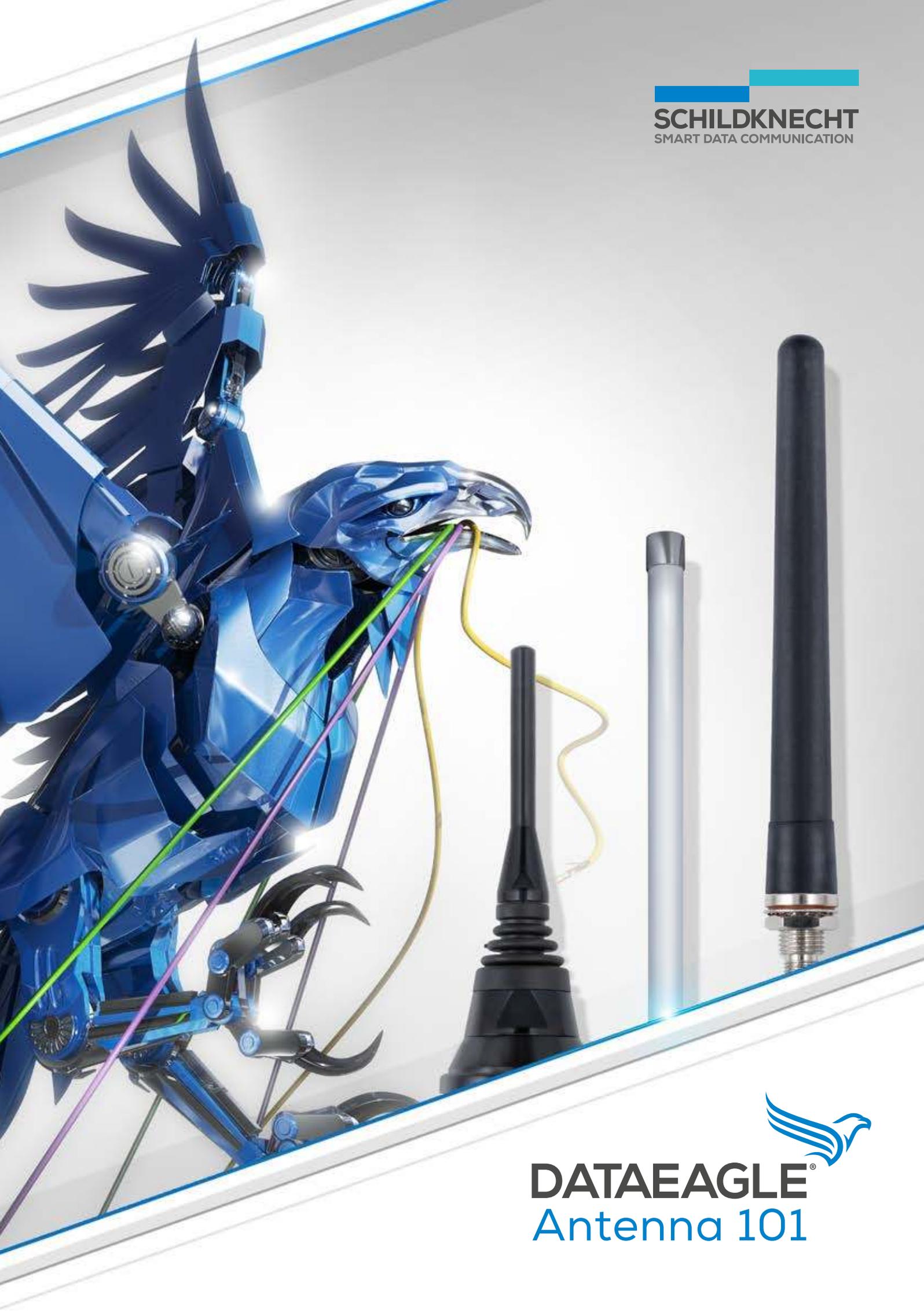


SCHILDKNECHT
SMART DATA COMMUNICATION



DATAEAGLE[®]
Antenna 101



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1. Introduction

What does an antenna do? It transmits and receives electro magnetic waves. To transmit, the antenna converts electric energy, for instance from a DATAEAGLE device, into electro magnetic waves. To receive, it works the other way round, converting electro magnetic waves into electric energy. You need to choose the right antenna and to mount it correctly to ensure the best transmission path and thus optimal conditions for data transfer.

In this Antenna 101 guide you can find all relevant technical terms explained. Also, we describe the specific antennas suited for different kinds of radio technologies. All antennas are tested and recommended by us. Furthermore you can find an overview over our antenna accessories, important information about antenna mounting together with useful mounting examples.



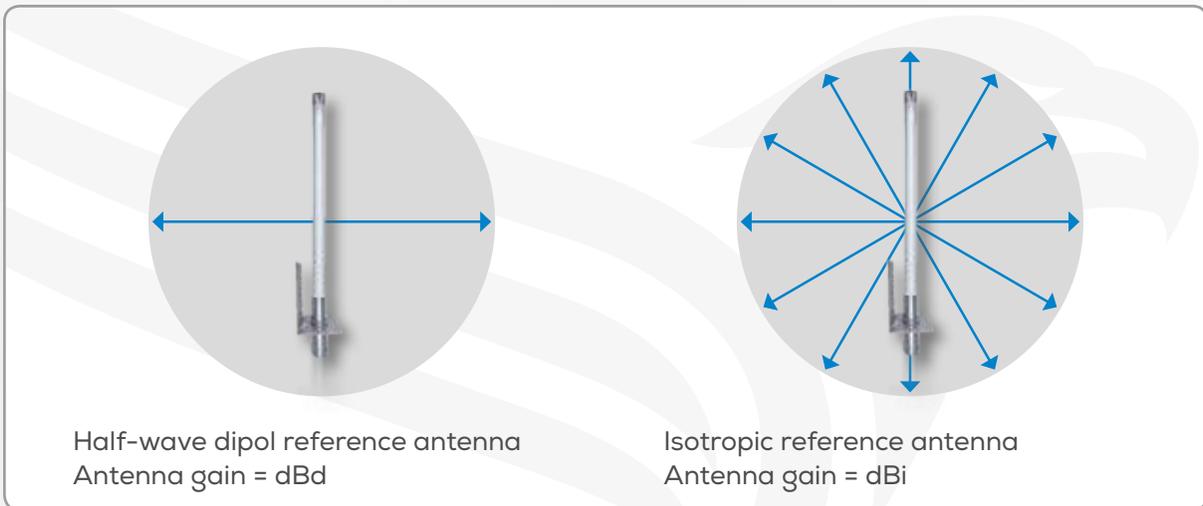


2. Technical terms

2.1 Antenna gain

The gain of an antenna indicates the increase of its transmission energy. Gain is a result of transmission energy focused through the antenna in horizontal and/or vertical direction (see 2.2 opening angle).

A ball emitter emitting transmission energy uniformly in all directions has no antenna gain (0 dBi or 0 dBd). The ball emitter is a theoretical concept used for calculating antenna gain. Omnidirectional antennas radiate transmission energy horizontally in a 360° radius, while less than 360° on a vertical axis. This means for instance that the antenna item number 10926 has an antenna gain of 2,5 dB.



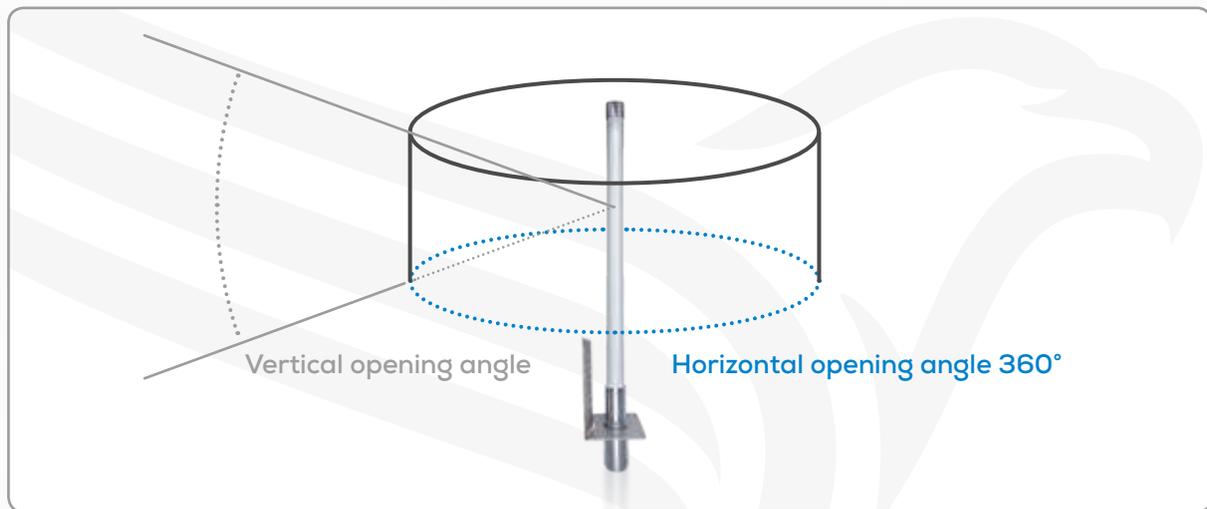
Higher antenna gain means longer reach, but with a comparatively narrower opening angle.



2. Technical terms

2.2 The radiation characteristics of an antenna

The radiation characteristics of an antenna, also called opening angle or beam width, is a graphical representation of the directivity of an antenna. The opening angle refers to the area in which you have at least half of maximum radiated power available.



The narrower the opening angle, the longer the reach.
The larger the opening angle, the shorter the reach.

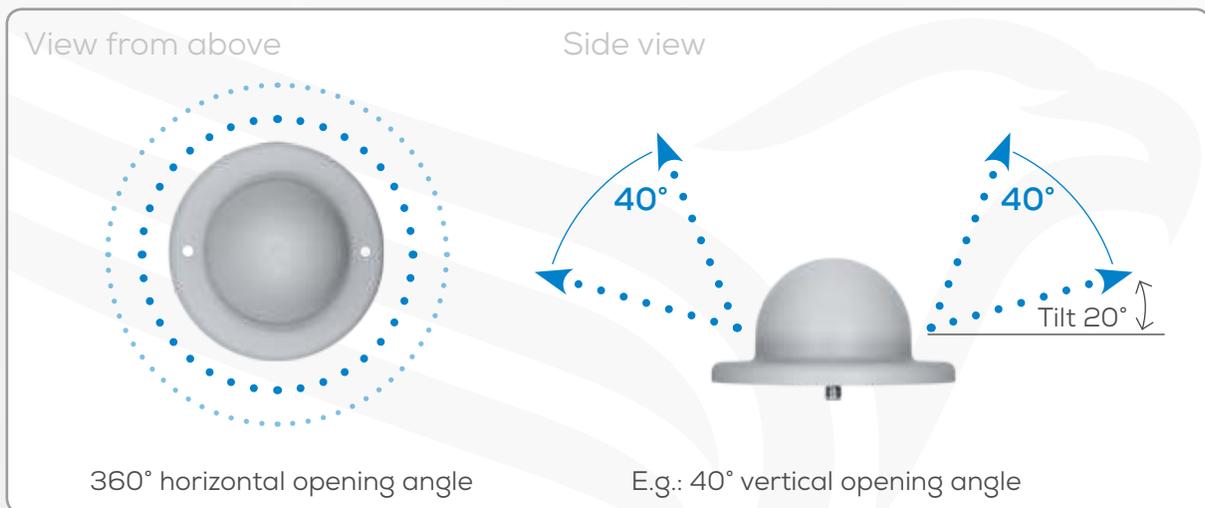


2. Technical terms

2.3 Omnidirectional antennas

An omnidirectional antenna has an even radiation pattern horizontally in all directions. That means it has a horizontal opening angle of 360° . Therefore it is often used for rotating or mobile applications.

Tilt refers to the shifting of the vertical opening angle of an omnidirectional antenna in a specific direction, related to the horizontal level. The image below shows a vertical opening angle of 40° with a tilt of 20° . This means the vertical opening angle has shifted 20° upwards.

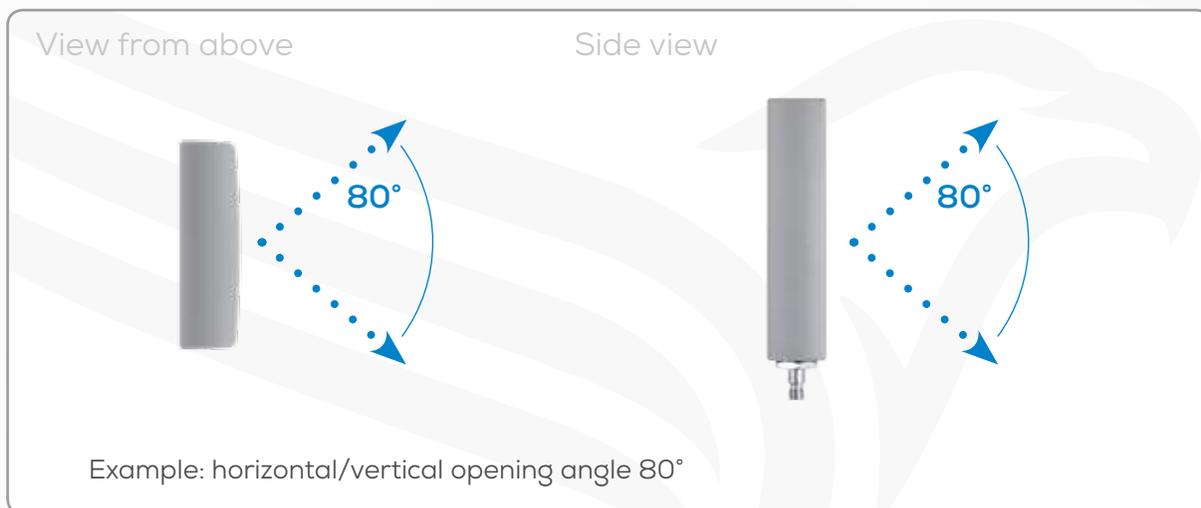




2. Technical terms

2.4 Directional antennas

A directional antenna focuses its radiation density in a specific direction. Due to its directivity, interfering transmitters placed outside of primary or secondary lobes are muted, and the antenna increases its reach in beam direction. Consequently the antenna radiates in one direction only, with an opening angle of e.g. 80°.



2.5 Transmitting power

Transmitting power, or EIRP (equivalent isotropically radiated power) indicates the actual output of the antenna. This value is a combination of the transmission power coming from the source (in this case the DATAEAGLE), minus attenuation loss coming from cable, adapter, lightning protector, plus antenna gain.

The equivalent transmitting power is regulated by law. The maximum values allowed differ depending on which frequency band is used, such as 100 mW / 20dBm on Bluetooth 2,4 GHz.



2. Technical terms

2.6 Link budget

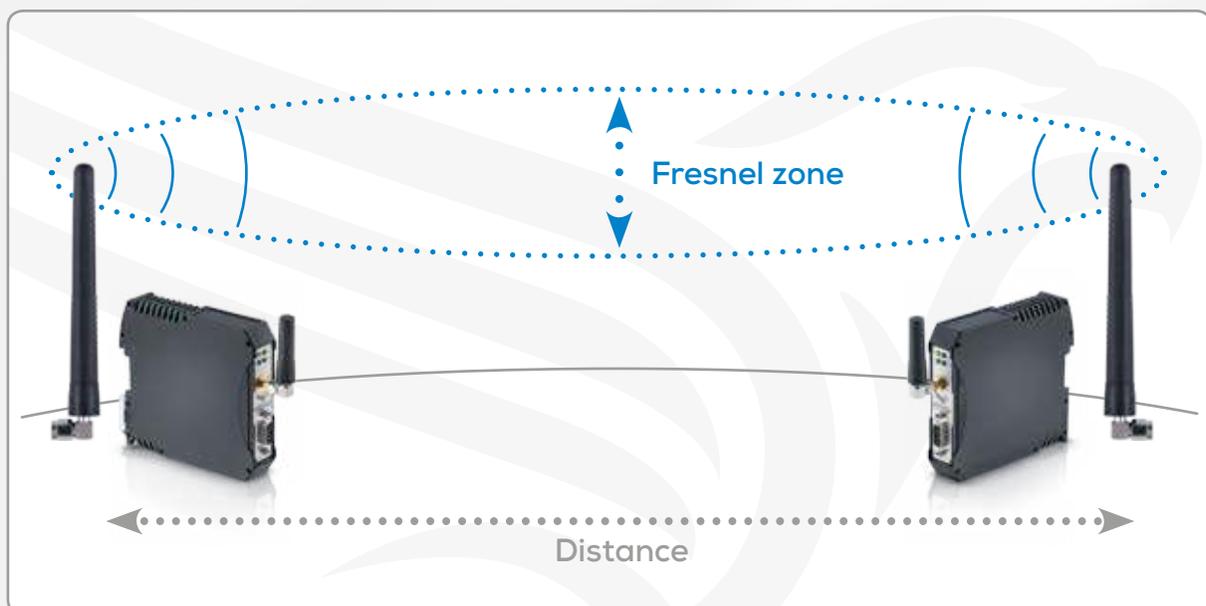
Link budget measures the difference between radiation power (EIRP) and receiver sensitivity. The link budget allows you to estimate the reach of the signal. To get a correct estimate you have to take a number of factors into account:

- Radiation power
- Antenna gain
- Receiver sensitivity
- Free space loss
- Cable attenuation

2.7 Fresnel zone

A Fresnel zone is a 3-dimensional ellipse drawn between transmitter and receiver. The radius of this zone is made up by transmission frequency and distance between the antennas. In an ideal setting there should not be any objects inside this zone. Objects inside the Fresnel zone have a negative influence on transmission range. Too many objects inside the Fresnel zone can block the connection entirely.

Example: At 2,4 GHz (DATAEAGLE with Bluetooth) and with a distance of 100m between antennas the Fresnel zone has a maximum radius of approx. 2m. At a frequency of 2,4 GHz, to ensure best possible operating conditions and longest reach, the antenna should be mounted at a height of 4 m.



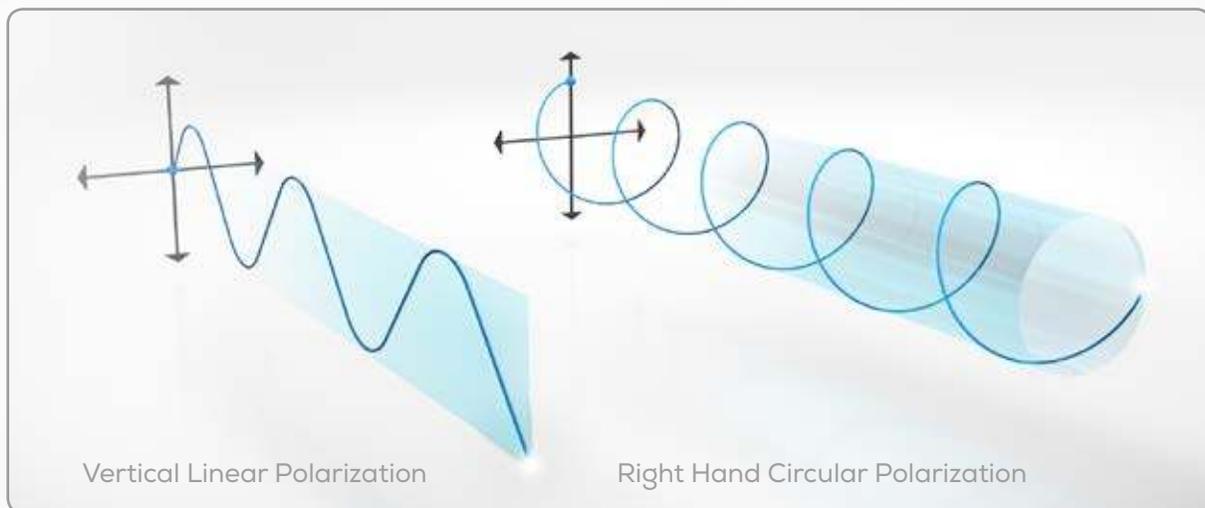


2. Technical terms

2.8 Polarization

Polarization indicates the direction of vibrations created by the electric field. You distinguish between horizontal and vertical linear polarization (VP), and right hand circular polarization (RHCP). The transmitting and the receiving antenna should have identical polarization. If you deploy unequally polarized antennas you can experience loss or no radio connection at all.

We use antennas with vertical linear polarization (VP) or right hand circular polarization (RHCP). An RHCP antenna is suitable for directional antennas with sight connection. For all other applications we recommend VP antennas.



2.9 Reflection

Reflections are disturbances that occur when radio signals meet obstacles on their way. The radio signal can be overlapped by reflections, thus causing interference.



3. Antenna assembly

3.1 DATAEAGLE device connector



The DATAEAGLE lines Compact, Classic and X-Treme all have an SMA-female port.





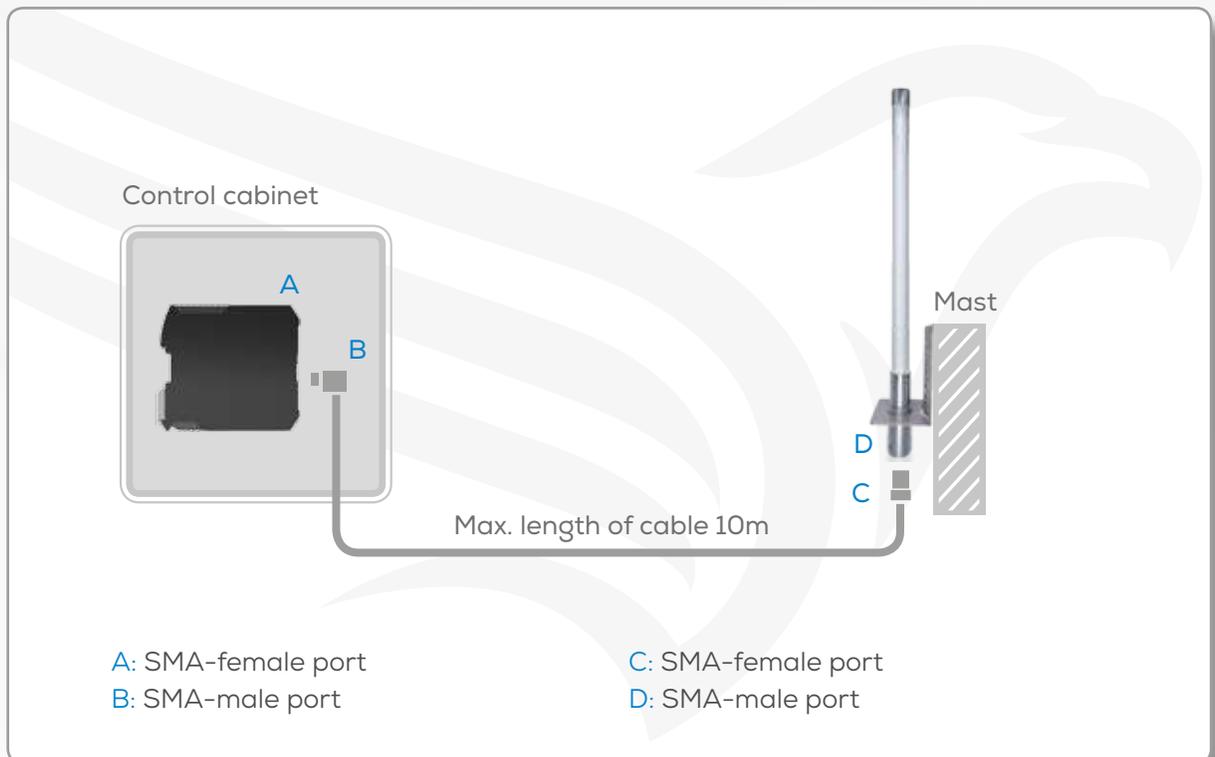
3. Antenna assembly

3.2 Antenna cabling

You can mount antennas directly on the DATAEAGLE or connect them via cable, e.g. on a control cabinet or mounted on a mast.



1. Connect the antenna cable via the antenna connection on the wireless modem (DATAEAGLE)
2. Attach the antenna at the designated spot, e.g. outside the control cabinet





3. Antenna assembly

3.3 Connections



SMA-male and SMA-female

SMA plug connectors are suited for frequency bands from 1 GHz to 18 or 26,5 GHz, dependent on model. SMA plug connectors are rather small, but yet very robust due to their screw lock.



FME-male and FME-female

These miniature plug connectors have an electrical impedance of 50Ω for frequencies up to 2 GHz.



TNC-male and TNC-female

These are coaxial plug connectors for high frequencies up to approx. 11 GHz. They are connected to each other by screw threads.



N-male and N-female

These coaxial plug connectors with screw lock are suited for frequencies up to 11 GHz. They are among the most widely used plug connectors in high-frequency engineering.



Socket: female, Plug: male



3. Antenna assembly

3.4 Antenna cables

To keep attenuation at a minimum, keep the antenna cable as short as possible. However, the most important thing is to find the perfect spot for your antenna, even if it requires a longer cable. We recommend that you keep cable length below 10m, as transmission power will decrease significantly if you choose a longer cable.



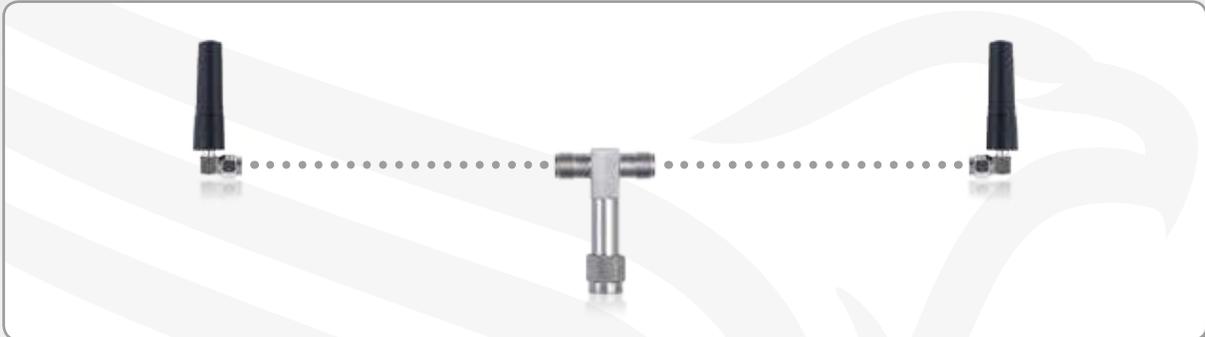
Antenna cables are very delicate and should not be bent. When installing the cable please observe its maximum bending radius of 30mm. Antenna cables should only be hand-tightened, without using tools.



3. Antenna assembly

3.5 Antenna splitter

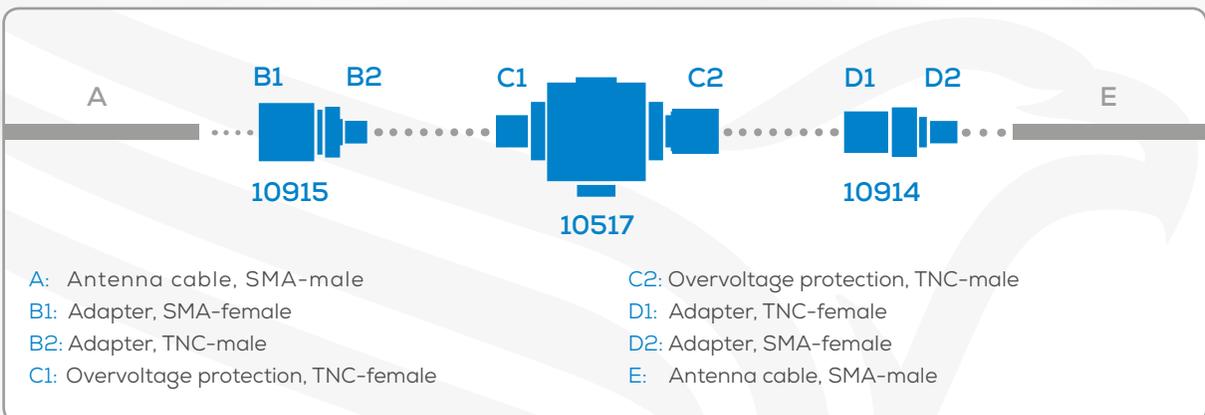
Antenna splitters offer you the opportunity to connect multiple antennas in parallel. For instance, antenna splitters are used when one antenna is mounted outside a building and another inside, e.g. at an entrance gate.



When using splitters transmission power is distributed between the connected antennas. Reach is reduced accordingly.

3.6 Overvoltage protection

The overvoltage protection is placed between the radio unit (DATAEAGLE) and the antenna.



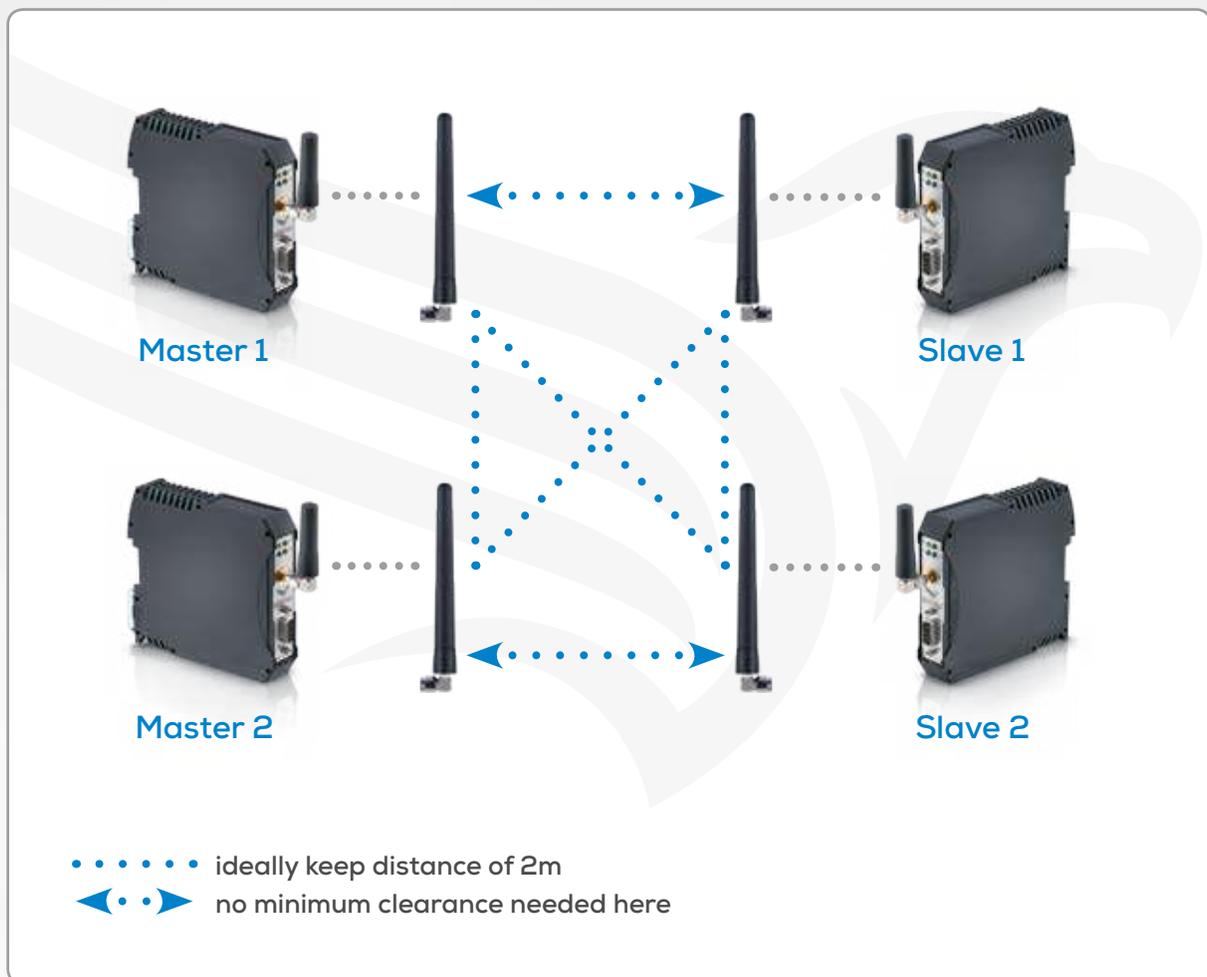
Transmission and receiving power of the antenna is dampened by the overvoltage protection and by the adapters.



4. Guidelines for antenna assembly

4.1 Antenna separation

If you want to install multiple transmission paths in parallel the antennas should ideally be placed 2m apart. This minimum clearance does not apply to the distance between a sending and a receiving antenna. However, you have to keep in mind that the opening angles have to overlap (e.g. the ball antenna 10361). See also 4.4 Radiation.





4. Guidelines for antenna assembly

4.2 Height requirements

Antennas (without tilt) in a transmission path are to be placed at an appropriate height. The larger the opening angle, the larger the possible height offset.

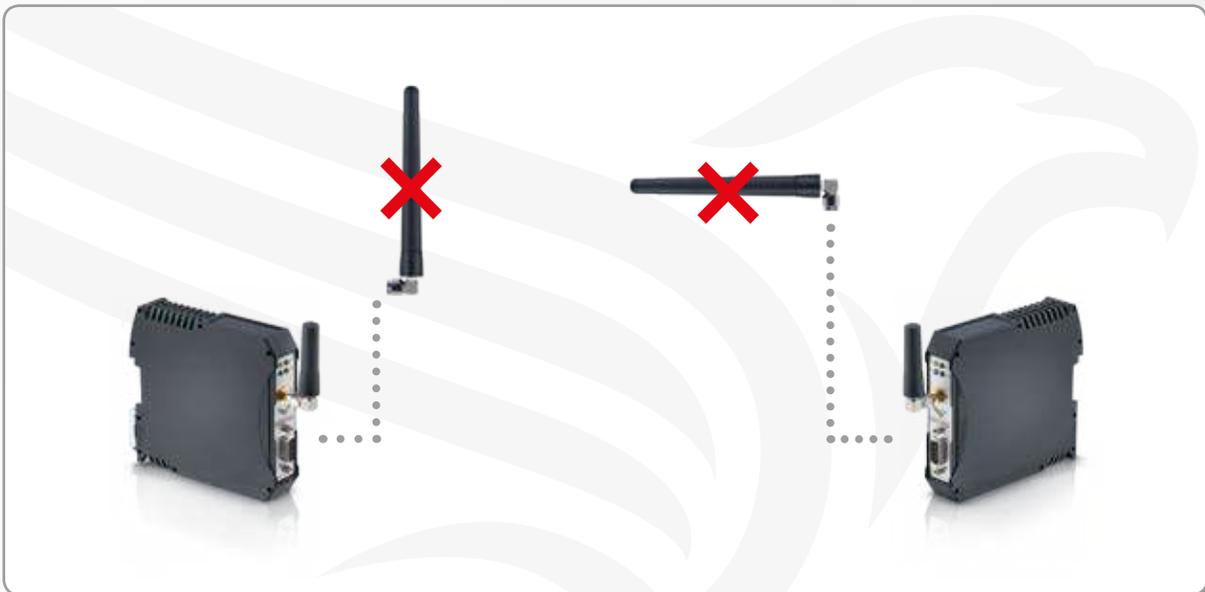
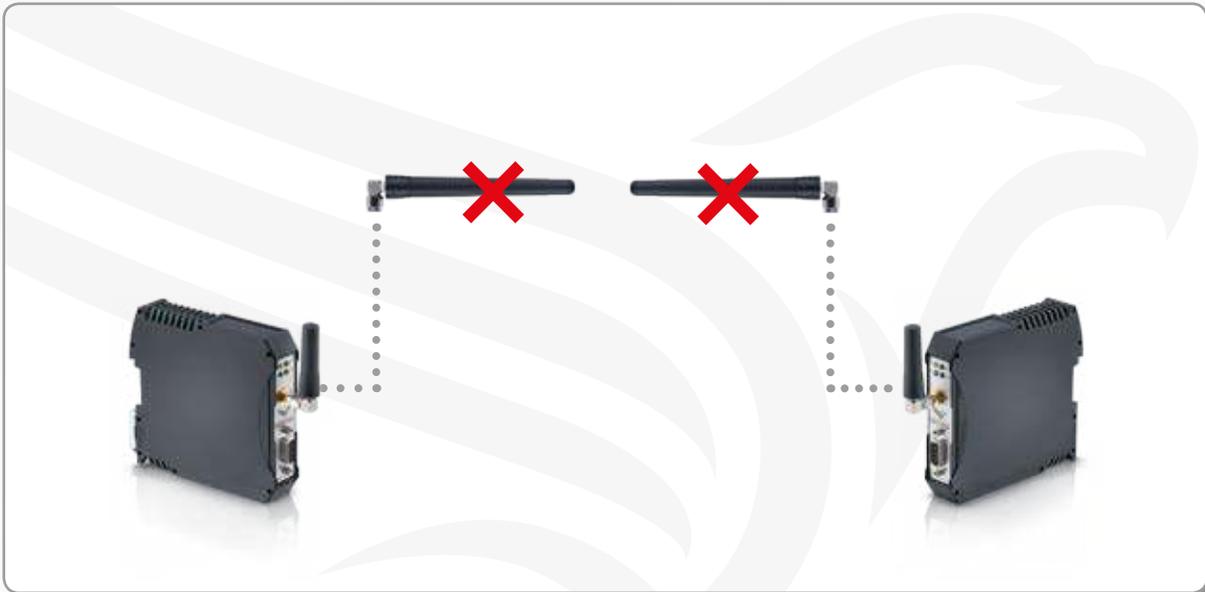




4. Guidelines for antenna assembly

4.3 Direction

Ideally, you need to direct the antennas in a transmission path in parallel to each other, e.g. all vertical and never head-to-head (see also 2.2 The radiation characteristics of an antenna).





4. Guidelines for antenna assembly

4.3 Direction

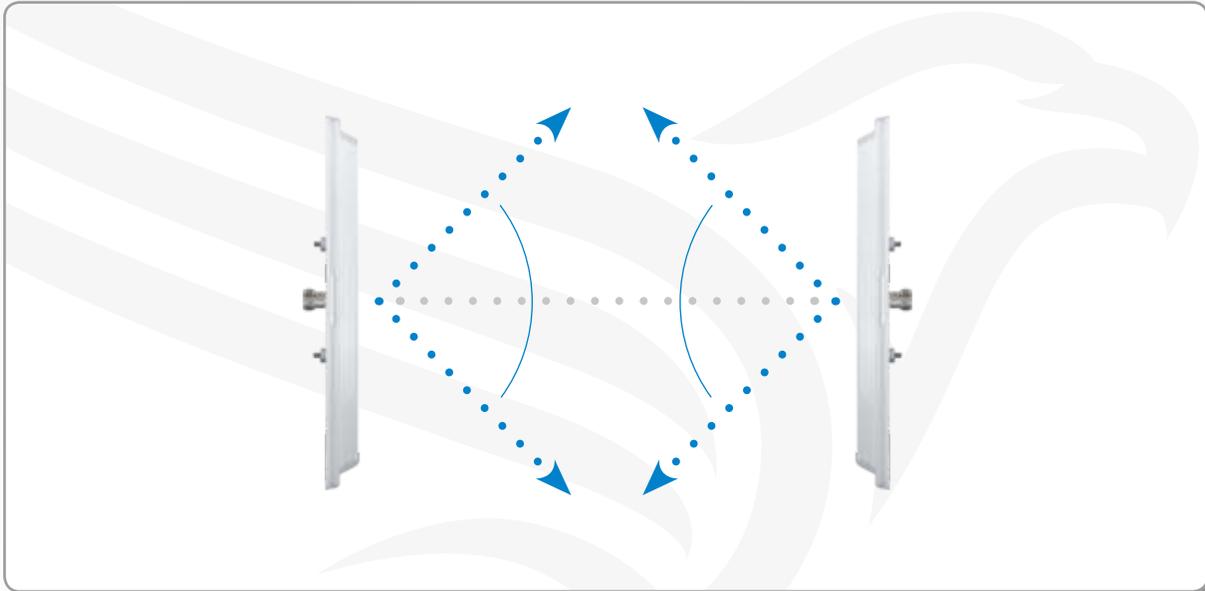




4. Guidelines for antenna assembly

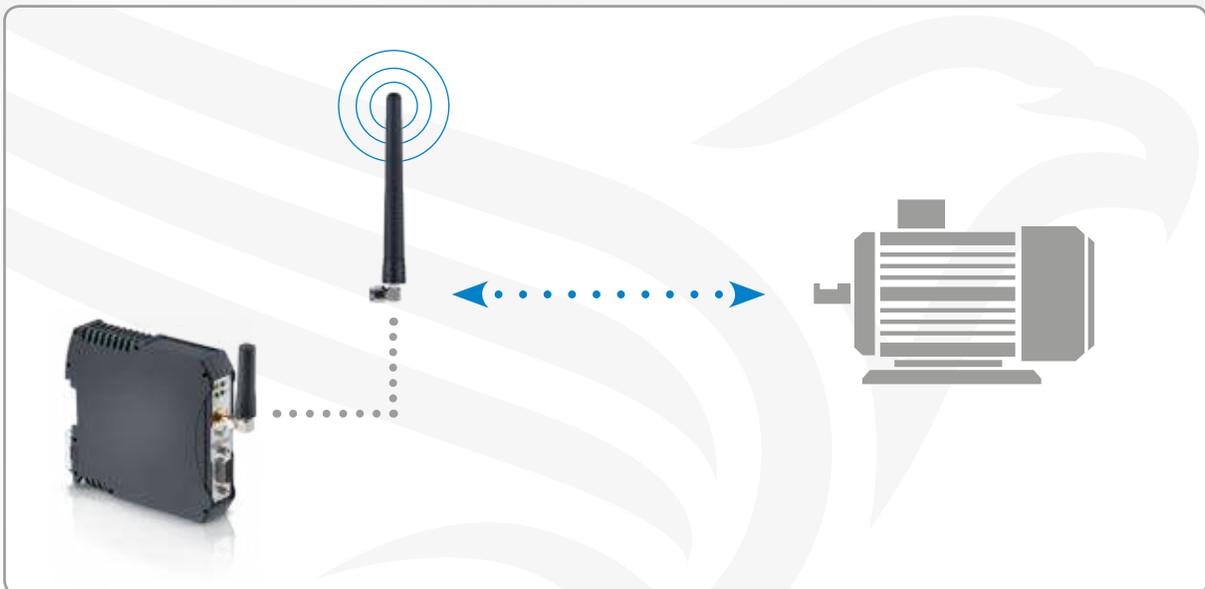
4.4 Radiation

When mounting antennas please be aware of their opening angles and the need for overlap.



4.5 Separation and free radiation

To avoid radiation disturbances and reflections do not install antennas close to metal parts, engines or frequency converters.

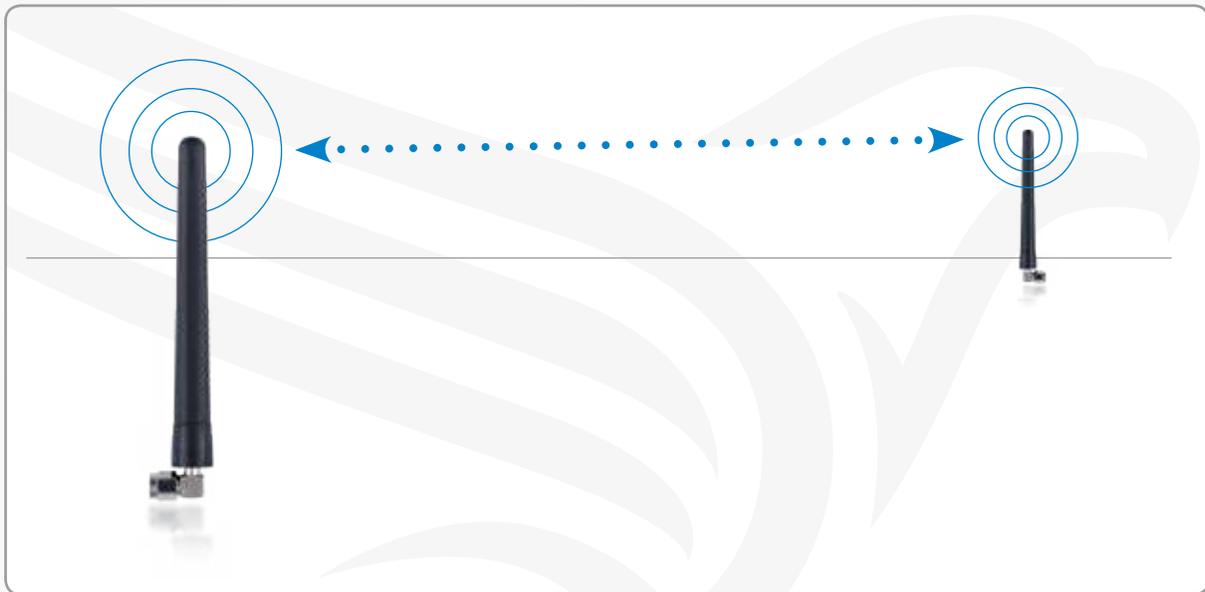




4. Guidelines for antenna assembly

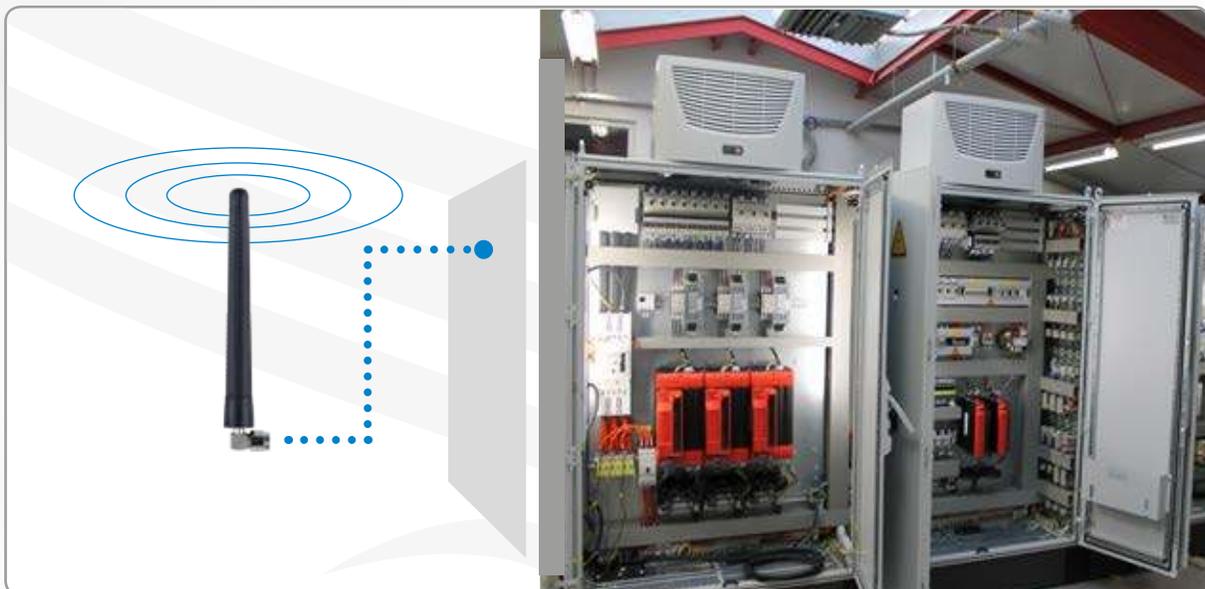
4.6 Line-of-sight connection

The antennas in a transmission path should have line-of-sight connection, to ensure optimal data transfer quality (see 2.7 Fresnel zone).



4.7 Get out of the control cabinet

Please mount the antennas outside the control cabinet. If made of metal the cabinet causes a significant damping of the transmission signal, thus reducing transmission reach. If the control cabinet is made of synthetic material you can place the antenna inside the cabinet, as this material only has low impact on signal strength.





4. Guidelines for antenna assembly

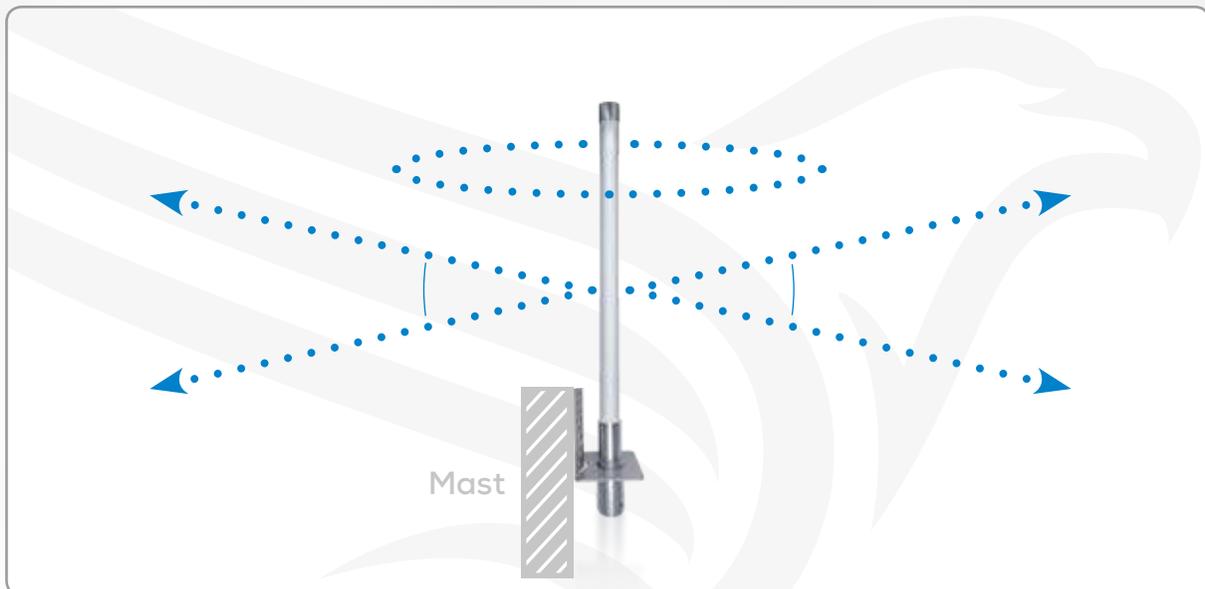
4.8 Wall mounting

To achieve the best result mount directional antennas on a wall. If you request the characteristics of an omnidirectional antenna and if short reach is required you can wall mount an omnidirectional antenna as well. Wall mounted omnidirectional antennas cause reflections that reduce transmission quality and reach.



4.9 Mast mounting

Ideally, choose a free standing mounting point for an omnidirectional antenna, e.g. on top of a mast, to achieve consistent horizontal radiation in all directions.

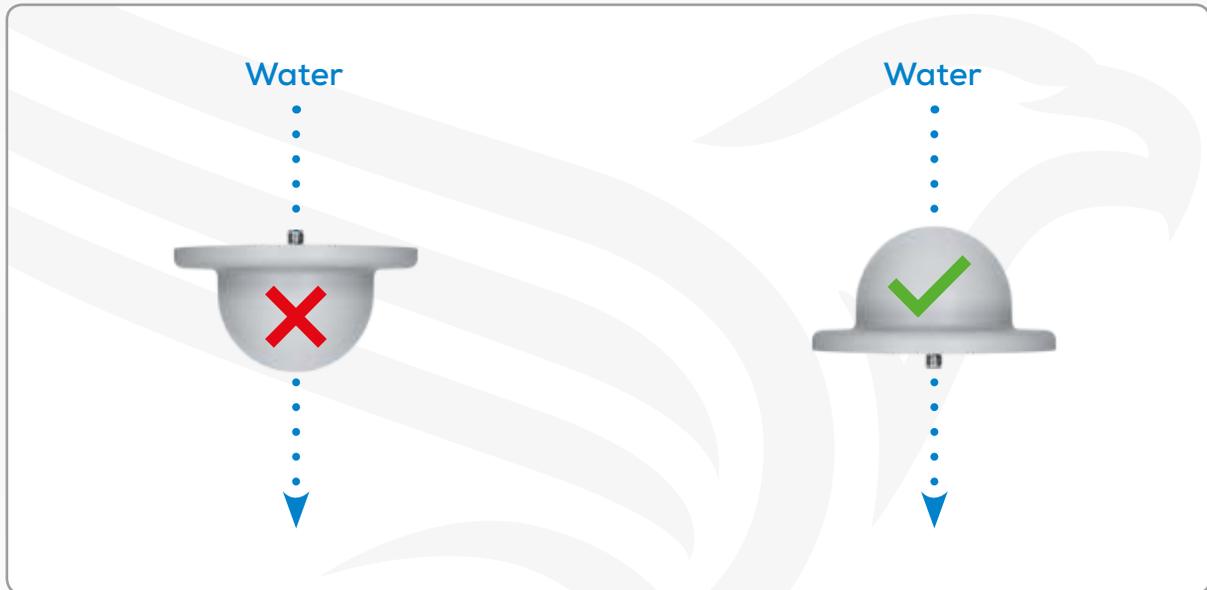




4. Guidelines for antenna assembly

4.10 Consider the protection class (IP)

When you are installing outdoor antennas, please note that water must not be allowed to get inside the antenna. Furthermore you have to consider the protection class of the particular antenna you want to install.



4.11 Polarization

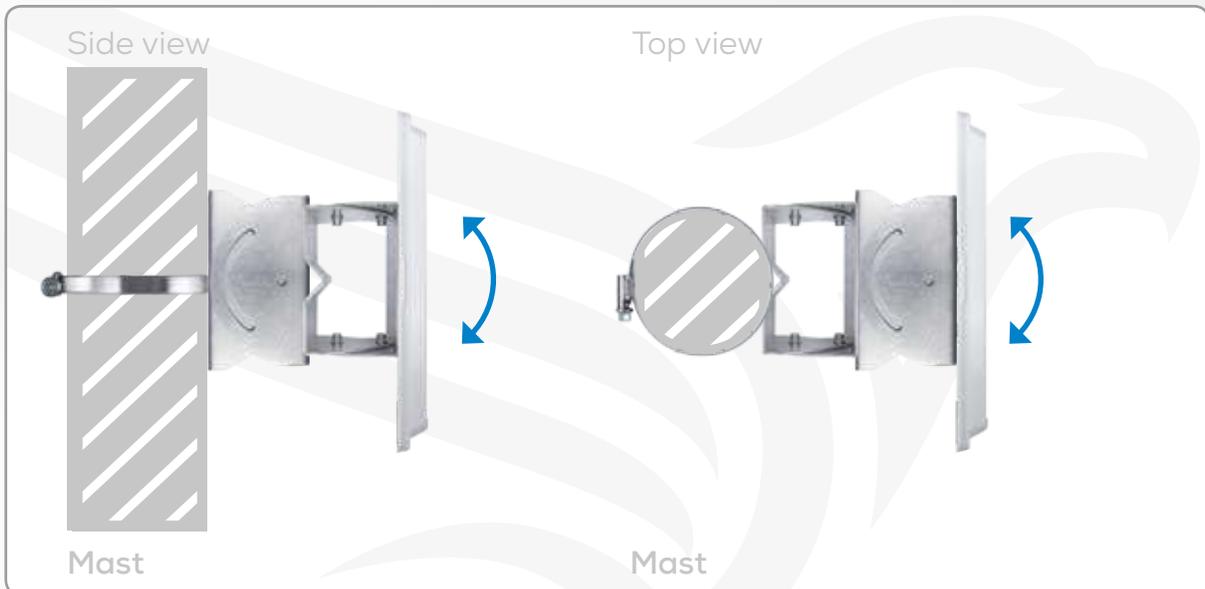
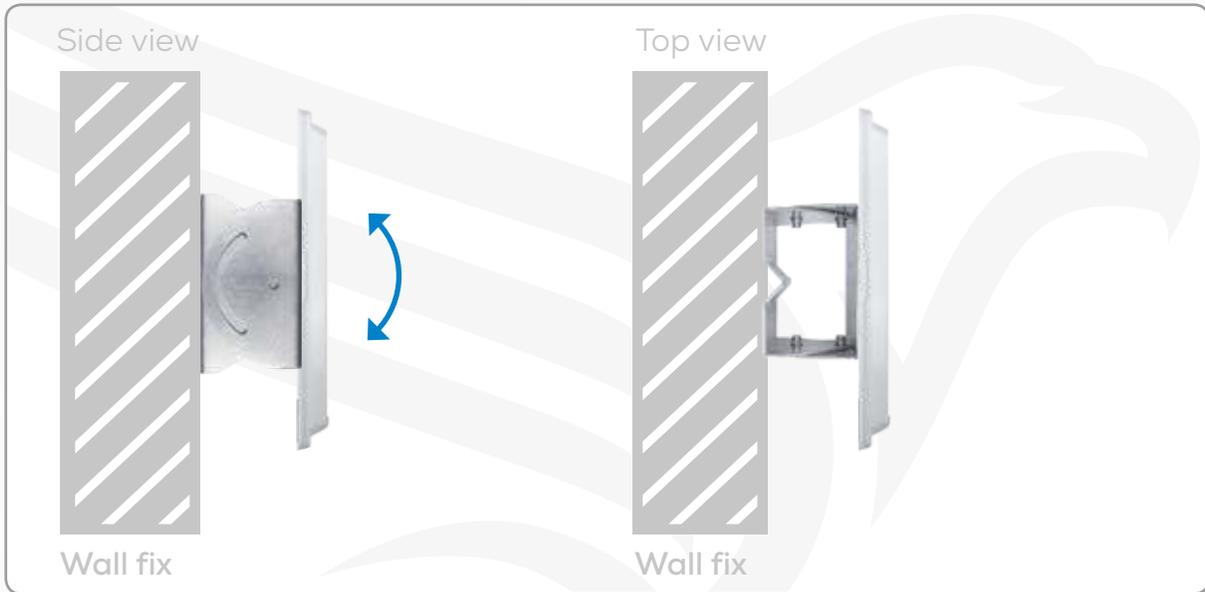
Antennas in a transmission path should ideally have similar polarization. Exception: For specific applications it can make sense to combine an antenna with a clockwise polarization – as a fixed station antenna – with a vertical polarizing antenna mounted on a mobile turning object.



4. Guidelines for antenna assembly

4.12 Mounting materials

Please use the mounting accessories offered by us, for the optimal positioning and orientation of directional antennas. The mounting materials match our antennas. By combining two mounting brackets (10519) you can pivot the antenna bilaterally.

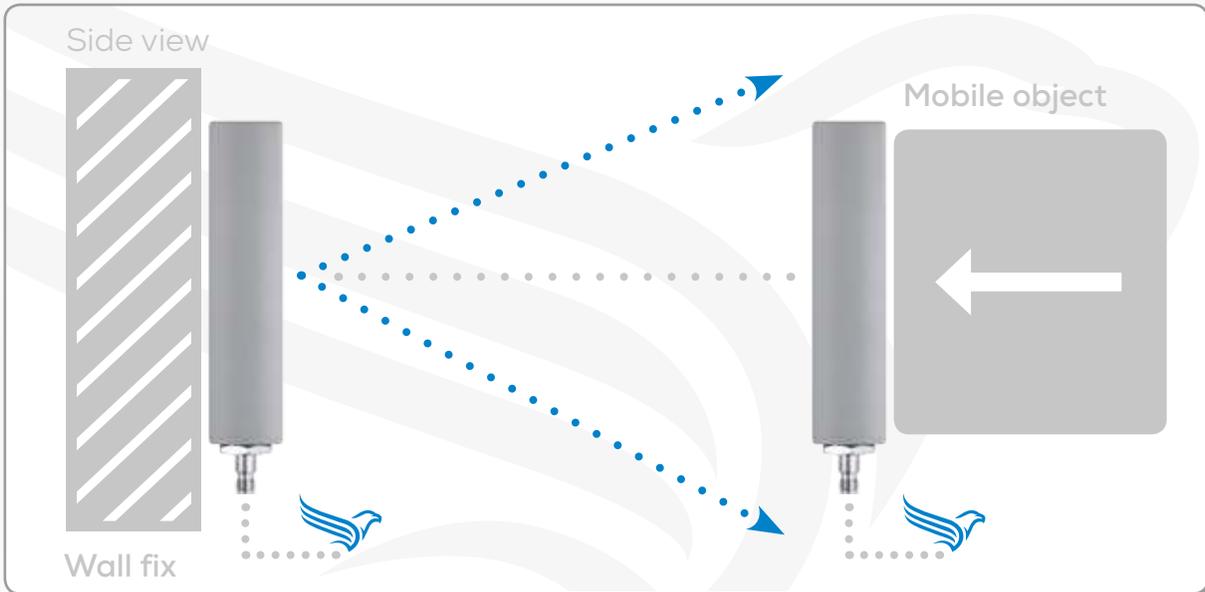




5. Use cases

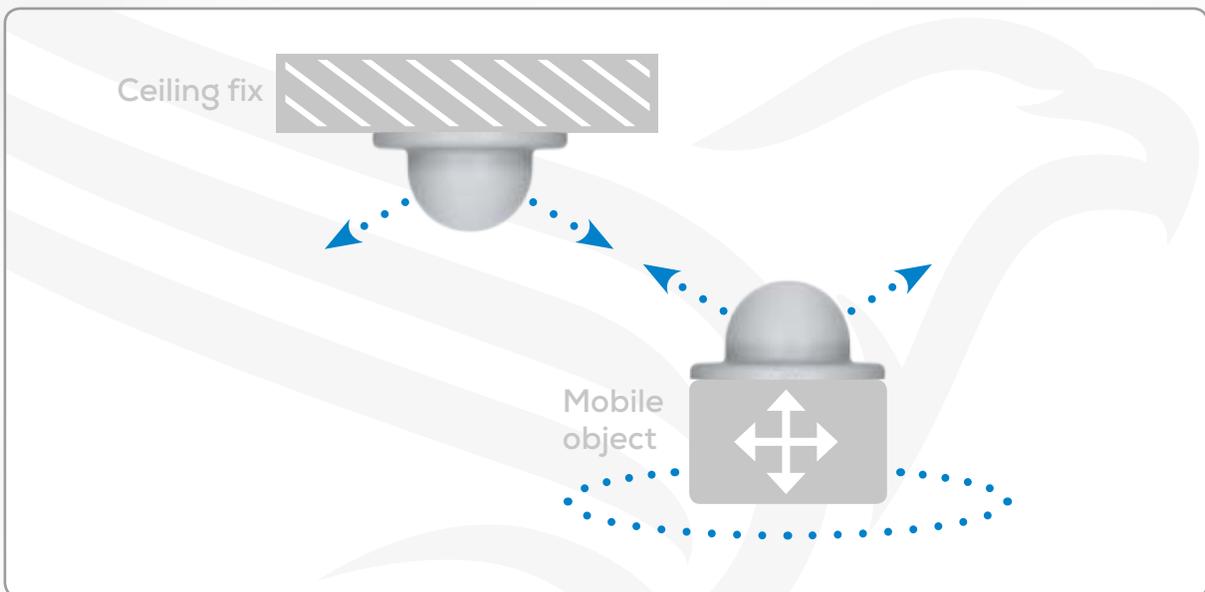
5.1 Two fixed objects or with linear movement

Optimally, you use a directional antenna between two fixed objects, or with an object in linear motion, e.g. inclined lifts, elevators or ceiling cranes that move in one direction only.



5.2 Two turning objects or mobile applications

You combine two omnidirectional antennas when you want to connect turning objects or mobile applications that move around independently, e.g. automated guided vehicles.

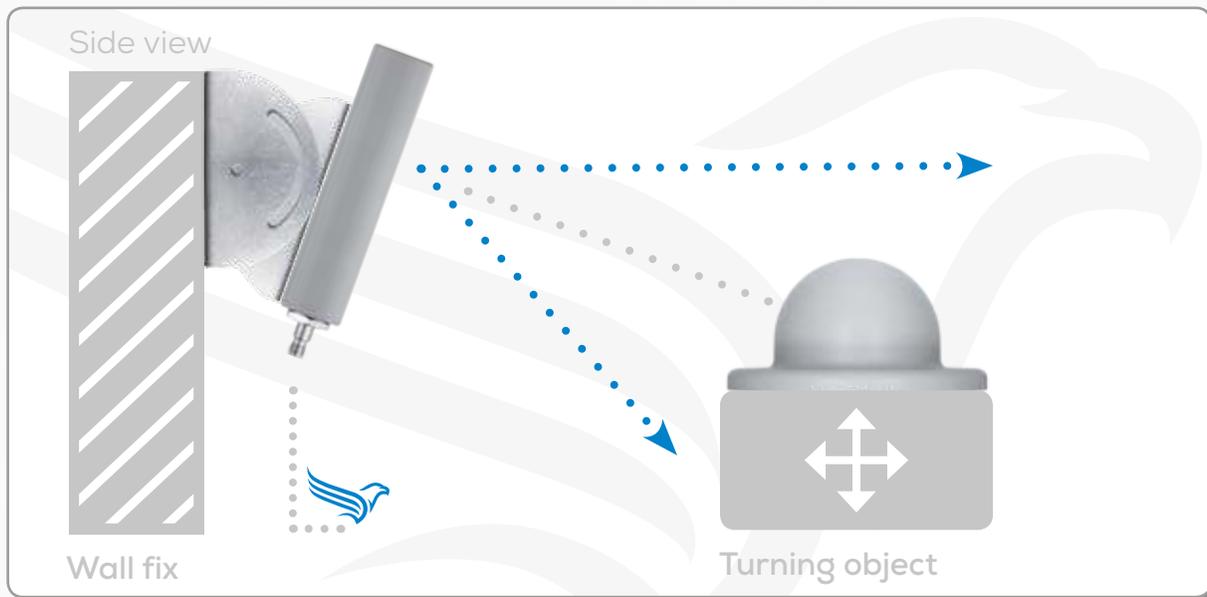




5. Use cases

5.3 One fixed and one turning object

For this application you combine a directional antenna mounted on a fixed object with an omnidirectional antenna mounted on a turning object. This is the case in sewage treatment plants with scrapers moving around in the wastewater basins. Please note the opening angles of both antennas.





6. Antenna accessories

6.1 Omnidirectional antennas for 2,4 GHz



Omnidirectional antenna 10248

Opening angle	h: 360° v: 60°
Polarization	Vertical
Antenna gain	2,5 dB / approx. 5 dB compared to ¼ wave
Protection class (IP)	IP20
Port	SMA-male
Assembly	90° direct assembly to DATAEAGLE compact
Suitable antenna cable	-
Optional mounting material	-
Dimensions in mm	Length: 110
Scope of delivery	Antenna, SMA-male 90° angle
Frequency	2310 - 2485 MHz



Omnidirectional antenna 10926

Opening angle	h: 360° v:60°
Polarization	Vertical
Antenna gain	2,5 dB
Protection class (IP)	IP20
Port	SMA-female
Assembly	Article No. 10959 or assembly in control cabinet
Suitable antenna cable	10589, 10629, 10279, 10273, 10935, 10284
Optional mounting material	10959 (antenna base for wall mount)
Dimensions in mm	Length: 110
Scope of delivery	Antenna rod, antenna base, O-ring, washer, nut
Frequency	2310 - 2485 MHz



6. Antenna accessories

6.1 Omnidirectional antenna for 2,4 GHz



Omnidirectional antenna 10926_OD

Opening angle	h: 360° v: 60°
Polarization	Vertical
Antenna gain	2,5 dB
Protection class (IP)	IP20
Port	SMA-female
Assembly	Only assembly directly at DATAEAGLE X-treme
Suitable antenna cable	-
Optional mounting material	-
Dimensions in mm	Length: 110
Scope of delivery	Antenna
Frequency	2310 - 2485 MHz



Omnidirectional antenna 10925

Opening angle	h: 360°, v:22°
Polarization	Vertical
Antenna gain	6 dB
Protection class (IP)	IP67
Port	N-female
Assembly	Wall or mast assembly
Suitable antenna cable	10567, 10667, 10528, 11112, 10535
Optional mounting material	-
Dimensions in mm	Length: 400
Scope of delivery	Antenna, mounting material for wall and mast assembly
Frequency	2400 - 2500 MHz



Omnidirectional antenna 10361

Opening angle	h: 360° v: 45° Tilt: 20°
Polarization	Vertical
Antenna gain	4 dBi
Protection class (IP)	IP20
Port	SMA-female
Assembly	In control cabinet
Suitable antenna cable	10589, 10629, 10279, 10273, 10935, 10284
Optional mounting material	-
Dimensions in mm	Height: 43, diameter: 86
Scope of delivery	Antenna, sealing ring (assembly necessary), mounting material for wall and ceiling assembly
Frequency	2400 - 2500 MHz



6. Antenna accessories

6.2 Directional antennas for 2,4 GHz



Directional antenna 10774

Opening angle	h: 70° v: 65°
Polarization	RHCP
Antenna gain	8,5 dBi
Protection class (IP)	IP20
Port	SMA-female
Assembly	Wall mount
Suitable antenna cable	10589, 10629, 10279, 10273, 10935, 10284
Optional mounting material	10519, 10882
Dimensions in mm	101 x 95 x 32
Scope of delivery	Antenna, mounting material for wall assembly
Frequency	2300 - 2500 MHz



Directional antenna 11111

Opening angle	h: 33° v: 33°
Polarization	RHCP
Antenna gain	14 dB
Protection class (IP)	IP67
Port	N-female
Assembly	Mast mount
Suitable antenna cable	10567, 10667, 10528, 11112, 10535
Optional mounting material	-
Dimensions in mm	203,20 × 203,20 × 40,64
Scope of delivery	Antenna, mounting material for mast assembly
Frequency	2400 - 2500 MHz



6. Antenna accessories

6.3 Omnidirectional antennas for 869 MHz



Omnidirectional antenna 10633

Opening angle	h: 360°
Polarization	Vertical
Antenna gain	0 dB
Protection class (IP)	IP67
Port	FME-male
Assembly	In control cabinet
Suitable antenna cable	10258, 10278, 10374, 10384, 10647, 10564
Optional mounting material	-
Dimensions in mm	Height: 82
Scope of delivery	Antenna
Frequency	820 - 905 MHz



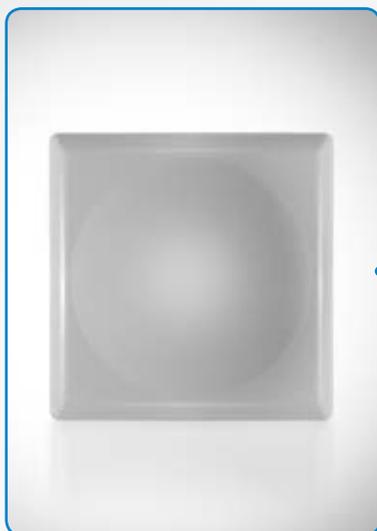
Omnidirectional antenna 11092

Opening angle	h: 360° v: 60°
Polarization	Vertical
Antenna gain	5 dB
Protection class (IP)	IP67
Port	SMA-male
Assembly	In control cabinet
Suitable antenna cable	-
Optional mounting material	-
Dimensions in mm	Height: 185
Scope of delivery	Antenna, 2m antenna cable
Frequency	868 - 870 MHz



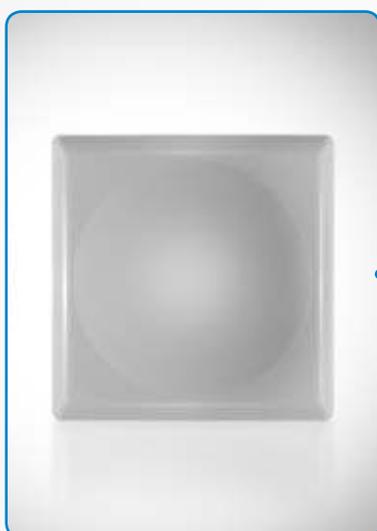
6. Antenna accessories

6.4 Directional antennas for 869 MHz



Directional antenna 11051

Opening angle	h: 70° v: 65°
Polarization	Vertical
Antenna gain	8 dBi
Protection class (IP)	IP67
Port	N-female
Assembly	Wall mount
Suitable antenna cable	10567, 10667, 10528, 11112, 10535
Optional mounting material	10519, 10882
Dimensions in mm	190 × 190 × 30
Scope of delivery	Antenna, mounting
Frequency	860 - 870 MHz



Directional antenna 11051_OH

Opening angle	h: 70° v: 65°
Polarization	Vertical
Antenna gain	8 dBi
Protection class (IP)	IP67
Port	N-female
Assembly	Wall mount
Suitable antenna cable	10567, 10667, 10528, 11112, 10535
Optional mounting material	
Dimensions in mm	190 × 190 × 30
Scope of delivery	Antenna
Frequency	860 - 870 MHz



Directional antenna 11003

Opening angle	h: 135° v: 90°
Polarization	RHCP (circular, right)
Antenna gain	3,5 dBi
Protection class (IP)	IP67
Port	SMA-female
Assembly	Wall mount
Suitable antenna cable	10589, 10629, 10279, 10273, 10935, 10284
Optional mounting material	10519, 10882
Dimensions in mm	101 × 80 × 35
Scope of delivery	Antenna, mounting material for wall assembly
Frequency	865 - 870 MHz



6. Antenna accessories

6.5 Omnidirectional antennas for cellular radio



Omnidirectional antenna 10549

Opening angle	h: 360° v: 55° - 75°
Polarization	Vertical
Antenna gain	2 dBi typ. (900 MHz) / -1 dBi typ. (1800 MHz)
Protection class (IP)	IP69K
Port	3m cable RG174 with GSM/UMTS - SMA (m)
Assembly	Roof and control cabinet
Suitable antenna cable	-
Optional mounting material	-
Dimensions in mm	Height: 76, diameter: 21
Scope of delivery	Antenna, 3m antenna cable FME-female
Frequency	GSM 900 / 1800 MHz



Omnidirectional antenna 10549-SMA

Opening angle	h: 360° v: 55° - 75°
Polarization	Vertical
Antenna gain	0 dBi bis +5 dBi
Protection class (IP)	IP69K
Port	3m cable RG174 with GSM/UMTS - SMA (m)
Assembly	Roof and control cabinet
Suitable antenna cable	-
Optional mounting material	-
Dimensions in mm	Height: 76, diameter: 21
Scope of delivery	Antenna, 3m antenna cable SMA-male
Frequency	GSM 850 - 2100 MHz UMTS/LTE Band



6. Antenna accessories

6.5 Omnidirectional antennas for cellular radio (also suited for 869 MHz)



Omnidirectional antenna 11085

Opening angle	h: 360° v: 80°
Polarization	Vertical
Antenna gain	0 dB
Protection class (IP)	IP20
Port	SMA-male
Assembly	90° directly at DATAEAGLE compact
Suitable antenna cable	-
Optional mounting material	-
Dimensions in mm	Height: 43
Scope of delivery	Antenna, angle piece 90°
Frequency	824 - 960 MHz, 1710 - 1990 MHz



Omnidirectional antenna 11085_MD

Opening angle	h: 360° v: 80°
Polarization	Vertical
Antenna gain	0 dB
Protection class (IP)	IP20
Port	SMA-female
Assembly	10959 or assembly on control cabinet
Suitable antenna cable	10589, 10629, 10279, 10273, 10935, 10284
Optional mounting material	-
Dimensions in mm	Height: 43
Scope of delivery	Antenna with feedthrough
Frequency	824 - 960 MHz, 1710 - 1990 MHz



6. Antenna accessories

6.6 Antenna cables

Item number	Antenna cable ports	Cable length
10258	SMA-male to FME-female	0,5
10278	SMA-male to FME-female	1
10374	SMA-male to FME-female	2
10384	SMA-male to FME-female	4
10647	SMA-male to FME-female	6
10564	SMA-male to FME-female	10
10567	SMA-male to N-male	1
10667	SMA-male to N-male	2
10528	SMA-male to N-male	4
11112	SMA-male to N-male	6
10535	SMA-male to N-male	10
10589	SMA-male to SMA-male	0,5
10629	SMA-male to SMA-male	1
10279	SMA-male to SMA-male	2
10273	SMA-male to SMA-male	4
10935	SMA-male to SMA-male	6
10284	SMA-male to SMA-male	10



6. Antenna accessories

6.7 Adapter

Item number	Adapter character
10371	FME-male to N-male
10372	FME-male to SMA-male
11123	N-female to SMA-male
10668	N-male to SMA-female
11122	SMA-female to FME-male
10937	SMA-female to FME- female
10261	SMA-female to SMA-female
10673	SMA-female to SMAR-female
10914	SMA-female to TNC-female
10915	SMA-female to TNC-male
10481	TNC-female to BNC-male
10544	TNC-female to TNC*-female (*feedthrough)
10536	TNC-female to TNC-female
10473	TNC-male to FME-male



For more information regarding different ports, please see page 12.



6. Antenna accessories

6.8 Antenna splitter



Double splitter item number 10297

Input 1: SMA-male
 Output 1: SMA-female
 Output 2: SMA-female

6.9 Mounting accessories



Mounting bracket item number: 10959

Mounting bracket for omnidirectional antenna 10926
 Dimensions in mm: 50x50x35



Antenna mounting assembly item number: 10519

Mounting bracket for directional antenna
 Can be pivoted in one direction
 With two mounting brackets it can be pivoted in two directions (see page 23)
 Dimensions in mm: 100x100x70



Fixing kit item number 10882

Mounting material for antenna mounting assembly 10519
 Fastening clips \varnothing 84mm



7. Closing remarks and contact information



For more than 25 years our customers have appreciated our expert knowledge in radio communication. This appreciation makes us proud and matches our servicing and consulting ambitions. To share the combined knowledge of the Schildknecht team in an easily accessible way, we have compiled this manual on Antenna 101. We have done it with great care and attention, and the manual can assist you in finding the correct antennas and accessories, since choosing the right equipment is crucial to the quality and performance of a radio link.

Our Antenna 101 manual does not cover all antennas available. But it covers the most important ones, and above all, the ones most commonly used. Thus you can find a solution for almost any application you come across when working with radio communication. However, if you have specific applications or additional questions, please get in touch. We would be happy to help you.

We are looking forward to sharing our expertise with you.



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