Cambium Networks™ XIRRUS

Antenna Guide

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Contents

Overview

To optimize the overall performance of a Cambium Networks Xirrus WLAN inan outdoor deployment itis important to understand how to maximizecoverage with theappropriateantenna selection and placement This document ismeant to serveas a guideline for anyonewho wishes to useXirrus' Antennas and related accessories with Xirrus' outdoor wireless products.The document is organized according to the following sub-sections:

- Basic technical background
- Types of available Xirrus Antennas and accessories
- Design considerations and reference use cases

Technical Background

ISM bands:

The U.S. Federal Communications Commission (FCC) authorizes commercial wireless network products to operate in the Industrial, Scientific and Medical (ISM) bands using spread spectrum modulation. The ISM bands are locatedat three different frequencies ranges -900 MHz. 2.4 GHz and 5 GHz. This document covers products that operate in the 2.4 and 5 GHz bands.

ISM bands allow manufacturers and users to operate wireless products in the U.S. without requiring specificlicenses. This requirement may vary in other countries. The products themselves must meet certain requirements in order to be certified for sale such as maximum Transmit Power (Tx Power) and Effective Isotropic Radiated Power (EIRP) ratings.

Each of the ISM bands has different characteristics. The lower frequency bands exhibit better range but with limited bandwidth and hence lower data rates.

Higher frequency bands have Jess range and are subject to greater attenuation from solid objects.

Antenna Properties, Ratings, and Representation

At the most fundamental levelanantenna provides a wireless communication system three main attributes that are inter-related to each other and ultimately influence the over all radiation pattern produced by the antenna:

- Gain
- Directivity
- Polarization

Gainof an Antenna is a measure of the increase in power that the antenna provides. Antenna gain is measured in decibels (dB) -a logarithmic unit used to express the ratio between two values of a given physical quantity. The gain is the antenna directivity including all the factors controlling the antenna's efficiency. Some of the factors are:

- Insertion losses
- Aperture efficiency
- Radation efficiency

In the general case. the gain in dB is a factor of the ratio of output power (or radiated power) to the input power of the antenna {that ratio is also called the "efficiency" of the antenna). In practice the gain of a given antenna is common expressed by comparing it to the gain of an isotropic antenna.

An isotropic antenna is a "theoretical antenna· with a perfectly uniform three-dimensional radiation pattern. When expressed relative to an isotropic antenna the gain of a given antenna is represented in dBi (i for isotropic). By that measure. a truly isotropic antenna would have a power rating of 0 dB. The U.S FCC uses dBi in its calculations.

Directivity is the ability of an antenna to focus electro-magnetic energy in a particular direction in space. Directivity does not change when transmitting or receving and remains the same. When considering directivity the efficiency is 100%. The antenna beamwidth is proportional to the directivity/gain (as the directivity goes up,the beamwidth gets narrower). The directivity/gain is expressed in dBi, which means its referenced to an isotropic antenna with 0 dB gain (isotropic antenna transmits evenly in all directions). The magnitude of directivity is directly related to the size of the antenna relative to the wavelength of the antenna.

Polarization is defined as the orientation of the electric field of an RMwave. Every antenna have certain polarization characteristics. These could be

- Linear polarization-Vertical orientation
- Linear polarization-Horizontal orientation
- Linear polarization-Slant 452 orientation
- Circular polarization

The polarization of an antenna is determined by the physical structure of the antenna and by its orientation. A simple straight wire antenna will have one polarization when mounted vertically and a different polarization when mounted horizontally It is important when establishing a communication link that the Antennas on either end of the link will have similar polarization/orientation. If not there would be some polarization mismatch loss factor that will affect the efficiency of the communication link. As an example. If a linearyl polarized antenna with vertical orientation is used on one end of a communication link, the antenna on the other end need to be vertically oriented as well. It the antenna is horizontally oriented, the two Antennas will be orthogonal to each other and the polarization mismatch factor could be greater than 20 dB.

When using a slant 452 antenna, it could be assumed that the antenna is capable of receiving or transmitting any polarization oriented electric field (when the electric field is not oriented exactly as the antenna on the other end, there will be some polarization loss involved. more in the 3 dB range).

When the antenna is circularly polarized, it could be either right hand CP or left hand CP. It is important when using CP Antennas to use the same sense for the communication link. When using a CP antenna on one end of a communication link. the antenna on the other end could have any polarization characteristics (vertical horizontal or slant 452). In such cases. there will be a polarization mismatch loss involved that could be in the 3 dB range.

Radiation Pattern of an antenna is a plot of the relative strength of the electromagnetic field of the radio waves emitted by the antenna at different angles. The radiation pattern of the oreticalisotropic antenna, which radiates equally in all directions, would look like a sphere.

Impedance Matching is an important consideration in the design of the overall wireless communication system. At each interface, depending on the impedance mismatch, some fraction of the propagating radio wave's energy will reflect back into the source. This reflecting wave is called a standing wave and the ratio of maximum power to minimum power in the standing wave is called the Voltage Standing Wave Ratio (VSWRl). AVSWR of 1:1 is ideal.

Types of Xirrus Antennas

The tables starting on the next page detail the specifications of the different Antennas Xirrus offers for use with its access points, in both 2.4 GHz and 5 GHz. Each type of antenna will offer certain coverage capabilities suited for specific applications (as discussed in the later section of this document). As a general rule of thumb as the gain of an antenna increases, there is some trade of to its coverage area. High gain Antennas will typically offer longer coverage distance but smaller (and more directed) coverage area.

Antenna and Cables (Per Radio)

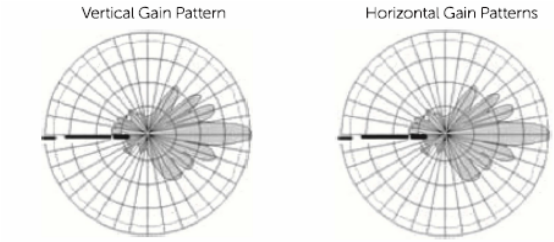
ANTENNAS	XH2-120 ANT-CAB-195-10-MM-02	XH2-240	XA4-240 ANT-CAB-195-6-MF
15 Degree 2.4GHz (ANT-DIR15-2X2-2.4G-01)	1 Antenna + 2 Cables	N/A	N/A
15 Degree 5 GHz (ANT-DIR15-2X2-5OG-01)	1 Antenna + 2 Cables	N/A	N/A
30 Degree Dual Band* (ANT-DIR3Q-2X2-01)	1 Antenna + 2 Cables	N/A	N/A
30 Degree Dual Band (ANT-IN-DIR30-4X4-RPSMA)	N/A	N/A	1 Antenna Direct Attach
30 Degree Dual Band (ANT-DIR30-4X4-0l)	N/A	1 Antenna	N/A
60 Degree Dual Band (ANT-DIR60-2X2-01)	1 Antenna + 2 Cables	N/A	N/A
60 Degree Dual Band (ANT-IN-DIR60-4X4-RPSMA)	N/A	N/A	1 Antenna Direct Attach
60 Degree Dual Band (ANT-DIR60-4X4-01)	N/A	1 Antenna	N/A
90 Degree Dual Band (ANT-DIR90-2X2-01)	1 Antenna + 2 Cables	N/A	N/A
Rubber Duck Dual Band (ANT-OMNI-1x1-03)	2 Antennas Direct Attach	4 Antennas Direct Attach	N/A
OMNI Stub Antenna Dual Band (ANT-OMNI-1x1 04)	2 Antennas Direct Attach	4 Antennas Direct Attach	N/A
OMNI Antenna Dual Band* (ANT-OMNI-2x2-03)	1 Antenna + 2 Cables	N/A	N/A
OMNI Antenna Dual Band (ANT-OMNI-4x4-01)	N/A	2 Antennas Direct Attach	N/A

•Each antenna can be connected simultaneously to 2 radios on different bands (2.4 GHz and 5 GHz) with additional cables. Additional antennas and cables are required to connect multiple radios on the same band.

15° Antenna for 2.4GHz Band (ANT-DIR15-2X2-2.4G-01)

Antenna Front

Antenna/Connectors

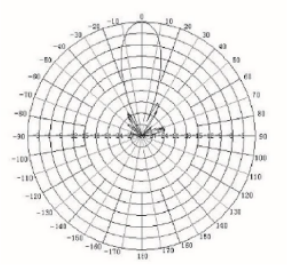
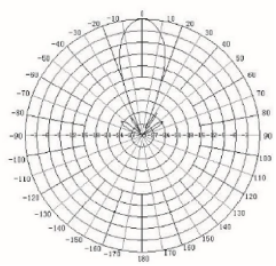
Description	15° Single Band 2.4 GHz 2x2 Panel Antenna
Gain Patterns	
Frequency Range (GHz)	2.4-2.5
Impedance	50 ohms
VSWR (50 ohms)	1.5
Peak Gain, dbi (2.4 GHz)	17+/-1
Polarization	2x +/-45
Half-Power Beamwidth AZ (H)	16° +/-3
Half-Power Beamwidth EL (V)	15° +/-3
Maximum Power	50W

Description	15° Single Band 2.4 GHz 2x2 Panel Antenna
Connector	N-Female x 2
Dimensions	17.7 in x 17.7 in x 1.6 in
Weight	4.4 lbs
Operating Temp	-40°C to +55°C
Mounting Options	Pole Mount Included (pole outer diameter 1.6-2 in)
Cable Specs XH2-120	LMR-195 N-Male connectors at both ends, 10 feet length (ANT-CAB-195-10-MM-02)
Extension Cable	LMR-400-N-Male to N-Female
What to Order (per radio)	For use with XH2-120 • 1 ANT-DIR15-2x2-XXX-01 • 2 ANT-CAB-195-10-MM-02

15° Antenna for 5 GHz Band(ANT-DIR15-2X2-5.0G-01)

Antenna Front

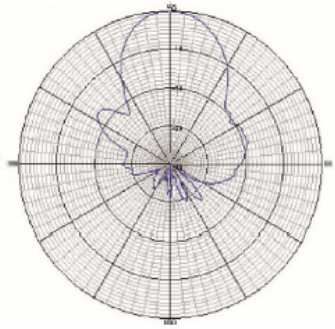
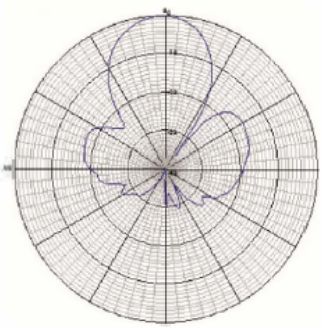
Antenna/Connectors

Description	15° Single Band 5 GHz 2x2 Panel Antenna
Gain Patterns	Vertical Gain Pattern  Horizontal Gain Pattern 
Frequency Range (GHz)	5.15-5.85
Impedance	50 ohms
VSWR (50 ohms)	1.8
Peak Gain, dbi (5 GHz)	17+/-1
Polarization	V/H
Half-Power Beamwidth Az (H)	17°
Half-Power Beamwidth El (V)	17°
Maximum Power	20W
Connector	N-Female x 2
Dimensions	10.3 in x 10.3 in x 1.4 in
Weight	2.5 lbs
Operating Temp	-40°C to +55°C
Mounting Options	Pole Mount Included (pole outer diameter 1.6-2 in)
Cable Specs XH2-120	LMR-195 N-Male connectors at both ends, 10 feet length (ANT-CAB-195-10-MM-02)
Extension Cable	LMR-400-N-Male to N-Female
What to Order (per radio)	For use with XH2-120 • 1 ANT-DIR15-2x2-XXX-01 • 2 ANT-CAB-195-10-MM-02

30°Antenna (ANT-DIR30-2X2-01)

Antenna Front

Antenna/Connectors

Description	30° Dual Band 2x2 Panel Antenna	
Gain Patterns	Vertical Gain Pattern 	Horizontal Gain Pattern 
Frequency Range (GHz)	2.4-2.5	5.15-5.825
Impedance	50 ohms	
VSWR (50 ohms)	2.0:1 max typ	
Peak Gain, dbi (2.4 GHz and 5 GHz)	11.7-13.5	12.5-14.0
Polarization	2x +/-45 V	2x +/-45 V
3 db Beamwidth Az (H)	35° +/-5	

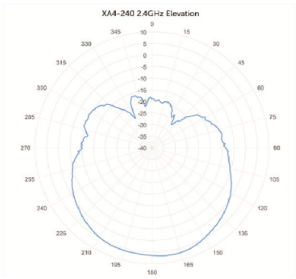
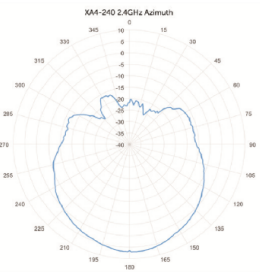
Description	30° Dual Band 2x2 Panel Antenna
3 db Beamwidth El (V)	35° +/-5
Maximum Power	10W max
Connector	N-Female x 2 N-Female x 2
Dimensions	16.5 in x 9.4 in x 1.4 in
Weight	3.75 lbs
Operating Temp	-40°C to +55°C
Mounting Options	Pole Mount Included
Cable Specs XH2-120	LMR-195 N-Male connectors at both ends, 10 feet length (ANT-CAB-195-10-MM-02)
Extension Cable	LMR-400-N-Male to N-Female
What to Order (per radio)*	For use with XH2-120 • 1 ANT-DIR30-2x2-01 • 2 ANT-CAB-195-10-MM-02

* Each antenna can be connected simultaneously to 2 radios on different bands (2.4 GHz and 5 GHz) with two additional cables. Additional Antennas and cables are required to connect multiple radios on the same band.

30°Antenna (ANT-IN-DIR30-4X4-RPSMA)

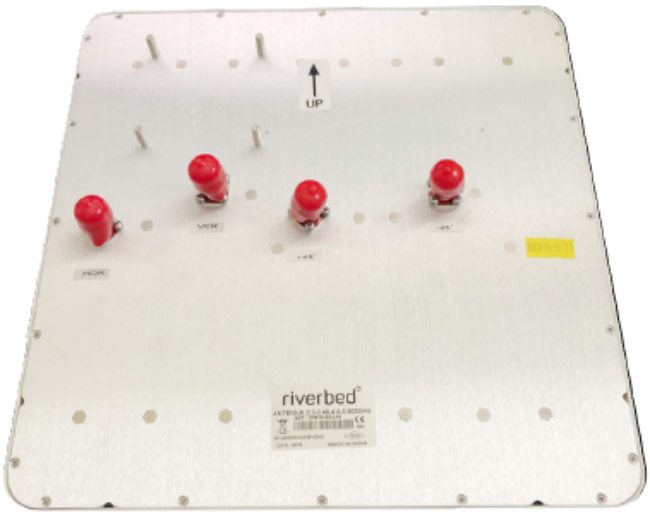
Antenna Front

Antenna/Connectors

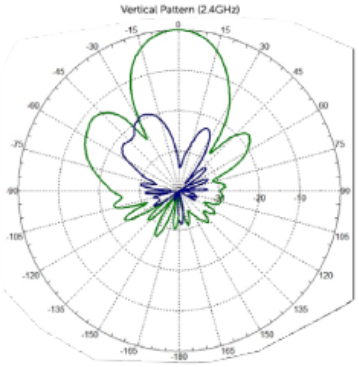
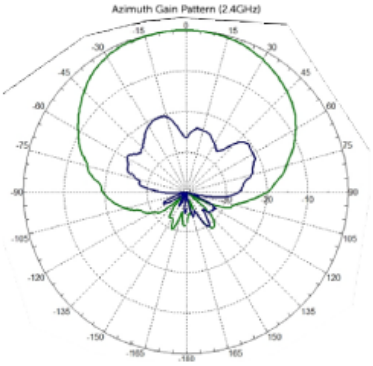
Description	30° Dual Band 4x4 Panel Antenna	
Gain Patterns	Vertical Gain Pattern 	Horizontal Gain Pattern 
Frequency Range (GHz)	2.4-2.5	5.15-5.85
Impedance	50 ohms	
VSWR (50 ohms)	20.1 max typ	
Peak Gain, dbi (2.4 GHz and 5 GHz)	10	11
Polarization	2 x vertical and Horizontal	2 x vertical and Horizontal
3 db Beamwidth Az (H)	65° +/-5	30° +/-5
3 db Beamwidth El (V)	65° +/-5	30° +/-5
Maximum Power	20W max	
Connector	RP-SMA Male x 4	
Dimensions	10.27 in x 10.27 in x 1.37 in	
Weight	1.41 lbs	
Operating Temp	-40°C to +55°C	
Mounting Options	Pole Mount Included	
Cable Specs XA4-240	Includes attached 3 feet of cable (LMR-100)	
Extension Cable	LMR-195 N-Male RP-SMA to Female RP-SMA, 6 feet length (ANT-CAB-195-6-MF)	
What to Order (per radio)	For use with XA4-240 • 1 ANT-IN-DIR30-4x4-RPSMA	

30°Antenna (ANT-DIR30-4X4-01)

Antenna Front



Antenna/Connectors

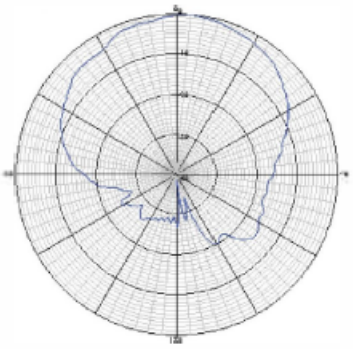
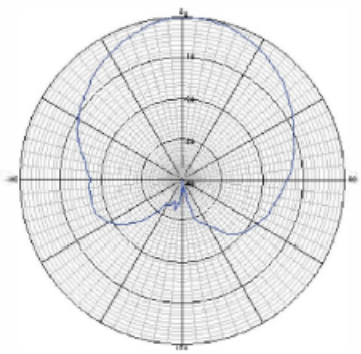
Description	30° Dual Band 4x4 Panel Antenna	
Gain Patterns	Vertical Gain Pattern 	Horizontal Gain Pattern 
Frequency Range (GHz)	2.3-2.7	4.9-5.925
Impedance	50 ohms	50 ohms
VSWR (50 ohms)	2.0:1 max typ	2.0:1 max typ
Peak Gain, dbi (2.4 GHz and 5 GHz)	11.5 dbi	14 dbi
Polarization	2 x +/-45, L,V	2 x +/-45, L,V

Description	30° Dual Band 4x4 Panel Antenna	
3 db Beamwidth Az (H)	60° typ	60° typ
3 db Beamwidth El (V)	30° typ	13° typ
Maximum Power	6W max	6W max
Connector	N-Female x 4	N-Female x 4
Dimensions	12 in x 12 in x 0.60 in	
Weight	0.45 lbs	
Operating Temp	-40°C to +55°C	
Mounting Options	Pole Mount Included	
Cable Specs XH2-240	LMR-400 N-Male connectors at both ends, includes attached 3 feet long cables.	
Extension Cable	LMR-400 N-Male to N-Female cable	
What to Order (per radio)	For use with XH2-240 • 1 ANT-DIR30-4x4-01	

60°Antenna (ANT-DIR60-2X2-01)

Antenna Front

Antenna/Connectors

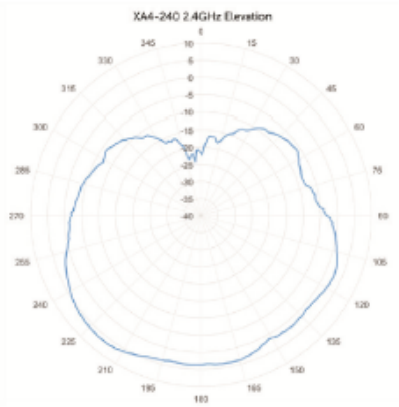
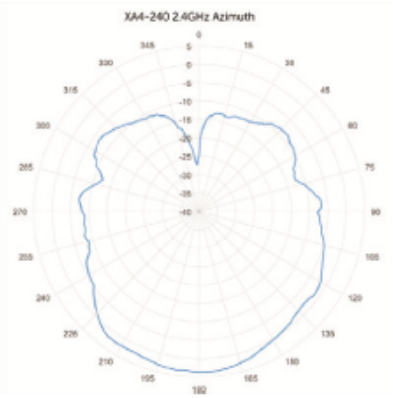
Description	60° Dual Band 2x2 Panel Antenna	
Gain Patterns	Vertical Gain Pattern 	Horizontal Gain Pattern 
Frequency Range (GHz)	2.4-2.48	5.15-5.850
Impedance	50 ohms	
VSWR (50 ohms)	2.0:1 max typ`	
Peak Gain, dbi (2.4 GHz and 5 GHz)	7-10	
Polarization	2 x +/-45, V	2 x +/-45, V
3 db Beamwidth Az (H)	65° +/-5	
3 db Beamwidth El (V)	65° +/-5	
Maximum Power	10W max	
Connector	N-Female x 3	N-Female x 3
Dimensions	8.6 in x 8.6 in x 1.18 in	
Weight	1.49 lbs	
Operating Temp	-40°C to +55°C	
Mounting Options	Pole Mount Included	
Cable Specs XH2-120	LMR-195 N-Male connectors at both ends, 10 feet length (ANT-CAB-195-10-MM-02)	
Extension Cable	LMR-400 N-Male to N-Female cable	
What to Order (per radio)*	For use with XH2-120 • 1 ANT-DIR60-2x2-01 • 2 ANT-CAB-195-10-MM-02	

*Each antenna can be connected simultaneously to 2 radios on different bands (2.4 GHzand 5 GHz) with two additional cables. Additional Antennas and cables are required to connect multiple radios on the same band.

60°Antenna (ANT-IN-DIR60-4X4-RPSMA)

Antenna Front

Antenna/Connectors

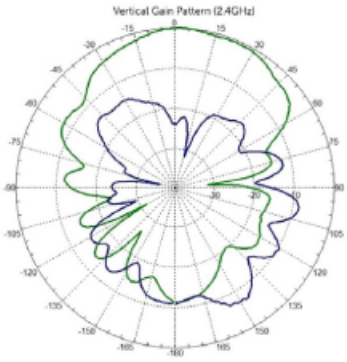
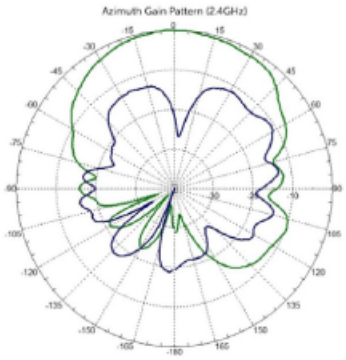
Description	60° Dual Band 2x2 Panel Antenna	
Gain Patterns	Vertical Gain Pattern 	Horizontal Gain Pattern 
Frequency Range (GHz)	2.4-2.5	5.15-5.85
Impedance	50 ohms	
VSWR (50 ohms)	2.0:1 max typ	2.5:1 max typ
Peak Gain, dbi (2.4 GHz and 5 GHz)	6	6

Description	60° Dual Band 2x2 Panel Antenna	
Polarization	Vertical	
3 db Beamwidth Az (H)	65° +/-5°	50° +/-10°
3 db Beamwidth El (V)	65° +/-5°	75° +/-5°
Maximum Power	20W max	
Connector	RP-SMA Male X 4	
Dimensions	10.27 in x 10.27 in x 1.37 in	
Weight	2.32 lbs	
Operating Temp	-40°C to +55°C	
Mounting Options	Pole/Ceiling Mount Included	
Cable Specs XA4-240	Includes attached 3 feet of cable (LMR-100).	
Extension Cable	LMR-195 Male RP-SMA to Female RP-SMA 6 feet length (ANT-CAB-195-6-MF)	
What to Order (per radio)*	For use with XA4-240 • 1 ANT-IN-DIR60-4x4-RPSMA	

60°Antenna (ANT-DIR60-4X4-01)

Antenna Front

Antenna/Connectors

Description	60° Dual Band 4x4 Panel Antenna	
Gain Patterns	Vertical Gain Pattern 	Horizontal Gain Pattern 
Frequency Range (GHz)	2.4-2.49	4.9-6
Impedance	50 ohms	50 ohms
VSWR (50 ohms)	2.0:1 max typ	2.0:1 max typ
Peak Gain, dbi (2.4 GHz and 5 GHz)	7.5 +/- 1.0 dbi	7.5 +/- 1.0 dbi
Polarization	2 x +/-45°	2 x +/-45°
3 db Beamwidth Az (H)	70° typ	70° typ
3 db Beamwidth El (V)	70° typ	70° typ
Maximum Power	6 W max	6 W max
Connector	N-Female x 4	N-Female x 4
Dimensions	7.5 in x 7.5 in x 1.57 in	
Weight	0.45 lbs	
Operating Temp	-40°C to +55°C	
Mounting Options	Pole Mount Included	

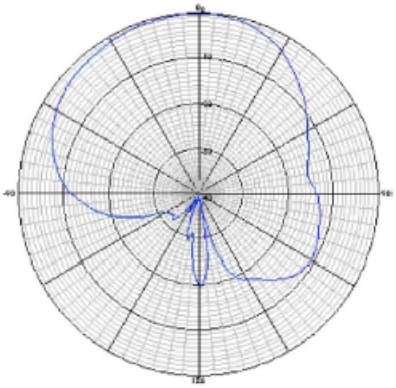
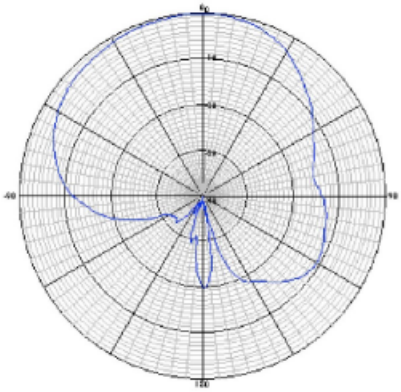
Description	60° Dual Band 4x4 Panel Antenna
Cable Specs XH2-240	LMR 100 N-Female at one end, includes attached 30 inch long cables
Extension Cable	LMR-400 N- Male to N-Female cable
What to Order (per radio)	For use with XH2-240 • 1 ANT-DIR60-4x4-01

90°Antenna (ANT-DIR90-2X2-01)

Antenna Front

Antenna Back

Connectors Closeup

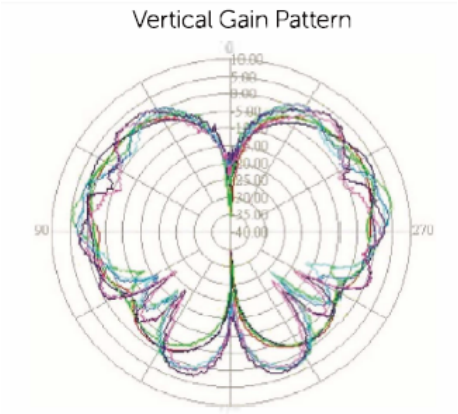
Description	60° Dual Band 4x4 Panel Antenna	
Gain Patterns	Vertical Gain Pattern 	Horizontal Gain Pattern 
Frequency Range (GHz)	2.4-2.5	5.15-5.85
Impedance	50 ohms	
VSWR (50 ohms)	2.0:1 max typ	
Peak Gain, dbi (2.4 GHz and 5 GHz)	4.0	6.5-9.5
Polarization	Vertical	
3 db Beamwidth Az (H)	90° typ	
3 db Beamwidth El (V)	90° typ	
Maximum Power	10 W max	
Connector	N-Female x 2*	
Dimensions	98 in x 9 in x 1.96 in	
Weight	1.7 lbs	
Operating Temp	-40°C to +60°C	
Mounting Options	Pole Mount	
Cable Specs XH2-120	LMR-195 N-Male connectors at both ends, 10 feet length (ANT-CAB-195-10-MM-02)	
What to Order (per radio)	For use with XH2-120 • 1 ANT-DIR90-2x2-01 • 2 ANT-CAB-195-10-MM-02	

*connectors apply for both 2.4 GHz and 5 GHz bands.

Rubber Duck Antenna (ANT-OMNI-1x1-03)

Connector Closeup

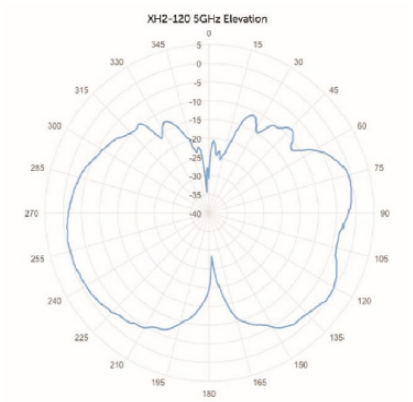
Antenna

Description	360° Dual Band (Omni Directional) 1x1 Antenna (Only for the XH2-120)	
Gain Patterns		
Frequency Range (GHz)	2.4-2.5	5.15-5.35, 5.725-5.85 MHz
Impedance	50 ohms	
VSWR (50 ohms)	2.0:1 max typ	
Peak Gain, dbi (2.4 GHz and 5 GHz)	2.0	4.0
Polarization	Linear Vertical	
3 db Beamwidth Az (H)	360° (Omnidirectional)	

Description	360° Dual Band (Omni Directional) 1x1 Antenna (Only for the XH2-120)
3 db Beamwidth El (V)	90° 60°
Maximum Power	10W max
Connector	N-Male x 1*
Dimensions	7.59 in x 0.5 in (diameter)
Weight	0.1 lbs
Operating Temp	-10°C to +70°C
Mounting Options	Direct Mount to AP
What to Order (per radio)	For use with XH2-120 • 2 ANT-OMNI-1x1-03

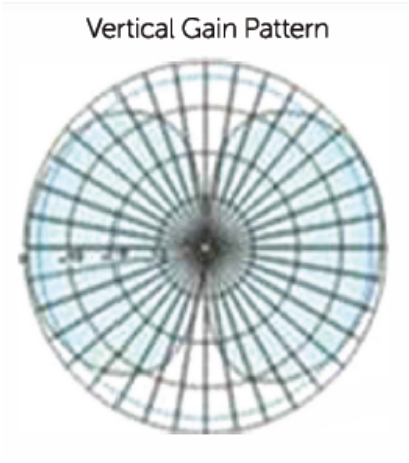
*Connectors apply for both 2.4 GHz and 5 GHz bands.

Omni Antenna (ANT-OMNI-1x1-04)

Description	360° Dual Band (Omni Directional) 1x1 Stub Antenna (Only for the XH2-120)	
Gain Patterns	Vertical Gain Pattern 	
Specifications	2.4GHz	5 GHz
Frequency Range (GHz)	2.4-2.5	5.15-5.825
Impedance	50 ohms	
VSWR (50 ohms)	2.0:1 max typ	
Peak Gain, dbi (2.4 GHz and 5 GHz)	+0.5	+1.5
Polarization	4 x V	4 x V
3 db Beamwidth Az (H)	360°	
3 db Beamwidth El (V)	90° typ	
Maximum Power	10W max	
Connector	N-type Male	
Dimensions	2.78 in x 0.830 in (diameter)	
Weight	1.5 oz	
Operating Temp	10°C to +70°C	
Mounting Options	Direct Mount to AP	
Cable Specs	Not Applicable	
What to Order (per radio)	For use with XH2-120 • 2 ANT-OMNI-1x1-04	

2X2 Omni Antenna (ANT-Omni-2X2-03)

Antenna

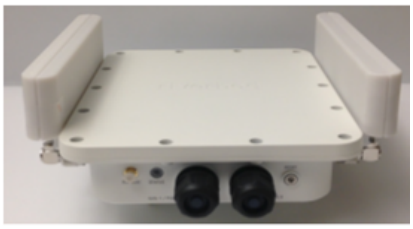
Description	360° Dual Band (Omni Directional) 2x2 Antenna (Only for the XH2-120)	
Gain Patterns		
Frequency Range (GHz)	2.4-2.5	5.15-5.825
Impedance	50 ohms	
VSWR (50 ohms)	1.7 max typ	2.0 max typ
Peak Gain, dbi (2.4 GHz and 5 GHz)	2.3	3.5
Polarization	4 X Vertical	
3 db Beamwidth Az (H)	360°	360°
3 db Beamwidth El (V)	60°	50°

Description	360° Dual Band (Omni Directional) 2x2 Antenna (Only for the XH2-120)
Maximum Power	50W
Connector	N-Female x 2 N-Female x 2
Dimensions	7.87 in x 4.444 in (diameter)
Weight	1.43 lbs
Operating Temp	-40°C to +55°C
Mounting Options	Pole Mount: 40-70 mm OD, 1.6-2.75 in OD
Cable Specs XH2-120	LMR-195 N-Male connectors at both ends, 10 feet length (ANT-CAB-195-10-MM-02)
Extension Cable	LMR-400 N-Male to N-Female
What to Order (per radio)*	For use with XH2-120 • 1 ANT-OMNI-2x2-03 • 2 ANT-CAB-195-10MM-02

*Each antenna can be connected simultaneously to 2 radios on different bands (2.4 GHzand 5 GHz) with two additional cables. Additional Antennas and cables are required to connect multiple radios on the same band.

Omni-Directional Antenna for XH2-240 Outdoor Access Point

Direct attach omni antenna



Two omni antennas attached on either side of the XH2-240 outdoor access point

Description	ANT-OM-4x4-01
Frequency Range (GHz)	2.4-2.48 5.15-5.825
Impedance	50 ohms
VSWR (50 ohms)	2.0:1 max typ

Description	ANT-OM-4x4-01
Peak Gain, dbi (2.4 GHz and 5 GHz)	3 dbi typ 5-6 dbi typ
Polarization	4 X Vertical
3 db Beamwidth Az (H)	360° typ
3 db Beamwidth El (V)	90° typ
Maximum Power	10W
Connector	N-Female x 4
Dimensions	9.00 in x 0.95 in x 2.80 in
Weight	0.5 lbs
Operating Temp	-40°C to +55°C
Mounting Options	Pole mount included
Cable Specs XH2-240	Direct attach No cable necessary
Extension Cable	LMR-400 N-Male to N-Female

There are several factors that impact the performance of a wireless LAN and must be kept in mind while designing for a deployment Some of the key considerations are as follows:

Mobility of the Application:

The mobility of the clients that will be connecting to the array through the antenna system is the first thing to think about when plannning a deployment. An application that has a lot of mobile users, such as a convention center is best served by a large number of omnidirectional microcells while a point-to-point application, which connects two or more stationary users may be best served by a directional antenna.

Physical Environment Some of the things to watch for in the environment where the WLAN deployment is planned include:

- Building construction-the density of the materials used in a building's construction determines the number of walls the RF signal can pass through and still maintain adequate coverage. The following is a good reference but the actual effect of the walls on RF must be tested through a site survey. A thick metal wall such as an elevator reflects signals, resulting in poor penetration of the signal and low quality of reception on the other side. Solid walls and floors and precast concrete walls can limit signal penetration to one or two walls without degrading coverage, but this can vary greatly depending on the amount of steel reinforcing with in the concrete. Concrete and concrete block walls will likely limit signal penetration to three or four walls. Wood or dry wall will typically allow for adequate signal penetration through five or six walls. Paper and Vinyl walls have little effect on signal penetration.
- Ceiling height
- Internal obstructions-product inventory and racking are factors to consider in a indoor environment such as a warehouse. In outdoor environments many objects can affect antenna patterns including trees, vehicles and buildings.
- Available mounting locations

In addition, consideration some consideration should also be given to aesthetic appearance.

Access to Network Connections (minimize antenna cable runs): Cabling between the array or AP and the antenna introduces losses in the system, therefore the length of this cable run must be minimized as much as possible.

Warehouse Use Case : In most cases, these installations require a large coverage area. Experience has shown that multiple omnidirectional Antennas (such as ANT-OMNI-1x1-01 or ANT-OMNI-2x2-02) mounted at 20 or 25 feet typically provide the best coverage. Of course this is also affected by the height of the racking the material in the racks and our ability to locate the antenna at this height. The antenna should be placed in the center of the desired coverage cell an in an open area for best performance. In cases where the celiingis too high and the array or AP will be located against a wall a directional antenna may be used.

Small Office or Small Retail Store: An omnidirectional dipole antenna (such as ANT-OMNI-1x1-01 or ANT-OMNI-2x2-02) will provide best coverage for type of scenario.

Enterprise or Large Retail Store: In most such deployments, there is a need for a fairly large coverage area and a combination of omnidirectional and directional Antennas must be used. Omnidirectional Antennas located just below the ceiling girders or just below the drop ceiling and directional Antennas located at the corners. Also for areas that are long and narrow such as long store aisles -a directional antenna at one end may provide better coverage. Keep in mind that the radiation angle of the antenna will also affect the coverage area.

Apartment Complex Backhaul (Point-to-Point): For an application where last mile connectivity is being provided using Wi-Fi (such as apartment complexes or senior living complexes that may not have traditional wiring infrastructure), point-to-point connections are common. When establishing point to point connections in outdoor environments, the distance, obstructions and antenna locations must be considered. For short distances (several hundred feet), a standard dipole antenna may be used. For very large distances (1/2 mile or more) high-gain drectional Antennas must be used. The Antennas must be installed as high as possible, above obstructions such as trees, buildings and similar. If directional Antennas are used they must be aligned so that their main radiated power lobes are directed at each other.

Learn More

For more information on Cambium Networks Xirrus including customer stories. product information and a free tria visit us at cambiumnetworks.com/xirrus.

Cambium Networks

Cambium Networks provides professional grade fixed wireless broadband and microwave solutions for customers around the world. Our solutions are deployed in thousands of networks in over 153 countries, with our innovative technologies providing reliable, secure, cost-effective connectivity that's easy to deploy and proven to deliver outstanding performance.

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