



# ***EUM3005***

## ***Installation Guide***

APCD-LM047-2.1

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## Regulatory Notices

This equipment has been tested and found to comply with the limits for a Class B Intentional Radiator, pursuant to Part 15 of the FCC Regulations. These limits are intended to provide protection against harmful interference when the equipment is operated in a residential environment.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

## Notice to User

Any changes or modifications to equipment that are not expressly approved by WaveRider may void the user's authority to operate the equipment.

# Contents

<b>Figures</b> .....	<b>vi</b>
<b>Tables</b> .....	<b>vii</b>
<b>Preface</b> .....	<b>viii</b>
<b>1 Introduction</b> .....	<b>1</b>
1.1 Document Scope .....	1
1.2 EUM3005 Features .....	2
1.3 EUM3005 - End-user Modem or Customer Premises Equipment .....	4
1.3.1 EUM3005 Active Diversity Indoor Antenna .....	6
1.3.2 EUM3005 Modem - External Indicators and Connectors .....	7
1.3.3 Ethernet Port .....	9
1.3.4 Power Supply .....	9
<b>2 Setup Menu</b> .....	<b>11</b>
2.1 Accessing the Setup Menu .....	11
2.2 Setup Menu .....	12
2.3 Radio Link Status Display .....	12
2.4 Troubleshooting Information Display .....	14
<b>3 Installation</b> .....	<b>17</b>
3.1 Installation Checklist .....	17
3.2 Pre-Installation Steps .....	18
3.2.1 Network and EUM3005 Configuration .....	18
3.2.2 Verifying the EUM3005 Components .....	19
3.2.3 End-Users PC .....	19
3.3 Installation Steps .....	19
3.3.1 Locating the EUM3005 Antenna .....	20
3.3.2 Mounting and Orienting the EUM3005 Antenna .....	21
3.3.3 Connecting the End-User's PC .....	21
3.3.4 Testing the Data Link .....	22
3.4 Post-Installation .....	26
<b>Appendix A Factory Configuration</b> .....	<b>27</b>
<b>Appendix B Ethernet Cables and Connectors</b> .....	<b>29</b>

# Figures

Figure 1	EUM3005 Indoor Modem with Indoor Active Diversity Antenna . . . . .	3
Figure 2	EUM3005 Components . . . . .	5
Figure 3	Indoor Antenna Components . . . . .	5
Figure 4	EUM3005 Indoor Antenna with Switched-beam Diversity . . . . .	6
Figure 5	EUM3005 Switched-beam Diversity Antenna — Beam Patterns . . . . .	7
Figure 6	EUM3005 Modem - External Indicators and Connectors . . . . .	8
Figure 7	Typical Installations of EUM3005 . . . . .	21
Figure 8	T568A Wiring . . . . .	31
Figure 9	T568B Wiring . . . . .	31

# Tables

Table 1	Ethernet Status LEDs . . . . .	8
Table 2	Power ON LED Status . . . . .	8
Table 3	Signal Level LED Status . . . . .	8
Table 4	Signal Strength Figure of Merit . . . . .	14
Table 5	Signal Quality Figure of Merit . . . . .	14
Table 6	Pre-Installation Stage Checklist . . . . .	17
Table 7	Installation Stage Checklist . . . . .	18
Table 8	Ethernet Interface Specifications . . . . .	30
Table 9	Wiring T568A and T568B ends for Ethernet Cables . . . . .	30

# Preface

## Conventions

The following conventions are used throughout this document:

### WARNING!



**Whenever you see this icon and heading, the associated text addresses or discusses a critical safety or regulatory issue.**



**CAUTION:** Whenever you see this icon and heading, the associated text discusses an issue, which, if not followed, could result in damage to, or improper use of, the equipment or software.



**TIP:** Whenever you see this icon and heading, the associated text provides a tip for facilitating the installation, testing, or operation of the equipment or software.

## Regulatory Notices

This device has been designed to operate with its indoor active diversity antenna only. This device has been tested using unshielded Ethernet CAT-5 cable.

### Industry Canada

The IC Certification Number for the EUM3005 (Cdn) is 3225B-EUM3003.

Operators must be familiar with IC RSS-210 and RSS-102. The EUM3005 (Cdn) has been designed and manufactured to comply with IC RSS-210 and RSS-102.

Due to different regulatory requirements, the EUM3005 (Cdn) outputs about 1.5 dB less power than the EUM3005 and is to be used in Canada. The EUM3005 (Cdn) is labelled clearly as such. An EUM3005 (Cdn) can be used in the US, since it has lower power than the FCC requirements. However, an EUM3005 cannot be used in Canada due to its higher output power.

## Federal Communications Commission

The EUM3005 has been designed and manufactured to comply with FCC Part 15.

Operators must be familiar with the requirements of the FCC Part 15 Regulations prior to operating any link using this equipment. For installations outside the United States, contact local authorities for applicable regulations.

The FCC ID for the EUM3005 equipment is OOX-EUM3005.

The transmitter of this device complies with Part 15.247 of the FCC Rules.

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

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and 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 help.

### Interference Environment

Operation is subject to the following conditions:

- This device may not cause harmful interference and,
- This device must accept any interference received, including interference that might cause undesired operation.

## Operational Requirements

In accordance with the FCC Part 15 regulations:

1. The maximum average power output of the intentional radiator shall not exceed one (1) watt (30 dBm) for all spread spectrum systems operating in the 902 to 928MHz band.
2. Stations operating in the 902 to 928MHz band may use transmitting antennas of directional gain greater than 6dBi, provided the average output power from the intentional radiator is reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.
3. The operator of a spread spectrum system and the user of the radio device are each responsible for ensuring that the system is operated in the manner outlined in *Interference Environment* on page ix.

The EUM3005 with its indoor diversity antenna complies with these requirements, since the maximum average transmitting power is 24.4 dBm measured at the antenna port. This is 5.6 dB below the maximum allowed, so the active diversity indoor antenna system with its 4.4 dBi gain, including the loss in the captive RF cable, is allowed.

## Warnings and Advisories

### General Advisory

Installers, operators and maintenance personnel must be familiar with the related safety requirements before they attempt to install or operate the EUM3005.

It is the responsibility of the operator to ensure that the public is not exposed to excessive Radio Frequency (RF) levels. The applicable regulations can be obtained from local authorities.

### WARNING!



To comply with FCC RF exposure limits, the EUM3005 must be fix-mounted indoors to provide a separation distance of 20cm (8 inches) or more from all persons to satisfy RF exposure requirements. The distance is measured from the nearest point of the modem to the human body. It is recommended that the modem be installed in a location with minimal pathway disruption by nearby personnel.

## Important Safeguards

### WARNING!



**CAUTION:** To reduce risk of electrical shock, do not remove covers, since there are no user-serviceable parts inside. Refer servicing to qualified personnel.

1. Read all these instructions before installing and operating the EUM3005.
2. Retain these instructions for future reference.
3. Heed all warnings on the EUM3005 and in these instructions.
4. Follow all instructions.
5. Do not use EUM3005 and power supply near water.
6. Unplug EUM3005 and power supply from the wall outlet before cleaning. Clean only with a damp cloth.
7. Use only attachments recommended by WaveRider.

8. The slots and vents in the housing protect the EUM3005 from overheating to ensure reliable operations. Do not cover the EUM3005 and power supply. Do not place the EUM3005 or power supply near or over a radiator, stove, heat register or other source of heat. Do not place the EUM3005 and power supply in a built-in installation such as a bookcase or rack unless proper ventilation is provided.
9. Operate the EUM3005 only from a 4.2 VDC power supply. This is a custom power supply. Using other AC/DC converters, even 4.5 VDC converters, can result in damage to the EUM3005.
10. Operate the power supply only from a 100 - 250 VAC, single phase, 47-63 Hz AC power source. The power supply is rated for indoor use only.
11. The power supply may be equipped with a 3-wire grounding-type plug, which will only fit into a grounding-type power outlet. This is a safety feature. If you are unable to insert the plug into the outlet, contact an electrician to replace your obsolete outlet. Do not defeat the purpose of the grounding-type plug.
12. Route the AC Power-supply cord, Ethernet cable and Antenna cable so that they are not likely to be walked on or pinched by items placed upon or against them, paying particular attention to cord and cables at their plugs, convenience receptacles and the points where the cords exit the equipment.
13. Provide strain relief for cables near their connections. This is typically done by leaving a loop in the cable near the connection.
14. Do not locate the EUM3005 in the vicinity of power lines or other electric light or power circuits, or where it can fall onto such power lines or circuits.
15. For added protection during a lightning storm, or when it is left unattended and unused for long periods of time, unplug the power supply to the EUM3005 and unplug the power supply from the wall outlet. This will power down the EUM3005.
16. Do not overload wall outlets and extension cords as this increases the risk of fire or electric shock.
17. Never push objects of any kind through openings in this wireless product as they may short-out parts that could result in a fire or electric shock. Never spill liquid of any kind on the power supply. The EUM3005 and its antenna are indoor units. They are not submersible nor immune to liquids.
18. Do not attempt to service this wireless product yourself. Refer all servicing to qualified service personnel.
19. Unplug power supply from the wall outlet and refer servicing to qualified service personnel under the following conditions:
  - When the power supply cord or plug is damaged.
  - If liquid has been spilled or objects have fallen into these products.
  - If the power supply or modem have been exposed to rain or water.
  - If the EUM3005 does not operate normally for an extended period of time when following the operating instructions. Note that it is possible that Internet traffic can be slow even under normal operations due to network congestion and radio interference and fading and not as result of problems with the EUM3005.
  - When the EUM3005 or power supply exhibit distinct changes in performance. This may indicate a need for service.

20. When replacement parts are required, be sure the service technician has used replacement parts specified by the WaveRider or with the same characteristics as the original part. Improper substitutions may result in fire, electric shock or other hazards.
21. Upon completion of any service or repairs to this wireless product, ask the service technician to perform safety checks to determine that the wireless product is in proper operating condition.
22. Install the EUM3005 in compliance with local and national electrical codes. The following are the national codes. The installer is responsible for knowing the appropriate local codes.
  - In the United States, use the National Electrical Code (NEC);
  - In Canada, use the Canadian Electrical Code, Part 1, CSA C22.1;
  - In other countries, use International Electrotechnical Commission (IEC) 364, part 1 through 7.

## Revision History

<b>Date</b>	<b>Revision</b>	<b>Description</b>
May 2004	0.1	Initial Version for lower power
Mar. 2005	1.0	Increased power due to FCC changes, update for new Software
Mar. 2005	1.1	Minor edits to correct procedures
June 2005	2.0	Change description of LEDs to reflect SW V10.3 and later. Improve installation instructions.
Feb 2006	2.1	Update for SW 11.0 - Security features

## Customer Support

An extensive knowledge base is available at [support.waverider.com](http://support.waverider.com).

WaveRider offers a complete training program. Please contact your sales representative for training information.

WaveRider also offers priority telephone and email support. Please contact your sales representative for details.

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# 1

## Introduction

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The LMS4000 900 MHz Radio Network provides wireless high-speed Internet connectivity to business, SOHO (small office, home office) and residential customers. LMS4000 operates in a point-to-multipoint configuration, with one base station efficiently serving many subscriber stations. LMS4000 transmission is based on a high-performance MAC protocol, and industry-standard IP routing, Ethernet switching and data encryption technology. No radio license is required, since LMS4000 operates in the 900 MHz ISM band. LMS4000 can deliver Internet service over long ranges and often where the radio paths between the base station and subscribers are partially or even totally obscured, that is, non-line-of-sight. Connection between the end-user's computer and the subscriber station is through an Ethernet port.

The EUM3005 is the latest indoor modem for the LMS4000 system and offers significant improvements over the EUM3004: higher output power, extended temperature range, DHCP Client, Automatic CCU Discovery, Automatic Remote Configuration, Secure Authentication and User Data Encryption support, easy-to-use Setup menu, and enhanced VoIP support.

### 1.1 Document Scope

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This Installation Guide covers only the EUM3005. It provides information on the installation of the EUM3005, its performance, and any required regulatory information, including approved installation notices.

Related information can be found in the suite of available LMS4000 manuals, which includes the following:

- *LMS4000 900 MHz Radio Networking Concepts* (APCD-LM053)
- *LMS4000 Data Networking Concepts* (APCD-LM050)
- *LMS4000 Managing the Network* (APCD-LM052)
- *LMS4000 CLI Reference Manual* (APCD-LM051)
- *LMS4000 SNMP Reference Manual* (APCD-LM049)
- *Acronyms and Glossary* (APCD-LM056 )

These manuals provide information not included in this Installation Guide, including information on:

- Planning, installing and managing the network.
- Diagnostic tools for the network and EUM.
- Details on the Command Line Interface and methods of accessing the EUM.
- Manual configuration of the EUM via the CLI.
- Glossary of network terms.

These manuals, as well as manuals for hardware elements, including EUMs and CCUs, can be found on WaveRider's Web site (<http://www.waverider.com>).

Other documents on the WaveRider web site are useful to assist in installing and operating the EUM3005.

WaveRider recommends that you be familiar with the following sections before proceeding with the instructions in this guide:

- *Software License Agreement* on page iii
- *Warranty* on page iv
- *Conventions* on page viii
- *Warnings and Advisories* on page x
- *Important Safeguards* on page x

**NOTE:** The information contained in this manual is subject to change without notice. The reader should consult the WaveRider web site for updates.

## 1.2 EUM3005 Features

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The EUM3005, shown in [Figure 1](#) with the indoor active diversity antenna, is an indoor wireless modem that connects to the end-user's computer through an Ethernet connection. It is installed indoors at the end-user's premises and provides an interface to the customer's computer or local area network on one side and wireless access to the LMS4000 network on the other.



**Figure 1 EUM3005 Indoor Modem with Indoor Active Diversity Antenna**

The EUM3005, which acts as a network bridge, receives data from the CCU (Communication Access Point Channel Unit or base station) over the 900 MHz radio link, and then forwards this data to EUM3005 internal processes or to the end-user's computer through the Ethernet port. In the other direction, the EUM3005 forwards data received from the end-user's computer over the radio link to the CCU3000.

The EUM3005 has new features that provide improved RF performance as well as ease of installation and extended temperature range. The RF performance is enhanced due to the improved transmit power. Hardware and software improvements make installation easier than ever, allowing rapid deployment, single person installation, and even end-user self-installation. These improvements include alignment tools, and Automatic Remote Configuration of key parameters using DHCP and RADIUS. Automatic Remote Configuration also allows the network operator to easily manage and reconfigure the EUM3005 after it is installed, including changing frequency, passwords, and SNMP parameters.

Key features of the EUM3005 include:

- **Easy Indoor Installation** - The EUM3005 is an indoor unit. The EUM3005 can work in uninhabited indoor locations, such as attics, if there is an adequate RF signal. The advantages of an indoor unit and an indoor antenna include:
  - More flexible installations.
  - An easily mounted antenna, designed for indoor use.
  - No long RF cable runs.
  - Lower installation costs, since the modem can be installed by the end-user.
- **Active diversity indoor antenna** - There are many advantages to the EUM3005's active diversity indoor antenna:
  - Reduced RF losses since there are no long cable runs.
  - Active diversity, which is done on a packet by packet basis, so that the EUM3005 performs better in a multi-path fading environment.
  - Easy mounting and positioning antenna, using a wall, window, window frame, or other surface.

- **Higher RF Power<sup>1</sup>** - As a result of changes to the FCC rules, the EUM3005 can provide higher output power. Previous indoor modems were limited to 26 dBm PEAK power at their antenna port. The EUM3005 provides 27.3 dBm PEAK power.
- **DHCP Client enabled** (factory default)- The EUM3005 can obtain its IP address, subnet mask and IP gateway information from a DHCP server, reducing the amount of configuration needed for installation. This also allows the Network Operator to re-assign IP addresses to EUMs without having to access the EUM itself.
- **Automatic CCU Discovery** (factory default) - The EUM3005 searches the full RF frequency range to locate CCUs. It then selects the CCU with the best RF signal that allows it to register. With this and DHCP Client enabled (factory defaults), the installer does not need to enter ANY configuration parameters into the EUM3005 in order to install it.
- **Automatic Remote Configuration** - The EUM3005 will accept parameters from a RADIUS server to set other configurable parameters in the modem. These parameters include: password, all SNMP parameters, RF Frequency (including enabling Automatic CCU Discovery), and number of customers.
- **Secure Authentication and User Data Encryption:** The EUM3005 can perform mutual authentication with the CCU using the secure 4-way handshake mechanism of WPA2. All user data flowing over the air can be encrypted using the industry standard IEEE802.11 TKIP cypher. Traffic to and from each EUM is encrypted using a key specific to that EUM, ensuring message integrity and privacy for each user.
- **Installation Tools** - The EUM3005 has LEDs and a SETUP Menu to make installation and alignment easy and error-free. The EUM3005 supports the local link IP address, 169.254.10.250, on its Ethernet port at all times. Using the local-link address, the user can use the password “setup” to call up the setup menu that allows any user to check the RF link quality to help align the EUM3005 and troubleshoot the link. This avoids needing to know the IP address and password of the modem.

Detailed specifications for the EUM3005 can be found on the WaveRider website.

## 1.3 EUM3005 - End-user Modem or Customer Premises Equipment

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Figure 2 and Figure 3 show the components that make up the EUM3005 Customer Premises Equipment.

Key components of the customer-premises equipment are described on the following pages:

- *EUM3005 Active Diversity Indoor Antenna* on page 6
- *EUM3005 Modem - External Indicators and Connectors* on page 7
- *Ethernet Port* on page 9
- *Power Supply* on page 9

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1. Does not apply to the EUM3005 (Cdn) used in Canada at this time.

EUM3005 Modem



AC/DC Power Supply



Crossover Ethernet Cable



**Figure 2 EUM3005 Components**

Antenna with RF Cable



Mounting Hardware



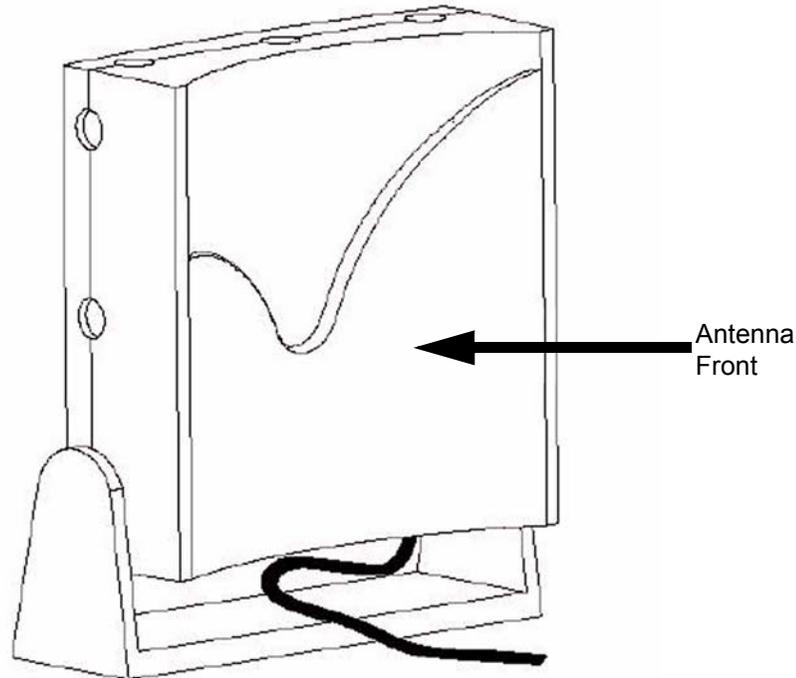
Mounting Bracket



**Figure 3 Indoor Antenna Components**

### 1.3.1 EUM3005 Active Diversity Indoor Antenna

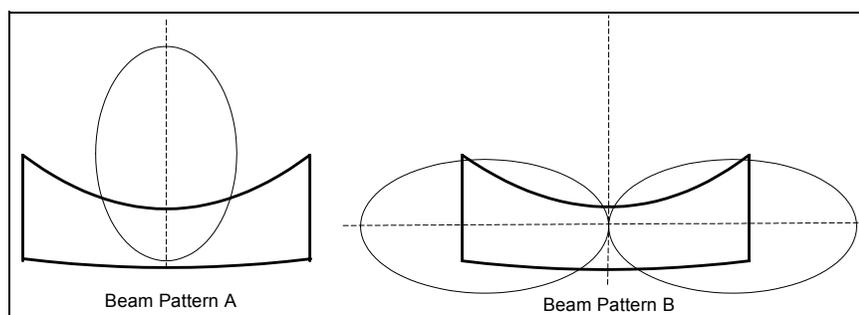
The EUM3005 Active Diversity Indoor Antenna uses switched-beam diversity. This antenna, shown in [Figure 4](#), performs very well in cases where the radio path to the CCU is obstructed and/or where there is significant multipath. The antenna comes with a mounting bracket and is designed to mount vertically on walls (using drywall screws), or horizontally (on desks, for example, using the suction cups). **The concave surface of the antenna is the front.**



**Figure 4 EUM3005 Indoor Antenna with Switched-beam Diversity**

The EUM3005 Active Diversity Indoor Antenna contains two vertical antenna elements mounted inside and on either side of the antenna housing. The phasing between these elements, which modifies the antenna pattern, is controlled by a DC voltage from the EUM3005. It produces two patterns, one perpendicular to the face of the antenna, which has a gain of about 6 dBi (not including cable loss), and the other, a dual-beam pattern off both sides, offering about 3 dBi gain for each beam. These beam patterns are illustrated in [Figure 5](#).

The EUM3005 samples the signal strength from both antenna patterns during the preamble of every received packet and automatically selects the best signal. When the EUM3005 transmits, it sends on the antenna pattern that was last used to receive a signal.



**Figure 5 EUM3005 Switched-beam Diversity Antenna — Beam Patterns**

The end user must position the switched-beam diversity antenna correctly to receive an adequate signal level. The Radio LED on the EUM3005, described in *section 1.3.2*, EUM3005 Modem - External Indicators and Connectors, or the setup menu, described in *Setup Menu* on page 11, can be used to help with the alignment. Since the switched-beam diversity antenna has a good front-to-back ratio, it can be positioned to suppress interference from other wireless devices at the end-user's premises.

The EUM3005 is not approved to be used with any other antenna. For installations requiring an outdoor antenna, the EUM3006 Integrated Outdoor Modem is recommended for its superior performance and ease of installation.

The EUM3005 Active Diversity Indoor Antenna comes equipped with a 3 m RF cable and connector. The connector is a proprietary WaveRider connector, which is mandated by the FCC requirement that the connectors used in ISM band products that are not professionally installed must be unique, or at least not readily available.

### 1.3.2 EUM3005 Modem - External Indicators and Connectors

The EUM3005 has 3 connectors on the back plate to connect the modem to the end-user's computer, the antenna and the power supply.

The EUM3005 also has 6 LEDs, three on the back plate and 3 on the front. Two of the back plate LEDs, Ethernet Link and Signal Level, are repeated on the front, making it easier for the user to see the status of the modem and its RF signal.

[Figure 6](#) shows the layout of the EUM3005 Connectors and LEDs, while [Table 1](#), [Table 2](#), and [Table 3](#) explain what each LED means.



**Figure 6 EUM3005 Modem - External Indicators and Connectors**

**Table 1 Ethernet Status LEDs**

LED State	Ethernet Status
Ethernet Link	If the Link LED is ON, the Ethernet physical connection is configured and working properly. If the Link LED is OFF, then the Ethernet physical connection is not working properly, which could be because the wrong type of cable was used or there is a problem with the host or device Ethernet interface. If connecting directly to the end-user PC, use the crossover Ethernet cable provided. If connecting to a router or switch, use a straight-through cable.
Ethernet Traffic	The Ethernet Traffic LED flashes whenever the link is transferring data.

**Table 2 Power ON LED Status**

Power On State	Status
ON	DC voltage is connected to the wireless modem.

**Table 3 Signal Level LED Status**

Signal Level State	Status
Flashing	The EUM has adequate signal level to support the radio link. As the signal level increases, the flash rate increases. Turn or move the antenna slowly until the Signal Level LED flashes as fast as possible.
Off	The EUM does not have adequate signal level (<-86 dBm). Move and/or turn the antenna until it begins flashing. A location near a window facing a street is usually best.

### 1.3.3 Ethernet Port

The EUM has one 10BaseT Ethernet port. Details on the Ethernet port are found in [Appendix B on page 29](#).



**CAUTION:** Any DC voltage applied to the Ethernet port may damage the EUM, the Ethernet cable, and/or network gear. The EUM3005 is not a Power-over-Ethernet device.

### 1.3.4 Power Supply

Power is provided to EUM3005 through its AC/DC Power supply, which supplies 4.2 VDC through a standard barrel (5.5 x 2.5 x 9.5 mm) connector to the modem.



**CAUTION:** Using any other power supply than that provided by WaveRider, especially any other DC voltage will result in damage to the modem.



---

# 2

## Setup Menu

---

The EUM3005 is equipped with a simple setup menu through which you can align the antenna, monitor the RF link quality and view the key parameters of the modem.

### 2.1 Accessing the Setup Menu

---

The setup menu is accessed by connecting a Telnet session to the 'local link' IP address of the EUM3005, 169.254.10.250, with password = 'setup'. The connection must be through the Ethernet port, not over the air via the RF link.

The computer needs to have an IP address of 169.254.x.y with a 16 bit mask (255.255.0.0), where x and y can be any value from 0 to 255 except for 10.250, 0.0, or 255.255. It is recommended that the address 169.254.10.251 be used unless another address is more convenient. This address will be used throughout.

The following assumes the computer has a Windows 2000 or Windows XP operating system. Other operating systems can be used provided the computer has an IP address of 169.254.10.251 and can use 'ping' and 'telnet' programs.

On Windows 2000, XP and similar systems, the IP Address is set using the Control Panel > Network and Dialup Connection > Local Area Connections > right mouse click to select Properties > Internet Protocol (TCP/IP) > Properties.

Once the computer's IP address is set to 169.254.10.251, open a DOS command window and try to ping the EUM3005, using the command "ping 169.254.10.250". If the EUM3005 does not respond, verify the Ethernet cables are connected correctly, that power supply has power and that the computer has the correct address and net mask.

When the EUM3005 replies to the ping command, establish a telnet session with the command "telnet 169.254.10.250".

Once a telnet connection is established, a password is requested. Enter "setup", which will enter the setup menu.

## 2.2 Setup Menu

---

The Setup Menu structure consists of a menu with four selections.

### **Setup Menu**

```
WaveRider Communications, Inc. EUM3005
Password: *****
```

```
WaveRider Communications Inc. Setup Menu
```

```
Modem Serial Number      : C00017
Station Identifier (EUM ID): 40:00:17
Software Version         : 10.0
Search State             : Searching for CCU
```

```
Menu
====
```

```
(R)adio Link Status - Use this for pointing the antenna
(T)roubleshooting information - for network operator
(H)elp
e(X)it
```

```
type option and press enter > r
```

The Setup menu identifies the modem, the software version and search state. In this case, the modem is configured for Automatic CCU Discovery and it is searching to find the best available CCU.

There are 4 options:

- Radio Link Status - see *section 2.3*, Radio Link Status Display
- Troubleshooting information - see *section 2.4*, Troubleshooting Information Display
- Help - this provides an on-line explanation of the options and the information displayed with each.
- Exit - this terminates the telnet session.

## 2.3 Radio Link Status Display

---

The Radio Link Status display is the key setup display for aligning the antenna and verifying the link. The Radio Link Status display shows the search state of the modem, which is either:

- **searching for a CCU** - A complete sweep of all frequencies takes about 30 seconds. The display shows which frequencies may be CCUs. A search is started when any of the following occurs:
  - the modem boots up, either due to a hard (power) reset or software reset,
  - no CCUs are found during the last frequency sweep, so that the modem cannot register with any CCU found during the last sweep,
  - the modem has received no signal from the CCU in the last two minutes. This indicates that the CCU or radio link is down.
- **attempting to register with a CCU** - When a frequency sweep has been completed, the modem attempts to register with the CCUs in the order of best signal down to poorest. The modem may not register with a CCU for a number of reasons, in which case the modem attempts the next CCU in the frequency list. If the modem cannot register with any CCU, contact the network operator. The reasons a modem may not be able to register with a CCU include:
  - The modem is not authorized to register at that CCU,
  - The signal detected is not a valid CCU.
- **registered with a CCU** - This state occurs when the modem has a frequency and has successfully registered with a CCU. At this point, the modem can provide a link to the Internet through the CCU.

An example of the Radio Link Status display is shown below.

**Radio Link Status Display**

```

Searching: found 9070 9086
Searching: found 9070 9086
Searching: found 9070 9086 9114
Searching: found 9070 9086 9114
Searching: found 9070 9086 9114 9142

Registered at 9114
          Signal Strength
          | Poor | Fair | Good
          | 1 2 3 4 5 6 7 8
4.0 *****
4.3 *****
5.0 *****
4.7 *****
6.7 *****
5.0 *****
3.7 *****
6.0 *****
8.7 *****
8.0 *****

          Signal Quality
          | Poor | Fair | Good
          | 1 2 3 4 5
1.5 *****
3.5 *****
3.0 *****
2.5 *****
2.0 *****
1.5 *****
4.0 *****
3.0 *****
3.5 *****
4.5 *****
    
```

The Signal Strength and Signal Quality graphs and values are Figures of Merit (FOM) and are interpreted using the tables below. The goal for aligning the antenna is a Signal Strength of 5 or better and a Signal Quality of 4 or 5, if possible.

**Table 4 Signal Strength Figure of Merit**

<b>FOM</b>	<b>Meaning</b>	<b>Received Signal is at least</b>	<b>Received Signal is less than</b>
1	Extremely poor		-92 dBm
2	Very Poor	-92 dBm	-89 dBm
3	Poor	-89 dBm	-86 dBm
4	Marginal	-86 dBm	-83 dBm
5	Okay	-83 dBm	-80 dBm
6	Good	-80 dBm	-77 dBm
7	Very Good	-77 dBm	-74 dBm
8	Excellent	-74 dBm	

**Table 5 Signal Quality Figure of Merit**

<b>FOM</b>	<b>Meaning</b>
0	Extremely Poor
1	Very poor
2	Poor
3	Adequate
4	Good
5	Very Good

Getting any Signal Strength reading at all indicates that packets are being received from the CCU. The higher the signal strength and signal quality indicators, the lower the packet error rate and the higher the fade margin for the EUM3005. The goal should be a signal strength of 5 or higher and a signal quality of 4 or 5. Regardless of the levels, the EUM3005 should be aligned so that the indicators are the highest possible for the given site.

## 2.4 Troubleshooting Information Display

---

The troubleshooting information is provided to allow the network operator to troubleshoot the link. It is also useful to record the status of the link once the modem is installed and aligned. This can form a reference baseline so that the network operator can judge if the link in future is better or worse than it was when the modem was installed.

The information provided below is a brief description of the statistics provided. A detailed understanding of this information is not required to install the EUM3005. If there are problems

with the installation, then the installer may contact the network operator and report the information on this display so that the network operator can troubleshoot the installation.

The troubleshooting information display is shown below.

### ***Troubleshooting information Display***

```

WaveRider Communications Inc. Diagnostic Information
----- MAC Summary -----
Transmitted Payloads
      10k :      1105  99.8%
      20k :         2   0.1%
      30k :         0   0.0%
      40k :         0   0.0%
      Fail Retry :      0   0.0%
      Fail Timeout :      0
Received Packets
      HCRC Error :      0   0.0%
      Directed :     5302  95.1%
      Broadcast :      287   5.1%
      No Match :         0   0.0%
Received Packets with Payloads
      FCS Error from Peer :      0   0.0%
FCS Error to Station :      0   0.0%
      ICV/MIC Error :      0   0.0%
      Duplicate :      0   0.0%
      Too Busy - Discard :      0   0.0%
      Delivered :     1617 100.2%
----- IP Summary -----
DHCP Enabled : YES
IP Address: 192.168.10.250 / 24
IP Subnet : 192.168.10.0 ( 255.255.255.0 )
Gateway IP Address: 192.168.10.1
----- Radio Summary -----
RF Power: 26 dBm
Auto Mode - Locked on frequency 9114
      RSSI[dBm]  RX;  TX;  R1;  R2;  R3;  F;Retry%;  SQ; RNA; RNB
RSSI: -69      1;  0;  0;  0;  0;  0;  0;  8;  31;  29

```

The MAC Summary shows the breakdown for transmitted and received packets and payloads. All values are expressed as a count and percentage of total packets or payloads. A payload is a packet with real data.

- Transmitted Payloads: shows how many payloads were successfully transmitted the 1st time or needed to be sent a 2nd, 3rd or 4th time to get through, as well as how many packets failed to get through at all. Note that traffic must be sent from the end user PC in order to generate enough traffic to be meaningful. The rules of thumb are:
  - 1OK should be at least 90%, otherwise the link may not be good enough.
  - The 1OK packets should be 1000 or more to be a reasonable representation of the link.
- Received packets: shows the classification of all packets received from the CCU, whether they contain payloads or not and whether they are directed to this modem or not. This data is for information only and does not indicate the quality of the link for the installer.
- Received packets with payloads: shows the disposal of the received packets with payloads. FCS Error from Peer shows the error rate for all packets from the CCU, whether directed to this modem or not. An error rate above 5% could indicate a poor link. The others are for payloads directed to this modem or broadcast to all modems. Only the delivered payloads are successfully received. The rule of thumb here is that the delivered payloads should be better than 95%, otherwise the link is suspect.

---

# 3 Installation

---

## 3.1 Installation Checklist

---

A successful installation is divided into pre-installation, installation and post-installation stages, with each stage outlined in the following checklists.

The Pre-Installation Stage Checklist involves the Network Operator as well as the installer.

**Table 6 Pre-Installation Stage Checklist**

<b>Step</b>	<b>Discussion</b>
<b>section 3.2.1, Network and EUM3005 Configuration</b>	The network must be properly configured by the Network Operator to accept the new modem.
<b>section 3.2.2, Verifying the EUM3005 Components</b>	Ensure that all the needed parts are included.
<b>section 3.2.3, End-Users PC</b>	The end-user's PC requires an Ethernet Network Interface to accept the data from the EUM3005.

When everything is ready for the installation stage, then the installer performs the following steps:

**Table 7 Installation Stage Checklist**

Step	Discussion
<b>section 3.3.1, Locating the EUM3005 Antenna</b>	Find the best location for mounting the EUM3005 antenna, with a good RF signal and at least 1 foot away from where people will stand.
<b>section 3.3.2, Mounting and Orienting the EUM3005 Antenna</b>	The EUM3005 antenna mounts to a wall, window or horizontal surface. Once a location with good signal levels is found, optimize the signal by selecting the best orientation of the antenna. Mount the antenna, using the hardware provided.
<b>section 3.3.3, Connecting the End-User's PC</b>	Connect the modem to the end-user's PC.
<b>section 3.3.4, Testing the Data Link</b>	Confirm that the link is functioning correctly.

Once the installation is complete and verified, the network operator can complete the Post-installation Stage, using the Automatic Remote Configuration feature or manually over the air. This is discussed in *section 3.4, Post-Installation*

## 3.2 Pre-Installation Steps

---

### 3.2.1 Network and EUM3005 Configuration

There are a number of steps that must be undertaken by the network operator before installing an EUM3005. For more information, see the *LMS4000 Data Networking Concepts*, *LMS4000 Radio Concepts* and *LMS4000 Managing the Network* manuals on the WaveRider web-site.

1. **CCU Authorization:** Ensure that the EUM is authorized at one or more CCUs with the appropriate Grade of Service.
2. **Secure Authentication:** If secure authentication and user data encryption are required, a secret authentication key must be configured in the EUM and CCU (or RADIUS server).
3. **IP Addresses:** Configure a DHCP server to accept the new EUM3005's request for an IP address, if the modem has DHCP enabled (factory default). If not using DHCP, then the EUM must be manually configured with the following settings:
  - IP address
  - Subnet mask
  - Gateway IP address
4. **Frequency Assignment:** If the Automatic CCU Discovery feature (factory default) is used, then the EUM will search for the CCU upon power up. This is the recommended

approach. If for some reason this is not acceptable, then the EUM3005 must be configured with its radio frequency.

The easiest installation uses the EUM3005 factory defaults, so that the modem will get all its IP address information from DHCP and its RF Frequency from the Automatic CCU Discovery feature.

Other useful information for the installer includes:

- Direction from the installation site to the CCU.
- Expected signal strength for the installation site based on the network operator's site survey or signal strength for other installations in the vicinity.
- The IP address of a site that accepts pings as well as the name of a site that accepts pings, for testing the data link.
- Whether modem is being connected directly to end-user PC or via an Ethernet switch or IP router. In the latter cases, the installer must provide a straight-through Ethernet cable to connect the modem to the switch/router.

### 3.2.2 Verifying the EUM3005 Components

See *EUM3005 - End-user Modem or Customer Premises Equipment* on page 4 for more information on the EUM3005 kit. Verify that the EUM3005 kit is complete with:

- EUM3005 modem
- Indoor antenna with its captive 10 feet of RF cable.
- Antenna Mounting hardware, including drywall plugs, screws and suction cups
- AC/DC power supply (may include AC power cable)
- Crossover Ethernet cable.

### 3.2.3 End-Users PC

Ensure that the end-user PC is equipped with an Ethernet interface.

## 3.3 Installation Steps

---

**NOTE:** Turn off all cordless phones in the customer's premises, and any other equipment that uses the 900MHz ISM band. Once the installation is complete, turn this equipment back on and monitor for interference or degraded signal quality.

**NOTE:** Neither the EUM3005 nor its antenna are weatherproof, so they must be mounted in a protected environment. Also, the EUM3005 is only FCC certified with its indoor active diversity antenna. No other antenna should be used with the EUM3005.

### 3.3.1 Locating the EUM3005 Antenna

The EUM3005 antenna should be mounted on or near an outside wall or window, pointing in the direction to the CCU. The higher in the building, the better the signal level will be. So locating in the attic or second storey is preferred to the main floor or basement.

You can use just the EUM3005 and its antenna to find a good signal, before connecting to the end-user's PC. Attach the antenna to the EUM3005, attach the DC cord from the power supply to the EUM3005, then connect the power supply to an AC socket. Wait 10 seconds for the EUM3005 to come up. Then you can use the Radio LED to find a good signal.

Alternatively, connect the user's PC as described in *section 3.2.3, End-Users PC* and use the Setup Menu as described in *section 2, Setup Menu* to get the figures of merit.

The goal for a good installation is to have the Signal Strength FOM in the range of 5-8 and the Signal Quality FOM to be in the range 4-5. However, there are many good installations with lower figures of merit. Using the LEDs or Setup Menu, the installer should find the location that provides the best signal figures of merit and then adjust the EUM3005 to maximize the FOM readings. In most cases, a signal strength of 5 with a signal quality of 4 is a better signal than a signal strength of 6 and signal quality of 2.

The following are suggested guidelines for determining where to locate the modem:

- Survey the area with the modem to assess the signal levels before installing the antenna
- Signal indicators should be good.
- Locate the EUM3005 at least 8 inches (20 cm) away from occupied areas to avoid any harm from emissions.
- Try several locations and several orientations and angles near the desired location. Moving the antenna by as little as 6 inches and swiveling the antenna by as little as 30 degrees can have dramatic effects on the received signal strength and quality.

Examples of typical installations can be seen in [Figure 7](#). Note that the EUM3005 can be far removed from the user's PC by using a longer crossover Ethernet cable than the cable provided.



Figure 7 Typical Installations of EUM3005

### 3.3.2 Mounting and Orienting the EUM3005 Antenna

Once a good location for the antenna has been selected, mount the antenna as required. Use the drywall plugs and screws if you are attaching the antenna to the wall. Note that the antenna holding bar has a release tab at one end. It is recommended that this tab be the upper tab when mounting the holding bar vertically.

When the EUM3005 antenna holding bar has been positioned and attached, the best orientation of the modem should be determined by trying different angles and seeing which give the highest signal strength and signal quality.

### 3.3.3 Connecting the End-User's PC

There are many ways to connect the EUM3005 to the end-user's PC, using Ethernet switches, IP routers, etc. The discussion below is for the simplest, most direct method of connection.

1. Connect the end-user's PC by attaching a crossover Ethernet cable between the Ethernet port on the end-user's computer and the Ethernet port on the modem.
2. Plug the power supply into the EUM3005 first, then into the AC socket. Wait 10 seconds for the EUM3005 to come up.
3. Check the Ethernet LEDs on the Ethernet interface of the modem and/or end-user's PC to ensure the Ethernet connection between the EUM3005 and the end-user's PC is active. Refer to [Table 1 on page 8](#) for an explanation of the Ethernet LEDs normally provided on Ethernet interface cards.
4. When attempting to send data to, or receive data from, the Internet, check the Ethernet Traffic LED to ensure data transmission is taking place. This LED flashes as data traffic passes between the end-user's PC and the EUM3005.

### 3.3.4 Testing the Data Link

The following are simple tests that the installer or end-user can perform to ensure that the link is functioning correctly. These tests are outlined below. If any test fails, then the subsequent tests are likely to fail as well until the problem is resolved.

1. **Ping the EUM:** Configure the end-user's PC to have the local link IP address and ping the EUM3005 at IP address "169.254.10.250" (see *Ping the EUM* on page 23 for more details if needed).
2. **Assess the Link:** Use the Setup Menu as described in *Setup Menu* on page 11 to assess the Radio Link Status and to get the Troubleshooting information to baseline the installation. This test verifies that the end-user's PC is communicating with the EUM3005 and provides insight into the state of the RF link. This test is recommended since it provides details on the state of the modem and what CCU(s) it has located.
3. **Verify DHCP:** If the network assigns end-user PC's IP addresses by DHCP, then reconfigure the end-user PC to use DHCP to automatically obtain its IP address. Verify the end-user PC has received an IP address, by using the DOS command "ipconfig" and seeing that an IP address is assigned along with Gateway and DNS server addresses. This confirms that the End user PC is contacting the DHCP server correctly. See *Verify DHCP* on page 24 if more details are required.
4. **Ping the Gateway:** Assuming the end-user PC has an IP address and a Gateway address as shown by the "ipconfig" command, ping the gateway to determine if it can be reached. See *Ping the Gateway* on page 24 if more details are required. This step assume your gateway will respond to pings.
5. **Ping Internet by IP address:** If everything is good so far, try pinging a known Internet address. If successful, then you know that the end-user PC can access the general Internet. See *Ping Internet by IP address* on page 25 if more details are required.
6. **Ping Internet by Name:** Ping a known named Internet address (e.g. "ping www.google.com" or some equivalent). Even if the site refuses ping commands, you should get the IP address for the named site. If so, this shows that DNS is working correctly. See *Ping Internet by Name* on page 25 if more details are required.
7. **Link Speed Test:** Go to a known web-site that offers link speed testing, such as "http://bandwidthplace.com/speedtest/". Follow their instructions and determine the link speed. There are many factors affecting the link speed between the end-user's PC and the test site, including the assigned grade-of-service for the modem, the loading on the CCU sector and the loading over the rest of the Internet. So this test is not the best test for ensuring that the modem to CCU link is operating at its correct speed. But it should indicate that the PC is able to communicate with a site on the Internet.

If any of these tests fail, then the installer may need to check the modem, its alignment, the cabling, the PC's configuration and the RF link. If all of these appear good, then the installer should contact the Network Operator for further troubleshooting advice.

Even if all the above tests indicate a good link, WaveRider recommends that the Network Operator remotely test the EUM-to-CCU data link more thoroughly soon after it is installed. The test facilities available to the Network Operator are outlined in the *LMS4000 Managing the Network* manual and other manuals on the WaveRider web-site.

The following sections provide more detail for some of the steps for Testing the Data Link.

## Ping the EUM

Note that the EUM3005 may be on a different sub-net than the end-user's PC, so pinging the IP address assigned to the EUM3005 will go through the CCU. Therefore, we ping the EUM3005 using the local link IP address as the 1st test.

1. Ensure the end-user's PC is configured with an IP address of 169.254.10.251, netmask = 16 (or 255.255.0.0). See *Setup Menu* on page 11 for more information.
2. Ping the EUM's local-link IP address 169.254.10.250, from the end-user's PC, as follows:
  - Open a DOS window in the end-user's PC.
  - At the command prompt, type `ping 169.254.10.250` and press **Enter**.
3. If there is no response, check the following:
  - The end-user's computer IP address settings.
  - The Ethernet link light on the PC.
  - The Ethernet crossover cable between the EUM3005 and the end-user's PC, to ensure that the pins have not been damaged.
  - The POWER LED should be on.
4. If there is a response, but with errors, check the Ethernet crossover cable.

This is what a successful ping from the end-user's PC to the EUM looks like:

```
C:\>ping 169.254.10.250

Pinging 169.254.10.250 with 32 bytes of data:

Reply from 169.254.10.250: bytes=32 time<10ms TTL=64

Ping statistics for 169.254.10.250:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

This is what an unsuccessful ping from the end-user's PC to the EUM looks like:

```
C:\>ping 169.254.10.250

Pinging 169.254.10.250 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 169.254.10.250:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

## Verify DHCP

This step is for networks that use DHCP to provide IP addresses to the end-user's computer. Assuming the Setup command shows that the modem has registered with a CCU and is receiving a signal, then reconfigure the end-user PC to use the correct IP address. This is usually done using DHCP to automatically obtain the IP address.

On Windows 2000, XP and similar systems, the IP Address is set using the Control Panel > Network and Dialup Connection > Local Area Connections > right mouse click to select Properties > Internet Protocol (TCP/IP) > Properties. To enable DHCP, click on the "Obtain an IP Address Automatically" button.

Once properly configured, verify the end-user has received an IP address. For a Windows 2000 or XP PC, in a DOS Window, type "ipconfig" and see that there is an IP address assigned along with a Gateway Address and DNS server addresses. This confirms that the End user PC is contacting the DHCP server correctly. Record the IP Address of the gateway and the DNS servers.

## Ping the Gateway

Ensure the end-user's PC is configured properly. Then ping the gateway address from a PC DOS window. The gateway address was recorded during the Verify DHCP address if using DHCP. Otherwise the installer will know the gateway address since it is needed to configure the end-user's PC.

Ping using short packets first (default size) to confirm the connection. Then use long packets (1472 byte packets) to confirm the RF performance. Errors observed on pings with long packets indicate a high error rate on the channel, caused by low signal levels or interference.

The following describes how to ping the gateway:

1. Open a DOS window.
2. At the command prompt, type `ping <aaa.bbb.ccc.ddd> -t -l 1472`, where `<aaa.bbb.ccc.ddd>` is the Gateway radio IP address and press **Enter**.
3. Press **Ctrl+c** to end the test.

**NOTE:** If this test fails with the long packets, but pinging the Gateway with the default packet size succeeds, then the connection is working but is not operating at maximum capacity, possibly due to poor antenna placement or orientation, poor signal levels, and/or interference.

The following example assumes the Gateway has an IP address of 172.16.4.1. Replace that address with the correct gateway address from the 'ipconfig' command:

```
C:\>ping 172.16.4.1 -t -l 1472

Pinging 172.16.4.1 with 1472 bytes of data:

Reply from 172.16.4.1: bytes=1472 time=40ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=81ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=80ms TTL=64
```

```

Reply from 172.16.4.1: bytes=1472 time=40ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=60ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=80ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=40ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=110ms TTL=64

Ping statistics for 172.16.4.1:
    Packets: Sent = 8, Received = 8, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 40ms, Maximum = 110ms, Average = 66ms
Ctrl-C
^C
C:\>

```

### Ping Internet by IP address

Use the following test to determine whether the end-user's PC can communicate with the Internet. If you do not know an IP address, try the DNS servers. Otherwise, skip this step.

```

C:\>ping 216.239.39.104

Pinging 216.239.39.104 with 32 bytes of data:

Reply from 216.239.39.104: bytes=32 time=90ms TTL=113
Reply from 216.239.39.104: bytes=32 time=80ms TTL=113
Reply from 216.239.39.104: bytes=32 time=80ms TTL=113
Reply from 216.239.39.104: bytes=32 time=70ms TTL=113

Ping statistics for 216.239.39.104:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 70ms, Maximum = 90ms, Average = 80ms

```

### Ping Internet by Name

Use the following test to verify that the DNS server IP address is correctly configured in the end-user's PC and is operating properly:

```

C:\> ping www.google.com

Pinging www.google.akadns.net [216.239.39.104] with 32 bytes of data:

Reply from 216.239.39.104: bytes=32 time=72ms TTL=241
Reply from 216.239.39.104: bytes=32 time=69ms TTL=241
Reply from 216.239.39.104: bytes=32 time=76ms TTL=241
Reply from 216.239.39.104: bytes=32 time=68ms TTL=241

Ping statistics for 216.239.39.104:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 68ms, Maximum = 76ms, Average = 71ms

```

## 3.4 Post-Installation

---

Once a good link between the CCU and the EUM3005 has been established, the configuration can be completed automatically using the Automatic Remote Configuration feature with a RADIUS Server and database in which the EUM3005 information has been entered.

To use this feature, the network operator must update the RADIUS database for the new modem. This can be done before the modem is installed, in which case the modem will be automatically configured as soon as it has established a link.

The configurable items that can be included in the Automatic Remote Configuration include:

- password,
- all SNMP parameters,
- RF Frequency (including enabling Automatic CCU Discovery)
- number of customers.

If the Automatic Remote Configuration feature is not used, then the network operator can connect to the EUM3005 over the air and complete the configuration.

Details on configuring a RADIUS Server or manually configuring an individual EUMs are covered in the *LMS4000 Managing the Network* manual or other manuals, available on the WaveRider web-site.

---

# Appendix A Factory Configuration

---

This appendix identifies the factory configuration settings for the EUM3005

Parameter	Default Configuration
Modem IP Address	From DHCP
Modem IP Netmask	From DHCP
Gateway IP Address	From DHCP
Local Link IP Address (Available on Ethernet Port only)	169.254.10.250
Local Link IP Netmask	16 255.255.0.0 ffff0000
Maximum Number of Customers*	5
Password*	By default, the EUM3005 has no password. Press <b>Enter</b> at the password prompt to enter a null password.
Port Filters	137 (both) 138 (both) 139 (both) 445 (both) 1512 (both)
Radio	Enabled
Radio Frequency*	Automatic CCU Discovery

Parameter	Default Configuration
Radio Power*	+26 dBm (High) - To be consistent with previous modems, +26 is used in the CLI to indicate maximum output power. The EUM3005 actually outputs about 27.3 dBm Peak power = 24.4.dBm averager power. (NOTE: For configuring the modem, the power values entered are rounded to the nearest dB)
Authentication Key Policy	<i>none</i>
SNMP Name* (= Console Prompt)	EUMID
SNMP Contact*	WaveRider Communications Ltd.
SNMP Location*	www.waverider.com
SNMP Read Communities*	None entered
SNMP Write Communities*	None entered
SNMP Traps*	None entered
Statistics Log Interval	15 minutes

\* These parameters can be set using Automatic Remote Configuration if the network is configured to use a RADIUS Server.

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## Appendix B Ethernet Cables and Connectors

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The EUM3005 may use cross-over or straight through Ethernet cables, depending on the type of installation:

- **EUM3005 Cross-over Cable:** If a cable is connected directly between the EUM3005 and a PC, use a crossover Ethernet cable; either the 3 foot one provided or a longer one if required. A cross-over cable has one end wired according to T568A and the other end according to T568B. Both ends have RJ45 connectors.
- **Straight-Through Cable:** If EUM3005 is connected to an Ethernet switch or router use a straight-through Ethernet cable, which has both ends wired according to T568A with RJ45 connectors. A straight-through cable can also be used as an extension cable, if the 3 foot crossover cable with the EUM3005 is not long enough. In this case, you will require a back-to-back pair of RJ45 sockets.

The Ethernet cable used for the EUM3005 must have at least the RX and TX pairs wired as shown in [Table 8](#) with NO power on the other wires.

**Table 8 Ethernet Interface Specifications**

EUM Physical Interface	RJ45 (Ethernet) socket
Wiring standard	TIA - T568A
Pin - Pair/Wire - Color	
Pin 1 - 3/a - Green/White	TX Data + (Output from EUM)
Pin 2 - 3/b - Solid Green	TX Data - (Output from EUM)
Pin 3 - 2/a - Orange/White	RX Data + (Input to EUM)
Pin 4 - 1/b - Solid Blue	Not Used.
Pin 5 - 1/a - Blue/White	Not Used.
Pin 6 - 2/b - Solid Orange	RX Data - (Input to EUM)
Pin 7 - 4/a - Brown/White	Not Used.
Pin 8 - 4/b - Solid Brown	Not Used.

The following table and figures show the definitions of wiring for T568A and T568B connectors, used to make cross-over and straight-through Ethernet cables as found in ANSI/TIA/EIA-568-B.2 "Balanced Twisted Pair Cabling Components".

**Table 9 Wiring T568A and T568B ends for Ethernet Cables**

#	Description	T568A	T568B
1	Connectors	RJ-45	RJ-45
2	Wiring standard	T568A	T568B
3	Pair/Wire - Color		(Pins in <b>bold</b> are different from T568A)
	3/a – Green/White	Pin 1	<b>Pin 3</b>
	3/b – Solid Green	Pin 2	<b>Pin 6</b>
	2/a - Orange/White	Pin 3	<b>Pin 1</b>
	1/b – Solid Blue	Pin 4	Pin 4
	1/a – Blue/White	Pin 5	Pin 5
	2/b – Solid Orange	Pin 6	<b>Pin 2</b>
	4/a – Brown/White	Pin 7	Pin 7
	4/b – Solid Brown	Pin 8	Pin 8

Straight-through Ethernet cables have T568A wiring at both ends while Cross-over cables have T568A at one end and T568B at the other end.

### T568A Wiring Scheme

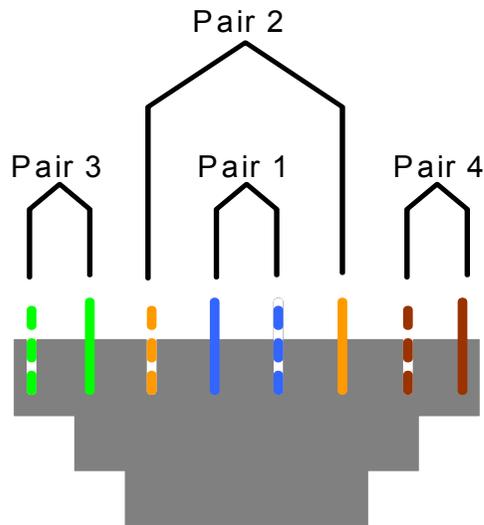


Figure 8 T568A Wiring

### T568B Wiring Scheme

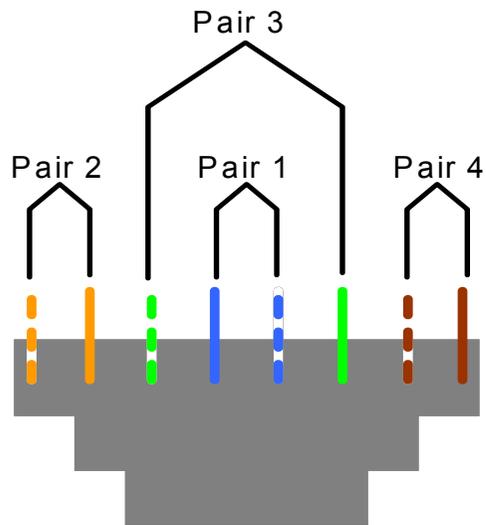


Figure 9 T568B Wiring