Cisco Vandal Resistant Omni-directional Dome Antenna for 860-928 MHz ISM, WPAN and LoRaWAN (ANT-UN-MP-OUT-QMA)

This chapter contains the following:

Overview

This document describes the Vandal Resistant Omni-directional Dome Antenna for 860-928 MHz ISM, WPAN and LoRaWAN routers. In addition, this document provides the antenna specifications and mounting instructions for the antenna.

Caution Read the information in the Safety Warnings before installing or replacing antennas.

Technical Specifications

This section covers the following topics:

Figure 1: Vandal Resistant Omni-directional Dome Antenna

Specifications

The following tables provide the Mechanical, Environmental, and Other Specifications.

Note While many antenna datasheets emphasize peak gain, in most outdoor applications gain at horizon is much more important. For low profile antennas from any vendor, it is important to evaluate gain at horizon prior to selecting the antenna for deployment.

Table 1: RF Specifications 863-876 MHz ETSI

Specification	Description	
(See **Note 1**)	No Ground Plane	With 2 foot diameter Ground Plane
Peak Gain (dBi) Typical(See **Note 2**)	+1.7	+3
Gain on Horizon (dBi) Average	+0.1	-1.2
Gain on Horizon (dBi) Minimum(See **Note 3**)	-2.0	-2.0
Efficiency	65%	76%
VSWR (Worst Case)	1.7:1	1.2:1
Elevation 3 dB Beamwidth (HPBW), degrees	65	66
Azimuth 3 dB Beamwidth (HPBW), degrees	360	
Nominal Impedance, ohms	50 ohms	
Polarization	Vertical	
RF Cable Length (ft)	5 foot (See **Note 4**)	
RF Connector	QMA (male), right angle	
Max RF Power (at 25°C), Watts	10 Watts	

Table 2: RF Specifications 902-928 MHz ISM

Specification	Decription	
(See **Note 1**)	No Ground Plane	With 2 foot diameter Ground Plane
Peak Gain (dBi) Typical(See **Note 2**)	+1.5	+1.9
Gain on Horizon (dBi) Average	+0.6	-1.4
Gain on Horizon (dBi) Minimum(See **Note 3**)	-2.0	-3.5
Efficiency	67%	69%
VSWR (Worst Case)	1.5:1	1.5:1
Elevation 3 dB Beamwidth (HPBW), degrees	75	72

Specification	Decription
Azimuth 3 dB Beamwidth (HPBW), degrees	360
Nominal Impedance, ohms	50 ohms
Polarization	Vertical
RF Cable Length (ft)	5 foot (See **Note 4**)
RF Connector	QMA (male), right angle
Max RF Power (at 25°C), Watts	10 Watts

Note 1: Antenna has been designed and tested to have excellent performance with and without a ground plane over the full 860-928 MHz frequency range. It can be installed on a metallic or non-metallic surface. RF parameters in the table are provided for both cases of ground plane vs no ground plane.

Note 2: Peak gain of monopole antennas installed on a finite size ground plane will not be at horizon, and will be elevated above the horizon. In contrast, typical terrestrial radio deployments with omni-directional antennas involve communications near the horizon. Therefore, in the most common deployment scenarios the gain at horizon is a more useful parameter than peak gain.

Note 3: The minimum horizon gain specification shows whether an antenna has radiation nulls in azimuth. Nulls are directions in which the antenna has poor gain (e.g. -6 dBI, -10 dBI, -20 dBI or worse), and nulls often result in severe transmit and receive signal loss in the direction of the null. The ANT-UN-MP-OUT-QMA antenna has a smooth horizon or azimuth radiation pattern, and does not have azimuth pattern nulls. When evaluating omni-directional antennas, it is important to ensure that the antenna pattern does not have nulls in azimuth, to ensure good transmission and reception signal quality in all directions at horizon.

Note 4: All provided RF specifications include the RF loss of the integrated 5 foot cable.

Table 3: Mechanical, Environmental, and Other Specifications

Specification	Description
Anti-Static Protection	DC Grounded(See **Note 1**)
Antenna Dimensions (Diameter x Height), mm, inch	147mm x 47mm, 5.8"x1.85"
Weight, kg (lbs)	0.6kg (1.35 lb)
Antenna Radome Color	Electrical utility box green color
UV resistance	UV resistant, UV stable material
Wind Operational & Survival	150mph minimum
Operating Temperature	-40 to +70C (-40 to +158F)
Storage Temperature	-40 to +85C (-40 to +185F)
Ingression Protection	IP67 when properly mounted to a flat surface
Material Substance Compliance	ROHS

Specification	Description
Impact Resistance	Higher than IK10 or IK10+
Environmental Testing	Antenna passed extensive environmental and mechanical tests appropriate for deployment on an outdoor electrical utility box.

Note 1: Antenna data sheets often claim lightning protection, while in reality only providing a DC ground path for ESD protection. Cisco recommends use of a dedicated, high quality lightning arrestor for all antennas potentially exposed to lightning strikes.

Vandal Resistance

Antenna has been specifically designed to withstand opportunistic direct impacts from all angles, from more commonly carried vandalism objects or tools, such as aluminum or wooden baseball bats, skateboards, scooters, small knives and similar objects, assuming proper installation of the antenna on a flat surface.

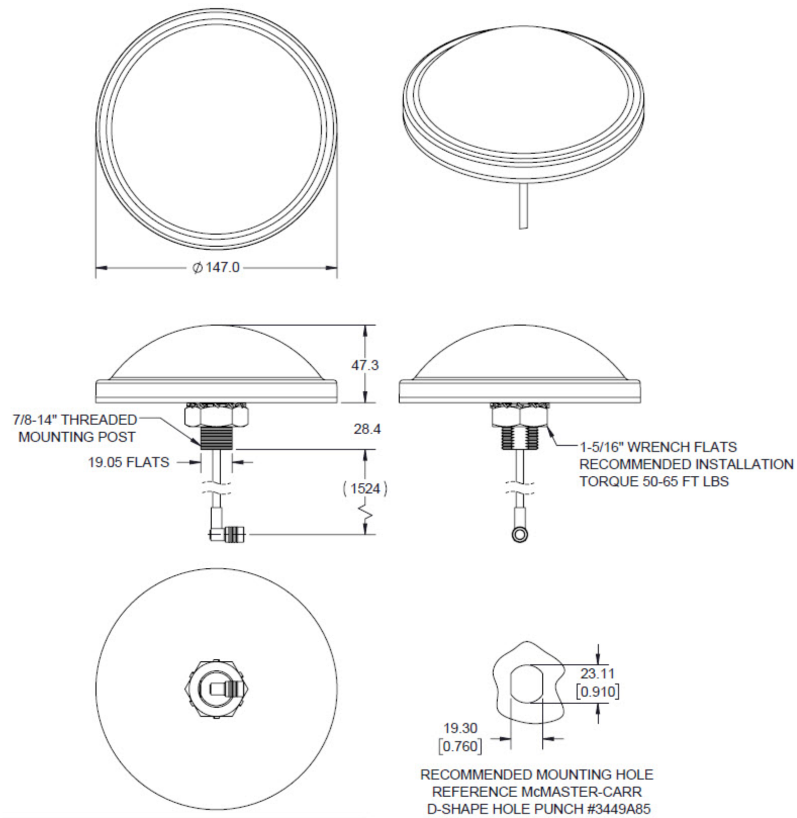
Antenna is not resistant to damage caused by intentional or unintentional tampering with professional tools used in isolation or in combination, such as long (e.g. 40") steel crowbars or pry bars, power drills, welding torches, axes, chainsaws, heavy duty sledge hammers and similar.

Additionally, while the antenna is resistant to occasional, opportunistic, impulsive vandalism with common items - it should be understood that a persistent, skilled and focused individual with the right common tools and given enough time will be able to damage or tamper with the antenna.

Dimensions

The following graphic shows the Antenna Dimensions.

Figure 2: Dimensions



Note Antenna Dimensions are shown in millimeters, except where explicitly specified in inches denoted by " or [ ].

Antenna Radiation Patterns

The following sequence of illustrations show the different antenna radiation patterns.

Note The pattern plots that follow show measurements for two different samples of the antenna, labeled S1 (Sample 1) and S2 (Sample 2).

Figure 3: 863 MHz Radiation Pattern - No Ground Plane

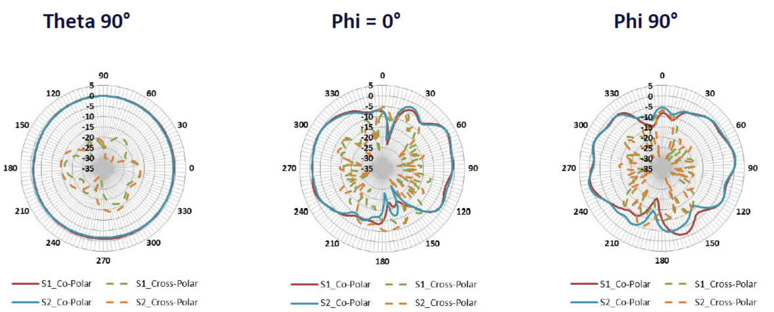


Figure 4: 863 MHz Radiation Pattern - With Ground Plane

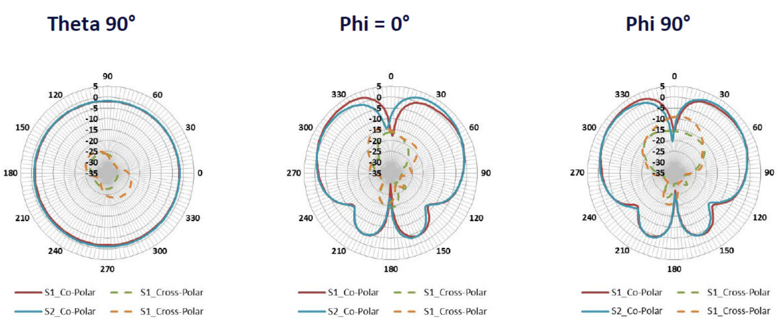


Figure 5: 876 MHz Radiation Pattern -No Ground Plane

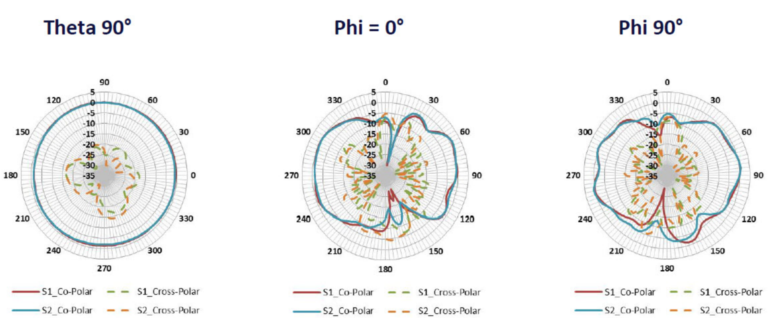


Figure 6: 876 MHz Radiation Pattern -With Ground Plane

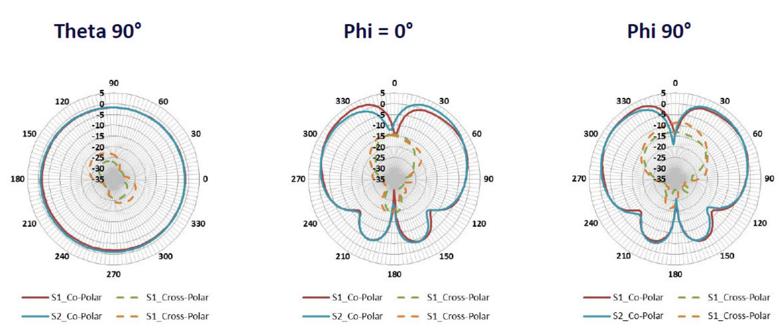


Figure 7: 902 MHz Radiation Pattern - No Ground Plane

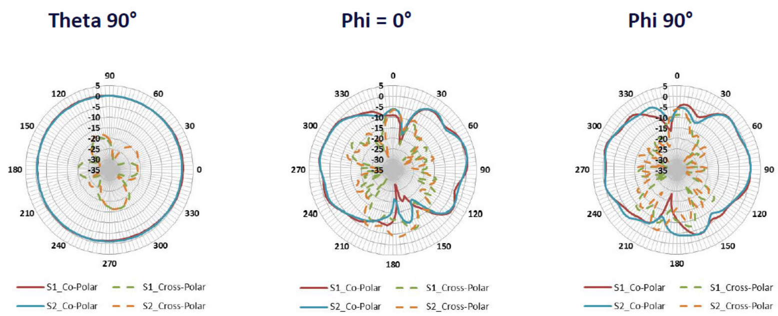


Figure 8: 902 MHz Radiation Pattern - With Ground Plane

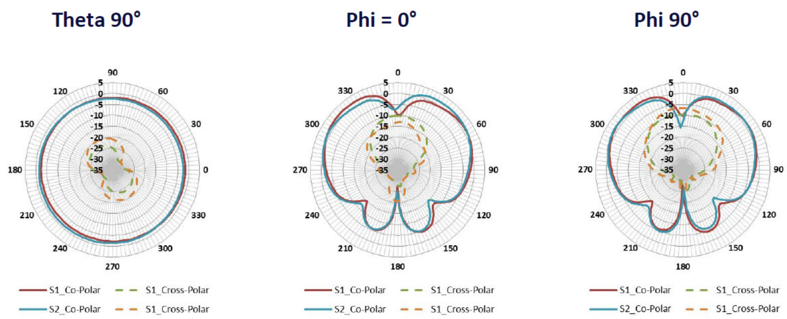


Figure 9: 915 MHz Radiation Pattern - No Ground Plane

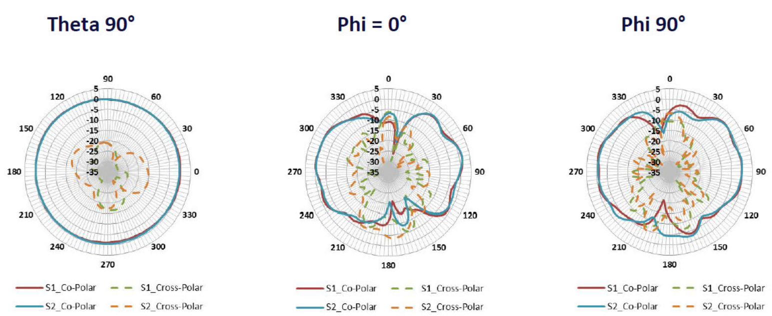


Figure 10: 915 MHz Radiation Pattern - With Ground Plane

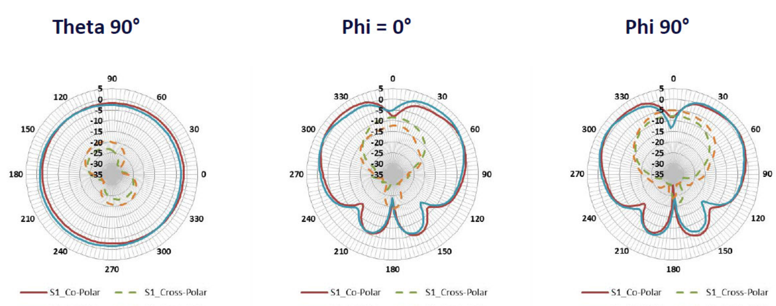


Figure 11: 928 MHz Radiation Pattern - No Ground Plane

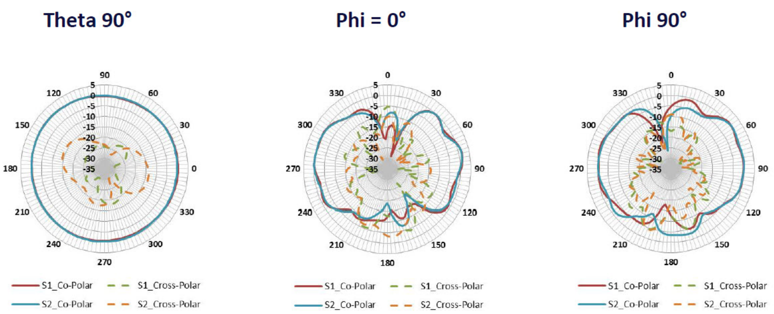
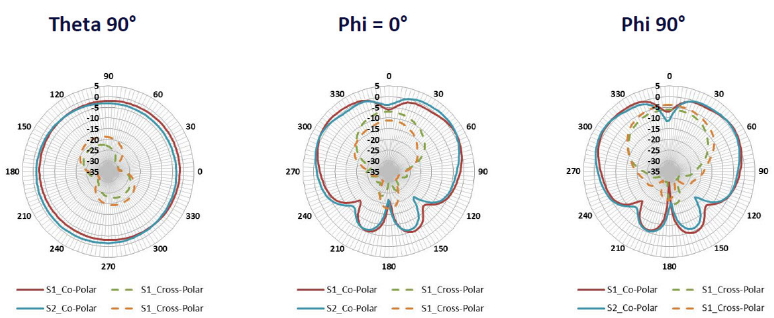


Figure 12: 928 MHz Radiation Pattern - With Ground Plane



General Safety Precautions

Warning This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. Use the statement number provided at the end of each warning to locate its translation in the translated safety warnings that accompanied this device. **Statement 1071**

Warning Do not work on the system or connect or disconnect cables during periods of lightning activity. **Statement 1001**

Warning Do not locate the outdoor antenna near overhead power lines or other electric light or power circuits, or where it can come into contact with such circuits. When installing the antenna, take extreme care not to come into contact with such circuits, as they may cause serious injury or death. For proper installation and grounding of the antenna, please refer to national and local codes (for example, U.S.:NFPA 70, National Electrical Code, Article 810, Canada:Canadian Electrical Code, Section 54). **Statement 1052**

Warning In order to comply with FCC radio frequency (RF) exposure limits, antennas should be located at a minimum of 7.9 inches (20 cm) or more from the body of all persons. **Statement 332**

Note For your safety, and to help you achieve a good installation, please read and follow these safety precautions.

Mast Mounted or Building Mounted Installations

The following instructions are common to most mast mounted or building mounted installations. For specific installation instructions for each antenna, see the antenna data-sheet and the router hardware installation guide.

- Find someone to help you—installing an antenna is often a two-person job.
- Select your installation site with safety, as well as performance, in mind. Remember that electric power lines and phone lines look alike. For your safety, assume that any overhead line can kill you.
- Contact your electric power company. Tell them your plans and ask them to come look at your proposed installation.
- Do not use a metal ladder.
- Do not work on a wet or windy day.
- Do dress properly—wear shoes with rubber soles and heels, rubber gloves, and a long-sleeved shirt or jacket.
- If the assembly starts to drop, move away from it and let it fall. Because the antenna, mast, cable, and metal guy wires are all excellent conductors of electrical current, even the slightest touch of any of these parts to a power line completes an electrical path through the antenna and the installer.
- If any part of the antenna system should come in contact with a power line, do not touch it or try to remove it yourself. Call your local power company to have it removed safely.
- If an accident should occur with the power lines, call for qualified emergency help immediately.
- Assemble your new antenna on the ground or a level surface at the installation site.
- Connect its coaxial cable while you are on the ground and attach the antenna to the mast.
- Ensure that the mast does not fall as you raise or remove it. Use a durable non-conductive rope secured at each two foot level as the mast is raised. Have an assistant tend the rope, ready to pull the mast clear of any hazards (such as power lines) should it begin to fall.
- Use the mounting bracket provided with the antenna.
- If the installation will use guy wires:
  - Install guy anchor bolts.
  - Estimate the length of guy wire and cut it before raising the mast.
  - Attach guy wires to a mast using guy rings.
  - In the case of a guyed (tall, thin mast) installation, you must have at least one assistant to hold the mast upright while the guy wires are attached and tightened to the anchor bolts.

- Attach a “DANGER” label at eye level on the mast.
- Install ground rods to remove any static electricity buildup and connect a ground wire to the mast and ground rod. Use ground rods designed for that purpose, not a spare piece of pipe.

Unused Antenna Ports

Port plugs must be installed in any unused antenna ports.

The weatherproof caps on the connectors protect the router interior from environmental elements including water, heat, cold, and dust. They are installed on unused ports before the router is shipped.

When you install a new antenna in a port with an N-connector:

- Chassis-mounted antennas—Remove the weather proof cap before installing a chassis-mounted antenna.
- External antennas—Remove weatherproof cap, then connect the supported Cisco cable to the connector.

Guidelines to Achieving Optimal RF and Antenna Performance

Antennas are a critical component of a wireless communication system. Selecting a suitable antenna, an optimal antenna location, or antenna site is essential for optimum performance of a wireless links.

This section covers general tips for optimizing RF performance of indoor and outdoor terrestrial radio systems in the 400-7125 MHz frequency range. Examples of terrestrial radio systems include 4G LTE, 5G NR, Wi-Fi, LoRa, LR-WPAN and similar. In this context GPS SPS would not be considered a terrestrial system as the signal is received from space, not from another terrestrial site.

Because the antenna transmits and receives radio signals over the air, overall RF performance of the link is susceptible to RF obstructions and common sources of RF interference that can reduce throughput and range of the system.

Follow these guidelines to optimize performance. When in doubt, consult a qualified RF professional, and check with your solution partner for specific recommendations.

Antenna Model Selection and Performance

Consider the following when planning your installation:

- When selecting the antenna, ensure that it covers the frequency ranges or frequency bands of interest, and that it has good RF parameters such as antenna efficiency, VSWR and suitable radiation pattern for every frequency range that your application will use with this antenna.
- Antenna pattern is important. Omni-directional antennas have lower gain, but allow communicating to devices in all azimuth directions. Directional antennas concentrate the beam in a specific direction, making them ideal for point to point communication.
- When a system has multiple RF ports for receive and / or transmit, as is the case for 4G LTE , 5G NR or Wi-Fi, it is highly recommended to populate all the RF ports with suitable antennas to take advantage of MIMO, rather than rely on a single port or single antenna to save on cost. Please see the MIMO section for a detailed description of MIMO benefits.
- For RF systems that support multiple RF ports and multiple RF standards such as LTE, Wi-Fi, and GPS: consider using a multi-element antenna that integrates multiple antennas under the same radome (cover).

Doing so may reduce cost compared to deploying and mounting a discrete single port antenna for every RF port.

- For communication between fixed infrastructure devices, such as mesh nodes or a point-to-point backhaul link, each device should have an antenna with the same polarization. If communicating with mobile devices that might be randomly oriented, consider dual-polarized antennas, such as those with both vertical and horizontal or slant +45° and -45° polarized elements.

Antenna Environmental Specifications

The selected antenna must have suitable mechanical and environmental specifications for the environment where it will be deployed. For example, shock and vibration specifications for transportation, corrosion resistant construction for marine and oil and gas industries, or IP (ingress protection) rating for outdoor deployment. Indoor antennas are typically not suitable for harsh industrial environments. Please check with your system integrator for environmental requirements for your application.

Antenna Accessories and Mounting

Consider the following when planning your installation:

- Carefully consider what type of other RF accessories, besides antenna, such as RF cables, lightning arrestors or RF adapters may be required in your installations. It is best to minimize long RF cable runs due to RF signal losses in the cable. Thinner RF cables have more RF loss , thicker cables are less flexible and more expensive.
- Carefully consider how the antenna will be physically mounted, as this may affect antenna selection. For example, a stud mount mechanical mounting design is a better fit for mounting on top of an electrical cabinet than a mast mount antenna.
- For outdoor deployments, follow installation instructions for the antenna. It is good practice to keep protective covers on the radio's RF ports and any antenna or accessory RF ports until the moment the interfaces are mated. This reduces chances of contamination, trapping water or condensation inside the connector, or accidental damage to RF interfaces.

MIMO Performance and Arrays

MIMO systems deliver benefits of higher SNR, higher reliability and higher throughput compared to single antenna systems. In more technical terms, MIMO delivers array gain, diversity gain and multiplexing gain compared to single antenna.

- Array gain — Improvement in SNR (signal to noise ratio) by coherently combining signals from multiple antennas. For example, increasing SNR through beamforming techniques.
- Diversity gain — Improvement in reliability by mitigating deep fading or strong destructive EM wave interference. For example, in a two-antenna system, if one antenna is experiencing deep fading due to an EM destructive null at its location at a given instant, the other antenna is unlikely to have a null at the same instant, and the combined SNR stays at a reliable level. In contrast, a single antenna would see SNR oscillating between good SNR and very poor SNR and reliability would degrade.
- Multiplexing gain — Increase in system capacity or throughput by sending independent data over multiple spatial streams simultaneously. The number of streams cannot be more than the number of antennas. For example, to support three spatial streams, a minimum of three antennas is required. Often there may be additional antennas for diversity or redundancy, such as in the case of 4x4:3, or 4x4 MIMO with 3 spatial streams.

If deploying multiple single-element antennas for a MIMO system in an array, ensure sufficient spacing between the antennas. Omnidirectional elements should generally be at least one wavelength apart at the lowest operating frequency.

Consider the following:

- For Wi-Fi systems operating in the 2.4, 5, and/or 6 GHz bands, space elements at least 5 inches (12.5 cm) apart.
- For 4G LTE and 5G systems with the lowest operating frequency of 617 MHz , space elements at least 20 inches (50 cm) apart.
- Note that spacing between elements inside multi-element MIMO antennas is often less than one wavelength. However multi-element antennas are engineered with MIMO performance in mind, by providing antenna diversity through pattern, polarization, and isolation between MIMO elements.

Antenna siting and location

Consider the following when planning your installation:

- Plan antenna location ahead of time. Ideal location for an antenna is in LOS (line of sight) of the counterpart that it is trying to communicate with. Under LOS conditions the signals propagate directly between the two communication nodes, without relying on signal bouncing off a wall or other structure to reach the counterpart. This is sometimes not possible to achieve in practice, but it is a useful goal to keep in mind when optimizing antenna location.
- While it is good to keep RF cables short, it is most desirable for an antenna to be in the best location it can be to provide the desired coverage.
- For large deployments involving multiple units communicating with each other across a complex urban or industrial landscape, consider running an RF propagation modeling study to predict approximate simulated coverage maps and determine initial placement of the units. A propagation study may help reduce overall deployment cost by discovering and mitigating issues with RF coverage before the infrastructure is physically installed.
- Keep the antenna away from metal obstructions such as heating and air-conditioning ducts, large ceiling trusses, building superstructures, and major power cabling runs. One exception is if the antenna is designed to be mounted on a ground plane. If mounting on a ground plane, mount the antenna on a flat metal surface away from adjacent obstructions.
- It is strongly recommended not to install antennas directly on the router or access point (AP), unless the router or AP is specifically engineered to directly mount the antennas. Products that are engineered for direct mounting of antennas specifically address each of the below issues.
- Reasons to mount antennas away from the router include:
    - Router location may not be optimal location for antenna to communicate with the counterpart wirelessly, so router and antenna may need to be in different locations.
    - Router may have a clutter of Ethernet cable and power cables around it, which will obstruct antenna signal.
    - A number of routers, such as the IR1835, are modular. They have plug-in RF modules for Wi-Fi , 4G LTE or 5G NR such as WP-WIFI6, P-LTEAP18-GL, P-5GS6-GL. These modules have RF connectors spaced close together, and while it is mechanically possible to install four or five antennas directly attached, this will result in significant degradation to RF performance of antennas due to

mutual de-tuning between closely spaced antennas. It is strongly recommended to install antennas away from the chassis in modular cases.

- If installing an antenna indoors, consider that the density and electromagnetic properties of the materials used in the building construction determines the number of walls the signal can pass through and still maintain adequate coverage.
    - Paper and vinyl walls have very little effect on signal penetration.
    - Solid and pre-cast concrete walls limit signal penetration to one or two walls without degrading coverage.
    - Concrete and wood block walls limit signal penetration to three or four walls.
    - A signal can penetrate five or six walls constructed of drywall or wood.
    - A thick metal wall causes signals to reflect off, causing poor penetration.
    - A chain link fence or wire mesh spaced between 1 and 1 1/2 in. (2.5 and 3.8 cm) acts as a harmonic reflector that blocks a 2.4-GHz radio signal.
    - Install the antenna away from microwave ovens and 2-GHz cordless phones. These products can cause signal interference because they operate in the same frequency range as the device your antenna is connected to.

Antenna Installation

The antenna installation includes the following procedures:

Tools and Equipment Required

In addition to the parts included in the antenna kit, you must provide the following tools to install the antenna on the router:

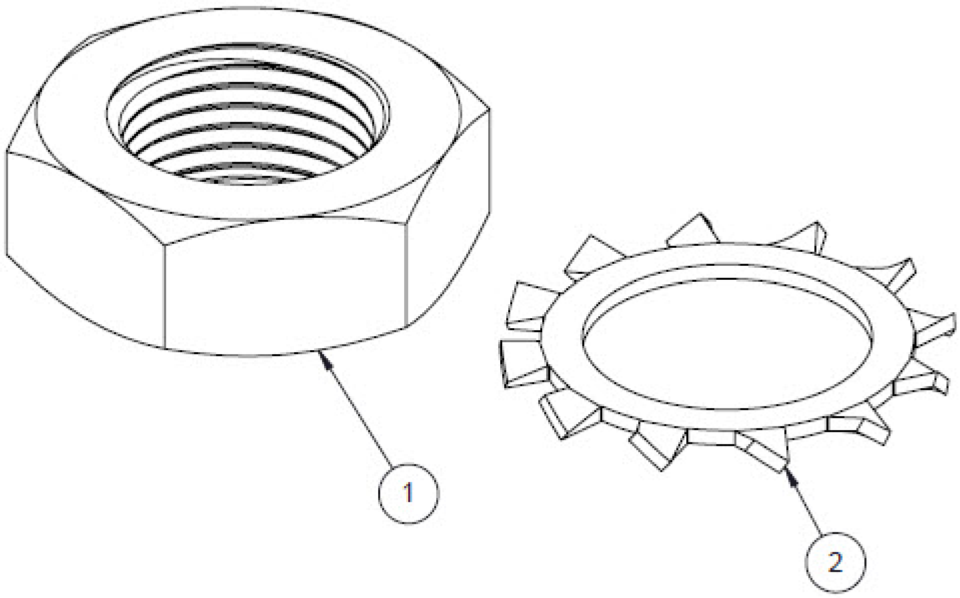
- 1-5/16" (1.3125"), or 33.34mm open-end wrench. Recommended torque is 50-65 ft-lb or 68-88 Nm.
- McMaster Carr Double-D Hole Punch P/N 3449A85 or equivalent. Alternatively, you can drill or use a circular hole punch to create a 0.91" diameter hole.

Mounting Components

Table 4: Antenna Mounting Components

Item Number	Description	Quantity
1	HEX NUT, THIN, 7/8-14, SS, PA	1
2	WASHER, EXT SERRATED, 7/8", SS, PA	1

Figure 13: Mounting Nut and Washer



Mounting the Antenna

A clean, flat surface at least 15 x 15 cm (6 x 6 in.) in area is required for mounting the antenna. Antenna mounting stud has a Double-D cross-section compatible with the McMaster Carr Double-D Hole Punch P/N 3449A85. The Double-D prevents antenna from rotating while the mounting nut is torqued. It also provides additional vandal resistance by not allowing the antenna to rotate around the axis.

Follow these instructions to mount the antenna. See the following graphic for a conceptual mounting illustration.

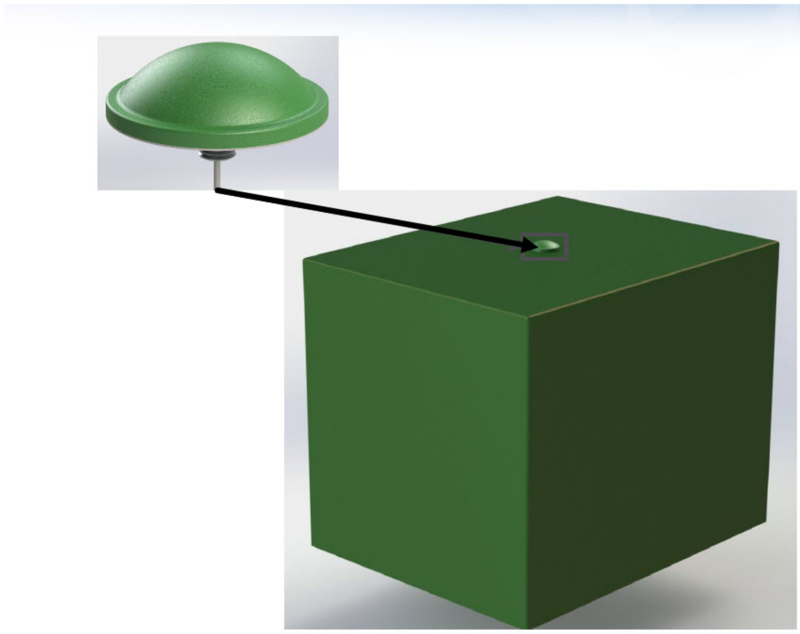
1. Mark the desired location where you plan to mount the antenna, and create a hole through the surface using a McMaster Carr Double-D Hole Punch P/N 3449A85, or equivalent punch tool. Alternatively, it is possible to drill a circular hole 0.91" in diameter.
2. Thread the cables through the hole and insert the Double-D mounting stud into the hole. Ensure that the gasket on the underside of the antenna sits flush against the mounting surface.
3. Place the metal washer and the metal nut onto the stud. Tighten the nut to a torque of 50-65 ft-lb or 68-88 Nm.

The following graphic shows the vandal resistant antenna mounted to a matching color outdoor electrical utility enclosure of a simple rectangular box shape. Many outdoor enclosures come in much more complicated shapes, with a number of rectangular boxes and compartments joined together. In general, it is recommended that the antenna be installed on the highest surface of the electrical enclosure box. In this manner, the radiation in the upper hemisphere is not obstructed by other nearby geometrical features of the enclosure.

In many deployments the nodes need to communicate to other nodes located near horizon. Placing the antenna on the highest enclosure surface is a good way to ensure that horizon communication is not obstructed. If it is not possible or feasible to place the antenna on the highest surface of the enclosure, please contact your

Cisco account representative for support or 3rd party qualified RF (radio-frequency) professional with experience in antenna installation and siting.

Figure 14: Antenna Placement on Electrical Enclosures



Using the McMaster Carr Stud Driven Hole Punch

This section describes the McMaster Carr Stud Driven Hole Punch for 0.76" Long, 0.91" Wide Double-D Shape. Information in this section is adapted by Cisco and published with written permission from McMaster Carr Supply Company. In duplicating the information Cisco seeks to achieve an antenna datasheet that is standalone, and seeks to ensure that if the 3449A85 McMaster product is changed or discontinued, a copy of the original information is available with the ANT-UN-MP-OUT-QMA antenna datasheet.

Note: Cisco is providing 3449A85 information for reference purposes only, and does not sell, distribute or provide technical support for the 3449A85 punch tool. For technical support and the most up to date information please contact McMaster Carr, and reference the information located in the McMaster Carr 3449A8 datasheet .

Also known as chassis punches, these tools cut through sheet metal to create holes for installing switches and instruments. They have an automatic centering design for accurate alignment. Drill pilot holes slightly larger than the size of the stud. All punches can be used with a manual wrench or hydraulic driver, but require a stud adapter (sold separately) when used with a hydraulic driver.

Figure 15: McMaster Carr Stud Driven Hole Punch

Table 5: Tool Details

Punching Action	Stud Driven
Shape	Double-D Shape
Hole Length	0.76"
Hole Width	0.91
Maximum Steel Thickness	1/16"
Tool Material	Steel
For Use On	Aluminum, Brass, Copper, Steel
Pilot Hole Required	Yes
Kit Includes	Punch, Die, Stud, Nut
Individual/Set	Individual
Related Products	Hydraulic Driver Stud Adapter 3449A172 11-Ton Straight Hydraulic Driver 3448A1 8-Ton Straight Hydraulic Driver 3484A15 8-Ton Right-Angle Hydraulic Driver 3490A21

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