Cisco 3200 Series Wireless and Mobile Router—2.4-GHz, 5GHz, and 4.9-GHz Antenna Guide

Cisco® 3200 Series wireless and mobile routers are rugged wireless routers that can be integrated into vehicles or outdoor environments. Cisco 3200 Series routers offer secure data, voice, and video communication, and support multiple wired and wireless links, including integrated 802.11b/g, 5GHz, and 4.9-GHz wireless technologies. When deployed as an outdoor wireless infrastructure in a metropolitan mobile network, Cisco 3200 Series routers can be used to create broadband wireless coverage areas or hotspots that can be interconnected or meshed across a city. Within a metro mobile network, the router provides choices in backhaul, whether wireless bridging, leased lines, or metro fiber is used for connecting these wireless coverage areas. Cisco 3200 Series routers support multiple 2.4-GHz, 5GHz,and 4.9-GHz Cisco wireless mobile interface cards (WMICs), which can be configured as wireless bridges or access points. Based on the function of the WMIC, different antenna types can be used to optimize wireless signals and provide flexibility in antenna placement.

This antenna guide provides information to assist Cisco sales engineers, field engineers, system integrators, and partners in understanding, selecting, and installing antennas when deploying the Cisco 3200 Series Wireless and Mobile Router in various outdoor and mobile environments. You will find information about antennas and accessories from different vendors, as well as about basic antenna types, design, deployment, and installation scenarios.

Overview of Antenna Types

Implementing various antenna systems for Cisco 3200 Series routers can greatly improve coverage and performance. To help optimize the overall performance of a Cisco 3200 Series router, it is important to understand how to maximize radio coverage with appropriate antenna selection and placement. An antenna system comprises numerous components, which can include the antenna, mounting hardware, connectors, antenna cabling, amplifiers, and lighting arrestors (see Figure 1 for example antennas). For a consultation on determining the right combination of these components, please contact a Cisco Wireless LAN Specialized Partner using the Partner Locator tool at: http://tools.cisco.com/WWChannels/LOCATR/jsp/partner_locator.jsp. Cisco certified and specialized partners can provide onsite engineering assistance for complex deployment scenarios.

Figure 1. Example 2.4-GHz, 5GHz, and4.9-GHz Antennas for Cisco 3200 Series Routers

An antenna gives the wireless system three fundamental properties—gain, direction, and polarization. Gain is a measure of increase in power. Direction is the shape of the transmission pattern.

Antenna gain ratings are measured in decibels, typically a ratio to the gain of an isotropic (dBi) or dipole (dBd) antenna. Higher-gain antennas offer transmission over a longer distance, but only in a certain direction. As the gain of an antenna increases, the coverage area (beamwidth) usually decreases. Many different types of antennas can be used for access point and bridging functions with the Cisco 3200 Series 2.4-GHz and 4.9-GHz WMICs. Every antenna deployed should meet FCC or other regulatory approval standards, based on country or regional requirements.

Antennas can be categorized by their directional properties:

- **Omnidirectional Antennas:** Designed to provide a 360-degree radiation pattern. This type of antenna is used when coverage in all directions is required. A standard 2.14-dBi dipole antenna is an example.
- **Directional Antennas:** Designed to provide extended range in a certain direction. Directional antennas do not add any additional power to the radio signals, but instead redirect the energy in a particular direction so that the radio energy can be focused in that direction. Directional antennas include the following types: patch antennas, Yagi antennas, sector (panel) antennas, and dish antennas.
- **Diversity Antenna Systems:** Designed to overcome a phenomenon known as multipath distortion or multipath fading. This antenna system uses two identical antennas, located at least a wavelength apart, so that the radio system can determine which antenna is receiving the better signal.

Antenna Selection in Cisco 3200 Series Router Deployments

Antennas are a vital component of any outdoor or vehicle deployment using the Cisco 3200 Series router. Because antennas distribute RF signals in large “lobed” coverage areas as determined by antenna design, successful coverage depends heavily on choosing the right antennas. The following section outlines the capabilities of antennas that you can use for deployment with Cisco 3200 Series routers in outdoor and vehicular environments, as well as in a Cisco metropolitan mobile network deployment.

Every wireless deployment is different. When you implement a meshed network or wireless grid, you need to consider many issues, including backhaul, hotspots, and distance physical obstructions between facilities; the number of transmission points; and multipath characteristics.

When designing a mobile or in-vehicle solution, the issues to consider include the mounting type, location, clearance, interference, and multipath characteristics.

Sector antennas are widely used in outdoor wireless deployments because they offer flexibility and scalability. The deployment can start with one sector and add additional sectors as the number of users grows. The pattern for each sector can be selected to provide the best coverage and signal strength. To increase signal strength and avoid interference, the downtilt can be adjusted to center the main lobe of the antenna over the coverage area.

Different polarizations can be used in each of the antenna sectors to avoid interference, although sector antennas are generally oriented to provide vertical polarization. Sector antennas can be adjusted to exclude interference in specific locations. For example, a sector could cover 120 degrees in the horizontal plane, which provides less exposure to unwanted interference than an omnidirectional antenna.

Omnidirectional antennas are used when symmetric coverage in all directions is required. While offering a uniform signal, these antennas have greater potential for generating and receiving interference and multipath fade. They are frequently replaced with sector antennas in many outdoor metro wireless applications, especially when the antenna needs to be mounted at a high location. This is not only because any interference in the 360 degree omnidirectional coverage area will affect communications, but also because it is often desirable to have significant gain oriented toward primary coverage areas.

Using high-gain omnidirectional antennas in an outdoor wireless deployment allows coverage across long distances, but the energy level directly below the antenna becomes lower, and coverage beneath the antenna may be poor. Thus, a high-gain antenna is a trade-off between distance and coverage area or angle. Downtilt—when the antenna is designed to radiate at a slight angle down rather that at 90 degrees from the vertical element—can be used to mitigate this trade-off. Downtilt will improve local coverage but reduce long-range coverage.

Directional antennas include the sector antenna (described previously), the parabolic dish antenna, the Yagi antenna, and the patch antenna.

- Parabolic dishes have very high gain (typically 21 dBi for Cisco 3200 Series router bridges) along with a very narrow radiation angle (typically 12.5 degrees on all sides) and must be accurately aimed at the connecting antenna.
- Yagi antennas have high gain (typically 13.5 dBi) and a wider radiation angle (typically 25 to 30 degrees from side to side). Yagi antennas must also be properly aimed at the connecting antenna.
- Patch antennas have high gain (typically 6 dBi) and a relatively broad radiation angle both in the vertical and horizontal planes. The patch antenna is more tolerant of suboptimal orientation, but must still be positioned to face the direction of the connecting antenna.

Because of the point-to-point nature of outdoor wireless networks an outdoor wireless solution can use directional antennas such as Yagi or dish antennas when the coverage area is narrowly defined. With thorough link engineering, directional antennas offer stable and interference-resistant connections.

Creating Outdoor Hotspots

Cisco 3200 Series routers and the antennas deployed with them can be placed on light poles or a rooftop of a building to create hotspot coverage in areas such as a parking lot. The Cisco 3200 Series WMIC can be configured as a root bridge or access point to create 2.4-GHz or 4.9-GHz coverage to vehicles or clients. You can apply both sector and omnidirectional antennas in this scenario. Omnidirectional antennas are used for high-density symmetrical cells. Sector antennas can cover longer distances and be down-tilted to include coverage below the antenna. Splitters are required if more than one sector is used for a single WMIC.

The height and downtilt angle of the antenna play a key role in determining the coverage area. In general, omnidirectional antennas do not have downtilt capability, so they need to be installed at relatively low heights and require null-filling capability (an additional element to provide coverage in the inner cell radius). Directional antennas are usually designed with adjustable downtilt capability so that coverage can be positioned as desired. It is possible to use more than one directional antenna to provide a wider range of coverage. If the outdoor antennas are installed on the rooftop of a building with substantial height, directional antennas should be installed with the downtilt adjusted accordingly.

In a deployment for on-street coverage or hotspots, you may want to select different antennas for urban and rural settings. In a rural area, antennas usually reach further since there are fewer obstacles and a better line of sight. In urban areas, antennas should be deployed more densely, and they usually need to be more accurately adjusted.

Metro Grid Antennas

Because Cisco 3200 Series routers have multiple radios (WMICs) you can use the same Cisco 3200 Series router mounted on light poles and rooftops to create coverage areas for backhaul to the core network or other peers via wireless bridging. This creates a wireless mesh network. To bridge back to the distribution backbone, the WMIC needs to be configured as a root or non-root bridge for a point-to-point or point-to-multipoint connection. In this case, highly directional, high-gain, and narrow beamwidth directional antennas are recommended. Line of sight is also required between two bridges. Patch or sector type antennas are usually best suited for this scenario.

Mobile Antennas for Vehicles

Moving vehicles must themselves be connected to a wireless network to maintain network access. The networks that vehicles can connect to include 2.4-GHz, 4.9GHz, 5GHz, and/or cellular networks. For Wi-Fi networks, vehicular coverage may include the entire route (all the areas that a bus travels, for example) or may simply include specific areas (such as bus terminals) where vehicles can connect to a larger network each time they pass through the coverage area.

Typically for WLAN radios, an omnidirectional antenna is mounted on the roof of the vehicle to connect it to the wireless network. This type of antenna has a low profile and a flexible core suitable for mounting on the vehicle's roof. Typical gain of these antennas is 3, 5, or 7 dBi. Vehicle antennas can be permanently or magnetically mounted. The antenna should be mounted as near as possible to the Cisco 3200 Series router (where the radio is located) to minimize cable loss. An important consideration for vehicle installations is the cable type. It is challenging to use thick transmission cables because of the space and multiple bends and turns in the cable path when running cables through the structure of the vehicle. If the vehicle is a public safety vehicle, the antenna installation should take into account the potential interference from light bars on the

vehicle's roof. In this case, it is important to ensure that the antenna is elevated above the light bar.

Because the Cisco 3200 Series router uses Mobile IP for roaming capabilities, it can use a cellular modem to provide a second or third wireless network that keeps the vehicle network connected. A separate antenna is used for the cellular modem. This antenna can also be mounted to the vehicle's roof to help optimize reception.

When a Cisco 3200 Series router is deployed in a vehicle, a second or third WMIC can be configured as an access point to create a vehicle hotspot. Because the objective for the vehicle hotspot is usually a few hundred feet of coverage around the car, the antenna for this WMIC can be a simple dipole antenna that is connected directly to the Cisco 3200 Series router chassis.

Amplifiers for 802.11 Systems

To reach extended distances in outdoor 802.11 deployments, amplifiers may be used to help optimize radio output and reception. There are specific regulatory requirements that pertain to the use of amplifiers.

In the United States, if an amplifier is being sold or added to a system, the system—including the amplifier, antennas, any filters, and minimum cable length—must be tested and certified before the system can be sold or installed. However, because the FCC ID number of the radios in the Cisco 3200 Series router WMICs does not include the use of an amplifier, the testing and certification of this system is the responsibility of the party that will be operating it. In these instances, the product will not be certified under the Cisco FCC ID; the customer or system integrator will be required to obtain certification under a new FCC ID. In Canada, the system must be certified under RSS-139-1, and the user may be required to obtain an approval.

In Europe, the system cannot exceed 100 mW equivalent isotopically radiated power (EIRP), and the entire system must be type-approved.

Although amplifiers are a useful way to compensate for the signal loss resulting from the length of the cable between the radio and antenna, amplifiers are less useful for increasing EIRP because of the increased in-band noise that they introduce.

Antenna Connectors

On each Cisco 3200 Series WMIC, there are two ultra-miniature coaxial connectors (U.FL connectors) that are used to connect the coaxial cables between the WMIC and the external antenna connectors. RP-TNC is the external antenna connector type used on the Cisco Rugged Enclosure Option for the 3200 Series, as well as most customized enclosures for the Cisco 3200 Series router. Therefore, when you use the Cisco Rugged Enclosure Option for the 3200 Series, the antennas, cables, and other components purchased must match the Cisco RP-TNC connector format.

Cables

Cables are used to connect an external antenna to the antenna connector on the Cisco 3200 Series router. As the length of the cable increases, the signal loss introduced by the cable also increases. To operate at optimal efficiency, cables should be as short as possible. You can use an amplifier to compensate for any loss that does occur.

Reference Sell Antennas for Cisco 3200 Series Routers

A variety of antennas that meet the various requirements of outdoor wireless and vehicle deployments are available for the Cisco 3200 Series router.

Each antenna must be FCC-approved for use with the WMIC that is configured as a bridge or access point. Cisco offers 2.4-GHz antennas for Cisco Aironet® WLAN devices; these antennas can be used with Cisco 3200 Series routers. Several antenna types are certified to be used with Cisco 3200 Series routers for 802.11b/g deployments, including one dipole omnidirectional, three mobile, and seven stationary antennas. Based on FCC regulations, any similar antenna that is of the same type and of equal or less directional gain can be certified for use with the Cisco 3200 Series 2.4-GHz WMIC. (Please check FCC rules at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-165A1.pdf. See page 22, section 15.204 in the document.)

For the 4.9-GHz WMIC targeted at the licensed public safety band, the equipment authorization certified under FCC rules states that the maximum antenna gain is 7.5 dBi for mobile operation and 21 dBi for fixed operation. Any similar antenna equal or below that gain can be used with the 4.9 GHz WMIC in a Cisco 3200 Series router for outdoor wireless deployment.

Table 1 lists the eight certified Cisco 2.4-GHz antennas. The first two columns of Table 5 list three certified 2.4-GHz mobile antennas: PCTEL/MAXRAD MUF24003, BMAXC24503 and BMAXC24505. For a complete description and specification for Cisco antennas, visit: http://www.cisco.com/en/US/prod/collateral/wireless/ps7183/ps469/product_data_sheet09186a008022b11b.html

In addition, the antennas of many third-party companies have met the appropriate regulations for use with the Cisco 3200 Series 4.9-GHz and 2.4 GHz WMICs. Tables 2, 3, 4, 5, and 6 provide examples of antennas that can be used for different applications in outdoor and vehicle deployments. These example antennas are primarily focused on the 4.9-GHz public safety band used in the United States.

The antenna radiation pattern, with both horizontal and vertical diagrams, will provide more comprehensive information about the antenna than the beamwidths listed in the tables. Contact information for each vendor, including Website addresses, is listed in Appendix A. Contact the vendor directly for up-to-date price information and complete specifications.

Table 1 lists eight certified Cisco 2.4-GHz antennas.

Table 1. Certified Cisco 2.4-GHz Antennas for Cisco 3200 Series Routers

Product Name	Product Photo	Description	Application	Gain	Beamwidth
AIR-ANT4941		2.2-dBi dipole omnidirectional antenna	• Lab use • In-vehicle access point applications	2.2 dBi	• 360°Horizontal (H) • 65°Vertical (V)
AIR-ANT2414S-R		Vertical polarized sector antenna	Outdoor long-range point-to-multipoint applications	14 dBi	90°H, 8.5°V
AIR-ANT1729		Patch directional antenna	Indoor/outdoor, unobtrusive, midrange antenna for use with access points or bridges	6 dBi	75°H, 65°V
AIR-ANT2506		Omnidirectional mast-mount antenna	Outdoor short-range point-to-multipoint applications	5.2 dBi	360°H, 38°V
AIR-ANT24120		High-gain, omnidirectional mast-mount antenna	Outdoor midrange point-to-multipoint applications	12 dBi	360°H, 7°V
AIR-ANT2410Y-R		Yagi mast-mount or wall-mount directional antenna	Indoor/outdoor directional antenna for use with access points or bridges	10 dBi	47°H, 55°V
AIR-ANT1949		Yagi mast-mount directional antenna	Outdoor midrange directional connections	13.5 dBi	30°H, 25°V
AIR-ANT3338		Solid dish directional antenna	Outdoor long-range directional connections	21 dBi	12.4°H, 12.4°V

Table 2. Certified Cisco 5-GHz Antennas for Cisco 3200 Series Routers

Product Name	Product Photo	Description	Gain
AIR-ANT5160V-R		Indoor or outdoor use omnidirectional 5 GHz antenna. Can be mast or ceiling mounted.	6 dBi
AIR-ANT5170P-R		Wall Mount diversity patch antenna with RP-TNC Connectors-Designed for use in both indoor and outdoor applications. It comes with wall mount hardware, and has a gain of 7 dBi. It has a plenum rated pigtail cable of 36”.	7 dBi
AIR-ANT5175V-N		A 7.5 dBi antenna which supports 4900-5825 MHz. It has a 12” pigtail cable and a N-type connector.	7.5 dBi
AIR-ANT5180V-N		5 GHz, 8 dBi direct mount omnidirectional antenna for mesh APs. Suitable for use on AP1520 series mesh APs in all deployments. Not suitable for use on AP1505 and AP1510 series mesh APs.	8 dBi
AIR-ANT5195P-R		Wall or Mast Mount Patch Antenna-Designed for use indoor or outdoors, this antenna comes with a wall mount and a plate that adapts to articulating mounting hardware (AIR-ACC2662), which is sold separately. It has a plenum rated pigtail cable of 36 in.	9.5 dBi
AIR-ANT5114P-N		5 GHz, 14 dBi patch antenna for use in the 4950-5850 MHz frequency band. The antenna has an N-type connector, and will require a separate low loss cable for mounting to the access point. Articulating mount included. Fits mast pole sizes 2” diameter maximum	14 dBi
AIR-ANT5117S-N		5 GHz, 17 dBi sector antenna for use in the 4950-5850 MHz frequency band. The antenna has an N-type connector, and will require a separate low loss cable for mounting to the access point. Fits mast pole sizes 1.5 to 3” diameter maximum.	17 dBi
AIR-ANT58G28SDA-N		This non-diversity parabolic antenna operates in the UNII-3 band (5725-5825 MHz). The antenna is designed to be mounted outdoors on a mast. The antenna is designed to be used at the hub or client site of a point-to-point installation, or point-to-multipoint client sites, providing extended range. The antenna is not compatible with other Cisco Aironet radio products operating in the 5 GHz frequency band.	28 dBi

Table 3. 4.9-GHz Omnidirectional Antennas (Stationary)

				
Product Name	**PCTEL/MAXRAD** MFB49009	**HyperLink** HGV-4907U	**MTI Wireless Edge** MT-462002/NV	**MARS ANTENNAS** MA-WO49-7X
Description	Omnidirectional antenna	Omnidirectional antenna	Omnidirectional antenna	Omnidirectional antenna
Applications	Outdoor stationary applications; access point applications; public safety applications	Outdoor stationary applications; access point applications; public safety applications	Outdoor stationary applications; access point applications; public safety applications	Outdoor stationary applications; access point applications; public safety applications
Gain	9 dBi	7 dBi	9 dBi	7.5 dBi
Frequency	4.9–5.0 GHz	4.9–5.0 GHz	4.9–5.1 GHz	4.94–4.99 GHz
Mount	Wall-mount, pipe-mount, or mast-mount	Mast-mounting kit included	2 bracket-to-pole 1.5–3 in. (38.1–76.2 mm) clamps	2.5 in. (63.5 mm) pole mount
Maximum Power	25W	100W	6W	50W
Maximum VSWR	<1.5:1	<2.0:1	<1.7:1	<1.7:1
Beamwidth	360°H, 8°V	360°H, 12°V	360°H, 8°V	360°H, 12°V
Cable and Connector	• N-type female connector • N-type male connector	N-type female bulkhead connector	N-type female connector	N-type female connector
Dimensions	20.2 in. (513.1 mm) H	14 in. (355 mm) H	18.1 x 2.2 in. (460 x 55 mm) H x W	16.5 x 1.3 in. (420 x 32 mm) H x W
Weight	0.5 lbs (226 g)	0.3 lbs (130 g)	1.3 lbs (600 g)	0.5 lbs (225 g)

Table 4. 4.9-GHz Directional Antennas (Stationary)

			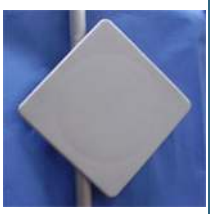	
Feature	**PCTEL/MAXAD** WISP4959018MBV	**MARS ANTENNAS** MA-WC49-5X MA-WD49-6X MA-WE49-7X	**MARS ANTENNAS** MA-WA49-1X	**PCTEL/MAXRAD** MP24580809PT MP24581820PT
Description	Directional antenna with adjustable sectors (60° or 90°)	Directional antenna with adjustable sectors (60°, 90°, 120°)	Directional patch antenna; diamond shape	Multiple-band directional panel antenna
Applications	Outdoor stationary applications; access point, grid, or backhaul applications; public safety applications	Outdoor stationary applications; access point, grid, or backhaul applications; public safety applications	Outdoor stationary applications; grid, or backhaul applications; public safety applications	Outdoor stationary applications; access point, grid, or backhaul applications; public safety applications; 802.11b/g applications
Gain	• 16 dBi with sector adjusted to 60° • 15 dBi with sector adjusted to 90°	• 17 dBi (MA-WC49-5X) • 16 dBi (MA-WD49-6X) • 15 dBi (MA-WE49-7X)	21 dBi	• 8 dBi (2.4) or 9 dBi (4.9) • 18 dBi (2.4) or 20 dBi (4.9)
Frequency	4.9–6.0 GHz	4.94–4.99 GHz (for MA-WC49-5X, MA-WC49-6X, MA-WC49-7X)	4.9–5.4 GHz	• 2.4–2.48 GHz (MP24580809PT) • 4.94–5.85 GHz (MP24581820)
Mount	Adjustable pipe mount permits uptilt or downtilt adjustment of +/-15 degrees	Tilt mount (0–12°) for pole 2–4 in., MNT-1 mounting bracket	Adjustable pole mount and brackets	Adjustable azimuth/ elevation mount brackets for both indoor and outdoor deployments
Maximum Power	10W	50W	10W	25W
Maximum VSWR	<1.7:1	<1.5:1	<1.9:1	<2.0:1
Beamwidth	60° or 90°H; 8°V	60°, 90°, or 120°H; 6°V	10.5°H, 1 0.5°V	60° or 50°H; 60° or 40°V
Cable and Connector	N-type female bulkhead connector	N-type female connector	N-type connector	12 in. (30.5 cm) plenum rated ML195
Dimensions (L x W x D)	24 x 6 x 3 in. (609 x 152 x 76 mm)	19.7 x 3.1 x 3.1 in. (500 x 80 x 80 mm)	12.0 x 12.0 x 0.6 in. (305 x 305 x 15 mm)	5.1 x 4.7 x 1.5 in. (129 x 119 x 38 mm)
Weight	4.5 lbs (2.1 kg)	6 lbs (2.7 kg)	6 lbs (2.7 kg)	0.5 lbs (230 g)

Table 5. 2.4-GHz and 4.9-GHz Antennas (Stationary)

				
Feature	**MTI Wireless Edge** MT-465005/N	**MTI Wireless Edge** MT-464002/NV MT-464003/NV	**PCTEL/MAXRAD XtremeWave MSP Serials** MSP24013120 (one example)	**PCTEL/MAXRAD Sectorized Omnidirectional** MSO24014NF MSO24014NM
Description	Directional patch antenna	Directional sector antenna	Directional sector panel antenna	Adjustable omnidirectional antenna
Applications	Outdoor stationary applications; access point, grid, or backhaul applications; public safety applications	Outdoor stationary applications; access point, grid, or backhaul applications; public safety applications	Outdoor stationary applications; access point, grid, or backhaul applications; 802.11b/g applications	Outdoor stationary applications; access point applications; 802.11b/g applications
Gain	21 dBi	• 16 dBi (MT 464002/NV) • 15.5 dBi (MT 464003/NV)	13 dBi	14 dBi (MSO24014NF, MSO24014NM)
Frequency	4.9–5.35 GHz	• 4.9–5.35 GHz (MT 464002/NV) • 4.9–5.1 GHz (MT 464003/NV)	2.4–2.5 GHz	2.4–2.5 GHz (MSO24014NF, MSO24014NM)
Mount	Mounting kit MT-120018 and DC grounding	Mounting kit MT-120019 and DC grounding	Adjustable stell bracket; +/–11° degrees of uptilt or downtilt	Center-pipe mount; direct tower-leg mount
Maximum Power	6W	6W	50W	50W
Maximum VSWR	<1.7:1	<1.7:1	<1.5:1	<1.5:1
Beamwidth	9°H, 9°V	• 60°H, 11.5°V (MT 464002/NV) • 90°H, 6°V (MT 464003/NV)	120°H, 16°V	360°H, 16°V
Cable and Connector	N-type female connector	N-type female connector	N-type female bulkhead connector	• 18-in. LMR195 N-type female connector; • N-type male connector
Dimensions (L x W x D)	12 x 12 x 0.6 in. (305 x 305 x 15 mm)	• 13.8 x 5.9 x 1.2 in. (350 x 150 x 30 mm) • 20.9 x 10.2 x 0.4 in. (530 x 260 x 11 mm)	21.5 x 6.5 x 2.8 in. (546 x 16.5 x 7.2 mm) L x W	19.75 x 5 in. (501 x 127 mm) L x W
Weight	2.6 lbs. (1.2 kg)	• 3.3 lbs. (1.5 kg) (MT 464002/NV) • 5.5 lbs. (2.5 kg) (MT 464003/NV)	43 lbs (19.5 kg)	8 lbs (3.6 kg)

Table 5 list three certified 2.4-GHz mobile antennas: PCTEL/MAXRAD MUF24003, BMAXC24503 and BMAXC24505. For a complete description and specification for Cisco antennas, visit: http://www.cisco.com/en/US/prod/collateral/wireless/ps7183/ps469/product_data_sheet09186a008022b11b.html

Table 6. 2.4-GHz Vehicle (Mobile) Omnidirectional Antennas

				
Product Name	**PCTEL/MAXRAD** MUF24005	**PCTEL/MAXRAD** BMAXC24503 BMAXC24505	**PCTEL/MAXRAD** (B)MEFC24005	**ICI Networks** 12001035
Description	Mobile omnidirectional antenna; brass mount nut w/ bright chrome finish	Mobile omnidirectional antenna; spring-loaded contact	Mobile omnidirectional antenna; elevated feed clearing the overhead light bars	Mobile omnidirectional antenna with spring base
Applications	Mobile/in-vehicle applications; 802.11b/g (certified) applications	Mobile/in-vehicle applications; 802.11b/g (certified) applications	Mobile/in-vehicle applications; 802.11b/g applications	Mobile/in-vehicle applications; 802.11b/g applications
Gain	5 dBi	• 3 dBi (BMAXC24503) • 5 dBi (BMAXC24505)	5 dBi	7 dBi
Frequency	2.4–2.48 GHz	2.2–2.9 GHz	2.4–2.5 GHz	2.4–2.5 GHz
Mount	3/4-in. hole permanent mount	3/4-in. hole permanent mount	Permanent mount	Magnetic mount included
Maximum Power	100W	100W	50W	100W
Maximum VSWR	<1.5:1	<1.5:1	<1.5:1	<1.5:1
Beamwidth	360°H	360°H	360°H, 45°V	360°H, 25°V
Cable and Connector	17-ft ML195 low- loss cable	17-ft ML195 low-loss cable	17 ft	N-type male connector
Dimensions (H)	8.75 in. (222.24 mm)	5.25 in. (133 mm)	7.5 in. (190 mm)	16 in. (406 mm)
Weight	0.10 lbs (45 g)	• 0.12 lbs (54 g) • 0.16 lbs (73 g)	0.5 lbs (227 g)	1.0 lbs (453 g)

Table 7. 4.9-GHz Vehicle (Mobile) Omnidirectional Antennas

				
Feature	**PCTEL/MAXRAD** MEFC49005	**Mobile Mark** ECOM6-4900	**Mobile Mark** RM3-4900 DM2-4900	**MARS ANTENNAS** MA-WO49-B-X
Description	Mobile omnidirectional antenna; 6-in. elevated feed above surface	ECO Series mobile omnidirectional antenna	Body-mount mobile omnidirectional antenna	Mobile omnidirectional antenna; rugged, aerodynamic blade shape
Applications	Mobile/in-vehicle applications; public safety applications	Mobile/in-vehicle applications; public safety applications	Mobile/in-vehicle applications; public safety applications	Mobile/in-vehicle applications; public safety applications
Gain	5.5 dBi	6 dBi	3 dBi	2 dBi
Frequency	4.9–5.0 GHz	4.8–5.0 GHz	4.4–5.0 GHz	4.94–4.99 GHz
Mount	3/4-in. hole permanent mount	Magnetic mount or trunk-lip mount	Body mount on roof, trunk, and bulkhead	Magnetic mount or rooftop fixed mount
Maximum Power	10W	10W	10W	50W
Maximum VSWR	<1.5:1	<1.5:1	<1.5:1	<1.5:1
Beamwidth	360°H, 18°V	360°H	360°H	360°H, 25°V
Cable and Connector	1-ft RF-195 cable	10-ft RF-195 cable, male TNC, N-type or SMA connector	1-ft RF-195 cable, SMA male connector	N-type female connector
Dimensions	12 in. (304.8mm) H	10 in. (154 mm) H	• RM3: 1.75 x 3 in. (43.2 mm x 76.2mm) • DM2: 3 x 1.5 in. (76.2mm x 38.1) (Diagonal x Heights)	8.7 x 3.9 x 4.5 in. (220 x 100 x 115 mm)
Weight	0.5 lbs			420 g

Antenna Installation Examples

Installation on Light Poles

For light pole installations, the antenna is usually installed on light poles that have arms protruding over the street. Generally, a directional or omnidirectional antenna should be mounted as high as possible and have good line of sight for the desired coverage area. A directional antenna should have the correct downtilt to provide coverage along the street. Multiple directional antennas can be used to create larger coverage areas. Long, low-loss cables are generally used to connect antennas to the WMICs in the Cisco 3200 Series enclosure. The antennas from both WMICs can be placed in such a way that the signals do not interfere with each other (Figures 2 and 3).

Figure 2. Example of Antenna Installation on Light Pole

Figure 3. Example of Antenna Installation on Light Pole

Installation on Building Rooftops

On rooftops, directional antennas are installed vertically with appropriate downtilt angles. The antenna is usually elevated to a certain height, and the downtilt should have line of sight to the place where coverage is desired. Multiple directional antennas can be positioned so that they face in different directions and angles in order to improve coverage as desired. Antennas should be firmly mounted, and then connected to cables that connect to the external connectors on the Cisco 3200 Series Rugged Enclosure (Figure 4).

Figure 4. Example Installation on Building Rooftops

Installation on Vehicle Roofs

For vehicles, mobile omnidirectional antennas should be installed. Antennas should be mounted vertically on a solid surface. They should be mounted as high as possible to have a direct line of site to the nearest hotspot. The best place to put a mobile antenna is on the roof of a vehicle. If there is interference from the light bar, the antenna should have enough elevation to reach above the light bar; alternatively, it can be mounted on the top of the back trunk or bumper. If a permanent-mount antenna is used, holes need to be drilled in the roof or trunk, and the antenna will be mounted on the holes with the cable connected from the inside of the car. For magnetically mounted antennas, the antenna will be put on top of the surface. The cable will run through a small drilled hole or an opening in the trunk or window (Figure 5).

Figure 5. Example Installation on Vehicle Roof

List of Vendors

Please contact the vendors listed here for the detailed antenna product information, specifications, and latest prices.

- **Cisco Systems:** http://www.cisco.com
- **PCTEL/MAXRAD:** http://www.maxrad.com, 800 323-9122, e-mail: antenna.sales@pctel.com
- **HyperLink Technologies:** http://www.hyperlinktech.com, 561 995-2256
- **Mobile Mark:** http://www.mobilemark.com, 847 671-6690, e-mail : sales@mobilemark.com
- **ICI Networks:** http://www.icinetworks.net, 330 665-2928, e-mail: sales@icinetworks.net
- **MTI Wireless Edge:** http://www.mtiwe.com, 972-3-9025050
- **Mars Antennas:** http://www.mars-antennas.com, e-mail: sales@mars-antennas.com

Cellular Modem Antennas

Most of the vendors listed here also offer cellular modem antennas for internal and external cellular modems used with Cisco 3200 Series routers. Please refer to your modem vendor for recommended antennas for specific modems. Make sure the antennas match the corresponding service provider and radio technologies, such as 1xRTT, EVDO, EDGE, GPRS, CDPD, and UMTS. The Cisco 3200 Series router modem guide also provides information on cellular modem antennas.

Documents and References

- **Cisco 3200 Series Wireless and Mobile Routers:** http://www.cisco.com/en/US/products/hw/routers/ps272/index.html
- **Cisco IOS® Software Documentation for the Cisco 3200 Series:** http://www.cisco.com/univercd/cc/td/doc/product/access/mar_3200/index.htm
- **Cisco Aironet Antenna Reference Guide:** http://www.cisco.com/en/US/prod/collateral/wireless/ps7183/ps469/product_data_sheet09186a008008883b.html
- **Cisco Aironet 2.4-GHz and 5-GHz Antennas and Accessories:** http://www.cisco.com/en/US/prod/collateral/wireless/ps7183/ps469/product_data_sheet09186a008022b11b.html
- **Cisco Aironet Antenna Reference Guide:** http://www.cisco.com/en/US/prod/collateral/wireless/ps7183/ps469/product_data_sheet09186a008008883b.html
- Wireless/Mobility Solutions for Large Enterprise: http://www.cisco.com/en/US/netsol/ns340/ns394/ns348/networking_solutions_packages_list.html
- **Cisco Aironet Outdoor Bridge Range Calculation Utility:** http://www.cisco.com/en/US/prod/collateral/wireless/ps5678/ps458/prod_technical_reference09186a00800a912a.ms-excel/en/us/guest/products/ps458/c1225/ccmigration_09186a00800a912a.xls

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