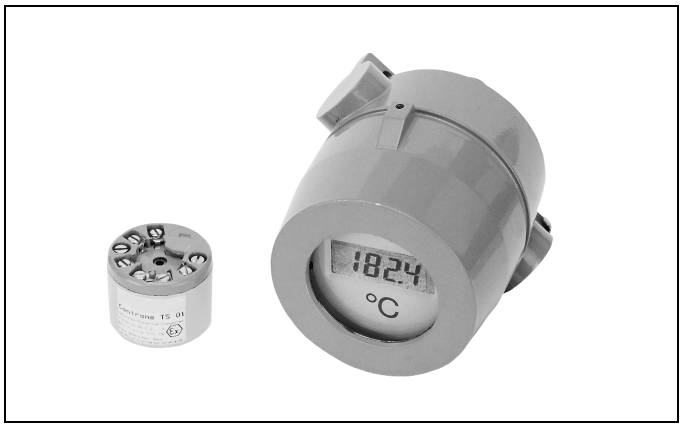
TS 11, TS 11-Ex

Intelligent transmitter
for temperature
sensor head mounting

Operating Manual 42/11-44 EN Rev. 2.0



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Important Instructions for Your Safety!
Please read and observe!

Correct and safe operation the apparatus calls for appropriate transportation and storage, expert installation and commissioning as well as correct operation and meticulous maintenance.

Only those persons conversant with the installation, commissioning, operation and maintenance of similar apparatuses and who possess the necessary qualifications are allowed to work on the apparatus.

Please take note of
- the contents of this Operating Manual,
- the safety regulations affixed to the apparatus,
- the safety regulations pertaining to the installation and operation of electrical systems as well as
- the directives and guidelines on explosion protection.

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

This apparatus has been designed and tested in accordance with DIN VDE 0411 Part 1, “Safety requirements for electronic measuring apparatuses”, and has been supplied in a safe condition. In order to retain this condition and to ensure safe operation, the safety instructions in this Operating Manual bearing the headline “Caution” must be observed. Otherwise, persons can be endangered and the apparatus itself as well as other equipment and facilities can be damaged.

The user must ensure that units connected to the apparatus fulfil the appropriate requirements of the accident prevention regulations VBG4.

If the information in this Operating Manual should prove to be insufficient in any point, the Hartmann & Braun Service Department will be delighted to give you more information.

Short description

The Transmitter is used to measure temperature and other process variables. It converts the input variable into a load-independent direct current 4...20 mA.

Installation and Commissioning

Scope of delivery

The following will be delivered with the Transmitter:
- 1 Operating Manual
- 1 Set of labelling plates

A set of labels is inclosed in the delivery of Transmitter.

Rating plate inscription


protective insulation


internal reference point


input


electrical power


output


observe Operating Manual!

electrical apparatus tested for conformity

measured value increasing − overrange

measured value decreasing underrange

LKS LKS interface

FSK FSK interface

1. Mounting location

Position of use
as required

Ambient temperature
−20...+70 °C with display
−40...+85 °C without display

Condensation
admissible with insulated terminals

2. Mounting

⚠ Attention

When mounting the transmitter bear in mind the directives governing electrical systems in hazardous areas (ElexV), the regulations pertaining to the installation of electrical systems in hazardous areas (DIN VDE 0165/2.91) and the Certificate of Conformity (PTB No.Ex-95.D.2181 X).

Mounting possibilities

− in sensor head (see fig. 1)

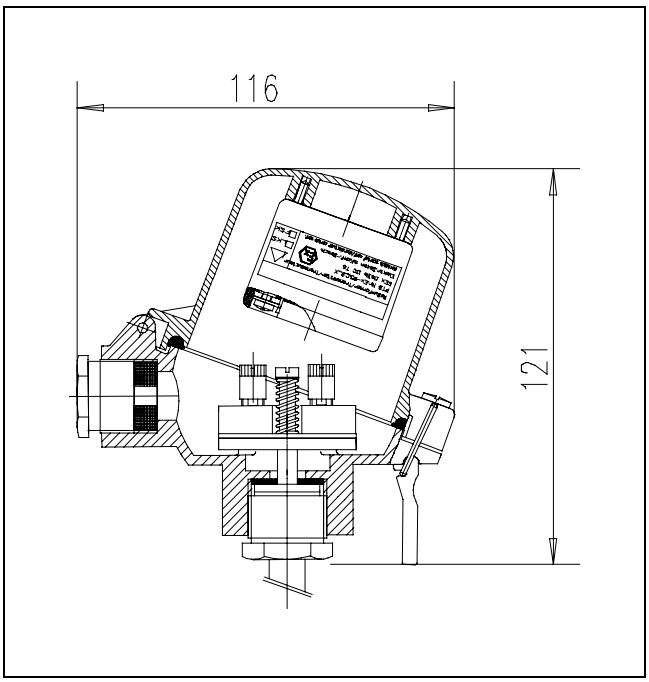

Fig. 1 Dimensional drawing − Mounting in sensor head
Z-18157 (dimensions in mm)

– on top-hat rail to DIN EN 50 022 (see fig. 2)

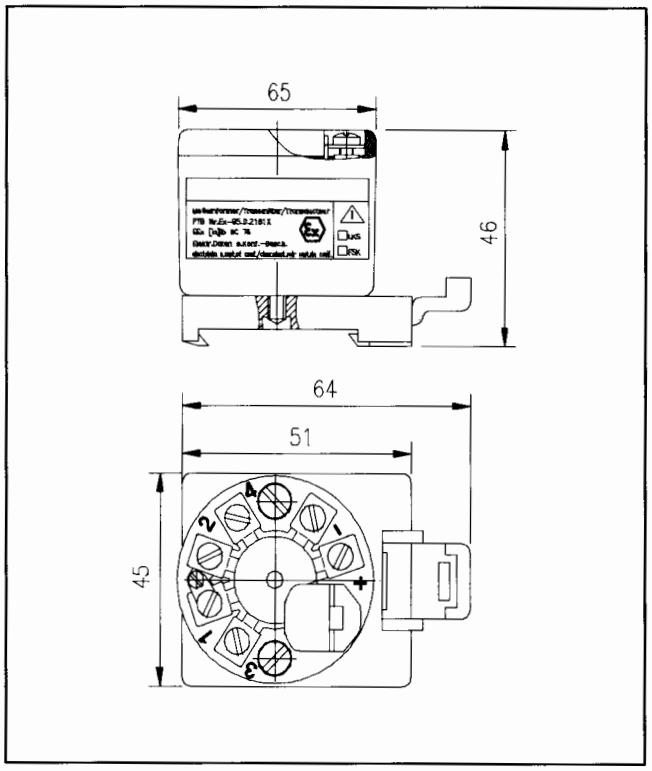

Fig. 2 Dimensional drawing – Mounting on top-hat rail
Z-18158 (dimensions in mm)

3. Connecting

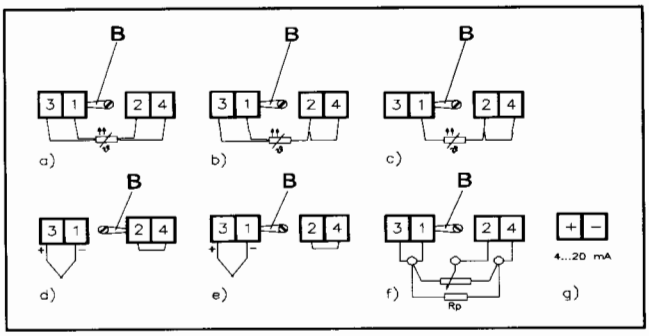

Fig. 3 Connection diagram
Z-18158 *B* Jumper
- a) Resistance thermometer or resistance measurement in 4-wire circuit
- b) Resistance thermometer or resistance measurement in 3-wire circuit
- c) Resistance thermometer or resistance measurement in 2-wire circuit
- d) Thermocouple measurement with internal reference junction
- e) Thermocouple or voltage measurement without internal reference junction
- f) Potentiometer input
- g) Output signal

Connecting the transmitter with FSK interface or LKS interface

− soldered connection and
− screw connection (screw terminals for wire 1,5 mm^2)

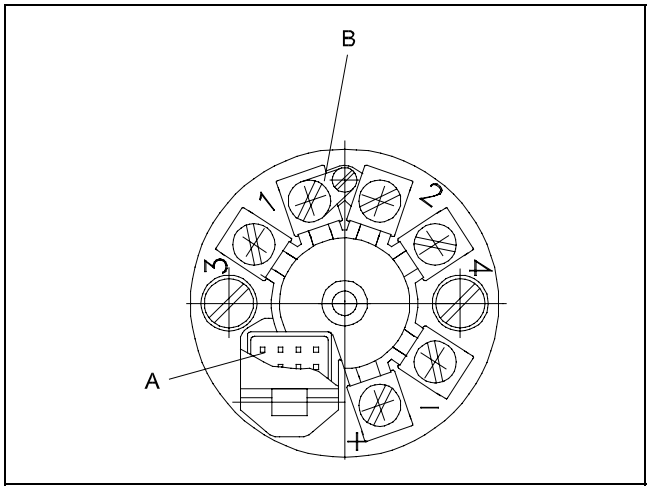

Fig. 4 Connecting the transmitter with FSK interface
Z-18160 or LKS interface
A Connection for parameterization plug LKS or digital display
B Jumper

4. Commissioning

⚠ Attention

When the apparatus is connected to its supply, terminals may be live, and the opening of covers or removal of parts is likely to expose live parts.

Safe isolation from circuits hazardous to the touch is only guaranteed if the units connected meet the requirements to VDE 0106 part 101 (basic requirements for safe isolation).

For safe isolation, lay instrument lines separately from circuits hazardous to the touch or provide additional insulation.

If, for functional reasons, the intrinsically safe current circuit has to be earthed through connection to the potential equalization, it may only be earthed at one point.

When a unit with a certified intrinsically safe output circuit is connected to transmitter evidence of the intrinsic safety of the interconnection must be provided to DIN VDE 0165/2.91. Please observe the maximum values stated in the Certificate of Conformity!

1. Open cover or connection head.
2. Connect sensor.
3. Connect power supply.
4. Close cover or connection head.
5. Connect power supply.

5. Line balancing

Necessary for:
- Resistance thermometer or resistance measurement in 2-wire circuit.
- Resistance thermometer or resistance measurement in 3-wire circuit (line resistances are not the same in each conductor). If the line resistances are not the same for each conductor, symmetry can be restored using a software.

Not required for:
- Resistance thermometer or resistance measurement in 3-wire circuit (line resistances must be the same in each conductor).
- Resistance thermometer or resistance measurement in 4-wire circuit.

Line balancing with software

Menu Device data / Expert / Unit / Adjustement / Line balancing.

Line balancing on the unit without PC

1. Parameterize transmitter as Pt 100 2-wire circuit.
2. Short-circuit sensor on site.
3. Close jumper terminals 1 and 3.
4. Wait for 30 seconds.
5. Open jumper terminals 1 and 3.
6. Connect sensor.

6. Adjustment

Transmitter is fully adjusted on delivery.

Communication

Communication with the transmitter is provided via a software.

–	PC	IBM or compatible
–	Memory	640 KByte RAM
–	Floppy drive	3½˝, 1,44 MByte
–	Monitor	Monochrom, Color
–	Graphics card	CGA, MCGA, EGA, VGA
–	Interfaces	1 x serial: RS 232C
		1 x parallel: for printer connection (optional)
–	Operating system	MS-DOS 3.2 or higher

The following interfaces are available, depending on the communication between the PC and the transmitter:

Local Communication Interface (LSK)

⚠ Attention

Potential separation is necessary with the LKS adapter (RS 232C at the PC) if the output of the transmitter (4...20 mA) and the PC are electrically connected to earth, as otherwise there might be incorrect measured values.

Ensure correct polarity of the LKS adapter on the transmitter.

Communication with LKS adapter is only permitted outside the hazardous areas (see PTB no.Ex-95.D.2181 X).

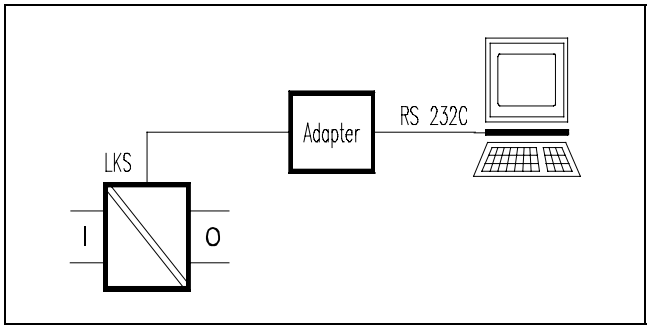

Fig. 5 PC-communication with LKS interface and LKS adapter
Z-18161

Equipment:
- PC with software
- LKS adapter

Both off-line and on-line communication are possible with transmitters with the LKS interface:

off-line communication
- Transmitter not operational (outside the hazardous area). The transmitter can be parameterized without power supply.

on-line communication
- Transmitter and sensor operational, but outside the hazardous area.

Frequency Shift Keying interface (FSK)

Equipment:
- PC with software
- FSK modem with terminal leads
- FSK bus connection card

With transmitters with the FSK interface only on-line communication is possible.

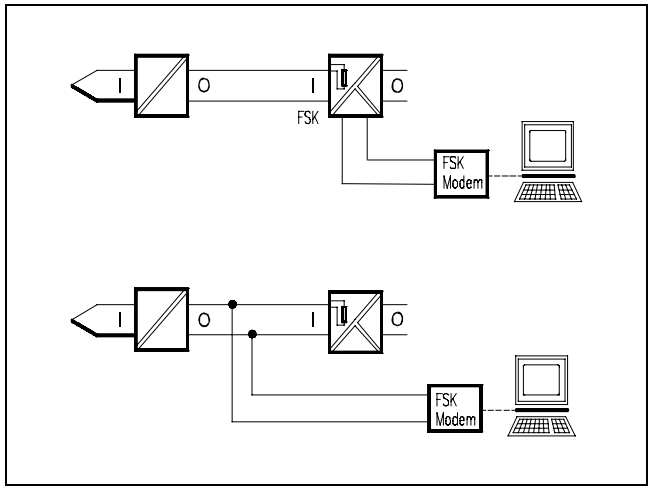

Fig. 6 PC-communication with FSK interface and FSK modem
Z-18162

FSK bus

The FSK interface may be connected to a bus. Up to 7000 different transmitters can be connected in parallel on the terminal level (FSK terminals of the supply unit). This connection is routed via the FSK bus connection card to the front panel (sockets).

FSK socket contacts on the front panel of the transmitter supply unit allow for a stand-alone operation, i.e.when plugging-in, the FSK connection in the terminal level will be interrupted.

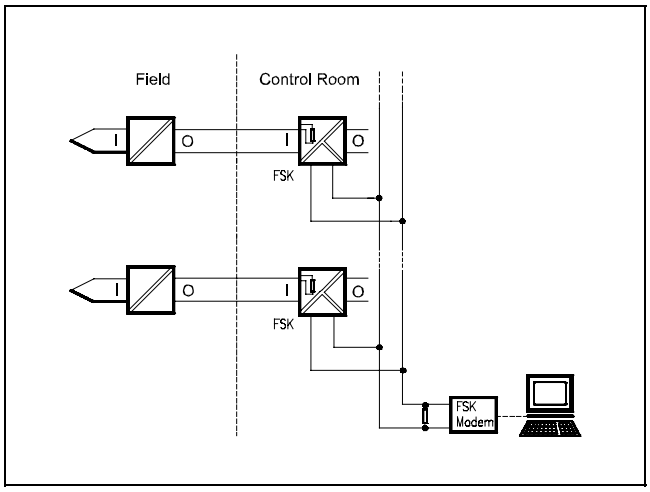

Fig. 7 PC communication with FSK bus (example)
Z-18163

The transmitter is factory-set to the bus address 00000:00. This address does not permit bus operation. Bus operation is only possible if set to 00:01. Setting of the bus address (> 00:00) is possible with PC software.

Device data

The transmitter is supplied with standard parameters (see table 1) or customer-specific parameters.

	Standard parameters
Sensor	Pt 100 / 3-wire circuit
Measuring range	0...100 °C
Output	4...20 mA
Underranging	3,6 mA
Overranging	22 mA
Output behaviour in the event of sensor fault	overranging
Damping / Response time	0,5 s
Display	0...100 °C

Tab. 1 Standard parameters

Standard parameters can be activated with PC software.

Maintenance

⚠ Attention

Work can be carried out on an explosion-protected apparatus by any electrician or in any workshop. However, the apparatus must be checked and certified by an expert before taking it into operation. This is not necessary if the work has been carried out by the manufacturer's authorized personnel.

Before beginning work on the instrument, the safety measures pertaining to the explosion protection must absolutely be borne in mind.

Whenever it is likely that protection has been impaired, the unit shall be made inoperative and be secured against any unintended operation.

It must be assumed that the protection has been impaired when
- **the unit shows visible signs of damage**
- **the unit no longer functions**
- **the unit has been stored for a long time under unfavourable conditions**
- **the unit has been subjected to adverse transport conditions.**

The transmitter does not require any maintenance. In the event of errors, the power source should first be inspected, then the source, connection leads and output circuit.

Description

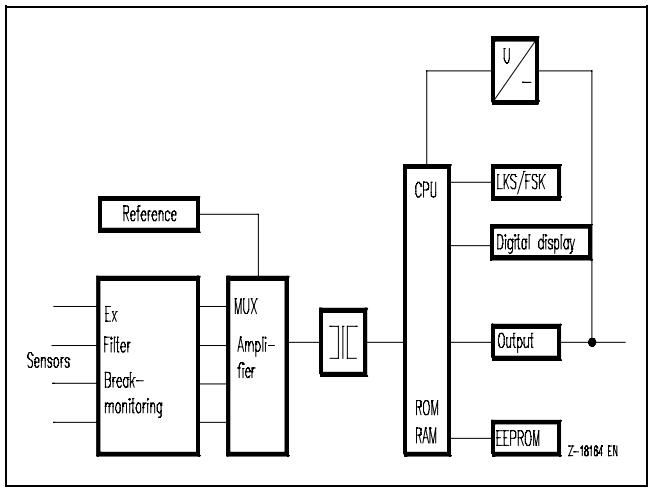

Fig. 8 Functional diagram
Z-18164

The input signals are routed via the **input protection circuit** to the **measuring point selector switch MUX**. The standard input variables (mV, Ω) are adapted to the input voltage range of the amplifier by means of a filter network. The input signal is routed to the CPU via the MUX, the amplifier, the A/D converter and the electrical isolation.

The (sensor) **break monitoring** checks the sensor impedance for maximum value. **Power supply** is via output current with an electrically isolated d.c.-d.c. converter. CPU processes self-monitoring, analog values and communication in sequence.

RAM and **ROM** contain operational data, firmware and fixed linearization tables. **EEPROM** contains user-specific parameter setting data.

Communication with the PC or with other systems is possible via interface **LKS** or interface **FSK**.

Functional modules

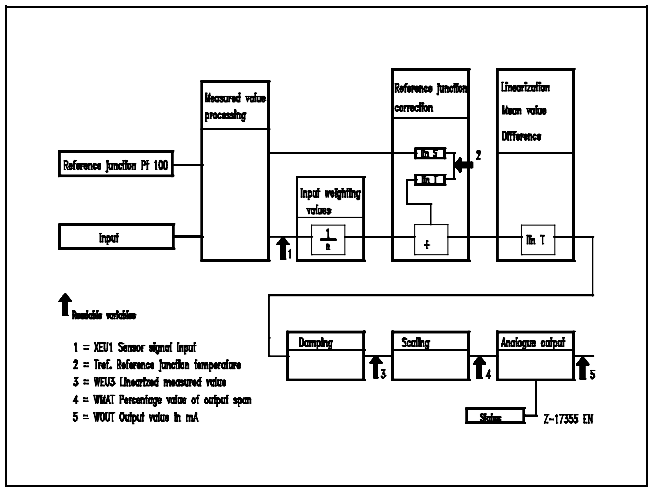

Fig. 9 Functional modules
Z-18165

Measured value processing

Mesuring range setting (sensor selection)
Sensor monitoring (break, short circuit)
Reference junction measurement for internal reference point, line resistance and series resistance of the sensor

Reference junction compensation

by means of internal reference junction

Linearization

based on standardized curves or customized (maximum 32 points)

Damping

Filter with 1st order delay (τ = 0.5...100 s)

Scaling

matching in the range 0 %...100 %.

Analog output

Underranging/overranging
Output action in the event of sensor and instrument fault

Technical data

Input

Resistance thermometers can be parameterized for
2-, 3- and 4-wire circuits

Thermocouples
can be parameterized with internal/external/without reference point

Input	Maximum span	Minimum Span
Ω	(0[1])5...391 Ω	6,7 Ω
Pt 100	−200...850 °C	20 K
mV	−8...120 mV[2]	2 mV

Tab. 2 1 0 Ω only if short-circuit monitoring is off
2 the minimum lower-range value possible corresponds to the sum of −8 mV full modulation and the thermovoltage of the maximum reference junction temperature:
e.g. Thermocouple Type J;
expected maximum reference junction temperature 40 °C corresponds to 2.058 mV;
−8 mV + 2.058 mV = −5.942 mV corresponds to −133 °C minimum lower-range value

Measuring range
can be parameterized

Input current
thermocouple < 70 nA

Measuring current
Pt 100, Ni 100 approximately 0.3 mA

Sensor monitoring
mV measurement
Break: gradient > 3 mV/s
Response threshold > 1.5 MΩ or > 120 mV
Ω measurement
Break: gradient > 391 Ω
Short-circuit: response threshold < 5 Ω

Line resistance

2-wire circuitry (balancing with/without PC possible):
Line resistance < 10 Ω

3-wire circuitry (balancing with PC possible):
0...10 Ω per wire, symmetrical

4-wire circuitry
0...50 Ω per wire

Input weighting values
n = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 1/2

Internal reference junction
built-in Pt100

Linearisation
according to normed characteristics
resistance thermometer Pt100, Ni100
Thermocouples Types B, E, J, K, L, N, R, S, T, U or
customer-specific (maximum 32 tiepoints) built-in Pt 100

Output

Output signal (rising/falling)
4...20 mA
rising/falling characteristic

Output simulation constant value
3.5...22 mA selectable

Supply voltage
11.5...42 V for non-ex version
11.5...29.4 V for ex version

Current drain
< 2.9 mA LKS
< 3.6 mA FSK

Maximum output current
23.6 mA

Permissible load and line resistance

$$R \leq \frac{U_s - 11.5\ V}{I_{a\ max}}$$

U_s = supply voltage
$I_{a\ max.}$ = max. permissible output current

Permissible residual ripple of the supply voltage
FSK: 0.5 V (peak-to-peak) < 120 Hz
LKS: 1 V (peak-to-peak) < 120 Hz

Residual ripple of the output signal
< 0.5 % (peak-to-peak)

Damping
digital filter with selectable time constant
(τ = 0; 0.5...100 s)

Response time
according to DIN IEC 770

selected time constante τ	Response time T
0 s	typically 0.8 s, maximum 1 s
0.5...100 s	2...400 s (T = 4τ)

Tab. 3

Output behaviour with sensor oder unit error

Underranging can be parameter-defined
≥ 2.9 (with LKS) ...4 mA
≥ 3.6 (with FSK) ...4 mA
factory setting: 3.6 mA

Overranging can be parameter-defined
20...23,6 mA
factory setting: 22 mA

Sensor switch-on delay
12 s

Interfaces

Local Communication Interface LKS
for workshop parameterization (power supplied from PC in off-line operation)

Frequency Shift Keying FSK
for remote parameterization and bus operation

Data format
HART protocol

Digital Display

Display
Single-line, 3.5 digits, 7 segments, 12.7 mm high
e.g. −199.9...00.0...199.9

Measuring range
Decimal point can be parameterized

Flashing
approximately 0.5 Hz with unit error, sensor error, overranging or underranging

Characteristics under nominal conditions (according to IEC 770)

Error of measurement including conformity error
Resistance measurement / Pt 100
typically 0.2 % of span; minimum 0.2 K / 80 mΩ
Thermocouple measurement / mV-measurement
typically 0.15 % of span; minimum 15 µV

Variations

Variation of the internal reference point
integrated Pt 100 according to DIN IEC 751 Cl. B

Variation of ambient temperature (related to measuring span)
maximum variation per 10 K:

for Pt 100

$$Variation = 0{,}05\,\% + 0{,}05\,\% \frac{mv}{msp} + 100\,\% \frac{0{,}063\ °C}{msp}$$

mv measuring value in °C
msp measuring span in °C (end − start > 0 !)

for Ω input

$$Variation = 0{,}05\,\% + 0{,}05\,\% \frac{mv}{msp} + 100\,\% \frac{10\ m\Omega}{msp}$$

mv measuring value in Ω
msp measuring span in Ω (end − start > 0 !)

for thermocouple

$$Variation = 0{,}05\,\% + 0{,}05\,\% \frac{mv}{msp} + 100\,\% \frac{X}{msp} + 100\,\% \frac{0{,}1\ °C}{msp}$$

mv measuring value in °C
msp measuring span in °C (end − start > 0 !)
X temperature in °C that (at the measuring point) corrsponds to an increase of 2 µV

Notice
The term “0,1 °C/msp” stands for the additional variation caused by the reference point.

for mV input

$$Fehler = 0{,}05\,\% + 0{,}05\,\% \frac{MW}{MSp} + 100\,\% \frac{2\ \mu V}{MSp}$$

mv measuring value in mV
msp measuring span in mV (end − start > 0 !)

Example thermocouple Type K

mv 250 °C
msp 1000 °C
X 0.05 °C

0.05 % + 0.05 % × (250 °C/1000 °C) + 100 % × (0.05 °C/1000 °C) + 100 % × (0.1 °C/1000 °C) =
0.05 % + 0.05 % × 0.25 + 100 % × 0.00005 + 100 % × 0.0001 =
0.05 % + 0.0125 % + 0.005 % + 0.01 % =
0.0775 %

Power supply
< 0.01 % / 10 V voltage variation

Electromagnetic compatibility
tested with standard paramerization (see tab. 1 on page 16)

General interference immunity based on NAMUR recommendation for: Transient overvoltage
Discharge of static electricity
Electromagnetic fields

Type of test	Severity	Variation	Standard
Burst on Signal line	1 kV	< 1 %, A[1]	IEC 801-4 NE 21
radiated HF field 150 kHz...80 MHz 27 MHz...1 GHz	 10 V/m 10 V/m	 < 2 % < 2 %	 IEC 801-3 IEC 801-3
Discharge static electricity Contac discharge Air discharge	 6 kV 8 kV	 A[1] A[1]	 IEC 801-2 IEC 801-2 NE 21
Electromagnetic fields 150 kHz...80 MHz	 10 V	 < 2 %	IEC 801-6 with EM 101

Tab. 4 1 Potential balancing nessecary

General and safety data

Climatic capabilities

Climatic category
GPC to DIN 40 040

Ambient temperature
−20...+70 °C with display
−40...+85 °C without display

Transportation and storage temperature
−20...+90 °C for with display
−40...+100 °C for without display

Relative humidity
≤ 80 % with display
≤ 100 % without display

Condensation
admissible with insulated terminals

Mechanical stress

Tested
according to DIN IEC 68 part 2-27 and DIN IEC 68 part 6
during transportation
Shock 30g / 18 ms / 18 Shocks
During operation
vibration 2g / 0.15 mm / 5...150 Hz / 3 x 5 cykles
2g / 10 mm / 1...35 Hz / 3 x 1 cykles

Seismic stress
heavy to very heavy earthquakes according to draft DIN IEC 50A(CO) 179

Connection, case, mounting

Electrical connections
soldered connection and
Screw connection (screw terminals for wire 1.5 mm^2)

Degree of protection according to DIN 40 050
integrated in field case: IP 65
integrated in connection head: IP 54 or higher

Degree of pollution
2

Overvoltage category
III

Test voltage according to DIN VDE 0411
Input against output 800 V DC
Circuits against case 800 V DC

Case
coated with zinc die-casting powder

Terminal board
glass-reinforced polycarbonate

Color
with explosion-protection: blue
without explosion-protection: black

Position of use
as required

Mass
approximately 110 g

Explosion protection
(Please pay attention to Certificate of conformity)

Intrinsic safety for type of protection
EEx [ia]ib IIC T6

Certificate of conformity
PTB No. Ex-95.D.2181 X
Dust ex-zone 10
(applied for)

Ambient temperature
T1...T5 +85 °C
T6 +70 °C

Mounting
within or outside the hazardous area

Supply circuit
EEx ib IIC
for connection to a certified, instrinsically safe circuit with the following maximum values:
U = 29,4 V; I = 130 mA; P = 800 mW

Effective internal inductance L_i
see Certificate of conformity

Effective internal capacitance C_i
see Certificate of conformity

Signal circuit
EEx ia IIC / IIB or EEx ib IIC / IIB

Maximum values of the signal circuit
see Certificate of conformity

Digital indicator
PTB-Nr. Ex-95.D.2181 X 1. supplement

Measuring with thermocouple type B

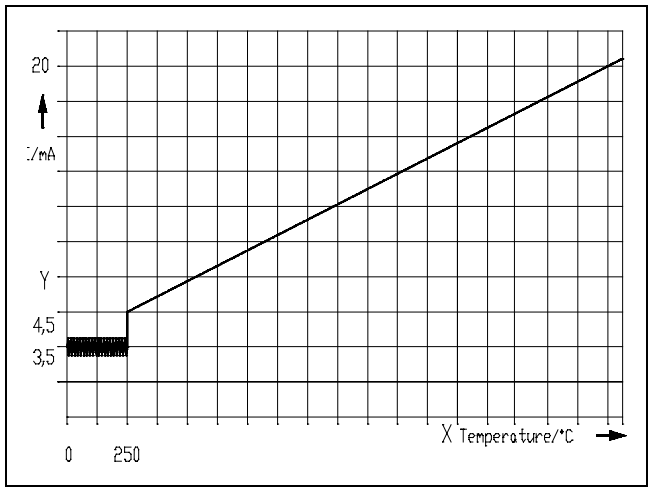

Fig. 10 Signal curve
Z-17350

- Thermocouple type B is connected without internal reference point. An active internal reference point generates an additional error of measurement of:
  - 100 µA at 250 °C
  - 0 µA at x °C (upper range limit)

  Intermediate values are linear between the above mentioned values.

- With set spans with start of scale below 250 °C, signal curve is as represented in fig. 10 due to physical laws.

The value Y for 250°C is then calculated as follows:

$$Y\,/\,mA = \left(\frac{16\,mA}{x\ °C} \times 250\,°C\right) + 4\,mA$$

with x = upper range limit and start of scale at 0 °C

Packaging for transport or for return to manufacturer

If the original packing is no longer available, the apparatus must be wrapped in an insulating air foil or corrugated board and packed in a sufficiently large crate lined with shock absorbing material (foamed material or similar) for the transportation. The amount of cushioning must be adapted to the weight of the apparatus and to the type of transport. The crate must be labelled “Fragile”.

For overseas shipment the apparatus must additionally be sealed airtight in 0.2 mm thick polyethylene together with a desiccant (e.g. silica gel). The quantity of the desiccant must correspond to the packing volume and the probable duration of transportation (at least 3 months). Furthermore, for this type of shipment the crate should be lined with a double layer of kraft paper.

Subject to technical changes.

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