SIEMENS

SIMATIC NET

Industrial Wireless LAN RCoax

System Manual

11/2024
C79000-G8976-C189-17

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠ DANGER

indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠ WARNING

indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠ CAUTION

indicates that minor personal injury can result if proper precautions are not taken.

NOTICE

indicates that property damage can result if proper precautions are not taken.

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The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

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Note the following:

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Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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Preface

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Purpose of the system manual

This system manual contains both an explanation of the fundamental technical aspects as well as a description of the individual RCoax components and their functionality. Installation/ commissioning and connection of RCoax components and their operating principle are explained. The possible applications of the various SIMATIC NET components are described.

Certification

The products and systems listed in this document are manufactured and marketed using a quality management system complying with DIN ISO 9001 (Certificate Register no. 2613) and certified by DQS. The DQS certificate is recognized in all IQNet countries (reg. no.: 2613).

Documentation on the Internet

You can find the current version of the document on the Internet at (https://support.industry.siemens.com/cs/ww/en/ps/15893/man)

Enter the name or article number of the product in the search filter.

Further documentation

For more detailed information on IWLAN products, refer to the following documentation:

- RCoax
- Industrial Ethernet / PROFINET Industrial Ethernet
- Industrial Ethernet / PROFINET Passive network components

In the system manuals "Industrial Ethernet / PROFINET Industrial Ethernet" and "Industrial Ethernet / PROFINET passive network components", you will find information on other SIMATIC NET products that you can operate along with the devices of this product line in an Industrial Ethernet network.

There, you will find among other things optical performance data of the communications partner that you require for the installation.

You will find the system manuals on the Internet pages of Siemens Industry Online Support under the following entry IDs:

- 27069465 (https://support.industry.siemens.com/cs/de/en/view/27069465) Industrial Ethernet / PROFINET Industrial Ethernet System Manual
- 84922825 (https://support.industry.siemens.com/cs/de/en/view/84922825) Industrial Ethernet / PROFINET - Passive network components System Manual

The "Industrial Wireless LAN and Industrial 5G Coaxial components" system manual covers coaxial components for establishing industrial WLAN and 5G networks.

- You will find the "Coaxial components" system manual on the Siemens Industry Online Support (https://support.industry.siemens.com/cs/ww/en/view/109971849) pages.

Cybersecurity notes

Siemens provides products and solutions with industrial cybersecurity functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial cybersecurity concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial cybersecurity measures that may be implemented, please visit
https://www.siemens.com/cybersecurity-industry (https://www.siemens.com/industrialsecurity).

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Cybersecurity RSS Feed under
https://new.siemens.com/cert (https://www.siemens.com/cert).

Recycling and disposal

The products are low in pollutants, can be recycled and meet the requirements of the WEEE directive 2012/19/EU for the disposal of electrical and electronic equipment.

Do not dispose of the products at public disposal sites.

For environmentally friendly recycling and the disposal of your old device contact a certified disposal company for electronic scrap or your Siemens contact (Product return (https://support.industry.siemens.com/cs/ww/en/view/109479891)).

Note the different national regulations.

SIMATIC NET glossary

Explanations of many of the specialist terms used in this documentation can be found in the SIMATIC NET glossary.

You will find the SIMATIC NET glossary on the Internet at the following address:

50305045 (https://support.industry.siemens.com/cs/ww/en/view/50305045)

Trademarks

The following and possibly other names not identified by the registered trademark sign ® are registered trademarks of Siemens AG:

SCALANCE, C-PLUG, RCoax

Basics of RCoax

2

2.1 Introduction

Note

You will find further notes and instructions on the use of RCoax on the Internet at : (https://support.industry.siemens.com/cs/ww/en/ps/15893)

Why is an RCoax installation necessary?

In wireless communication, electromagnetic waves are transmitted and received by antennas. There are, however, conditions in which the transmission or reception range cannot be covered well or even at all with the transmission and reception range of conventional antennas. Such conditions can occur in certain buildings (for example tunnels, canals and elevator shafts) or in communication involving rail vehicles.

In such situations, the fact that cable also emits electromagnetic waves can be put to good use if the cable has a suitable physical design. With leaky feeder cables, the emission can be adapted to the spatial conditions.

The RCoax cables provide a reliable wireless connection without wear and tear particularly for conveyor systems and all types of rail-guided vehicles (overhead monorails, automated guided vehicles).

Examples of the use of RCoax cables are as follows:

- Overhead monorail conveyors
- Automated guided vehicles (AGV)
- Cranes
- High bay storage systems
- Transfer lines
- Tool changer carriages
- Tunnels
- Elevators

Short distance between RCoax cable and antenna

The advantage here is that the RF field has a good quality when the distance to the leaky feeder is short. This ensures that the wireless connection to a node is as good as possible when its antennas move along the leaky feeder cable if they remain in the close vicinity of the cable (as is the case, for example, with rail-guided vehicles). It must nevertheless not be forgotten that the radio waves radiated by the leaky feeder cable exist not only in the immediate vicinity of the moving node but also that radio waves from third-party systems can affect the leaky feeder cable. This means that interference to the communication between antenna and leaky feeder cable or between other wireless components is possible.

Principle of electromagnetic radiation of cables

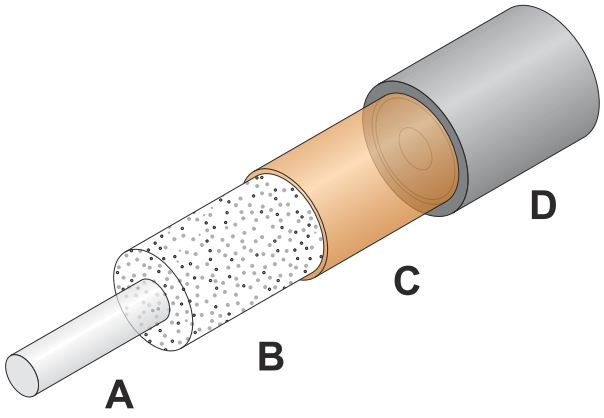
The determining variables of an electromagnetic wave are an electric and a magnetic field. These two fields are perpendicular to each other and to the direction of propagation.

Electromagnetic waves can also propagate within a coaxial cable. If the cable has a closed outer conductor, no electromagnetic radiation can be detected outside this shield and no electromagnetic fields outside the cable can affect the wave in the inner conductor. If the outer conductor has slots in it, there is electromagnetic coupling between the inner conductor and the environment of the cable at these points. In this case, the electromagnetic fields of the inner conductor can be measured outside the cable. In the other direction, and electromagnetic field outside the cable can affect the inner conductor.

2.2 Construction of RCoax cables

The typical construction of leaky feeder cables is shown below:

- Inner conductor
- Dielectric:
  normally air or a plastic with a low dielectric constant and low HF losses.
- Outer conductor:
  with longitudinal and transverse slots. The geometry and number of these slots define the radiation characteristics of the cable.
- Cable jacket:
  The outer insulation of Siemens RCoax cables is flame-retardant and halogen-free (HLFR).



A	Inner conductor	C	Outer conductor
B	Dielectric	D	Cable jacket

Figure 2-1 Structure of an RCoax cable

2.3 Function of RCoax cables

The constructive setup of RCoax cables depends on the intended operating mode:

- **Radiation mode**
  Leaky feeder cables for radiation mode have punched out slots in the outer conductor at regular intervals. The electromagnetic waves are only emitted from the leaky feeder cable at the punched out points and are radiated at a certain angle. The spacing between these openings in the outer conductor is determined by the wavelength or the frequency to be radiated. This means that the usable frequency of this cable is limited to a comparatively narrow frequency band because the coupling loss rises considerably above and below this nominal frequency. One advantage is that interference outside this range is attenuated by this bandpass action.
- **Coupling mode**
  The outer conductor of a leaky feeder cable for the coupling mode is interrupted at regular intervals over the entire distance. The electromagnetic waves are emitted over the entire distance of the leaky wave cable and are radiated radially. This omnidirectional radiation results in a higher coupling loss of this cable type.

Cables in radiating mode

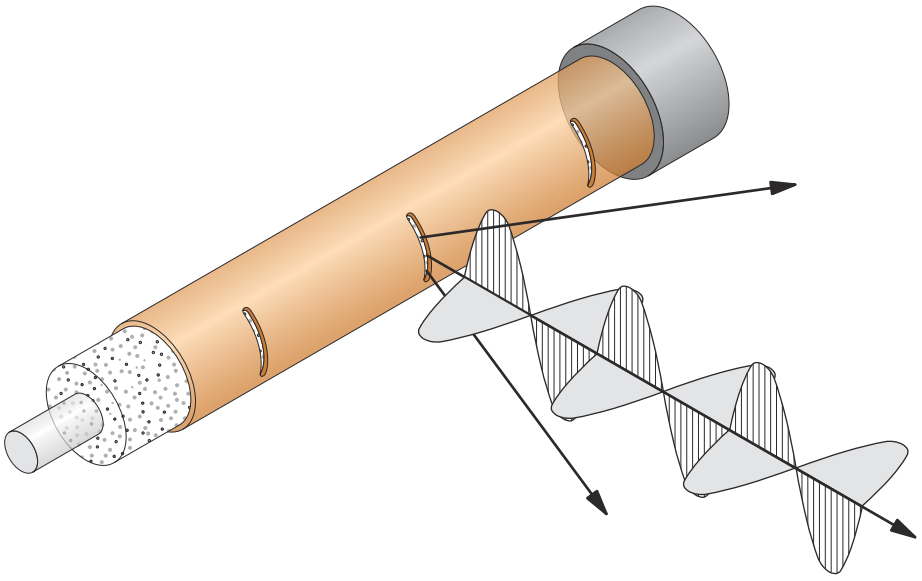


Figure 2-2 Radiation from an opening in the outer conductor

The schematic diagram shows the radiation from a slot in the outer conductor.
The electrical field is in a plane parallel to the cable axis and is shown in gray. The magnetic field is in a plane perpendicular to the cable axis and is shown in hatched gray. Both fields are perpendicular to the direction of propagation (black arrows).

2.4 Note on usage

The distances between the openings in the outer conductor determine the usable frequency of an RCoax cable. Different RCoax cables are therefore required for the 2.4 GHz and 5 to 6 GHz range.

Note

Within the area of an RCoax installation, there should be no other wireless networks operating in the same frequency range.

Product overview

3

3.1 RCoax cables

Due to slots in the outer conductor, the IWLAN RCoax cable 1/2" has the function of an antenna and is available in the following frequency bands:

RCoax cable	Article number
2.4 GHz	6XV1875-2A
5 GHz	6XV1875-2D

Note

Technical specifications

You can find technical information on RCoax cables and their accessories in the section "Technical specifications (Page 39)".

You can find information about further accessories for cabling in the "Industrial Wireless LAN and Industrial 5G Coaxial components (https://support.industry.siemens.com/cs/ww/en/view/109971849)" system manual.

3.2 Active components

Note

Access points and clients

You can find the most important features of different SCALANCE W products in the "Ordering overview Industrial Wireless LAN Access Points and Client Modules" document.
This document can be found under the following entry ID:

- 109766333 (https://support.industry.siemens.com/cs/ww/de/view/109766333/en)

You can find detailed information on individual SCALANCE W devices in the operating instructions for the relevant device.

Observe the current country-specific approvals when using the RCoax antenna in connection with a SCALANCE W device. You can find additional information under Wireless approvals (https://www.siemens.com/wireless-approvals).

3.3 Accessories

The components listed are suitable for use with 2.4 GHz and 5 GHz RCoax cables:

Table 3-1 RCoax accessories that are described in this system manual.

Component	Description	Article number
RCoax N-Connect female On-Site-Assembly	RCoax cable connector for attaching further components, connector N-connect female	6GK5798-0CN00-0AA0
RCoax Threaded Washer M6 for Cable Clip 1/2"	RCoax threaded washer M6 for RCoax securing clip	
	Pack of 10	6GK5798-8MC00-0AC1
	Pack of 100	6GK5798-8MC00-0AM1
RCoax Spacer 85 mm for Cable Clip 1/2"	RCoax spacer 85 mm for RCoax securing clip	
	Pack of 10	6GK5798-8MD00-0AC1
	Pack of 100	6GK5798-8MD00-0AM1
RCoax N-Connect Stripping Tool	Stripping tool for an RCoax cable.	6GK1901-1PH00
RCoax Cable Clip 1/2"	RCoax securing clip, cable clip for RCoax cable	
	Pack of 10	6GK5798-8MB00-0AC1
	Pack of 100	6GK5798-8MB00-0AM1

You will find technical information on these products in the section "Technical specifications (Page 39)".

Note

There is a comprehensive range of accessories with antennas, cabling technology and mounting accessories for SCALANCE W products. You can find information on this on the Internet (https://www.siemens.com/global/en/products/automation/industrial-communication/industrial-wireless-lan/antenna-accessories.html) or in the "Industrial Wireless LAN and Industrial 5G Coaxial components (https://support.industry.siemens.com/cs/ww/en/view/109971849)" system manual.

3.4 Antennas

RCoax antennas

Component	Description	Article number
IWLAN RCoax N-Connect Female Antenna ANT792-4DN	RCoax helical antenna with circular polarization for RCoax systems, 2.4 GHz	6GK5792-4DN00-0AA6
IWLAN RCoax N-Connect Female Antenna ANT793-4MN	RCoax λ5/8 antenna with vertical polarization for RCoax systems, 5 GHz	6GK5793-4MN00-0AA6

You will find technical information on RCoax antennas in the section "Technical specifications (Page 39)".

Note

Other antennas

The range of accessories for SCALANCE W includes a broad portfolio of antennas (omnidirectional antennas, directional antennas and sector antennas). You will find technical information on these antennas on the Internet (https://www.siemens.com/global/en/products/automation/industrial-communication/industrial-wireless-lan/antenna-accessories.html) or in the compact operating instructions of the relevant antenna.

Installation

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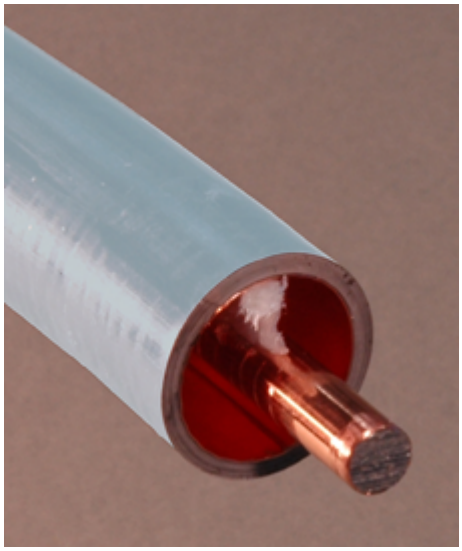
4.1 Fitting connector to RCoax cable

To fit a connector to an RCoax cable, you require an RCoax N-connect stripping tool to strip the RCoax cable and two 22 gauge open-ended wrenches.

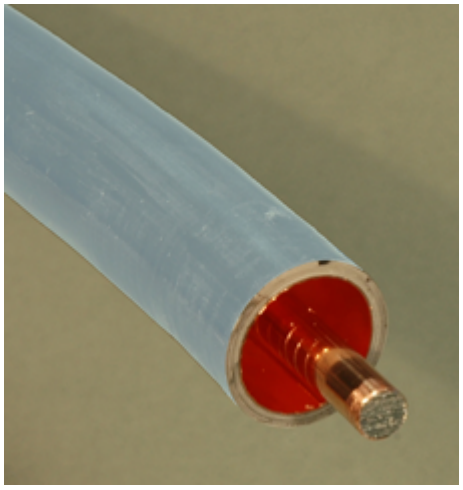
Have the RCoax N-connect stripping tool to strip the RCoax cable at hand.

Place the stripping tool on the end of the RCoax cable and turn the tool in a clockwise direction.

After reaching the fixed cutting depth of 37 mm, the tip of the inner conductor meets the tool. This completes the preparation for fitting the connector.



The dielectric between the inner and outer conductor is now cut out to a length of 23 mm. The outer conductor is flush with the cable jacket. The inner conductor extends 14 mm beyond the cable jacket and outer conductor.

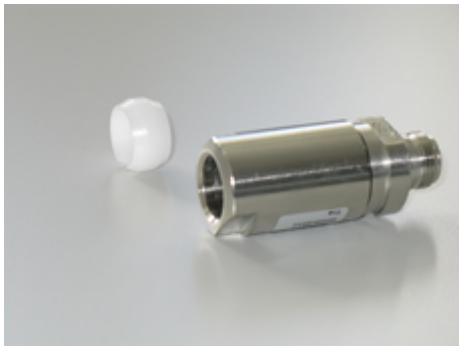


Carefully remove any remnants of the dielectric from the cable.

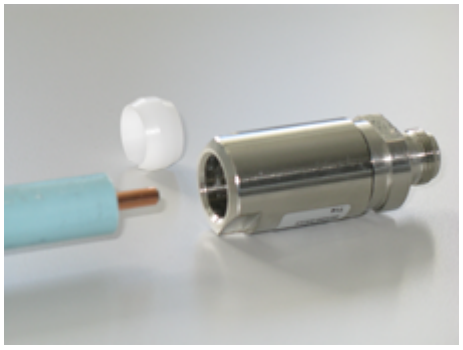
Chamfer the edge of the cable jacket and inner conductor with a file.

Make sure that no shavings get into the cable.

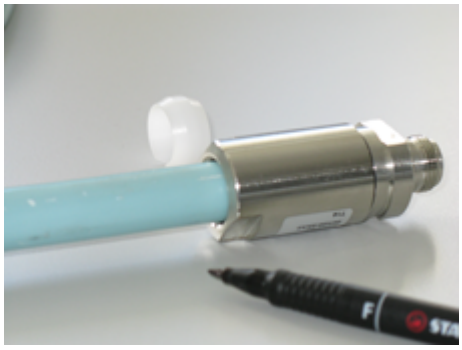
Unscrew the connector to open it and remove the white plastic ring.



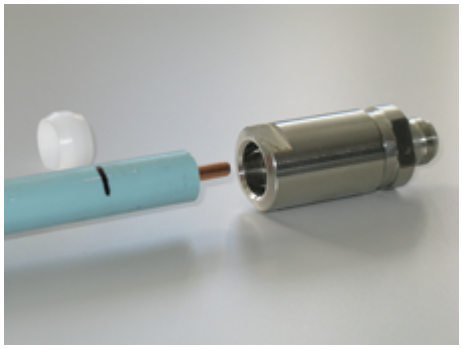
Screw the two parts of the connector together again. Do not tighten these.



Push the connector as far as possible onto the stripped end of the RCoax cable.

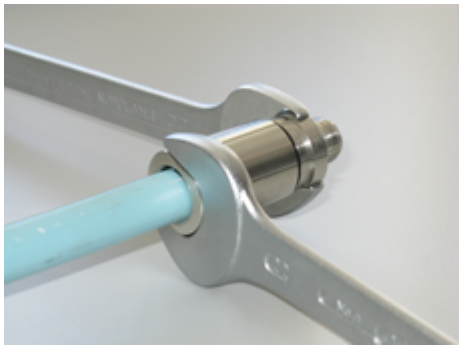


Mark the point where the RCoax cable enters the connector on the cable jacket.



Remove the connector from the RCoax cable again and open it.

Position the parts of the connector on the RCoax cable as shown in the figure. Push the right half of the connector as far as possible onto the RCoax cable.



Screw the two parts of the connector housing together until the O ring is covered by the outer part of the housing.

As the tool use two open-ended wrenches with a width of 22 across the flats. With one wrench, hold the right-hand part of the connector in a fixed position and tighten the sleeve with the second wrench (maximum torque 30 Nm).

The distance from the marking on the cable jacket to the connector must not exceed four millimeters.

A larger distance means that the connector is not correctly mounted. In this case mount a new connector. To do this, repeat the steps.

Note

Only use new connectors, a connector must not be assembled more than once.

General information

When cabling with the RCoax cable, remember the following points:

- **Alignment of the cable**
  To help orientation of the RCoax cable during installation, there is a flat ridge on the outer jacket. The cable should be aligned so that this ridge is on the side towards the carrier monorail and away from the antenna. In the photograph below, this ridge is indicated by a red arrow.

Note

The maximum gap between two successive segments must not exceed 1 m (see also section "Segment lengths (Page 36)").

- **Bending radius**
  When laying the cable, make sure that the cable is not bent tighter than the minimum bending radius of 20 cm to avoid damaging the RCoax cable.

Note

Avoid kinking.

- **Securing the cable**
  Keep the distance between securing clips between 0.5 m and 1.2 m. The maximum distance between two suspension points of the RCoax cable is 1.20 m. Make sure that the securing clips do not cover the openings in the coaxial shield of the RCoax cable (decoupling points as transverse slots, every 15 cm).

Note

Using metallic clamps can have a detrimental effect on the radiation characteristics and the matching of the RCoax cable.
Use only the recommended clips and spacers to secure the RCoax cable to the rail.

- RCoax securing clip ½" (article number 6GK5798-8MB00-0A**)
- RCoax threaded washer M6 for securing clip ½" (Article number 6GK5798-8MC00-0A**)
- RCoax spacer 85 mm for securing clip ½" (Article number 6GK5798-8MD00-0A**)

- **Securing the RCoax antenna**
  The distance from the tip of the antenna to the cable should be approx. 4 to 7 cm at 2.4 GHz and approx. 10 cm at 5 GHz. Good results are normally achieved with an angle of 90° between antenna and cable (see figure below).

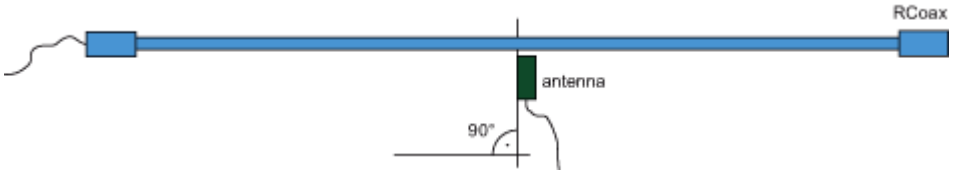


Figure 4-1 Alignment of the antenna

4.2 Installation

Preparing for installation

1. Check the cable lengths of the individual segments.
2. Strip the RCoax cable as required.

Note

To strip the RCoax cable, use a suitable iron saw to achieve a straight and flat cut. (If you use, for example, cable pliers, the RCoax cable will be put out of shape to an unacceptable degree.)

3. Fit the connectors to the RCoax cable segments, see section "Fitting connector to RCoax cable (Page 17)".
4. Protect the connectors (for example tape them) so that they are not damaged or contaminated during installation.

Laying RCoax cable

1. Align the RCoax cable roughly before fitting it in the rail, see aection "Fitting connector to RCoax cable (Page 17)".
2. Start securing the cable at one end of the segment or the other, see section "Fitting connector to RCoax cable (Page 17)" and "Mounting the fixing clip and spacer (Page 23)".
3. There should be two people to lay the RCoax cable and even three if the segments are long. One person secures the cable in the rail and tells the other or others which way to twist the cable so that it is oriented towards the antenna.

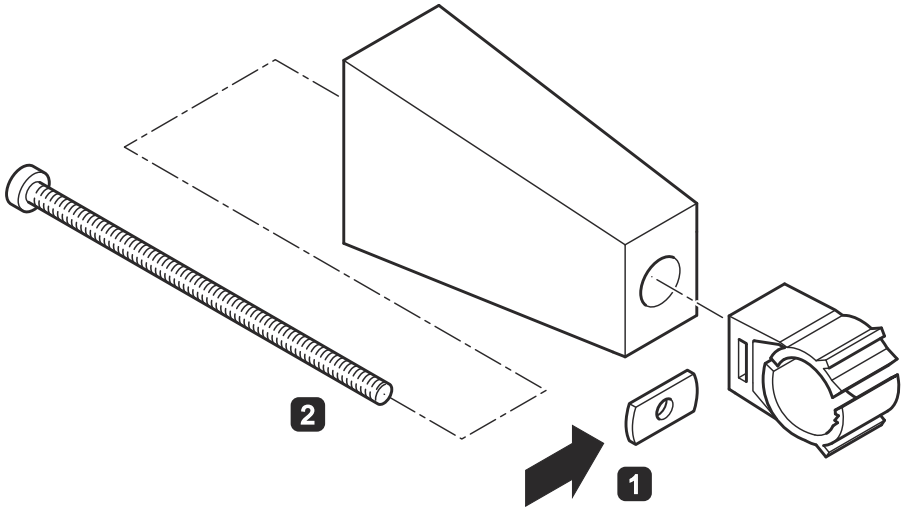
Note

Make sure that the orientation of the cable is correct while laying the cable because twisting it is extremely difficult once secured in the clips.

4.3 Mounting the fixing clip and spacer

Mounting fixing clip clips and spacers with an M6 screw

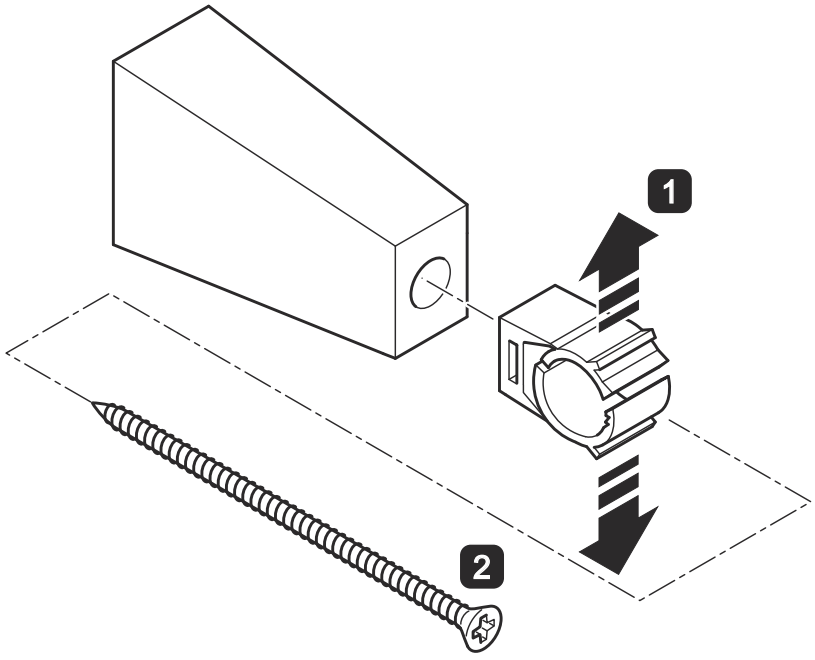
On thin walls, you can mount the fixing clip clip and spacer from the back with a suitably long M6 machine screw. Follow the steps outlined below:



1. Insert the threaded washer in the fixing clip clip and position the spacer and cable clip at the required location.
2. Feed the M6 screw through the hole in the spacer and secure it with the threaded washer in the fixing clip.

Mounting fixing clip clips and spacers with a wooden screw

If they can only be mounted from the front, the fixing clip clip and spacer are installed using a wooden screw with a suitable plug in the brickwork or concrete. Follow the steps outlined below:



1. Position the spacer and fixing clip clip at the required location and push the two halves of the cable clip apart.
2. Feed the wood screw through the holes in the fixing clip clip and spacer and screw it to the wall or support.

4.4 Example of an overhead monorail

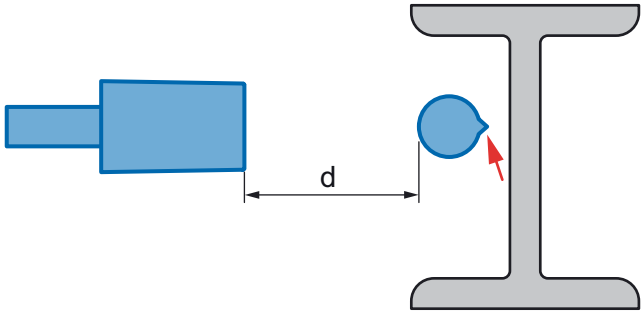


Figure 4-2 Cross-section through an overhead monorail rail and RCoax cable

The ridge lies on the outer jacket faces the overhead monorail rail. For the distance d between the RCoax cable and RCoax antenna, the following values apply as a rule of thumb:

5 GHz band: 10 cm

2.4 GHz band: 4 to 7 cm

Points to note when working with overhead monorails

- Laying the RCoax cable in the immediate vicinity of the metallic rail changes the characteristics of the radiated field (shielding/shadow areas). It must be expected that communication on the far side of the rail will be restricted.
- The close proximity of the RCoax cable to metal surfaces causes an increase in the longitudinal attenuation Δ_{rc}.
- Cables running parallel to the RCoax cable or metallic constructions along the cable (rails) can increase the coupling loss Δ_{co}.
- An RCoax cable running parallel can influence the transmission characteristics (coupling in of fields). The behavior cannot be predicted with any precision. Such an arrangement is therefore not recommended.
- For overhead monorail applications, the antenna is located in the near field of the RCoax cable. This near field is characterized by signal level fluctuations.

Note

The maximum gap between two successive segments should not exceed 1 m (see also section "Segment lengths (Page 36)").

Connecting

5

5.1 Connection to SCALANCE W

SCALANCE W as access point

All access points of the SCALANCE W range with an external antenna connector can be used to feed the signal into the RCoax cable. The access points differ from each other not only in their design but also in the number of radio interfaces. One RCoax cable per radio interface can be connected.

Connect a flexible connecting cable to an R-SMA or N-Connect socket of an access point. Connect the other end of the connecting cable to the RCoax cable.

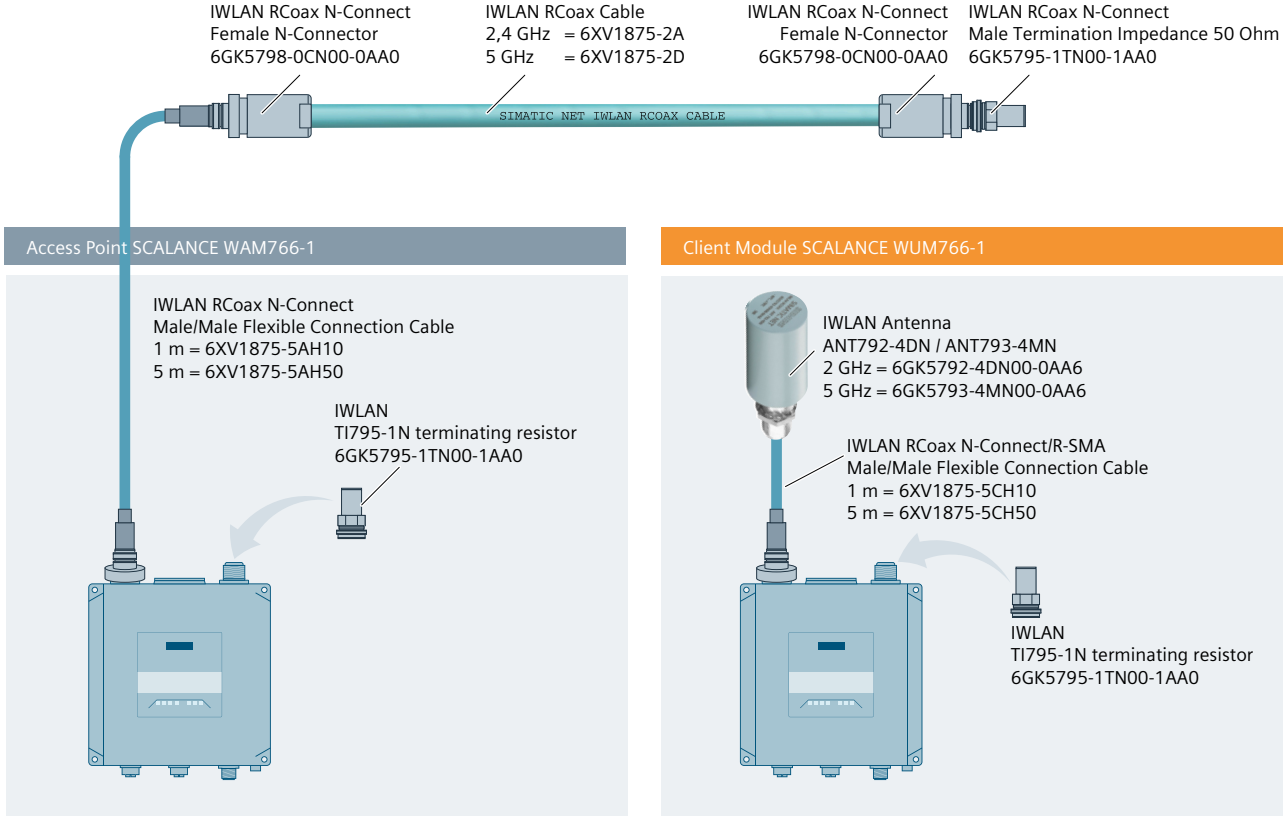


Figure 5-1 SCALANCE W700ax with connected, flexible connection cable and RCoax connector, beside it an R-SMA terminator 50 Ω

Note

Transmission disruptions

SCALANCE W devices have up to four antenna ports. Since only one antenna connector can be used to connect to the RCoax cable, the unused connectors must be fitted with a 50 Ω terminator.

With SCALANCE W devices, the antennas R1A1 and R2A1 (if present) must always be connected as soon as the corresponding WLAN interface is activated. If no antenna is connected, the corresponding interface must be deactivated. Otherwise, there may be transmission disruptions.

The antennas need to be suitably configured on the device. You can find additional information on the relevant device in the configuration manuals.

The maximum possible transmit power of the device can be specified in the configuration of the device. To avoid exceeding the legally stipulated maximum transmit power, it is necessary to reduce the transmit power of the antenna. Reducing the transmit power effectively reduces cell size. With short RCoax cable segment lengths, the input damping may be necessary to avoid radiated emissions affecting other RCoax cables running parallel to them. There are also separate attenuators available for this purpose.

Note

The maximum possible transmit power varies depending on the channel and data rate. You will find detailed information on the transmit power of SCALANCE W devices in the following documents on the Siemens Industry Online Support (https://support.industry.siemens.com/cs/ww/en/ps/15859/man) pages:

- Performance data SCALANCE W700 802.11ax
- Performance data SCALANCE W1700 802.11ac
- Performance data 802.11 abgn SCALANCE W760/W720
- Performance data 802.11 abgn SCALANCE W770/W730
- Performance data 802.11abgn PCIe Minicard MPCIE-R1-ABGN-U3 SCALANCE W780/W740

5.2 Feeding into RCoax from both ends

Initial situation

An RCoax cable is fed into by an access point at both ends.

Note

Same/overlapping channels

The two access points must not transmit on the same or overlapping channels.

Effects

In contrast to the standard use case, in which the 50 Ω terminator at the end of the cable largely prevents reflections, when feeding in a signal at both ends, the signals are partially reflected by a frequency-dependent input impedance at the ends of the RCoax cable.

These reflections impair the quality of the communication. This is noticeable due to the increased CRC and ACK error rates. The retry rate also increases.

When feeding a signal into both ends of the RCoax cable, it can be expected that the maximum possible data throughput will be considerably reduced.

Possible solutions

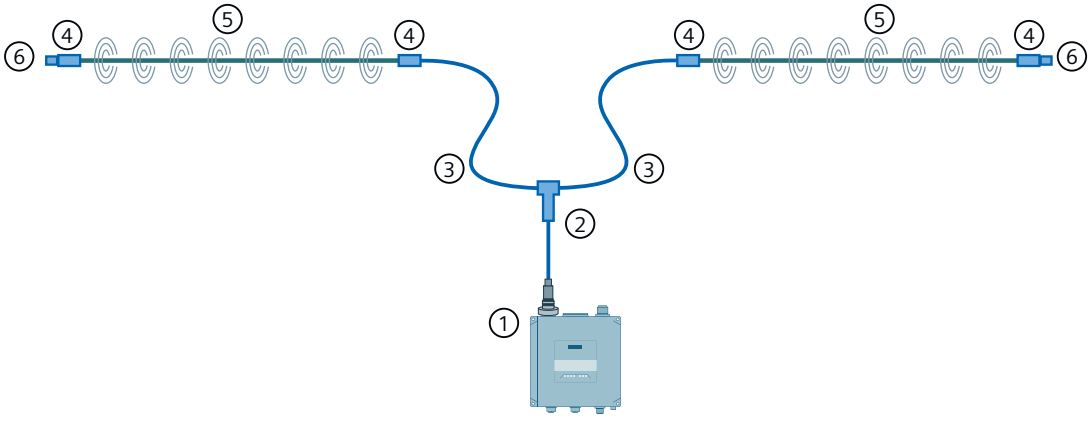
The effects of the signal reflections at the ends of the cable can be reduced by including an attenuator at the cable ends but they cannot be prevented entirely.

Remember that by including attenuators, you further reduce the coverable distance.

5.3 Supplying two sections of cable

Configuration example

The range of an RCoax wireless segment can be increased by connecting a power splitter in the center of the RCoax cable. The following example shows how the individual components are used.



1. N-Connect/ R-SMA male/male flexible Connection Cable preassembled 6XV1875-5C**0
2. N-Connect female Power Splitter 6GK5798-0SN00-0EA0
3. N-Connect male/male flexible Connection Cable preassembled 6XV1875-5A**0
4. RCoax N-Connect female 6GK5798-0CN00-0AA0
5. RCoax cable 6XV1875-2*
6. N-Connect male termination Impedance TI795-1N 50 Ω 6GK5795-1TN00-1AA0

Note

In a concrete situation, the wildcards ** and * would be replaced by specific article numbers depending on the cable length and/or the frequency range you are using.

5.4 Connecting mobile nodes

The mobile participants in communication via RCoax must be equipped with a client module. The SCALANCE W product group offers client modules for the wireless standards IEEE 802.11ax, IEEE 802.11ac and IEEE 802.11n. You can find an overview on the Internet. (https://www.siemens.com/global/en/products/automation/industrial-communication/industrial-wireless-lan.html)

Designing and calculating RCoax systems

6

Note

Technical specifications

You can find technical information on RCoax cables and their accessories in the section "Technical specifications (Page 39)".

You can find information about further accessories for cabling in the "Industrial Wireless LAN and Industrial 5G Coaxial components (https://support.industry.siemens.com/cs/ww/en/view/109971849)" system manual.

6.1 Calculating in decibels

Decibels as a logarithmic unit of measure

In wireless engineering, calculations are normally made in decibels (dB) to simplify the calculation of the transmission behavior of a series of transmission elements. Decibel means the logarithm of a ratio. Formulated mathematically, this can be shown by the following equation:

Decibel value = 10 * log (ratio)

Using sample calculations, the following decibel values are obtained:

Ratio	Decibel value
0.001	-30 dB
0.1	-10 dB
0.2	-7 dB
0.4	-4 dB
0.5	-3 dB
1	0 dB
2	3 dB
4	6 dB

As can be seen in the example, halving a value reduces the decibel value by 3 dB. This remains true regardless of the selected reference variable because only the ratio counts. Which reference variable is used can be recognized by the additional letters or numbers following the dimension dB. In acoustics, for example, the threshold of audibility is the reference variable for a value in dB(A).

6.2 Power specifications

Explanation of the power specifications

Specifying power in dBi

If power is specified in dBi, the reference variable is the transmit power of an isotropic antenna or unipole. Such a (hypothetical) antenna radiates energy from a central point uniformly in all directions.

From the directional radiation of a real antenna, a dBi value is obtained known as the antenna gain. This term is misleading in as far as no energy is gained by an antenna in the physical sense. The higher radiation of a passive antenna results solely from the concentration of radiation in a certain direction. In other spatial segments, there is accordingly less power.

You will find the antenna gain in the compact operating instructions of the relevant antenna.

Specifying power in dBm

A commonly used reference variable in wireless technology is a power of 1 mW. Power can then be specified in the decibel milliwatt unit (dBm). The following formula is used:

P [dBm] = 10 * log (P [mW] / 1 mW)

This results in the following power specifications in dBm:

0.5 mW	≈	-3 dBm
1 mW	=	0 dBm
2 mW	≈	3 dBm
4 mW	≈	6 dBm
10 mW	≈	10 dBm
100 mW	≈	20 dBm
200 mW	≈	23 dBm
1000 mW	≈	30 dBm

Using power specifications, it is simple to calculate gain and attenuation. To calculate an entire system, the individual values for gain and attenuation must simply be added.

Receiver sensitivity

The receiver sensitivity is the minimum power that must be fed to a receiver to allow communication to take place. The receiver sensitivity is a device-specific property and depends on the transmission technique and data rate.

Transmit power P_0 in dBm

This power is input into the RCoax cable by a transmitter, for example a SCALANCE W700 access point.

Information on receiver sensitivity and transmit power

You will find detailed information on the receiver sensitivity and transmit power of SCALANCE W devices in the following documents on the Siemens Industry Online Support (https://support.industry.siemens.com/cs/ww/en/ps/15859/man) pages:

- Performance data SCALANCE W700 802.11ax
- Performance data SCALANCE W1700 802.11ac
- Performance data 802.11 abgn SCALANCE W760/W720
- Performance data 802.11 abgn SCALANCE W770/W730
- Performance data 802.11abgn PCIe Minicard MPCIE-R1-ABGN-U3 SCALANCE W780/W740

Received power P_e in dBm

This power is usable for a receiver. It corresponds to the input power reduced by the losses such as longitudinal attenuation and coupling loss.

Note

Values for the coupling loss are often specified according to IEC 61196-4. The measurement according to this standard is made at a distance of 2 m and with a λ/2 radiator. Such measurements therefore also include part of the free space attenuation (loss between RCoax cable and communication partner).

6.3 Losses with RCoax cables

Longitudinal loss

The transmission of energy within the cable is also subject to loss. This loss is known as longitudinal attenuation (a_{rc}) and is calculated from the attenuation coefficient and length of the cable:

$a_{rc} = \alpha_{rc} * l$

a_{rc} Longitudinal attenuation of the cable in dB
α_{rc} Attenuation coefficient in dB/m as specified in the technical specifications of the cable
l Total length of the cable in m

The attenuation coefficient (a_{rc}) depends on the following parameters:

- Frequency of the electromagnetic wave in the cable. The higher the frequency, the higher the longitudinal attenuation.
- Dielectric and structure of the cable
- Number, size and shape of the slots in the shield
- Surroundings of the cable since the electromagnetic wave in a leaky feeder cable also radiates outside the cable.

Coupling loss

The transmission of energy from the inner cable to the outside of the leaky feeder cable is not free of loss. A measure of the efficiency of this transmission is the coupling loss C_d.

The coupling loss is the ratio of the power inside the leaky feeder cable at the point at which the power is coupled out to the power available at the point of measurement outside the cable, for example for a wireless receiver. It is made up of the actual coupling out loss (power in the interior to power on the jacket) and the spatial loss between the cable and the measurement location. The coupling loss depends on the following parameters:

- Distance between cable and device
- Number, size and shape of the slots in the shield
- Environmental influences such as reflection, absorption, interference or additional attenuation due to substances between the RCoax cable and the client

C_{95} and C_{50}

The actual signal strength at a measuring point fluctuates along the leaky feeder cable.

When designing wireless systems, the line of the 95% level or 50% level is normally taken as the basis. This line is an idealized characteristic of the received power for which more than 95% (C_{95}) or 50% (C_{50}) of the measured values are above the idealized line. This means that C_{95} is always higher than C_{50}.

Since the received power and therefore the possible segment lengths depends on the value of the coupling loss, only the value actually required for a system should be used. What is necessary depends on the type of communication.

C_{95} for safety-related communication

For communication involving the safety of persons or equipment, the coupling loss must be calculated using the C_{95} value.

C_{50} for standard communication

When exchanging data that is not relevant to safety and in which the loss of a frame or the repetition of a frame can be tolerated, it is adequate to use the lower C_{50} value.

Note

No distinction in the near field

Due to the physical properties in the immediate surroundings of the cable (up to 0.5 m distance), the C_{95} and C_{50} values do not differ in the near field.

Near and far field

Near field

In the immediate surroundings of the radiating cable, various physical effects influence the propagation of the electromagnetic waves so that a mathematical calculation of measured values is not possible. Information about coupling losses for this area is only possible as discrete values for distances actually measured in realistic surroundings.

In practice, with RCoax cables, the near field is assumed to be up to a distance of 0.5 m from the cable. This is therefore the range in which the receiving antenna is normally positioned for RCoax applications.

Far field

As of a distance of approximately 0.5 m, the propagation of the electromagnetic waves and therefore the associated measured variables can be described mathematically. This means, for example, that coupling losses can be calculated using a formula depending on the distance from the cable as is specified in IEC 61196-4.

IEC 61196-4

Values for the coupling loss in the far field are often specified according to IEC 61196-4. The measurement according to this standard is made at a distance of 2 m and with a λ/2 radiator. Such measurements therefore also include part of the free space attenuation (loss between RCoax cable and communication partner).

To calculate the actual coupling loss, a spatial attenuation must therefore be deducted from this value for the distance of 2 m. The coupling loss C_{50} and C_{95} for a specified distance between the RCoax cable and the antenna of the communications partner is therefore calculated according to the following formulas:

$C_d = C_{50}+10*\log*(d/2)$

$C_d = C_{95}+20*\log*(d/2)$

C_d	Coupling loss of the cable in dB for a specified distance (>0.5 m) between RCoax cable and antenna
$C_{50/}$ C_{95}	$C_{50/}$ C_{95} value of the coupling loss at a distance of 2 m. (For $C_{50/}$ C_{95} values, see the section "Technical specifications (Page 39)")
d	Distance between RCoax cable and antenna in m

For the calculation according to the specified formula, d must be > 0.5 m (far field).

Losses due to power splitters and feed cables

The feed cables (a_{fe}) and power splitters (a_{PS}) cause losses. The values of these losses can be found in the "Technical specifications" section of the "SIMATIC NET Industrial Wireless LAN and Industrial 5G Coaxial components" (https://support.industry.siemens.com/cs/ww/en/view/109971849) system manual.

6.4 System calculation

Procedure

The calculation of the entire system shows whether communication is possible at the desired transmission rate using the desired components. All losses (longitudinal attenuation, spatial attenuation, power splitters etc.) are deducted from the transmit power. An antenna gain is added. The result is the power fed to a receiver. This power must be higher than the minimum necessary input power at the receiver so that a wireless link can exist.
The calculation can be made with the following formula:

$P_e = P_0 - a_{rc} - a_{fe} - c_d - a_{ps} + G_{ANT} - \Delta_{Sys} > P_{e\,min}$

P_e	Receiver input power in dBm
P_0	Transmit power dBm
a_{rc}	Longitudinal attenuation of the RCoax cable in dB
a_{fe}	Longitudinal attenuation of the feed cable in dB
c_d	Coupling loss for the distance between RCoax cable and communication partner (see Section "Losses with RCoax cables (Page 33)")
a_{ps}	Power splitter losses in dB
G_{ANT}	Antenna gain in dB
Δ_{Sys}	Link budget in dB. Depending on the field strength fluctuations, losses due to plug-in connections and the concrete operating conditions are between 10 and 20 dB.
$P_{e\,min}$	Minimum necessary receiver input power in dBm

6.5 Segment lengths

The calculation example for an RCoax system is illustrated in this section. It is based on the calculation formula explained in the previous paragraph.

The RCoax cable is connected to an access point at one end and has a terminating resistor at the other end. It should be checked whether the minimum required input power $\mathbf{P_{e\,min}}$ of **-64 dB** can be achieved at the receiver for an RCoax cable with a **length of 60 meters**. The following values result for the parameters:

- **Transmit power P_0**
  With a device corresponding to IEEE 802.11ax, a transmit power of **17 dBm** is set when the 5 GHz frequency band (5.2 GHz, 40 MHz channel) is used.
- **Longitudinal attenuation a_{rc} of the RCoax cable**
  With cable installation 15 mm above an aluminum rail, a value of **24.2 dB/100 m** is used for 5.2 GHz; see Technical specifications, RCoax cables (Page 39).
- **Longitudinal attenuation a_{to} the feed cables**
  A preassembled, flexible connecting cable (length 1 m, article number 6XV1875-5AH10) is used between the access point and RCoax cable or client and RCoax antenna. At 5.2 GHz, the longitudinal attenuation is **0.83 dB/m** for the Antenna Cable N-Connect (https://support.industry.siemens.com/cs/ww/en/pv/6XV1875-5AH10/td).

- **Coupling loss c_d for the distance between antenna and RCoax cable**
  At 5.2 GHz and a distance of 10 cm between RCoax cable and RCoax antenna of the client, the coupling loss is c_{50} **42 dB**, see Technical specifications, RCoax cables (Page 39).
- **Power splitter losses a_{ps}**
  There is no power splitter in the example, so this parameter is ignored.
- **Antenna gain G_{ANT}**
  A max. antenna gain of **6 dB** is given for the antenna ANT793-4MN in the Technical specifications section, λ5/8 antenna for RCoax cable (5 GHz) (Page 46).
- **System reserve Δ_{Sys}**
  In practice, ambient conditions mean that there may be considerable deviations from the values in the table, so a system reserve of **15 dB** is assumed.

The following value results for the input power at the receiver:

$P_e = P_0 - a_{rc} - a_{fe} - c_d - a_{ps} + G_{ANT} - \Delta_{Sys} > P_{e\,min}$

P_e = 17 dB - 0.242 dB/m x 60 m - 2 x 1 m x 0.83 dB/m - 42 dB + 6 dB - 15 dB = **-50.18 dB > -64 dB**

The $P_e > P_{e\,min}$ requirement is met in this case.

Note

The signal strengths actually measurable at the client can deviate significantly from the theoretically calculated values as a result of environmental influences; see also coupling loss (Page 33).

Note

You can increase the distances covered by your RCoax cables by feeding in at the center of the cable and using power splitters. Please remember the 3 dB attenuation properties of the splitter.

Note

Stable PNIO communication is only possible when it is guaranteed that a WLAN client is in a cell with more than 60% or -65 dBm signal strength at all times. This can be checked by activating and deactivating the various segments.

Technical data

7

Note

Technical specifications

You can find information about further accessories for cabling in the "Industrial Wireless LAN and Industrial 5G Coaxial components" (https://support.industry.siemens.com/cs/ww/en/view/109971849) system manual.

Note

The following tightening torques apply to the connectors:

- with N-Connect connectors: 1.7 Nm
- with SMA/R-SMA connectors: 1 Nm

7.1 RCoax cables

The information relates to the following two RCoax cables:

- **IWLAN RCoax Cable PE 2.4GHz**
  Article number 6XV1875-2A
- **IWLAN RCoax Cable PE 5GHz**
  Article number 6XV1875-2D

Note

Laying cables outdoors

In terms of UV stability and provided the specified temperature range is not exceeded, the cables listed above are suitable for use outdoors. Correctly fitted connectors have degree of protection IP68 and form a unit with the cable that meets degree of protection IP65/IP67. Temporary exposure to rain, fog or snow is permitted. However, the cable segment must not be installed permanently under water because the cable jacket is not suitable due to the limited steam permeability.

Ambient conditions such as moisture, ice or deposits can have a significant impact on the coupling loss.

Technical specifications		
Article number	2.4 GHz	6XV1875-2A
	5 GHz	6XV1875-2D
Electrical data		

Technical specifications		
Impedance		50 +/- 3 Ω
Ratio of propagation speed		88%
Capacitance		76 pF/m
DC resistance at 20 °C	Inner conductor	1.48 Ω/km
	Outer conductor	2.8 Ω/km
Permitted ambient conditions		
Ambient temperature	During operation	-40 ... +85 °C
	During operation according to UL performance	-40 ... +85 °C
	During storage	-70 ... +85 °C
	During installation	-25 ... +60 °C
Resistance to fire		
Low corrosive gas emission		IEC 60754-2
Flame retardant		IEC 60332-1 IEC 60332-3 Cat. C
Low smoke emission		IEC 61034
Design, dimensions and weight		
Weight		0.232 kg/m
Minimum bending radius (once)		20 cm
Tensile strength		110 daN (1daN = 10 N)
Recommended securing intervals		0.5 m
Materials	Inner conductor	• Copper-clad aluminum • Diameter: 4.8 mm
	Dielectric	• Polyethylene foam • Diameter: 12.4 mm
	Outer conductor	Overlapping copper foil with openings in the coaxial shield of the RCoax cable bonded to the cable jacket.
	Cable jacket	• Halogen-free polyolefin NA5, pastel turquoise • Diameter: 15.5 mm • Jacket thickness: 1.3 mm
Attenuation properties – 2.4 GHz		
Longitudinal attenuation (1) at 20 °C	f [MHz]	2400
	α [dB/100m]Cable installation 10 mm over concrete	15
	α [dB/100m]Cable installation 15 mm over aluminum rail	17

Technical specifications					
Coupling loss (2) at 20 °C	f [MHz]	2400			
	Distance between antenna and RCoax cable	C_{50} [dB]		C_{95} [dB]	
	2 cm	31		31	
	5 cm	32		32	
	10 cm	35		35	
	20 cm	37		37	
	50 cm	41		41	
	2 m	54		60	
Attenuation properties – 5 GHz					
Longitudinal attenuation (1) at 20 °C	f [MHz]	5150		5850	
	α [dB/100m]Cable installation 10 mm over concrete	22,5		24	
	α [dB/100m]Cable installation 15 mm over aluminum rail	24,2		27	
Coupling loss (2) at 20 °C measured in the near field	f [MHz]	5200		5700	
	Distance between antenna and RCoax cable	C_{50} [dB]		C_{50} [dB]	
	2 cm	36		35	
	5 cm	39		38	
	10 cm	42		40	
	20 cm	45		44	
	50 cm	49		47	
Coupling loss (2) at 20 °C measured according to IEC 61196-4 ground-level method	f [MHz]	5200		5800	
	Distance between antenna and RCoax cable	C_{50} [dB]	C_{95} [dB]	C_{50} [dB]	C_{95} [dB]
	2 m	62	71	55	59

(1) Nominal value, manufacturing tolerance +/- 5%

(2) Nominal value, manufacturing tolerance +/- 3 dB

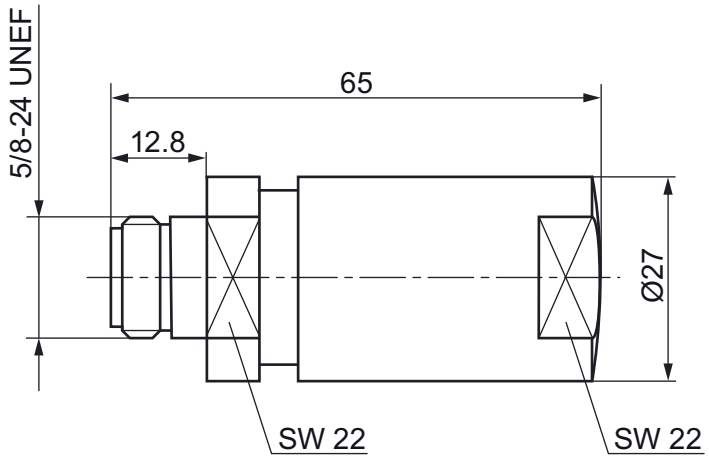
7.2 N Connector for RCoax female

Technical specifications		
Article number		6GK5798-0CN00-0AA0
Electrical data		
Impedance		50 Ω
Frequency range		6 GHz
Contact resistance	Inner conductor:	< 2 mΩ
	Outer conductor	< 0.5 mΩ
Seal		NBR / EPDM, silicone-free

Technical specifications			
Insulation		PTFE / PPO, silicone-free	
Connector torque		4 ... 6 Nm	
Max. number of insertion cycles		> 500	
Design, dimensions and weight			
Dimensions (length x diameter)		65 x 27 mm	
Materials		Spring contact	Other metal parts
	Core material	Copper alloy	Brass
	Coating	Cu_2Ag_5	$CuSnZn_3$
Degree of protection		IP68 (0.5 bar / 24h)	
Permitted ambient conditions			
Ambient temperature		-40 ... +85 °C	
Cables for 2.4 GHz and 5 GHz			
Lead	Type	RCoax cable PE 1/2"	
	Resistance	Sun resistant	

Dimension drawing

The dimensions are specified in mm.

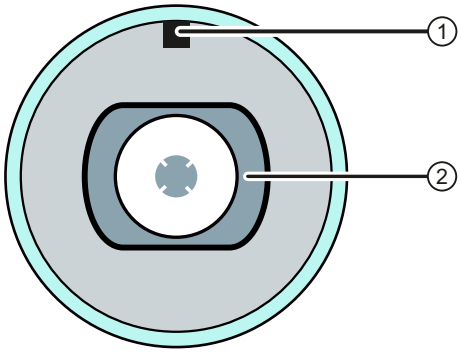


7.3 Antennas for RCoax application

Aid to orientation

To help you to read the data from the antenna diagram, the antenna is drawn in in the antenna diagrams.

On the rear of the antenna, there is a groove to aid with orientation. The groove is shown on the antenna drawing by this symbol ●.



① Groove
② N-Connect

Figure 7-1 View from below

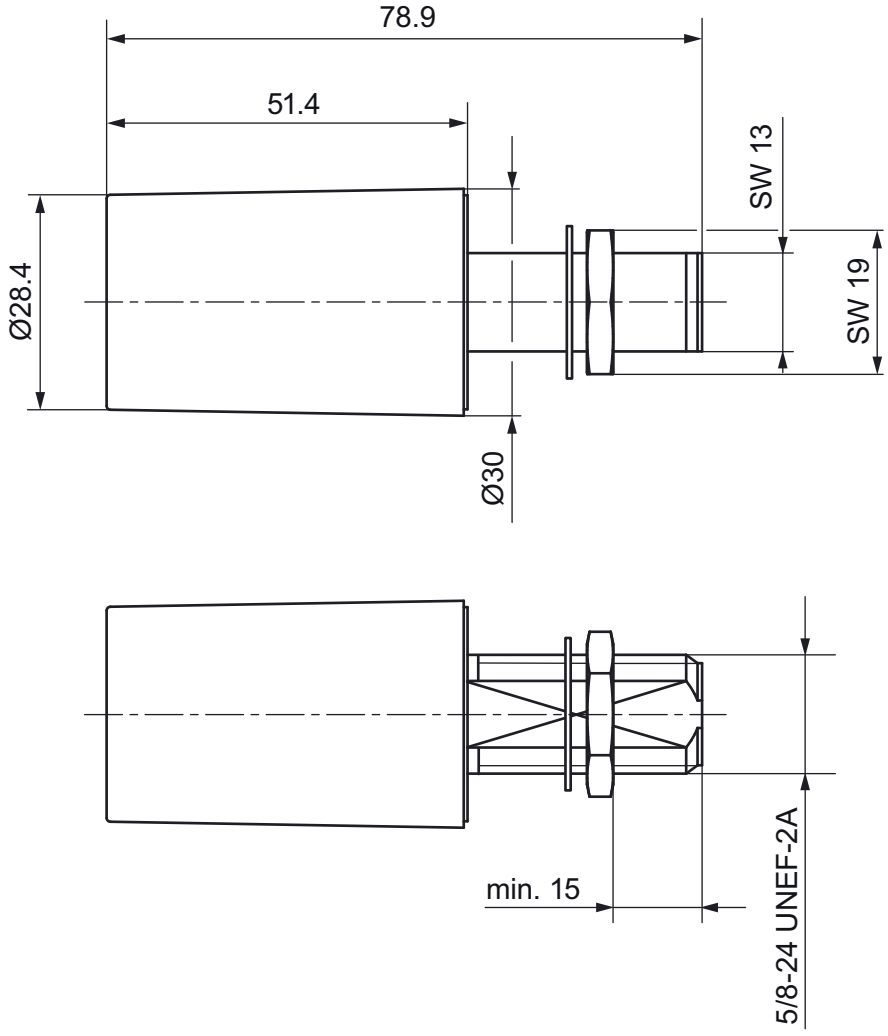
7.3.1 Helical antenna for RCoax cable (2.4 GHz)

RCoax N-Connect Female ANT792-4DN (antenna 2.4 GHz, circular polarization)

Technical specifications	
Article number	6GK5792-4DN00-0AA6
Electrical data	
Frequency range	2.4 ~ 2.4835 GHz
Max. antenna gain	4 dB
Impedance	50 Ω
Polarization	Circular, clockwise
Standing wave ratio (VSWR)	≤1.8
Construction and dimensions	
Dimensions (length x diameter)	78.9 x 30 mm
Length of securing thread	27.5 mm
Connector	N connector, female
External material	Lexan
Degree of protection	IP65
Permitted ambient conditions	
Ambient temperature	-40 ... +70 °C

Dimension drawing

The dimensions are specified in mm.



Horizontal antenna diagram

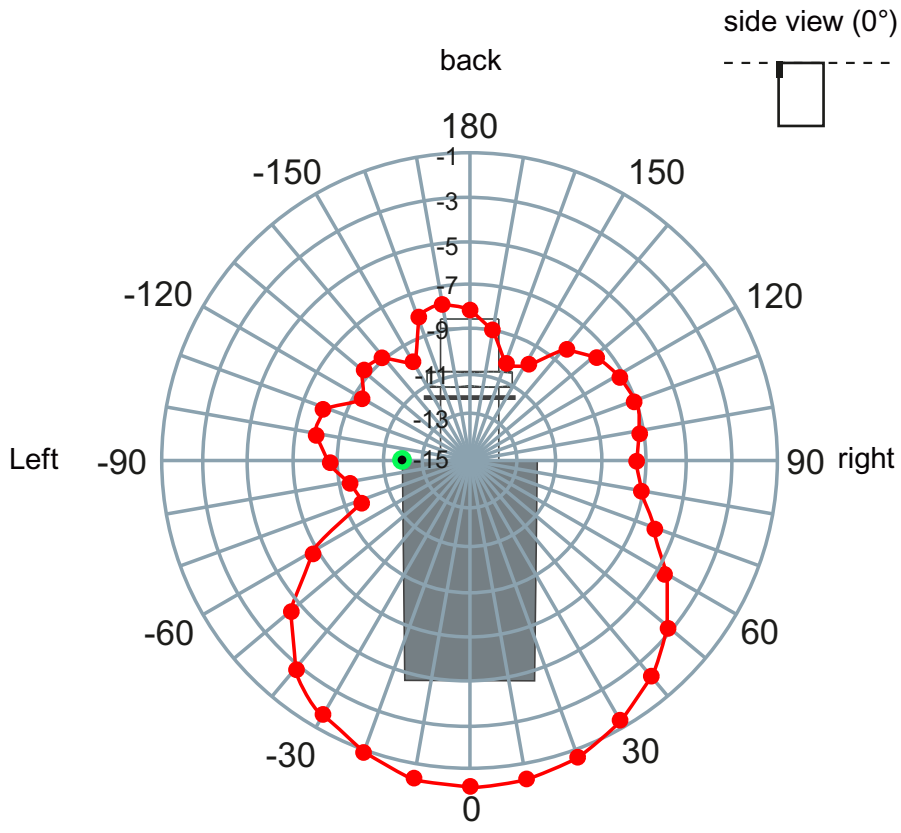


Figure 7-2 Horizontal directional characteristics of the helical antenna

Vertical antenna diagram

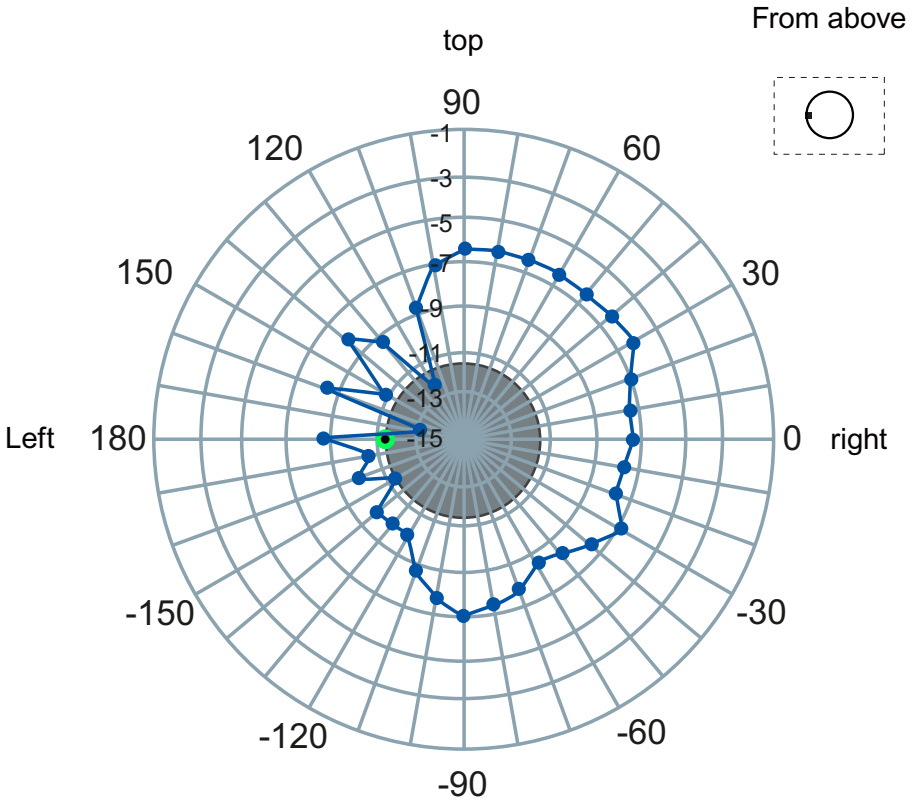


Figure 7-3 Vertical directional characteristics of the helical antenna

7.3.2 λ5/8 antenna for RCoax cable (5 GHz)

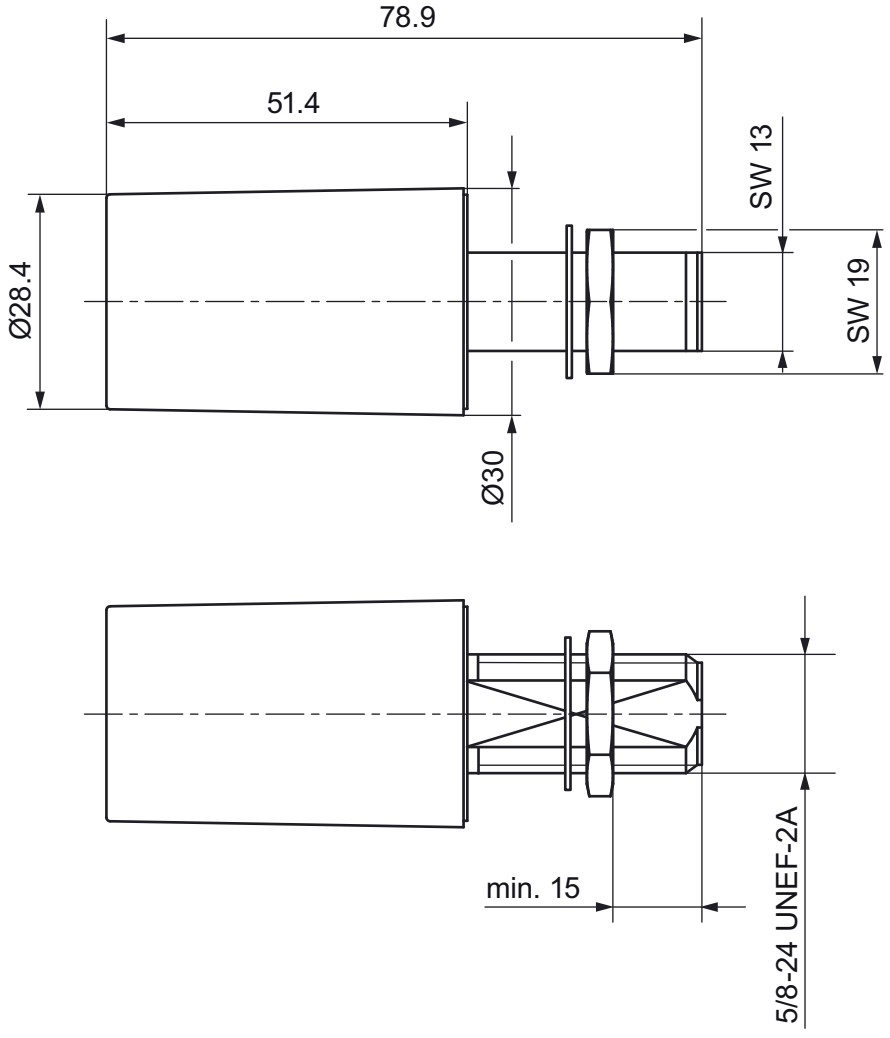
RCoax N-Connect Female ANT793-4MN (antenna 5 GHz, λ5/8)

Technical specifications	
Article number	6GK5793-4MN00-0AA6
Electrical data	
Frequency range	5.15 ~ 5.85 GHz
Max. antenna gain	6 dBi
Impedance	50 Ω
Polarization	Vertical (λ5/8 characteristic)
Standing wave ratio (VSWR)	≤2.0
Construction and dimensions	
Dimensions (length x diameter)	78.9 x 30 mm
Length of securing thread	27.5 mm
Connector	N connector, female

Technical specifications	
External material	Lexan
Degree of protection	IP65
Permitted ambient conditions	
Ambient temperature	-40 ... +70 °C

Dimension drawing

The dimensions are specified in mm.



Horizontal antenna diagram at 5.2 GHz in dB

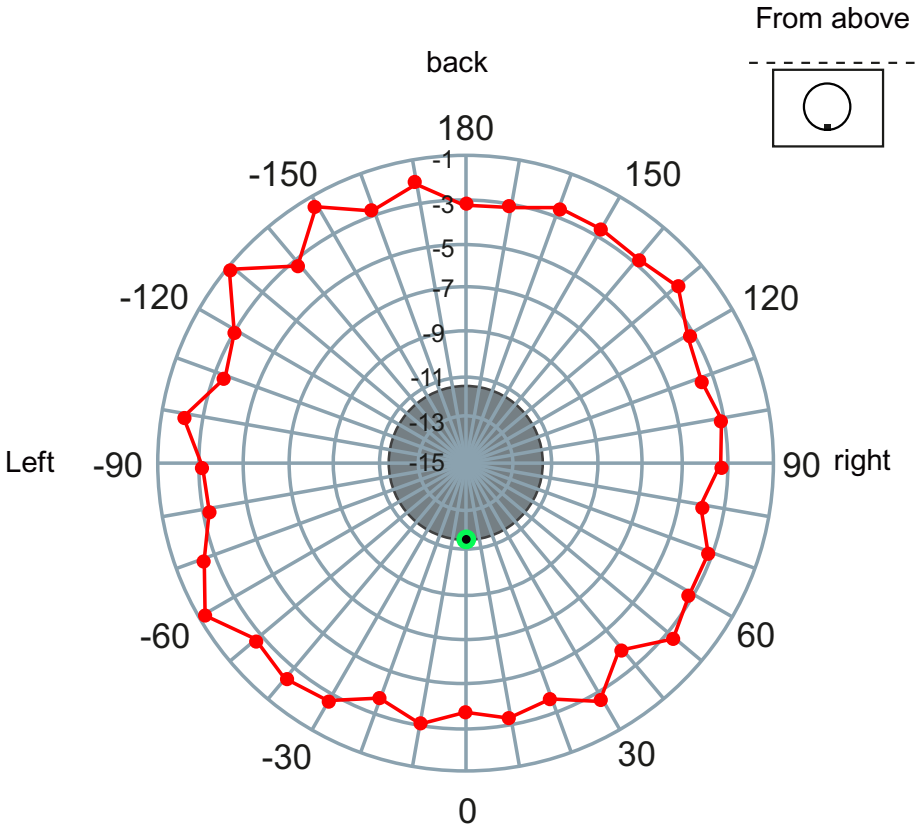


Figure 7-4 Horizontal radiation pattern ANT793-4MN

Vertical antenna diagram for different azimuth angles at 5.2 GHz in dB

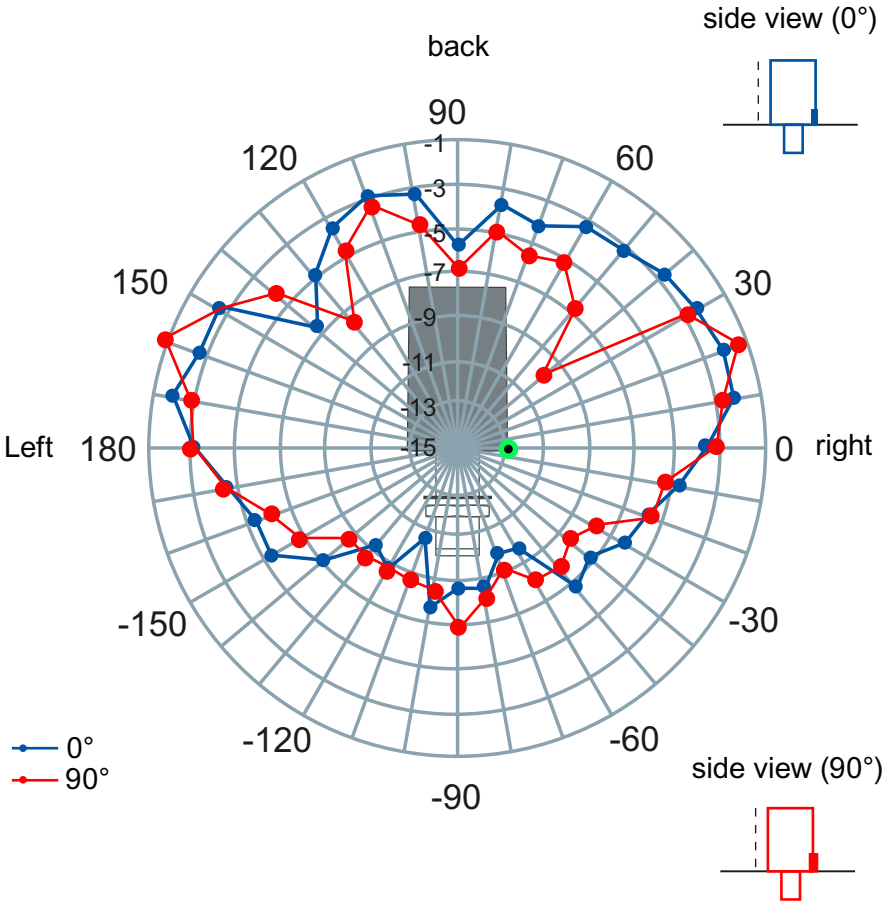


Figure 7-5 Vertical radiation pattern ANT793-4MN

Horizontal antenna diagram at 5.7 GHz in dB

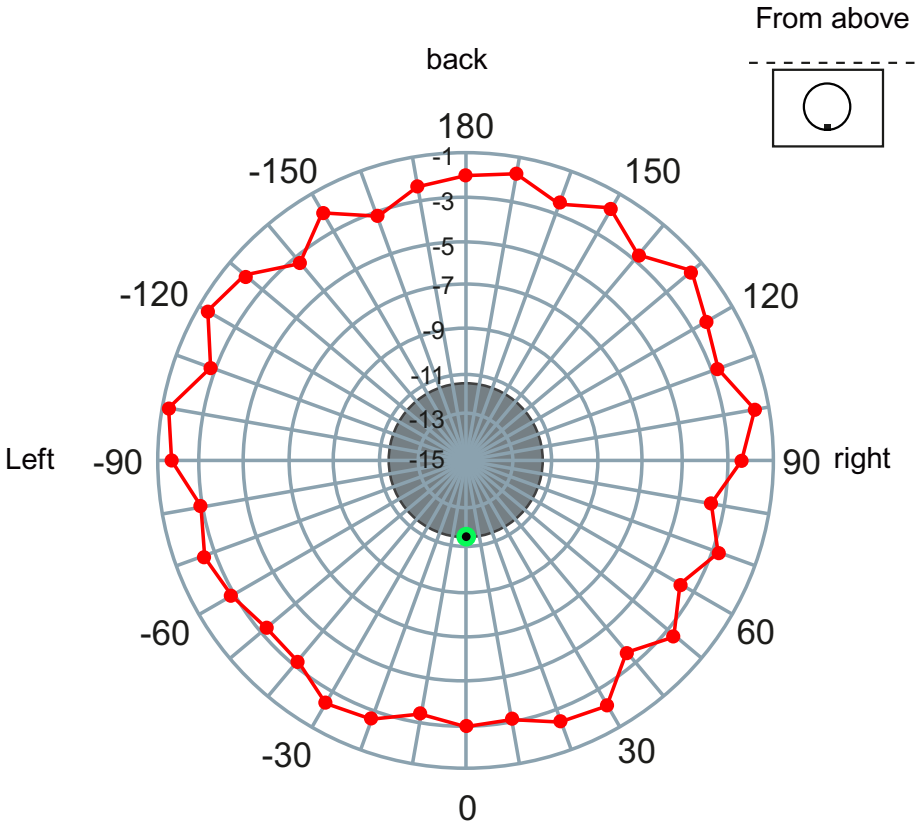


Figure 7-6 Horizontal radiation pattern ANT793-4MN at 5.7 GHz

Vertical antenna diagram for different azimuth angles at 5.7 GHz in dB

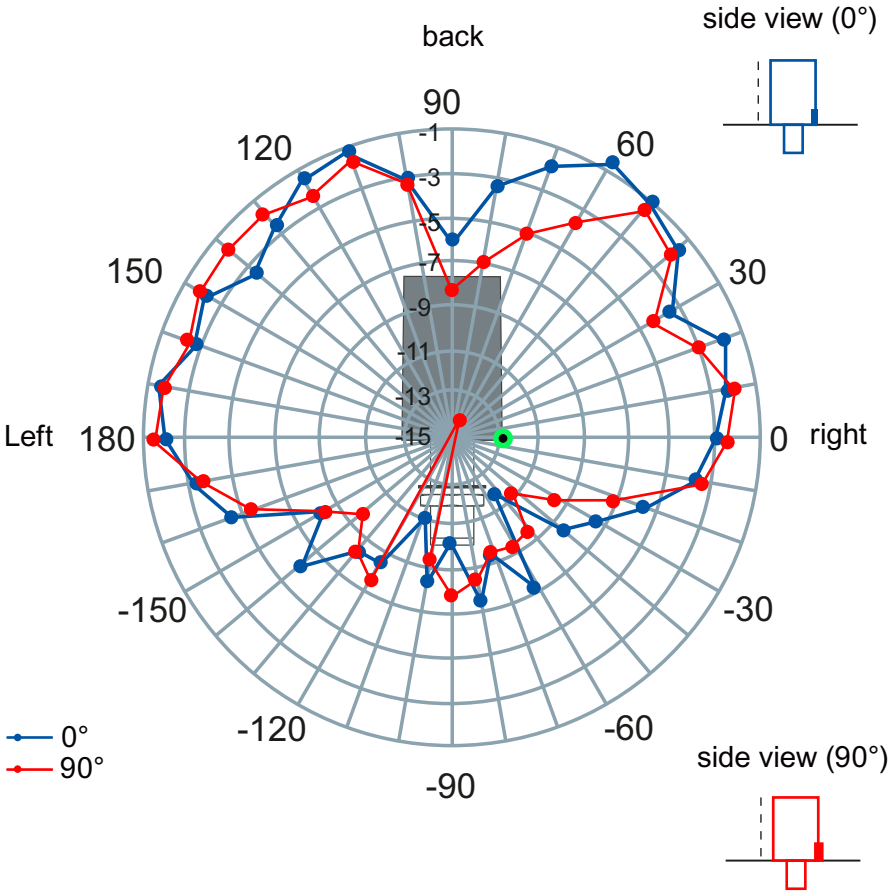


Figure 7-7 Vertical radiation pattern ANT793-4MN at 5.7 GHz

Antenna gain

The diagram shows the typical maximum antenna gain.

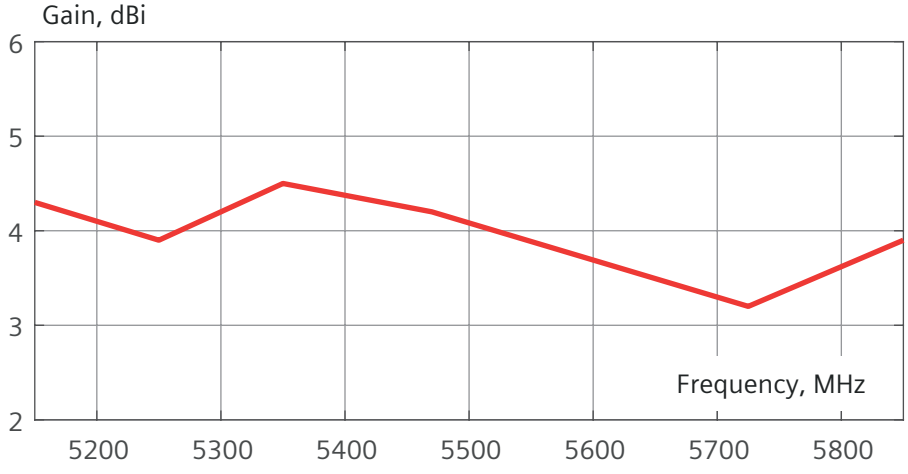


Figure 7-8 Typical antenna gain ANT793-4MN

7.4 Wall mounting

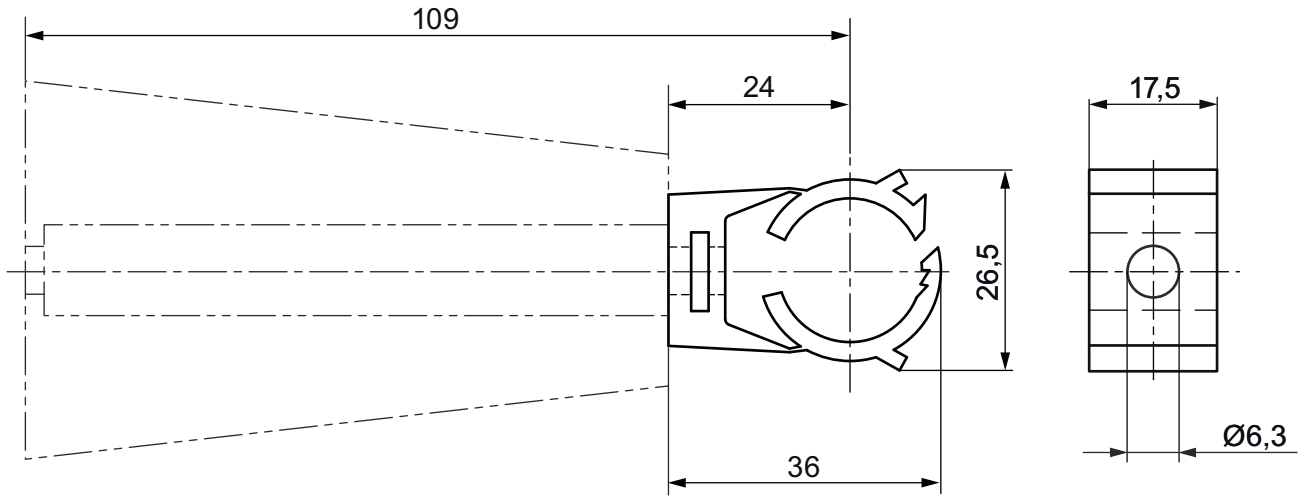
RCoax securing clip ½"

Technical specifications		
Article number	Pack of 10	6GK5798-8MB00-0AC1
	Pack of 100	6GK5798-8MB00-0AM1
Resistance to fire		
Flame class		UL 94HB
Construction and materials		
Materials		High-class polyamide (UV resistant): • Halogen-free • Chemical-resistant
Color		black
Permitted ambient conditions		
Ambient temperature		-40 ... +70 °C
Mechanical data		
Stress		max. 600 N
Securing range (cable diameter ∅)		14.3 ... 16.8 mm

Figure 7-9 RCoax securing clip ½" with threaded washer M6 and spacer 85 mm

Dimension drawing RCoax securing clip ½"

The dimensions are specified in mm.

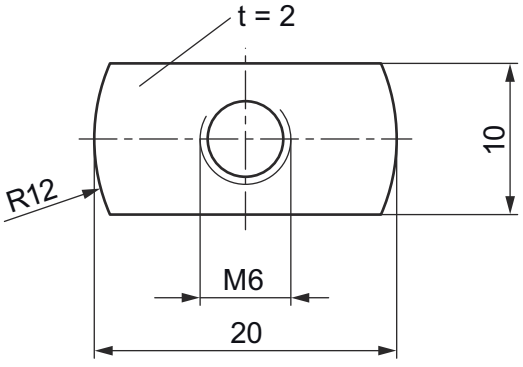


RCoax threaded washer M6 for securing clip ½"

Technical specifications		
Article number	Pack of 10	6GK5798-8MC00-0AC1
	Pack of 100	6GK5798-8MC00-0AM1
Construction and materials		
Materials		Stainless steel
Thread		M6

Dimension drawing RCoax threaded washer 85 mm for securing clip ½ "

The dimensions are specified in mm.

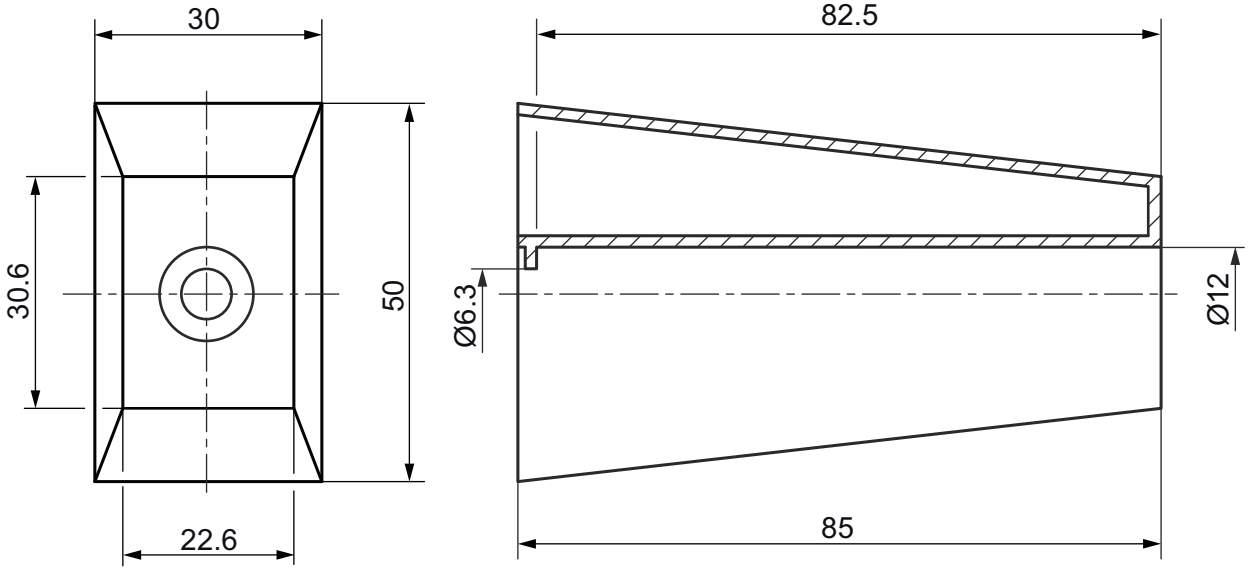


RCoax spacer 85 mm

Technical specifications		
Article number	Pack of 10	6GK5798-8MD00-0AC1
	Pack of 100	6GK5798-8MD00-0AM1
Dimensions and materials		
Dimensions (W x H x D)		50 x 30 x 85 mm
Materials		Polyamide (halogen-free, resistant to UV light)

Dimension drawing RCoax spacer 85 mm

The dimensions are specified in mm.



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