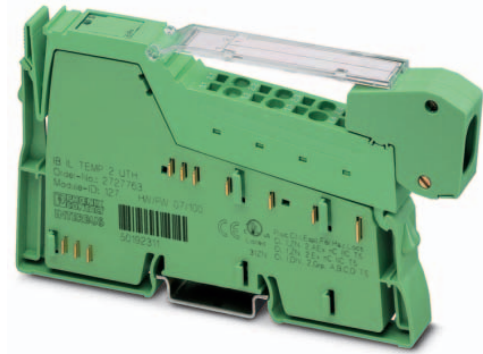


IB IL TEMP 2 UTH-PAC

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

Data sheet
5722_en_08

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1 Description

The terminal is designed for use within an Inline station. This terminal can be used to acquire signals from standard thermocouples. It supports 13 different types of thermocouples according to DIN EN 60584-1 and DIN 43710, as well as a linear voltage input of -15 mV to +85 mV.

Features

- 2 differential inputs for thermocouples or linear voltage
- 1 input for an external cold junction, Pt 1000 or Ni 1000
- The channels are parameterized independently of one another via the bus system
- Internal detection and compensation of cold junction temperature (can be parameterized)
- Absolute and differential temperature measurement (can be parameterized)
- Pt 1000 sensor in the vicinity of the connection terminal blocks 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/product/2861386

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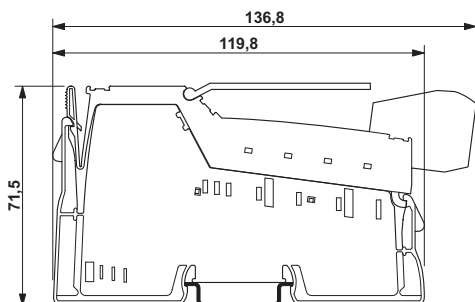
3 Ordering data

Description	Type	Order No.	Pcs./Pkt.
Inline, temperature measurement terminal, analog UTH inputs: 2 (Thermocouples or linear voltage), connection method: 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			
Inline shield connector (Connector/Adapter)	IB IL SCN 6-SHIELD-TWIN	2740245	5
Inline shield connector (Connector/Adapter)	IB IL SCN-6 SHIELD	2726353	5
Labeling field, width: 12.2 mm (Marking)	IB IL FIELD 2	2727501	10
Insert strip, Sheet, white, unlabeled, can be labeled with: Office printing systems: Laser printer, mounting type: insert, lettering field size: 62 x 10 mm (Marking)	ESL 62X10	0809492	1
Thermoelectric voltage terminal block pair, TC type T, nom. voltage: 400 V, nominal current: 1 A, connection method: Screw connection, number of connections: 4, number of positions: 2, cross section: 0.2 mm ² - 4 mm ² , AWG: 24 - 12, width: 10.4 mm, color: gray, mounting type: NS 35/7,5, NS 35/15, NS 32	MTKD-CU/CUNI	3100059	50
Thermoelectric voltage terminal block pair, TC type J, nom. voltage: 400 V, nominal current: 1 A, connection method: Screw connection, number of connections: 4, number of positions: 2, cross section: 0.2 mm ² - 4 mm ² , AWG: 24 - 12, width: 10.4 mm, color: gray, mounting type: NS 35/7,5, NS 35/15, NS 32	MTKD-FE/CUNI	3100046	50
Thermoelectric voltage terminal block pair, TC type E, nom. voltage: 400 V, nominal current: 1 A, connection method: Screw connection, number of connections: 4, number of positions: 2, cross section: 0.2 mm ² - 4 mm ² , AWG: 24 - 12, width: 10.4 mm, color: gray, mounting type: NS 35/7,5, NS 35/15, NS 32	MTKD-NICR/CUNI	3100075	50
Thermoelectric voltage terminal block pair, TC type K, nom. voltage: 400 V, nominal current: 1 A, connection method: Screw connection, number of connections: 4, number of positions: 2, cross section: 0.2 mm ² - 4 mm ² , AWG: 24 - 12, width: 10.4 mm, color: gray, mounting type: NS 35/7,5, NS 35/15, NS 32	MTKD-NICR/NI	3100062	50
Thermoelectric voltage terminal block pair, TC type R, nom. voltage: 400 V, nominal current: 1 A, connection method: Screw connection, number of connections: 4, number of positions: 2, cross section: 0.2 mm ² - 4 mm ² , AWG: 24 - 12, width: 10.4 mm, color: gray, mounting type: NS 35/7,5, NS 35/15, NS 32	MTKD-E-CU/A-CU	3100091	50

Accessories	Type	Order No.	Pcs./Pkt.
Thermoelectric voltage terminal block pair, TC type B, nom. voltage: 400 V, nominal current: 1 A, connection method: Screw connection, number of connections: 4, number of positions: 2, cross section: 0.2 mm ² - 4 mm ² , AWG: 24 - 12, width: 10.4 mm, color: gray, mounting type: NS 35/7,5, NS 35/15, NS 32	MTKD-S-CU/E-CU	3100101	50
Documentation	Type	Order No.	Pcs./Pkt.
User manual, English, Automation terminals of the Inline product range	IL SYS INST UM E	-	-
Data sheet, English, INTERBUS addressing	DB GB IBS SYS ADDRESS	-	-

4 Technical data

Dimensions (nominal sizes in mm)



Width	12.2 mm
Height	136.8 mm
Depth	71.5 mm
Note on dimensions	Housing dimensions

General data

Color	green
Weight	67 g (with connector)
Operating mode	Process data operation with 2 words
Ambient temperature (operation)	-25 °C ... 55 °C
Ambient temperature (storage/transport)	-25 °C ... 85 °C
Permissible humidity (operation)	10 % ... 95 % (non-condensing)
Permissible humidity (storage/transport)	10 % ... 95 % (non-condensing)
Air pressure (operation)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Air pressure (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: Inline connector

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

Connection data for UL approvals: Inline connector

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

Interface: Inline local bus

Number	2
Connection method	Inline data jumper
Transmission speed	500 kbps

Communications power (U_L)

Supply voltage	7.5 V DC (via voltage jumper)
Current draw	typ. 43 mA max. 60 mA

Supply of analog modules (U_{ANA})

Supply voltage	24 V DC (via voltage jumper)
Supply voltage range	19.2 V DC ... 30 V DC (including all tolerances, including ripple)
Current draw	typ. 11 mA max. 18 mA

Power consumption

Power consumption	typ. 587 mW max. 882 mW
-------------------	----------------------------

Analog UTH inputs

Number of inputs	2 (Thermocouples or linear voltage)
Connection method	Inline connector
Connection technology	2-wire, Shielded compensating line for TC with encapsulated sensors
Sensor types that can be used (TC)	U, T, L, J, E, K, N, S, R, B, C, W, HK
A/D conversion time	typ. 120 μs (per channel)
Measuring principle	Successive approximation
Measured value representation	16 bits (15 bits + sign bit)
Process data update	max. 30 ms (For both channels)
Absolute accuracy	typ. ± 0.6 K (Sensor type K)
Permissible cable length	< 30 m (For shielded cable)
Surge protection (TC channels)	up to ±40 V
Limit frequency (3 dB)	48 Hz

Programming data (INTERBUS, local bus)

ID code (hex)	7F
ID code (dec.)	127
Length code (hex)	02
Length code (dec.)	02
Process data channel	32 Bit
Input address area	4 Byte
Output address area	4 Byte
Parameter channel (PCP)	0 Byte
Register length (bus)	32 Bit



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

Configuration and parameter data in a PROFIBUS system

Required parameter data	6 Byte
Required configuration data	4 Byte

Error messages to the higher level control or computer system

Failure of the internal I/O supply	I/O error message sent to the bus coupler
Failure of or insufficient communications power U_L	I/O error message sent to the bus coupler
Peripheral fault	Error message in the process data
User error	Error message in the process data

Electrical isolation/isolation of the voltage areas

Test section	Test voltage
7.5 V supply (bus logics)/24 V analog supply (analog I/O)	500 V AC, 50 Hz, 1 min.
7.5 V supply (bus logics) / 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.

Approvals

For the latest approvals, please visit phoenixcontact.net/products.



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

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 (Ⓔ) are not approved for use in potentially explosive areas.

5 Tolerance and temperature response

All **percentage tolerance values** refer to the relevant positive measuring range final value.

Unless stated otherwise, nominal operation is used as the basis.

Nominal operation: nominal voltage, preferred mounting position, default format, identical measuring range setting for channels

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 under influences of electromagnetic interferences.

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.

5.1 Tolerances of the measuring inputs at $T_A = +25^\circ\text{C}$

All **percentage tolerance values** refer to the relevant positive measuring range final value.

* Below the indicated range, more errors are to be expected because of the very low sensitivity of the sensor elements.

The tolerance values of the TC sensors refer to a differential temperature measurement without cold junction compensation. The tolerances of the sensor element and the cold junction must also be taken into consideration (see corresponding table).

No.	Input	Sensor type	Measuring range for tolerance value		Absolute tolerance		Relative tolerance (with reference to MRFV)		
			Lower limit	Upper limit	Typical	Maximum	Typical	Maximum	
1	Thermocouples	B	+500 °C	+1820 °C	*	±4.2 K	±16.7 K	±0.23 %	±0.92 %
2		E	-226 °C	+1000 °C	*	±0.4 K	±1.6 K	±0.04 %	±0.15 %
3		J	-210 °C	+1200 °C		±0.5 K	±1.9 K	±0.04 %	±0.15 %
4		K	-200 °C	+1372 °C	*	±0.6 K	±2.4 K	±0.04 %	±0.17 %
5		N	-200 °C	+1300 °C	*	±1.0 K	±3.7 K	±0.07%	±0.29%
6		R	-50 °C	+1768 °C		±2.5 K	±10.0 K	±0.14 %	±0.57 %
7		S	-50 °C	+1768 °C		±2.5 K	±10.0 K	±0.14 %	±0.57 %
8		T	-270 °C	+400 °C		±0.7 K	±2.5 K	±0.16 %	±0.63 %
9		C	-18 °C	+2316 °C		±1.7 K	±6.7 K	±0.07%	±0.29%
10		W	-18 °C	+2316 °C		±2.1 K	±8.4 K	±0.09 %	±0.36 %
11		HK	-200 °C	+800 °C		±0.4 K	±1.5 K	±0.05 %	±0.18 %
12		L	-200 °C	+900 °C		±0.5 K	±1.9 K	±0.05 %	±0.21 %
13		U	-200 °C	+600 °C		±0.7 K	±2.5 K	±0.11 %	±0.42 %
14	Internal cold junction	Pt 1000	-25 °C	+85 °C		±0.3 K	±1.9 K	±0.04 %	±0.22 %
15	Voltage input	Linear voltage	-15 mV	+85 mV		±25 µV	±100 µV	±0.03%	±0.12 %

MRFV= Measuring range final value

5.2 Tolerances of the measuring inputs at $T_A = -25^{\circ}\text{C}$ to $+55^{\circ}\text{C}$

All percentage tolerances refer to the relevant measuring range final value.

* Below the indicated range, more errors are to be expected because of the very low sensitivity of the sensor elements.

The tolerance values of the TC sensors refer to a differential temperature measurement without cold junction compensation. The tolerances of the sensor element and the cold junction must also be taken into consideration (see corresponding table).

No.	Input	Sensor type	Measuring range for tolerance value		Absolute tolerance		Relative tolerance (with reference to MRFV)		
			Lower limit	Upper limit	Typical	Maximum	Typical	Maximum	
1	Thermocouples	B	+500 °C	+1820 °C	*	±10.0 K	±25.0 K	±0.55 %	±1.37%
2		E	-226 °C	+1000 °C	*	±0.9 K	±2.3 K	±0.09 %	±0.23 %
3		J	-210 °C	+1200 °C		±1.1 K	±2.8 K	±0.09 %	±0.23 %
4		K	-200 °C	+1372 °C	*	±1.4 K	±3.6 K	±0.10%	±0.26%
5		N	-200 °C	+1300 °C	*	±2.2 K	±5.6 K	±0.17 %	±0.43%
6		R	-50 °C	+1768 °C		±6.0 K	±15.0 K	±0.34%	±0.85%
7		S	-50 °C	+1768 °C		±6.0 K	±15.0 K	±0.34%	±0.85%
8		T	-270 °C	+400 °C		±1.5 K	±3.8 K	±0.38 %	±0.95%
9		C	-18 °C	+2316 °C		±4.0 K	±10.0 K	±0.17 %	±0.43%
10		W	-18 °C	+2316 °C		±5.0 K	±12.5 K	±0.22 %	±0.54%
11		HK	-200 °C	+800 °C		±0.9 K	±2.2 K	±0.11 %	±0.28 %
12		L	-200 °C	+900 °C		±1.1 K	±2.8 K	±0.12 %	±0.31%
13		U	-200 °C	+600 °C		±1.5 K	±3.8 K	±0.25%	±0.63 %
14	Internal cold junction	Pt 1000	-25 °C	+85 °C		±0.4 K	±2.0 K	±0.05 %	±0.24%
15	Voltage input	Linear voltage	-15 mV	+85 mV		±60 μV	±150 μV	±0.07%	±0.18 %

5.3 Temperature response

No.	Input	Sensor type	Measuring range		Drift	
			Lower limit	Upper limit	Typical	Maximum
15	Voltage input	Linear voltage	-15 mV	+85 mV	15 ppm/K	35 ppm/K

5.4 Tolerances of the internal cold junction

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

Error type	Typical	Maximum
Sensor tolerance Pt 1000 ($T_A = 25^\circ\text{C}$)	$\pm 0.2\text{ K}$	$\pm 0.43\text{ K}$
Temperature distribution error for channel 1 and 2	-	-
Linearity error	$\pm 0.01\text{ K}$	$\pm 0.01\text{ K}$
Total cold junction error at $T_A = 25^\circ\text{C}$	$\pm 0.3\text{ K}$	$\pm 1.9\text{ K}$
Total cold junction error at $T_A = -25^\circ\text{C}$ to $+55^\circ\text{C}$	$\pm 0.4\text{ K}$	$\pm 2.0\text{ K}$



After applying the supply voltage, the warm-up phase lasts 30 minutes. Immediately after switch-on, the tolerances of the cold junction can be increased by the typical tolerance. The curve in the figure below shows the transient response.

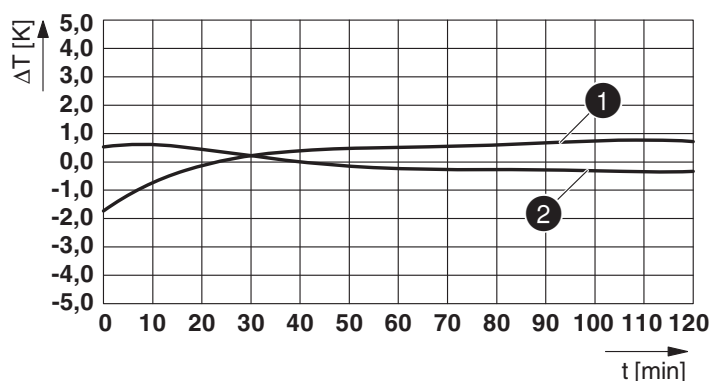


Figure 1 Transient response

Key:

t [min] Time after switch-on in minutes

ΔT [K] Temperature deviation from the measured value in Kelvin (absolute tolerance)

The total system tolerance for an absolute temperature measurement shown in the diagram is made up of the sensor tolerance, the device tolerance, and the cold junction tolerance.

(1) Curve for channel 1

(2) Curve for channel 2

5.5 Tolerances due to linearization

No.	Input	Sensor type	Standard	Measuring range (software-supported)		Maximum tolerance due to linearization
				Lower limit	Upper limit	
1	Thermocouples	B	EN 60584-1 (DIN EN 60584-1)	+50 °C	+1820 °C	±0.05 K
2		E		-270 °C	+1000 °C	±0.05 K
3		J		-210 °C	+1200 °C	±0.05 K
4		K		-270 °C	+1372 °C	±0.05 K
5		N		-270 °C	+1300 °C	±0.05 K
6		R		-50 °C	+1768 °C	±0.05 K
7		S		-50 °C	+1768 °C	±0.05 K
8		T		-270 °C	+400 °C	±0.05 K
9		C		-18 °C	+2316 °C	±0.1 K
10		W		-18 °C	+2316 °C	±0.1 K
11		HK		-200 °C	+800 °C	±0.1 K
12		L	DIN 43710	-200 °C	+900 °C	±0.05 K
13		U		-200 °C	+600 °C	±0.05 K
14	Internal cold junction	Pt 1000		-200 °C	+850 °C	±0.01 K
15	Voltage input	Linear voltage		-	-	-

5.6 Additional tolerances influenced by electromagnetic interference

Type of electromagnetic interference	Standard	Level	Additional tolerances of measuring range final value	Criterion
Electromagnetic fields	EN 61000-4-3/ IEC 61000-4-3	10 V/m	Channel 1: ±9.6%, channel 2: ±5.0%	A
Conducted interference	EN 61000-4-6/ IEC 61000-4-6	Class 3 (test voltage 10 V)	Channel 1: ±4.2%, channel 2: ±2.5%	A
Fast transients (burst)	EN 61000-4-4/ IEC 61000-4-4	Class 3	-	B
Transient overvoltage	EN 61000-4-5/ IEC 61000-4-5		-	B
Electrostatic discharge (ESD)	EN 61000-4-2/ IEC 61000-4-2	6 kV contact discharge / 6 kV air discharge	-	B



Additional tolerances may occur due to the influence of high-frequency interference caused by wireless transmission systems in the immediate vicinity.

The listed values refer to operation in the presetting (TC type K with cold junction compensation) for direct electromagnetic interference of the components without the use of additional shielding measures such as a steel cabinet, etc.

The above tolerances can be reduced by additional shielding measures for the I/O module. For example, you can use a shielded control box or control cabinet.

Please refer to the recommended measures in the Inline system manual.

6 Internal circuit diagram

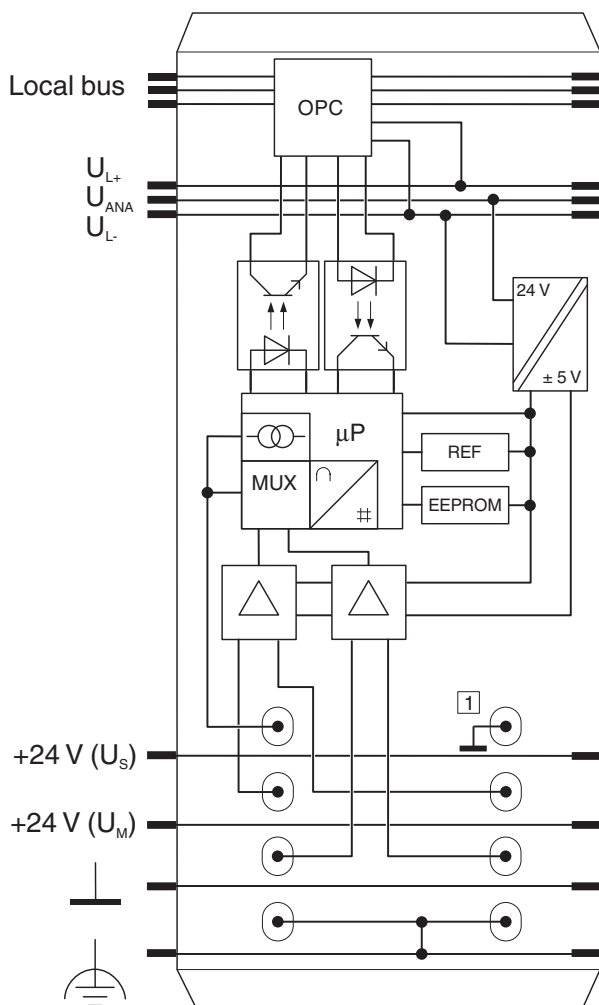
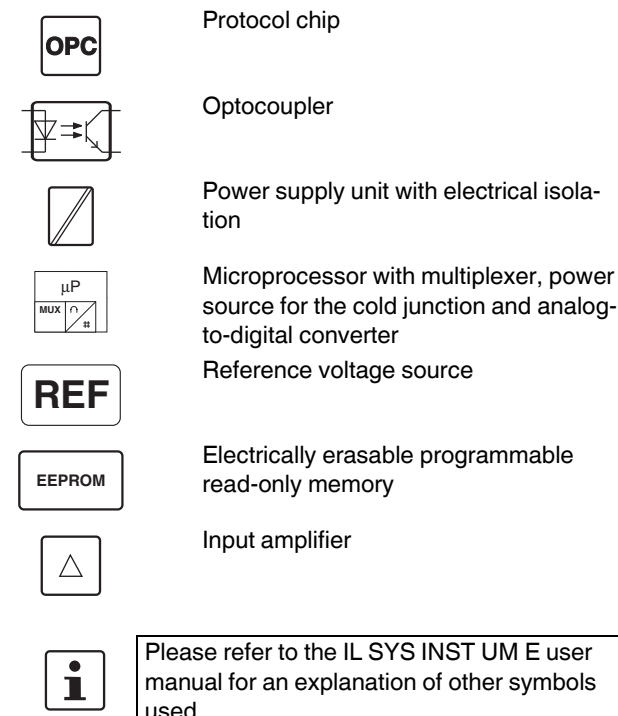


Figure 2 Internal wiring of the terminal points

Key:



7 Electrical isolation

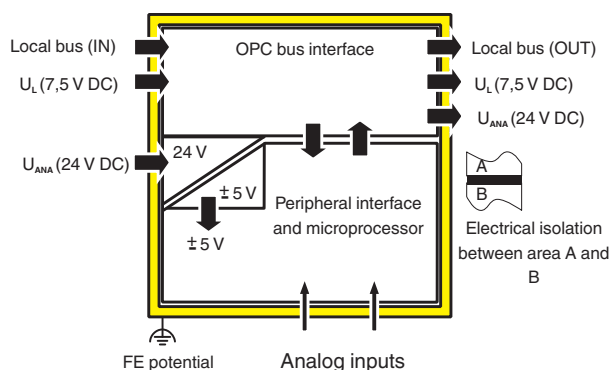


Figure 3 Electrical isolation of the individual function areas

8 Terminal point assignment

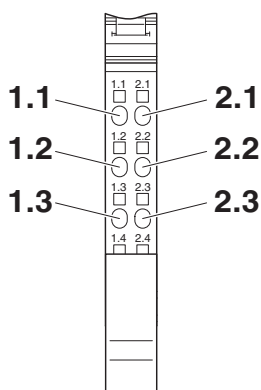


Figure 4 Terminal point assignment

Terminal point	Signal	Assignment	
1.1	RTD _{Ext} ⁺	optional (for laboratory applications only), external cold junction sensor (Pt 1000, Ni 1000)	Positive input
2.1	RTD _{Ext} ⁻	optional (for laboratory applications only), external cold junction sensor (Pt 1000, Ni 1000)	Negative input
1.2	TC2 ⁺	Thermocouple	Positive input channel 2
2.2	TC2 ⁻	Thermocouple	Channel 2 minus input
1.3	TC1 ⁺	Thermocouple	Positive input channel 1
2.3	TC1 ⁻	Thermocouple	Negative 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).

Please note for this terminal that due to 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

Connecting the thermocouples

Always connect the thermocouples using twisted pair equalizing conductors.

Use encapsulated thermocouples.

Thermoelectric voltage terminal blocks are available for extending thermocables (Phoenix Contact MTKD type, see ordering data).

Connecting the shield

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 required.

Insulate the shielding at the sensor.

11 Connection examples



When connecting the shield at the terminal, you must insulate the shield on the sensor side. Use a connector with overall shielding braid when installing the sensors. The figures below illustrate the connection (without overall shielding braid).

11.1 Absolute temperature measurement

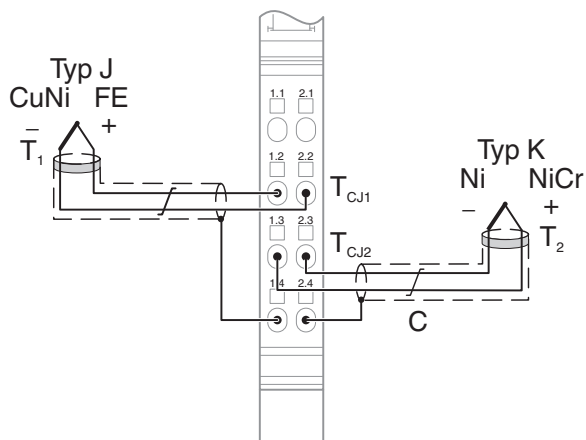


Figure 5 Absolute temperature measurement on two channels

For absolute temperature measurement, the measuring temperature of T1 or T2 is determined by means of cold junction compensation (TCJ1, TCJ2).

11.2 Differential temperature measurement

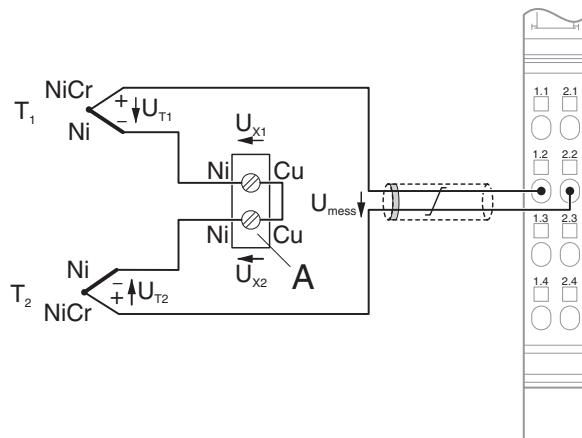


Figure 6 Differential temperature measurement with two type K thermocouples

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

If both terminal points (A) are at the same temperature level, the absolute values of U_{X1} and U_{X2} are equal. Both voltages cancel each other out. The difference between U_{T1} and U_{T2} remains.

11.3 Extension of the compensating line

When connecting the shield to a central grounding point, insulate the shield on the opposite side (shown in gray in the figure).

Use a plug with shield connection when connecting the sensors. The figure shows the connection schematically (without shield connecting plug).

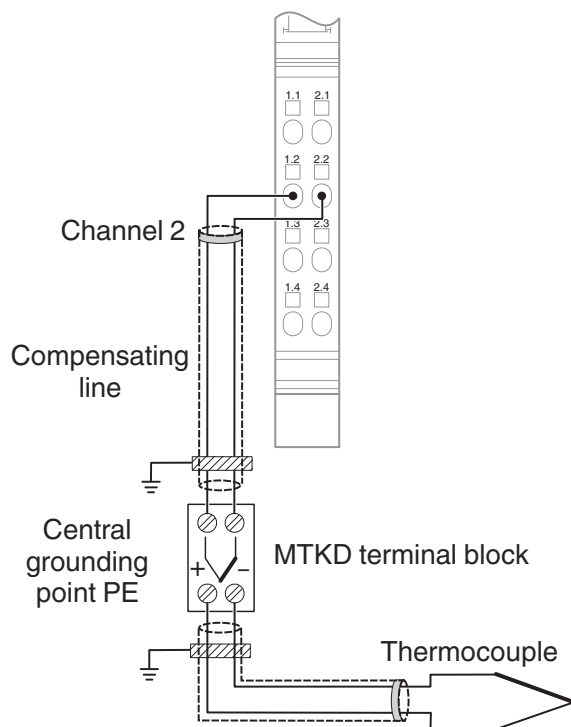


Figure 7 Extending the compensating line with thermocouple terminal blocks

11.4 Improved interference suppression

The figure below shows an application for improved interference suppression. The bridges reduce interference caused by coupling in 50 Hz or 60 Hz frequencies and their electromagnetic fields (e.g., at heating cartridges).

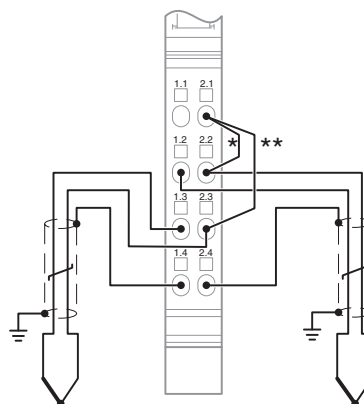


Figure 8 TC two-channel operation at high interference voltages

- * External bridge between 2.1 and 2.2 for improved interference suppression at channel 1
- ** External bridge between 2.1 and 2.3 for improved interference suppression at channel 2



In this application, TC1- is connected to TC2-.

11.5 Signal conditioner

The figure below shows an application for high noise immunity in an environment subjected to electromagnetic interference with electrical isolation between the channels of adjacent modules.

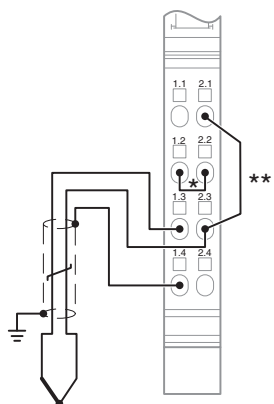


Figure 9 TC operation on channel 1 at high interference voltages

- * External bridge between 2.1 and 2.2
- ** External bridge between 2.1 and 2.3



You can only use channel 1 in this application.

12 Local diagnostic indicator

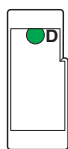


Figure 10 Local diagnostic indicator

Designation	Color	Meaning
D	Green	Diagnostics (bus and logic voltage)



For detailed information on diagnostics, please refer to the IL SYS INST UM E user manual.

Function identification

Green

13 Process data

The terminal uses two words of IN process data and two words of OUT process data.

Each channel is mapped to a word.

The analog values are transmitted via the input process data.

The terminal can be parameterized via the OUT process data.

13.1 OUT process data

You can parameterize each channel independently of the other channels. Parameterize the first channel via the first output word and the second channel via the second output word.

The following parameterization options are available:

- Sensor type selection
- Resolution setting
- Selecting the formats for representing measured values
- Cold junction selection

The parameterization is not saved. Transmit the parameterization in each bus cycle.

After applying voltage (power up) to the Inline station, the message "Measured value invalid" (error code 8004_{hex}) appears in the process data input words. After a maximum of one second, the preset parameterization is accepted and the first measured value is available.

If you change the parameterization, the corresponding channel is re-initialized.

The message "Measured value invalid" (error code 8004_{hex}) appears in the process data output words for maximum 100 ms.

The following values are preset on the terminal:

Sensor type	TC type K
Resolution	0.1°C (1 μV)
Format	IB IL
Cold junction	Internal

Order of the process data words:

Output process data (parameter words)	
Word 0	Word 1
Channel 1	Channel 2

Assignment of the parameter words

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Parameterization	Reserved				Cold junction			Resolution		Format		Sensor type			

Bit 15

Code		Parameterization
dec	bin	
0	0	Default
1	1	Parameterization

When bit 15 = 0, the preset (default) is active.

In order to parameterize the terminal, set bit 15 to 1.

Bits 14 ... 11

These bits are reserved. Set these bits to 0.

Bit 10 ... 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 Pt 1000, TC measurement with external cold junction compensation at an isothermal block (for laboratory applications only)
3	011	External cold junction Ni 1000, TC measurement with external cold junction compensation at an isothermal block (for laboratory applications only)
Other		Reserved

Bit 7 ... 6

Code		Resolution based on IB IL format
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 ... 4

Code		Format
dec	bin	
0	00	IB IL (15 bits + sign bit, default)
1	01	IB ST (12 bits + sign bit + 3 diagnostic bits)
2	10	IB RT (15 bits + sign bit)
3	11	Reserved

See "Measured value representation in the different formats".

Bit 3 ... 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: linear voltage (-15 mV ... +85 mV)
15	1111	Reserved



Use IB IL 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. This shortens the update time for the terminal.

13.2 IN process data

The measured values and diagnostic messages (in the IB IL format) are transmitted channel-by-channel to the controller via the process data input words.

Order of the process data words:

Input process data	
Word 0	Word 1
Channel 1	Channel 2

13.3 Assignment of the terminal points to IN process data

(Word.bit) view	Word	Word x															
	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 1	Signal	Terminal point 1.3															
	Signal reference	Terminal point 2.3															
	Shielding	Terminal point 1.4, 2.4															
Channel 2	Signal	Terminal point 1.2															
	Signal reference	Terminal point 2.2															
	Shielding	Terminal point 1.4															

Word x	Channel
0	1
1	2

14 Formats for representing measured values



Phoenix Contact recommends format IB IL for all controllers as this format contains the most comprehensive diagnostic codes.

The other formats are only intended for simplifying reconfiguration on IB IL analog modules in existing projects.

14.1 IB IL format

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 $> 8000_{\text{hex}}$ indicate an error.

Supported error codes

Code (hex)	Error
8001	Measuring range exceeded (overrange)
8002	Open circuit
8004	Measured value invalid or no valid measured value available
8008	Cold junction defective
8010	Configuration invalid
8040	Device faulty
8080	Below measuring range (underrange)

Measured value representation in IB IL format

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V	Analog value														

V Sign bit

Significant measured values

Sensor type (bits 3 ... 0)		TC and CJ sensor (0 ... 13)	Linear voltage (14)
Resolution (bits 7 ... 6)		00 _{bin} or 10 _{bin}	00 _{bin}
Process data item (= analog value)		0.1°C or 0.1°F	1 µV
hex	dec	°C or °F	µV
8002	-	Open circuit	-
8001	-	Measuring range exceeded (over-range)	> 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		Below measuring range (under-range)	< -15000

Sensor type (bits 3 ... 0)		TC and CJ sensor (0 ... 13)	Linear voltage (14)
Resolution (bits 7 ... 6)		01 _{bin} or 11 _{bin}	01 _{bin}
Process data item (= analog value)		1°C or 1°F	10 µV
hex	dec	°C or °F	µV
8002	-	Open circuit	-
8001	-	Measuring range exceeded (over-range)	> 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		Below measuring range (under-range)	< -15000



If the measured value is outside the display range of the process data, the "Overrange" or "Underrange" error message is generated.



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

14.2 IB ST format

The measured value is represented in bits 14 to 3.

An additional bit (bit 15) is available as a sign bit.

Bits 2 to 0 are available as measuring range and error bits.

IB ST format corresponds to the data format used on INTERBUS ST modules.

Measured value representation in IB ST format

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V	Analog value												0	OC	BÜ

V	Sign bit
0	Reserved
OC	Open circuit
BÜ	Overrange

Significant measured values

Sensor type (bits 3 ... 0)		TC and CJ sensor (0 ... 13)	
Resolution (bits 7 ... 6)		00 _{bin} or 10 _{bin}	01 _{bin} or 11 _{bin}
Process data item (= analog value)		0.1°C or 0.1°F	1°C or 1°F
hex	dec	°C or °F	°C or °F
xxxx xxxx xxxx xxx1 _{bin}		Overrange (AV = positive final value for the measuring range)	
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}		Underrange (AV = negative final value for the measuring range)	
xxxx xxxx xxxx xx1 _{bin}		Open circuit/short circuit (AV = negative final value for the measuring range)	

AV	Analog value
x	Can have the value 0 or 1



If the measured value is outside the display range of the process data, bit 0 is set to 1.
In the event of an open circuit, bit 1 is set to 1.

14.3 IB RT format

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

IB RT format corresponds to the data format used on INTERBUS RT modules.

Measured value representation in IB RT format

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
V	Analog value														

V Sign bit

Significant measured values

Sensor type (bits 3 ... 0)		TC and CJ sensor (0 ... 13)
Resolution (bits 7 ... 6)		00 _{bin} or 10 _{bin}
Process data item (= analog value)		0.1°C or 0.1°F
hex	dec	°C or °F
Upper limit value + 1 LSB		Measuring range exceeded (overrange)
7D00	32000	-
2710	10000	1000.0
000A	10	1
0001	1	0.1
0000	0	0
FFFF	-1	-0.1
FC18	-1000	-100.0
Lower limit value - 1 LSB		Below measuring range (underrange)
Lower limit value - 2 LSB		Open circuit

Sensor type (bits 3 ... 0)		TC and CJ sensor (0 ... 13)
Resolution (bits 7 ... 6)		01 _{bin} or 11 _{bin}
Process data item (= analog value)		1°C or 1°F
hex	dec	°C or °F
Upper limit value + 1 LSB		Measuring range exceeded (overrange)
6400	25600	-
03E8	1000	1000
0001	1	1
0000	0	0
FFFF	-1	-1
FF9C	-100	-100
ED40	-4800	-
Lower limit value - 1 LSB		Below measuring range (underrange)
Lower limit value - 2 LSB		Open circuit

15 Measuring ranges

15.1 Measuring ranges depending on the resolution

IB IL and IB RT format

Resolution (bits 7 ... 6)	Thermocouples		Linear voltage sensors	
	Resolution	Measuring range	Resolution	Measuring range
00	0.1 °C	-273 °C ... +3276.8 °C	1 µV	-15 mV ... +32.768 mV
01	1 °C	-273 °C ... +32768 °C	10 µV	-15 mV ... +85 mV
10	0.1 °F	-459 °F ... +3276.8 °F		
11	1 °F	-459 °F ... 32760 °F		

IB ST format

Resolution (bits 7 ... 6)	Thermocouples	
	Resolution	Measuring range
00	0,8 °C	-272.8 °C ... +3276.0 °C
01	8 °C	-272 °C ... +32760 °C
10	0,8 °F	-459,2 °F ... 3276 °F
11	8 °F	-456 °F ... +32760 °F



Temperature values in °C can be converted to °F using the following formula:

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

Where:

T [°F] Temperature in °F

T [°C] Temperature in °C

15.2 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	+1820 °C
2		E		-270 °C	+1000 °C
3		J		-210 °C	+1200 °C
4		K		-270 °C	+1372 °C
5		N		-270 °C	+1300 °C
6		R		-50 °C	+1768 °C
7		S		-50 °C	+1768 °C
8		T		-270 °C	+400 °C
9		C			-18 °C
10		W		-18 °C	+2316 °C
11		HK		-200 °C	+800 °C
12		L	DIN 43710	-200 °C	+900 °C
13		U		-200 °C	+600 °C
14	Internal cold junction	Pt 1000	DIN IEC 60751	-200 °C	+850 °C
15	Voltage input	Linear voltage		-15 mV	+85 mV



In the event of an underrange or overrange of the specified measuring range limits, the terminal outputs the "Underrange" or "Overrange" error message in IB IL format.

16 Process data update time

The process data update time is the response time of the terminal 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.



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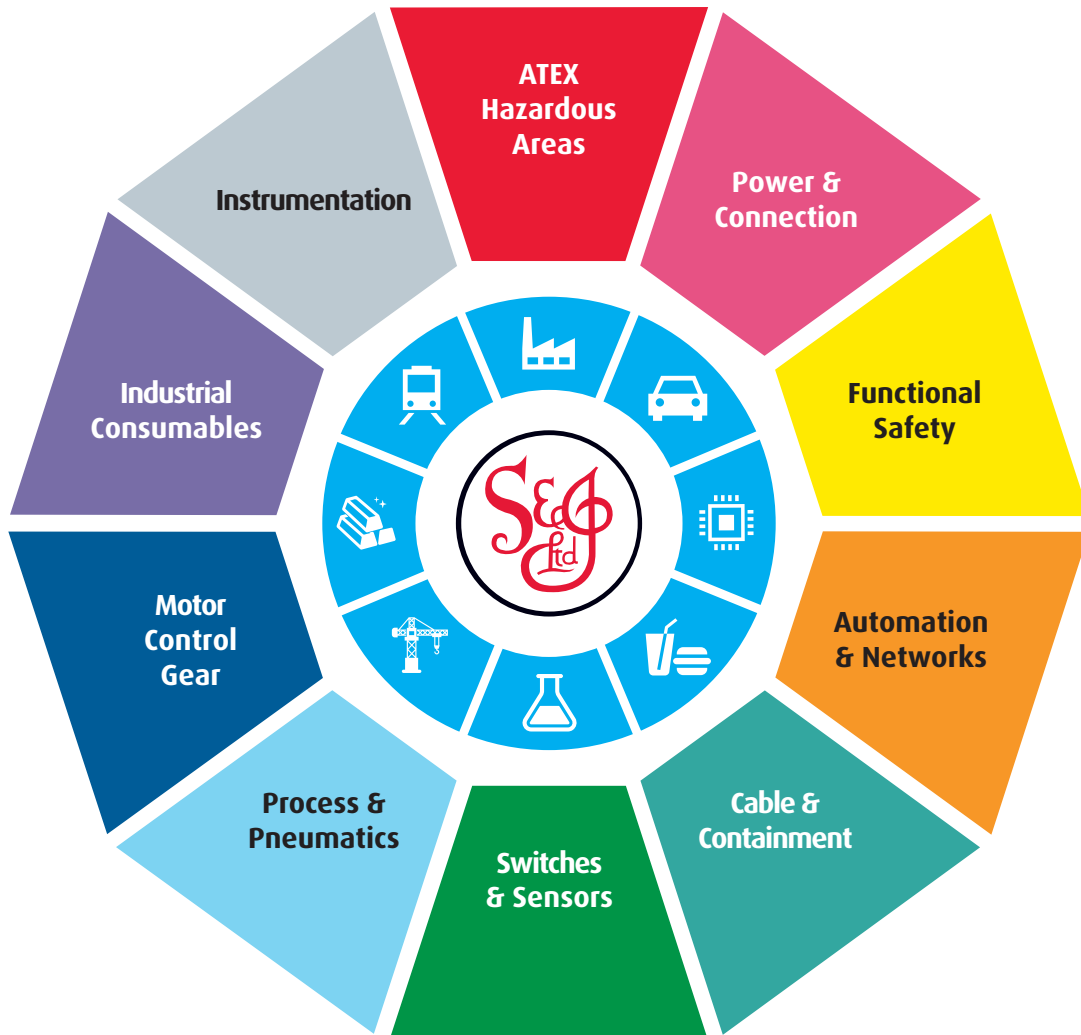
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