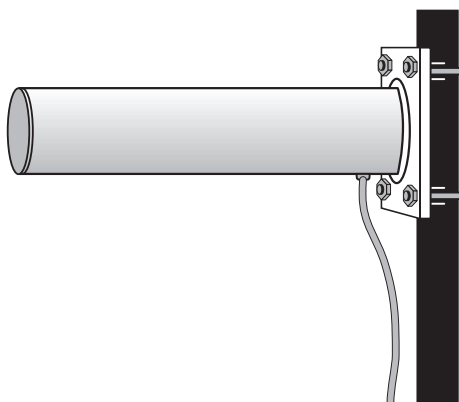


RoamAbout 802.11 Outdoor Antenna Installation Guide



RoamAbout 802.11 Outdoor Antenna Installation Guide

Notice

Cabletron Systems reserves the right to make changes in specifications and other information contained in this document without prior notice. The reader should in all cases consult Cabletron Systems to determine whether any such changes have been made.

The hardware, firmware, or software described in this manual is subject to change without notice.

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Web Site: <http://www.cabletron.com/wireless>

Regulatory Information

Canada

The products included with the RoamAbout Outdoor Kit for outdoor antenna installations comply with GL-36 of Industry and Science Canada.

USA - Federal Communications Commission (FCC)

The devices included with this outdoor kit comply with Part 15 of FCC Rules. Operation of the devices in a RoamAbout Outdoor System is subject to the following conditions:

- This device may not cause undesired interference.
- This device must accept any interference that may cause undesired operation.

Europe - EU Declaration of Conformity

Cabletron Systems declares that the RoamAbout products included in the RoamAbout Outdoor Kit conform to the specifications listed below, following the provisions of the EMC Directive 89/336/EEC:

- EMC prETS 300-826 General EMC requirements for Radio equipment.
- Radio ETS300-328 Technical requirements for Radio equipment.

User Information

To comply with the regulations listed above, you must install and use each of the RoamAbout Outdoor Kit components (Lightning Protector, Cables and Antennas) in strict accordance with the instructions in this guide.



This equipment may cause exposure to Radio Frequency radiation. Antennas shall be mounted in such a manner to minimize the potential for human contact during normal operation. To avoid the possibility of exceeding FCC radio frequency exposure limits, do not touch the antenna during operation.

When connecting RoamAbout devices to equipment other than the Cabletron Systems RoamAbout products described in this guide, the antenna installation may no longer comply with the regulations as defined above. In this case, it is the responsibility of the user to ensure that the entire antenna installation complies with local radio regulations.

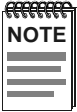
- Consult the user documentation that came with the other equipment to determine whether additional instructions, cautions, or regulations apply.
- Verify that the antenna installer is aware of these issues and regulations.

There is no guarantee that interference to radio communications will not occur in a particular commercial installation.

- If this device does cause interference, which can be determined by turning the host equipment off and on, the user should refer to the host equipment documentation, or contact the local equipment supplier.
- In case the device does cause interference with an authorized radio service, the user/operator shall promptly stop operating the device until interference is eliminated.
- Cabletron Systems is not responsible for any radio or television interference caused by unauthorized modification of the devices included with the RoamAbout Outdoor Kit, or the substitution or attachment of connecting cables and equipment other than that specified by Cabletron Systems.
- The correction of interference caused by such unauthorized modification, substitution or attachment is the responsibility of the user.

Notes, Cautions and Warnings

This guide uses the following conventions for notes, cautions and warnings:



The **NOTE** symbol calls the reader's attention to important information.



The **CAUTION** symbol cautions against actions that could result in equipment damage.



The **WARNING** symbol warns against actions that could result in personal injury or death.



The **ELECTRICAL HAZARD WARNING** symbol warns against electrical hazards that could result in personal injury or death.

Getting Help

Before calling your service provider for assistance, have the following information ready:

- Your service contract number
- A description of the problem
- A description of any action(s) already taken to resolve the problem.
- The serial and revision numbers of all involved products in the network
- A description of your network environment (layout, cable type, etc.)
- Network load and frame size at the time of trouble (if known)
- The device history (i.e., have you returned the device before, is this a recurring problem, etc.)
- Any previous Return Material Authorization (RMA) number.

If you purchased your system through a Channel Partner, contact that Channel Partner for assistance.

If you purchased your system from Cabletron, contact Cabletron using one of the following methods:

World Wide Web	http://www.cabletron.com http://www.cabletron.com/wireless
Phone	(603) 332-9400
Internet mail	http://www.cabletron.com/support/forms /email-support.form
FTP Login Password	ftp://ftp.cabletron.com/ <i>anonymous</i> <i>your email address</i>
To send comments or suggestions concerning this document, contact the Cabletron Systems Technical Writing Department via the following email address: TechWriting@cabletron.com <i>Make sure to include the document Part Number in the email message.</i>	

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Introduction

1

About This Guide

This *RoamAbout 802.11 Outdoor Antenna Installation Guide* explains how to install and set up a RoamAbout Outdoor Antenna link. Information is also provided to verify the wireless link quality and correct any problems that may arise during installation or operation.

This guide does *not* explain how to erect the antenna mast or how to install a safety grounding system. These are prerequisites that *must* be in place before the antenna is installed.

Who Should Use This Guide

The installation of Outdoor Antenna Links requires technical expertise. At the very least, you should be able to:

- Install and configure the network components, such as the RoamAbout Access Point and the RoamAbout Access Point Manager.
- Mount the outdoor antenna and lightning protector. Cabletron Systems recommends that the installation is performed by a qualified antenna installation service.

Organization of this Guide

In this guide you will find information to prepare for and verify the antenna installation. The information is organized as follows:

Chapter 1 - Introduction (This Chapter)

Introduces the RoamAbout Outdoor Kit and describes where you can find the information to set up a wireless system.

Chapter 2 - Installation Guidelines

Describes the requirements that a site must meet before you start the antenna installation.

Chapter 3 - Determining Range & Clearance

Provides a quick reference to determine antenna height and clearance requirements.

Chapter 4 - Installing the Antenna

Describes how to mount a RoamAbout Outdoor Antenna to a mast or wall, and how to connect the antenna to the cable and to the Lightning Protector.

Appendix A - The RoamAbout 14-dBi Directional Antenna

Describes the RoamAbout 14-dBi Directional Antenna used to set up long-distance, point-to-point antenna links.

Appendix B - The RoamAbout 7-dBi Omni-Directional Antenna

Describes the RoamAbout 7-dBi Omni-Directional antenna used to set up point-to-point antenna links.

Appendix C - The Antenna Cabling System

Describes the hardware specifications of the certified RoamAbout Cable Assembly, Lightning Protector and Low-loss Antenna Cable, which you will need to connect a RoamAbout Access Point or other computing device to an outdoor antenna installation.

Appendix D - Calculating Range & Clearance

Describes how to calculate the typical and/or maximum distance that you can achieve using products available through the RoamAbout Outdoor Kit. Also describes how to determine which antennas and/or cables you need to cover a predefined distance.

The RoamAbout Outdoor Kit

The RoamAbout Outdoor Kit is a set of antenna products that enable you to connect multiple buildings or LANs via a wireless outdoor point-to-point link.

The kit provides a selection of high-gain, low-noise antennas and components to fully utilize the Spread Spectrum Technology features of the RoamAbout PC Card. If desired, the antenna products in the RoamAbout Outdoor Kit may be purchased separately.

Antenna choices include:

- The RoamAbout 14-dBi Yagi antenna designed to provide high gain for your building-to-building communications link while still allowing for ease of use and installation of your outdoor equipment.
- The RoamAbout 7-dBi Omni-Directional antenna designed to provide a wide range radio beam.

Together with the high sensitivity of RoamAbout PC Cards, the antenna products available through the RoamAbout Outdoor Kit provide the best solution to set up high-speed wireless point-to-point communication links.

Introduction

The RoamAbout Outdoor Kit



1. *The outdoor antennas supplied with your RoamAbout Outdoor Kit are intended for mounting on a roof or the side of a building.*
2. *Antennas should only be installed by a qualified installer or antenna installation service.*
3. *Site prerequisites should be verified by a person familiar with national codes, local electrical codes, and with other regulations governing this type of installation.*
4. *Cabletron Systems, its channel partners, resellers, and distributors assume no liability for personal injury, property damage, or violation of government regulations that may arise from failing to comply with the instructions in this guide.*

Finding Additional Information

Installing a RoamAbout Access Point

The installation of a RoamAbout Access Point is described in the *RoamAbout Access Point User's Guide* included with each RoamAbout Access Point.

Configuration and Management

The configuration and management of outdoor antenna links is controlled via the RoamAbout Access Point Manager, which is described in the *RoamAbout Access Point User's Guide* shipped with each RoamAbout Access Point.

Context-Sensitive Help

Context-sensitive help for the RoamAbout Access Point Manager program is available by clicking the Help button on the screen or pressing the **F1** function key.

Hardware Specifications

- RoamAbout Access Point hardware specifications are described in the *RoamAbout Access Point User's Guide*.
- Radio Frequency specifications for the RoamAbout interface of the RoamAbout Access Point are described in the *RoamAbout IEEE DS/PC Card and ISA Adapter Card User's Guide* shipped with each RoamAbout PC Card.
- Hardware specifications for the outdoor antennas and RoamAbout Lightning Protector are listed in the Appendices of this guide.

Additional files on your diskettes

All software diskettes that come with your RoamAbout products include a *readme.txt* file which contains information about the software version and/or drivers on the diskette.

You are advised to print and read the *readme.txt* file prior to installing your RoamAbout products, as it may contain additional information that was not available when this document was printed.

Other Sources of Information

All documentation listed above can be downloaded from the RoamAbout website at:

`http://www.cabletron.com/wireless`

You are advised to visit the website at regular intervals for the latest available information, documentation and software updates and other RoamAbout news.

Installation Guidelines

2

Site Prerequisites

Please review all requirements outlined within the sections listed below before the installation process begins:

- *Pre-Installation Checklist*
- *Overview of the Indoor Installation*
- *Overview of the Outdoor Installation*
- *Before Climbing the Roof..*

Prior to climbing on the roof or any other area where you intend to install the outdoor antenna, you are advised to:

- Verify you have arranged all safety measures for outdoor/ rooftop installation.
- Verify you have all equipment and tools required to install the outdoor antennas.
- Install and verify proper operation of the equipment.



Carefully plan your antenna installation. Do not install the antenna in wet, windy, icy, or otherwise unsafe weather conditions.

Pre-Installation Checklist

Before you install the RoamAbout antenna system, you must configure the communications link as follows:

RoamAbout Access Point (AP) Configuration:

- √ **Bridge Mode** - LAN-to-LAN (same setting for each AP)
- √ **Remote Wireless MAC Address** - MAC address of the wireless device at the remote AP
- √ **Transmit Rate** - same setting for each AP (typically **Auto Rate**)
- √ **Channel Selection** - same frequency setting for each AP
- √ **Management Software** - RoamAbout Access Point Manager V3.4 (minimum) installed on PC
- √ **AP Firmware** - Version 3.4 (minimum)

Refer to the *RoamAbout Access Point User's Guide* for details about AP configuration.

Overview of the Indoor Installation

Figure 2-1 shows an overview of the hardware setup for the indoor installation. On each end of the wireless link you will need:

- A RoamAbout PC Card (A). Refer to *Selecting the Right RoamAbout PC Card* on page 2-3.
- A RoamAbout Access Point (B).
- The 50-cm RoamAbout Cable Assembly (C) to connect the RoamAbout PC Card (A) to the lightning protector (D).
- A lightning protector (D) to protect your RoamAbout equipment from static discharge and transients that may be received from your antenna (see Figure C-1 on page C-6 for details).

Installation Guidelines

Overview of the Indoor Installation

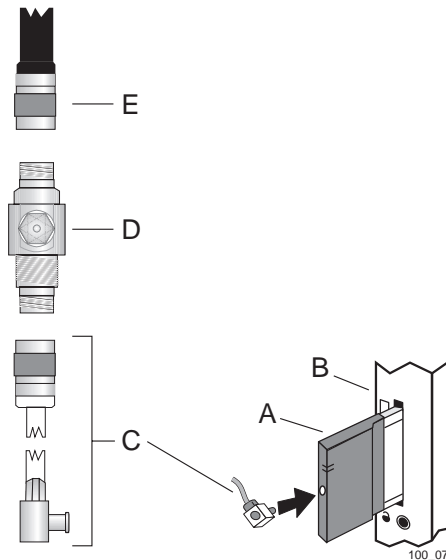
- A low-loss antenna cable (E) to connect the indoor installation to the outdoor antenna.

All of these components are included in the RoamAbout Outdoor Kit. Each component can be purchased separately.



*The RoamAbout Access Point, lightning protector, and the antenna must **must be connected to the same grounding system** as described in Grounding System on page 2-15.*

Figure 2-1 Indoor Installation Overview



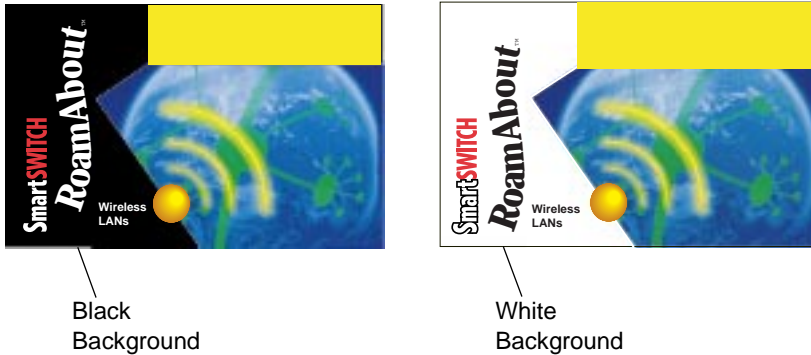
Selecting the Right RoamAbout PC Card

Wireless communication is usually subject to local radio regulations. To comply with such regulations, Cabletron Systems offers two types of RoamAbout Cards to connect a RoamAbout Access Point to an outdoor antenna installation (see Figure 2-2).

Installation Guidelines

Overview of the Indoor Installation

Figure 2-2 RoamAbout PC Card Identification



- In countries that adhere to FCC regulations¹, use the RoamAbout PC Card with the *black-background label*.
- In France, Japan, and countries that adhere to ETSI regulations², you **must** select the card-type based upon the antenna that is used:
 - You can use the RoamAbout PC Card with the *black-background label* when connecting the PC Card to the RoamAbout 7-dBi Omni-Directional Antenna.
 - You **must** use the RoamAbout PC Card with the *white-background label* when connecting the PC Card to the RoamAbout 14-dBi Directional Antenna for outdoor use.

1 As defined by the United States Federal Communications Commission (FCC)

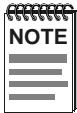
2 As defined by the European Telecommunications Standards Institute (ETSI)

Installation Guidelines

Overview of the Indoor Installation

When you order a RoamAbout Outdoor Kit, the kit marketed in your country will include the correct card type that complies with the regulations that apply in your country.

If you purchase RoamAbout outdoor antenna equipment as separate components, make sure you order the correct items as determined by country regulations. If you have any questions, contact your local Cabletron Systems Sales Office for additional information.



It is always the responsibility of the end-user to ensure that an outdoor antenna installation complies with local radio regulations. The end-user must verify that:

- 1. The antenna installer is aware of these regulations.*
- 2. The correct type of RoamAbout PC card is used to connect the RoamAbout Access Point to the outdoor antenna installation.*
- 3. The correct type of cables and lightning protector have been used, according to the instructions described in this guide.*

Installation Guidelines

Overview of the Indoor Installation

Placement of the RoamAbout Access Point

The ideal location to install your RoamAbout Access Point must satisfy the following requirements:

- The location must be indoors to protect the unit from extreme weather conditions, excessive heat and humidity, and to keep the unit free from vibration and dust.
- The location must provide a connection to a grounding type AC wall outlet (100-240 VAC), using the standard power cord supplied with the unit.
- The AC wall outlet ground must be connected to the same grounding system as the *RoamAbout Lightning Protector* and antenna mast (see *Grounding System* on page 2-15).
- The location must provide a connection to the network backbone via an Ethernet LAN cable going to a hub, bridge, or directly into a patch panel.
- The location must be as close as possible to the point where the antenna cable will enter the building (see *Placement of the Lightning Protector* on page 2-8).

Installation Guidelines

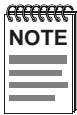
Overview of the Indoor Installation

Prior to mounting the RoamAbout Access Point, you are advised to carefully calculate:

- The distance between the intended location of your RoamAbout Access Point and the location of the antenna mast.
- The height of the antenna on the mast.

If the low-loss antenna cable is not long enough to cover this distance, you have one of two options:

- Select another location that satisfies the requirements listed on the previous page to mount your RoamAbout Access Point.
or
- Select another low-loss cable length (refer to Appendix C - The Antenna Cabling System: Table C-4 on page C-8, Table C-5 on page C-9, and Table C-6 on page C-9).



1. *As the length of the antenna cable may affect the actual transmission/reception range of your outdoor antenna installation, the first option is preferred.*
2. *Shortening the cable will void the Cabletron Systems Warranty, and may conflict with radio certifications and/or approvals.*

Installation Guidelines

Overview of the Indoor Installation

Placement of the Lightning Protector

Lightning protection is designed to protect people, property and equipment by providing a path to the ground whenever lightning strikes your antenna installation. The RoamAbout Lightning Protector is an indispensable part of such a grounding system to protect your electronic equipment from transients and/or electrostatic discharges at the antenna.

For optimal protection, the location of the *RoamAbout Lightning Protector*:

- Must be as close as possible to the point where the antenna cable enters the building.
- Allow for easy installation/removal of the lightning protector using the cables shown in Figure 2-1 on page 2-3.
- Provide a connection to the same grounding system as the RoamAbout Access Point and the outdoor antenna mast as described in *Grounding System* on page 2-15.

Antenna Cable Route

The antenna cable must be connected to the RoamAbout Access Point via the RoamAbout Lightning Protector and Cable Assembly as pictured in Figure 2-1 on page 2-3. To plan the route of the antenna cable please consider the following questions:

- Does the cable route require drilling through a wall or ceiling?
- Do you have a building plan of the desired location showing any other existing cabling routes like electricity, telephone or networking?
- Does the building material require special tools for drilling?
- Is there adequate space and drainage for installing all necessary antenna cable drip loops?

Installation Guidelines

Overview of the Indoor Installation

The cable should not be installed into tight positions, as bending or applying excessive force to the connectors may damage the antenna cable. Always allow the cable to bend naturally around corners.

The recommended bend radius is 25 mm (1 in.).

The antenna cable must be secured along its complete length. No part of the antenna cable should be allowed to hang free. This is particularly important for cable parts that are installed outdoors.



Antenna cable and cable connectors are not designed to withstand excessive force:

- 1. Do not use connectors as cable grips to pull cable through raceways or conduits.*
- 2. Do not use cable connectors to support the weight of the cable during or after installation.*
- 3. Do not use tools to tighten connectors (finger-tighten only).*
- 4. Always seal connectors with waterproof stretch tape.*

Before sealing outdoor connectors and permanently securing cables, verify that the installation is correct and all components function properly.

Overview of the Outdoor Installation

Verify the availability of the following components required for the outdoor installation of the point-to-point link:

- The RoamAbout Systems Antenna.
- The RoamAbout Systems low-loss antenna cable (available in different cable lengths).
- *Antenna Mast/Wall Bracket* (not included in kit).
- An adequate *Grounding System* that meets the requirements described on page 2-15.
- Waterproof stretch tape to seal all outdoor coax cable connections.

Installation Guidelines

Overview of the Outdoor Installation

Antenna Placement

To achieve maximum performance for your wireless outdoor connection, the RoamAbout Outdoor Antennas must have clear line-of-sight which is defined as:

- No obstacles in the direct path between the two antennas.
- No obstacles within a defined zone around the antenna beam.

The shape of a radio beam is not straight and narrow like a laser beam. The radio beam, also referred to as Fresnel Zone, is bulged in the middle, like a football or rugby ball. The exact shape and width of the Fresnel Zone is determined by the path length and frequency of the radio signal.

If any significant part of this zone is obstructed, a portion of the radio energy will be lost, resulting in reduced performance. Reduced performance may also occur when obstacles that are close to the antenna beam cause signal reflections or noise that interfere with the radio signal.

Figure 2-3 shows some typical examples of obstacles that you must avoid for a directional antenna to operate effectively:

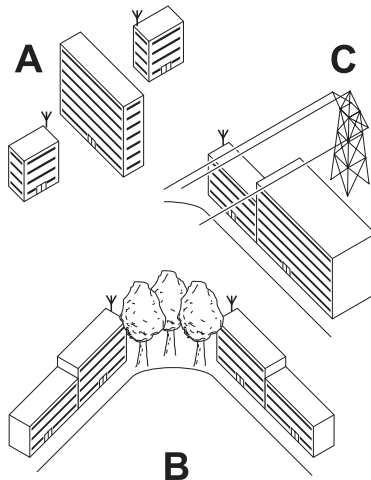
- A. Neighboring Buildings
- B. Trees or other obstructions
- C. Power lines

To allow optimal performance, ensure that the type and placement of the antennas allows sufficient clearance of the Fresnel Zone at the maximum width of the bulge, typically at the midpoint between the antennas. For more information, see *Chapter 3 - Determining Range & Clearance*.

Installation Guidelines

Overview of the Outdoor Installation

Figure 2-3 Potential Obstacles for a Directional Antenna



To minimize the influence of obstacles, signal interference or reflections please note the following guidelines:

- Mount the antenna as high as possible above ground to allow maximum clearance:
 - In open areas, *ground* is the actual surface of the earth
 - In dense urban areas *ground* is defined as the height of the highest obstacle in the signal path between the two antenna sites.
- Avoid trees or other foliage in the signal path to prevent interference or signal absorption due to dynamic changes in seasons (leaves/ice).
- Install the antenna at least 2 m (6 ft) away from all other antennas.

Other situations where reflections of the radio signal may cause interference are environments where large reflecting surfaces exist in parallel or partly perpendicular to the antenna beam.

Installation Guidelines

Overview of the Outdoor Installation

Environments with large reflective surfaces include:

- Buildings with mirrored-glass or low emissivity (low-e) glass
- Crowded parking lots
- Water or moist earth and moist vegetation
- Above ground power/telephone lines

Seasonal factors that could have an effect on signal propagation may occur in the following situations:

- If there are lots of trees in the signal path, marginal communications during times of low foliage could fail at other times when foliage is high.
- In subfreezing conditions, the communications link could fail if an antenna is exposed to ice buildup or covered with snow.

In these cases, consult your antenna installation contractor, or take other appropriate steps to maintain/optimize wireless performance.

Antenna Mast/Wall Bracket

Two examples of mounting an antenna include:

- *Tripod Mount*
- *Wall (Side) Mount*

Tripod Mount

The tripod mount is used primarily on peaked and flat roofs. The antenna mast must be secured to the roof using 3 or 4 guy wires that are equally spaced around the mast. When the height of the antenna mast is more than 3 meters (10 ft), you are advised to use at least three guy wires for each 3 meter (10 ft) section of the mast.

Installation Guidelines

Overview of the Outdoor Installation

Wall (Side) Mount

A wall (side) mount allows for mounting an antenna (mast) on the side of a building or other structure. This provides a convenient mounting location when the roof overhang is not excessive and/or the location is high enough to provide a clear line of sight.

- When installing the RoamAbout 14-dBi Directional Antenna, you can mount the antenna directly to the wall, if the mounting location allows you to aim the antenna at the opposite end of the antenna link.
- When installing the RoamAbout 7-dBi Omni-Directional Antenna, you must supply an antenna mast (and wall brackets for that mast).

Antenna Mast Requirements

To accommodate the RoamAbout antennas, the antenna mast must satisfy the following requirements:

1. The mast must be constructed of sturdy, weatherproof, noncorrosive material such as galvanized or stainless steel construction pipe.
2. Mast diameter should be between 35 mm (1.4 in.) and 42 mm (1.6 in.).
3. Antenna mast length must be sufficient to allow an antenna height at least 1.5 m (5 ft) above the roof peak. If the roof is metal, the antenna height should be a minimum of 3 m (10 ft) above the roof (see *Chapter 3 - Determining Range & Clearance*).
4. The mast or wall-bracket must be free from any substance that may prevent a good electrical connection with the antenna; for example, paint.

Installation Guidelines

Overview of the Outdoor Installation

Grounding System



A properly-installed safety grounding system is necessary to protect your RoamAbout Outdoor installation from lightning strikes and static electricity build-up.

The grounding system must satisfy the following requirements:

1. The antenna mast, RoamAbout Access Point, and RoamAbout Lightning Protector must be connected to the same ground, using a low-resistance bonding conductor.
2. A good electrical connection must be made to one or more ground rods, using at least a 10AWG ground wire and noncorrosive hardware.
3. The grounding system must comply with electrical codes and safety standards that apply in your locality.
4. Have a qualified electrician verify that your RoamAbout Outdoor installation is properly grounded.

RoamAbout Antennas

The RoamAbout 14-dBi Directional Antenna is a Yagi antenna designed to provide high gain for your outdoor solution while still allowing for ease of use and installation.

The RoamAbout 7-dBi Omni-Directional Antenna is a vertical antenna designed to provide a wide-range radio beam.

Installation Guidelines

Overview of the Outdoor Installation

Antenna Polarization

Radio waves emitting from a Yagi antenna are linear, leaving the antenna in the same plane as the antenna elements.

- When the elements are positioned *up and down*, the radio waves are *vertically* polarized.
- When the antenna elements are positioned *left and right*, the radio waves are *horizontally* polarized.

Vertical polarization is standard for the RoamAbout 14-dBi Directional Antenna.

With RoamAbout outdoor antenna products, it does not matter what type of polarization you choose, as long as the antenna at one end of the communications link is mounted in the same plane as the antenna at the other end.

In some cases you might decide to mount the antenna for horizontal polarization. For example to minimize the influence of cross-talk between antennas when:

- Multiple antennas are mounted on the same antenna mast.
- Your wireless link transmissions cross another radio beam from a neighboring installation.

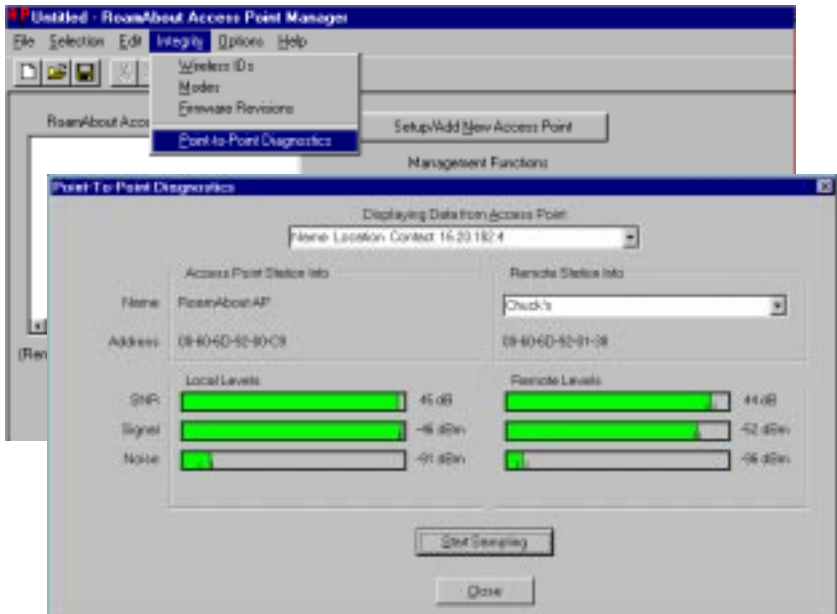
Antenna Alignment

For optimal performance, make sure the antennas are properly aligned:

1. Use a pair of binoculars, a compass, and/or a map of the area to point the antennas at each other.
2. Analyze the quality of the radio link using the AP Manager Point-to-Point Diagnostics feature described in the *RoamAbout Access Point User's Guide*.

The AP Manager Point-to-Point Diagnostics feature allows you to display the strength of the RoamAbout radio signal relative to any noise in the signal path (see Figure 2-4).

Figure 2-4 AP Manager Point-to-Point Diagnostics Screen



Installation Guidelines

Overview of the Outdoor Installation

You can optimize antenna alignment by making small modifications in the antenna orientation while observing the resultant changes displayed on the AP Manager Point-to-Point Diagnostics screen.

Aligning an omni-directional antenna is less critical due to its wide radiation pattern.

If necessary, consult a professional Antenna Installation Service to optimize the antenna alignment.

Antenna Cable Routing

The antenna cable must be routed and fixed in such a way to clear the passage area for installation technicians.

All connectors that are located outdoors must have a weatherproof seal. You are advised to seal connectors *only after* you have completed final radio tests.

Installation Guidelines

Overview of the Outdoor Installation

Before Climbing the Roof..

Before you start the installation, check the contents of your RoamAbout Outdoor Kit. If there are signs of shipping damage, contact the shipping carrier to file a claim.

Verify that you have all of the items required for the installation:

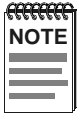
1. RoamAbout Access Point.
2. RoamAbout PC Card.
3. RoamAbout 50-cm Cable Assembly.
4. RoamAbout Lightning Protector.
5. Low-loss antenna cable. Depending on your order, this cable length is either 6 m (20 ft), 15 m (50 ft) or a 22 m (75 ft).
6. RoamAbout Outdoor Antenna. Depending on the antenna components you ordered, this is either:
 - The RoamAbout 14-dBi Directional Antenna (an encapsulated yagi antenna).
 - or*
 - The RoamAbout 7-dBi Omni-Directional Antenna.
7. RoamAbout Wall Mount Kit (instructions included with kit).

Determining Range & Clearance

3

The Fresnel Zone

As identified in *Chapter 2 - Installation Guidelines*, you need a clear line-of-sight to set up an outdoor antenna installation that meets your requirements in terms of range and throughput performance.



A wireless outdoor antenna connection that lacks sufficient clearance will suffer from poor performance. When radio performance is poor, the network response is poor as well, due to many retransmission attempts of lost data frames.

In Chapter 2, we described the shape of the radio beam (Fresnel Zone) as being bulged in the middle. The exact shape and width of the Fresnel Zone is determined by the path length and frequency of the radio signal.

If any significant part of the Fresnel Zone is obstructed, a portion of radio energy is lost, resulting in reduced performance. For optimal performance, you must ensure that the antenna products you choose, in combination with the height of the antenna installation above ground, will provide sufficient clearance to allow your antenna installation to cover the distance between the two wireless sites.

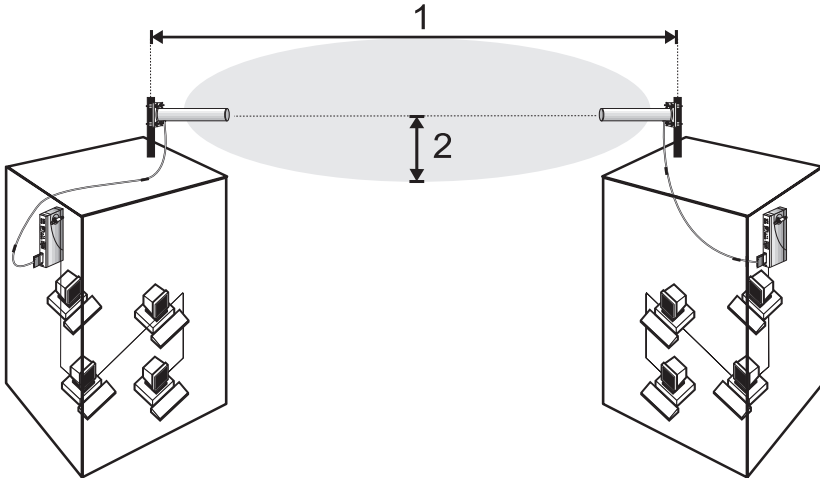
Determining Range & Clearance

The Fresnel Zone

As shown in Figure 3-1, there are two major variables that determine the shape of the Fresnel Zone:

- The distance between the antennas (1)
- The minimum clearance required for optimal performance (2).

Figure 3-1 Fresnel Zone



Refer to the following table to determine the minimum clearance required for your installation as defined by the distance between the antennas. For more information, refer to *Appendix D - Calculating Range & Clearance*.

Distance Between Antennas (1)		Minimum Clearance Required (2)	
kilometers	(miles)	meters	(feet)
2.1	(1.3)	5.8	(19.1)
3.5	(2.2)	7.8	(25.7)
6.5	(4.0)	11.1	(36.5)
9.6	(6.0)	14.4	(47.4)

Other Considerations

In most literature concerning wireless outdoor products, two parameters are usually listed to indicate transmitted signal strength: *output power* of the radio, and *gain* of the antenna system.

- Output Power of radio equipment is often subject to maximum limits as defined by local radio regulations. Consequently Output Power is not by definition the way to enhance wireless performance.
- High gain antennas are larger in size than low gain antennas, and are characterized by a narrow focus of the radio beam. These two characteristics make it more difficult to aim the antennas, and/or adjust antenna alignment to optimize the performance of the wireless point-to-point link.

With these points in mind, the design of antennas and components supplied with the RoamAbout Outdoor Kit are based upon the following principles:

- An output power and antenna gain that comply with the maximum limits as defined by local governing bodies concerning radio transmissions.
- Enhanced radio sensitivity for optimal reception of RoamAbout radio signals transmitted by remote antennas.

Refer to *Appendix D - Calculating Range & Clearance* for detailed information to help you calculate the optimal range of your antenna system.

Installing the Antenna

4

Planning the Antenna Installation



Carefully plan your antenna installation. Do not install the antenna in wet, windy, icy, or otherwise unsafe weather conditions.

The grounding system for the antenna mast, RoamAbout Access Point, and RoamAbout Lightning Protector should be installed *before* the cable from the antenna is connected to the lightning arrester. This will protect you and your equipment in case lightning should strike the antenna during installation.

Familiarize yourself with the antenna and the antenna specific mounting instructions prior to climbing any roof or ladder. Installing and testing all equipment before beginning the actual rooftop installation will help you to determine whether all required equipment and items are available and are functioning properly.



When testing the outdoor antennas in an indoor environment, we recommend that you keep the antennas back to back to avoid excessively strong radio signals.

Installing the Antenna

Planning the Antenna Installation

To verify the equipment prior to installation, you may need to proceed with the guidelines described in the *RoamAbout Access Point User's Guide* before performing the procedures in this chapter. The *RoamAbout Access Point User's Guide* is shipped with the RoamAbout Access Point, and can be downloaded from the RoamAbout website at: <http://www.cabletron.com/wireless>

Safety Precautions

Please read this section carefully before starting the installation. All requirements listed below should be satisfied prior to starting installation of your RoamAbout outdoor antennas.



Do not climb rooftops in wet or windy conditions, during a thunderstorm, or when the area where the equipment will be installed is covered with ice or snow.



ELECTRICAL HAZARD WARNINGS

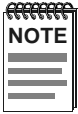
1. *Antennas and cables are electrical conductors. Do not touch antennas, RoamAbout Lightning Protectors, or antenna cables during a thunderstorm.*
2. *The location where you install each antenna must be at a safe distance from power lines or telephone lines. The safe distance should be at least twice the height of the antenna mast **plus** the height of the antenna.*
3. *The Contact between antenna components and power lines can result in serious personal injury, or possibly death.*
4. *Do not install antennas or cables where there is any possibility of contact with high-voltage arc-over from power cables or service drops to buildings.*
5. *During installation or removal, the antenna, supporting mast and/or tower must not be close to any power lines.*



ELECTRICAL HAZARD WARNINGS (Continued)

6. *The low-loss antenna cable that connects the antenna to the lightning protector must be at least 1m (3 ft) away from any high voltage or high current cable.*
7. *Check whether the antenna mast and its guy wires or wall bracket are positioned correctly and secured properly to the roof or wall(s).*
8. *Check whether the grounding system for the antenna mast, the RoamAbout Access Point, and RoamAbout Lightning Protector have been installed. The grounding system must comply with the requirements as described in Chapter 2, Grounding System on page 2-15.*
9. *Always consult a qualified electrician if you are in doubt as to whether the antenna mast, Lightning Protector, and/or RoamAbout Access Point is properly grounded.*
10. *The low-loss antenna cable between the antenna and the lightning arrestor must be grounded at all times. If the cable is disconnected at one end for some reason (for example, to replace the lightning arrestor), you must locally ground the exposed metal connector of the cable during the work.*
11. *Install the Danger label shipped with the antenna on a plainly visible area of the antenna support structure.*

Installation Overview



Refer to Appendix C to identify antenna installation components.

The installation process is summarized in the following steps:

1. Make sure the AP's are configured as specified in the *Pre-Installation Checklist* on page 2-2.
2. Verify that the antenna support structure is connected to the grounding system.
3. Connect the exposed metal connectors of the low-loss antenna cable to the grounding system.
4. Mount the antenna to the support structure, following the guidelines as described for your antenna:
 - *Mounting the Directional Antenna* on page 4-5.
 - *Mounting the Omni-directional Antenna* on page 4-8.
5. Connect the antenna cable to the antenna.
6. Route the antenna cable to the RoamAbout Lightning Protector which has been installed indoors.
7. Connect the antenna cable to the Lightning Protector.
8. Connect the Cable Assembly to the Lightning Protector.
9. Connect the opposite end of the Cable Assembly to the connector in the extended part of the RoamAbout PC Card.



When you remove or relocate the antenna, follow the Safety Precautions described on page 4-2, and perform the steps above in reverse order.

10. Run the AP Manager Point-to-Point Diagnostics program to aim the antenna and verify optimal placement.

Installing the Antenna

Mounting the Antenna

11. After verifying that the communications link is fully operational, secure all cables and use weatherproofing tape to seal all outdoor connectors.

Mounting the Antenna

The RoamAbout antennas are available as a RoamAbout 14-dBi Directional and a RoamAbout 7-dBi Omni-Directional. This section includes mounting instructions for each of these antenna types.

When mounting multiple antennas on a single mast, use the following methods to minimize cross-talk between antennas:

- Place the antennas as far apart as possible.
- Alternate the mounting of directional antennas for vertical and horizontal polarization (figures on the following pages illustrate mounting for *vertical* polarization).

Mounting the Directional Antenna

You can mount the RoamAbout 14-dBi Directional Antenna on a mast or on a flat vertical surface such as a wall. In most cases, mounting the antenna on a mast allows more flexibility in adjusting the height and direction of the antenna in order to better aim it at the opposite end of the wireless link.

Mounting on a Mast

To mount the RoamAbout 14-dBi Directional Antenna on a mast, proceed as follows:

1. Verify that you have all the items listed below:
 - The RoamAbout 14-dBi Directional Antenna
 - A metal backing plate (included with antenna)
 - Two U-bolts and two clamps (included with antenna)

Installing the Antenna

Mounting the Antenna

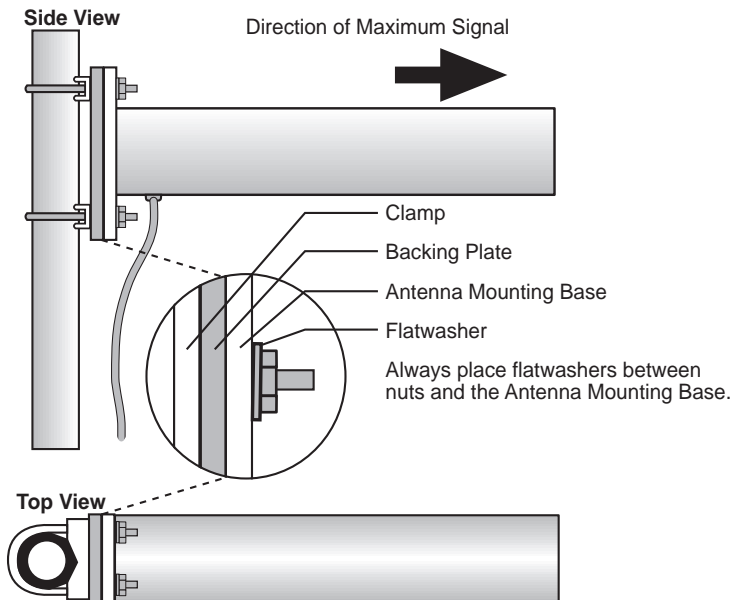
- Four flatwashers and four nuts (included with antenna)
 - A socket wrench to tighten the nuts
2. Note the arrows on the plastic antenna mounting base.
 3. Install the antenna with the arrows pointing up.
 4. Attach the antenna mounting base and metal backing plate to the mast using U-bolts, clamps, flat washers and nuts as shown in Figure 4-1.



Always place flatwashers between nuts and the plastic antenna mounting base. Avoid overtightening the nuts to prevent damage to the plastic antenna mounting base.

5. Proceed to *Connecting the Antenna Cable* on page 4-10.

Figure 4-1 Mounting the 14-dBi Antenna to a Mast



Mounting on a Flat Surface

When mounting the antenna on a flat vertical surface, you must provide a smooth surface for the backing plate. On wall surfaces such as brick, block or stucco, install an intermediate plate between the wall and the backing plate. The intermediate plate must be strong enough to prevent distortion of the backing plate and the plastic antenna mounting base when the mounting hardware is tightened.

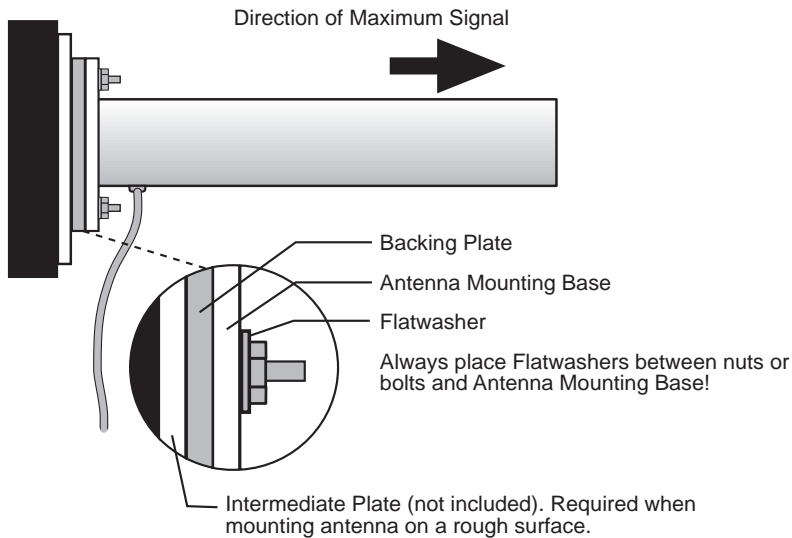
To mount the antenna proceed as follows:

1. Verify that you have all the items required for your particular installation:
 - The RoamAbout 14-dBi Directional Antenna
 - A backing plate (included with antenna)
 - An intermediate plate (not included)
 - All mounting hardware required for your particular installation
 - All tools required for your particular installation
2. Note the arrows on the antenna mounting base.
3. Mount the antenna with the arrows pointing up.
4. Attach the antenna mounting base, metal backing plate and intermediate plate to the wall using hardware required for your particular installation (see Figure 4-2).
5. Proceed to *Connecting the Antenna Cable* on page 4-10.

Installing the Antenna

Mounting the Antenna

Figure 4-2 Mounting the 14-dBi Antenna to a Wall



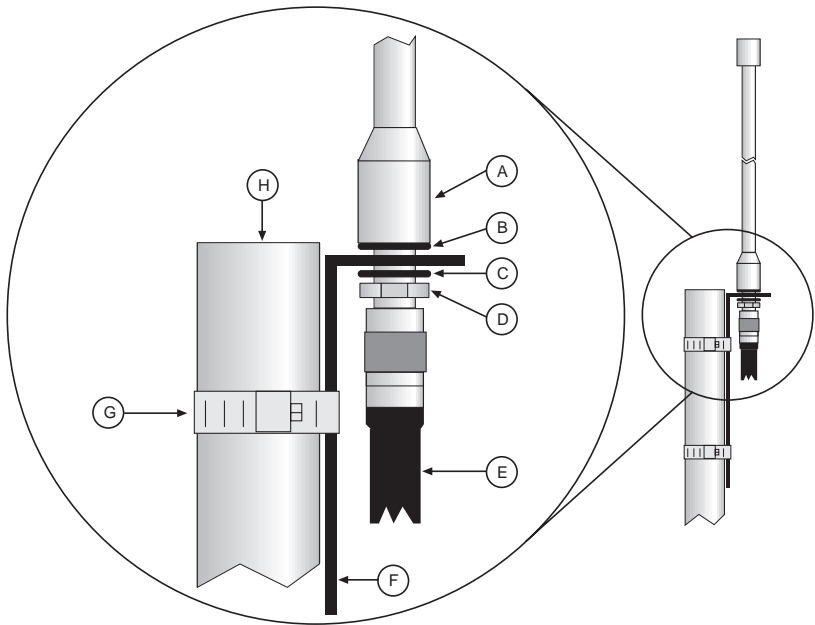
Always use flatwashers between the mounting screws/nuts and the plastic antenna mounting base. Avoid overtightening the mounting screws/nuts to prevent damage to the antenna mounting base.

Mounting the Omni-directional Antenna

It is recommended that you mount the RoamAbout 7-dBi Omni-Directional antenna to a mast. Proceed as follows:

1. Verify that you have the following items:
 - The RoamAbout 7-dBi Omni-Directional Antenna
 - A metal mounting bracket (included)
 - Two hose-clamps (included)
 - Nut and lockwasher (included)
 - A standard screwdriver or small wrench to tighten the nut on each hose-clamp

Figure 4-3 Mounting the Omni-Directional Antenna to a Mast



2. Referring to Figure 4-3, make sure the gasket (B) is installed on the antenna mounting base (A).
3. Insert the threaded portion of the antenna mounting base through the hole in the top of the metal mounting bracket (F).
4. Secure the antenna to the metal mounting bracket using lockwasher (C) and nut (D).
5. Slide two hose-clamps (G) over the mast (H).

Installing the Antenna

Connecting the Antenna Cable

6. Secure the metal mounting bracket (with antenna) to the mast using two hose-clamps.



Avoid overtightening each hose-clamp nut to avoid damage to the hose-clamp and/or antenna.

7. Connect the outdoor portion of the antenna cable (E) to the threaded portion of the antenna mounting base.
8. Proceed to *Connecting the Antenna Cable*.

Connecting the Antenna Cable

Once the antenna is properly installed, you can connect the antenna to the RoamAbout Access Point via the RoamAbout Lightning Protector.

1. Verify that the low-loss antenna cable is properly connected to the antenna.
2. Secure the antenna cable to the mast such that the cable connectors do not support the full weight of the cable.
3. Provide a drip-loop at the bottom of the cable just before it enters the building.
4. Connect the opposite end of the antenna cable to the RoamAbout Lightning Protector.

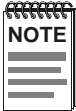


To avoid damage to the antenna cable and connectors, do not use tools to tighten cable connectors.

Installing the Antenna

Connecting the Antenna Cable

5. Prior to securing the cable along its complete length, run the Point-to-Point diagnostics of the RoamAbout Access Point Manager program to analyze wireless performance and optimal placement of the outdoor antenna (see Figure 2-4 on page 2-17).



The RoamAbout Access Point Manager program is described in the RoamAbout Access Point User's Guide, which is shipped with the RoamAbout Access Point.

6. If required, adjust the direction of the antenna.
7. Once the installation has been fully tested, tighten antenna mounting nuts to lock the antenna into its position.



To prevent damage, avoid overtightening the connectors, nuts, and screws used to mount the antenna.

8. Secure the cable along its complete length. No part of the cable should be allowed to hang free. This is especially important for those parts that are routed outside the building.
9. Use waterproof stretch tape to seal all outdoor connectors.

Installing the Antenna

Connecting the Antenna Cable

Sealing the Cable Connectors

Most problems associated with wireless outdoor installations are related to degrading performance due to the effects of corrosion of the antenna cable and cable connectors. To avoid this type of problem, always seal the cable connectors that are located outdoors using waterproof stretch tape.

You are advised to seal the connectors **after** you have verified optimal antenna alignment. Doing so will enable you to adjust antenna placement and cable routing without removing the tape.

1. Prepare the cable and connectors so that they are free from dust, dirt and grease.
2. Attach the tip of the weather proofing tape to the cable just above the connector.
3. Hold the tape in position, and stretch the tape and wind it half-lapped around the cable and connectors to form a void-free joint.

The degree of stretch can vary in different sections of the joint, as long as the overlaps accomplish a void-free application.



To protect the weatherproofing stretch tape from the effects of Ultra-Violet (UV) radiation (for example from direct sunlight), you should protect the joint with two half-lapped layers of any vinyl-plastic electrical tape. Alternatively, you can apply silicone sealer to protect the weatherproofing tape from sunlight, rain and other weather conditions.

The RoamAbout 14-dBi Directional Antenna



General Description

The RoamAbout 14-dBi Directional Antenna is a high-gain antenna for the 2.4 GHz frequency band.

The antenna is a totally enclosed 16-element Yagi designed for point-to-point communications.

It has a typical VSWR of 1.5:1 and is less than 2:1 over the entire frequency band. The gain is 14-dBi and the half-power beamwidth is 30 degrees. This antenna is normally mounted on a mast and is vertically polarized.

Contents of the Antenna Box

- One antenna
- Metal Backing Plate for the antenna
- Two U-bolt clamps (for mast mounting)
- Four flatwashers, and four nuts (to attach the antenna to the U-bolt clamps).
- Manual

For mounting instructions please consult *Chapter 4 - Installing the Antenna*.

The RoamAbout 14-dBi Directional Antenna

General Description

Table A-1 Specifications 14-dBi Directional Antenna

Mechanical	
• Size	45.7 cm (18 in)
• Mounting Method	• Vertical mast with an outside diameter between 35 mm (1.4 in) and 42 mm (1.6 in) using u-bolts. • Wall using plugs and screws.
Cable	
• Type	RG-58A/U, 50 ohm low-loss coax
• Length	20 cm (7.5 in)
• Color	White
Connector¹	
• FCC Countries	Reverse Polarity-N (Male)
• ETSI Countries	Standard-N (Female)
• France	Standard-N (Female)
• Japan	Standard-N (Female)
Electrical	
• Frequency Range	2.4 GHz
• VSWR	Less than 2:1, 1.5:1 Nominal
• Nominal Impedance	50 Ohms
• Gain	14 dBi
• Front-to-Back Ratio	greater than 20 dB
• Half-Power Beamwidth	(-3 dB)
• Vertical (E-plane °)	30.8 Degrees
• Horizontal (H-plane °)	31.4 Degrees
• Polarization	Linear, Vertical or Horizontal (see page 4-5).
Antenna Environment	
• Operating Temperature	+60°C (140°F) - 40°C (-40°F)
• Wind/survival (mph)	At least 128 km/h (80 mph) ²
• Wind Surface Area	7.56 square cm (0.248 square ft)

1 See Selecting the Correct Connector Type on page C-1.

2 At least 104 km/h (65 mph) with 1.25 cm (0.5 in) ice.

The RoamAbout 7-dBi Omni-Directional Antenna

B

General Description

The RoamAbout 7-dBi Omni-Directional Antenna is a broadband antenna for the 2.4 GHz frequency band featuring an omni-directional pattern with a nominal gain of 7 dBi.

This antenna is encapsulated in a weatherproof protective covering. With the hardware provided, this vertically-polarized antenna can be mounted on an antenna mast with an outside diameter of up to 51mm (2 in).

For mounting instructions, refer to *Chapter 4 - Installing the Antenna*.

For detailed specifications see Table B-1 on page B-2.

Contents of the Antenna Box

- One encapsulated antenna
- Metal mounting bracket
- Two hose clamps
- Nut and lockwasher

For mounting instructions please consult *Chapter 4 - Installing the Antenna*.

The RoamAbout 7-dBi Omni-Directional Antenna

General Description

Table B-1 Specifications of the 7-dBi Omni-Directional Antenna

Mechanical	
• Size	45,7 cm (18 in.)
• Mounting method	Clamps to vertical mast with outside diameter up to 51mm (2 in.)
Cable	
• Type	RG-58A/U, 50 ohm low-loss coax
• Length	15 cm (6 in.)
• Color	White
Connector¹	
• FCC Countries	Reverse Polarity-N (male)
• ETSI Countries	Standard-N (female)
• France	Standard-N (female)
• Japan	Standard-N (female)
Electrical	
• Frequency Range	2.4 GHz
• VSWR	Less than 2:1 Nominal
• Nominal Impedance	50 Ohms
• Gain	7 dBi
• Polarization	Linear Vertical
Antenna Environment	
• Operating Temperature	+60°C (140°F) - 40°C (-40°F)
• Wind/survival (mph)	At least 128 km/h (80 mph) ²
• Wind Surface Area	7.56 square cm (0.248 square feet)

1 See Selecting the Correct Connector Type on page C-1.

2 At least 104 km/h (65 mph) with 1.25 cm (0.5 in.) ice.

The Antenna Cabling System

C

The Outdoor Cabling Components

To connect your RoamAbout Access Point to an outdoor antenna installation you will need the following cabling components as pictured on the right side of this page:

- A. RoamAbout Cable Assembly
- B. RoamAbout Lightning Protector
- C. Low-Loss Antenna Cable
- D. Outdoor Antenna Cable:
 - The RoamAbout 14-dBi Directional Antenna (described in Appendix A), or
 - The RoamAbout 7-dBi Omni-Directional Antenna (described in Appendix B)

Selecting the Correct Connector Type

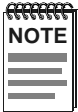
Subject to the country where the RoamAbout Outdoor Kit and/or antennas are purchased, the components listed above are equipped with either Standard N-Type connectors or Reverse Polarity N-Type connectors.



The Antenna Cabling System

The Outdoor Cabling Components

When ordering separate components, ensure that you order products with the correct N-Type connector to match the other outdoor cabling components that apply to your country



The term *Male* or *Female* is not related to the thread of the connector, but to its **center pin**.

- Male connectors have a solid center pin.
- Female connectors have a hollow center pin.

Table C-1 Selecting the Correct N-Type Connector

<table border="1"> <thead> <tr> <th>ETSI Countries, France & Japan</th> <th>FCC Countries</th> </tr> </thead> <tbody> <tr> <td> Standard-N Male Standard-N Female </td> <td> Reverse Polarity-N Female Reverse Polarity-N Male </td> </tr> <tr> <td> A 1 - PC Card connector 2 - Standard-N male </td> <td> 1 - PC Card connector 2 - Reverse Polarity-N Female </td> </tr> <tr> <td> B Standard-N Female (both ends) </td> <td> Reverse Polarity-N Male (both ends) </td> </tr> <tr> <td> C Standard-N Male (both ends) </td> <td> Reverse Polarity-N Female (both ends) </td> </tr> <tr> <td> D Standard-N Female </td> <td> Reverse Polarity-N Male </td> </tr> </tbody> </table>		ETSI Countries, France & Japan	FCC Countries	Standard-N Male Standard-N Female	Reverse Polarity-N Female Reverse Polarity-N Male	A 1 - PC Card connector 2 - Standard-N male	1 - PC Card connector 2 - Reverse Polarity-N Female	B Standard-N Female (both ends)	Reverse Polarity-N Male (both ends)	C Standard-N Male (both ends)	Reverse Polarity-N Female (both ends)	D Standard-N Female	Reverse Polarity-N Male
ETSI Countries, France & Japan	FCC Countries												
Standard-N Male Standard-N Female	Reverse Polarity-N Female Reverse Polarity-N Male												
A 1 - PC Card connector 2 - Standard-N male	1 - PC Card connector 2 - Reverse Polarity-N Female												
B Standard-N Female (both ends)	Reverse Polarity-N Male (both ends)												
C Standard-N Male (both ends)	Reverse Polarity-N Female (both ends)												
D Standard-N Female	Reverse Polarity-N Male												



ELECTRICAL HAZARD WARNINGS

1. *Outdoor antennas and antenna cables are electrical conductors. Transients or electrostatic discharges that may occur at the antenna (e.g., lightning) may damage your electronic equipment and cause personal injury or death to persons touching the exposed metal connectors of the antenna cable.*
2. *To avoid damage and personal injury, the entire antenna cabling system **must** be grounded at all times.*
3. *When installing, disconnecting or replacing one of the cabling components, you must ensure at all times that each exposed metal connector of the antenna cabling system is grounded locally during the work. For example when mounting or replacing the RoamAbout Lightning Protector:*
 - *Connect each of the low-loss antenna cable connectors to the grounding system.*
 - *Connect the RoamAbout 50-cm Cable Assembly connector to the grounding system.*
 - *Connect the RoamAbout Lightning Protector to the grounding system.*
4. *Before you proceed, verify that each component is properly grounded and that the ground is not interrupted when disconnecting any one of the antenna system components.*
5. *Check with a qualified electrician if you are in doubt as to whether the lightning protector and cable connectors are properly grounded.*
6. *Only after verifying that each item is properly grounded, replace the lightning protector and reconnect the cables in reverse order.*

RoamAbout Cable Assembly

The RoamAbout Cable Assembly is a proprietary cable used to connect the RoamAbout PC Card to a RoamAbout outdoor antenna system. This cable is included in the RoamAbout Outdoor Kit.

One end of the cable has a proprietary connector which is connected to the RoamAbout PC Card.

The N-Type connector at the opposite end of the cable matches the polarity of the N-connectors of the other components that are part of your outdoor antenna cabling system, subject to the country where the RoamAbout Outdoor Kit and/or Cable Assembly was purchased.

Table C-2 Cable Assembly Specifications

Mechanical	
Length	50 cm (19.5 in)
Connectors ¹	
• FCC Countries	Reverse Polarity-N (Female)
• ETSI Countries	Standard-N (Male)
• France	Standard-N (Male)
• Japan	Standard-N (Male)
Operating Temperature	-40°C to +85°C (-40°F to +185°F)
Electrical	
Frequency Range	800-2500 MHz
Insertion Loss	0.9 dB

1 See *Selecting the Correct Connector Type* on page C-1.

RoamAbout Lightning Protector

The RoamAbout Lightning Protector is a surge arrester that protects your sensitive RoamAbout equipment from high-voltage currents caused by discharge and transients at the antennas.

Table C-3 lists the specifications for the RoamAbout Lightning Protector.

Table C-3 Lightning Protector Specifications

Mechanical	
Size	
Height	69 mm (2.7 in)
Diameter	26 mm (1 in)
Weight	133 g (4.7 oz.)
Connectors ¹	
• FCC Countries	Reverse Polarity-N (Male on both ends)
• ETSI Countries	Standard-N (Female on both ends)
• France	Standard-N (Female on both ends)
• Japan	Standard-N (Female on both ends)
Operating Temperature	-40°C to +85°C (-40°F to +185°F)
Electrical	
Frequency Range	800-2500 MHz
Insertion Loss	0.2 dB
Surge Current	2000 Amp
Nominal Impedance	50 Ohms

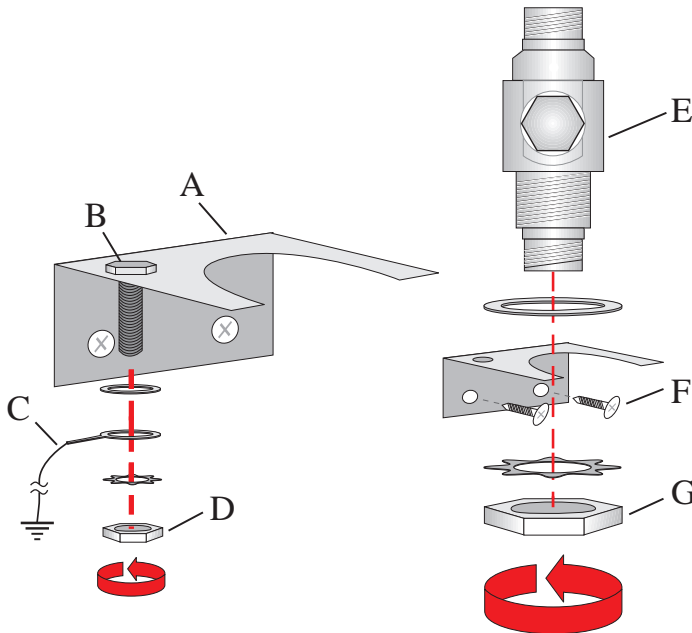
¹ See *Selecting the Correct Connector Type* on page C-1.

Installation

To install the RoamAbout Lightning Protector:

1. Determine a suitable location for the Lightning Protector as described in Chapter 2 - Installation Guidelines.
2. As shown in Figure C-1, secure bracket (A) to the wall using two screws (F).

Figure C-1 Lightning Protector Installation



3. Use a ring-terminal to connect ground-wire (C) to bolt (B). *The ring-terminal and ground wire are provided by the installer.*
4. Secure bolt (B) to the bracket using washers and locknut (D).
5. Loosely install washers and hexnut (G) onto the RoamAbout Lightning Protector (E).

The Antenna Cabling System

RoamAbout Lightning Protector

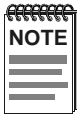
6. Insert the Lightning Protector into the opening in bracket (A).
7. Tighten hexnut (G) to secure the RoamAbout Lightning Protector in its position, and ensure that the Protector is properly connected to the grounding system.



To avoid damage to electronic equipment and your RoamAbout equipment, always install the RoamAbout Lightning Protector between the outdoor antenna installation and the RoamAbout Access Point or other computing device connected to the outdoor antenna.

Routine Maintenance

Routine maintenance is required for each RoamAbout Lightning Protector in your outdoor antenna installation. Maintenance involves replacing the Gas Discharge Tube (GDT) at some interval depending on the lightning/transient discharge activity in your area.



Contact a local antenna installation company to determine the maintenance schedule for each RoamAbout Lightning Protector in your outdoor antenna installation.

Low-Loss Antenna Cable

A 15m (50 ft) Low-loss antenna cable is included in the RoamAbout Outdoor Kit (see Table C-5). Cable is also available in two other standard lengths:

- 6m (20 ft) - see Table C-4
- 22m (75 ft) - see Table C-6

To ensure you order the right cable length, carefully determine the distance between the locations where you intend mounting the RoamAbout Access Point and outdoor antenna.

Table C-4 Cable Specifications for the 6m (20 ft) Antenna

Mechanical Specifications	
Length	6 meter (20 ft)
Diameter	5 mm (0.195 in)
Weight	32,75 gram/meter (0.022 lbs/ft)
Bend Radius	
Connectors ¹	
• FCC Countries	Reverse Polarity-N (Female on both ends)
• ETSI Countries	Standard-N (Male on both ends)
• France	Standard-N (Male on both ends)
• Japan	Standard-N (Male on both ends)
Operating Temperature	-40°C to +85°C (-40°F to +185°F)
Electrical Specifications	
Insertion Loss	0.55 dB/meter (16.9 dB/100 feet)
Total for this cable	3.5 dB

¹ See *Selecting the Correct Connector Type* on page C-1.

The Antenna Cabling System

Low-Loss Antenna Cable

Table C-5 Cable Specifications for the 15m (50 ft) Antenna

Mechanical Specifications	
Length	15 meter (50 ft)
Diameter	10 mm (0.4 in)
Weight	101.2 gram/meter (0.068 lbs/ft)
Bend Radius	25 mm (1 in)
Connectors¹	
• FCC Countries	Reverse Polarity-N (Female on both ends)
• ETSI Countries	Standard-N (Male on both ends)
• France	Standard-N (Male on both ends)
• Japan	Standard-N (Male on both ends)
Operating Temperature	-40°C to +85°C (-40°F to +185°F)
Electrical Specifications	
Insertion Loss	0.22 dB/meter (6.8 dB/100 feet)
Total for this cable	3.5 dB

Table C-6 Cable Specifications for the 22m (75 ft) Antenna

Mechanical Specifications	
Length	22 meter (75 ft)
Diameter	10 mm (0.4 in)
Weight	101.2 gram/meter (0.068 lbs/ft)
Bend Radius	25 mm (1 in)
Connectors¹	
• FCC Countries	Reverse Polarity-N (Female on both ends)
• ETSI Countries	Standard-N (Male on both ends)
• France	Standard-N (Male on both ends)
• Japan	Standard-N (Male on both ends)
Operating Temperature	-40°C to +85°C (-40°F to +185°F)
Electrical Specifications	
Insertion Loss	0.22 dB/meter (6.8 dB/100 feet)
Total for this cable	5.1 dB

Calculating Range & Clearance

D

Introduction

This appendix presents reference information to help you:

- Calculate the typical and/or maximum communications range you can achieve using components available in the RoamAbout Outdoor Kit.
- Select optimal antenna height for your installation.
- Determine which antennas and/or cables you need to cover a predefined distance.

This information along with other considerations described in this appendix allow you to accurately determine the *Dynamic Range Budget* for your specific installation.

The Dynamic Range Budget

The Dynamic Range Budget is the sum of the following factors as determined at both ends of the wireless outdoor link:

- Type of RoamAbout Outdoor Antenna:
 - RoamAbout 7-dBi Omni-Directional Antenna, or
 - RoamAbout 14-dBi Directional Antenna
- Length of the Antenna Cable required to connect the RoamAbout Access Point to the outdoor antenna.
- Type of RoamAbout PC Card used¹:
 - The RoamAbout PC Card with the *black-background label*,
or
 - The RoamAbout PC Card with the *white-background label*.

To determine the Dynamic Range Budget that applies in your situation, use either Table D-1 on page D-3, or Table D-2 on page D-4 (subject to radio regulations that apply in your country):

- Use Table D-1, for the USA, Canada, and any other country that adheres to the radio regulations as defined by the United States Federal Communications Commission (FCC).
- Use Table D-2, for all European countries, Japan, and any other countries that adhere to the radio regulations as defined by the European Telecommunications Standards Institute (ETSI).

To determine the Dynamic Range Budget, use the horizontal axis of the table to select the equipment installed in building X, and the vertical axis to select the equipment in building Y.

1 The choice of this card is subject to local radio regulations (see *Selecting the Right RoamAbout PC Card* on page 2-3).

Table D-1 Dynamic Range (FCC)

Link Speed	Antenna Type		Omni-Directional 7-dBi		Directional 14-dBi	
2 MBit/s	Cable Length		6m (20 ft) / 15m (50 ft)	22m (75 ft)	6m (20 ft) / 15m (50 ft)	22m (75 ft)
	Omni-Directional 7-dBi	6m (20 ft) / 15m (50 ft)	110.2 dB	108.5 dB	117.2 dB	115.5 dB
		22m (75 ft)	108.5 dB	106.8 dB	115.5 dB	113.8 dB
	Directional 14-dBi	6m (20 ft) / 15m (50 ft)	117.2 dB	115.5 dB	124.2 dB	122.5 dB
		22m (75 ft)	115.5 dB	113.8 dB	122.5 dB	120.8 dB

Link Speed	Antenna Type		Omni-Directional 7-dBi		Directional 14-dBi	
1 Mbit/s	Cable Length		6m (20 ft) / 15m (50 ft)	22m (75 ft)	6m (20 ft) / 15m (50 ft)	22m (75 ft)
	Omni-Directional 7-dBi	6m (20 ft) / 15m (50 ft)	113.2 dB	111.5 dB	120.2 dB	118.5 dB
		22m (75 ft)	111.5 dB	109.8 dB	118.5 dB	116.8 dB
	Directional 14-dBi	6m (20 ft) / 15m (50 ft)	120.2 dB	118.5 dB	127.2 dB	125.5 dB
		22m (75 ft)	118.5 dB	116.8 dB	125.5 dB	123.8 dB

The diameter of the 15m (50 ft) and 22m (75 ft) cables is larger than the diameter of the 6m (20 ft) cable. Therefore the cable loss of 50 ft cables is the same as for 20 ft cables, resulting in the same Dynamic Range Budget value.

Table D-2 Dynamic Range (ETSI, France & Japan)

Link Speed	Antenna Type		Omni-Directional 7-dBi		Directional 14-dBi	
2 Mbit/s		Cable Length	6m(20 ft) / 15m (50 ft)	22 m (75 ft)	6m (20 ft) / 15m (50 ft)	22m (75 ft)
	Omni-Directional 7-dBi	6m (20 ft) / 15m (50 ft)	110.2 dB	108.5 dB	110.2 dB	108.5 dB
		22m (75 ft)	108.5 dB	106.8 dB	108.5 dB	106.8 dB
	Directional 14-dBi	6m (20 ft) / 15m (50 ft)	110.2 dB	108.5 dB	117.2 dB	115.5 dB
		22m (75 ft)	108.5 dB	106.8 dB	115.5 dB	113.8 dB

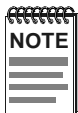
Link speed	Antenna Type		Omni-Directional 7-dBi		Directional 14-dBi	
1 Mbit/s		Cable Length	6m (20 ft) / 15m (50 ft)	22m (75 ft)	6m (20 ft) / 15m (50 ft)	22m (75 ft)
	Omni-Directional 7-dBi	6m (20 ft) / 15m (50 ft)	113.2 dB	111.5 dB	113.2 dB	111.5 dB
		22m (75 ft)	111.5 dB	109.8 dB	111.5 dB	109.8 dB
	Directional 14-dBi	6m (20 ft) / 15m (50 ft)	113.2 dB	111.5 dB	120.2 dB	118.5 dB
		22m (75 ft)	111.5 dB	109.8 dB	118.5 dB	116.8 dB

The diameter of the 15m (50 ft) and 22m (75 ft) cables is larger than the diameter of the 6m (20 ft) cable. Therefore the cable loss of 50 ft cables is the same as for 20 ft cables, resulting in the same Dynamic Range Budget value.

Calculating Range & Clearance

The Dynamic Range Budget

Link speed versus Range



For the values referenced in Table D-2 on page D-4, each 7-dBi antenna is connected to the RoamAbout PC Card with a black-background label.

For the values referenced in Table D-2, each 14-dBi antenna is connected to the RoamAbout PC Card with a white-background label.

- *The values printed in italics use a black-background RoamAbout PC Card at each end of the wireless link.*
- *All other values use a white-background RoamAbout PC Card at one or both ends of the antenna link.*

The listed Dynamic Range Budget values include the loss of the mandatory RoamAbout Lightning Protector.

Communications at lower data speeds may travel longer distances. In situations where range is more critical to your network than data speed, you may wish to limit the data speed to 1Mbit/s to increase the range of your wireless point-to-point link.

We have included the Dynamic Range Budgets for both 2 Mbit/s and 1 Mbit/s links with each table to help you determine which data speed is appropriate for your situation.

Determine Line-of-Sight Clearance

Use Table D-3 on page D-6 to determine the minimum clearance of the signal path clearance required to achieve the maximum possible range with the type of antennas and cable lengths you selected.

Calculating Range & Clearance

The Dynamic Range Budget

To read Table D-3 correctly:

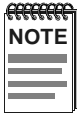
- Use the Dynamic Range Budget value that you read from either Table D-1 or Table D-2.
- Locate this value in Table D-3:
 - Values marked with an asterisk (*) in Table D-3 correspond to Dynamic Range Budgets for 1-Mbit/s link-speed connections.
 - All other values correspond to Dynamic Range Budgets for 2-Mbit/s link-speed connections.
 - Values in **Bold** apply only to FCC regulated countries.

Table D-3 Minimum Clearance for Maximum Range

Dynamic Range	Minimum Clearance		Maximum Range	
	meters	(feet)	kilometers	(miles)
106.8 dB	5.8	(19.1)	2.1	(1.3)
108.5 dB	6.5	(21.4)	2.5	(1.6)
109.8 dB*	7.0	(23.0)	2.9	(1.8)
110.2 dB	7.2	(23.7)	3.0	(1.9)
111.5 dB*	7.8	(25.7)	3.5	(2.2)
113.2 dB*	8.7	(28.6)	4.3	(2.7)
113.8 dB	9.0	(29.6)	4.6	(2.9)
115.5 dB	10.1	(33.2)	5.6	(3.5)
116.8 dB*	11.1	(36.5)	6.5	(4.0)
117.2 dB	11.5	(37.8)	6.8	(4.2)
118.5 dB*	12.6	(41.5)	7.9	(4.9)
120.2 dB*	14.4	(47.4)	9.6	(6.0)
120.8 dB	15.1	(49.7)	10.3	(6.4)
122.5 dB	17.5	(57.6)	12.6	(7.8)
123.8 dB*	19.8	(65.1)	14.6	(9.1)
124.2 dB	20.6	(67.8)	15.3	(9.5)
125.5 dB*	23.5	(77.3)	17.7	(11.0)
127.2 dB*	28.5	(93.8)	21.6	(13.4)

Calculating Range & Clearance

The Dynamic Range Budget



The minimum clearance in Table D-3 on page D-6 should be interpreted as follows:

- In **open areas** without obstacles in the signal path, clearance is measured as height above the surface of the earth. For example, if the antenna is mounted on the roof, this height includes the height of the building plus the height of the mast above the rooftop.
- In **areas with obstacles** in the signal path between the two antenna(s), the clearance should be measured as height above the highest obstacle(s) in the signal path.
- In **dense urban areas**, the clearance should be measured as height above the highest rooftop or any other obstacle(s) in the signal path between the two antennas.

The values listed in Table D-3 are based upon calculations that assume optimal radio conditions. There is no guarantee that the same maximum distance can be achieved at your location. Different performance figures may result from:

- Sources of interference or unexpected reflections in the signal path that affect the communications quality of the radio signal (see *Antenna Placement* on page 2-11).
- Incorrect antenna alignment (see page 2-17).

When selecting equipment for an outdoor antenna link, make sure you consider an extra safety margin for the maximum range of 100 m (300 ft) or more.

Calculating Range & Clearance

The Dynamic Range Budget

Determine Typical Range

After looking at the minimum clearance requirements in Table D-3 on page D-6, you may realize that local regulations, local building codes, or other restrictions could prohibit the installation of an antenna which meets the desired criteria.

In these situations, it may not be possible to achieve full line-of-sight clearance. However, this may not be required since the distance that your wireless outdoor installation needs to cover is less than the maximum range listed in Table D-3.

Table D-4 on page D-9 will help you determine how to meet the requirements in these situations. This table identifies typical ranges that can be achieved in conditions where the minimum clearance requirements may only be partially met.

To read Table D-4 correctly:

- Use the Dynamic Range Budget value that you read from either Table D-1 or Table D-2.
- Select the Line-of-Sight clearance available at your site. The value you select should be based on the same principles listed in the Note on page D-7.
- Read the shaded columns in Table D-4 to determine minimum clearance as required for the maximum range identified in Table D-3.
 - Values marked with an asterisk (*) in Table D-4 correspond to Dynamic Range Budgets for 1-Mbit/s link-speed connections.
 - All other values correspond to Dynamic Range Budgets for 2-Mbit/s link-speed connections.
 - Values in **Bold** apply only to FCC regulated countries.

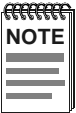
Table D-4 Actual Clearance and Typical Range

Dynamic Range	Optimal Clearance		Line-of-Sight Clearance that is Actually Available							
			5 m (16.5 ft)		10 m (33 ft)		15 m (50 ft)		20 m (66 ft)	
	meters	(ft)	km	(mi)	km	(mi)	km	(mi)	km	(mi)
106.8 dB	5.8	(19.1)	2.0	(1.2)	2.1	(1.3)	2.1	(1.3)	2.1	(1.3)
108.5 dB	6.5	(21.4)	2.2	(1.4)	2.5	(1.6)	2.5	(1.6)	2.5	(1.6)
109.8 dB*	7.0	(23.0)	2.4	(1.5)	2.9	(1.8)	2.9	(1.8)	2.9	(1.8)
110.2 dB	7.2	(23.7)	2.5	(1.6)	3.0	(1.9)	3.0	(1.9)	3.0	(1.9)
111.5 dB*	7.8	(25.7)	2.7	(1.7)	3.6	(2.2)	3.6	(2.2)	3.6	(2.2)
113.2 dB*	8.7	(28.6)	3.1	(1.9)	4.3	(2.7)	4.3	(2.7)	4.3	(2.7)
113.8 dB	9.0	(29.6)	3.2	(2.0)	4.6	(2.9)	4.6	(2.9)	4.6	(2.9)
115.5 dB	10.1	(33.2)	3.6	(2.2)	5.6	(3.5)	5.6	(3.5)	5.6	(3.5)
116.8 dB*	11.1	(36.5)	3.9	(2.4)	6.2	(3.9)	6.5	(4.0)	6.5	(4.0)
117.2 dB	11.5	(37.8)	4.1	(2.5)	6.5	(4.0)	6.8	(4.2)	6.8	(4.2)
118.5 dB*	12.6	(41.5)	4.4	(2.7)	7.3	(4.5)	8.0	(5.0)	8.0	(5.0)
120.2 dB*	14.4	(47.4)	5.1	(3.2)	10	(6.2)	9.7	(6.0)	9.7	(6.0)
120.8 dB	15.1	(49.7)	5.2	(3.2)	8.2	(5.1)	10.3	(6.4)	10.3	(6.4)
122.5 dB	17.5	(57.6)	5.7	(3.5)	9.1	(5.7)	12.0	(7.5)	12.0	(7.5)
123.8 dB*	19.8	(65.1)	6.4	(4.0)	9.6	(6.0)	12.7	(7.9)	14.6	(9.1)
124.2 dB	20.6	(67.8)	6.7	(4.2)	10.1	(6.3)	12.7	(7.9)	15.3	(9.5)
125.5 dB*	23.5	(77.3)	7.1	(4.4)	10.7	(6.6)	14.1	(8.8)	16.9	(10.5)
127.2 dB*	28.5	(93.8)	7.8	(4.8)	11.8	(7.3)	14.9	(9.3)	17.9	(11.1)

Which Antenna do You Need

If you have not yet purchased a RoamAbout Outdoor Kit, you can read the tables in this appendix in *reverse order* to determine the type of antenna you will need.

1. Determine the distance between the two sites that you wish to connect via a wireless link.
2. Determine the line-of-sight clearance that you can achieve for the signal path between the two sites.
3. Look in Table D-4 on page D-9 and select a column that matches the value you identified in step 2.



Preferably you should look in Table D-3 and in Table D-4 for a Dynamic Range value printed without an asterisk, which represents the values for a connection that supports the full 2 Mbit/s link speed.

4. In the Line-of-Sight column in Table D-4, look for a distance value equal to, or greater than the required distance to connect the two sites.
 - If the line-of-sight clearance column you selected does not include such a value, you may need to:
 - Investigate whether another location for the antennas might provide a better line-of-sight clearance
 - Investigate the possibility of increasing antenna mast height
 - If the Line-of-Sight clearance column does include such a value, read the Dynamic Range Budget value from the first column in the same row.
5. Once you have determined the **minimum** Dynamic Range Budget, use Table D-1 or Table D-2 to select which combination of products provide the Dynamic Range you need.

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