CRT

ACCURATE MEASUREMENT

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Data Sheet DS/TTF350-EN Rev. A

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 Ω)
— 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

Contents

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 Ω

0 … 5000 Ω

Sensor connections

2-, 3-, 4-wire circuit

Connecting cables

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

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

Measurement current

< 300 µA

Sensor short-circuit

< 5 Ω (for RTD)

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

Measuring range 0 ... 500 Ω	> 0.6 ... 10 kΩ
Measuring range 0 ... 5 kΩ	> 5.3 ... 10 kΩ

Corrosion detection in accordance with NAMUR NE 89

3-wire resistance reading > 50 Ω

4-wire resistance reading > 50 Ω

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 kΩ, total 3 kΩ

Sensor wire break monitoring in accordance with Namur NE 89

pulsed with 1 µA outside the measurement interval

Thermoelement measurement	5.3 ... 10 kΩ
Voltage measurement	5.3 ... 10 kΩ

Input resistance

> 10 MΩ

Internal reference junction

Pt100, DIN IEC 60751 Cl. B

(no jumpers necessary)

Customer specific curve, 32-tie points

Resistance measurement up to max. 5 kΩ

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 Ia = 4 mA

Differential measurement: Zero point where Ia = 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 ... 42 V DC

Ignition-proof applications with or without LCD display:

U_S = 11 ... 30 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

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

Max. load

R_{Load} = (supply voltage – 11 V) / 22 mA

Max. load Ω) depending on supply voltage (V DC)

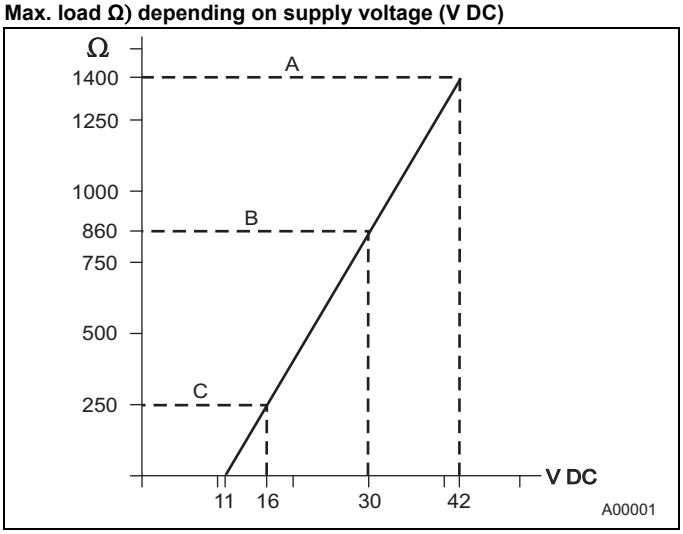

Fig. 1

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

Max. power consumption

P = U_S x 22 mA

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

2 General information

Galvanic isolation (input/output)	3.5 kV AC (approx. 2.5 KV DC) 60 s (insulation test voltage)
MTBF time	28 years at 60 °C ambient temperature
Input filter	50 / 60 Hz
Switch-on delay	< 10 s (I_a ≤ 3.6 mA during starting cycle)
Warm-up time	5 min.
Ramp-up time t90	400 … 1000 ms
Readingupdated[1)]	10/s with 1 sensor, 5/s with 2 sensors
Output filter	Digital filter 1st order: 0 ... 100 s

[1)] 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[1)]	6 kV	no
• Sensor terminals[1)]	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

[1)] 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[1] (16-bit DA)
Standard	**Sensor**				
Resistance sensors/potentiometer					
DIN IEC 60 751	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)[2]	**-200 ... 850 °C / -328 ... 1562 °F**	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 %
JIS C1604-81	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 %
MIL-T-24388	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 %
DIN 43760	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 %
Thermocouples[3]/voltages					
IEC 584	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 %
DIN 43710	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 %
ASTM E 988	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 %

[1] percentages refer to the configured measuring span
[2] Standard model
[3] include the internal reference junction error for digital accuracy: Pt100, DIN IEC 60751 Cl. B
[4] without reference junction error

Total accuracy = digital measuring accuracy [°C] + (D/A measuring accuracy [%] x I conf. measuring span [°C] I /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[4]: Digital accuracy + D/A accuracy; ± 0,35 °C + (± 0,50 °C) = ± 0,85 °C

Long-term drift
± 0.05 °C or ± 0.05%[1] per year, the larger value applies.

2.4.1 Block diagram

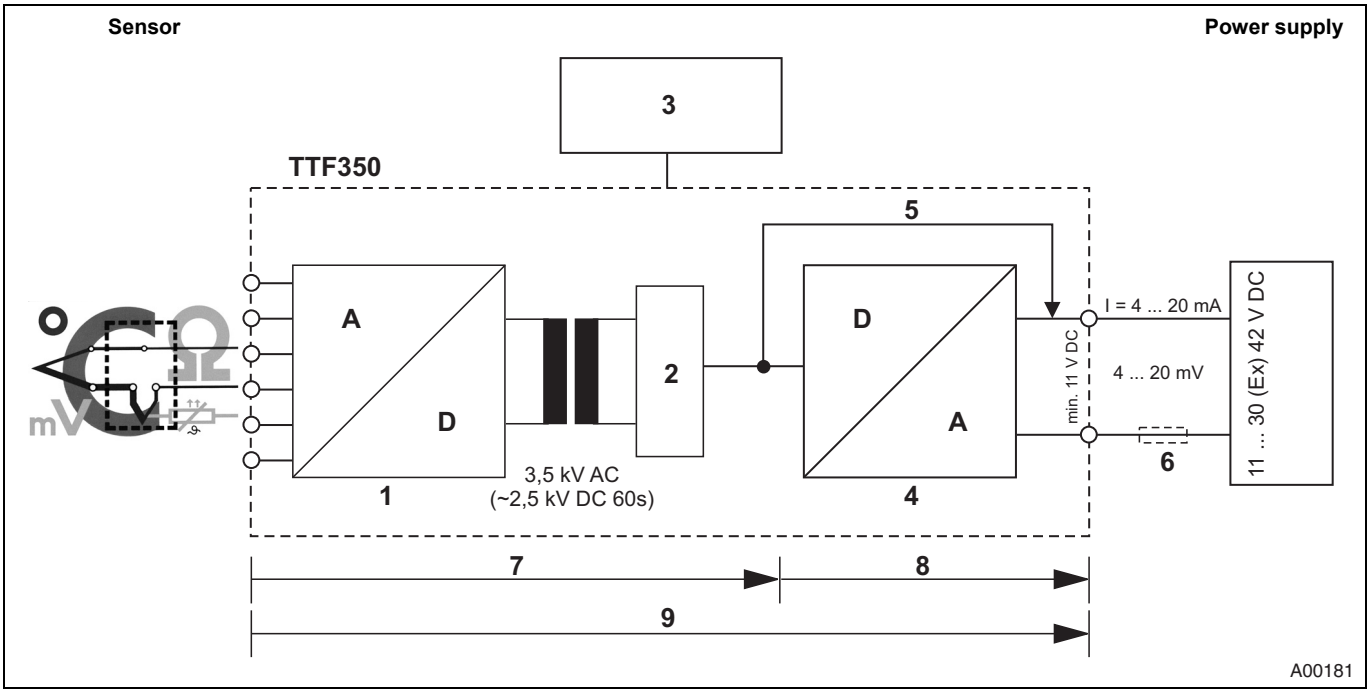

Fig. 2

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

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[1] 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])] [1]	± 0.003 %
Voltage measurement		
-125 ... 125 mV	± 1.5 µV	± 0.003 %
-125 ... 1100 mV	± 15 µV	± 0.003 %

[1] 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)^2 + (D/A accuracy) + (digital value temp. influence) + (D/A temp. influence)]
Example 1: Pt100, 0 ... 100°C at 33 °C ambient temperature = $\sqrt{(0.08\,°C)^2 + (0.05\,°C)^2 + (0.04\,°C)^2 + (0.03\,°C)^2} = 0.10\,°C$

Example 2: Thermoelement type K, 0 ... 1000 °C at 33 °C ambient temperature = $\sqrt{(0.35\,°C)^2 + (0.50\,°C)^2 + (0.19\,°C)^2 + (0.3\,°C)^2} = 0.70\,°C$ (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 ½" 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^2 M5 internal 2.5 mm^2 terminal
- Terminals for lines up to max. 2.5 mm^2 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.

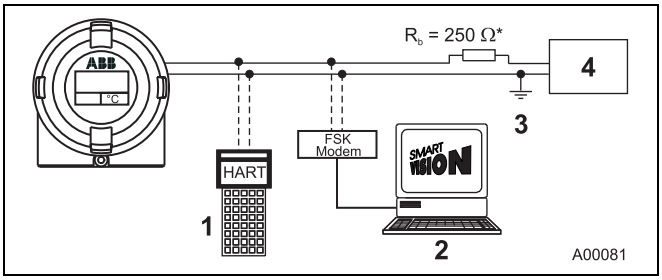

Fig. 3

* if necessary

1	DHH691 (691HT), STT04, HC275, FC375	3	Ground connection (optional)
2	FDT/DTM technology or EDD technology	4	Power supply (process 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])

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 V	U_o = 6,5 V	U_o = 1,2 V	U_o = 6,2 V
Short-circuit current	I_i = 130 mA	I_o = 25 mA	I_o = 50 mA	I_o = 65,2 mA
Max. power	P_i = 0,8 W	P_o = 38 mW	P_o = 60 mW	P_o = 101 mW
Internal inductance	L_i = 0,5 mH	L_i = 0 mH	L_i = 0 mH	L_i = 0 mH
Internal capacitance	C_i = 5 nF	C_i = 49 nF	C_i = 49 nF	C_i = 0 nF
Maximum permissible external inductance		L_o= 5 mH	L_o = 5 mH	L_o= 5 mH
Maximum permissible external capacitance		C_o= 1,55 µF	C_o= 1,05 µF	C_o= 1,4 µF

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

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

FM	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
CSA	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

FM	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)
CSA	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 (Ω / mV)
  - Sensor 2 electrical (Ω / 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

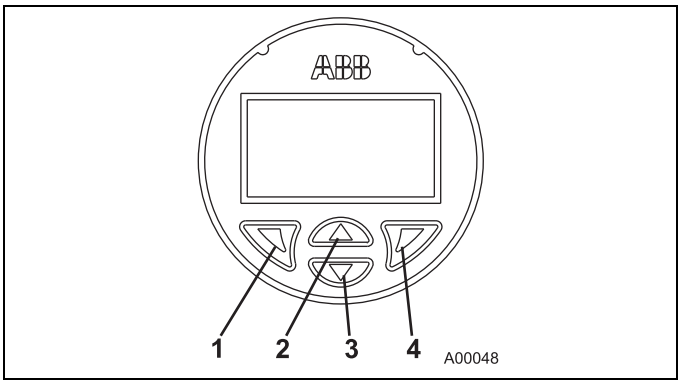

Fig. 4

1 Exit/Cancel
2 Scroll back
3 Scroll forward
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 V
Short-circuit current	I_i = 65,2 mA
Max. power	P_i = 101 mW
Internal inductance	L_i = 0 mH
Internal capacitance	C_i = 342 nF

8 Terminal connection diagrams

RTD resistance sensors

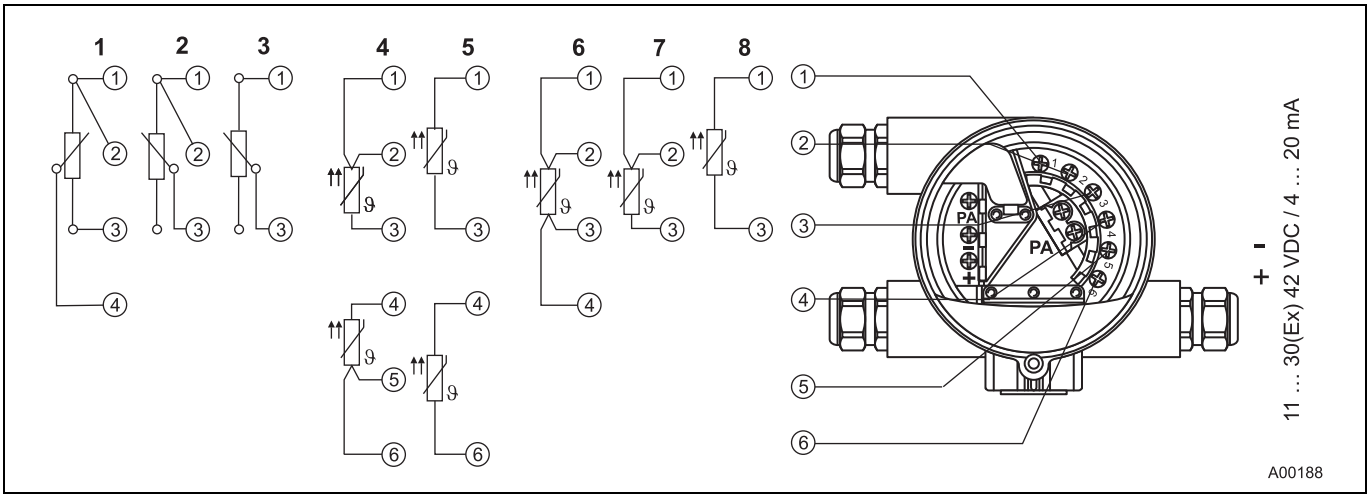

Fig. 5

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

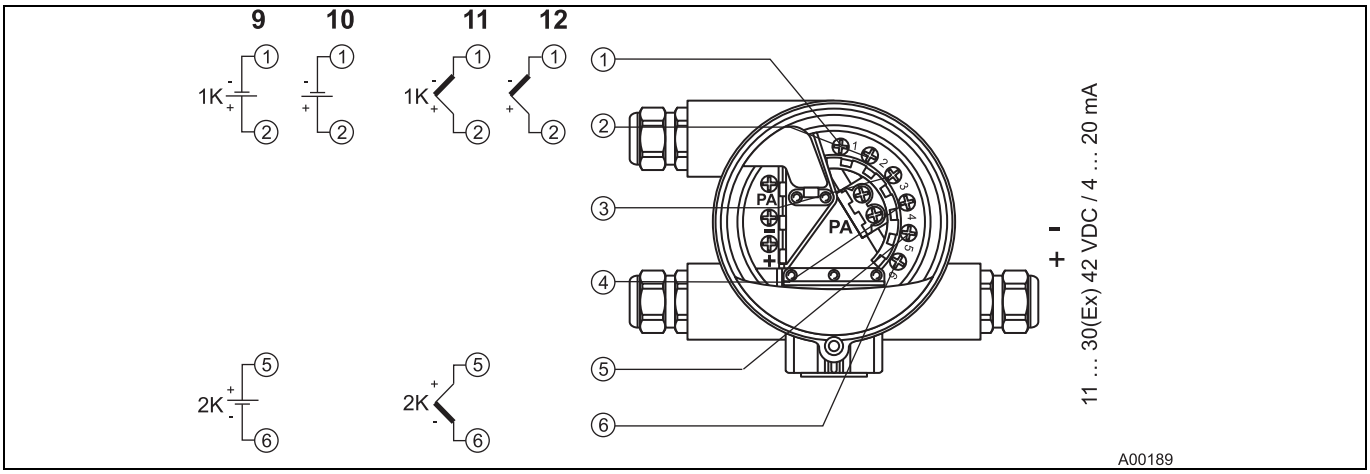

Fig. 6

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

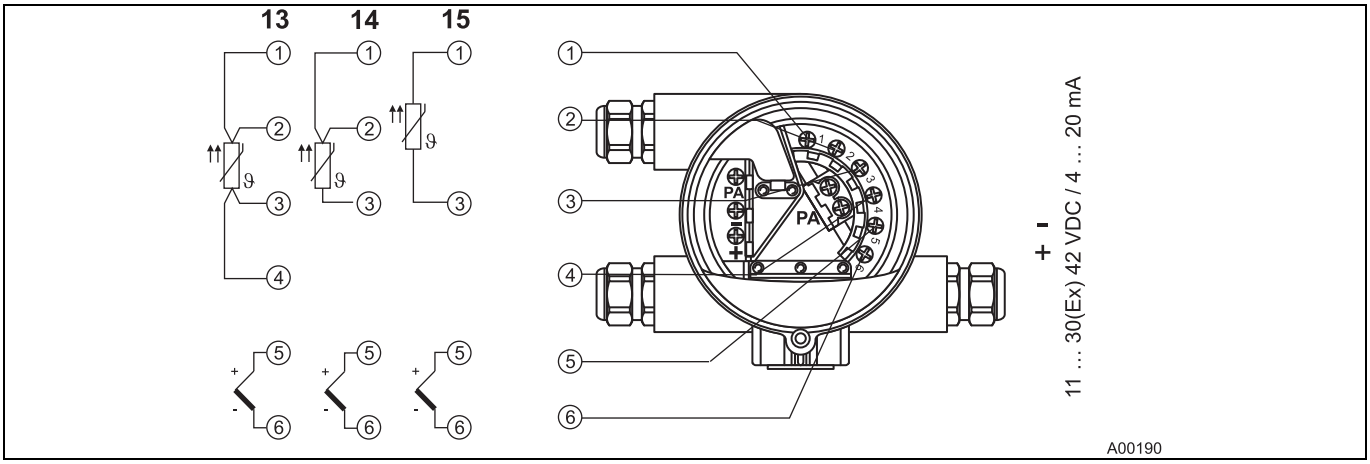

Fig. 7

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

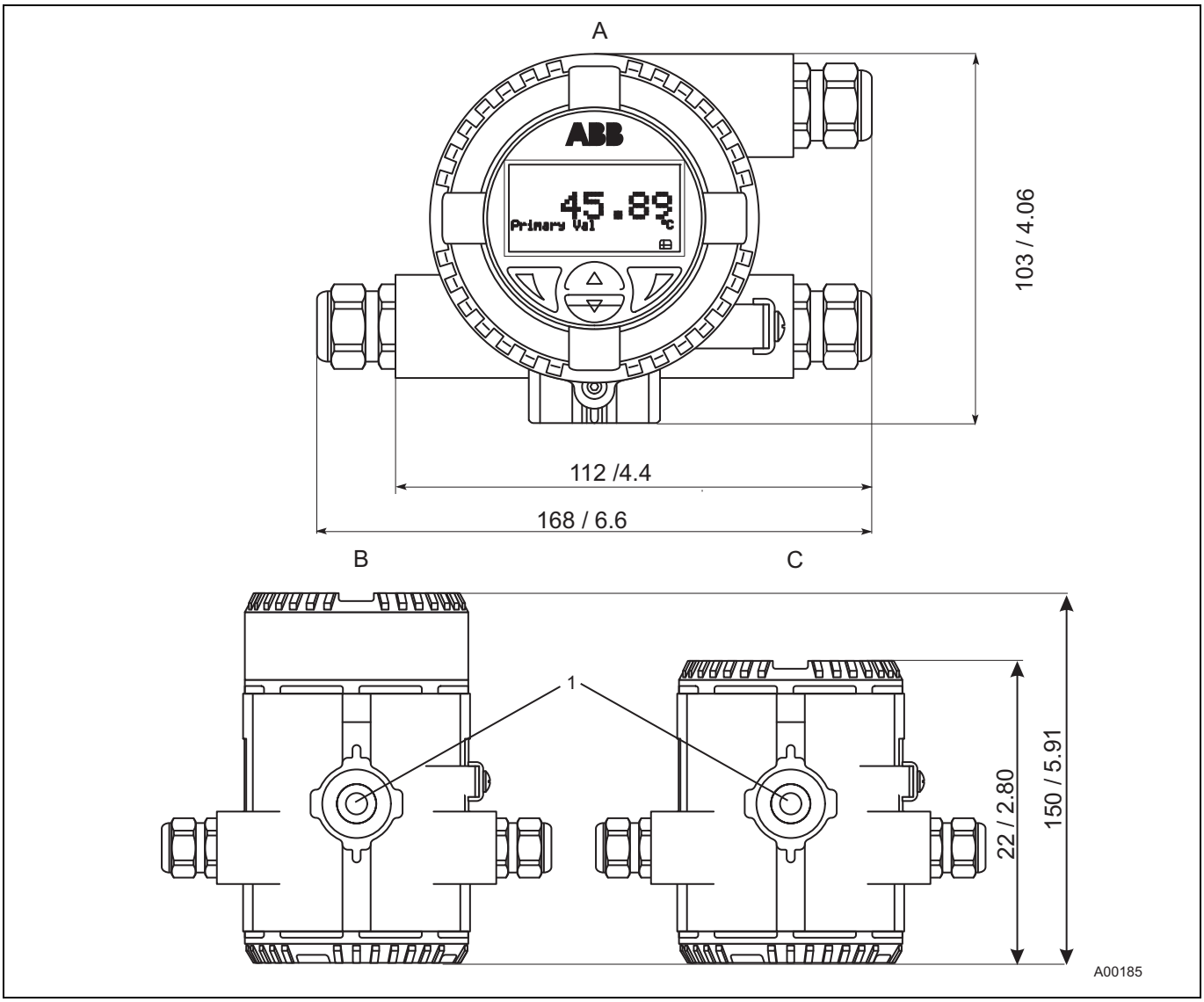

Fig. 8: Housing and mounting type with dimensions in mm/inches

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

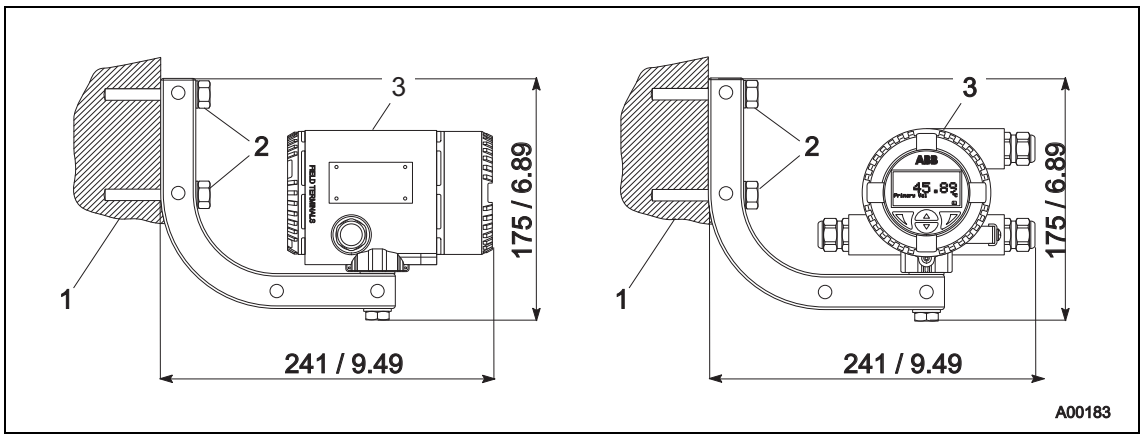

Fig. 9: Dimensions in mm/inch

1 Wall
2 Wall mount
3 Transmitter TTF350

9.1.2 Pipe installation

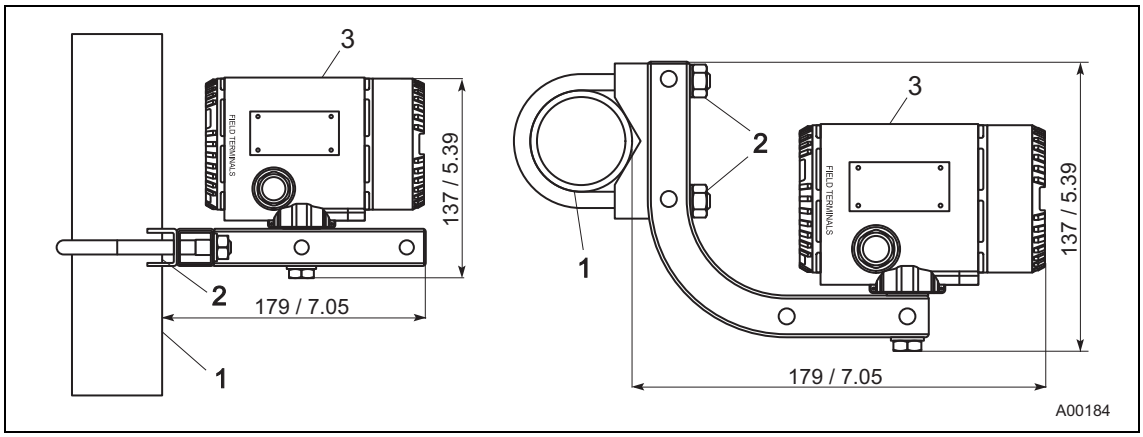

Fig. 10: Dimensions in mm/inch

1 Pipe (max. Ø 2 inches)
2 Pipe mount
3 Transmitter TTF350

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	Variant digit No.	1 - 7	8	9	10	11	12	Code			
TTF350	Catalog No.	**TTF350-**									
Explosion Protection											
Without explosion protection			**Y**	**0**							
Type of Protection: Intrinsic Safety ATEX											
ATEX Zone 0: II 1 G EEx ia IIC T6			E	1							
Zone 1 (0): II 2 (1) G EEx [ia] ib IIC T6											
Zone 1 (20): II 2 G (1D) Ex [iaD] ib IIC T6											
Type of Protection: "nA" (Non-Sparking) ATEX											
ATEX Zone 2 / Zone 22: II 3 G EEx nA II T6 and II 3 D IP 65 T135°C			E	5							
Type of Protection: Intrinsic Safety FM & CSA											
FM IS, Class I, Div. 1+2, Groups A, B, C, D, Class II, E, F, G, Class III			L	4							
Class I, Zone 0, AEx ia IIC T6											
FM Non-Incendive, Class I, Div. 2, Groups A, B, C, D,			L	5							
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			R	4							
CSA Non-Incendive, Class I, Div. 2, Groups A, B, C, D,			R	5							
Class II, E, F, G, Class III											
Dust Explosion Protection ATEX											
ATEX Zone 20: II 1 D IP 65 T135°C			D	1							
ATEX Zone 0 / Zone 20: II 1 G EEx ia IIC T6 and II 1 D IP 65 T135°C			D	2							
Type of Protection: Flameproof Enclosures ATEX											
ATEX Zone 1: II 2 G EEx d IIC T6			E	3							
ATEX Zone 1 / Zone 0: II 2 G EEx d IIC T6 and II 1 G EEx ia IIC T6			E	4							
Type of Protection:											
Explosionproof, Non-Incendive, Dust-Ignitionproof FM & CSA											
FM XP, NI, DIP, Class I, II, III, Div. 1+2, Groups A-G, factory sealed			L	3							
CSA XP, NI, DIP, Class I, II, III, Div. 1+2, Groups A-G, factory sealed			R	3							
Housing / Display											
Dual-compartment housing / Without display	(Aluminium)				**N**						
Dual-compartment housing / With LCD display HMI type B	(Aluminium)				R						
Cable Entry											
Thread 3 x M20 x 1.5						**5**					
Thread 3 x 1/2 in. NPT						6					
Thread 3 x 3/4 in. NPT (via 1/2 in. > 3/4 in. adapter)						7					
Cable screw connection 3 x M20 x 1.5						8					
Communication Protocol											
HART							**H**				

Additional ordering information

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

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

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