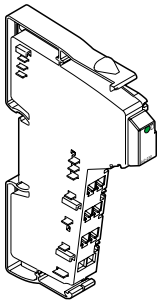
IB IL 24 AI 2/SF-230

INTERBUS Inline Terminal
With Two Analog Input Channels



Data Sheet 6232A 01/2001 6232A001

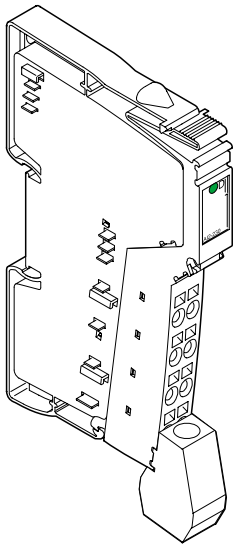
This data sheet is only valid in association with the IB IL SYS PRO UM E "Configuring and Installing the INTERBUS Inline Product Range" User Manual.

Function

The terminal is designed for use within an INTERBUS Inline station. It is used to measure analog voltage or current signals.

Features

- Two analog single-ended signal inputs for the connection of either voltage or current signals
- Connection of sensors in 2- and 3-wire technology
- Three current measuring ranges: 0 mA through 20 mA, ±20 mA, 4 mA through 20 mA
- Two voltage measuring ranges: 0 V through 10 V, ±10 V
- Configuration of the independent channels through INTERBUS
- Measured values can be represented in four different formats
- Resolution independent of the representation format and the measuring range
- Process data update of both channels in 1.5 ms, maximum
- Diagnostic indicator
- 230 Hz input filter



6232A002

Figure 1 IB IL 24 AI 2/SF-230 terminal with connector

Please note that the connector is not supplied as standard with the terminal. Please refer to the ordering data on page 31 to order the appropriate connectors for your application.

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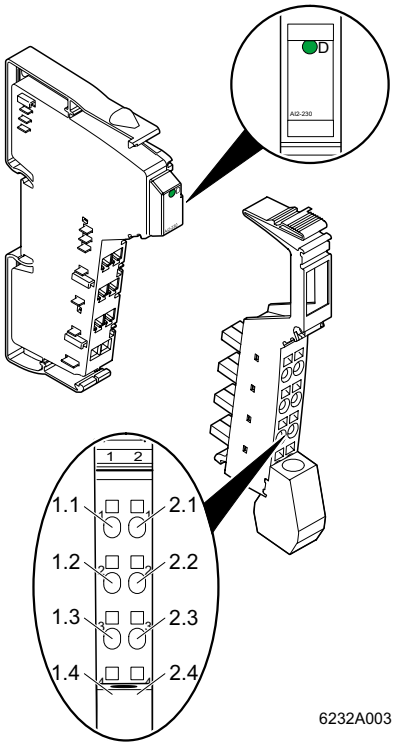


Figure 2 IB IL 24 AI 2/SF-230 terminal with the appropriate connector

Local Diagnostic and Status Indicators

Des.	Color	Meaning
D	Green	Bus diagnostics

Terminal Assignment

Terminal Points	Signal	Assignment
1.1	**+U1**	Voltage input channel 1
2.1	**+U2**	Voltage input channel 2
1.2	**+I1**	Current input channel 1
2.2	**+I2**	Current input channel 2
1.3	**-1**	Return for channel 1 (common for current and voltage)
2.3	**-2**	Return for channel 2 (common for current and voltage)
1.4, 2.4	**Shield**	Shield connection

Installation Instructions

High current flowing through the voltage jumpers U_M and U_S leads to a temperature rise of the voltage jumpers and the inside of the terminal. Note the following instructions to keep the current flowing through the voltage jumpers of the analog terminals as low as possible:

All of the analog terminals need a separate main circuit.

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.

Internal Circuit Diagram

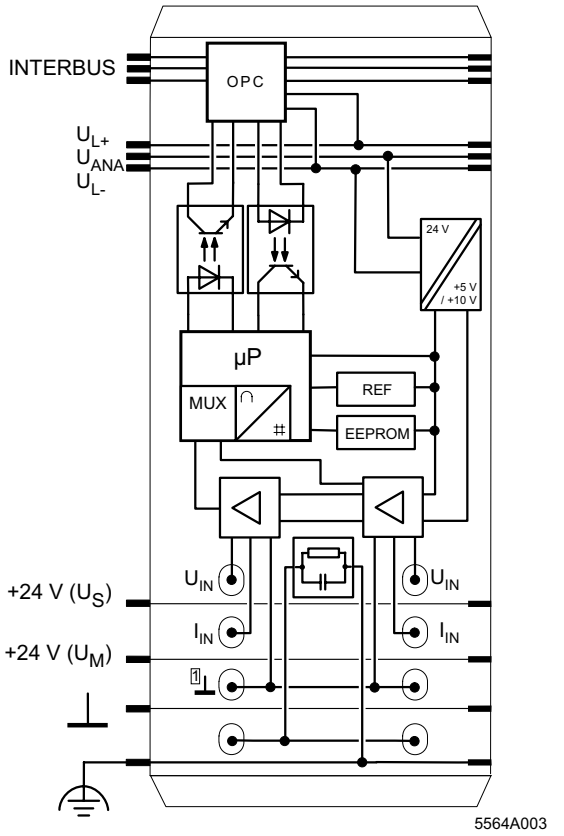
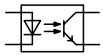


Figure 3 Internal wiring of the terminal points

Key:

Protocol chip



Optocoupler

Power supply unit with electrical isolation

Microprocessor with multiplexer and analog/digital converter

Reference voltage

Electrically erasable programmable read-only memory

Amplifier

Coupling network

Other symbols are explained in the IB IL SYS PRO UM E User Manual.

Electrical Isolation

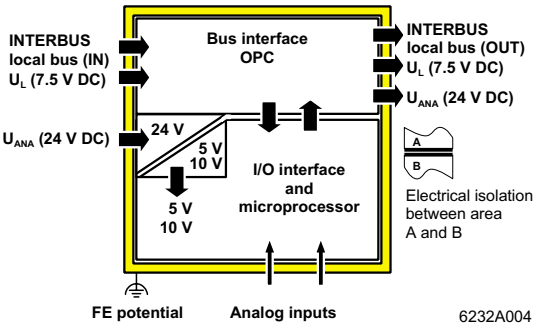


Figure 4 Electrical isolation of the single function areas

Connection Notes

Do not connect voltages above ±5 V to a current input. The electronics module will be damaged if the maximum permissible current of ±100 mA is exceeded.

Always connect analog sensors using twisted and shielded cables (see Figure 5).

Connect the shielding of the terminal using the shield connector clamp. The clamp connects the shield with high resistance and capacitance to FE on the module side. Additional wiring is not necessary.

When connecting the sensor shielding with the PE potential, ensure a large surface connection.

Within the terminal, ground is connected to FE via an RC element.

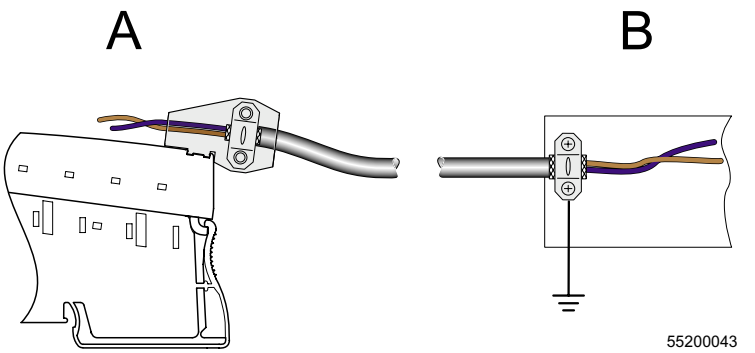


Figure 5 Connection of analog sensors, signal cables

If you want to use **both** channels of the IB IL 24 AI 2/SF-230 terminal, you can connect the shield in various ways depending on the cable feed.

1 If **one** multi-wire cable is used to connect both sensors, connect the shielding as described above using the shield connector (see Figure 5).

2 If **two individual** cables are used to connect the sensors, proceed as follows to prevent ground loops (see Figure 6):

- Install a busbar with a connection to the ground potential in front of the Inline terminal (B in Figure 6). Place the outer sheath of the two cables in the appropriate position and connect the shields of both cables, e.g., using an SK shield clamp (see "CLIPLINE" Catalog). The busbar must be the **only** point at which the shield of every cable is connected with ground potential.
- Lead the cables to the Inline terminal and connect the shield, as described above, using the shield connector (A in Figure 6).
- Lead the sensor cable into the sensor making sure to maintain the integrity of the cable **insulation** (C in Figure 6).

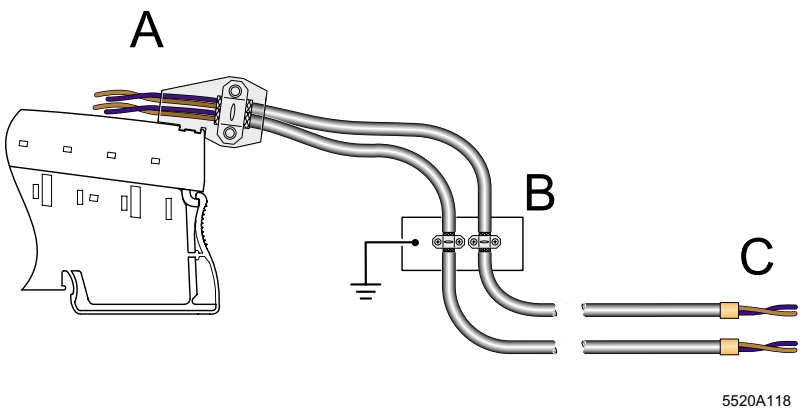


Figure 6 Connection of two analog sensors with individual cables

Connection Examples

Use a connector with shield connection when installing the sensors. Figure 7 and Figure 8 show the connection schematically (without shield connector).

Connection of Active Sensors

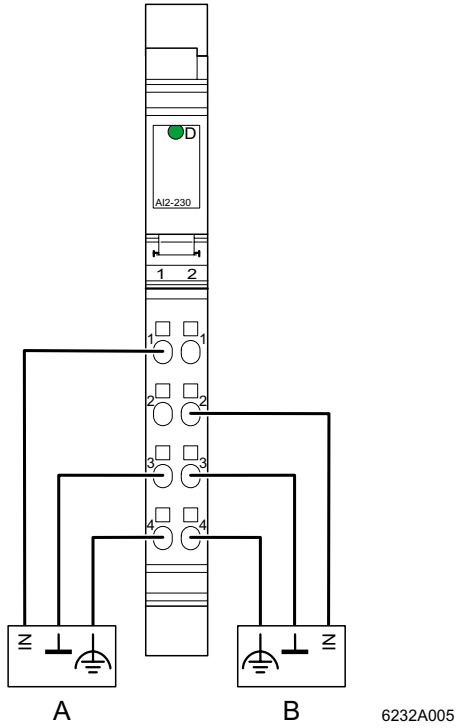


Figure 7 Connection of active sensors in 2-wire technology with shield connection

A Active sensor with voltage output (channel 1)

B Active sensor with current output (channel 2)

Connection of Passive Sensors

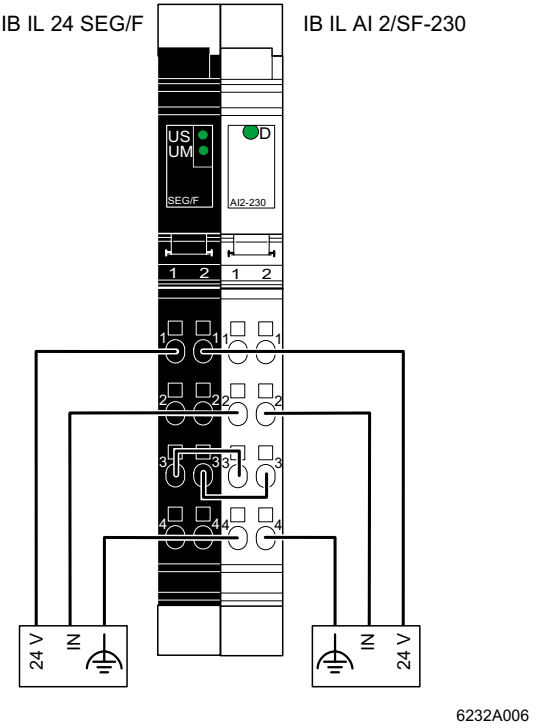


Figure 8 Connection of two passive sensors in 2-wire technology with shield connection

Figure 8 shows the passive sensor supply. The sensors are supplied through a pre-connected segment terminal with a fuse. The sensors can also be supplied from an external power supply.

Connection for Battery Monitoring

Both reference inputs (minus inputs) of each IB IL 24 AI 2/SF-230 terminal are connected with each other. If signal sources are connected in series, wrong connections can lead to a short circuit of individual signal sources.

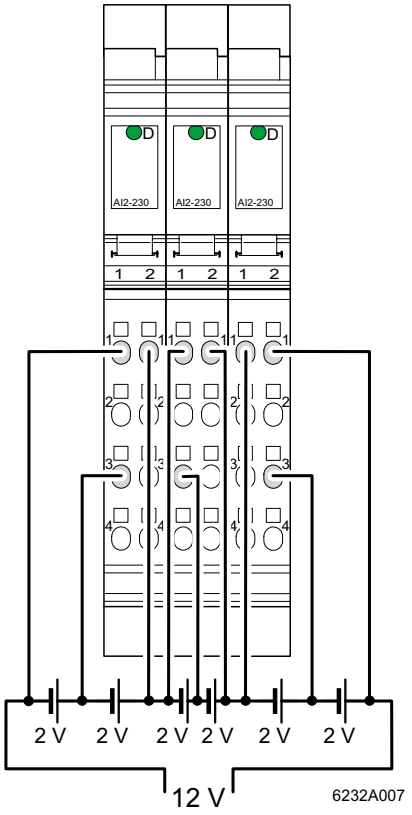


Figure 9 Connection for battery monitoring

Because of the single-ended inputs, the following connections are necessary:

Connect the reference input of a terminal between two voltage sources.

Channel 1 measures the first voltage source with opposite polarity. The measured value must be adapted in the control system to the polarity.

Channel 2 measures the second voltage source with correct polarity.

Configure the terminal to bipolar (±10 V).

Programming Data

ID code	$7F_{hex}$ (127_{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

INTERBUS Process Data Words

Process Data Output Words for the Configuration of the Terminal (see page 13)

INTERBUS reference	Word	Word x															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 1	Assignment	1	0	0	0	0	0	Filter		0	0	Format		Measuring range			
Channel 2	Assignment	1	0	0	0	0	0	Filter		0	0	Format		Measuring range			

Assignment of the Terminal Points to the Process Data Input Words (see page 14)

INTERBUS reference	Word	Word x															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 1	Signal	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		Terminal point 1.1: voltage input Terminal point 1.2: current input															
	Signal reference	Terminal point 1.3															
	Shielding (FE)	Terminal point 1.4															
Channel 2	Signal	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		Terminal point 2.1: voltage input Terminal point 2.2: current input															
	Signal reference	Terminal point 2.3															
	Shielding	Terminal point 2.4															

INTERBUS OUT Process Data Output Words

With the two process data output words you can configure each channel of the terminal independently. The following configurations are possible:

– Selecting a measuring range according to the input signal
– Switching off mean-value generation
– Changing the formats of the measured value representation

The configuration setting is not saved. It must be transmitted in each INTERBUS cycle.

After applying voltage (power up) to the Inline station, the message "Measured value invalid" (error code 8004_{hex}) appears in the process data input words. After 1 s (maximum) the preset configuration is accepted and the first measured value is available. If you change the configuration the corresponding channel is re-initialized. The message "Measured value invalid" (error code 8004_{hex}) appears in the process data output words for 100 ms (maximum).

Default:

Measuring range:	0 through 10 V
Mean-value generation:	Switched on
Output format:	IL format

Mean-value generation should be deactivated for the analysis of dynamic signals.

You cannot change the signal input type through the process data output words. Current or voltage measurement is selected by applying the measured signal to the current or voltage input.

In addition, select the corresponding measuring range through the process data output words.

Do not simultaneously apply current and voltage signals to an input channel as you will not receive valid measured values.

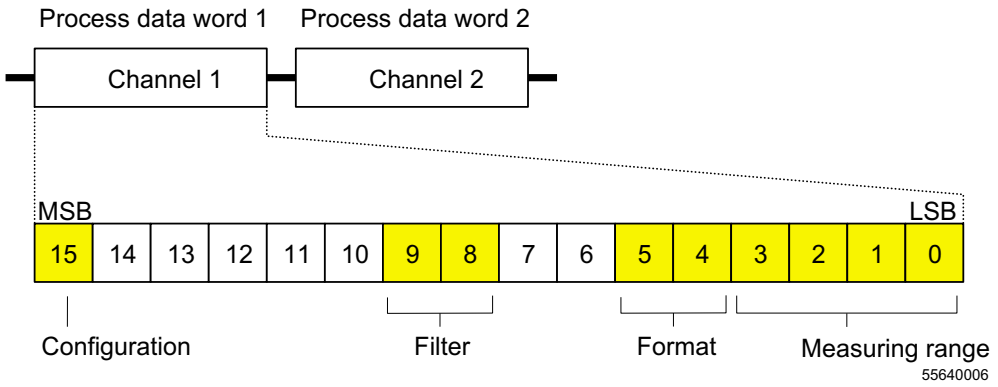


Figure 10 Process data output words

MSB Most significant bit

LSB Least significant bit

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

Set bit 15 of the corresponding output word to 1 to configure the terminal. If bit 15 = 0 the preset configuration is active.

Bit 15:

Code	Configuration
0	**Default**
1	Configuration data

Bit 9 and bit 8:

Code	Filter
00	**16-sample mean value (default)**
01	Mean-value generation Off
10, 11	Reserved

Bit 5 and bit 4:

Code	Format
00	**IB IL (15 bits) (default)**
01	IB ST (12 bits)
10	IB RT (15 bits)
11	Standardized display

Bit 3 through bit 0:

Code	Measuring Range (Voltage)
0000	**0 V through 10 V (default)**
0001	±10 V
0010 through 0111	Reserved

Code	Measuring Range (Current)
1000	0 mA through 20 mA
1001	±20 mA
1010	4 mA through 20 mA
1011 through 1111	Reserved

Set all reserved bits to 0.

INTERBUS IN Process Data Input Words

The measured values are transmitted, per channel, through the INTERBUS IN process data input words to the controller board or the computer.

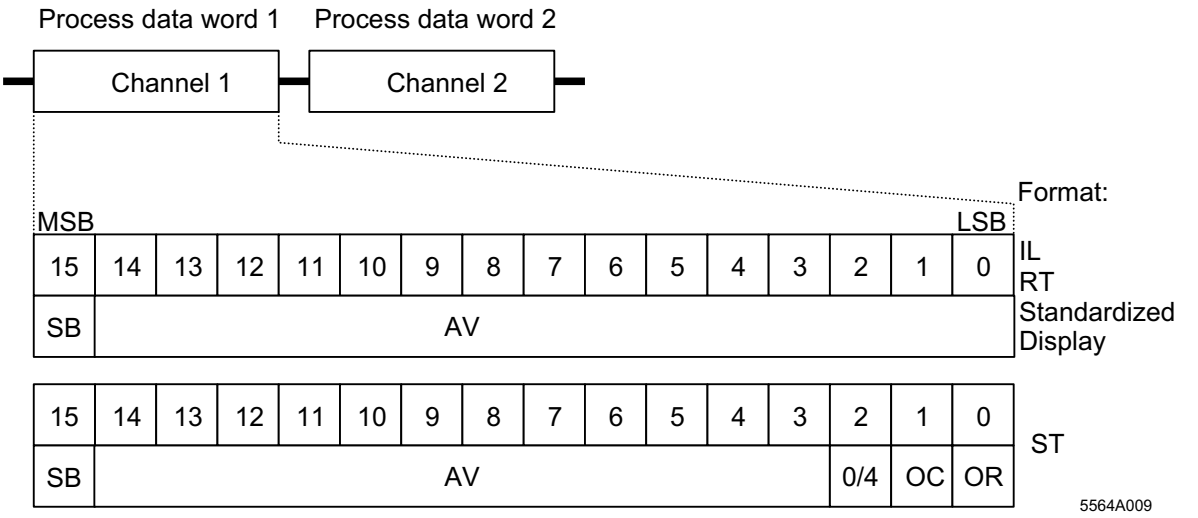


Figure 11 Sequence of the process data input words in the INTERBUS ring and display of the bits of the first process data word in different formats

SB	Sign bit	OC	Open circuit
AV	Analog value	OR	Overrange
0/4	Measuring range 4 through 20 mA		
MSB	Most significant bit	LSB	Least significant bit

The process data formats "IB IL" and "Standardized display" support extended diagnostics. The following error codes are possible:

Code (hex)	Error
8001	Overrange
8002	Open circuit
8004	Measured value invalid/no valid measured value available
8010	Configuration invalid
8040	Module defective
8080	Below range

Formats for Representing the Measured Values

"IB IL" Format

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

This format supports extended diagnostics. Values > 8000_{hex} indicate an error. The error codes are listed on page 15.

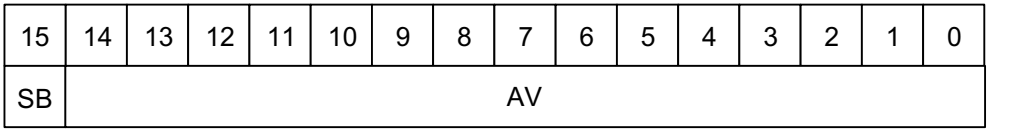


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Figure 12 Measured value representation in "IB IL" format (15 bits)

SB Sign bit AV Analog value

This format is preset (default). To ensure that the terminal can be operated in previously used data formats, the measured value representation can be switched to different formats.

Significant Measured Values

Some codes are used for diagnostic functions. Therefore, the resolution is not 15 bits but exactly 14.9886847 bits.

Measuring range 0 mA through 20 mA/0 V through 10 V

Input Data Word (Two's Complement)		0 mA Through 20 mA I_{Input}	0 V Through 10 V U_{Input}
hex	dec	mA	V
8001	Overrange	> +21.6746	> +10.837
7F00	32512	+21.6746	+10.837
7530	30000	+20.0	+10.0
0001	1	+0.66667 µA	+333.33 µV
0000	0	0	0
0000	0	< 0	< 0

Measuring range -20 mA through +20 mA/-10 V through +10 V

Input Data Word (Two's Complement)		-20 mA Through +20 mA I_{Input}	-10 V Through +10 V U_{Input}
hex	dec	mA	V
8001	Overrange	> +21.6746	> +10.837
7F00	32512	+21.6746	+10.837
7530	30000	+20.0	+10.0
0001	1	+0.66667 µA	+333.33 µV
0000	-1	0	0
FFFF	0	-0.66667 µA	-333.33 µV
8AD0	-30000	-20.0	-10.0
8100	-32000	-21.6746	-10.837
8080	Below range	<-21.6746	<-10.837

Measuring range 4 mA through 20 mA

Input Data Word (Two's Complement)		4 mA Through 20 mA I_{Input}
hex	dec	mA
8001	Overrange	> +21.339733
7F00	32512	+21.339733
7530	30000	+20.0
0001	1	+4.00053333
0000	0	+4.0 through 3.2
8002	Open circuit	<+3.2

"IB ST" Format

The measured value is represented in bits 14 through 3. The remaining 4 bits are sign bit, measuring range, and error bits.

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

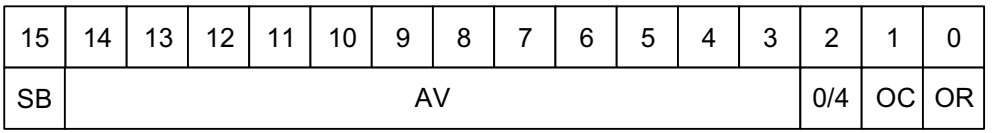

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Figure 13 Measured value representation in "IB ST" format (12 bits)

SB	Sign bit	OC	Open circuit
AV	Analog value	OR	Overrange
0/4	Measuring range 4 through 20 mA		

Significant Measured Values

Measuring range 0 mA through 20 mA/0 V through 10 V

Input Data Word (Two's Complement)	0 mA Through 20 mA I_{Input}	0 V Through 10 V U_{Input}
hex	mA	V
7FF9	>21.5	>10.75
7FF8	20.0 through 21.5	10.00 through 10.75
7FF8	19.9951	9.9975
4000	10.0	5.0
0008	0.0048828	0.002441
0000	0	0

Measuring range -20 mA through +20 mA/-10 V through +10 V

Input Data Word (Two's Complement)	-20 mA Through +20 mA I_{Input}	-10 V Through +10 V U_{Input}
hex	mA	V
7FF9	>21.5	>10.75
7FF8	20.0 through 21.5	10.00 through 10.75
7FF8	19.9951	9.9975
0008	0.0048828	0.002441
0000	0	0
FFF8	-0.0048828	-0.002441
8000	-20.0 through -21.5	-10.00 through -10.75
8001	<-21.5	<-10.75

Measuring range 4 mA through 20 mA

Input Data Word (Two's Complement)	4 mA Through 20 mA I_{Input}
hex	mA
7FFD	>21.5
7FFC	20.0 through 21.5
7FFC	19.9961
000C	4.003906
0004	3.2 through 4.0
0006	< 3.2

"IB RT" Format

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

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

In this data format error codes or error bits are not defined. Open circuit is indicated through the positive final value $7FFF_{hex}$.

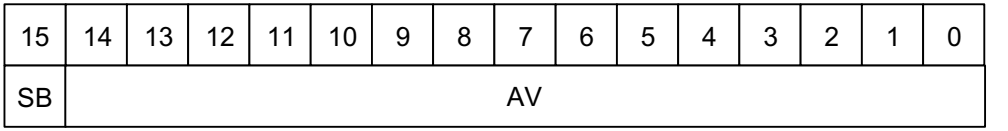

Figure 14 Measured value representation in "IB RT" format (15 bits)

SB Sign bit AV Analog value

Significant Measured Values

Measuring range 0 mA through 20 mA/0 V through 10 V

Input Data Word (Two's Complement)	0 mA Through 20 mA I_{Input}	0 V Through 10 V U_{Input}
hex	mA	V
7FFF	≥ 19.999385	≥ 9.999695
7FFE	19.9987745	9.999939
4000	10.0	5.0
0001	0.6105 µA	305.0 µV
0000	≤ 0	≤ 0

Measuring range -20 mA through +20 mA/-10 V through +10 V

Input Data Word (Two's Complement)	-20 mA Through +20 mA I_{Input}	-10 V Through +10 V U_{Input}
hex	mA	V
7FFF	≥ +19.999389	≥ +9.999939
7FF7	+19.998779	+9.99939
4000	+10.0	+5.0
0001	+0.61035 µA	+305.0 µV
0000	0	0
FFFF	-0.61035 µA	-305.0 µV
8001	-19.999389	-9.99939
8000	≤-20.0	≤-10.0

Measuring range 4 mA through 20 mA

Input Data Word (Two's Complement)	4 mA Through 20 mA I_{Input}
hex	mA
7FFF	≥ 19.9995116
7FFE	19.9990232
4000	12.0
0001	0.4884 µA
0000	4.0
0000	3.2 through 4.0
7FFF	< 3.2

"Standardized Display" Format

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

In this format, data on the measuring range is standardized and represented in such a way that it indicates the corresponding value without conversion. In this format one bit has the value of 1 mV or 1 µA.

This format supports extended diagnostics. Values > 8000_{hex} indicate an error. The error codes are listed on page 15.

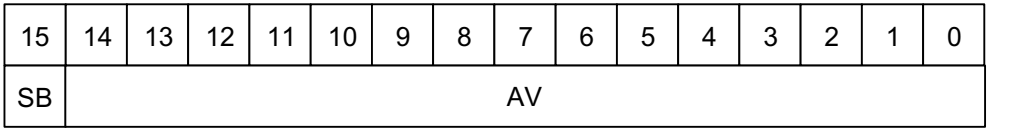

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Figure 15 Measured value representation in "Standardized display" format (15 bits)

SB Sign bit AV Analog value

Significant Measured Values

Because of the display standardization not all of the possible codes are used. In addition, some codes are used for diagnostic functions. Therefore, the resolution is not 15 bits but exactly 13.287713 bits.

Measuring range 0 V through 10 V

Input Data Word (Two's Complement)		0 V Through 10 V U_{Input}
hex	dec	V
8001	Overrange	> +10.837
2A55	10837	+10.837
2710	10000	+10.0
0001	1	+0.001
0000	0	≤ 0

Measuring range 0 mA through 20 mA

Input Data Word (Two's Complement)		0 mA Through 20 mA I_{Input}
hex	dec	mA
8001	Overrange	> +21.674
54AA	21674	+21.674
4E20	20000	+20.0
0001	1	+0.001
0000	0	≤ 0

Measuring range -10 V through +10 V

Input Data Word (Two's Complement)		-10 V Through +10 V U_{Input}
hex	dec	V
8001	Overrange	> +10.837
2A55	10837	+10.837
2710	10000	+10.0
0001	1	+0.001
0000	0	0
FFFF	-1	-0.001
D8F0	-10000	-10.0
D5A6	-10837	-10.837
8080	Below range	<-10.837

Measuring range -20 mA through +20 mA

Input Data Word (Two's Complement)		-20 mA Through +20 mA I_{Input}
hex	dec	mA
8001	Overrange	> +21.674
54AA	21674	+21.674
4E20	20000	+20.0
0001	1	+0.001
0000	0	0
FFFF	-1	-0.001
B1E0	-20000	-20.0
A656	-21674	-21.674
8080	Below range	<-21.674

Measuring range 4 mA through 20 mA

Input Data Word (Two's Complement)		4 mA Through 20 mA I_{Input}
hex	dec	mA
8001	Overrange	> 21.339
43BB	17339	21.339
3E80	16000	20.0
0001	1	4.001
0000	0	4.0 through 3.2
8002	Open circuit	< 3.2

Example

Measured value representation in different data formats.

Measuring range: 0 mA through 20mA

Measured value: 10 mA

Input data word:

Format	HEX Value	DEC Value	Measured Value
IB IL	3A98	15 000	10 mA
IB ST	4000	16 384	10 mA
IB RT	4000	16 384	10 mA
Standardized display	2710	10 000	10 mA

Technical Data

General	
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	47 g (without connector)
Operating mode	Process data operation with 2 words
Connection method for the sensors	2-wire and 3-wire technology
Power supply for the sensors	With an external power supply or with an additional segment terminal with a fuse (IB IL 24 SEG/F)
Permissible temperature (operation)	-25°C to +55°C (-13°F to +131°F)
Permissible temperature (storage/transport)	-25°C to +85°C (-13°F to +185°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 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 2000 m [6562 ft.] above sea level)
Permissible air pressure (storage/transport)	70 kPa to 106 kPa (up to 3000 m [9843 ft.] above sea level)
Degree of protection	IP 20 according to IEC 60529
Class of protection	Class 3 according to VDE 0106, IEC 60536

Deviations From Common Technical Data That Are Indicated in the IB IL SYS PRO UM E User Manual	
Noise Immunity Test According to EN 50082-2	
Electrostatic discharge (ESD) according to IEC 61000-4-2	Criterion B 6 kV contact discharge 6 kV air discharge
Mechanical Demands	
Shock test according to IEC 60068-2-27, IEC 60068-2-27	15g load for 11 ms, half sinusoidal wave, three shocks in each space direction and orientation 25g load for 6 ms, half sinusoidal wave, three shocks in each space direction and orientation

Interface	
INTERBUS interface	Data routing

Power Consumption	
Communications power U_L	7.5 V
Current consumption from U_L	Approximately 45 mA, typical
I/O supply voltage U_{ANA}	24 V DC
Current consumption from U_{ANA}	Approximately 12 mA, typical
Total power consumption	Approximately 625 mW, typical

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

Analog Inputs				
Number		2 analog single-ended inputs		
Signals/resolution in the process data word (quantization)				
Voltage	0 - 10 V	0 - 10.837 V 0 - 10.000 V 0 - 10.000 V 0 - 10.837 V	(Format IB IL) (Format IB ST) (Format IB RT) (Standardized display)	0.333 mV/LSB 2.441 mV/LSB 0.305 mV/LSB 1.000 mV/LSB
	±10 V	±10.837 V ±10.000 V ±10.000 V ±10.837 V	(Format IB IL) (Format IB ST) (Format IB RT) (Standardized display)	0.333 mV/LSB 2.441 mV/LSB 0.305 mV/LSB 1.000 mV/LSB
Current	0 - 20 mA	0 - 21.6746 mA 0 - 20.000 mA 0 - 20.000 mA 0 - 21.6746 mA	(Format IB IL) (Format IB ST) (Format IB RT) (Standardized display)	0.6666 µA/LSB 4.8828 µA/LSB 0.6105 µA/LSB 1.000 µA/LSB
	±20 mA	±21.6746 mA ±20.000 mA ±20.000 mA ±21.6746 mA	(Format IB IL) (Format IB ST) (Format IB RT) (Standardized display)	0.6666 µA/LSB 4.8828 µA/LSB 0.6105 µA/LSB 1.000 µA/LSB
	4 - 20 mA	4 - 21.339 mA 4 - 20.000 mA 4 - 20.000 mA 4 - 21.339 mA	(Format IB IL) (Format IB ST) (Format IB RT) (Standardized display)	0.533 µA/LSB 3.906 µA/LSB 0.4884 µA/LSB 1.000 µA/LSB

Analog Inputs (Continued)	
Measured value representation	In the formats IB IL (15 bits with sign bit) IB ST (12 bits with sign bit) IB RT (15 bits with sign bit) Standardized display (15 bits with sign bit)
 For measured value representation in the formats "IB IL" and "Standardized display" observe the information on page 16 and page 22.	
Mean-value generation	Over 16 measured values (can be switched off)
Conversion time of the A/D converter	120 µs, approximately

Analog Input Stages	
Voltage Inputs	
Input resistance	> 220 kΩ
Limit frequency (-3 dB) of the input filter	230 Hz
Process data update of both channels	< 1.5 ms
Behavior upon sensor failure	Going to 0 V
Maximum permissible voltage between analog voltage inputs and analog reference potential	±32 V
Common mode rejection (CMR) Reference: Voltage input signal, valid for permissible DC common mode voltage range	90 dB, minimum 110 dB, typical
Permissible DC common mode voltage for CMR	40 V between voltage input and FE

Analog Input Stages (Continued)	
Current Inputs	
Input resistance	50 Ω (shunt)
Limit frequency (-3 dB) of the input filter	230 Hz
Process data update of both channels	< 1.5 ms
Behavior upon sensor failure	Going to 0 mA/4 mA
Maximum permissible voltage between analog current inputs and analog reference potential	±5 V (corresponding with 100 mA across the sensor resistances)
Common mode rejection (CMR) Reference: Current input signal, valid for permissible DC common mode voltage range	90 dB, minimum 110 dB, typical
Permissible DC common mode voltage for CMR	40 V between current input and FE
Maximum permissible current	±100 mA

Tolerance and Temperature Response of the Voltage Inputs (The error indications refer to the final value of the measuring range: 10 V)		
	Typical	**Maximum**
Error at +23°C (73.4°F)		
Offset error	±0.03%	±0.06%
Gain error	±0.05%	±0.10%
Differential non-linearity	±0.10%	±0.20%
Total error of the voltage inputs at +23°C (73.4°F) Offset error + gain error + linearity error	±0.15%	±0.30%
Temperature response at -25°C to +55°C (-13°F to 131°F)		
Offset drift T_{KVO}	±6 ppm/K	±12 ppm/K
Gain drift T_{KG}	±30 ppm/K	±50 ppm/K
Total voltage drift $T_{Ktot} = T_{KVO} + T_{KG}$	±36 ppm/K	±62 ppm/K
Total error of the voltage inputs (-25°C to +55°C[-13°F to +131°F]) Offset error + gain error + linearity error + drift error	±0.30%	±0.50%

Tolerance and Temperature Response of the Current Inputs (The error indications refer to the measuring range final value of 20 mA)		
	Typical	**Maximum**
Error at +23°C (73.4°F)		
Offset error	±0.03%	±0.06%
Gain error	±0.10%	±0.10%
Differential non-linearity	±0.10%	±0.30%
Total error of the current inputs at +23°C (73.4°F) Offset error + gain error + linearity error	±0.20%	±0.40%
Temperature response at -25°C to +55°C (-13°F to +131°F)		
Offset drift T_{KIO}	±6 ppm/K	±12 ppm/K
Gain drift T_{KG}	±30 ppm/K	±50 ppm/K
Total drift $T_{Ktot} = T_{KIO} + T_{KG}$	±36 ppm/K	±62 ppm/K
Total error of the current inputs (-25°C to +55°C [-13°F to +131°F]) offset error + gain error + linearity error + drift error	±0.35%	±0.60%

Additional Tolerances for Electromagnetic Interference				
Type of Electromagnetic Interference	**Typical Deviation of the Final Value of the Measuring Range (Voltage Input)**		**Typical Deviation of the Final Value of the Measuring Range (Current Input)**	
	Relative	**Absolute**	**Relative**	**Absolute**
Electromagnetic fields field strength 10 V/m according to IEC 61000-4-3/IEC 61000-4-3	< ±2%	< ±200 mV	< ±2%	< ±400 µA
Conducted interference Class 3 (test voltage 10 V) according to IEC 61000-4-6/IEC 61000-4-6	< ±1%	< ±100 mV	< ±1%	< ±100 µA
Fast transients 4 kV supply, 2 kV input according to IEC 61000-4-4/IEC 61000-4-4	< ±1%	< ±100 mV	< ±1%	< ±100 µA

Safety Devices	
Surge voltage	Suppressor diodes in the analog inputs

Electrical Isolation/Isolation of the Voltage Areas
To provide electrical isolation between the logic level and the I/O area it is necessary to supply the bus terminal and the sensors, which are connected to the anaolg input terminal described in this data sheet, from separate power supplies. Interconnection of the 24 V power supplies is not permitted.
Common Potentials
24 V main power, 24 V segment voltage, and GND have the same potential. FE is a separate potential area.
Separate Potentials in the System Consisting of Bus Terminal/Power Terminal and I/O Terminal

- Test Distance	- Test Voltage
5 V supply incoming remote bus/7.5 V supply (bus logic)	500 V AC, 50 Hz, 1 min
5 V supply outgoing remote bus/7.5 V supply (bus logic)	500 V AC, 50 Hz, 1 min
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
I/Os/functional earth ground	500 V AC, 50 Hz, 1 min

Error Messages to the Higher-Level Control or Computer System	
Failure of the internal voltage supply	Yes
I/O error/user error	Yes, error message through the process data input words (see page 14)

Ordering Data

Description	Order Designation	Order No.
Terminal with two analog input channels	IB IL 24 AI 2/SF-230	27 40 81 8
Connector with shield connector	IB IL SCN-6 SHIELD	27 26 35 3
"Configuring and Installing the INTERBUS Inline Product Range" User Manual	IB IL SYS PRO UM E	27 43 04 8

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