REFERENCE GUIDE

Xirrus External Antenna Guide

High Performance Wireless Networks

Xirrus External Antenna Guide

Overview

To optimize the overall performance of a Xirrus WLAN in an outdoor deployment it is important to understand how to maximize coverage
with the appropriate antenna selection and placement. This document is meant to serve as a guideline for anyone who wishes to use Xirrus' antennas and related accessories with Xirrus' newest outdoor wireless products (XH2-120, XR-520H, and XR-2425H). 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 located at three different frequencies ranges – 900MHz, 2.4GHz and 5GHz. This document covers products that operate in the 2.4 and 5GHz bands.

ISM bands allow manufacturers and users to operate wireless products in the U.S. without requiring specific licenses.
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 less range and are subject to greater attenuation from solid objects.

Antenna Properties, Ratings and Representation

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

- Gain
- Directivity
- Polarization

Gain of 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. 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 commonly 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 factor that was referred to in the previous discussion about antenna gain and its relation to efficiency. Mathematically, the gain of an antenna is its directivity times its efficiency. And like its gain, the directivity of a given antenna is also expressed relative to an isotropic antenna. The
directivity measures the power density that an antenna radiates in the direction of its strongest emission, relative to the power density radiated by an ideal isotropic antenna (which emits uniformly in all directions), when they are both radiating the same total power.

Polarization of an antenna is the orientation of the electric field of the radio wave that it produces relative to the earth's surface. 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. A linear polarized antenna radiates wholly in one plain containing the direction of propagation of the radio wave while, in a circular polarized antenna, the plane of polarization rotates in a circle making one complete revolution during one period of the wave. A linear polarized antenna may be either Horizontally Polarized (if the direction of propagation is parallel to the earth's surface) or Vertically Polarized (if the direction of propagation is perpendicular to the earth's surface). A circular polarized antenna may be either Right-Hand-Circular (RHC) or Left-Hand-Circular (LHC) depending on whether the direction of rotation of the plane of propagation is clockwise or counterclockwise respectively. Polarization is an important design consideration, particularly in Line of Sight (LOS) or Point-to-Point type deployments because maximum signal strength between sending and receiving antennas occurs when both are using identical polarization.

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. Radiation patterns are typically represented by either a three-dimensional graph or by a set of two separate two-dimensional polar plots of the horizontal and vertical cross sections. The radiation pattern of the theoretical isotropic antenna, which radiates equally in all directions, would look like a sphere.

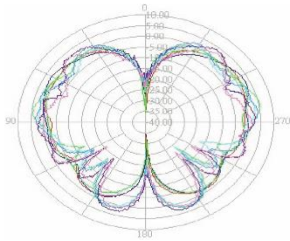
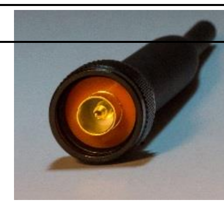
Impedance Matching is an important consideration in the design of the overall wireless communication system. This is because an electromagnetic wave traveling through various parts of a communication system (radio, cable, connectors, air) may encounter differences in impedance. At each interface, depending 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 (VSWR). A VSWR of 1:1 is ideal.

Types of Xirrus Antennas

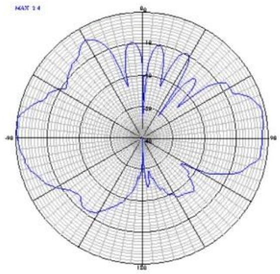
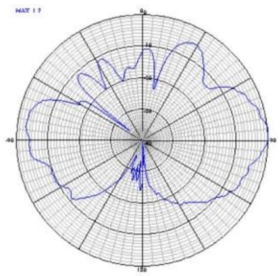
The tables starting on the next page detail the specifications of the different antennas Xirrus offers for use with its Access Points and Arrays, in both 2.4GHz and 5GHz. Each type of antenna will offer certain coverage capabilities suited for specific applications (as discussed in the later section of this document). The radiation patterns listed below also provide some guidance on the coverage to be expected from a given antenna. As a general rule of thumb as the gain of an antenna increases, there is some tradeoff to its coverage area. High gain antennas will typically offer longer coverage distance but smaller (and more directed) coverage area.

Omni-Directional Antennas:

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

DESCRIPTION	360° (OMNIDIRECTIONAL) ANTENNA		ANTENNA
Gain Pattern (Omni-Directional)			 
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 and 5GHz)	2.0	4.0	
Polarization	Linear Vertical		
3dB Beamwidth Az (H)	360° (Omnidirectional)		
3dB Beamwidth El (V)	90°	60°	
Maximum Power	10 W max.		
Connector	1 x N Male		
What to order	For use with one XH2-120: 4 ANT-OMNI-1x1-03	For use with one XR-2425H: 8 ANT-OMNI-1X1-03	

2x2 Omni Antenna (ANT-OMNI-2x2-02)

DESCRIPTION	360° (OMNIDIRECTIONAL) ANTENNA	
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 and 5GHz)	2.3	5
Polarization	4 x V (Linear, Vertical)	
3dB Beamwidth Az (H)	360°	
3dB Beamwidth El (V)	60°	
Maximum Power	10 W.	
Connector	RP-TNC male	
Dimensions	8.6 H x 6.3 OD inches	
Operating Temp	-30° C to + 70° C	
Storage Temp	-40° C to + 85° C	
Ingress Protection	IP-54	
Mounting Options	1.5" stud mount Universal wall and mast mountable with included articulating mount. All tools and hardware included. Mounts to mast up to 1-1/2" in diameter. Ceiling mountable to 1" thick ceiling tile with jam nut. Also includes rubber washer for mounting to smooth surfaces such as NEMA enclosures.	
Cable Specs	LMR-195, male RP-TNC to male N connectors and 10' length	
Connector	Four Reverse Polarity TNC (male) ANSI 7/16-28 UNEF 2B threads	
What to order	For use with one XH2/XR-520H: • 1 ANT-OMNI-2x2-02	For use with one XR-2425H: • 1 ANT-OMNI-2X2-02

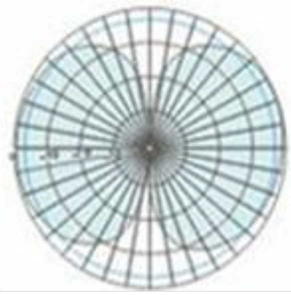
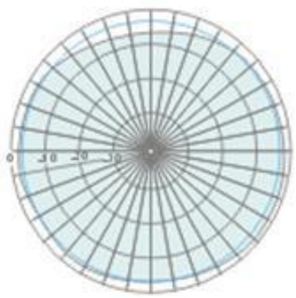
ANTENNA

MOUNTS

CONNECTOR CLOSEUP

2x2 Omni Antenna (ANT-OMNI-2x2-03)

Single Band Antenna, operating in either the 2.4 GHz or 5 GHz band.

DESCRIPTION	360° (OMNIDIRECTIONAL) ANTENNA	
Vertical Gain Pattern		
Horizontal Gain Pattern		
Frequency Range (GHz)	2.4 – 2.5	5.15 – 5.85
Impedance	50 ohms	
VSWR (50 ohms)	1.7 max. typ.	2.0 max. typ.
Peak Gain, dBi (2.4 and 5GHz)	2.3	3.5
Polarization	4 x Vertical	
3dB Beamwidth Az (H)	360°	360°
3dB Beamwidth El (V)	60°	50°
Maximum Input Power	50 W	
Connector	4 x N female	
Dimensions (mm)	200 H x 110 OD (outer diameter)	
Operating Temp	-40° C to + 55° C	
Rated Wind Velocity	36.9 (m/s) 82.5 mph	
Mounting Options	Pole mount: 40-70mm OD, 1.6-2.75in OD	
Cable Specs	LMR-195, male N connectors at both ends, 10' length	
Connector	Four N Female	
What to order	For use with one XH2-120/XR-520H: 1 ANT-OMNI-2x2-03	

ANTENNA

Design Considerations and Reference Use Cases

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 planning 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 within 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 – The strength of the signal to the user devices and also the overlapping coverage from different antennas vary based on how high the ceiling is and where the antennas are installed.
- 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 your 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 ceiling is 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. Omni- directional 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 directional 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.

Support & Maintenance

Xirrus is committed to the success of our customers and provides warranties and support options to best fit your needs.. For further information on the Xirrus hardware warranties, software support and premium support offerings visit:

http://www.xirrus.com/support/

About Xirrus

To organizations who depend on wireless access to transform their business, Xirrus is the wireless network solution provider that provides the world's most powerful, scalable, and trusted solutions. Through product invention and system design, commitment to customer success, and the industry's best price performance, Xirrus gives you confidence that your wireless network performs under even the most demanding circumstances. Xirrus is a privately held company headquartered in Thousand Oaks, CA.

High Performance Wireless Networks

1.800.947.7871 Toll Free in the US
+1.805.262.1600 Sales
+1.805.262.1601 Fax
2101 Corporate Center Drive
Thousand Oaks, CA 91320,
USA

To learn more
visit: xirrus.com or
email info@xirrus.com