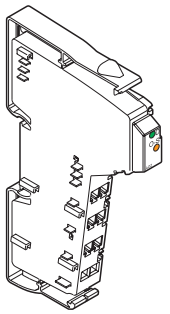
IB IL AO 2/U/BP
IB IL AO 2/U/BP-PAC

Inline Terminal
With Two Analog Voltage Outputs



Data Sheet 566001 02/2004 56600001

The IB IL AO 2/U/BP and IB IL AO 2/U/BP-PAC only differ in the scope of supply (see "Ordering Data" on page 33). Their function and technical data are identical.

For greater clarity, the order designation IB IL AO 2/U/BP is used throughout this document.

This data sheet is only valid in association with the user manual for your bus system, see "Ordering Data" on page 33.

Function

The terminal is designed for use within an Inline station. It is used to output analog voltage signals.

Features

- Two analog signal outputs
- Actuator connection (using 2-wire technology and shield connection)
- Voltage ranges:
  -10 V to +10 V (13-bit resolution) and
  0 V to +10 V (12-bit resolution)
- Output value data available in two formats (IB IL and IB ST)
- Parameterizable behavior of the outputs in the event of an error
- Process data update including conversion time of the digital/analog converter < 1 ms
- Very good output driver properties, therefore also suitable for long actuator cables
- Diagnostic indicators

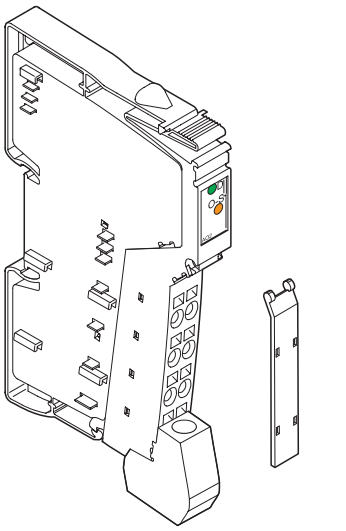


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Figure 1 IB IL AO 2/U/BP-PAC terminal

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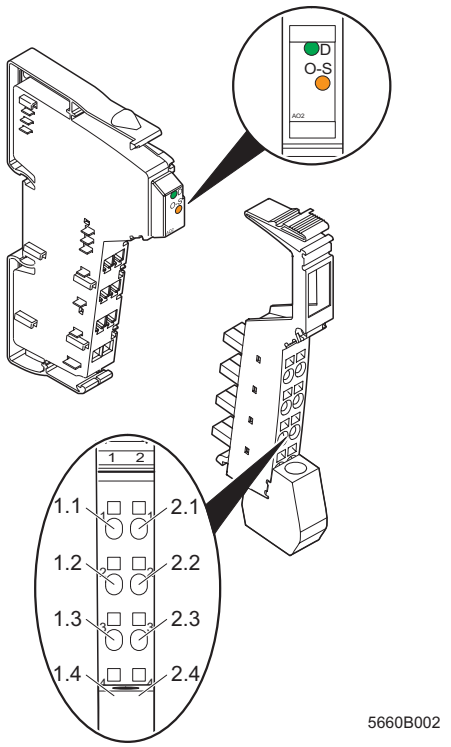

Figure 2 IB IL AO 2/U/BP with appropriate connector

Local LED Diagnostic and Status Indicators

Des.	Color	Meaning
D	Green	Diagnostics
O-S	Orange	Original default state parameterized

Terminal Point Assignment

Terminal Point	Signal	Assignment
1.1	**U1**	Voltage output 1
2.1	**U2**	Voltage output 2
1.2, 2.2	**–**	Not used
1.3, 2.3	**AGND**	Voltage output ground
1.4, 2.4	**Shield**	Shield connection

Parameterized Default Upon Delivery

By default upon delivery, the parameters are set as follows:

Data format:	IB IL
Behavior of the outputs in the event of an error:	Outputs hold the last value (Hold)
Output range:	-10 V to +10 V

The following terminal parameters can be configured according to your conditions using the process data:

Data format:	IB ST
Behavior of the outputs in the event of an error:	Outputs are reset to 0 V (Reset)
Output range:	0 V to +10 V

When parameterizing you must switch to parameterization mode. The connection procedure is described in "Parameterization" on page 24.

Installation Instructions

High current flowing through the potential jumpers U_M and U_S causes the temperature of the potential jumpers and the internal temperature of the terminal to rise. Note the following instruction to keep the current flowing through the potential jumpers of the analog terminals as low as possible:

Create a separate main circuit for each analog terminal

If this is not possible in your application and if you are using analog terminals in a main circuit together with other terminals, place the analog terminals behind all the other terminals at the end of the main circuit.

Note the derating curve shown on page 28

Internal Circuit Diagram

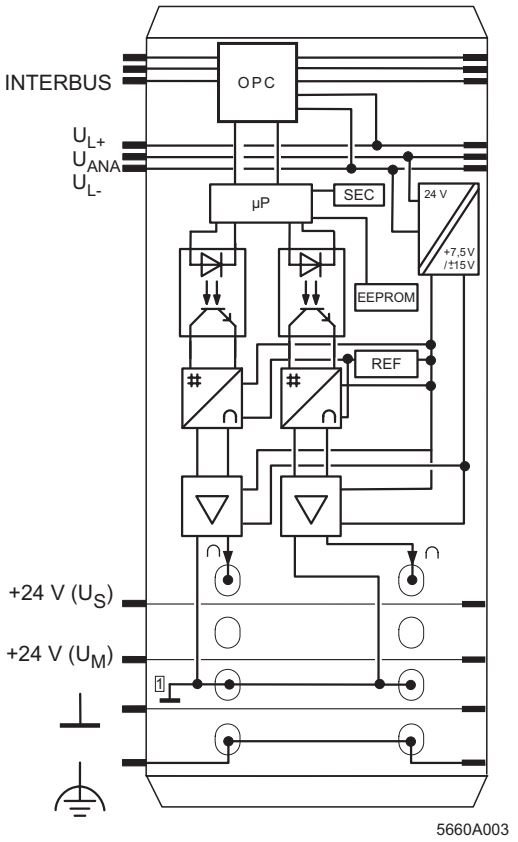

Figure 3 Internal wiring of the terminal points

Key:

OPC	INTERBUS protocol chip
	Optocoupler
µP	Microprocessor
SEC	Safety circuit
EEPROM	Electrically erasable, reprogrammable ROM
	DC/DC converter with electrical isolation
REF	Reference voltage
	Amplifier
	Digital-to-analog converter
	Analog output
1	Analog ground, electrically isolated from ground of potential jumper
	Other symbols are explained in the user manual for your bus system.

Electrical Isolation

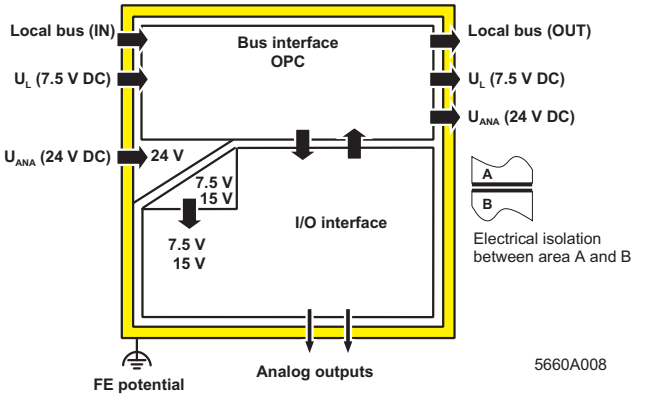

Figure 4 Electrical isolation of the single function areas

Connection Notes

Analog actuators with a cable length of **< 10 m** (32.808 ft.) can be connected with unshielded twisted-pair cables.

Connect analog actuators with a cable length of **> 10 m** (32.808 ft.) with shielded twisted-pair cables.

Connect one end of the shielding to PE functional earth ground. Fold the outer cable sheath back and connect the shield to the terminal via the shield connector clamp (with strain relief). The clamp connects the shield directly to FE (functional earth ground) on the terminal side.

Ensure that the braided shield is 15 mm (0.291 in.) longer than the strain relief, when connecting a shielded actuator cable to the I/O connector. Connect the actuator cable as described in "Connecting Shielded Cables Using the Shield Connector" on page 8.

Connection Example

Use a connector with shield connection when installing the actuators. Figure 5 shows the connection schematically (without shield connector).

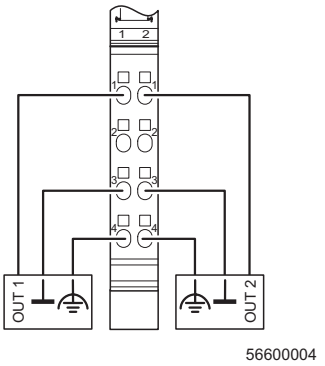

Figure 5 Connection of two voltage actuators with shield connection, using 2-wire technology

Connecting Shielded Cables Using the Shield Connector

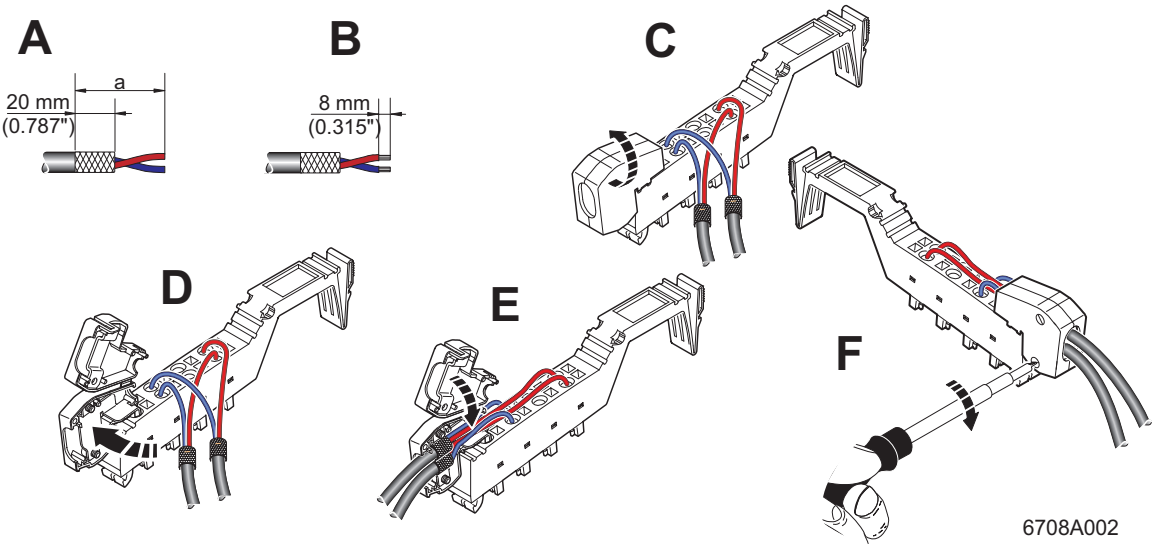

Figure 6 Connecting the shield via the shield connector

The diameter of the actuator cable is usually too large to allow the cable to be installed into the strain relief of the shield connector with sheathed and folded shield. The connection procedure for this cable therefore differs from the connection procedure described in the user manual. The comparative differences with the user manual are marked in bold text.

Connection of the cables according to Figure 6 should be carried out as follows:

Stripping cables

- Strip the outer cable sheaths to the desired length (a). (A)
  The desired length (a) depends on the connection position of the wires and whether the wires should have a large or small amount of space between the connection point and the shield connection.
- Shorten the braided shield to **20 mm** (0.787 in.). (A)
- Do not fold the braided shield back over the outer sheath. (B)
- Remove the protective foil.
- Strip 8 mm (0.31 in.) off the wires. (B)

Inline wiring is normally without ferrules. However, it is possible to use ferrules. If using ferrules, make sure they are properly crimped.

Wiring the connectors
(According to the user manual)

- Push a screwdriver into the slot of the appropriate terminal point, so that you can insert the wire into the featherkey opening. Phoenix Contact recommends the SZF 1 -0,6X3,5 screwdriver (Order No. 12 04 51 7).
- Insert the wire. Remove the screwdriver from the opening. The wire is now clamped.

The connector pin assignment can be found in the table on page 3.

Connecting the shield

- Open the shield connector (see user manual). (C)
- Place the shield clamp in the shield connector corresponding to the cable width (see user manual).
- Place the cables in the shield connection. (D)
  Push the outer cable sheaths up to the shield clamp. The wires with the braided shield must be underneath the shield clamp. The braided shield must project approximately 15 mm (0.591 in.) over the shield clamp.
- Close the shield connector. (E)
- Fasten the screws for the shield connector using a screwdriver. (F)

Programming Data

INTERBUS

ID code	$5B_{hex}$ (91_{dec})
Length code	02_{hex}
Process data channel	32 bits
Input address area	4 bytes
Output address area	4 bytes
Parameter channel (PCP)	0 bytes
Register length (bus)	4 bytes

Other Bus Systems

For programming data for other bus systems, please refer to the corresponding electronic device data sheet (GSD, EDS).

Process Data Words

Assignment of the Terminal Points to the OUT Process Data Words

(Word.bit) view	Byte	Word 0														
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Assignment	IB IL format	SB	Channel 1 output value														
Assignment	IB ST format	SB	Channel 1 output value												0	0	0
Terminal points	Signal	Terminal point 1.1: Voltage output 1															
	Signal reference	Terminal point 1.3															
	Shielding (FE)	Terminal point 1.4															

(Word.bit) view	Byte	Word 1														
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Assignment	IB IL format	SB	Channel 2 output value														
Assignment	IB ST format	SB	Channel 2 output value												0	0	0
Terminal points	Signal	Terminal point 2.1: Voltage output 2															
	Signal reference	Terminal point 2.3															
	Shielding (FE)	Terminal point 2.4															

SB Sign bit

0 In "IB ST" format bits 2 through 0 are irrelevant. Set these bits to "0".

Assignment of IN Process Data Words

(Word.bit) view	Byte	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Assignment		SB	Mirrored channel 1 output value												F	B	H

(Word.bit) view	Byte	Word 1															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Assignment		SB	Mirrored channel 2 output value												F	B	H

SB Sign bit

F Output data format

B Voltage Area

H Hold/Reset

OUT Process Data Words

The OUT process data words specify the output values in each cycle.

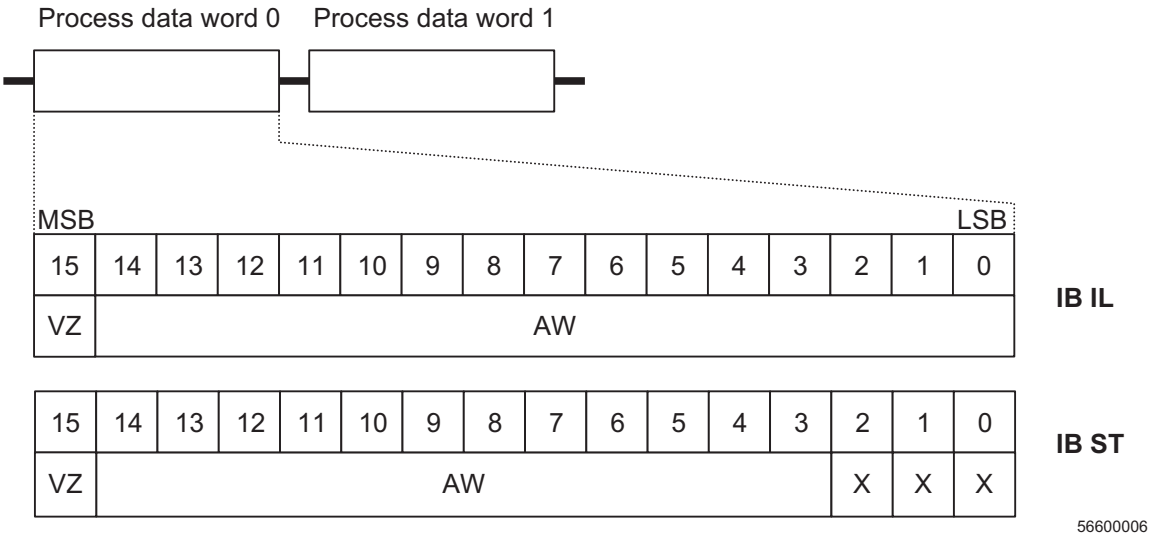

Figure 7 OUT Process data words in IB IL and IB ST formats

SB Sign bit
AV Output value
X Irrelevant bit
MSB Most significant bit
LSB Least significant bit

Set the irrelevant bits to 0.

IN Process Data Words

Bits 15 through 3 of the OUT process data words are mirrored in the IN process data words. Bit 15 is the sign bit. Bits 2 through 0 are available as status bits. They contain information about the parameterized behavior of the terminal.

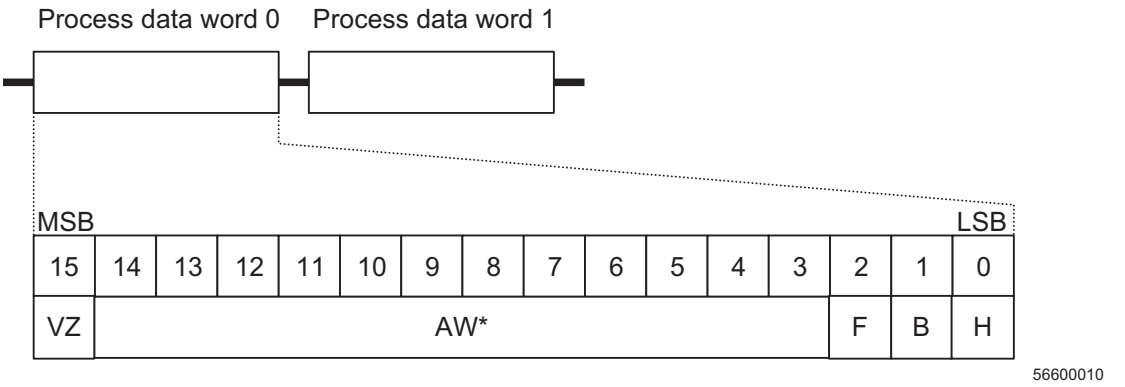

Figure 8 IN process data words

SB	Sign bit
OV*	Mirrored output value
F	Output data format
B	Voltage Area
H	Hold/Reset
MSB	Most significant bit
LSB	Least significant bit

Bits 2 through 0 have the following meaning:

Bit	Designation	Meaning	Bit x = 0	Bit x = 1
2	F	Output data format	IL	ST
1	B	Voltage Area	-10 V to +10 V	0 V to +10 V
0	H	Hold/Reset	Hold	0

Output Value Representation Formats

The IB IL AO 2/U/BP terminal has format compatibility with the IB IL AI 2/SF input terminal. This means that it is possible to use these terminals in multiplexer systems (e.g., IB IL MUX).

"IB IL" is the default format on the terminal. To ensure that the terminals can be operated in previously used ST data formats, the output value representation can be switched to "IB ST" format.

"IB IL" Format

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

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

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Figure 9 Output value representation in "IB IL" format (15 bits + sign bit)

SB	Sign bit
AV	Output value

Significant Output Values in "IB IL" Format

The IB IL 24 AO 2 /U/BP terminal has two analog output channels that can supply voltages from -10 V to +10 V with 13-bit resolution.

Output range -10 V to +10 V

Output Data Word (Two's Complement)		-10 V Through +10 V U_{output}	Remark
hex	dec	V	
<7FFF	32767	+10.837	
>7F00	32512	+10.837	
7F00	32512	+10.837	
7530	30000	+10.0	
0008	8	+2.667 mV	Smallest DAC quantization step
0001	1	+333.33 µV	Process data resolution
0000	0	0	
FFF8	-8	-2.667 mV	
8AD0	-30000	-10.0	
8100	-32512	-10.837	
<8100	*Processed separately:*		
8001	-32767	+10.837	(Overrange)
8080	-32640	-10.837	(Underrange)
80xx	(Other)	Hold last value	

For the 0 V to 10 V output range only the upper range is used (see Figure 7). The resolution for this range is thus limited to 12 bits.

Bits 2 through 0 are not always considered as "irrelevant bits". For use as a field multiplexer, error messages as well as overrange or underrange information must be evaluated appropriately. Overrange (8001_{hex}) outputs 10.837 V, underrange (8080_{hex}) 0 V. With an error code (1000 0000 0xxx $xxx0_{bin}$) the last valid value from the digital-to-analog converter is output.

Output range 0 V to 10 V

Output Data Word (Two's Complement)		0 V Through 10 V U_{output}	Remark
hex	dec	V	
≤ 7FFF	32512	+10.837	
> 7500	32512	+10.837	
7F00	32512	+10.837	
7530	30000	+10.0	
0008	8	+2.667 mV	Smallest DAC quantization step
0001	1	+333.33 µV	Process data resolution
< 0000	0	0	
< 8100	*Processed separately:*		
8001	-32767	+10.837	(Overrange)
8080	-32640	0	(Underrange)
80xx	(Other)	Hold last value	

The $80xx_{hex}$ range is reserved exclusively for error and message codes.

"IB ST" Format

The output value is represented in bits 14 through 3. Bit 15 is available as sign bit. Bits 2 through 0 are irrelevant.

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

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
VZ	AW												X	X	X

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Figure 10 Output value representation in "IB ST" format (12 bits + sign bit)

SB Sign bit

AV Output value

X Irrelevant bit (Set this bit to 0.)

Bits 2 through 0 are not always considered as "irrelevant bits". The values $7FF9_{hex}$ and 8001_{hex} are recognized as overranges or underranges and interpreted as $7FF8_{hex}$ or 8008_{hex} and further processed as normal process data. In this way MUX-compatibility is ensured. The only exceptions are error codes (with ST only an open circuit). With this error code (xxxx xxxx xxxx $xx1x_{bin}$) the last value is maintained.

Significant Output Values in "IB ST" Format

Output range 0 V to 10 V

Output Data Word (Two's Complement)	0 V Through 10 V U_{output}
hex	V
>7FF8	9.9975
7FF8	9.9975
4000	5.0
0008	0.002441
< 0000	0

Output range -10 V to +10 V

Output Data Word (Two's Complement)	-10 V Through +10 V U_{output}
hex	V
>7FF8	9.9975
7FF8	9.9975
0008	0.002441
0000	0
FFF8	-0.002441
8008	-9.9975
< 8008	-9.9975

Output Behavior

Output Behavior During Error-Free Operation (Normal Operation)

On power up during normal operation, the output range and the data format are read using the terminal EEPROM (non-volatile).

Volatile parameterization is also possible for these settings as well as for the behavior of the terminal in the event of an error. This parameterization can be carried out for runtime by a process data sequence.

Output Behavior in the Event of an Error

In the event of an error the outputs behave as set in the EEPROM (non-volatile) or as subsequently parameterized (volatile). This means that the outputs hold the last value (HOLD, default setting) or are reset to 0 (RESET, can be parameterized).

Output Behavior of the Voltage Output

Take output behavior (in the event of an error) into account when configuring your system!

Switching Operation/ State of the Supply Voltage	Marginal Condition	INTERBUS OUT Process Data Word (hexadecimal)	Behavior/Status of the Analog Outputs
U_{ANA} from 0 V to 24 V	U_L = 0 V	xxxx	0 V
U_{ANA} from 24 V to 0 V	U_L = 7.5 V	xxxx	0 V
Bus in Stop	U_{ANA} = 0 V	xxxx	0 V
Bus in Stop	U_{ANA} = 24 V	xxxx	Hold last value
Bus reset (e.g., remote bus cable break)		xxxx	Hold last value (default setting) or 0 V (parameterizable)

U_{ANA} Analog supply voltage of the terminal

U_L Supply voltage of the module electronics (communications power)

xxxx Any value in the range from 0000_{hex} to $FFFF_{hex}$

Response to a Hardware Signal of a Control System or a Computer for Different Control or Computer Systems

Signal	Control or Computer System	Status After the Switching Operation	
		INTERBUS OUT Process Data Word (hexadecimal)	Analog Output U_{out}
NORM*	AEG Schneider Automation	0000	0 V
BASP	Siemens S5	0000	0 V
CLAB	Bosch	0000	0 V
SYSFAIL	VME	0000	0 V
SYSFAIL	PC	0000	0 V
CLEAR OUT	Moeller IPC	0000	0 V

* On controller boards for AEG Schneider Automation control systems it is possible to set the NORM signal so that the OUT process data word and the analog output maintain the last value.

Response of the Voltage Output to a Control Command From the INTERBUS Controller Board

Command	Status After the Switching Operation	
	OUT Process Data Word (hexadecimal)	Analog Output U_{out}
STOP	xxxx	Hold last value
ALARM-STOP (reset)	xxxx	Maintain last value (default setting) or 0 V (parameterizable)

Input Behavior

When analyzing input behavior, a distinction is made between normal operation and parameterization mode. Input behavior in parameterization mode is described in "Parameterization" on page 24.

During **error-free normal operation,** the output data is mirrored in the input words as "acknowledgment" in bits 15 through 3 as soon it is transmitted to the DAC.

Bits 2 through 0 are available as status bits and are used to display and read the set behavior of the terminal.

As the IB IL AO 2/U/BP terminal evaluates bits 15 through 3 as data bits both in IB IL and IB ST format, only these 13 bits are mirrored in the input data word (see notes on error codes, overranges and underranges).

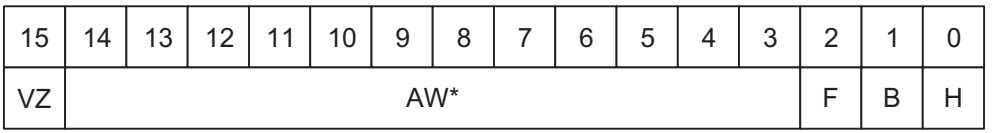


Figure 11 Input data in "IB IL" and "IB ST" formats

SB	Sign bit		
OV*	Mirrored output value		
F	Data format	0: IB IL	1: IB ST
B	Output Range	0: -10 V to +10 V	1: 0 V to 10 V
H	Hold/Reset	0: Hold	1: Reset

If an **error** is detected by the terminal, it is indicated by an error code in the first IN process data word. Possible error codes can be found in the following table.

Error Codes:

Input Data Word (Two's Complement) hex	Cause	Remedy
8010	This code can only appear in parameterization mode and can have two causes:	
	1 Carry out configuration	Continue configuration
	In step 2 of parameterization, this code appears after sending the code 8055_{hex} in the first input word. **No errors indicated at this point!**	
	2 Configuration invalid	Check parameterization
8020	DAC voltage falls below the permissible value I/O error is triggered.	Check the bus terminal voltage supply; Check that the potential jumpers are connecting safely; Replace the terminal
8040	Terminal faulty	Replace the terminal

The error codes overwrite the status bits (bits 2 through 0) with "0". This means that in IB ST data format, it is also possible to clearly distinguish valid process data.

Parameterization

By default upon delivery, the terminal parameters are set as follows:

Data format:	IB IL
Behavior of the outputs in the event of an error:	Outputs hold the last value (Hold)
Output range:	-10 V to +10 V

You can configure the following terminal parameters according to your conditions, using the process data:

Data format:	IB ST
Behavior of the outputs in the event of an error:	Outputs are reset to 0 (Reset)
Output range:	0 V to +10 V

In order to parameterize the terminal you must change to parameterization mode. In the first process data output word, transmit codes 8033_{hex} and 8055_{hex} one after the other.

In order not to change accidentally to parameterization mode, you should set bits 2 through 0 to 0 in normal operation when transmitting process data.

The parameterization is valid for both channels.

Parameterizing the Terminal:

Step 1:	**Transmission of code 8033_{hex} in the first OUT process data word.** In bits 15 through 3 of the first IN process data word this code is acknowledged as a normal process data item.  For every subsequent code which is not equal to 8055_{hex} in the first process data word, normal operation continues and the code is interpreted as a process data item.
Step 2:	**Transmission of code 8055_{hex} in the first OUT process data word.** Acknowledgment takes place via code 8010_{hex} in the first input word. In this case, this code does not indicate an error, but shows that a configuration word is eventually expected (in step 3).  For every subsequent code that is not equal to $80xx_{hex}$ in the first process data word, parameterization mode is quit.

Step 3:	**Transmission of the parameterization code: 1000 0000 1000 $p_3p_2p_1 1_{bin}$.** Where p_x are the terminal parameters: p_3: data format (0: IB IL; 1: IB ST) p_2: output range (0: -10 V bis +10 V; 1: 0 V bis 10 V) p_1: reset behavior (0: Hold; 1: Reset) Acceptance of the value is confirmed in bits 15 through 0 of the first input word through mirroring of the code. If an invalid configuration is displayed, code 8010_{hex} appears in the first input data word, which indicates the error "Invalid Configuration". This step can be repeated as often as you like. If a code that is not equal to $80xx_{hex}$ is transmitted in the first process data word, parameterization mode is quit without the parameterization taking effect.
Step 4:	In this step you specify, whether the parameterization stored in the EEPROM is volatile (dynamic) or non-volatile (static).
	Volatile parameterization: After a power up this setting is no longer available. Subsequent operation uses the settings stored in theEEPROM. Transmission of the 8077_{hex} code.
	Non-volatile parameterization: The parameterization is stored in the EEPROM. After a power up this parameterization from the EEPROM is used. Transmission of the 8099_{hex} code.
	After writing 8077_{hex} or 8099_{hex} the parameterization takes effect and parameterization mode is quit. This is displayed in the first input word through the mirroring of code 8077_{hex} or 8099_{hex}. These values have a dedicated acknowledgment function. Only the next process data item is processed as normal.

If parameterization was aborted, it is possible to switch to parameterization mode using a restart with step 1. The orange O-S LED on the terminal indicates whether the original configuration is present or if the current configuration differs from the default configuration of the terminal upon delivery. The LED is on if the default state is parameterized.

Technical Data

General Data	
Order designation/order number	IB IL AO 2/U/BP 27 32 73 2 IB IL AO 2/U/BP-PAC 28 61 46 7
Housing dimensions (width x height x depth)	12.2 mm x 120 mm x 71.5 mm (0.480 in. x 4.724 in. x 2.815 in.)
Weight	48 g (without connectors)
Operating mode	Process data mode with 2 words
Type of actuator connection	2-wire technology
Permissible temperature (operation)	-25 °C to +55 °C (+32°F to +131°F)
Permissible temperature (storage/transport)	-25 °C to +85 °C (+32°F to +131°F)
Permissible humidity (operation)	75% on average, 85% occasionally

In the range from -25°C to +55°C (-13°F to +131°F) appropriate measures against increased humidity (> 85%) must be taken.

Permissible humidity (storage/transport)	75% on average, 85% occasionally

For a short period, slight condensation may appear on the outside of the housing if, for example, the terminal is brought into a closed room from a vehicle.

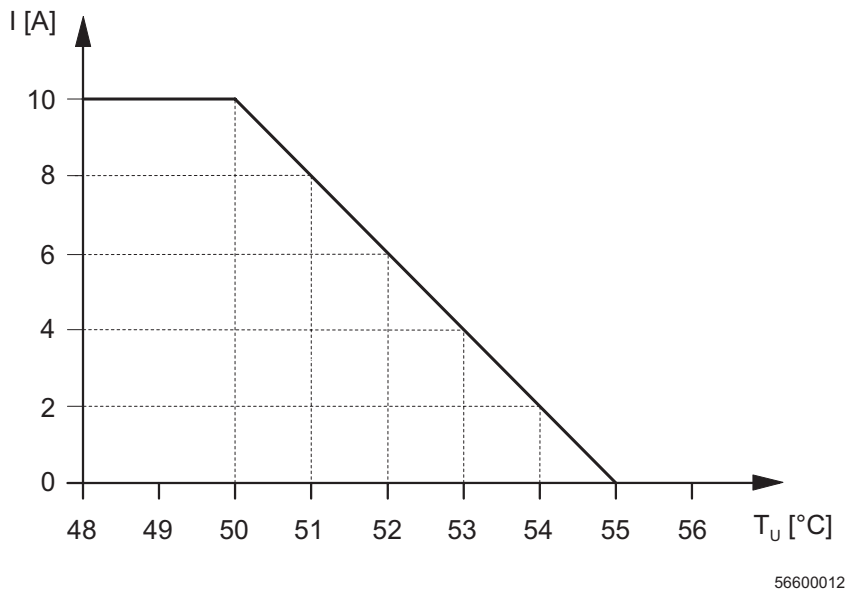
Permissible air pressure (operation)	80 kPa to 106 kPa (up to 2,000 m [9,843 ft.] above sea level)
Permissible air pressure (storage/transport)	70 kPa to 106 kPa (up to 3,000 m [9,843 ft.] above sea level)
Degree of protection	IP20 according to IEC 60529
Class of protection	Class 3 according to VDE 0106, IEC 60536

Interface	
INTERBUS interface	Data routing

Power Consumption	
Communications power U_L	7.5 V
Current consumption from U_L	33 mA, approximately (typical); 40 mA, maximum
I/O supply voltage U_{ANA}	24 V DC
Current consumption at U_{ANA}	
No-load operation (R_L > 10 MΩ)	18 mA, typical; 28 mA, maximum
Full load operation (R_L = 2 kΩ)	25 mA, typical; 35 mA, maximum
Total power consumption	
No-load operation (R_L > 10 MΩ)	0.68 W, typical
Full load operation (R_L = 2 kΩ)	0.85 W, typical

Supply of the Module Electronics and I/O Through the Bus Terminal/Power Terminal	
Connection method	Potential routing

Permissible Ambient Temperature Depending on the Current of the Potential Jumpers U_M and U_S (Total Current)



Upwards of T_U = +50°C (122°F) the derating is 2 A/K.

T_U	Ambient temperature in °C
I	Current flowing through potential jumpers U_M and U_S (A)

Analog Outputs		
Number		2
Signal connection method		2-wire technology, single-ended
Signals/resolution in the process data word (quantization)		
Voltage	-10 V to +10 V	333.33 µV/LSB
Voltage	0 V to +10 V	333.33 µV/LSB
Representation of output value		
	-10 V to +10 V	16-bit two's complement
	0 V to +10 V	16-bit two's complement
Smallest DAC quantization step		
-10 V to +10 V		2.667 to 13 mV
0 V to +10 V		2.667 to 12 mV
Basic error limit		±0.02%, typical, of the output range final value
Output load		2 kΩ, minimum
Process data update time including the conversion time of the digital/analog converter		1 INTERBUS cycle (dependent on the bus configuration); < 1 ms
Signal rise time (slew rate)		
10% to 90% of the final value		15 µs, typical
0% to > 99% of the final value		31 µs, typical
Signal rise time (slew rate) (-9.0 V to +9.0 V)		
No-load operation		0.35 V/µs, typical
With ohmic load (R_L = 2 kΩ)		0.24 V/µs, typical
With ohmic/capacitative load R_L = 2 kΩ / C_L = 10 nF		0.24 V/µs, typical
With ohmic/capacitative load R_L = 2 kΩ / C_L = 220 nF		0.09 V/µs, typical

For the representation of the output value in the different formats please refer to the notes in "Output Value Representation Formats" on page 15.

Analog Outputs (Continued)	
Transient protection of analog outputs	Yes
Maximum cable length for the LiYCY (TP) cable type, (shielded twisted power station cable)	500 m
Electrical features of LiYCY (TP)	N x 2 x 0.5 (N= number of wire pairs, conductor cross-section ≥ 0.5 mm^2
Inductivity	0.67 mH/km, typically
Effective capacitance	120 mH/km, typically

Tolerance and Temperature Response (Absolute Tolerance Values) (The tolerance values refer to the output range final value of 10 V.)		
	Typical	**Maximum**
Tolerance at 23°C (73.4°F)		
Total offset voltage	±0.5 mV	±4.0 mV
Gain error	±2.5 mV	±6.0 mV
Differential non-linearity	±1.3 mV	±3.9 mV
Total tolerance at 23°C (73.4°F)	**±4.3 mV**	**±13.9 mV**
Temperature response at -25°C to +55°C (-13°F to 131°F)		
Offset voltage drift T_{KVO}	±2.1 mV	±5.0 mV
Gain drift T_{KG}	±9.2 mV	±20.0 mV
Total voltage drift $T_{Ktot} = T_{KVO} + T_{KG}$	±11.3 mV	±25.0 mV
Total tolerance of the voltage output (-25°C to 55°C [-13°F to 131°F]) Offset error + gain error + linearity error + drift error	**±15.6 mV**	**±38.9 mV**

Tolerance and Temperature Response (Relative Tolerance Values) (The tolerance values refer to the output range final value of 10 V.)		
	Typical	**Maximum**
Tolerance at 23°C (73.4°F)		
Total offset voltage	±0.005 %	±0.027 %
Gain error	±0.025 %	±0.060 %
Differential non-linearity	±0.013 %	±0.027 %
Total tolerance at 23°C (73.4°F)	**±0.09 %**	**±0.14 %**
Temperature response at -25°C to +55°C (-13°F to 131°F)		
Offset voltage drift T_{KVO}	4 ppm/K	10 ppm/K
Gain drift T_{KG}	18 ppm/K	40 ppm/K
Total voltage drift $T_{Ktot} = T_{KVO} + T_{KG}$	23 ppm/K	50 ppm/K
Total tolerance of the voltage output (-25°C to 55°C [-13°F to 131°F]) Offset error + gain error + linearity error + drift error	**±0.16 %**	**±0.39 %**

Additional Tolerances Influenced by Electromagnetic Fields		
Type of Electromagnetic Interference	**Typical Deviation of the Output Range Final Value (Voltage Output)**	
	Relative	**Absolute**
Electromagnetic fields; Field strength 10 V/m according to EN 61000-4-3 / IEC 61000-4-3	< ±0.2 %	< ±20 mV
Conducted interference Class 3 (test voltage 10 V) according to EN 61000-4-6 / IEC 61000-4-6	< ±2.8 %	< ±280 mV

The values are valid for shielded and unshielded twisted actuator cables.

Safety Equipment	
Transient protection of analog outputs	Yes

Electrical Isolation/Isolation of the Voltage Areas	
 The electrical isolation of the logic level from the I/O area is ensured through the DC/DC converter.	
Common Potentials	
24 V I/O voltage, 24 V segment voltage, and GND have the same potential. FE is a separate potential range.	
Separate Potentials in the System Consisting of Bus Terminal/Power Terminal and I/O Terminal	
- Test Distance	**- Test Voltage**
7.5 V supply (bus logic)/24 V supply U_{ANA}/I/O	500 V AC, 50 Hz, 1 min
7.5 V supply (bus logic)/24 V supply U_{ANA}/functional earth ground	500 V AC, 50 Hz, 1 min
24 V supply (I/O)/functional earth ground	500 V AC, 50 Hz, 1 min

Error Messages to the Higher-Level Control or Computer System	
Failure of or falling below communications power U_L	Yes, I/O error message to the bus terminal

Ordering Data

Description	Order Designation	Order No.
Terminal with two analog voltage outputs, including connectors and labeling field	IB IL AO 2/U/BP-PAC	28 61 46 7
Terminal with two analog voltage outputs	IB IL AO 2/U/BP	27 32 73 2
The shield connector listed below is needed for the complete fitting of the IB IL AO 2/U/BP connector.		
Connector with six spring-cage connections and shield connection (green, w/o color print) pack of 5	IB IL SCN-6 SHIELD-TWIN	27 40 24 5
Configuring and Installing the INTERBUS Inline Product Range	IB IL SYS PRO UM E	27 43 04 8

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