ANTENNA OPTIONS

The antenna is a basic component of all wireless communication systems. It's function is to provide a transition between a guided electromagnetic wave (such as in a coaxial cable) and a wave that propagates in free space. Attached to a transmitter it radiates electromagnetic energy to other points. Attached to a receiver it collects the energy from an incident electromagnetic field. One of the least appreciated aspects of wireless communication is that the key to a successful link between transmitter and receiver is the proper selection and placement of antennas.

BACKGROUND

Premier Wireless offers a variety of antenna's for use in different applications depending on range and whether it is fixed or mobile. Wireless systems include both high power and low power (FCC Part 15) transmitters. The standard connector on all receivers and high power transmitter is a SMA Jack (female). To comply with FCC Part 15 rules (no user license) the connector interface between a low power transmitter and antenna is of a non-standard SMA configuration. Because of the FCC rules on radiated power the use of antennas with gain greater than Premier specifies is prohibited on Part 15 transmitters. There are no limitations on receive or high power transmitter antennas and long range is achieved by using high gain antennas.

Omni-Directional CP Antennas

The following pages provide detailed specifications for the standard antenna's currently offered by Premier Wireless. The majority of applications can be satisfied by the proper selection of one of these antennas. For applications with unique requirements please consult our Sales Department for specific antenna solutions not included here.

5.8 GHz Dish Antenna

RANGE:

Transmission range is specified in terms of "clear line of sight". Although RF and Microwave signals will penetrate walls and foliage, signal strength is greatly reduced and maximum range is achieved only with a **clear line of sight** between transmitter and receiver antenna. Typical transmission range achievable with Premier Wireless equipment is summarized below.

TYPICAL TRANSMISSION RANGE

Low Power Systems (Part 15)

Freq	TX Antenna	RX Antenna	Max Range
2.4 GHz	Omni	Omni	1000 ft.
5.8 GHz			400 ft.
2.4 GHz	Patch	Patch	2000 ft.
5.8 GHz			1000 ft.
2.4 GHz	Patch	Panel	3000 ft.
5.8 GHz			3000 ft.
2.4 GHz	Patch	Dish	2 mi.
5.8 GHz			2 mi.
2.4 GHz	Panel**	Panel	1 mi.
5.8 GHz			2 mi.
2.4 GHz	Panel**	Dish	4 mi.
5.8 GHz			8 mi.
2.4 GHz	Dish**	Dish	18 mi.
5.8 GHz			28 mi.

** (Hi Gain transmit antennas not allowed on Part 15 devices in the US)

High Power Systems: 2.4 GHz (250 mW) and 1.8 GHz (500 mW)

Freq	TX Antenna	RX Antenna	Max Range (Mi)
2.4 GHz	Omni	Omni	2.0
1.8 GHz			3.0
2.4 GHz	Patch	Patch	4.0
1.8 GHz			6.0
2.4 GHz	Patch	Panel	8.0
1.8 GHz			12.0
2.4 GHz	Panel	Panel	16.0
1.8 GHz			24.0
2.4 GHz	Patch	Dish	25.0
2.4 GHz	Panel	Dish	50.0
2.4 GHz	Dish	Dish	100.0

DIPOLE ANTENNAS

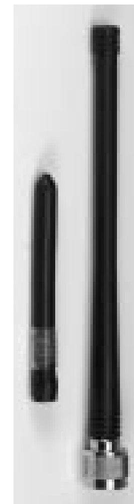
Gain: 2-3 dBi

Beamwidth: ± 40° (Typ) Vertical

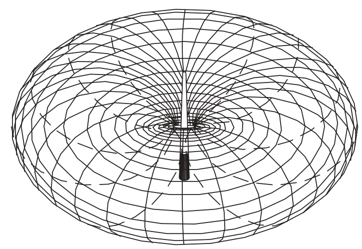
± 180° Horizontal (Omni-directional)

Model	Frequency	Polarization	Connector	Dimensions
AS-10	2.4 GHz	Linear	SMA Plug (RP)*	0.5” Dia x 4” Long
AS-11	2.4 GHz	Linear	SMA Plug (Male)	0.5” Dia x 4” Long
AM-901	900 MHz	Linear	Male Type N	1.0” Dia x 8” Long
AM-903	900 MHz	Linear	Male Type N	1.25” Dia x 24” Long

Typical Application: Dipoles are commonly used in short range fixed point-to-point installations.



AS-11 & AM-901
(AM-903 not shown)



Radiation Pattern

PATCH ANTENNAS

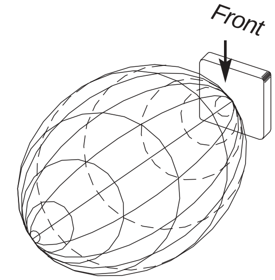
Gain: 5 dB

Beamwidth: ± 35° (Typ) Vertical and Horizontal

Model	Frequency	Polarization	Connector	Dimensions
AS-22R	2.4 GHz	Circular	SMA PLug (RP)*	2.25” Sq x 0.7”D
AS-23R	2.4 GHz	Circular	SMA Plug (Male)	2.25” Sq x 0.7”D
AS-24	2.4 GHz	Linear	SMA Plug (RP) & 8” cable	3.5” Dia x 0.9”D
AS-25	2.4 GHz	Linear	SMA Plug (Male) & 8” cable	3.5” Dia x 0.9”D
AS-26R	5.8 GHz	Circular	SMA Plug (RP)	2.25” Sq x 0.7”D
AS-27R	5.8 GHz	Circular	SMA Plug (Male)	2.25” Sq x 0.7”D
AS-28	5.8 GHz	Linear	SMA Plug (RP) & 8” cable	2.25” Sq x 0.7”D
AS-29	5.8 GHz	Linear	SMA Plug (RP) & 8” cable	2.25” Sq x 0.7”D
AS-37	5.8 GHz	Linear	SMA Jack & 8” cable	2.25” Sq x 0.7”D
AS-41	1.8 GHz	Linear	SMA Plug (Male) & 8” cable	2.25” Sq x 0.7”D
AS-43R	1.8 GHz	Circular	SMA Plug (Male)	2.25” Sq x 0.7”D

Orientation: Rotation is critical only for linear polarized antennas. Cable on top or bottom for vertical and either side for horizontal polarization.

Applications: The patch is used in both fixed (linear polarized) and mobile (circular polarized) installations. It is an ideal antenna when either the transmitter or receiver is above the other in a ground to air or air to ground transmission.



Radiation Pattern AS-2X

*RP (Reverse Polarity): Non-standard convector required by FCC for Part 15 transmitters.

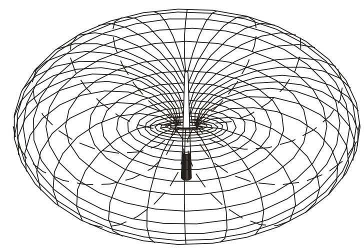
OMNI DIRECTIONAL

Gain: 2 dBc

Beamwidth: ± 35° (Typ) Vertical
± 180° Horizontal (Omni-directional)

Model	Frequency	Polarization	Connector	Dimensions
AS-32R	2.4 GHz	Circular	SMA Plug (RP)	2.72” Dia x 4” Long
AS-33R	2.4 GHz	Circular	SMA Plug (Male)	2.72” Dia x 4” Long
AS-34R	5.8 GHz	Circular	SMA Plug (RP)	1.3” Dia x 4.5” Long (2.5” Dia Flange)
AS-35R	5.8 GHz	Circular	SMA Plug (Male)	1.3” Dia x 4.5” Long (2.5” Dia Flange)

Applications: Omni CP Antennas are commonly used in mobile applications where either end of the link (typically transmitter) is moving. The circular polarization helps reduce the effects of multipath.



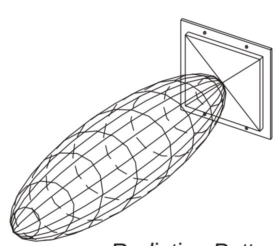
Radiation Pattern

PANEL ANTENNAS

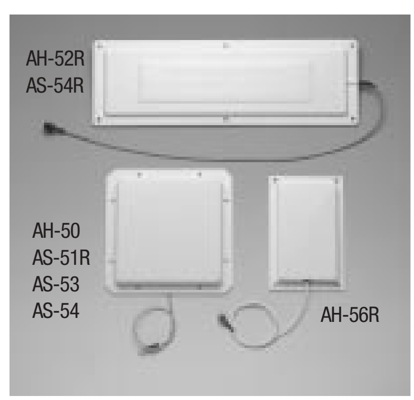
Model	Frequency	Polarization	Gain	Beamwidth (Typ) Vertical	Horizontal	Cable Length	Dimensions
AH-50	2.4 GHz	Linear	11 dBi	± 20°	± 20°	12”	7.5” Sq x 0.8”D
AH-51R	2.4 GHz	Circular	11 dBi	± 20°	± 20°	12”	7.5” Sq x 0.8”D
AH-52R	2.4 GHz	Circular	13 dBi	± 10°	± 30°	24”	16”H x 5.25”W x 0.6”D
AH-53	1.8 GHz	Linear	13 dBi	± 20°	± 20°	12”	7.5” Sq x 0.8”D
AH-54R	1.8 GHz	Circular	13 dBi	± 10°	± 30°	24”	16”H x 5.25”W x 0.6”D
AH-55	5.8 GHz	Linear	17 dBi	± 10°	± 10°	12”	7.5” Sq x 0.8”D
AH-56R	5.8 GHz	Circular	16 dBi	± 10°	± 30°	24”	7”H x 4.5”W x 0.9”D

Orientation: Rotation is critical only for linear polarized antennas. Cable on top or bottom for vertical and either side for horizontal polarization.

Application: Panel antennas are used in fixed installations to extend transmission range or in mobile applications where circular polarization is required to reduce multipath.



Radiation Pattern



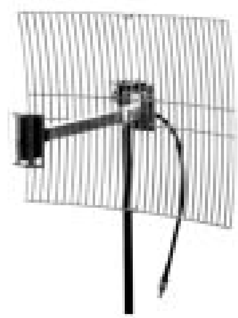
DISH ANTENNAS

Model	Frequency	Gain	Beamwidth	Dimensions	Weight	Connector
AH-65	2.4 GHz	17 dBi	± 7.0°	16”H X 20”W X 15”D	2.75 lbs	Type N (Male) with 18” cable
AH-70	2.4 GHz	23 dBi	± 3.75 °	24”H X 36”W X 15”D	5.0 lbs	Type N (Male) with 18” cable
AH-80	5.8 GHz	28 dBi	± 2.0 °	36” Dia X 24”D	12.0 lbs	Type N (Male) with 6’ cable
AH-82	5.8 GHz	23 dBi	± 3.75°	16” Dia X 18”D	3.5 lbs	Type N (Male) with 6’ cable

Polarization: Linear

Application: Used primarily in fixed point-to-point installations to extend transmission range.

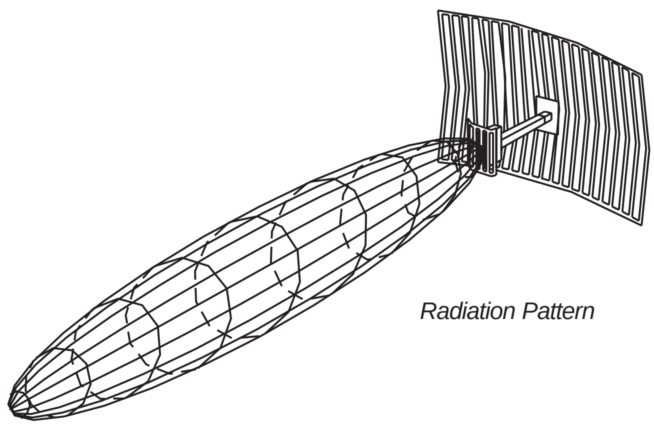
AH-70



AH-65

AH-82

AH-80



Radiation Pattern

YAGI ANTENNAS

Polarization: Linear

Model	Frequency	Gain	Beamwidth	Dimensions
AM-906	900 MHz	6.0 dBi	± 30°	7”W x 17” Long
AM-911	900 MHz	11.0 dBi	±12°	7”W x 48” Long

Connector: Type N Male with 6 foot cable.

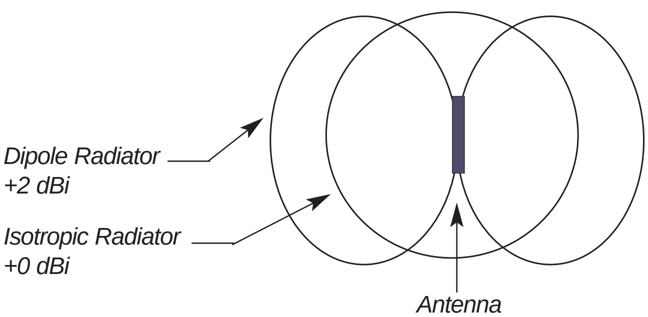
AM-906 (AM-911 not shown)

ANTENNA TERMINOLOGY

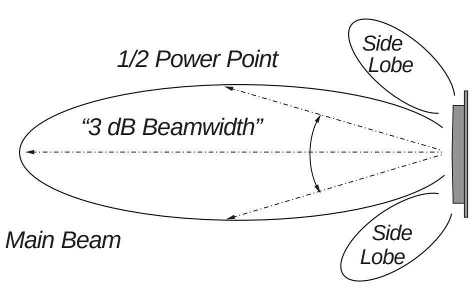
The basic electrical parameters that determine antenna performance include radiation pattern (spatial distribution of radiated energy), gain, beam-width and polarization.

Gain: The power gain of an antenna in a specified direction is defined by the ratio of the power density radiated in that direction to the power density which would be radiated by a lossless isotropic antenna with the same input power. Mathematically, the gain is expressed as:

$$\text{Gain (dBi)} = 10 \text{ Log} \left(\frac{\text{Antenna Power}}{\text{Isotropic Power}} \right)$$



Beamwidth: The half-power beamwidth is defined as the angular separation between the points on the beam where the power density is one half (or 3 dB below) that at the beam center. It is commonly referred to as the "3 dB" beamwidth. Another important parameter for defining the radiation pattern is the maximum sidelobe level. The maximum sidelobe level is the ratio of power density at the maximum pattern separated from the main beam to that at the center of the main beam. It is commonly expressed in decibels.



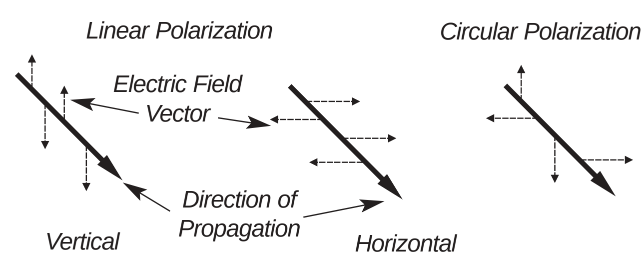
Polarization: At large distances from a radiating antenna the electric field vector of the radiated field is perpendicular to the direction of propagation. The Polarization of an electromagnetic field is defined in terms of the direction in space of its electric field vector.

LINEAR: If the electric field vector is always in one plane then it is said to be linearly polarized. Special cases are vertical polarization for transmission in a vertical plane and horizontal polarization for transmission in a horizontal plane.

CIRCULAR: In general the electric field vector rotates about a line parallel to the direction of propagation and its tip traces out an ellipse. This is known as Elliptical Polarization. Circular polarization is a special case of elliptical polarization in which the trace of the electric field vector is a circle. Because the electric field vector travels with the wave the actual pattern is that of a spiral with an elliptical or circular cross section.

The polarization properties of an antenna are related to the fields they radiate or receive. The polarization of the receive antenna must be matched to the polarization of the transmit antenna in order to extract maximum power from the field. If the antenna polarization is perpendicular to the field polarization (such as vertical vs horizontal or right hand vs left hand circular) the antenna will extract zero power.

REFLECTIONS: Dependent on the angle of incidence, and other factors of the surface the electric field will change phase upon reflection. In the case of circular polarized signals this will cause a change to the opposite polarization. Due to this phenomena, circularly polarized antennas are often used when "multipath" caused by reflected signals is a problem (such as in mobile applications).



LOCATION . . . . LOCATION . . . . LOCATION

When installing a wireless system performance is critically dependent on where it is installed. At the frequency of operation (2.4 Ghz) the maximum range is achieved when there is a clear line of sight between the transmit and receive antenna. Although RF and Microwave signals will penetrate walls and foliage significant reduction in the achievable transmission range will occur, especially when attempting to transmit through foliage.

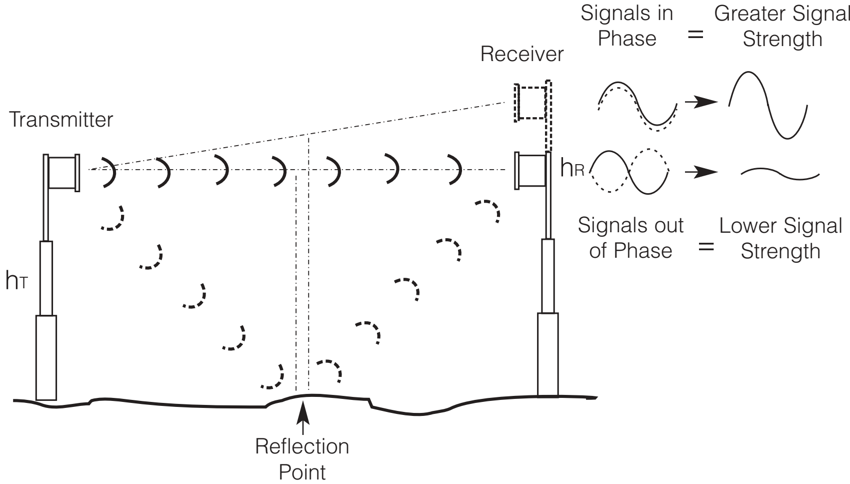
However, even with a clear line of sight, the presence of reflected signals at the receive antenna (a phenomena called "Multipath") can affect the maximum transmission range by more than a factor of ten. Reflected signals (see illustration) can either increase or decrease the signal strength of the direct signal. If the reflected signal arrives 180 degrees out of phase with the direct signal then almost complete cancellation can occur if the path lengths are substantially the same. If the signals arrive in phase then the strength can increase by up to a factor of two (6.0 dB). The actual amount of increase or decrease is very dependent on the nature of the reflecting surface and its location. The strongest effects are those from reflection points close to either antenna. Also, the farther the reflecting signal has to travel compared to the direct signal the weaker it will be and the less the effect. These reflection minimum and maximum zones (sometimes referred to as "Fresnel Zones") occur whenever the reflected signal path length is longer by a multiple of one-half wavelength. The first zone is a maximum, followed by a minimum, maximum, etc.

For example, using the formula below for a path length of 1,000 feet and a transmit antenna height of 20 feet then the first reflection zone (a maximum) is at 5 feet, the next minimum is at 10 feet, ...etc. At 20 foot elevation the receive antenna would be at a minimum signal strength. By moving the receive antenna up or down five feet the signal strength would increase to a maximum. Note that the higher the antennas are placed for a given path length the less the separation between each reflection minimum and maximum.

INSTALLATION

The formula can provide a rough idea of what the reflection zone spacings at the receive site will be. Because of the possibility of multiple reflected signals it is difficult to precisely determine the best position prior to actual installation. When planning installation allow for adequate vertical movement of the receive antenna to maximize signal strength. All of Premier Wireless video transmission systems have a Received Signal Strength Indicator (RSSI) port on the receiver. A digital volt meter should be used to measure the voltage at this port (from 0 to 3.0 volts) while adjusting the vertical position of the receive antenna. The maximum voltage measured will be determined primarily by the total path length and gain of the receive antenna.

FREQ. BAND	λ	h_R	First H_T Maximum (N=1) for h_T = 25 ft. at distance		
			D = 1000 ft.	D = 2000 ft.	D = 1 mile
900 MHz	1.08 ft.	$N \frac{0.269\,D}{h_T}$	10.8 ft.	21.5 ft.	56.8 ft.
2.4 GHz	0.40 ft.	$N \frac{0.10\,D}{h_T}$	4 ft.	8 ft.	21 ft.
5.8 GHz	0.17ft.	$N \frac{0.042\,D}{h_T}$	1.70 ft.	3.39 ft.	8.95 ft.



$$h_R \doteq \frac{N\lambda d}{4h_T}$$

h_T = Transmit antenna height (feet) above reflection point

h_R = Height reflection zone at receive site.

D = Path length in feet

λ = Wavelength of signal

N = Integer 1....N

Odd numbers give maximum signal strength, even numbers minimum

Note: Formula most accurate for $d \gg h_T, h_R$

PREMIER WIRELESS, INC.
1104 Buchanan Rd., Suite C3, Antioch, CA 94509 • Tel: 925/776-1070 • Fax: 925/776-1074 • www.premierwirelessinc.com