad / Out of service	Bad / Out of service			
Transducer Block		Reason ->	Mode_BLK = OOS	measurement failure	Sensor shortcut	Sensor break	Loss of data in EEPROM memory
	XD_Error		0	0x01, 0x02, 0x03, 0x04, 0x08, 0x10	0	0	0
	BlockError		out of service	0	0	0	Lost static data
		AI Block					
		BlockError	0	Input failure	Input failure	Input failure	out of service
		PV Status	no influence	Bad / Device failure	Bad / NoComm_withLastUsableValue	Bad / Sensor failure	Bad / Out of service
AI Block		Reason ->	Mode_BLK = OOS	Simulate enable	wrong configuration in AI Block		
	BlockError		out of service	SimulationActive	Block Error Configuration		
	PV Status		Bad / Out of service	no influence	Bad / Out of service		

5 Commissioning

5.1 Device Description (DD)

To configure the device in a host system the following files are required:
0101.ffo, 0101.sym, 010101.cff. For advanced graphical representation additional bitmap graphics are provided. These files are delivered with every device. The filenames do not include the device type but the device revision. The device type is specified by the device id and enables the engineering tool to create a directory structure for its connected FF devices. The TF02 gets the device id 000320001E, which includes the manufacturer id too (000320 = ABB).

5.2 Capabilities File Format (CFF)

The purpose of a common file is to hold a human-readable document which contains some or all of the information that can be read from a fieldbus device over the wire. A common file holds data for no more than one device, at this time. The device may contain more than one VFD. It can be transported by anything that can move a file (for example, a floppy disk or File Transfer Protocol over Ethernet). The common file is intended to contain information in a vendor/device independent format, so that it can be freely transported within and between systems. There is no requirement that a particular system must maintain its own data in common files.

5.3 Commissioning with ABB Control Builder F and FIO-100

Pending.
See related documentation of Control Builder F and FIO-100

6 Technical Data

6.1 Technical data TF02/TF02-Ex/TF202/TF202-Ex

Technical data

Device type
Basic Device

Power supply (at transmitter terminals)

Supply voltage
U_s = 9...32 V DC

for explosion protection application
dependent on the Ex supply unit

Supply voltage, poling protected

Current consumption

Operating (quiescent): 10.5 mA

Fault current limiting: 15 mA

Output

Interface/Protocol
FOUNDATION Fieldbus H1 IEC 61158-2 / FF-H1Version 1.4
31.25 kbit/s
FF Registration: IT015000 Interoperbility Test Kit 4.1

Function blocks

tested function blocks operating time: 25 ms	2 x AI (s)
other function blocks	1 x RB (s) 1 x TB (c)

Input

Resistance

Resistance thermometer
n · Pt100 up to Pt1000 (IEC 751: n = 0.1; 0.5; 1; 2; 5; 10)
(JIS 1604: n = 0.1; 0.5; 1; 2; 10) (SAMA: n = 0.1; 0.5; 1)
Ni50, Ni100, Ni120, Ni1000, Cu10, Cu100

Resistance	Range	Accuracy
	0...500 Ω	2 mΩ
	0...4000 Ω	20 mΩ

Max. line resistance (R_W) per core
2-, 3-, 4-wire 5 Ω, 10 Ω, 50 Ω

Measuring current
300 µA

Sensor short-circuit
< 5 Ω

Sensor break (temperature/resistance measurement, 2-, 3-, 4-wire)
Measuring range 0... 500 Ω > 520 Ω
Measuring range 0...4000 Ω > 4200 Ω

Sensor wire break monitoring in accordance with NAMUR
Sensor wire break detection
3-wire resistance measurement > 35 Ω
4-wire resistance measurement > 3.7 kΩ

Input filter
50/60 Hz

Thermocouples/Voltages

Types
B, C, D, E, J, K, L, N, R, S, T, U

Voltages

Range	Accuracy
-120 mV...+1200 mV	10 µV
- 75 mV...+ 75 mV	2 µV

Sensor monitoring current
1 µA between the measuring cycles

Sensor wire break monitoring in accordance with NAMUR
Thermocouple measurement > 5 kΩ
Voltage measurement > 5 kΩ

Input filter
50/60 Hz

Internal reference junction
Pt100, via software switchable (no jumper necessary)

LC display (optional for TF202)
pluggable and rotating construction

Input element		Measuring range	
Standard	**Sensor**		
IEC 584-1	Thermocouple type B	0...+1820 °C	(+ 32...+3308 °F)
	Thermocouple type E	-270...+1000 °C	(-454...+1832 °F)
	Thermocouple type J	-210...+1200 °C	(-346...+2192 °F)
	Thermocouple type K	-270...+1372 °C	(-454...+2502 °F)
	Thermocouple type R	- 50...+1768 °C	(- 58...+3215 °F)
	Thermocouple type S	- 50...+1768 °C	(- 58...+3215 °F)
	Thermocouple type T	-270...+ 400 °C	(-454...+ 752 °F)
	Thermocouple type N	-270...+1300 °C	(-454...+2372 °F)
W3, ASTME 998	Thermocouple type C Thermocouple type D	0...+2315 °C 0...+2315 °C	(+ 32...+4200 °F) (+ 32...+4200 °F)
DIN 43710	Thermocouple type L	-200...+ 900 °C	(-328...+1652 °F)
	Thermocouple type U	-200...+ 600 °C	(-328...+1112 °F)
IEC 751; JIS; SAMA[1)] 2-, 3- and 4-wire	Resistance thermometer Pt100 Resistance thermometer Pt1000	-200...+ 850 °C -200...+ 850 °C	(-328...+1562 °F) (-328...+1562 °F)
DIN 43760 2-, 3- and 4-wire (a = 0.00618)	Resistance thermometer Ni100 Resistance thermometer Ni1000	- 60...+ 250 °C - 60...+ 250 °C	(- 76...+ 482 °F) (- 76...+ 482 °F)
Resistance, 2-, 3- and 4-wire	Ω	0...500 Ω / 0...4000 Ω	
Voltage	mV	-120 mV...+1200 mV - 75 mV...+ 75 mV	

[1)] IEC 751 a = 0.00385; JIS a = 0.003916; SAMA a = 0.003902

General characteristics

Response time
< 0.5 s

Vibration resistance

Vibration in operation	2 g acc. to DIN IEC 68T.2-6
Resistance to shock	2 g acc. to DIN IEC 68T.2-27

Electrical isolation (I/O)
1.5 kV AC

Long-term stability
≤ 0.1 % p. a. or 0.2 K p. a.

Environment conditions

Ambient temperature range
-40...+85 °C

Transport and storage temperature
-40...+100 °C

Relative humidity
< 100 % (100 % humidity with isolated terminals only)

Condensation
permitted

Electromagnetic compatibility (EMC)

According to NAMUR NE 21 recommendation

With Pt100 sensor and thermocouple

Type of test	Degree	Standard
Burst to signal/ data lines	1 kV	EN 61000-4-4 EN 61326
Static disgarge contact discharge to: contact plate terminals	8 kV 6 kV	EN 61000-4-2
radiated field 80 MHz...2 GHz	10 V/m	EN 61000-4-3
coupling 150 kHz - 80 MHz	10 V	EN 61000-4-6

Influences

Influence of ambient temperature acc. to IEC 68-2-2

Pt 100		± 0.025 K/10 K
resistance measurement	0...500 W	± 10 mΩ/10 K
	0...4000 Ω	± 100 mΩ/10 K
Thermocouple e. g. type K		± 0.025 K/10 K
voltage measurement	-120 mV...+1200 mV	± 150 µV/10 K
	- 75 mV...+ 75 mV	± 10 µV/10 K

Characteristics at rated conditions

acc. to IEC 770 (related to 25 °C)

Measuring error incl. characteristic deviation

Pt 100		± 0.1 K
resistance measurement	0...500 Ω	± 40 mΩ
	0...4000 Ω	± 320 mΩ
Thermocouple e. g. type K		± 0.25 K
voltage measurement	-120 mV...+1200 mV	± 50 µV
	- 75 mV...+ 75 mV	± 10 µV
Additional influence of the internal ref. junction	Pt100 DIN IEC 751 Cl. B	

Parameterization / structure

Type of input (2 independent channels), measuring range, input filter, damping, alarm function, limit values, safing all data proof against mains failure

Standard parameter (factory settings)

Channel 1
Pt100, 4-wire circuit, 0…+100 °C
damping 0 s, unit °C

Channel 2
disabled

6.2 Mecanical construction TF02/TF02-Ex

Dimensions
cf. dimensional drawing

Weight
61 g

Housing material
Polycarbonat

Color (Epoxy)
black (Non-Ex type), blue (Ex-type)

Terminals, pluggable
2.5 mm^2, screw terminals (stainless steel screws)

6.3 Mechanical construction TF202/TF202-Ex

Dimensions
cf. dimensional drawing

Weight
1.25 kg (without accessories)

Housing material
Aluminium/stainless steel

Type of protection
IP 66 and IP 67

Color (Epoxy)
light grey (RAL 9002)

6.4 Explosion protection TF02-Ex

Intrinsically safe

EC Certificate DMT 02 ATEX E 068 X
(Intrinsically safe Zone 0/1 and Mine)

Zone 0/1		II 1 G EEx ia IIC T6	
Zone 0	T1…T5	Ambient temperature:	-20…+60 °C
	T6	Ambient temperature:	-20…+50 °C
Zone 1	T1…T4	Ambient temperature:	-40…+85 °C
	T5	Ambient temperature:	-40…+65 °C
	T6	Ambient temperature:	-40…+50 °C
Mine		I M 1 EEx ia I	
		Ambient temperature:	-20…+60 °C

Supply circuit	Supply and communi-cation circuit ia/ib IIC	Supply and communi-cation circuit ia/ib IIB	Measuring circuit ia/ib
Max. voltage	$U_i \leq 24$ V	$U_i \leq 24$ V	$U_o = 5.5$ V
Short-circuit current	$I_i = 360$ mA	$I_i = 380$ mA	$I_o < 25$ mA
Max. power	$P_i = 2.52$ W	$P_i = 5.32$ W	$P_o < 35$ mW
Internal inductance	$L_i \leq 10$ µH	$L_i \leq 10$ µH	neglectable
Internal capacitance	$C_i = 5$ nF	$C_i = 5$ nF	$C_i = 60$ nF

Suitable for connceting to systems according to

– Entity model and
– FISCO model

Non sparking “nA“ ATEX

EC Certificate BVS 03 E 171 X

Zone 2 (TF02-Ex N)		II 3 G EEx nA [nL] IIC T6	
	T1…T4	Ambient temperature:	-40…+85 °C
	T5	Ambient temperature:	-40…+65 °C
	T6	Ambient temperature:	-40…+50 °C

Canadian Standards Association and Factory Mutual

Intrinsically Safe

FM	Class I	Div. 1/Div. 2, Groups A, B, C, D T6	
	Class I	Zone 0, AEx ia	
	or	Zone 0, AEx ib IIC	
CSA	Class I	Div. 1/Div. 2, Groups A, B, C, D T6	

Nonincendive

FM	Class I	Div. 2, Groups A, B, C, D T6
CSA	Class I	Div. 2, Groups A, B, C, D T6

6.5 Explosion protection TF202-Ex

Intrinsically safe

EC-Type-Examination certificate
Transmitter: DMT 02 ATEX E 068 X
LC display: PTB 05 ATEX 2079 X

(Intrinsically safe Zone 0/1 and Mine)

Zone 0/1		II 1 G EEx ia IIC T6	
Zone 0	T1…T5	Ambient temperature:	-20…+60 °C
	T6	Ambient temperature:	-20…+50 °C
		with LC display:	-20…+44 °C
Zone 1	T1…T4	Ambient temperature:	-40…+85 °C
	T5	Ambient temperature:	-40…+65 °C
	T6	Ambient temperature:	-40…+50 °C
		with LC display:	-40…+56 °C
Mine		I M 1 EEx ia I	
		Ambient temperature:	-20…+60 °C

Supply circuit	Supply and communi-cation circuit ia/ib IIC	Supply and communi-cation circuit ia/ib IIB	Measuring circuit ia/ib
Max. voltage	$U_i \leq 24$ V	$U_i \leq 24$ V	$U_o = 5.5$ V
Short-circuit current	$I_i = 360$ mA	$I_i = 380$ mA	$I_o < 25$ mA
Max. power	$P_i = 2.52$ W	$P_i = 5.32$ W	$P_o < 35$ mW
Internal inductance	$L_i \leq 10$ µH	$L_i \leq 10$ µH	neglectable
Internal capacitance	$C_i = 5$ nF	$C_i = 5$ nF	$C_i = 60$ nF

The connection values of the LC display have no influence on the values indicated in the table.

Suitable for connceting to systems according to

– Entity model and
– FISCO model

Non sparking “nA“ ATEX

EC-Type-Examination certificate BVS 03 E 171 X

Zone 2 (TF202-Ex N)		II 3 G EEx nA [nL] IIC T6	
	T1…T4	Ambient temperature:	-40…+85 °C
	T5	Ambient temperature:	-40…+65 °C
	T6	Ambient temperature:	-40…+50 °C

Dust Ex

EC-Type-Examination certificate DMT 02 ATEX E 248

(TF202-Ex D)		II 1 D IP 65 T 135 °C

Pressure proof enclosure/Flameproof

EC-Type-Examination certificate PTB 99 ATEX 1144

(TF 202-Ex d)		II 2 G EEx d IIC T6	
	T1…T4	Ambient temperature:	-40…+85 °C
	T5	Ambient temperature:	-40…+65 °C
	T6	Ambient temperature:	-40…+50 °C

Canadian Standards Association and Factory Mutual

Intrinsically Safe

FM/CSA	Class I	Div. 1/Div. 2, Groups A, B, C, D T6	
	Class II	Div. 1/Div. 2, Groups E, F, G	
	Class III	Div. 1	
FM	Class I	Zone 0, AEx ia IIC T6	

Nonincendive

FM/CSA	Class I	Div. 2, Groups A, B, C, D T6	
	Class II	Div. 2, Groups F, G	(FM)
	Class II	Div. 2, Groups E, F, G	(CSA)
	Class III	Div. 2	

Explosionproof (FM and CSA approvals in preparation)

FM/CSA	Class I	Div. 1/Div. 2, Groups A, B, C, D T6
	Class II	Div. 1/Div. 2, Groups E, F, G
	Class III	Div. 1

7 EEC Certificate of Conformity

Translation

(1) **EC-Type Examination Certificate**

(2) **- Directive 94/9/EC -**
Equipment and protective systems intended for use in potentially explosive atmospheres

(3) **DMT 02 ATEX E 068 X**

(4) **Equipment:** **Temperature-Transmitter Typ TF 02-Ex, TF 102-Ex, TF 202-Ex und TF 202-Ex M**

(5) **Manufacturer:** **ABB Automation Products GmbH**

(6) **Address:** **D - 63754 Alzenau**

(7) The design and construction of this equipment and any acceptable variation thereto are specified in the schedule to this type examination certificate.

(8) The certification body of Deutsche Montan Technologie GmbH, notified body no. 0158 in accordance with Article 9 of the Directive 94/9/EC of the European Parliament and the Council of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres, given in Annex II to the Directive.
The examination and test results are recorded in the test and assessment report BVS PP 02.2040 EG.

(9) The Essential Health and Safety Requirements are assured by compliance with:

EN 50014:1997 + A1 - A2	General requirements
EN 50020:1994	Intrinsic safety
EN 50284:1999	Equipment Group II Category 1G
EN 50303:2000	Equipment Group I Category M1

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EC-Type Examination Certificate relates only to the design, examination and tests of the specified equipment in accordance to Directive 94/9/EC.
Further requirements of the Directive apply to the manufacturing process and supply of this equipment. These are not covered by this certificate

(12) The marking of the equipment shall include the following:

Ex II 1G or Ex I M1 (details see 15.1)

Deutsche Montan Technologie GmbH
Essen, dated 25. April 2002

Signed: Dr. Jockers
DMT-Certification body

Signed: Dr. Eickhoff
Head of special services unit

Page 1 of 4 to DMT 02 ATEX E 068 X

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DMT

(13) Appendix to

(14) # EC-Type Examination Certificate

DMT 02 ATEX E 068 X

(15) 15.1 Subject and type

Temperature-Transmitter

Type TF 02-Ex	Sensor-head transmitter	Ex II 1G EEx ia IIC T6 or Ex I M1 EEx ia I
Type TF 102-Ex	Sensor-head transmitter in series-rail housing	Ex II 1G EEx ia IIC T6 or Ex I M1 EEx ia I
Type TF 202-Ex	Sensor-head transmitter in field housing	Ex II 1G EEx ia IIC T6
Type TF 202-Ex M	Sensor-head transmitter in stainless steel field housing	Ex I M1 EEx ia I

15.2 Description

The Temperature-Transmitters are used as measured value sensors to detect, amplify and transfer measured values in intrinsically safe circuits. Supply and communication of the values are effected via an intrinsically safe fieldbus.

15.3 Parameters

15.3.1 Supply/communications circuit in the type of protection EEx ia IIC or EEx ia IIB
Connection for type TF 02-Ex via terminals or solder terminals (+) and (-)
Connection for type TF 202-Ex and TF 202-Ex M via terminals (+) and (-)
Connection for type TF 102-Ex via terminals 31 and 32 (Circuit 1) and
Terminals 41 and 42 (Circuit 2)

For connection to intrinsically safe circuits with the following maximum values in accordance with the FISCO/ENTITY-concept:

			IIC
Maximum input voltage	U_i	DC	24 V
Maximum input current	I_i		360 mA
Maximum input power	P_i		2,52 W

			IIB
Maximum Input voltage	U_i	DC	24 V
Maximum Input current	I_i		380 mA
Maximum Input power	P_i		5,32 W
Maximum internal capacitance	C_i		5 nF
Maximum internal inductance	L_i		10 µH

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DMT

15.3.2 Measurement circuit in the type of protection EEx ia IIC or EEx ia IIB
Connection for type TF 02-Ex via terminals or solder terminals 1, 2, 3 and 4
Connection for type TF 202-Ex and TF 202-Ex M via terminals 1, 2, 3 and 4
Connection for type TF 102-Ex via terminals 11, 12, 13 and 14 (circuit 1) and terminals 21, 22, 23 and 24 (circuit 2)

Maximum output voltage	U_o	DC	5,5	V
Maximum output current	I_o		25	mA
Maximum output power	P_o		35	mW
Characteristic: linear				
Maximum internal capacitance	C_i		60	nF
Maximum internal inductance	L_i		negligible	

For the connection of passive sensors, refer to the following table for the maximum permitted values for C_o and L_o:

	IIC	IIB
L_o in mH	C_o in µF	C_o in µF
2	2.6	15
1	2.9	17
0.5	3.6	21
0.2	4.5	27

For the connection of active sensors with the maximum values $U_o \leq 1{,}2$ V, $I_o \leq 50$ mA, $P_o \leq 60$ mW, C_i and L_i negligible small, refer to the following table for the maximum permitted values for C_o and L_o:

	IIC	IIB
L_o in mH	C_o in µF	C_o in µF
2	1.6	9.8
1	1.9	12
0.	2.3	14
0.2	3.0	19

15.3.3 Display/Service interface in the type of protection EEx ia IIC or EEx ia IIB, only for type TF 02-Ex, TF 202-Ex and type TF 202-Ex M; connection via 6-pin edge connector

Maximum Output voltage	U_o	DC	8,7	V
Maximum Output current	I_o		55	mA
Maximum Output power	P_o		74	mW
Characteristic: linear				

Refer to the following table for the maximum permitted values for Co and Lo:

	IIC	IIB
L_o in mH	C_o in µF	C_o in µF
2	0.8	2
1	0.8	3
0.5	0.8	3
0.2	1	4

DMT

15.3.4 Ambient temperatures or temperatures at the installation site

Equipment Group II, for use in zones of category 1 (Zone 0)	
Temperature class T1 ... T5	- 20 °C to + 60 °C
Temperature class T6	- 20 °C to + 50 °C
Equipment Group II, for use in zones of category 2 (Zone 1)	
Temperature class T1 ... T4	- 40 °C to + 85 °C
Temperature class T5	- 40 °C to + 65 °C
Temperature class T6	- 40 °C to + 50 °C
Equipment Group I, for use in zones of categories M1 and M2	- 20 °C to + 60 °C

(16) Test and assessment report
BVS PP 02.2040 EG as of 25.04.02

(17) Special conditions for safe use

17.1 The Temperature-Transmitter Type TF 02-Ex and TF 102-Ex have to be installed in a housing which guarantee a minimum type of protection IP20 in accordance with EN 60529.

17.2 When using the Temperature-Transmitter Type TF 02-Ex, TF 102-Ex and TF 202-Ex M in underground mines which are endangered by mine gas and/or inflammable dust (Equipment Group I, Categories M1 and M2), interconnections with other intrinsically safe circuits have to be separated tested and certificated.
In addition, the incorporation of the Temperature-Transmitter Types TF 02-Ex and TF 102-Ex into suitable housings (IP54) have to be separated tested and certificated.

17.3 The Temperature-Transmitters are suitable for the following ambient temperatures or installation site temperatures:

Equipment Group II, for use in zones of category 1 (Zone 0)	
Temperature class T1 ... T5	- 20 °C to + 60 °C
Temperature class T6	- 20 °C to + 50 °C
Equipment Group II, for use in zones of category 2 (Zone 1)	
Temperature class T1 ... T4	- 40 °C to + 85 °C
Temperature class T5	- 40 °C to + 65 °C
Temperature class T6	- 40 °C to + 50 °C
Equipment Group I, for use in zones of categories M1 and M2	- 20 °C to + 60 °C

We confirm the correctness of the translation from the German original.
In the case of arbitration only the German wording shall be valid and binding.

45307 Essen, 04.09.2002
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