

3.4 Radiofrequency Radiation Exposure Evaluation

During the power output measurement, a maximum power output of **18.7dBm** was obtained on channel 6 at the antenna port. Adding the worst case manufacturer supplied antenna gain (**13dBi** for the Patch Array antenna) to the maximum power output gives an EIRP of **31.7dBm**.

A calculation based on the FCC's **Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields (Edition 97-01)** gives a minimum distance for human exposure of 11cm for the patch array antenna, 3.9cm for the patch antenna and 3.2cm for the dipole antenna. Equation (4) on page 19 of that document was used to calculate these distances using the $1\text{mW}/\text{cm}^2$ limit found in the General Population Exposure Limits table on page 67.

Since the product is classified as a mobile device, the installation manual contains instructions for installing the antennas with a minimum separation distance of 20cm between the antennas and the user or other nearby persons. This 20cm distance is well beyond the 11cm required by the RF exposure limits of section 2.1091.

6.2 User's Manual

Below is a copy of the antenna installation instructions. Please note the circled paragraph on page 3 of the manual that states the 20cm minimum separation requirement.



ANTENNA OPTIONS and INSTALLATION INSTRUCTIONS

ZoomAir Wireless Network Interface Cards are available with either an integrated antenna or an external antenna. ZoomAir Model #4007, supporting both PCMCIA and ISA formats, and shipping with the ZoomAir Hardware Access Point, comes with an external dipole antenna, providing more uniform coverage and up to 30% greater range in specific settings. Additional antenna models are available to meet specific wireless networking installation needs.

MAXIMIZING RANGE

The built-in patch antenna on PCMCIA Model #4000 and ISA Model #4005 has a horizontal pattern shaped like a cone. When using two ZoomAir cards with the integrated patch antenna in an office environment where set-up is less than 10 ft. apart, you can minimize packet errors by placing the units on different planes. Once the units are further than 10 ft. apart, the antenna signals will reflect off walls, tables, and people, thus changing signal polarization. Outdoor polarization has an even greater effect. If there are not any objects in the path of the two radio cards, the two cards should be on different planes to achieve the best range and to minimize packet errors.

The external dipole antenna on Model #4007 has an omni pattern. It transmits and receives signals equally in all directions. When using ZoomAir cards with external dipole antennas, it's best to have them all oriented in the same direction. If you have one card with a dipole antenna and another with an integrated antenna, we recommend that the dipole be at 90° to the integrated patch.

With all cards, placement is very important. If one computer is under a desk, loss will occur. Glass and metal will also cause degradation (e.g. inside a car). Weather conditions such as snow and rain water increase signal attenuation. Essentially, different materials affect the propagation of radio waves: Some cause more attenuation than others. See below for some common examples:

Material	Examples	Attenuation
• Wood	Floors	Low
• Plaster	Walls	Low
• Glass	Windows	Low
• Water	Damp Wood; Aquariums	Medium
• Bricks	Inner and Outer Walls	Medium
• Marble	Inner Walls	Medium
• Paper	Paper Rolls	High
• Concrete	Floors and Outer Walls	High
• Metal	Desks; Partitions	Very High

ANTENNAS

■ DIPOLE ANTENNA



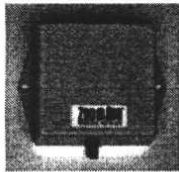
The **ZoomAir 2.2 dBi Dipole Antenna Model #98110-02** is supplied as standard equipment with the ZoomAir Wireless Network Interface Card Model #4007 and the ZoomAir Hardware Access Point. It attaches directly to each device's built-in antenna jack. The ZoomAir Dipole Antenna's radiation pattern is omni-directional: It transmits and receives signals equally well in all directions. When compared with the ZoomAir Model #4000 and #4005 NIC's integrated antenna, the ZoomAir Dipole typically provides more uniform coverage and up to 30% greater range.

Model 98110-02 Specifications

Frequency range	2.4-2.483 GHz
Gain ¹	2.2 dBi
Polarization ²	Linear
Nominal impedance	50 ohms
Connector	Right angle reverse polarity SMA male (plug)
Dimensions	3.25" length; 9/32" diameter
Weight	< 0.5 oz

Omni-directional to 300 ft. in a typical partitioned office environment or 1,000 ft. with an unobstructed line of sight

■ OMNI-DIRECTIONAL ANTENNA

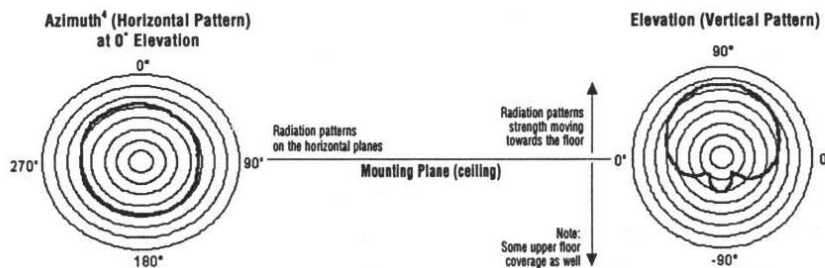


ZoomAir coverage can often be improved through the use of the **ZoomAir 4.0 dBi Omni-Directional Antenna Model #98110-04**. The antenna attaches to the ZoomAir Model #4007 Wireless Network Interface Card or a ZoomAir Hardware Access Point through a 1-meter or 3-meter low-loss coaxial cable (sold separately). Cable length can be extended to a maximum recommended 6 meters by attaching additional cable segments through a supplied adapter. The ZoomAir Omni-Directional Antenna package includes mounting hardware.

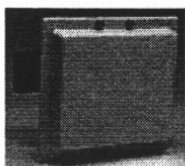
Model 98110-04 Specifications

Frequency range	2.4-2.484 GHz
Gain ¹	4.0 dBi (circular)
3 dB (beamwidth) (elevation)	220° (typical)
Polarization ³	Right-hand circular
Nominal impedance	50 ohms
Connector	Reverse polarity SMA female (jack)
Dimensions	3" W x 3" H x 1.5"D
Weight	3.0 oz

Point-to-point to 450 ft. in a typical partitioned office environment or 1,500 ft. with an unobstructed line of sight (tested with 3 meter cables)



■ DIRECTIONAL ANTENNA



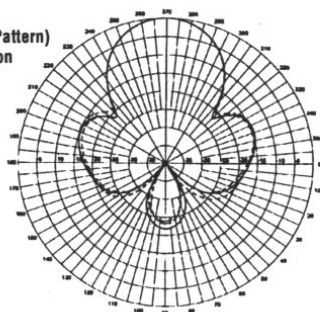
A range of one mile can be achieved if a line-of-sight position is established using two **ZoomAir 13.0 dBi Directional Antennas Model #98110-13**. The unit is designed for both indoor and outdoor use. Connection is made through a 1-meter or 3-meter low-loss coaxial cable (sold separately). Cable length may be extended to a maximum recommended 6 meters by attaching additional cable segments through a supplied adapter. Mounting/positioning hardware is included.

Model 98110-13 Specifications

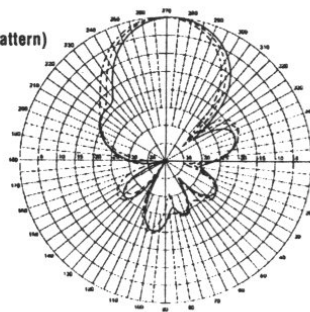
Frequency range	2.3-2.500 GHz
Gain ¹	13.0 dBi
Polarization ²	Linear
Azimuth and elevation beamwidth	35°
Nominal impedance	50 ohms
Lightning protection	DC grounded
Connector	Reverse polarity SMA female (jack)
Dimensions	8.7"W x 7.9"H x 1.4"D
Weight	0.77 lb

~1 mile point-to-point unobstructed line of sight (tested with 3 meter cables)

Azimuth⁴
(Horizontal Pattern)
at 0° Elevation



Elevation
(Vertical Pattern)



Antenna Products and Application Summary

98110-02	2.2 dBi dipole omni-directional antenna with an SMA male/plug connector – rated at 300 ft. coverage in a typical indoor office and over 1,000 ft. space in an open environment. Provided as standard equipment with ZoomAir Model #4007 Wireless Network Interface Card and ZoomAir Hardware Access Points.	98110-13	13 dBi directional patch antenna with SMA female/jack connector (for indoor or outdoor use) provides up to 1 mile point-to-point range. Includes fully adjustable mounting bracket.
98110-04	4.0 dBi (circular) omni-directional antenna with an SMA female/jack bulk-head connector for improved indoor coverage or point-to-point application use. Typical range: 450 ft. in an office environment and 1500 ft. unobstructed point-to-point application use. Mounting hardware included.	98112-3	3-meter low-loss cable with SMA male/plug connectors (total loss of ~1.0 dB); includes an extension adapter (~0.2 dB loss).
		98112-1	1-meter low-loss cable with SMA male/plug connectors (total loss of ~0.5 dB); includes an extension adapter (~0.2 dB loss).

Footnotes:

- ¹ Gain: Decibel (dBi or dBic for circular) expression for the ratio of the radiation intensity in a given direction relative to a theoretical isotropic (omni-directional) radiator.
- ² Polarization (Linear): A pattern requiring antennas to be placed in the same orientation with close attention to polarization alignment angle (alignment should be within ±5° for optimum performance).
- ³ Polarization (Right-hand circular): A pattern that reduces the effects of reflections in a typical indoor environment (best suited as an access point).
- ⁴ Azimuth: The radiation intensity pattern located in the horizontal plane.

Contact Your ZoomAir Dealer or Visit www.zoom.com

Important Installation Note:

ZoomAir and its resellers or distributors are not liable for injury, damage, or violation of government regulations, or state and local codes, associated with the installation and use of ZoomAir antenna products. Professional antenna installers are recommended if there are any questions, concerns, unknowns, or liability risk with the handling of these products.

Caution:

Due to the danger of electrocution, do not allow antennas to come in contact with electric power lines or close to high voltage electric fields. To avoid excessive exposure to the radio frequency radiation, antennas should also be positioned in such a way that a separation distance of at least 20 cm is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons.

ANTENNA INSTALLATION INSTRUCTIONS

■ DIPOLE ANTENNA

Remove the antenna from the box. You'll notice that the antenna is L-shaped and the short part of the L has a built-in connector with a silver hexagonal collar. The ZoomAir Card's mating connector has a knurled brass collar.

To maintain consistent antenna orientation, hold the antenna vertically and gently tighten the hexagonal collar on the antenna body until the antenna stays in place. **Do not attempt to turn the knurled brass collar on the PC Card. It is glued in place.**

Note: If you later want to reposition the antenna due to orientation changes, you must first loosen the antenna's hexagonal nut, reposition the antenna, and then retighten the nut.

■ OMNI-DIRECTIONAL ANTENNA

- 1 Carefully remove the existing dipole antenna: Gently unscrew the hexagonal collar on the antenna body. **Do not attempt to turn the knurled brass collar on the PC Card. It is glued in place.**
- 2 Attach one end of the cable* to the omni-directional antenna and the other to the ZoomAir PC Card. Again, be careful of the collar glued in place.
- 3 3A. If you are using a ZoomAir Hardware Access Point, mount the antenna in a central location as an "umbrella" to provide optimal coverage.
3B. If you are using ZoomAir in a point-to-point application, mount both antennas so that they are facing each other in a line of sight orientation.

■ DIRECTIONAL ANTENNA

- 1 Carefully remove the existing dipole antenna: Gently unscrew the hexagonal collar on the antenna body. **Do not attempt to turn the knurled brass collar on the PC Card. It is glued in place.**
- 2 Attach one end of the cable* to the directional antenna and the other to the ZoomAir PC Card. Again, be careful of the collar glued in place.
- 3 Using the supplied universal mounting and positioning hardware, position the antenna in a vertical orientation so that the receiving antenna is in the line of sight.

Note: With the omni-directional and directional antennas, you can couple cables to achieve a recommended maximum length of 6 meters before experiencing an unacceptable signal dB loss.

* Sold separately

See Antenna Options for Selection Information



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