NCL 1155
User Guide

Version 0.1

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Because some states/jurisdictions do not allow the exclusion or limitation of liability for consequential or incidental damages, the above limitation may not apply to you.

In no event will WaveRider's liability exceed the amount paid for the product.

Regulatory Notices

This equipment has been tested and found to comply with the limits for a Class A Intentional Radiator, pursuant to Part 15 of the FCC Regulations, and RSS-210 of the IC Regulations. These limits are intended to provide protection against harmful interference when the equipment is operated in a commercial/business/industrial 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.

Any changes or modifications to equipment that are not expressly approved by the manufacturer may void the user's authority to operate the equipment. The NCL1155 contains no user-serviceable parts. Unauthorized opening of the unit voids this warranty.

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Preface

About this Guide

This document provides a complete overview of the **WaveRider** NCL1155 bridge/router, including system features, network planning, and procedures for implementing, installing, operating, and troubleshooting this device.

Before proceeding, we recommends that you read the following sections:

- *Software License Agreement* on page ii
- *Warranty* on page iv
- *Regulatory Notices* on page x
- *Warnings and Advisories* on page xii

Regulatory Notices

Industry Canada

The NCL1155 complies with IC RSS–210.

Operators must be familiar with IC RSS–210 and RSS–102.

The IC certification number for the NCL1155 is 32251032130.

WARNING!

To prevent radio interference to the licensed service, this device is intended to be operated indoors and away from windows to provide maximum shielding. Equipment (or its transmit antenna) that is installed outdoors is subject to licensing.

Federal Communications Commission

The NCL1155 complies with FCC Part 15 Regulations.

The FCC ID for the NCL1155 is OOX-WRM1151.

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

WARNING!

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.

Interference Environment

Manufacturers and operators of spread-spectrum devices are reminded that the operation of these devices is subject to the conditions that:

- Any received interference, including interference from industrial, scientific, and medical (ISM) operations, must be accepted; and
- These devices are not permitted to cause harmful interference to other radio services.

If the operation of these systems does cause harmful interference, the operator of the spread-spectrum system must correct the interference problem, even if such correction requires the Part 15 transmitter to cease operation. The FCC does not exempt spread-spectrum devices from this latter requirement regardless of the application. The FCC strongly recommends that utilities, cellular stations, public safety services, government agencies, and others that provide

critical communication services exercise due caution to determine if there are any nearby radio services that can be affected by their communications.

Operational Requirements

In accordance with the FCC Part 15 regulations:

1. The maximum peak power output of the intentional radiator shall not exceed one (1) watt for all spread-spectrum systems operating in the 2.4000-2.4835 GHz band.

2. Systems operating in the 2.4000-2.4835 GHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi, provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

3. Stations operating in the 2.4000-2.4835 GHz band that are used for fixed, point-to-multipoint operations may use transmitting antennas of directional gain greater that 6 dBi, provided the peak output power from the intentional radiator is reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

4. Fixed, point-to-point operation, as used in Point 2, excludes the use of point-to-multipoint systems, omni-directional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread-spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations.

5. The operator of a spread-spectrum system is responsible for ensuring that the system is operated in the manner outlined in *Interference Environment* on page x.

Warnings and Advisories

General Advisory

Operator and maintenance personnel must be familiar with the related safety requirements before they attempt to install or operate the NCL1155 equipment.

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!

This system must be professionally installed. Antennas and associated transmission cable must be installed by qualified personnel. WaveRider assumes no liability for failure to adhere to this recommendation or to recognized general safety precautions.

WARNING!

To comply with FCC RF exposure limits, the antenna for this transmitter must be fix-mounted on outdoor permanent structures to provide a separation distance of 2 metres (6.6 feet) from all persons to satisfy RF exposure requirements. The distance is measured from the front of the antenna and the human body. It is recommended that the antenna be installed in a location with minimal pathway disruption by nearby personnel.

WARNING!

Do not operate the NCL1155 without connecting a 50-ohm termination to the antenna port. This termination can be a 50-ohm antenna or a 50-ohm resistive load capable of absorbing the full RF output power of the transceiver. Failure to terminate the antenna port properly may cause permanent damage to the NCL1155.

WARNING!

Connect only shielded twisted pair (STP) Ethernet cable to the NCL1155 10Base Tx Ethernet (RJ-45) port. It is the responsibility of the installer to supply and use the correct type of Ethernet cable.

Customer Support

If you have any problems with the hardware or software, please contact WaveRider Communications Inc. Please provide your NCL1155 model number and software version when requesting support.

Telephone:	+1 416–502–3161
Fax:	+1 416–502–2968
Email:	**Product Assistance:** techsupport@waverider.com
URL:	www.waverider.com

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

1 NCL1155 Overview

1.1 Introduction

The NCL1155 is an intelligent, wireless Internet Protocol (IP) bridge/router that provides high-capacity 2.4 GHz connections between local- and wide-area networks via broadband radio links. Employing Direct-Sequence Spread Spectrum (DSSS) transmission techniques, the NCL1155 allows you to access the Internet at high speeds, extend Ethernet networks, and connect to remote locations without the ongoing costs of leased telephone or data lines.

Figure 1   The NCL1155

1.2   Features

- **Flexible deployment**—the NCL1155 can operate as either a bridge or router. In routing mode, you can set up the NCL1155 to use communications strategies such as Routing Information Protocol (RIP), and Dynamic Host Control Protocol (DHCP).

- **Ethernet compatibility**—the NCL1155 allows users to connect with most Ethernet networks or devices.

- **Microprocessor-controlled signal processing**—all functions of WaveRider's spread-spectrum transceiver are controlled through the integration of a powerful on board microprocessor.

- **Architectural flexibility**—you can set up NCL1155s as separate point-to-point links, or in a mulitipoint configuration. A single NCL1155 operating in "master" mode can deliver data to and receive data from up to 20 NCL1155s operating in "station" mode.

- **User-configurable operating system**—you can upgrade the NCL1155 remotely via FTP.

- **User-customizable monitoring**—the NCL1155 operating system supports Simple Network Management Protocol (SNMP), which allows for continual status monitoring of any NCL1155 in your network.

- **Low interference**—Direct Sequence Spread-Spectrum (DSSS) technology transmits signal information over a wide channel bandwidth, which reduces the potential for interference with neighboring communications systems. The NCL1155 design permits three master units to operate in close proximity without interfering with each other. For example, three master units supporting 20 station units each can operate in close proximity, thus providing 60 end-user links.

1.3   About Spread-Spectrum Radio Technology

Spread-spectrum communications systems differ from conventional narrowband communications systems because they use a much larger transmission bandwidth to send the same amount of information.

There are two primary forms of spread spectrum—direct sequence and frequency hopping. The NCL1155 uses Direct-Sequence Spread-Spectrum (DSSS). In DSSS systems, the transmitted information, along with a digital spreading sequence, are used to modulate the transmit carrier. The received signal is de-spread using the same digital spreading sequence, and the information recovered.

Although spread spectrum appears complex and uses a wider bandwidth, the use of DSSS offers the following advantages:

- **Reduced power spectral density**—Spreading over a wider bandwidth reduces the spectral density (power per Hz of bandwidth) of the transmitted signal, allowing simultaneous operation of many spread spectrum systems in the same frequency band and geographic area. The reduced spectral density also allows you meet the regulatory emissions requirements in frequency bands such as the ISM band.
- **Transmission security**—It is technologically more difficult to surreptitiously recover (or jam, in the case of military communications systems) spread-spectrum signals than it is to recover conventional narrowband signals.
- **Interference suppression**—The same mechanism that de-spreads the desired signal in the receiver, also spreads undesired signals, which then appear to the receiver as lower levels of RF noise.

For more information about spread spectrum communications, contact the ***WaveRider* Product Assistance**.

2   Network Considerations

How you configure your NCL1155 depends on its intended role in your network.

Before proceeding, answer the following questions:
- What network topology will I be implementing?
- Will my NCL1155 be operating in bridging or routing mode?
- Have I developed a network plan?

2.1   Network Topology

The NCL1155 can be deployed in three different network configurations:
- point-to-multipoint
- point-to-point
- repeater

Regardless of network configuration, each NCL1155 must be installed as either a bridge or router; it cannot operate simultaneously in both modes.

2.1.1 Point-to-Multipoint

In a typical point-to-multipoint application (see Figure 2) a designated master unit A, transmits and receives data among station units B, C, D, and E, which are programmed to communicate with each other only through their master unit. In this type of configuration, the throughput of unit A is shared among all stations.
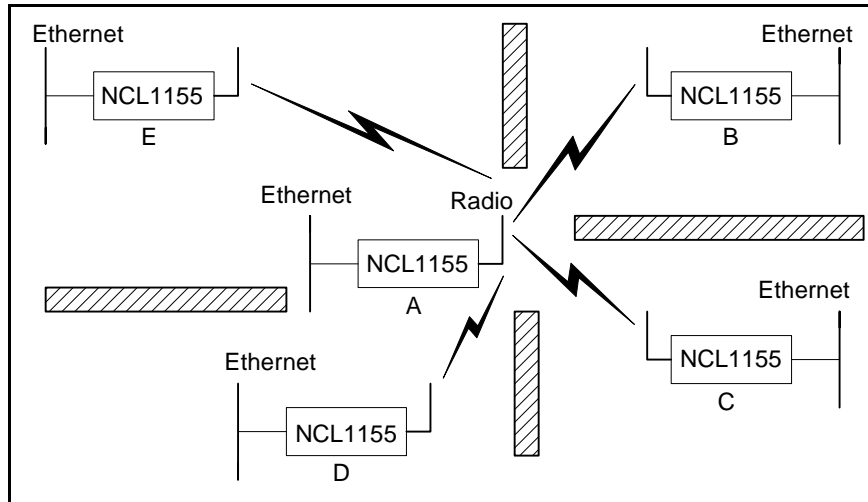
Figure 2   Point-to-Multipoint Application

2.1.2 Point-to-Point

In a typical point-to-point application, (see Figure 3), unit A communicates directly with unit B. The NCL1155 can perform this type of link in either bridging or routing mode.
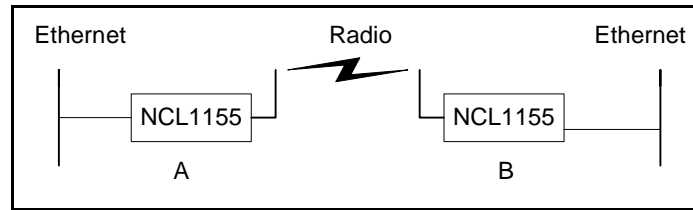
Figure 3   Point-to-Point Application

2.1.3 Repeater

In a typical repeater application, (see Figure 4), unit A communicates with unit B via back-to-back NCL1155 units C and D, with different frequencies used for each leg of the path. You would implement an NCL1155 in a repeater configuration whenever you need to circumvent large obstacles in the radio link path, or when the link from unit A to unit B is too long to maintain reasonable signal levels and data throughput.
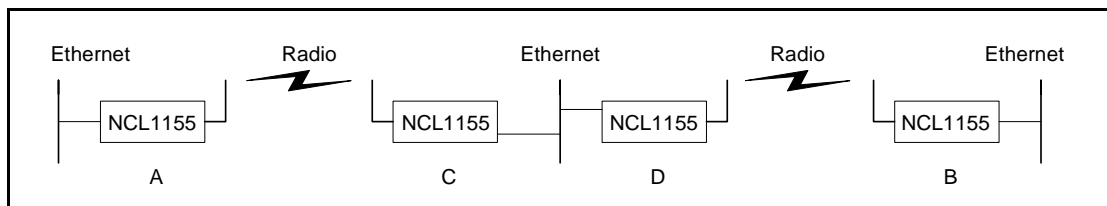
Figure 4   Repeater Application

In this configuration, the effective data throughput among any combination of units is equal to or less than the throughput between the slowest links.

2.2   Bridging and Routing Network Configurations

2.2.1   Point-to-Multipoint Bridging Network

In a typical point-to-multipoint bridging network, (see Figure 5) unit A is installed as the network master, with units B, C, and D configured as stations, each defined by two network parameters:

- **Master ID**—which must be the same as the Unit ID for A.
- **Unit ID**—which must be added to the Remote Station List for A before it can be recognized as a network device.

If a station has a Master ID that does not match the unit ID for A, or it is not on the Master Remote Station List for A, it will not be able to communicate across the network.
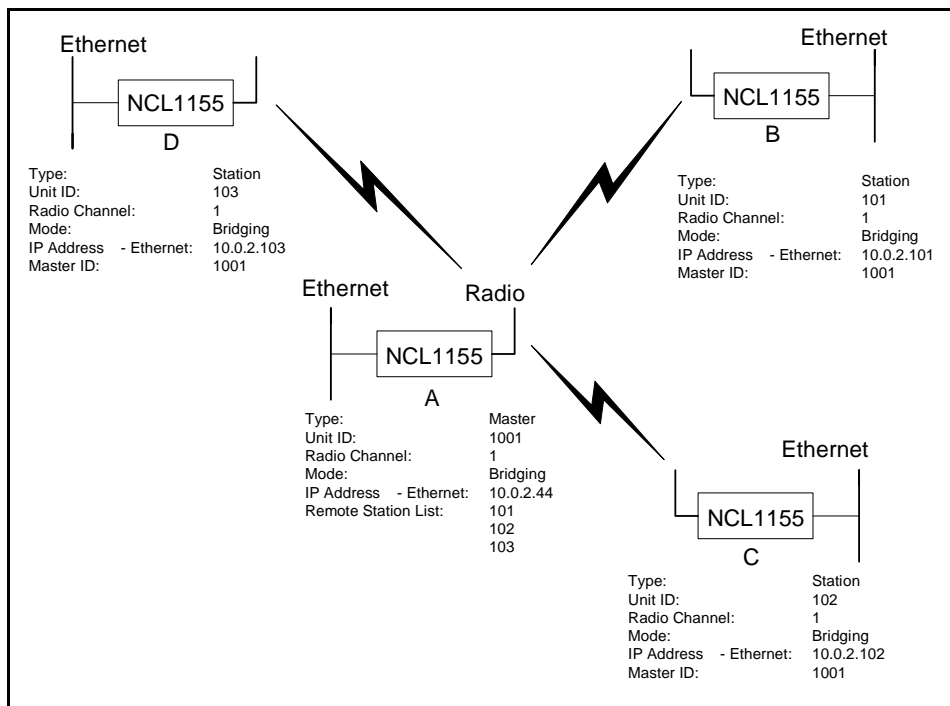
Figure 5   Point-to-Multipoint Bridging Network Example

2.2.2 Point-to-Multipoint Routing Networks

In a typical point-to-multipoint routing network, (see Figure 6), NCL1155 unit A is dedicated as a router, while NCL1155 units B through D are operating in Station mode as gateways to their respective networks.
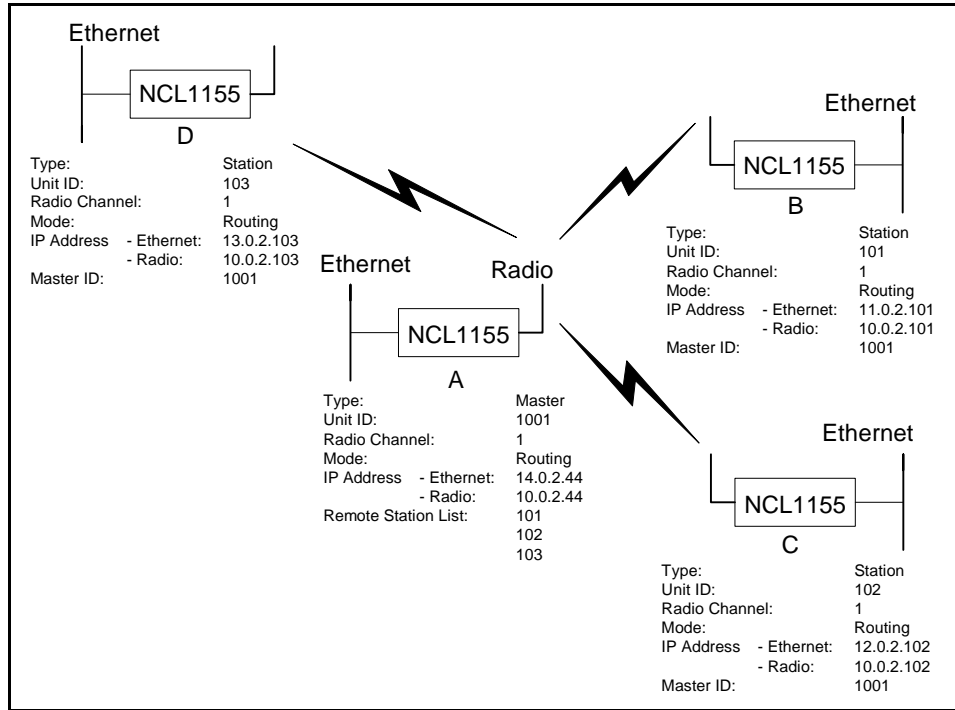
Figure 6   Point-to-Multipoint Routing Network Example

2.3   Planning an NCL1155 Configuration

Configuring each NCL1155 correctly is crucial to the proper operation of your network. Review the flowchart in Figure 7 before starting the configuration to ensure that you have the necessary information to configure the unit correctly.

Record your configuration options for each unit in a configuration record similar to the one provided in Appendix E. Use the Configuration Data Record to help you plan your network and keep track of NCL1155 network assignments.
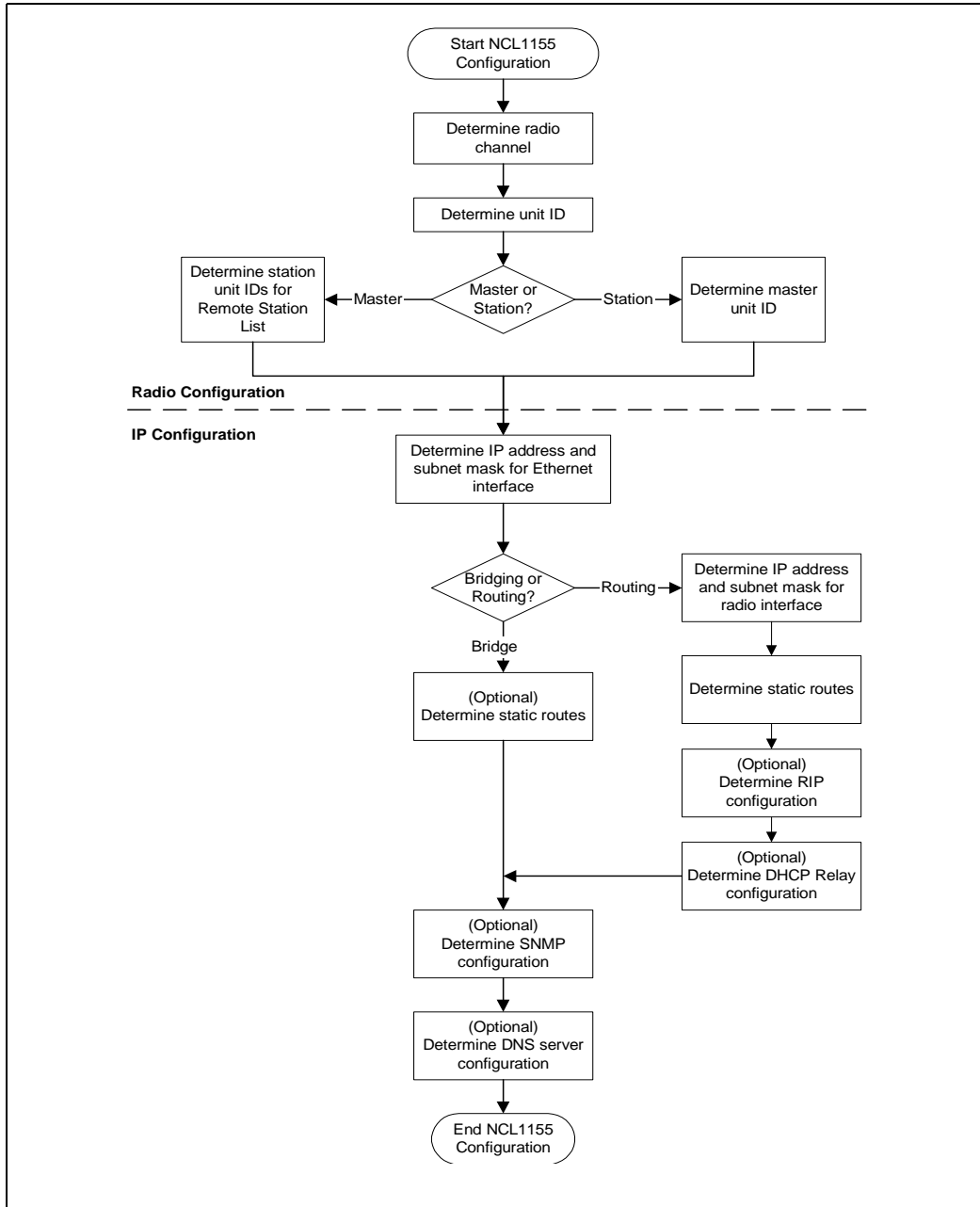
Figure 7   NCL1155 Configuration Planning Flowchart

3   **Installing the NCL1155**

This section describes the steps required to connect and initialize the NCL1155 hardware prior to configuring the device as a bridge or router.

WARNING!

Antennas and associated transmission cable must be installed by qualified personnel. Failure to terminate the antenna port correctly can permanently damage the NCL1155. WaveRider assumes no liability for failure to adhere to this recommendation or to recognized general safety precautions.

WARNING!

Connect only shielded twisted pair (STP) Ethernet cable to the 10Base Tx Ethernet (RJ-45) port on the NCL1155. It is the responsibility of the installer to supply and use the correct type of Ethernet cable.

3.1   Connecting the NCL1155

1. Attach an antenna or 50-ohm load to the antenna port at the rear of the NCL1155. Do NOT plug the NCL1155 to the power outlet until you have the antenna or load connected.

    NOTE: To prevent equipment damage, the NCL1155 is factory preset with its radio transmission capabilities disabled. However, as a general precaution, WaveRider recommends that you always connect the antenna or load <u>before</u> connecting to a power source.

Rear   **Front**

Power Connector

10Base Tx Ethernet Connector (RJ-45)

RS-232 Connector (DB-9) Console Port

Antenna Connector (Reverse-Polarity SMA)

Radio Link Indicator

Receive Signal Strength Indicator

Power ON Indicator
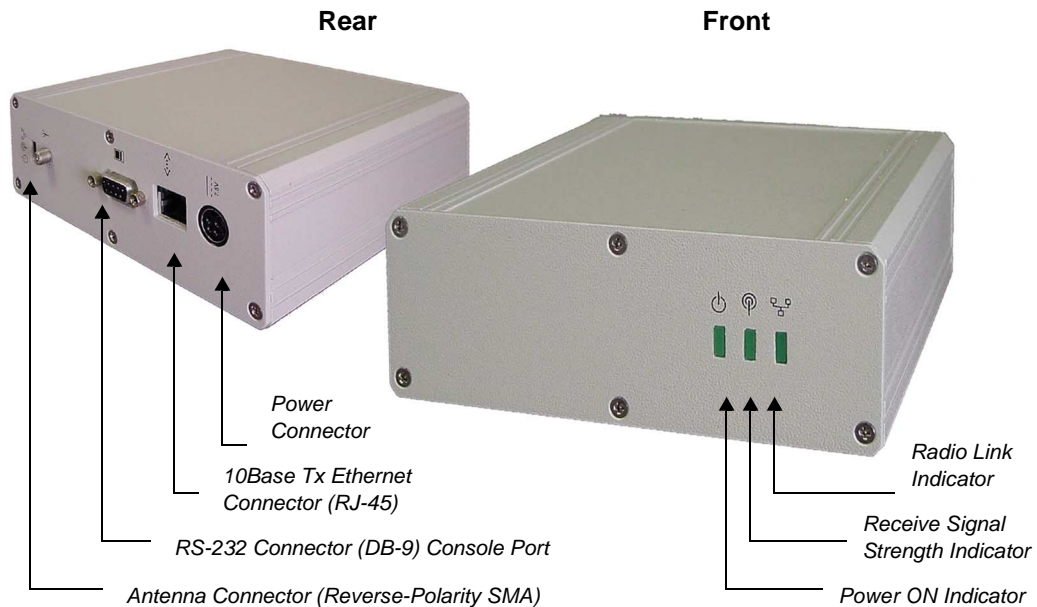
Figure 8   NCL1155 Connectors and Indicators

2. Use an RS-232 straight-through cable to connect a terminal to the DB9 console port.

    NOTE: You can use any ASCII terminal, such as a single-function terminal or a computer running terminal-emulation software to communicate with the NCL1155 through its console port. Use this port for configuring and debugging only; you do not have to remain connected through it during normal operation. Figure 9 illustrates the pin-out for the console port.

```
        1   2   3   4   5      DB9 Male DTE Configuration

          ● ● ● ● ●            Pin 2 Tx line
           ● ● ● ●             Pin 3 Rx line
                               Pin 4 DSR
          6   7   8   9        Pin 5 Ground
                               Pin 6 DTR
```
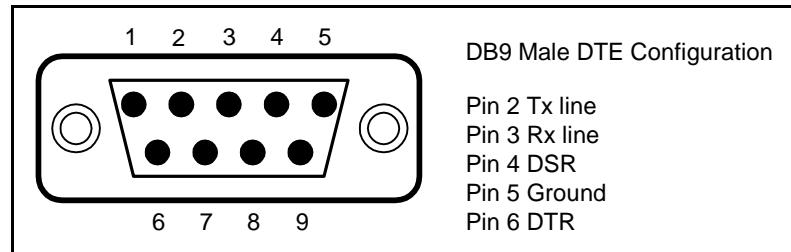
Figure 9   Console Port Pin-out Diagram

3. If you are using a terminal-emulation package, such as HyperTerminal, start the application.

4. In the terminal-emulation application, select the communications port that you are using to connect to the NCL1155.

5. Configure the application using the following settings:
   - 9600 bps
   - 8 data bits
   - no parity
   - 1 stop bit
   - no flow control

6. Plug the NCL1155 into a 110 or 220 V AC power source using the custom power cord provided with the unit.

   NOTE: When disengaging and removing the NCL1155 power cord, carefully slide back the locking collar around its DC connector.

3.2   Initializing the NCL1155

As the unit powers-up, and the initialization sequence begins, progress messages are displayed on the terminal screen. When initialization is complete, you will receive a message indicating that the system is operational, followed by the `PASSWORD:` prompt. The factory default password for the NCL1155 is a <blank field>. If this is an acceptable password **Enter**. Otherwise,

> **To change the password** of your NCL1155, follow the instructions in *Changing the NCL1155 Password*, on page 15.
>
> **To specify a system name** for your NCL1155, follow the instructions in *Setting the NCL1155 System Name*, on page 16.
>
> **To reload the default settings** of an NCL1155 already configured for use elsewhere in your network, follow the instructions is *Resetting an NCL1155 to Factory Defaults*, on page 16. If the NCL1155 is a factory-configured unit, you can omit this step.
>
> For each of these procedures, you must be connected to the NCL1155 and logged into the device.

3.2.1 Changing the NCL1155 Password

Use this procedure if you want to request a password before users log on.

For maximum security, we recommend that you set a unique password for each unit in your network, and record all passwords on the Configuration Data Record for the group. Refer to Appendix E for a copy of the NCL1155 Network Group Configuration Data Record.

To change the password of the NCL1155

1. At the `NCL1155>` prompt, type `<system password>`.

2. At the `Enter Current Password:` prompt, type the old password.

3. At the `Enter New Password:` prompt, type the new password.

> **TIP:** Use a maximum of sixteen (16) alphanumeric characters. Passwords are case-sensitive. For example, "abc" is not the same as "aBc".

4. At the `Verify password:` prompt, type the new password again.

    The system will display a message that your password has been successfully changed.

5. Type `<write>` or `<save>` to save the settings to memory.

Your session to change the password may be similar to the following example session:

```
NCL1155> system password
Enter Current Password: *******
Enter New Password: ****
Verify password: ****
System password has been changed.
NCL1155>
```

> **CAUTION:**   Remember to record the password in your Data Configuration Record. Unlocking the NCL1155 can be a complicated process. If you forget your NCL1155 password, contact **WaveRider Product Assistance**.

3.2.2 Setting the NCL1155 System Name

Use this procedure if you want to uniquely identify your system by either name or location.

To change the system name of the NCL1155

1. At the `NCL1155>` prompt, type `<system name `*`your_system_name`*`>` to name the NCL1155 in your system.

> **TIP:** We recommend that you use a system name that uniquely identifies each unit, based on its location, its purpose, or a combination of both. For example, a system name, Station_firehall identifies the NCL1155 configured as a Station and located at the firehall.

   Example: To change the system name from `NCL1155` to `Station_firehall` would look like this:

   ```
   NCL1155> system name Station_firehall
   System name changed to: Station_firehall


   Station_firehall>
   ```

2. Type `<write>` or `<save>` to save the settings to memory.

   > **NOTE:** In this User Manual, the command-line prompt will always be shown as `NCL1155>`.

3.2.3 Resetting an NCL1155 to Factory Defaults

Use this procedure if the NCL1155 has already been configured for use elsewhere in your network and you need to restore its factory settings.

To reset the factory defaults of the NCL1155

1. Connect the NCL1155 to a terminal or terminal-emulation software and at the `NCL1155>` prompt, type `<write erase>` to reset the unit to its factory-default settings.

2. Type `<reboot>` for the unit to recognize the factory-default settings.

4 Configuring the NCL1155

This section describes the steps required to configure the NCL1155 as either a bridge or router, including the options available for routing and system monitoring. You can perform these steps three ways:

- Console Port command line interface (CLI)
- **WaveRider** Configuration Utility (GUI)

Before proceeding, familiarize yourself with the NCL1155 command definitions and keyboard syntax (See *NCL1155 Command-Line Syntax* on page 57.), plus command and help keyboard shortcuts (See Table 7 on page 58.)

> **NOTE:** The following section describes the procedures for configuring the NCL1155 via CLI. To download the **WaveRider** Configuration Utility, visit WaveRider's web site at: *<http://www.waverider.com/techsupport/>*.

The procedures for configuring the NCL1155 via command-line interface are divided into two categories:

- Radio configuration—see *Setting the Radio Configuration* on page 18
- IP configuration—see *Setting the IP Configuration* on page 19

You can also configure the NCL1155 for the following options:

- Routing Information Protocol (RIP)—see *Setting RIP Configuration* on page 20
- Dynamic Host Control Protocol (DHCP) Relay—see *Setting the DHCP Relay Configuration* on page 22
- Simple Network Management Protocol (SNMP)—see *Setting the SNMP Configuration* on page 22
- Domain Name Service (DNS) Resolver—see *Setting the DNS Resolver Configuration* on page 23

4.1   Setting the Radio Configuration

Before setting the radio configuration parameters, ensure that the NCL1155 has been connected to a terminal and initialized as described in *Connecting the NCL1155*, on page 12, and that the password has been set as described in *Changing the NCL1155 Password*, on page 15.

WARNING!

Antennas and associated transmission cable must be installed by qualified personnel. Failure to terminate the antenna port correctly can permanently damage the NCL1155. WaveRider assumes no liability for failure to adhere to this recommendation or to recognized general safety precautions.

1. Determine the radio channel for the network. See Appendix C for a list of operating frequencies.

2. At the `NCL1155>` prompt, type `<radio channel *channel*>` to set the radio channel for the NCL1155, where *channel* is the number of the network radio channel on which the unit will operate.

3. Determine the unit IDs for the Master and Stations for this NCL1155 network group. The unit ID is a unique number, from 1 to 16383, that is used to identify the NCL1155 within the network group.

4. At the `NCL1155>` prompt, type `<radio unitid *unit_id*>` to set the NCL1155 unit ID.

5. To set the NCL1155 as a Master, type `<radio type master>`. To set the NCL1155 as a Station, type `<radio type station>`.

    If the NCL1155 is a Master, add the unit IDs for the Stations that are configured for this network group. At the `NCL1155>` prompt, type `<radio station add *station_unitid*>` where *station_unitid* is the unit ID for a Station.

    NOTE: To remove a Station from the Remote Station List, type `<radio station del *station_unitid*>` where *station_unitid* is the unit ID for the Station you want removed.

6. Repeat step for each Station that you want to add to the Remote Station List for the Master NCL1155. A maximum of 20 Stations can be added to one Master.

7. If the NCL1155 is a Station, add the Master unit ID for the network group. At the `NCL1155>` prompt, type `<radio masterID *master_unitid*>` where *master_unitid* is the unit ID for Master NCL1155 in the network group.

    TIP: To display a list of Stations associated with a specific NCL1155 Master, type `<radio station>` at the `NCL1155>` prompt.

8. At the `NCL1155>` prompt, type `<write>` to save the settings to memory.

4.2   Setting the IP Configuration

Check that the NCL1155 is has been connected to a terminal and initialized as described in *Connecting the NCL1155*, on page 12 and you have changed the password as described in *Changing the NCL1155 Password*, on page 15.

Before configuring IP options, complete the radio configuration as described in *Setting the Radio Configuration*, on page 18.

1. At the `NCL1155>` prompt, type `<ip address ethernet aaa.bbb.ccc.ddd nn>` to set the IP address for the Ethernet interface. `aaa.bbb.ccc.ddd` is the IP address of the NCL1155 and *nn* is the number of bits in the subnet mask (for example, 24 represents a subnet mask of 255.255.255.0).

2. At the `NCL1155>` prompt, type `<mode bridging>` or `<mode routing>` to set the forwarding mode.

   If you are setting the NCL1155 to operate in bridging mode, go directly to Step 3.

   If setting the NCL1155 to routing mode, type `<ip address radio remote_unit_id aaa.bbb.ccc.ddd eee.fff.ggg.hhh>` to set the IP address for the radio interface to the remote unit. `aaa.bbb.ccc.ddd` is the IP address for the local unit and `eee.fff.ggg.hhh` is the IP address for the remote unit.

   NOTE: If you change the radio IP address for a Station at a later time, remember to update the Master with the new Station IP address. If you change the radio IP address for a Master at a later time, remember to update each Station in the Remote Station List with the new remote IP address for the Master.

3. For a Master unit, repeat step 2 for every Station in the group. For a Station unit, you only need to enter the remote unit IP address for the Master.

4. Optionally, you can add up to 256 static routes for the NCL1155. At the `NCL1155>` prompt, type `<ip route add aaa.bbb.ccc.ddd eee.fff.ggg.hhh subnet_mask>` where `aaa.bbb.ccc.ddd` is the IP address for the destination network, `eee.fff.ggg.hhh` is the IP address for the gateway, and `subnet_mask` is specified in the number of bits.

5. If the mode is routing and the NCL1155 is a Master, type `<ip route add station_ethernet_subnet station_radio_ip_address subnet_mask>` to route the Master subnet traffic to the Master.

6. If the mode is routing and the NCL1155 is a Station, type `<ip route add 0.0.0.0 master_radio_ip_address 0>` to add a default static route to route all unknown subnets through the Master.

7. At the `NCL1155>` prompt, type `<radio enable>` to enable the NCL1155 to transmit messages. Ensure that the NCL1155 antenna port is terminated.

8. At the `NCL1155>` prompt, type `<write>` to save the settings to memory.

9. When done configuring the NCL1155, disconnect the terminal from the NCL1155.

4.3   Configuration Options

For added performance, flexibility, and convenience, the NCL1155 offers users the following configuration options:

Routing Mode

- Routing Information Protocol (RIP)—see *Setting RIP Configuration* on page 20
- Dynamic Host Control Protocol (DHCP) Relay—see *Setting the DHCP Relay Configuration* on page 22

System Monitoring

- Simple Network Management Protocol (SNMP)—see *Setting the SNMP Configuration* on page 22
- Domain Name Service (DNS) Resolver—see *Setting the DNS Resolver Configuration* on page 23

After completing these procedures, it is important to confirm that the configuration is correct before deploying the NCL1155 in the field. Refer to Chapter 5, *Testing and Deployment*, on page 35.

Two example configuration diagrams and sessions are provided in *Examples of Bridging and Routing Configurations*, on page 24: one for a point-to-multipoint bridging network, and the second for a point-to-multipoint routing network.

4.3.1   Setting RIP Configuration

When the NCL1155 is operating in Routing Mode, you can optionally enable the Routing Information Protocol (RIP) feature. RIP is a protocol that runs between two routers (for example, two NCL1155s) or servers to allow exchange information about routes. When RIP is enabled in routing mode, the NCL1155 can be configured to "advertise" default routes and static routes, as well as interface routes.

In bridging mode, enabling RIP has no effect.

The NCL1155 supports both RIP versions 1 and 2. You can set RIP version 2 to either broadcast, compatible, or multicast modes.

CAUTION: RIP version 1 exchanges the minimal amount of information necessary for an NCL1155 to route packets through a network, and does not consider subnetting, which is required to determine the best route. If the designated RIP route is a network route, RIP version 1 will interpret the network mask and subnet mask as the same, which may not always be correct. To avoid possible problems, we recommend NCL1155 users install RIP version 2, which exhanges explicit subnet and 'next-hop' information for each route.

1. At the `NCL1155>` prompt, type `<ip rip enable>` to enable RIP as the routing mode.

2. To transmit the route information in packets, type `<ip rip active>`. If RIP is set to `quiet`, it receives and processes RIP packets, but it does not transmit them.

3. Type `<ip rip version>` to display the current version of RIP.

4. If RIP is version 1, it is broadcast only. To change RIP routing to support version 2, type `<ip rip version 2>`.

5. If you set RIP to version 2, you can additionally specify how RIP handles packets.

To do this....	Type...
Disable RIP Routing	`<ip rip disable>`
Enable RIP routing.	`<ip rip enable>`
Send version 2 advertisements as broadcast.	`<ip rip broadcast>`
Send version 2 advertisements to RIP version 2 multicast addresses. This is generally more efficient than broadcast.	`<ip rip multicast>`

6. To enable RIP to advertise the default route, if one exists, in the advertisement, type `<ip rip default>`.

To set RIP to advertise static routes, as well as all other RIP information, type `<ip rip update>`. To send all route information except static route data, type `<ip rip noupdate>`.

4.3.2 Setting the DHCP Relay Configuration

When the NCL1155 is in routing mode, you can optionally enable Dynamic Host Control Protocol (DHCP) relay which makes the NCL1155 aware of the protocol for DHCP traffic and forwards the responses to the designated DHCP server.

> **NOTE:** When the NCL1155 is operating in bridging mode, DHCP Relay is transparent, and therefore, not an available option.

You can specify up to five DHCP servers in the NCL1155 configuration.

1. At the `NCL1155>` prompt, type `<dhcp mode relay>` to enable DHCP Relay in the device.

2. To add a DHCP server, type `<dhcp relay add ip_address>` where `ip_address` is the IP Address for the DHCP Server available for the NCL1155 to forward and receive DHCP traffic.

3. At the `NCL1155>` prompt, type `<save>` to transfer the settings to memory.

> **NOTE:** To remove a DHCP server, type `<dhcp relay delete ip_address>`. To disable DHCP Relay, type `<dhcp mode none>`.

4.3.3 Setting the SNMP Configuration

Simple Network Management Protocol (SNMP) enables a network management station to remotely monitor and control network devices incorporating an SNMP agent.

SNMP allows you to look at SNMP variables using READ communities, and to set SNMP variables using WRITE communities. Communities are optional on the NCL1155, but it can support a maximum of five communities. An NCL1155 is factory-configured with two communities, a READ community called "public" and a WRITE community called "private."

SNMP also provides a mechanism called trap, which notifies a network management station that a significant event has taken place. A significant event can be an interface going down or coming up, a unit performing a cold or warm start, or an authentication failure. Refer to RFC 1157 for details.

Associated with SNMP are Management Information Bases (MIBs). These specify a collection of management information available from the agent. This information can be controlled and monitored from a network management station.

The NCL1155 implements SNMPv2c and includes a number of standard SNMP MIBs:
- RFC1157 (MIB-II)
- RFC1493 (bridging)
- an NCL1155-specific MIB

WaveRider MIBs can be downloaded from the technical support page at www.waverider.com. The following procedure describes how to configure standard SNMP communities for read/write access to the NCL1155 SNMP agent and to specify a server IP address to which trap messages are sent.

1. At the `NCL1155>` prompt, type `<snmp>` to display the current SNMP settings for the NCL1155.

2. To add a new community, type `<snmp community add community READ|WRITE>` where *community* is the name of the community and `READ|WRITE` is the community type. You can have a maximum of five communities.

3. If a community is not set up the way you want it, delete it by typing `<snmp community del community READ|WRITE>` where *community* is the name of the community and `READ|WRITE` is the community type.

4. At the `NCL1155>` prompt, type `<snmp location location>` to change the geographical location of the NCL1155.

5. Type `<snmp contact contact>` to change the contact name for the NCL1155. The contact can be a name and phone number, a URL, or an email address.

6. To add a trap server to the NCL1155 configuration, type `<snmp trap add aaa.bbb.ccc.ddd community>` where *aaa.bbb.ccc.ddd* is the IP address of the trap server and *community* is the name of the community on the trap server.

7. To delete a trap server from the NCL1155 configuration, type `<snmp trap del aaa.bbb.ccc.ddd community>` where *aaa.bbb.ccc.ddd* is the IP address of the trap server and *community* is the name of the community on the trap server.

8. At the `NCL1155>` prompt, type `<save>` to transfer the settings to memory.

4.3.4 Setting the DNS Resolver Configuration

The NCL1155 implements Domain Name Server/Service (DNS) resolver software. Once configured, you can use host names instead of IP addresses when you make a Telnet connection from the NCL1155 console to other IP hosts on the network, or when you issue ping or traceroute commands to test connectivity.

Adding DNS lists is optional on the NCL1155, but you can configure the NCL1155 to use a maximum of five DNS servers. An NCL1155 is factory-configured with no DNS servers listed.

You can also configure the NCL1155 to include a domain name for your local IP network.

The following procedure describes how to configure the NCL1155 to implement DNS resolver software and configure the NCL1155 domain name. Setting the DNS resolver configuration is optional.

1. At the `NCL1155>` prompt, type `<ip dns>` to display the current DNS setup used by the NCL1155.

2. To add a DNS Server, type `<ip dns server add aaa.bbb.ccc.ddd>` where *aaa.bbb.ccc.ddd* is the IP address of the DNS Server.

3. To delete a DNS Server, type `<ip dns server del aaa.bbb.ccc.ddd>` where *aaa.bbb.ccc.ddd* is the IP address of the DNS Server.

4. To set the domain name for your local IP network, type `<ip dns domain domain_name>` where *domain_name* is the name for your local IP network.

5. At the `NCL1155>` prompt, type `<save>` to transfer the settings to memory.

4.4 Examples of Bridging and Routing Configurations

The following diagrams show typical point-to-multipoint bridging and routing network topologies, plus the corresponding command-line entries required to configure the devices in the network.

In a point-to-multipoint network configuration, each NCL1155 must be configured to operate as either a bridge or router. You cannot mix operational modes.

4.4.1 Point-to-Multipoint Bridging Network

Figure 10 shows a configuration of a typical point-to-multipoint bridging network.
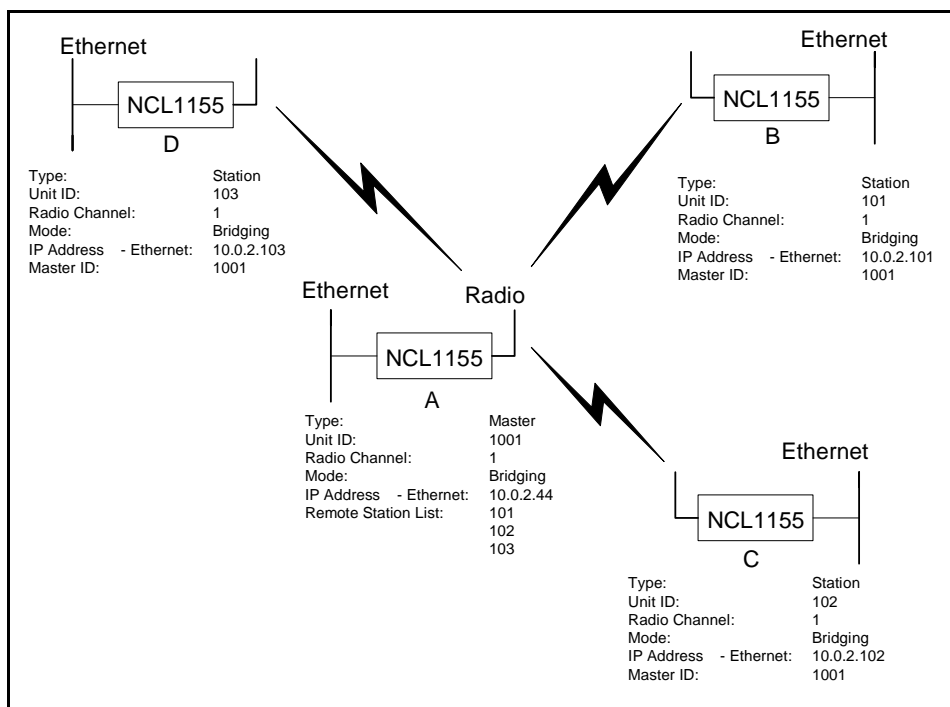
Figure 10   Example of Point-to-Multipoint Bridging Network

In Figure 10, unit A has been configured as the Master of the system with remote units B, C, and D configured as Stations. Units B, C, and D unit IDs have been manually added to the Master (unit A) Remote Station List. The Master unit ID on each Station is set to the unit ID for unit A. If a unit is not in the Master Remote Station List, or does not have the Master unit ID set, it will not be able to join the network.

The following example session shows how to configure the Master NCL1155 for the bridging network shown in Figure 10.

```
NCL1155>

NCL1155> radio channel 1                          Sets the radio channel
Radio channel changed to: 1

NCL1155> radio unitid 1001                         Sets the NCL1155 unit ID
Unit ID changed to: 1001

NCL1155> radio type master                         Sets the NCL1155 type to Mas
Radio type changed to: Master

NCL1155> radio station add 101                      Adds a station to the Master
Station added.                                      Remote Station List

NCL1155> radio station add 102
Station added.

NCL1155> radio station add 103
Station added.

NCL1155> radio                                      Displays the radio
RADIO CONFIGURATION:                                configuration information
Radio type       : Master
Wireless ID      : 1001
Speed            : 11Mbs
Channel          : 1
Regulatory Domain : FCC/IC
Frequency        : 2.412 GHz
Interframe spacing: 32 (281.6 micro seconds)
Hardware address  : 00:90:27:CA:62:A3
Network Card IRQ  : 5
NIC Base Address  : 0x0d0000
Remote Stations   : 101
                  : 102
                  : 103

NCL1155> ip address ethernet 10.0.2.44 16           Changes the local
IP addresses:                                        Ethernet IP address
  Ethernet: 10.0.2.44/16

NCL1155> mode bridging                               Sets the mode to bridging
Forwarding mode: Bridging

NCL1155> ip                                          Displays the IP configuration
Forwarding Mode: BRIDGING                            information
Addresses:
  Ethernet: 10.0.2.44/16
Routing: IP Routing (Static Only)
Routing Table:
Destination     Mask Gateway         Flags        Protocol  Interface
--------------------------------------------------------------------
10.0.0.0        16   10.0.2.44        UC           Local     eeE0
10.0.2.44       0    10.0.2.44        UHL          ICMP      lo0
127.0.0.1       0    127.0.0.1        UH           Local     lo0
--------------------------------------------------------------------
DNS Domain Name:
DNS Servers:
No DNS servers defined.

NCL1155> write                                      Saves the configuration
```

The following example session shows how to configure Station B in Figure 10 to join the network. To configure the remaining Stations, use the same procedure, replacing the unit ID and IP address for each with the appropriate information for that Station.

```
NCL1155>

NCL1155> radio channel 1
Radio channel changed to: 1

NCL1155> radio unitid 101
Unit ID changed to: 101

NCL1155> radio type station
Radio type changed to: Station

NCL1155> radio masterid 1001
Master Id changed to: 1001

NCL1155> ip address ethernet 10.0.2.101 16
IP addresses:
  Ethernet: 10.0.2.101/16

NCL1155> mode bridging
Forwarding mode: Bridging

NCL1155> radio
RADIO CONFIGURATION:
Radio type        : Station
Wireless ID       : 101
Speed             : 11Mbs
Channel           : 1
Regulatory Domain : FCC/IC
Frequency         : 2.412 GHz
Interframe spacing: 32 (281.6 micro seconds)
Hardware address  : 00:90:27:CA:62:A3
Network Card IRQ  : 5
NIC Base Address  : 0x0d0000
Master ID         : 1001

NCL1155> ip
Forwarding Mode: BRIDGING
Addresses:
  Ethernet: 10.0.2.101/16
Routing: IP Routing (Static Only)
Routing Table:
Destination     Mask Gateway          Flags        Protocol  Interface
-------------------------------------------------------------------
10.0.0.0        16   10.0.2.101        UC           Local     eeE0
10.0.2.101      0    10.0.2.101        UHL          ICMP      lo0
127.0.0.1       0    127.0.0.1         UH           Local     lo0
-------------------------------------------------------------------
DNS Domain Name:
DNS Servers:
No DNS servers defined.

NCL1155> write
```

Sets the NCL1155 type to Station

Identifies the unit ID of the Master for this

4.4.2 Point-to-Multipoint Routing Network

Figure 11 shows a configuration of a typical point-to-multipoint routing network.
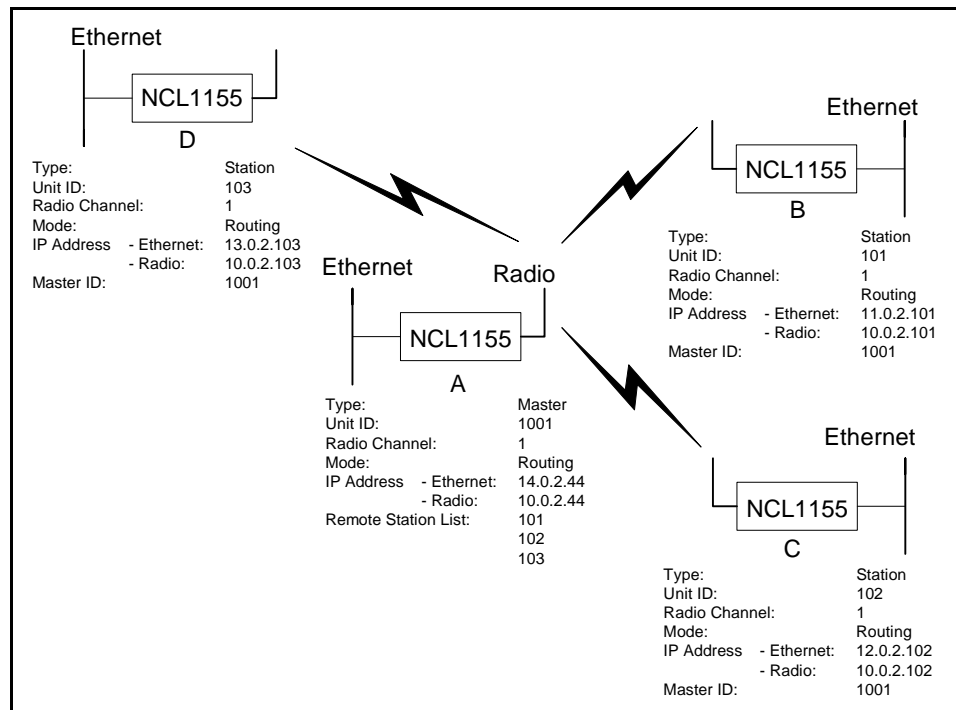
Figure 11   Example of Point-to-Multipoint Routing Network

The following example session shows how to configure the Master NCL1155 for the routing network shown in Figure 11.

```
NCL1155>
NCL1155> ip address ethernet 14.0.2.44 16
IP addresses:
  Ethernet: 14.0.2.44/16

NCL1155> mode routing                                          Sets the mode to routing
Forwarding mode: IP Routing

NCL1155> dhcp                                                  DHCP Relay is disabled by
DHCP Disabled                                                 default

NCL1155> dhcp mode relay                                      Enable DHCP Relay
DHCP Relay Enabled

NCL1155> dhcp relay add 10.0.1.44                            Add a DHCP Server to the
DHCP Servers/Relay Agents:                                    DHCP Relay table
  10.0.1.44

NCL1155> radio channel 1

NCL1155> radio type master
Radio type changed to: Master

NCL1155> radio unitid 1001
Unit ID changed to: 1001

NCL1155> radio station add 101
```

```
Station added.

NCL1155> radio station add 102
Station added.

NCL1155> radio station add 103
Station added.

NCL1155> ip                                    ◄──────────    Displays the IP
Forwarding Mode: IP ROUTING                                    configuration
Addresses:
  Ethernet: 14.0.2.44/16
  Radio:   101, 10.0.2.44 p-t-p ?             ◄──────────    The ? means that the IP
           102, 10.0.2.44 p-t-p ?                            address for the remote unit
           103, 10.0.2.44 p-t-p ?                            in the routing network has
Routing: IP Routing (Static Only)                            not been set
Routing Table:
Destination     Mask Gateway
Flags      Protocol  Interface
-----------------------------------------------------------------
14.0.2.44       0   14.0.2.44      UHL         ICMP      lo0
14.0.0.0        16  14.0.2.44      UC          Local     eeE0
127.0.0.1       0   127.0.0.1      UH          Local     lo0
-----------------------------------------------------------------
DNS Domain Name:
DNS Servers:
No DNS servers defined.

NCL1155> radio
RADIO CONFIGURATION:
Radio type        : Master
Wireless ID       : 1001
Speed             : 11Mbs
Channel           : 1
Regulatory Domain : FCC/IC
Frequency         : 2.412 GHz
Interframe spacing: 32 (281.6 micro seconds)
Hardware address  : 00:90:27:CA:62:A3
Network Card IRQ  : 5
NIC Base Address  : 0x0d0000
Remote Stations   : 101
                  : 102
                  : 103

NCL1155> ip address radio 101 10.0.2.44 10.0.2.101  ◄──    Sets the radio IP address
IP addresses:                                                 for the route to station B
  Ethernet: 14.0.2.44/16                                      (unit ID 101)
  Radio:   101, 10.0.2.44 p-t-p 10.0.2.101
           102, 10.0.2.44 p-t-p ?
           103, 10.0.2.44 p-t-p ?

NCL1155> ip address radio 102 10.0.2.44 10.0.2.102  ◄──    Sets the radio IP address
IP addresses:                                                 for the route to station C
  Ethernet: 14.0.2.44/16                                      (unit ID 102)
  Radio:   101, 10.0.2.44 p-t-p 10.0.2.101
           102, 10.0.2.44 p-t-p 10.0.2.102
           103, 10.0.2.44 p-t-p ?

NCL1155> ip address radio 103 10.0.2.44 10.0.2.103  ◄──    Sets the radio IP address
IP addresses:                                                 for the route to station D
  Ethernet: 14.0.2.44/16                                      (unit ID 103)
  Radio:   101, 10.0.2.44 p-t-p 10.0.2.101
           102, 10.0.2.44 p-t-p 10.0.2.102
           103, 10.0.2.44 p-t-p 10.0.2.103
```

```
NCL1155> ip route add 11.0.0.0 10.0.2.101 16
Routing Table:
Destination     Mask Gateway         Flags      Protocol  Interface
-------------------------------------------------------------------
14.0.2.44       0    14.0.2.44       UHL        ICMP      lo0
10.0.2.101      0    10.0.2.44       UHC        Local     mdr1
10.0.2.102      0    10.0.2.44       UHC        Local     mdr2
10.0.2.103      0    10.0.2.44       UHC        Local     mdr3
14.0.0.0        16   14.0.2.44       UC         Local     eeE0
11.0.0.0        16   10.0.2.101      UC         Static    mdr1
127.0.0.1       0    127.0.0.1       UH         Local     lo0
-------------------------------------------------------------------
```

For each Station, route the Ethernet subnet to the radio IP address of the Station

```
NCL1155> ip route add 12.0.0.0 10.0.2.102 16
Routing Table:
Destination     Mask Gateway         Flags      Protocol  Interface
-------------------------------------------------------------------
14.0.2.44       0    14.0.2.44       UHL        ICMP      lo0
10.0.2.101      0    10.0.2.44       UHC        Local     mdr1
10.0.2.102      0    10.0.2.44       UHC        Local     mdr2
10.0.2.103      0    10.0.2.44       UHC        Local     mdr3
14.0.0.0        16   14.0.2.44       UC         Local     eeE0
11.0.0.0        16   10.0.2.101      UC         Static    mdr1
12.0.0.0        16   10.0.2.102      UC         Static    mdr2
127.0.0.1       0    127.0.0.1       UH         Local     lo0
-------------------------------------------------------------------


NCL1155> ip route add 13.0.0.0 10.0.2.103 16
Routing Table:
Destination     Mask Gateway         Flags      Protocol  Interface
-------------------------------------------------------------------
14.0.2.44       0    14.0.2.44       UHL        ICMP      lo0
10.0.2.101      0    10.0.2.44       UHC        Local     mdr1
10.0.2.102      0    10.0.2.44       UHC        Local     mdr2
10.0.2.103      0    10.0.2.44       UHC        Local     mdr3
14.0.0.0        16   14.0.2.44       UC         Local     eeE0
11.0.0.0        16   10.0.2.101      UC         Static    mdr1
12.0.0.0        16   10.0.2.102      UC         Static    mdr2
13.0.0.0        16   10.0.2.103      UC         Static    mdr3
127.0.0.1       0    127.0.0.1       UH         Local     lo0
-------------------------------------------------------------------

NCL1155> ip
Forwarding Mode: IP ROUTING
Addresses:
  Ethernet: 14.0.2.44/16
  Radio:   101, 10.0.2.44 p-t-p 10.0.2.101
           102, 10.0.2.44 p-t-p 10.0.2.102
           103, 10.0.2.44 p-t-p 10.0.2.103
Routing: IP Routing (Static Only)
Routing Table:
Destination     Mask Gateway         Flags
Protocol  Interface
-------------------------------------------------------------------
14.0.2.44       0    14.0.2.44       UHL        ICMP      lo0
10.0.2.101      0    10.0.2.44       UHC        Local     mdr1
10.0.2.102      0    10.0.2.44       UHC        Local     mdr2
10.0.2.103      0    10.0.2.44       UHC        Local     mdr3
14.0.0.0        16   14.0.2.44       UC         Local     eeE0
11.0.0.0        16   10.0.2.101      UC         Static    mdr1
12.0.0.0        16   10.0.2.102      UC         Static    mdr2
13.0.0.0        16   10.0.2.103      UC         Static    mdr3
127.0.0.1       0    127.0.0.1       UH         Local     lo0
-------------------------------------------------------------------
DNS Domain Name:
```

Note the IP addresses for the remote Stations are

```
DNS Servers:
No DNS servers defined.

NCL1155> write
```

The following example session shows how to configure Station B in Figure 11 to join the routing network. To configure the remaining Stations, use the same procedure, replacing the unit ID for each Station with the appropriate ID for that Station.

```
NCL1155>
NCL1155> ip address ethernet 11.0.2.101 16
IP addresses:
  Ethernet: 11.0.2.101/16
  Radio:   200, 10.0.2.44 p-t-p ?

NCL1155> dhcp mode relay                           Enable DHCP Relay
DHCP Relay Enabled

NCL1155> dhcp relay add 10.0.1.44                  Add a DHCP Server to
DHCP Servers/Relay Agents:                         the DHCP Relay table
  10.0.1.44

NCL1155> radio channel 1                           Set the radio channel

NCL1155> mode routing
Forwarding mode: IP Routing

NCL1155> radio type station
Radio type changed to: Station

NCL1155> radio unitid 101
Unit ID changed to: 101

NCL1155> radio masterid 1001
Master Id changed to: 1001

NCL1155> ip address radio 1001 10.0.2.101          Set the radio IP address
10.0.2.44                                          for the route to the Master
IP addresses:                                      NCL1155
  Ethernet: 11.0.2.101/16
  Radio:   1001, 10.0.2.101 p-t-p 10.0.2.44

NCL1155> ip route add 0.0.0.0 10.0.2.44 16         Set the default static route

Routing Table:
Destination     Mask Gateway         Flags        Protocol   Interface
-------------------------------------------------------------------
10.0.2.44       0    10.0.2.101       UHC          Local      mdr1
11.0.2.101      0    11.0.2.101       UHL          ICMP       lo0
11.0.0.0        16   11.0.2.101       UC           Local      eeE0
0.0.0.0         0    10.0.2.44        UC           Static     mdr1
127.0.0.1       0    127.0.0.1        UH           Local      lo0
-------------------------------------------------------------------

NCL1155> radio
RADIO CONFIGURATION:
Radio type        : Station
Wireless ID       : 101
Speed             : 11Mbs
Channel           : 4
Regulatory Domain : FCC/IC
Frequency         : 2.412 GHz
Interframe spacing: 32 (281.6 micro seconds)
```

```
Hardware address  : 00:90:27:CA:62:A3
Network Card IRQ  : 5
NIC Base Address  : 0x0d0000
Master ID         : 1001

NCL1155> ip
Forwarding Mode: IP ROUTING
Addresses:
  Ethernet: 11.0.2.101/16
  Radio:  1001, 10.0.2.101 p-t-p 10.0.2.44
Routing: IP Routing (Static Only)
Routing Table:
Destination    Mask Gateway        Flags        Protocol  Interface
-------------------------------------------------------------------
10.0.2.44      0    10.0.2.101     UHC          Local     mdr1
11.0.2.101     0    11.0.2.101     UHL          ICMP      lo0
11.0.0.0       16   11.0.2.101     UC           Local     eeE0
0.0.0.0        0    10.0.2.44      UC           Static    mdr1
127.0.0.1      0    127.0.0.1      UH           Local     lo0
-------------------------------------------------------------------
DNS Domain Name:
DNS Servers:
No DNS servers defined.
```

4.5   Updating an NCL1155 Using Remote Connections

You can connect to the NCL1155 remotely through either of the following methods:
- FTP
- Telnet

To access an NCL1155 remotely, you will require the following information:
- IP address for the NCL1155
- Password for the NCL1155 (Refer to the Configuration Data Record)

> **NOTE:** If your network has a firewall, you may be able to access the
> NCL1155 only from within the network. Before attempting to
> configure the NCL1155 using a remote connection, you should be
> familiar with the configuration procedures described in
> *Configuring the NCL1155*, on page 17.

4.5.1   Establishing an FTP Connection

Use an FTP session to upload firmware upgrades to the NCL1155. Specific instructions to upgrade firmware will be provided with each new release.

> **NOTE:** The following procedure assumes that you are using a basic
> command-line FTP application.

1. From a computer or terminal, start an FTP session following the instructions for the FTP application you are using.

2. Log into the NCL1155.

3. At the `User Name` prompt, press **Enter**. For FTP sessions, the User Name for the NCL1155 is blank.

4. At the `Password` prompt, type the NCL1155 password that you defined for the device. Refer to the Configuration Data Record for the NCL1155.

5. On the FTP client, change the Transfer Mode to binary. For example, type `<binary>`.

6. On the FTP client, put the file to the client (for example: type `<put `*`filename.exe filename.exe`*`>`). The file transfer will require approximately one minute to complete.

7. After the confirmation message is received, quit the FTP session. For example, type `<quit>`.

> **NOTE:** Once finished with the FTP session, you will need to follow up
> with a Telnet session to reboot the NCL1155 for the upgrade to
> take effect.

4.5.2 Establishing a Telnet Session

Use a Telnet connection to the NCL1155 to modify configuration parameters or to restart the NCL1155 from a remote location.

CAUTION: If you connect to the NCL1155 using Telnet and change the Routing Tables, Mode, or Radio or Ethernet IP addresses, your connection to the device may be dropped. You will need to reconnect to the NCL1155 using the new IP address in order to save your changes to the device. When you use a local serial connection, this does not occur.

You can use a standard Telnet application to connect to the NCL1155.

1. Start the Telnet application on your computer.

2. Use a remote system connection to connect to the IP address for the NCL1155.

3. At the Password prompt, type the NCL1155 password. The application opens a terminal-emulation screen.

4. Modify the configuration parameters as necessary.

5. When done, type `<exit>` to close the Telnet session.

   NOTE: If you restart or reboot while connected to the NCL1155 through Telnet, it will drop your connection. After restarting, you must reconnect to the NCL1155 before continuing.

5 Testing and Deployment

This section describes the tests that you can perform before and after deployment to optimize the performance of your NCL1155:

Before Deployment
- radio connection (pinging)

After Deployment
- signal strength (antenna alignment)
- continuous transmit and receive
- transmit and receive loopback

5.1 Performing a Ping Test

Use the Ping Test to verify that the NCL1155 is configured correctly and able to communicate with other bridges and routers.

> **NOTE:** This test requires two NCL1155 units, one configured as a Master, and the other, a Station, set up on either side of a room, at least 12 feet apart.

1. Ensure that each NCL1155 has an antenna connected to it. Do NOT plug the NCL1155 to the power outlet until you have an antenna connected.

WARNING!

Antennas and associated transmission cable must be installed by qualified personnel. Failure to terminate the antenna port correctly can permanently damage the NCL1155. WaveRider assumes no liability for failure to adhere to this recommendation or to recognized general safety precautions.

2. Plug the NCL1155 back into the power source and at the terminal console keyboard, log into the NCL1155.

3. At the `NCL1155>` prompt, type `<ip ping `*`ip_address`*`>` where *`ip_address`* is the IP address for the other NCL1155.

4. Let the `ip ping` command run for approximately 10 seconds. Press any key to end the `ip ping` command. If the configuration is correct, you should get a response similar to the following:

```
NCL1155>
NCL1155> ip ping 10.0.2.52
Press any key to stop.
PING 10.0.2.52: 56 data bytes
64 bytes from 10.0.2.52: icmp_seq=0. time=0. ms
64 bytes from 10.0.2.52: icmp_seq=1. time=30. ms
64 bytes from 10.0.2.52: icmp_seq=2. time=0. ms
64 bytes from 10.0.2.52: icmp_seq=3. time=0. ms
64 bytes from 10.0.2.52: icmp_seq=4. time=0. ms
64 bytes from 10.0.2.52: icmp_seq=5. time=0. ms
64 bytes from 10.0.2.52: icmp_seq=6. time=0. ms
----10.0.2.52 PING Statistics----
7 packets transmitted, 7 packets received, 0% packet loss
round-trip (ms)  min/avg/max = 0/4/30

NCL1155>
```

If the connection does not work, you will receive the following message:

```
NCL1155>
NCL1155> ip ping 10.0.2.52
Press any key to stop.
PING 10.0.2.52: 56 data bytes
no answer from 10.0.2.52

NCL1155>
```

You receive replies only if the link is operational. Refer to Chapter 7, *Troubleshooting*, on page 53 if the device does not respond.

5.2 Optimizing Signal Strength

5.2.1 Running the Continuous Transmit (Tx) Test

This test should only be used when setting up a Master and the first Station of a new network. The purpose of this test is to send a continuous stream of messages from an NCL1155 Master to a Station which receives and discards the messages, or to a spectrum analyzer for signal monitoring. The Radio Packet Error Rate (PER) is displayed at a Station receiving the Continuous Transmit messages and using that information, an installer aligns the antenna accordingly. Refer to section 6.2, *Radio Packet Error Rate (PER)*, on page 44 for more information.

You will need one NCL1155 configured as a Master. At the other end of the link, you can have an NCL1155 Station or a spectrum analyzer. The following procedure describes the test for a Master NCL1155 and one Station NCL1155. If you are using a spectrum analyzer, adjust the antenna for maximum received signal.

CAUTION: Do NOT run this test in a working network. Doing so will cause network operations to slow down. These tests must be performed individually on each NCL1155 unit.

1. Ensure that the NCL1155s (one Master and one Station) have been configured and tested.

2. Deploy the Master and Station connecting the antennas as required.

WARNING!

Antennas and associated transmission cable must be installed by qualified personnel. Failure to terminate the antenna port correctly can permanently damage the NCL1155. WaveRider assumes no liability for failure to adhere to this recommendation or to recognized general safety precautions.

3. Connect a terminal at each NCL1155 using a serial cable and log into each device.

4. At the Master NCL1155 console terminal, type `<radio txTest start>` to begin the Continuous Transmit Test. "Radio Tx Test On" is displayed above the `NCL1155>` prompt when the test is running.

5. At the Station NCL1155 console terminal, type `<radio per continuous>` to begin displaying the Radio PER. Refer to section 6.2, *Radio Packet Error Rate (PER)*, on page 44 for more information.

6. Using the information from Radio PER, align the antenna at the NCL1155 Station so that the number of packets missed is at a minimum rate.

7. When done with the antenna alignment, stop the test at the Master NCL1155. Type `<radio txTest stop>.`

8. At the Station NCL1155, press any key to end the Radio PER output.

> **NOTE:** By default, a Master NCL1155 keeps track of the Radio PER of each Station. A Station does not track the Radio PER of another visible Station unless it is running the Continuous Receive test. Refer to section 5.2.2, *Running the Continuous Receive (Rx) Test*, on page 38. A Station does track the Radio PER of both direct and broadcast communication with the Master.

The information received from Radio PER during the Continuous Transmit test will be similar to the following output. The following output is from a Station (unit ID 2) communicating with the Master (unit ID 1) that is running the Continuous Transmit test.

```
station> radio per continuous

Unit Id     Link Status   Total # Received  Total # Missed  PER (%)
---------   -----------   ----------------  --------------  -------
1           UP            2                 0               0
broadcast                 5                 0               0

Unit Id     Link Status   Total # Received  Total # Missed  PER (%)
---------   -----------   ----------------  --------------  -------
1           UP            2                 0               0
broadcast                 820               56              6

Unit Id     Link Status   Total # Received  Total # Missed  PER (%)
---------   -----------   ----------------  --------------  -------
1           UP            2                 0               0
broadcast                 1679              91              5

Unit Id     Link Status   Total # Received  Total # Missed  PER (%)
---------   -----------   ----------------  --------------  -------
1           UP            2                 0               0
broadcast                 2545              126             4

Unit Id     Link Status   Total # Received  Total # Missed  PER (%)
---------   -----------   ----------------  --------------  -------
1           UP            2                 0               0
broadcast                 3411              149             4

station>
```

5.2.2 Running the Continuous Receive (Rx) Test

The purpose of this test is to help you deploy an additional Station in an existing network without interrupting traffic to the currently active Stations in the network. The test is run from the new Station to "sniff" packets destined to every other Station (originated by the Master) in the system. The test is run simultaneously with Radio PER which displays the number of packets received and missed for each Station that is sniffed. This test can also be used at existing Stations to analyze throughput in a running system.

1. Ensure that the new Station NCL1155 has been configured and tested.

2. Deploy the Station and connect the antenna.

WARNING!

Antennas and associated transmission cable must be installed by qualified personnel. Failure to terminate the antenna port correctly can permanently damage the NCL1155. WaveRider assumes no liability for failure to adhere to this recommendation or to recognized general safety precautions.

3. Connect a terminal at the Station NCL1155 using a serial cable and log into the device.

4. At the Station NCL1155, type `<radio rxTest start>` to begin "sniffing" the transmissions and automatically start the Radio PER display. "Continuous Rx test started" is displayed when the test is started.

   NOTE: If you stop the Radio PER display (press any key), you can restart the display by typing `<radio per continuous>`. Refer to section 6.2, *Radio Packet Error Rate (PER)*, on page 44 for more information.

5. Using the information from Radio PER, align the antenna at the NCL1155 Station so that the number of packets missed is at a minimum rate.

6. When done with the antenna alignment, press any key to stop the Radio PER display, then type `<radio rxTest stop>` to stop the test.

The information received from Radio PER during the Continuous Receive test will be similar to the following output. The following output is from a Station (unit ID 2) communicating with the Master (unit ID 1) that is also transmitting to another Station (unit ID 3).

```
station> radio rxtest start

Continuous Rx test started

Unit Id     Link Status     Total # Received  Total # Missed  PER (%)
---------   -----------   ----------------  --------------  -------
1           UP              1                 0               0
broadcast                   509               0               0
3           UP              1                 0               0

Unit Id     Link Status     Total # Received  Total # Missed  PER (%)
---------   -----------   ----------------  --------------  -------
1           UP              1                 0               0
broadcast                   510               0               0
3           UP              1                 0               0

Unit Id     Link Status     Total # Received  Total # Missed  PER (%)
---------   -----------   ----------------  --------------  -------
1           UP              1                 0               0
broadcast                   512               0               0
3           UP              1                 0               0
```

```
Unit Id      Link Status    Total # Received  Total # Missed  PER (%)
---------    -----------    ----------------  --------------  -------
1            UP             1                 0               0
broadcast                   515               0               0
3            UP             1                 0               0

Unit Id      Link Status    Total # Received  Total # Missed  PER (%)
---------    -----------    ----------------  --------------  -------
1            UP             1                 0               0
broadcast                   518               0               0
3            UP             1                 0               0

[Radio Rx Test On]
station> radio rxtest stop
station>
```

5.2.3 Performing the Transmit/Receive Loopback Test

This test should only be used when setting up a new network. The purpose of this test is to ensure that the Master NCL1155 can "see" the Station. It also determines the quality of the links between Master and Station. The test originates at the Master NCL1155, repeatedly sending test packets to the Stations. A Station recognizes these as test packets from the Master and echoes them back to the Master. When the Master receives the replies from the Station, it updates its Radio PER for that Station. One Master NCL1155 can have up to ten Stations simultaneously echoing test packets back to it.

You will need one NCL1155 configured as a Master and at least one NCL1155 Station.

CAUTION: Do NOT run this test in a working network. Doing so will cause every device in the network to slow down.

1. Ensure that the Master NCL1155 and Station NCL1155s have been configured and tested.

2. Deploy the Master and at least one Station connecting the antennas for each device as required.

WARNING!

Antennas and associated transmission cable must be installed by qualified personnel. Failure to terminate the antenna port correctly can permanently damage the NCL1155. WaveRider assumes no liability for failure to adhere to this recommendation or to recognized general safety precautions.

3. Connect a terminal to the Master NCL1155 using a serial cable and log into the device.

4. At the Master NCL1155 console terminal, type `<radio txrx start>` to begin the Transmit/Receive Loopback test and automatically start the Radio PER display. "Tx/Rx test started" is displayed when the test is started. Refer to section 6.2, *Radio Packet Error Rate (PER)*, on page 44 for more information.

5. Using the information from Radio PER, determine the quality of the link between the Master and Stations.

6. When done, press any key to stop Radio PER, then stop the Transmit/Receive Loopback Test by typing `<radio txrx stop>.`

The information received from Radio PER during the Transmit/Receive Loopback test will be similar to the following output. The following output is from a Master (unit ID 1) communicating with two Stations (unit IDs 2 and 3).

```
master> radio txrx start

Tx/Rx test started

Unit Id     Link Status    Total # Received   Total # Missed   PER (%)
---------   -----------    ----------------   --------------   -------
2           UP             9                  0                0
3           UP             5                  0                0

Unit Id     Link Status    Total # Received   Total # Missed   PER (%)
---------   -----------    ----------------   --------------   -------
2           UP             827                53               6
3           UP             820                56               6

Unit Id     Link Status    Total # Received   Total # Missed   PER (%)
---------   -----------    ----------------   --------------   -------
2           UP             1689               85               4
3           UP             1679               91               5

Unit Id     Link Status    Total # Received   Total # Missed   PER (%)
---------   -----------    ----------------   --------------   -------
2           UP             2566               109              4
3           UP             2545               126              4

Unit Id     Link Status    Total # Received   Total # Missed   PER (%)
---------   -----------    ----------------   --------------   -------
2           UP             3423               141              3
3           UP             3411               149              4

[Radio TxRx Test On]
master>  radio txrx stop
master>
```

6 System Reporting and Diagnostics

After an NCL1155 has been configured, tested, and deployed, you can generate on demand reports about its performance in key system areas:

- Receive Signal Strength Indication (RSSI)
- Radio Packet Error Rate (PER)
- Interface Statistics

6.1 Radio Receive Signal Strength Indication (RSSI)

Radio RSSI calculates the average and peak receive signal strength values based on factory set threshold (floor) value. This value can be reconfigured by the user.

To display the current Radio RSSI for an NCL1155 during normal operation, type `<radio rssi>`. Press any key to stop.

At a Master or Station NCL1155, you will receive output similar to the following example:

```
RSSI THRESHOLD=0
RSSI;PEAK
radio rssi=24;25
radio rssi=24;25
radio rssi=24;25
radio rssi=24;25
radio rssi=24;25
radio rssi=24;25
radio rssi=24;25
radio rssi=24;25
radio rssi=24;25
radio rssi=24;26
radio rssi=24;25
radio rssi=24;25
```

Press any key to stop.

6.2   Radio Packet Error Rate (PER)

Radio PER can be displayed at any time, including during tests. See Chapter 5.2, *Optimizing Signal Strength*, on page 37 for other tests that use Radio PER statistics.

To display the current Radio PER for an NCL1155 during normal operation, type `<radio per>` or `<radio per single>`.

Table 1 defines how to interpret the Radio PER output.

At a Master NCL1155, you will receive output similar to the following. The following example was taken at a Master NCL1155 communicating with two Stations (unit IDs 2 and 3).

```
master> radio per single

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
2           UP             2                 0               0
3           UP             2                 0               0

master>
```

At a Station NCL1155, you will receive output similar to the following. The following example was taken at a Station (unit ID 2) communicating with a Master (unit ID 1).

```
station> radio per single

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
1           UP             1                 0               0
broadcast                  72                0               0

station>
```

To display the radio PER once every second during normal operation, type <radio per continuous>.

To clear the Radio PER statistics, type <radio per reset>.

To stop the Radio PER display, press any key.

At a Master NCL1155, you will receive output similar to the following. The following example was taken at a Master (unit ID 1) communicating with two Stations (unit IDs 2 and 3).

```
master> radio per continuous

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
2           UP             2                 0               0
3           UP             2                 0               0

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
2           UP             102               0               0
3           UP             42                0               0

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
2           UP             112               1               0
3           UP             4                 0               0

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
2           UP             140               2               0
3           UP             85                0               0

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
2           UP             171               2               0
3           UP             101               0               0

master>
```

At a Station NCL1155, you will receive output similar to the following. The following example was taken at a Station (unit ID 2) communicating with a Master (unit ID 1).

```
station> radio per continuous

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
1           UP             1                 0               0
broadcast                  236               0               0

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
1           UP             1                 0               0
broadcast                  237               0               0

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
1           UP             1                 0               0
broadcast                  239               0               0

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
1           UP             1                 0               0
broadcast                  240               0               0

Unit Id     Link Status    Total # Received  Total # Missed  PER (%)
---------   -----------    ----------------  --------------  -------
1           UP             1                 0               0
broadcast                  241               0               0


station>
```

Table 1   Radio Packet Error Rate Assessment

Radio PER Ratio	Transmission Quality
less than 1%	excellent
1% to 4%	good
5% to 7%	marginal
greater than 7%	poor

TIP: Use Radio PER during testing and deployment testing to monitor transmission quality. Refer to Chapter 5.2, *Optimizing Signal Strength*, on page 37 for other tests that benefit from Radio PER statistics.

6.3   Interface Statistics

The interface statistics command displays the configuration information and statistics for the three interfaces associated with the NCL1155: radio, Ethernet and loopback.

The loopback interface is an interface on a logical network that returns all output packets as input packets. The address for this logical network is 127.0.0.0 and the address for the loopback interface is usually 127.0.0.1. This means that any packets sent to the IP address 127.0.0.1 will be turned around and queued as input packets to the same interface. The values of the input and output statistics for the loopback interface should both be the same.

To see the interface information for a NCL1155, type <interface statistics> at the NCL1155> prompt.

Table 2 provides definitions for the statistics labels.

For a Master NCL1155, information similar to the following example is displayed:

```
NCL1155> interface statistics
Statistics For Loopback
------------------
Flags                      UP LOOPBACK NOTRAILERS RUNNING MULTICAST
MTU                        32768
Hardware Address
Administrative Status      UP(1)
Operational Status         UP(1)
Input Octets               3808
Input Unicast Packets      64
Input Non-Unicast Packets  0
Input Discards             0
Input Errors               0
Input Unknown Protocols    0
Output Octets              3808
Output Unicast Packets     64
Output Non-Unicast Packets 0
Output Discards            0
Output Errors              0
more...
Statistics For Ethernet
------------------
Flags                      UP BROADCAST NOTRAILERS RUNNING MULTICAST
MTU                        1500
Hardware Address           00:90:27:b1:aa:ad
Administrative Status      UP(1)
Operational Status         UP(1)
Input Octets               31614896
Input Unicast Packets      20923
Input Non-Unicast Packets  0
Input Discards             9022
Input Errors               0
Input Unknown Protocols    0
Output Octets              3371158
Output Unicast Packets     2255
Output Non-Unicast Packets 0
Output Discards            2215
Output Errors              0
more...
Statistics For Master Radio
-------------------------
Flags                      UP POINT-TO-POINT NOTRAILERS RUNNING NOARP MULTIC
```

```
AST
MTU                          1552
Hardware Address             00:90:27:b1:aa:ad
Administrative Status        UP(1)
Operational Status           UP(1)

Input Statistics
-------------------------
Remote              Non-
Station   Input     Unicast   Unicast                        Unknown
ID        Octets    Packets   Packets   Discards  Errors     Protocols
-------   ------    -------   -------   --------  ------     ---------
101       967998    0         645       0         0          0
102       1218723   0         808       0         0          0
103       1251987   0         830       0         0          0
more...

Output Statistics
-------------------------
Remote              Non-
Station   Output    Unicast   Unicast
ID        Octets    Packets   Packets   Discards  Errors
-------   ------    -------   -------   --------  ------
101       10419675  6943      1         45        0
102       10446473  6958      0         33        0
103       10402915  6929      0         43        0
```

For a Station NCL1155, information similar to the following example is displayed:

```
NCL1155> interface statistics
Statistics For Loopback
-------------------
Flags                        UP LOOPBACK NOTRAILERS RUNNING MULTICAST
MTU                          32768
Hardware Address
Administrative Status        UP(1)
Operational Status           UP(1)
Input Octets                 2975
Input Unicast Packets        50
Input Non-Unicast Packets    0
Input Discards               0
Input Errors                 0
Input Unknown Protocols      0
Output Octets                2975
Output Unicast Packets       50
Output Non-Unicast Packets   0
Output Discards              0
Output Errors                0
more...
Statistics For Ethernet
-------------------
Flags                        UP BROADCAST NOTRAILERS RUNNING MULTICAST
MTU                          1500
Hardware Address             00:90:27:b1:ad:01
Administrative Status        UP(1)
Operational Status           UP(1)
Input Octets                 7479220
Input Unicast Packets        4941
Input Non-Unicast Packets    0
Input Discards               0
Input Errors                 0
Input Unknown Protocols      0
```

```
Output Octets              25364516
Output Unicast Packets     16759
Output Non-Unicast Packets 0
Output Discards            76
Output Errors              0
more...
Statistics For Radio
-------------------
Flags                      UP POINT-TO-POINT NOTRAILERS RUNNING NOARP MULTIC
AST
MTU                        1552
Hardware Address           00:90:27:b1:ad:01
Administrative Status      UP(1)
Operational Status         UP(1)
Input Octets               25331759
Input Unicast Packets      16769
Input Non-Unicast Packets  5
Input Discards             0
Input Errors               0
Input Unknown Protocols    0
Output Octets              7441747
Output Unicast Packets     4970
Output Non-Unicast Packets 0
Output Discards            0
Output Errors              0
```

Table 2   Interface Statistics

Label	Description
Flags	Specifies the operational state and properties of the interface. Possible flags are: • BROADCAST: interface is for a broadcast network • MULTICAST: interface supports multicasting • POINT-TO-POINT: interface is for a point-to-point network • LOOPBACK: interface is for a loopback network • RUNNING: resources are allocated for this interface • SIMPLEX: interface cannot receive its own transmissions • ALLMULTI: interface is receiving all multicast packets • DEBUG: debugging is enabled for the interface • NOARP: do not use ARP on this interface • NOTRAILERS: avoid using trailer encapsulation • PROMISCUOUS: interface receives all network packets • TX: a transmission is in progress • UP: interface is operating
MTU	Maximum transmission unit or the size of the largest packet the interface can handle.
Hardware Address	MAC address or Ethernet address of the interface.
Administrative Status	Desired state of the interface. The NCL1155 supports UP and DOWN states.
Operational Status	Current operational state of the interface.

Label	Description
Input Octets	Number of bytes that arrived on this interface since the last `interface reset` or `reboot`.
Input Unicast Packets	Number of unicast packets that arrived on this interface since the last `interface reset` or `reboot`.
Input Non-Unicast Packets	Number of non-unicast packets that arrived on this interface since the last `interface reset` or `reboot`.
Input Discards	Number of packets that arrived on this interface and were discarded since the last `interface reset` or `reboot`.
Input Errors	Number of packets that arrived on this interface with errors since the last `interface reset` or `reboot`.
Output Octets	Number of bytes that were sent from this interface since the last `interface reset` or `reboot`.
Output Unicast Packets	Number of unicast packets that were sent from this interface since the last `interface reset` or `reboot`.
Output Non-Unicast Packets	Number of non-unicast packets that were sent from this interface since the last `interface reset` or `reboot`.
Output Discards	Number of outbound packets that were dropped because of implementation limits since the last `interface reset` or `reboot`.
Output Errors	Number of outbound packets dropped because of errors since the last `interface reset` or `reboot`.

6.3.1 IP Statistics

To see the IP protocol layer statistics for a NCL1155, at the `NCL1155>` prompt, type `<ip statistics>`.

Table 3 provides definitions for the statistics labels.

Information similar to the following example is displayed. The statistics for this command are from the time of the last reboot of the NCL1155.

```
NCL1155> ip statistics

IP STATISTICS
-------------
Total packets received          50
Bad checksum discards            0
Packet too short discards        0
Not enough data discards         0
Bad header length discards       0
Bad data length discards         0
Fragments received               0
Fragments dropped                0
Fragments timed out              0
Packets forwarded                0
Couldn't forward discards        0
Redirected forwards              0
Unknown protocol discards       25
```

```
No space discards                    0
Packets reassembled                  0
Fragments sent                       0
No route discards                    0
```

Table 3   IP Statistics

Label	Descriptions
Total packets received	Number of packets sent to the IP layer.
Bad checksum discards	Number of packets discarded due to a bad checksum.
Packet too short discards	Number of packets dropped due to an invalid data length.
Not enough data discards	Number of packets dropped because they did not contain enough data to be an IP packet.
Bad header length discards	Number of packets discarded because of inconsistent IP header and IP data lengths.
Fragment received	Number of packet fragments received.
Fragments dropped	Number of fragments dropped due to lack of space or duplicates.
Fragments timed out	Number of fragments that were timed-out.
Packets forwarded	Number of packets forwarded at the IP layer.
Couldn't forward discards	Number of packets received for unreachable destinations.
Redirected forwards	Number of redirect messages that were sent.
Unknown protocol discards	Number of packets of unknown or unsupported protocol received and discarded.
No space discards	Number of packets dropped because of resource shortages.
Packets reassembled	Number of packets that needed to be reassembled.
Fragments sent	Number of fragments successfully sent.
No route discards	Number of packets discarded because there was no route to the destination given.

6.3.2 Radio Statistics

To see radio statistics for the NCL1155, at the `NCL1155>` prompt, type
`<radio statistics>`. The statistics displayed are since the last reboot of the NCL1155.

Table 4 provides definitions for the statistics labels.

Information similar to the following example is displayed:

```
NCL1155> radio statistics

RADIO STATISTICS:
----------------------------------------------------------------------
Transmitted               :              1455
Tx Underflows             :              0
Tx Overflows              :              0
TX_RDY Error              :              0
Rx Packets                :              120106
Rx Underflows             :              0
Rx Overflows              :              0
MD_RDY Error              :              0
Rx Data CRC Error         :              1
ALF Header Chksum Error   :              0
Rx MAC Header CRC Error   :              0
Rx Invalid Data Length    :              0
Broadcast Discards        :              0
Rx Length Mismatch        :              0
Tx Length Mismatch        :              0
Missed Complete           :              0
Missed Header             :              0
```

Table 4   Radio Statistics

Label	Description
Transmitted	Number of packets sent.
Tx Blocks delayed	Number of transmitted blocks delayed.
Rx Packets	Number of packets received.
Rx Data CRC Error	Number of received data CRC errors that occurred.
ALF Header Chksum Error	Number of packets received with an invalid Air Link Frame (ALF) header.
Rx MAC Header CRC Error	Number of times packets were discarded because headers were invalid.
Rx MAC Header CRC Fixed	Number of times the MAC header CRC was fixed.
RX Invalid Data Length	Number of packets received with an invalid length (that is, greater than the maximum size).
NIC Failure	Number of network interface card failures.
Broadcast Discards	Number of broadcast packets that the NCL1155 received and discarded.
Transmit Timeouts	Number of transmit timeouts due to the radio channel being too busy or due to interference.

7 Troubleshooting

Use this section to identify and correct common problems associated with NCL1155 operation.

To verify that the connection has been re-established, test the connection using a ping test described in *Performing a Ping Test*, on page 35.

To verify the routing, follow the procedures in *Verifying NCL1155 Routing*, on page 55.

Table 5   Common Problems and Solutions

Symptom	Possible Cause	Solution
Power LED on back panel of NCL1155 is off	NCL1155 is not receiving power.	• Ensure that the device is plugged into a 110 - 220 V AC outlet and that there is power at the outlet. • Check all cables for loose or faulty connections. Replace cables if necessary.
Cannot communicate with NCL1155 from the Ethernet side and the Ethernet light is off	NCL1155 is not receiving power.	• Ensure that the device is plugged into a 110 - 220 V AC outlet and that there is power at the outlet. • Check all cables for loose or faulty connections. Replace cables if necessary.
	Ethernet cable is faulty or the wrong type (crossover vs. straight-through).	• Replace Ethernet cable, if necessary.
Cannot communicate with NCL1155 from the Ethernet side and the Ethernet light is on	NCL1155 configuration is incorrect.	Connect a computer to the RS-232 port and log into the NCL1155. • Verify Ethernet IP address. • Verify bridging or routing. • Verify Routing Table, if applicable. See *Verifying NCL1155 Routing*, on page 55.

Symptom	Possible Cause	Solution
Master cannot communicate with any Stations	Master NCL1155 is disabled.	Connect a computer to the RS-232 port and log into the NCL1155. • Ensure that the radio transmission is enabled. • Check RSSI.
	Master NCL1155 configuration is incorrect.	Connect a computer to the RS-232 port and log into the NCL1155. • Verify radio channel. • Verify Master unit ID. • Verify Station IDs have been added to Remote Station List. • Verify that the Master has all Stations enabled. • Verify routing or bridging. • Verify Routing Table, if applicable. See *Verifying NCL1155 Routing*, on page 55.
	Master NCL1155 antenna system has a problem.	• Check RSSI. • Verify RF connections. • Check RF cable for damage. • Check antenna for damage.
Master cannot communicate with an individual Station	Station is not receiving power.	• Ensure that the device is plugged into a 110 - 220 VAC outlet and that there is power at the outlet. • Check all cables for loose or faulty connections. Replace cables if necessary.
	Station NCL1155 antenna system has a problem.	• Check RSSI. • Verify RF connections. • Check RF cable for damage. • Check antenna for damage. • Check for any deviation from set direction.
	Antenna line-of-sight (LOS) to master has been obstructed.	• Check RSSI. • Ensure that a clear LOS still exists to the Master NCL1155 antenna.
	Station configuration is incorrect.	Connect a computer to the RS-232 port and log into the NCL1155. • Verify radio channel. • Verify Station unit ID. • Verify Master unit ID. • Verify routing or bridging. • Verify Routing Table, if applicable. See *Verifying NCL1155 Routing*, on page 55.
	Station is disabled.	Connect a computer to the RS-232 port and log into the Master NCL1155 for the group. • Verify that the Station has been enabled from the Master. • Check RSSI.
	Station has not been added to the Master NCL1155 Remote Station List.	Connect a computer to the RS-232 port and log into the Master NCL1155 for the group. • Verify the Station has been added to the Remote Station List. • Verify the Routing Table, if applicable. See *Verifying NCL1155 Routing*, on page 55.

7.1 Verifying NCL1155 Routing

To verify the routing is correct, you will need to verify both the Master and Station Routing Tables. If the Routing Tables are incorrect, configure the devices with the corrected values.

7.1.1 Verify the NCL1155 Routing Table

Use the Configuration Data Record for the NCL1155 to verify the information is configured correctly in the device.

1. Connect to the NCL1155 using a crossover serial cable.

2. Log in to the NCL1155. You will be prompted for the NCL1155 password when you log in.

3. Type `<mode>` to verify bridging or routing is set correctly for the NCL1155 group.

4. At the `NCL1155>` prompt, type `<ip>`. The configuration information is displayed.

5. Verify the NCL1155 Ethernet IP address and subnet mask are configured correctly.

6. Verify the radio IP address is correct, if applicable.

7. Verify the Routing Table is correct according to your routing plan.

8. If the forwarding mode is routing, at a Station NCL1155, ensure that the default static route is set. At a Master NCL1155, ensure the Ethernet subnet for each Station is set.

Appendix A   NCL1155 Command-Line Syntax

The NCL1155 can be configured using the commands listed in Table 8.

Table 6 shows the typographical conventions used to represent command-line syntax. Press ENTER after typing a command to execute the command.

Table 7 provides a list of shortcuts and methods to get help on commands.

Table 6   NCL1155 Command-Line Syntax Conventions

Convention	Use	Examples
`<monospaced font>`	Indicates that you must type the text inside the angle brackets, not the angle brackets.	`<ip route>`
ENTER	Indicates a keyboard key press. A plus sign (+) indicates key combinations. For example, for CTRL+U, press and hold down the CTRL key, then press the U key.	ENTER ESC CTRL+U
italic	Specifies a variable name or other information that you must replace with a real name or value.	`ip address ethernet` `ipaddress`
bold **ch**aracters	Indicates the shortcut characters for a command.	`<`**`ra`**`dio `**`ch`**`annel>` can also be typed as `<ra ch>`
`[ ]`	Indicates optional items. Do not type the brackets as part of the command.	`ip address` `[ethernet|radio]`
`|`	Separates two mutually exclusive choices in a command. Type one choice and do not type the vertical bar.	`interface|if`
`( )`	Encloses a range of values from which you can choose a value.	`radio channel (1-15)`

Table 7   Command-Line Shortcuts and Getting Help

Type	To do this...
`?`	display the names of the root commands.
`[`*command_name*`] ?`	display the syntax for a command.
`help`	display all the commands, their subcommands and the parameters and options for each command.
`help [`*command_name*`]`	display the parameters and options for the command.
`!!`	repeat the last command that was executed.
ESC	cancel the command you are typing.

Subnet Masks

Where a command requires you to enter a subnet mask, you can do one of the following:

- Enter it as a range, which is the number of bits (0-32 are valid) in the subnet mask.
- Do not enter it, and let the NCL1155 decide what value to use. Note that the NCL1155 does not necessarily pick the correct subnet mask.

Table 8   NCL1155 Command-line Syntax Descriptions

Command Syntax	Description
arp	Displays the Address Resolution Protocol (ARP) configuration information.
arp **f**lush	Removes the temporary ARP table entries from the ARP table.
arp **a**dd *aaa.bbb.ccc.ddd aa:bb:cc:dd:ee:ff*	Adds an entry to the ARP table. *aaa.bbb.ccc.ddd* is the IP address of the entry that you want to add. *aa:bb:cc:dd:ee:ff* is the MAC address associated with the IP address.
arp **d**el *aaa.bbb.ccc.ddd*	Deletes a specified entry from the ARP table. *aaa.bbb.ccc.ddd* is the IP address of the entry that you want to delete.
bridge **st**atistics	Displays the bridge statistics (frames in, frames out, etc.). Only available in bridging mode.
bridge **t**able	Displays the bridge table entries. Only available in bridging mode.
bridge **t**able **f**lush	Removes the learned entries from the bridge table. Only available in bridging mode.

Command Syntax	Description
bridge **t**able **t**imeout	Sets the time-out value for entries in the bridge table. If the NCL1155 receives no packet from the specified entry's address during the time-out period you set (for example, 15 s), then it clears the address from the table. Valid times are 10 to 1 000 000 s; the default is 300 s. Only available in bridging mode.
dhcp **m**ode [**n**one|**re**lay]	Sets the NCL1155 to use Dynamic Host Configuration Protocol (DHCP). • none - disables DHCP Relay. • relay - enables DHCP Relay. Available only if the mode is set to routing.
dhcp **r**elay [**add**|**del**ete *ip_address*]	Adds or removes the IP address of a Dynamic Host Configuration Protocol (DHCP) server. Available only if the mode is set to routing and DHCP mode is set to Relay.
interf**ace**|**if st**atistics	Displays configuration information and statistics for all interfaces.
interf**ace**|**if st**atistics **eth**ernet|**rad**io|**loo**pback	Displays configuration information and statistics for each interface: Ethernet, radio, or loopback.
interf**ace**|**if r**eset	Resets the statistics for all interfaces.
interf**ace**|**if r**eset **eth**ernet|**rad**io|**loo**pback	Resets the statistics for the specified interface.
ip	Displays the IP configuration information.
ip address	Displays the IP addresses for the Ethernet and radio interface. In bridging mode, the IP address is for management purposes only. An IP address is not required to perform bridge functions. When in Bridging mode, if you assign an IP address to the NCL1155, you only need to assign it to the Ethernet interface, because the radio and Ethernet are considered as one interface. In routing mode, you must configure both addresses.
ip address **eth**ernet *aaa.bbb.ccc.ddd [subnet mask]*	Changes the IP address for the Ethernet interface for routing or bridging. aaa.bbb.ccc.ddd is the IP address for the Ethernet interface and *[subnet mask]* is specified in either dotted decimal format or number of bits.

Command Syntax	Description
ip address **radio** *remote_unit_id* *aaa.bbb.ccc.ddd eee.fff.ggg.hhh*	Changes the radio interface IP route and binds the radio channel between the remote NCL1155 and the local NCL1155 using the IP addresses. This command is only available in routing mode. For an NCL1155 configured as a Station, *remote_unit_id* is the unit ID of the remote master; *aaa.bbb.ccc.ddd* is the radio IP address for the local station NCL1155; and *eee.fff.ggg.hhh* is the radio IP address for the remote master NCL1155. For an NCL1155 configured as a Master, *remote_unit_id* is the unit ID of the remote station NCL1155; *aaa.bbb.ccc.ddd* is the radio IP address for the local master NCL1155; and *eee.fff.ggg.hhh* is the radio IP address for the remote station NCL1155. Repeat this command for each station in the Remote Station List.
ip dns	Displays the DNS configuration information.
ip dns **s**erver	Displays the list of domain name servers.
ip dns **s**erver **add**|**del** *aaa.bbb.ccc.ddd*	Adds or deletes a server from the DNS table. *aaa.bbb.ccc.ddd* is the IP address for the DNS server that you want to add or delete.
ip dns **dom**ain	Displays the DNS domain name.
ip dns **dom**ain *DNS_domain_name*	Changes the DNS domain name. *DNS_domain_name* can be a maximum of 256 ASCII characters.
ip ospf area	Displays Open Shortest Path First (OSPF) area configuration.
ip ospf area **add**|**del** *Area aaa.bbb.ccc.ddd*	Adds or deletes an OSPF area. *Area aaa.bbb.ccc.ddd* is the area and IP address that you want to add or delete
ip ospf **d**isable|**en**able	Disables or enables the OSPF protocol.
ip ospf interface *Area aaa.bbb.ccc.ddd*	Configures OSPF interface parameters.
ip ping *destination*	Sends ICMP echo requests to a remote host that is used to see if you can reach a remote IP address or for network debugging. *destination* is the radio IP address for the remote host that you want to reach.
ip rip	Displays the Routing Information Protocol (RIP) configuration. Available only if routing mode is set to RIP.
ip rip **b**roadcast|**m**ulticast	Specifies how the RIP handles packets.Available only if the routing mode is set to RIP, and the RIP version is 2. • broadcast sends RIP version 2 advertisements as broadcast. • multicast sends version 2 advertisements to RIP version 2 multicast addresses. Multicast is generally more efficient than broadcast.

Command Syntax	Description
`ip ri`p `d`isable|`en`able	Disables or enables the RIP
`ip ri`p expire	Displays the length of time an NCL1155 waits before deleting a RIP route.
`ip ri`p expire *(XX)*	Assigns a duration (in seconds) that an NCL1155 waits without receiving any RIP updates before it will consider that route invalid, and delete it.
`ip ri`p interval	Displays the length of time (in seconds) that an NCL1155 waits before transmitting updated RIP information.
`ip ri`p interval *(XX)*	Assigns a duration (in seconds) that an NCL1155 waits before transmitting updated RIP information.
`ip ri`p `nod`efault|`d`efault	Disables or enables RIP to advertise the default route. Available only if routing mode is set to RIP. default - if a default route exists, it is sent in the advertisement. nodefault - the default route is not sent, whether or not it exists.
`ip ri`p `nou`pdate|`u`pdate	Disables or enables RIP advertisement of static routes. update - sends static route information in a RIP advertisement, as well as all other RIP information. noupdate - sends everything except the static route information. Available only if routing mode is set to RIP.
`ip ri`p `q`uiet|`a`ctive	Disables or enables RIP advertisement of static routes. Available only if routing mode is set to RIP. active - transmits route information, in packets, to the interfaces. quiet - disables RIP packets from being sent.
`ip ri`p `v`ersion 1|2	ip rip version displays the current version. Switches 1 or 2, display/change RIP to the respective version. Available only if routing mode is set to RIP. Note that version 1 is broadcast only; version 2 can be multicast, broadcast, or compatible (both).
`ip route`	Displays the routing table information. Local interface routes are always present as long as an address for the interface exists.
`ip route add`|`del` *Network(aaa.bbb.ccc.ddd) Gateway(eee.fff.ggg.hhh) Mask(0-32)*	Adds or deletes a static route. *Network(aaa.bbb.ccc.ddd)* is the IP address of the destination network; *Gateway(eee.fff.ggg.hhh)* is the IP address for the gateway; and *Mask(0-32)* is specified in either dotted decimal format or number of bits.
`ip route f`lush	Removes all dynamic entries from the routing table. Dynamic entries are those routes that the system has learned.
`ip route e`rase	Removes all static and dynamic entries, except interface routes, from the routing table.

Command Syntax	Description
`ip st`atistics	Displays the IP statistics information.
`ip te`lnet *host(aaa.bbb.ccc.ddd)*	Establishes a Telnet session with a remote host to access and control a remote computer. *host(aaa.bbb.ccc.ddd)* is the IP address of the remote host.
`ip tr`aceroute *destination(aaa.bbb.ccc.ddd)*	Displays the route that the packets take to a remote destination. *destination(aaa.bbb.ccc.ddd)* is the IP address of the remote destination. The maximum is 30 hops. An asterisk (*) represents each unsuccessful try. For example, 1 * * *. Press any key to stop the `ip traceroute` output.
`m`ode	Displays the forwarding mode: Bridging or IP Routing.
`m`ode `bri`dging|`rou`ting	Changes the forwarding mode. `bridging`: connects two networks on the same subnet (they have the same subnet address). `routing`: connects two networks on different subnets.
`ra`dio	Displays the radio configuration information.
`ra`dio `ch`annel	Displays the radio channel.
`ra`dio `ch`annel (1–14)	Changes the radio channel.
`ra`dio `d`isable|`en`able	Disables or enables the NCL1155 radio transmission capabilities. The NCL1155 is factory-configured as disabled to prevent accidental damage should it be powered up without an antenna or load connected.
`ra`dio `m`asterID	Displays the Master Unit ID to which the NCL1155 belongs. Available only if the NCL1155 radio type is Station.
`radio m`asterID (1–16383)	Changes the Master Unit ID to which the NCL1155 belongs. Available only if the NCL1155 radio type is Station.
`ra`dio `per` [`s`ingle|`c`ontinuous|`r`eset]	Displays or resets the cumulative radio packet error rate statistics to the screen. This command is available during tests and normal operation. • `single` displays the current statistics. • `continuous` displays the statistics every one second. • `reset` resets the calculations.
`ra`dio `r`eset	Forces the NCL1155 radio to reset. If you reset the NCL1155 radio instead of shutting down, the statistics will not be lost.
`ra`dio `rssi`	When serially connected to the NCL1155, displays changes in the average and peak receive signal strength every half second.
`ra`dio `rssi` threshold	Changes the threshold (floor) value used to calculate the average receive signal strength.

Command Syntax	Description
radio **rx**test **sta**rt|**sto**p	Starts and stops the Radio Continuous Receive Test. When you start this test, the Radio PER display is also automatically started. Available only at the Station NCL1155. Use this test to deploy a new Station NCL1155 in an existing network.
radio **set**ting	Displays the current Media Access Control (MAC) settings for the NCL1155 radio: • IFS • slot time • backoff range • backoff mode.
radio **set**ting **d**efault	Changes the default MAC settings for the NCL1155 radio.
radio **st**ation	Displays the list of unit IDs to which the master unit can talk. Available only if the NCL1155 radio type is Master.
radio **st**ation **add** (1–16383)	Adds a remote Unit ID to the list of stations to which a Master Unit can talk. Available only if the NCL1155 radio type is Master.
radio **st**ation **del** (1–16383)	Removes a remote Unit ID from the list of stations to which a Master Unit can talk. Available only if the NCL1155 radio type is Master.
radio **st**ation **d**isable|**e**nable *unitID*	Disables or enables the transmission capabilities of the remote station. *unitID* is the unit ID of the remote station that you want to disable. Available only if the NCL1155 radio type is Master.
radio **st**atistics | **stats**	Displays the current radio statistics.
radio **st**atistics | **stats r**eset	Resets all radio counters to zero.
radio **tx**test **sta**rt|**sto**p	Starts and stops the Radio Continuous Transmit Test. Available only at the Master NCL1155. Use this test to set up a Master and Station for a new network.
radio **txrx sta**rt|**sto**p	Starts and stops the Radio Transmit/Receive Loopback Test. When you start this test, the Radio PER display is also automatically started. Available only at the Master NCL1155. Use this test for a new installation only.
radio **t**ype	Displays the NCL1155 radio type.
radio **t**ype **mas**ter|**sta**tion	Changes the radio type. Use this to configure an NCL1155 as a master unit. All NCL1155 units are factory-configured as 'station'.
radio unitid	Displays the NCL1155 unit ID.
radio unitid (1–16383)	Changes the NCL1155 unit ID. An NCL1155 unit ID is a unique number between 1 and 16383.

Command Syntax	Description
snmp	Displays the SNMP configuration information. SNMP is useful for monitoring network performance and debugging.
snmp **com**munity	Displays the SNMP community table. The default SNMP communities are: public read and private write.
snmp **com**munity **add**|**del** *community* **r**ead|**w**rite	Adds a community name to or deletes one from the SNMP community table. A community name can be a maximum of 32 ASCII characters. • read: enables the community to view the variables in SNMP. • write: enables the community to change and view the variables. To change SNMP variables, you must have a write community. To view SNMP variables, you must have a write or read community.
snmp **con**tact	Displays the SNMP system contact (that is, the person or company).
snmp **con**tact *contact*	Changes the SNMP system contact and telephone number. *contact* can be a maximum of 256 ASCII characters that you can use to define the contact person or address for the NCL1155.
snmp **l**ocation	Displays the SNMP geographical location of the system.
snmp **l**ocation *location*	Changes the SNMP geographical location of the system. *location* can be a maximum of 256 ASCII characters that you can use to define the physical location of the NCL1155.
snmp **t**rap	Displays the list of SNMP trap servers defined for the NCL1155.
snmp **t**rap **add**|**del** *server(aaa.bbb.ccc.ddd)* *community*	Adds a trap to or deletes one from the SNMP trap server table. *server(aaa.bbb.ccc.ddd)* is the IP address for the trap server. *community* is the name of the community on the trap server and can be a maximum or 16 ASCII characters.
system	Displays the system configuration information.
system **m**emory	Displays the memory statistics, such as memory allocation information.
system **na**me	Displays the system name.
system **na**me *name*	Changes the system name. *name* can be a maximum of 64 ASCII characters that you can use to name the NCL1155 in your system. The system name is used for the command-line prompt for the NCL1155.
system **ne**twork	Displays the network system statistics from the network buffer memory pools.
system **ne**twork **eth**ernet|**rad**io|**dat**a|**sys**tem	Displays network buffer pool-allocation information for each parameter:

Command Syntax	Description
system **pa**ssword	Changes the password for the NCL1155.
system **pr**otocol	Displays information about the configuration of protocols bound to the interface.
system **pr**otocol *interface*	Displays the protocol configuration for the specific interface that you name. *interface* is either Ethernet or Radio.
system **u**ptime	Displays how long the system has been running. If the uptime is more than 24 hours, the time appears as *n* days, *hh:mm:ss* where *n* is the number of days and *hh:mm:ss* is the hours:minutes:seconds.
system **v**ersion	Displays the build date and time, and lists all software libraries and their version numbers.
test **r**adio	Performs self tests and displays the results for all the radio device. If you use this command, the link service is disrupted for the duration of the test.
reboot|**re**start|**re**load|**re**set	Resets the NCL1155.
write|**sa**ve	Saves the current configuration. If you want to save the new configuration, you must write (save) any configuration changes before you reboot the NCL1155; otherwise, the NCL1155 reverts to the previously saved configuration.
write **d**efault|**e**rase	Removes all configuration changes, even if you saved them, and resets the NCL1155 to the factory default configuration.
help [*command*]	Displays a list of all commands. If you type a command name after help, the syntax for that command is displayed. For example, type help ip to display all IP commands and the syntax for each.
exit|**q**uit|**by**e	Closes the console session.

Appendix B   Abbreviations and Terminology

Table 9   Acronyms and Abbreviations

Acronym or Abbreviation	Definition
AC	Alternating Current
ALF	Air Link Frame
ARQ	Automatic Retry reQuest
ARP	Address Resolution Protocol
ASCII	American Standard Code for Information Interchange
dB	decibel
dBi	decibel, with respect to an isotropic antenna
CAP	Communication Access Point
CCU	CAP Channel Unit
CLI	Command Line Interface
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CSA	Canadian Standards Association
CSMA	Carrier Sense Multiple Access
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
CSMA/CD	Carrier Sense Multiple Access with Collision Detect
CTS	Clear To Send
DCE	Data Communication Equipment
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Service
DPRAM	Dual Port Random-Access Memory

Acronym or Abbreviation	Definition
DRAM	Dynamic Random-Access Memory
DSR	Data Set Ready
DSSS	Direct-Sequence Spread Spectrum
DTE	Data Terminal Equipment
ESN	Electronic Serial Number
ETSI	European Telecommunications Standards for Industry
EUM	End-User Modem
FCC	Federal Communications Commission (U.S.A.)
FTP	File Transfer Protocol
GHz	Gigahertz
IBL	Inter Building Link
IC	Industry Canada
ICMP	Internet Control Message Protocol
ID	Identifier, Identification
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
IP	Internet Protocol
ISM	Industrial, Scientific, and Medical (unlicensed radio band)
LAN	Local Area Network
LED	Light-Emitting Diode
LLC	Link Layer Control
LMS	Last Mile Solution
MAC	Media Access Control, Medium Access Controller
Mbps	Megabits per second
MHz	Megahertz
MIB	Management Information Base
MTU	Maximum Transmission Unit
NAP	Network Access Point
NCL	Network Communication Link, as in NCL1155, a WaveRider product
NIC	Network Interface Card
OSPF	Open Shortest Path First
PC	Personal Computer
PCI	Personal Component Interconnectbus
PER	Packet Error Rate

Acronym or Abbreviation	Definition
PHY	Physical Layer
PTMP	Point-to-Point
PTP	Point-to-Multipoint
RADIUS	Remote Access Dial In User Server
RF	Radio Frequency
RFC	Request For Comments
RIP	Routing Information Protocol
RMA	Returned Merchandise Authorization
RSSI	Receive Signal Strength Indicator
RTS	Request To Send
Rx	Receive
SNMP	Simple Network Management Protocol
SRAM	Static Random Access Memory
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
Tx	Transmit
URL	Uniform Resource Locator
V	Volt
WCU	WaveRider Channel Unit
WEP	Wireline Equivalent Privacy (as per 802.11 specification)
WMM	WaveRider MAC Module
WRM	WaveRider Radio Module
x86	Intel 86 architecture processor family

Table 10   NCL1155 Network Terminology

Term	Definition
Address Resolution Protocol (ARP)	The layer below the IP layer; maps the IP and MAC addresses together.
Bridge	A device that connects and passes packets between two network segments. A bridge operates at the MAC layer. A bridge filters or forwards an incoming frame based on the MAC address of the frame. A learning bridge listens to traffic on its interfaces and maintains a table of addresses. See also *Router*.
Channel	Generally, the medium through which information is communicated. In wireless communications, the channel is usually defined by the center frequency, modulation type, and occupied bandwidth.
Command Line Interface (CLI)	In contrast to a graphical user interface, a CLI is a configuration and control interface based on keyboard-entry commands and responses.
Console Port	Typically, the 9-pin RS 232 serial port on an NCL1155 to which a terminal or laptop computer is connected to configure or control the device.
Domain Name Server (DNS)	A database system that translates IP addresses into domain names. For example, 207.23.187.242 is converted into waverider.com.
Direct-Sequence Spread Spectrum (DSSS)	A form of spread-spectrum communications that uses a high-speed code sequence, along with the information being sent, to modulate the RF carrier.
Master	The NCL1155 defined as a master provides the access control for all NCL1155 stations in the same radio network. The master configuration determines the channel that the NCL1155 stations use. There must be only one master using the same channel in the radio network. You must configure a master within the coverage area of another master to use a different channel.
Master ID	Improves security on the wireless network. NCL1155s must have the same master ID in order to communicate with each other.
Master vs. Station	Decide which NCL1155 is the master. In the point-to-point configurations, it does not matter which NCL1155 is master, just remember that the master provides the access control to the station. In the case of point-to-multipoint, the master must have a line of sight to each station, but each station may not have a radio communication path to other stations.

Term	Definition
Media Access Control (MAC) address	The 6-byte low-level hardware or physical address of an Ethernet device.
Radio Channel	A 22 MHz wide RF channel with a center frequency specified in Appendix C. In any given network, all NCL1155s must operate on the same radio channel to communicate.
Radio Type	This parameter specifies the role of the NCL1155 in the radio network. Each NCL1155 is classified as either a master or a station.
Receive Signal Strength Indicator (RSSI)	Displays the average and peak radio receive signal strength of the NCL1155, based on a factory calibrated threshold (floor) value, calculated every half second.
Router	A device that connects and passes packets between two or more network segments. A router filters or forwards an incoming packet based on the IP address of the packet. Routers use static routes which take precedence over routes chosen by all dynamic routing protocols. See also *Bridge*.
Routing Information Protocol	A routing protocol for IP networks based on the distance-vector algorithm, where all or a portion of the routing table is sent to all other neighbouring devices along with each message.
Static Route	A route that is explicitly configured and entered in the routing table. Static routes take precedence over routes chosen by dynamic routing protocols.
Station	An NCL1155 defined as a station synchronizes with an NCL1155 master that has the same station and master ID setting.
System Name	A name that allows a user to identify a particular NCL1155. Once the Name is assigned, the system name appears as the prompt.
System Password	A set of characters that prevents unauthorized access to console commands. The same password applies when accessing the console from the RS-232 port, from the network using Telnet, or when connecting to the FTP server.
Unit ID	In the case of a station, unit ID provides the wireless address at the station. In the case of a Master, a list of unit IDs forms the access list of stations allowed to communicate with the Master. Any station not on the list will be disabled whenever the station attempts to access the Master.

Appendix C   Operating Channel Frequencies

The following table defines the channel frequency set for each WaveRider regulatory domain.

Channel ID	FCC/IC Channel Frequencies (USA/ Canada)	MKK Channel Frequencies (Japan)	ETSI Channel Frequencies (Europe)	French Channel Frequencies	Spanish Channel Frequencies
1	2412 MHz	not available	2412 MHz	not available	not available
2	2417 MHz	not available	2417 MHz	not available	not available
3	2422 MHz	not available	2422 MHz	not available	not available
4	2427 MHz	not available	2427 MHz	not available	not available
5	2432 MHz	not available	2432 MHz	not available	not available
6	2437 MHz	not available	2437 MHz	not available	not available
7	2442 MHz	not available	2442 MHz	not available	not available
8	2447 MHz	not available	2447 MHz	not available	not available
9	2452 MHz	not available	2452 MHz	not available	not available
10	2457 MHz	not available	2457 MHz	2457 MHz	2457 MHz
11	2462 MHz	not available	2462 MHz	2462 MHz	2462 MHz
12	not available	not available	2467 MHz	2467 MHz	not available
13	not available	not available	2472 MHz	2472 MHz	not available
14	not available	2484 MHz	not available	not available	not available

Appendix D   NCL1155 Specifications

The followiing tables list the technical specifications for the NCL1155 (FCC/IC RF Regulatory Domains).

Table 11   Network Interface

Topology	Point-to-Multipoint, Point-to-Point, or Repeater
Operational Modes	Bridging or Routing
Transmission Protocols Supported	TCP/IP, Telnet, SNMP, FTP
Routing Protocols Supported	Standard: Static Optional: RIP, DHCP Relay
Simultaneous Stations per Master	20
Operational Master/Station groups in designated coverage area	3 (one channel per Master/Station group)
Air Frame Format	Standard - WaveRider proprietary

Table 12   Physical Interface

Ethernet	Standard - RJ-45, 10/100Base Tx autosensing Optional - RJ-45, 100Base Tx autosensing
Serial	DB-9, serial DTE RS-232
RF Connector	Reverse SMA

Table 13   Radio Performance

Minimum Channel Centre Frequency	2.412 GHz
Maximum Channel Centre Frequency	2.462 GHz
Channel Bandwidth	22 MHz
Center Frequency Spacing Increment	5 MHz
Minimum Separation Between Orthogonal Channels	25 MHz
Maximum Orthogonal Channels	3
Orthogonal Channel Set	1, 6, 11
Orthogonal Channel Set Centre Frequencies	2.412 GHz, 2.437 GHz, 2.462 GHz
Modulation Scheme	CCK (Complementary Code Keying) DSSS (Direct Sequence Spread Spectrum)
Maximum Over-the-Air, Raw Data Rate	11 Mbps
Maximum Throughput Point-to-Point	8 Mbps
Maximum Throughput Point-to-Multipoint	6.6 Mbps
Center Frequency Spacing Increment	5 MHz
Minimum Receive Sensitivity	-82 dBm
Maximum Operating Range	16 km (line of sight)

Table 14   Power Supply

AC Input	90 to 260 VAC, single phase
AC Input Frequency	47 to 63 Hz
Maximum Input Current	1.5 A

Table 15   Environmental Considerations

Operating Temperature	0° to 55° C
Storage Temperature	-20° to 70° C

Table 16   Regulatory

Safety	UL, CSA, IEC
Standards	Industry Canada RSS-210, RSS-102 Federal Communications Commission - CFR47, Part 15B, Sections 15.205, 15.209, 15.247

Appendix E   Configuration Data Record

Use the following form to record your NCL1155 information for each NCL1155 group.

NCL1155 Network Group Configuration Data Record

Radio Channel	Subnet Mask	Software Version	Bridge or Router	SNMP Communities		SNMP Trap Server	
				Community Name	R/W	Community Name	IP Address

Master Information

System Name	Unit ID	Serial Number	Password	Radio Settings				IP Address		Location	Ethernet Hardware Address	Antenna (Yagi/ parabolic/omni/ panel)		Cable	
				IFS	Slot Time	Backoff Mode	Backoff Range	Ethernet	Radio (Routing only)			Type	Gain	Type	Loss

Station Information

System Name	Unit ID	Serial Number	Password	Radio Settings				IP Address		Location	Ethernet Hardware Address	Antenna (Yagi/ parabolic/omni/ panel)		Cable	
				IFS	Slot Time	Backoff Mode	Backoff Range	Ethernet	Radio (Routing only)			Type	Gain	Type	Loss

WaVeRider®
The World's Wireless Web Company

Telephone: +1 416–502–3161
Fax: +1 416–502–2968
Email: techsupport@waverider.com
URL: www.waverider.com