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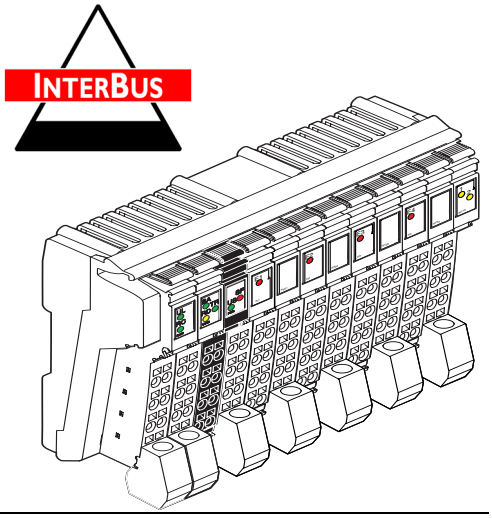
ILB IB AI4 AO2

Inline Block IO Module for INTERBUS
With 4 Analog Inputs and 2 Analog Outputs



AUTOMATIONWORX

Data Sheet
7280_en_02

1 Description

The ILB IB AI4 AO2 module is designed for use within an INTERBUS network. It is used to acquire analog input signals and output analog signals.

Features of INTERBUS

- Remote bus branch; Inline connector
- 500 kbps transmission speed
- I/O areas can be parameterized individually for each channel
- Parameterization via process data or PCP

Features of Inputs

- 4 differential analog signal inputs or 4 universal RTD inputs
- Connection of sensors in 2, 3 or 4-wire technology
- Sensor supply with channel-specific integrated short-circuit and overload protection
- Three current measuring ranges:
  0 mA to 20 mA, ±20 mA, 4 mA to 20 mA
- Four voltage measuring ranges:
  0 V to 5 V, ±5 V, 0 V to 10 V, ±10 V
- Various RTD measuring ranges:
  E.g., linear R: 0 Ω to 9500 Ω, Pt 100, Pt 1000, Ni 1000
- Measured value representation in four possible formats
- 16-bit measured value resolution (15 bits + sign bit)
- Adjustable filter times

Features of Outputs

- 2 universal analog signal outputs to connect either voltage or current signals
- Connection of actuators in 2-wire technology
- Three current ranges:
  0 mA to 20 mA, ±20 mA, 4 mA to 20 mA
- Four voltage ranges:
  0 V to 5 V, ±5 V, 0 V to 10 V, ±10 V
- Short-circuit-proof outputs

Please refer to the "Assembly and Removal of Inline Block IO Modules" application note (see "Ordering Data" on page 4).

Make sure you always use the latest documentation.
It can be downloaded at www.download.phoenixcontact.com.

A conversion table is available on the Internet at
www.download.phoenixcontact.com/general/7000_en_00.pdf.

Table of Contents

2 Ordering Data

Module

Description	Type	Order No.	Pcs./Pck.
Inline Block IO module for INTERBUS with 4 analog inputs and 2 analog outputs	ILB IB AI4 AO2	2878777	1

Accessories: Connectors as Replacement Item

Description	Type	Order No.	Pcs./Pck.
Shield connector for the bus connection (with color print)	IB IL SCN-6 SHIELD-CP	2863151	5
Connector for the supply (with color print)	On request		
Shield connector for the connection of analog sensors (without color print)	IB IL SCN-6 SHIELD	2726353	5
Shield connector for the connection of analog actuators (without color print)	IB IL SCN 6-SHIELD-TWIN	2740245	5
Connector (without color print)	IB IL SCN-8	2726337	10

Accessories: Other

Description	Type	Order No.	Pcs./Pck.
Recommended end clamp; placed both to the right and left of the module to secure it on the DIN rail	CLIPFIX 35-5	3022276	50

Documentation

Description	Type	Order No.	Pcs./Pck.
"Assembly and Removal of Inline Block IO Modules" application note	AH ILB INSTALLATION	9014931	1
"General Introduction to the INTERBUS System" user manual	IBS SYS INTRO G4 UM E	2745211	1
"Peripherals Communication Protocol (PCP)" user manual	IBS SYS PCP G4 UM E	2745169	1
"Porting Using PCP Compact" user manual	IBS PCP COMPACT UM E	9015349	1

3 Technical Data

General Data	
Housing dimensions with connectors (width x height x depth)	156 mm x 59 mm x 141 mm
Weight	505 g (with connectors)
Operating mode	INTERBUS
Transmission speed	500 kbps
Connection method for sensors	2, 3, and 4-wire technology (shielded)
Connection method for actuators	2-wire technology (shielded)

Housing Dimensions

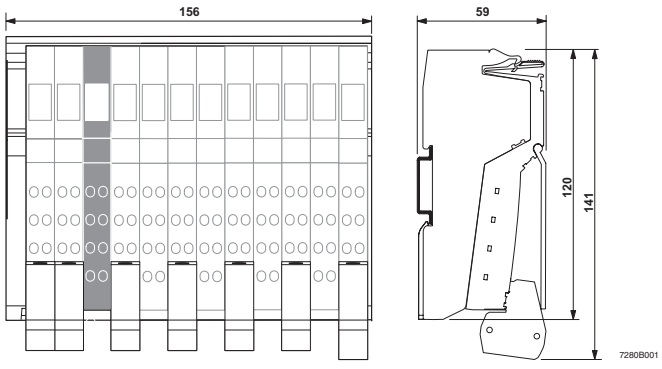


Figure 1 Module housing dimensions (in mm)

Ambient Conditions

Guidelines	Developed according to VDE 0160/EN 50178/IEC 62103, UL 508
Ambient temperature (operation)	-25°C to +60°C
Ambient temperature (storage/transport)	-25°C to +85°C
Humidity (operation/storage/transport)	10% to 95%, according to DIN EN 61131-2
Air pressure (operation)	80 kPa to 108 kPa (up to 2000 m above sea level)
Air pressure (storage/transport)	66 kPa to 108 kPa (up to 3500 m above sea level)
Degree of protection according to DIN 40050, IEC 60529	IP20
Protection class according to DIN 57106-1	Class 3 according to VDE 0106/IEC 60536
Air and creepage distances	According to DIN VDE 0110/IEC 60664, IEC 60664A, DIN VDE 0160/EN 50178/IEC 62103
Housing material	Plastic, PVC-free, PBT, self-extinguishing (V0)
Pollution degree according to EN 60664-1/IEC 60664-1, EN 61131-2/IEC 61131-2	2; condensation not permitted during operation
Surge voltage class	II

Electrical Isolation/Isolation of the Voltage Areas

Test Distance	Test Voltage
Incoming remote bus/logic area, outgoing remote bus	500 V AC, 50 Hz, 1 min.
Incoming remote bus/analog I/O	500 V AC, 50 Hz, 1 min.
Incoming remote bus/communications power U_L (primary)	500 V AC, 50 Hz, 1 min.
Incoming remote bus/initiator supply U_{IS}	500 V AC, 50 Hz, 1 min.
Incoming remote bus/functional earth ground	500 V AC, 50 Hz, 1 min.
Logic area, outgoing remote bus/analog I/O	500 V AC, 50 Hz, 1 min.
Logic area, outgoing remote bus/communications power U_L (primary)	500 V AC, 50 Hz, 1 min.
Logic area, outgoing remote bus/initiator supply U_{IS}	500 V AC, 50 Hz, 1 min.
Logic area, outgoing remote bus/functional earth ground	500 V AC, 50 Hz, 1 min.
Analog I/O/communications power U_L (primary)	500 V AC, 50 Hz, 1 min.
Analog I/O/initiator supply U_{IS}	500 V AC, 50 Hz, 1 min.
Analog I/O/functional earth ground	500 V AC, 50 Hz, 1 min.
Communications power U_L (primary)/initiator supply U_{IS}	500 V AC, 50 Hz, 1 min.
Communications power U_L (primary)/functional earth ground	500 V AC, 50 Hz, 1 min.
Initiator supply U_{IS}/functional earth ground	500 V AC, 50 Hz, 1 min.
Outgoing remote bus/analog I/O	500 V AC, 50 Hz, 1 min.
Outgoing remote bus/functional earth ground	500 V AC, 50 Hz, 1 min.

Mechanical Requirements

Vibration test sinusoidal vibrations according to EN 60068-2-6/IEC 60068-2-6	5g load, 2.5 hours in each space direction
Shock test according to EN 60068-2-27/IEC 60068-2-27	30g load for 11 ms, half sinusoidal wave, 3 shocks in each space direction and orientation
Broadband noise according to EN 60068-2-64/IEC 60068-2-64	0.78g load, 2.5 hours in each space direction

Conformance With EMC Directive 89/336/EEC		
Noise Immunity Test According to EN 61000-6-2		
Electrostatic discharge (ESD)	EN 61000-4-2 IEC 61000-4-2	Criterion B 6 kV contact discharge 8 kV air discharge
Electromagnetic fields	EN 61000-4-3 IEC 61000-4-3	Criterion A Field strength: 10 V/m
Fast transients (burst)	EN 61000-4-4/ IEC 61000-4-4	Criterion B Remote bus: 2 kV Power supply: 2 kV I/O cables: 2 kV Criterion A All interfaces: 1 kV
Surge voltage	EN 61000-4-5 IEC 61000-4-5	Criterion B DC supply lines: ±0.5 kV/±0.5 kV (symmetrical/asymmetrical) Signal lines: ±0.5 kV/±0.5 kV (symmetrical/asymmetrical)
Conducted interference	EN 61000-4-6 IEC 61000-4-6	Criterion A Test voltage 10 V
Noise Emission Test According to EN 61000-6-4		
Noise emission of housing	EN 55011	Class A

Interface: INTERBUS	
Incoming remote bus	Copper cable (RS-422), connected with Inline shield connector; supply electrically isolated; shielding connected with a capacitor to functional earth ground
Outgoing remote bus	Copper cable (RS-422), connected with Inline shield connector; supply electrically isolated; shielding connected directly to functional earth ground
Recommended cable lengths	See INTERBUS system data in the IBS SYS INTRO G4 UM E user manual

24 V Module Supply (Communications Power and Sensor Supply; U_L and U_S)	
Nominal value	24 V DC
Tolerance	-15%/+20% according to EN 61131-2
Ripple	±5% according to EN 61131-2
Permissible range	19.2 V DC to 30.0 V DC
Current consumption at U_L	See "Current Consumption at U_L and U_S"
Current consumption at U_S	See "Current Consumption at U_L and U_S"
Power dissipation at U_L	See "Power Consumption at U_L and U_S" on page 7
Power dissipation at U_S	See "Power Consumption at U_L and U_S" on page 7
Safety equipment for U_L	Transient surge protection via arresters, serial protection against polarity reversal
Safety equipment for U_S	Transient surge protection via arresters, serial protection against polarity reversal, channel-specific short-circuit protection with single-channel diagnostics
Connection	Via power connectors
Diagnostics	Single-channel diagnostics in the process data Failure indication via group error LED at PWR slot Single-channel failure indication via LED at slot for the sensors

Electronically Protected Initiator Supply U_{IS} (via Supply of U_S)	
Nominal value U_{IS}	24 V DC
Nominal current I_{IS} per channel	50 mA
Protection	Internal, channel-specific electronic fuse, short-circuit-proof with single-channel diagnostics

Current Consumption at U_L and U_S	Typical	Maximum
Current consumption at U_L		
No-load operation of outputs and AI mode	100 mA	130 mA
RTD nominal load	100 mA	130 mA
AO U nominal load (U_{OUT1} and U_{OUT2} = 10 V with R_L = 2 kΩ)	110 mA	140 mA
AO I nominal load (I_{OUT1} and I_{OUT2} = 20 mA with R_L = 0 Ω)	135 mA	175 mA
Current consumption at U_S		
I_{iS} = 0 mA (no load)	12 mA	20 mA
I_{iS} = 4 x 20 mA (nominal load)	92 mA	100 mA
I_{iS} = 4 x 50 mA (maximum full load)	212 mA	220 mA
Total current consumption at U_L and U_S		
No-load operation of outputs and AI mode; I_{iS} = 0 mA (no load)	112 mA	150 mA
AO U nominal load and AI nominal load; I_{iS} = 4 x 20 mA	202 mA	240 mA
AO I nominal load and AI nominal load; I_{iS} = 4 x 20 mA	227 mA	275 mA
AO I nominal load and AI full load; I_{iS} = 4 x 50 mA	347 mA	395 mA

Power Consumption at U_L and U_S

(Current Consumption at Voltages U_L and U_S; Specifications for Nominal Operation (U_L = 24 V; U_S = 24 V Without Load), Full Load Same as Nominal Operation But With U_S Under Load)

Typical Supply of Control Cabinet Power Supply Unit P_{24V_Supply}	AO Load	Marginal Conditions	Typical Supply Current	Typical Power Dissipation
Typical power supply P_{24V_Supply} in U nominal operation	U mode of the analog outputs ($U_{OUT1,2}$ = 10 V with R_L = 10 K)	I_S = 0 mA	125 mA	3.00 W
Typical power supply P_{24V_Supply} in I nominal operation	I mode of the analog outputs ($I_{OUT1,2}$ = 20 mA, with R_b = 0 Ω)	I_S = 0 mA	150 mA	3.60 W
Typical power supply P_{24V_Supply} in nominal operation	U mode of the analog outputs ($U_{OUT1,2}$ = 10 V with R_L = 10 K)	I_S = 4 x 20 mA	200 mA	4.80 W
Typical power supply P_{24V_Supply} at full load	I mode of the analog outputs ($I_{OUT1,2}$ = 20 mA, with R_b = 0 Ω)	I_S = 4 x 20 mA	230 mA	5.45 W
Typical power supply P_{24V_Supply} in nominal operation	U mode of the analog outputs ($U_{OUT1,2}$ = +10 V with R_L = 10 K)	I_S = 4 x 50 mA	325 mA	7.75 W
Typical power supply P_{24V_Supply} at full load	I mode of the analog outputs ($I_{OUT1,2}$ = 20 mA, with R_b = 0 Ω)	I_S = 4 x 50 mA	350 mA	8.35 W

Analog Inputs		
Number	4 differential analog inputs	
Measured value resolution	16 bits (15 bits + sign bit)	
Measured value representation	In the following formats:	
	IB IL	(15 bits with sign bit)
	RT	(15 bits with sign bit)
	S7-compatible	(15 bits with sign bit)
	Standardized representation	(15 bits with sign bit)

For measured value representation, please refer to the notes on page 24 and onwards.

Filtering	RFI filtering; passive TP 1st order
Filter time of the A/D converter	4.5 ms (default) or 1.1 ms; adjustable for each channel
Conversion time of the A/D converter	180 µs
Channel conversion times and process data update time	See "Channel Conversion Times and Process Data Update Time" on page 39
Limit frequency (-3 dB) of the input filters	120 Hz (for 4.5 ms filter default) or 450 Hz (for 1.1 ms filter)
Transient protection	Yes, via arresters
Signal connection method	2, 3, and 4-wire connection; shielded, twisted pair cable
Overload protection	Yes, ±30 V DC, minimum

Differential Analog Voltage Inputs

Number	4
Input range	0 V to 10 V; ±10 V; 0 V to 5 V; ±5 V
Input resistance	276 kΩ, typical
Open circuit response	Goes to 0 V
Maximum permissible voltage between analog voltage inputs and functional earth ground	±50 V DC

Differential Analog Current Inputs

Number	4
Input range	0 mA to 20 mA; ±20 mA; 4 mA to 20 mA
Input resistance	107 Ω, typical
Open circuit response	Goes to 0 mA
Maximum permissible current per current input	Electronic overload protection
Overload protection at the analog current inputs	Yes, ±30 V DC, minimum

Analog RTD Inputs

Number	4
Input range	Pt 100, Pt 500, Pt 1000, Ni 100, Ni 1000, Ni 1000 L&S, 0 Ω to 3200 Ω, 0 Ω to 9500 Ω
Sensor supply current	231 mA, typical

Analog Outputs

Number	2
Voltage output range	0 V to 10 V; ±10 V; 0 V to 5 V; ±5 V
Current output range	0 mA to 20 mA; ±20 mA; 4 mA to 20 mA
Measured value resolution	16 bits (15 bits + sign bit)
Measured value representation	In the following formats: IB IL (15 bits with sign bit) RT (15 bits with sign bit) S7-compatible (15 bits with sign bit) Standardized representation (15 bits with sign bit)

For measured value representation, please refer to the notes on page 24 and onwards.

Conversion time of the D/A converters	70 µs, typical
Resolution of the D/A converters	16 bits
Process data update time	See "Channel Conversion Times and Process Data Update Time" on page 39
Output load	
Voltage output	R_{Lmin} = 2 kΩ
Current output	R_{LB} = 0 Ω to 500 Ω
Transient protection	Yes, internally via arresters
Signal connection method	2-wire termination; shielded, twisted pair cable
Short-circuit protection	
Voltage output	Yes, permanent electronic short-circuit protection
Current output	Yes, permanent electronic short-circuit protection
Enabling function	Yes, internal electronic
Optical indicators	5% output LED, channel-specific

Permissible Cable Lengths

Permissible cable lengths	250 m
Reference conditions	The specifications refer to nominal operation observing the installation instructions. The specifications refer to the following reference cable type: Shielded power station cable: LiYCY; 2 x 2 x 0.5 mm^2; VDE0812

The ambient conditions and the local conditions in the system can result in special requirements for the installation of cables. These must be observed accordingly.

For the integration of shielded I/O cables in an equipotential bonding concept for the automation system, the following applies in principle:
Shielded analog I/O cables may only be connected directly to functional earth ground potential at a single point.
This results in the prevention of voltage equalization currents via the analog cable. Additional information is available on request.

Other:
In order to observe the tolerance of RTD inputs, make allowance for the effects of the connecting cable and connection method (2, 3, and 4-wire technology).

Limit Values for Temperature Measurement

Sensor Type	Nominal Range	
	Lower Limit	Upper Limit
Pt DIN	-200°C	+850°C
Ni DIN	-60°C	+180°C
Ni 1000 L&S	-50°C	+160°C

In the event of underrange or overrange of the nominal range, the "Underrange" or "Overrange" error message is generated.

Tolerances at T_A = 25°C

AI Measuring Range	Absolute (Typical)	Absolute (Maximum)	Relative (Typical)	Relative (Maximum)
0 V to 5 V, ±5 V	±5.0 mV	±20 mV	0.10%	±0.40%
0 V to 10 V, ±10 V	±6.0 mV	±25 mV	0.06%	±0.25%
0 mA to 20 mA, ±20 mA, 4 mA to 20 mA	±12 µA	±50 µA	0.06%	±0.25%
Pt 100 (-200°C ... +850°C)	±0.3 K	±1.6 K	0.03%	±0.19%
Pt 500 (-200°C ... +850°C)	±0.2 K	±1.4 K	0.02%	±0.17%
Pt 1000 (-200°C ... +850°C)	±0.2 K	±1.3 K	0.02%	±0.15%
Ni 100 (-60°C ... +180°C)	±0.2 K	±0.9 K	0.11%	±0.50%
Ni 1000 (-60°C ... +180°C)	±0.1 K	±0.5 K	0.08%	±0.28%
Ni 1000 L&S (-50°C ... +160°C)	±0.1 K	±0.3 K	±0.02%	±1.6%
0 Ω to 3200 Ω	±0.4 Ω	±2.75 Ω	0.01%	±0.18%
0 Ω to 9500 Ω	±2.0 Ω	±12.0 Ω	0.02%	±0.13%

AO Output Range	Absolute (Typical)	Absolute (Maximum)	Relative (Typical)	Relative (Maximum)
0 V to 5 V, ±5 V	±10 mV	±30 mV	0.20%	±0.60%
0 V to 10 V, ±10 V	±10 mV	±30 mV	0.10%	±0.30%
0 mA to 20 mA, ±20 mA, 4 mA to 20 mA	±20 µA	±60 µA	0.10%	±0.30%

The data contains the offset error, gain error, and linearity error. All percentage tolerance values refer to the relevant measuring range final value. Unless otherwise stated, nominal operation (nominal voltage $U_S = U_L$ = 24 V, preferred mounting position, default format "IB IL", default filter setting (4.5 ms), identical measuring range setting for channels, etc.) is used as the basis. For RTD inputs, the tolerances are specified in 4-wire connection method, the installation instructions should be implemented accordingly. 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 measuring ranges. Moreover, the theoretical maximum possible tolerances of the calibration and test equipment have been taken into consideration.

Tolerance and Temperature Response at T_A = -25°C to +60°C

AI Measuring Range	Drift (Typical)	Drift (Maximum)
0 V to 5 V, ±5 V	±15 ppm/K	±35 ppm/K
0 V to 10 V, ±10 V	±15 ppm/K	±35 ppm/K
0 mA to 20 mA, ±20 mA, 4 mA to 20 mA	±20 ppm/K	±50 ppm/K
Pt 100 (-200°C ... +850°C)	±40 ppm/K	±100 ppm/K
Pt 500 (-200°C ... +850°C)	±35 ppm/K	±90 ppm/K
Pt 1000 (-200°C ... +850°C)	±30 ppm/K	±80 ppm/K
Ni 100 (-60°C ... +180°C)	±60 ppm/K	±110 ppm/K
Ni 1000 L&S (-50°C ... +180°C)	±20 ppm/K	±50 ppm/K
Ni 1000 (-60°C ... +180°C)	±20 ppm/K	±50 ppm/K
0 Ω to 3200 Ω	±20 ppm/K	±60 ppm/K
0 Ω to 9500 Ω	±25 ppm/K	±50 ppm/K
AO Output Range	**Drift (Typical)**	**Drift (Maximum)**
0 V to 5 V, ±5 V, 0 V to 10 V, ±10 V	±55 ppm/K	±95 ppm/K
0 mA to 20 mA, ±20 mA, 4 mA to 20 mA	±50 ppm/K	±90 ppm/K

The values refer to the relevant measuring range final value.
The values refer to nominal operation in the recommended mounting position (horizontal wall mounting).

Formula for Calculating the Tolerance Influenced by Temperature

Typical temperature drift

$Drift_{typ} = \Delta\vartheta \times T_{Ctyp} * MFV$

Where:

$Drift_{typ}$	Typical temperature drift
$\Delta\vartheta$	Temperature difference between the ambient temperature of the module T_A and +25°C
T_{Ctyp}	Typical temperature coefficient in ppm/K
MFV	Measuring range final value (e.g., +850°C for Pt 100)

Maximum temperature drift

$Drift_{max} = \Delta\vartheta \times T_{Cmax} * MFV$

Where:

$Drift_{max}$	Maximum temperature drift
$\Delta\vartheta$	Temperature difference between the ambient temperature of the module T_A and +25°C
T_{Cmax}	Maximum temperature coefficient in ppm/K
MFV	Measuring range final value (e.g., +850°C for Pt 100)

Example

Sensor = Pt 100; ambient temperature T_A = +40°C

$\Delta\vartheta$ = +15 K

T_{Ctyp} = ±40 ppm/K (typical); T_{Cmax} = ±100 ppm/K

Measuring range final value Pt 100 MFV = +850°C

$Drift_{typ} = \Delta\vartheta \times T_{Ctyp} \times MFV = 15\ K \times ±40\ ppm/K \times 850°C = ±0.51°C$

$Drift_{max} = \Delta\vartheta \times T_{Cmax} \times MFV = 15\ K \times ±100\ ppm/K \times 850°C = ±1.28°C$

The maximum drift is a worst-case value (theoretical assumption).

Tolerances Influenced by Electromagnetic Interference

		Analog Input			Analog Output	
		Current	Voltage	RTD	Current	Voltage
Electromagnetic fields	EN 61000-4-3 IEC 61000-4-3	< ±1.5%	< 0.2 %	< ±2.0%	< ±0.5%	< ±0.5%
Fast transients (burst)	EN 61000-4-4/ IEC 61000-4-4	< ±1.5%	< 0.2 %	< ±2.0%	< ±0.5%	< ±0.5%
Conducted interference	EN 61000-4-6 IEC 61000-4-6	< ±1.5%	< 0.2 %	< ±2.0%	< ±0.5%	< ±0.5%

Under the influence of high-frequency electromagnetic interference phenomena caused by radio transmission systems in close proximity, additional tolerances can occur. The values specified refer to nominal operation in the event of direct interference to components without additional shielding such as a steel cabinet, etc.

This information is valid for device firmware ID HW/FW 04/100 or later.

The tolerances specified above can be reduced through additional shielding for the I/O module (e.g., use of a shielded control box/control cabinet, etc.). Please refer to the recommended measures in the Inline system manual for your bus system.

Signal Rise Times: Voltage Output 0 V to 10 V (Typical Values)

	10% to 90%	0% to > 99%
Ohmic load R_L = 2 k Ω	160 µs	240 µs
Ohmic/capacitive load R_L = 2k Ω/C_L = 10 nF	160 µs	240 µs
Ohmic/capacitive load R_L = 2k Ω/C_L = 220 nF	170 µs	240 µs
Ohmic/inductive load R_L = 2k Ω/L_L = 3.3 mH	170 µs	240 µs

Signal Rise Times: Current Output 0 mA to 20 mA (Typical Values)

	10% to 90%	0% to > 99%
Ohmic load R_L = 500 Ω	450 µs	730 µs
Ohmic/capacitive load R_L = 500 Ω/C_L = 10 nF	460 µs	750 µs
Ohmic/capacitive load R_L = 500 Ω/C_L = 220 nF	770 µs	1.3 ms
Ohmic/inductive load R_L = 500 Ω/L_L = 3.3 mH	610 µs	1.1 ms
Ohmic/capacitive load R_L = 50 Ω/C_L = 100 nF	11 ms	20.7 ms

Signal Rise Times: Current Output 4 mA to 20 mA (Typical Values)

	10% to 90%	0% to > 99%
Ohmic load R_L = 500 Ω	400 µs	810 µs
Ohmic/capacitive load R_L = 500 Ω/C_L = 10 nF	470 µs	840 µs
Ohmic/capacitive load R_L = 500 Ω/C_L = 220 nF	800 µs	1.4 ms
Ohmic/inductive load R_L = 500 Ω/L_L = 3.3 mH	590 µs	990 µs

Approvals

For the latest approvals, please visit www.download.phoenixcontact.com.

4 Internal Circuit Diagram

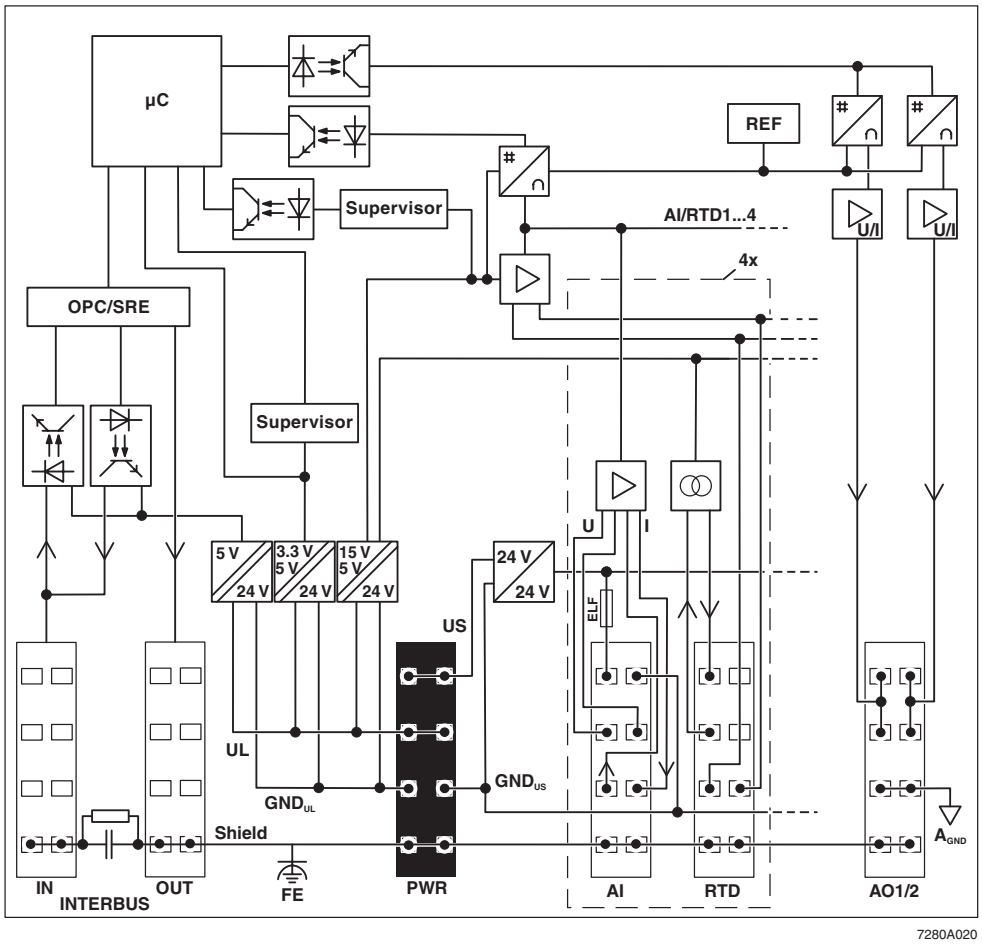


Figure 2 Internal wiring of the terminal points

Key:

µC — Microprocessor

OPC / SRE — Protocol chip with register expansion

Optocoupler

Supervisor — Hardware monitoring

Digital/analog converter

U/I — Universal output driver with integrated output shutdown

REF — Reference voltage

Amplifier

Constant current source

Power supply unit with electrical isolation

ELF — Electronic fuse

5 Electrical Isolation

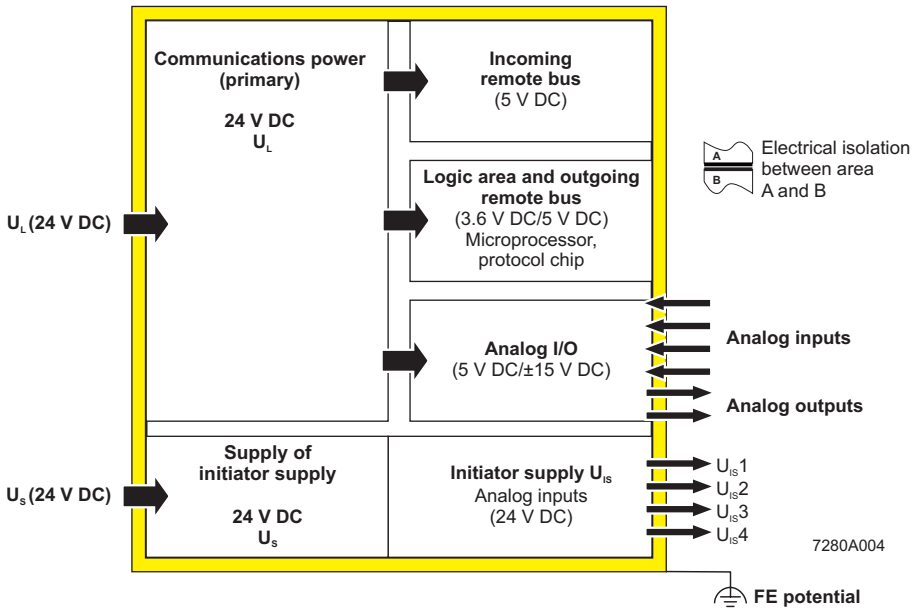


Figure 3 Electrical isolation of the individual function areas

6 Local Diagnostic and Status Indicators

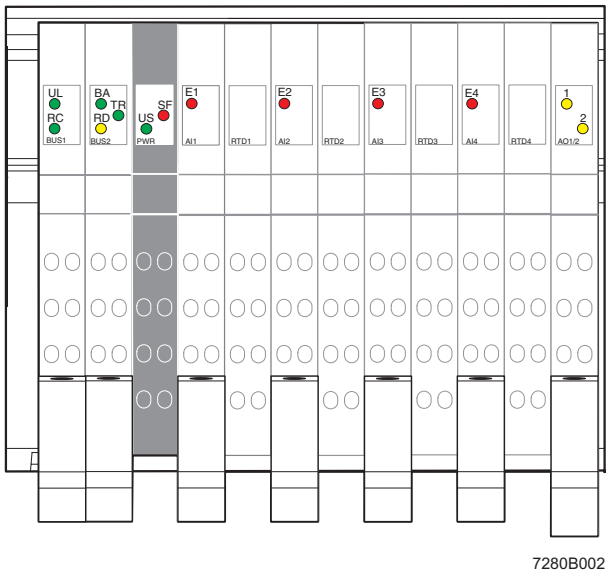


Figure 4 Diagnostic and status indicators

Designation	Color	Meaning
BUS		
UL	Green	Communications power
RC	Green	Remote bus cable check
BA	Green	Bus active
RD	Yellow	Outgoing remote bus disabled
TR	Green	PCP communication active
PWR		
US	Green	Sensor supply
SF	Red	Group error
AI		
E1 to E4	Red	Channel-specific error indication (sensor supply short circuit or open circuit)
AO		
1, 2	Yellow	Analog output value is ≥ 5% of the positive measuring range final value

7 Connection of INTERBUS, Supply, Analog Sensors, and Actuators

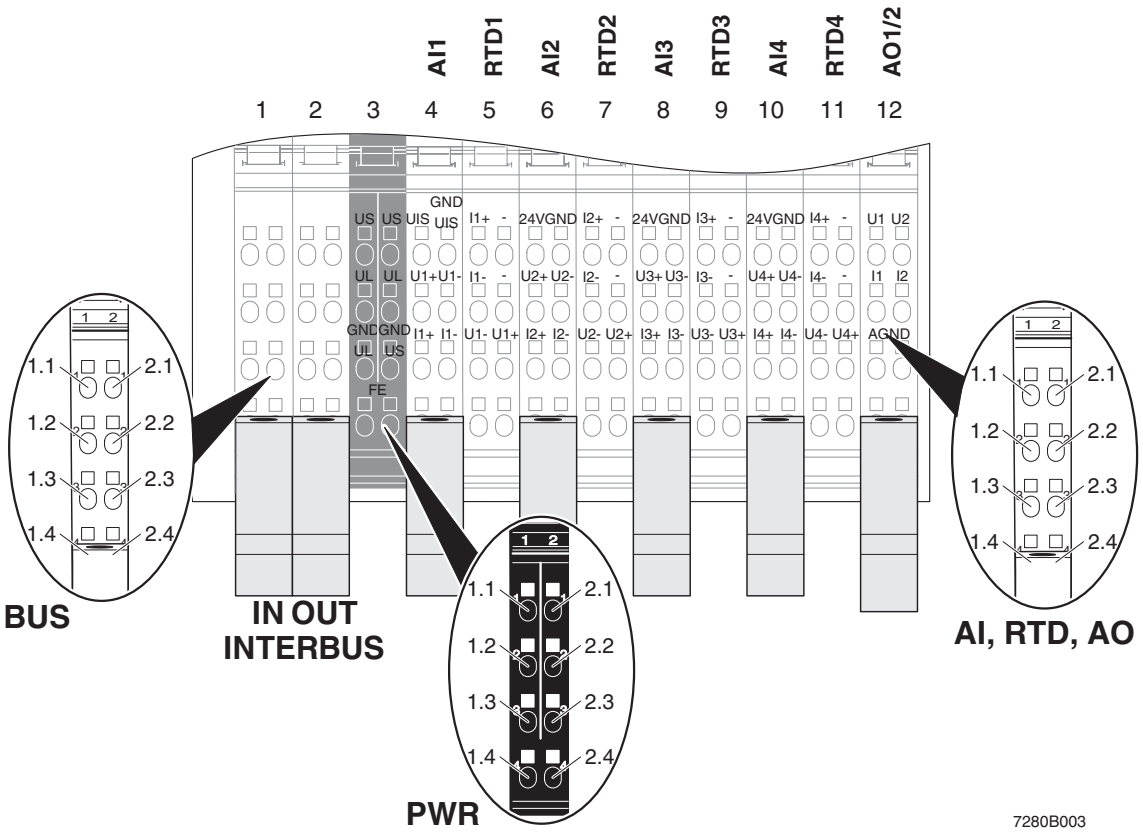


Figure 5 Terminal point assignment of the connectors

7.1 Terminal Point Assignment of the INTERBUS Connectors

Terminal Point	Assignment	Remark/Wire Color in the INTERBUS Standard Cable	
Connector 1 (BUS 1) Incoming Remote Bus			
1.1	$\overline{DO1}$	Receive	Green
2.1	$\overline{DO1}$	Receive	Yellow
1.2	$\overline{DI1}$	Transmit	Pink
2.2	DI1	Transmit	Gray
1.3	F-GND	Reference potential	Brown
2.3			Not used
1.4, 2.4	Shield	Shield potential is connected with a capacitor to functional earth ground (FE) of the potential jumper.	
Connector 2 (BUS 2) Outgoing Remote Bus			
1.1	$\overline{DO2}$	Transmit	Green
2.1	$\overline{DO2}$	Transmit	Yellow
1.2	$\overline{DI2}$	Receive	Pink
2.2	DI2	Receive	Gray
1.3	R-GND	Reference potential	Brown
2.3			Not used
1.4, 2.4	Shield	Shield potential is connected directly to functional earth ground (FE) of the potential jumper.	

7.2 Terminal Point Assignment of the Power Connector

Terminal Point	Assignment
Connector 3 (PWR)	
1.1, 2.1	24 V supply U_S
1.2, 2.2	24 V communications power U_L
1.3,	GND U_L
2.3	GND U_S
1.2, 2.4	FE

7.3 Terminal Point Assignment of the Connectors for the Analog Inputs

(AI; connectors 4, 6, 8, and 10 in Figure 5 on page 14)

Terminal Point				Signal	Assignment
Connector 4 (AI1)	**Connector 6 (AI2)**	**Connector 8 (AI3)**	**Connector 10 (AI4)**		
1.1	**1.1**	**1.1**	**1.1**	U_{ISx} (24 V)	Initiator supply for channel x
2.1	**2.1**	**2.1**	**2.1**	GND_{iSx}	Ground of U_{iSx}
1.2	**1.2**	**1.2**	**1.2**	Ux+	Positive voltage input for channel x
2.2	**2.2**	**2.2**	**2.2**	Ux-	Negative voltage input for channel x
1.3	**1.3**	**1.3**	**1.3**	Ix+	Positive current input for channel x
2.3	**2.3**	**2.3**	**2.3**	Ix-	Negative current input for channel x
1.4, 2.4	**1.4, 2.4**	**1.4, 2.4**	**1.4, 2.4**	Shield	Shield connection

x = 1 to 4

7.4 Terminal Point Assignment of the Connectors for the Analog RTD Inputs

(RTD; connectors 5, 7, 9, and 11 in Figure 5 on page 14)

Terminal Point				Signal	Assignment
Connector 5 (RTD1)	**Connector 7 (RTD2)**	**Connector 9 (RTD3)**	**Connector 11 (RTD4)**		
1.1	**1.1**	**1.1**	**1.1**	Ix+	Positive constant current supply for RTD sensor channel x
2.1	**2.1**	**2.1**	**2.1**	–	Reserved
1.2	**1.2**	**1.2**	**1.2**	Ix-	Negative constant current supply for RTD sensor channel x
2.2	**2.2**	**2.2**	**2.2**	–	Reserved
1.3	**1.3**	**1.3**	**1.3**	Ux-	Negative voltage input for RTD sensor channel x
2.3	**2.3**	**2.3**	**2.3**	Ux+	Positive voltage input for RTD sensor channel x
1.4, 2.4	**1.4, 2.4**	**1.4, 2.4**	**1.4, 2.4**	Shield	Shield connection

x = 1 to 4

7.5 Terminal Point Assignment of the Connectors for the Analog Outputs

(AO, connector 12 in Figure 5 on page 14)

Terminal Point	Signal	Assignment
Connector 12 (AO)		
1.1	U1/I1	Voltage or current output channel 1
2.1	U2/I2	Voltage or current output channel 2
1.2	U1/I1	Voltage or current output channel 1
2.2	U2/I2	Voltage or current output channel 2
1.3	AGND	Analog ground channel 1
2.3	AGND	Analog ground channel 2
1.4, 2.4	Shield	Shield connection

The relevant unused terminal point for voltage or current output of a channel can be used for test purposes.

8 Connection Notes

Always connect the analog sensors using shielded, twisted pair cables.

Connect the shielding to the module using the shield connection clamp. The clamp connects the shield to FE on the module side. Avoid connection to FE from both sides.

The module is supplied with a shield connector and a standard connector for each input channel. The shield connection can be used for the standard signal (current/voltage) as well as for the RTD signal.

The module has an FE spring (metal clip) on the bottom of the electronics base. This spring establishes an electrical connection to the
DIN rail. Use grounding terminals to connect the DIN rail to protective earth ground. The module is grounded when it is snapped onto the DIN rail.

To ensure reliable functional earth grounding of the module even when the DIN rail is dirty or the metal clip is damaged, always ground the module via the FE terminal point (see Figure 6).

9 Connection Examples

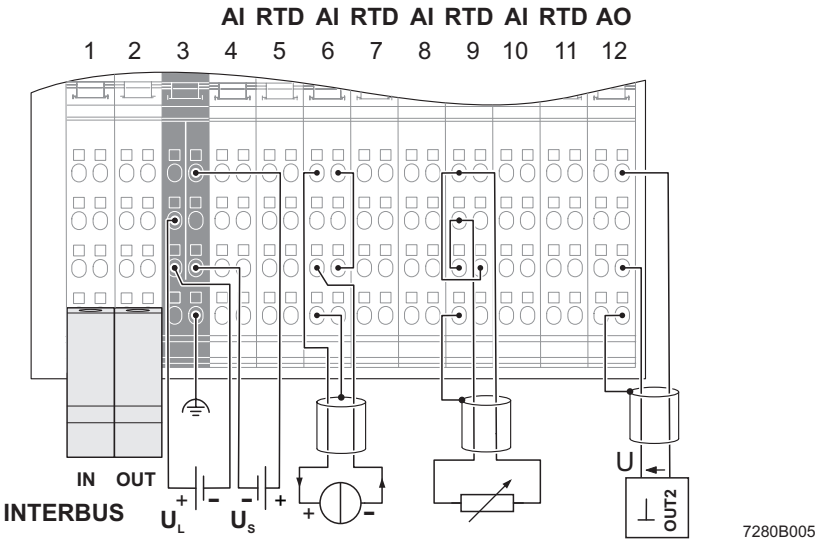


Figure 6 General connection example

Ideal current source
Application: Passive 2-wire transmitter

Variable resistor

General actuator

The numbers above the module illustration indicate the connector slots.

9.1 Connection Examples for Analog Inputs

Ideal current source

Ideal voltage source

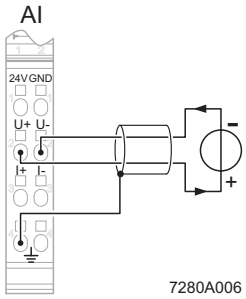


Figure 7 Voltage measurement

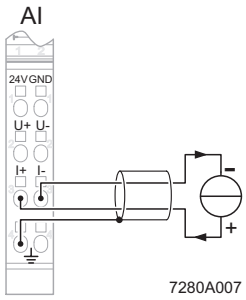


Figure 8 Current measurement

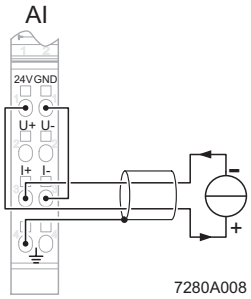


Figure 9 Passive transmitter (4 mA to 20 mA)

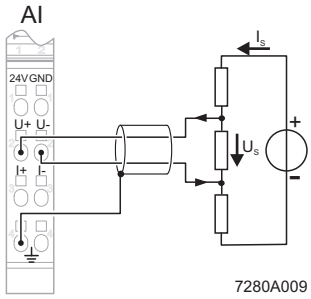


Figure 10 Differential mode voltage measurement, e.g., for shunt, jumpering, and battery charging applications

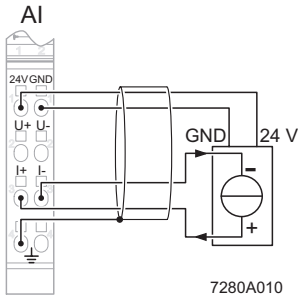


Figure 11 Active transmitter (4 mA to 20 mA)

9.2 Connection Examples for RTD Inputs

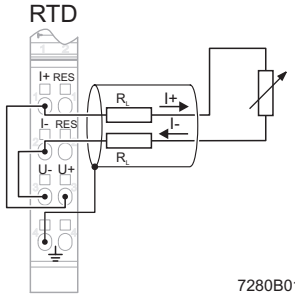


Figure 12 RTD 2-wire connection with connector compensation

Please refer to the connection notes for the RTD 2-wire connection in "RTD 2-Wire Connection With Connector Compensation" on page 41.

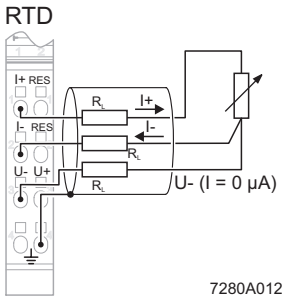


Figure 13 RTD 3-wire connection

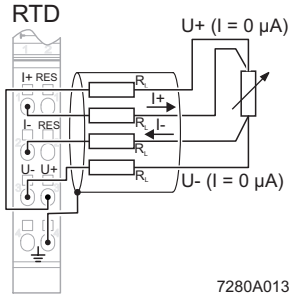


Figure 14 RTD 4-wire connection

9.3 Connection Examples for Analog Outputs

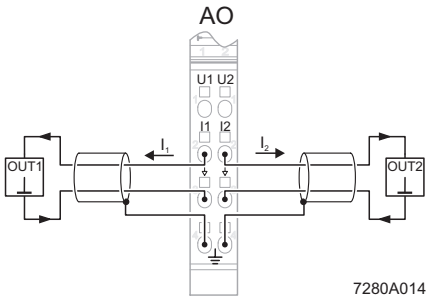


Figure 15 Analog current output

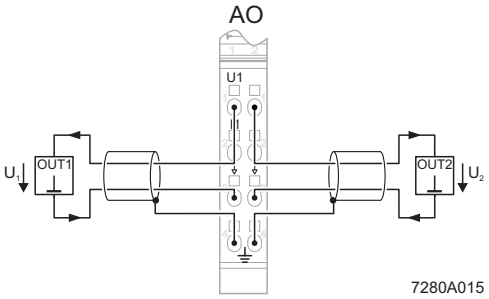


Figure 16 Analog voltage output

10 Programming Data

ID code	$F3_{hex}$ (243_{dec})
Length code	05_{hex}
Process data channel	80 bits
Input address area	5 words
Output address area	5 words
Parameter channel (PCP)	1 word
Register length (bus)	6 words

11 Process Data

The device has 5 process data words and 1 PCP word.

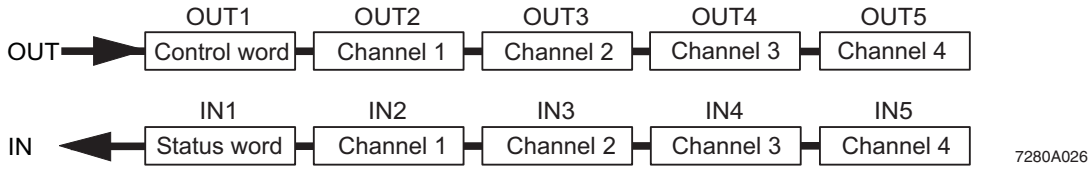


Figure 17 Order of the process data words

11.1 Assignment of the Process Data to the Terminal Points for the "Read and Write Analog Values" Command

Assignment of the Terminal Points for Connector 12 to the Process Data Output Words

(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
Word 2: Channel AO1	Signal	Terminal point 1.1: Voltage output Terminal point 1.2: Current output															
	Signal reference	Terminal point 1.3: Analog ground															
	Shielding (FE)	Terminal point 1.4, 2.4															
Word 3: Channel AO2	Signal	Terminal point 1.1: Voltage output Terminal point 1.2: Current output															
	Signal reference	Terminal point 1.3: Analog ground															
	Shielding (FE)	Terminal point 1.4, 2.4															

Assignment of the Terminal Points to the Process Data Input Words

(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
AI Word 2: Channel 1 (connector 4) Word 3: Channel 2 (connector 6) Word 4: Channel 3 (connector 8) Word 5: Channel 4 (connector 10)	Signal	Terminal point 1.2: Positive voltage input Terminal point 1.3: Positive current input															
	Signal reference	Terminal point 2.2: Negative voltage input Terminal point 2.3: Negative current input															
	Shielding (FE)	Terminal point 1.4, 2.4															
RTD Word 2: Channel 1 (connector 5) Word 3: Channel 2 (connector 7) Word 4: Channel 3 (connector 9) Word 5: Channel 4 (connector 11)	Signal	Terminal point 2.3: Voltage input for RTD sensor															
	Signal reference	Terminal point 1.3 (negative voltage input for RTD sensor)															
	Constant current supply	Terminal point 1.1 (positive constant current supply) Terminal point 1.2 (negative constant current supply)															
	Shielding (FE)	Terminal point 1.4, 2.4															

12 OUT Process Data Words

Five OUT process data words are available.

The first output word (OUT1) represents the control word, the following words (OUT2 to OUT5) each refer to an analog channel. They are used for channel-specific configuration and to output analog values. As confirmation for a control word action, the first input word contains a partial copy of the control word.

	OUT1															
	Byte 0								Byte 1							
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment	Command code								0	0	0	0	0	0	0	0

Bit 15 to bit 8 (command code)

Bit 15 to Bit 8								OUT1	Command Function
0	1	0	0	0	0	0	0	$40xx_{hex}$	**Configure device.** The channel parameters of the four channels are configured in OUT2 to OUT5.
									Read configuration. The configuration of each channel is displayed channel-by-channel in IN2.
0	0	0	1	0	0	0	0	1000_{hex}	Configuration channel 1
0	0	0	1	0	0	0	1	1100_{hex}	Configuration channel 2
0	0	0	1	0	0	1	0	1200_{hex}	Configuration channel 3
0	0	0	1	0	0	1	1	1300_{hex}	Configuration channel 4
									Read and write analog values. The analog values for the input channels are displayed in IN2 to IN5. The analog values for the output channels are displayed in OUT2 and OUT3.
0	0	0	0	0	0	0	0	0000_{hex}	OUT process data not transmitted, the analog outputs are not modified.
0	0	0	0	0	0	0	1	0100_{hex}	The analog outputs accept the value specified via OUT2 and OUT3.
0	0	1	1	1	1	0	0	$3C00_{hex}$	**Read device data.** The firmware version and the device ID are displayed in IN2, see "Input Words IN2 to IN5" on page 23.

13 IN Process Data Words

13.1 Input Word IN1 (Status Word)

	OUT1															
	Byte 0								Byte 1							
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment	EB	Mirrored command code*							0	0	0	0	0	0	0	0

Error bit:

EB = 0 No error has occurred.

EB = 1 An error has occurred.

The error bit is available as a group error message. Possible errors and their effects are listed in "Diagnostics" on page 38.

*** Mirrored command code:**

A command code mirrored from the control word. Here, the MSB is suppressed.

13.2 Input Words IN2 to IN5

The measured values, firmware version or configuration are transmitted to the controller board or the computer via IN process data words IN2 to IN5 according to the configuration.

IN1*	IN2	IN3	IN4	IN5
	Configure device.			
	Configuration data following transmission to the channels			
$40xx_{hex}$	Configuration data channel 1	Configuration data channel 2	Configuration data channel 3	Configuration data channel 4
	Read configuration.			
1000_{hex}	Configuration channel 1	Not relevant	Not relevant	Not relevant
1100_{hex}	Configuration channel 2			
1200_{hex}	Configuration channel 3			
1300_{hex}	Configuration channel 4			
	Read and write analog values.			
$00xx_{hex}$	Measured value of the analog input channel 1	Measured value of the analog input channel 2	Measured value of the analog input channel 3	Measured value of the analog input channel 4
$01xx_{hex}$				
	Read device data.			
$3C00_{hex}$	Firmware version and device ID, see below	Not relevant	Not relevant	Not relevant

* Input data IN1 contains the error bit and the mirrored command code.

Example for "Read device data":

	IN2															
Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment (hex)	1				2				3				4			
Meaning	Firmware Version 1.23												Device ID 4_{hex}			

14 Formats for the Representation of Measured Values (IN2 to IN5)

14.1 Format: "IB IL" (Default Setting)

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 "IB IL" format (15 bits)

MSB LSB

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

SB Sign bit

This format supports extended diagnostics. Values > 8000_{hex} and < 8100_{hex} indicate an error. Following an error message in the status word (error bit), the following errors/messages are displayed in words IN2 to IN5:

Input Data Word (hex)	Errors
8001	Overrange
8002	Open circuit
8004	Measured value invalid
8020	Sensor and/or analog supply not present
8040	Module faulty
8080	Underrange

Significant Measured Values

Input Data Word (Two's Complement)		0 V to 10 V U_{Input}	±10 V U_{Input}	0 V to 5 V U_{Input}	±5 V U_{Input}	0 mA to 20 mA I_{Input}	±20 mA I_{Input}	4 mA to 20 mA I_{Input}
hex	**dec**	**V**	**V**	**V**	**V**	**mA**	**mA**	**mA**
8001	Overrange	> +10.837	> +10.837	> +5.419	> +5.419	> +21.6747	> +21.6747	> +21.339733
7F00	32512	+10.837	+10.837	+5.419	+5.419	+21.6747	+21.6747	+21.339733
7530	30000	+10.0	+10.0	+5.0	+5.0	+20.0	+20.0	+20.0
0001	1	+333.33 µV	+333.33 µV	+166.67 µV	+166.67 µV	+0.6667 µA	+0.6667 µA	+4.0005333
0000	0	≤ 0	0	≤ 0	0	≤ 0	0	+4.0 ... +3.2
FFFF	-1	–	-333.33 µV	–	-166.67 µV	–	-0.6667 µA	–
8AD0	-30000	–	-10.0	–	-5.0	–	-20.0	–
8100	-32512	–	-10.837	–	-5.419	–	-21.6747	–
8080	Underrange	–	< -10.837	–	< -5.419	–	< -21.6747	–
8002	Open circuit	–	–	–	–	–	–	< +3.2

Input Data Word (Two's Complement)		R: 0 ... 3.2 kΩ R_{Input}	R: 0 ... 9.5 kΩ R_{Input}	Pt and Ni
hex	dec	Ω	Ω	°C
8001	Overrange	> 3200	> 10000	> Limit value
251C	9500	–	9500	–
03E8	1000	100.0	1000	+100.0
0001	1	+0.1	+1.0	+0.1
0000	0	≤0	≤0	0
FFFF	-1	–	–	-0.1
FC18	-1000	–	–	-100.0
8080	Underrange	–	–	< Limit value

For the limit values, please refer to "Limit Values for Temperature Measurement" on page 9.

Output Data Word		0 V to 10 V U_{Output}	±10 V U_{Output}	0 V to 5 V U_{Output}	±5 V U_{Output}	0 mA to 20 mA I_{Output}	±20 mA I_{Output}	4 mA to 20 mA I_{Output}
hex	dec	V	V	V	V	mA	V	mA
8001	Overrange	+10.837	+10.837	+5.419	+5.419	+21.6764	+10.837	+21.3397
7FFF to 7F01	–	+10.837	+10.837	+5.419	+5.419	+21.6764	+21.6764	+21.3397
7F00	+32512	+10.837	+10.837	+5.419	+5.419	+21.6764	+21.6764	+21.3397
7530	+30000	+10.0	+10.0	+5.0	+5.0	+20.0	+20.0	+20.0
3A98	+15000	+5.0	+5.0	+2.5	+2.5	+10.0	+10.0	+12.0
0001	+1	+333.33 µV	+333.33 µV	+166.67 µV	+166.67 µV	+0.6667µA	+0.6667µA	+4.000533
0000	0	0	0	0	0	0	0	+4.0
FFFF	-1	0	-333.33 µV	0	-166.67 µV	0	-0.6667µA	+4.0
C568	-15000	0	-5.0	0	-2.5	0	-10.0	+4.0
8AD0	-30000	0	-10.0	0	-5.0	0	-20.0	+4.0
8100	-32512	0	-10.837	0	-5.419	0	-21.6764	+4.0
80FF to 8000 without 8001, 8080, 8002	–	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD
8080	Underrange	0	-10.837	0	-5.419	0	-10.837	HOLD
8002	Line break	HOLD	HOLD	HOLD	HOLD	HOLD	HOLD	0