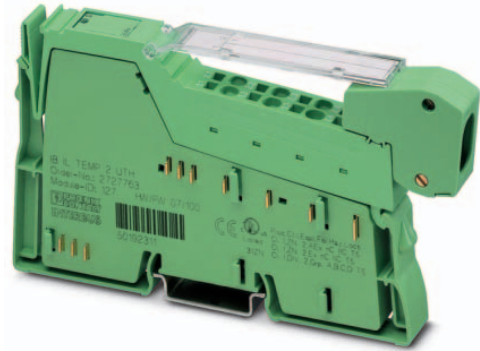


IB IL TEMP 2 UTH-PAC

**Inline, temperature measurement terminal,
analog UTH inputs: 2,
connection technology: 2-wire**

Data sheet
5722_en_04

© PHOENIX CONTACT 2017-04-03



1 Description

The terminal is designed for use within an Inline station. It is used to acquire signals from standard thermocouples. 13 different types of thermocouples are supported in accordance with DIN EN 60584-1 and DIN 43710 as well as a linear voltage input of -15 mV to +85 mV.

Features

- Two differential inputs for thermocouples or linear voltage; one input for an external Pt1000 or Ni1000 cold junction
- Parameterization of channels via the bus system
- Internal detection of cold junction temperature (can be parameterized)
- Absolute or differential temperature measurement (can be parameterized)
- Pt1000 sensor in the vicinity of the connection terminals of the thermocouple inputs for internal measurement of the cold junction temperature
- Measured values can be represented in three different formats



This data sheet is only valid in association with the IL SYS INST UM E user manual.



Make sure you always use the latest documentation.
It can be downloaded at phoenixcontact.net/products.

Table of contents

1	Description.....	1
2	Ordering data.....	3
3	Technical data	4
4	Tolerance and temperature response	7
4.1	Tolerances at an ambient temperature $T_A = +25^{\circ}\text{C}$	7
4.2	Tolerances at an ambient temperature $T_A = -25^{\circ}\text{C}$ to $+55^{\circ}\text{C}$	9
4.3	Temperature response	9
4.4	Tolerances of the internal cold junction	10
4.5	Tolerances due to linearization.....	10
4.6	Additional tolerances when subject to EMI	12
5	Internal basic circuit diagram	13
6	Electrical isolation	13
7	Local diagnostic indicator	14
8	Terminal point assignment.....	14
9	Installation instructions	15
10	Connection notes.....	15
11	Connection examples	16
11.1	Absolute temperature measurement	16
11.2	Differential temperature measurement	16
11.3	Equalizing conductor extension.....	17
12	Process data.....	18
12.1	Output data for parameterization of the terminal (see page 19).....	18
12.2	Assignment of the terminal points to the input data (see page 21)	18
12.3	Process data output words (OUT)	19
12.4	Process data input words (IN)	21
13	Formats for representing measured values.....	22
13.1	Format 1: IB standard	22
13.2	Format 2	23
13.3	Format 3	24
14	Measuring ranges	25
14.1	Measuring range depending on the resolution (format 1 (IB standard) and format 3).....	25
14.2	Measuring ranges depending on the resolution (format 2)	25
14.3	Input measuring ranges	26
15	Process data update time	26

2 Ordering data

Products

Description	Type	Order No.	Pcs. / Pkt.
Inline, Temperature measurement terminal, Analog UTH inputs: 2, Connection technology: 2-wire, Transmission speed in the local bus 500 kbps, Degree of protection IP20, including Inline connector and labeling field	IB IL TEMP 2 UTH-PAC	2861386	1

Accessories

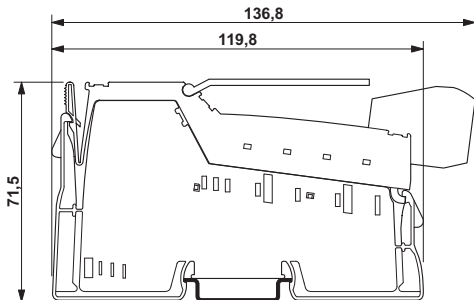
Description	Type	Order No.	Pcs. / Pkt.
Inline shield connector for analog Inline terminals	IB IL SCN-6 SHIELD TWIN	2740245	5
Insert strip, sheet, white, unlabeled, can be labeled with: office printing systems, plotter: laser printer, mounting type: insertion, lettering field size: 62 x 10 mm	ESL 62X10	0809492	1
Thermoelectric voltage terminal block pair for equalizing conductor extension			
Thermoelectric voltage terminal block pair for CU/CUNI44 copper/constantan	MTKD-CU/CUNI	3100059	
Thermoelectric voltage terminal block pair for FE/CUNI44 iron/constantan	MTKD-FE/CUNI	3100046	
Thermoelectric voltage terminal block pair for NICR/CU-NI44 nichrome/constantan	MTKD-NICR/CUNI	3100075	
Thermoelectric voltage terminal block pair for NICR/NI nichrome/nickel	MTKD-NICR/NI	3100062	
Thermoelectric voltage terminal block pair for E-CU/A-CU copper/cupro-nickel	MTKD-E-CU/A-CU	3100091	
Thermoelectric voltage terminal block pair for S-CU/E-CU S-copper/copper	MTKD-S-CU/E-CU	3100101	

Documentation

Description	Type	Order No.	Pcs. / Pkt.
"Automation terminals of the Inline product range" user manual	IL SYS INST UM E	-	-
"INTERBUS addressing" data sheet	DB GB IBS SYS ADDRESS	-	-

3 Technical data

Dimensions (nominal sizes in mm)



Housing dimensions (width x height x depth)	12.2 x 136.8 x 71.5 mm
---	------------------------

General data

Color	Green
Weight	67 g (with connector)
Operating mode	Process data mode with 2 words
Connection method for sensors	2-wire technology
Ambient temperature (operation)	-25°C ... +55°C
Ambient temperature (storage/transport)	-25°C ... +85°C
Permissible humidity (operation/storage/transport)	10% ... 95%, non-condensing
Permissible air pressure (operation/storage/transport)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Degree of protection	IP20
Protection class	III, IEC 61140, EN 61140, VDE 0140-1

Connection data

Designation	Inline connector
Connection method	Spring-cage connection
Conductor cross section, solid/stranded	0.08 mm ² ... 1.5 mm ²
Conductor cross section [AWG]	28 ... 16
Stripping length	8 mm

Connection data for UL approvals

Designation	Inline connector
Connection method	Spring-cage connection
Conductor cross section, solid/stranded	0.2 mm ² ... 1.5 mm ²
Conductor cross section [AWG]	24 ... 16
Stripping length	8 mm

Inline local bus interface

Connection method	Inline data jumper
Transmission speed	500 kbps

Supply of the module electronics and I/O through bus coupler/power terminal

Connection technology Potential routing

Power consumption

Communications power U_L 7.5 V
 Current consumption at U_L 43 mA (typical), 60 mA (maximum)
 Analog supply voltage U_{ANA} 24 V DC
 Current consumption at U_{ANA} 11 mA (typical), 18 mA (maximum)
 Total power consumption 590 mW (typical)

Analog inputs

Number 2 inputs for thermocouples or linear voltage
 Connection of signals 2-wire, shielded equalizing conductor for TC with encapsulated sensors
 Cable length Shorter than 30 m for shielded cables
 Sensor types that can be used B, C, E, J, K, L, N, R, S, T, U, W, HK
 Standards for characteristic curves DIN EN 60584-1: 1995 (B, E, J, K, N, R, S, T)
 DIN 43710 (U, L)
 Voltage input range -15 mV ... +85 mV
 Temperature measuring unit Either Celsius, Fahrenheit or μ V scale
 Temperature measuring range See table on page 26
 Resolution in the process data word (quantization) Can be parameterized, see table on page 20
 Resolution of measuring values See table on page 25
 Measured value representation In the formats
 Format 1 (IB standard) (15 bits with sign bit)
 Format 2 (12 bits with sign bit)
 Format 3 (15 bits with sign bit)
 Conversion method of the analog/digital converter Successive approximation
 Conversion time of the analog/digital converter 120 μ s, typical
 Process data update 30 ms, maximum, for both channels
 Limit frequency of the analog filter 48 Hz

Safety equipment

Surge proof up to ± 40 V TC channels: Connections 1.2 and 2.2 as well as 1.3. and 2.3

Electrical isolation/isolation of the voltage areas

To provide electrical isolation between the logic level and the I/O area, it is necessary to supply the station bus coupler and the sensors connected to the analog input terminal described here from separate power supply units. Interconnection of the power supply units in the 24 V area is not permitted (see also IL SYS INST UM E user manual).

Common potentials

The 24 V main voltage U_M , 24 V segment voltage U_S , and GND have the same potential. FE is a separate potential area.

Separate potentials in the system consisting of bus terminal/power terminal and analog I/O terminal

- Test distance	- Test voltage
7.5 V supply (bus logic)/24 V supply (I/O)	500 V AC, 50 Hz, 1 min
7.5 V supply (bus logic)/24 V analog supply (analog I/O)	500 V AC, 50 Hz, 1 min
24 V supply (I/O)/functional earth ground	500 V AC, 50 Hz, 1 min
24 V analog supply (analog I/O)/functional earth ground	500 V AC, 50 Hz, 1 min

Error messages to the higher-level control or computer system

Failure of the internal voltage supply	Yes
Failure of or insufficient communications power U_L	Yes, I/O error message sent to the bus terminal
I/O error/user error	Yes, error message via the process data input words (see page 21)

Programming data

Local bus (INTERBUS)	
ID code	$7F_{\text{hex}}$ (127_{dec})
Length code	02_{hex}
Input address area	4 bytes
Output address area	4 bytes
Parameter channel (PCP)	0 bytes
Register length (bus)	4 bytes



For the programming data/configuration data of other bus systems, please refer to the corresponding electronic device data sheet (e.g., GSD, EDS).

PROFIBUS telegram data

Required parameter data	6 bytes
Required configuration data	4 bytes

Approvals

For the latest approvals, please visit www.phoenixcontact.net/catalog.



The terminal was approved for use in potentially explosive areas of Zone 2 according to ATEX directive 94/9/EC until the start of 2017 and marked accordingly (Ex).

If you are using a terminal of this type in a potentially explosive area, observe the associated terminal-specific documentation.

See also the information in application note AH DE IL SAFE (German) or AH EN IL SAFE (English).

Terminals without corresponding marking (Ex) are not approved for use in potentially explosive areas.

4 Tolerance and temperature response



The percentage tolerance values refer to the relevant positive measuring range final value. Unless stated otherwise, nominal operation (nominal voltage, preferred mounting position, default format, identical measuring range setting for channels) is used as the basis. The tolerance values refer to the operating temperature range specified in the tables. The operable range outside this temperature range is not taken into consideration. Please also observe the values for temperature drift and the tolerances influenced by electromagnetic interference. The maximum tolerance values represent the worst-case measurement inaccuracy. They contain the theoretical maximum possible tolerances in the corresponding measuring ranges as well as the theoretical maximum possible tolerances of the calibration and test equipment.

4.1 Tolerances at an ambient temperature $T_A = +25^\circ\text{C}$



All percentage values refer to the relevant measuring range final value.
 * Below the indicated range, more errors are to be expected because of the low sensitivity of the sensor elements. The tolerance indications of the TC sensors refer to a differential temperature measurement without cold junction compensation. In addition, the tolerances of the sensor element and the cold junction must be considered (see table on page 10).

No.	Input	Sensor type	Measuring range for tolerance value*	Relative error	Absolute error	Maximum relative error	Maximum absolute error
1	Thermocouples	B	+500°C ... +1820°C* +932°F ... +3308°F	±0.23%	±4.2 K	±0.92%	±16.7 K
2		E	-226°C ... +1000°C* -374.8°F ... +1832°F	±0.04%	±0.4 K	±0.15%	±1.6 K
3		J	-210°C ... +1200°C -346°F ... +2192°F	±0.04%	±0.5 K	±0.15%	±1.9 K
4		K	-200°C ... +1372°C* -328°F ... +2501°F	±0.04%	±0.6 K	±0.17%	±2.4 K
5		N	-200°C ... +1300°C* -328°F ... +2372°F	±0.07%	±1.0 K	±0.29%	±3.7 K
6		R	-50°C ... +1768°C -58°F ... +3214°F	±0.14%	±2.5 K	±0.57%	±10.0 K
7		S	-50°C ... +1768°C -58°F ... +3214°F	±0.14%	±2.5 K	±0.57%	±10.0 K
8		T	-270°C ... +400°C -454°F ... +752°F	±0.16%	±0.7 K	±0.63%	±2.5 K
9		C	-18°C ... +2316°C 0°F ... +4200°F	±0.07%	±1.7 K	±0.29%	±6.7 K
10		W	-18°C ... +2316°C 0°F ... +4200°F	±0.09%	±2.1 K	±0.36%	±8.4 K
11		HK	-200°C ... +800°C -328°F ... 1472°F	±0.05%	±0.4 K	±0.18%	±1.5 K
12		L	-200°C ... +900°C -328°F ... +1652°F	±0.05%	±0.5 K	±0.21%	±1.9 K
13		U	-200°C ... +600°C -328°F ... +1112°F	±0.11%	±0.7 K	±0.42%	±2.5 K

No.	Input	Sensor type	Measuring range for tolerance value*	Relative error	Absolute error	Maximum relative error	Maximum absolute error
14	Internal cold junction	Pt1000	-25°C ... +85°C	±0.04%	±0.3 K	±0.22%	±1.9 K
15	Voltage input	Linear signals	-15 mV ... +85 mV	±0.03%	±25 µV	±0.12%	±100 µV

4.2 Tolerances at an ambient temperature $T_A = -25^{\circ}\text{C}$ to $+55^{\circ}\text{C}$



All percentage values refer to the relevant measuring range final value.
 * Below the indicated range, more errors are to be expected because of the low sensitivity of the sensor elements.
 The tolerance indications of the TC sensors refer to a differential temperature measurement without cold junction compensation. In addition, the tolerances of the sensor element and the cold junction must be considered (see table on page 10).

No.	Input	Sensor type	Measuring range for tolerance value*	Relative error	Absolute error	Maximum relative error	Maximum absolute error
1	Thermocouples	B	+500°C ... +1820°C* +932°F ... +3308°F	±0.55%	±10.0 K	±1.37%	±25.0 K
2		E	-226°C ... +1000°C* -374.8°F ... +1832°F	±0.09%	±0.9 K	±0.23%	±2.3 K
3		J	-210°C ... +1200°C -346°F ... +2192°F	±0.09%	±1.1 K	±0.23%	±2.8 K
4		K	-200°C ... +1372°C* -328°F ... +2501°F	±0.10%	±1.4 K	±0.26%	±3.6 K
5		N	-200°C ... +1300°C* -328°F ... +2372°F	±0.17%	±2.2 K	±0.43%	±5.6 K
6		R	-50°C ... +1768°C -58°F ... +3214°F	±0.34%	±6.0 K	±0.85%	±15.0 K
7		S	-50°C ... +1768°C -58°F ... +3214°F	±0.34%	±6.0 K	±0.85%	±15.0 K
8		T	-270°C ... +400°C -454°F ... +752°F	±0.38%	±1.5 K	±0.95%	±3.8 K
9		C	-18°C ... +2316°C 0°F ... +4200°F	±0.17%	±4.0 K	±0.43%	±10.0 K
10		W	-18°C ... +2316°C 0°F ... +4200°F	±0.22%	±5.0 K	±0.54%	±12.5 K
11		HK	-200°C ... +800°C -328°F ... 1472°F	±0.11%	±0.9 K	±0.28%	±2.2 K
12		L	-200°C ... +900°C -328°F ... +1652°F	±0.12%	±1.1 K	±0.31%	±2.8 K
13		U	-200°C ... +600°C -328°F ... +1112°F	±0.25%	±1.5 K	±0.63%	±3.8 K
14	Internal cold junction	Pt1000	-25°C ... +85°C	±0.05%	±0.4 K	±0.24%	±2.0 K
15	Voltage input	Linear signals	-15 mV ... +85 mV	±0.07%	±60 μV	±0.18%	±150 μV

4.3 Temperature response

No.	Input	Sensor type	Measuring range for tolerance value	Typical drift	Maximum drift
15	Voltage input	Linear signals	-15 mV ... +85 mV	15 ppm/K	35 ppm/K

4.4 Tolerances of the internal cold junction

Operation at an ambient temperature $T_A = -25^\circ\text{C} \dots +55^\circ\text{C}$

No.	Error type	Typical	Maximum
1	Sensor tolerance Pt1000 ($T_A = 25^\circ\text{C}$)	$\pm 0.2 \text{ K}$	$\pm 0.43 \text{ K}$
2	Temperature distribution error (channel 1 and channel 2)	-	-
3	Linearity error due to linearization	$\pm 0.01 \text{ K}$	$\pm 0.01 \text{ K}$
4	Total error of the cold junction for $T_A = 25^\circ\text{C}$	$\pm 0.3 \text{ K}$	$\pm 1.9 \text{ K}$
5	Total error of the cold junction for $T_A = -25^\circ\text{C} \dots +55^\circ\text{C}$	$\pm 0.4 \text{ K}$	$\pm 2.0 \text{ K}$



After supplying the voltage, the warm up time lasts approximately 30 minutes. Directly after startup, the tolerances of the cold junction can be increased by the typical tolerance.
The curve displaying the transient response is shown in Figure 1.

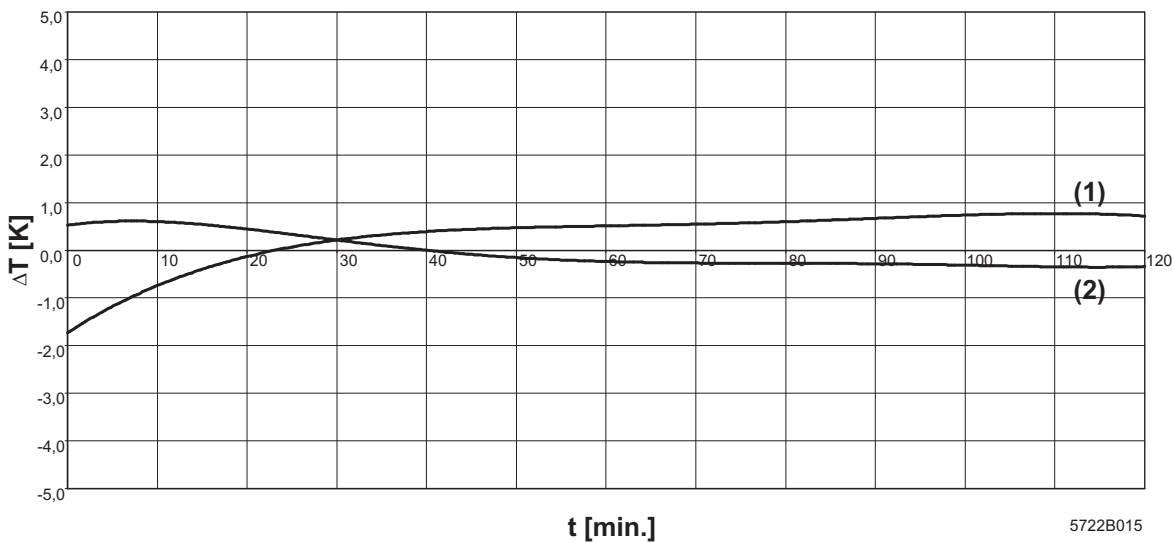


Figure 1 Transient response of the IB IL TEMP 2 UTH-PAC terminal

t [min] Time after switching on in minutes
 ΔT [K] Temperature deviation from the measured value in Kelvin (absolute error)
 The total system error for an absolute temperature measurement (see Figure 1) consists of the sensor tolerance, the device error, and the cold junction error.

- (1) Curve for channel 1
- (2) Curve for channel 2

4.5 Tolerances due to linearization

No.	Input	Sensor type	Standard	Measuring range (software-supported)	Maximum error due to sensor linearization
1	Thermocouples	B	EN 60584-1 (DIN EN 60584-1)	+50°C ... +1820°C +122°F ... +3308°F	±0.05 K
2		E		-270°C ... +1000°C -454°F ... +1832°F	±0.05 K
3		J		-210°C ... +1200°C -346°F ... +2192°F	±0.05 K
4		K		-270°C ... +1372°C -454°F ... +2501°F	±0.05 K
5		N		-270°C ... +1300°C -454°F ... +2372°F	±0.05 K
6		R		-50°C ... +1768°C -58°F ... +3214°F	±0.05 K
7		S		-50°C ... +1768°C -58°F ... +3214°F	±0.05 K
8		T		-270°C ... +400°C -454°F ... +752°F	±0.05 K
9		C		-18°C ... +2316°C 0°F ... +4200°F	±0.1 K
10		W		-18°C ... +2316°C 0°F ... +4200°F	±0.1 K
11		HK		-200°C ... +800°C -328°F ... 1472°F	±0.1 K
12		L	DIN 43710	-200°C ... +900°C -328°F ... 1652°F	±0.05 K
13		U		-200°C ... 600°C -328°F ... 1112°F	±0.05 K
14	Internal cold junction	Pt1000		-200°C ... +850°C -328°F ... 1562°F	±0.01 K
15	Voltage input	Linear signals		-	-

4.6 Additional tolerances when subject to EMI

Type of electromagnetic interference	Typical relative deviation from the measuring range final value	Criterion
Electromagnetic fields according to IEC 61000-4-3; EN 61000-4-3; field strength 10 V/m	Channel 1: $\pm 9.6\%$ Channel 2: $\pm 5.0\%$	A
Conducted interferences (0.15 MHz to 80 MHz) according to IEC 61000-4-6; EN 61000-4-6; class 3 (10 V)	Channel 1: $\pm 4.2\%$ Channel 2: $\pm 2.5\%$	A
Fast transients (burst) according to IEC 61000-4-4; EN 61000-4-4; 2 kV; class 3	–	B
Surge voltage according to IEC 61000-4-5; EN 61000-4-5	–	B
Electrostatic discharge (ESD) according to IEC 61000-4-2; EN 61000-4-2 (6 kV contact discharge/6 kV air discharge)	–	B



Additional tolerances might occur under the influence of high-frequency electromagnetic interference caused by wireless transmission systems in the nearest vicinity. The listed values refer to the operation in the pre-setting (TC type K with cold junction compensation) for direct electromagnetic interference of the components without additional shielding such as steel cabinet, etc.

The above mentioned tolerances can be reduced by providing further shielding measures for the I/O module (e.g., use of a shielded control box/control cabinet). Please observe the measures recommended in the Inline system manual for your bus system.

5 Internal basic circuit diagram

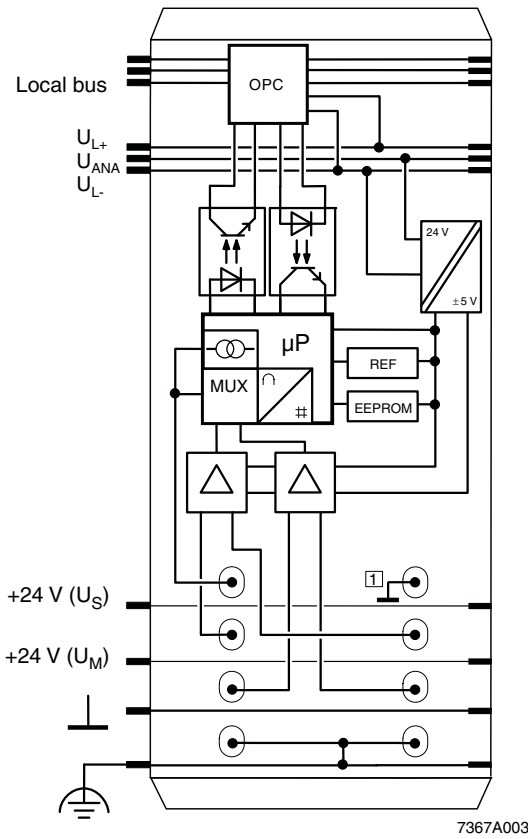

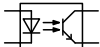









Figure 2 Internal wiring of the terminal points

Key:

-  Protocol chip
-  Optocoupler
-  DC/DC converter with electrical isolation
-  Microprocessor with multiplexer, power source for the cold junction, and analog/digital converter
-  Reference voltage
-  Electrically erasable programmable read-only memory
-  Amplifier
-  Analog ground, electrically isolated from ground of the potential jumper

 Other symbols used are explained in the IL SYS INST UM E user manual.

6 Electrical isolation

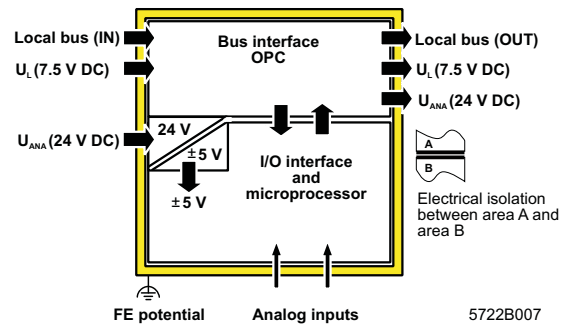


Figure 3 Electrical isolation of the individual function areas

7 Local diagnostic indicator



Figure 4 Local diagnostic indicator

Des.	Color	Meaning
D	Green	Diagnostics

Function identification

Green

8 Terminal point assignment

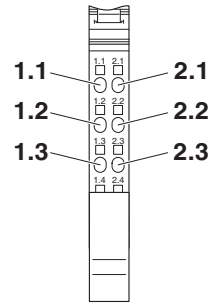


Figure 5 Terminal point assignment

Terminal points	Signal	Assignment
1.1	RTD _{EXT+}	Optional (for lab applications only) external cold junction sensor (Pt1000, Ni1000) (plus input)
2.1	RTD _{EXT-}	Optional (for lab applications only) external cold junction sensor (Pt1000, Ni1000) (minus input)
1.2	TC+	Thermocouple (plus input) channel 2
2.2	TC-	Thermocouple (minus input) channel 2
1.3	TC+	Thermocouple (plus input) channel 1
2.3	TC-	Thermocouple (minus input) channel 1
1.4, 2.4	Shield	Shield connection (channel 1 and 2)

9 Installation instructions

High current flowing through potential jumpers U_M and U_S leads to a temperature rise in the potential jumpers and inside the terminal. To keep the current flowing through the potential jumpers of the analog terminals as low as possible, always place the analog terminals after all the other terminals at the end of the main circuit (for the sequence of the Inline terminals: see also IL SYS INST UM E user manual).

Regarding this terminal, please also observe that via potential routing the current always distorts the temperature of the internal cold junction. Therefore, position this terminal after **all** of the other terminals to minimize the current flowing through **all** potential jumpers.

10 Connection notes

Thermocouple connection

Always connect the thermocouples using shielded, twisted pair cables.

Use encapsulated thermocouples.

For thermocable extension, thermoelectric voltage terminal blocks are available (Phoenix Contact MTKD type; see Figure 8 on page 17 and ordering data).

Shield connection

The connection examples show how to connect the shield (Figure 6 to Figure 8).

Connect the shielding to only one side of the Inline terminal using the shield connection clamp. In this way, the creation of ground loops that might occur when connecting the shielding to PE on both sides can be prevented. The clamp connects the shield directly to FE on the module side. Additional wiring is not necessary.

Insulate the shield at the sensor.

11 Connection examples

When connecting the shield at the terminal you must insulate the shield on the sensor side (shown in gray in Figure 6 and Figure 7).

Use a connector with shield connection when installing the sensors. Figure 6 and Figure 7 show the connection schematically (without shield connector).

11.1 Absolute temperature measurement

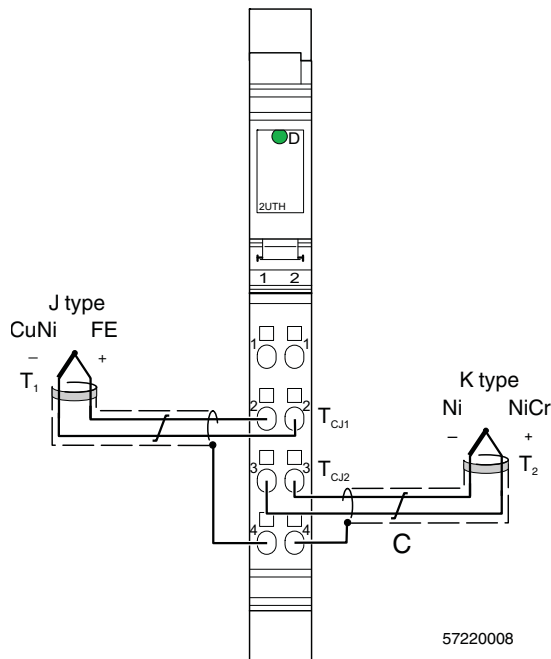


Figure 6 Absolute temperature measurement at two channels

For absolute temperature measurement, the measuring temperature of T_1 or T_2 is determined via cold junction compensation (T_{CJ1} , T_{CJ2}).

11.2 Differential temperature measurement

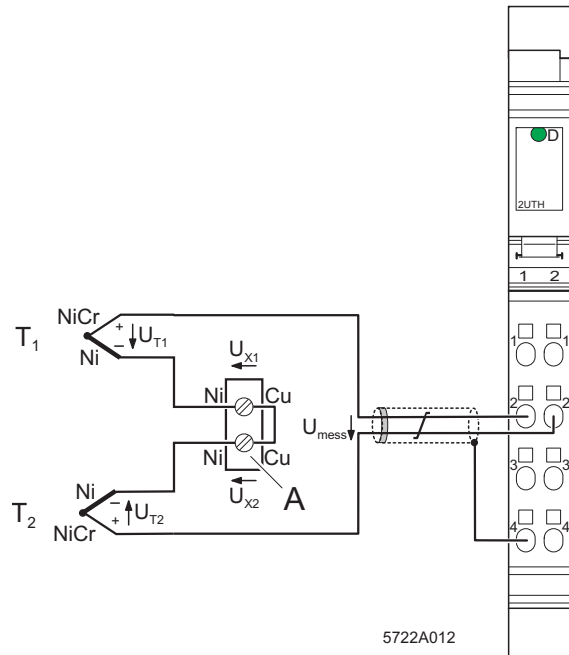


Figure 7 Differential temperature measurement using two thermocouples, type K

$$U_{\text{meas}} = U_{T1} - U_{X1} + U_{X2} - U_{T2} = U_{T1} - U_{T2}$$

The absolute value of U_{X1} equals U_{X2} , the prerequisite being that both terminal points (A) are on the same temperature level. Both voltages compensate each other. It is the difference between U_{T1} and U_{T2} that remains.

11.3 Equalizing conductor extension

When connecting the shield to a central grounding point, you must insulate the shield at the opposite side (shown in gray in Figure 8).

Use a connector with shield connection when installing the sensors. Figure 8 shows the connection schematically (without shield connector).

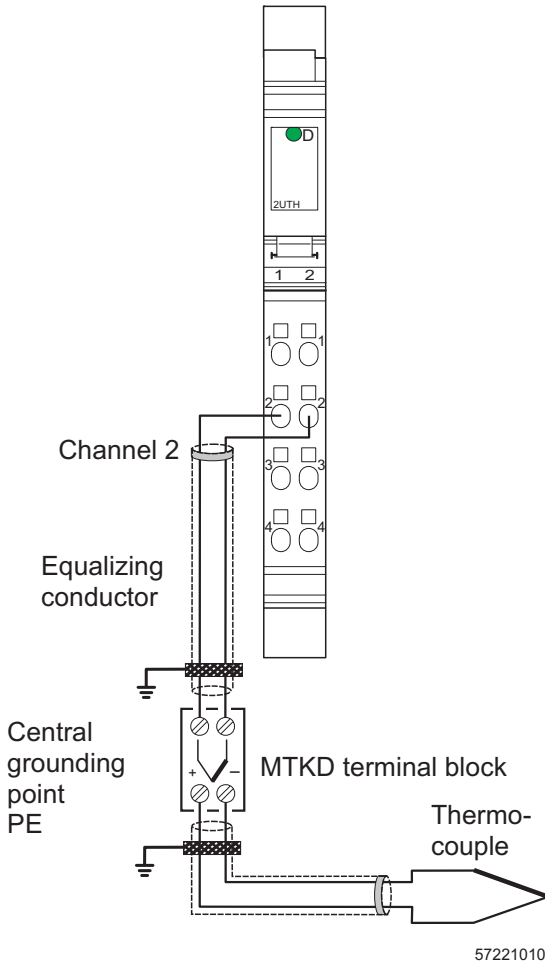


Figure 8 Equalizing conductor extension using thermocouples

12 Process data



For the assignment of the illustrated (byte.bit) view to your INTERBUS control or computer system, please refer to the DB GB IBS SYS ADDRESS data sheet.

12.1 Output data for parameterization of the terminal (see page 19)

(Word.bit) view	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 2	Assignment	1	0	0	0	0	0	0	CJ	Resolution	Format	Sensor type					
(Word.bit) view	Word	Word 1															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 1	Assignment	1	0	0	0	0	0	0	CJ	Resolution	Format	Sensor type					

CJ Cold junction

12.2 Assignment of the terminal points to the input data (see page 21)

(Word.bit) view	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 2	Signal	Terminal point 1.2															
	Signal reference	Terminal point 2.2															
	Shield	Terminal point 1.4, 2.4															
(Word.bit) view	Word	Word 1															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 1	Signal	Terminal point 1.3															
	Signal reference	Terminal point 2.3															
	Shield	Terminal point 1.4, 2.4															

12.3 Process data output words (OUT)

The terminal channels can be parameterized using the two process data output words. The following parameterization options exist for each channel independent of the other channel:

- Sensor type selection
- Resolution setting
- Changing the formats for the representation of measured values
- Cold junction selection

The parameterization settings are not stored. They must be transmitted in every bus cycle.

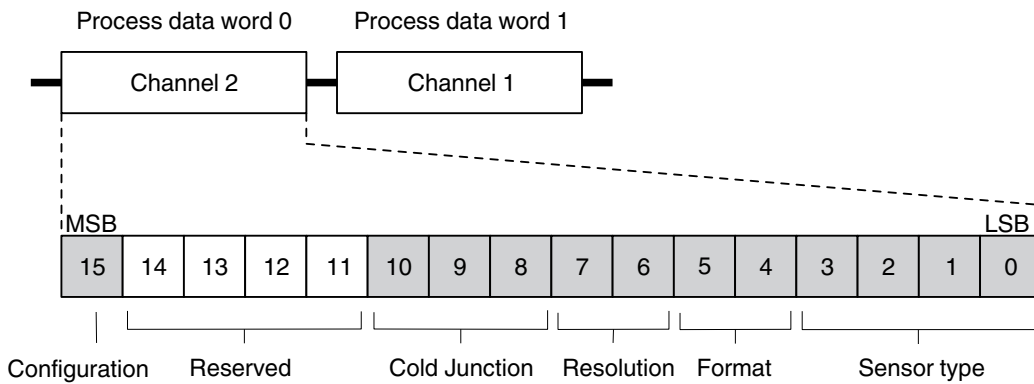
After applying voltage (power up) to the Inline station, the "Measured value invalid" message (error code 8004_{hex}) appears in the input process data.

After a maximum of 1 s, the preset parameterization is accepted and the first measured value is available. If you change the parameterization, the corresponding channel is re-initialized. The "Measured value invalid" message (error code 8004_{hex}) appears in the output process data for 100 ms, maximum.

Default:

Sensor type:	TC type K
Resolution:	0.1°C (1 μV)
Output format:	Format 1 (IB standard)
Cold junction:	Internal

One process data output word is available for the parameterization of each channel.



5722C006

Figure 9 Process data output words

i

Set all reserved bits to 0.

In order to parameterize the terminal, set bit 15 of the corresponding output word to 1. If bit 15 = 0, the preset parameterization is active.

Bit 15:

Code		Parameterization
Dec	Bin	
0	0	Default
1	1	Parameterization data

Bit 10 to bit 8:

Code		Cold junction compensation
Dec	Bin	
0	000	Internal cold junction active; TC measurement with internal cold junction compensation
1	001	Internal cold junction inactive; TC differential measurement without cold junction compensation
2	010	External cold junction Pt1000; TC measurement with external cold junction compensation at an isothermal block (for lab applications only)
3	011	External cold junction Ni1000; TC measurement with external cold junction compensation at an isothermal block (for lab applications only)
4 to 7	100 to 111	Reserved

Bit 7 and bit 6

Code		Resolution (referring to format 1 (IB standard))
Dec	Bin	
0	00	0.1°C (1 µV)
1	01	1°C (10 µV)
2	10	0.1°F
3	11	1°F

Bit 5 and bit 4

Code		Format
Dec	Bin	
0	00	Format 1: IB standard 15 bits + sign bit with extended diagnostics
1	01	Format 2: 12 bits + sign bit + 3 diagnostic bits
2	10	Format 3 15 bits + sign bit
3	11	Reserved

Bit 3 to bit 0:

Code		Sensor type
Dec	Bin	
0	0000	TC type K
1	0001	TC type J
2	0010	TC type E
3	0011	TC type R
4	0100	TC type S
5	0101	TC type T
6	0110	TC type B
7	0111	TC type N
8	1000	TC type U
9	1001	TC type L
10	1010	TC type C
11	1011	TC type W
12	1100	TC type HK
13	1101	Cold junction (CJ)
14	1110	U: Voltage (-15 mV ... +85 mV)
15	1111	Reserved



Use the IB standard format to represent the measured values of sensor type 14 (linear voltage).



If you select cold junction as the sensor type, the input data word displays the cold junction temperature (terminal temperature). In addition, the channel parameterized in this way will not be evaluated within the measuring cycle, leading to a reduced update time for the terminal.

12.4 Process data input words (IN)

On each channel the measured values are transmitted to the controller board or the computer by means of the process data input words.

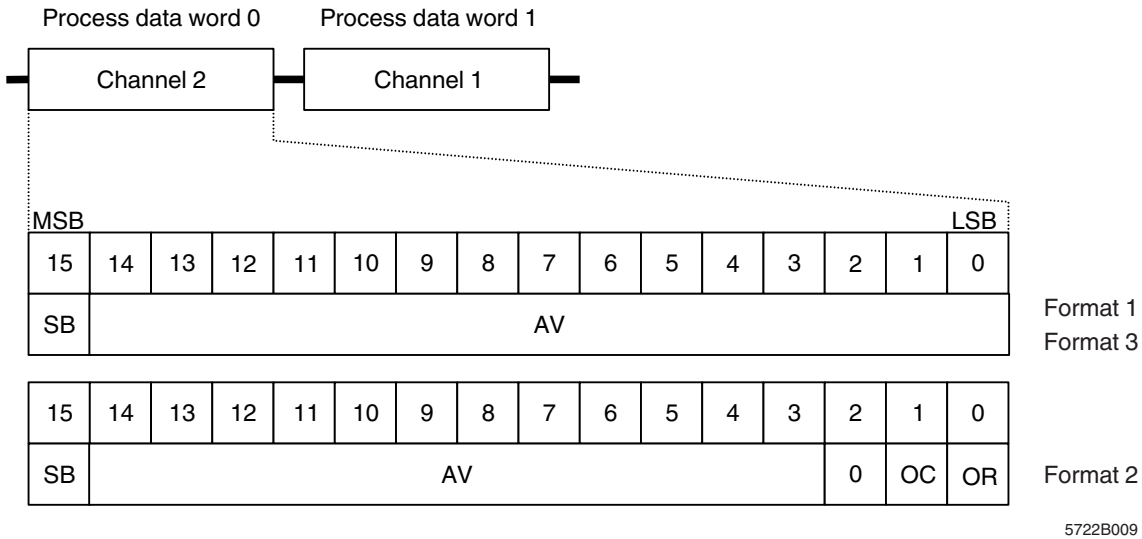


Figure 10 Sequence of the process data input words and display of the bits of the first process data word in the different formats

Key

- MSB Most significant bit
- LSB Least significant bit
- SB Sign bit
- AV Analog value
- 0 Reserved
- OC Open circuit
- OR Overrange

The process data format 1 (IB standard) supports extended diagnostics.

The following error codes are possible:

Code (hex)	Error
8001	Overrange
8002	Open circuit
8004	Measured value invalid/no valid measured value available
8008	Cold junction defective
8010	Parameterization invalid
8040	Terminal faulty
8080	Underrange

13 Formats for representing measured values

13.1 Format 1: IB standard

The measured value is represented in bits 14 to 0. An additional bit (bit 15) is available as a sign bit.

This format supports extended diagnostics. Values > 8000_{hex} indicate an error. The error codes are listed on page 21.

Measured value representation in format 1 (IB standard; 15 bits)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SB	AV														

SB Sign bit

AV Analog value

Typical analog values depending on the resolution

Sensor type (bits 3 to 0)		TC and CJ sensor (0 to 13)	Linear voltage (14)
Resolution (bits 7 and 6)		00 _{bin} /10 _{bin}	00 _{bin}
Process data _{hex} (= Analog value _{hex})	Analog value _{dec}	0.1°C/0.1°F (°C)/(°F)	1 μV (μV)
8002		Open circuit	-
8001		Overrange	> 32768
2710	10000	1000.0	10000
000A	10	1.0	10
0001	1	0.1	1
0000	0	0	0
FFFF	-1	-0.1	-1
FC18	-1000	-100.0	-1000
C568	-15000	-	-15000
8080		Underrange	< -15000

Sensor type (bits 3 to 0)		TC and CJ sensor (0 to 13)	Linear voltage (14)
Resolution (bits 7 and 6)		01 _{bin} /11 _{bin}	01 _{bin}
Process data _{hex} (= Analog value _{hex})	Analog value _{dec}	1°C/1°F (°C)/(°F)	10 μV (μV)
8002		Open circuit	-
8001		Overrange	> 85000
2134	8500	-	85000
03E8	1000	1000	10000
0001	1	1	10
0000	0	0	0
FFFF	-1	-1	-10
FF9C	-100	-100	-1000
FA24	-1500	-	-15000
8080		Underrange	< -15000



If the measured value is larger than the representation range of the process data, the “overrange” or “underrange” error code is generated.

The “open circuit” error message is only generated in TC operation.

13.2 Format 2

The measured value is represented in bits 14 to 3. The remaining 4 bits are available as sign and error bits.

Measured value representation in format 2 (12 bits)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SB	AV												0	OC	OR

- SB Sign bit
- AV Analog value
- 0 Reserved
- OC Open circuit/broken wire
- OR Overrange

Typical analog values depending on the resolution

Sensor type (bits 3 to 0)		TC and CJ sensor (0 to 13)	
Resolution (bits 7 and 6)		00 _{bin} /10 _{bin}	01 _{bin} /11 _{bin}
Process data _{hex} (= Analog value _{hex})	Analog value _{dec}	0.1°C/0.1°F (°C)/(°F)	1°C/1°F (°C)/(°F)
xxxx xxxx xxxx xxx1 _{bin}		<i>Overrange</i> (AV = positive final value from the table on page 26)	
2710	10000	1000	–
03E8	1000	100	1000
0008	8	0.8	8
0000	0	0	0
FFF8	-8	-0.8	-8
FC18	-1000	-100	–
xxxx xxxx xxxx xxx1 _{bin}		<i>Underrange</i> (AV = negative final value from the table on page 26)	
xxxx xxxx xxxx xx1x _{bin}		<i>Open circuit</i> (AV = negative final value from the table on page 26)	

- AV Analog value
- x Can have the value 0 or 1



If the measured value is larger than the representation range of the process data, bit 0 is set to 1.
For an open circuit, bit 1 is set to 1.

13.3 Format 3

The measured value is represented in bits 14 to 0. An additional bit (bit 15) is available as a sign bit.

Measured value representation in format 3 (15 bits)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SB	AV														

SB Sign bit
 AV Analog value

Typical analog values depending on the resolution

Sensor type (bits 3 to 0)		TC and CJ sensor (0 to 13)
Resolution (bits 7 and 6)		$00_{bin}/10_{bin}$
Process data _{hex} (= Analog value _{hex})	Analog value _{dec}	$0.1^{\circ}\text{C}/0.1^{\circ}\text{F}$ ($^{\circ}\text{C}$)/($^{\circ}\text{F}$)
<i>Upper limit value* + 1 LSB</i>		<i>Overrange</i>
7D00	32000	–
2710	10000	1000.0
000A	10	1
0001	1	0.1
0000	0	0
FFFF	-1	-0.1
FC18	-1000	-100.0
B500	-19200	–
<i>Lower limit value* - 1 LSB</i>		<i>Underrange</i>
<i>Lower limit value* - 2 LSB</i>		<i>Open circuit</i>

Sensor type (bits 3 to 0)		TC and CJ sensor (0 to 13)
Resolution (bits 7 and 6)		$01_{bin}/11_{bin}$
Process data _{hex} (= Analog value _{hex})	Analog value _{dec}	$1^{\circ}\text{C}/1^{\circ}\text{F}$ ($^{\circ}\text{C}$)/($^{\circ}\text{F}$)
<i>Upper limit value* + 1 LSB</i>		<i>Overrange</i>
6400	25600	–
03E8	1000	1000
0001	1	1
0000	0	0
FFFF	-1	-1
FF9C	-100	-100
ED40	-4800	–
<i>Lower limit value* - 1 LSB</i>		<i>Underrange</i>
<i>Lower limit value* - 2 LSB</i>		<i>Open circuit</i>

* The limit values are given in the table on page 26

14 Measuring ranges

14.1 Measuring range depending on the resolution (format 1 (IB standard) and format 3)

Resolution (Bits 7 and 6)	Thermocouples	Linear voltage sensors
00	-273°C ... +3276.8°C; Resolution: 0.1°C	-15 mV ... +32.768 mV Resolution: 1 µV
01	-273°C ... +32768°C; Resolution: 1.0°C	-15 mV ... +85 mV Resolution: 10 µV
10	-459°F ... +3276.8°F Resolution: 0.1°F	
11	-459°F ... +32768°F Resolution: 1.0°F	

14.2 Measuring ranges depending on the resolution (format 2)

Resolution (Bits 7 and 6)	Thermocouples
00	-272.8°C ... +3276.0°C; Resolution: 0.8°C
01	-272°C ... +32760°C; Resolution: 8°C
10	-459.2°F ... +3276°F Resolution: 0.8°F
11	-456°F ... +32760°F Resolution: 8°F

Temperature values can be converted from °C to °F according to the following formula:

$$T [^{\circ}\text{F}] = T [^{\circ}\text{C}] \times \frac{9}{5} + 32$$

Where:

T [°F] Temperature in degrees Fahrenheit
T [°C] Temperature in degrees Celsius

14.3 Input measuring ranges

No.	Input	Sensor type	Standard	Measuring range (software-supported)	
				Lower limit	Upper limit
1	Thermocouples	B	EN 60584-1 (DIN EN 60584-1)	+50°C +122°F	+1820°C +3308°F
2		E		-270°C -454°F	+1000°C +1832°F
3		J		-210°C -346°F	+1200°C +2192°F
4		K		-270°C -454°F	+1372°C +2501°F
5		N		-270°C -454°F	+1300°C +2372°F
6		R		-50°C -58°F	+1768°C +3214°F
7		S		-50°C -58°F	+1768°C +3214°F
8		T		-270°C -454°F	+400°C +752°F
9		C		-18°C 0°F	+2316°C +4200°F
10		W		-18°C 0°F	+2316°C +4200°F
11		HK		-200°C -328°F	+800°C +1472°F
12		L	DIN 43710	-200°C -328°F	+900°C +1652°F
13		U		-200°C -328°F	+600°C +1112°F
14	Internal cold junction	Pt1000	DIN IEC 60751	-200°C	+850°C
15	Voltage input	Linear voltage signal		-15 mV	+85 mV



For under and overrange of the limits indicated above, the “Over-/Underrange” error message is generated in the “IB standard” format 1.

15 Process data update time

(Module response time for the output of the required channel address with the corresponding measured value)

Action	Time	Number of bus cycles
Refreshing the measured value in the process data with a constant process data output word (e.g., PD-OUT = 0000 _{hex})	< 30 ms	= Time/cycle time



The time is the response time of the module electronics up to the point in time when the valid values are present in the process data output words.