

SIEMENS

SITRANS

Temperature transmitter SITRANS TR200/TR300

Operating Instructions

7NG3032-*JN00 SITRANS TR200 7NG3033-*JN00
SITRANS TR300

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Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

DANGER

indicates that death or severe personal injury **will** result if proper precautions are not taken.

WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

CAUTION

with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

CAUTION

without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

NOTICE

indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation for the specific task, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

WARNING

Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be adhered to. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of the Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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Introduction

1.1 Purpose of this documentation

These instructions contain all information that you will require to commission and use the device. Read these instructions carefully prior to installation and commissioning. In order to use the device correctly, first make yourself acquainted with its principle of operation.

The instructions are aimed both at persons mechanically installing the device, connecting it electronically, configuring the parameters and commissioning it as well as service and maintenance engineers.

1.2 History

This history establishes the connection between the current documentation and the valid firmware of the device.

The documentation of this edition applies to the following firmware:

Edition	Firmware identification nameplate	System integration	Installation path for PDM
01 04/2007	FW: 01.01.05 HW: 01.00	TR200: SIPROM T V1.2.0 TR300: PDM V6.0 DD Rev. 1.00	TR200: Not applicable TR300: SITRANS TR300
02 09/2008	FW: 01.01.05 HW: 01.02	TR200: SIPROM T V1.2.1 TR300: PDM V6.0 DD Rev. 01.01	TR200: Not applicable TR300: SITRANS TR300
03 06/2010	FW: 01.01.05 HW: 01.02	TR200: SIPROM T V1.2.1 TR300: PDM V6.0 DD Rev. 01.01	TR200: Not applicable TR300: SITRANS TR300

The following table shows the most important changes in the documentation compared to each previous edition:

Edition	Remark
01 04/2007	First edition
02 09/2008	Revision of content and layout
03 06/2010	Nameplate has been revised, functional safety as new inclusion

1.3 Notes on warranty

The contents of this programming manual shall not become part of or modify any prior or existing agreement, commitment or legal relationship. All obligations on the part of Siemens AG are contained in the respective sales contract, which also contains the complete and solely applicable warranty conditions. Any statements on the device versions described in the programming manual do not create new warranties or modify the existing warranty.

The content reflects the technical status at the time of printing. We reserve the right to make technical changes in the course of further development.

See also

Contacts (<http://www.siemens.com/processinstrumentation/contacts>)

Product information on SITRANS T in the Internet (<http://www.siemens.com/sitranst>)

Instructions and Manuals (<http://www.siemens.com/processinstrumentation/documentation>)

1.4 Environmental protection

Recycling

Devices described in this programming manual can be recycled owing to the low content of noxious substances in their version.

Please contact a certified waste disposal company for eco-friendly recycling and to dispose of your old devices.

General safety notes

2.1 General information

This device left the factory free from safety problems. In order to maintain this status and to ensure safe operation of the device, please observe the safety information and warnings contained in these instructions.

Safety information and symbols must be observed without exception. They must not be removed and must be maintained in legible condition at all times.

2.2 Correct usage

The device may only be used for the purposes specified in these instructions.

Insofar as they are not expressly stated in these instructions, all changes to the device are the sole responsibility of the user.

2.3 Qualified Personnel

Qualified personnel are people who are familiar with the installation, mounting, commissioning, and operation of the product. These people have the following qualifications:

- They are authorized, trained or instructed in operating and maintaining devices and systems according to the safety regulations for electrical circuits, high pressures and aggressive as well as hazardous media.
- For explosion-proof devices: They are authorized, trained, or instructed in carrying out work on electrical circuits for hazardous systems.
- They are trained or instructed in maintenance and use of appropriate safety equipment according to the safety regulations.

2.4 Laws and directives

Observe the test certification, provisions and laws applicable in your country during connection, assembly and operation. These include, for example:

- National Electrical Code (NEC - NFPA 70) (USA)
- Canadian Electrical Code (CEC) (Canada)
- The working reliability regulation (Germany)

Further provisions for hazardous areas, these are for example:

- IEC 60079-14 (international)
- EN 60079-14 (formerly VDE 0165, T1) (EU, Germany)

See also

Certificates (<http://www.siemens.com/processinstrumentation/certificates>)

2.5 Measures

In the interests of safety, the following precautions must be observed:

WARNING

"Intrinsic safety" type of protection

Connect the device only to certified, intrinsically safe circuits. These circuits must comply with the technical data specified on the nameplate or in the certificates and approvals. Should these circuits not match the details given in the certificates and approvals, then the safety required for the approval can no longer be guaranteed.

"Device connection through intrinsic safety" type of protection ic (Zone 2)

Devices of the protection type "limited energy" can be connected and disconnected during operation.

"Non-sparking" type of protection nA (Zone 2)

Devices of the protection type "non-sparking" may only be connected and disconnected when in a powered-down state.

WARNING

Electrostatic-sensitive devices in potentially explosive environment

It is essential to avoid electrostatic charges. These could develop e.g. when cleaning the plastic enclosure with a dry cloth.

CAUTION

Modules susceptible to electrical discharge

The device contains modules susceptible to electrical discharge. Modules susceptible to electrical discharge can be destroyed by voltages that fall far below the limits of human perception. These voltages even occur if you touch a component part or electrical connections of a module without being electrostatically discharged. The damage to a module caused by overvoltage cannot normally be detected immediately, it only becomes apparent after a longer period of operating time has elapsed.

Description

3.1 Application range

The SITRANS TR200 and SITRANS TR300 temperature transmitters are 2-wire devices for DIN rail installation. They are suitable for use in all sectors, thanks to their universal sensor input and type of installation. The following sensor and signal sources can be connected to their input stage:

- Resistance thermometer
- Thermocouples
- Resistance-type transmitter/potentiometer
- DC voltage sources

The output signal is an output current of 4 to 20mA that corresponds to the sensor characteristic curve.

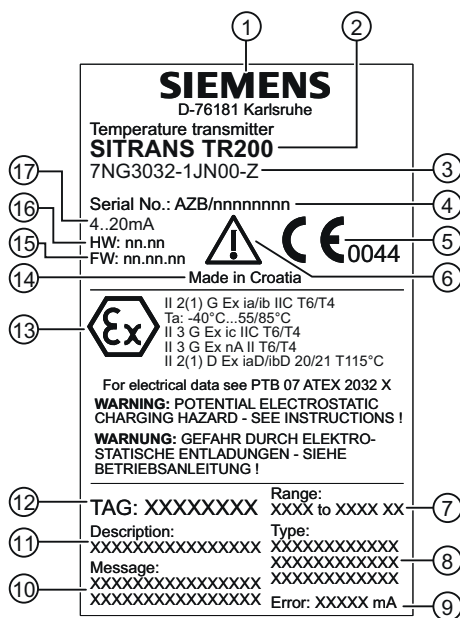
Explosion-proof transmitters can be installed and operated within hazardous area in accordance with the information on the EC type examination certificate to ATEX and these operating instructions.

3.2 Product features

- Transmitter with two-wire technology
- Installation on a DIN rail to DIN EN 60715
- The transmitters are freely programmable, for example their sensor activation and measuring range.
 - SITRANS TR200 with a special modem in connection with the SIPROM T software
 - SITRANS TR300 via the HART protocol
- Electrical isolation
- Intrinsically safe device version for operation in potentially explosive atmospheres
- Two additional test pins for connecting a multimeter make it possible to measure the current signal without interrupting the current loop.
- Status message: LED green, red flashing or red
- Special characteristic curve
- Diagnostic functions of the SITRANS TR300: Min/max pointer, runtime meter, simulation

3.3 Structure of the nameplate

The nameplate is located on the housing and shows the order number and other important product information.



- | | |
|---------------------------|---------------------------------------|
| ① Manufacturer | ② Product name |
| ③ Order number | ④ Serial number |
| ⑤ CE mark | ⑥ Consult the operating instructions. |
| ⑦ Measuring range | ⑧ Sensor type |
| ⑨ Error signal | ⑩ Message |
| ⑪ Description | ⑫ Marking (TAG) |
| ⑬ Ex marking with EX data | ⑭ Place of manufacture |
| ⑮ Firmware revision | ⑯ Hardware revision |
| ⑰ Communications | |

Figure 3-1 Layout of a nameplate using SITRANS TR200 as an example

3.4 Operating principle

The mode of operation of the transmitter is explained below, using the function block diagram.

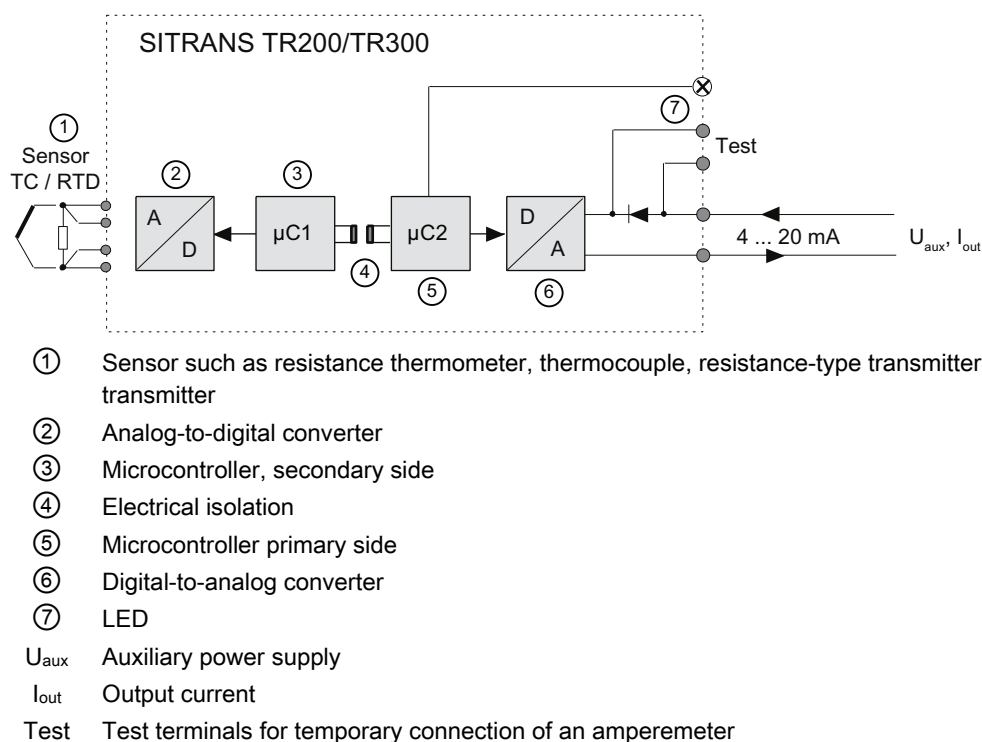


Figure 3-2 SITRANS TR200/TR300 function block diagram

Mode of operation of transmitters

- The sensor ① supplies an electrical signal.
- This signal is converted to a digital signal in an analog-to-digital converter ②.
- The digital signal is evaluated in a secondary-side microcontroller ③ and corrected to match the sensor characteristic curve.
- The signal is transferred across the electrical isolation ④ to the primary-side microcontroller ⑤.
- The analog output value is computed in the primary-side microcontroller ⑤. The functional status is indicated by LED ⑦ and the communications data prepared.
- Then the digital-to-analog converter ⑥ converts the signal into the output current of 4 to 20 mA.
- The auxiliary power supply source is located in the output signal circuit.

3.5 Communication

3.5.1 Overview

SITRANS TR200

This device version does not have an interface to HART. The parameters of the SITRANS TR200 can only be set in the "Offline" state using the modem for SITRANS TH100/TH200/TR200.

SITRANS TR300

The device has a parameter assignment interface according to the HART specification. This parameterization interface permits access to all the functions of the device via a HART modem or a HART communicator. Connect the HART modem or a HART communicator as shown in the diagram "HART communication with supply from a voltage source".

WARNING
Operate intrinsically safe HART modems or HART communicators on intrinsically safe circuits only. Note the intrinsically safe parameters.

See also

HART communication with supply from a voltage source (Page 17)

3.5.2 HART communication with supply from a voltage source

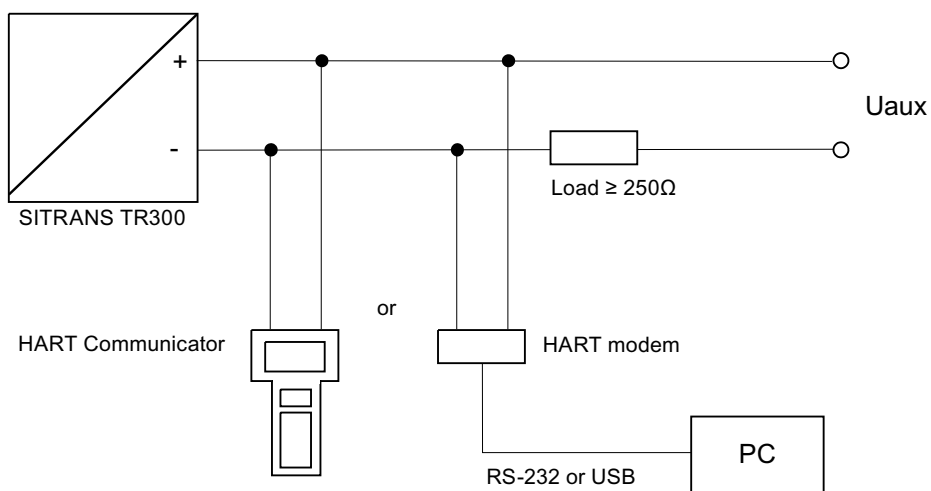
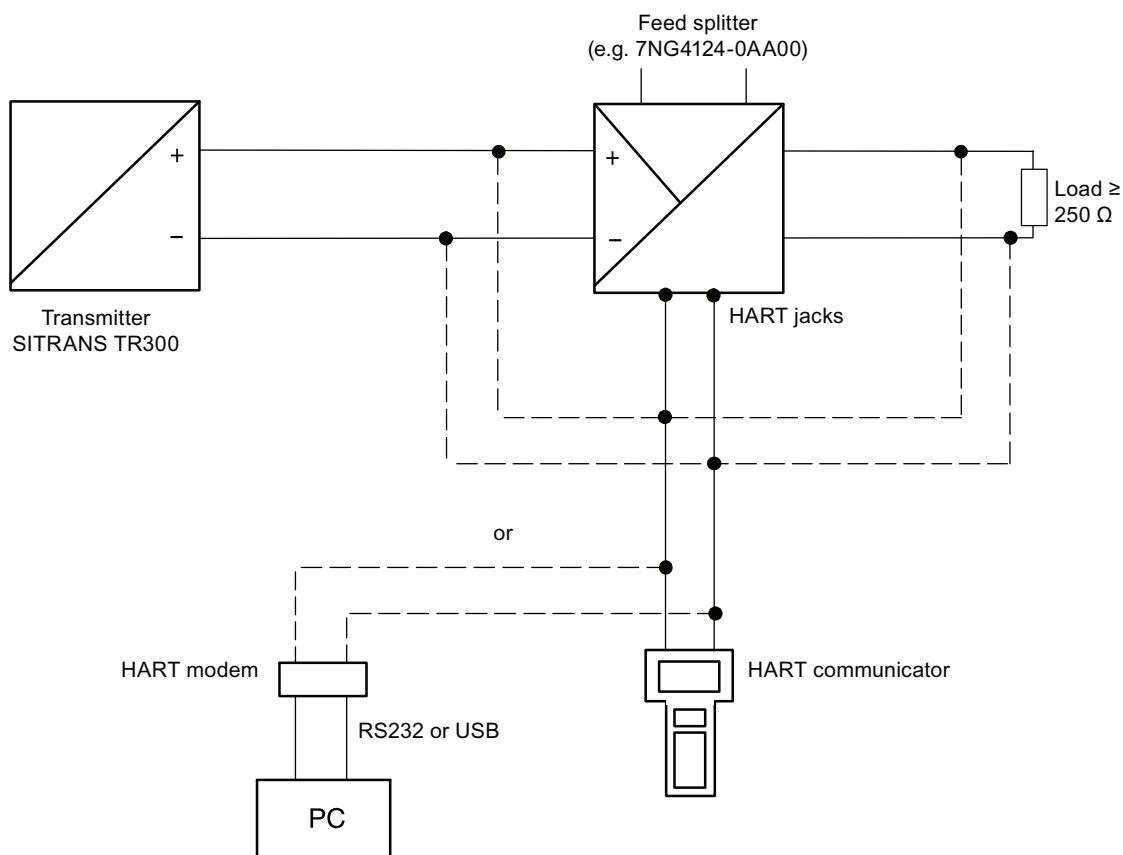


Figure 3-3 HART communication with supply from a voltage source

3.5.3 HART communication with supply from a feed splitter



- ① Only intrinsically safe HART communicators or HART modems are allowed to be used with an intrinsically safe supply.
- ② HART communication via the HART jacks of the feed splitter
- ③ Load $\geq 250 \Omega$ is relevant only if HART communication is performed via this branch. Otherwise for variant ① or ② load 0 to 650Ω

Figure 3-4 HART communication with supply from a feed splitter

The transmitter is secured to a 35 mm DIN rail to DIN EN 60715.
Comply with the ambient conditions specified in the technical data.

WARNING

Hazardous areas

- Gas hazardous area:
 - The enclosure has IP20 degree of protection. With an intrinsically-safe power supply, you can therefore assemble the intrinsically-safe device versions without an additional enclosure.
 - For ic and nA modes, use a suitable protective enclosure / terminal box which satisfies at least IP54 degree of protection.
- Dust hazardous zone:
For use in a dust hazardous zone, install in a suitable metal protective enclosure / terminal box which satisfies at least IP6X degree of protection.

CAUTION

Electromagnetic Compatibility

If the sensor is installed outside a closed building, you must check the transmitter for correct functioning following a lightning stroke.

Connecting

5.1 Safety notes on connection

5.1.1 General safety notes on the connection

Note**To improve the resistance:**

- Lay signal cables separately from cables with voltages > 60 V.
 - Use cables with twisted wires.
 - Avoid getting too close to large electrical systems and/or use shielded cables.
 - Use shielded cables to ensure the full specification according to HART, revision 5.9 in SITRANS TR300.
 - Use only cable entries and covers that are approved for the relevant use.
 - At an ambient temperature $T \geq 60\text{ °C}$, use heat-resistant cables approved for an ambient temperature of at least 20 K higher.
 - Use cables with wires that have a maximum cross-sectional area of 2.5 mm^2 .
-

5.1.2 Safety notes when connecting in hazardous areas

WARNING

Observe the degree of protection

The device must be connected to the supply and signal circuits named in the certificate or on the nameplate.

When installing the device in hazardous areas:

Use enclosures/connection heads with the degree of protection corresponding to the test certificate applicable in your country.

WARNING

Electrical connection in hazardous areas

The national directives and laws for hazardous areas valid in your country must be observed for electrical connection. In Germany these are, for example:

- The health and safety at work regulations
- The directive for "Installation of electrical systems in hazardous areas", DIN EN 60079-14 (previously VDE 0165,T1)
- The EC type examination certificate

When a auxiliary power supply is needed, check whether the auxiliary power supply matches that given on the nameplate and with the inspection certificate valid in your country.

CAUTION

Limited range of use

If the device has been operated outside the ambient conditions specified for potentially explosive atmospheres, you may no longer operate the device in potentially explosive atmospheres. Make sure to permanently mask all Ex markings on the nameplate.

NOTICE

Loss of type of protection "Intrinsic safety"

If the transmitter is not operated with an intrinsically-safe power supply, the type of protection "Intrinsic safety" is no longer guaranteed and the intrinsically-safe approval may be revoked.

Permanently erase, therefore, the irrelevant types of protection on the nameplate before commissioning to ensure that erroneous deployment is avoided.

4 to 20 mA input and sensor circuits are galvanically isolated and tested with a test voltage of 2.12 kVDC/1 minute.

The sensor circuit is reliably galvanically isolated from the auxiliary power supply and signal circuit, up to a peak value of the rated voltage of 60 V. Be sure to observe the construction directives valid at the construction location for electrical resources in hazardous areas. In Europe, this is the standard EN 60079-14.

Zone 1 in type of protection "i" - intrinsic safety

- Only connect the transmitter, in accordance with the certificate of compliance, to devices certified as intrinsically-safe.

Maximum values of the auxiliary power supply and signal circuits:		
$U_i = \text{DC } 30 \text{ V}$	$I_i = 100 \text{ mA}$	$P_i = 750 \text{ mW}$
$L_i = 2 \text{ }\mu\text{H}$	$C_i = 13 \text{ nF}$	

Maximum values of the sensor circuit:				
$U_0 = \text{DC } 6 \text{ V}:$	$I_0 = 25 \text{ mA}$		$P_0 = 37 \text{ mW}$	
$L_0 [\text{mH}]$	50	10	1	0,1
$C_0 [\mu\text{F}]$	1	1,6	2,6	4,8

Zone 2 in type of protection "ic" - device connection through intrinsic safety

- Install the transmitter in a housing to degree of protection IP54 according to EN 60529.
- Connect the transmitter only to devices that have been approved as "ic" certified devices (device protection through intrinsic safety) in category 3.
- Be sure to observe the respective values.

Maximum values of the auxiliary power supply and signal circuits:		
$U_i = \text{DC } 30 \text{ V}$	$I_i = 100 \text{ mA}$	$P_i = 750 \text{ mW}$
$L_i = 2 \text{ }\mu\text{H}$	$C_i = 13 \text{ nF}$	

Zone 2 in type of protection "nA" - non-sparking resources

- Install the transmitter in a housing to degree of protection IP54 according to EN 60529.
- Adhere to the conditions for installers applicable to this type of protection.
- The maximum approved input voltage is $U_n = 32 \text{ V DC}$.
- Take measures to ensure that the supply voltage (including transients) does not rise above 140 % of the rated voltage.

Additional requirements for use in dust explosion protected areas

Install the transmitter in an enclosure suitable for the respective type of dust and corresponding Zone in accordance with the inspection certificate valid in your country.

5.2 Connecting the auxiliary power supply

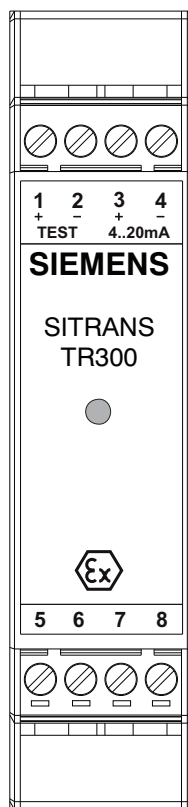
Procedure

Connect the wires for the auxiliary power supply to terminals "3"(+) and "4"(-). Ensure that the polarity is correct. The device is reverse polarity protected.

See also

Connector pin assignment (Page 24)

5.3 Connector pin assignment



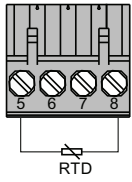
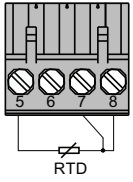
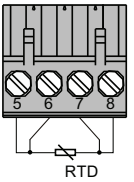
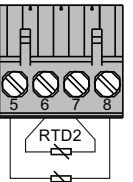
Ports

- | | |
|-----------------|---|
| 1 (+) and 2 (-) | Test terminals (test) for measuring the output current using an amperemeter |
| 3 (+) and 4 (-) | Auxiliary power supply U_{aux} , output current I_{out} |
| 5, 6, 7 and 8 | Connection of sensors, see terminal diagrams SITRANS TR200/TR300 (Page 25) |

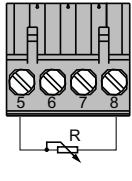
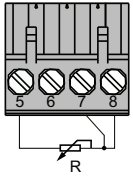
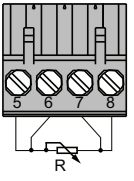
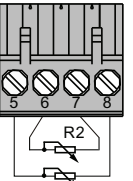
Figure 5-1 Connector pin assignment SITRANS TR200/TR300

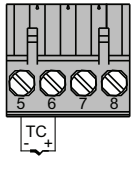
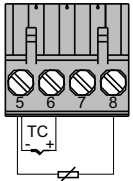
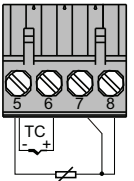
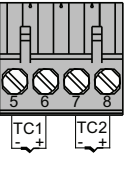
5.4 Connection diagrams

5.4.1 Sensor/input

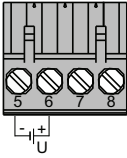
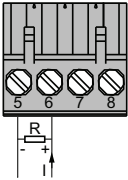
Resistance thermometer			
			
Two-wire input ¹⁾	Three-wire input	Four-wire input	Calculation of mean value/ differential value ¹⁾

¹⁾ Line resistance to the correction can be programmed

Resistance-type sensor			
			
Two-wire input ¹⁾	Three-wire input	Four-wire input	Calculation of mean value/ differential value ¹⁾
¹⁾ Line resistance for correction is programmable.			

Thermocouple			
			
Cold junction compensation/fix value	Cold junction compensation with external Pt100 in two- wire input ¹⁾	Cold junction compensation with external Pt100 in three- wire input	Calculation of mean value/ differential value with internal cold junction compensation

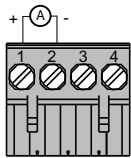
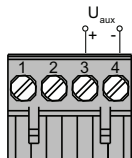
¹⁾ Line resistance for correction is programmable.

Voltage measurement	Current measurement
	

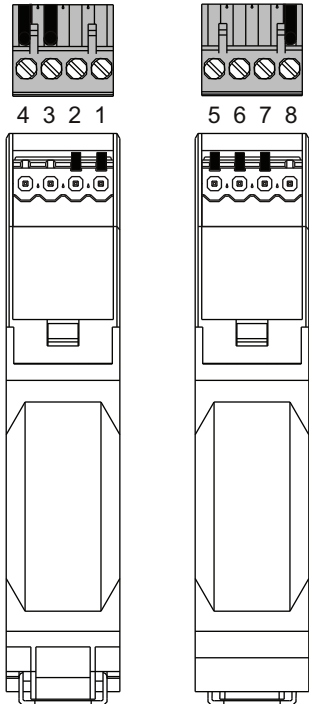
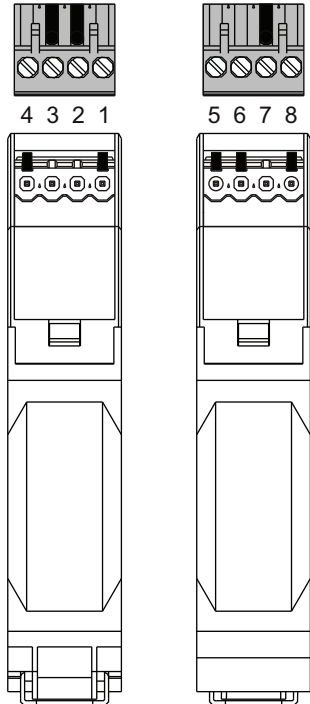
See also

Connector pin assignment (Page 24)

5.4.2 Auxiliary power supply/current loop 4 to 20 mA and test terminals

Test terminals (Test)	Auxiliary power supply connection/4 to 20 mA (U_{aux})
	

5.4.3 Coding profiles

Coding profile for SITRANS TR200/TR300 with protection against explosions (intrinsically safe)	Coding profile for SITRANS TR200/TR300 without protection against explosions
	
MLFB: 7NG303*-1JN00	MLFB: 7NG303*-0JN00

5.5 Notes on measuring current

If you use the transmitter for measuring current, connect an external measuring resistor R across the transmitter connection terminals 5 and 6. The transmitter uses this resistor to perform the required current measurement as a voltage measurement. Therefore, the following instructions must be complied with in the parameter assignment software SIPROM T for SITRANS TR200 and SIMATIC PDM or HART communicator for SITRANS TR300:

- Sensor class selection = Millivolt transmitter
- Process value scale: Multiply each of the start of scale value and end of scale value for desired current range with the value of the resistor R that is connected externally across terminals 5 and 6 of the transmitter.
- **Example:** Measurement of a 0 to 20 mA current via an external resistor R of 10 Ohm
sensor class = millivolt transmitter
process value scale:
 - *Start of scale value* = $0 \text{ mA} \cdot 10 \Omega = 0 \text{ mV}$
 - *Full scale value* = $20 \text{ mA} \cdot 10 \Omega = 200 \text{ mV}$

The 4 to 20 mA output current now follows the profile of the sensor input, i.e. the 0 to 20 mA current signal.

If during current measurement the measured values are called up via the digital interface, such as HART for SITRANS TR300, the measurement data are shown in the operating software as voltage signals mV units. The voltage signals are scaled by the factor of the externally connected resistance value R.

5.6 Test terminals for output signal

The "Test +" and "Test -" test terminals are used for checking the 4 to 20mA current with an amperemeter. The voltage drop across the amperemeter must not exceed 0.4V for a 23mA output current.

Operation

6.1 Operating and parameterizing the SITRANS TR200/TR300

Operation and parameterization

The SITRANS TR200 and SITRANS TR300 are operated and configured using a PC. The PC is connected to the two-wire line using a suitable coupling module. The SITRANS TR300 can also be parameterized using a HART communicator. The signals needed for SITRANS TR300 communications in accordance with the HART protocol are superimposed on the output current in accordance with frequency shift keying. Frequency shift keying is also abbreviated to FSK.

Measurement transmitter and parameter assignment data are stored in non-volatile memory.

Note

After parameter assignment of the SITRANS TR200/TR300, switch off the power supply to the transmitter only after the LED on the device flashes red or lights up green and remains lit.

6.2 Operating the with SITRANS TR200 PC/laptop and modem

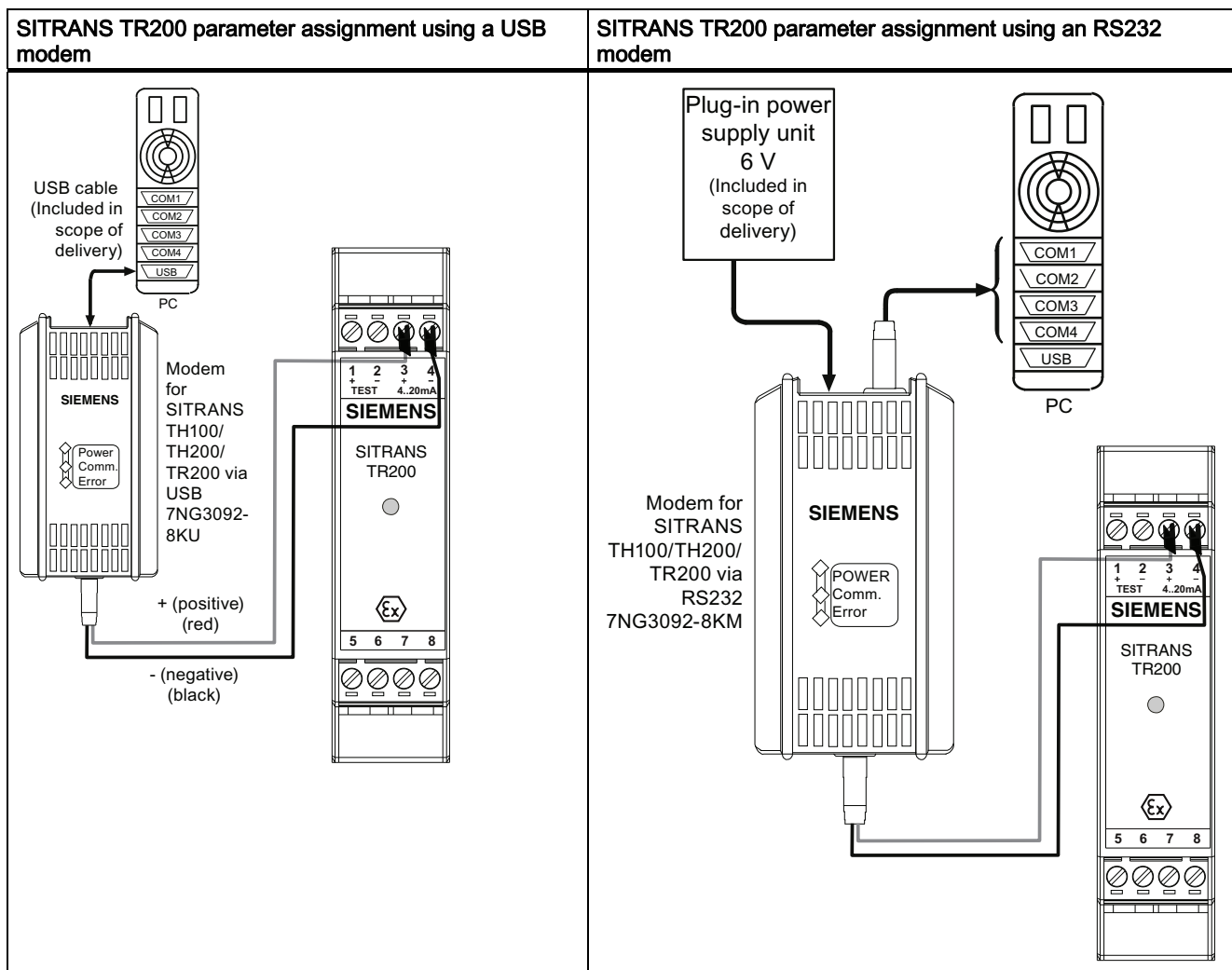
NOTICE
Parameters may only be assigned to the SITRANS TR200 in the "offline" state using the parameter assignment modem and the SIPROM T operating software. Any 4 to 20mA current loop connected to the transmitter needs to be disconnected before parameters are assigned.

Proceed as follows

- For parameter assignment, connect the transmitter to the PC via the modem.
- Use the SIPROM T parameterization software to configure the transmitter.

The power required by the transmitter is provided via:

- the USB interface of the PC if using a USB modem
- an external plug-in power supply if using an RS232 modem



Note

After parameter assignment of the SITRANS TR200, switch off the power supply to the transmitter only after the LED on the device flashes red or lights up green and remains lit.

For detailed information on parameter assignment of the transmitter, refer to the operating instructions for the following products:

- Modem for SITRANS TH100/TH200/TR200 and the SIPROM T parameterization software; order numbers: 7NG3092-8KM and 7NG3092-8KU
- "sitrans t - temperature transmitters" CD, order number A5E00364512

6.3 SITRANS TR300 operation

6.3.1 Operation using a HART modem and SIMATIC PDM

The transmitter can be operated and parameterized with the PC, using the SIMATIC PDM parameter assignment software and a HART modem.

Commissioning procedure

- For this, connect the HART modem to the output circuit.
- The transmitter power supply must be operational.
- The load in the circuit must be at least 250 Ω , refer to the circuit diagram in chapter HART communication with supply from a voltage source (Page 17)
- Operation is via the SIMATIC PDM parameterization software.

6.3.2 Operation with HART communicator

Action buttons



This button switches the HART communicator on and off. After switch-on, the hand-held terminal automatically establishes communication with the transmitter. The online menu appears on the display.



This button moves the cursor up through the menu bar. The selected menu line is indicated.



This button moves the cursor down through the menu bar. The selected menu line is indicated.



This button moves the cursor to the right through the menu bar or branches into a subroutine. The name of the selected subroutine is displayed at the top edge of the display.



This button moves the cursor to the left through the menu bar or exits a subroutine.

Function keys

Function keys F1 to F4 are located below the digital display. The various functions of the keys in the individual menus are displayed on the bottom edge of the display.

Alphanumeric button and shift buttons

Alphanumeric values can be entered using these buttons. The function (number or letter button) depends on the menu in question. Letters are selected by confirming the corresponding shift button first.

Refer to the operating instructions of the HART communicator for further information about operation and technical data.

Functional safety

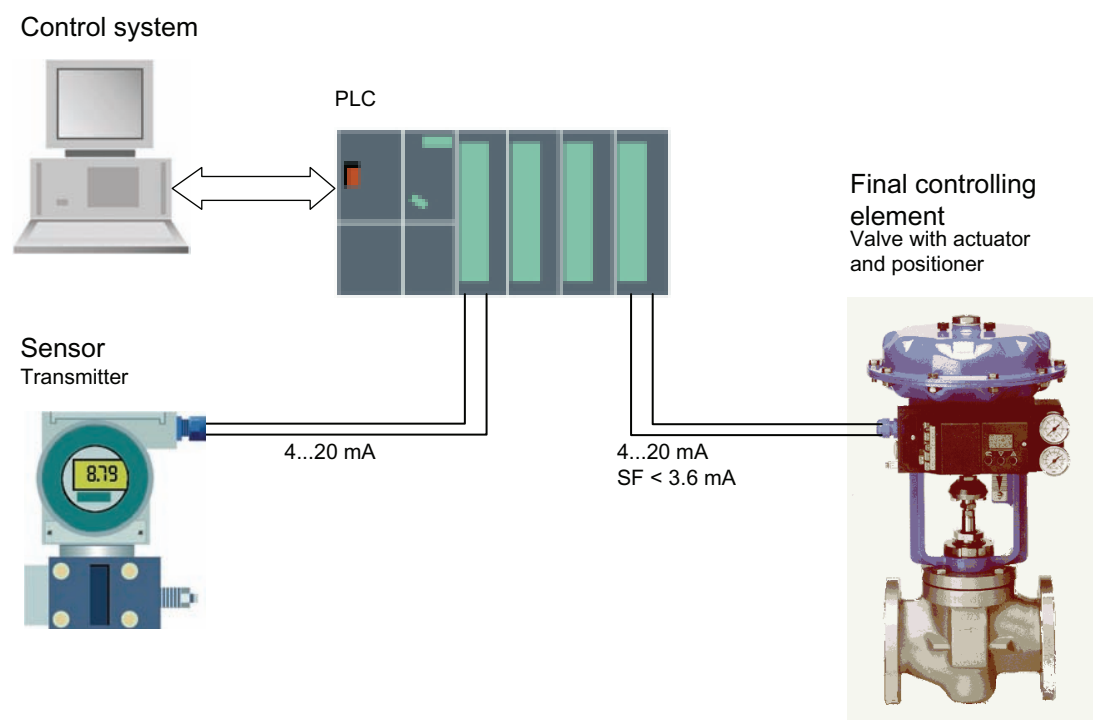
7.1 General safety information

7.1.1 Safety-instrumented system

This chapter describes the functional safety in general and not specific to a device. The devices in the examples are selected as representative examples. The device-specific information follows in the next chapter.

Description

The sensor, logic unit/control system and final controlling element combine to form a safety-instrumented system, which executes a safety function.



S_F Failure signal

Figure 7-1 Example of a safety-instrumented system

Functioning of the system as shown in the example

The transmitter generates a process-specific analog signal. The downstream control system monitors this signal to ensure that it does not fall below or exceed a set limit value. In case of a fault, the control system generates a failure signal of $< 3.6 \text{ mA}$ or $> 22 \text{ mA}$ for the connected positioner, which switches the associated valve to the specified safety position.

7.1.2 Safety Integrity Level (SIL)

The international standard IEC 61508 defines four discrete Safety Integrity Levels (SIL) from SIL 1 to SIL 4. Each level corresponds to the probability range for the failure of a safety function.

Description

The following table shows the dependency of the SIL on the "average probability of dangerous failures of a safety function of the entire safety-instrumented system" (PFD_{AVG}). The table deals with "Low demand mode", i.e. the safety function is required a maximum of once per year on average.

Table 7- 1 Safety Integrity Level

SIL	Interval
4	$10^{-5} \leq PFD_{AVG} < 10^{-4}$
3	$10^{-4} \leq PFD_{AVG} < 10^{-3}$
2	$10^{-3} \leq PFD_{AVG} < 10^{-2}$
1	$10^{-2} \leq PFD_{AVG} < 10^{-1}$

The "average probability of dangerous failures of the entire safety-instrumented system" (PFD_{AVG}) is normally split between the three sub-systems in the following figure.

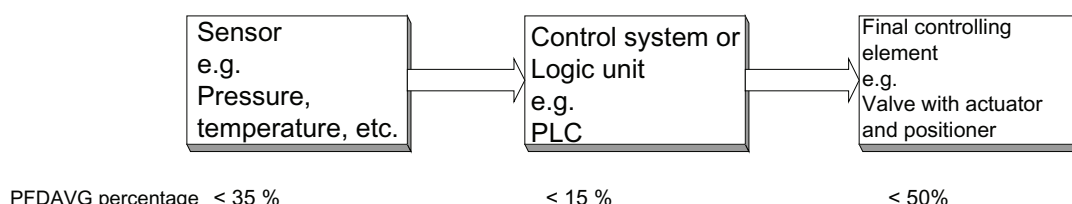


Figure 7-2 Example of PFD distribution

The following table shows the achievable Safety Integrity Level (SIL) for the entire safety-instrumented system for type B subsystems depending on the safe failure fraction (SFF) and the hardware fault tolerance (HFT). Type B subsystems include analog transmitters and shut-off valves without complex components, e.g. microprocessors (also see IEC 61508, Section 2).

SFF	HFT		
	0	1 (0) ¹⁾	2 (1) ¹⁾
< 60 %	Not permitted	SIL 1	SIL 2
60 to 90 %	SIL 1	SIL 2	SIL 3
90 to 99 %	SIL 2	SIL 3	SIL 4
> 99 %	SIL 3	SIL 4	SIL 4

¹⁾ As per IEC 61511-1, Section 11.4.4

According to IEC 61511-1, Section 11.4.4, the hardware fault tolerance (HFT) can be reduced by one (values in brackets) for sensors and final controlling elements with complex components if the following conditions are applicable for the device:

- The device is proven-in-use.
- The user can configure only the process-related parameters, e.g. control range, signal direction in case of a fault, limiting values, etc.
- The configuration level of the firmware is blocked against unauthorized operation.
- The function requires SIL of less than 4.

The device fulfills these conditions.

7.2 Device-specific safety instructions

7.2.1 Safety function

Measuring temperature is the safety function with the temperature transmitters.

It is applicable for output currents from 4 to 20 mA and ensures an accuracy of $\pm 2\%$ in the maximum measurement range.

The output value will be updated at least every 620 ms (filter time constant of the electrical damping = 0 s).

The partial system is of type B. The calculations are valid for the operating mode with low demand rate in single-channel operation. The specific values are listed in the manufacturer declaration for the product (Declaration of Conformity, Functional Safety according to IEC 61508 and IEC 61511): Certificates (Page 83) .

7.2.2 Requirements

Requirements

The temperature transmitter meets the following requirements:

- Functional safety to SIL 2 under IEC 61508 or IEC 61511-1, from firmware version FW: as of 1/1/2005 (with order option C20 only)
- Explosion protection for corresponding versions
- Electromagnetic compatibility in compliance with EN 61326
- EC Declaration of Conformity

7.2.3 Settings

CAUTION
Current sensor function / Simulation
The use of the current sensor function and the simulation in safety applications can result in undesirable operating states.
The use of both functions is not permitted in safety applications.

Operation/configuration

While operating/configuring, ensure that the technical data of the temperature transmitter are adhered to in their respective version.

Checking the safety function

We recommend that:

- You check the status for warnings and alarms.
- Check the upper and lower alarm current value.
- Perform a 2-point calibration.
- You check the measuring accuracy that must be in the range of $\pm 2\%$ for the safety function. You check the measuring accuracy, for example, with a sensor calibration.

Note

Configuration changes in SITRANS TR300 not protected by passwords

If there is no password protection, you may have to deal with undesirable changes in the configuration of the device.

We recommend that you enable password protection for your device after checking the safety function.

7.2.4 Behavior in case of faults

Repairs

Defective devices should be sent in to the repair department with details of the fault and the cause. When ordering replacement devices, please specify the serial number of the original device. The serial number can be found on the rating plate.

The address of the responsible SIEMENS repair center, contacts, spare parts lists, etc. can be found on the Internet.

7.2.5 Maintenance/Checking

Interval

We recommend that the functioning of the temperature transmitter is checked at regular intervals of one year.

Checking the safety function

We recommend that:

- You check the status for warnings and alarms.
- Check the upper and lower alarm current value.
- Perform a 2-point calibration.
- You check the measuring accuracy that must be in the range of $\pm 2\%$ for the safety function. You check the measuring accuracy, for example, with a sensor calibration.

Checking safety

You should regularly check the safety function of the entire safety circuit in line with IEC 61508/61511. The testing intervals are determined during the calculation for each individual safety circuit in a system (PFD_{AVG}).

7.2.6 Safety characteristics

The safety characteristics necessary for using the system are listed in the "SIL declaration of conformity". These values apply under the following conditions:

- The SITRANS TR200 / TH300 temperature transmitters are only used in applications with a low demand rate for the safety function (low demand mode).
- The communication is used for the following purposes only:
 - Device configuration
 - Reading diagnostic values
- The devices are operated differently:
 - SITRANS TR200: Operation via SIPROM T
 - SITRANS TR300: Operation via SIMATIC PDM or handheld communicator
- The safety function test has been concluded successfully.
- The transmitter is blocked against unwanted and unauthorized changes/operation.
- The following condition applies to the transmitter:
 - The current signal is evaluated by a safe system.
- The specified error rates apply to the typical demand of an industrial environment as in IEC 60654-1 class C. IEC 60654-1 class C means a protected place of application, with an average temperature of max. 40 °C for an extended period of time.
- The calculation of error rates is based on a MTTR of 72 hours.

The maximum application time of the SITRANS TR200 or TR300 in a safety application is 20 years. Replace the device after this time.

Commissioning

8

8.1 Commissioning

 WARNING
Missing type of protection If the transmitter is not operated with an intrinsically-safe power supply, the type of protection "Intrinsic safety" is no longer guaranteed and the intrinsically-safe approval may be revoked. Permanently erase, therefore, the irrelevant types of protection on the nameplate before commissioning to ensure that erroneous deployment is avoided.

Procedure

1. Program the transmitter's operating data according to the actual requirements.
If applicable, enter the changed operating data on the additional plate on the enclosure.
2. Assemble the transmitter.
3. Connect the sensor to the power supply, see Chapter Connecting (Page 21).
4. Turn on the auxiliary power supply.
5. Wait about 10 seconds. After this start-up time the transmitter is operational.

Note

Warming-up

To obtain exact measured values, the transmitter needs to be allowed to warm up for five minutes or so after the power supply has been switched on.

8.2 LED operating indicator

- Operating indicator does not light: No supply voltage
- Constant green light: Everything OK, normal error-free operating state
- Constant/flashing red light: Disrupted operation
 - Flashing (ca. 2 Hz) red light: Indication of faults independent of the device, e.g. wire break, sensor short circuit, violation of sensor limits
 - Constant red light: Indication of errors in the device, e.g. **RAM-, ROM-, EEPROM-, CHECKSUM-, WATCHDOG-, STACK error** or violation of the permitted ambient temperature limits and if the minimum supply voltage for the device is not reached.

Functions

9.1 General information

You can operate the SITRANS TR300 using either the SIMATIC PDM parameterization software or the HART communicator. You can operate the SITRANS TR200 using the SIPROM T parameterization software.

The following functions are available to you when operating the SITRANS TR300/TR200:

- Identification
 - Information on operational safety: Day, description, message, assembly number
- Device data; this information is read-only
 - Manufacturer and product name
 - Order number, device serial number
 - Revision numbers for the firmware and hardware revision
- Information about the measuring procedure
 - Sensor class and sensor type, e.g. Pt100 resistance thermometer or thermocouple type B
 - Sensor factor
 - Sensor characteristic curve, e.g. linear temperature
 - Measuring range and measuring unit
- Information on measurement interface
 - Type of interface: standard, differential or mean value circuit
 - Type of connection/sensor connection: two-wire, three-wire or four-wire connection with resistance-type transmitters
 - Resistors for line compensation
 - Offset to the measuring signal
 - Additional information for the cold junction in thermocouples: internal, external or fixed
 - Enable/disable the broken wire or short circuit test
- Information about the output signal
 - Filter time constant for noise suppression attenuation
 - Output limit values: alarm and saturation limits
- Certificates and approvals
 - The following information is read-only: Information whether the transmitter may be operated in intrinsically safe mode or not. This function can only be performed using the SIMATIC PDM parameterization software or with the HART communicator.

- Free material parameters: Fields for more detailed description of the sensor that is connected
 - Type of the sensor
 - Composition of the protective tube
 - Length of the protective tube
 - Screw thread / installation flange
 - Supplier / manufacturer
 - F no. of sensor
 - Order number
- Further parameterizable functions are:
 - Slave pointer functions
 - Hour meter
 - Sensor calibration function with selectable trimming range within the limits of the measuring range
 - Calibrating the analog output: for SITRANS TR200 from 4 to 16 mA, for SITRANS TR300 from 4 to 20 mA
 - Factory reset: Resetting the operating data to the factory settings
 - Simulation of measurement input. Only for SITRANS TR300: Simulation of signal input, analog output, and electronics temperature
 - Only for SITRANS TR300: Individual password protection

The operating data is stored in a non-volatile memory (EEPROM).

9.2 Broken wire monitoring

Broken wire monitoring on a specific measurement channel can be performed for thermocouples and millivolt transmitters. Break monitoring is permanently active in resistance thermometers and resistance-type transmitters. No reference temperature of the internal sensor which measures the electronics temperature can be obtained if there is a broken wire.

When broken wire monitoring is switched on, all sensor cables are permanently monitored for broken wires. The programmed fault current, 3.6mA to 23mA, is output in the event of an error.

Note

If a broken wire occurs when broken wire monitoring is switched off, invalid values may be obtained for the measured value and the internal electronics temperature in the min/max pointer pairs and their runtime meters.

9.3 Short-circuit monitoring

Short circuit monitoring on a specific measurement channel is only possible with resistance thermometers and resistance-type transmitters. The threshold value for the short circuit check can be set in the parameters.

The programmed fault current, 3.6mA to 23mA, is output in the event of a sensor short circuit.

9.4 Line compensation

Trimming the line resistance values can be performed in the following measurements:

- Resistance thermometer or resistance-type transmitter in two-wire connection
- Resistance thermometer or resistance-type transmitter for calculating differential value or mean value
- Thermocouple with external cold junction with Pt100 in two-wire connection

The trimming is performed by numerical preset of the measured line resistance. The line resistance is the combined total of sending and return conductors.

9.5 Type of characteristic curve (rising or falling)

The type of the characteristic curve at the 4 to 20 mA analog output can be selected (rising or falling). The characteristic curve type is defined as follows by setting the parameters for the start of scale value and full scale value:

- Rising characteristic: Full scale value is greater than start of scale value.
- Falling characteristic: Full scale value is less than start of scale value.

9.6 Measured value offset

An offset response on a specific measurement channel can be set in the parameters for applications in which the process variable to be measured cannot be measured directly at the measuring point.

9.7 Sensor factor

The sensor factor is used to adapt the characteristic curve when resistance thermometers are connected in series or parallel and when thermocouples are connected in series. You must multiply the sensor factor with the basic series of the resistance thermometer or thermocouple. Values from 0.25 to 10.0 can be set as the scaling factor in resistance thermometers, while values from 1 to 10 can be set for thermocouples.

Example 1: 3 x Pt500 parallel: Sensor factor = $5/3 = 1.67$ (basis is Pt100)

Example 2: 4 x TC serial: Sensor factor = $4 \times 1 = 4$

9.8 Cold junction compensation with thermocouples

In order to measure the cold junction for thermocouples, you can choose between the following cold junction compensation versions:

- Internal: in this case, the thermocouple or the compensating line is directly connected to the transmitter. The cold junction temperature is obtained by an internal Pt100.
- External with fixed value: specify the external cold junction temperature, e.g. of a thermostat, as a fixed value. The transmitter then compensates according to this constant cold junction temperature.
- External with Pt100: an external Pt100 measures the cold junction temperature in this version. You can connect the Pt100 to the transmitter in two-wire or three-wire input. The cold junction is compensated on the basis of the current temperature of the external Pt100.

9.9 Calculation of differential value/mean value

The differential and averaging circuit interfaces have the following special features compared to the standard connection:

Setting the start of scale value and full scale value:

- Enter the start of scale value and full scale value for both individual sensors first. The start of scale value and full scale value are the same for both sensors. It is not possible to assign different measuring ranges for the individual sensors in the parameters. Tip: use the largest measuring range.
- Following this, assign the parameters for the start of scale value and full scale value for the differentiation or the average value measurements.

Sensor calibration:

- Trim the individual sensors at the selected limits of the measuring range. The differentiation or average set in the parameters cannot be trimmed.

9.10 Electrical damping

You can set the filter time constant of electrical damping to a point within a range from 0 to 30 s.

9.11 Current transmitter function (only for SITRANS TR300)

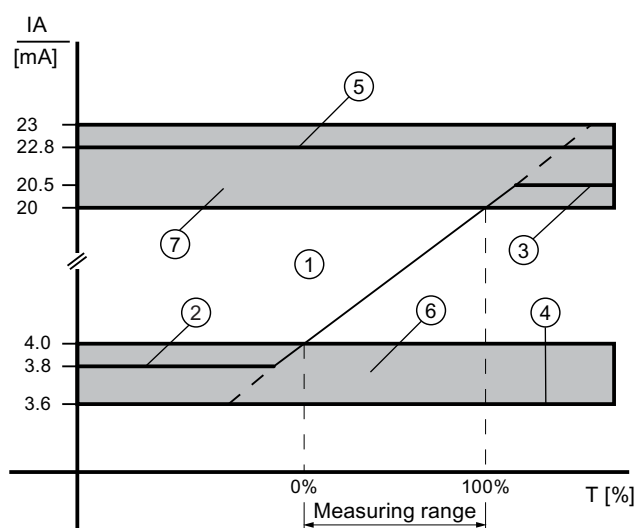
You can use this function to switch the transmitter into constant current mode for test purposes. In that case, the output current no longer corresponds to the process variable.

9.12 Alarm current

This function is used to set the magnitude of the alarm current. The alarm current signals a sensor fault or a hardware/firmware fault.

The intensity of the alarm current can be freely selected within the preset limits of the current control range of 3.6 mA to 23 mA. The upper and lower limit of the linear control range can also be freely selected within the preset limits of the current control range of 3.6 mA to 23 mA.

One example of this is shown in the following diagram. The specified accuracy values of the output signal only apply to the corresponding nominal ranges.



- ① Linear control range
- ② Lower limit of the control range (default value = 3.80 mA)
- ③ Upper limit of the control range (default value = 20.5 mA)
- ④ Lower fault current value (default value = 3.6 mA)
- ⑤ Upper fault current value (default value = 22.8 mA)
- ⑥ Recommended setting range for lower fault current range and lower control range limit
- ⑦ Recommended setting range for upper fault current range and upper control range limit

Figure 9-1 Current limits with output signal 4 to 20 mA

9.13 Sensor calibration

9.13.1 Sensor calibration (one point)

This function allows the characteristic curve of the sensor that is connected to be shifted to intersect the zero point. This allows calibration of the start of scale value of the input sensor. This does not affect the measuring span.

Entering a one point trim is equivalent to entering a sensor offset. The result of the one-point trim is saved in the "offset sensor" variables.

9.13.2 Sensor calibration (two point)

This function allows the characteristic curve of the sensor that is connected to be shifted to intersect two calibration points. The results are then correct measured values at the sensor trim points. A two point trim makes it possible to reduce the proportion of errors due to the characteristic curve.

Trimming the lower sensor calibration point

With these function:

- Apply the process variable on which the lower sensor calibration should be performed is applied, e.g. temperature or resistance, to the transmitter input.
- Use the operating software to command the transmitter to load this process value.
SITRANS TR200 uses SIPROM T operating software, SITRANS TR300 uses SIMATIC PDM operating software or the HART communicator.

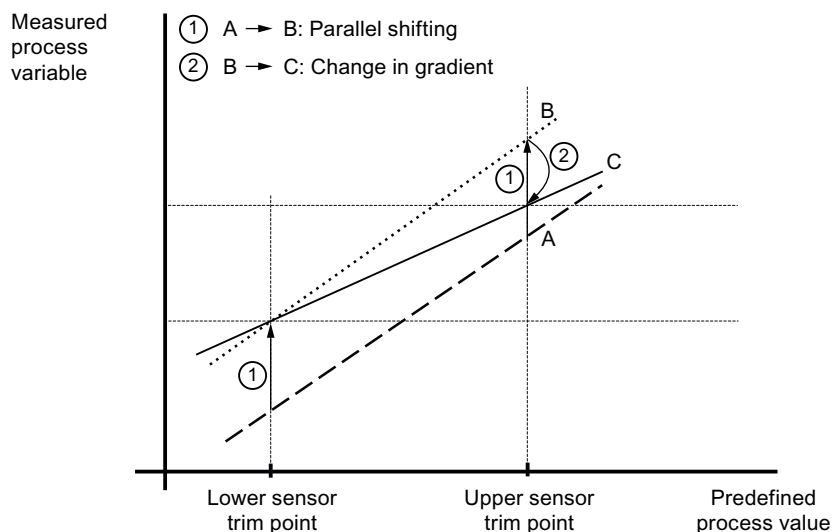
Loading the process value represents an offset shift of the characteristic curve, see B, in the "Sensor calibration" diagram.

Trimming the upper sensor calibration point

With these function:

- Apply the process variable on which the upper sensor calibration should be performed is applied, e.g. temperature or resistance, to the transmitter input.
- Use the operating software to command the transmitter to load this process value.

Loading the process value represents a slope correction of the characteristic curve, see C, in the "Sensor calibration" diagram. The lower sensor trim point is not affected by this.



- O Output characteristic
 B Characteristic curve after lower sensor trim
 C Characteristic curve after upper sensor trim

Figure 9-2 Sensor calibration

Note

If any of the following device parameters is changed by re-parameterization, a two point sensor calibration of SITRANS TR200/TR300 performed specifically for a customer is automatically reset:

- Sensor class
- Sensor type
- Interface
- Sensor connection
- Sensor factor

A double point sensor calibration performed by the user is also reset if the device is restored to its factory settings.

The sensor calibration can be performed both for measurement channel 1 and for measurement channel 2 in the differential value or mean value interface type.

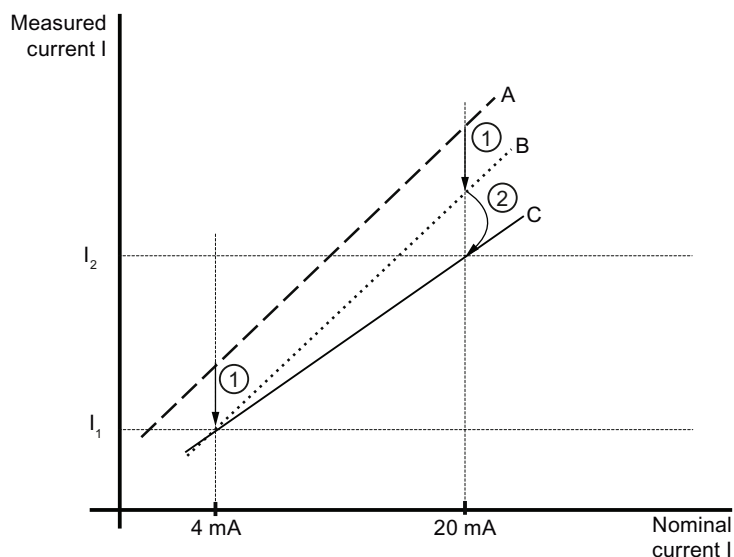
9.14 Current sensor calibration (D/A trim)

9.14.1 Function

This function allows you to calibrate the current output by the transmitter regardless of the sensor circuit. This function allows compensation of inaccuracies in the process chain downstream from the transmitter. The trim can only be performed as follows:

- Device version 200: at 4 mA and at 16 mA
- Device version 300: at 4 mA and at 20 mA

The following figure shows the principle of trimming using the example of the 4 to 20 mA current output.



- | | | | |
|---|---|---|-------------------------|
| O | Output characteristic | ① | A→B: Parallel offset |
| B | Characteristic curve after current transmitter trim 4 mA | ② | B→C: Change in gradient |
| C | Characteristic curve after current transmitter trim 20 mA | | |

Figure 9-3 Current transmitter trim

See also

Application example: Current input calibration at 4 mA and 20 mA (Page 52)

9.14.2 Application example: Current input calibration at 4 mA and 20 mA

NOTICE
The multimeter used must have a higher accuracy class than the transmitter.

Trim at 4 mA (offset correction)

1. Use the menu item D/A trim to assign 4 mA output to the transmitter.
2. Read the measured value at the ammeter.
3. Enter the measured current value using the operating software.

The transmitter uses this value for offset correction of the current.

Trim at 20 mA (gradient correction)

1. Use the menu item D/A trim to assign 20 mA output to the transmitter.
2. Read the measured value at the ammeter.
3. Enter the measured current value using the operating software.

The transmitter uses this value for gradient correction of the current.

The value for 4 mA is not affected by this.

9.15 Special characteristic curve

The transmitter makes it possible to connect sensors to the device. Sensor characteristic curves valid for a large number of sensors are already programmed in the device.

Nevertheless, there are sensors, e.g. Cu100, for which this device does not offer sensor linearization as standard. In this case, however, it is possible to store a customer-specific special characteristic curve in the device. The sensor characteristic curve is then corrected by scaling the measured value output.

The transmitter requires pairs of values (x-values, y-values) for customer-specific characteristic curve correction. These pairs of values form sampling points and the output characteristic curve is generated in between these points by linear interpolation from the input characteristic curve. The maximum number of sampling points is restricted to 30 pairs of values. The individual pairs of values are entered as a percentage of the set measuring span.

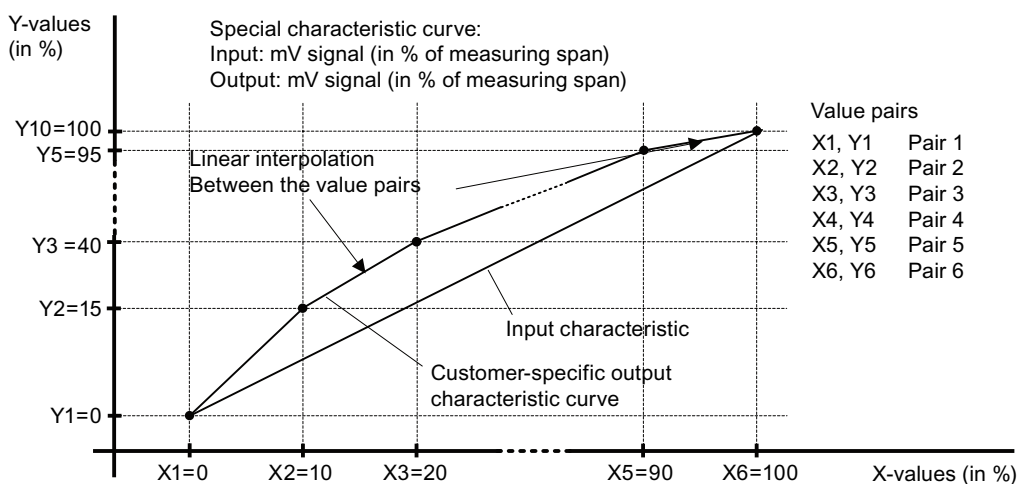


Figure 9-4 Principle of customer-specific characteristic curve correction

Notes on parameter assignment

Be sure to observe the following notes when assigning the parameters for the customer-specific special characteristic curve. These notes are irrespective of the parameter assignment software and apply to both device versions of the transmitter.

- The starting point of the characteristic curve correction is:
 - The resistance-type transmitter sensor class for the required special resistance thermometer;
 - The mV transmitter sensor class for the required special thermocouple.

The sensor characteristic curve of the resistance-type transmitter or mV transmitter form the basis (0 to 100%) for the following characteristic curve correction.

- The individual pairs of values must always be specified in the unit % of the set measuring span.
- The first pair of values is always (X = 0 %; Y = 0 %). The last pair of values is always (X=100 %; Y=100 %). The first and last pairs of values are specified by the parameter assignment software and cannot be changed. If a correction of the first and last pair of values is required, this is only possible by means of a two point trim of the sensor.
- The x-values must rise monotonously when the characteristic curve is input, the y-values must rise or fall monotonously.
- The x-values do not have to be input in equidistant intervals.

Example

The transmitter is used for measuring a customer-specific thermocouple. The thermocouple supplies the following mV signals in this case:

- At the start of scale value: - 10 mV (equals -100 °C)
- At full scale value: 40 mV (equals +400 °C)

Proceed as follows

Note

It may be necessary to perform a sensor calibration at the start of scale value (-10 mV) and full scale value (40 mV) before the sensor characteristic is recorded and the correction values have been entered.

1. The mV transmitter sensor class is selected using the parameter assignment software SIPROM T or SIMATIC PDM.
2. Characteristic curve correction of the thermocouple should be performed across 6 pairs of values. The type of cold junction compensation is a fixed value = 0 °C.
3. Parameter entries

Sensor signal at transmitter input	Characteristic curve pair			Measured value [i] after characteristic curve correction
	Pair of values	X[i]	Y[i]	
-10 mV	i = 1	0 %	0 %	-100 °C
-5 mV	i = 2	10 %	15 %	-25 °C
0 mV	i = 3	20 %	20 %	0 °C
15 mV	i = 4	50 %	55 %	175 °C
35 mV	i = 5	90 %	95 %	375 °C
40 mV	i = 6	100 %	100 %	400 °C

Example for a parameter

Determining the pairs of values $X[i]$ and $Y[i]$ using, as an example, the pair of values $i = 3$ is explained below.

Calculation $X[i=3]$

$$\underline{\underline{X[3] = \frac{\text{Sensor signal [mV]} - \text{start of scale value [mV]}}{\text{Full scale value [mV]} - \text{start of scale value [mV]}} \cdot 100\% = \frac{0 \text{ mV} - (-10 \text{ mV})}{40 \text{ mV} - (-10 \text{ mV})} \cdot 100\% = 20\%}}$$

The characteristic curve parameter $X[3] = 0 \text{ mV}$ corresponds with 20 % as a percentage in relation to
start of scale value = - 10 mV and full scale value = 40 mV.

Calculation $Y[i=3]$

$$\underline{\underline{Y[3] = \frac{\text{Temperature value [°C]} - \text{start of scale value [°C]}}{\text{Full scale value [°C]} - \text{start of scale value [°C]}} \cdot 100\% = \frac{0^\circ\text{C} - (-100^\circ\text{C})}{400^\circ\text{C} - (-100^\circ\text{C})} \cdot 100\% = 20\%}}$$

The following pair of values must be transferred to the parameter assignment software for the characteristic curve correction of the pair of values $i = 3$: $X[3] = 20 \%$ and $Y[3] = 20 \%$.

9.16 Factory parameters

Using the menu command **Device → Factory trim → Reset factory settings**, the configuration of the transmitter is reset to its default values.

Note

Factory reset

- The menu command **Device → Factory trim → Reset factory settings** always resets the parameters of the transmitter to the default values in the table listed below.
- This factory reset has the same effect for "devices supplied ex stock" or "devices set customer-specifically".
- Furthermore, resetting the transmitter to its default values also resets a customer-specific digital-to-analog converter trim and sensor calibration (one point trim or two point trim).

Once a factory reset has been performed, the transmitter has the following configuration:

Parameter	Reset to value
DAY	Is not reset
Description	Is not reset
Message	Is not reset
Serial number	Is not reset
Installation date (electronics)	Is not reset
Sensor class	Resistance thermometer
Sensor type	Pt100 DIN IEC 751
Interface	Standard connection
Sensor connection	Three-wire input
Sensor factor	1.00
Sensor offset 1	0.00 °C
Start of scale value	0 °C
Full scale value	100 °C
Unit	°C
Break monitoring	ON
Short circuit monitoring	ON
Short circuit limit	10 Ω
Lower end point analog output	Is not reset
Upper end point analog output	Is not reset
Alarm value	Is not reset
Linearization type	Linear to temperature
Attenuation	0.00 s
Runtime meters PV	Are all reset to 0 h
Runtime meters, field device	Are not reset
Min/max pointers PV	Are all reset to 0
Min/max pointers for electronics temperature	Are not reset
Manufacturer data sensor	Are not reset

9.17 Diagnostics

9.17.1 Diagnostics functions

The diagnostic concept of the SITRANS TR200 and the SITRANS TR300 envisages that a diagnostic warning can be set in the parameters for diagnostic functions that are used for monitoring limit values. A diagnostic interrupt can be set in the parameters for diagnostic functions that are used for monitoring error conditions.

Diagnostics interrupts

Diagnostic interrupts are output via:

- Analog output
- Operating indicator (LED)
- Only for SITRANS TR300: HART communication

The device goes into the alarm current state. In addition, the diagnostic event is made available via the operating software. The following table summarizes all the diagnostic functions that can be set in the parameters. If multiple errors occur simultaneously, the priority settings apply. Priority 1 is the highest priority.

Diagnostic function	Priority	HART ¹⁾	Analog output	LED
Hardware/firmware defect				
RAM/ROM error	1	Status	On alarm value	Red
Flash/EEPROM error	1	Status	On alarm value	Red
Watchdog error	1	Status	On alarm value	Red
Electronics defect (hardware/firmware)	1	Status	On alarm value	Red
Electronics temperature outside limit ²⁾	1	Status	On alarm value	Red
Undershoot of min. supply voltage	1	-	< 3.6 mA	Red
Sensor error				
Sensor breakage	2	Status	On alarm value	Red 2 Hz
Sensor short circuit	2	Status	On alarm value	Red 2 Hz
Measured value (PV) outside the sensor limit ³⁾	2	Status	On alarm value	Red 2 Hz

¹⁾ Only in TR300

²⁾ A diagnostics interrupt is not triggered unless the measured value is higher or lower than the limit value by 3 °C (5.40 °F).

³⁾ A diagnostics warning is triggered immediately when the measured value exceeds the limit value. The diagnostic interrupt is triggered in any case if the limit value is exceeded by more than 2%.

Diagnostics warnings

Diagnostic warnings are output via:

- HART communication, only for SITRANS TR300

The device transmits the diagnostics event that has occurred via the operating software. The analog output value is unchanged.

Diagnostics function	Priority	HART ¹⁾	Analog output	LED
Measured value out of the measuring range		Status	Unchanged	Green
Output saturation warning		Status	Unchanged	Green
Measured value (PV) outside the sensor limit		Status	Unchanged	Green
Electronics temperature outside the limit		Status	Unchanged	Green

¹⁾ Only in TR300

9.17.2 Violations of specification

WARNING

Non-observance of Ex ambient conditions

If the device has been operated outside the ambient conditions specified for potentially explosive atmospheres, you may no longer operate the device in potentially explosive atmospheres.

Additionally make sure to permanently mask all Ex markings on the nameplate.

CAUTION

Operation outside the permissible temperature limits

If you use the transmitter outside the permissible temperature limits, it no longer corresponds to the specification. The transmitter then outputs the parameterized fault current.

The message "Ambient temperature error/electronics temperature error" remains set in the device even after the power supply has been switched off and on again.

Operate the transmitter within the permissible temperature limits again, and reset the message "Ambient temperature error/electronics temperature error".

Reset

If you have guaranteed by means of sensor and D/A trimming that the transmitter is working with a tolerable accuracy, you can reset the transmitter.

Use the software tool SIPROM T or SIMATIC PDM to carry out the reset:

- SIPROM T menu item for SITRANS TR200:
Device → **Device status** → Device reset after ambient temperature error
- SIMATIC PDM menu item for SITRANS TR300:
View → **Device status** → Device reset after ambient temperature error

Note

Incorrect configuration

The configuration will not be completely stored in the device if the supply voltage fails during a write operation to the device. The diagnostic bit "HW/FW error" is set via HART.

Faulty or incomplete configurations are signaled by continuous lighting-up of the red diagnostics LED on the device.

Repeat the loading procedure for the configuration. The device will then revert to working in accordance with the specifications.

9.18 Operating hours counter in temperature classes

The SITRANS TR200/TR300 has different operating hours counters. The operating hours counters are for monitoring the connected process flows.

1. Operating hours counter for transmitter electronics

- Monitors the number of operating hours that the transmitter has been in continuous operation subject to the ambient temperature.
- Records the process of operating hours of the transmitter in 9 ranges of ambient temperature.
- Begins with the first commissioning at the plant.
- The user cannot reset or adjust the operating hours counter or temperature ranges.
- The operating hours counter is only updated when it is in measuring mode. The operating hours counter is not updated in simulation mode.

2. Operating hours counter for process variable

- Monitors the process of the sensor connected to the transmitter in different process ranges.
- Records the process of operating hours of the process variable in 9 ranges. Subdivision takes place subject to the connected sensor and its sensor limits. The user cannot adjust the ranges.
- The operating hours counter is reset automatically if one of its following parameters is changed:
 - Sensor class
 - Sensor type
 - Interface connection
 - Sensor connection
 - Sensor factor

The parameter assignment software SIPROM T for SITRANS TR200 or SIMATIC PDM or HART communicator on SITRANS TR300 can read out the operating hours counters. The operating hours counters are automatically stored to the non-volatile memory once an hour. If the power supply to the device is interrupted, the operating hours counters are available upon restarting the device.

9.19 Slave pointer

This device offers a total of two min/max pointer pairs by means of which the following measured variables can be monitored for the lowest and highest values:

- Min/max pointer pair for measured value (e.g. temperature differential T1-T2 with two resistance thermometers in a differential circuit)
- Min/max pointer pair for electronics temperature (cannot be reset)

Resetting the min/max pointer is only possible for the measured value. A reset is performed:

- At the user's request
- Automatically when any of the following parameters is changed in the device:
 - Sensor class
 - Sensor type
 - Interface
 - Sensor connection
 - Sensor factor

9.20 Simulation (only for SITRANS TR300)

With the "Simulation" diagnostic function, you can receive and process (quasi-) measurement data without having a process value at the device. This allows you to run individual process operations in the "cold" state and thus simulate process states. In addition, you can check the wire layout for the analog output by adding on the simulation values.

The value to be simulated can be predetermined as a fixed value or in the form of a ramp function. The following simulations for the measuring input and analog output are possible:

- **Measuring input:**
 - Fixed value simulation or ramp simulation for a primary process variable
 - Fixed value simulation or ramp simulation for electronics temperature
- **Measuring outputs:**
 - Fixed value simulation of the analog output

Simulation of the primary process variable, electronics temperature, and analog output are managed the same way for parameter assignment and function. For this reason, only the general simulation processes "fixed value" and "ramp function" are described in the following using the measuring input as an example.

For safety reasons, all simulation data are held only in the working memory. This means that when the device is restarted any simulation which may be active will be shut down.

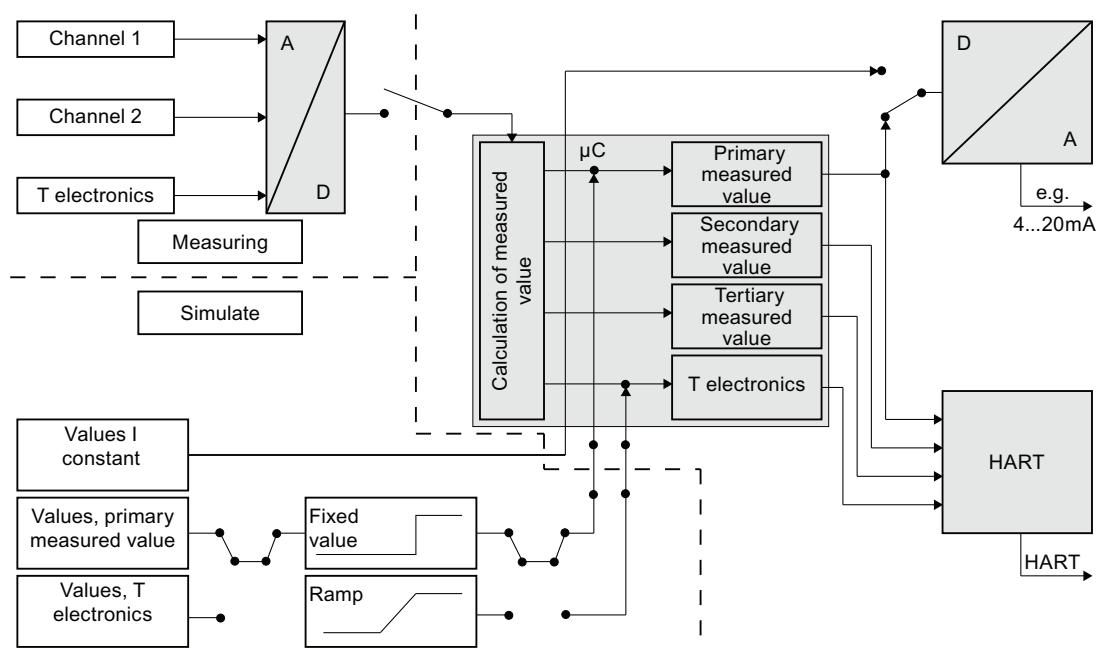


Figure 9-5 Block diagram of simulation

Measuring input simulation

Note

Simulation

The transmitter does not respond to sensor input signals when the simulation is active.

The device may not be parameterized to "thermocouple with internal cold-junction compensation" for simulating the internal electronics temperature. In this case, the internal electronics temperature is a measured variable and cannot be replaced by a simulation value.

- Simulation as fixed value

Taking the physical unit into account you can parameterize fixed simulation values for both the primary measured value and electronics temperature. The analog output value sets itself to the appropriate specification for the primary measured value.

- Simulation with a periodical ramp function

In addition to adjustable fixed values, you can parameterize a ramp function that returns periodically for each of the two simulation paths. An adjustable lower and upper value determines the limits that the simulation values can move between with a rising or falling tendency. The step width can be calculated with the step number, which is also adjustable.

$$\text{Step width} = \frac{\text{Upper value} - \text{lower value}}{\text{Increment}}$$

The duration between two consecutive simulation values is predefined by the step duration. The analog output follows the simulated values when simulating for the first primary measured value.

9.21 Individual password protection (SITRANS TR300 only)

Description

The individual password protection prevents unauthorized write access to the device.

Note

Password protection

- Change the default password immediately after commissioning the device. You will then prevent write access to the device by unauthorized persons.
 - Store your new password in a secure location.
 - Consult the Siemens contact person in your region to receive your "super pin".
 - When you activate the password protection in the device, write protection will be set automatically after the device has been switched on.
-

In the condition of goods delivered, every transmitter is set with the default password **2457**. Password protection is deactivated. If you reset the transmitter to the factory setting, the current password will not be reset to the default password. Should you no longer know your password, then the data in the device can only be altered using a "super pin", therefore not using the default password. The super pin can be obtained from your regional Siemens contact person.

Procedure for writing data in a password protected device

1. Select the "Deactivate password protection" menu in the parameterization software.
2. Enter your 4-digit password. Password protection is deactivated.
3. Change the values according to your application.
4. Select the "Activate password protection" menu in the parameterization software. The device is write protected again.

Service and maintenance

The transmitter is maintenance-free.

Technical data

11.1 Technical data

Input point

Resistance thermometer input point	
Measured variable	Temperature
Sensor type	
• According to IEC 60751	Pt25 ... Pt1000
• According to JIS C 1604; $\alpha=0.00392$ K-1	Pt25 ... Pt1000
• According to IEC 60751	Ni25 ... Ni1000
• Special type	Via special characteristic curve (max. 30 points)
Sensor factor	0.25 ... 10 (adaptation of the basic type, e.g. Pt100, to version Pt25 ... Pt1000)
Units of measurement	°C or °F
Interface	
• Standard connection	1 resistance thermometer (RTD) in two-wire, three-wire or four-wire input
• Averaging	2 equal resistance thermometers in two-wire input for averaging the temperature
• Differentiation	2 equal resistance thermometers (RTD) in two-wire input (RTD 1 - RTD 2 or RTD 2 - RTD 1)
Connection	
• Two-wire input	Line resistance can be assigned in the parameters $\leq 100 \Omega$ (loop resistance)
• Three-wire input	No trim necessary ¹⁾
• Four-wire input	No trim necessary
Sensor current	≤ 0.45 mA
Measuring cycle	≤ 250 ms for 1 sensor with break monitoring
Break monitoring	Always active (cannot be switched off)
Short circuit monitoring	Can be switched on/off (default value = ON)
Measuring range	Can be set in the parameters (see table in chapter Digital measuring error (Page 76))
Min. measuring span	10 °C (18 °F)
Characteristic curve	Linear to temperature or special characteristic curve

1) Prerequisites: same resistance for all three lines.

Resistance-type transmitter input point	
Measured variable	Ohmic resistance
Sensor type	Resistance, potentiometer
Units of measurement	Ω
Interface	
• Standard connection	1 resistance-type transmitter (R) in two-wire, three-wire or four-wire input
• Averaging	2 resistance-type transmitters in two-wire input for averaging
• Differentiation	2 resistance-type transmitters in two-wire input (R1 - R2 or R2 - R1)
Connection	
• Two-wire input	Line resistance can be assigned in the parameters $\leq 100 \Omega$ (loop resistance)
• Three-wire input	No trim necessary ¹⁾
• Four-wire input	No trim necessary
Sensor current	$\leq 0.45 \text{ mA}$
Measuring cycle	$\leq 250 \text{ ms}$ for 1 sensor with break monitoring
Break monitoring	Always active (cannot be switched off)
Short circuit monitoring	Can be switched on/off (default value = OFF)
Measuring range	Setting range max. 0 ... 2200 Ω (see table in chapter Digital measuring error (Page 76))
Min. measuring span	5 or 25 Ω (see table in chapter Digital measuring error (Page 76))
Characteristic curve	Linear to resistance or special characteristic curve

1) Prerequisites: same resistance for all three lines.

Thermocouples' input point	
Measured variable	Temperature
Sensor type (thermo pairs)	
• Type B	Pt30Rh-Pt6Rh according to DIN IEC 584
• Type C	W5%-Re according to ASTM 988
• Type D	W3%-Re according to ASTM 998
• Type E	NiCr-CuNi according to DIN IEC 584
• Type J	Fe-CuNi according to DIN IEC 584
• Type K	NiCr-Ni according to DIN IEC 584
• Type L	Fe-CuNi according to DIN 43710
• Type N	NiCrSi-NiSi according to DIN IEC 584
• Type R	Pt13Rh-Pt according to DIN IEC 584
• Type S	Pt10Rh-Pt according to DIN IEC 584
• Type T	Cu-CuNi according to DIN IEC 584
• Type U	Cu-CuNi according to DIN 43710
Units of measurement	°C or °F
Interface	
• Standard connection	1 thermocouple (TC)
• Averaging	2 equal thermocouples (TC)
• Differentiation	2 equal thermocouples (TC) (TC1 - TC2 or TC2 - TC1)
Measuring cycle	≤ 250 ms for 1 sensor with break monitoring
Break monitoring	Can be switched off
Cold junction compensation	
• Internal	With integrated resistance thermometer Pt100
• External	With external Pt100 IEC 60751 (two-wire or three-wire connection)
• External fixed	Cold junction temperature can be set as fixed value
Measuring range	Can be set in the parameters
Min. measuring span	Min. 40 ... 100 °C (72 ... 180 °F) (see table in chapter Digital measuring error (Page 76))
Characteristic curve	Linear to temperature or special characteristic curve

Millivolt transmitter input point	
Measured variable	DC voltage
Sensor type	DC voltage source (DC voltage source is possible via a resistor that is connected externally)
Units of measurement	mV
Measuring cycle	≤ 250 ms for 1 sensor with break monitoring
Break monitoring	Can be switched off
Measuring range	Setting range max. -100 ... 1100 mV
Min. measuring span	2 mV or 20 mV
Overload capacity of the input point	-1.5 ... 3.5 V DC
Input resistance	≥ 1 MΩ
Characteristic curve	Linear to voltage or special characteristic curve

Output

Output signal	4 ... 20 mA, two-wire line With SITRANS TR300, additionally with communication according to HART rev. 5.9
Auxiliary power supply	11 ... 35 V DC (to 30 V in Ex "i"/"ic"; to 32 V with Ex "nA")
Max. load	(U _{aux} - 11 V)/0.023 A
Overrange	3.6 mA ... 23 mA infinitely adjustable (default range: 3.80 mA to 20.50 mA)
Error signal (e.g. in case of sensor failure)	3.6 mA ... 23 mA continuously adjustable (default value: 22.8 mA)
Setting time:	
• Dead time	< 360 ms
• T63 (without electrical attenuation, without dead time)	< 260 ms
Attenuation	Software filter 1st order 0 ... 30 s (can be set in the parameters)
Protection	Against reverse polarity
Electrical isolation	Input for output DC 2.12 kV (AC 1.5 kV)

Measuring accuracy

The digital accuracy is the accuracy following analog-to-digital conversion including linearization and measured value calculation.

The 4 to 20 mA output current is subject to an additional error arising from the digital-to-analog conversion. This error is called a digital-to-analog error.

The overall error on the analog output under reference conditions is the total of the digital error and the digital-to-analog error. Where applicable, plus the cold junction error in the case of thermocouple measurements.

Measuring accuracy	
Reference conditions	
Auxiliary power supply	24 V $\pm$ 1 %
Load	500 Ω
Ambient temperature	23 °C
Interfering fields	None
Heat-up time	> 5 min
Digital measuring error	See table in chapter Digital measuring error (Page 76)
Analog output error (digital-to-analog error)	< 0.025 % of the output current span (16 mA)
Fault due to internal cold junction	< 0.5 °C (0.9 °F)
Ambient temperature influence	
Analog measuring error	0.02 % of the output current span (16 mA)/ 10 °C (18 °F)
Digital measuring error	
In resistance thermometers	0.06 °C (0.11 °F)/10 °C (18 °F)
In thermocouples	0.6 °C (1.1 °F)/10 °C (18 °F)
Influence of the auxiliary power supply	< 0.001 % of the output current span (16 mA)/V
Influence of load	< 0.002 % of the output current span (16 mA)/ 100 Ω
Long-term drift (start of scale value, measuring span)	< 0.02 % of the measuring span in the first month < 0.2 % of the span after one year < 0.3 % of the span after five years

Rated conditions

Operating conditions	
Ambient conditions	
Ambient temperature	-40 ... +85 °C (-40 ... +185 °F)
Storage temperature	-40 ... +85 °C (-40 ... +185 °F)
Relative humidity	≤ 98 %, condensing
Electromagnetic compatibility	
In accordance with	DIN EN 61326 and NE21
Errors under EMC influence	< 0,1 % ¹⁾ of span

- ¹⁾ With radiated electromagnetic fields in accordance with EN61000-4-3, deviations <0.5% of the span may occur.

Construction

Construction	
Material	Plastic, potted
Weight	122 g (0.27 lb)
Dimensions	See Dimension drawings (Page 79)
Cross section of the connecting cables	Max. 2.5 mm ² (AWG 13)
Degree of protection according to IEC 60529	
Housing	IP20

Certificates and approvals

Certificates and approvals	
<i>Explosion protection ATEX and further approval authorities</i>	
Only the technical data listed in the certificates, e.g. PTB 07 ATEX 2032 X, applies to applications in hazardous areas.	
"Intrinsic safety" type of protection	• II 2(1) G Ex ia/ib IIC T6/T4 • II 3(1) G Ex ia/ic IIC T6/T4 • II 3 G Ex ic IIC T6/T4 • II 2(1) D Ex iaD/ibD 20/21 T115 °C
Type of protection "Non-sparking resources"	• II 3 G Ex nA II T6/T4

Factory setting

Factory setting	
Pt100 (IEC 751)	In three-wire input
Measuring range	0 ... 100 °C (32 ... 212 °F)
Fault current	22.8 mA
Sensor offset	0 °C (0 °F)
Attenuation	0.0 s

11.2 Digital measuring error

Digital measuring errors for resistance thermometers

Input point	Measuring range in °C (°F)	Minimum measuring span in °C (°F)	Digital accuracy in °C (°F)
<i>According to IEC 60751</i>			
Pt25	-200 ... +850 (-328 ... +1562)	10 (18)	0,3 (0.54)
Pt50	-200 ... +850 (-328 ... +1562)	10 (18)	0,15 (0.27)
Pt100 ... Pt200	-200 ... +850 (-328 ... +1562)	10 (18)	0,1 (0.18)
Pt500	-200 ... +850 (-328 ... +1562)	10 (18)	0,15 (0.27)
Pt1000	-200 ... +350 (-328 ... +662)	10 (18)	0,15 (0.27)
<i>According to JIS C1604-81</i>		10 (18)	
Pt25	-200 ... +649 (-328 ... +1200)	10 (18)	0,3 (0.54)
Pt50	-200 ... +649 (-328 ... +1200)	10 (18)	0,15 (0.27)
Pt100 ... Pt200	-200 ... +649 (-328 ... +1200)	10 (18)	0,1 (0.18)
Pt500	-200 ... +649 (-328 ... +1200)	10 (18)	0,15 (0.27)
Pt1000	-200 ... +350 (-328 ... +662)	10 (18)	0,15 (0.27)
Ni25 ... Ni1000	-60 ... +250 (-76 ... +482)	10 (18)	0,1 (0.18)

Digital measuring errors for resistance-type transmitters

Input point	Measuring range [Ω]	Minimum span in [Ω]	Digital accuracy [Ω]
Resistance	0 ... 390	5	0,05
Resistance	0 ... 2200	25	0,25

Digital measuring errors for thermocouples

Input point	Measuring range in °C (°F)	Minimum measuring span in °C (°F)	Digital accuracy in °C (°F)
Type B	+100 ... +1820 (212 ... 3308)	100 (180)	2 (3.6)
Type C (W5)	0 ... +2300 (32 ... 4172)	100 (180)	2 (3.6)
Type D (W3)	0 ... +2300 (32 ... 4172)	100 (180)	2 (3.6)
Type E	-200 ... +1000 (-328 ... +1832)	50 (90)	1 (1.8)
Type J	-210 ... +1200 (-346 ... +2192)	50 (90)	1 (1.8)
Type K	-230 ... +1370 (-382 ... +2498)	50 (90)	1 (1.8)
Type L	-200 ... +900 (-328 ... +1652)	50 (90)	1 (1.8)
Type N	-200 ... +1300 (-328 ... +2372)	50 (90)	1 (1.8)
Type R	-50 ... +1760 (-58 ... +3200)	100 (180)	2 (3.6)
Type S	-50 ... +1760 (-58 ... +3200)	100 (180)	2 (3.6)
Type T	-200 ... +400 (-328 ... +752)	40 (72)	1 (1.8)
Type U	-200 ... +600 (-328 ... +1112)	50 (90)	2 (3.6)

Digital measuring errors for millivolt transmitters

Input point	Measuring range in mV	Minimum measuring span in mV	Digital accuracy in µV
Millivolt transmitter	-10 ... +70	2	40
Millivolt transmitter	-100 ... +1100	20	400

Dimension drawings

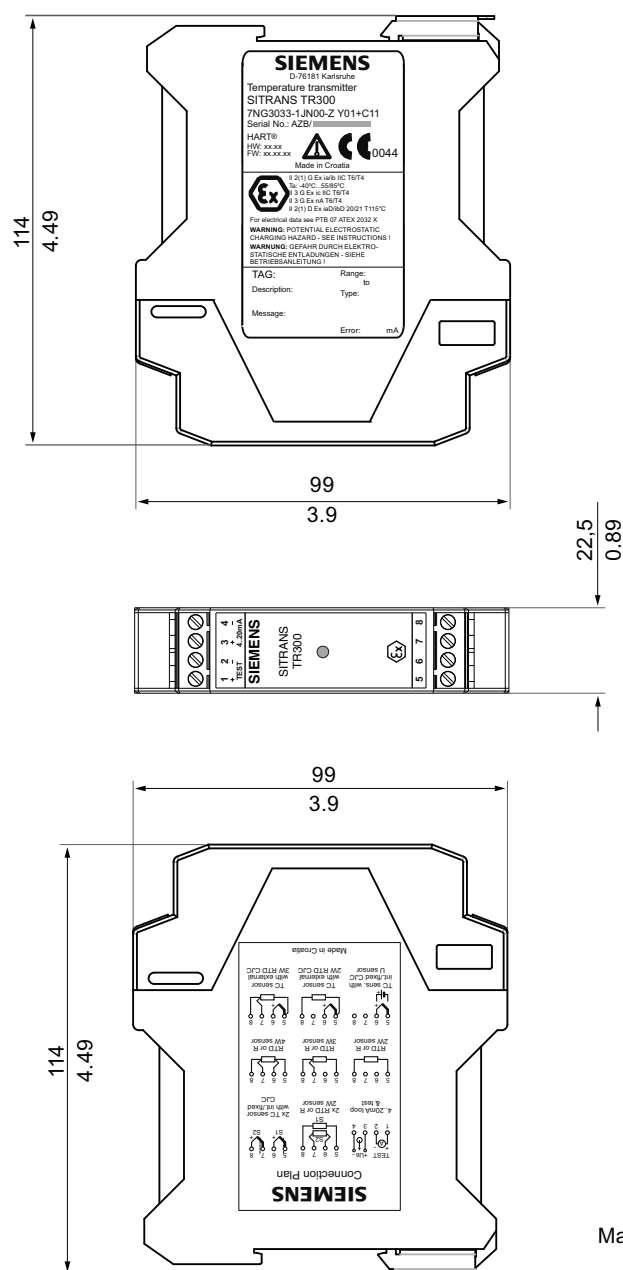


Figure 12-1 SITRANS TR200/TR300 dimensional drawing

Spare parts and accessories

13

Name	Order number
SITRANS TR200 temperature transmitter for installation on DIN rails, two-wire technology 4 to 20 mA, programmable, with electrical isolation, with documentation on CD	
• Without explosion protection	7NG3032-0JN00 ¹⁾
• With explosion protection according to ATEX type of protection "Intrinsic safety" Ex ia/ib/ic, non-sparking (nA)	7NG3032-1JN00 ¹⁾
SITRANS TR300 temperature transmitter for installation on DIN rails, two-wire technology 4 to 20 mA, HART, with electrical isolation, with documentation on CD	
• Without explosion protection	7NG3033-0JN00 ¹⁾
• With explosion protection according to ATEX type of protection "Intrinsic safety" Ex ia/ib/ic, non-sparking (nA)	7NG3033-1JN00 ¹⁾

Additional specifications Add "-Z" to order no. and specify order code.	Order code
Set the operating data as desired (Describe operating data in plain text)	Y01
with test report (5 measuring points)	C11
With SIL 2 (functional safety)	C20

Name	Order number
Modem for SITRANS TH100, TH200 and TR200 including the SIPROM T parameterization software	
• With USB connection	7NG3092-8KU ¹⁾
CD for temperature measuring instruments containing documentation in German/English/French/Spanish/Italian/Portuguese and the SIPROM T parameterization software	A5E00364512 ¹⁾
HART modem	
• With RS232 serial interface	7MF4997-1DA ¹⁾
• With USB interface	7MF4997-1DB ¹⁾

1) Available from stock

Appendix

A.1 Certificates

You can find the certificates on the "sittrans t - temperature transmitters" CD, available separately, order no. A5E00364512; and on the Internet.

See also

Certificates (<http://www.siemens.com/processinstrumentation/certificates>)

A.2 Technical support

Technical Support

You can contact Technical Support for all IA and DT products:

- Via the Internet using the **Support Request**:
Support request (<http://www.siemens.com/automation/support-request>)
- E-mail (<mailto:support.automation@siemens.com>)
- **Phone**: +49 (0) 911 895 7 222
- **Fax**: +49 (0) 911 895 7 223

Further information about our technical support is available in the Internet at
Technical Support (<http://www.siemens.com/automation/csi/service>)

Service & Support on the Internet

In addition to our documentation, we offer a comprehensive knowledge base online on the Internet at:

Services & Support (<http://www.siemens.com/automation/service&support>)

There you will find:

- The latest product information, FAQs, downloads, tips and tricks.
- Our newsletter, providing you with the latest information about your products.
- A Knowledge Manager to find the right documents for you.
- Our bulletin board, where users and specialists share their knowledge worldwide.
- You can find your local contact partner for Industry Automation and Drives Technologies in our partner database.
- Information about field service, repairs, spare parts and lots more under "Services."

Additional Support

Please contact your local Siemens representative and offices if you have any questions about the products described in this manual and do not find the right answers.

Find your contact partner at:

Partner (<http://www.automation.siemens.com/partner>)

A signpost to the documentation of the various products and systems is available at:

Instructions and Manuals (<http://www.siemens.com/processinstrumentation/documentation>)

List of abbreviations

B.1 Abbreviations

Abbreviation	Full term in English	Meaning
FIT	Failure in Time	Frequency of failure Number of faults withing 10^9 hours
HFT	Hardware Fault Tolerance	Hardware fault tolerance: Capability of a function unit to continue executing a required function in the presence of faults or deviations.
MooN	"M out of N" voting	Classification and description of the safety-instrumented system in terms of redundancy and the selection procedures used. A safety-instrumented system or part that consists of "N" independent channels. The channels are connected to each other in such a way that "M" channels are in each case sufficient for the device to perform the safety instrumented function. Example: Pressure measurement: 1oo2 architecture. A safety-instrumented system decides that a specified pressure limit has been exceeded if one out of two pressure sensors reaches this limit. In a 1oo1 architecture, there is only one pressure sensor.
MTBF	Mean Time Between Failures	Average period between two failures
MTTR	Mean Time To Restoration	Average period between the occurrence of a fault in a device or system and restoration of functionality
PFD	Probability of Failure on Demand	Probability of dangerous failures of a safety function on demand
PFD _{AVG}	Average Probability of Failure on Demand	Average probability of dangerous failures of a safety function on demand
SFF	Safe Failure Fraction	Proportion of safe failures: Proportion of failures without the potential to bring the safety-instrumented system into a dangerous or non-permissible functional status.
SIL	Safety Integrity Level	The international standard IEC 61508 defines four discrete Safety Integrity Levels (SIL 1 to SIL 4). Each level corresponds to a range of probability for failure of a safety function. The higher the Safety Integrity Level of the safety-instrumented system, the lower the probability that it will not execute the required safety functions.
SIS	Safety Instrumented System	A safety-instrumented system (SIS) executes the safety functions that are required to achieve or maintain a safe status in a system. It consists of a sensor, logic unit/control system and final controlling element.
TI	Test Interval	Testing interval of the protective function

Glossary

Analog

One variable, e.g. voltage which is infinitely adjustable, in contrast to "Digital".

ATEX

ATEX is an abbreviation of the French term "Atmosphère explosible" (potentially explosive atmosphere). ATEX stands for both EC directives in the area of explosion protection: ATEX product directive 94/9/EC and ATEX operating directive 1999/92/EC.

Auxiliary power supply

Auxiliary power supply is an electrical supply voltage or reference voltage, such as many electrical circuits require in addition to the standard power supply.
The auxiliary power supply is specially stabilized, has a specific level and polarity and/or has other properties that are important for correct operation of circuit components.

Auxiliary voltage

→ *Auxiliary power supply*

CE

Communautés Européennes: European communities

Dangerous failure

Failure with the potential to bring the safety-instrumented system into a dangerous or non-functional status.

DC

Direct Current: Direct Current

Digital

Representation of a variable, e.g. time, in the form of characters or numbers. In its digital representation, this variable can be changed only in pre-defined steps. In contrast to "Analog".

DIN

Deutsches Institut für Normung e. V. - German institute for standardization

EC low-voltage directive

The EC low voltage directive applies to electrical resources with rated voltages of:

- AC from 50 V to 1000 V;
- DC from 75 V to 1500 V.

EEPROM

Electrically **E**rasable **P**rogrammable **R**ead **O**nly **M**emory

EEPROMs are often used where individual bytes of data (e.g. configuration data or runtime meters) change over time and must be stored safely in the event of a mains power failure.

EMC

Electromagnetic **c**ompatibility

Definition in accordance with EMC law.

EMC is the capability of a device to operate satisfactorily in an electromagnetic environment without itself emitting electromagnetic signals which interfere with other devices in that environment.

EN

Europäische **N**orm - European standard

EU

European **C**ommunity

Fail-safe

The capability of a control to maintain the safe state of the controlled device, e.g. machine, process, or to bring the device to a safe state even when faults/failures occur.

Failure/Fault

Failure:

A resource is no longer capable of executing a required function.

Fault:

Undesired state of a resource indicated by the incapability of executing a required function.

Fault

→ *Failure/Fault*

Fault tolerance

Fault tolerance N means that a device can execute the intended task even when N faults exist. The device fails to execute the intended function in case of N+1 faults.

Final controlling element

Converter that converts electrical signals into mechanical or other non-electrical variables.

Firmware

Firmware (FW) is software which is embedded in a chip in electronic devices – unlike software that is stored on hard drives, CD ROMs, or other media. These days, firmware is mostly stored in a flash memory or EEPROM.

Firmware usually contains the elementary functions for controlling the device, as well as input and output routines.

Frequency shift keying

Frequency shift keying in a simple form of modulation in which the digital values 0 and 1 are represented by two different frequencies.

Frequency Shift Keying (FSK)

→ *Frequency shift keying*

HART

HART (Highway Addressable Remote Transducer) is a standardized, widely used communications system used to structure industrial fieldbuses. The communications system provides digital communications for multiple participants (field devices) via a common databus. HART is based especially on the equally widely used 4/20 mA standard for the transfer of analog sensor signals. The cabling from existing older systems can be used directly and both systems operated in parallel.

HART specifies several protocol levels in the OSI model. It facilitates the transfer of process and diagnostics data and control signals between field devices and high-level control systems. Standardized parameter sets can be used for the manufacture-independent operation of all HART devices.

Typical applications include transmitters for measuring mechanical and electrical dimensions.

IP

International Protection = international degree of protection

Microcontroller

Microcontrollers (also written μ Controllers, μ C, MCU) are single-chip computer systems which have virtually all their components - such as main processor, program memory, working memory and the input/output interfaces - accommodated on a single chip.

Non-volatile memory

→ *EEPROM*

Risk

The combination of probability of a damage occurring and its magnitude.

RS -232

RS: Recommended **S**tandard

A recognized industry standard for serial data transfer. For cable lengths shorter than 15 m. No differential evaluation. Transmit and receive on different lines.

Safety function

Defined function executed by a safety-instrumented system with the objective of achieving or maintaining a safe system status taking into account a defined dangerous occurrence.

Example:

Limit pressure monitoring

Safety Instrumented Function

→ *SIF*

Safety Integrity Level

→ *SIL*

Safety-instrumented system

A safety-instrumented system executes the safety functions that are required to achieve or maintain a safe status in a system. It consists of a sensor, logic unit/control system and final controlling element.

Example:

A safety-instrumented system is made up of a pressure transmitter, a limit signal sensor and a control valve.

Sensor

In electrical engineering, a sensor is a component that can qualitatively measure not only specific physical or chemical properties (such as heat radiation, temperature, humidity, pressure, excess pressure, sound, brightness, magnetism, acceleration, force) as well as the physical condition of its surroundings or register them as quantitatively measured variables.

Sensor

Converter that converts mechanical or other non-electrical variables into electrical signals.

SIF

A part/function of a safety-instrumented system that reduces the risk of a dangerous failure occurring.

SIL

The international standard IEC 61508 defines four discrete Safety Integrity Levels (SIL) from SIL 1 to SIL 4. Each level corresponds to the probability range for the failure of a safety function. The higher the SIL of the safety-instrumented system, the higher probability that the required safety function will work.

The achievable SIL is determined by the following safety characteristics:

- Average probability of dangerous failure of a safety function in case of demand (PFD_{AVG})
- Hardware fault tolerance (HFT)
- Safe failure fractions (SFF)

USB

The Universal Serial Bus (USB) is a serial bus system for connecting a PC/laptop to external devices such as: modems.

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