

# TTF350

## Field mounted Temperature Transmitter

Sensor adjustment  
Redundancy 2 x Pt100 3-L  
Sensor drift monitoring



### HART, Dual-compartment Housing Technology, Pt100 (RTD), thermocouples

#### Input

- Resistance thermometers, thermocouples
- Resistance-type transmitter (0 ... 5000  $\Omega$ )
- Voltages, mV transmitter (-125 ... 1100 mV)

#### Input functionality

- 1 or 2 sensors (e.g., 2 x Pt100 3-L)
- Sensor backup/redundancy
- Sensor drift monitoring

#### Output

- 2-wire technique
- 4 ... 20 mA temperature linear, HART signal

#### Measurement error

- 0.1 K

#### Specific linearization

- Callendar-Van Dusen coefficients
- Table of variate pairs / 32 points

#### Fieldhousing

- Dual-compartment technology
- 3 cable glands (2 sensor inputs)
- Protection class IP 66 / 67, NEMA 4X, ENCL 4X

#### Continuous sensor and self-monitoring

- Supply voltage monitoring
- Wire break and corrosion monitoring (NE 89)
- Extended diagnostics (NE 107)

#### Device safety in accordance with NE 53, NE 79

#### Approvals for explosion protection

- Intrinsic Safety: ATEX EEx ia (Zone 0), FM, CSA
- Non-incendive: ATEX EEx n A
- Dust-ignition Proof: ATEX / Zone 20
- Flameproof Enclosures: ATEX / Zone 1, FM, CSA

#### Configuration

- Display with TTF350 configuration options
- FDT/DTM (e.g., SMART VISION DSV401)
- EDD

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## 1 Technical data

### 1.1 Input

#### 1.1.1 Resistance

##### RTD resistance thermometer

Pt100 in acc. with DIN IEC 60751, JIS, MIL, Ni in acc. with DIN 43760, Cu

##### Resistance measurement

0 ... 500  $\Omega$

0 ... 5000  $\Omega$

##### Sensor connections

2-, 3-, 4-wire circuit

##### Connecting cables

2-, 3-, 4-wire max. sensor line resistance ( $R_W$ ) for each wire 50  $\Omega$   
in acc. with NE 89 (March 2003);

(3-wire balanced, 2-wire circuit compensation up to 100  $\Omega$  sensor  
total line resistance)

##### Measurement current

< 300  $\mu$ A

##### Sensor short-circuit

< 5  $\Omega$  (for RTD)

##### Sensor wire break (temperature resistance measurement 2-, 3-, 4-wire)

Measuring range 0 ... 500  $\Omega$  > 0.6 ... 10 k $\Omega$

Measuring range 0 ... 5 k $\Omega$  > 5.3 ... 10 k $\Omega$

##### Corrosion detection in accordance with NAMUR NE 89

3-wire resistance reading > 50  $\Omega$

4-wire resistance reading > 50  $\Omega$

#### 1.1.2 Thermocouples/Voltages

##### Types

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

##### Voltages

-125 mV ... 125 mV

-125 mV ... 1100 mV

##### Connecting cables

Max. sensor line resistance ( $R_W$ ) for each line 1.5 k $\Omega$ , total 3 k $\Omega$

##### Sensor wire break monitoring in accordance with Namur NE 89

pulsed with 1  $\mu$ A outside the measurement interval

Thermoelement measurement 5.3 ... 10 k $\Omega$

Voltage measurement 5.3 ... 10 k $\Omega$

##### Input resistance

> 10 M $\Omega$

##### Internal reference junction

Pt100, DIN IEC 60751 Cl. B

(no jumpers necessary)

##### Customer specific curve, 32-tie points

Resistance measurement up to max. 5 k $\Omega$

Voltages up to max. 1.1 V

##### Sensor matching

via Callendar van Dusen coefficients

via table of 32 sampling points

via single point (offset adjustment)

via two point adjustment

##### Input functionality

1 Sensor

2 Sensors:

mean measurement

Differential measurement: Zero point where  $I_a = 4$  mA

Differential measurement: Zero point where  $I_a = 12$  mA

Sensor redundancy

##### Sensor fault signaling

RTD sensor:

Short circuit and wire break

Linear resistance measurement:

Wire break

Thermocouple:

Wire break

Linear voltage measurement:

Wire break

### 1.2 Output

##### Transmission characteristics

temperature linear

resistance linear

voltage linear

##### Output signal

Configurable 4 ... 20 mA (standard)

Configurable 20 ... 4 mA

(NE43 dynamic range: 3,8 ... 20.5 mA)

##### Simulation mode

3,5 ... 23,6 mA

##### Induced current consumption

< 3,5 mA

##### Maximum output current

23,6 mA

##### Configurable error current signal

override 22 mA (20.0 ... 23.6 mA)

underdrive 3.6 mA (3.5 ... 4.0 mA)

Configurable analog alarm pulse if

maintenance required.

In redundancy mode when a sensor fails and/or in

drift mode if the maximum sensor drift value will exceeded.

(For details, refer to OI TTF350.)

##### Two configurable warning limits

HART-Signal/diagnostic bit information

##### Two configurable alarm limits

HART-Signal/diagnostic bit information

### 1.3 Power supply (polarity safe)

(2-wire technique; power lines = signal lines)

#### Supply voltage

Non ignition-proof application with or without LCD display:

$$U_s = 11 \dots 42 \text{ V DC}$$

Ignition-proof applications with or without LCD display:

$$U_s = 11 \dots 30 \text{ V DC}$$

#### Max. permissible residual ripple for supply voltage

Max. permissible ripple for supply voltage during communication in accordance with HART FSK "Physical Layer" specification, version 8.1 (08/1999) Section 8.1

#### Undervoltage detection

$$U_{\text{Terminal-Mu}} < 10 \text{ V results in } I_a = 3.6 \text{ mA}$$

#### Max. load

$$R_{\text{Load}} = (\text{supply voltage} - 11 \text{ V}) / 22 \text{ mA}$$

#### Max. load $\Omega$ depending on supply voltage (V DC)

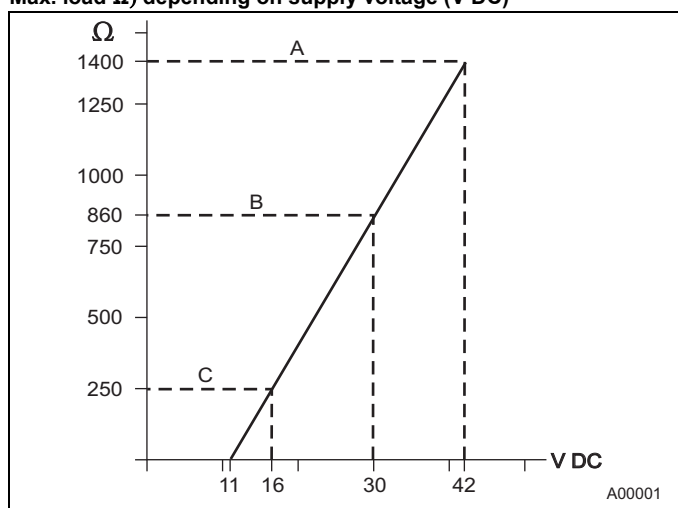


Fig. 1

- A TTF350, C HART communication - resistor  
B TTF350 in EEx ia design

#### Max. power consumption

$$P = U_s \times 22 \text{ mA}$$

e.g.,  $U_s = 24 \text{ V} \rightarrow P_{\text{max}} = 0.528 \text{ W}$

## 2 General information

<b>Galvanic isolation (input/output)</b>	3.5 kV AC (approx. 2.5 kV DC) 60 s (insulation test voltage)
<b>MTBF time</b>	28 years at 60 °C ambient temperature
<b>Input filter</b>	50 / 60 Hz
<b>Switch-on delay</b>	< 10 s ( $I_a \leq 3.6 \text{ mA}$ during starting cycle)
<b>Warm-up time</b>	5 min.
<b>Ramp-up time t90</b>	400 ... 1000 ms
<b>Reading updated<sup>1)</sup></b>	10/s with 1 sensor, 5/s with 2 sensors
<b>Output filter</b>	Digital filter 1st order: 0 ... 100 s

<sup>1)</sup> depending on sensor type and sensor circuit

### 2.1 Ambient conditions

#### Ambient temperature:

Standard: -40 ... 85 °C / -40 ... 185 °F

Optional: -50 ... 85 °C / -58 ... 185 °F

For use with LCD display HMI type B:

-20 ... 70 °C / -4 ... 158 °F

For ignition-proof design, see prototype test certificate PTB 05 ATEX 2079 X.

#### Transport / storage

temperature: -40 ... 85 °C / -40 ... 185 °F

#### Climate class:

Cx (-40 ... 85 °C / -40 ... 185 °F, 5 ... 95% relative humidity)  
DIN EN 60654-1

#### Max. permissible humidity:

99% relative humidity IEC 60068-2-78

#### Vibration resistance\*:

10 ... 2000 Hz at 5 g acc. to IEC 60068-2-6

#### Shock\*:

gn = 30 in accordance with IEC 60068-2-27

#### Earthquake resistance:

Acc. to EN1473

#### Salt fog:

acc. to IEC 60068-2-11

#### Protection class:

IP66 and IP67; NEMA 4X, ENCL 4X

\* applies to operation and transport

### 2.2 Electromagnetic compatibility

Emitted interference in accordance with IEC 61326 (2006) and Namur NE21 (02/2004)

### 2.3 Interference immunity

Interference immune in accordance with IEC 61326 (2002) and Namur NE21 (02/2004)

Pt100: Measuring range 0 ... 100 °C, span 100 K

Type of test	Testing accuracy	Influence
Burst to signal/data lines	2 kV	< 0.5%
Static discharge		
• Contact plate (indirect)	8 kV	no
• Supply terminals <sup>1)</sup>	6 kV	no
• Sensor terminals <sup>1)</sup>	4 kV	no
Radiated field		
80 MHz ... 2 GHz	10 V/m	< 0.5%
Coupling		
150 kHz ... 80 MHz	10 V	< 0.5%
Surge		
between the lines	0.5 kV	no malfunction
Line to earth	1 kV	no malfunction

<sup>1)</sup> Air discharge (at 1 mm distance)

## 2.4 Measuring accuracy

Includes linearity deviation, reproducibility/hysteresis at 23 °C ± 5 K and 20 V supply voltage

Information on measuring accuracy corresponds to 3 σ (Gaussian distribution)

Input element		Measuring range limits	Minimum span	Digital measuring accuracy (24-bit A/D converter)	D/A accuracy <sup>1)</sup> (1 6-bit DA)
Standard	Sensor				
<b>Resistance sensors/potentiometer</b>					
<b>DIN IEC 60 751</b>	RTD Pt10 (a=0,003850)	-200 ... 850 °C / -328 ... 1562 °F	10 °C / 18 °F	± 0,80 °C / ± 1,44 °F	± 0,05 %
	RTD Pt50 (a=0,003850)	-200 ... 850 °C / -328 ... 1562 °F	10 °C / 18 °F	± 0,16 °C / ± 0,29 °F	± 0,05 %
	RTD Pt100 (a=0,003850) <sup>2</sup>	<b>-200 ... 850 °C / -328 ... 1562 °F</b>	10 °C / 18 °F	± 0,08 °C / ± 0,14 °F	± 0,05 %
	RTD Pt200 (a=0,003850)	-200 ... 850 °C / -328 ... 1562 °F	10 °C / 18 °F	± 0,24 °C / ± 0,43 °F	± 0,05 %
	RTD Pt500 (a=0,003850)	-200 ... 850 °C / -328 ... 1562 °F	10 °C / 18 °F	± 0,16 °C / ± 0,29 °F	± 0,05 %
	RTD Pt1000 (a=0,003850)	-200 ... 850 °C / -328 ... 1562 °F	10 °C / 18 °F	± 0,08 °C / ± 0,14 °F	± 0,05 %
<b>JIS C1604-81</b>	RTD Pt10 (a=0,003916)	-200 ... 645 °C / -328 ... 1193 °F	10 °C / 18 °F	± 0,80 °C / ± 1,44 °F	± 0,05 %
	RTD Pt50 (a=0,003916)	-200 ... 645 °C / -328 ... 1193 °F	10 °C / 18 °F	± 0,16 °C / ± 0,29 °F	± 0,05 %
	RTD Pt100 (a=0,003916)	-200 ... 645 °C / -328 ... 1193 °F	10 °C / 18 °F	± 0,08 °C / ± 0,14 °F	± 0,05 %
<b>MIL-T-24388</b>	RTD Pt10 (a=0,003920)	-200 ... 850 °C / -328 ... 1562 °F	10 °C / 18 °F	± 0,80 °C / ± 1,44 °F	± 0,05 %
	RTD Pt50 (a=0,003920)	-200 ... 850 °C / -328 ... 1562 °F	10 °C / 18 °F	± 0,16 °C / ± 0,29 °F	± 0,05 %
	RTD Pt100 (a=0,003920)	-200 ... 850 °C / -328 ... 1562 °F	10 °C / 18 °F	± 0,08 °C / ± 0,14 °F	± 0,05 %
	RTD Pt200 (a=0,003920)	-200 ... 850 °C / -328 ... 1562 °F	10 °C / 18 °F	± 0,24 °C / ± 0,43 °F	± 0,05 %
	RTD Pt1000 (a=0,003920)	-200 ... 850 °C / -328 ... 1562 °F	10 °C / 18 °F	± 0,08 °C / ± 0,14 °F	± 0,05 %
<b>DIN 43760</b>	RTD Ni50 (a=0,006180)	-60 ... 250 °C / -76 ... 482 °F	10 °C / 18 °F	± 0,16 °C / ± 0,29 °F	± 0,05 %
	RTD Ni100 (a=0,006180)	-60 ... 250 °C / -76 ... 482 °F	10 °C / 18 °F	± 0,08 °C / ± 0,14 °F	± 0,05 %
	RTD Ni120 (a=0,006180)	-60 ... 250 °C / -76 ... 482 °F	10 °C / 18 °F	± 0,08 °C / ± 0,14 °F	± 0,05 %
	RTD Ni1000 (a=0,006180)	-60 ... 250 °C / -76 ... 482 °F	10 °C / 18 °F	± 0,08 °C / ± 0,14 °F	± 0,05 %
	RTD Cu10 (a=0,004270)	-50 ... 200 °C / -58 ... 392 °F	10 °C / 18 °F	± 0,80 °C / ± 1,44 °F	± 0,05 %
	RTD Cu100 (a=0,004270)	-50 ... 200 °C / -58 ... 392 °F	10 °C / 18 °F	± 0,08 °C / ± 0,14 °F	± 0,05 %
	Resistance measurement	0 ... 500 Ω	4 Ω	± 32 mΩ	± 0,05 %
	Resistance measurement	0 ... 5000 Ω	40 Ω	± 320 mΩ	± 0,05 %
<b>Thermocouples<sup>3)</sup>/voltages</b>					
<b>IEC 584</b>	Type K (Ni10Cr-Ni5)	-270 ... 1372 °C / -454 ... 2502 °F	50 °C / 90 °F	± 0,35 °C / ± 0,63 °F	± 0,05 %
	Type J (Fe-Cu45Ni)	-210 ... 1200 °C / -346 ... 2192 °F	50 °C / 90 °F	± 0,35 °C / ± 0,63 °F	± 0,05 %
	Type N (Ni14CrSi-NiSi)	-270 ... 1300 °C / -454 ... 2372 °F	50 °C / 90 °F	± 0,35 °C / ± 0,63 °F	± 0,05 %
	Type T (Cu-Cu45Ni)	-270 ... 400 °C / -454 ... 752 °F	50 °C / 90 °F	± 0,35 °C / ± 0,63 °F	± 0,05 %
	Type E (Ni10Cr-Cu45Ni)	-270 ... 1000 °C / -454 ... 1832 °F	50 °C / 90 °F	± 0,35 °C / ± 0,63 °F	± 0,05 %
	Type R (Pt13Rh-Pt)	-50 ... 1768 °C / -58 ... 3215 °F	100 °C / 180 °F	± 0,95 °C / ± 1,71 °F	± 0,05 %
	Type S (Pt10Rh-Pt)	-50 ... 1768 °C / -58 ... 3215 °F	100 °C / 180 °F	± 0,95 °C / ± 1,71 °F	± 0,05 %
	Type B (Pt30Rh-Pt6Rh)	-0 ... 1820 °C / +32 ... 3308 °F	100 °C / 180 °F	± 0,95 °C / ± 1,71 °F	± 0,05 %
<b>DIN 43710</b>	Type L (Fe-CuNi)	-200 ... 900 °C / -328 ... 1652 °F	50 °C / 90 °F	± 0,35 °C / ± 0,63 °F	± 0,05 %
	Type U (Cu-CuNi)	-200 ... 600 °C / -328 ... 1112 °F	50 °C / 90 °F	± 0,35 °C / ± 0,63 °F	± 0,05 %
<b>ASTM E 988</b>	Type C	-0 ... 2315 °C / +32 ... 4200 °F	100 °C / 180 °F	± 1,35 °C / ± 2,43 °F	± 0,05 %
	Type D	-0 ... 2315 °C / +32 ... 4200 °F	100 °C / 180 °F	± 1,35 °C / ± 2,43 °F	± 0,05 %
	Voltage measurement	-125 mV ... 125 mV	2 mV	± 12 μV	± 0,05 %
	Voltage measurement	-125 mV ... 1100 mV	20 mV	± 120 μV	± 0,05 %

<sup>1)</sup> percentages refer to the configured measuring span

<sup>2)</sup> Standard model

<sup>3)</sup> include the internal reference junction error for digital accuracy: Pt100, DIN IEC 60751 Cl. B

<sup>4)</sup> without reference junction error

Total accuracy = digital measuring accuracy [°C] + (D/A measuring accuracy [%] x | conf. measuring span [°C] | /100%)

(refer to the block diagram on next page)

### Example 1:

Pt100 (IEC 60751), conf. measuring range 0 ... 100 °C, conf. measuring span = measurement end – measurement start = 100 °C

Digital measuring accuracy: ± 0,08 °C

D/A measuring accuracy ± 0,05% x (100 °C/100%) = ± 0,05 °C

Total accuracy: Digital accuracy + D/A accuracy; ± 0,08 °C + (± 0,05 °C) = ± 0,13 °C

### Example 2:

Thermocouple type K, conf. measuring range 0 ... 1000 °C, conf. measuring span = measurement end – measurement start = 1000 °C

Digital measuring accuracy: ± 0,35 °C

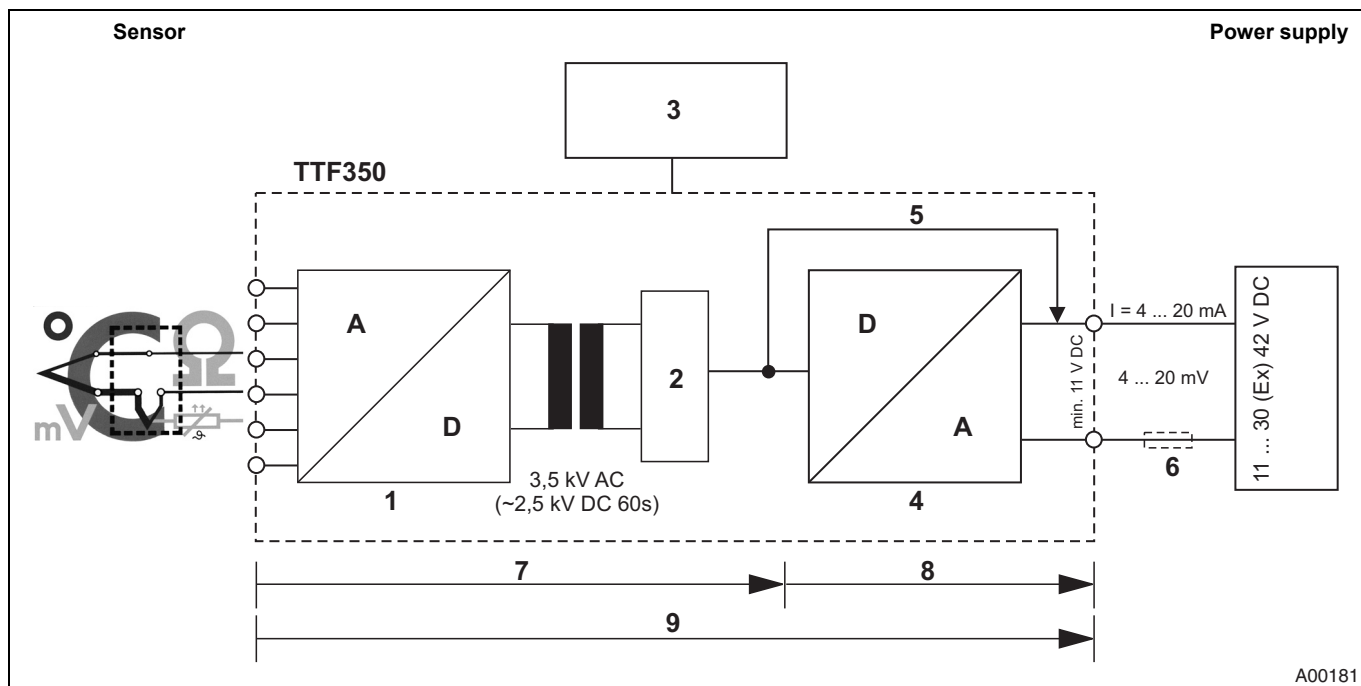
D/A measuring accuracy ± 0,05% x (1000 °C/100%) = ± 0,50 °C

Total accuracy<sup>4)</sup>: Digital accuracy + D/A accuracy; ± 0,35 °C + (± 0,50 °C) = ± 0,85 °C

### Long-term drift

± 0.05 °C or ± 0.05%<sup>1)</sup> per year, the larger value applies.

2.4.1 Block diagram



A00181

Fig. 2

- |   |  |   |  |
|---|--|---|--|
| 1 | 24-bit A/D converter                                 | 6 | Load (observe voltage drop, refer to the section "Terminal connection diagrams") |
| 2 | Microcontroller                                      | 7 | Digital measuring accuracy   |
| 3 | LCD display with TTF300/TTF350 configuration options | 8 | D/A measuring accuracy   |
| 4 | 16-bit D/A converter                                 | 9 | Overall measuring accuracy   |
| 5 | HART signal  |   |  |

## 2.5 Operating conditions

The percentages refer to the configured measuring span.

**Supply voltage influence/load influence:** within the specified limits for the voltage/load the total influence is less than 0.001% per volt

**Common-mode interference** no influence up to 100 V Veff (50 Hz) or 50 VDC

**Ambient temperature influence:** based on 23 °C / 73.4 °F (ambient temperature range: -40 ... 85 °C / -40 °F ... 185 °F)

Sensor	Ambient temperature influence For 1 °C / 1.8 °F dev. to 23 °C / 73,4 °F for digital readings	Ambient temperature influence <sup>1)</sup> For 1 °C / 1.8 °F dev. to 23 °C / 73,4 °F for D/A converter
2-, 3-, 4-wire circuit		
RTD Pt10 IEC, JIS, MIL	± 0.04 °C / ± 0.072 °F	± 0.003 %
RTD Pt50 IEC, JIS, MIL	± 0.008 °C / ± 0.014 °F	± 0.003 %
RTD Pt100 IEC, JIS, MIL	± 0.004 °C / ± 0.007 °F	± 0.003 %
RTD Pt200 IEC, MIL	± 0.02 °C / ± 0.036 °F	± 0.003 %
RTD Pt1000 IEC, MIL	± 0.004 °C / ± 0.007 °F	± 0.003 %
RTD Ni50 DIN 43760	± 0.008 °C / ± 0.014 °F	± 0.003 %
RTD Ni100 DIN 43760	± 0.004 °C / ± 0.007 °F	± 0.003 %
RTD Ni120 DIN 43760	± 0.003 °C / ± 0.005 °F	± 0.003 %
RTD Ni1000 DIN 43760	± 0.004 °C / ± 0.007 °F	± 0.003 %
Resistance measurement 0 ... 500 Ω	± 0.002 Ω	± 0.003 %
Resistance measurement 0 ... 5000 Ω	± 0.02 Ω	± 0.003 %
Thermoelement for all defined types	± [(0.001% x (ME[mV] / MS[mV]) + (100% x (0.009 °C / MS [°C])) <sup>1)</sup>	± 0.003 %
Voltage measurement -125 ... 125 mV	± 1.5 μV	± 0.003 %
-125 ... 1100 mV	± 15 μV	± 0.003 %

<sup>1)</sup> percentages refer to the configured measuring span  
ME - Measuring end, MS - Measuring span

### Example 1

Pt100 configured measuring range 0 ... 100 °C, (measuring span 100 °C), ambient temperature 33 °C

Dev. from standard temperature: 33 ... 23 °C (reference) = 10 °C

Affect of ambient temperature on digital measurement: 10 °C x ± 0.004 °C / °C = ± 0.04 °C

Affect of ambient temperature on D/A converter: 10 °C x (± 0.003 % / °C) x (100 °C / 100 %) = ± 0.03 °C

### Example 2

TC type K, conf. measuring range 0 ... 1000 °C, (measuring span 1000 °C), ambient temperature 33 °C

Measuring start 0 °C corresponds to 0.0 mV; measuring end = 1000 °C corresponds to 41.6 mV; measuring span = 1000 °C or 41.6 mV

Dev. from standard temperature: 33 ... 23 °C (reference) = 10 °C

Affect of ambient temperature on digital measurement: 10 °C x [(± 0.001% x 41.6 mV / 41.6 mV) + (100% x ± 0.009 °C / 1000°C)] x (1000°C / 100%) / °C = ± 0.19 °C

Affect of ambient temperature on D/A converter: 10 °C x [± 0.003 % x 1000 °C / 100 %] / °C = ± 0.3 °C

### Worst case total error analysis

Max. possible total error = SQR [(digital accuracy)<sup>2</sup> + (D/A accuracy) + (digital value temp. influence) + (D/A temp. influence)]

Example 1: Pt100, 0 ... 100°C at 33 °C ambient temperature =  $\sqrt{(0.08^{\circ}\text{C})^2 + (0.05^{\circ}\text{C})^2 + (0.04^{\circ}\text{C})^2 + (0.03^{\circ}\text{C})^2} = 0.10^{\circ}\text{C}$

Example 2: Thermoelement type K, 0 ... 1000 °C at 33 °C ambient temperature =  $\sqrt{(0.35^{\circ}\text{C})^2 + (0.50^{\circ}\text{C})^2 + (0.19^{\circ}\text{C})^2 + (0.3^{\circ}\text{C})^2} = 0.70^{\circ}\text{C}$   
(without reference junction error)

### 3 Mechanical design

**Dimensions:** Refer to dimensioned drawings  
**Weight:** 1,40 kg

- Housing: Aluminum die cast, chromized inside/outside, 70 µm epoxy-coated (aluminum, magnesium content < 6%, copper-free < 0.5%)
- Color: gray RAL9002
- Types of protection: IP66 and IP67; NEMA 4X, ENCL 4X

**Installation conditions:**

- Installation position: No limitations

**Electrical connection:**

- Thread (selectable) 3 x M20 x 1.5 / 3 x 1/2" NPT / 3 x 3/4" NPT (via reducing piece)
- with cable gland 3 x M20 x 1.5:

**Polyamide/gray:**  
Non ignition-proof design, non-incendive max. cable outer diameter 5 ... 9 mm, temp. range acc. to data for cable gland

**Polyamide/blue:**  
EEx ia design, intrinsic safety, max. cable outer diameter 5 ... 9 mm, temp. range acc. to data for cable gland

**Metal cable gland:**  
dust-ignition proof, flame-proof, explosion-proof  
max. cable outer diameter 6 ... 7.5 mm, temp. range -20 ... 90 °C / -4 ... 194 °F

- Ground screw external 6 mm<sup>2</sup> M5 internal 2.5 mm<sup>2</sup> terminal
- Terminals for lines up to max. 2.5 mm<sup>2</sup> and hand-held terminal interface

**Lightning protection:**

- **model NGV220-NO**  
Non ignition-proof lightning protection for M20 x 1.5 cable gland (see data sheet 10/63-6.15)
- **model NGV220-Ex**  
Intrinsically safe lightning protection for M20 x 1.5 cable gland (see data sheet 10/63-6.15)



## 4 Communication

### HART protocol version 5

The system is registered with the HART Communication Foundation.

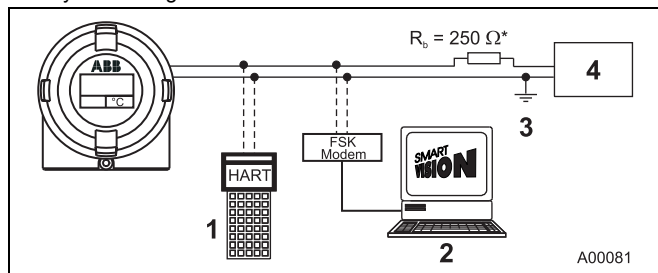


Fig. 3

\* if necessary

- |   |   |   |                                     |
|---|---|---|-------------------------------------|
| 1 | DHH691 (691HT), STT04,<br>HC275, FC375  | 3 | Ground connection<br>(optional)     |
| 2 | FDT/DTM technology or<br>EDD technology | 4 | Power supply (process<br>interface) |

### Operating modes

- Point-to-point communication mode: standard (general address 0)
- Multidrop mode (addressing 1 ... 15)
- Burst mode

### Configuration options and tools

#### Driver-independent:

- HMI indicator type B with configuration function

#### Driver-dependent:

#### Device management/asset management tools

- FDT/DTM technology  
e.g., DSV401 (SMART VISION) via TTX300-DTM driver
- EDD technology  
e.g., Simatic via TTX300 EDD driver

### Configuration parameters

#### Measurement type

- Sensor type, connection type
- Fault signaling
- Measuring range
- General information, e.g., TAG number
- Damping
- Warning and alarm limits
- Signal simulation of output
- See "Order form configuration"

### Write Protection

- Software write protection via HART/indicator
- Hardware write protection via DIP switch

### Diagnostic information (NE107)

#### Standard

- Sensor error (wire break or short circuit)
- Device error
- Over/under alarm limits
- Over/under measuring range
- Simulation activated

#### Extended mode

- Redundancy/sensor backup active (in case sensor fails) with configurable analog alarm pulse signaling (see the operating instructions)
- Drift monitoring with configurable alarm pulse signaling (see the operating instructions)
- Sensor/sensor line corrosion
- Supply voltage to low
- Drag indicator for sensor 1, sensor 2 and ambient temperature
- Ambient temperature exceeding (> 85 °C)
- Ambient temperature to low (< 40°C)
- Operating hours counter

## 5 Explosion-protection relevant information

### 5.1 TTF350-E1 .. H: (intrinsic safety) TTF350

Approved for use in zone 0.

#### Designation:

- II 1G EEx ia IIC T6 (Zone 0)
- II 2 (1) G EEx [ia] ib IIC T6 (zone 1 [0])
- II 2 G (1D) Ex [iaD] ib IIC T6 (zone 1 [20])

#### **i** Important

The Ex or ignition-proof designation is provided on the name plate.

EC prototype test certificate: Refer to PTB 05 ATEX2017 X.

#### Temperature table

Temperature class	Permissible ambient temperature range	
	Device category 1 use	Device category 2 use
T6	-50 ... 44 °C	-50 ... 56 °C
T5	-50 ... 56 °C	-50 ... 71 °C
T4	-50 ... 84 °C	-50 ... 85 °C

#### Safety-relevant data

##### Intrinsically safe EEx ia IIC explosion protection

	Supply circuit	Measurement current circuit / passive transducer (RTD)	Measurement current circuit / active transducer (RTD)	Display interface
Max. voltage	$U_i = 30 \text{ V}$	$U_o = 6,5 \text{ V}$	$U_o = 1,2 \text{ V}$	$U_o = 6,2 \text{ V}$
Short-circuit current	$I_i = 130 \text{ mA}$	$I_o = 25 \text{ mA}$	$I_o = 50 \text{ mA}$	$I_o = 65,2 \text{ mA}$
Max. power	$P_i = 0,8 \text{ W}$	$P_o = 38 \text{ mW}$	$P_o = 60 \text{ mW}$	$P_o = 101 \text{ mW}$
Internal inductance	$L_i = 0,5 \text{ mH}$	$L_i = 0 \text{ mH}$	$L_i = 0 \text{ mH}$	$L_i = 0 \text{ mH}$
Internal capacitance	$C_i = 5 \text{ nF}$	$C_i = 49 \text{ nF}$	$C_i = 49 \text{ nF}$	$C_i = 0 \text{ nF}$
Maximum permissible external inductance		$L_o = 5 \text{ mH}$	$L_o = 5 \text{ mH}$	$L_o = 5 \text{ mH}$
Maximum permissible external capacitance		$C_o = 1,55 \text{ }\mu\text{F}$	$C_o = 1,05 \text{ }\mu\text{F}$	$C_o = 1,4 \text{ }\mu\text{F}$

### 5.2 TTF350-E2 .. H: (non-incendive) TTF350 ..

Approved for use in zone 2/22.

#### Designation:

- II 3 G EEx n A II T6
- II 3 D IP 65 T 135 °C

#### **i** Important

The Ex or ignition-proof designation is provided on the name plate.

ABB statement of conformity in accordance with ATEX directive.

#### Temperature table

Temperature class	Permissible ambient temperature range
T6	-50 °C ... 56°C
T5	-50 °C ... 71°C
T4	-50 °C ... 85°C

**FM and CSA**

**Intrinsic Safety**

<b>FM</b>	Class I, Div. 1 + 2, Groups A, B, C, D T6 Class II, Groups E, F, G; Class III Class I, Zone 0, AEx ia IIC T6 Product variant: -L4 .. H Control-Drawing: -L4 .. H
<b>CSA</b>	Class I, Div. 1 + 2, Groups A, B, C, D Class II, Groups E, F, G; Class III Product variant: -R4 .. H Control-Drawing: -R4 .. H

**Non-Incendive**

<b>FM</b>	Class I, Div. 2, Groups A, B, C, D (Class II, Groups E, F, G; Class III Product variant: -L5 .. H Control-Drawing: -L5 .. H (2 pages)
<b>CSA</b>	Class I, Div. 2, Groups A,B,C,D (Class II, Groups E, F, G; Class III Product variant: -R5 .. H Control-Drawing: -R5 .. H (2 pages)

**Dust-explosion protection**

**-D1 ... : Dust-explosion protection**

Dust / Zone 20:

Designation: "Ex mark" II 1 D IP 65 T 135 °C  
EC prototype test certificate BVS06 ATEX E029

**-D2 .. H: Dust-explosion protection + Intrinsic safety**

Dust / Zone 20 + Gas / Zone 0:

Designation: "Ex mark" II 1 D IP 65 135 °C  
"Ex mark" II 1G EEx ia IIC T6

EC prototype test certificate BVS06 ATEX E029  
EC prototype test certificate PTB 05 ATEX 2017 X  
EC prototype test certificate ZELM 07 ATEX 0331 U

**Flameproof (Enclosure)**

**-E3...: flameproof (enclosure)**

Zone 1:

Designation: "Ex mark" II 2G EEx d IIC T6  
EC prototype test certificate ATEX

**-E4 .. H: flameproof (enclosure) + intrinsic safety**

Zone 1:

Designation: "Ex mark" II 2G EEx d IIC T6  
"Ex mark" II 1G EEx ia IIC T6

EC prototype test certificate ATEX  
EC prototype test certificate PTB 05 ATEX 2017 X  
EC prototype test certificate ZELM 07 ATEX 0331 U

**Explosionproof, Non-Incendive, Dust-Ignitionproof**

**-L3 ... FM Explosionproof, Non-Incendive, Dust-Ignitionproof**

XP,NI, DIP Class I, II, III, Div. 1 + 2, Groups A-G, factory sealed  
Control-Drawing: -L3

**-R3 ... CSA Explosionproof, Non-Incendive, Dust-Ignitionproof**

XP,NI, DIP Class I, II, III, Div. 1 + 2, Groups A-G, factory sealed  
Control-Drawing: -R3

**6 Approvals**

**CE mark**

The TTF350 including type B LCD display / configuration software meets all requirements for the CE mark in accordance with IEC 61326 (2002).

**Namur**

The TTF350 including type B LCD display / configuration software complies with NAMUR NE 21 (02/2004).

**Ignition protection**

The TTF350 meets requirements for ATEX, FM and CSA. For additional information, refer to the section "Explosion-protection relevant information".

**SIL: Functional safety (optional)**

acc. to IEC 61508.

Device with certificate of conformity for use in safety-relevant applications, including SIL Level 2. For additional information, refer to the SIL safety manual for the TTH300 / TTF300 / TTF350.

## 7 LCD-display

Dual function: LCD display with TTF350 configuration options

### 7.1 Features of the LCD display

- Transmitter-controlled graphic (alphanumeric) LCD display
  - Character height, mode-dependent
  - Sign, 4 digits, 2 decimal places
- Bar graph display
- Plug in to 4 positions each 90° apart
- Display options:
  - Sensor 1 process data
  - Sensor 2 process data
  - Sensor 1 electrical ( $\Omega$  / mV)
  - Sensor 2 electrical ( $\Omega$  / mV)
  - Electronics/ambient temperature
  - Output/current
  - Output %
- Display diagnostic information related to transmitter and sensor status

#### 7.1.1 Technical data of LCD display

**Temperature range:** -20 ... 70 °C  
(-50 ... -20 °C or 70 ... 85 °C no function)

**Humidity:** 0 ... 99% relativ humidity IEC 60068-2-78

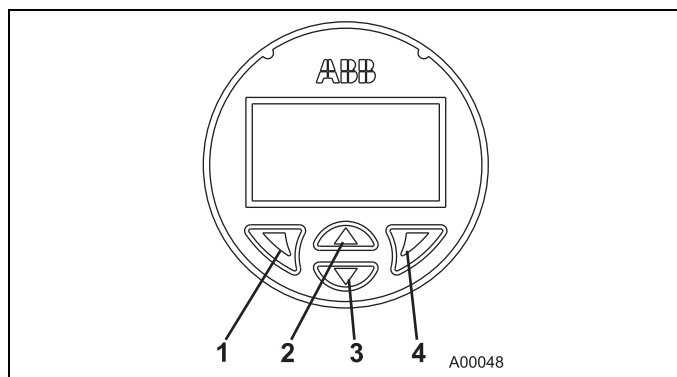


Fig. 4

- |               |                  |
|---------------|------------------|
| 1 Exit/Cancel | 3 Scroll forward |
| 2 Scroll back | 4 Select         |

### 7.2

### Configuration function of LCD display

- Configurable TTF350 transmitter parameters per display: All parameters (sensor/type circuit, measuring range, leakage current signal, etc.)  
except: table-based sensor and freestyle characteristics, Callendar van Dusen coefficients, warning and alarm limits, drift parameters, NE107 "Maintenance required" alarm pulse signal
- Software write protection for TTF350 configuration

### 7.3 LCD display HMI ignition-proof type B (Intrinsic Safety)

Approved for use in zone 0.

#### Designation:

- II 1G EEx ia IIC T6



#### Important

The Ex or ignition-proof designation is provided on the name plate.

EC prototype test certificate: ZELM 07 ATEX 0331 U

#### Temperature table

Temperature class	Permissible ambient temperature range	
	Device category 1 use	Device category 2 use
T6	-40 ... 40 °C	-40 ... 40 °C
T5	-40 ... 55 °C	-40 ... 55 °C
T4	-40 ... 85 °C	-40 ... 85 °C

For the ambient temperature range from -50 ... -20 °C, additional mechanical protection is required.

#### Safety-relevant data

Intrinsically safe EEx ia IIC explosion protection

	Supply circuit
Max. voltage	$U_i = 9 \text{ V}$
Short-circuit current	$I_i = 65,2 \text{ mA}$
Max. power	$P_i = 101 \text{ mW}$
Internal inductance	$L_i = 0 \text{ mH}$
Internal capacitance	$C_i = 342 \text{ nF}$

## 8 Terminal connection diagrams

### RTD resistance sensors

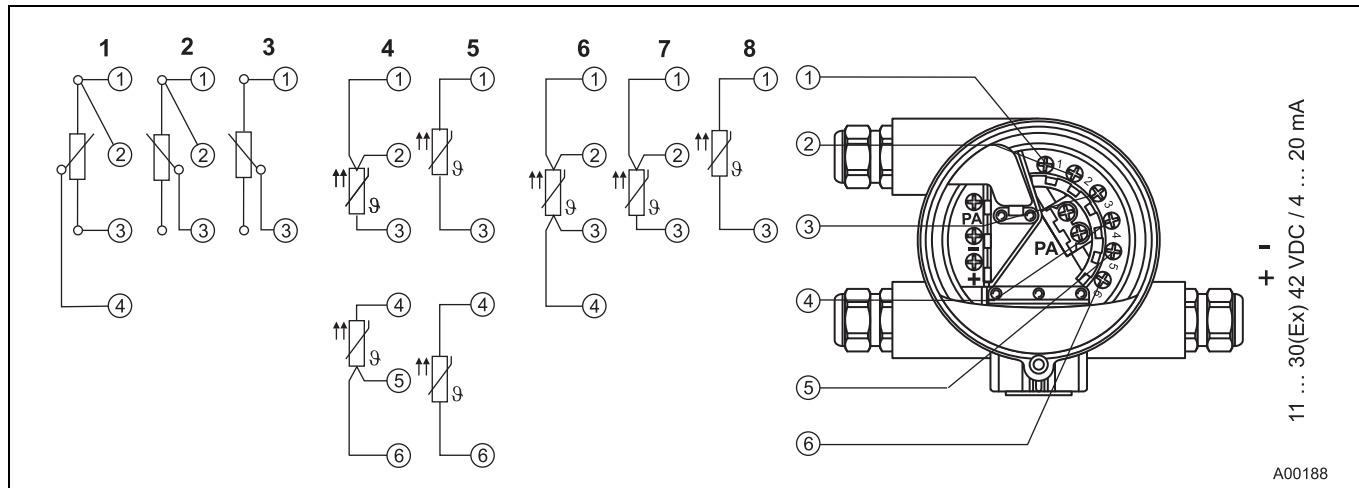


Fig. 5

### Potentiometer: 0 ... 500 Ω or 0 ... 5000 Ω

- 1 Potentiometer, 4-wire circuit
- 2 Potentiometer, 3-wire circuit
- 3 Potentiometer, 2-wire circuit
  
- 4 2 x RTD, 3-wire circuit (sensor backup/redundancy, sensor drift monitoring, average value or differential temperature measurement)
- 5 2 x RTD, 2-wire circuit (sensor backup/redundancy, sensor drift monitoring, average value or differential temperature measurement)
  
- 6 RTD, 4-wire circuit
- 7 RTD, 3-wire circuit
- 8 RTD, 2-wire circuit

**Thermocouples/Voltages**

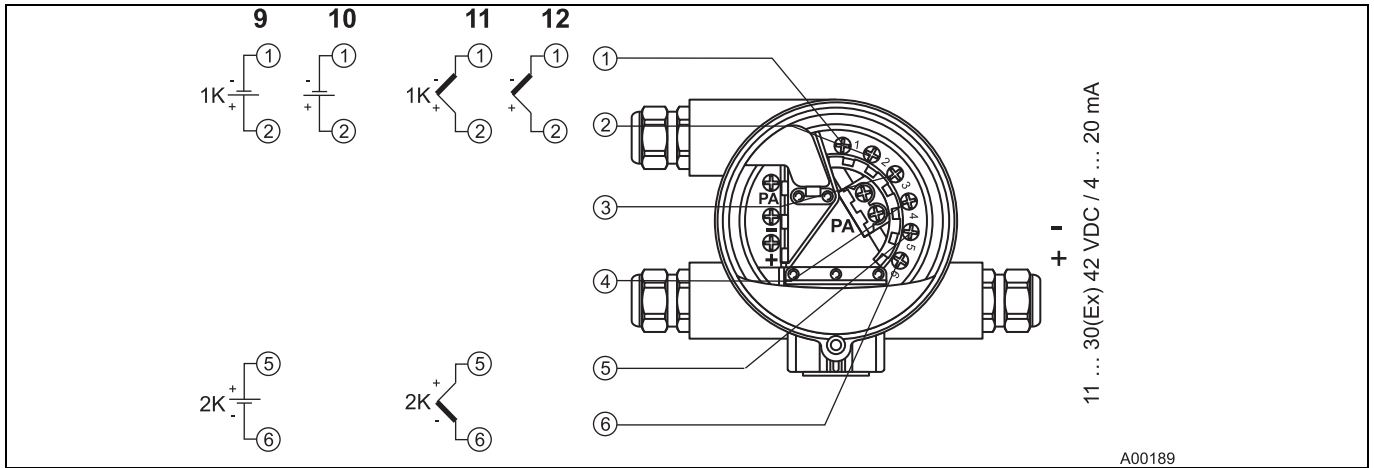


Fig. 6

- 9 2 x voltage measurement (sensor backup/redundancy, sensor drift monitoring, average value or differential temperature measurement)
- 10 Voltage measurement
- 11 2 x thermocouple (sensor backup/redundancy, sensor drift monitoring, average value or differential temperature measurement)
- 12 Thermocouple

**RTD/thermocouples configuration**

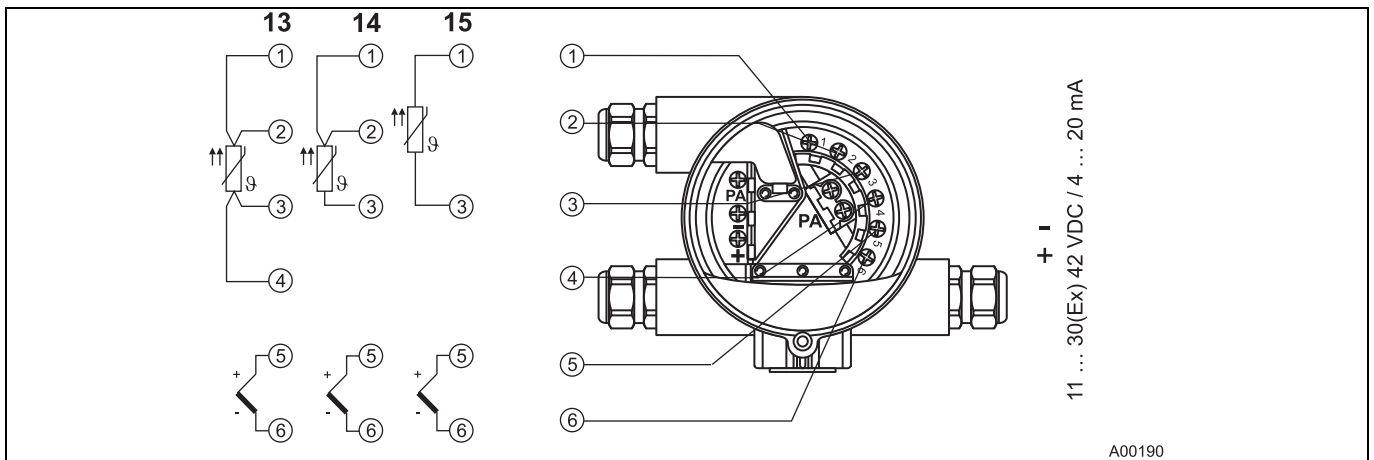


Fig. 7

- 13 1 x RTD, 4-wire circuit and thermocouple (sensor backup/redundancy, sensor drift monitoring, average value or differential temperature measurement)
- 14 1 x RTD, 3-wire circuit and thermocouple (sensor backup/redundancy, sensor drift monitoring, average value or differential temperature measurement)
- 15 1 x RTD, 2-wire circuit and thermocouple (sensor backup/redundancy, sensor drift monitoring, average value or differential temperature measurement)

## 9 Dimensional drawings

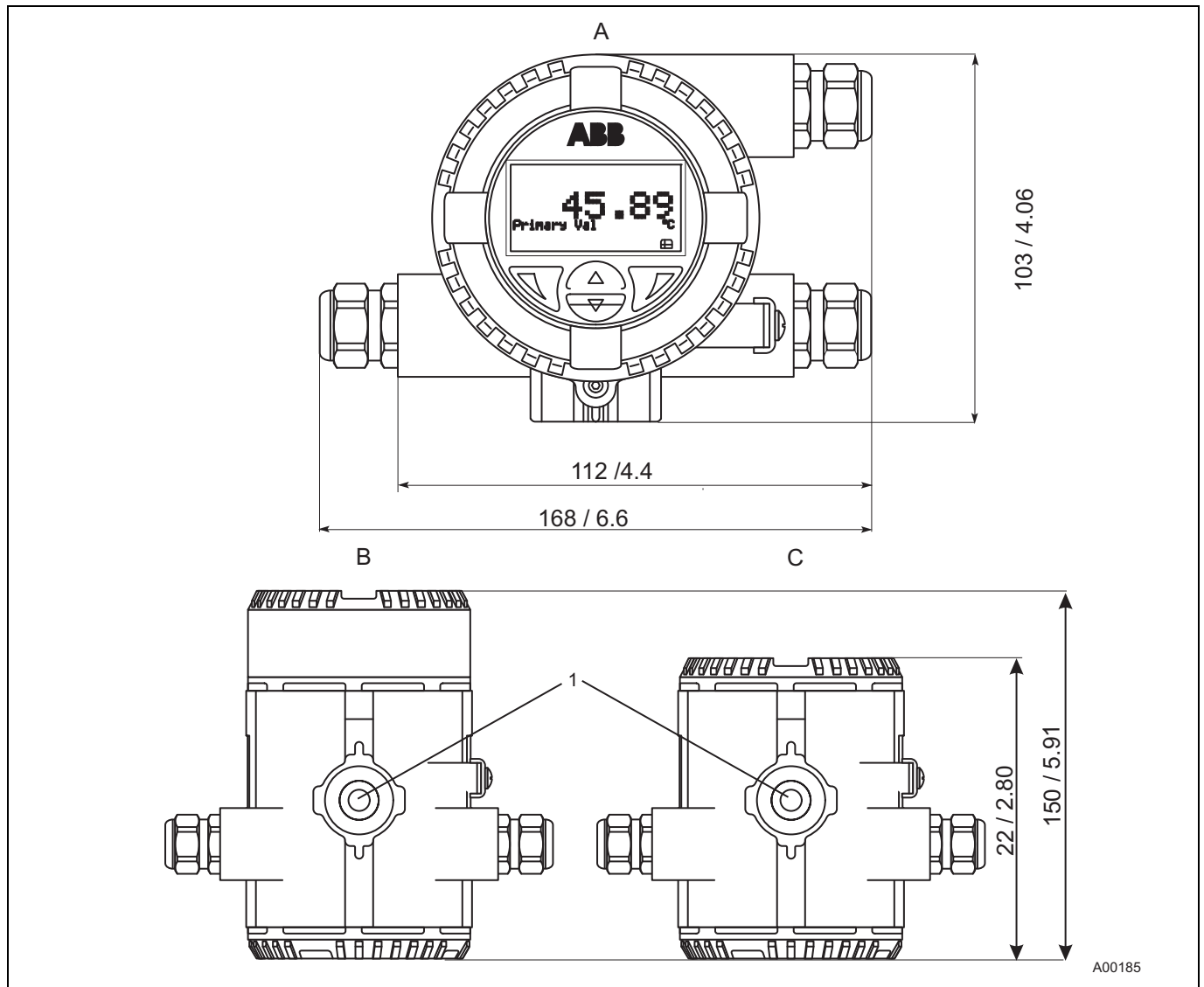


Fig. 8: Housing and mounting type with dimensions in mm/inches

- A Housing, display view (display installation option 4 x 90°)
    - without cable gland (threads M20 x 1.5 or NPT ½")
    - with cable gland (M20 x 1.5)
  - B Housing, bottom view with display option (fastening screw thread M8 (depth 10 mm))
  - C Housing, bottom view without display option (fastening screw thread M8 (depth 10 mm))
- 1 Housing (fastening screw thread M8 (depth 10 mm))

## 9.1 Installation

### 9.1.1 Wall installation

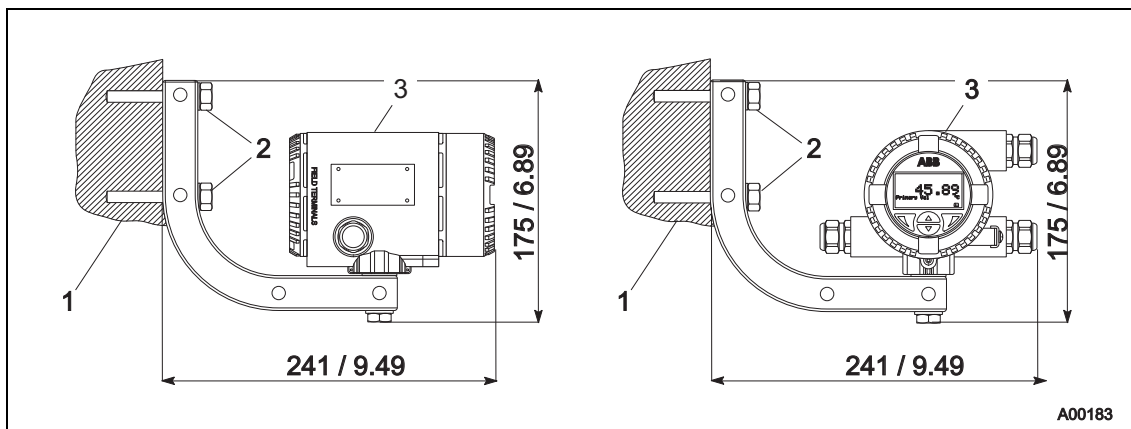


Fig. 9: Dimensions in mm/inch

1 Wall

3 Transmitter TTF350

2 Wall mount

### 9.1.2 Pipe installation

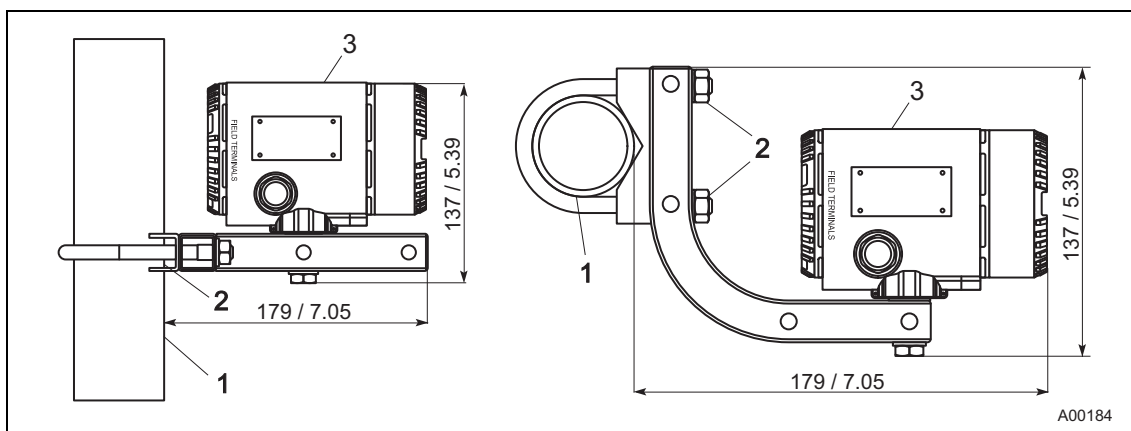


Fig. 10: Dimensions in mm/inch

1 Pipe (max. Ø 2 inches)

3 Transmitter TTF350

2 Pipe mount



#### Important

The wall and pipe installation set supports variable installation positions. A few examples of the different options are shown here. The mounting screw allows infinitely adjustable positioning (0° ... 360°) of the housing.



## 10 Ordering information

Field mounted Temperature Transmitter TTF350	Variant digit No.	1 - 7	8	9	10	11	12	Code			
	Catalog No.	TTF350-									
<b>Explosion Protection</b>											
Without explosion protection											
<b>Type of Protection: Intrinsic Safety ATEX</b>											
ATEX Zone 0: II 1 G EEx ia IIC T6											
ATEX Zone 1 (0): II 2 (1) G EEx [ia] ib IIC T6											
ATEX Zone 1 (20): II 2 G (1D) Ex [iaD] ib IIC T6											
<b>Type of Protection: "nA" (Non-Sparking) ATEX</b>											
ATEX Zone 2 / Zone 22: II 3 G EEx nA II T6 and II 3 D IP 65 T135°C											
<b>Type of Protection: Intrinsic Safety FM &amp; CSA</b>											
FM IS, Class I, Div. 1+2, Groups A, B, C, D, Class II, E, F, G, Class III											
FM Class I, Zone 0, AEx ia IIC T6											
FM Non-Incendive, Class I, Div. 2, Groups A, B, C, D,											
FM Class II, E, F, G, Class III											
CSA IS, Class I, Div. 1+2, Groups A, B, C, D, Class II, E, F, G, Class III											
CSA Non-Incendive, Class I, Div. 2, Groups A, B, C, D,											
CSA Class II, E, F, G, Class III											
<b>Dust Explosion Protection ATEX</b>											
ATEX Zone 20: II 1 D IP 65 T135°C											
ATEX Zone 0 / Zone 20: II 1 G EEx ia IIC T6 and II 1 D IP 65 T135°C											
<b>Type of Protection: Flameproof Enclosures ATEX</b>											
ATEX Zone 1: II 2 G EEx d IIC T6											
ATEX Zone 1 / Zone 0: II 2 G EEx d IIC T6 and II 1 G EEx ia IIC T6											
<b>Type of Protection: Explosionproof, Non-Incendive, Dust-Ignitionproof FM &amp; CSA</b>											
FM XP, NI, DIP, Class I, II, III, Div. 1+2, Groups A-G, factory sealed											
CSA XP, NI, DIP, Class I, II, III, Div. 1+2, Groups A-G, factory sealed											
<b>Housing / Display</b>											
Dual-compartment housing / Without display (Aluminium)											
Dual-compartment housing / With LCD display HMI type B (Aluminium)											
<b>Cable Entry</b>											
Thread 3 x M20 x 1.5											
Thread 3 x 1/2 in. NPT											
Thread 3 x 3/4 in. NPT (via 1/2 in. > 3/4 in. adapter)											
Cable screw connection 3 x M20 x 1.5											
<b>Communication Protocol</b>											
HART											

**Additional ordering information**

TTF350	Code			
<b>Configuration</b>				
Customer specific configuration with report, except user curve	1)	BF		
Customer specific configuration with report, including user curve		BG		
<b>Certificates</b>				
SIL2 - Declaration of conformity		CS		
<b>Calibration Certificate</b>				
With 5-point works calibration certificate		EM		
<b>Mounting Bracket</b>				
Wall mounting / 2 in. pipe mounting bracket (Stainless steel)		K2		
<b>Extended Ambient Temperature range</b>				
-50 ... 85 °C		SE		
<b>Device Identification Plate</b>				
Stainless steel		T0		
<b>Additional Tag Plate</b>				
Stainless steel		I1		
<b>Customer specific model acc. to NL no.</b>				
(please specify)		Z9		

<b>Accessories</b>		Catalog No.			
NGV220-NO	Surge / Lightning protection for M20 x 1.5 cable glands, non-Ex version	see data sheet 10/63-6.15 EN			
NGV220-EX	Surge / Lightning protection for M20 x 1.5 cable glands, Ex version	see data sheet 10/63-6.15 EN			

1) (i. e. TAG number)

### 10.1 Order form configuration

Information on customer-specific configuration of temperature transmitter TTF350.

Configuration		Selection
Number of sensors		<input type="checkbox"/> <b>1 sensor (standard)</b> <input type="checkbox"/> 2 sensors
Measurement type (for 2-sensor selection only)		<input type="checkbox"/> Redundancy/sensor backup <input type="checkbox"/> Sensor drift monitoring .....°C / K Sensor drift differential .....s time limit for drift overshoot <input type="checkbox"/> Differential measurement: Zero point where I <sub>a</sub> = 4 mA <input type="checkbox"/> Differential measurement: Zero point where I <sub>a</sub> = 12 mA <input type="checkbox"/> Mean
DIN IEC 60 751	RTD	<input type="checkbox"/> Pt10 <input type="checkbox"/> Pt50 <input type="checkbox"/> <b>Pt100 (standard)</b> <input type="checkbox"/> Pt200 <input type="checkbox"/> Pt500 <input type="checkbox"/> Pt1000 <input type="checkbox"/> Pt10 <input type="checkbox"/> Pt50 <input type="checkbox"/> Pt100 <input type="checkbox"/> Pt10 <input type="checkbox"/> Pt50 <input type="checkbox"/> Pt100 <input type="checkbox"/> Pt200 <input type="checkbox"/> Pt1000 <input type="checkbox"/> Ni50 <input type="checkbox"/> Ni100 <input type="checkbox"/> Ni120 <input type="checkbox"/> Ni1000 <input type="checkbox"/> Cu10 <input type="checkbox"/> Cu100
JIS C1604-81		
MIL-T-24388		
DIN 43760		
Cu		
	Linear Resistance measurement	<input type="checkbox"/> 0 ... 500 Ω <input type="checkbox"/> 0 ... 5000 Ω
IEC 584	Thermocouple	<input type="checkbox"/> Type K <input type="checkbox"/> Type J <input type="checkbox"/> Type N <input type="checkbox"/> Type R <input type="checkbox"/> Type S <input type="checkbox"/> Type T <input type="checkbox"/> Type E <input type="checkbox"/> Type B <input type="checkbox"/> Type L <input type="checkbox"/> Type U <input type="checkbox"/> Type C <input type="checkbox"/> Type D
DIN 43710		
ASTME 988		
	Linear voltage measurement	<input type="checkbox"/> -125 mV ... 125 mV <input type="checkbox"/> -125 mV ... 1100 mV
Sensor circuit (for RTD + resistance measurement only)		<input type="checkbox"/> 2-wire <input type="checkbox"/> <b>3-wire (standard)</b> <input type="checkbox"/> 4-wire 2-wire circuit: Compensation of sensor-wire resistance max. 100 Ω <input type="checkbox"/> Sensor 1: ..... Ω <input type="checkbox"/> Sensor 1: ..... Ω
Reference junction (for thermocouples only)		<input type="checkbox"/> Internal (for standard thermocouple, except type B) <input type="checkbox"/> no (TC type B) <input type="checkbox"/> External/temp.: ..... °C
Measuring range		<input type="checkbox"/> Measurement start: ..... (Standard: <b>0</b> ) <input type="checkbox"/> Measurement end: ..... (Standard: <b>100</b> )
Unit		<input type="checkbox"/> <b>Celsius</b> (standard) <input type="checkbox"/> Fahrenheit <input type="checkbox"/> Rankine <input type="checkbox"/> Kelvin
Failure signalisation		<input type="checkbox"/> <b>Overrange/22 mA</b> (standard) <input type="checkbox"/> Underrange/3.6 mA
Damping (T <sub>63</sub> )		<input type="checkbox"/> <b>Off</b> (standard) <input type="checkbox"/> Seconds (1 sec. ... 100 sec.)
Sensor number		<input type="checkbox"/> Sensor 1..... <input type="checkbox"/> Sensor 2.....
Resistor value at 0°C / R <sub>0</sub> Callendar van Dusen coefficient A Callendar van Dusen coefficient B Callendar van Dusen coefficient C (optional for RTD/Pt sensors only)		Sensor 1: R <sub>0</sub> : .....    Sensor 2: R <sub>0</sub> : ..... A: .....    A: ..... B: .....    B: ..... C: .....    C: .....
User characteristics based on linearization table		<input type="checkbox"/> based on attached table of variate pairs
TAG number		<input type="checkbox"/> ..... (max. 8 characters)
Software write protection		<input type="checkbox"/> <b>Off</b> (standard) <input type="checkbox"/> On
"Maintenance required" alarm pulse or continuous signaling (NE107)		<input type="checkbox"/> <b>Off</b> (standard) pulse width .....s (0.5 ... .59.5 s increment 0.5 s) <input type="checkbox"/> continuous signal

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