3Com®

3Com® Wireless Antennas

PRODUCT GUIDE

Introduction

3Com offers small businesses and enterprises a range of antennas specifically designed to optimize 802.11 wireless connectivity in particular environments. These antennas extend the flexibility and coverage of 3Com® wireless bridges and enterprise access points (APs) that support external antenna options, enabling their deployment in a variety of in-building and building-to-building network environments.

Wireless bridging cost-effectively and securely connects buildings and LANs over short or long distances with antenna transmitters mounted on the roof in line-of-sight with antenna receivers. Wireless connectivity eliminates the installation costs and right-of-way problems with fiber cable and the monthly expenses of T1/E1 lines.

Figure 1: 3Com 802.11 Wireless Antenna Family

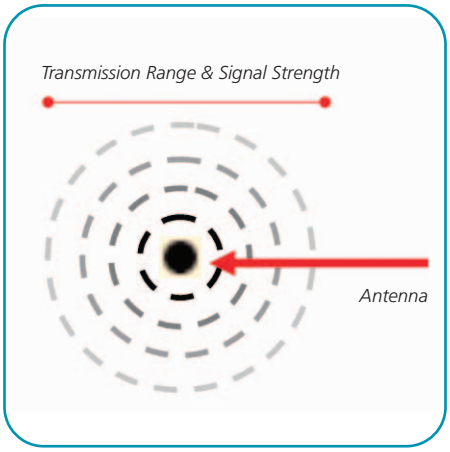
With wireless LAN (WLAN) deployment in an enterprise network, desktop clients can easily connect to the WLAN through APs (in infrastructure mode) while mobile users with laptops can roam inside buildings and connect to LAN resources over the 802.11 wireless AP network.

This guide covers antenna technology, including optimal positioning and placement inside and outside buildings to maximize throughput potential with 3Com 802.11a/b/g wireless building-to-building bridges and APs.

Antenna Variations

Performance characteristics of each antenna vary and are based upon radio frequency (RF) transmitted, size, gain, radiation patterns, and other factors beyond the scope of this document. The guide explains the different types of antennas and what effect they have on performance in various environments.

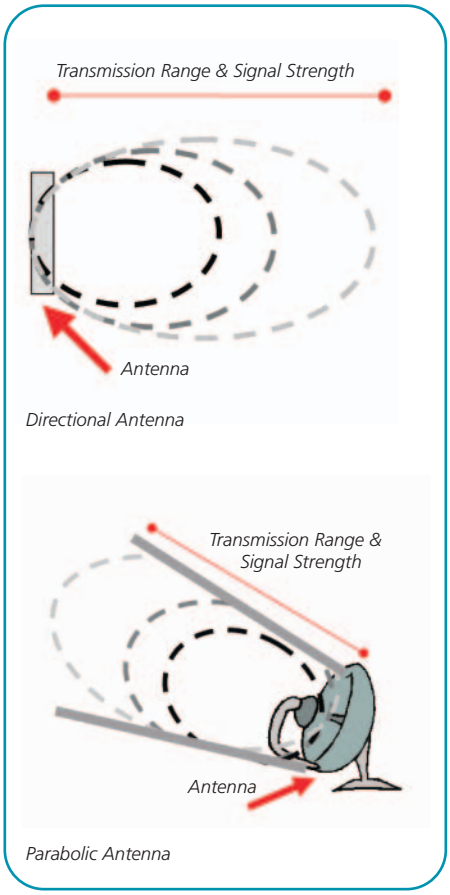
Figure 2: Omnidirectional Antenna



Omnidirectional Antennas

Omnidirectional antennas do just what their name implies, they receive signals from all directions, which means they cover a 360-degree pattern around the antenna. Omnidirectional antennas are great for hotspots in meeting rooms or public facilities or in office spaces where teams of employees need to work together effectively and efficiently. Figure 2 shows a top view of an omnidirectional antenna radio transmission pattern.

Figure 3: Directional Antennas



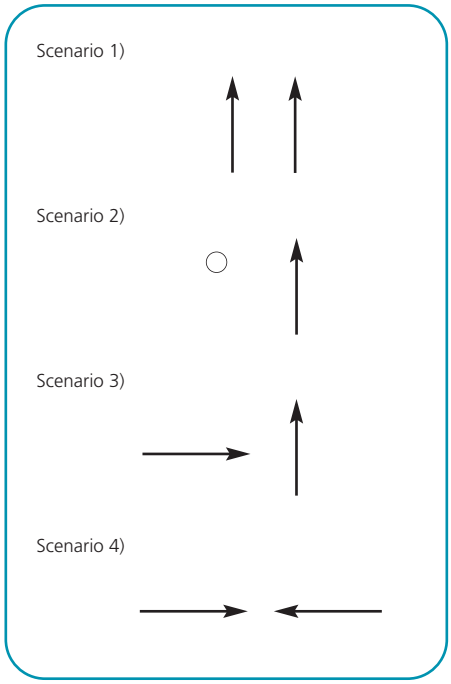
Directional Antennas

Directional antennas—also known as sector panel, bidirectional, parabolic, patch, or Yagi antennas—come in a variety of designs. These antennas operate by focusing and re-directing the radio waves from the transmitting unit to the receiver in the antenna.

The advantage of directional antennas is that they can be used to pick up weak signals at greater distances than other designs. They also optimize the signal because they can partly reject interference when the interferer is located in the path of the antenna. There is a trade-off, however. As shown in Figure 3, the more gain, or power the antenna has (measured in dBi) the smaller the receiving angle of the signal it can pick up. As an example, an 8 dBi antenna might be able to support a vertical beam width of 60 degrees, but an identical antenna with an 18 dBi gain might only be able to receive the signal in a 19-degree arc.

Antenna Radiation Patterns

Figure 4: Antenna Polarization Scenarios

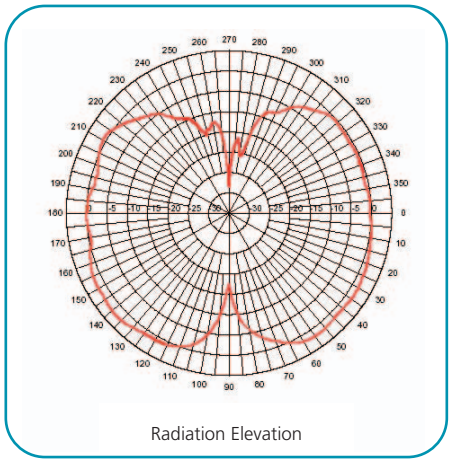


Antenna radiation patterns are often used to display the characteristics and capabilities of a particular antenna. Antenna radiation patterns indicate how the electromagnetic wave propagates away from the antenna. A radiation pattern is dependent on something called *polarization* between the transmit antenna and receive antenna. Antenna polarization can be horizontal, vertical or circular; knowing which one is correct and how to apply it to your environment is essential for optimal antenna system performance.

Vertically-polarized antennas have their electric field perpendicular to the earth's surface, while horizontally-polarized antennas have their electric field parallel to the earth's surface. An antenna that is circularly polarized radiates the signal in both the vertical and horizontal planes and everywhere in between.

As shown in Figure 4, there are four possible configurations for transmit and receive antennas, known as cross-couplings. For most applications, an antenna system should use Scenario #1. Note that when two antennas are 90 degrees offset an effect called *polarization loss* occurs. The best signal strength occurs when two devices use the same polarization method.

Figure 5: Two-Dimensional Radiation Pattern



A typical, desired antenna pattern for an omnidirectional antenna looks like the one in Figure 5. This flat diagram shows the vertical intersection (elevation plane) of a radiation diagram. The line circulating around the inside of the graph shows the strength of the signal relative to the radial location in a 360-degree arc.

Figure 6: Three-Dimensional Side View of an Omnidirectional Antenna Radiation Pattern

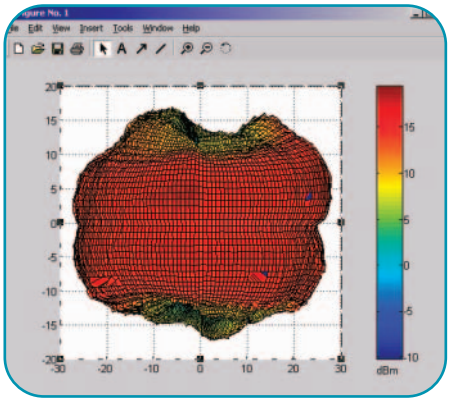
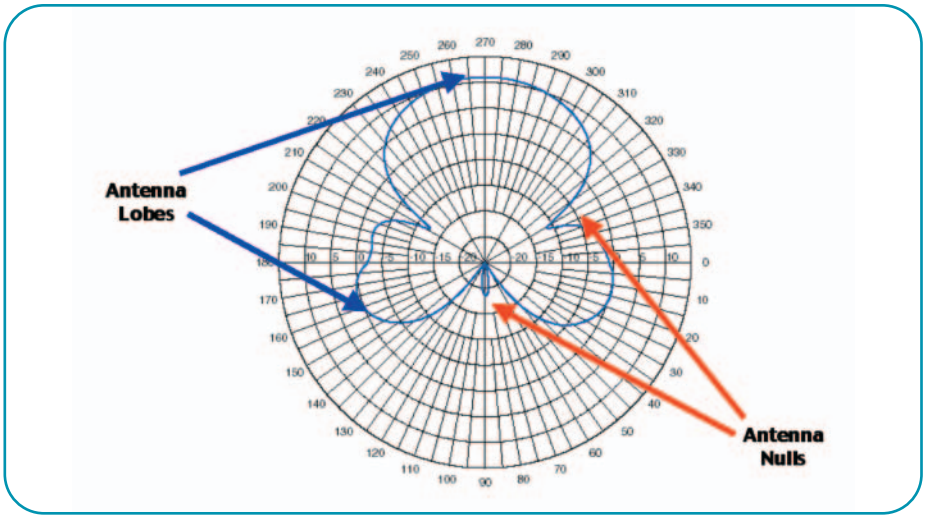


Figure 6 shows a detailed three-dimensional side view of an omnidirectional antenna with relative signal strength in relation to the antenna in the middle. As you can see, the shape is like a doughnut or apple.

Figure 7: Radiation Pattern Showing Lobes and Nulls



To select the proper antenna for your wireless networking application, you need to understand antenna performance patterns. On many patterns you will see bulges called *lobes* and indentations known as *nulls*. Lobes identify where the stronger area of the signal is relative to the antenna. Nulls identify where the signal is weaker—you don't want the nulls of an antenna to be in your most populated locations. Figure 7 shows a sample radiation pattern indicating some of the lobes and nulls.

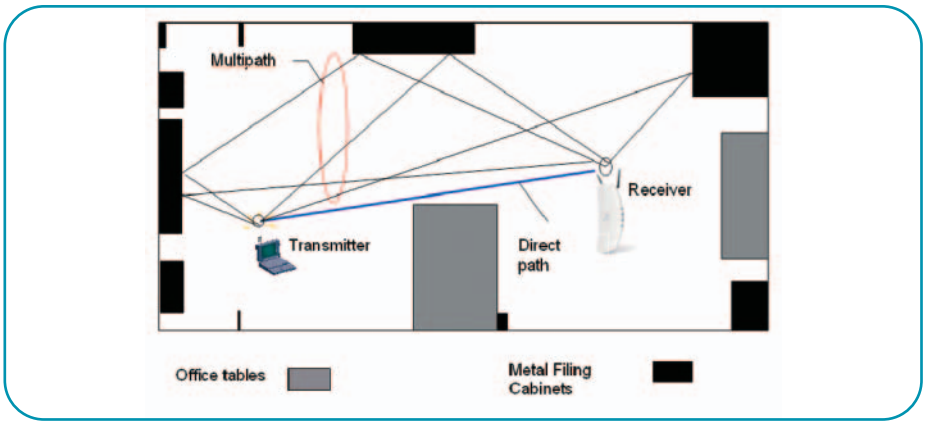
Antenna Diversity Systems

3Com's access points come with two external antennas mounted on the outside of the unit separated by a short distance. This dual-antenna configuration is known as a *diversity antenna*. Diversity antennas are designed to cover the same geographic space to optimize throughput and performance by receiving the best possible signal in one specific region. The two antennas are placed in relatively close proximity, but at least a one-quarter wavelength distance apart. In an 802.11b or 802.11g radio, this distance equates to 3cm, a quarter of the wavelength of the 2.4 GHz radio signal. Note that diversity antennas are not meant to cover two separate 802.11b or 802.11g geographic areas.

Figure 8 shows examples of 3Com enterprise wireless LAN access points with diversity antenna systems.

Figure 8: 3Com APs with Diversity Antenna Systems

Figure 9: Flat Fading and Multipath Signals



When buildings and offices have a lot of radio-reflective surfaces—such as metallic filing cabinets, or metal desks and tables—radio signals can bounce off them and create *reflective signals*. These reflective RF signals can arrive at the receiving device antenna in opposite phase, causing what is known as *flat fading*. Figure 9 shows an example of this multipath distortion.

Antenna diversity helps improve radio reception performance in an environment with multipath fading. When the receiving antenna receives the bounced and reflected signal, the signal can be of very low strength and is essentially indiscernible. An AP with a diversity antenna will constantly evaluate which antenna is receiving the stronger signal. Once it determines which of the two antennas receives the better signal, the AP will use that antenna for the remainder of the wireless packet transmission. When the AP responds, it automatically uses the antenna most recently receiving from the transmitter. If, for some reason, the AP is unable to contact the remote transmitter, it automatically switches over to the other antenna and attempts the transmission again.

Note that most wireless AP installations with optional antennas only use one external antenna. In these cases you don't have antenna diversity and may not experience improved performance in a highly multipath environment.

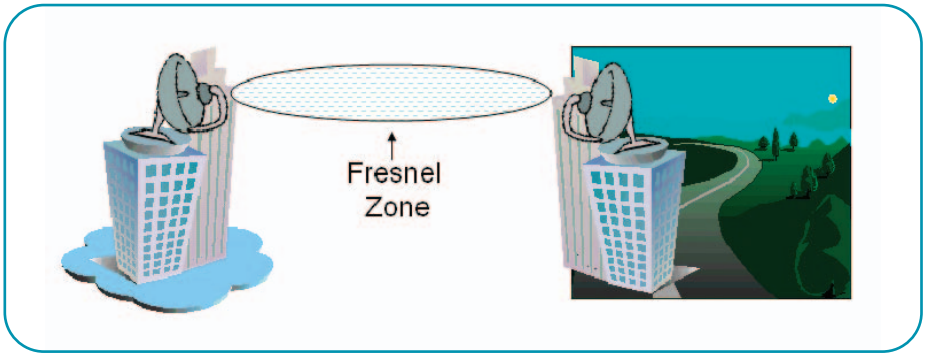
When you use a single antenna, you must configure the AP to transmit signals out of the port where the antenna is attached. See your product user guide for configuration details.

Antenna Range and Positioning

For optimal throughput, antenna systems must have sufficient gain to communicate between the two endpoints and have no objects in the line of sight between them. Trees, power lines, buildings, and other natural or man-made objects can all impact antenna performance. Obstructions typically result in reduced throughput between locations; in extreme cases, there is no connection at all.

Depending on the type of antennas used, beam width can be diverse and scattered (omnidirectional) or narrow with focused reception (directional). If the antennas are located outside, a decrease in gain of 6dB cuts the achievable theoretical distance in half. An increase in gain of 6dB theoretically doubles the possible distance between two antennas.

Figure 10: Fresnel Zone Location



Line-of-Sight Positioning with Outdoor Antennas

Outdoor antennas used to connect WLAN bridges between buildings or locations are best served when the antennas have a direct line of sight between two locations. Ideally, you should be able to see the remote antenna from the top of the building, either directly or with a pair of binoculars or telescope. Remember that at a certain point the curvature of the earth will begin to block the zone of the signal (known as the Fresnel zone) and the antennas will need to be located higher on the building. Figure 10 shows the approximate location of the Fresnel zone where an optimal signal can be found. Any objects or interruptions to this signal zone can severely impact antenna performance.

Line-of-Sight Positioning with Indoor Antennas

Metal floors, file cabinets, and even metal roofs can act as a "wave guide" for radio transmissions and can actually propagate the signal. However, this situation also increases the multipath of RF signals, which will reduce receiver performance. Antenna diversity will partly address this phenomena. Office cubical walls often contain internal metal sheets which can create RF reflections and multipath distortion between the AP and the client PCs inside the cubicles. It's good practice to have an unobstructed line of sight between the AP antenna and the client antenna if possible.

If the wireless client is in a cubicle, a horizontal polarization of the antenna is beneficial for both AP and the client. The signal will reflect from the ceiling to the floor a couple of times, but will "jump" into the cubicle.

When two diversity antennas are offset 90 degrees will give you polarization diversity. Tests and practical experience show that polarization gain provides significantly better results than traditional diversity gain in office environments.

Dual-Band Antenna Considerations

3Com offers wireless APs and bridges that operate in both 2.4 GHz (802.11b/g) and 5 GHz (802.11a) radio spectra. Dual-band antennas allow you to design wireless coverage for both 2.4 and 5 GHz applications. Radio waves perform differently in these different frequency ranges, however, so there are a number of things to keep in mind when designing your dual-band wireless network.

Power Dissipation: Due to the physics of radio wave power dissipation, 5 GHz signals of equal power output only travel approximately half the distance of 2.4 GHz signals. This difference can be compensated for to some degree by increasing the gain of the 5 GHz antenna element. Keep in mind that increasing the gain means that the coverage pattern will narrow. Study the antenna coverage patterns and installation requirements carefully to ensure that you are providing adequate coverage in the required frequencies.

Absorption and Penetration: Radio waves in 2.4 GHz are absorbed differently than waves in 5GHz. Some materials absorb 2.4GHz more than 5 GHz waves and vice versa. For example, 2.4 GHz waves are absorbed very efficiently by water; in fact, a microwave oven functions by exciting water molecules with 2.4 GHz radio waves. Table 1 shows the attenuation properties of common building materials.

As you can see from the table, nearly all building materials attenuate RF signals substantially, which is why a wireless LAN performs best with line-of-site transmissions. A closed room or secluded area will not be covered adequately unless a transmitter is placed in that area.

Site Surveys: Because of the different power dissipation and absorption characteristics of radio waves at 2.4 and 5 GHz, it is important to measure the coverage of your network in actual operating conditions. For example, if you are designing a wireless LAN deployment in an office building, you should perform the site survey after the cubicles and office furniture are installed. If you are designing a wireless LAN deployment in a warehouse or industrial application, you should perform the site survey during actual operating conditions. This will help you to design a network that provides the desired coverage when there are large reflecting objects like vehicles or assembly equipment that would not be accounted for otherwise.

Antenna Cables: The coax cable used to transmit and receive RF signals is an important component of your WLAN or wireless bridge network. Note that the longer the coax cable between the access point or bridge and the antenna system, the greater the signal loss, and the weaker the transmitting or receiving signal. Optimally, WLAN antenna cables should be less than 10 feet long. If longer cable lengths are necessary, use antenna cables labeled "low loss" or "ultra-low loss," such as the 3Com ultra low loss cables, to maximize the performance of your antennas.

Table 1: Attenuation Properties of Common Building Materials

BUILDING MATERIAL	5GHZ ATTENUATION (dBi)	2.4GHZ ATTENUATION (dBi)
Solid Wood Door 1.75"	10	6
Hollow Wood Door 1.75"	7	4
Interior Office Door w/Window 1.75"/0.5"	6	4
Steel Fire/Exit Door 1.75"	25	13
Steel Fire/Exit Door 2.5"	32	19
Steel Rollup Door 1.5"	19	11
Brick 3.5"	10	6
Concrete Wall 18"	30	18
Cubical Wall (Fabric) 2.25"	30	18
Exterior Concrete Wall 27"	45	53
Glass Divider 0.5"	8	12
Interior Hollow Wall 4"	3	5
Interior Hollow Wall 6"	4	9
Interior Solid Wall 5"	16	14
Marble 2"	10	6
Bullet-Proof Glass 1"	20	10
Exterior Double Pane Coated Glass 1"	20	13
Exterior Single Pane Window 0.5"	6	7
Interior Office Window 1"	6	3
Safety Glass-Wire 0.25"	2	3
Safety Glass-Wire 1.0"	18	13

3Com Dual-Band Antennas

3Com offers five dual-band antennas to fit a range of indoor and outdoor environments:

- 3Com 6/8 dBi Dual-Band Omni Antenna (3CWE591)
- 3Com 3/4 dBi Dual-Band Ceiling Mount Omni Antenna (3CWE592)
- 3Com 18/20 dBi Dual-Band Panel Antenna (3CWE596)
- 3Com 4/6 dBi Dual-Band Hallway Antenna (3CWE597)
- 3Com 8/10 dBi Dual-Band Panel Antenna (3CWE598)

3COM PRODUCT	3COM PRODUCT	ANTENNA TYPE	DEPLOYMENT	GAIN	VSWR ACROSS	MAX POWER	TEMPERATURE RANGE	ANTENNA DIMENSIONS	ANTENNA WEIGHT
3CWE591	3Com 6/8 dBi Dual-Band Omni Antenna	Omnidirectional	Medium range point-to-mulitpoint	2.4 GHz: 6 dBi 5 GHz: 8 dBi	<2.0:1	25 Watts	-40° C to 80° C -40° F to 176° F	Length: 58.2 cm (22.9 in), Diameter (mounting base): 3.2 cm (1.2 in)	.2 kg (7.8 oz)
3CWE592	3Com 3/4 dBi Dual-Band Ceiling Mount Omni Antenna	Omnidirectional	Close-range connections; allows ceiling AP installation	2.4 GHz: 3 dBi 5 GHz: 4 dBi	<1.35:1	50 Watts	-40° C to 80° C -40° F to 176° F	Height: 4.3 cm (1.7 in), Diameter: 10.8 cm (4.2 in)	.2 kg (7.4 oz)
3CWE596	3Com 18/20 dBi Dual-Band Panel Antenna	Panel	Long range point-to-point	2.4 GHz: 18 dBi 5 GHz: 20 dBi	<1.5:1	20 Watts	-40° C to 80° C -40° F to 176° F	Height: 35.4 cm (13.9 in), Width: 38.4 cm (15.1 in), Depth: 4.8 cm (1.9 in)	1.8 kg (63.5 oz)
3CWE597	3Com 4/6 dBi Dual-Band Hallway Antenna	Bidirectional	Midrange hallway installations	2.4 GHz: 4 dBi 5 GHz: 6 dBi	<1.5:1	10 Watts	-40°C to 71°C -40°F to 160°F	Height: 5.3 cm (2.1 in), Width: 7.6 cm (3 in), Depth: .5 cm (.2 in)	.1 kg (2.9 oz)
3CWE598	3Com 8/10 dBi Dual-Band Panel Antenna	Panel	Medium range point-to-point	2.4 GHz: 8 dBi 5 GHz: 10 dBI	<1.5:1	20 Watts	-40° C to 80° C -40° F to 176° F	Height: 12.7 cm (5 in), Width: 13.7 cm (5.4 in), Depth: 3.6 cm (1.4 in)	.3 kg (12.3 oz)

3Com® Omnidirectional Antennas

3Com 6/8 dBi Dual-Band Omni Antenna (3CWE591)

This omnidirectional antenna supplies uniform coverage in all directions. It is designed for a wide variety of 802.11 wireless networking installations for not-so-flexible environments. The antenna works well for static wireless connections, roaming users, and building-to-building connections. It provides point-to-multipoint connections between 3Com WLAN building-to-building bridges and also supports 3Com enterprise APs to deliver uniform coverage over a wide open area.

The omnidirectional antenna is built to supply maximum performance and reliability under the toughest outdoor conditions. A U.V.-stable, vented enclosure provides ultimate protection against weather elements. The antenna can be mast, wall or ceiling mounted.

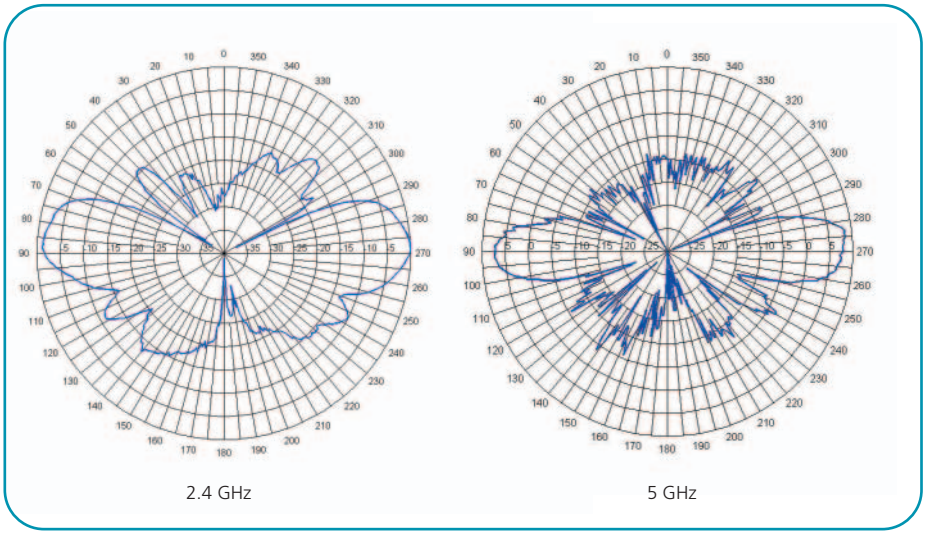
Features and Benefits:

- Supports point-to-multipoint connections between 3Com indoor and outdoor building-to-building bridges
- Supports 3Com enterprise access points with removable antennas
- U.V.-stable fiberglass enclosure enables outdoor installation even in harsh climates

- Vented system design provides reliable performance by protecting the electrical design against extreme moisture and/or temperatures
- Thread relief improves accessibility for taping, reduces installation time, and improves overall effectiveness
- Internal O-ring seal in the base of the antenna with integrated connector creates a watertight seal to prevent water from migrating into the antenna

General Specifications:
Polarization: Vertical
Nominal impedance: 50 Ohms
Bandwidth at 1.5:1 VSWR: 100 MHz
2.4 GHz vertical beam width (50% power): 30 degrees
5 GHz vertical beam width (50% power): 20 degrees
Equivalent flat plate rate: 0.06 ft
Wind survival: 125 mph
Lateral thrust at rated wind: 5.2 lbs
Bending movement at rated wind: 4.4 ft-lbs
Connector: N Female
Antenna housing: UV-resistant fiberglass
Mounting method: Mast, wall or ceiling mounted
Gain: 2.4 GHz: 6 dBi; 5 GHz: 8 dBi

Elevation Plane Radiation

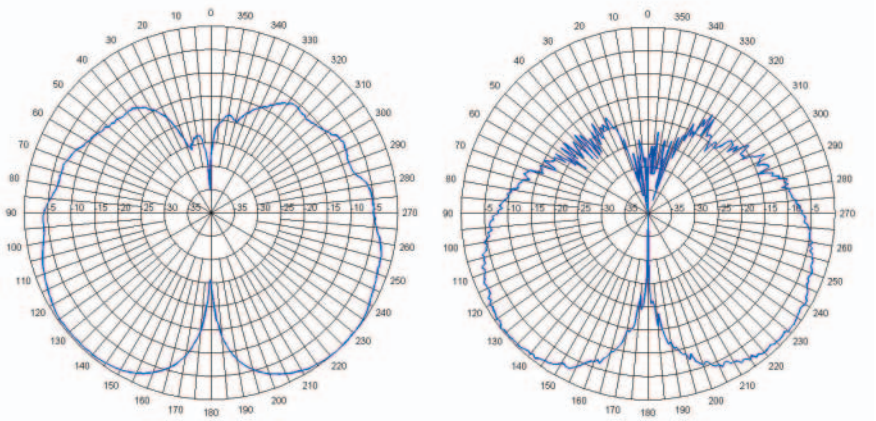


3Com 3/4 dBi Dual-Band Ceiling Mount Omni Antenna (3CWE592)

This antenna provides an appealing, low-profile ceiling mount solution for indoor applications requiring minimum visibility. The omnidirectional antenna offers uniform coverage in all directions in open areas such as lobbies or conference rooms. Its attractive housing blends in well with office environments and other locations where aesthetic considerations are important. The antenna can be easily mounted to drop ceiling tiles or to a solid ceiling surface where cable routing access is available.

Features and Benefits:
- Supports all 3Com enterprise APs with removable antennas
- For indoor installation only
- Includes a 12-inch pigtail with an N connector
- UL-listed materials and cable meet the strictest safety specifications
- Single-hole stud connection can be easily installed on standard ceiling tiles or solid ceiling surfaces

Elevation Plane Radiation Patterns



2.4 GHz 5 GHz

General Specifications:
Polarization: Vertical, linear
Nominal impedance: 50 Ohms
Connector: N Female
Antenna housing: UL-listed plastic
Cable: 12-inch (30.5 cm) Plenum RG58/U
Mounting method: Stud mount, single hole
Gain: 2.4 GHz: 3 dBi; 5 GHz: 4 dBi

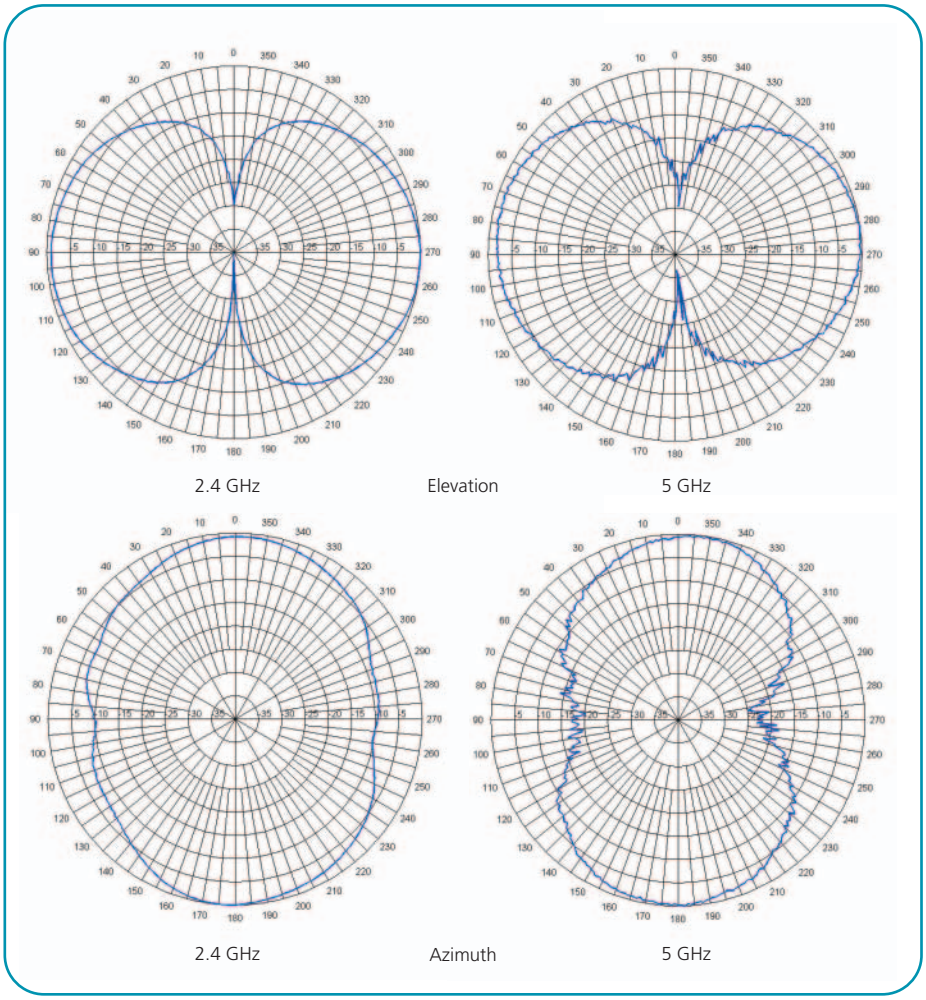
3Com Bidirectional Antenna

3Com 4/6 dBi Dual-Band Hallway Antenna (3CWE597)
This diminutive antenna is the perfect solution for extending the reach of your wireless network down long hallways and through narrow spaces. It is ideal for use in long corridors where more focused radiated energy is necessary to achieve adequate signal coverage You can use the antenna with 3Com enterprise APs to provide two-way directed coverage in these tough locations.

Features and Benefits:

- Supports 3Com enterprise access points with removable antennas
- Provides bi-directed point-to-point coverage in narrow hallways and corridors
- For indoor installation only
- Provides extended wireless coverage in two directions
- Attractive, low-profile housing blends well in office environments and other locations where aesthetic considerations are important
- UL-listed materials and cable meet the strictest safety specifications
- Single-hole stud mount or side cable exit option make it easy to install on standard ceiling tiles or solid ceiling surfaces

Elevation and Azimuth Radiation Patterns



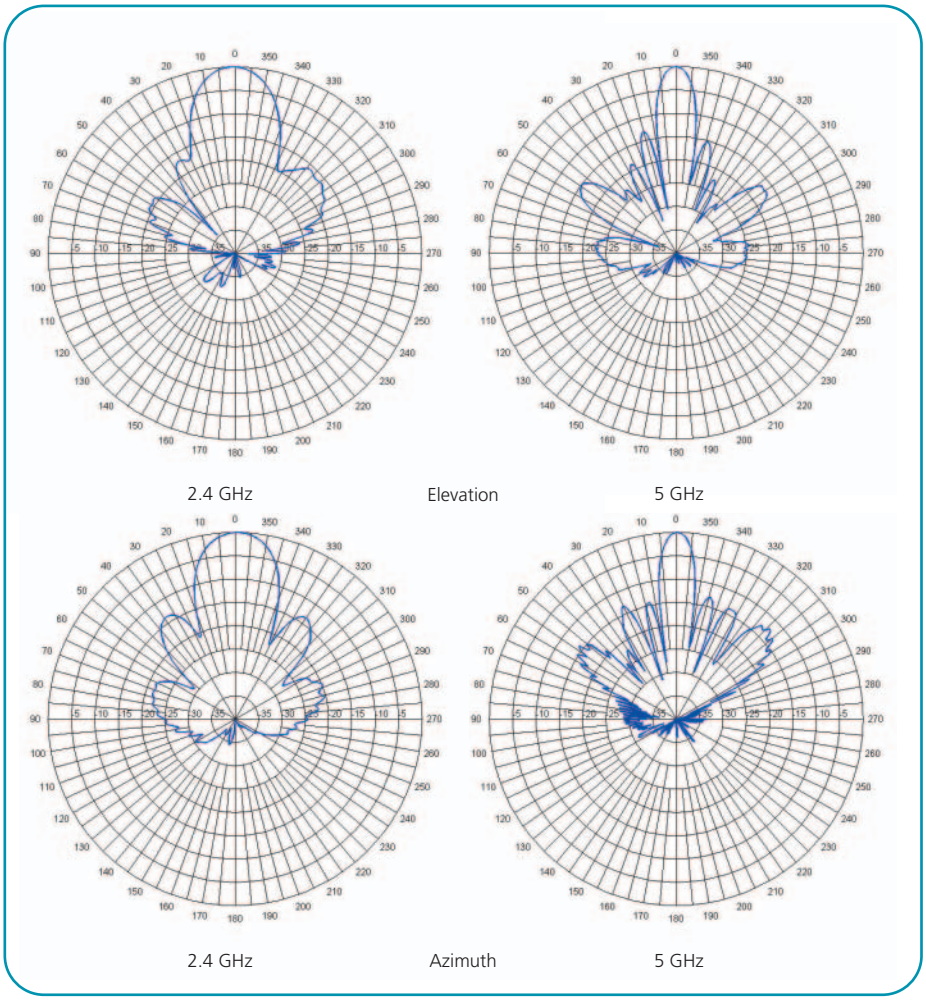
General Specifications:
Polarization: Vertical
Nominal impedance: 50 Ohms
2.4 GHz vertical beam width: 100 degrees
5 GHz vertical beam width: 75 degrees
Connector: N Female
Cable: 12-inch (30.5 cm) Plenum RG58/U
Antenna housing: UL94-VO plastic
Mounting method: Mast, wall or ceiling mounted
Gain: 2.4 GHz: 4 dBi; 5 GHz: 6 dBi

3Com Panel Antennas

3Com 18/20 dBi Dual-Band Panel Antenna (3CWE596)

This antenna enables long-range links for the 3Com wireless LAN indoor building-to-building bridge. The versatile antenna can be mounted practically anywhere and in any orientation, providing directed coverage in both indoor and outdoor environments. The antenna transmits data to another building or remote site equipped with another 3Com building-to-building bridge and antenna. It is ideal for midrange, point-to-point connections that require longer cables to run between the antenna and bridge.

Elevation and Azimuth Radiation Patterns



Features and Benefits:

- Supports the 3Com 11g 54Mbps Wireless LAN Indoor Building-to-Building Bridge, 3Com Wireless LAN Building-to-Building Bridge, and 3Com enterprise access points with removable antennas
- Flat-panel directional antenna provides stable and directed coverage in both indoor and outdoor environments
- Versatile antenna can be mounted practically anywhere and in any orientation for long-distance point-to-point wireless connections
- Corner exit RG-58/U pigtail design allows the polarized panel to be mounted in vertical or horizontal polarity
- Adjustable mounting brackets provide flexibility for both indoor or outdoor installations

General Specifications:

Polarization: Linear, vertical or horizontal
Nominal impedance: 50 Ohms
3dB horizontal beam width: 18 degrees
3dB vertical beam width: 19 degrees
Front-to-back ration: > 25 dB
Connector: N Female
Cable: 12-inch (30.5 cm) Plenum RG58/U
Wind loading (frontal) @ 100 Mph wind: 85 lbs
Antenna housing: UL94-VO plastic
Mounting method: Indoor or outdoor with mounting brackets
Gain: 2.4 GHz: 18 dBi; 5 GHz: 20 dBi

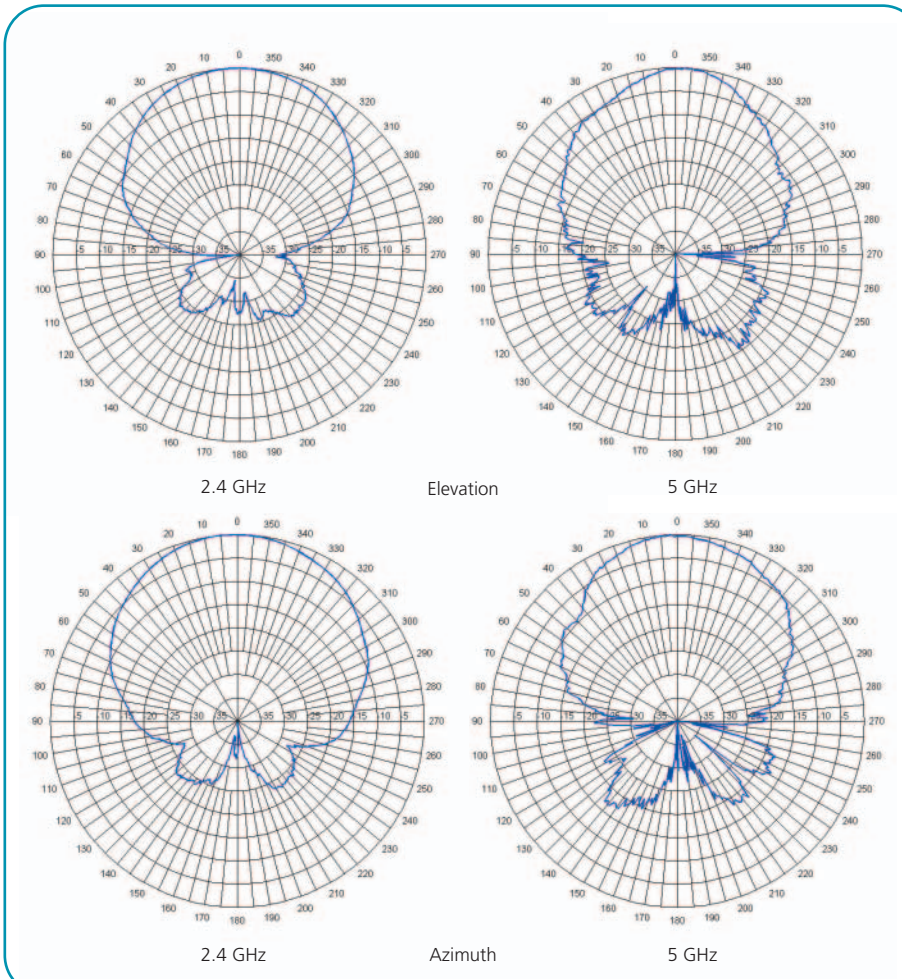
3Com 8/10 dBi Dual-Band Panel Antenna (3CWE598)

This antenna shapes the coverage pattern of 3Com enterprise wireless LAN managed access points with removable antennas, and enables short-range links for the 3Com WLAN indoor building-to-building bridge. The versatile antenna can be mounted practically anywhere and in any orientation, providing directed coverage in both indoor and outdoor environments. The antenna transmits data to another building or remote site equipped with another 3Com building-to-building bridge and antenna. It is ideal for point-to-point connections or for shaping AP coverage to a specific area.

Features and Benefits:

- Supports the 3Com enterprise access points and the 3Com 54Mbps Wireless Indoor Building-to-Building Bridge
- Flat-panel directional antenna provides stable and directed coverage in both indoor and outdoor environments
- Versatile antenna can be mounted practically anywhere and in any orientation for long-distance point-to-point wireless connections
- An excellent choice for short range point-to-point connections
- Corner exit RG-58/U pigtail design allows the polarized panel to be mounted in vertical or horizontal polarity
- Adjustable mounting brackets provide flexibility for both indoor or outdoor installations

Elevation and Azimuth Radiation Patterns



General Specifications:
Polarization: Linear, vertical or horizontal
Nominal impedance: 50 Ohms
3dB horizontal beam width: 60 degrees
3dB vertical beam width: 60 degrees
Front–to-back ration: > 15 dB
Connector: N Female
Cable: 12-inch (30.5 cm) Plenum RG58/U
Wind loading (frontal) @ 100 Mph wind: 9.3 lbs
Antenna housing: UL94-VO plastic
Mounting method: Indoor or outdoor with mounting brackets
Gain: 2.4 GHz: 8 dBi; 5 GHz: 10 dBi

3Com Ultra-Low Loss Antenna Cables

All 3Com 802.11 wireless antennas must be used with 3Com antenna cables. The antenna cables provide a certified connection between the 3Com access point and the 3Com antenna. The cables also provide the conversion between the SMA connector on the 3Com access points and the N-type connector on the antenna.

3Com uses ultra-low loss cables to maximize the performance of your wireless installation in either 2.4 GHz or 5GHz applications. Note that you should always choose the shortest cable that is appropriate for your installation.

Features and Benefits:

- Support 3Com dual band antennas, 3Com enterprise WLAN access points with removable antennas, and wireless building-to-building bridges
- Ultra-low loss characteristics ensure the maximum performance of your external antenna installation
- Enable remote antenna installations to meet aesthetic and performance requirements of your WLAN
- For indoor and outdoor installation

3COM PRODUCT NUMBER	3COM PRODUCT NAME	CABLE LENGTH	GAIN TYPE	CONNECTOR
3CWE580	3Com Ultra-Low Loss 6-Foot Antenna Cable	1.83 m (6 ft)	2.4 GHz: -0.6 dBi 5 GHz: -1.2 dBi	SMA (male) to N type (male)
3CWE581	3Com Ultra-Low Loss 20-foot Antenna Cable	6.1 m (20 ft)	2.4 GHz: -2.0 dBi 5 GHz: -4.0 dBi	SMA (male) to N type (male)
3CWE582	3Com Ultra-Low Loss 50-foot Antenna Cable	15.2 m (50 ft)	2.4 GHz: -5.0 dBi 5 GHz: -10.0 dBi	SMA (male) to N type (male)

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3Com Corporation, Corporate Headquarters, 350 Campus Drive, Marlborough, MA 01752-3064

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