ILB BT ADIO 2/2/16/16

Bluetooth I/O module with 16 digital inputs, 16 digital outputs, 2 analog inputs, and 2 analog outputs

Data sheet
7476_en_03

1 Description

The ILB BT ADIO 2/2/16/16 module is used to acquire and output digital and analog signals. It wirelessly transmits 16 digital and 2 analog input and output signals to the Bluetooth base station used.

Features of the wireless interface

- Bluetooth 1.2, HID profile
- Frequency range 2.4000 GHz ... 2.4835 GHz, ISM band
- The maximum emitted transmission power can be set between 0 dBm ... 14 dBm, automatically controlled
- Diagnostics and status indicators

Features of digital inputs

- Connections for 16 digital sensors
- Connection of sensors in 1-wire technology
- Status indicators

Features of digital outputs

- Connections for 16 digital actuators
- Connection of actuators in 1-wire technology
- Nominal current of each output: 0.5 A
- Total current of all outputs: 8 A
- Short-circuit and overload-protected outputs
- Status indicators

Features of analog inputs

- Two analog single-ended signal inputs for the connection of either voltage or current signals
- Connection of sensors in 2 and 3-wire technology
- Current measuring range 0 mA ... 20 mA
- Voltage measuring range 0 V ... 10 V

Features of analog outputs

- Two analog single-ended signal outputs for the connection of either voltage or current signals
- Connection of actuators in 2 and 3-wire technology
- Current measuring range 0 mA ... 20 mA
- Voltage measuring range 0 V ... 10 V

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

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2 Ordering data

Module

Description	Type	Order No.	Pcs. / Pkt.
Bluetooth I/O module with 16 digital inputs, 16 digital outputs, 2 analog inputs, and 2 analog outputs	ILB BT ADIO 2/2/16/16	2884282	1 set
Fieldline Modular Bluetooth base station	FLM BT BS3 M12	2736770	1
Factoryline Bluetooth base station	FL BT MOD IO AP	2884758	1

Accessories

Connectors as replacement items	Type	Order No.	Pcs. / Pkt.
Shield connector	IB IL SCN-6 SHIELD-TWIN	2740245	5
Connector for the supply (with color print)	IB IL SCN-PWR IN-CP	2727637	10
Connector for input and output terminals	IB IL SCN-8	2726337	10
Antennas			
Panel antenna	RAD-ISM-2400-ANT-PAN-8-0	2867610	1
Pigtail antenna cable for panel antenna	RAD-PIG-EF-316-SMA-SMA	2885618	1
Omnidirectional antenna with protection against vandalism	RAD-ISM-2400-ANT-VAN-3-0-SMA	2885867	1

Operation of the wireless system is only permitted if accessories available from Phoenix Contact are used. The use of any other components can lead to withdrawal of the operating license.

You can find the approved accessories for this wireless system listed with the product at phoenixcontact.net/products.

Additional accessories

Recommended end bracket; placed to the right of the module to secure it on the DIN rail	CLIPFIX 35-5	3022276	50

Accessories for extending the antenna cable are available on request.

3 Technical data

General data	
Housing dimensions with connectors (width x height x depth)	117 mm x 73 mm x 121 mm
Weight (without antenna)	305 g (with connectors, ID plug, and antenna)
Connection method for sensors and actuators	1-wire technology

Housing dimensions

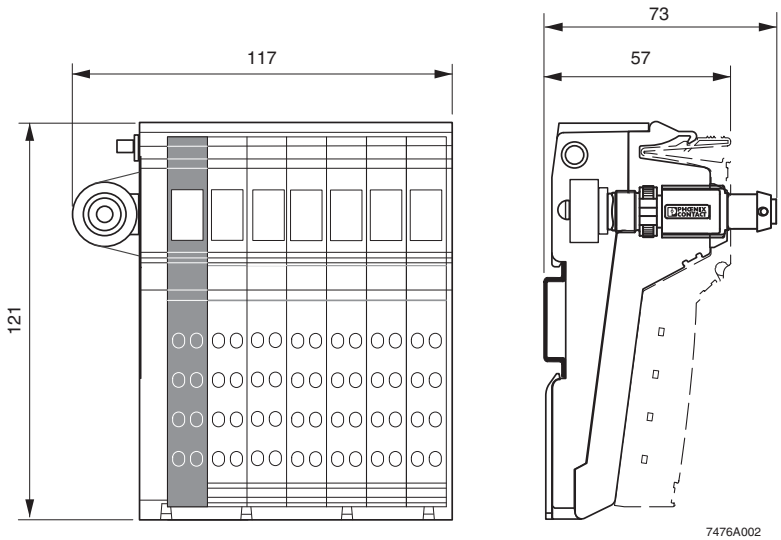


Figure 1 Housing dimensions of the module (mm)

Ambient conditions	
Regulations	Developed according to VDE 0160, UL 508
Ambient temperature (operation)	-25°C ... +60°C
Ambient temperature (storage/transport)	-25°C ... +85°C
Humidity (operation)	75% on average, 85% occasionally, non-condensing

In the range between -25°C ... +60°C, appropriate measures against increased humidity (>85%) must be taken.

Humidity (storage/transport)	95%

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

Air pressure (operation)	80 kPa ... 108 kPa (up to 2000 m above sea level)
Air pressure (storage/transport)	66 kPa ... 108 kPa (up to 3500 m above sea level)
Degree of protection according to DIN 40050, IEC 60529	IP20
Protection class according to EN 61131-2, IEC 61131-2	3
Air clearances and creepage distances	According to IEC 60664/IEC 60664A DIN VDE 0110: 1989-01 and DIN VDE 0160: 1988-05
Housing material	Plastic, PVC-free, PBT, self-extinguishing (V0)
Pollution degree according to EN 60664, EN 61131-2	2; condensation not permitted during operation
Surge voltage class	II

Electrical isolation/isolation of the voltage areas

Common potentials

24 V communications power, 24 V actuator supply, and GND have the same potential. FE is a separate potential area.

- Test distance	- Test voltage
24 V supply (I/O)/functional earth ground	500 V AC, 50 Hz, 1 min.
24 V supply (I/O)/analog channels	500 V AC, 50 Hz, 1 min.
Analog channels/FE	500 V AC, 50 Hz, 1 min.

Mechanical requirements

Vibration test, sinusoidal vibrations according to IEC 60068-2-29; EN 60068-2-29	5g load, 2.5 hours in each space direction
Shock test according to IEC 60068-2-27; EN 60068-2-27	25g load for 11 ms, half sinusoidal wave, three shocks in each space direction and orientation
Broadband noise according to IEC 60068-2-64; EN 60068-2-64	0.78g load, 2.5 hours in each space direction

Conformance with EMC directive 89/336/EEC

Noise immunity test according to EN 61000-6-2

Electrostatic discharge (ESD)	EN 61000-4-2 IEC 61000-4-2	Criterion B 6 kV contact discharge 8 kV air discharge
Electromagnetic fields	EN 61000-4-3 IEC 61000-4-3	Criterion A Field strength: 10 V/m
Fast transients (burst)	EN 61000-4-4/ IEC 61000-4-4	Criterion B Remote bus: 2 kV Power supply: 2 kV I/O cables: 2 kV Criterion A All interfaces: 1 kV
Surge voltage	EN 61000-4-5 IEC 61000-4-5	Criterion B DC supply lines: ±0.5 kV/±0.5 kV (symmetrical/asymmetrical) Signal lines: ±0.5 kV/±0.5 kV (symmetrical/asymmetrical)
Conducted interference	EN 61000-4-6 IEC 61000-4-6	Criterion A Test voltage 10 V

Noise emission test according to EN 61000-6-4

Noise emission of housing	EN 55011	Class A (industrial applications)

Check for wireless approval

EMC	ETSI EN 301 489-17
Wireless	ETSI EN 300 328
Safety	EN 60950-1
Health	EN 50371

Wireless interface

Wireless interface	Bluetooth 1.2
Frequency range	2.4000 GHz ... 2.4835 GHz
Channel distance	1 MHz
Number of channels	79
Modulation	GFSK (Gaussian Frequency Shift Keying)
Maximum transmission power at the antenna connection	Can be set between 0 dBm ... 14 dBm, in 4 dB increments
Antenna connection	SMA socket

24 V module supply

Communications power

Nominal value	24 V DC
Tolerance	-15%/+20% according to EN 61131-2
Ripple	±5% according to EN 61131-2
Permissible range	19.2 V ... 30.0 V
Current consumption at U_L	75 mA
Protection against polarity reversal	Yes
Surge protection	Yes
Connection	Via power connector

Actuator supply

Nominal value	24 V DC
Tolerance	-15%/+20% according to EN 61131-2
Ripple	±5% according to EN 61131-2
Permissible range	19.2 V ... 30.0 V
Current consumption at U_L	≤8 A
Number of potential groups	1
Overload protection	Yes
Protection against polarity reversal	No
Connection	Via power connector

Digital outputs

Number	16
Number of voltage groups	1
Connection method for actuators	1-wire technology
Nominal output voltage U_{OUT}	24 V DC
Differential voltage for I_{nom}	≤1 V
Nominal current I_{nom} per channel	0.5 A
Total current	8 A
Protection	Short circuit; overload
Nominal load	
Ohmic	48 Ω/12 W
Lamp	12 W
Inductive	12 VA (1.2 H, 50 Ω)
Switching frequency with nominal inductive load	0.5 Hz (1.2 H, 50 Ω)
Overload response	Auto restart
Behavior in the event of inductive overload	Output may be damaged
Reverse voltage protection against short pulses	Yes
Resistance to permanently applied reverse voltages	Yes, maximum permissible current 2 A
Response upon power down	The output follows the supply voltage without delay.
Limitation of the voltage induced on circuit interruption	-41 V
Single maximum energy in freewheeling	1 J, maximum
Protective circuit type	Integrated freewheeling circuit in the output chip
Overcurrent shutdown	At 0.7 A, minimum
Maximum output current when switched off	10 µA

When not loaded, a voltage can be measured even at an output that is not set.

Digital inputs

Number	16
Connection method for sensors	1-wire technology
Input design	According to EN 61131-2 Type 1
Definition of the switching thresholds	
Maximum low-level voltage	U_{Lmax} < 5 V
Minimum high-level voltage	U_{Hmin} > 15 V
Common potentials	Ground
Nominal input voltage U_{IN}	24 V DC
Permissible range	-30 V < U_{IN} < +30 V DC
Nominal input current at U_{IN}	3.6 mA per channel, typical
Current flow	Linear in the range 1 V < U_{IN} < 30 V
Delay time	≤300 µs
Permissible cable length to sensor	100 m
Use of AC sensors	AC sensors in the voltage range < U_{IN} are limited in application

Typical power dissipation with 24 V supply voltage

Formula for calculating the power dissipation of the electronics

$$P_{TOT} = 0.552\ W + \sum_{n=0}^{16} (0.065\ W + I_{Ln}^2 \times 0.28\ \Omega) + \sum_{m=0}^{16} 0.086\ W + \sum_{l=0}^{2} 0.372\ W + \sum_{k=0}^{2} 0.044\ W$$

Where:

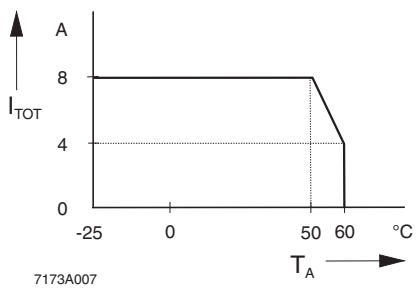
P_{TOT}	Total power dissipation in the module
n	Index of the number of set digital outputs (n = 0 ... 16)
I_{LN}	Load current of output n
m	Index of the number of set digital inputs (m = 0 ... 16)
l	Index of the number of analog outputs used (l = 0 ... 2)
k	Index of the number of analog inputs used (k = 0 ... 2)

Simultaneity, derating

No limitation of simultaneity, derating

Derating of the outputs

Ambient temperature (T_A)	Total current (I_{TOT})
-25°C ... +50°C	8 A
+50°C ... +60°C	8 A - ((T_A - 50°C) x 0.4 A/°C)

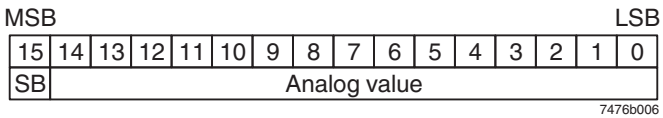


Analog outputs	
Number	2
Signals/resolution	
Voltage 0 V ... 10 V	2.44 mV
Current 0 mA ... 20 mA	4.88 µA
Output load	
Voltage output	2 kΩ, minimum
Current output	0 Ω ... 500 Ω

Output value representation

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

Output value representation



Significant output values

Output range 0 mA ... 20 mA and 0 V ... 10 V

Output data word (two's complement)		0 mA ... 20 mA I_{Output}	0 V ... 10 V U_{Output}
hex	dec	mA	V
≤FFFF	≤32767	+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

Safety equipment
Transient protection for voltage and current outputs

Tolerance and temperature response of analog outputs
The tolerance values refer to the measuring range final value.

Tolerances at T_A = +23°C

Measuring range	Absolute (typical)	Absolute (maximum)	Relative (typical)	Relative (maximum)
0 V ... 10 V	±31 mV	±93 mV	±0.31%	±0.93%
0 mA ... 20 mA	±112 µA	±194 µA	±0.56%	±0.97%

Temperature and drift response (T_A = -25°C ... +60°C)

Drift in reference to the measuring range final value

Measuring range	Typical	Maximum
0 V ... 10 V	306 ppm/K	750 ppm/K
0 mA ... 20 mA	306 ppm/K	740 ppm/K

Analog inputs

Voltage inputs

Input resistance	>150 kΩ
Cut-off frequency (-3 dB) of the input filters	40 Hz
Maximum permissible voltage between analog voltage inputs and analog reference potential	±32 V
Common mode rejection (CMR)	103 dB
Permissible DC common mode voltage for CMR	40 V between voltage input and FE

Current inputs

Input resistance	110 Ω (shunt)
Cut-off frequency (-3 dB) of the input filters	40 Hz
Maximum permissible voltage between analog current inputs and analog reference potential	±32 V (input current is limited internally)
Common mode rejection (CMR)	103 dB
Permissible DC common mode voltage for CMR	40 V between current input and FE
Maximum permissible current	Internally limited by protective circuit

Safety equipment

Surge voltage	Suppressor diodes in the analog inputs, current limitation via internal protective circuit

Tolerance and temperature response of analog inputs

The tolerance values refer to the measuring range final value.

Tolerances at T_A = +23°C

Measuring range	Absolute (typical)	Absolute (maximum)	Relative (typical)	Relative (maximum)
0 V ... 10 V	±30 mV	±74 mV	±0.30%	±0.74%
0 mA ... 20 mA	±80 µA	±164 µA	±0.40%	±0.82%

Temperature and drift response (T_A = -25°C ... +60°C)

Drift in reference to the measuring range final value

Measuring range	Typical	Maximum
0 V ... 10 V	40 ppm/K	170 ppm/K
0 mA ... 20 mA	40 ppm/K	175 ppm/K

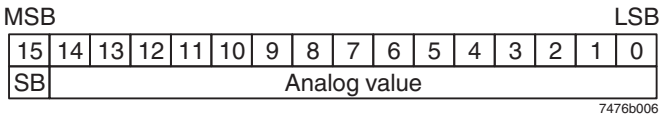
Additional tolerances influenced by electromagnetic fields

Type of electromagnetic interference	Typical deviation of the measuring range final value (voltage and current channels)
	Relative
Electromagnetic fields; field strength 10 V/m according to EN 61000-4-3/IEC 61000-4-3	<±0.5%
Conducted interference, Class 3 (test voltage 10 V) according to EN 61000-4-6/IEC 61000-4-6	<±0.5%
Fast transients (burst), 4 kV supply, 2 kV input according to EN 61000-4-4/IEC 61000-4-4	<±0.5%

Input value representation

The input value is represented in bits 14 ... 0. An additional bit (bit 15) is available as a sign bit. This format supports extended diagnostics. Values >8000_{hex} indicate an error.

Input value representation



Significant measured values

Input range 0 mA ... 20 mA and 0 V ... 10 V

Input data word (two's complement)		0 mA ... 20 mA I_{Input}	0 V ... 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

4 Usage notes

WARNING:

The use of products described in this data sheet is oriented exclusively to electrically skilled persons or persons instructed by them, who are familiar with applicable national standards and other regulations regarding electrical engineering and, in particular, the relevant safety concepts. Phoenix Contact accepts no liability for erroneous handling or damage to products from Phoenix Contact or third-party products resulting from disregard of information contained in this data sheet.

This device meets the basic requirements and additional corresponding specifications of directive 1999/5/EU.

This device complies with R&TTE device class 1, with the following restrictions on use according to ERC recommendation 70-03:

Norway	The device must not be operated within 20 km of the Ny Ålesund town center.

Operation of the wireless system is only permitted if accessories available from Phoenix Contact are used. The use of any other components can lead to withdrawal of the operating license.

You can find the approved accessories for this wireless system listed with the product at phoenixcontact.net/products.

Tested to Comply with FCC Standards

This device contains:

FCC ID: PVH071902
IC: 5325A-0719X

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operations.

4.1 Transmission power

Depending on the maximum possible transmission power, the operation of this device must be registered or approved in some countries. In addition, there may be a usage restriction on the transmission power for indoor and outdoor use.

The maximum permissible transmission power must be set (default upon delivery: 14 dBm) prior to starting up the device. The antenna gain of the antenna used should be taken into account. For the antenna provided (gain 0 dBi), the transmission power values printed on the device apply. The maximum transmission power is set using the DIP switches on the rear of the device.

To apply the transmission power setting, restart the device.

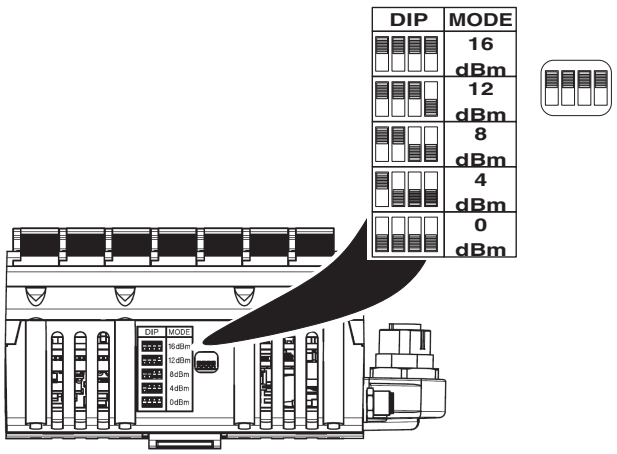


Figure 2 DIP switches for setting the transmission power

5 Local diagnostics and status indicators

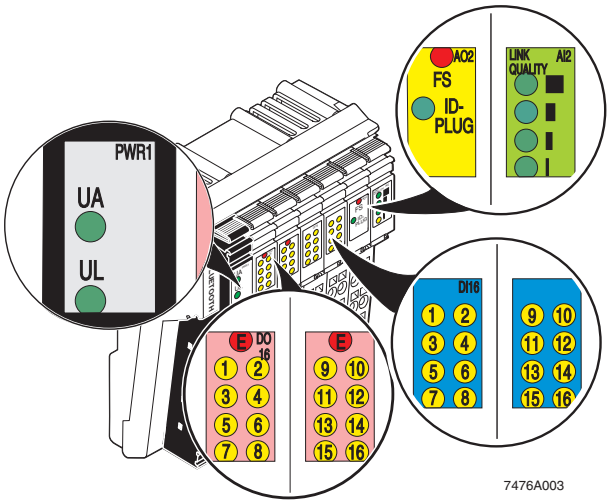


Figure 3 Diagnostics and status indicators of the module

Designation	LED color	Meaning
PWR		
UA	Green	24 V actuator supply
UL	Green	24 V communications power
OUT		
E	Red	Short circuit or overload at one of the outputs
1 ... 16	Yellow	Output status indicators
IN		
1 ... 16	Yellow	Input status indicators
FS		
FS	Red	Failsafe, analog and digital outputs set to 0
ID-PLUG		
ID	Green/yellow/ red	ID plug status (normal operation)
	Green ON	ID plug was read successfully
	Yellow ON	ID plug is being read
	Red ON	ID plug cannot be read
	OFF	ID plug not present
	Green/yellow/ red	ID plug status (clear mode/Bluetooth network login) Please observe the information in the “Clearing and reprogramming function” section.
	Flashing green	Ready for Bluetooth network login
	Yellow ON	Ready to clear/program the ID plug

Designation	LED color	Meaning
LINK QUALITY		
LQ		Quality of the Bluetooth connection (bit error rate; BER)
	4 green LEDs	BER 0% ... 0.05%
	3 green LEDs	BER 0.05% ... 0.1%
	2 green LEDs	BER 0.1% ... 1.7%
	1 green LED	BER > 1.7%
	4 LEDs OFF	No Bluetooth connection established

If the error LED (E) of a group of 16 outputs lights up (e.g., connector 2 and connector 3), this indicates that a short circuit or overload is present at one or more of the outputs in this group.

6 Connecting the supply, actuators, and sensors

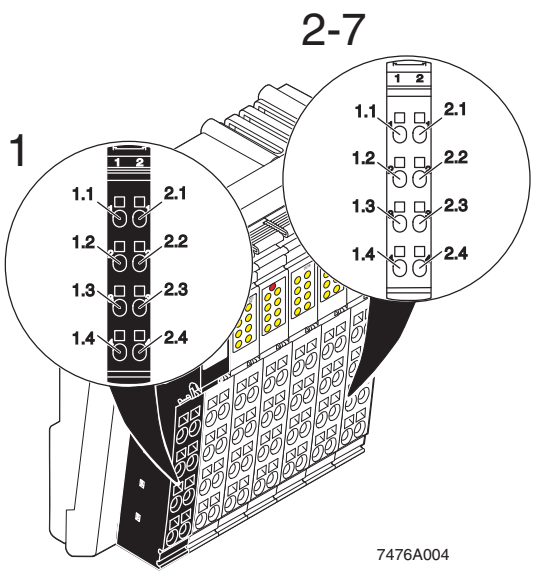


Figure 4 Terminal point assignment of the connectors

NOTE: Device damage

The terminal points for GND and U_L can have a total current of 8 A per terminal point. The maximum current carrying capacity of 8 A must not be exceeded.

The feeding points have the same ground potential. All ground supplies on a module are electrically connected with one another.
The communications power is also electrically connected via all contacts. In this way, it can supply all potentials with just one supply without the need for additional terminals, see “Connection example for the supply” on page 16.

Terminal point assignment of the power connector

Terminal point	Assignment
Connector 1 (PWR)	
1.1, 2.1	24 V actuator supply U_A
1.2, 2.2	24 V communications power U_L
1.3, 2.3	GND
1.4, 2.4	FE

Terminal point assignment of the digital output and input connectors

Connector 2 (OUT1)				Connector 3 (OUT2)				Connector 4 (IN1)				Connector 5 (IN2)			
1.1	O1	**2.1**	O2	**1.1**	O9	**2.1**	O10	**1.1**	I1	**2.1**	I2	**1.1**	I9	**2.1**	I10
1.2	O3	**2.2**	O4	**1.2**	O11	**2.2**	O12	**1.2**	I3	**2.2**	I4	**1.2**	I11	**2.2**	I12
1.3	O5	**2.3**	O6	**1.3**	O13	**2.3**	O14	**1.3**	I5	**2.3**	I6	**1.3**	I13	**2.3**	I14
1.4	O7	**2.4**	O8	**1.4**	O15	**2.4**	O16	**1.4**	I7	**2.4**	I8	**1.4**	I15	**2.4**	I16

Terminal point assignment of the analog output connector

Connector 6 (analog OUT)			
1.1	+U1, voltage output, channel 1	**2.1**	+U2, voltage output, channel 2
1.2	+I1, current output, channel 1	**2.2**	+I2, current output, channel 2
1.3	AGND, analog ground	**2.3**	AGND, analog ground
1.4	Shield connection	**2.4**	Shield connection

Terminal point assignment of the analog input connector

Connector 7 (analog IN)			
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	AGND, analog ground	**2.3**	AGND, analog ground
1.4	Shield connection	**2.4**	Shield connection

7 Internal basic circuit diagram

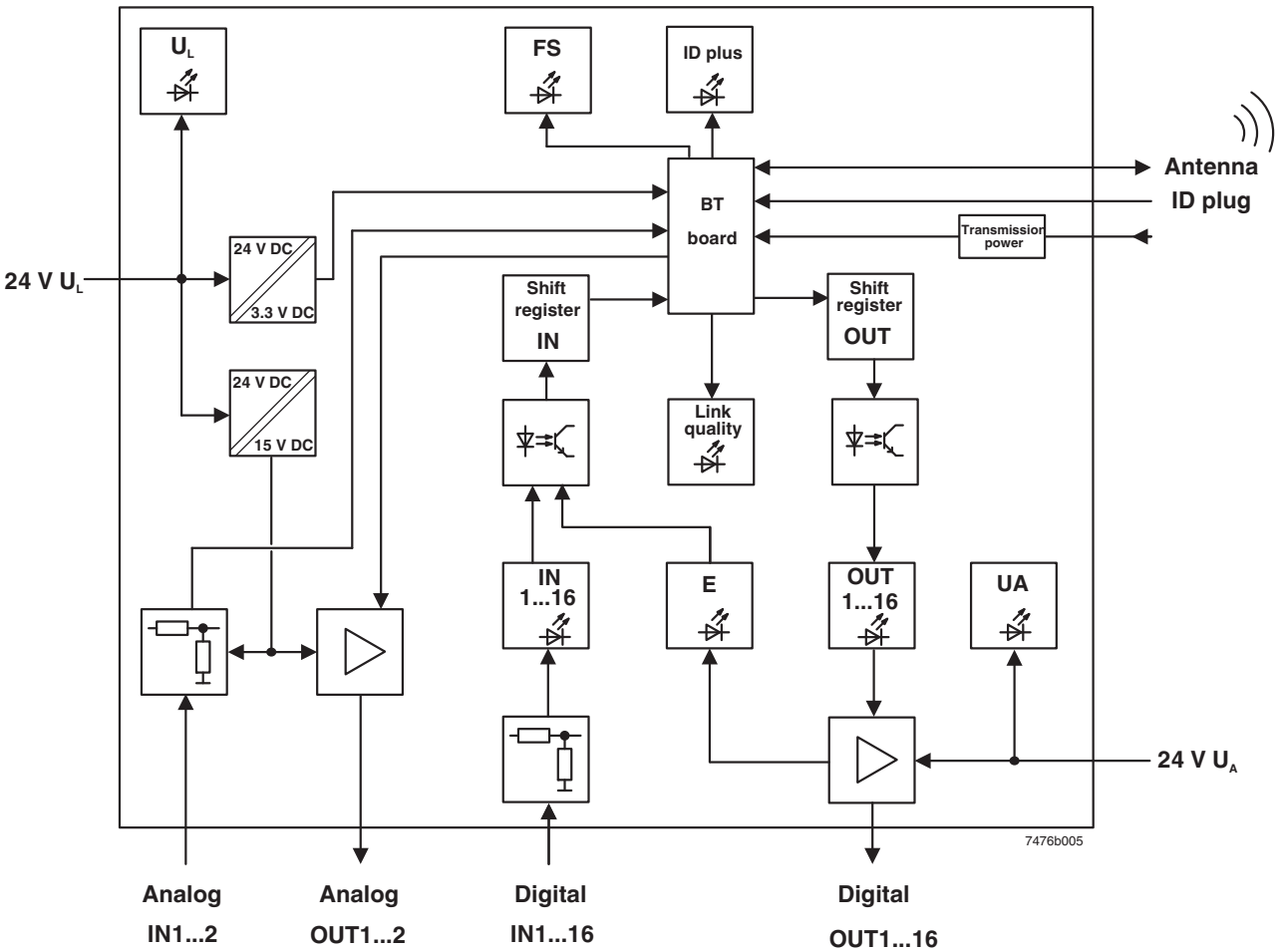


Figure 5 Internal wiring of the terminal points

Key:

	Power supply unit with electrical isolation
	Optocoupler
	Input filter
	Output driver

8 Connection example

The numbers above the module illustration identify the connector slots.

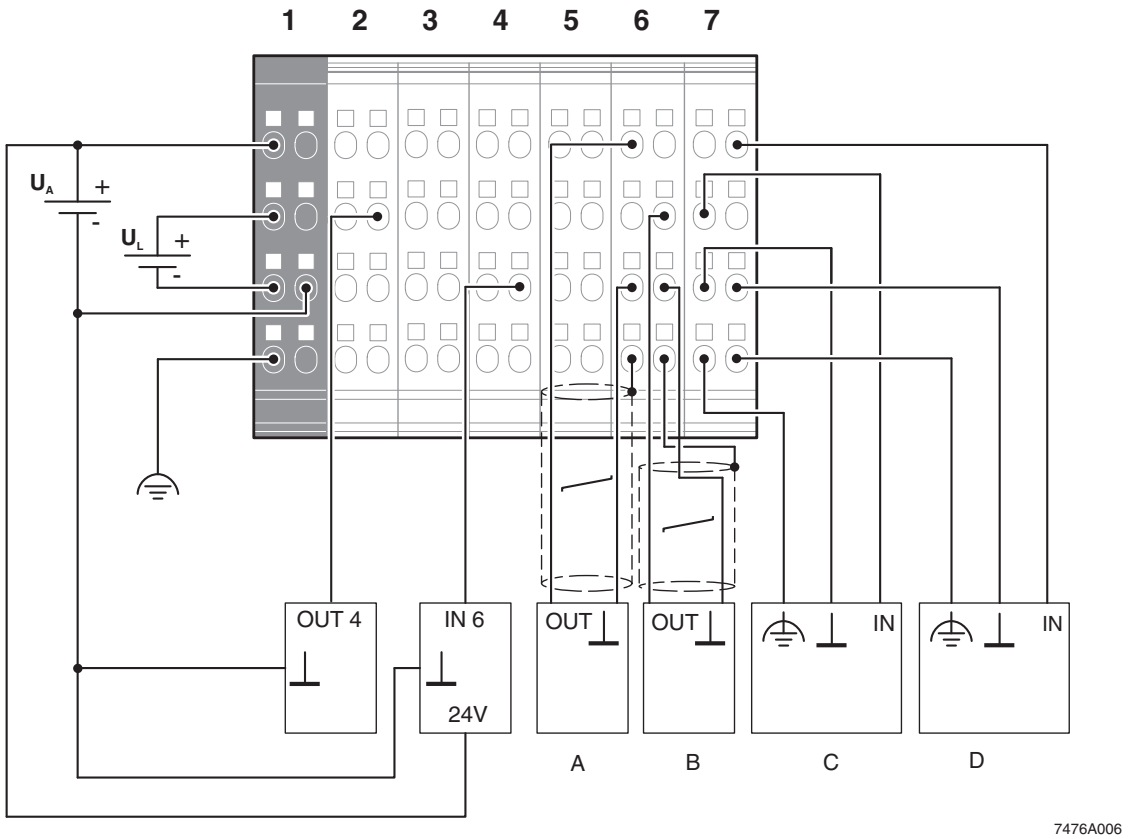


Figure 6 Connection example for the supply

Key:

A: Actuator at the voltage output (channel 1)
B: Actuator at the current output (channel 2)
C: Active sensor with current output (channel 1)
D: Active sensor with voltage output (channel 2)

9 Startup with the Fieldline base station (observe compatibility table)

The ID plug is programmed on the base station. For additional information, refer to the data sheet for the FLM BT BS 3 base station.
The base station requires version 01/1.20/1.10 or later (HW/FW/FW) for operation of the module.

- Insert the programmed ID plug into the module before switching on the power supply.
- Switch on the supply voltage. The connection data is then read from the ID plug.
- The module connects automatically to the base station programmed on the ID plug.
- Once the connection has been established (FS LED goes off), process data is exchanged cyclically between the base station and the module.

10 Startup with the Factoryline base station

- Please observe the compatibility table.
- Insert the enclosed ID plug into the I/O device before switching on the power supply.

Following connection establishment, the ID plug is programmed by the base station via the I/O device. For additional information, refer to the data sheet for the FL BT MOD IO AP.

- Switch on the supply voltage. The Bluetooth login is started. If the ID plug is already programmed, connection data is read from the ID plug.

11 Clearing and reprogramming function

- When replacing the Factoryline base station in the existing Bluetooth network, the ID plug needs to be reprogrammed for Bluetooth network login.
- Remove the ID plug from the I/O device and switch on the power supply. The ID LED flashes yellow for around 10 seconds. Insert the ID plug during this time. The ID plug is cleared and reprogrammed. The ID LED flashes green to indicate successful programming. The I/O device is ready again for Bluetooth network login.

As a rule, if the ID plug is not inserted in the I/O device when the power supply is switched on, the clearing and reprogramming function will start briefly. If an ID plug is inserted during this time, it will be cleared and reprogrammed for Bluetooth network login mode. Any previous connection data will be lost.

12 Compatibility table

Fieldline Modular Bluetooth base station

Base station	I/O device	Compatibility
FLM BT BS3 M12 Version HW/FW/FW	ILB BT ADIO 2-2-16-16 Version HW/FW	
00/1.10/1.10	00/1.00	No
	01/2.00	No
01/1.10/1.10	00/1.00	No
	01/2.00	No
01/1.20/1.10	00/1.00	Yes, with limited I/O device functions and diagnostics
	01/2.00	No
01/1.30/2.00	00/1.00	Yes
	01/2.00	Yes

12.1 Factoryline Bluetooth base station

Base station	I/O device	Compatibility
FL BT MOD IO AP Version HW/FW	ILB BT ADIO 2-2-16-16 Version HW/FW	
1.0/1.xx	00/1.00	No
	01/2.00	Yes

13 Process data

The module process data is integrated into the process data of the base station.

Input process image

	Word 2															
Bit	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Assignment	OUT 16	OUT 15	OUT 14	OUT 13	OUT 12	OUT 11	OUT 10	OUT 9	OUT 8	OUT 7	OUT 6	OUT 5	OUT 4	OUT 3	OUT 2	OUT 1

	Word 3															
Bit	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Assignment	Analog channel 1															

	Word 4															
Bit	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Assignment	Analog channel 2															

Output process image

	Word 2															
Bit	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Assignment	OUT 16	OUT 15	OUT 14	OUT 13	OUT 12	OUT 11	OUT 10	OUT 9	OUT 8	OUT 7	OUT 6	OUT 5	OUT 4	OUT 3	OUT 2	OUT 1

	Word 3															
Bit	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Assignment	Analog channel 1															

	Word 4															
Bit	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Assignment	Analog channel 2															

14 Diagnostics

Error table with status indicators

Error type	Diagnostic data	Status indicators
Communications power U_L too low	None	UL LED is OFF.
Sensor supply U_A too low	None	UA LED is OFF.
Short circuit/overload of a digital output	I/O error message	E LED of the affected output group is red.
Wireless connection aborted	I/O error message	FS LED is ON.

15 Antennas

The aim of Phoenix Contact wireless transmission solutions is to provide users with the simplest possible access to the wireless transmission medium.

This explanation of the complex area of antenna technology will therefore be kept as simple as possible. However, in order to build reliable systems, a few basic properties of antenna technology must be taken into account.

Antenna alignment

When installing two antennas, it is generally desirable to have a line of sight between them wherever possible, as any obstacles between the antennas will adversely affect the connection.

The Fresnel zone, which extends around the direct connecting line between transmitting and receiving antennas, should also be taken into account. If this zone is disturbed by any obstacles or the terrain, this will adversely affect the wireless connection.

Figure 7 illustrates an ideal installation with undisturbed connection.

In Figure 8, the Fresnel zone is adversely affected by the terrain. The low height of the antenna masts still allows for a line of sight, but the Fresnel zone is not completely clear.

In Figure 9, the connection is attenuated by obstacles in the Fresnel zone, even though there is a line of sight.

The radius of the Fresnel zone depends on the transmission frequency and the distance between the transmitting and receiving antennas.

The radius R corresponds to the minimum height of the antenna mast (if the terrain is flat). For a 2.4 GHz system, the mast height R/m, depending on the distance to be covered D/m, is given in the characteristic curve in Figure 10.

Example (Figure 10):

For a distance of 100 m, the antenna should be installed at a minimum height of 1.80 m to provide a clear Fresnel zone.

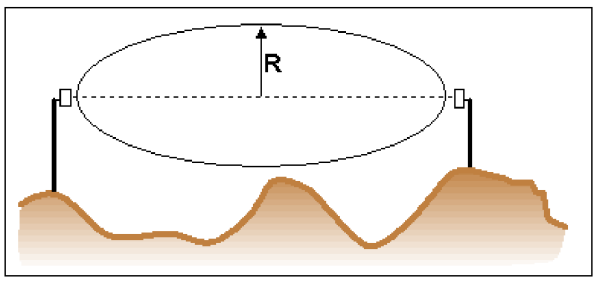


Figure 7 Ideal antenna installation

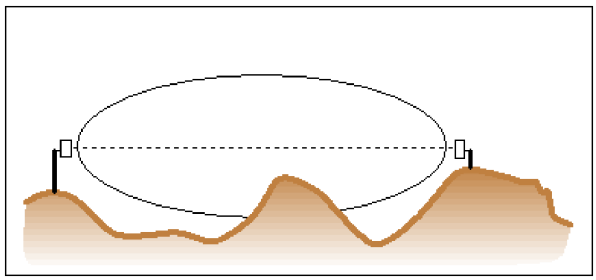


Figure 8 Fresnel zone adversely affected by the terrain

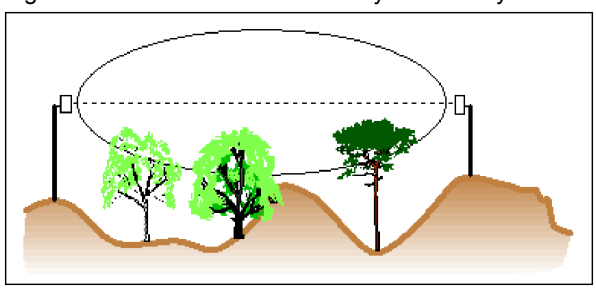


Figure 9 Fresnel zone adversely affected by obstacles

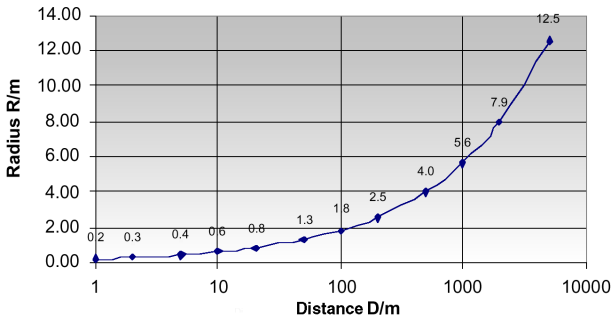


Figure 10 Radius R of the Fresnel zone over distance D