

# IB IL EX-IS AIO 4/EF-PAC

Intrinsically safe Inline analog I/O terminal for hazardous locations



Data sheet  
2764\_en\_C

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## 1 Description

The IB IL EX-IS AIO 4/EF-PAC terminal is an intrinsically safe analog input/output module for sensor or actuator connection right into Zone 1 or 0. The terminal and accompanying intrinsically safe power supply (IB IL EX-IS PWR IN-PAC) is installed in Zone 2 or safe area.

The terminal provides four independently configurable analog channels for standard voltage and current signals.

## 2 Features

- Four single-ended analog signal inputs for the connection of either voltage or current signals
- Connection of sensors in 2- or 3-wire technology
- Two current measuring ranges:  
0 mA to 20 mA, 4 mA to 20 mA
- Voltage measuring range: 0 V to 10 V
- Measured values can be represented in three different formats
- Mean-value generation of measured values
- Diagnostic indicators
- Communication via either process data or parameter channel (PCP)
- Channels are independently configurable
- Resolution up to 16-bits (depends on the representation format and the measuring range)
- -25... +60°C operating range
- Shield termination



This data sheet is only valid in association with the IB IL SYS PRO UM E user manual or the Inline system manual for your bus system.



Make sure you always use the latest documentation.  
It can be downloaded at [phoenixcontact.com](http://phoenixcontact.com).



This data sheet is valid for all products listed on the following page:

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### 3 Ordering data

#### Products

Description	Type	Order No.	Pcs. / Pkt.
Terminal with four analog input channels; 500 kbps transmission speed; includes accessories (connectors and labeling fields)	IB IL EX-IS AIO 4/EF-PAC	2869912	1

#### Documentation

Description	Type	Order No.	Pcs. / Pkt.
User manual: "Configuring and Installing the INTERBUS Inline Product Range"	IB IL SYS PRO UM E	2743048	1
User manual: "Automation Terminals of the Inline Product Range"	IL SYS INST UM E	2698737	1

### 4 Technical data

#### General data

Housing dimensions (width x height x depth)	48.8 mm x 136.8 mm x 71.5 mm
Weight	222 g (without connectors)
Operating mode	Process data mode with 5 words/1 word PCP
Transmission speed	500 kbps
Connection method for sensors	2- and 3-wire technology (shielded)
Permissible temperature (operation)	-25°C to +60°C
Permissible temperature (storage/transport)	-25°C to +85°C
Permissible humidity (operation/storage/transport)	10% to 95%, according to DIN EN 61131-2
Permissible air pressure (operation/storage/transport)	70 kPa to 106 kPa (up to 3000 m above sea level)
Degree of protection	IP20 according to IEC 60529
Protection class	Class 3 according to VDE 0106, IEC 60536
Connection data for connector	
Connection method	Spring-cage terminals
Conductor cross section	0.2 mm <sup>2</sup> - 1.5 mm <sup>2</sup> (solid or stranded), 24 - 16 AWG

#### Interface

Local bus	Data routing
-----------	--------------

**Power consumption**

Communications power $U_L$	5 V
Current consumption from $U_L$	100 mA (typical)/120 mA (maximum)
I/O supply voltage $U_{EX}$	28 V DC
Current consumption at $U_{EX}$	90 mA (typical)/187 mA (maximum)
Total power consumption	1500 mW (typical)/2200 mW (maximum)

**Hazardous location ratings**

	Output		
Module supply voltage $U_{EX}^1$	28 V DC		
Voltage input $U_i$	0 V DC		
Voltage output $U_o$	28 V DC		
Current output $I_o$	108 mA		
Power output $P_o$	750 mW		
	IIC	IIB	IIA
Capacitance $C_o^2$	0.082 $\mu$ F	0.649 $\mu$ F	2.149 $\mu$ F
Inductance $L_o^2$	1.015 mH	3.045 mH	8.12 mH

<sup>1</sup>  $U_{EX} = U_m$  as listed in the SIRA Certification

<sup>2</sup> The quoted entity parameters of  $C_o$  and  $L_o$  are applicable for the distributed capacitance and inductance in cable. Where there is circuit capacitance or inductance in the connected equipment (represented by  $C_i$  and  $L_i$  respectively), then these values shall not exceed 50% of the quoted  $C_o$  and  $L_o$ .

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

Connection method	Potential routing
-------------------	-------------------

**Sensor supply voltage  $U_{IS}$**

Nominal value $U_{IS}$	24 V
Nominal current $I_{IS}$ per channel	20 mA
Nominal source resistance $R_{IS}$	300 $\Omega$
Protection	Internal, channel-specific electronic fuse, short-circuit-proof with single-channel diagnostics

**Analog inputs**

Number	4 analog inputs (can also be configured as outputs)
Signals/resolution in the process data word (quantization)	See tables on page 19 and onwards
Measured value representation	In the following formats: IB IL (15 bits with sign bit) S7-compatible (15 bits with sign bit) Standardized representation (15 bits with sign bit)



Please read the notes on page 19 and page 22 on measured value representation in "IB IL" and "standardized representation" format.

Digital filtering (mean-value generation)	First order lag filter (tau) selectable as 100 or 1000 ms None or over 4, 16 or 32 measured values Default setting: 16 measured values
Nominal conversion time of the A/D converter	50 $\mu$ s
Process data update of the channels	< 1 ms
Limit frequency (-3 dB) of the input filters	< 30 Hz
Bus synchronism	Yes
Transient protection	Yes

### Analog voltage inputs

Number	4
Input range	0 V to 10 V
Input resistance	10 kΩ ±1%
Maximum permissible voltage between analog voltage inputs and analog return	±30 V DC

### Analog current inputs

Number	4
Input range	0 mA to 20 mA; 4 mA to 20 mA
Input resistance	51 Ω ±2%
Open circuit detect	Yes
Maximum permissible current per current input	40 mA
Maximum permissible voltage at the analog current inputs	±1.5 V DC

### Analog outputs

Number	4 analog outputs (can also be configured as inputs)
Signals/resolution in the process data word (quantization)	See tables on page 19 and onwards
Measured value representation	In the following formats: IB IL (15 bits with sign bit) S7-compatible (15 bits with sign bit) Standardized representation (15 bits with sign bit)



Please read the notes on page 19 and page 22 on measured value representation in "IB IL" and "standardized representation" format.

Conversion time of the D/A converter	10 μs
Process data update of the channels (configurable)	10 ms ... 200 ms
Bus synchronism	Yes
Transient protection	Yes, via arresters

### Analog current outputs

Number	4
Input range	0 mA to 20 mA; 4 mA to 20 mA
Open circuit detect	Yes
Short circuit protection	Yes

**Tolerance and temperature response**

**T<sub>A</sub> = 25°C**

	Measuring range	Tolerance	Error
Current input	4... 20 mA	±0.5%	0.1 mA
Voltage input	0 V to 10 V	±0.5%	0.05 V
Current output	4 mA to 20 mA	±0.5%	0.1 mA

**T<sub>A</sub> = -25°C... +25°C**

	Measuring range	Temperature coefficient (typical)	Error (typical)	Temperature coefficient (maximum)	Error (maximum)
Current input	4... 20 mA	50 ppm/°C	0.05 mA	100	0.1 mA
Voltage input	0 V to 10 V	50 ppm/°C	25 mV	100	50 mV
Current output	4 mA to 20 mA	50 ppm/°C	0.05 mA	100	0.1 mA

**T<sub>A</sub> = -25°C... +60°C**

	Measuring range	Temperature coefficient (typical)	Error (typical)	Temperature coefficient (maximum)	Error (maximum)
Current input	4... 20 mA	50 ppm/°C	0.035 mA	100	0.07 mA
Voltage input	0 V to 10 V	50 ppm/°C	17.5 mV	100	35 mV
Current output	4 mA to 20 mA	50 ppm/°C	0.035 mA	100	0.07 mA



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

**Additional tolerances influenced by electromagnetic fields**

Type of electromagnetic interference	Typical deviation from the measuring range final value (voltage input)	Typical deviation of the measuring range final value (current input)
	Relative	Relative
Electromagnetic fields; field strength 10 V/m according to EN 61000-4-3/IEC 61000-4-3	< ±1%	< ±1%
Conducted interference Class 3 (test voltage 10 V) according to EN 61000-4-6/IEC 61000-4-6	< ±1%	< ±1%
Fast transients (burst) 4 kV supply, 2 kV input according to EN 61000-4-4/IEC 61000-4-4	< ±1%	< ±1%

**Safety equipment**

Inputs	Transient surge protection via arresters
Sensor supply voltage	Short-circuit protection with electronic fuse

**Electrical isolation/isolation of the voltage areas**



**NOTE:**

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 user manual.)

**Common potentials**

The 4 analog channels have the same potential. The 24 V  $U_{EX}$  and 5 V  $U_L$  are separate potential areas. The FE and shield have the same potential.

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

**- Test distance**

- 5 V supply (bus logic), 24 V supply  $U_{ANA}$ /analog I/O
- 5 V supply (bus logic), 24 V supply  $U_{ANA}$ /functional earth ground
- Analog I/O/functional earth ground

**- Test voltage**

- 500 V AC, 50 Hz, 1 min.
- 500 V AC, 50 Hz, 1 min.
- 500 V AC, 50 Hz, 1 min.

**Error messages to the higher-level control or computer system**

Failure of the internal I/O voltage supply	Yes, I/O error message sent to the bus coupler
Failure of or insufficient communications power $U_L$	Yes, I/O error message sent to the bus coupler
Peripheral fault/user error	Yes, error message via the IN process data (see page 17)

**Conformance/approvals**

CE	94/9/EC EN 60079-0:2009 EN 60079-11:2007 EN 60079-15:2010
ATEX	Sira 09ATEX2339X; Ex nA [ia Ga Da] IIC T4 Gc
IECEX	IECEX SIR 10.0033X; Ex nA [ia Ga Da] IIC T4 Gc
	Ex II 3(1)GD
UL/cUL	Class I, Division 2, Groups A, B, C, D
FM	Class I, II, Division 2, Group A-G; Class I, Zone 2 AEx nA [ia] IIC T4

For the latest approvals, please visit [phoenixcontact.com](http://phoenixcontact.com).

## 5 Local diagnostic and status indicators and terminal point assignment

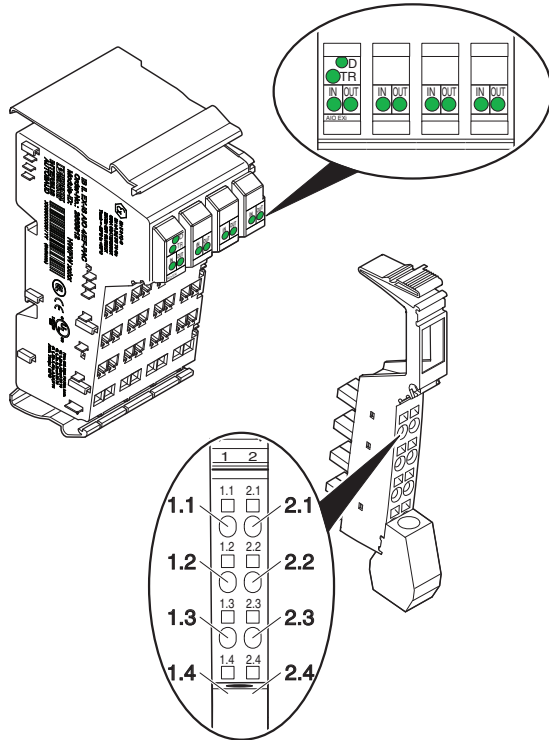


Figure 1 IB IL EX-IS AIO 4/EF-PAC terminal with an appropriate connector

### 5.1 Local diagnostic and status indicators

Des.	Color	Meaning
<b>D</b>	Green	Diagnostics
	0.5 Hz	Local bus stop
	2 Hz	Peripheral fault or $U_{EX}$ low or off
	4 Hz	Local bus failure
<b>TR</b>	Green	PCP communication active
<b>IN</b>	Green (on)	Input on and OK
	Red (on)	Broken wire or under/over range
<b>OUT</b>	Green (on)	Output on

### 5.2 Terminal point assignment for each connector

Terminal points	Signal	Assignment
1.1	$U_{Vx}$ (24 V)	Initiator supply for channel x
1.2	$AI_{Ix}$	Current input for channel x
1.3	$AI_{Ux}$	Voltage input for channel x
1.4	Shield	Shield connection
2.1	$AO_{Ix}$	Current output for channel x
2.2	$-AO_{Ix}$	Return for channel x (GND)
2.3	$-AO_{Ix}$	Return for channel x (GND)
2.4	Shield	Shield connection

x = 1 to 4



## 6 Internal circuit diagram

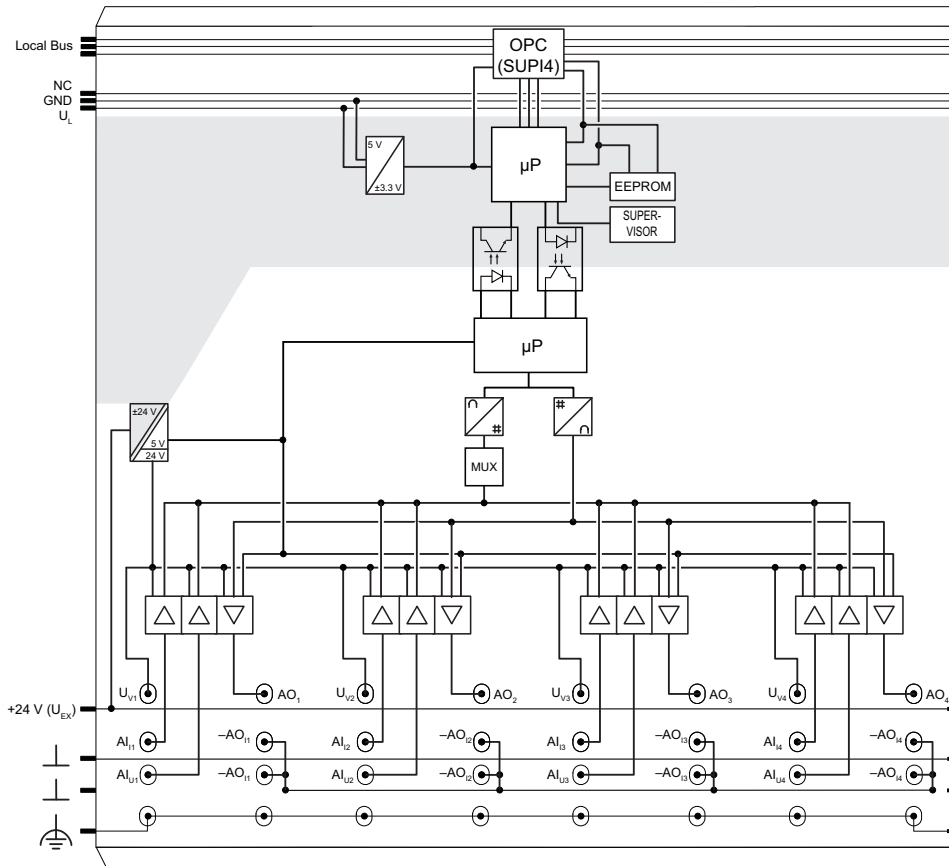












Figure 2 Internal wiring of the terminal points

Key:

	Protocol chip		Digital/analog converter
	Power supply unit with electrical isolation		Analog/digital converter
	Optocoupler		Amplifier
	Microprocessor		Multiplexer
	Electrically erasable programmable read-only memory		Microprocessor monitoring



Other symbols used are explained in the IB IL SYS PRO UM E user manual or in the Inline system manual for your bus system.

## 7 Safety regulations installation notes



For a list of terminals that are approved for the potentially explosive areas of Zone 2, please refer to the AH EN IL EX ZONE 2 application note. Verify use by checking the label on the Inline terminal and the packaging.



### **WARNING: Explosion hazard**

The following conditions must be observed to adhere to the ATEX 94/9/EC directive.

### 7.1 Special conditions for safe use

The module shall only be supplied from the IB IL EX-IS PWR IN-PAC module.

If the module is installed in a zone 2 hazardous area, it shall be housed in an enclosure that is coded Ex nA, Ex e, Ex d or Ex p. If the module is installed in a zone 22 or 21 hazardous area, it shall be housed in an enclosure that is coded Ex tD or Ex t. For some types of enclosure, additional certification is required to permit the installation of the module within the enclosure. Reference should be made to the enclosure certificate. The installer shall ensure that the maximum ambient temperature of the module, when installed, is not exceeded.

If the module is installed in a non-hazardous area, the enclosure or location shall provide suitable protection. This may be either by the use of an enclosure approved for use in zones 1, 2, 21, or 22 or otherwise meet the following requirements:

- Non-metallic enclosures must be capable of withstanding the thermal endurance requirements of IEC 60079-0 prior to impact and IP54 testing.
- Any enclosure must be capable of withstanding an impact of 7J or the module is otherwise protected from impact.
- The enclosure or location must provide an ingress protection of at least IP54.
- If exposed to sunlight, non-metallic enclosures must be capable of meeting the requirements of IEC 60079-0 clause 26.10 regarding resistance to light.

The installer is responsible for ensuring that the mounting of the module does not reduce the segregation distances between different modules. There shall be a minimum of 6 mm between any intrinsically safe terminals and other conductors or earthed metal, in accordance with IEC 60079-14:2007 clause 12.2.3. In addition, there shall be a minimum of 50 mm between the intrinsically safe terminals of the module and any non-intrinsically safe terminals.

When the module is mounted in a zoned area, live connection and disconnection of the module from the rail is only permitted if the potentially explosive atmosphere is shown to be absent.

The four channels of the IB IL EX-IS AIO 4/EF-PAC shall be treated as separate, intrinsically safe circuits.

Each channel shares a common zero volts with the other channels in the IB IL EX-IS AIO 4/EF-PAC module as well as other IB IL EX-IS AIO 4/EF-PAC modules and non-isolated IB IL EX-IS...IO... modules connected to the same IB IL EX-IS PWR IN-PAC (power supply) module. If the field devices do not maintain 500 V AC isolation from earth/ground, then all the non-isolated devices from the same IB IL EX-IS PWR IN-PAC module shall be installed in a location (such as the same vessel) where a difference in earth/ground potential is unlikely to occur. If the field devices maintain 500 V AC isolation from earth/ground, there is no such limitation.

The quoted entity parameters of  $C_0$  and  $L_0$  are applicable for the distributed capacitance and inductance in cable. Where there is circuit capacitance or inductance in the connected equipment (represented by  $C_i$  and  $L_c$  respectively), these values shall not exceed 50% of the quoted  $C_0$  and  $L_0$ .

### 7.2 Safety instructions

#### Installation instructions

The device is an associated equipment of the “intrinsically safe” protection type and suitable for installation in zone 2.

Follow the installation instructions.

Installation, operation and maintenance may only be carried out by qualified personnel.

Always remove power from Inline station before installing or removing any Inline terminal.

Comply with the valid safety regulations (including national safety regulations) for the installation and operation, accident prevention regulations, and the general rules and regulations pertaining to technology. The safety relevant data may be derived from the operating instructions and the certificates (EC type examination certificate, possibly additional ratings).

Access to the circuits within the device is prohibited. Do not repair the device yourself, but replace it with an equivalent device. Repairs may only be carried out by the manufacturer.

The IP20 degree of protection (IEC 60529/EN 60529) is intended for a clean and dry environment. Do not expose the device to any mechanical or thermal influences that exceed the limits described.

### Intrinsic safety

When carrying out measurements on the intrinsically safe side, it is imperative that you observe the relevant regulations regarding connecting intrinsically safe electrical equipment. Only use equipment approved for intrinsically safe circuits.

If the device was used in circuits that are not intrinsically safe, it is forbidden to use it again in intrinsically safe circuits. Label the device clearly as being not intrinsically safe.

### Installation in Zone 2

Observe the specified conditions for use in potentially explosive areas! Use a suitable housing of the minimum protection IP54 for the installation. Within this context observe the requirements of IEC 60079-14/EN 60079-14, i.e., steel housing with a wall thickness of 3 mm.

Do not connect any live cables/lines within the potentially explosive area.

Only use IB IL EX-IS...IO... modules of category 3G (ATEX 94/9EG).

### Potentially dust-explosive areas

The device is not designed for use in environments capable of dust explosions.

Only make the connection to the intrinsically safe circuit in potentially dust-explosive areas of zones 20, 21 and 22 if the equipment connected to this circuit is certified for this zone (e.g., category 1D, 2D or 3D).

### 7.3 FM compliance

In addition to the previous statements, FM compliance requires that the module is mounted in an enclosure that meets the requirements of ANSI/ISA 601010 and is installed in compliance with the enclosure, mounting, spacing and segregation requirements of the ultimate application.

## 8 Electrical isolation

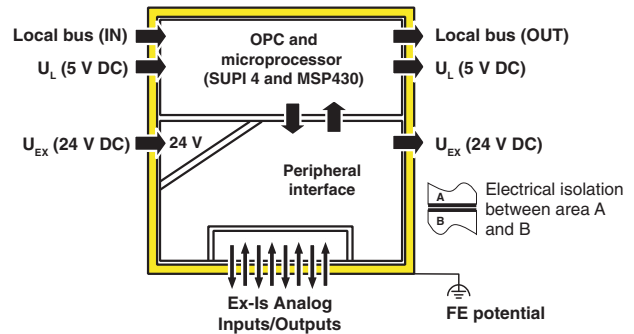


Figure 3 Electrical isolation of the individual function areas

## 9 Connection notes



**NOTE:**

**Always** connect the analog sensors using shielded, twisted-pair cables. Connect the shielding to the terminal using the shield connection clamp. The clamp connects the shield to FE on the module side. Avoid connection to FE from both sides.

### 9.1 Power budget

The IB IL EX-IS PWR IN-PAC provides power to the IB IL EX-IS AIO 4/EF-PAC terminal in two ways:

- 1000 mA is available for the logic functions ( $U_L$ ).
- 1000 mA is available for the I/O functions ( $U_{EX}$ ).

The number of terminals that can be powered by the IB IL EX-IS PWR IN-PAC varies according to the type of terminal and the number and type of I/O connections.

Based on the logic functions, the maximum number of terminals that can be connected is 10.

The IB IL EX-IS AIO 4/EF-PAC terminal draws different power depending on the type of connection. To determine the number of I/O points that can be connected, refer to Table 1.

Table 1  $U_{EX}$  Current Draw

	IB IL EX-IS AIO 4/EF-PAC
Terminal overhead	45 mA
Output	25 mA
Input	25 mA

To calculate the power requirements of a system, list the number and type of each connected point. From this list, determine the number and type of terminals required. Multiply

the number of each I/O point by the appropriate current draw listed in Table 1.

head current draw determines the total current draw from the IB IL EX-IS PWR IN-PAC. The maximum current draw is 1000 mA.

Add the terminal overhead current for each terminal used. The sum of the I/O point current draw and the terminal over-

## 10 Connection examples



Use a connector with shield connection when installing the sensors. Figure 4 shows the connection schematically.

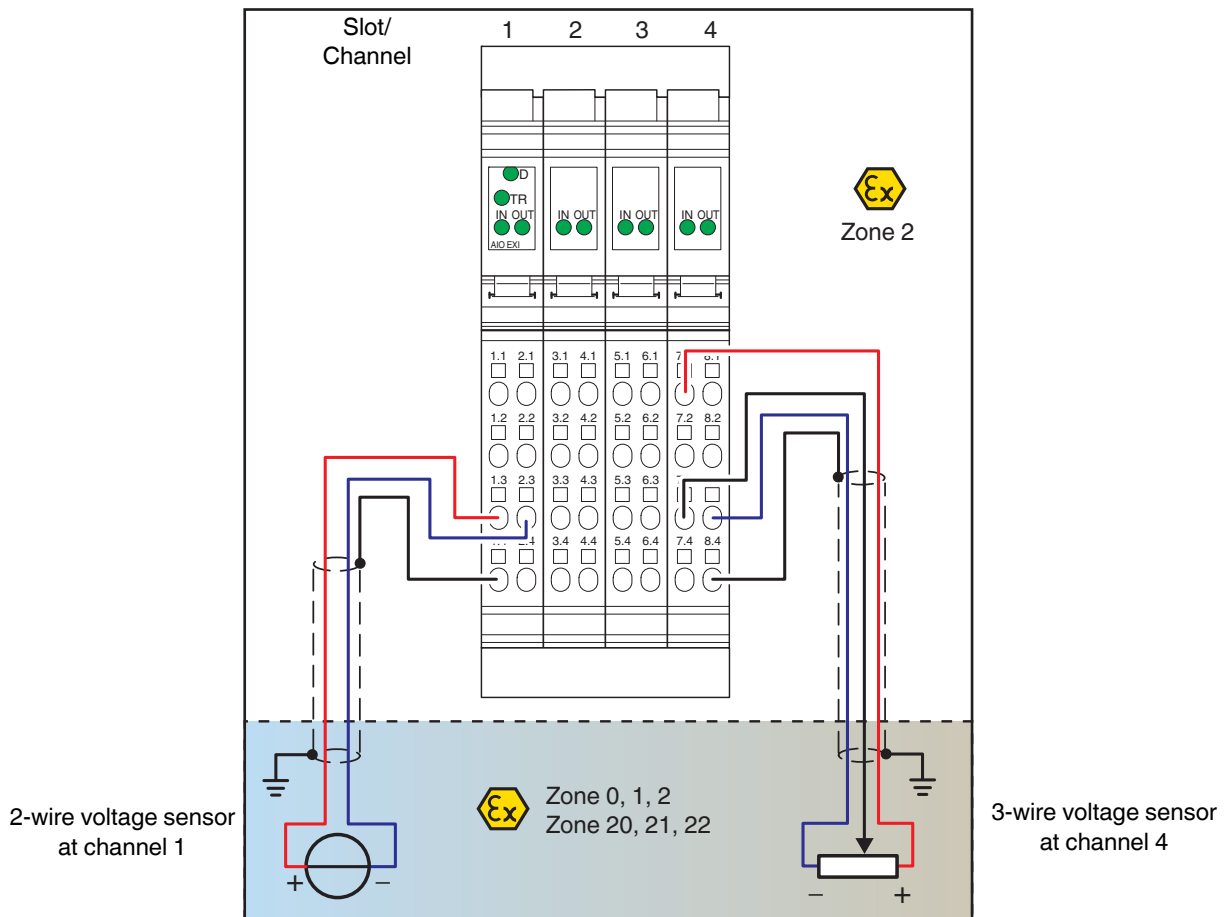


Figure 4 Connection of voltage sensors with shield connection

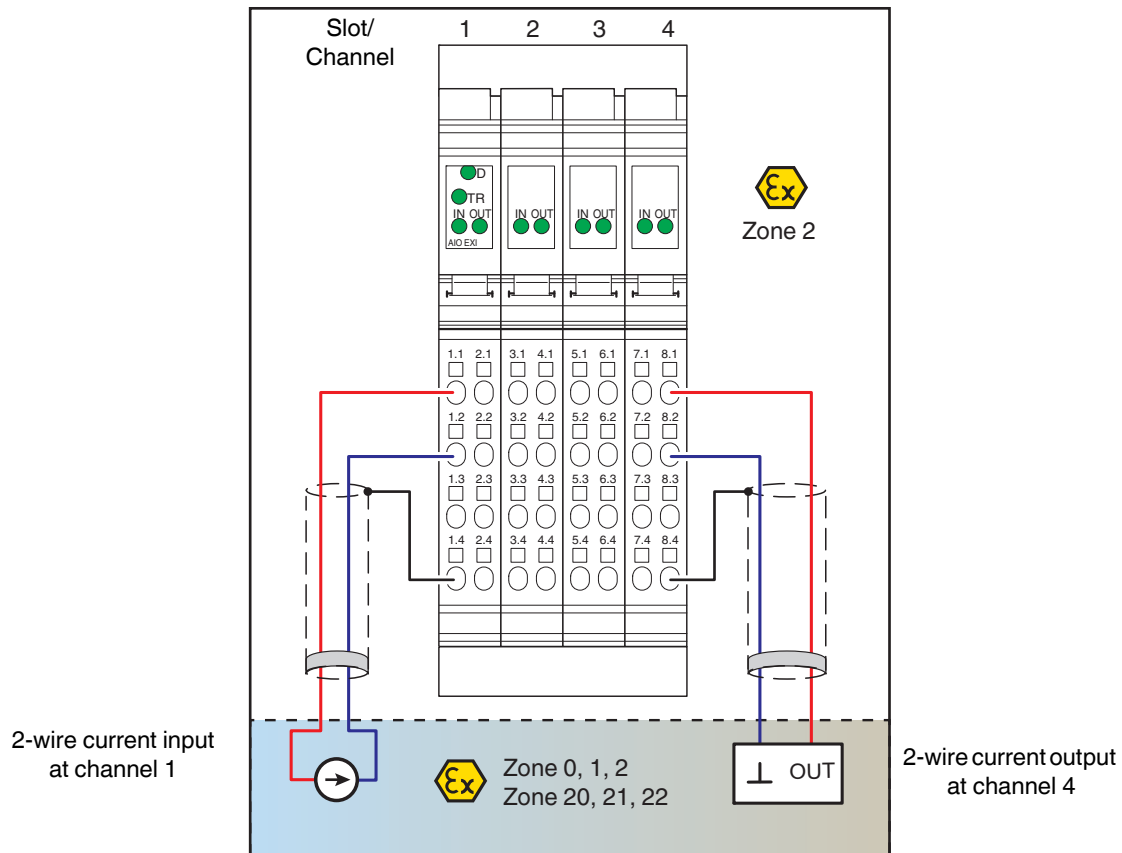


Figure 5 Connection of current devices with shield connection

## 11 Configuration and analog values

You can either configure the device via process data or via PCP and transmit analog values accordingly.

If the device was configured via PCP, the configuration can no longer be modified the via process data.

## 12 Programming data/configuration data

### 12.1 INTERBUS

ID code	0xDF
Length code	05
Input address area	5 words
Output address area	5 words
Parameter channel (PCP)	1 word
Register length (bus)	6 words

### 12.2 Other bus systems



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

### 13 Assignment of the process data to the terminal points for the “Read Analog Value” and “Configure Device and Read Analog Value” commands

(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
<b>AI</b> Word 2: Channel 1 (connector 1) Word 3: Channel 2 (connector 2) Word 4: Channel 3 (connector 3) Word 5: Channel 4 (connector 4)	24 V	Terminal point 1.1: Sensor supply															
	GND	Terminal point 2.1: Ground															
	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															

### 14 Process data

The device has 5 process data words and 1 PCP word. The first output word represents the control word because the assignment of the following words depends on the configuration. As confirmation for a control word action, the first input word contains a partial copy of the control word.

For the device configuration, channel-specific configuration data is set in the relevant channel output words. Once configuration has been completed, and depending on the format set, the measured values in the corresponding input words are either transmitted to the controller board or to the computer.

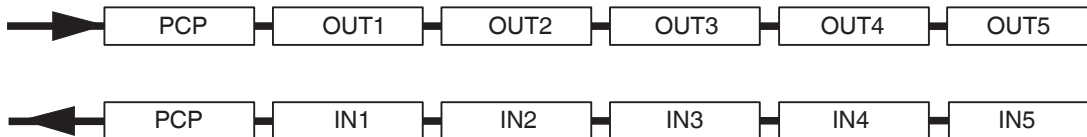


Figure 6 Order of the process data words

### 15 OUT process data words

#### 15.1 Output word OUT1 (control word)

- For command code 400x<sub>hex</sub>

		OUT1															
		Byte 1								Byte 0							
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment		Command code 0x40								0	0	RR	PF	AO Format	AI Format		

Field	Value (Binary)	Description
AI format	00	IB IL (default)
	01	Reserved
	10	S7 compatible
	11	Standardized representation
AO format	00	IB IL (default)
	01	Reserved
	10	S7 compatible
	11	Standardized representation
RR (Refresh rate input channels)	0	200 ms (default)
	1	10 ms
PF (Peripheral fault)	0	Not permitted (default)
	1	Permitted: Flag the StatErr bit on any error condition on input

- For all other command codes

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

OUT1	Command description
0x40xx	Configure device. The configuration parameters are sent on OUT2 to OUT5
0x1000	Read configuration one channel at a time Configuration for selected channel is displayed in IN2
0x1100	Read configuration for channel 1
0x1200	Read configuration for channel 2
0x1300	Read configuration for channel 3
0x1300	Read configuration for channel 4
0x0000	Read analog values for all channels. Values are displayed on IN2 to IN5
0x0100	Write analog values for all channels. Values are sent on OUT2 to OUT5
0x3C00	Read device info – Firmware version and 4-bit device

### 15.2 Output words OUT2 to OUT5 (configuration)

Each channel can be configured independently of the other channels. The first channel is configured via the second output word, the second channel via the third output word, etc.

If the configuration changes, the corresponding channel is re-initialized. If the format "IB IL" is set, the error code "Measured value invalid" is output.

If the configuration is invalid, a corresponding error message is output in the status word. The configuration is stored in a volatile memory.

For command 40xx<sub>hex</sub>, specify the parameters for the appropriate channels 1 to 4 in OUT2 to OUT5. The parameter words are only evaluated by this command.

		OUT2 to OUT5															
Bit	Assignment	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		CO		AO reset behavior			AO output range			CI	AI filter	Wire			AI measuring range		

Field	Value (binary)	Description
AI measuring range	0000	0... 10 V
	00xx	Reserved
	0100	0... 20 mA
	0101	Reserved
	0110	4... 20 mA (Default)
	0111	Reserved
	0xxx	Reserved
Wire	0	2 wire (default)
	1	3 wire
AI Filter	0	No filter
	1	First order lag filter; 100 ms for 10 ms update rate, 1 s for 200 ms update
CI (Channel input)	0	Input mode disabled
	1	Input mode enabled
AO Output range	0xx	Reserved
	100	0... 20 mA
	101	Reserved
	110	4... 20 mA (default)
	111	Reserved
AO Reset behavior	00	Hold (default)
	01	Reset
	10	Fail safe
	11	Reserved
CO (Channel output)	0	Output mode disabled
	1	Output mode enabled

Default configuration: all channels are disabled.

Either of CI or CO has to be set for enabling the channel in input or output mode. If both CI and CO are reset, the channel is disabled. If both CI and CO are set, error is returned.

For output channel, device supports only 2 wire technology.

Selection of any reserved value in any field results in an error.

Refresh rate of 10 ms is supported only for 4-20 mA range on input channels.

The selected refresh rate will apply to all input channels.

The output channels will have a fixed refresh rate of 200 ms.



## 16 IN Process Data Words

### 16.1 Input word IN1 (Status word)

		OUT1															
		Byte 1								Byte 0							
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment		Command code 0x10, 0x11, 0x12, 0x13								0	0	0	0	0	0	0	0

### 16.2 Input word IN1 (Status word)

		IN1															
		Byte 1								Byte 0							
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 indicates incorrect or unrecognized command entered.

### 16.3 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.

For control words **0000<sub>hex</sub>** (error-free standard operation) the measured values are transmitted in IN2 to IN5. For control word **1x00<sub>hex</sub>**, the configuration of the selected channel is indicated in IN2. For control word **3C00<sub>hex</sub>**, IN2 supplies the firmware version and the device ID.

Example:

		IN2															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Meaning		Firmware Version 1.00												Device ID 0x3			

For control word **4000<sub>hex</sub>** (configuration mode), the configuration data is mirrored in the input words after transfer.

## 17 OUT process data words

### 17.1 Read analog values via process data

		OUT1															
		Byte 1							Byte 0								
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment		Command code 0x00							0	0	0	0	0	0	0	0	

### 17.2 Input word IN1 (Status Word)

		IN1															
		Byte 1							Byte 0								
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment		ERR	Mirrored command code 0x00							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 “Supported error codes for the “IB IL” and “Standardized Display” formats” on page 23.

Only an analog value corresponding to a configured input channel is processed.

In case of a read analog value on an unconfigured channel, the return value will be in accordance with representation format (IB IL and Standard Representation: 0x8004; S7-compatible: 0x8000).

### 17.3 Write analog values via process data

		OUT1															
		Byte 1							Byte 0								
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment		Command code 0x01							0	0	0	0	0	0	0	0	

		OUT2 to OUT5 for channel 1 to channel 4															
		Byte 1							Byte 0								
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment		SB	Command code 0x01														

### 17.4 Input word IN1 (Status word)

		IN1															
		Byte 1							Byte 0								
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment		SB	Mirrored command code 0x01							0	0	0	0	0	0	0	0

Only the analog value corresponding to a configured output channel is processed.

In case of a write analog value on an unconfigured channel, the value will be ignored without any error returned.

If any channels are configured as inputs, the corresponding input values appear on IN2 to IN5 for channel 1 to channel 4.

17.5 Read device information via process data

		OUT1															
		Byte 1							Byte 0								
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment		Command code 0x3C							0	0	0	0	0	0	0	0	

		IN1															
		Byte 1							Byte 0								
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment		Mirrored command code 0x3C							0	0	0	0	0	0	0	0	

		IN2															
		Byte 1							Byte 0								
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment		Firmware version 1.00							Device ID 0x3								

18 Formats for the representation of measured values (IN2 to IN5)

18.1 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.

This format supports extended diagnostics. Values > 8000<sub>hex</sub> and < 8100<sub>hex</sub> indicate an error. The error codes are listed on page 23.

		IN2 to IN5 for channel 1 to channel 4															
		Byte 1							Byte 0								
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment	SB	Analog value in IB IL format															

Significant measured values

Input measuring range 0 mA to 20 mA/4 mA to 20 mA/0 V to 10 V

IB Input Word hex	0 mA to 20 mA $I_{Input}$ mA	4 mA to 20 mA $I_{Input}$ mA	0 V to 10 V $U_{Input}$ V
8001 over range	> +21.6747	> +21.339733	> +10.837
7F00	+21.6747	+21.339733	+10.837
7530	+20.0	+20.0	+10.0
0001	+0.6667 $\mu$ A	+4.0005333	+333.33 $\mu$ V
0000	$\leq$ 0	+3.2 to +4.0	0
8002 open circuit	-	< +3.2	-

Output measuring range 0 mA to +20 mA/4 mA to 20 mA

OutputData Word	0 mA to +20 mA $I_{\text{Output}}$	4 mA to 20 mA $U_{\text{Output}}$
hex	mA	mA
8001 over range	> +21.6747	> +21.3397
7FFF - 7F01	+21.6747	+21.3397
7F00	+21.6747	+21.3397
7530	+20.0	+20.0
3A98	+10.0	+12.0
0001	+0.6667 $\mu\text{A}$	+4.000533
0000	0	+4.0
FFFF	0	+4.0
C568	0	+4.0
8AD0	0	+4.0
8100	0	+4.0
80FF - 8000 (excluding 8001, 8002, 8080)	Hold	Hold
8080 under range	0	Hold
8002 open circuit	Hold	0

**18.2 Format: "S7-compatible"**

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 "S7-compatible" format

MSB	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	LSB
SB	Analog value in S7 format																

**Significant measured values**

Measuring range 0 mA to 20 mA/4 mA to 20 mA/0 V to 10 V

Input Data Word	0 mA to 20 mA $I_{Input}$	4 mA to 20 mA $I_{Input}$	0 V to 10 V $U_{Input}$
hex	mA	mA	V
7FFF over range	> +23.5157	> +22.8142	> +11.759
7EFF	+23.5157	+22.8142	+11.759
6C00	+20.0	+20.0	+10.00
0001	+0.7234 $\mu$ A	+4.0005787	+361.39 $\mu$ V
0000	$\leq$ 0	+4.0	$\leq$ 0
F940	-	+3.0	-
8000 Line break	-	< +1.11852	-

Output measuring range 0 mA to +20 mA/4 mA to 20 mA

Output Data Word	0 mA to +20 mA $I_{Output}$	4 mA to 20 mA $U_{Output}$
hex	mA	mA
7FFF - 7F01 over range	0	0
7EFF	+23.5150	+23.8100
6C00	+20.0	+20.0
5100	+15.0	+16.0
0001	+0.7234 $\mu$ A	+4.000578
0000	0	+4.0
FFFF	0	+3.99942
E501	0	+0.578 $\mu$ A
E500	0	0
EF00	0	0
9400	0	0
8100	0	0
80FF - 8000 under range	0	0

**Formula for calculating the measured value from the process data input value for the 4 ma to 20 ma measuring range**

$$\text{Measured value} = \text{Process data input value} \times 0.0005787 \text{ mA} + 4 \text{ mA}$$

	Example 1	Example 2
Process data input value	6C00 <sub>hex</sub> = 27648 <sub>dec</sub>	F940 <sub>hex</sub> -> FFFF <sub>hex</sub> - F940 <sub>hex</sub> + 1 = -1728 <sub>dec</sub>
Value x resolution	27648 x 0.0005787 mA = 16 mA	-1728 x 0.0005787 mA = -1 mA
+ 4 mA	16 mA + 4 mA = 20 mA	-1 mA + 4 mA = 3 mA
Measured value	20 mA	3 mA

**18.3 Format: "Standardized Representation"**

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

Measured value representation in "standardized representation" format

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

**Significant measured values**

Measuring range 0 mA to 20 mA/4 mA to 20 mA/0 V to 10 V

Input data word	0 mA to 20 mA	4 mA to 20 mA	0 V to 10 V
hex	I <sub>Input</sub> mA	I <sub>Input</sub> mA	U <sub>Input</sub> V
8001 over range	> +21.6747	> +21.339	> +10.837
4E20	+20.0	-	-
2710	+10.0	+14.0	+10.0
1388	+5.0	+9.0	+5.0
0001	+0.001	+4.001	+0.001
0000	≤ 0	+4.0 to +3.2	≤ 0
8002 open circuit	-	< +3.2	-

Output measuring range 0 mA to +20 mA/4 mA to 20 mA

Output Data word	0 mA to +20 mA	4 mA to 20 mA
hex	I <sub>Output</sub> mA	U <sub>Output</sub> mA
8001 over range	> +21.674	> +21.3397
7FFF - 54AB	+21.674	+21.3397
54AA	+21.674	+21.3397
4E20	+20.0	+21.3397
2710	+10.0	+14.0
1388	+5.0	+9.0
0001	+1.0 μA	+4.001
0000	0	+4.0
FFFF	0	+4.0

Output Data word	0 mA to +20 mA $I_{Output}$	4 mA to 20 mA $U_{Output}$
hex	mA	mA
EC78	0	+4.0
D8F0	0	+4.0
B1E0	0	+4.0
AB56	0	+4.0
AB55 - 8100	0	+4.0
80FF - 8000 (excluding 8001, 8002, 8080)	Hold	Hold
8080 under range	0	Hold
8002 open circuit	Hold	0

#### 18.4 Supported error codes for the “IB IL” and “Standardized Display” formats

After an error message, the following errors/messages for “IB IL” and “standardized representation” format are displayed in words IN2 to IN5 in the status word (error bit):

##### Supported error codes in “IB IL” format

Input data word (hex)	Error
8001	Overrange (input only)
8002	Open circuit/broken wire (4-20 mA input, 4-20 mA output)
8004	Measured value invalid/channel disabled
8040	Device fault
8080	Underrange (input only)

## 19 PCP communication



For information on PCP communication, please refer to the IBS SYS PCP G4 UM E (Order No. 2745169) and IBS PCP COMPACT UM E (Order No. 9015349) user manuals.

By default, the IB IL EX-IS AIO 4/EF-PAC is configured to the default settings. The module can be configured via process data or PCP to adapt to a particular application. In PCP mode, the device is configured with the “Config Table” object.



The IBS CMD (for standard controller boards) and PC WorX (for Field Controllers (FC) and Remote Field Controllers (RFC)) programs are available for the configuration and parameterization of your INTERBUS system. For additional information, please refer to the “IBS CMD SWT G4 UM E” (Order No. 2722250) user manual and the documentation for your applied PC WorX version.

PCP can be used to

- identify the device.
- configure the device.
- read/write analog values to channels.
- get diagnostic information.

### 19.1 Object dictionary

Index	Data Type	Length	Meaning	Object Name	Rights
01	Visible string	58 max. bytes	Phoenix Contact GmbH & Co. Kg	VendorName	R
02	Visible string	6 bytes	Vendor ID 000A45	VendorID	R
04	Visible string	58 max. bytes	Device family	DeviceFamily	R
06	Visible string	58 max. bytes	Product family "INLINE"	ProductFamily	R
07	Visible string	58 max. bytes	IB IL EX-IS AIO 4/EF-PAC	ProductName	R
09	Visible string	58 max. bytes	Intrinsically safe Analog IO module	ProductText	R
0A	Visible string	58 max. bytes	2869912	OrderNumber	R
0B	Visible string	58 max. bytes	YYYY-MM-DD Hardware Version	HardwareVersion	R
0C	Visible string	58 max. bytes	YYYY-MM-DD Firmware Version	FirmwareVersion	R
0D	Record	2 fields	YYYY-MM-DD PCP Compact Version	PCPVersion	R
0E	Visible string	3 bytes	633	CommProfile	R
11	Record	2 fields	YYYY-MM-DD Basic Profile Version	ProfileVersion	R
12	Visible string	58 max. bytes	URL http:// www.phoenixcontact.com	VendorURL[ ]	R
17	Record	2 fields	Language English	Language	R
25	Octet string	5 units	IN Process Data	PDIN	R
26	Octet String	5 units	OUT Process Data	PDOOUT	R
32	Record	2 fields	ID_code and PD length	IBS_ID	R
3A	Array	4 fields	VersionCount	VersionCount	R
80	Visible string	58 max. bytes	Hardware Version	Config table	R/W
81	16-bit array, unsigned		Input data	Analog IN values	R
85	16-bit array, unsigned		Output data	Analog OUT values	R/W



**19.2 Configuration via PCP**

**Config Table object**

The Configuration Table object can be used for configuring the module using PCP compact. Following are the Index and Subindex fields along with their respective descriptions.

Object	Config table	
Access	Read, write	
Data type	16-bit array, unsigned	
Index (hex)	0080	
Subindex (hex)	00	Configure device all channels
	01	Configure channel 1
	02	Configure channel 2
	03	Configure channel 3
	04	Configure channel 4
	05	AO format AI format
	06	Output failsafe value for channel 1
	07	Output failsafe value for channel 2
	08	Output failsafe value for channel 3
	09	Output failsafe value for channel 4
Length	08	Subindex 00
	02	Subindex 01 to 09
Data	Configuration data	

**Configuration data**

For subindex 00 to 04, configuration data is per channel, the same as that explained in configuration via process data (see “Output words OUT2 to OUT5 (configuration)” on page 15).

Bit	Byte 1								Byte 0							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment	CO		AO reset behavior		AO output range			CI	AI filter	Wire	AI measuring range					

For subindex 05, configuration data is

Bit	Byte 1								Byte 0							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Assignment	Command code 0x40								0	0	RR	PF	AO format	AI format		

For subindex 06 to 09, data is a 16-bit value contained in 2 bytes. This value is valid only if the **AO Reset Behavior** (bits 13 and 12) are set to **Failsafe** in the process dat comand 0x40. This failsafe value is loaded to the outputs in case of Interbus failure.

### 19.3 Analog IN values object

This object can be used for reading 16-bit analog values from the configured input channels.

Object	Analog IN values	
Access	Read	
Data type	16-bit array, unsigned	
Index (hex)	0081	
Subindex (hex)	00	Read all channels
	01	Read analog value channel 1
	02	Read analog value channel 2
	03	Read analog value channel 3
	04	Read analog value channel 4
Length (bytes, hex)	08	Subindex 00
	02	Subindex 01 to 04
Data	Channel analog values	

#### Channel analog values

MSB															LSB
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SB	Analog value in selected format														



Channel analog value of 2 bytes per channel. SB is error bit. For details, refer to “Formats for the representation of measured values (IN2 to IN5)” on page 19.

### 19.4 Analog Out values object

This object can be used for writing analog values on configured output channels.

Object	Analog OUTvalues	
Access	Read, write	
Data type	16-bit array, unsigned	
Index (hex)	0085	
Subindex (hex)	00	Write to all channels
	01	Write analog value channel 1
	02	Write analog value channel 2
	03	Write analog value channel 3
	04	Write analog value channel 4
Length (bytes, hex)	08	Subindex 00
	02	Subindex 01 to 04
Data	Channel analog values	

**Channel analog values**

MSB															LSB
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SB	Analog value in selected format														



Channel analog value of 2 bytes per channel. SB causes the output to be clipped. For details, refer to “Formats for the representation of measured values (IN2 to IN5)” on page 19.

**19.5 DiagState object**

This object can be used to obtain the diagnostics from the IB IL EX-IS AIO 4/EF-PAC module in the standard format. Useful information, like the number of errors occurred, brief description text, channel number, etc., for the error and error code can be obtained using this object.

Object	DiagState	
Access	Read	
Data type	Record	
Index (hex)	0018	
Subindex (hex)	00	Read all channels
	01	Total count of number of errors occurred Resets to 0 when full
	02	Priority U8 0x00 - no error occurred 0x02 - any error
	03	Channel U8 channel number for last occurred error
	04	Error code U16 error code from basic profile Always shows last error code
	05	More follows U8 always 0x00
	06	Text 10 bytes text equivalent of supported error codes
Length (bytes, hex)	11	Subindex 00 length
	02	Subindex 01 length
	01	Subindex 02 length
	01	Subindex 03 length
	02	Subindex 04 length
	01	Subindex 05 length
	0A	Subindex 06 length
Data	As specified above	

**Supported error codes**

Error code (hex)	Error
0x0000	OK
0x6330	Invalid data
0x8910	Overrange (input only)
0x8920	Underrange (input only)
0x7790	Open circuit/broken wire (4-20 mA input, 4-20 mA output)
0x5010	Hardware failure - note - code checksum