

# ***BreezeNET DS.11 Series***

***BU-DS.11***

***RB-DS.11***

## **User's Guide**

**PRELIMINARY**

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In the following warranty text, “the Company” shall mean:

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- BreezeCOM Ltd., for products located outside the USA.

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For warranty service or repair, the product must be returned to a service facility designated by the Company. Authorization to return products must be obtained prior to shipment. The buyer shall pay all shipping charges to the Company and the Company shall pay shipping charges to return the product to the buyer.

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## **Electronic Emission Notices**

This device complies with Part 15 of the FCC rules, ETSI 300-328, UL, UL/C, TUV/GS, and CE.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

## **FCC Radio Frequency Interference Statement**

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- 1 Reorient or relocate the receiving antenna.
- 2 Increase the separation between the equipment and receiver.
- 3 Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- 4 Consult the dealer or an experienced radio/TV technician for help

Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

## **FCC Radiation Exposure Statement**

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with the minimum distance between your body and the antenna, as shown in the table below:

High gain outdoor antennas (>8dBi)	30cm (12 inches)
------------------------------------	------------------

## **Professional Installer (Antennas)**

**WARNING:** It is the responsibility of the installer to insure that when using the outdoor

antenna kits in the United States (or where FCC rules apply), only those antennas certified with the product are used. The use of any antenna other than those certified with the product is expressly forbidden in accordance to FCC rules CFR47 part 15.204.

The installer should configure the output power level of antennas, according to country regulations and per antenna type.

## **Information to User**

Any changes or modifications of equipment not expressly approved by the manufacturer could void the user's authority to operate the equipment and the company's warranty.

## **Contacting BreezeCOM Technical Support**

Should you need assistance beyond the scope of this guide, please contact your local BreezeCOM reseller or distributor. If they cannot solve your problem, feel free to contact the BreezeCOM Technical Support Department. The support representatives can assist you in solving any problems that cannot be solved by your reseller.

When requesting support, please have the following items available:

- 5 Configuration of the system, including models of the BreezeCOM equipment used.
- 6 Antenna type and cable lengths.
- 7 Site information such as possible radio path problems (like trees, machines, and buildings).
- 8 Distance between devices.
- 9 Configuration, statistic counters, and error messages as seen on the monitor.
- 10 Description of problems encountered.

To contact BreezeCOM Technical Support, refer to the Technical Support page of the BreezeCOM web site: [www.breezecom.com](http://www.breezecom.com)

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# 1. INTRODUCTION

## 1.1 General

This chapter describes the scope of this manual and the main features of the BreezeNET BU-DS.11 (Wireless Base Station) and RB-DS.11 (Wireless Bridge Client).

Also in this chapter: relevant standards, compatibility issues, product functionality and use of the DS (Direct Sequence) WLAN.

## 1.2 System Description

The BreezeNET DS.11 Wireless Base Station and Wireless Bridge Client are designed to provide long range point-to-multipoint links for outdoor applications. The products use direct sequence, spread spectrum radio technology operating at a frequency of 2.4 – 2.4835 GHz, a part of the FCC's unlicensed Industrial, Science, Medical (ISM) band. Data is transmitted at rates of up to 11 Mbps, providing network users with full 10BASE-T Ethernet speeds.

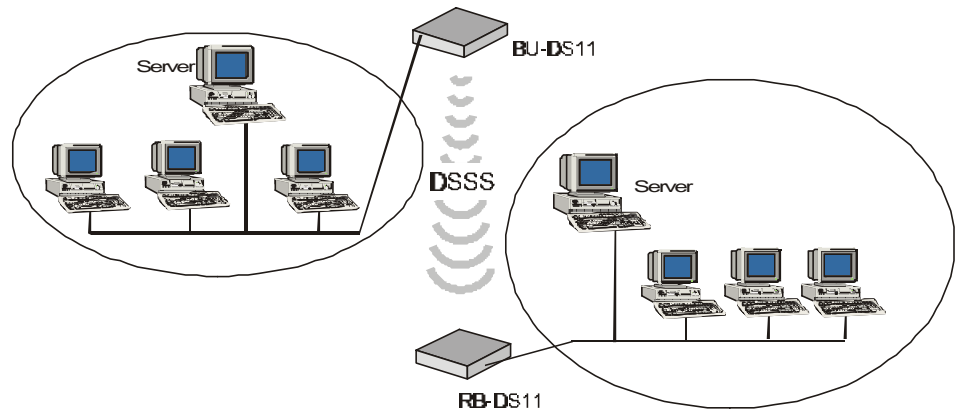
### 1.2.1 BreezeNET DS.11 Compatibility and Standards

BreezeNET DS.11 products are compatible with the following standards and are interoperable with other IEEE 802.11 TGb-compatible, 2.4 GHz direct sequence products.

- 1 FCC 15.203
- 2 IEEE 802.11 TGb Wireless LAN
- 3 IEEE 802.3 10BASE-T Ethernet
- 4 IEEE 802.1Q support for Virtual LAN
- 5 DHCP for automatic IP address assignment
- 6 SNMP for system management

## 1.3 BreezeNET DS.11 Functional Description

The BreezeNET BU-DS.11 and RB-DS.11 can be used as a high speed connection between two remote networks.



*Figure 1-1. DS.11 Outdoor Application*

### BU-DS.11 Wireless Base Station

The BU-DS.11 is an IEEE 802.11 T/Gb-compliant base station bridge that is used to connect either a single remote site or multiple remote sites to a central server or Internet connection. It is the central unit for a multipoint configuration and always one side of a point-to-point configuration.

The BU-DS.11 comes in two options: the basic unit comes with an antenna integrated on the front cover of the Outdoor unit. In this model, the front cover also functions as a protective sun cover.

In BU-DS.11D models with no integral antenna, the unit is provided with two antenna connectors (on the Outdoor unit) for connection of one or two external antennas. Refer to Section Sections 2.6.4 and 2.6.12 for information on how to select external antennas. When two antennas are connected to the Outdoor unit, the unit supports the antenna diversity feature described in Section 2.6.6.

## **RB-DS.11 Wireless Bridge Client**

The RB-DS.11 connects a remote Ethernet network to a BU-DS.11 Multipoint Base Station bridge located at a central server or Internet site. It can be programmed to handle up to 1024 MAC addresses.

When a station on the Ethernet LAN sends a message that is not destined for a local station, the RB-DS.11 wirelessly forwards the message to the BU-DS.11. When the BU-DS.11 receives a message destined for a station on the RB-DS.11's LAN, the BU-DS.11 wirelessly forwards it to the RB-DS.11. In this manner, the RB-DS.11 and the BU-DS.11 work together like a standard network bridge.

The first time each station on the RB-DS.11's LAN sends a message, the station's address is registered in the RB-DS.11 and the BU-DS.11. The RB-DS.11 and BU-DS.11 can hold all the addresses necessary to support an entire LAN connected to a RB-DS.11.

The RB-DS.11 comes in two options: the basic unit comes with an antenna integrated on the front cover of the Outdoor unit.

The RB-DS.11D has no integral antenna, and provides two antenna connectors (on the Outdoor unit) for connection of one or two external antennas. Refer to Section Sections 2.6.4 and 2.6.12 for information on how to select external antennas. When two antennas are connected to the Outdoor unit, the unit supports the antenna diversity feature described in Section 2.6.6.

## 1.4 How to Use This Guide

This User's Manual provides instructions for planning and setting up your Wireless LAN. This includes details on how to install each unit, including antennas and accessories.

This manual contains the following chapters:

- ⇒1 **Chapter 1: Introduction** - Explains how to use this manual and presents the BreezeNET DS.11 series.
- ⇒2 **Chapter 2: Installation** - Describes how to install the units.
- ⇒3 **Chapter 3: Using the DS.11 Management Utility** - Describes how to use the DS.11 Management utility to setup, configure, and manage BreezeNET DS.11 series units.
- ⇒4 **Chapter 4: System Troubleshooting** - Contains a troubleshooting guide for some of the more common problems which may occur when installing and using the BreezeNET DS.11 products.
- ⇒5 **Chapter 5: Downloading Software Upgrades** - Explains how to perform software upgrades using a TFTP application.
- ⇒6 **Chapter 6: Installing Accessories** - Describes various accessories that can be installed in specific situations.
- ⇒7 **Chapter 7: Technical Specifications** - Lists the technical specifications for the BreezeNET DS.11 series units.
- ⇒8 **Appendix A: Radio Signal Propagation** - Explains many of the terms related with antennas and RF (Radio Frequency) systems.
- ⇒9 **Appendix B: DS.11 FAQ**- Answers to customers Frequently Asked Questions.

## **2. INSTALLATION**

### **2.1 Quick Start to Wireless Networking**

Perform the following steps to configure a WLAN for the first time:

1. Physically connect the BU-DS.11/RB-DS.11 units to the Ethernet LAN. Make sure they are switched on. The DS.11 wireless network will be up and running immediately. If you are content with the default settings of the BU-DS.11/RB-DS.11 units, you can stop right here. It is more likely however, that you want to assign different radio frequencies to each BU-DS.11/RB-DS.11, or impose some restrictions on the use of your wireless network.
2. To be able to manage the BU-DS.11/RB-DS.11 units via SNMP, each BU-DS.11/RB-DS.11 needs a unique IP address. If you provide a DHCP or BOOTP service on your LAN (and have sufficient free IP addresses available) this will be taken care of automatically. If not, refer to Section 3.1.1 for further information on assigning IP addresses.
3. Use the BreezeNET DS.11 Management utility, described in Chapter 3 of this manual, to configure the network settings to reflect your configuration.
4. Select the radio channels of the BU-DS.11/RB-DS.11 units according to your cell plan. See Section 3.1.5 for further information. Add descriptive information about each unit for later reference.

## **2.2 Packing List**

When you first open the package, verify that the unit is complete with the following components:

- 1 Indoor unit
- 2 Outdoor unit (includes integrated antenna or antenna connectors for optional connection to external antennas)
- 3 Pole mounting kit for the Outdoor unit (2 U-bolts that fit up to 2” poles)
- 4 110/220 VAC Power Cord (may be open-ended, depending on destination country)

## **2.3 Other Items Required for Installation**

- 1 Indoor-to-Outdoor cable\* (available in different lengths)
- 2 Antenna(s) and RF cable(s) if using an external antenna
- 3 Power mains cable termination plug per country of installation (if the supplied cable is open-ended)
- 4 Ground cable with an appropriate termination
- 5 Ethernet cable (straight)
- 6 3 RJ-45 connectors; one of the RJ45 connectors, designated for connection to the Indoor unit, is equipped with a plastic cover.
- 7 Appropriate means for installing the Outdoor unit. A suitable pole and/or a wall mounting kit\* (if the unit is to be installed on a wall).
- 8 Installation tools and materials
- 9 Crimping tool

---

*Items marked with an asterisk (\*) are available as options from BreezeCOM.*

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## **2.4 Installation Overview**

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**Note:** *Outdoor units and antennas should be installed ONLY by experienced installation professionals who are familiar with local building and safety codes and, wherever applicable, are licensed by the appropriate government regulatory authorities. Failure to do so may void the BreezeCOM product warranty and may expose the end user or the service provider to legal and financial liabilities. BreezeCOM and its resellers or distributors are not liable for injury, damage or violation of regulations associated with the installation of outdoor units or antennas.*

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The typical installation scheme is depicted in Figure 2-1. The installation process should follow these general steps:

1. Select appropriate locations for the Outdoor unit, the antenna (if using an optional external antenna) and the Indoor unit.
2. Mount the Outdoor unit and the external antennas (optional). Connect the Outdoor unit to the antenna if installing external antennas.

---

**Note:** *The FCC 15.203 requirement prohibits the connection of external antennas with standard N-type connectors. In order to meet this requirement, the external antenna connectors provided on DS.11D models (with no integral antenna) are non-standard, featuring left-handed (counter-clockwise) rotation.*

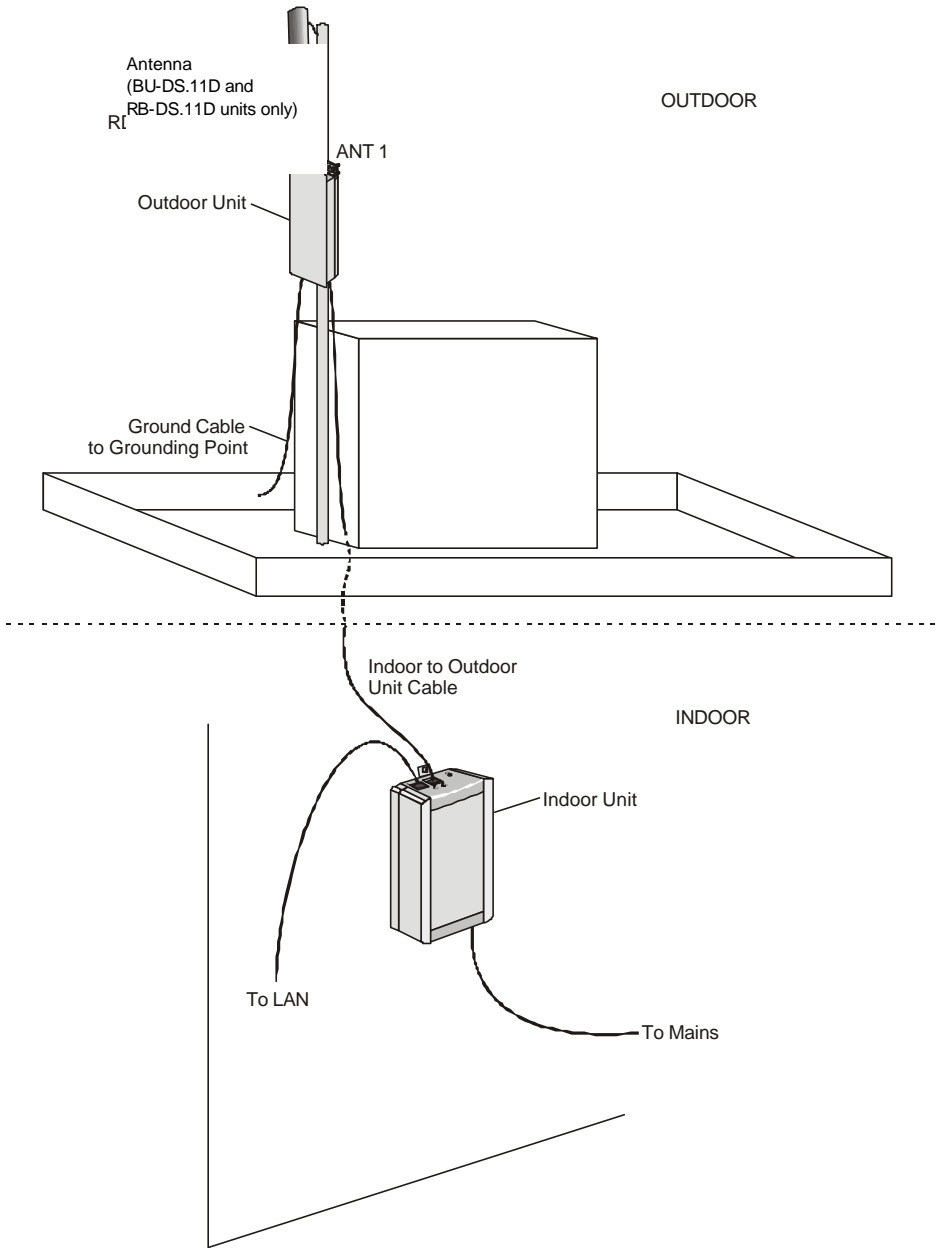
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3. Connect a ground cable between the Outdoor unit and an appropriate grounding point.
4. Connect the Indoor-to-Outdoor cable to the Outdoor unit and route it to the location selected for the Indoor unit. Assemble the enclosed connector on the cable. Refer to Appendix B for instructions on preparing the Indoor-to-Outdoor cable.
5. Mount the Indoor unit. Connect the Indoor-to-Outdoor cable to the Indoor unit **Radio** port. Prepare the power cable and use it to connect the Indoor unit to the AC mains.
6. Connect the Indoor unit Ethernet port to the user's network/PC using an Ethernet cable.
7. Align the antenna and verify connectivity with the Base Station.

---

**Note:** *The Indoor unit should be connected to the power source only after it has been connected to the Outdoor unit.*

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**Figure 2-1. General Installation Scheme - Pole Mounting**

## 2.5 Guidelines for Placement of BU-DS.11 Units

Each Wireless Base Station in the network forms the center of a cell, or BSS. The placement of BU-DS.11 units should be such that cells overlap slightly, to guarantee seamless wireless connectivity everywhere. Neighboring BU-DS.11 units should preferably send and receive on different channels for maximum throughput.

Creating a cell plan for your site can be complicated, and is usually done by experts equipped with special measuring equipment.

Furthermore, the radio channels you may use depend on both the capabilities of the PC-cards you are deploying, as well as the regulations in your area. Table 2-1 provides specifications for the main regulatory domains:

*Table 2-1. Regulatory Domains Specifications*

<b>Regulatory Domain</b>	<b>Region</b>	<b>Permissible Channels</b>	<b>Predefined Channels</b>
FCC	United States	1 - 11	1, 6, 11
DOC	Canada	1 - 11	1, 6, 11
ETSI	Europe except Spain and France	1 - 13	1, 7, 13
SPAIN	Spain	10	10
FRANCE	France	10	10
MKK	Japan	1-14	1-14

## **2.6 Outdoor Installation Considerations**

This chapter describes various considerations to take into account when planning an outdoor installation including site selection, antenna alignment, antenna polarization, antenna seal, and cell size.

### **2.6.1 Co-locating DS.11 Outdoor Units**

Up to 3 BU-DS.11 or RB-DS.11 units can be co-located on the same building top or tower. Each unit is assigned to one of the non-overlapping channels, 1, 6, or 11.

When co-locating outdoor units on the same building top or tower, the antennas should be mounted at least 2 feet apart when using UNI-16's, 15 feet when using UNI-24's, and 75 feet when using OMNI-8's. For omni antennas, the maximum link distance is reduced by up to 50%. Greater separation will improve the link distance.

### **2.6.2 Site Selection Factors**

When selecting a location for external antennas, remember to take into consideration the following guidelines:

- 1 Minimum distance between sites
- 2 Maximum height above the ground
- 3 Maximum line of sight clearance

#### **Path of Clearest Propagation**

A propagation path is the path that signals traverse between the antennas of any two bridges. The "line" between two antenna sites is an imaginary straight line, which may be drawn between the two antennas. Any obstacles in the path of the "line" degrade the propagation path. The best propagation path is, therefore, a clear line of sight with good clearance between the "line" and any physical obstacle.

### **Physical Obstacles**

Any physical object in the path between two bridges can cause signal attenuation. Common obstructions are buildings and trees. Any buildings or other physical structure such as trees, mountains or other natural geographic features higher than the antenna and situated in the path between the two sites can constitute obstructions. Install outdoor antennas high enough to avoid any obstacles, which may block the signal.

### **Minimal Path Loss**

Path loss is determined mainly by several factors:

- 4 **Distance between sites** – Path loss is lower and system performance better when distances between sites are shorter.
- 5 **Clearance** – Path loss is minimized when there exists a clear line of sight. The number, location, size, and makeup of obstacles determine their contribution to path loss.
- 6 **Antenna height** – Path loss is lower when antennas are positioned higher. Antenna height is the distance from the imaginary line connecting the antennas at the two sites to “ground” level. “Ground” level in an open area is the actual ground. In dense urban areas, “ground” level is the average height of the buildings between the antenna sites.

## 2.6.3 Rooftop Installation

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**WARNING!**      *Rooftop antenna installations are extremely dangerous! Incorrect installation may result in death, serious injury and/or damage. Such installations should be performed by professional antenna installers only!*

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Rooftop installations offer several advantages:

- 1 Increased antenna range.
- 2 Fewer obstacles in path.
- 3 Improved performance due to greater height.
- 4 Reduced multipath problems.

## 2.6.4 Antennas for Outdoor Applications

The BreezeNET DS.11 series can be used in point-to-point or point-to-multipoint configurations.

### Point-to-Point

The BU-DS.11/RB-DS.11 must be equipped with one or two directional antennas. The necessary antenna gain depends on the required range and performance.

### Point-to-Multipoint

Setting up a point-to-multipoint link requires the use of a BU-DS.11 equipped with omni-directional antennas and at least two RB-DS.11 units equipped with high-gain directional antennas.

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**Note:**      *The FCC 15.203 requirement prohibits the connection of external antennas with standard N-type connectors. In order to meet this requirement, the external antenna connectors provided on DS.11D models (with no integral antenna) are non-standard, featuring left-handed (counter-clockwise) rotation.*

---

## 2.6.5 Antenna Alignment

Low gain antennas do not require alignment due to their very wide radiation pattern. High gain antennas have a narrow beamwidth necessitating an alignment procedure in order to optimize the link.

Check antenna alignment by using the RSSI bar on the bottom panel of the RB-DS.11 bottom panel.

### ***P 1 To perform antenna alignment:***

1. Assemble antennas according to the assembly instructions included with the antenna set.
2. Mount the antennas as high as possible.
3. Connect the coaxial cable to the BU-DS.11 at the main site.
4. Connect the coaxial cable to the RB-DS.11 at the remote site.
5. Power on both units.
6. Synchronize the units by aligning the antennas at the main and remote sites until maximum signal quality is obtained. Check the signal quality RSSI bar on the bottom panel of the RB-DS.11 bottom panel. If the received signal quality is lower than expected for this antenna/range combination, change antenna height and verify RF cables connections.

## 2.6.6 Antenna Diversity

In applications where no multipath propagation is expected, a single antenna is sufficient for good performance levels. However, in cases where multipath propagation exists BreezeCOM recommends using two antennas in order to utilize the space diversity feature. By using two antennas per unit, the system can select the best antenna on a per-packet basis (every several milliseconds).

Multipath propagation is to be expected when there are potential reflectors between the main and remote sites. These reflectors may be buildings or moving objects such as airplanes and motor vehicles. If this is the case, the radio signal does not travel in a straight line, but is reflected or deflected off of the object, creating multiple propagation paths.

When installing a single antenna, modify the **transmit diversity** option to either antenna 1 or antenna 2, according to the antenna being used (refer to page 3-9).

## **2.6.7 Antenna Polarization**

Antenna polarization must be the same at either end of the link. In most applications, the preferred orientation is vertical polarization. Above-ground propagation of the signal is better when it is polarized vertically. To verify antenna polarization, refer to the assembly instructions supplied with the antenna set.

## **2.6.8 Antenna Seal**

When using outdoor antennas, you must seal unused antenna connectors against rain with the antenna connector seals provided with the unit.

## **2.6.9 Cell Size**

Cell size is determined by the maximum possible distance between the BU-DS.11 and the RB-DS.11 unit, usually related to point-to-multipoint installations using external antennas. For open outdoor areas with an unobstructed line of sight between the BU-DS.11 and the RB-DS.11 units, the suggested maximum distance is up to 7KM (4.3 miles).

## **2.6.10 Link Distance**

For open outdoor areas with an unobstructed line of sight between the BU-DS.11 and the wireless bridge, the suggested maximum distance is:

BU-DS.11 with external antennas up to 24Km (15 miles) in the USA	Up to 15Km in Europe
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**Note:**    *The maximum distance of 24Km/15 miles is achieved using 24 dBi antennas.  
              The maximum distance of 15Km is achieved using 18 dBi antennas.*

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## 2.6.11 Using Outdoor Range Tables

Outdoor installations must have a clear line-of-sight. Solid obstacles such as buildings or hills prevent the establishment of a link. Partial obstacles such as trees or traffic can reduce range. Extending coaxial cables can cause an increase in assembly signal loss and a reduction in range.

Specific range tables, guidelines and information about extending cables can be obtained from your local dealer or the BreezeCOM central offices.

## 2.6.12 Available Antennas and Antenna Kits

Table 2-2 and Table 2-3 list several transmit/receive antennas that work well with BreezeNET DS.11 units. Antenna types that passed the regulation phase for both ETSI and FCC are indicated in bold type.

The cable length should be minimized in order to gain max link budget.

*Table 2-2. FCC Available Antennas (USA)*

<b>Model</b>	<b>Ant. Gain</b>	<b>Ideal for:</b>	<b>Dispersion</b>	<b>Dimensions H x W x D</b>
OMNI-8	8 dBi	Establishing 360° coverage for outdoor multipoint links	360°H/ 22° V	16"x0.75" Tubular
UNI-16P	16 dBi	Medium to long range outdoor multipoint links requiring compact form factors	28°H/ 28° V	11"x11"x3.5"
UNI-24	24 dBi	Long range outdoor point-to-point links	6°H/ 10° V	24"x36"x15"

\* Antenna types that passed the regulation phase for both ETSI and FCC are indicated in bold type.

**Table 2-3. ETSI Available Antennas (Europe and Rest-of-World)**

<b>Model</b>	<b>Ant. Gain</b>	<b>Ideal for:</b>	<b>Dispersion</b>	<b>Dimensions H x W x D</b>
OMNI-8	8 dBi	Establishing 360° coverage for outdoor multipoint links	360°H/ 22° V	16"x0.75" Tubular
UNI-16P	16 dBi	Medium to long range outdoor multipoint links requiring compact form factors	28°H/ 28° V	11"x11"x3.5"
UNI-24	24 dBi	Long range outdoor point-to-point links	6°H/ 10° V	24"x36"x15"

---

**Note:** *The FCC 15.203 requirement prohibits the connection of external antennas with standard N-type connectors. In order to meet this requirement, the external antenna connectors provided on DS.11D models (with no integral antenna) are non-standard, featuring left-handed (counter-clockwise) rotation.*

---

## **2.6.13 Precautions**

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**Note:** *Detached antennas, whether installed indoors or out, should be installed ONLY by experienced antenna installation professionals who are familiar with local building and safety codes and, wherever applicable, are licensed by the appropriate government regulatory authorities.*

*Failure to do so may void the BreezeNET Product Warranty and may expose the end user to legal and financial liabilities. BreezeCOM and its resellers or distributors are not liable for injury, damage or violation of government regulations associated with the installation of detached antennas.*

---

### **Transmit Antenna**

Regulations regarding maximum antenna gains vary from country to country. It is the responsibility of the end user to operate within the limits of these regulations and to ensure that the professional installer is aware of these regulations, as well.

Violation of government regulations exposes the end user to legal and financial liabilities. BreezeCOM, its resellers and distributors shall not be liable for expense or damage incurred as a result of installations which exceed local transmit gain limitations.

## **2.6.14 Lightning Protection**

Lightning protection is designed to protect people, property and equipment by providing a path to ground for the lightning's energy. The lightning arrestor diverts the strike energy to ground through a deliberate and controlled path instead of allowing it to choose a random path. Lightning protection for a building is more forgiving than protection of electronic devices. A building can withstand up to 100,000 volts, but electronic equipment may be damaged by just a few volts.

The Outdoor unit contains an internal lightning protection unit, and should be installed and grounded at the point where the cable enters the building.

## 2.6.15 Rain Proofing

18 and 24 dBi antennas must be sealed against rain at the point the cable enters the pole before they are suitable for external use.

## 2.7 Installing the Outdoor Unit

The outdoor unit can be secured to the pole using one of the following options:

- 1 Special brackets (supplied with each unit)
- 2 U-bolts - size A (inner installation holes, up to 2" pole)
- 3 U-bolt - size B (outside installation holes, up to 3" pole)
- 4 Metal bands (9/16" wide, minimum 12" long)

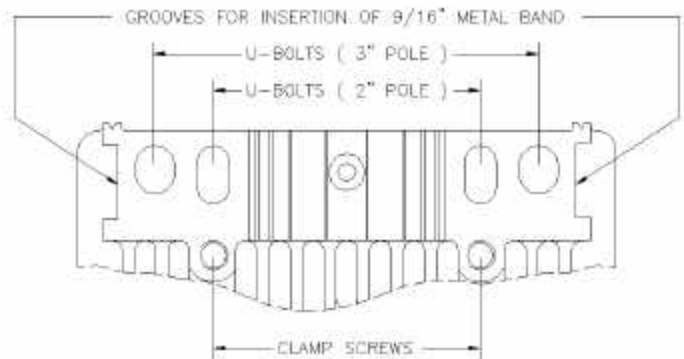
Figure 2-2 shows the locations of the holes, grooves and screw holes on the rear side of the unit.

Figure 2-3 illustrates the method of installing an unit on a pole using the supplied brackets.

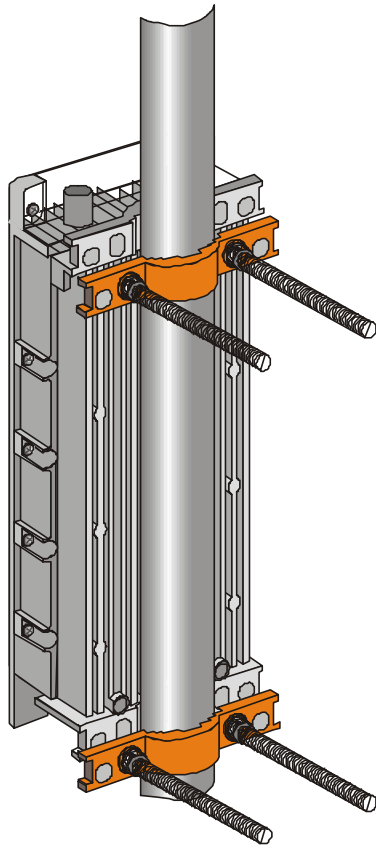
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**Note:** *Make sure to install the unit with the bottom panel (the panel with the signal strength bar and LEDs) facing downward.*

---



**Figure 2-2. Holes/Grooves/Screw Holes**



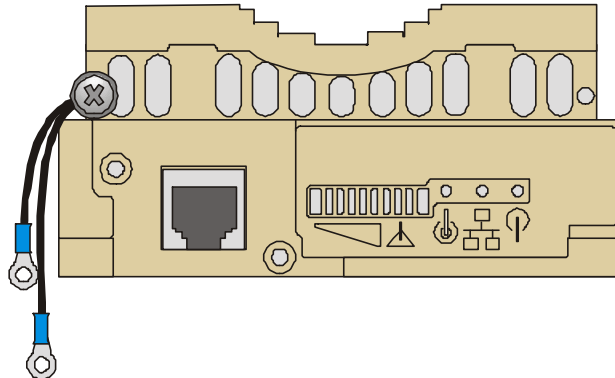
*Figure 2-3. Pole Mounting Installation Using the Supplied Brackets*

## **2.7.1 Connecting the Ground and Antenna Cables**

The Ground terminal (marked  $\oplus$ ) is located on the bottom panel of the Outdoor unit, shown in Figure 2-4. The Antenna RF connectors (marked  $\nabla$  1 and  $\nabla$  2 respectively) are located on the top panel of the Outdoor unit.

1. Connect one end of the grounding cable to the Ground terminal and connect the other end to a good ground connection.
2. Connect an RF cable between each ANT connector and the antenna. When connecting two antennas, the Antenna Diversity feature described in Section 2.6.6 is supported.

When connecting only one antenna, use the  $\nabla$  1 connector; make sure to seal the  $\nabla$  2 connector using the waterproof seal provided with the unit.



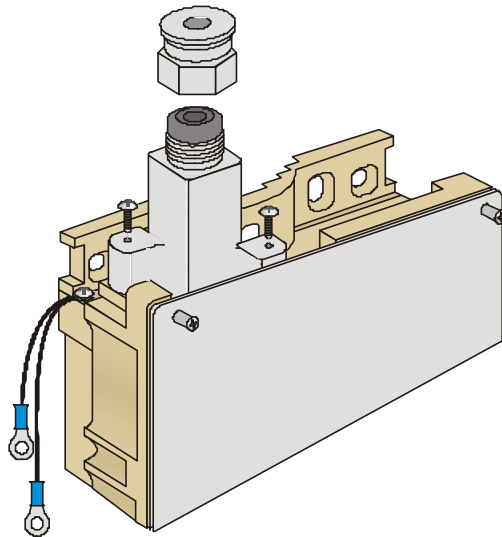
*Figure 2-4. Outdoor Radio Unit Bottom Panel*

## **2.7.2 Connecting the Indoor-to-Outdoor Cable**

1. Remove the two screws holding the waterproof seal assembly to the Outdoor unit and remove the waterproof seal.
2. Unscrew the top nut from the waterproof seal.
3. Route an uncrimped straight Ethernet cable (8-wire, 24 AWG pin-to-pin) through the top nut and the waterproof seal. Refer to Appendix B for instructions on preparing the RJ-45 cable connector.

**Note:** The 8-wire cable should be shielded.

1. Insert and crimp the RJ45 connector.
2. Connect the Ethernet cable to the Outdoor unit Ethernet connector.
3. Replace the waterproof seal assembly to the Outdoor unit and then replace the top nut.



*Figure 2-5. Routing the Indoor-to-Outdoor Cable through the Waterproof Seal*

### 2.7.3 Verifying Correct Operation of the Outdoor Unit

To verify proper operation, view the LED indicators located on the bottom panel of the outdoor unit as shown in Figure 2-4.

Table 2-4 lists the various LED states.

*Table 2-4: Outdoor Unit LEDs*

<b>Name</b>	<b>Description</b>	<b>Functionality</b>
WLAN	Wireless Link	Blinking Green – Data received or transmitted on wireless link Green –No data on link
DC Power	Self Test and Power indication	Green – Self test passed and 12VDC power is supplied to the unit Red – Self test failed and 12VDC is not available
ETH	Ethernet activity	Green –Ethernet link is operational, with no traffic on the port. Blinking Green –Ethernet link is operational, with traffic on the port. Red – No Ethernet link.

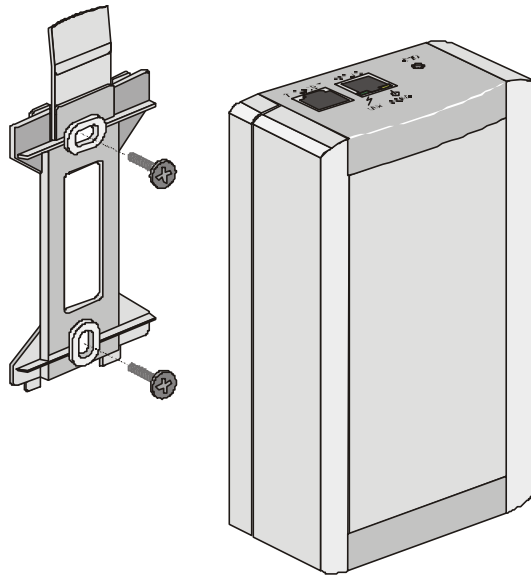


<b>Name</b>	<b>Description</b>	<b>Functionality</b>
RSSI Bar on RB-DS.11 units	Series of LEDs	Displays the RSSI (Received Signal Strength Indication, or the received RF signal level) at the Outdoor radio unit, as follows:  Bar0 (red)                   -91dBm Bar1 (green)               -87dBm Bar2 (green)               -83dBm Bar3 (green)               -80dBm Bar4 (green)               -77dBm Bar5 (green)               -74dBm Bar6 (green)               -71dBm Bar7 (green)               -66dBm Bar8 (green)               -61dBm Bar9 (yellow)              -55dBm
RSSI Bar on BU-DS.11 units	Series of LEDs	Indicates the number of RB-DS.11 units associated with the BU-DS.11; for each LED that lights up, one RB-DS.11 is associated.  Bar0 (red)                   1 Bar1 (green)                2 Bar2 (green)                3 Bar3 (green)                4 Bar4 (green)                5 Bar5 (green)                6-7 Bar6 (green)                8-15 Bar7 (green)                16-31 Bar8 (green)                32-63 Bar9 (yellow)               64-128

## 2.8 Installing the Indoor Unit

According to the specific conditions of the installation, route the Indoor-to-Outdoor cable into the building so that it conveniently reaches the Indoor unit to ensure minimal interference, leaving some spare. The cable is supplied open ended at the side of the Indoor unit, to allow for conveniently threading it into the building through a hole that is as small as possible. Assemble the connector and cover plug supplied with the cable. Appendix B provides instructions on how to assemble the connector on the Indoor-to-Outdoor cable.

1. Remove the wall mounting bracket clipped to the rear of the Indoor unit and mount the Indoor unit on a wall as shown in Figure 2-6.
2. Connect the Indoor-to-Outdoor cable to the Radio connector, located on the front panel of the Indoor unit shown in Figure 2-8. The Indoor-to-Outdoor cable should be connected to the unit before it is connected to the mains power.



*Figure 2-6. Wall Mounting the Indoor Unit*

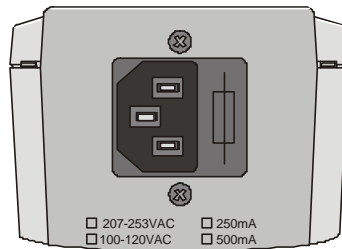
**Note:** If the power cord supplied with the unit is open ended, connect to it a power plug appropriate to the country in which the unit is being installed. The color codes of the cable are:

brown	phase ~
blue	neutral 0
yellow/green	grounding ≡

The operating AC mains voltage of the Indoor unit is marked on the rear panel of the unit.

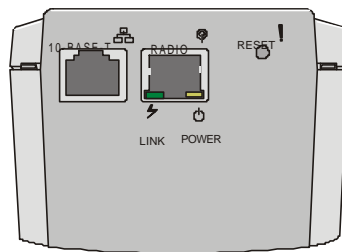
---

3. After connecting the Outdoor unit to the Indoor unit using the Indoor-to-Outdoor cable, connect the power cord to the unit's AC outlet, located on the rear panel shown in Figure 2-7. Connect the other end of the power cord to the AC mains.



**Figure 2-7. Indoor Unit Rear Panel**

4. Verify that the POWER LED located on the rear panel lights Green, indicating that the unit self-test passed and that 48 VDC output to the Outdoor unit is not shorted.



**Figure 2-8. Indoor Unit Front Panel**

5. Connect the 10-BASE-T connector to the network. The cable connection should be straight.

---

**Note:** *The length of the Ethernet cable connecting the Indoor unit to the user's equipment, together with the length of the Indoor-to-Outdoor cable, should not exceed 100 meters.*

---

## 2.8.1 Verifying Correct Operation of the Indoor Unit

To verify proper operation, view the LED indicators located on the rear panel of the outdoor unit as shown in Figure 2-8, and as described in Table 2-5.

**Table 2-5. Indoor Unit LEDs**

<b>Name</b>	<b>Description</b>	<b>Functionality</b>
POWER	Power indication	Lights Green when the Indoor unit supplies 48VDC to the Outdoor unit; OFF when no power is supplied.
LINK	Self Test and Remote Ethernet Link indication	OFF - Self test failed and no Ethernet link. Green – Self test passed and remote Ethernet link is OK. Blinking Green – Self test passed (instantaneously blinks when the baseband cable is connected, regardless of the Ethernet link status).

## 2.8.2 Reloading Factory Default Settings

The Reset button, located on the Indoor unit front panel, is used to restore the factory default parameter settings of the Outdoor unit (in the event that the default settings were changed via an SNMP management station).

To reset the unit:

1. Disconnect the power cable from the Indoor unit.
2. Insert a paper clip and press the **Reset** button while inserting the power cable back into its socket at the same time.

## 2.8.3 Connecting the Unit to the Ethernet Port

- 1 Connect one end of a an Ethernet 10BaseT cable (not supplied) to the RJ-45 port on the front panel of the Indoor unit, using a *straight* cable.
- 2 Connect the other end of the connector cable to the Ethernet outlet.



### **3. THE DS.11 MANAGEMENT UTILITY**

The DS.11 Management utility is an SNMP-based (Simple Network Management Protocol) utility that provides a consistent view of the wireless network. The system administrator can use the DS.11 Management utility to control a large number of DS.11 units from a single location. The management utility can be used to manage the following DS.11 units: BU-DS.11 and RB-DS.11

Among the supported features:

- 1 Assign radio channels for optimal cell management
- 2 Program units with a specified IP address
- 3 Set the SNMP Read/Write Community strings
- 4 Verify the status of all units in the network
- 5 Perform a site survey
- 6 Antenna selection and diversity
- 7 Configuration of parameters
- 8 View the counters
- 9 Set the antenna diversity
- 10 Obtain general information

### 3.1 DS.11 Management Utility Main Window

The DS.11 Management utility main window consists of two main areas, as can be seen in Figure 3-1:

- 1 **The IP Address and Community Selection area** - In this area, you select the community string and address of the unit you wish to manage or edit.
- 2 **The Tabs area** - This area consists of several tabs, each corresponding to a dialog box containing parameters required for the management of the selected unit; the number of tabs displayed varies between the type of managed unit. The different tabs are described in the following sections. When you switch between the tabs, the IP Selection area with the selected unit address remains displayed.

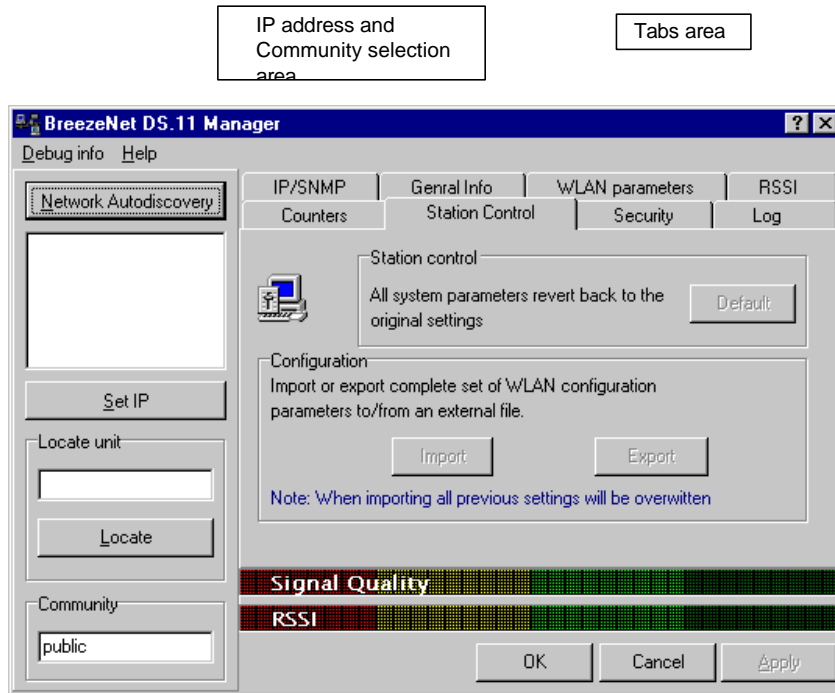





Figure 3-1. DS.11 Management Utility Main Window (Station Control Tab)

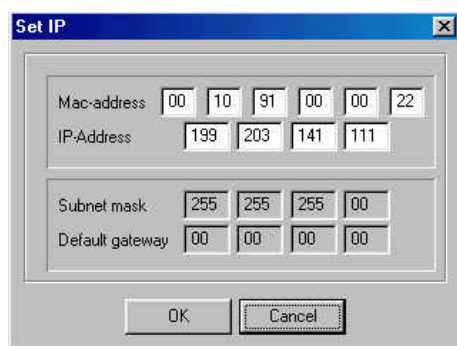
The DS.11 Management utility main window contains the following buttons:



- 3  – Implements any changes you made and closes the window.
- 4  – Closes the window without implementing any changes you made.
- 5  – Implements any changes you made but leaves the window open.

### 3.1.1 Assigning and Editing IP Addresses Manually

1. Click the  button. The Set IP dialog box is displayed.



*Figure 3-2. The Set IP Dialog Box*

2. Type the parameters in the appropriate fields and click **OK**; the MAC address is written underneath the unit. A message box is displayed notifying you when the changes are to take affect. This feature can be used only if the Manager is on the same Ethernet segment as the unit and not behind the router.



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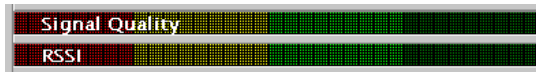
**Note:** *In order to see the unit after assigning the IP address, the PC with the Manager should be on the same IP subnet as the assigned DS.11 IP address.*

---

### 3.1.2 Selecting Units

You can select a unit to manage in one of the following ways:

- 1 Click the  button. All the current units IP addresses (under the selected community) are displayed in the list box underneath the button. Double-click on an address to select it. The default read community is public and the write is private.
- 2 For stations which are located behind a router, type the unit's address in the Locate unit field and click  to display its parameters.
- 3 **Signal Quality and RSSI bars** - These bars appears only if the selected IP address is an RB-DS.11. The Signal Quality bar displays the signal quality between the selected client and the BU-DS.11 connected to it. The RSSI bar displays the signal strength.



*Figure 3-3. Signal Quality and RSSI Bar Display*

### 3.1.3 IP/SNMP Tab

Software upgrades can be downloaded to DS.11 units using the TFTP protocol. The IP/SNMP tab allows you to define or edit the IP parameters for the DS.11 units, used for the download procedure.

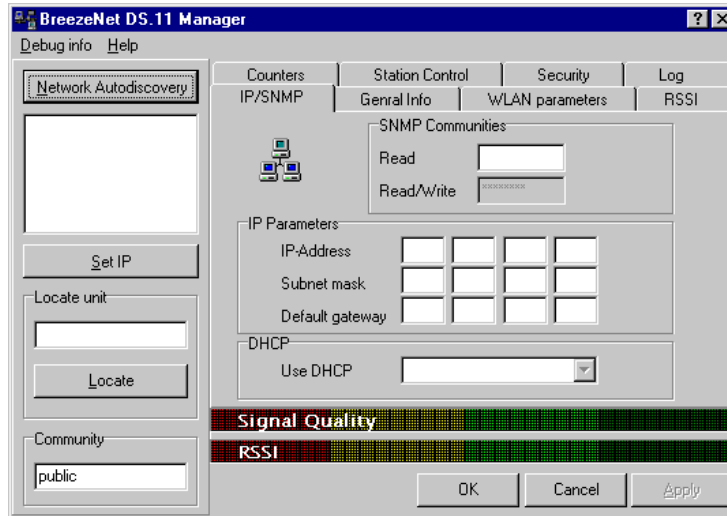


Figure 3-4. IP/SNMP Tab

### 3.1.3.1 Assigning and Editing IP Parameters Using Network Autodiscovery

Type the known Read/Write Community string in the **Community** field (the default string is Public for read and Private for read/write).

Select a unit address as describe in Section 0. The unit's Read-Read/Write Community strings appear in the SNMP Communities area of the window, and the unit's parameters appear in the IP Parameters area of the window:

- 1 **Read** - The read only community string of the unit.
- 2 **Read/Write** - The read/write community string of the unit.
- 3 **IP Address** - The IP address of the selected unit.
- 4 **Subnet mask** -The Subnet mask of the selected unit.
- 5 **Default gateway** - The default gateway of the selected unit.
- 6 **DHCP** - Sets the way your system utilizes the Dynamic Host Configuration Protocol (DHCP, used for automatic IP assignment).
  - 7 **Always** - The system searches for a DHCP server each time the PC is turned on.
  - 8 **Smart - This is the default value**. The system searches for a DHCP server only if no IP address was assigned. If an IP address was assigned manually, the system will not search for a DHCP server.
  - 9 **Never** - The system never searches for a DHCP server.

### 3.1.4 General Info Tab

The General Info tab displays general information regarding the unit's firmware and hardware versions, and general unit address information.

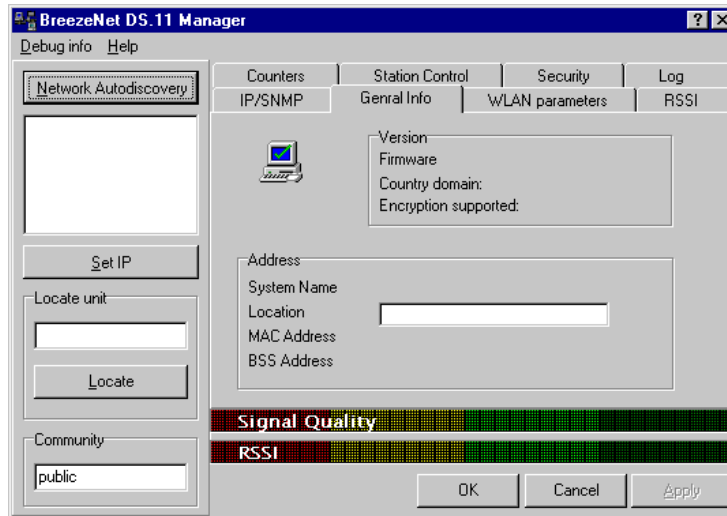


Figure 3-5. General Info Tab

- 1 **Firmware** - The current firmware version.
- 2 **Hardware** - The current hardware version.
- 3 **System Name** - The name of the selected unit.
- 4 **Location** - Location of the selected unit.
- 5 **MAC Address** - MAC address of the selected unit.
- 6 **BSS Address** - In the RB-DS.11, this defines the BSS address (the BU-DS.11 that the unit is associated with). In the BU-DS.11, it defines the MAC address of the unit.

---

*Note:* You can select a unit's address either by selecting the address from the list, or typing it directly.

---

### 3.1.5 WLAN Parameters Tab

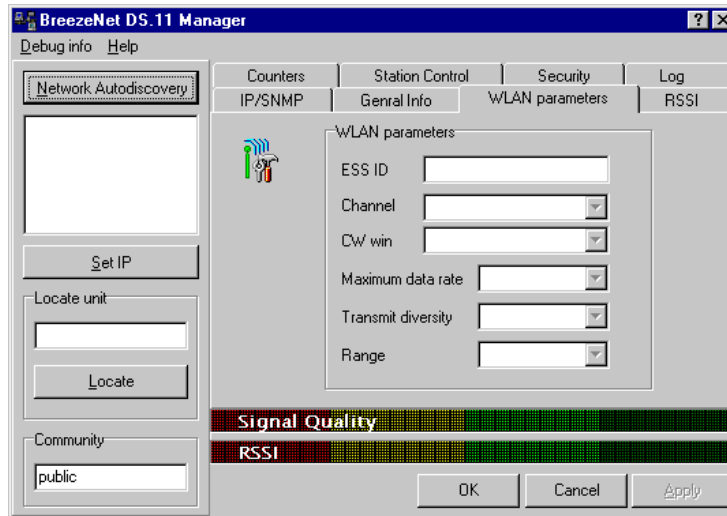


Figure 3-6. WLAN Parameters Tab

- 1 **ESSID** - An ASCII string of up to 32 characters used to identify a WLAN that prevents the unintentional merging of two co-located WLANs. It is essential that the ESSID is set to the same value in all stations and Wireless Base Stations in the extended WLAN. The ESSID field is case-sensitive.
- 2 **Channel** - Select that the unit will use by selecting a value (range: 1-14) from the pulldown menu. Refer to Table 3-1 for the list of corresponding frequencies. When the RB-DS.11 unit will power up, it will automatically change channels, search for the BU-DS.11 unit and synchronize with it; there is therefore no need for channel assignment. Once the channel on the RB-DS.11 is assigned, it will no longer change channels automatically.

---

**Note:** The channel selection must match the selection at the other side of the link.

---

Table 3-1. Frequency Selection List

Channel Selection	Frequency
1	2412 MHz
2	2417 MHz
3	2422 MHz
4	2427 MHz
5	2432 MHz
6	2437 MHz
7	2442 MHz
8	2447 MHz
9	2452 MHz
10	2457 MHz
11	2462 MHz

- 1 **CW Win** - select the contention window size to 15 or 31. The contention window backoff algorithm is a well know method used to resolve contention between different stations wanting to access the medium. More information on the considerations for setting this parameter can be found in the DS.11 FAQ in Appendix B.
- 2 **Maximum data rate** - By default, the unit adaptively selects the highest possible rate for transmission. Under certain conditions (for range/speed trade-off) you may decide not to use the higher rates. Possible values are 2, or 5.5 or 11 Mbps. The default value is 11 Mbps.
- 3 **Transmit diversity** - Set the antenna diversity option, which can be Antenna No. 1, No. 2, or both (default: both antennas).

---

*Note:* In the present product release, antenna diversity is not supported; therefore, always select Antenna No. 1.

---

- 4 **Range** - Select the operative range of your WLAN in the drop down list.

### 3.1.6 RSSI Tab

This tab only appears for BU-DS.11 units and allows you to view signal quality of all the associated clients (RB-DS.11).

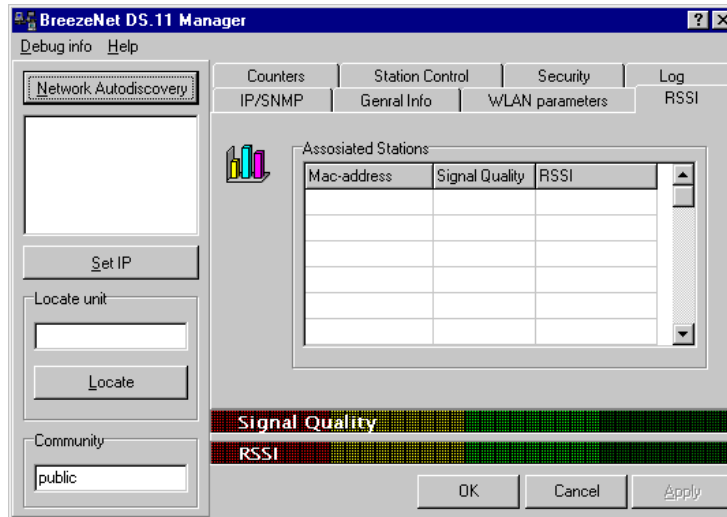


Figure 3-7. RSSI Tab

Select an IP address as explained previously in Section 0.

In the **Associated Stations** table, you can see all the stations associated with the selected unit and their signal quality.



### 3.1.7 Counters Tab

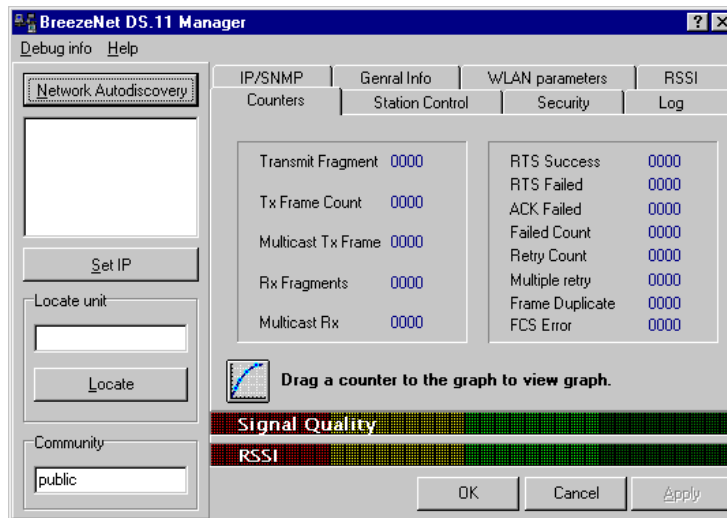



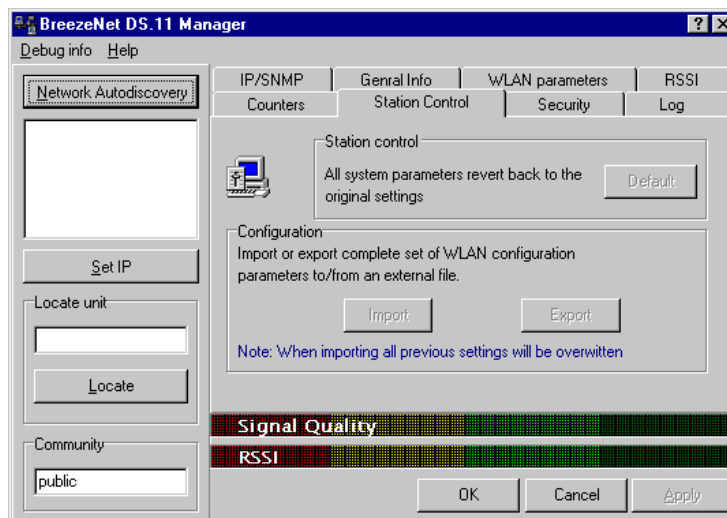
Figure 3-8. Counters Tab

Select a counter and drag it to the  icon to view the graph.

- 1 **Transmit Fragment** - The number of transmitted frames. The count includes data, control, management frames and the number of retransmissions of data frames (for example, if the same data frame is retransmitted ten times then the count will increase ten times).
- 2 **Tx Frame Count** - The number of frames transmitted to the wireless media. The count includes the first transmission of data frames (without retransmissions), and the number of control and management frames.
- 3 **Multicast Tx Frames** - The number of transmitted multicast frames.
- 4 **Rx Fragments** - The number of frames received, including data, control, and duplicate data frames.
- 5 **Multicast Rx** - The number of received multicast frames.
- 6 **RTS Success** - The number of successful Request To Send frames sent.
- 7 **RTS Failed** - The number of failed Request To Send frames sent by the station.

- 8 **ACK Failed** - The number of times the station stopped transmitting a frame after failing to receive an acknowledgment packet.
- 9 **Failed Count** - This counter is incremented when a packet is not transmitted successfully due to the number of transmit attempts exceeding either the Short Retry Limit or Long Retry Limit. These thresholds can be set by users that are in the Technician login mode.
- 10 **Retry Count** - The number of retransmissions.
- 11 **Multiple Retry** - This counter is incremented when an packet is successfully transmitted after more than one retransmission.
- 12 **Frame Duplicate** - The number of duplicate frames that were sent or received.
- 13 **FCS Error** - The number of CRC errors.

### 3.1.8 Station Control Tab



*Figure 3-9. The Station Control Tab*

**Station Control** - Click the **Reset** button to revert to the factory default settings.

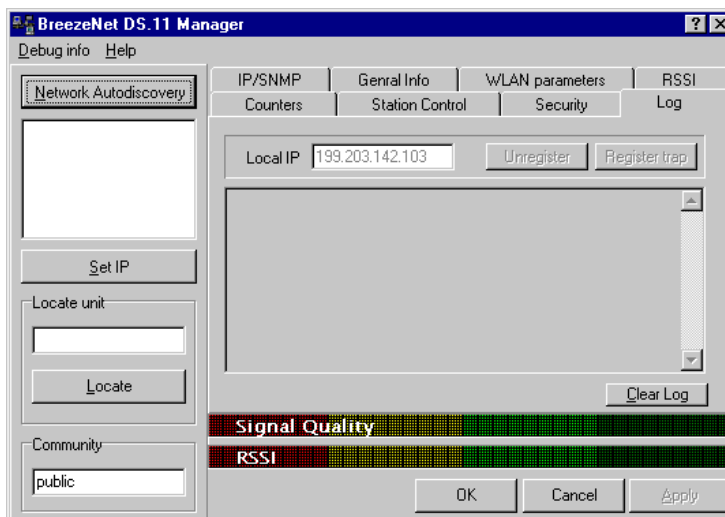
---

**WARNING!** This will erase all settings.

---

**Configuration** - Click **Import/Export** to import or export a complete set of configuration parameters to an external file.

### 3.1.9 Log Tab



*Figure 3-10. Log Tab*

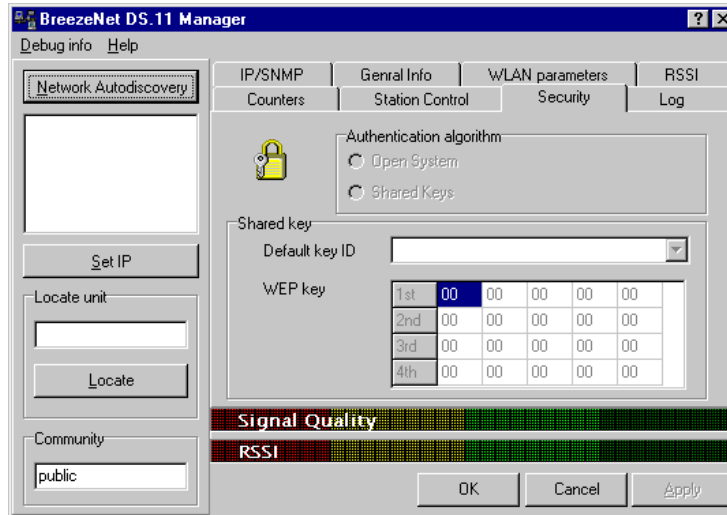
When an event occurs, a trap is sent to the defined host address. The Log tab allows you to configure the host address to which the traps are sent.

A list of the last traps is displayed in the event log area, below the Local IP field.

The default host address is the IP address of the PC running the DS.11 Management utility.

1. Select the IP address as explained in Section 0. The selected address appears in the Local IP field.
2. Click the **Register trap** button to register this address as the host address.
3. Repeat Step 2 for all the IP addresses you wish to send traps to.

### 3.1.10 Security Tab



**Figure 3-11. Security Tab**

The BU-DS.11 can use one of the following authentication algorithms (as defined in the 802.11 standard).

- **Open System**– any station in the WLAN can associate with a BU-DS.11 and receive and transmit data (null authentication).
- **Shared Key** – only stations using a shared key encryption identified by the BU-DS.11 are allowed to associate with it. You can only select this option if the card was ordered with the Privacy option. When the option is ordered, the words

Encryption Supported are displayed in the *Version* box in the General Info tab shown in Figure 3-5 on page 3-7.

Values:	Unknown	Card is not inserted.
	Implemented	Shared Key authentication is enabled.
	Not Implemented	Shared Key authentication is disabled. Only open system authentication is available in this mode.

If you selected the Shared Key algorithm, proceed to set the following parameters:

- 1 **Default Key ID** – Sets the default key for encryption in the Authentication process. This is the encryption key that will be used for transmissions between the station and the BU-DS.11.
- 2 **WEP Key** – Define the encryption keys used for transmissions between the station and the BU-DS.11. Specify each key by clicking the appropriate WEP Key row (First, Second, Third or Fourth) and entering 10 Hex digits (5 pairs of characters) for each of the 4 keys.

### 3.1.11 Debug Info(rmation)

This option allows you to create a log file named *BreezeLog.log*. You can send this log file to BreezeCOM technical support and receive help based on the information recorded in this file.

To start recording, open the Debug Info option and select Start Log.

When you finish recording (usually after 24 hours) select Stop Log and send the file to BreezeCOM technical support representatives.



## 4. SYSTEM TROUBLESHOOTING

The following troubleshooting guide provides answers to some of the more common problems which may occur when installing and using the BreezeNET DS.11. If problems not mentioned in this guide should arise, checking the Ethernet and WLAN counters may help (see Section 3.1.7). If the problem persists, please feel free to contact your local distributor or the BreezeCOM Technical Support Department.

### 4.1 Troubleshooting Guide

*Table 4-1. Troubleshooting*

<b>Problem and Indication</b>	<b>Possible Cause</b>	<b>Corrective Action</b>
No Power to Unit. Power LED is off.	1. Power cord is not properly connected. 2. Power supply is defective.	1. Verify power cord is properly connected to the BreezeNET unit and to the power outlet. 2. If this is not the cause, replace the power supply.

<b>Problem and Indication</b>	<b>Possible Cause</b>	<b>Corrective Action</b>
<p>Failure to establish wireless link. LINK LED is off and unit resets every few minutes.</p>	<p>1. Power supply to units may be faulty 2. The RB-DS.11 units may not have the same ESSID as the BU-DS.11.</p>	<p>1. Verify power to units. 2. Verify that all units in the network have the same ESSID as the BU-DS.11 (ESSID must be identical in all units in the WLAN; the ESSID is case sensitive). Check that the units are on the same channel.</p> <ul style="list-style-type: none"> <li>•1 Verify wireless link:</li> <li>•2 Set BU-DS.11 and Bridge unit side by side.</li> <li>•3 Power on each unit and see if a wireless link is established (even “D” models without their external antennas should establish a link if placed side by side with the BU-DS.11).</li> <li>•4 If the units fail to associate, reset units to factory default values reset unit (see Section 2.3). The units should now establish a wireless link.</li> </ul>
<p>Failure to establish wireless link (“D” models/external antennas)</p>	<p>1. Power supply to units may be faulty. 2. Cables may be improperly connected 3. There may be some problem with antenna installation.</p>	<p>1. Verify power to units. 2. Verify that all cables are connected securely. 3. Refer to previous Section and verify wireless link between the units. 4. Verify that the antenna(s) are properly installed (see relevant section in this manual):</p> <ul style="list-style-type: none"> <li>•5 Check antenna alignment.</li> <li>•6 Verify that antenna polarization is the same at both ends.</li> <li>•7 Verify that the range matches specifications.</li> <li>•8 Verify line-of-sight/antenna alignment/antenna height.</li> </ul>



<b>Problem and Indication</b>	<b>Possible Cause</b>	<b>Corrective Action</b>
<p>Wireless link established, but there is no Ethernet activity (BU-DS.11 and RB-DS.11 units).</p>	<p>1. Ethernet hub port or UTP cable is faulty. Ethernet port in unit is faulty. The station is associated to a BU-DS.11 unit that is not connected correctly to the LAN</p>	<p>1. Check that the LINK LED is lighted Green. If this is not the case, the port is inactive. Try another port on the hub or another UTP cable. 2. Verify that Ethernet port in unit is working. Ping unit to verify Ethernet connection. 3. Verify that you are using a cross-over UTP cable (pins 1 &amp; 3, 2 &amp; 6) if connected directly to workstation, or a straight-through cable if connected to a hub. 4. Check the unit's LINK LED indicator and check the Ethernet counters in the monitor to verify Ethernet activity (see Section 3.1.6). Check that there is no other BU-DS.11 that has the same channel and ESSID, but is not connected to the LAN.</p>



## 5. SOFTWARE DOWNLOAD PROCEDURE

1. Set the unit's IP address, using the DS.11 Management utility, and verify that the PC's IP address belongs to the same Subnet Mask as the unit.
2. Ping the unit's IP address. Make sure that the Ping replies are being received.
3. Use the TFTP utility on the PC:
  - ) *Syntax:* TFTP [-i] destination host [PUT] source file [password]
  - ) *Example:* TFTP -i 199.203.141.30 put ap1100.arm private

Download will be completed within two minutes, and a message of successful file transfer will be shown on the screen.

4. The unit resets itself automatically.
5. Check the diagnostics LEDs to verify that there is not hardware failure, and use the DS.11 Management utility to make sure that the version number is correct.

---

**Note:** *Do not disconnect any cables or try to stop the process before downloading is completed.*

*All configured parameters are kept during the upgrade/download procedure.*

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## **6. INSTALLING ACCESSORIES**

This chapter introduces some of the accessories available for specific installations, and describes how to install them.

### **6.1 RFS 122 Radio Frequency Splitter**

The RFS 122 Radio Frequency Splitter is used to split the RF signal generated by a transmitter into two signals. These signals are then sent to two different and independent antennas. The RFS 122 enables radio transmission using two directional antennas connected to the same port of the BreezeNET DS.11 unit. Similarly, the splitter is used to combine two receiving antennas to one antenna connector.

Before installing the RFS 122, configure the BreezeNET DS.11 unit using the DS.11 Management utility to transmit through Antenna 2 only (see Section 3.1.5), and connect the RFS 122 to antenna connector 2.



## 7. TECHNICAL SPECIFICATIONS

### 7.1 Supported Standards

- Compliant with ETS 300 328 and ETS 300 826 (CE marked)
- IEEE 802.11 TGb standard for Wireless LAN at 11 and 5.5 Mbps
- IEEE 802.11 standard for 1 and 2 Mbps
- Most of the major networking protocols (including IP, IPX)

### 7.2 Power Specifications

Power Supply Input (via Indoor unit)	207VAC - 253VAC 250mA OR 100VAC - 120VAC 500mA  AC Mains option is factory wired.
Power Supply Output (from Indoor unit to Outdoor unit)	48VDC

### 7.3 Wired LAN Interface

Compliant with	Ethernet/IEEE 802.3 CSMA/CD
Physical interface	10Base-T
Connector type	RJ-45
Network operating systems	All
Wireless LAN interface	Compliant with IEEE 802.11

## 7.4 Radio Specifications

Type	Direct sequence spread spectrum
Range	Europe/ETSI: 15Km USA/FCC: 24Km (15 miles)
Transmit power	Range: 24dBm (max) to -4dBm (min)  Dependable upon Antenna type , system app. & country regulation.
Frequency range	2.4-2.4835 Ghz
Number of channels	Europe: 13 (3 non-overlapping) US: 11 (3 non-overlapping) France: 4 (1 non-overlapping)

## 7.5 Sensitivity

@ 1Mbps	-92dBm, IE-5 BER
@ 2Mbps	-88dBm, IE-5 BER
@ 5.5Mbps	-87dBm, IE-5 BER
@ 11Mbps	-85dBm, IE-5 BER

## 7.6 Configuration and Management

Configuration and setup	SNMP and Windows-based Manager utility
Site survey	Yes
LED indicators	Yes
SNMP management	Yes



## 7.7 Specific Features

Data rate	<ul style="list-style-type: none"> <li>• 11 Mbps</li> <li>• 5.5 Mbps</li> <li>• 2 Mbps</li> <li>• 1Mbps</li> </ul>
Utility Software	BreezeNET Management utility, runs on Windows 95 and Windows NT

## 7.8 Size

Dimensions (without antennas)	TBD
-------------------------------	-----

## 7.9 Environmental

	Indoor Unit	Outdoor Unit
Operating temperature (ambient)	0°C to 40°C (32°F to 104°F)	-40°C to 50°C (-40°F to 122°F)
Storage temperature	-5°C to 70°C (23°F to 158°F)	-5°C to 70°C (23°F to 158°F)
Operating humidity	10% to 90% (non-condensing)	10% to 90% (non-condensing)
Storage humidity	10% to 90% (non-condensing)	10% to 90% (non-condensing)



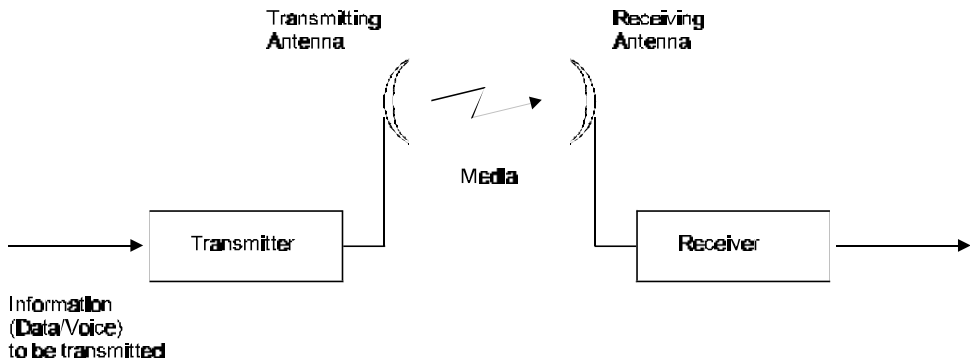
# APPENDIX A. RADIO SIGNAL PROPAGATION

## A.1 Radio Signal Propagation

### A.1.1 Introduction

This section explains and simplifies many of the terms relating to antennas and RF (Radio Frequency) used when dealing with an RF installation system.

The following diagram depicts a typical radio system:



*Figure A-1. A Typical Radio System*

A radio system transmits information to the transmitter. The information is transmitted through an antenna which converts the RF signal into an electromagnetic wave. The transmission medium for electromagnetic wave propagation is free space.

The electromagnetic wave is intercepted by the receiving antenna which converts it back to an RF signal. Ideally, this RF signal is the same as that originally generated by the transmitter. The original information is then demodulated back to its original form.

## A.1.2 RF Terms and Definitions

### dB

The dB convention is an abbreviation for decibels. It shows the relationship between two values.

### RF Power Level

RF power level at either the transmitter output or the receiver input is expressed in Watts. It can also be expressed in dBm. The relation between dBm and Watts can be expressed as follows:

$$P_{\text{dBm}} = 10 \times \text{Log } P_{\text{mw}}$$

For example: 1 Watt = 1000 mW;  $P_{\text{dBm}} = 10 \times \text{Log } 1000 = 30 \text{ dBm}$   
100 mW;  $P_{\text{dBm}} = 10 \times \text{Log } 100 = 20 \text{ dBm}$

For link budget calculations, the dBm convention is more convenient than the Watts convention.

### Attenuation

Attenuation (fading) of an RF signal is defined as follows:



*Figure A-2. Attenuation of an RF signal*

$P_{\text{in}}$  is the incident power level at the attenuated input  
 $P_{\text{out}}$  is the output power level at the attenuated output

Attenuation is expressed in dB as follows:  $P_{\text{dB}} = -10 \times \text{Log } (P_{\text{out}}/P_{\text{in}})$

For example: If, due to attenuation, half the power is lost ( $P_{out}/P_{in} = 1/2$ ), attenuation in dB is  $-10 \times \text{Log}(1/2) = 3_{dB}$

### **Path Loss**

Loss of power of an RF signal traveling (propagating) through space. It is expressed in dB. Path loss depends on:

- The distance between transmitting and receiving antennas
- Line of sight clearance between the receiving and transmitting antennas
- Antenna height

### **Free Space Loss**

Attenuation of the electromagnetic wave while propagating through space. This attenuation is calculated using the following formula:

$$\text{Free space loss} = 32.4 + 20 \times \text{Log}(F_{\text{Mhz}}) + 20 \times \text{Log}(R_{\text{Km}})$$

F is the RF frequency expressed in Mhz.

R is the distance between the transmitting and receiving antennas.

At 2.4 Ghz, this formula is:  $100 + 20 \times \text{Log}(R_{\text{Km}})$

## Antenna Characteristics

### *Isotropic Antenna*

A hypothetical antenna having equal radiation intensity in all directions. Used as a zero dB gain reference in directivity calculation (gain).

### *Antenna Gain*

A measure of directivity. It is defined as the ratio of the radiation intensity in a given direction to the radiation intensity that would be obtained if the power accepted by the antenna was radiated equally in all directions (isotropically). Antenna gain is expressed in dBi.

### *Radiation Pattern*

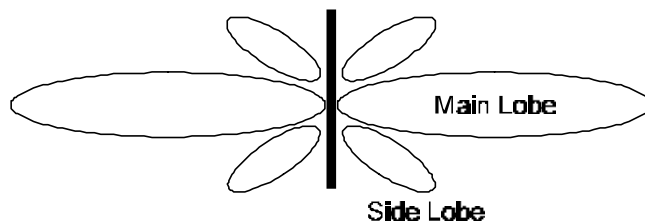
A graphical representation in either polar or rectangular coordinates of the spatial energy distribution of an antenna.

### *Side Lobes*

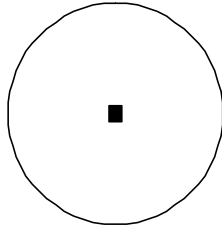
The radiation lobes in any direction other than that of the main lobe.

### *Omni-directional Antenna*

Radiates and receives equally in all directions in azimuth. The following diagram shows the radiation pattern of an omni-directional antenna with its side lobes in polar form.



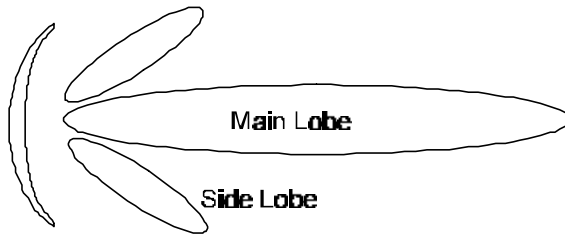
*Figure A-3. Side View*



*Figure A-4. Top View*

*Directional Antenna*

Radiates and receives most of the signal power in one direction. The following diagram shows the radiation pattern of a directional antenna with its side lobes in polar form:



*Figure A-5. Radiation Pattern of Directional Antenna*

*Antenna Beamwidth*

The directiveness of a directional antenna. Defined as the angle between two half-power (-3 dB) points on either side of the main lobe of radiation.

## System Characteristics

### *Receiver Sensitivity*

The minimum RF signal power level required at the input of a receiver for certain performance (e.g. BER).

### *EIRP (Effective Isotropic Radiated Power)*

The antenna transmitted power. Equal to the transmitted output power minus cable loss plus the transmitting antenna gain.

$P_{out}$  Output power of transmitted in dBm

$C_t$  Transmitter cable attenuation in dB

$G_t$  Transmitting antenna gain in dBi

$G_r$  Receiving antenna gain in dBi

$P_l$  Path loss in dB

$C_r$  Receiver cable attenuation is dB

$S_i$  Received power level at receiver input in dBm

$P_s$  Receiver sensitivity is dBm

$$S_i = P_{out} - C_t + G_t - P_l + G_r - C_r$$

$$EIRP = P_{out} - C_t + G_t$$



*Example:*

**Link Parameters:**

Frequency: 2.4 Ghz

$P_{out} = 4 \text{ dBm}$  (2.5 mW)

Tx and Rx cable length (Ct and Cr) = 10 m. cable type RG214 (0.6 dB/meter)

Tx and Rx antenna gain (Gt and Gr) = 18 dBi

Distance between sites = 3 Km

Receiver sensitivity (Ps) = -84 dBm

**Link Budget Calculation**

$EIRP = P_{out} - Ct + Gt = 16 \text{ dBm}$

$Pl = 32.4 + 20 \times \text{Log}(\text{FMhz}) + 20 \times \text{Log}(\text{RKm}) \cong 110 \text{ dB}$

$Si = EIRP - Pl + Gr - Cr = -82 \text{ dBm}$

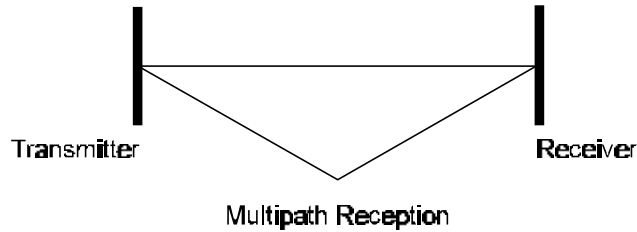
In conclusion, the received signal power is above the sensitivity threshold, so the link should work. The problem is that there is only a 2 dB difference between received signal power and sensitivity. Normally, a higher margin is desirable due to fluctuation in received power as a result of signal fading.

**Signal Fading**

Fading of the RF signal is caused by several factors:

- Multipath

The transmitted signal arrives at the receiver from different directions, with different path lengths, attenuation and delays. The summed signal at the receiver may result in an attenuated signal.



**Figure A-6. Multipath Reception**

### *Bad Line of Sight*

An optical line of sight exists if an imaginary straight line can connect the antennas on either side of the link.

Radio wave clear line of sight exists if a certain area around the optical line of sight (Fresnel zone) is clear of obstacles. A bad line of sight exists if the first Fresnel zone is obscured.

- Link Budget Calculations
- Weather conditions (rain, wind, etc.)

At high rain intensity (150 mm/hr), the fading of an RF signal at 2.4 GHz may reach a maximum of 0.02 dB/Km. Wind may cause fading due to antenna motion.

- Interference

Interference may be caused by another system on the same frequency range, external noise, or some other co-located system.

### **The Line of Sight Concept**

An optical line of sight exists if an imaginary straight line can be drawn connecting the antennas on either side of the link.

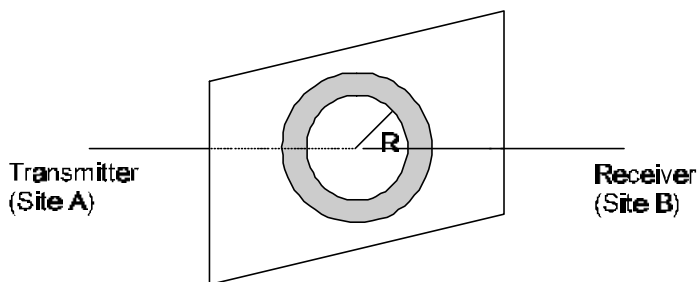
### *Clear Line of Sight*

A clear line of sight exists when no physical objects obstruct viewing one antenna from the location of the other antenna.

A radio wave clear line of sight exists if a defined area around the optical line of sight (Fresnel Zone) is clear of obstacles.

**Fresnel Zone**

The Fresnel zone is the area of a circle around the line of sight. The Fresnel Zone is defined as follows:



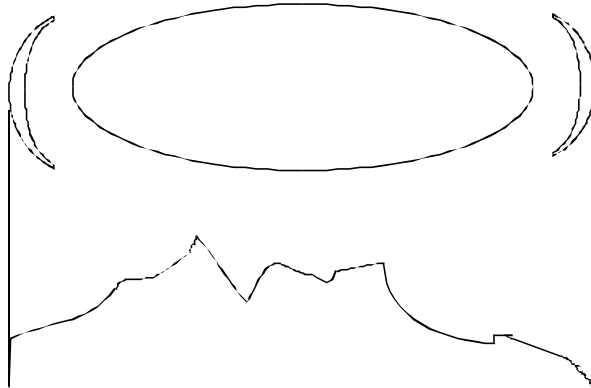
**Figure A-7. Fresnel Zone**

$$R = \frac{1}{2} \sqrt{(\lambda \times D)}$$

R: radius of the first Fresnel zone

$\lambda$ : wavelength

D: distance between sites



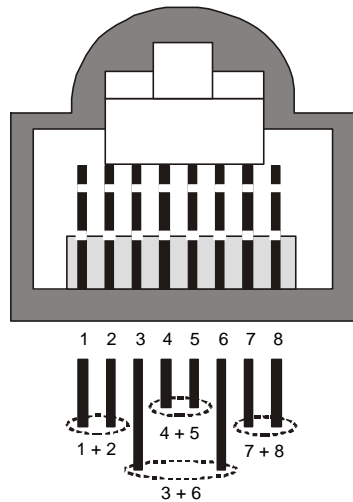
***Figure A-8. Fresnel Zone Clear of Obstacles***

When at least 80% of the first Fresnel Zone is clear of obstacles, propagation loss is equivalent to that of free space.

## APPENDIX B. PREPARING THE INDOOR TO OUTDOOR CABLE

The Indoor-to-Outdoor cable provides pin-to-pin connection on both sides. It is supplied open-ended at the one side, to allow the installer to conveniently route the cable into the waterproof seal off the Outdoor unit.

Figure 7-1 shows the wire pair connections required for the Indoor-to-Outdoor cable.



*Figure 7-1. Ethernet Connector Pin Assignments*

The pins are supplied crimped, with an additional set of spare uncrimped pins. Use the contact insertion and removal tool supplied with the unit (Amphenol P/N 17 D 438 SP) to insert the crimped pins into the RJ45 connector.



## APPENDIX C. DS.11 FAQ

### *How many BU-DS.11 or RB-DS.11 units can be co-located on the same building top or tower?*

You can co-locate up to 3 BU-DS.11 or RB-DS.11 units on the same structure. Each unit is assigned to one of the non-overlapping channels, 1, 6, or 11.

### *What is the antenna separation requirement for co-locating BU-DS.11 or RB-DS.11 units on the same building top or tower?*

The antennas should be mounted at least 2 feet apart when using UNI-16's, 15 feet when using UNI-24's, and 75 feet when using OMNI-8's. For omni antennas, the maximum link distance is reduced by up to 50%. Greater separation will improve the link distance.

### *Can my FH network operate in the same area as the DS?*

Yes, in a co-located network, both products will suffer some loss in performance. This depends on network utilization. For example, the higher the utilization of the FH network, the higher the level of impact on the DS network, and visa versa. Typically, in light to moderate utilized networks, the performance loss is not perceivable.

### *Can I use DS.11 Bridges to feed a FH distribution point?*

Yes, bandwidth sharing between the DS and FH products can be minimized if the network is designed using cross polarized directional antennas, and as much spatial separation as possible. Contact technical support for assistance with this.

### *What is the throughput of the DS.11?*

The BU-DS.11/RB-DS.11 bridge link typical performance is 4.2Mbps using TCP and 6.2Mbps using UDP. For long range links, the performance will drop about 5%.

***Why are there 11 channels and only 3 usable?***

The IEEE802.11 specification calls out 11 selectable channels (USA) between 2414MHz and 2462MHz. Because of the transmission bandwidth of the DS modulation, only 3 channels are non-overlapping. Those are channels 1, 6, and 11, therefore, only 3 systems may be co-located. The other channels may be used, however, if used with another DS system co-located on another nearby channel, the overlap will cause them to share the bandwidth yielding no increase in aggregate data bandwidth. When operating in a single channel network, the other channels may be used to move away from any in band interference that may exist.

***What if the DS.11 link experiences interference?***

If interference is affecting the DS.11 link, one of the other channels may be selected to operate away from the frequency of the interference. Also, physically re-locating the antennas may help.

***What is the typical latency of a BU-DS.11/RB-DS.11?***

A point to point link would realize about 3mS latency.

***Can the BU-DS.11/RB-DS.11 firmware be upgraded?***

Yes, the firmware in the BU-DS.11/RB-DS.11 is stored in flash and is upgraded using the built in TFTP server.

***Can just anyone erase my BU-DS.11/RB-DS.11 flash or change the firmware?***

No, the TFTP server in the BU-DS.11/RB-DS.11 requires the SNMP write community name (password) to perform an upgrade.

***Can I corrupt my firmware flash when upgrading to a new version?***

If the TFTP file transfer is interrupted during a flash update it is possible to corrupt the firmware. Fortunately, the DS.11 has a backup flash, which contains the previous version for firmware. If the primary flash is corrupt, then the backup is automatically used to return the unit to an operating state.

***When does the back up flash image get upgraded?***

After completing a firmware upgrade, the backup flash containing the old firmware version is overwritten with the new version on the new power on cycle.



***Can I downgrade my DS.11 firmware?***

Yes, an earlier version of firmware can overwrite a newer version.

Can I keep the previous version of firmware? No and yes. The previous version of firmware can not be kept on the DS.11 itself, but can be stored on your PC and loaded if needed.

***Does DS.11 support 802.1Q VLAN?***

Yes, but the support is limited to transparent operation. Meaning, DS.11 does not take any action on 802.1Q frames, but will transparently pass them within a VLAN network.

***Can I change the regulatory domain (country) of my DS.11?***

No. The regulatory domain is factory set.

***How can I configure or manage my DS.11 if I forgot the SNMP Community name?***

Press the reset button on the back panel with a paper clip. This will set the read and write Community names to public and private, respectively.

***How can I return the DS.11 unit to factory default settings?***

There are two ways. One way is to use the Default button on the Station Control Tab in the DS.11 Manager Utility. The other is to press and hold the reset button on the back of the unit while powering on the unit. Remember that all settings including IP addresses will be lost when setting defaults.

***Can I use the BreezeNET PI-CAT5 product with my DS.11 unit?***

No. The PI-CAT5 is specifically for the PRO.11 units only. The voltage is not the same between the two devices.

***Can I place the BU-DS.11/RB-DS.11 DS.11 unit outdoors?***

No, not directly. The BU-DS.11/RB-DS.11 is specified to operate at 0°C to 40°C and is not weather proof. It is best to mount the DS.11 indoors or in a protective cabinet.

***Can I use the ODB-1 product with my DS.11 unit?***

No. The ODB-1 is specifically for the PRO.11 units only.

***What is the maximum number of networked PC's the BU-DS.11/RB-DS.11 can learn?***

1024 network MAC addresses can be learned by the BU-DS.11/RB-DS.11.

***Can the BU-DS.11/RB-DS.11 be used for multi-point as well as point to point links?***

Yes. The BU-DS.11 can support multiple RB-DS.11 units creating a multi-point network.

***How many RB-DS.11 units can one BU-DS.11 support?***

The maximum number of associations is 128.

***What is the practical limit to the number of client bridges per BU-DS.11? And, what performance can I expect for a multi-point link?***

This really depends on average throughput expectations. All clients would have the maximum throughput available for burst traffic, however the overall average would depend on the utilization of the network. For example, in a heavily utilized network needing about 350Kbps to 500kbps average net throughput per site, 9 to 12 RB-DS.11's would be the limit. For a moderately utilized network needing about 175Kbps to 258Kbps average, 18 to 24 RB-DS.11's should be used, and for a lightly used network needing 32Kbps to 48Kbps average net throughput per site could use up to 128 RB-DS.11's.

***What is the range of the BU-DS.11/RB-DS.11 Bridges?***

15 miles or 24Km can be achieved using the UNI-24 antenna kits for a point to point link. Consult the antenna and accessory guide range tables for distances using other antenna combinations.

***What is the power supply ratings for the DS.11?***

The DS.11 power supply is rated for 100 – 240VAC input (47-63Hz) and 9VDC at 1.67A output. Polarity doesn't matter.

***Can I use the same antenna systems and accessories on my DS.11 as on my PRO.11?***

Yes. The RF connector on the DS.11 is the same unique SMA type as used on the PRO.11, so all the same antennas and cables can be used.

***What management options are available on DS.11?***

The BU-DS.11/RB-DS.11 DS.11 comes with a graphical management utility that operates on any Windows based network ready PC. With this utility you can configure and monitor every DS.11 on your network. You can also use the DS.11 SNMP MIB on standard management platforms like SNMPc, and HP Openview.

***Does the DS.11 offer out-of-band management?***

No, the DS.11 does not offer out-of-band management, such as a serial port. The DS.11 is managed in-band only via the DS.11 manager utility or SNMP.

***Can I use the AMP250 or AMP500 on the DS.11?***

No. The AMP250/500 products are not tested or certified for use with the DS.11 products.

***What installation and site survey tools are available for BU-DS.11/RB-DS.11?***

The DS.11 comes with a Windows based manager utility. With this utility you can configure link parameters and monitor signal quality and RSSI (received signal strength indication). Optimizing antenna alignment is done using the signal quality and RSSI display. Any computer on the network can use this utility to manage the BU-DS.11/RB-DS.11.

***Is the DS.11 compatible with other DS equipment from other vendors?***

Yes. However, for the outdoor bridges, interoperability can vary from vendor to vendor, and in some cases it may not operate if the manufacturer's implementation is not pure 802.11. The BU-DS.11/RB-DS.11 can operate at 1 and 2Mbps with legacy 802.11 DS equipment, and at 5.5Mbps and 11Mbps with 802.11b High Rate DS equipment.

***Does the BU-DS.11/RB-DS.11 DS.11 support 802.1d spanning tree protocol?***

No, the BU-DS.11/RB-DS.11 does not support spanning tree. This is because the BU-DS.11 can also support roaming devices.

***What is the normal PER (packet error rate) for the BU-DS.11/RB-DS.11?***

The error rate will be about 4%-6% (transmitted fragments vs. retry count). This is typical when operating in a non-interference environment at maximum range for bi-directional traffic loads. If the traffic load is more uni-directional, then the PER will be less.

***What is the best value for the CW win parameter on the DS.11?***

Setting the CW win parameter to 31 for heavy bi-directional traffic loads will minimize the PER. Setting the CW win to 15 will improve performance for more uni-directional traffic loads. CW win 7 should only be used for short range point-to-point links, and 63 should be used for large, long range multi-point links.