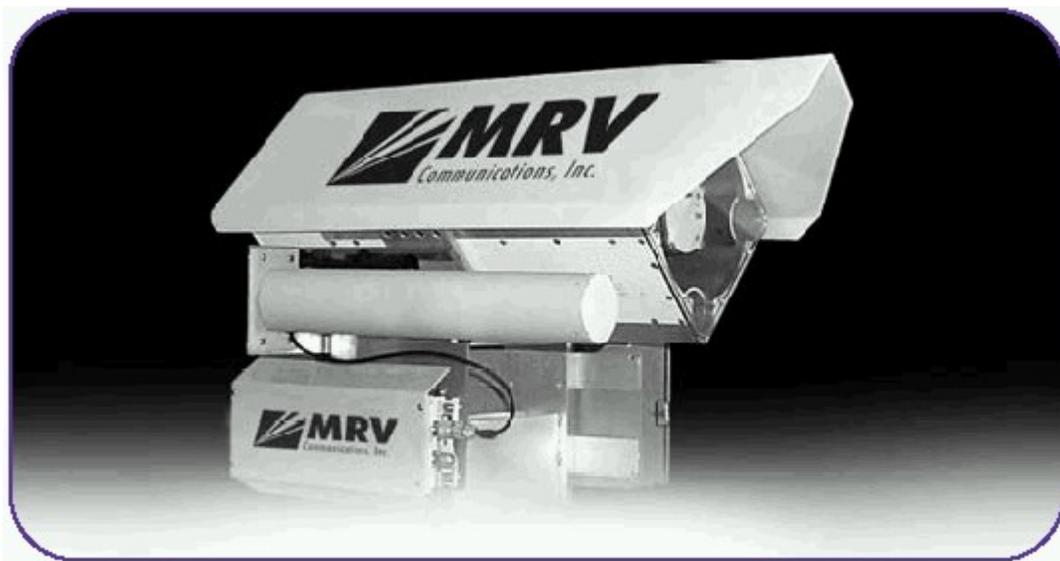




Fusion System



SET-UP AND OPERATIONS MANUAL

December 2002

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Statement of Conditions

The information contained in this manual is subject to change without notice. MRV Communications shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this manual or equipment supplied with it.

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. If not installed and used in accordance with the instructions, this equipment may cause harmful interference to radio communications. 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:

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

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 indicated below:

High gain outdoor antennas (>8dBi)

30cm (12 inches)

Antenna Installation

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 rule CFR47 part 15.204. The installer should configure the output power level of the antennas according to country regulations and 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.

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1. INTRODUCTION

1.1 General

This chapter describes the scope of this manual and the main features of the MRV Communications Fusion: Wireless Base Unit (BU-Fusion) and Wireless Remote Bridge (RB-Fusion) unit. Also in this chapter: relevant standards, compatibility issues, product functionality and use of the DS (Direct Sequence) WLAN.

If at any time you have questions regarding the manual or the Fusion system, please call the MRV Communications Customer Service Organization closest to you:

Customer Service Organization Americas

Phone: 858-657-9663

Fax: 858-657-9677

E-mail: service@opticalaccess.com

Customer Service Organization Europe/Asia

Phone: 972-(4)-9936200

Fax: 972-(4)-9892743

Email: support@opticalaccess.co.il

1.2 System Description

The MRV Communications BU-Fusion and RB-Fusion 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 10BaseT Ethernet speeds.

1.2.1 Compatibility and Standards

MRV Communications Fusion products are compatible with the following standards and are interoperable with other IEEE 802.11b compatible, 2.4 GHz direct sequence products.

- IEEE 802.11b Wireless LAN
- IEEE 802.3 10BaseT Ethernet
- IEEE 802.1Q and 802.1P virtual LAN transparent
- DHCP for automatic IP address assignment
- SNMP for system management

1.3 Functional Description

The MRV Communications BU-Fusion and RB-Fusion can be used as a high-speed connection between two remote networks.

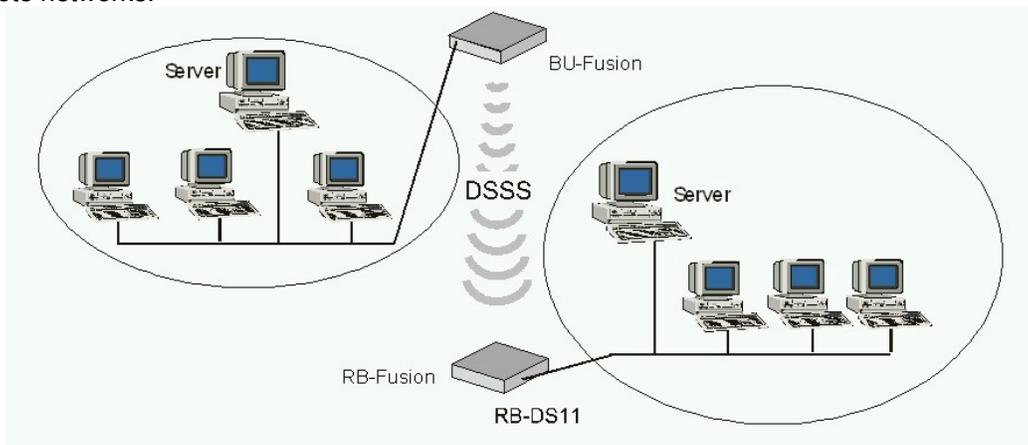


Figure 1-1. Fusion Outdoor Application

INTRODUCTION

1.3.1 Wireless Base Unit (BU-Fusion)

The BU-Fusion is an IEEE 802.11b compliant base station bridge that is used to connect a single remote site to a central server or Internet connection.

In BU-Fusion models, the outdoor unit is provided with two antenna connectors for connection to one external antenna. MRV Communications supplies a Yagi antenna. In addition, a protective sun cover is supplied with the unit and should be mounted on the front of the outdoor unit.

1.3.2 Wireless Remote Bridge Unit (RB-Fusion)

The RB-Fusion connects a remote Ethernet network to a BU-Fusion Base Unit bridge located at a central server or Internet site. The unit can handle up to 1024 MAC addresses simultaneously from the LAN side. The Aging algorithm is applied at all times.

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

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

As with the BU-Fusion unit, a protective sun cover is supplied with the unit and should be mounted on the front of the outdoor unit.

1.4 How to Use This Guide

This User's Manual provides instructions for planning and setting up your Wireless LAN. It includes details on how to install and configure each unit. The manual is broken down into the following chapters:

- **Chapter 1: Introduction** - Explains how to use the manual and presents the MRV Communications Fusion system.
- **Chapter 2: Installation** - Describes how to install the units.
- **Chapter 3: Using the Fusion Configuration Utility** - Describes how to use the Fusion Configuration Utility to set up, configure and manage MRV Communications Fusion units.
- **Chapter 4: System Troubleshooting** - Contains a troubleshooting guide for some of the more common problems, which may occur when installing and using the MRV Communications Fusion products.
- **Chapter 5: Downloading Software Upgrades** - Explains how to perform software upgrades using a TFTP application.
- **Chapter 6: Technical Specifications** - Lists the technical specifications of the MRV Communications Fusion units.
- **Appendix A: Fusion Quick Install Guide** - Simplifies the installation of the stand-alone Fusion system.
- **Appendix B: Preparing the indoor-to-outdoor cable:** Describes the correct procedure for inserting the cable into the connector and crimping it securely to provide a strong seal.

INTRODUCTION

- **Appendix C: Radio Signal Propagation** - Explains many of the terms related to antennas and RF (Radio Frequency) systems.
- **Appendix D: Mounting** – Describes mounting the Fusion system with an MRV Communications TereScope.
- **Appendix E: Configuring** – Describes configuring a Switch when mounting a Fusion system with a TereScope.
- **Appendix F: Fusion FAQ's**- 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-Fusion/RB-Fusion units to the Ethernet LAN. Make sure they are switched on. The Fusion wireless network will be up and running immediately. If you are content with the default settings of the BU-Fusion/RB-Fusion units, you don't need to go any farther. It is more likely however, that you will want to assign different radio frequencies to each unit, or impose some restrictions on the use of your wireless network.
2. To manage the BU-Fusion/RB-Fusion units via SNMP, each BU-Fusion/RB-Fusion will need 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 implemented automatically. If not, refer to Section 3.1.1 for further information on assigning IP addresses.
3. Use the MRV Communications Fusion Configuration Utility described in Chapter 3 of this manual to configure the network settings to reflect your configuration.

Select the radio channels of the BU-Fusion/RB-Fusion units according to your cell plan.

2.2 Packing List

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

- Indoor unit
- Outdoor unit
- Sun cover with screws
- RF Mount
- 110/220 V AC Power Cord 20 meter indoor-to-outdoor cable (with optional upgrade to 60 m)
- (4) shielded RJ-45 connectors
- Yagi Antenna

2.3 Other Items Required for Installation

- Ground cable with an appropriate termination
- Ethernet cable (straight)
- Installation tools and materials, including mounting kit for installing the outdoor unit
- Crimping tool for RJ-45 connectors

2.4 Installation Overview

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

A sample installation scheme is depicted in Figure 2-1. Remember that this procedure is for the installation of a stand-alone Fusion system. For instructions on mounting a Fusion system with an MRV Communications TereScope™, see Appendix D of this manual. The installation process should follow these general steps:

1. Select appropriate locations for the outdoor unit, the antennas and the indoor unit.

INSTALLATION

2. Mount the outdoor unit and the antenna. Connect the outdoor unit to the antenna.
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. 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's radio port. Prepare the power cable (if supplied open-ended) and use it to connect the indoor unit to the AC main.
6. Connect the indoor unit Ethernet port to the user's network using an Ethernet cable.
7. Align the antenna and verify connectivity with the other units.

Note: The indoor unit should be connected to the power source only after it has been connected to the outdoor unit.

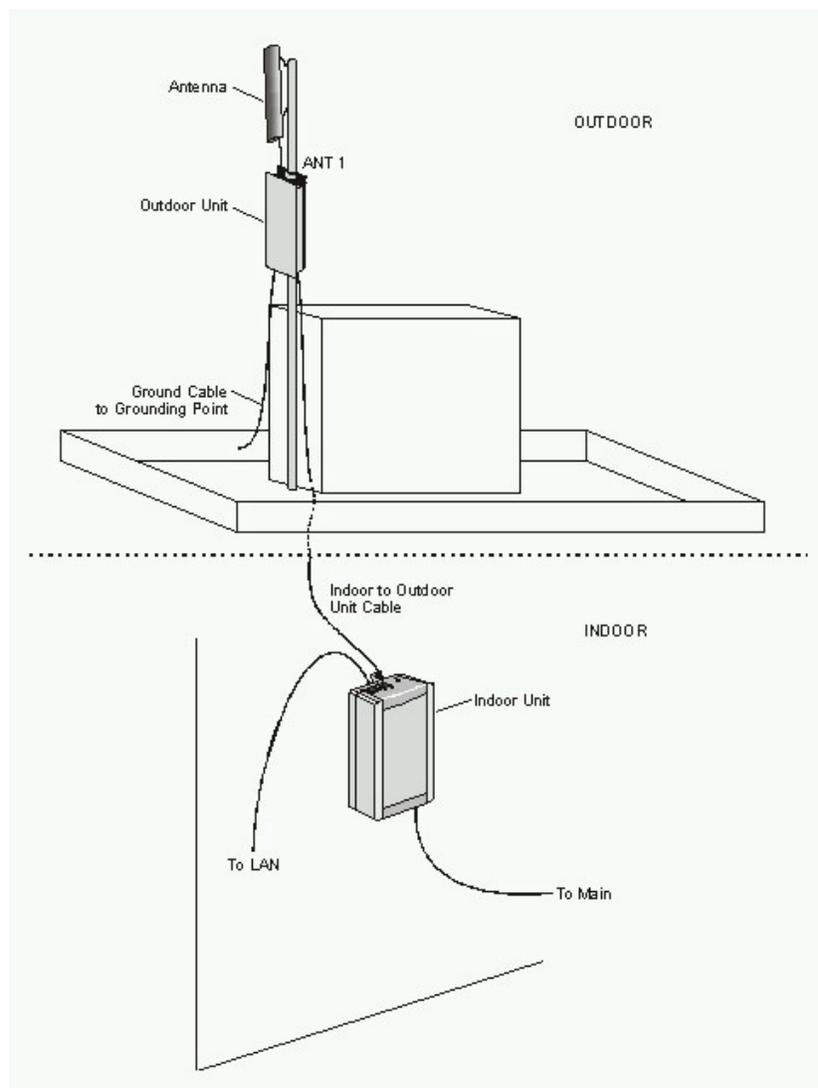


Figure 2-1. General Installation Scheme - Pole Mounting

Note: Use a straight Ethernet cable to connect the indoor unit to a hub, or use a crossed cable to connect it directly to the PC's Network Interface Card (NIC).

2.5 Guidelines for Placement of BU-Fusion Units

Each Wireless Base Unit in the network forms the center of a cell, or BSS. For maximum throughput, it is preferable for neighboring BU-Fusion units to send and receive on different channels.

Creating a cell plan for your site can be complicated and is usually done by MRV Communications technicians equipped with special measuring equipment. If necessary, MRV Communications can provide training for your employees.

Table 2-1 describes the channels used in each regulatory domain: lowest channel, highest channel, default channel, maximum output power and default output power.

REGUALTORY DOMAIN	LOWEST CHANNEL	HIGHEST CHANNEL	DEFAULT CHANNEL	MAXIMMUM OUTPUT POWER	DEFAULT OUTPUT POWER
ETSI (Europe)	1	13	7	14	4
FCC (USA)	1	11	6	24	24
TELEC	1	14	7	14	6
FRANCE	10	13	11	14	4
CANADA	1	11	6	24	24

Table 2-1. Regulatory Domains Specifications

2.6 Outdoor Installation Considerations

This chapter describes various considerations and precautions to take into account when planning an outdoor installation.

2.6.1 Co-locating Fusion Outdoor Units

For best performance, up to three BU-Fusion units (the exact number depends on the regulatory domain) can be co-located on a building top or tower. Each unit is assigned to one of the non-overlapping channels.

2.6.2 Site Selection Factors

When selecting a location for the external antennas, remember the following guidelines:

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

As well as:

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 a clear line of sight with good clearance between the “line” and any physical obstacle.

Physical Obstacles

A physical object in the path between two bridges can cause signal attenuation. Buildings or physical structures including trees or mountains 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 could block the signal.

Minimal Path Loss

Path loss is determined by several factors including:

INSTALLATION

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

2.6.3 Rooftop Installation

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!

Rooftop installations offer several advantages:

- Increased antenna range
- Fewer obstacles in path
- Improved performance

2.6.4 Antennas for Outdoor Applications

The Yagi antenna supplied with each Fusion unit has the following parameters:

Frequency Range	2400-2483.5 MHz
VSWR	<2:1, 1.5:1 nominal
Front-to-Back Ratio	>20 dB
Gain	13.5 dBi (11.3 dBd) nominal
Vertical Beamwidth @ 1/2 Power	30°
Horizontal Beamwidth @ 1/2 Power	28°
Equivalent Flat Plate Area	0.375 ft ²
Lateral Thrust at Rated Wind	31.4 lbs
Bending Moment at Base at Rated Wind	23.6 lb-ft
Cable Length	18 inches
Cable Type	RG58A/U
Connector	Type N, male
Length	18 inches
Weight	.76 lbs
Polarization	Vertical

Table 2-2. Yagi Antenna Specifications

Note: MRV Communications will not guarantee operation of the Fusion system with antennas other than the Yagi antenna supplied.

2.6.5 Link Distance

For open outdoor areas with an unobstructed line of sight between the BU-Fusion and the RB-Fusion, the suggested maximum distance is:

USA: Up to 24km (15 miles)

Europe: Up to 10km

INSTALLATION

2.6.6 Precautions

Detached antennas, whether installed indoors or out, should be installed ONLY by experienced antenna installation professionals familiar with local building and safety codes and, where applicable, are licensed by the appropriate government regulatory authorities. Failure to do so may void the MRV Communications Product Warranty and expose the end user to legal and financial liabilities. MRV Communications and its resellers or distributors are not liable for injury, damage or violation of government regulations associated with the installation of detached antennas.

2.6.7 Lightning Protection

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

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

2.7 Installing the Outdoor Unit

This section refers to the installation of a stand-alone Fusion system. For installation of the Fusion with an MRV Communications TereScope™ system, see Appendix E of this manual.

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

- Special brackets sets (supplied with each unit).
- U-bolts - size A (inner installation holes, up to 2" pole)
- U-bolt - size B (outside installation holes, up to 3" pole)
- 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 and Figure 2-3 illustrates the method of installing a unit on a pole using the supplied brackets.

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

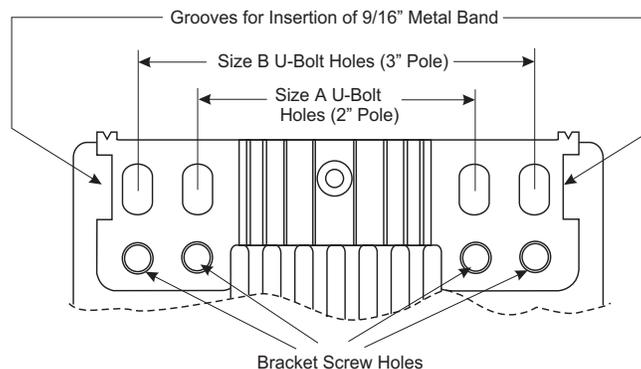


Figure 2-2. Holes/Grooves/Screw Holes

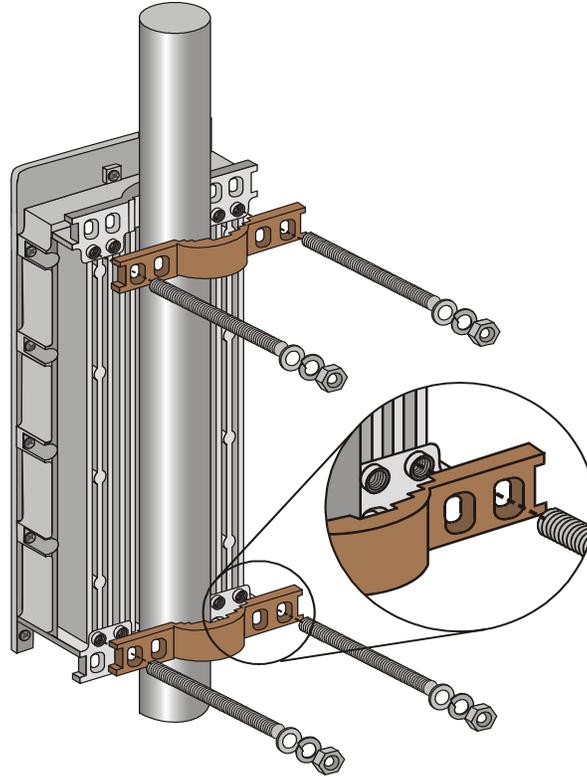


Figure 2-3. Pole Mounting Installation Using the Supplied Brackets

Note: When inserting the open-ended screws, make sure to insert them with the grooves pointing outwards; these grooves are intended to allow fastening of the screws with a screwdriver.

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 ∇ 1 and ∇ 2 respectively) are located on the top panel of the Fusion 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. For Fusion units, connect an RF cable between each ANT connector and the antenna. The Yagi antenna is connected to ∇ 1.

Note: Make sure to seal the ∇ 2 connector using the waterproof seal provided with the unit.

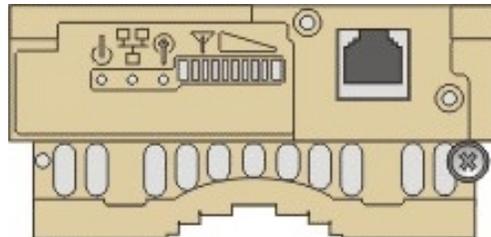


Figure 2-4. Outdoor Radio Unit Bottom Panel

INSTALLATION

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.

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

4. Insert and crimp the RJ-45 connector. Refer to Appendix B for instructions on preparing the RJ-45 cable connector.
5. Connect the Ethernet cable to the outdoor unit's RJ-45 connector.

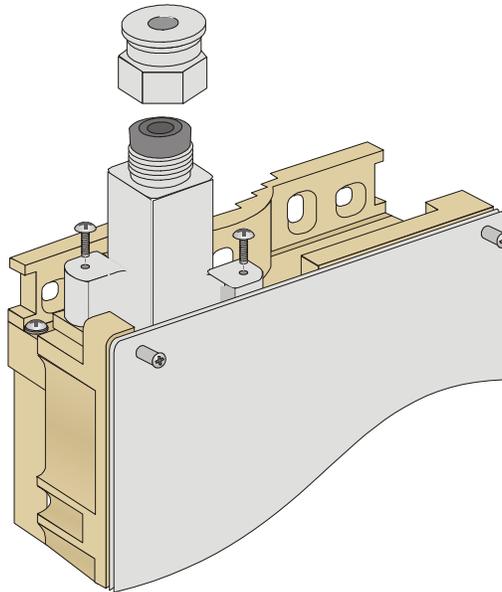


Figure 2-5. Routing the Indoor-to-Outdoor Cable Through the Waterproof Seal

6. Replace the waterproof seal assembly on the outdoor unit and replace the top nut. To guarantee a good seal, make sure that the external jacket of the cable is well inside the service box.
7. Route the cable to the location selected for the indoor unit.
8. Assemble an RJ-45 connector with a protective cover on the indoor side of the indoor-to-outdoor cable and connect it to the indoor unit's radio port.

2.8 Installing the Indoor Unit

1. Route the indoor-to-outdoor cable into the building, leaving some spare so that it can conveniently reach the indoor unit. The cable is supplied open ended to allow for threading it into the building through as small a hole as possible.
2. Assemble the connector on the cable. Appendix B provides instructions on how to assemble the connector on the indoor-to-outdoor cable.

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3. Remove the wall-mounting bracket clipped to the rear of the indoor unit and mount it on a wall as shown in Figure 2-6. Mount the indoor unit on the mounting bracket.
4. 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 main power supply.

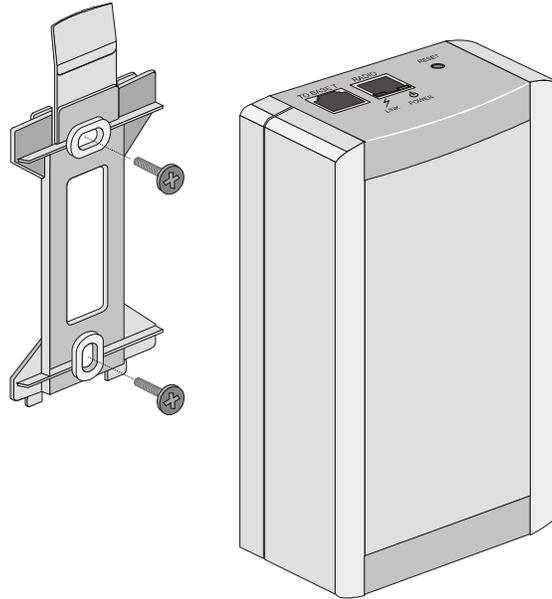


Figure 2-6. Wall Mounting the Indoor Unit

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 main voltage of the indoor unit is marked on the rear panel of the unit.

5. 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). After verifying that the unit is rated for the AC main voltage in the country of use, connect the other end of the power cord to the AC main. The AC rating can be found on the label on the rear panel of the indoor unit.

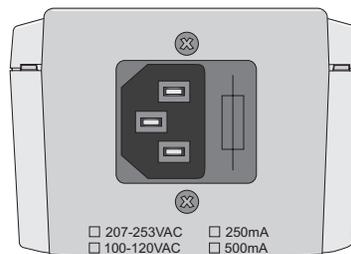


Figure 2-7. Indoor Unit Rear Panel

INSTALLATION

6. Verify that the POWER LED located on the front panel lights yellow, indicating that the 48 V DC output to the outdoor unit is not shorted.

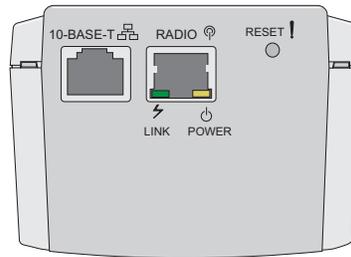


Figure 2-8. Indoor Unit Front Panel

7. Connect the 10BaseT connector to the network. The cable connection should be straight Ethernet when connecting the indoor unit to a hub and a crossed cable when connecting it directly to a PC Network Interface Card (NIC).

Note: The length of the Ethernet cable connecting the indoor unit to the user's equipment, including the length of the indoor-to-outdoor cable, should not exceed 90 meters.

2.8.1 Antenna Alignment

Low gain antennas do not normally require alignment due to their very wide radiation pattern. High gain antennas, including the integral antenna of Fusion units, have a narrow beamwidth, necessitating alignment to optimize the link.

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 antenna to the BU-Fusion, using a suitable RF cable at the main site.
4. Connect the antenna to the RB-Fusion, using a suitable RF cable 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-Fusion bottom panel. If the received signal quality level is lower than expected for this antenna/range combination, change the antenna height and verify RF cables connections to maximize significant quality.
7. For proper operation, the RSSI values should be between -85 dBm and -61 dBm (MRV Communications recommends -79 dBm RSSI). Table 2-3 displays the mapping between the power bars and received power on the RB-Fusion outdoor unit. The Configuration Utility provides the RSSI reading under the Counters tab for the RB-Fusion unit and the Station Status tab for the BU-Fusion.

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	Bar0 (red)	-91 dBm
	Bar1 (green)	-87 dBm
	Bar2 (green)	-83 dBm
	Bar3 (green)	-80 dBm
	Bar4 (green)	-77 dBm
	Bar5 (green)	-74 dBm
	Bar6 (green)	-71 dBm
	Bar7 (green)	-66 dBm
	Bar8 (green)	-61 dBm
	Bar9 (yellow)	-55dBm

Table 2-3. Mapping vs. Received Power on the RB-Fusion Outdoor Unit

Note: When using external antennas, make sure that the connectors are properly sealed and waterproofed.

2.8.2 Verifying Correct Operation of the Indoor Unit

To verify proper operation, view the LED indicators located on the front panel of the indoor unit (shown in Figure 2-8 and described in Table 2-4).

Name	Description	Functionality
POWER	Power Indication	<i>Green</i> - 48 VDC present on the radio RJ-45 port. <i>Off</i> - No power is supplied to the radio RJ-45 port.
LINK	Self Test and Remote Ethernet Link Indication	<i>Off</i> - No Ethernet conductivity detected between the outdoor unit and the device connected to the indoor unit. <i>Orange</i> - Self-test passed and Ethernet connection is confirmed by the outdoor unit (Ethernet integrity check passed). Note: the LINK LED indicates end-to-end connection between the outdoor unit and the Ethernet connection to the indoor unit.

Table 2-4. Indoor Unit LEDs

2.8.3 Verifying Correct Operation of the Outdoor Unit

To verify proper operation, view the LED indicators located on the bottom panel of the outdoor unit, shown in Figure 2-4 and described in Table 2-5 below.

NAME	DESCRIPTION	FUNCTIONALITY
WLAN 	Wireless Link Indicator	<i>Blinking Green</i> – Data received or transmitted on wireless link. Blinking rate is lower when there is no wireless traffic.
DC Power 	Self Test and Power indication	<i>Green</i> – Self test passed and power is received by the outdoor unit <i>Red</i> – Self-test failed. Firmware did not load successfully. See paragraph following this table.
ETH 	Ethernet activity/ connectivity indication	<i>OFF</i> –Ethernet connectivity is OK. No traffic activity detected on the port. <i>Blinking Green</i> –Ethernet connectivity is OK, with traffic on the port. <i>Red</i> – No Ethernet connectivity. If this occurs, check the Ethernet cable and indoor-to-outdoor cable connections.
RSSI BAR		<i>RB-Fusion:</i> Received Signal Strength Indication <i>BU-Fusion:</i> Number of associated RB-Fusion units

Table 2-5. Outdoor Unit LED's

When the Self Test fails:

If the DC POWER LED light is red, this indicates the self-test has failed- try resetting the unit. If that does not work, reset the factory defaults. If that is not successful, call the MRV Communications Customer Service Organization for assistance.

2.8.4 Resetting the SNMP Community Strings and Reloading Factory Settings

The SNMP read/write Community strings are an SNMP security feature included to restrict management access from unauthorized individuals. Refer to Section 3.1.2 for additional information.

To reset the SNMP community strings, insert a suitable tool and press the **Reset** button while the unit is operating. The community strings are reset to “private” and “public”, respectively.

To reset the unit to the factory defaults:

1. Disconnect the power cable from the indoor unit.
2. Insert a suitable tool and press the **Reset** button. Keep the **Reset** button pressed while simultaneously inserting the power cable back into its socket.

2.8.5 Reloading Factory Default Settings

The **Reset** button, located on the indoor unit front panel, can be used to perform two reset functions:

1. Reset the SNMP community strings
2. Reset the unit to its factory default parameter settings.

To reset the unit to the factory defaults:

1. Disconnect the power cable from the indoor unit.
2. Insert a suitable tool and press the **Reset** button. Keep the **Reset** button pressed while simultaneously inserting the power cable back into its socket.

2.8.6 Connecting the Unit to the Ethernet Port

Follow the steps below to connect the Fusion units to the Ethernet ports:

1. Connect one end of an Ethernet 10BaseT cable to the RJ-45 port on the front panel of the indoor unit.
2. Use a straight cable to connect to a hub; use a crossed cable to connect to the PC's Network Interface Card (NIC).
3. Connect the other end of the connector cable to the Ethernet outlet.

3. THE FUSION CONFIGURATION UTILITY

The Fusion Configuration 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 Fusion Configuration Utility to control a large number of Fusion units from a single location.

Among the supported features:

- Assign the radio channels for optimal cell operation.
- Configure the units with specified IP addresses.
- Set the SNMP read/write Community strings.
- Verify the status of all units in the network.
- Select the antenna and diversity setting.
- Configure a wide range of operational parameters, including WLAN, IP and Security parameters.
- View the Tx and Rx counters.
- Obtain general information, including the Firmware version and system name.

3.1 Fusion Configuration Utility Main Window

The Control Window section - In this section, you can perform the following:

- View the Fusion units that have been discovered by their IP address.
- Select the IP address of the unit you wish to manage.
- Assign unit IP addresses.
- Set the Configuration Utility access rights.
- Set the SNMP Community information.

If there are a large number of units in the managed network, enlarge the list box by clicking on the horizontal line above the list; click again to toggle back the default display state. The list box also displays the location of each unit, as set in the Station Status dialog box (see Section 3.3.1).

The Tabs Section - This section consists of several tabs, each containing parameters required for the management of the selected unit; the number of tabs displayed varies with the types of managed units. The different tabs are described on the following pages. When you switch between the tabs, the IP Selection section with the selected unit address remains displayed.

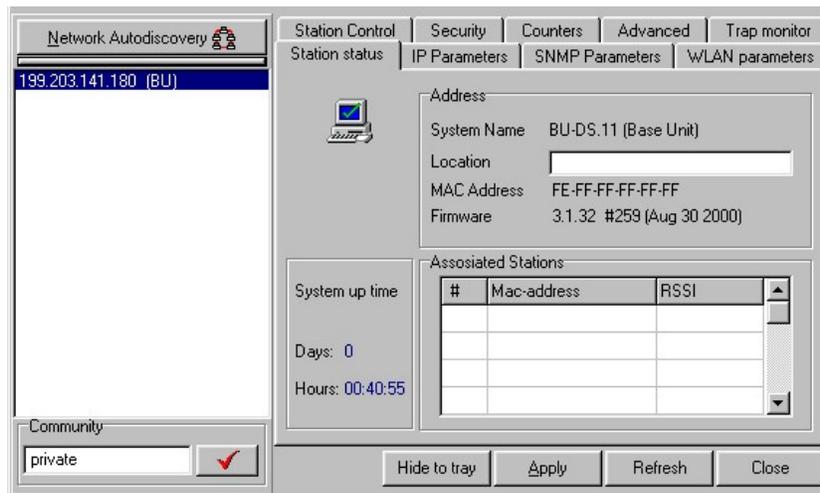
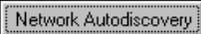


Figure 3-1. Fusion Configuration Utility Main Window (Station Status Tab)

THE FUSION CONFIGURATION UTILITY

3.1.1 Selecting Units

There are two ways to select a unit to manage:

1. Click the  button. All the current units IP addresses (under the selected community) are displayed in the list box underneath the button. Click on an address to select the corresponding unit for viewing and configuration.
2. For stations that are located behind a router, type the unit's address in the Locate Unit field and click .

3.1.2 Setting the SNMP Community Information

Type the known read/write Community string in the Community field (the default string is “public” for read and “private” for read/write) and click the  button to confirm.

3.1.3 Assigning and Editing IP Addresses Manually

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

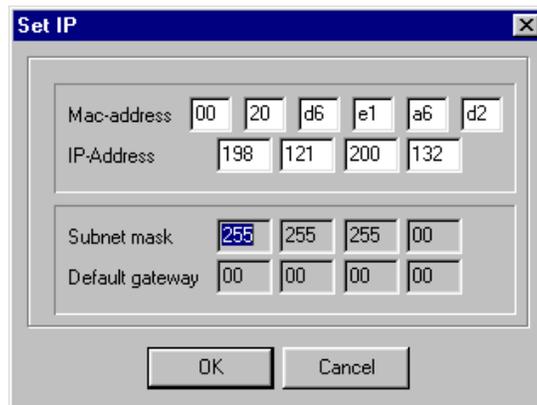


Figure 3-2. The Set IP Dialog Box

2. Type the parameters in the appropriate fields and click OK; the MAC address is written on the bottom label of the indoor unit and on the outdoor unit. A message box is displayed, notifying you when the changes are to take affect. This feature can be used only if the Fusion Configuration Utility is on the same Ethernet segment as the unit and not behind the router.

Notes: To see the unit after assigning the IP address, the PC with the Configuration Utility should be on the same IP subnet as the assigned IP address.

Units receive an auto IP address if there is no DHCP server and the unit is configured to work in the Smart mode (as described in Section 3.3.2). The IP address will be chosen randomly in the 169.254.x.x range with a subnet mask of 255.255.0.0.

3.1.4 Application Control Buttons

All Configuration Utility windows and tab areas contain the following buttons. Additional buttons, specific to certain windows, are explained where relevant.

-  – Closes the window without implementing any changes made.
-  – Implements any changes made.

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-  – Refreshes the window with the most recent data queried from the unit.
-  – Minimizes the application into the  icon, in the Windows task bar (at the bottom of the Windows desktop). To restore the application, click the  icon.

3.2 Configuration Utility Modes

There are several Fusion Configuration Utility modes of operation; these options are chosen via the Options menu in the Configuration Utility main window shown below.

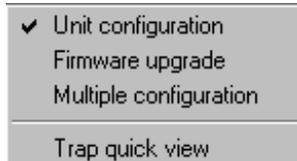


Figure 3-3. Options Menu in Configuration Utility main window

The selected option(s) is indicated by a check mark next to the option in the menu.

- **Unit Configuration** - default mode; used for setting the parameters detailed in this manual.
- **Firmware Upgrade** - allows upgrading the embedded software in managed units; refer to Section 3.2.1 for instructions on using this feature.
- **Multiple Configuration** - allows downloading configuration of parameters to more than one unit simultaneously; refer to Section 3.2.2 for instructions on using this feature.
- **Trap Quick View** - when set to this mode, the PC station (if set as the trap host as described in Section 3.3.3) switches automatically to the Trap Monitor tab (described in Section 3.3.9) when the Configuration Utility is active.

3.2.1 Firmware Upgrade

This mode of operation allows upgrading of the embedded software in managed units. When you select this mode from the mode menu, the dialog box below is displayed.

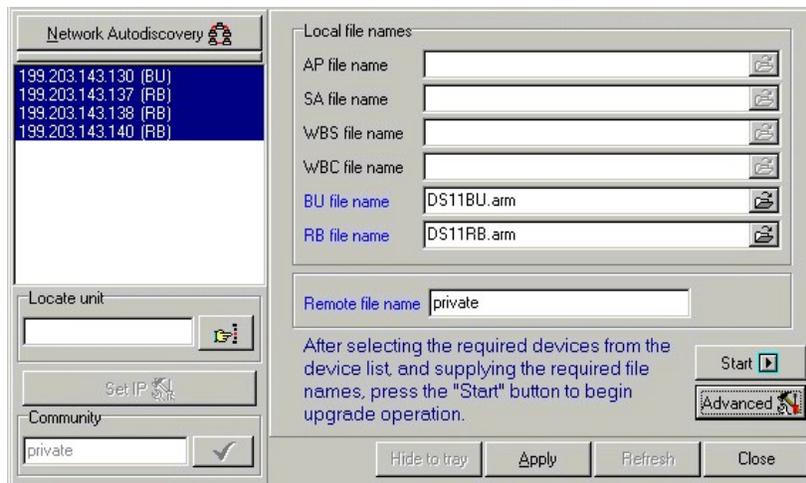


Figure 3-4. Firmware Upgrade

Note: The Configuration Utility does not resolve the topology of the cell. Therefore, firmware upgrades should be made from the central point where the BU-Fusions are located.

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The list box on the left-hand side of the dialog box displays the managed units; it is sorted sequentially by BU-Fusion followed by RB-Fusion units.

1. From the list box, select the units you wish to upgrade. Use *Shift-Click* and/or *Ctrl-Click* to select multiple units, or select multiple units by dragging with the mouse.
2. In the Local File Name fields, specify the firmware file you wish to use; there are separate fields for files of different device types. The field text is displayed in blue when corresponding unit types in the list box are selected.
3. In the Remote File Name field, enter the read/write community string of the unit(s).
4. Click the  button to change the settings of the TFTP session used in the upgrade download.

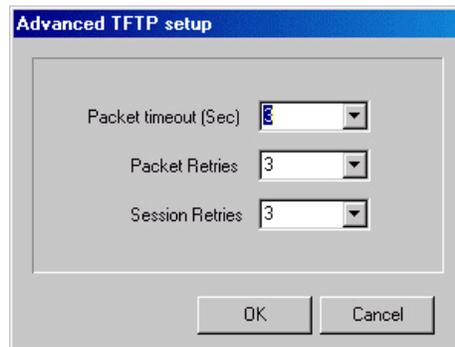


Figure 3-5. Advanced TFTP Setup

The Advanced TFTP Setup window enables you to tune the TFTP session parameters for an efficient firmware upgrade.

Packet timeout - defines the time (in seconds) for a timeout of a specific packet sent. The range is 1-30 seconds; the default is 3 seconds.

Packet Retries - defines the number of times in a TFTP session that a packet will be sent after packet timeout. The range is 1-5 retries; the default is 3 retries.

Session Retries - defines the number of times of TFTP sessions will be repeated before the firmware upgrade operation is determined as failed. The range is 1-5 retries; the default is 3 retries.

5. Click  to initiate the firmware upgrade; progress bars are displayed to indicate the progress of the operation. If both BU-Fusion and RB-Fusion devices are selected, the program will upgrade the RB-Fusion units first. At the end of the upgrade session, the following window is displayed, which will indicate that the operation was successful.

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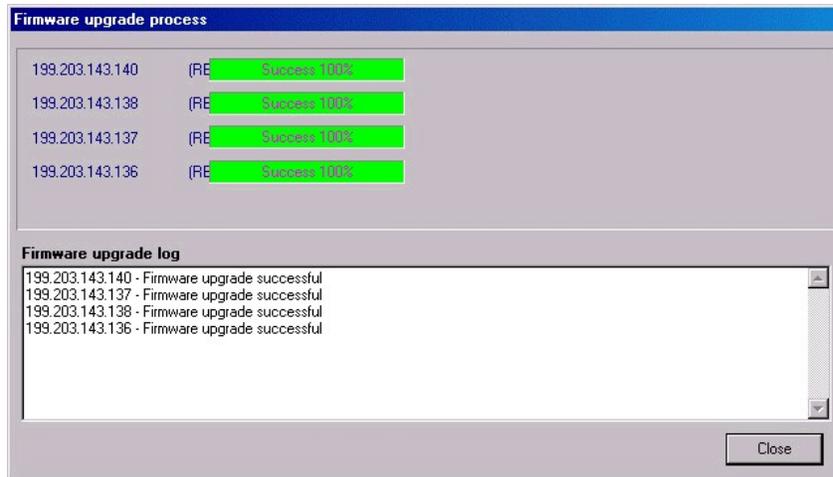


Figure 3-6. Firmware Upgrade Process

3.2.2 Multiple Unit Configuration

This feature allows downloading of configuration parameters to multiple units simultaneously. When you select this option in the Options menu, all configuration windows become write-only (with some of the parameters grayed out if not relevant).

Note: *The Configuration Utility does not resolve the topology of the cell. Therefore, multiple unit configuration operations should be made from the central point where the BU-Fusions are located.*

From the list box on the left-hand side of all dialog box tabs, select the units that you wish to upgrade. Use *Shift-Click* and/or *Ctrl-Click* to select multiple units. Enter the configuration parameter values and click . The following dialog box is displayed.

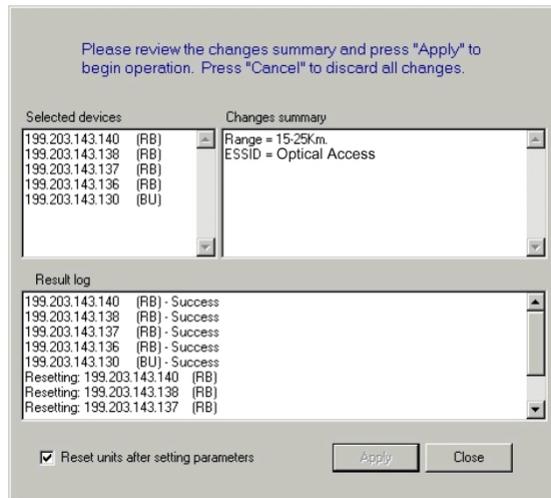


Figure 3-7. Multiple Configuration

This dialog box displays the selected units and a list of the requested configuration changes to be made in the multiple configuration session. Check the **Reset units after setting parameters** box to reset all affected units. A log of the multiple configuration session is displayed during and after the operation.

3.3 Utility Configuration Windows

3.3.1 Station Status Tab

The Station Status tab displays general information regarding the unit's firmware and hardware versions, as well as general unit address information.

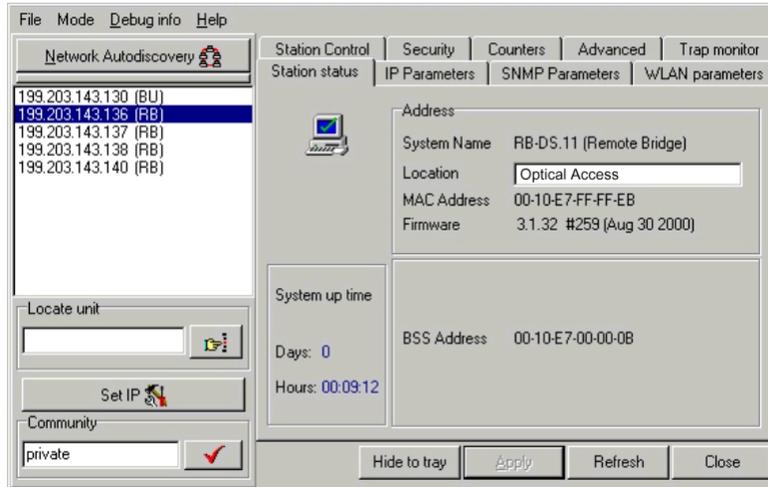


Figure 3-8. Station Status Tab

- **System Name** - The name of the selected unit.
- **Location** - A user-defined 28 ASCII characters description of the location of the selected unit (optional).
- **MAC Address** - MAC address of the selected unit.
- **Firmware** - The current firmware version.
- **BSS Address** (displayed for RB-Fusion units only) - This defines the BSS MAC address, which is the BU-Fusion the unit is associated with.

3.3.2 IP Parameters Tab

The IP Parameters tab allows you to define or edit the IP parameters of the units.

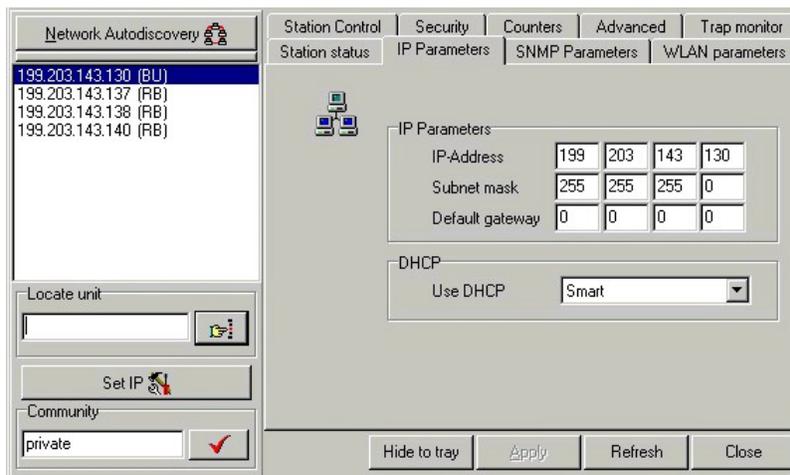


Figure 3-9. IP Parameters Tab

THE FUSION CONFIGURATION UTILITY

- **IP Address** - The IP address of the selected unit.
- **Subnet mask** -The Subnet mask of the selected unit.
- **Default gateway** - The default gateway of the selected unit.
- **DHCP** - Sets the way your system utilizes the Dynamic Host Configuration Protocol (DHCP, used for automatic IP assignment).
- **Always** - The system searches for a DHCP server each time the unit is turned on.
- **Smart** - 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.
- **Never** - The system never searches for a DHCP server. The default value is Smart.

Note: When the unit is configured to use a DHCP server and none exists, the unit will assign itself an automatic class B address of 169.254.0.0; this can be used when the MAC address is not available.

3.3.3 SNMP Parameters Tab

The SNMP parameters tab allows you to define or edit the SNMP community strings and the SNMP-related parameters.



Figure 3-10. SNMP Parameters Tab

- **Read** - The read-only community string of the unit. Default is “public.”
- **Read/Write** - The read/write community string of the unit. Default is “private.” For security purposes this value is displayed as asterisks.
- **Trap Host IP Address** - Enter the IP of the host to which SNMP traps are sent.

Click the  icon directly beneath this field clear the Trap Host IP Address field and enter a new IP address.

Click the  icon directly beneath this field to disable sending of traps (inserts a value of 255.255.255.255).

3.3.4 Counters Tab

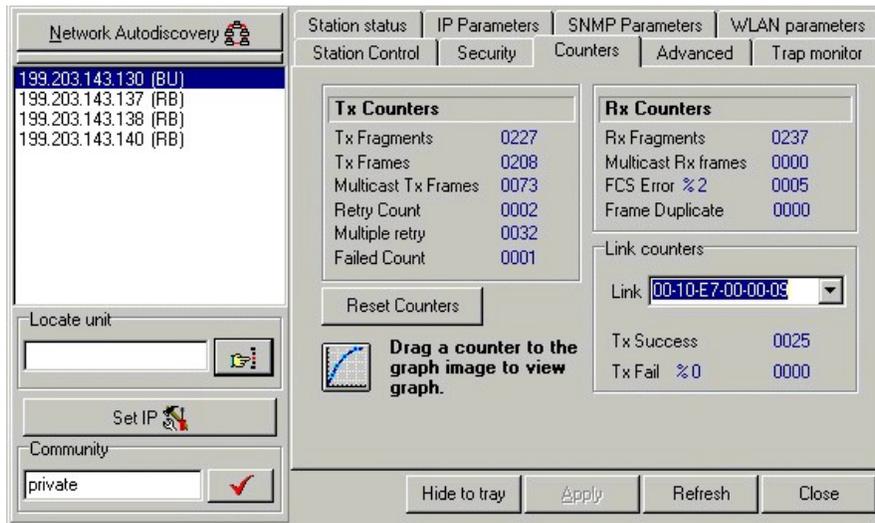


Figure 3-11. Counters Tab (BU-Fusion Units)

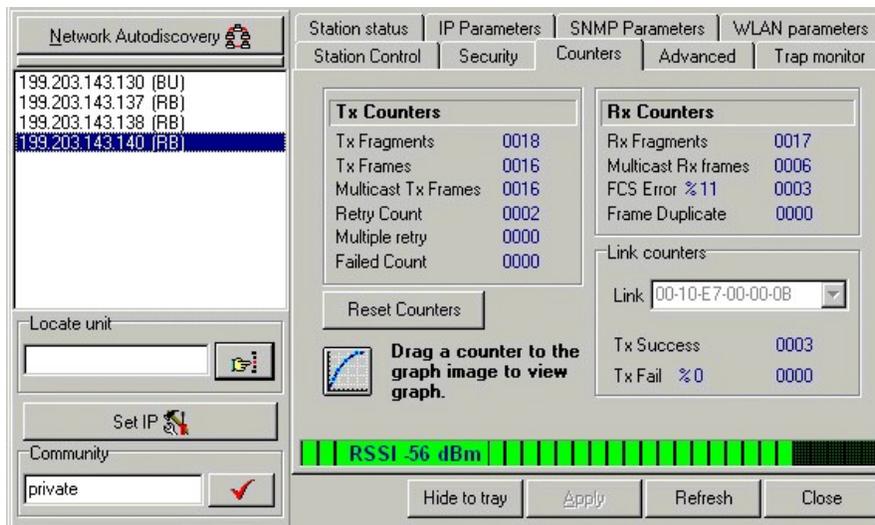


Figure 3-12. Counters Tab (RB-Fusion Units)

Using the Counters windows, you can view a wide range of performance data from both sides of the link. For RB-Fusion units, you can monitor the received signal strength through the RSSI (Received Signal Strength Indication) bar indicator at the bottom of the window. This RSSI bar can be used to optimize antenna alignment and improve link quality.

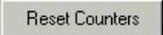
Additional performance counters displayed in this window include the following. To obtain a graph that displays the counter values, select a counter and drag it to the  icon.

- **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).
- **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.

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- **Multicast Tx Frames** - The number of transmitted multicast frames.
- **Rx Fragments** - The number of frames received, including data, control and duplicate data frames.
- **Multicast Rx** - The number of received multicast frames.
- **RTS Success** - The number of successful Request To Send frames sent.
- **RTS Failed** - The number of failed Request To Send frames sent by the station.
- **ACK Failed** - The number of times the station stopped transmitting a frame after failing to receive an acknowledgment packet.
- **Failed Count** - This counter is incremented when a packet is not transmitted successfully due to the number of transmit attempts exceeding the Short or Long Retry Limit. Users that are in the Technician Login Mode can set these thresholds.
- **Retry Count** - The number of retransmissions.
- **Multiple Retry** - This counter increases when a packet is successfully transmitted after more than one retransmission.
- **Frame Duplicate** - The number of duplicate frames that were sent or received.
- **FCS Error** - The number of CRC errors in addition to the percentage of CRC errors out of the total frames.

3.3.4.1 Resetting Counters

You can reset the counters displayed in the Counters tab by clicking the  button. All displayed values are reset to zero.

***Note:** This action does not reset the counters stored in the actual unit, but rather resets the values displayed on the screen (an exception is the link-specific counters described in the next section). If you exit the Counters tab after performing a reset and reopen it at a later time, the counter values are displayed to reflect the values stored in the unit. To reset the counters in the unit, turn off the unit and then turn it back on.*

3.3.4.2 Link-Specific Counters (BU-Fusion Only)

The Tx Success and Tx Fail counters displayed at the end of the Counters List are link-specific. To activate these counters for a specific link, select the MAC address of the unit at the other end of the link and click Apply.

When you click the  button, these counters are completely reset (unlike the other counters which are only reset on screen).

3.3.5 WLAN Parameters Tab

The WLAN Parameters tab allows you to define or edit parameters related to the Wireless LAN environment in which the selected unit is operating. The window displayed varies depending on the type of unit selected.

THE FUSION CONFIGURATION UTILITY

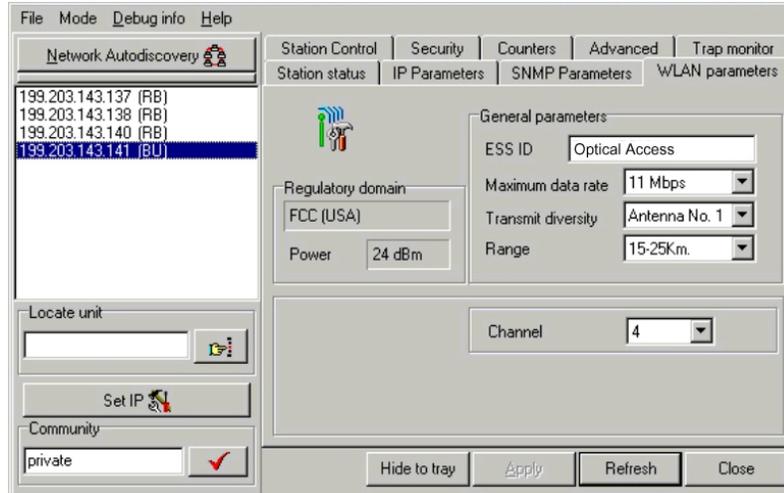


Figure 3-13. WLAN Parameters Tab (BU-Fusion Units)

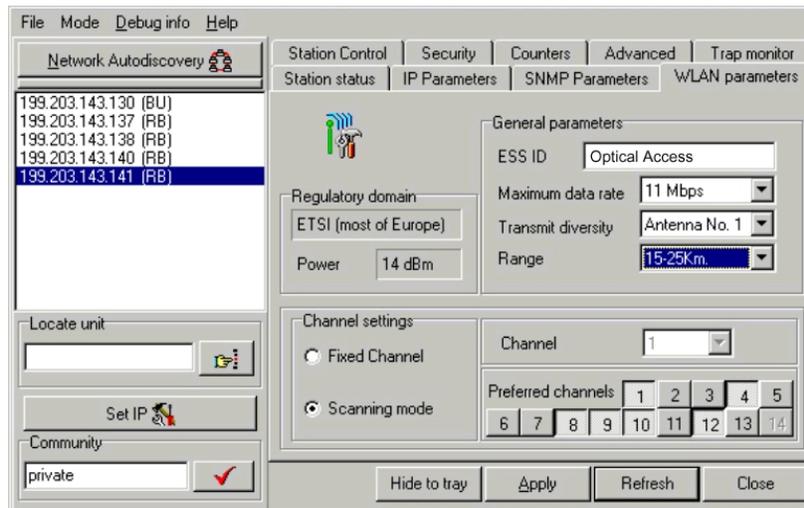


Figure 3-14. WLAN Parameters Tab (RB-Fusion Units)

- **Regulatory Domain** - This read-only field displays the regulatory authorities in the country of use.
- **Power** - This read-only field displays the current output power level at the antenna port configured.
- **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 BU-Fusion units in the extended WLAN. The ESSID field is case-sensitive.
- **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. The default value is 11 Mbps.
- **Transmit diversity** - Sets the antenna diversity option to antenna number 1 (default is antenna number 1).
- **Range** - Select the operative range of your WLAN or Wireless Link in the drop down list. This parameter affects the delay time, which needs to be increased in long links. The default value is up to 5 km.
- **Channel** - The method of channel selection varies depending on the type of unit.

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For BU-Fusion units, select the channel by selecting a value (range: 1-14, depending on your regulatory domain) from the Channel pull down field. Refer to Table 3-1 for the list of corresponding frequencies.

For RB-Fusion units, there are two channel setting options: if you select the *Fixed Channel* option by clicking the appropriate radio button, then the RB-Fusion will search for the BU-Fusion unit on the selected channel (from the Channel pull down field) and synchronize with it. The channel you select must match the channel selected in the BU-Fusion unit at the other end of the link.

If you select the *Scanning Mode* option (by clicking the appropriate radio button), you can specify preferred channels by clicking one or more of the buttons displayed at the bottom of the window. In this mode, the RB-Fusion will first search for the BU-Fusion unit on the channel you select in the Channel pull down field and synchronize with it if the link is established. If the RB-Fusion does not find the BU-Fusion, it will scan and search for one of the referred channel frequencies you selected. If it does not find the BU-Fusion on any of the preferred channels, it will continue to scan until it finds the BU-Fusion on one of the channels permitted according to the regulatory domain.

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
12	2467 MHz
13	2472 MHz
14*	2484 MHz

* Japan only

Table 3-1. Frequency Selection List

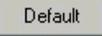
Note: The frequencies listed in the table are at the center of the channel. Each channel occupies 22 MHz; therefore each channel occupies -11 MHz to $+11$ MHz from the frequency specified.

3.3.6 Station Control Tab

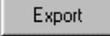


Figure 3-15. The Station Control Tab

THE FUSION CONFIGURATION UTILITY

Station Control- This option reverts system parameters back to original factory default settings. Click the  button for all parameters to revert to defaults.

Reset Unit - Click the  button to reset the unit and apply any changes made to the system parameters.

Export - Click the  button to export the current basic configuration of this unit to a file. A popup window is displayed, prompting you to specify the name of the file. The file can be used to save the configuration information or to send it to the MRV Communications Customer Service Organization as a reference for troubleshooting.

3.3.7 Security Tab

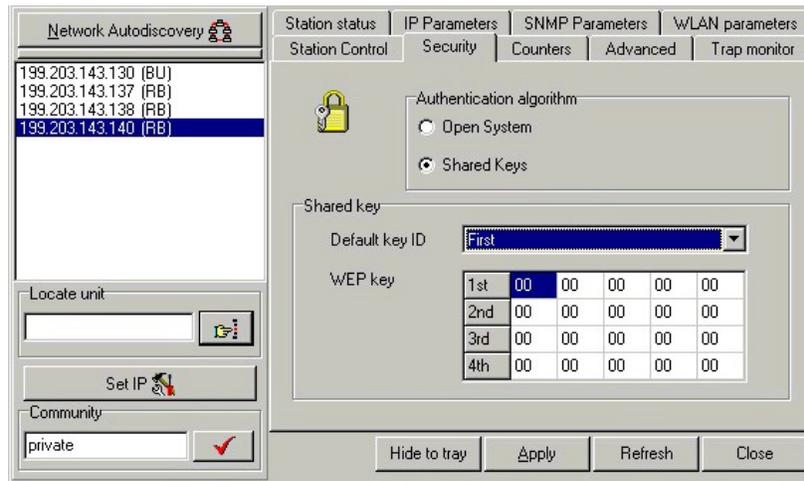


Figure 3-16. Security Tab

This window displays the following read-only information regarding the security configuration of the unit. Wired Equivalent Privacy (WEP) is an authentication algorithm, which protects authorized Wireless LAN users against eavesdropping and is implemented in MRV Communications Fusion units. WEP is defined in the IEEE 802.11b standard. The encryption is applicable for both authentication and data. The key length is 40 bits.

Fusion units can use one of the following authentication algorithms (as defined in the IEEE 802.11b standard).

- **Open System** – any station in the WLAN can associate with a BU-Fusion and receive and transmit data (null authentication).
- **Shared Key** – only stations using a shared key encryption identified by the BU-Fusion are allowed to associate with it.

The default authentication algorithm is Open System.

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

- **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 RB-Fusion and the BU-Fusion.
- **WEP Key** – Define the encryption keys used for transmissions between the station and the BU-Fusion. 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. By clicking

THE FUSION CONFIGURATION UTILITY

<apply> after accepting the values, the WEP Key values are displayed as zeros for security reasons.

The default WEP key is the first key. All units in the same cell should use the same key.

3.3.8 Advanced Tab

The Advanced tab provides additional performance information.

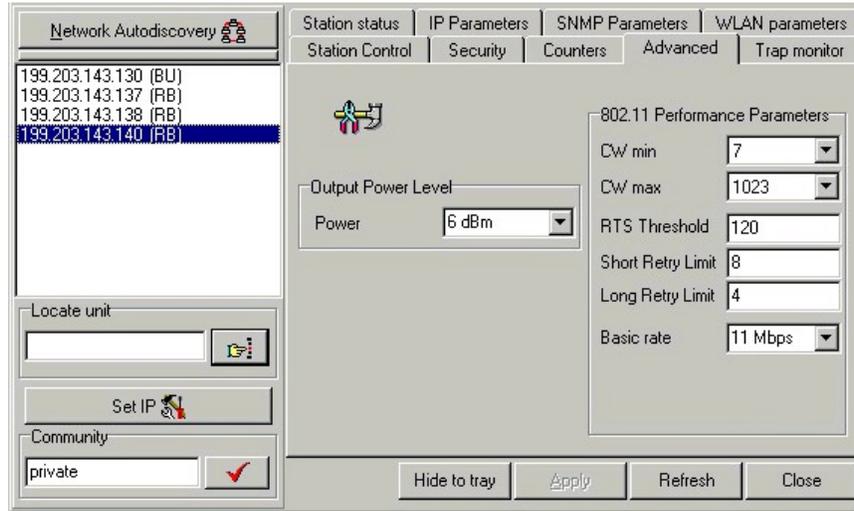


Figure 3-17. Advanced Tab

CW Min/Max - Select the contention window size. The contention window backoff algorithm is a well-known method used to resolve contention between different stations wanting to access the medium. Defaults are 31 for CW Min and 1023 for CW Max.

RTS Threshold - Enter the minimum packet size requiring an RTS (Request to Send) before the data packet is sent. For packets with a size below the RTS Threshold Value, an RTS is not sent and the data packet is transmitted directly to the WLAN.

Short Retry Limit - Indicates the maximum number of transmission attempts of a frame, the length of which is less than or equal to the RTS Threshold Value, that shall be made before a failure condition is indicated. The default value is 8.

Long Retry Limit - Indicates the maximum number of transmission attempts of a frame, the length of which is greater than RTS Threshold, that shall be made before a failure condition is indicated. The default value is 4.

Basic Rate – Determines the maximum rate of multicast and broadcast transmissions. Multicast and broadcast transmissions are not acknowledged; therefore, there is a chance that such transmissions will not be properly received without using the acknowledgement mechanism for retransmission. It is recommended that a lower rate for transmission of broadcast, multicast and control frames be used to increase the probability that they will be received without errors. Enter the data rate at which broadcast, multicast and control packets are transmitted. The default value is 2 Mbps.

Note: The Basic Rate parameter should be changed only if you are sure that all units in the cell can handle the defined rate. Use this parameter with caution, as it could bring the link down.

3.3.9 Trap Monitor Tab

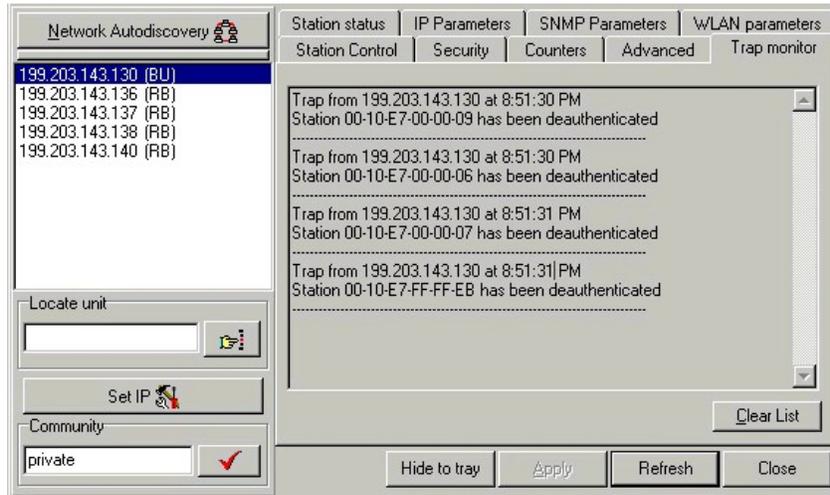


Figure 3-18. Trap Monitor Tab

When an event occurs, a trap is sent to the defined host address (the setting is made in the SNMP Parameters tab described in Section 3.3.3). This window displays the recorded traps.

Click the button to clear the display area.

3.3.10 Debug Info

This option allows you to create a log file named *OAFusion.log*. You can send this log file to the MRV Communications Customer Service Organization and receive help based on the information recorded in this file.

When you finish recording (usually after 24 hours) select Stop Log and send the file to MRV Communications Customer Service Organization.

4. SYSTEM TROUBLESHOOTING

The following troubleshooting guide provides answers to some of the more common problems, which may occur when installing and using the MRV Communications Fusion system. If problems not covered here should arise, check the Ethernet and WLAN counters (see Section 3.3.4). If the problem persists, please contact the MRV Communications Customer Service Organization.

4.1 Troubleshooting Guide

Problem and Indication	Possible Cause	Corrective Action
No Power to Unit. Power LED is off.	<ol style="list-style-type: none"> 1. Power cord is not properly connected. 2. Power supply is defective. 	<ol style="list-style-type: none"> 1. Verify power cord is properly connected to the MRV Communications unit and to the power outlet. If the cord is properly connected, you may need to replace the power supply.
Failure to establish wireless link. LINK LED is off and unit resets every few minutes.	<ol style="list-style-type: none"> 1. Power supply to units may be faulty. 2. The RB-Fusion units may not have the same ESSID as the BU-Fusion. 	<ol style="list-style-type: none"> 1. Verify power to units. 2. Verify that all units in the network have the same ESSID as the BU-Fusion (ESSID must be identical in all units in the WLAN; the ESSID is case sensitive). 3. Check that the units are on the same channel. 4. Verify wireless link: <ul style="list-style-type: none"> • Set BU-Fusion and RB-Fusion unit side by side. • Power on each unit and see if a wireless link is established • If the units fail to associate, reset units to factory default values (see Section 2.3). The units should now establish a wireless link.
Failure to establish wireless link	<ol style="list-style-type: none"> 1. Power supply to units may be faulty. 2. Cables may be improperly connected. 3. There may be some problem with antenna installation. 	<ol style="list-style-type: none"> 1. Verify power to units. 2. Verify that all cables are connected securely. 3. Refer to section above and verify the wireless link between the units. 4. Verify that the antenna(s) are properly installed (see relevant section in this manual): <ul style="list-style-type: none"> • Check antenna alignment. • Verify that antenna polarization is the same at both ends. • Verify that the range matches specifications. • Verify line-of-sight/antenna alignment/ antenna height.
Wireless link established, but there is no Ethernet activity (BU-Fusion and RB-Fusion units).	<ol style="list-style-type: none"> 1. Ethernet hub port or UTP cable is faulty. 2. Ethernet port in unit is faulty. 3. The station is associated to a BU-Fusion unit that is not connected correctly to the LAN. 	<ol style="list-style-type: none"> 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 crossover UTP cable (pins 1 & 3, 2 & 6) if connected directly to workstation, or a straight cable if connected to a hub. 4. Check the unit's LINK LED indicator and verify the Ethernet counters in the monitor to confirm Ethernet activity (see Section 3.3.4). Check that there are no other BU-Fusion units with the same channel and ESSID, but not connected to the LAN.
The TereScope link appears to be down, but the changeover to the Fusion has not occurred	<ol style="list-style-type: none"> 1. The fiber on one end of the link may have come off the unit. 2. One fiber may have been damaged. 	<p>Check the Tx and Rx lights on the back of the TereScope. If they are both lit, contact the MRV Communications Customer Service Organization for assistance.</p>

Table 4-1. Troubleshooting

5. SOFTWARE DOWNLOAD PROCEDURE

1. Set the unit's IP address using the Fusion Configuration 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. Utilize the Firmware Upgrade procedure using the Fusion Configuration Utility, as described in Section 3.2.1. Download will be completed within two minutes and a message of a successful file transfer will be shown on the screen. The unit resets itself automatically.
4. Check the diagnostics LEDs to verify that there has not been a hardware failure and use the Fusion Configuration Utility to ensure the version number is correct.

Note: Do not disconnect any cables or try to stop the process before downloading is complete. All configured parameters are kept during the upgrade/download procedure.

6. TECHNICAL SPECIFICATIONS

6.1 Supported Standards

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

6.2 Power Specifications

Power Supply Input (via indoor unit)	207 VAC – 253 VAC 250 mA OR 100 VAC – 120 VAC 500 mA AC main option is factory wired.
Power Supply Output (from indoor unit to outdoor unit)	48 VDC

6.3 Wired LAN Interface

Compliant with	Ethernet/IEEE 802.3 CSMA/CD
Physical interface	10BaseT
Connector type	RJ-45
Network operating systems	All

6.4 Radio Specifications

Type	Direct Sequence Spread Spectrum
Range	Europe/ETSI: 10 km USA/FCC: 24 km (15 miles)
Transmit Power	USA/FCC: 24 dBm (max) to –4 dBm (min) Europe/ETSI: 14 dBm (max) to –4 dBm (min) Dependent upon system application & country regulation.
Frequency range	2.4-2.4835 GHz
Number of channels	Europe/ETSI: 13 (3 non-overlapping) USA/FCC: 11 (3 non-overlapping) France: 4 (1 non-overlapping)

6.5 Sensitivity

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

TECHNICAL SPECIFICATIONS

6.6 Configuration and Management

Configuration and setup	SNMP and Windows-based Configuration Utility
Site Survey	Yes
LED Indicators	Yes
SNMP Management	Yes

6.7 Specific Features

Data rate	<ul style="list-style-type: none"> • 11 Mbps • 5.5 Mbps • 2 Mbps • 1 Mbps
Utility Software	MRV Communications Configuration Utility, runs on Windows 95, 98, 2000 and Windows NT

6.8 Size

Dimensions	Fusion outdoor unit: 30 cm x 30 cm x 7.2 cm (including Antenna) Indoor unit: 15.4 cm x 8.4 cm x 5.6 cm
------------	--

6.9 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, weather protected)
Storage Humidity	10% to 90% (Non-condensing)	10% to 90% (Non-condensing)

6.10 Yagi Antenna Specs

Frequency Range	2400-2483.5 MHz
VSWR	<2:1, 1.5:1 nominal
Front-to-Back Ratio	>20 dB
Gain	13.5 dBi (11.3 dBd) nominal
Vertical Beamwidth @ 1/2 Power	30°
Horizontal Beamwidth @ 1/2 Power	28°
Equivalent Flat Plate Area	0.375 ft ²
Lateral Thrust at Rated Wind	31.4 lbs
Bending Moment at Base at Rated Wind	23.6 lb-ft
Cable Length	18 inches
Cable Type	RG58A/U
Connector	Type N, male
Length	18 inches
Weight	.76 lbs
Polarization	Vertical

7. Warranty Information

LIMITED WARRANTY

MRV Communications warrants its equipment to be in good working order for thirteen (13) months from the date of shipment. If equipment proves to be defective and MRV Communications is notified within the warranty period, MRV Communications will, at its option, repair or replace the equipment at no charge. All repairs will be done at MRV Communications' repair facility. Damage to equipment resulting from negligence, misuse, tampering or acts of God is not covered by this warranty. MRV Communications will make every effort to rerun your equipment to you as quickly as possible. Shipping costs for the return of equipment for repair by MRV Communications shall be the responsibility of the purchaser.

All defective equipment must be returned to MRV Communications for repair in the original shipping container. If MRV Communications' Technical Support Department determines that your equipment, or any part of it, will need to be returned to the factory for repair, an RMA number must be obtained prior to shipping equipment. Failure to obtain an RMA number prior to shipment will result in delays with repairing the equipment. This number must be marked clearly on the outside of the shipping container.

Limitations of Liability: Except for liability allowed by applicable law, (I) in no event shall MRV Communications be liable under any legal theory, however caused, for any loss of profits, loss of business, loss of use or data, interruption of business, or for indirect, special, incidental or consequential damages of any kind, even if MRV Communications has been advised of the possibility of such damages and (II) in no event will MRV Communications' aggregate liability arising out of or related to this warranty exceed the amount paid or payable to MRV Communications for the defective equipment. These limitations of liability will continue beyond the expiration of this warranty. This warranty is in lieu of all other warranties, express or implied or statutory, including any warranty of merchantability or fitness for a particular purpose.

8. Contact Us

Equipment Return Address:

Attn: Technical Services Center
MRV Communications - San Diego Operations
10343 Roselle Street
San Diego, California 92121

Phone:

858-657-9663

Fax:

858-657-9677

E-mail:

service@mrv.com

www.mrv.com

www.opticalaccess.com

APPENDIX A. MRV Communications Quick Install Guide for the Fusion System

Fusion Quick Installation Guide

This Quick Installation Guide is intended for experienced installers and network administrators. Please refer to the complete MRV Communications Fusion Set Up and Operations Manual for further details and information regarding the installation procedures. Read this guide thoroughly before installing the Fusion system.

System Description

The MRV Communications Fusion System consists of two units, the Base Unit (BU-Fusion) and a Remote Bridge (RB-Fusion). Both the RB and the BU have indoor and outdoor components, including a directional Yagi antenna.

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

Please have the following equipment on hand before beginning the installation:

<u>Item</u>	<u>Quantity</u>
PC or Laptop	2
CAT 5 Cables (Straight)	2
CAT 5 Cables (crossed)	2
Fusion RF Radio system*	1 Link
Indoor and Outdoor BU-Fusion unit*	1 each
Indoor and Outdoor RB-Fusion unit*	1 each
Yagi Antenna*	2
Indoor-to-Outdoor cables	2

*Items marked with an * are supplied by MRV Communications.

The installation process should follow these general steps:

1. Select appropriate locations for the outdoor unit, the antenna and the indoor unit.
2. Perform an indoor link verification and configuration on the RB-Fusion side. Follow **Sections A & B** below.
3. Complete the outdoor installation by mounting the outdoor unit and the Yagi antenna and connecting the outdoor unit to the antenna(s) using antenna port 1 (Y1). See **Section B** below.
4. Connect a ground cable between the outdoor unit and an appropriate grounding point.
5. Remove the service box assembly of the outdoor unit, unscrew the top nut and route the indoor-to-outdoor cable through the top nut and the service box. Assemble an RJ-45 connector on the cable, connect it to the Ethernet connector and replace the service box. Tighten the nut. Make sure that the external jack of the cable is well inside the service box to guarantee a good seal. Route the cable to the location selected for the indoor unit. See **Section C** for specific instructions.

APPENDIX A: QUICK INSTALL GUIDE

6. Mount the indoor unit. Assemble an RJ-45 connector with a protective cover on the indoor side of the indoor-to-outdoor cable and connect it to the indoor unit's radio port. See **Section D** for additional instructions on connecting the indoor-to-outdoor cable.
7. Connect the indoor unit's Ethernet port to the Ethernet hub using a straight Ethernet cable or directly to the PC's NIC using a crossed cable.
8. Align the antenna and verify connectivity with the other unit(s). See **Sections E & F** for specific instructions.
9. For proper operation, RSSI should be between -85 dBm and -61 dBm (MRV Communications recommends -79 dBm RSSI). Table 1 displays the mapping between the power bars and received power on the RB-Fusion outdoor unit. The Configuration Utility provides the RSSI reading under the Counters tab for the RB-Fusion unit and the Station Status tab for the BU-Fusion.
10. The link should now be operational.

	Bar0 (red)	-91 dBm
	Bar1 (green)	-87 dBm
	Bar2 (green)	-83 dBm
	Bar3 (green)	-80 dBm
	Bar4 (green)	-77 dBm
	Bar5 (green)	-74 dBm
	Bar6 (green)	-71 dBm
	Bar7 (green)	-66 dBm
	Bar8 (green)	-61 dBm
	Bar9 (yellow)	-55 dBm

Table A-1. Mapping of Received Power by Color on the RB-Fusion Outdoor Unit

Section A: Indoor Link Verification of the RB-Fusion Side

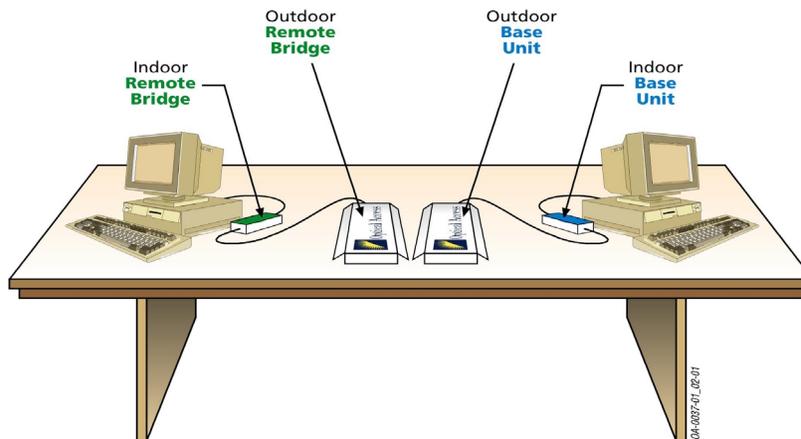


Figure A-1. Indoor Link Verification Set Up

It is important to perform an indoor system verification before transporting the links to their final locations. However, you should NOT connect the Yagi antenna to perform this verification.

APPENDIX A: QUICK INSTALL GUIDE

1. Connect the RB-Fusion outdoor unit to the indoor unit using a straight CAT 5 cable.
2. Connect the BU-Fusion outdoor unit to the indoor unit using a straight CAT 5 cable.

Note: Each indoor and outdoor unit has a Media Access Control (MAC) address. Make sure that the indoor unit and the outdoor unit you match have the same MAC addresses.

3. Power up the RB-Fusion indoor unit.
4. Power up the BU-Fusion indoor unit. Make sure the orange power LED light is on.
5. Connect the indoor RB-Fusion unit to a PC using a crossed CAT 5 cable.
6. Connect the indoor BU-Fusion unit to a PC using a crossed CAT 5 cable. Make sure the green LED light is lit on the indoor units.
7. Follow **Section B** to complete an indoor link verification.
8. Run a ping session between the two PCs connected to the RB-Fusion and BU-Fusion.

Note: Both PC's must be on the same IP subnet.

Section B: Installing the MRV Communications Fusion Configuration Utility Software

Note: The software only needs to be installed on one of the two PCs you will be using during the configuration process.

1. Set the IP address

1. Click the  button. The Set IP dialog box is displayed.
2. Enter the MAC address and the assigned IP address.
3. Type the parameters in the appropriate fields and click **OK**. A message box will be displayed, notifying you when the changes are to take effect. The MAC address can be found on the bottom label of the indoor unit and on the outdoor unit. This feature can be used only if the Fusion Configuration Utility is on the same Ethernet segment as the unit and not behind the router.

Note: To see the unit after assigning the IP address, the PC with the Configuration Utility should be on the same IP subnet as the assigned IP address. Units receive an auto IP address if there is no DHCP server and the unit is configured to work in the Smart mode as described in Section 3 of the Fusion Set Up and Operations Manual. The IP address will be chosen randomly in the 169.254.X.X range with a subnet mask of 255.255.0.0. For further information on the entire software configuration process, please see the MRV Communications Fusion Set Up and Operation Manual, Section 3.

Note: As with the indoor link verification, both PC's must be on the same subnet and both units must have the same ESS ID.

4. In order to input, modify or update the radio parameters, change the community parameter from "public" to "private" and click the check () box.

2. WLAN Parameter

APPENDIX A: QUICK INSTALL GUIDE

1. Enter the ESS ID (remember that it is case sensitive). This is done for security reasons. Please note that both units have the same ESS ID.
2. Select the speed.
3. Select the channel on the BU-Fusion. The RB-Fusion must be in Scanning Mode.
4. For additional information on speed, antenna and range, see the MRV Communications Fusion Set Up and Operations Manual.

Note: MRV Communications recommends that Antenna #1 be connected to the Yagi antenna. The initial power should be set at the maximum range and should be scaled back after installation.

Section C: Preparing the Indoor-to-Outdoor Cable

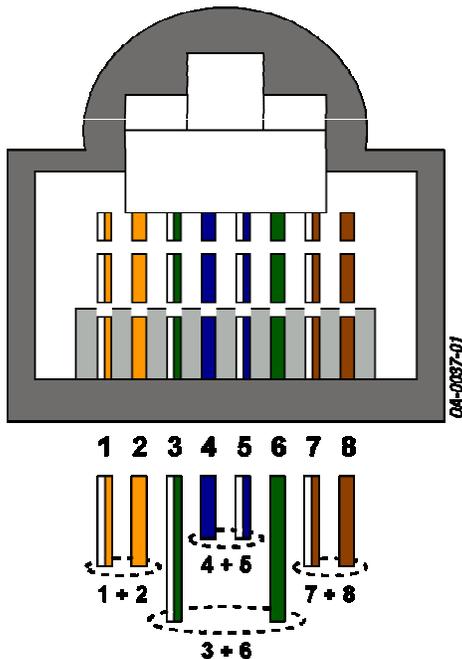
The indoor-to-outdoor cable provides pin-to-pin connection on both sides. It is supplied open-ended, to allow the installer to conveniently route the cable through the service box of the outdoor unit and into the building.

Figure A-2 shows the wire pair connections required for the indoor-to-outdoor cable.

Use a standard RJ-45 crimp tool to prepare the wires. Insert them into the appropriate pins and use the crimp tool to crimp the connector. Make sure to do the following:

1. Remove as small a length of the external jacket as possible.
2. Be sure that the external jacket is well inside the service box when connected to the outdoor unit. This will ensure a good seal.
3. Pull back the shield drain wire before inserting the cable into the RJ-45 connector to ensure a good connection with the connector's shield after crimping.

For additional explanation of the preparation process for the indoor-to-outdoor cable, see the MRV Communications "Preparing the Indoor-to-Outdoor Cable" process, found in Appendix B of the MRV Communications Fusion Set Up and Operations Manual.



Pin	Color Code
1	White/Orange
2	Orange
3	White/Green
4	Blue
5	White/Blue
6	Green
7	White/Brown
8	Brown

Table A-2. Wire Pin Colors for Preparing the Indoor-to-Outdoor Cable

Figure A-2. Pinout of Indoor-to-Outdoor Cable

APPENDIX A: QUICK INSTALL GUIDE

Section D: Connecting the Indoor-to-Outdoor Cable

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

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.

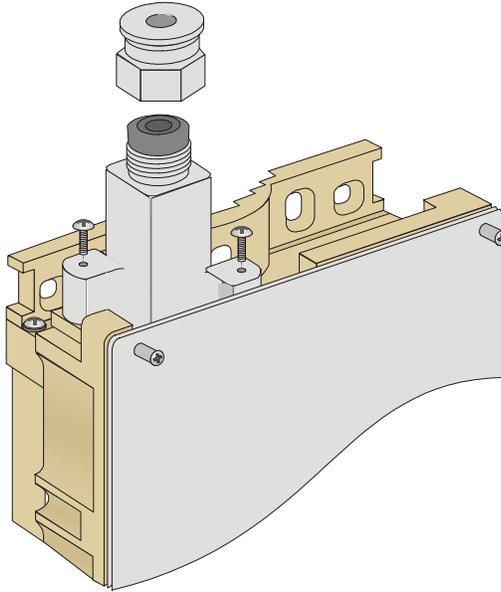


Figure A-3. Routing the Indoor-to-Outdoor Cable through the Waterproof Seal

3. Route an uncrimped straight Ethernet cable (8-wire, 24 AWG pin-to-pin) through the top nut and the waterproof seal.

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

4. Insert and crimp the RJ-45 connector.
5. Connect the Ethernet cable to the outdoor unit's RJ-45 connector.
6. Replace the waterproof seal assembly to the outdoor unit and then replace the top nut. Make sure that the external jack of the cable is well inside the service box to guarantee a good seal.
7. Route the cable to the location selected for the indoor unit.
8. Assemble an RJ-45 connector with a protective cover on the indoor side of the indoor-to-outdoor cable and connect it to the indoor unit's radio port.

Section E: To Perform Antenna Alignment

1. Power on both units.
2. Synchronize the units by aligning the antennas at the main and remote sites until maximum signal quality is obtained. Check the signal strength RSSI bar on the bottom panel of the RB-Fusion bottom panel. If the received signal quality is lower than expected for this antenna/range combination, change the antenna height and verify the RF cable connections. See the general installation process in this guide for specific information on appropriate RSSI values.

APPENDIX A: QUICK INSTALL GUIDE

Section F: Verifying Correct Operation

To verify proper operation of the outdoor unit, view the LED indicators located on the bottom panel of the unit as shown in the following table:

Outdoor Unit LEDs

Name	Description	Functionality
WLAN	Wireless Link Indicator	<i>Blinking Green</i> – Data received or transmitted on wireless link. Blinking rate is lower when there is no wireless traffic.
DC Power	Self Test and Power indication	<i>Green</i> – Self test passed and 48 V DC power is received by the outdoor unit <i>Red</i> – Self-test failed. Firmware did not load successfully.
ETH	Ethernet activity/ Connectivity indication	<i>Off</i> – Ethernet connectivity is OK. No traffic activity detected on the port. <i>Blinking Green</i> – Ethernet connectivity is OK, with traffic on the port. <i>Red</i> – No Ethernet connectivity.
RSSI BAR (RB-Fusion)	Received Signal Strength Indicator	For Optimal operation, RSSI values should be between –85 and –61 dBm (MRV Communications recommends –79 dBm RSSI). If the RSSI value falls within that range, the RSSI bar will be green.
RSSI BAR (BU-Fusion)	Number of Associated RB-Fusion Units	This bar will always be red because there is always one RB for each BU.

Table A-3. Outdoor Unit LEDs

To verify proper operation of the indoor unit, view the LED indicators located on the front panel of the unit as shown in the following table:

Indoor Unit LEDs

Name	Description	Functionality
POWER	Power indication	<i>Green</i> -The indoor unit supplies 48 V DC to the radio port <i>Off</i> - No power is supplied to the radio port.
LINK	Self Test and Remote Ethernet Link indication	<i>Off</i> – No Ethernet connectivity has been detected between the outdoor unit and the device connected to the indoor unit. <i>Orange</i> – Self-test passed and Ethernet connection between the outdoor unit and the device connected to the indoor units is detected. Note: <i>The LINK LED indicates end-to-end connection between the outdoor unit and the Ethernet connection to the indoor unit.</i>

Table A-4. Indoor Unit LEDs

APPENDIX B: PREPARING THE INDOOR-TO-OUTDOOR CABLE

Appendix B: Preparing the Indoor-to-Outdoor Cable

This section describes, in detail, the procedure for preparing the indoor-to-outdoor cable. Only one end of the cable is terminated with a connector. To make it easier to test the cable, two cables can be made together by doubling the length and terminating each end with a connector. After testing, the cable is cut in half to form 2 cables with one connector on each end.

Special Tools or Supplies:

Item	Qty.	Description
1	*	Cable, RJ-45 CAT 5, insulated
2	1 **	Shielded Connector
3	1	Copper tape, 1" wide
4	1	Cable Tester
5	1	Portable Vice
6	1	Modular plug hand tool assembly (Crimper)
7	1	Jacket Stripper
8	1	Pair of small wire cutters
9	1	Pair of tweezers (suggested)
10	1	Pair of regular needle nose pliers

Table B-1. Supplies needed

* Amount of cable required is dependent on customer requirements.

** Bring several extra connectors as spares.

Procedure:

1. Measure cable length.
2. Strip insulation. Use a jacket stripper to remove 1" of insulation (and the paper surrounding the cable) from the end of the cable.
3. Fold shield back over insulation.
4. Trim .75" from the shield, leaving approximately .25".
5. Bend the shield back over the insulation to use as a ground.
6. Wrap copper tape once around the base of the shielded wires.
7. Arrange wires in correct color order. See table below for correct placement.

Pin	Color Code
1	White/Orange
2	Orange
3	White/Green
4	Blue
5	White/Blue
6	Green
7	White/Brown
8	Brown

Table B-2. Pin colors

APPENDIX B: PREPARING THE INDOOR-TO-OUTDOOR CABLE

8. Cut off the end of the wires to leave approximately .50" of wire.
9. Make sure that the wires are still in the correct color order.
10. Insert cable into vice with bare end hanging forward. This frees both of your hands to work directly with the cable.
11. Ensure the wires are close together and flat; use a needle nose pliers to flatten the end of the wire covered by the copper tape.
12. Insert the wires into the Connector. Looking at the top of the connector (top view below), make sure the wires are in their correct location and they are pushed all the way to the end of the connector. To ensure a tight fit, the connector needs to fit snugly over the wires and .25" of the copper tape.

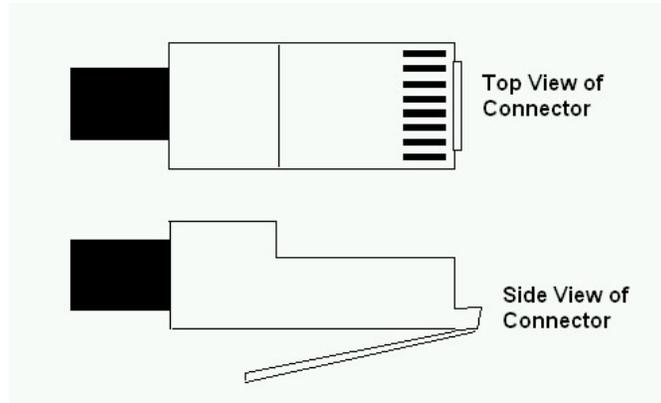


Figure B-1. Top and side view of connector

13. Crimp connector. Before crimping, inspect the connector to make sure the shield and .25" of the copper tape is inside the connector. A pull test may be necessary to ensure the connection is strong.

APPENDIX C. RADIO SIGNAL PROPAGATION

C.1 Radio Signal Propagation

C.1.1 Introduction

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

The following diagram depicts a typical radio system:

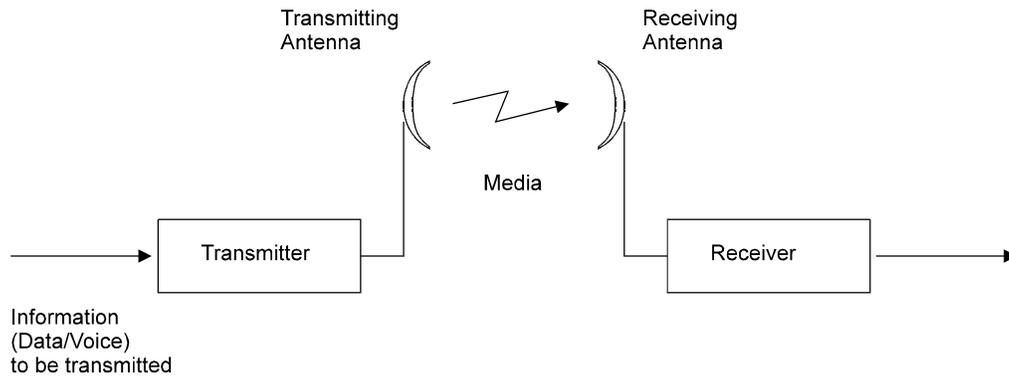


Figure C-1. A Typical Radio System

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.

C.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:

$$Pd_{Bm} = 10 \times \text{Log } P_{mw}$$

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

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

APPENDIX C: RADIO SIGNAL PROPAGATION

Attenuation

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



Figure C-2. Attenuation of an RF signal

P_{in} is the incident power level at the attenuated input

P_{out} is the output power level at the attenuated output

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

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

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:

$$\text{Free space loss} = 32.4 + 20 \times \text{Log}(\text{FMHz}) + 20 \times \text{Log}(\text{Rkm})$$

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: $100 + 20 \times \text{Log}(\text{Rkm})$

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. 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.

APPENDIX C: RADIO SIGNAL PROPAGATION

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.

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:

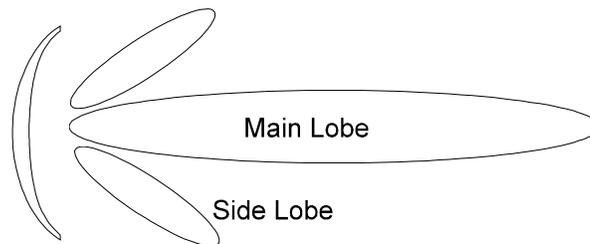


Figure C-3. Radiation Pattern of a Directional Antenna

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

APPENDIX C: RADIO SIGNAL PROPAGATION

PsReceiver 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 dBm (2.5 Mw)

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

Tx and Rx antenna gain (G_t and G_r) = 18 dBi

Distance between sites = 3 km

Receiver sensitivity (P_s) = -84 dBm

Link Budget Calculation

$$EIRP = P_{out} - C_t + G_t = 16 \text{ dBm}$$

$$P_l = 32.4 + 20 \times \log(F \text{ MHz}) + 20 \times \log(R \text{ km}) \cong 110 \text{ dB}$$

$$S_i = EIRP - P_l + G_r - C_r = -82 \text{ dBm}$$

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. A higher margin is normally 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.

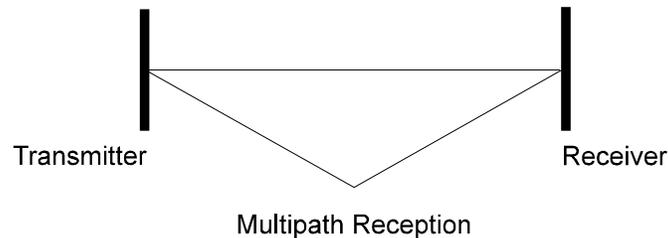


Figure C-4. Multipath Reception

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

APPENDIX C: RADIO SIGNAL PROPAGATION

- 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:

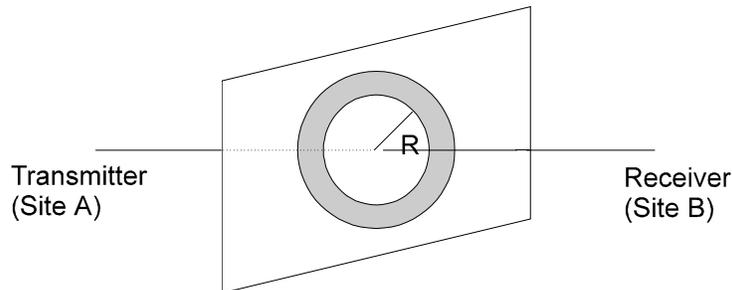


Figure C-5. Fresnel Zone

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

R: radius of the first Fresnel zone

λ : wavelength

D: distance between sites

APPENDIX C: RADIO SIGNAL PROPAGATION

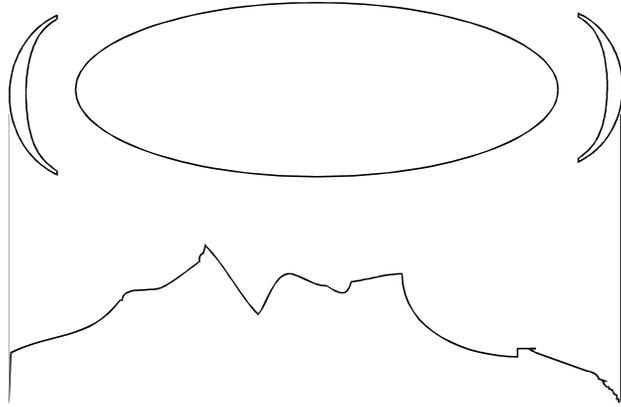


Figure C-6. Fresnel Zone Clear of Obstacles

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

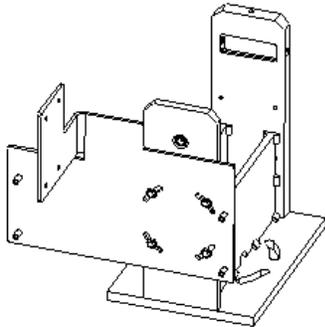
APPENDIX D: MOUNTING THE FUSION SYSTEM WITH ANY MRV
COMMUNICATIONS TERESCOPE™

Appendix D: Mounting the Fusion System with an MRV Communications TereScope™

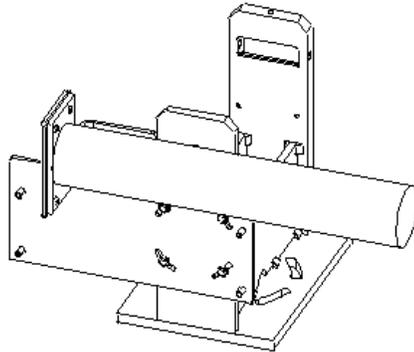
Purpose:

The following procedures describe the correct assembly process for installing a microwave antenna and radio on a TereScope unit. Follow the correct procedure depending on TereScope product being used.

Procedure:

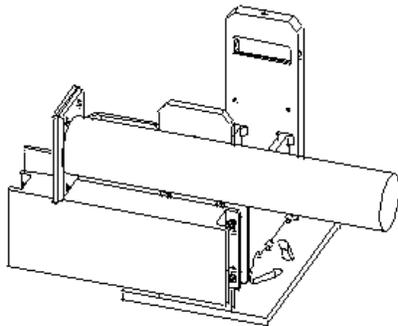


STEP 1 Orient the RF Mount and bolt it onto the Gimbal using #10-24 hex head screws and #10 SAE washers (large washers). Torque to 25±2 in-lbs. Do not over torque.

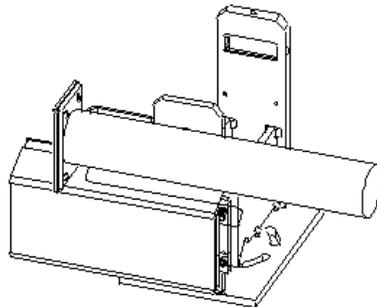


**MOUNTING FUSION TO
A TS1000 SERIES AND
155 PROTOCOL
INDEPENDENT SERIES**

STEP 2 Bolt the antenna onto the mount using #10-32 button head screws.



STEP 3 Bolt the radio onto the mount using #10-32 socket head screws with NAS C10 washers. Make sure to orient the radio so the LED's are in back (same side as the TereScope LED's). Torque to 25±2 in-lbs. Do not over torque.



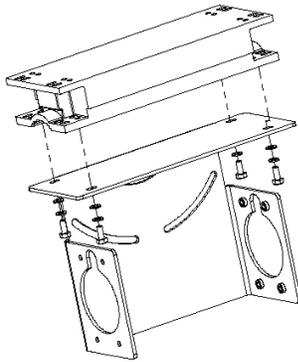
STEP 4 Attach the weather shield to the radio using given hardware. Make sure the text on the shield is right side up.

STEP 5 Connect the antenna cable to port 1 on the radio.

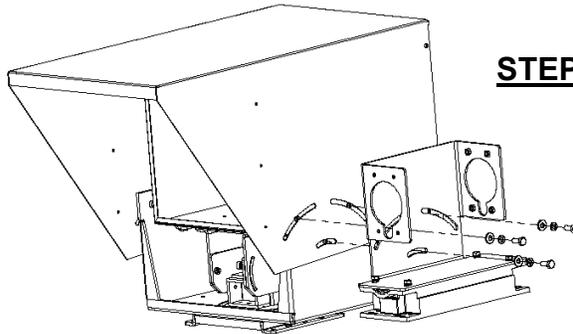
STEP 6 Connect the Ethernet cable to the RJ-45 connector on the radio.

APPENDIX D: MOUNTING THE FUSION SYSTEM WITH ANY MRV COMMUNICATIONS TERESCOPE™

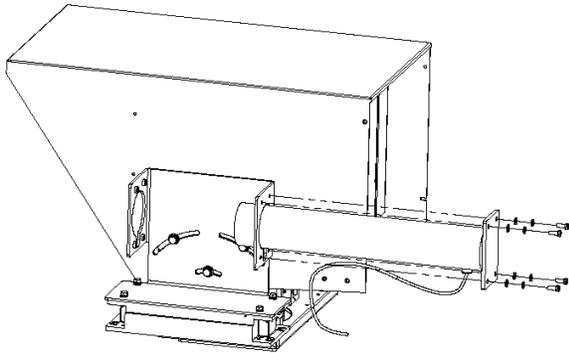
**MOUNTING FUSION TO
A TS4400 OR 940
SERIES CHASSIS.**



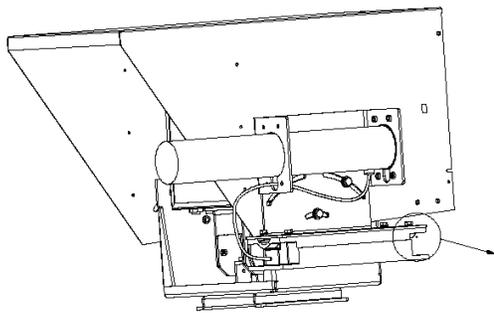
STEP 1 Base Unit Attachment



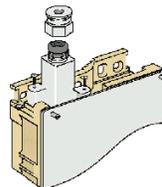
STEP 2 Attachment to TereScope



STEP 3 Yagi Antenna Attachment



STEP 4 Yagi Antenna Connection to Unit



APPENDIX E: CONFIGURING A SWITCH WHEN MOUNTING A FUSION SYSTEM WITH AN MRV COMMUNICATIONS TERESCOPE™

APPENDIX E: CONFIGURING A SWITCH WHEN MOUNTING A FUSION SYSTEM WITH A TERESCOPE™

If you are using the Fusion as a backup to a TereScope link and are completing the package with an OptiSwitch switching mechanism, you will need the following information. If you have questions regarding switch configuration that are not covered in this section, please call the MRV Communications Customer Service Organization.

Subject to proper RF spectrum analysis, the OptiSwitch supports multiple RF backup to each TereScope.

Software Version

The current software version supporting the laser/microwave switchover is 2.45 UEC2.

Switching occurs at the physical layer based on optical signal loss at the TX and RX fiber interfaces. The OptiSwitch is equipped with a hybrid copper/fiber module to accommodate the Fusion system. It is suggested that media converters not be used in this situation.

Switchover Mechanism

a. Configuring the Switch:

The command to configure the switch is:

```
SYS_console>new_ec (Create a new EtherChannel)
    [arg #0] data base type – either {run|nvram|all}
    [arg #1] Ports –ports list in format: S1.D1-...-Sn.Dn (all the RF backup and the laser ports)
    [arg #2] Forced port (Laser port) – this port will pass all traffic; default: None
```

Example:

If the laser is on port 5 on module 1 and the RF backups are on port 2 and 3 on the same module, then:

```
SYS_console>new-ec 1.02-1.03-1.05 1.05
```

b. Setting-up the Delay Time

In addition to configuring the primary and backup ports, it is possible to configure the wait-time from the laser to RF (ex. 1 sec.) and from the RF to the laser (ex. 5 sec.) independently using the command:

```
SYS_console> set-wait-times (Wait before making changes after a link change)
    [arg #0] time to wait when forced port link fall in seconds: 1 to 60 seconds
    [arg #1] time to wait when forced port link arise in seconds: 1 to 60 seconds
```

Example:

```
SYS_console>set-wait-times 1 5
```

In this example, the switch will not switch back to the laser until it is stable for at least 5 seconds without flickering. To read the fall and arise time parameters, use the following commands:

```
SYS_console> get-wait-times
```

APPENDIX E: CONFIGURING A SWITCH WHEN MOUNTING A FUSION SYSTEM WITH AN MRV COMMUNICATIONS TERESCOPE™

Link waiting time when forced port fall is _1_ seconds

Link waiting time when forced port arise is _5_ seconds

c. Testing the Switching Mechanism:

After proper installation, unplug both the TX and RX fibers from the switch on the BU-Fusion side. The system should properly switch to the Fusion back up.

Block the optical beam on the outdoor unit (on both the RB-Fusion and BU-Fusion sides). The system should properly switch to the Fusion back up.

APPENDIX F. FUSION FAQ

What is the TereScope Fusion?

The TereScope Fusion combines the attributes of two transport mediums, Free Space Optics (FSO) and Radio Frequencies (RF), to provide 99.999% available communications links for enterprise and carrier-class customers.

How does the TereScope Fusion work?

A TereScope FSO system is operated in parallel with a Fusion RF system. If the TereScopes are unable to effectively communicate, they will stop sending a signal to a switch or router, causing that device to switchover to the Fusion RF link until the TereScopes become available. We recommend using our OptiSwitch layer 2 switches, with a hybrid fiber and copper module, to perform this function.

How many BU-Fusion or RB-Fusion units can be co-located on the same building top or tower?

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

Do you need a frequency license to use the Fusion?

No, the Fusion RF units transmit over unlicensed frequencies of 2.4 GHz and do not require FCC frequency allocation.

What is the antenna separation requirement for co-locating Fusion units on the same building top or tower?

The antennas should be mounted at least 2 feet apart. Greater separation will improve the link distance.

What is the throughput of the Fusion?

As a backup to a TereScope, the Fusion link typical performance is 4.2 Mbps using TCP and 6.2 Mbps using UDP. For longer-range links, the performance will drop about 5%.

Why are there 11 channels and only 3 usable?

The IEEE802.11b specification calls out 11 selectable channels in the USA between 2414 MHz and 2462 MHz. Because of the transmission bandwidth of the Fusion 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 Fusion 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 Fusion link experiences interference?

If interference is affecting the Fusion link, one of the other channels may be selected to operate away from the frequency of the interference. Physically re-locating the antennas may help as well.

What is the typical latency of a BU-Fusion/RB-Fusion?

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

Can the BU-Fusion/RB-Fusion firmware be upgraded?

APPENDIX F: FREQUENTLY ASKED QUESTIONS

Yes, the firmware in the Fusion is stored in Flash and is upgraded using the built-in TFTP server.

Can just anyone erase my Fusion Flash or change the firmware?

No, the TFTP server in the BU-Fusion/RB-Fusion 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 Fusion has a backup Flash, which contains the previous version of firmware. If the primary flash is corrupted, the backup is automatically used to return the unit to an operating state.

When does the backup 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 Fusion firmware?

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

Can I keep the previous version of firmware?

The previous version of firmware cannot be kept on the Fusion itself, but can be stored on your PC and loaded if needed.

Does Fusion support 802.1Q VLAN?

Yes, but the support is limited to transparent operation. Fusion 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 Fusion?

No. The regulatory domain is factory set.

How can I configure or manage my Fusion if I forget the SNMP Community name?

Using a suitable tool, press the <reset> button on the back panel. This will set the read and write Community names to “public” and “private” respectively.

What is the maximum number of networked PCs the Fusion can learn?

From the LAN side, 1024 network MAC addresses can be learned by the BU-Fusion/RB-Fusion.

What is the range of the Fusion Bridges?

For a point-to-point link, 15 miles or 24 km.

What are the power supply ratings for the Fusion?

The Fusion power supply is rated for 100 – 240 V AC input (47-63 Hz) and 9 V DC at 1.67 A output. Polarity doesn't matter.

APPENDIX F: FREQUENTLY ASKED QUESTIONS

What management options are available on Fusion?

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

Does the Fusion offer out-of-band management?

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

What installation and site survey tools are available for Fusion?

The Fusion 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-Fusion/RB-Fusion.

What is the normal PER (packet error rate) for the BU-Fusion/RB-Fusion?

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

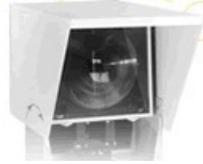
What is the best value for the CW win parameter on the Fusion?

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.

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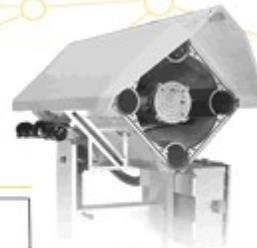


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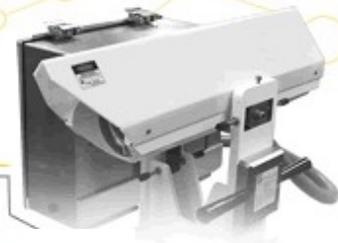
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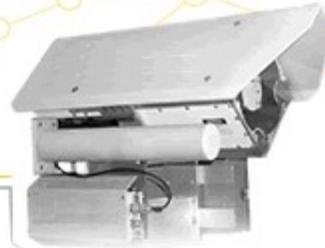
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