

ILB BT ADIO MUX...

Wireless-MUX module with 16 digital inputs, 16 digital outputs, 2 analog inputs, and 2 analog outputs

Data sheet
7173_en_11

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1 Description

The set consists of two modules that form a fixed pair as the master and slave.

The Wireless-MUX module transmits 16 digital and 2 analog signals bidirectionally by means of wireless communication. It therefore replaces a 40-wire signal cable. The wireless solution has been developed specifically for use under industrial conditions. It is reliable, robust, and easy to handle.

Features

- Easy startup, plug and play
- Bar graph for wireless diagnostics
- Range of up to 400 m outdoors
- 16 digital inputs
- 16 digital outputs
- Diagnostic and status indicators
- 2 analog single-ended signal inputs for the connection of either voltage or current signals
- 2 analog single-ended signal outputs for the connection of either voltage or current signals



Please note the maximum permissible transmission power for the country of use.
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3 Ordering data

Description	Type	Order No.	Pcs./Pkt.
Wireless-MUX set, two modules with 16 digital inputs and outputs and 2 analog inputs and outputs (0 ... 20 mA, 0 ... 10 V) each, incl. omnidirectional antennas with 1.5 m cable	ILB BT ADIO MUX-OMNI	2884208	1
Wireless-MUX set, two modules with 16 digital inputs and outputs and 2 analog inputs and outputs (0 - 20 mA, 0 - 10 V) each, without antennas	ILB BT ADIO MUX	2702875	1
Accessories	Type	Order No.	Pcs./Pkt.
Inline shield connector	IB IL SCN 6-SHIELD-TWIN	2740245	5
Connector, colored, for Inline power and segment terminal blocks	IB IL SCN-PWR IN-CP	2727637	10
Connector, for digital 1, 2 or 8-channel Inline terminals	IB IL SCN-8	2726337	10
Labeling field, width: 12.2 mm	IB IL FIELD 2	2727501	10
Insert strip, Sheet, white, unlabeled, can be labeled with: Office printing systems, CMS-P1-PLOTTER: Laser printer, Mounting type: Insert, Lettering field: 62 x 10 mm	ESL 62X10	0809492	1
Zack Marker strip, flat, white, for terminal block width: 6.2 mm	ZBF 6:SO/CMS	0808778	1
Flat zack marker sheet, white, for terminal block width: 6.2 mm	ZBFM 6:SO/CMS	0803650	1
Flat zack marker sheet, Sheet, white, unlabeled, can be labeled with: CMS-P1-PLOTTER, PLOTMARK, Mounting type: Snap into flat marker groove, for terminal block width: 6.2 mm, Lettering field: 5 x 5.5 mm	ZBFM 6/WH:UNBEDRUCKT	0803618	10
Quick mounting end clamp for NS 35/7,5 DIN rail or NS 35/15 DIN rail, with marking option, with parking option for FBS...5, FBS...6, KSS 5, KSS 6, width: 5.15 mm, color: gray End clamp, Width: 5.15 mm, Height: 35 mm, Length: 48.5 mm, Color: gray	CLIPFIX 35-5	3022276	50
Omnidirectional antenna, 2.4 GHz, 2 dBi, linear vertical, 1.5 m cable, RSMA (male), IP65, 50 Ω impedance	RAD-ISM-2400-ANT-OMNI-2-1-RSMA	2701362	1
Omnidirectional antenna with protection against vandalism, 2.4 GHz, 3 dBi gain, IP55 degree of protection, 1.5 m cable length, RSMA connection (male), h/v 360°/85° apex angle. Appropriate mounting material is available for wall mounting.	RAD-ISM-2400-ANT-VAN-3-0-RSMA	2701358	1
Omnidirectional antenna, 2.4 GHz, 6 dBi, linear vertical, opening angle 360°/30°, N (female), IP67, incl. mounting bracket and mast clips for 45 mm - 100 mm diameter, stainless steel, ATEX & IECEx approval, salt water resistant	RAD-ISM-2400-ANT-OMNI-6-0	2885919	1

Accessories	Type	Order No.	Pcs./Pkt.
Omnidirectional antenna, 2.4 GHz, 6 dBi, linear vertical, opening angle h/v 360°/20°, N (female), IP65, salt water resistant	RAD-2400-ANT-OMNI-6-0-SW	2903219	1
Dual band omnidirectional antenna with protection against vandalism; IP68 protection; frequency band/gain: 2.4 GHz/up to 6 dBi, 5 GHz/up to 8 dBi; EN 50155; temperature range: -40°C to +80°C; N (f) connection; 1 m long adapter cable, N (m) - SMA (m) connection.	RAD-ISM-2459-ANT-FOOD-6-0	2692526	1
Panel antenna, 2.4/5 GHz, 9 dBi, linear vertical, N (female), IP67, incl. mounting bracket and mast clips for 25 mm - 85 mm diameter, stainless steel, ATEX & IECEx approval	ANT-DIR-2459-01	2701186	1
Adapter cable as control cabinet feed-through, N (female) -> RSMA (male), impedance: 50 Ω, length: 0.5 m	RAD-PIG-EF316-N-RSMA	2701402	1
Antenna cable, 0.5 m in length; N (male) -> RSMA (male), impedance 50 ohms	RAD-PIG-RSMA/N-0.5	2903263	1
Antenna cable, 1 m in length; N (male) -> RSMA (male), impedance 50 ohms	RAD-PIG-RSMA/N-1	2903264	1
Antenna cable, 2 m in length; N (male) -> RSMA (male), impedance 50 ohms	RAD-PIG-RSMA/N-2	2903265	1
Antenna cable, 3 m in length; N (male) -> RSMA (male), impedance 50 ohms	RAD-PIG-RSMA/N-3	2903266	1
Antenna cable, 5 m in length; N (male) -> RSMA (male), impedance 50 ohms	RAD-PIG-RSMA/N-5	2702140	1
Attachment plug with Lambda/4 technology as surge protection for coaxial signal interfaces. Connection: N connectors socket-socket	CN-LAMBDA/4-5.9-BB	2838490	1
Adapter, N (female) -> N (female); insertion attenuation < 0.3 dB at 2.4 GHz	RAD-ADP-N/F-N/F	2867843	1
Adapter, RSMA (male) -> RSMA (female) 90°; Insertion loss < 0.3 dB at 2.4 GHz	RAD-ADP-RSMA/M-RSMA/F-90	2904790	1
Antenna cable, 3 m in length, N (male) -> N (male), 50 Ω impedance	RAD-CAB-EF393-3M	2867649	1
Antenna cable, 5 m in length, N (male) -> N (male), 50 Ω impedance	RAD-CAB-EF393-5M	2867652	1
Antenna cable, 10 m in length, N (male) -> N (male), 50 Ω impedance	RAD-CAB-EF393-10M	2867665	1
Antenna extension cable, 15 m in length, N (male) -> N (male), 50 Ω impedance	RAD-CAB-EF393-15M	2885634	1

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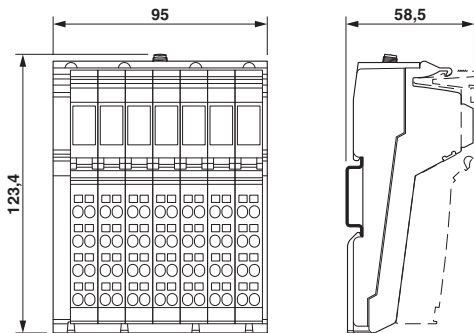
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Accessories	Type	Order No.	Pcs./Pkt.
Control box for robust construction of wireless systems for industrial applications, IP66, 25 x 18 x 13 cm, polycarbonate material, gray, drilled, incl. DIN rail, plugs, and screw connections, without devices	FL RUGGED BOX	2701204	1
Set for mast mounting of the FL RUGGED BOX housing, incl. screw clamps for masts up to 89 mm	FL RUGGED BOX POLE SET	2701205	1
Vulcanizing sealing tape for external protection of adapters, cable connections, etc. against the effects of weather, roll length: 3 m	RAD-TAPE-SV-19-3	2903182	1

4 Technical data

Dimensions



Dimensions W/H/D	95 mm / 123.4 mm / 57 mm
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General data

Overvoltage category	II
Degree of protection	IP20
Protection class	III
Degree of pollution	2
Housing material	PA 6.6-FR
Weight	274 g
Vibration resistance in acc. with EN 60068-2-6/ IEC 60068-2-6	5g
Shock in acc. with EN 60068-2-27/IEC 60068-2-27	25g, 11 ms period, half-sine shock pulse
MTTF (mean time to failure) Telcordia standard, 25°C temperature, 21% operating cycle (5 days a week, 8 hours a day)	1458 Years
MTTF (mean time to failure) Telcordia standard, 40°C temperature, 34.25% operating cycle (5 days a week, 12 hours a day)	557 Years
MTTF (mean time to failure) Telcordia standard, temperature 40 °C, operating cycle 100 % (7 days a week, 24 hours a day)	219 Years

Power supply for module electronics	
Supply voltage	24 V DC
Supply voltage range	19.2 V DC ... 30.5 V DC (via power connector)
Current consumption	60 mA (Communications power at 24 V DC, 25 °C)
	25 mA (Actuator supply, +load current Digital OUT (8 A))
Protective circuit	Polarity protection, surge protection
Connection method	Inline connector

Wireless interface	
Frequency range	2.402 GHz ... 2.48 GHz (ISM bandwidth)
Channel distance	2 MHz
No. of channels	40
Modulation type	GFSK (Gaussian Frequency Shift Keying)
Transmission power	5 dBm
Receiver sensitivity	-95 dBm
Antenna connection method	RSMA (female)

Digital inputs	
Number of inputs	16
Connection method	Spring-cage connection
Connection method	1-wire
Input voltage range "0" signal	< 5 V
Input voltage range "1" signal	> 15 V
Common potentials	Ground
Nominal input voltage U_{IN}	24 V DC
Typical input current per channel	2.3 mA
Permissible conductor length to the sensor	100 m
Use of AC sensors	AC sensors in the voltage range < U_{IN} are limited in application (according to the input design)

Digital outputs	
Number of outputs	16
Connection method	Spring-cage connection
Connection method	1-wire
Nominal output voltage	24 V DC
Voltage difference with nominal current	≤ 1 V
Protective circuit	Short-circuit protection, overload protection, protected against reverse voltages
Maximum output current per channel	500 mA
Output current	8 A
Nominal load, ohmic	12 W (48 Ω)
Nominal load, lamp	12 W
Nominal load, inductive	12 VA (1.2 H, 50 Ω)
Operating frequency with inductive nominal load	0.5 Hz
Behavior with overload	Auto restart

Digital outputs	
Behavior with inductive overload	Output can be destroyed
Reverse voltage resistance to short pulses	Reverse voltage proof
Resistance to permanent reverse voltage	≤ 2 A
Behavior at voltage switch-off	The output follows the power supply without delay
Overcurrent shut-down	≥ 0.7 A
Output current when switched off	$\leq 10 \mu\text{A}$ (When not loaded, a voltage can be measured even at an output that is not set.)

Analog inputs	
Number of inputs	2
Description of the input	Single ended
Measured value resolution	12 bits
Current input signal	0 mA ... 20 mA
Input resistance current input	110 Ω (Shunt)
Voltage input signal	0 V ... 10 V
Input resistance of voltage input	> 150 k Ω
Type of protection	Suppressor diodes in the analog inputs, current limitation via internal protective circuit

Analog outputs	
Number of outputs	2
DAC resolution	12 Bit
Current output signal	0 mA ... 20 mA
Load/output load current output	$\leq 500 \Omega$
Voltage output signal	0 V ... 10 V
Load/output load voltage output	≥ 2 k Ω
Type of protection	Transient protection

Test voltage	
Test voltage	500 V AC (50 Hz, 1 min.)

Ambient conditions	
Ambient temperature (operation)	-25 °C ... 60 °C
Ambient temperature (storage/transport)	-25 °C ... 85 °C
Permissible humidity (operation)	95 % (non-condensing)
Permissible humidity (storage/transport)	95 %
Air pressure (operation)	795 hPa ... 1080 hPa (up to 2000 m above mean sea level)
Air pressure (storage/transport)	66 kPa ... 108 kPa (up to 3500 m above mean sea level)

Certification

Conformance	FCC Directive, Part 15.247 ISC Directive RSS 210 EAC
UL, USA/Canada	UL 508 Listed

Emitted interference in acc. with EN 61000-6-4

Emitted radio interference in acc. with EN 55011	EN 55011 class A industrial area of application
Interference emission	EN 61000-6-4

Conformance

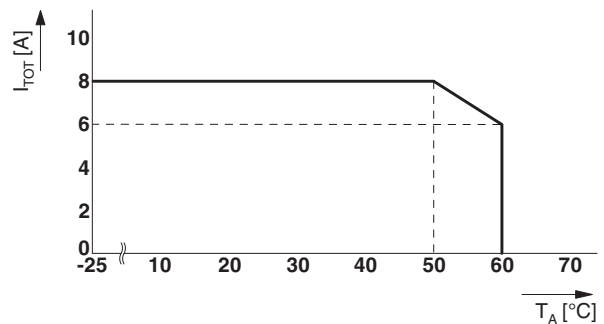
Effective use of the radio spectrum according to	EN 300328
Noise immunity according to	EN 61000-6-2
Noise emission according to	EN 61000-6-4
Health according to	EN 50385
Electrical safety according to	EN 60950-1

Limitation of simultaneity, derating

No limitation of simultaneity

Derating of outputs

Ambient temperature T_A	Total current I_{tot}
-25 °C ... +50 °C	8 A
+50 °C ... +60 °C	$8 A - ((T_A - 50 °C) \times 0.2 A/°C)$



Tolerance of analog inputs and outputs

An analog channel consists of an input and output. The tolerance values refer to the measuring range final value. They include all tolerances of the input and output.

Precision	0.3%, typical; 0.6%, maximum
Temperature response	220 ppm/°C

5 Safety regulations and installation notes

5.1 Intended use

The devices are intended for application in industrial environments.

The wireless system is Class A equipment and may cause radio interference in residential areas. In this case, the operator may be required to implement appropriate measures and to pay the costs incurred as a result.

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 Ny Ålesund town center.
- Turkey:** The device must only be operated with Phoenix Contact antennas - according to the regulations in Gazette "Short Range Radio Devices (SRD) Regulations" no. 26464 dated 16/03/2007.

Please note that, in combination with antennas, the maximum permissible transmission power may be exceeded. In this case, set the transmission power via the software.



Install the wireless module at least 1 m away from other devices using the 2.4 GHz frequency band (e.g., WLAN, Bluetooth, microwave ovens). Otherwise, both the transmission quality and data transmission rate will be reduced.

5.2 Installation notes



WARNING:

Observe the following safety notes when using the device.

- Installation, operation, and maintenance may only be carried out by qualified electricians. Follow the installation instructions as described.
- When installing and operating the device, the applicable regulations and safety directives (including national safety directives), as well as general technical regulations, must be observed. The technical data is provided in the package slip and on the certificates (conformity assessment, additional approvals where applicable).
- The device must not be opened or modified. Do not repair the device yourself, replace it with an equivalent device. Repairs may only be carried out by the manufacturer. The manufacturer is not liable for damage resulting from violation.
- The IP20 protection (IEC 60529/EN 60529) of the device is intended for use in a clean and dry environment. The device must not be subject to mechanical strain and/or thermal loads, which exceed the limits described.
- The device complies with the EMC regulations for industrial areas (EMC class A). When using the device in residential areas, it may cause radio interference.
- The device is only intended for operation in the control cabinet and with SELV according to IEC 60950/EN 60950/VDE 0805. The device may only be connected to devices, which meet the requirements of EN 60950.
- Operation of the wireless system is only permitted when using accessories available from Phoenix Contact. The use of any other components can lead to the withdrawal of the operating license.

5.3 FCC approval

This device complies with Part 15 of the FCC rules and Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference.
- (2) This device must accept any interference received, including interference that may cause undesired operation.



NOTE: Interference

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case, the user will be required to correct the interference at his own expense.

Any changes or modifications not explicitly approved by Phoenix Contact could cause the device to cease to comply with FCC rules Part 15, and thus void the user's authority to operate the equipment.

Radio frequency exposure:

The device contains a radio transmitter and receiver. During communication the device receives and transmits radio frequency (RF) electromagnetic fields (microwaves) in the frequency range of 2400 MHz to 2483.5 MHz.

RF Exposure Statement:

This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

5.4 Approval for Japan

Japanese Radio Law and Japanese Telecommunications Business Law Compliance

The device is granted pursuant to the Japanese Radio Law (電波法). This device should not be modified (otherwise the granted designation number will become invalid).
Contains:



6 Local diagnostic and status indicators

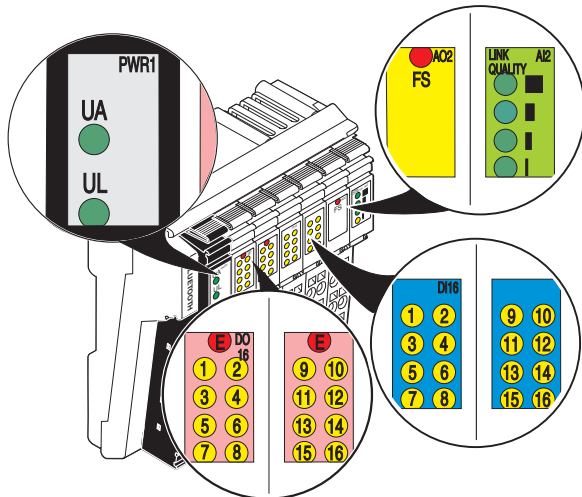


Figure 1 Diagnostic and status indicators

LED	Color	Meaning
PWR		
UA	Green	24 V actuator supply
UL	Green	24 V communications power
OUT		
E	Red	Short circuit/overload at one of the outputs
1 ... 16	Yellow	Status of the outputs
IN		
1 ... 16	Yellow	Status of the inputs
FS		
FS	Red	Wireless connection interrupted, analog and digital outputs set to 0
LINK QUALITY		
LQ	Green	Link quality (bit error rate)
	4 LEDs	0 % ... 0,05 %
	3 LEDs	0,05 % ... 1 %
	2 LEDs	0.1 % ... 1.7 %
	1 LED	>1.7 %
	OFF	No connection established



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

7 Connect supply, actuators, and sensors



CAUTION: Electric shock

The device is only intended for operation with SELV according to IEC 60950/EN 60950/VDE 0805.

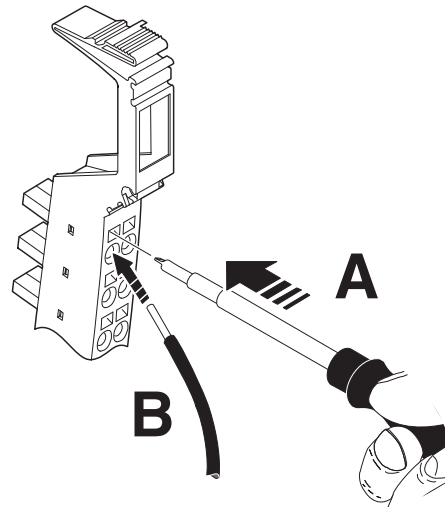
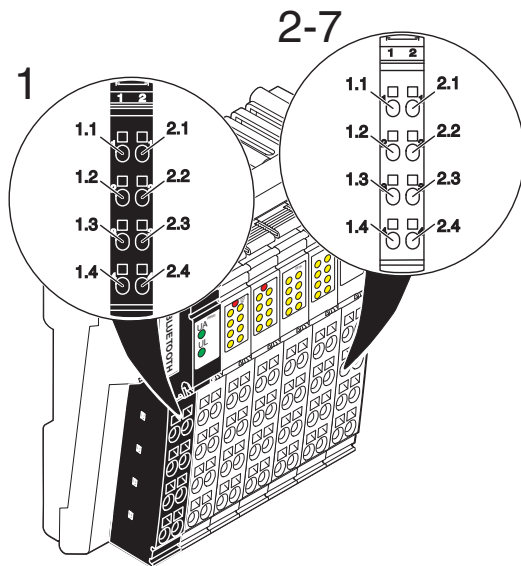


Figure 2 Connecting cables

- Strip 8 mm off the cables.
- Secure the cable by removing the screwdriver.

7.1 Terminal point assignment



NOTE: device damage
 The terminal points for GND and U_L can have a total current of 8 A per terminal point. Make sure that this value is not exceeded.

The feeding points have the same ground potential. All ground supplies on a device 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 feed-in, without the need for additional terminals.

Power plug

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

Figure 3 Terminal point assignment

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

Analog output connector

Connector 6: Analog OUT					
1.1	+U1	Channel 1 voltage output	2.1	+U2	Channel 2 voltage output
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	

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	

8 Basic circuit diagram

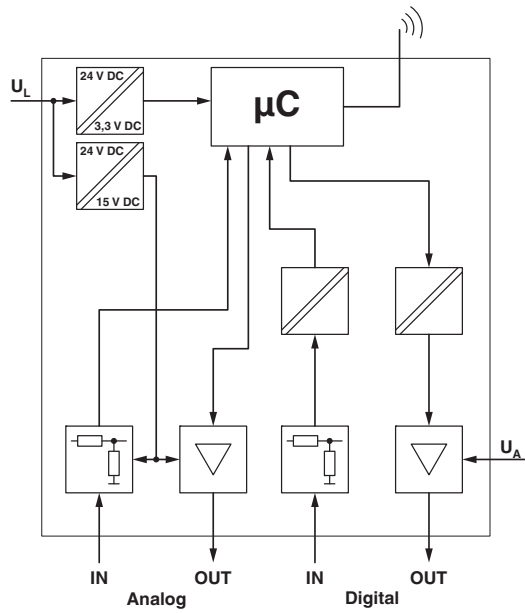


Figure 4 Basic circuit diagram

9 Connection example

The numbers above the device identify the connector slots.

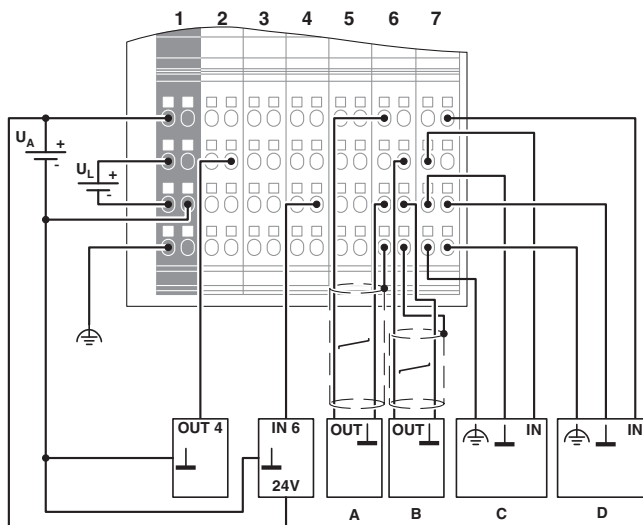


Figure 5 Connection example

- 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)

10 Assignment of terminal points to the remote station

Master	Slot	4 (IN)								5 (IN)							
	Terminal point	1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4	1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4
	LED	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Slave	Slot	2 (OUT)								3 (OUT)							
	Terminal point	1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4	1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4
	LED	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8

Slave	Slot	4 (IN)								5 (IN)							
	Terminal point	1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4	1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4
	LED	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Master	Slot	2 (OUT)								3 (OUT)							
	Terminal point	1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4	1.1	2.1	1.2	2.2	1.3	2.3	1.4	2.4
	LED	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8

Master	Slot	Connector 7: Analog IN			
	Terminal point	1.1	2.1	1.2	2.2
Slave	Slot	Connector 6: Analog OUT			
	Terminal point	1.1	2.1	1.2	2.2

Slave	Slot	Connector 7: Analog IN			
	Terminal point	1.1	2.1	1.2	2.2
Master	Slot	Connector 6: Analog OUT			
	Terminal point	1.1	2.1	1.2	2.2

11 Antennas

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

The Fresnel zone, which extends around the direct connecting line between transmitting and receiving antennas, should also be taken into account. For an optimum wireless connection, this zone must be free of obstacles.

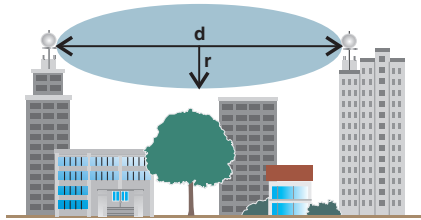


Figure 6 Fresnel zone

The radius of the Fresnel zone depends on the transmission frequency and the distance between the transmitting and receiving antennas. The radius corresponds to the minimum height of the antenna mast if the terrain is flat.

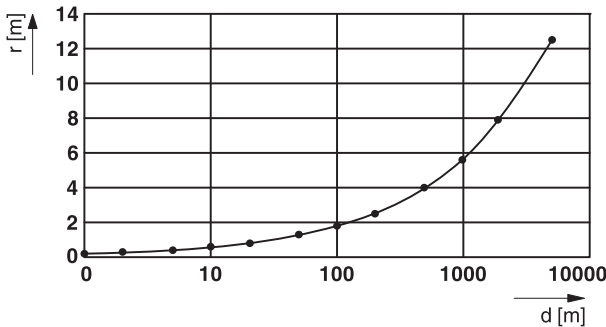


Figure 7 Radius depending on the distance

Example: for a distance of 100 meters, you must install the antenna at a minimum height of 1.8 meters. The Fresnel zone can then be formed.

11.1 Omnidirectional antennas

Areas of application for omnidirectional antennas:

- Where the position of the transmitter and receiver may change, e.g., in moving applications
- In applications with no line of sight, because the signal then travels from the transmitter to the receiver via reflections

Assembly

Choose a location that provides a clear signal path in the direction of the partner antenna. The ideal installation location is the top of a mast or on a control cabinet. This ensures that the antenna has the largest possible amount of free space around it.

In this case, an omnidirectional antenna has almost uniform directional characteristics over 360° on the horizontal plane. Unfortunately, optimum installation of the antenna is not always possible. If an omnidirectional antenna is mounted on the side of a mast or control cabinet, specific distances must be observed.

	1	2
A	Antenna	Antenna
B	Mast or surface (diameter or width)	
C	Antenna distance = 3 cm	Antenna distance = 6 cm

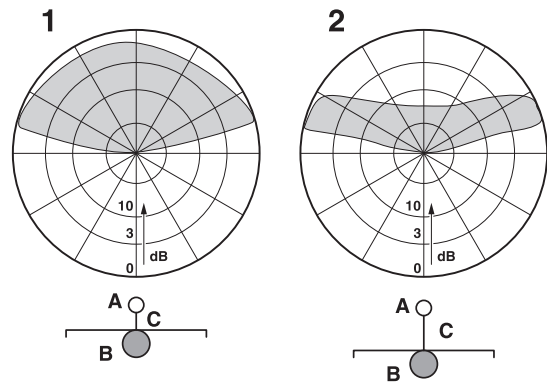


Figure 8 Antenna with preferred direction (1) and antenna with substantially reduced range (2)

- In order to achieve a high transmission speed, observe the Link Quality display during startup.
- Install the antennas in such a way that at least three LEDs light up.

Depending on the system, occasional fluctuations in the display may occur during operation.

RAD-ISM-2400-ANT-OMNI-2-1-RSMA omnidirectional antenna (supplied as standard)

Order No.	2701362
Temperature range	-20 °C ... +65 °C
Degree of protection	IP65
Impedance	50 Ω
Gain	2 dBi
Cable length	1.5 m
Connection	RSMA (male)
Horizontal / vertical apex angle	360°/75°
VSWR	≤2

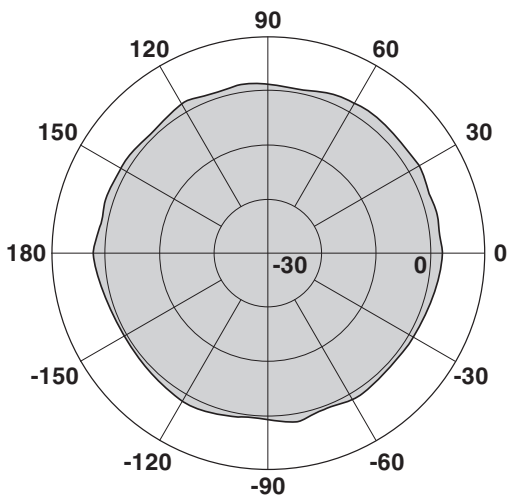


Figure 9 Horizontal

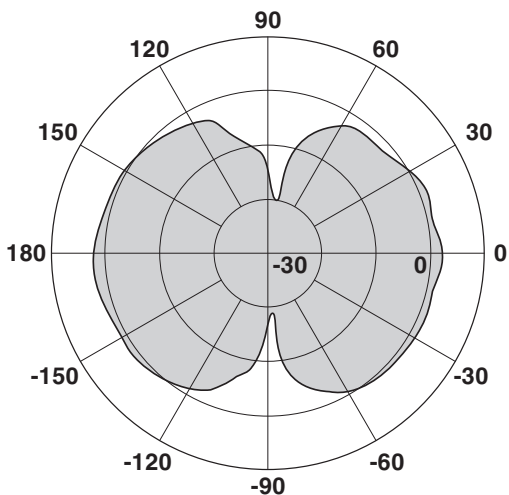


Figure 10 Vertical

Wall mounting

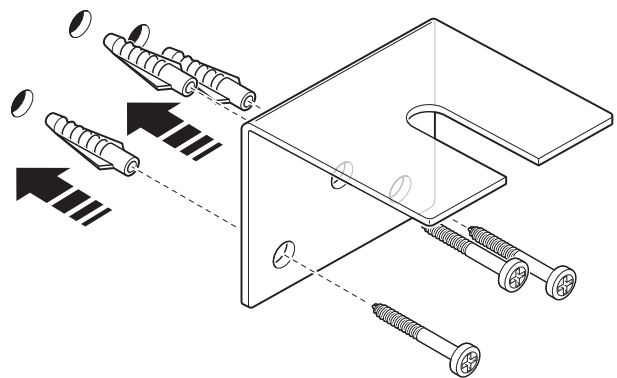


Figure 11 Mounting brackets

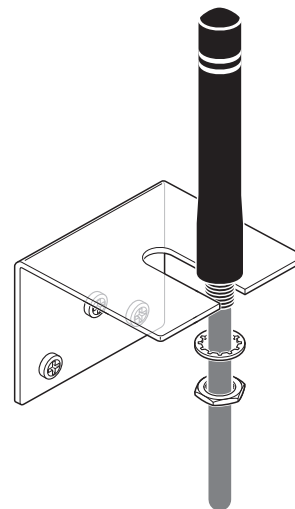


Figure 12 Wall mounting

Mounting on the control cabinet

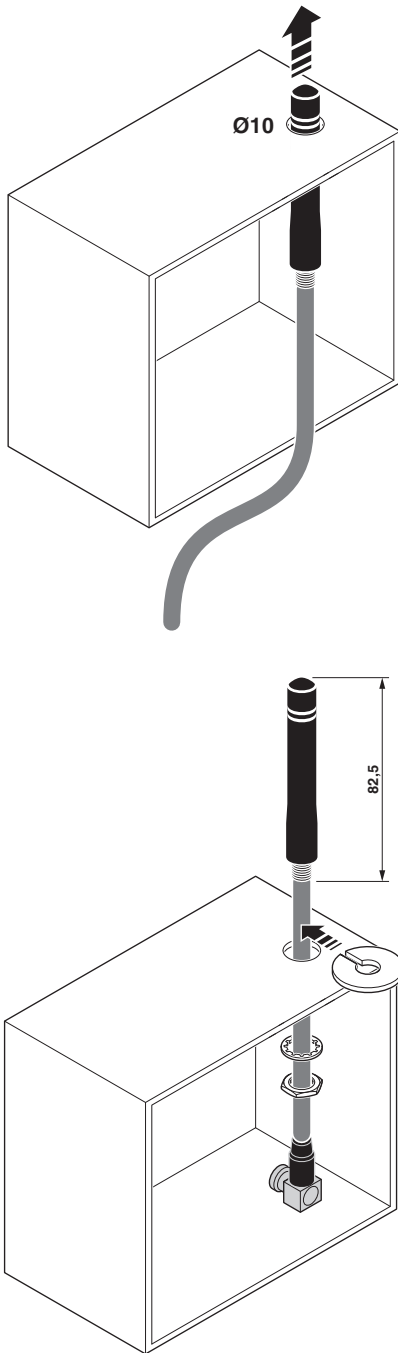


Figure 13 Control cabinet feed-through

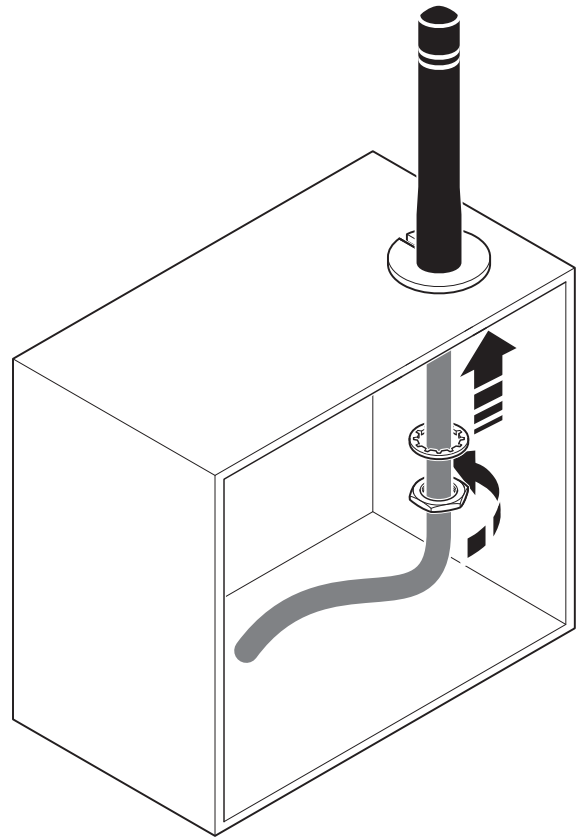


Figure 14 Mounting on the control cabinet

Preliminary

Preliminary

Preliminary

Preliminary

11.2 Range

Specifying ranges is very difficult due to the influence of various factors. Based on practical tests, it is possible to provide the following guide values. They may be significantly higher or lower depending on the actual application.

The range depends on the following:

- Length of the antenna cable (the shorter the cable, the lower the attenuation)
- Antenna used
- Mounting location
- Line of sight
- Adherence to the Fresnel zone

Antenna	Gain	Range [m]
Indoors, free line of sight		
Omnidirectional antenna	2 dBi	50 ... 100
Outdoors, free line of sight		
Omnidirectional antenna	2 dBi	< 200
Omnidirectional antenna	6 dBi	< 300
Panel directional antenna	9 dBi	< 400

In order to minimize signal losses, keep the antenna cable as short as possible.

11.3 Typical combinations of antennas and adapter cables

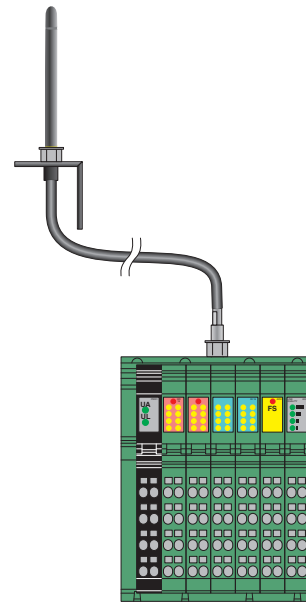


Figure 15 Omnidirectional antenna, 2 dBi, supplied as standard

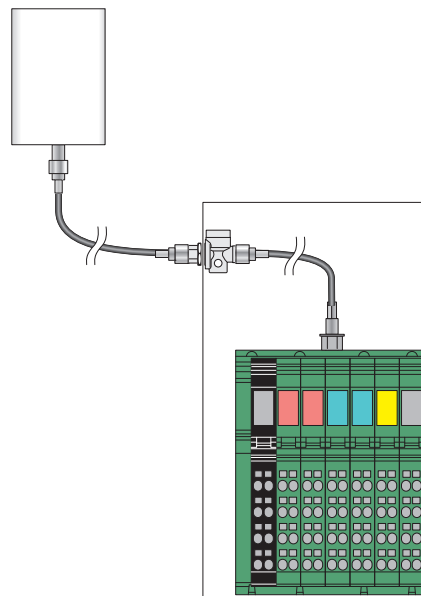


Figure 16 Directional antenna, 9 dBi, with surge protection