NL6000 *Wireless Modem*

NL6000 User Manual

Rev 1.1

rf neulink

DIVISION OF RF INDUSTRIES

WWW.RFNEULINK.COM

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Notice:

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1. Product Overview

The RF Neulink NL6000 is an integrated radio modem that provides reliable bi-directional RS-232 data transmissions on a land mobile radio channel. Configurable RS-232, radio, and packet data parameters provide the NL6000 with the flexibility necessary for use in both simple and complex networks.

In its simplest configuration, the NL6000 transmits wireless data from one modem to another to send instructions and receive a response. In many cases, the factory-configured default parameters make the unit ready to use after just setting two address IDs. Figure 1 shows a simple system to transmit data between two terminals.
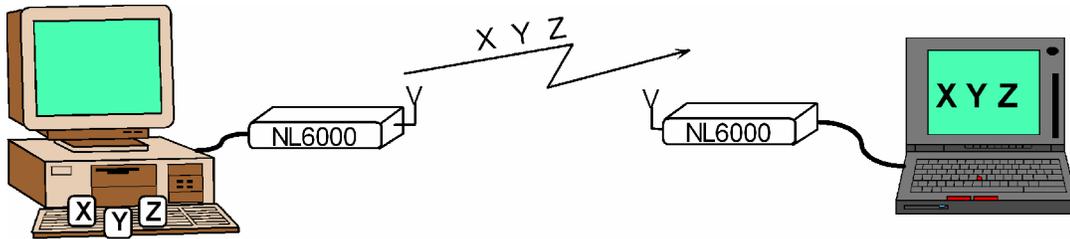
Figure 1: Use the NL6000 in a Simple Configuration

In a more sophisticated configuration, the NL6000 provides wireless communication between multiple units in a network. A unit configured as a base station can transmit instructions to multiple remote units and collect responses from those remotes for analysis and management reporting. Configuration of multiple units is a simple task using the menu-driven user interface. Figure 2 shows a system for maintaining the water level for a number of water tanks.
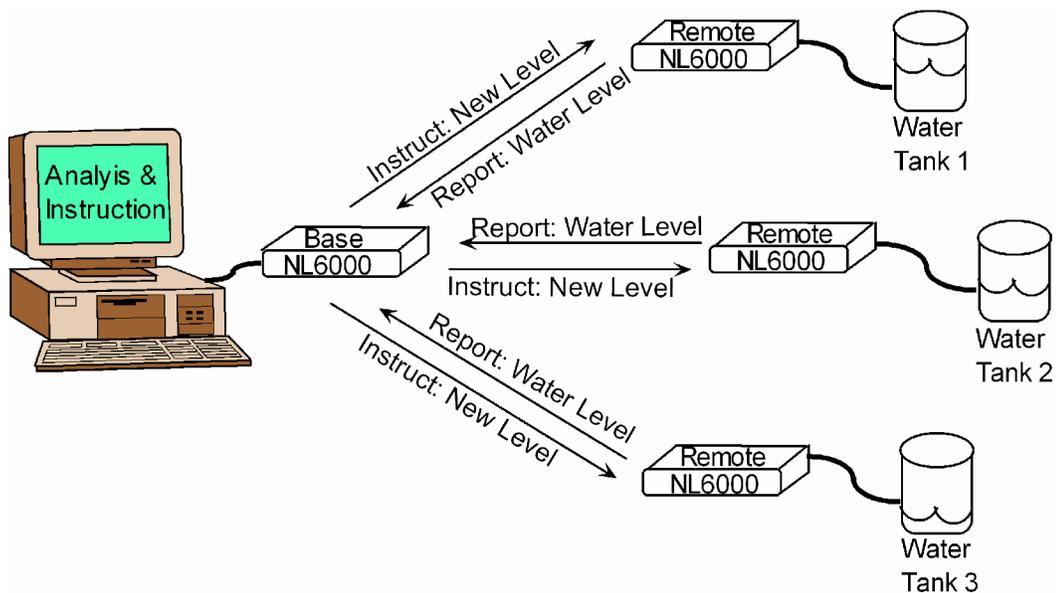
Figure 2: Use the NL6000 in a Multi-Unit Network

The NL6000's powerful and efficient packet communications protocol provides a solution to many of the problems affecting conventional wireless data networks. Bursts of noise, RF interference, inter-modulation, overload, and signal fade can corrupt and interrupt radio data links. The NL6000 eliminates these problems through the use of advanced technologies including sophisticated forward error correction technology.

The NL6000 can transmit in any of the following frequency ranges:

- VHF 136 – 162 MHz

- VHF 148 – 174 MHz

- VHF 216 – 235 MHz

- UHF 400 – 420 MHz

- UHF 450 – 470 MHz

1.1. Features

The following list highlights the primary features of the NL6000:

Product Reliability	The NL6000 makes extensive use of Digital Signal Processing (DSP) technology resulting in outstanding performance under adverse environmental conditions.
Data Reliability	Advanced signaling end error control technologies provide exceptional performance under poor channel conditions.
RF Data Rate	The NL6000 can transmit or receive at over-the-air rates of 12,000 bps within narrowband or 22,050 bps within wideband channels.
Protocol Flexibility	The NL6000 provides three data transmission modes resulting in peak system performance for a wide range of data communication scenarios.
Easy Use Interface	An easy to follow menu-based user interface makes configuring the NL6000 a simple task.
Base Station Configuration	The NL6000 can be configured as a remote or a base station. A remote transmits data to a specific unit or group of units. A base station transmits data to multiple units or groups.
Repeater Configuration	In areas where you lack a reliable path, you can configure an NL6000 unit as a repeater to reach a hidden unit. This feature can fill in RF blind spots or extend the usable range of the system's desired coverage area.

Single and Multi- Point Addressing

An NL6000 can be configured to transmit to a single unit, a group of units, or to broadcast to all units within range.

Acknowledgement

The NL6000 can be configured to request an acknowledgement (ACK) from the destination modem with each transmission. If it does not receive an ACK, the unit can retransmit a specified number of times.

Auto-Transmit

The NL6000 will automatically trigger transmission of data over the RF link: The NL6000 will wait for characters to arrive via the serial port in order to completely fill a packet size as defined under Network/Max Packet Size before transmitting. The typical default setting for TX CHAR TIMEOUT is 100 and MAX PACKET SIZE is 300. This will give you a reasonable response time between serial data arrival and transmitting data. The MAX PACKET SIZE should be set based on your applications typical maximum packet size.

Configuration Templates

The NL6000 software allows you to save a configuration as a template and download the parameters in that template to other units that share the same configuration. This saves time when configuring a large network. Care should be taken in maintaining the Diagnostics configuration settings. These settings are normally factory set using radio test equipment and are unique to each NL6000 radio

2. Regulatory Information

<u>**Notice**</u>

It is the responsibility of the user of this equipment to obtain the proper FCC license to operate this product on the desired channel of operation.

<u>**FCC Part 15**</u>

This product complies with Part 15 of the FCC rules and regulations (Code of Federal Regulations 47CFR Part 15). It may not be modified without the expressed consent of RF Neulink. Modification of this product could void the user's authorization to use the product.

<u>**FCC Part 90**</u>

The NL6000 has been type accepted for operation by the FCC in accordance with Part 90 of the FCC rules (47CFR Part 90). See the label on the unit for the specific FCC ID and any other certification designations.

<u>**FCC Part 101**</u>

The NL6000 has been type accepted for operation by the FCC in accordance with Part 101 of the FCC rules (47CFR Part 101). See the label on the unit for the specific FCC ID and any other certification designations.

<u>**406.0 to 406.1 MHz Operation**</u>

The frequency band from 406.0 to 406.1 MHz is reserved for use by distress beacons. As such, the NL6000 should not be programmed to transmit on any frequency within this band. Caution should be used when programming frequencies into the NL6000 to eliminate the possibility of NL6000 users interfering with rescue operations on this band.

<u>**Safety Warning**</u>

In order to ensure the safe operation of this radio equipment, the following practices should be observed.

- DO NOT operate radio equipment near electrical blasting caps or in an explosive atmosphere.

- DO NOT operate any radio transmitter unless all RF connectors are secure and any open connectors are properly terminated.

- DO NOT allow the antenna to come close to, or touch, the eyes, face, or any exposed body parts while the radio is transmitting.

- DO NOT operate the radio unless it has been installed and inspected by a qualified radio technician.

- DO NOT let children operate transmitter equipment.

3. Specifications

GENERAL SPECIFICATIONS	
Dimensions	3.0 in L x 2.6 in W x 1.6 in H
DC voltage input	Nominal 10-15 VDC
Operating temperature	-30° C to +60° C
Number of Channels	64
Number of ID codes	65,525
Over-the-air (Tx) data rate	12,000 bps or 22,050 bps
Serial port baud rates	1200 bps, 2400 bps, 4800 bps, 9600 bps, 19.2 kbps, 28.8 kbps, 38.4 kbps
RF input/output connector	SMA-F
Data interface	9-pin (DB9)
Serial interface	RS-232 async
Mode of operation	Simplex or Half Duplex
Frequency control	PLL synthesizer
Error control	3 data transmission modes provide progressively increasing error correction strength

UHF RADIO SPECIFICATIONS	
Model Numbers	NL6000
Transmission frequencies	450-470 MHz & 400-420 MHz
Current Drain at 12 V:	
IDLE radio channel	0.2 amps
Receive	0.2 amps
Transmit: 0.5 watts	1.0 amps
Transmit: 1.0 watts	1.2 amps
Transmit: 2.0 watts	1.6 amps
Transmit: 3.0 watts	1.9 amps
Transmit: 4.0 watts	2.2 amps
Transmit: 5.0 watts	2.6 amps
Transmit: 6.0 watts	3.1 amps
Transmitter:	
RF power	1 to 6 watts
Modulation	4-FSK with spectral precoder
Frequency stability	1.5 ppm
Channel spacing	12.5 kHz (narrow), 25 kHz (wide)
Channel step size	6.25 kHz UHF
Duty cycle	5% to 75%, depending upon voltage, power level, and ambient temperature
RF load impedance	50 ohms
Receiver:	
Sensitivity (95% reliability, 500 user data bytes per packet)	Basic Telemetry Mode –109 dBm Enhanced Telemetry Mode –115 dBm Mobile Data Mode –115 dBm
Selectivity	60dB min (narrow), 70dB min (wide)
Intermodulation	70dB min
RF input impedance	50 ohms

VHF RADIO SPECIFICATIONS	
Model Numbers	NL6000-VHF (148-174 MHz)
	NL6000-VHF1 (136-162 MHz)
Transmission frequencies	136-162 MHz, 148-174 MHz
Current Drain at 12 V:	
IDLE radio channel	0.2 amps
Receive	0.2 amps
Transmit: 0.5 watts	1.0 amps
Transmit: 1.0 watts	1.3 amps
Transmit: 2.0 watts	1.7 amps
Transmit: 3.0 watts	2.1 amps
Transmit: 4.0 watts	2.4 amps
Transmit: 5.0 watts	2.6 amps
Transmit: 6.0 watts	2.8 amps
Transmitter:	
RF power	1 to 6 watts
Modulation	4-FSK with spectral pre-coder
Frequency stability	1.5 ppm
Channel spacing	12.5 kHz (narrow), 25 kHz (wide)
Channel step size	2.5 kHz VHF
Duty cycle	5% to 75%, depending upon voltage, power level, and ambient temperature
RF load impedance	50 ohms
Receiver:	
Sensitivity (95% reliability, 500 user data bytes per packet)	Basic Telemetry Mode –106 dBm
	Enhanced Telemetry Mode –112 dBm
	Mobile Data Mode –112 dBm
Selectivity	60dB min (narrow), 70dB min (wide)
Intermodulation	70dB min
RF input impedance	50 ohms

4. Hardware Installation and Operation

4.1. Parts Description
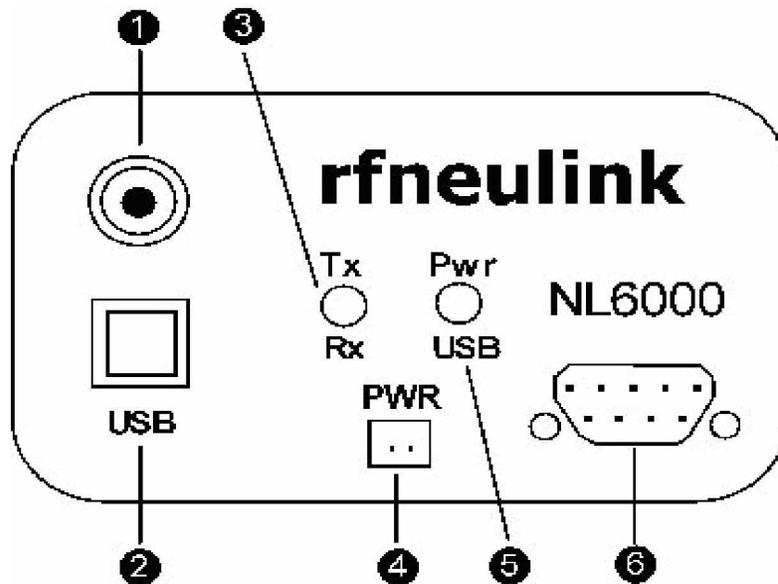
Figure 3: Parts Description of the NL6000

Part #	Description
(1)	Antenna Connector
(2)	USB Port (used by factory)
(3)	Tx/Rx LED
(4)	Power Connector
(5)	Pwr/USB LED
(6)	Serial Port (DB9 Connector)

4.2. Power Connections

Connect a 12 VDC power supply to the power connector to provide power to the NL6000.

Note: If you want to use an external power amplifier, contact the RF Neulink sales department.

4.3. Serial Port

The serial port on the NL6000 is a 9 pin female connector.

The NL6000 is a Data Communications Equipment (DCE) device. Other equipment that can connect to the NL6000 via the serial port fall into one of the following categories:

DTE   Data Terminal Equipment (computers, mainframes, terminals)

DCE   Data Communications Equipment (modems, printers, other peripherals)

Connect a DTE device to the DB9 connector with a 9-pin male connector wired one-for-one as shown in Figure 4 and Figure 5.
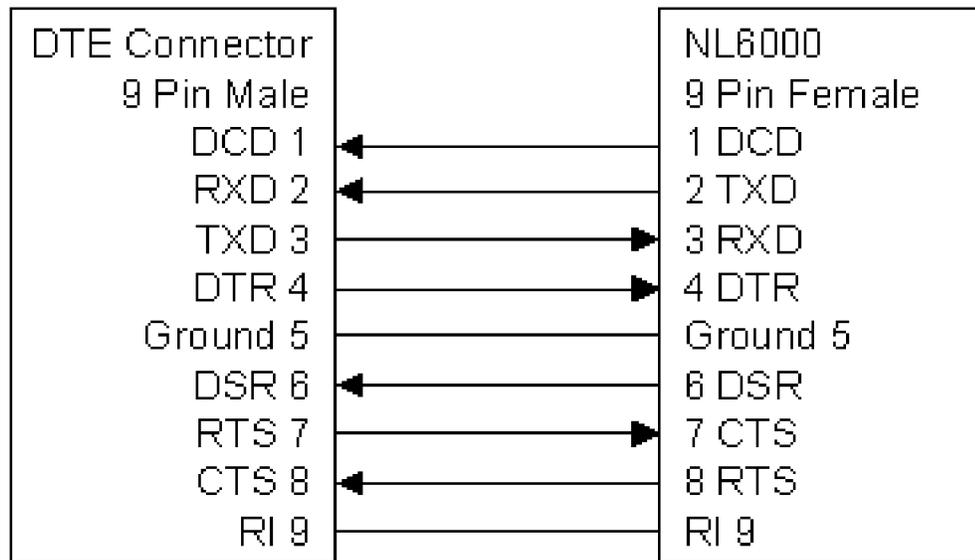
Figure 4: DTE to DCE Connection

DTE, 9 Pin Male on Computer   DCE, 9 Pin Female on NL6000
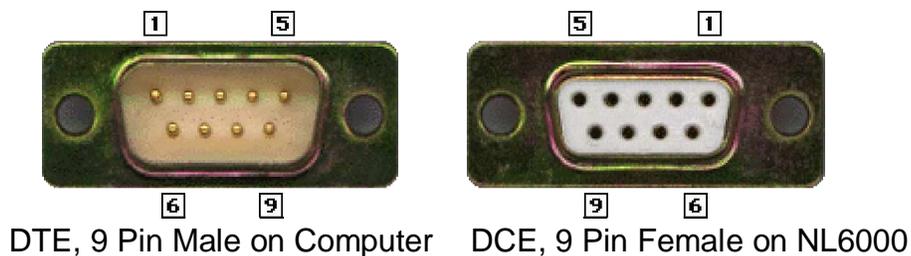
Figure 5: Male and Female Connectors with Numbered Pins

Connect a DCE device to the DB9 connector with a "null modem" cable wired as shown in Figure 6.

```
DTE Connector          NL6000
  9 Pin Male         9 Pin Female
    DCD 1  ◄────────── 1 DCD
    RXD 2  ───────┐ ┌─ 2 TXD
    TXD 3  ◄────┐  X  ► 3 RXD
    DTR 4  ───┐  X  ┌─► 4 DTR
  Ground 5  ──┼──X──┼── Ground 5
    DSR 6  ◄──┘  X  └── 6 DSR
    RTS 7  ◄────┘  └──► 7 CTS
    CTS 8  ──────────► 8 RTS
     RI 9                RI 9
```
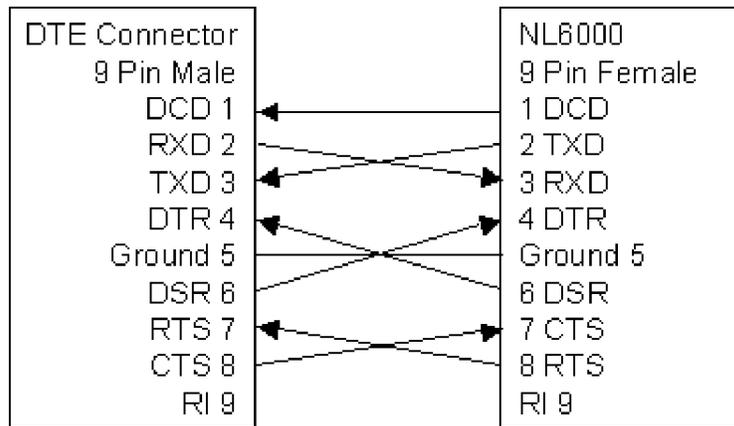
Figure 6: DTE to DTE Connection

4.4.   Antenna Connection

You must connect a suitable antenna to the RF antenna connection. This antenna is used for both transmitting and receiving over-the-air messages.

Caution: Do not operate the radio modem without an antenna.

4.5.   LEDs

Table 1 interprets the two LEDs on the NL6000.

LED	Color	Meaning
Tx/Rx	**Red**	Transmitting
	Green	Receiving a signal on the active channel.
	None	Not receiving or transmitting
Pwr	**Amber Blinking**	Powered on
	None	Powered off

Table 1: NL6000 LEDs

Note: If the Rx LED is continuously green, this means an open squelch or interference problem exists that will inhibit transmissions.

4.6.   Operation

It is the responsibility of the user to obtain the proper FCC license to operate this product on the desired channel of operation.

The NL6000 comes factory-configured for the broadcast mode of operation and tuned and tested on the default frequency of 464.550 MHz (UHF), 154.6000 MHz (VHF) and 221.5 MHz for the 216-235 MHz band.

The NL6000 operates automatically after you properly install the physical units and configure the software parameters. In most networks with more than two units, you must set the MYID and TOID parameters before operation. Sections 5 and 6 discuss the available software parameters and the procedures for setting them.

4.7.   Technical Support

Telephone support is available Monday through Friday, 7:00 am to 4:00 pm Pacific Time at (858) 549-6340.

5. Software Configuration

5.1.   Prerequisites

To configure the NL6000, you must connect a computer to the RS232 port and run a terminal emulator such as HyperTerminal or ProComm.

5.2.   Preparation

Plan the network before configuring the parameters that control each individual unit. The network plan must address the following questions:

- What is the location of each unit in the network?

- Which units are remotes and base stations?

- Does the network require any repeaters?

- How many frequencies are available?

- Which transmission mode should be used?

You can configure the NL6000 as a remote or a base station. A remote is limited to transmitting data to a pre-programmed destination. A base station can transmit data to any remote using a destination ID specified in the data string it receives from the serial port. See Section 5.3 for additional detail on the data requirements for a base station.

Assign each NL6000 with a unique address (MYID). If the unit is a remote, you also assign a destination address (TOID). The destination address can be specific to a single unit or can include wildcards for transmitting to a group of units. If the unit is a base station, the software determines the TOID from the received data string. See Section 5.4 for examples of addressing and wildcards.

If a reliable path does not exist between a remote unit and a base station, you can configure one or more NL6000 units as a repeater to reach the hidden unit. The repeater can work with both simplex and half duplex networks. See Section 5.5 for additional detail on the unique behavior of a repeater unit.

You can select from three radio channel transmission modes that provide increasing levels of error control. By evaluating the signal strength and path between two modems, you can select a transmission mode that results in the best performance. See Section 5.6 for a description of each transmission mode.

5.3.   Unique Data Requirements for a Base Station

When configured as a base station, there are specific requirements for the data strings sent through the NL6000's serial port. Because a base station is the central point of a network, it must be able to selectively transmit to any remote. To provide for selective destinations, each data string coming into the serial port must begin with a colon (:) followed by four ASCII characters that specify the destination TOID. The data string must immediately follow the ASCII characters with no pause between them as in the example:

```
:ABCD[user data]
```

5.4.   Source and Destination Addressing

Specify a unique identification number for each NL6000 unit in the network plan. This number, the MYID, references the source of the data packet. The TOID is the destination address for the packet, so the TOID is the MYID of the unit for which the data is intended. Both the MYID and TOID are a hexadecimal value from 0000 to FFFF. Figure 7 illustrates point-to-point addressing.
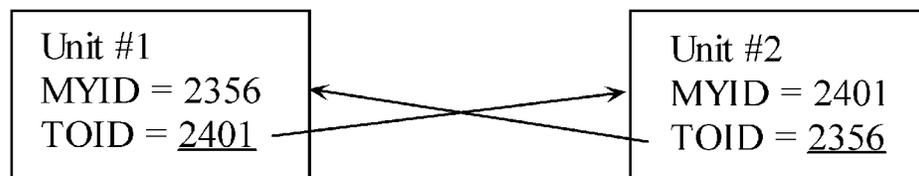
Figure 7: Point-to-Point Addressing

Use the FF character as a wildcard to designate a group of destination units. For example, a TOID may be FF56 or 42FF. A packet sent with a TOID of FF56 is a match to destination units with a MYID of 1256 and 8856. A packet sent with a TOID of 12FF is a match to destination units with a MYID of 1277 and 1219. A TOID of FFFF is a broadcast to all units.

Figure 8 shows the use of a wildcard (12FF) to transmit data to multiple units within range of Unit #1 that have a MYID starting with "12"
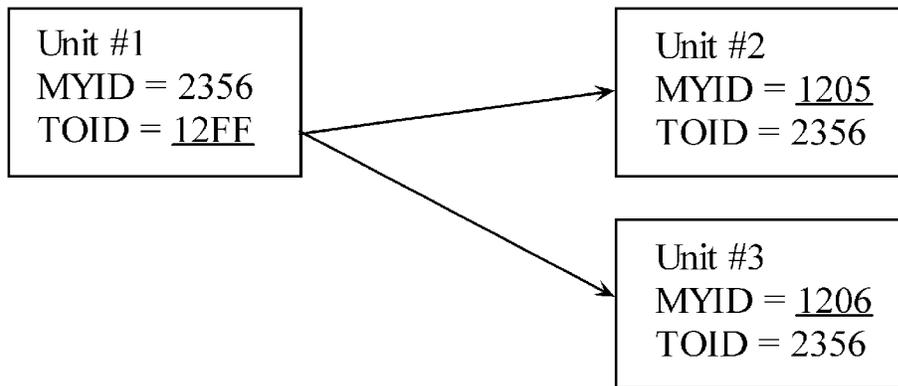
Figure 8: Addressing with Wildcards

Figure 9 shows the use of a wildcard (FFFF) to broadcast data to all units within range of Unit #1.
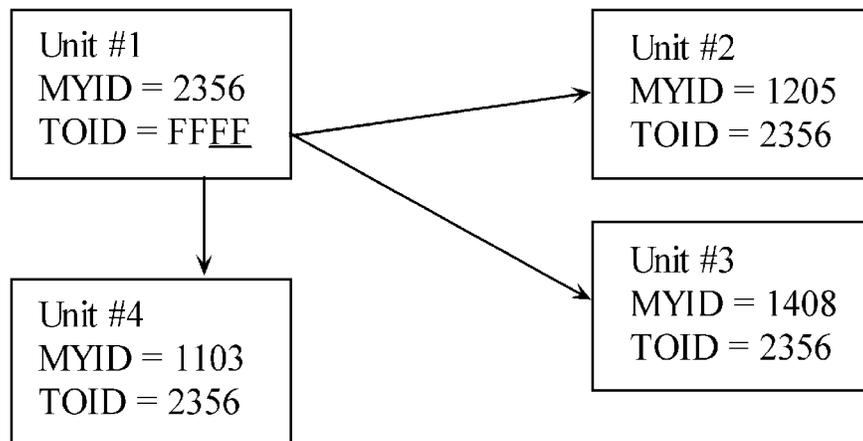
Figure 9: Using Wildcards to Broadcast

5.5.   Behavior of Repeater Units

When configured as a repeater, the unit listens for packets that qualify for repeating – in addition to its normal functions. A unit qualifies a packet for repeating based upon the TOID or MYID value associated with the packet. The trigger for repeating a packet from a base station to a remote is the value in the packet's TOID field. The trigger for repeating a packet from a remote to a base station is the value in the packet's MYID field. You can establish up to eight triggers for each repeater unit.

Consider the following example of a repeater (MYID3000) configured to repeat packets transmitted from a base station (MYID2000) to a hidden remote (MYID4203). Unit MYID3000 is configured with a repeater entry that has a Trigger = TOID and ID = 4203. This entry tells unit MYID3000 to listen for packets that have a destination address of TOID4203. If the repeater receives a packet matching the criteria, it immediately repeats the packet. Figure 10 illustrates this scenario.
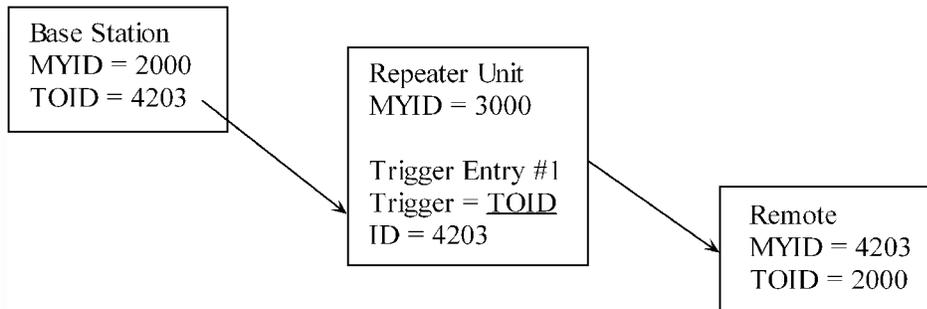
Figure 10: Repeat from a Base to a Remote

Consider the following example of a repeater (MYID3000) configured to repeat packets transmitted from a hidden remote (TOID4201) to a base station (TOID2000). Unit MYID3000 is configured with a repeater entry that has a Trigger = MYID and ID = 4201. This entry tells unit MYID3000 to listen for packets that have a source address of MYID4201. If the repeater receives a packet matching the criteria, it immediately repeats the packet. Figure 11 illustrates this scenario.
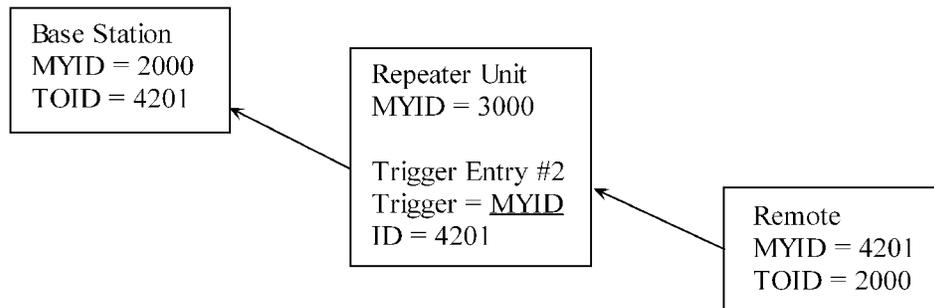
Figure 11: Repeat from a Remote to a Base Station

Because MYID and TOID values may use wildcards, it is possible to set up a single repeater entry that will repeat all packets destined to a group of hidden remotes. In Figure 12, a repeater entry with a Trigger = TOID and ID = 42FF repeats any packet with a destination matching TOID42FF.
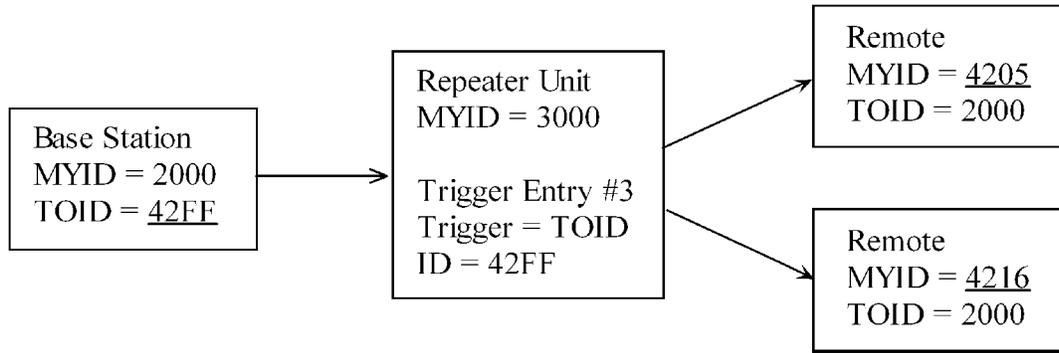
Figure 12: Repeat to Multiple Remotes using Wildcard

Likewise, it is possible to set up a single repeater entry that will repeat packets received from any member of a group of hidden remotes. In Figure 13, a repeater entry with a Trigger = MYID and ID = 42FF repeats any packet received from the group of remotes matching MYID42FF.
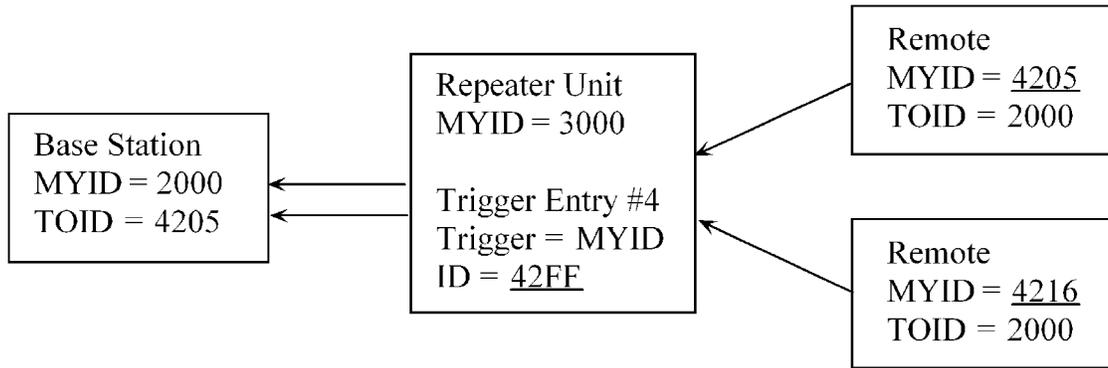
Figure 13: Repeat from Multiple Remotes using Wildcard

If you plan to use more than one frequency in your network, frequency planning is important when you use repeaters. Repeaters, like any other unit, have only one receive frequency. It is important that all units transmitting data to a repeater transmit on the repeater's receive frequency (F_A), as shown in Figure 14.
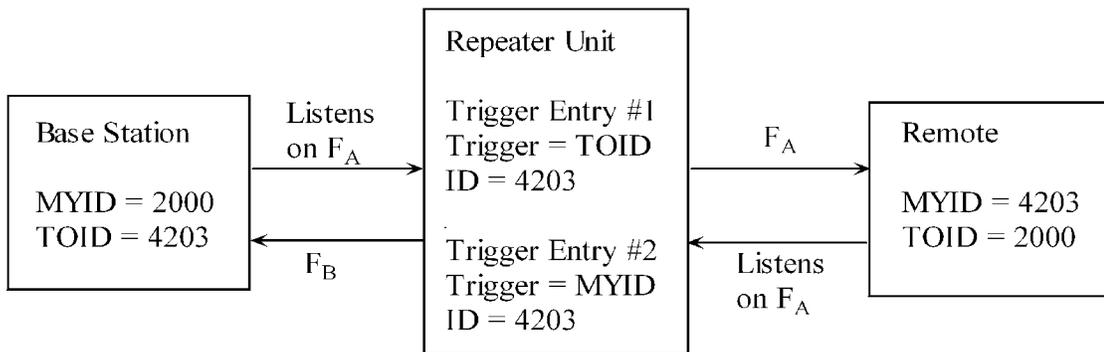
Figure 14: Sample Frequency Plan for a Repeater

In Figure 14, the repeater unit listens on F_A for transmissions from both the base station and the remote. The example shows a half-duplex channel between the repeater and base station (F_A and F_B) and a simplex channel between the repeater and remote (F_A only).

If the network plan requires more than one repeater unit to reach the hidden remote, you can specify a Transmit Delay (msec) to stagger the transmissions from each repeater. Figure 15 shows a sample network with two repeaters. Each repeater trigger entry has its own transmit delay.
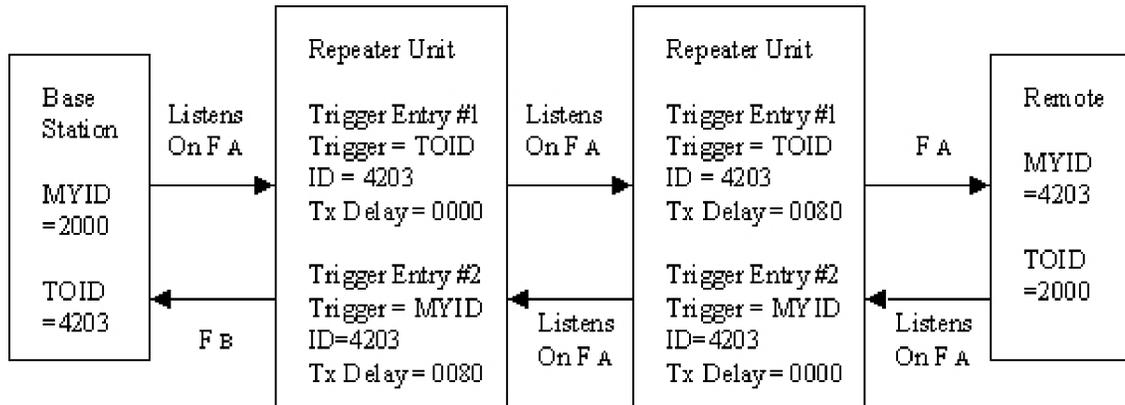
Figure 15: Sample Network with Two Repeaters

In a scenario with two repeaters, such as Figure 15, determine how to set the Transmit Delay based upon the following conditions:

- Is it possible that both repeaters may hear the same transmission?

- Is it possible for the ultimate destination to hear the transmission of both repeaters?

If either these conditions is false, you may set Transmit Delay for both repeaters to zero (0).

If both of these conditions are true, you should set Transmit Delay on one repeater to a larger value, such as 0080 msec, and you must enable Carrier Sense Multiple Access (CSMA). See Section 5.6.5 for more information about CSMA. In this case, the delay must be large enough so the delayed repeater recognizes that the other repeater has started transmitting.

5.6.   Packet Data Options

5.6.1. Transmission Mode

The NL6000 supports the following three packet transmission modes:

- Basic Telemetry mode

- Enhanced Telemetry mode

- Mobile Data mode

Table 2 summarizes the characteristics of each transmission mode

	Basic Telemetry Mode	Enhanced Telemetry Mode	Mobile Data Mode
Spectral Pre-coding	Yes	Yes	Yes
Randomization	Yes	Yes	Yes
CRC	Yes	Yes	Yes
FEC	No	Yes	Yes
Interleaving	No	No	Yes

Table 2: Transmission Mode Characteristics

To select the best transmission mode for a unit, consider the following factors:

- Signal strength between the unit and its destination unit(s)
- Reliability of the path between the unit and its destination unit(s)
- Noise, RF interference, and fading expected on the radio channel
- Movement of the unit or movement of its surroundings

Each transmission mode is designed to provide a different level of error control. The level of error control influences the optimum packet size that will produce the desired throughput. Use the scenarios on the next page to help determine which Transmission Mode and Maximum Packet Size is best for a unit.

Note: If you are not sure which mode to use, use Enhanced Telemetry mode.

You can configure the transmission mode and packet size parameters differently for each unit in the network. All transmission modes share a common mode field as part of the packet. This field allows the receiving modem to determine the mode prior to decoding a received message.

Scenario #1

Description: You have above average signal strength and a reliable path between the radio modem units. You do not expect noise bursts, RF interference, or signal fading to corrupt the radio data link.

Best Choice: Basic Telemetry Mode

Because you have a clean channel, use the mode that uses the least overhead for each packet. Basic Telemetry mode uses error detection only, so

it contains the least amount of overhead and the highest percentage of user data in each packet. Basic Telemetry mode provides the highest throughput on a clean channel.

However, if there is a transmission error, you will lose the entire packet. Therefore, when using Basic Telemetry mode, use a smaller Maximum Packet Size so that you lose very little user data if an error does occur. In this situation, smaller packets have a better chance of getting through.

Why not use Enhanced Telemetry Mode or Mobile Data Mode for this scenario? If the channel is clean and the signal is strong, there is no need to use a mode that reduces the percentage of user data in each packet.

Scenario #2

Description: You have average signal strength or a less reliable path between the radio modem units. You expect occasional corruption on the radio data link from noise bursts, RF interference, or signal fading.

Best Choice: Enhanced Telemetry Mode

Because you expect the channel to have occasional corruption, use Enhanced Telemetry mode. In addition to error detection, Enhanced Telemetry mode uses Reed-Solomon forward error correction for increased transmission reliability. This mode requires more overhead than Basic Telemetry mode and lowers the percentage of user data in each packet.

However, because you are less likely to lose data with Enhanced Telemetry mode than with Basic Telemetry mode, you can use a larger Maximum Packet Size. A larger packet size can compensate for the lower percentage of user data in each packet and provide good throughput on an occasionally corrupt channel.

Why not use Basic Telemetry Mode for this scenario? Basic Telemetry mode is not useful when you expect a corrupt channel because a single transmission error will cause a packet failure. Lost packets will degrade throughput. Basic Telemetry mode cannot recover data errors, so throughput would be poor.

Why not use Mobile Data Mode for this scenario? Mobile Data mode requires that the interleaver be filled for each packet. If the data packets are smaller than the interleaver size, throughput will suffer because the interleaver is "filled" prior to transmission. Since fading is not a big issue in this scenario, the interleaver is not necessary.

Scenario #3

Description: You have fluctuating signal strength and a less reliable path between the radio modem units. You expect noise bursts, RF interference, or signal fading to corrupt the radio data link. The remote unit is moving, or it is located in an area where the surroundings are moving, such as a busy street.

Best Choice: Mobile Data Mode

Because you expect a corrupt channel, use the mode that has the greatest amount of error control. Mobile Data mode includes three types of error control, Reed-Solomon forward error correction, error detection, and a block interleaver. This mode provides for maximum transmission reliability on a corrupt channel. Since the packet size is large, any data added to the packet to fill the interleaver is insignificant.

Because you are more likely to recover from transmission errors with Mobile Data mode, you can use a large Maximum Packet Size. A larger packet size can compensate for the lower percentage of user data in each packet and provide good throughput on a corrupt channel.

Why not use Basic Telemetry Mode for this scenario? Basic Telemetry mode is not useful when you expect a corrupt channel because it uses error detection only. Basic Telemetry mode cannot recover data errors, so throughput would be poor.

Why not use Enhanced Telemetry Mode for this scenario? Enhanced Telemetry mode provides error correction, but if both the signal strength and path are poor, you might need to reduce the Maximum Packet Size to increase reliability. With Mobile Data mode you can increase the Maximum Packet Size and get better throughput on a very corrupt channel.

5.6.2. Maximum Packet Size

The NL6000 transmits a data packet on the radio channel when the amount of data in the input buffer is equal to the Maximum Packet Size or when there is a timeout on the serial port. The maximum packet size is the largest amount of user data in one RF packet.

5.6.3. Over-the-Air Data Rates

The NL6000 supports two over the air data rates: 12,000 bps or 22,050 bps. Select the data rate you want to use depending upon the bandwidth you occupy and your license.

5.6.4. Acknowledgements

The NL6000 can request an acknowledgement (ACK) from the destination modem with each transmission. If this option is enabled, the unit will retransmit a packet up to a specified number of times if it does not receive an ACK. If it does not receive an ACK after the final retry, the unit will transmit the next packet. You specify the desired maximum number of retries with the Max Retries option.

> **Note:** When acting as a repeater, the unit never generates an ACK. ACKs are end-to-end and do not affect the repeater unit.

5.6.5. Carrier Sense Multiple Access

If a unit's transmit and receive frequencies are the same, it may be helpful to enable Carrier Sense Multiple Access (CSMA). This option does not allow transmission of a packet until the channel is free of contention.

5.7. Serial Connection to an I/O Device

5.7.1. Basic Serial Parameters

The NL6000 can receive data strings from a variety of I/O devices through its RS232 serial port. Configure the NL6000 serial port parameters based upon how the I/O device will send data to the unit. The following is a list of the basic serial parameters you must configure:

- Baud rate – This parameter is the data rate between the I/O device and the NL6000 modem. Set the baud rate to the rate of the I/O device.

- Data bits – This parameter is the number of bits the I/O device sends in a byte. The options available are 7 or 8. The NL6000 does not use parity bits.

- Stop bits – This parameter is the number of bits used for the end of a byte. The options available are 1 or 2.

- Transmit Character Timeout – The NL6000 transmits a data packet on the radio channel when there is a timeout on the serial port equal to this value or when the amount of data in the input buffer is equal to the Maximum Packet Size.

5.7.2. Flow Control

Prior to configuration of the NL6000, determine if you want to use flow control to prevent the serial device or modem from overflowing its buffer. If flow control is desired, two types are available – RTS/CTS and XON/XOFF. With RTS/CTS, the modem monitors the RTS signal to determine when to send data to the serial device. In addition, the modem asserts CTS when the modem is ready to accept data from the serial device. RTS/CTS is the preferred method of flow control, but it requires separate lines for RTS and CTS. If you cannot use hardware flow control, you may use the XON/XOFF software option for flow control. This option may only be used for ASCII data and requires the use of special characters to identify when it is OK to send/ receive data to/from the serial device.

5.7.3. DCD Mode

The DCD Mode parameter identifies how the I/O device interprets the current state of the modem using the DCD line between the device and the modem. If the mode is set to Enable, the modem asserts the DCD line when it is receiving data over-the-air. If the mode is set to Disable, the modem asserts the line when it is in a normal operating state and negates the line when it is in

a programming state. If the mode is set to DCD 232, certain I/O devices can 'wake up' when the DCD signal is asserted and turn off when the signal is negated.

5.7.4. Pre- and Post-Data DCD Time

Two additional parameters, Pre-Data DCD Time and Post-Data DCD Time, must be set when using the DCD 232 option. The pre-data time value sets the number of milliseconds it takes for the device to wake up after the modem asserts the line. The post-data time value sets the number of milliseconds it takes for the device to turn off after the modem negates the line. These settings ensure the modem does not transmit data unless the device is ready. Figure 16 illustrates the pre- and post-DCD time periods.
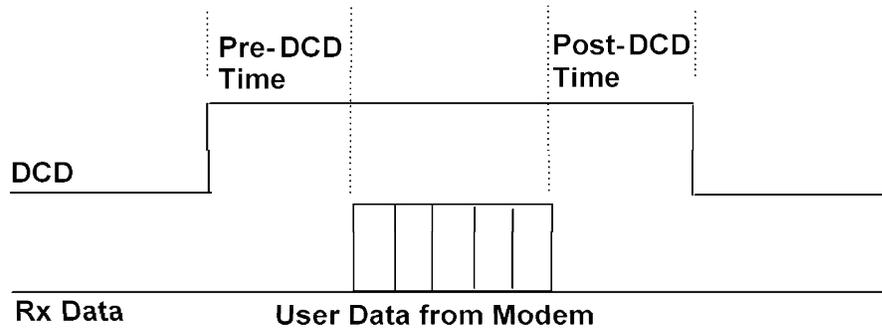
Figure 16: Pre- and Post-DCD Time

5.8. Planning the RF Channel

For each unit in the network plan, you must specify the active channel as well as receive and transmit frequencies used on that channel. Determine these radio parameters as part of your network plan.

Each NL6000 unit arrives from the factory tuned and tested on the default frequency appropriate for that unit. Retuning requires that a qualified radio technician use the procedures in Appendix A – Diagnosing and Correcting Performance Problems.

5.9. Factory Default Parameters

Appendix B provides a list of the default parameters set for each NL6000 unit at the factory. It also provides a blank column for you to record any custom values you want to set.

6. Procedures

This section includes step-by-step procedures for configuring all the parameters that control the operation of the NL6000. The procedures are grouped into the following categories:

- General Procedures

- Radio Network Setup

- Serial Connection Setup

- Data Setup

- Repeater Setup

- File Management

Configuration of the NL6000 parameters is easy using the menu-driven user interface. When you enter programming mode using the terminal emulator, a **Main Menu** appears. The procedures in this section assume you always begin at the **Main Menu**. The **Main Menu** appears as in Figure 17.
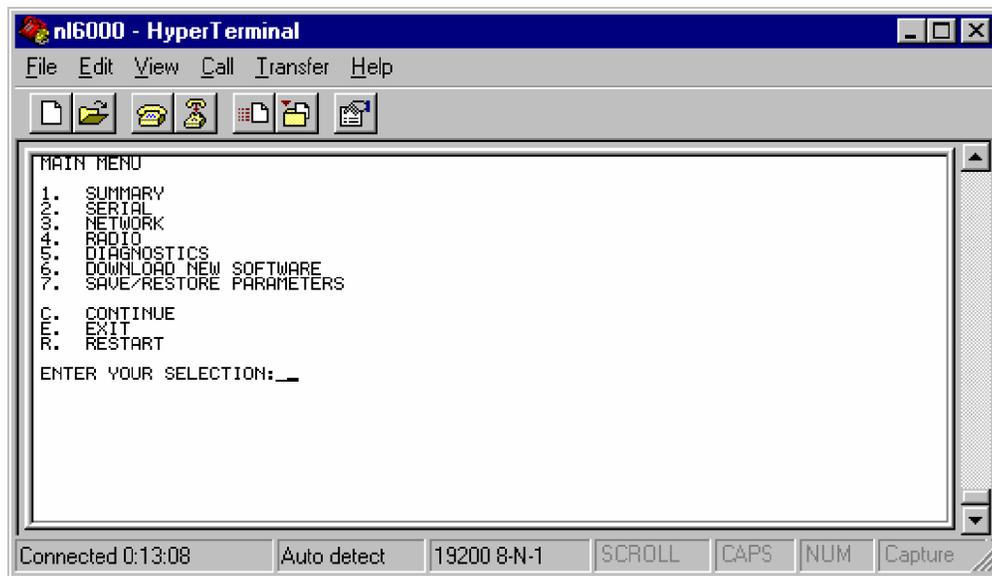
Figure 17: NL6000 Main Menu

In most procedures, you must enter at least one submenu to perform a task. The following text is an example of a step that leads you to the correct submenu option:

"Select **Network** ä **Unit Type**"

This example means that from the **Main Menu**, you must select the **Network** option and then select the **Unit Type** option from the submenu that appears. Throughout this section, the arrow (ä) directs you through a series of submenu options.

6.1. General Procedures

Entering Programming Mode

Perform this procedure when you need to reset any of the existing configuration parameters for the NL6000.

> **Note:** If the **Programming Mode** is **Disabled**, you must perform this procedure within five seconds of powering on the unit.

1. Open **HyperTerminal** or **Procomm**.

2. Type **…//**
   The **Main Menu** opens.

Setting the Program Mode

The **Program Mode** parameter determines when the operator can enter programming mode from operational mode.

1. Select **Serial** ä **Program Mode**.

2. Select from the following options:

   1-Disabled   Enter programming mode within five seconds of power-on. Select this option under normal operating conditions to prevent accidental resetting of parameters.

   2-Enabled   Enter programming mode whenever you type the key sequence **…//** . There must be a pause before and after the sequence. Select this option during factory configuration or during initial configuration of a unit.

Saving Configuration Changes to Flash Memory

Select **E - Exit** from the **Main Menu** to save the updated parameter settings to the unit's flash memory. The unit immediately begins using the new configuration.

Saving Configuration Changes Temporarily

Select **C - Continue** from the **Main Menu** to temporarily save the updated settings for the current operating session. The configuration is not saved to flash memory. You can revert to the prior configuration by cycling power to the unit.

Reverting to the Prior Configuration

Select **R - Restart** from the **Main Menu** to ignore the changes you made and revert back to the prior configuration.

Returning to the Previous Menu

Press the **ESC** key at any time to return to the previous menu. The changes you made up to that point are saved until you leave the **Main Menu** using **Exit**, **Continue**, or **Restart**.

Displaying the Configuration Summary Window

Select **1 - Summary** from the **Main Menu**. The summary window appears as in Figure 18.

Figure 18: Summary Window

6.2. Radio Network Setup

Setting the Unit Type

1. Select **Network** ä **Unit Type**.

2. Select from the following options:

   1-Base   Configure as a base station. This unit type receives the TOID from the data packet received through the serial port.

   2-Remote   Configure as a remote. This unit type receives the TOID from its configuration.

Setting the Unit ID (MYID)

1. Select **Network** ä **MYID**.

2. Enter a unique identification for the unit. The value must be a hexadecimal value between 0001 and FFFE. For more information about addressing and wildcards, refer to Section 5.4.

Setting the Target Unit ID (TOID)

You only need to set this parameter if the **Unit Type** is **Remote**. The system ignores this parameter if the **Unit Type** is **Base**.

1. Select **Network** ä **TOID**.

2. Enter the destination address for packets from this unit. The destination address is the MYID of the unit for which the data is intended. The value must be a hexadecimal value in the range 0000 – FFFF. For more information about addressing and wildcards, refer to Section 5.4.

Setting the Active Channel

1. Select **Radio** ä **Select Active Channel**.

2. Enter the channel assignment for this unit. The value must be a number in the range 01 – 64.

Setting the Receive Frequency

1. Select **Radio** ä **Receive Frequency for Active Channel**.

2. Enter the receive frequency for the active radio channel in MHz. The value must be a number in the format **nnn.nnnn**.

Setting the Transmit Frequency
1. Select **Radio** ä **Transmit Frequency for Active Channel**.
2. Enter the transmit frequency for the active radio channel in MHz. The value must be a number in the format **nnn.nnnn**.

6.3 Serial Connection Setup

Setting the Baud Rate

1. Select **Serial** ä **Baud Rate**.

2. Select a baud rate for the connection between the modem and I/O device. The options range from 1200 to 38400.

Setting the Data Bits

1. Select **Serial** **Data Bits**.

2. Select the number of data bits per byte sent from the I/O device. The options are **7** or **8** bits per byte.

Setting the Stop Bits

1. Select **Serial** ä **Stop Bits**.

2. Select the number of number of bits used to designate the end of a byte. The options are **1** or **2** bits.

Setting the Transmit Character Timeout

1. Select **Serial** ä **Transmit Character Timeout**.

2. Enter the expected pause between data strings through the serial port. The value must be in the range 10 – 9999 milliseconds.

Setting the Flow Control Option

1. Select **Serial** ä **Flow Control**.

2. Select from the following options:

   1-None   Do not use flow control.

   2-RTS/CTS   Monitor the Ready To Send (RTS) signal to determine when to send data to the serial device and assert CTS to tell the serial device when it can send data to the modem.

   3-XON/XOFF Use special ASCII characters to determine when to send/receive data to/from the serial device.

Setting the DCD Mode

1. Select **Serial** ä **DCD Mode**.

2. Select from the following options:

   1-Enable   In this mode the modem asserts the DCD line when it is receiving data over-the-air.

   2-Disable   In this mode the modem asserts the line when it is in a normal operating state and negates the line when it is in a programming state.

3-DCD 232   In this mode, certain I/O devices can wake up when the DCD signal is asserted and turn off when the signal is negated. If you select this option, the **DCD 232** menu appears for you to set the **Pre-Data DCD Time** and **Post-Data DCD Time**.

Setting the Pre-Data DCD Time

1. Select **Serial DCD Mode** ä **Pre-Data DCD Time**.

2. Enter the number of milliseconds it takes for the device to wake up after the modem asserts the line. The value must be a 3-digit number. The post-data time value sets the number of milliseconds it takes for the device to turn off after the modem negates the line

Setting the Post-Data DCD Time

1. Select **Serial** ä **DCD Mode** ä **Post-Data DCD Time**.

2. Enter the number of milliseconds it takes for the device to turn off after the modem negates the line. The value must be a 3-digit number.

6.4. Data Setup

Setting the Maximum Packet Size

1. Select **Network** ä **Max Packet Size**.

2. Enter the largest amount of continuous bytes of user data you expect in a single transmission. The value must be in the range 1 – 1023.

Note: The **Packet Mode** affects how much user data can be in a packet. For Enhanced Telemetry and Mobile Data modes, the maximum will be less than 1023 due to memory constraints. The **Max Packet Size** window displays the actual value for these two modes.

Setting the Packet Mode

1. Select **Network** ä **Packet Mode**.

2. Select from the following options:

1-Basic Telemetry   This mode uses a simple Cyclic Redundancy Check (CRC) for error detection.

2-Enhanced Telemetry   This mode is similar to **Basic Telemetry** mode, but it includes Reed-Solomon forward error correction.

3-Mobile Data   This mode uses forward error correction and a block interleaver for maximum transmission reliability.

Refer to Section 5.6.1 for more information about each packet mode

Setting the Data Rate

1. Select **Network** ä **Data Rate**.

2. Select the data rate you want to use depending upon the bandwidth you occupy and your licenses. The available options are **12,000** bps and **22,050** bps.

Setting the Request ACKs Option

1. Select **Network** ä **Request ACKs**.

2. Select from the following options:

    1-Enable   When the modem sends data it requests an ACK from the destination modem. If it does not receive an ACK, the modem will retransmit up to the number of times you specify in the Max Retries option.

    2-Disable   When the modem sends data it does not request an ACK from the destination modem.

Setting the Contention Option

1. Select **Network** ä **Contention**.

2. Select from the following options:

    1-None   Do not use contention to determine when to transmit.

    2-CSMA   Enable Carrier Sense Multiple Access (CSMA) so that transmission waits until the channel is free of contention. This option is helpful if a unit's transmit and receive frequencies are the same.

Setting the Max Retries Option

You only need to set this parameter if the **Request ACKs** option is enabled. The system ignores this parameter if it is disabled.

1. Select **Network** ä **Max Retries**.

2. Enter the greatest number of times you want to retransmit if you do not receive an ACK response. The value must be in the range 1 – 9.

6.5. Repeater Setup

Each NL6000 unit may have up to eight repeater entries. Each repeater entry includes a trigger, trigger ID, transmit channel, and transmit delay value. If a unit does not act as a repeater, do not set up any repeater entries. For more information about setting up a repeater unit, refer to Section 5.5

Table 3 shows how to set up the **Trigger** and **ID** values for each type of repeater trigger.

Trigger Field	ID Value	Use
MYID	nnnn (hex)	Used to repeat a packet from a remote to a base station. The ID value is the MYID of the remote, or group of remotes if using a wildcard.
TOID	nnnn (hex)	Used to repeat a packet from a base station to one or more remotes. The ID value is the TOID of the remote, or group of remotes if using a wildcard.

Table 3: Setup of Repeater Trigger Fields

Selecting the Repeater Entry to Edit

1. Select **Network** ä **Repeater** ä **Select Repeater Entry**.

2. Enter the number assigned to the repeater entry you want to set or edit. Repeater entries are assigned a number in the range 1 – 8. After you select an entry number, the system displays the current parameter settings for that repeater entry.

3. Press **ESC** to return to the **Repeater** menu where you can set any of the four repeater parameters.

Setting the Repeater Trigger

1. Select **Network** ä **Repeater** ä **Trigger**.

2. Select from the following options:

   1-MYID   Trigger the repeater function for packets addressed with a **MYID** equal to the **ID** value. Set the trigger **ID** to the **MYID** of the remote unit from which you want to repeat packets. Refer to Table 3.

   2-TOID   Trigger the repeater function for packets addressed with a **TOID** equal to the trigger **ID** value. Set the trigger **ID** to the **TOID** of the destination unit. Refer to Table 3.

Setting the Repeater Trigger ID

1. Select **Network** ä **Repeater** ä **ID**.

2. Enter the value of the trigger ID as follows:

   - If the **Trigger** is **MYID**, type the **MYID** value of the destination remote unit. The value must be a hexadecimal value between 0001 and FFFE.

   - If the **Trigger** is **TOID**, type the **TOID** value of the destination base station. The value must be a hexadecimal value in the range 0001 to FFFF.

     Note: An **ID** of 0000 and a **Trigger** of MYID indicates the repeater entry is ignored.

Setting the Repeater Transmit Channel

1. Select **Network** ä **Repeater** ä **Transmit Channel**.

2. Enter the channel number on which the repeater transmits the repeated data. The value must be a number in the range 01 – 64.

Note: The transmit frequency used on this channel is the Tx Frequency you set in the Radio menu.

Setting the Repeater Transmit Delay

1. Select **Network** ä **Repeater** ä **Transmit Delay**.

2. Enter the number of milliseconds you want the repeater to wait before repeating the transmission. The value must be in the range 0000 – 9999 milliseconds. Normally, this value is set to 0000.

6.6. File Management

Downloading a Software Upgrade

The software that runs the NL6000 is stored in flash memory. There is room in the flash memory for two software versions. This allows you to keep the current software version while you download a new version. If the download is not valid, the unit can still run on the older version.

The NL6000 can determine if the new download is complete and valid. The system uses a checksum function to determine if the download is valid. If the download is corrupt, the system continues to use the older version. If the download is valid, the modem switches over to use the upgrade when you cycle power.

1. Ensure you have access to the NL6000 software upgrade files.

2. From the **Main Menu** select **Download New Software**. The **Download New Software** window opens.

3. Press **Y** to continue with the software download. If you do not want to

initiate the download at this time, press **ESC**. There is a delay while the system erases the flash to prepare for the download.

4. When the system prompts you to send the DSP build, initiate the download from the terminal emulator.

- If you use Procomm, use the **Send ASCII Text** option.

- If you use HyperTerminal, use the **Send Text File** option.

A message appears with the estimated download time. The estimate is based upon the time it takes using Procomm. If you use HyperTerminal, the download may take longer.

A countdown message shows the progress of the download. A success message appears when the download is complete.

5. When the download is complete, cycle power to reset the modem. This causes the modem to use the new software build.

6. Press **ESC** to continue using the **Main Menu**.

Saving Parameters to Disk

If you want to duplicate parameter values on several NL6000 units, you can save the settings to disk and restore them to multiple units. Use the following procedure to save parameter values from the unit currently attached to the serial port.

1. Select **Save/Restore Parameters** ä **Save Parameters to Disk**.

2. Using Procomm or HyperTerminal, open the file where you want to save the parameters.

3. Press **Y** to confirm that you want to save parameters. If you do not want to save parameters at this time, press **ESC**.

4. Wait until the output to the terminal emulator stops. You will see a checksum at the end.

5. Stop the text capture function on the terminal emulator and close the file.

6. Press **ESC** to continue using the **Save/Restore Parameters** menu.

Restoring Parameters from Disk

If you want to duplicate parameter values on several NL6000 units, you can save the settings to disk and restore them to multiple units. Use the following procedure to restore saved parameter settings to the unit currently attached to the serial port.

1. Select **Save/Restore Parameters** ä **Restore Parameters from Disk**.

2. Using Procomm or HyperTerminal, open the file that holds the parameter settings.

3. Press **Y** to confirm that you want to restore parameters. If you do not want

to restore parameters at this time, press **ESC**.

When you press **Y**, the system erases the current parameter file in flash memory.

4. When the system prompts you to send the parameter file, initiate the restore using the terminal emulator.

- If you use Procomm, use the **Send ASCII Text** option.

- If you use HyperTerminal, use the **Send Text File** option.

A success message appears when the restore is complete.

5. When the download is complete, cycle power to let the modem start using the new parameter settings.

6. Press **ESC** to continue using the **Save/Restore Parameters** menu.

Restoring Default Parameters

Use the following procedure to restore factory-delivered default parameter settings to the unit currently attached to the serial port.
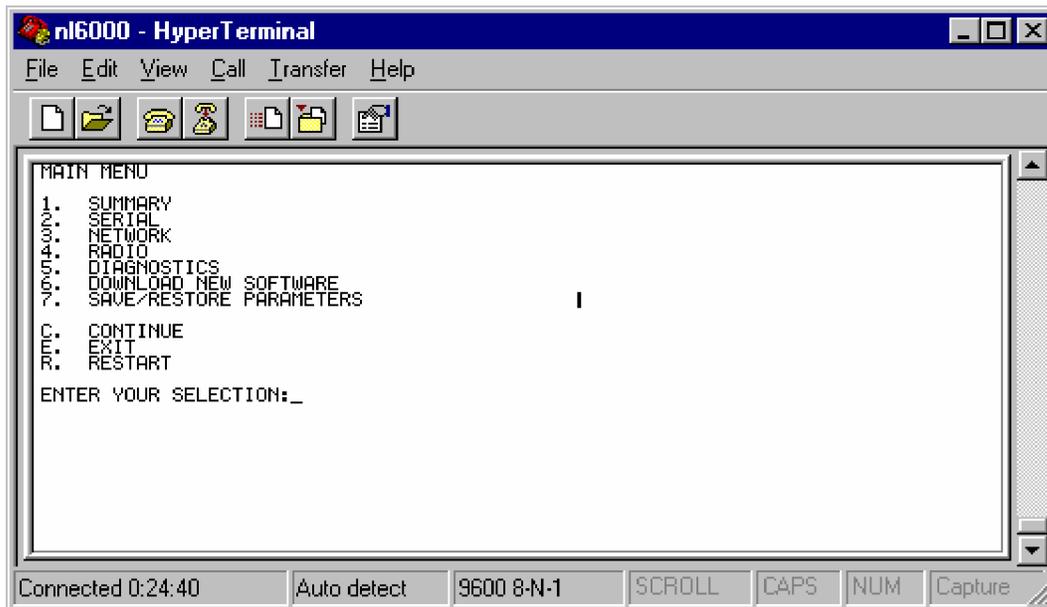
1. Select **Save/Restore Parameters** ä **Restore Default Parameters**. The system prompts you to confirm that you want to restore the default parameter settings.

2. Press **Y** to confirm that you want to restore the default settings. If you do not want to restore default settings at this time, press **ESC**.

When you press **Y**, the system erases the parameter file in flash memory and restores the default settings. A success message appears when the restore is complete.
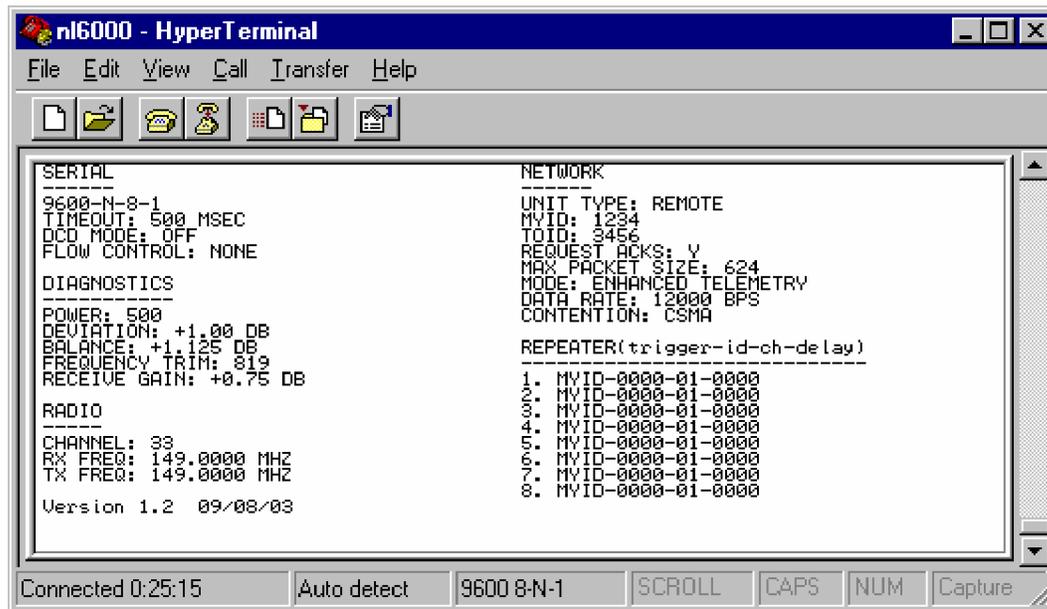
3. When the download is complete, cycle power to let the modem start using the new parameter settings.

4. Press **ESC** to continue using the **Save/Restore Parameters** menu.
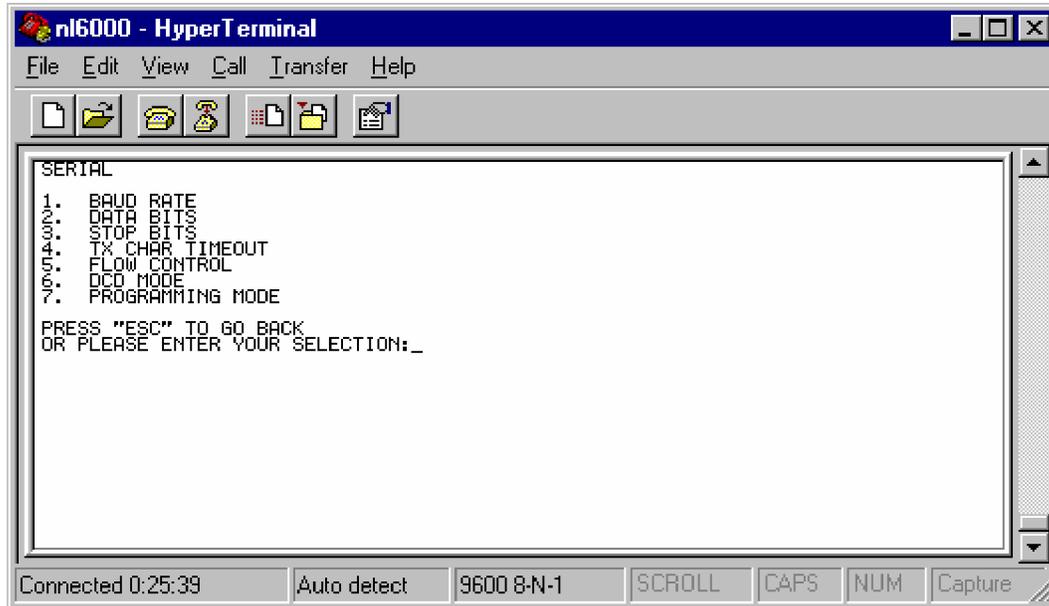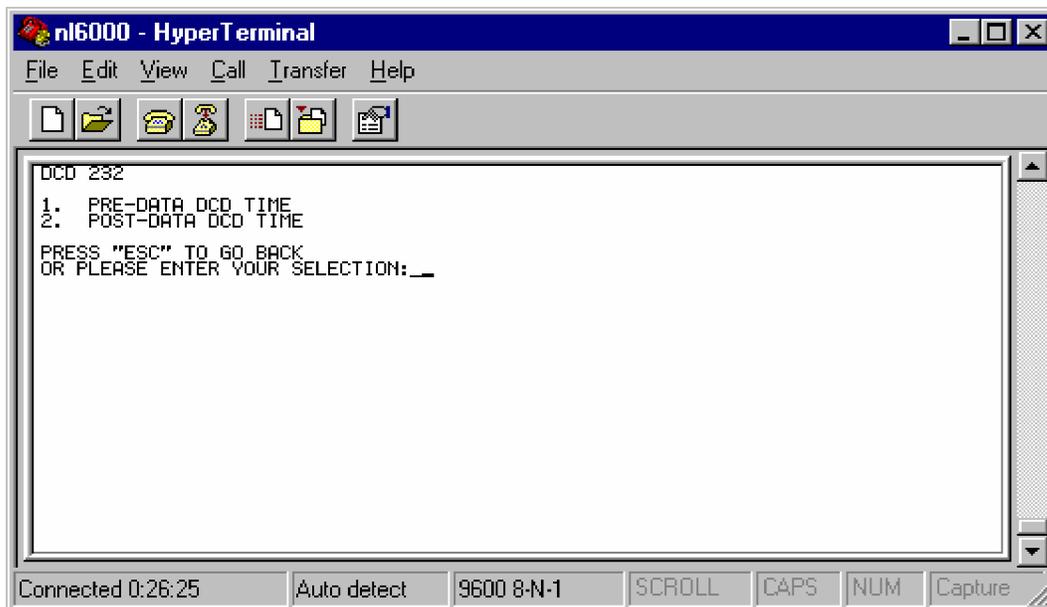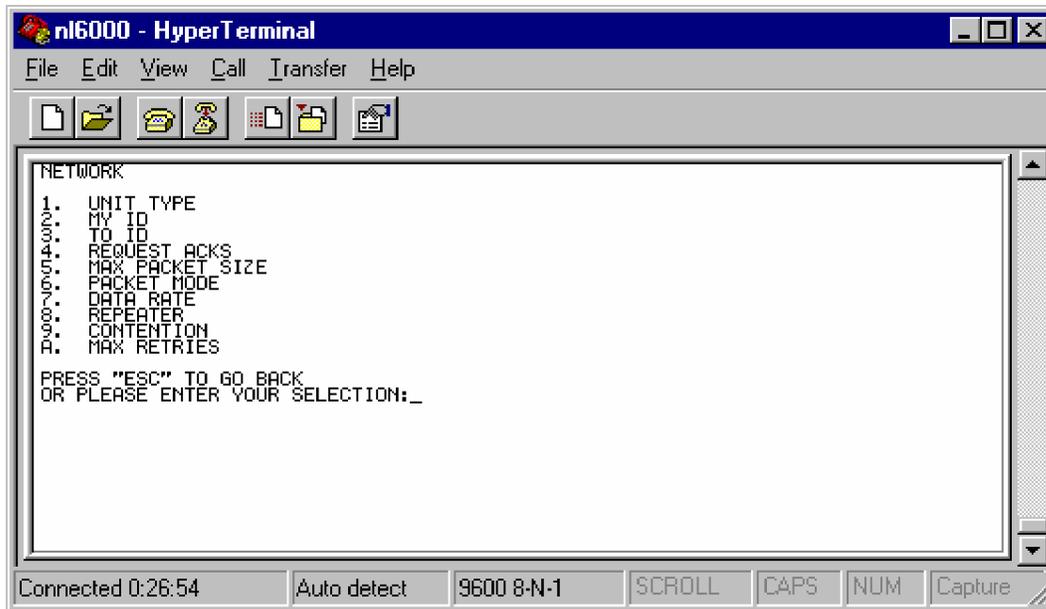
7. Menu Quick Reference

7.1.　Main Menu

```
nl6000 - HyperTerminal
File  Edit  View  Call  Transfer  Help

MAIN MENU

1.  SUMMARY
2.  SERIAL
3.  NETWORK
4.  RADIO
5.  DIAGNOSTICS
6.  DOWNLOAD NEW SOFTWARE
7.  SAVE/RESTORE PARAMETERS

C.  CONTINUE
E.  EXIT
R.  RESTART

ENTER YOUR SELECTION:_

Connected 0:24:40    Auto detect    9600 8-N-1    SCROLL  CAPS  NUM  Capture
```

7.2.　Summary Window

```
nl6000 - HyperTerminal
File  Edit  View  Call  Transfer  Help

SERIAL                          NETWORK
------                          -------
9600-N-8-1                      UNIT TYPE: REMOTE
TIMEOUT: 500 MSEC               MYID: 1234
DCD MODE: OFF                   TOID: 3456
FLOW CONTROL: NONE              REQUEST ACKS: Y
                                MAX PACKET SIZE: 624
DIAGNOSTICS                     MODE: ENHANCED TELEMETRY
-----------                     DATA RATE: 12000 BPS
POWER: 500                      CONTENTION: CSMA
DEVIATION: +1.00 DB
BALANCE: +1.125 DB              REPEATER(trigger-id-ch-delay)
FREQUENCY TRIM: 819             -----------------------------
RECEIVE GAIN: +0.75 DB          1. MYID-0000-01-0000
                                2. MYID-0000-01-0000
RADIO                           3. MYID-0000-01-0000
-----                           4. MYID-0000-01-0000
CHANNEL: 33                     5. MYID-0000-01-0000
RX FREQ: 149.0000 MHZ           6. MYID-0000-01-0000
TX FREQ: 149.0000 MHZ           7. MYID-0000-01-0000
                                8. MYID-0000-01-0000
Version 1.2  09/08/03

Connected 0:25:15    Auto detect    9600 8-N-1    SCROLL  CAPS  NUM  Capture
```

7.3. Serial Menu

7.4. DCD RS-232 SubMenu

7.5.   Network Menu
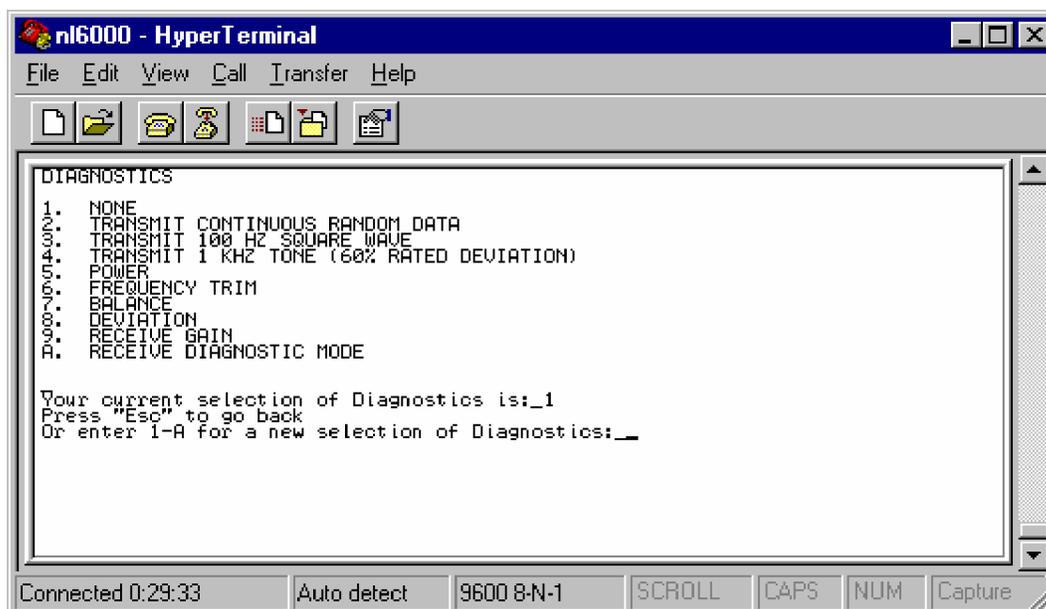
```
nl6000 - HyperTerminal
File  Edit  View  Call  Transfer  Help

NETWORK

1.   UNIT TYPE
2.   MY ID
3.   TO ID
4.   REQUEST ACKS
5.   MAX PACKET SIZE
6.   PACKET MODE
7.   DATA RATE
8.   REPEATER
9.   CONTENTION
A.   MAX RETRIES

PRESS "ESC" TO GO BACK
OR PLEASE ENTER YOUR SELECTION:_

Connected 0:26:54     Auto detect     9600 8-N-1     SCROLL   CAPS   NUM   Capture
```

7.6.   Repeater SubMenu

```
nl6000 - HyperTerminal
File  Edit  View  Call  Transfer  Help

REPEATER

1.   SELECT REPEATER ENTRY TO EDIT
2.   TRIGGER
3.   ID
4.   TRANSMIT CHANNEL
5.   TRANSMIT DELAY

PRESS "ESC" TO GO BACK
OR PLEASE ENTER YOUR SELECTION:_

Connected 0:28:35     Auto detect     9600 8-N-1     SCROLL   CAPS   NUM   Capture
```

7.7.   Radio Menu

```
nl6000 - HyperTerminal
File  Edit  View  Call  Transfer  Help

RADIO

1.   SELECT ACTIVE CHANNEL
2.   RECEIVE FREQUENCY FOR ACTIVE CHANNEL (MHz)
3.   TRANSMIT FREQUENCY FOR ACTIVE CHANNEL (MHz)

PRESS "ESC" TO GO BACK
OR PLEASE ENTER YOUR SELECTION:_

Connected 0:29:03    Auto detect    9600 8-N-1    SCROLL   CAPS   NUM   Capture
```

7.8.   Diagnostics Menu

```
nl6000 - HyperTerminal
File  Edit  View  Call  Transfer  Help

DIAGNOSTICS

1.   NONE
2.   TRANSMIT CONTINUOUS RANDOM DATA
3.   TRANSMIT 100 HZ SQUARE WAVE
4.   TRANSMIT 1 KHZ TONE (60% RATED DEVIATION)
5.   POWER
6.   FREQUENCY TRIM
7.   BALANCE
8.   DEVIATION
9.   RECEIVE GAIN
A.   RECEIVE DIAGNOSTIC MODE

Your current selection of Diagnostics is:_1
Press "Esc" to go back
Or enter 1-A for a new selection of Diagnostics:__

Connected 0:29:33    Auto detect    9600 8-N-1    SCROLL   CAPS   NUM   Capture
```

7.9.   Save/Restore Parameters Menu

```
nl6000 - HyperTerminal
File  Edit  View  Call  Transfer  Help

SAVE/RESTORE PARAMETERS

1.   SAVE PARAMETERS TO DISK
2.   RESTORE PARAMETERS FROM DISK
3.   RESTORE DEFAULT PARAMETERS

PRESS "ESC" TO GO BACK
OR PLEASE ENTER YOUR SELECTION:_

Connected 0:30:16    Auto detect    9600 8-N-1    SCROLL   CAPS   NUM   Capture
```

8. Other Considerations

8.1. Duty Cycle

When the NL6000 transmits data, it generates heat and the case gets warm. If the NL6000 is forced to transmit large amounts of data without a cooling-off period, damage due to excessive temperature can result.

There are two considerations: first, limit data transmission time so that the unit will not overheat. Second, limit the duty cycle of data transmission. When operated in still air, the limits in Table 4 apply.

Power Output	Temperature	Duty Cycle	Maximum Data Transmission
6W	25° C	30%	15 Seconds
6W	60° C	5%	5 Seconds
3W	25° C	50%	20 Seconds
3W	60° C	5%	5 Seconds
1W	25° C	75%	30 Seconds
1W	60° C	10%	5 Seconds

Table 4: Duty Cycle and Transmission Limits

The limits above can be increased significantly by placing heat sinks on the unit and/or cooling with forced air.

8.2. Troubleshooting

8.2.1. Use a Good Antenna

The antenna is the most important, but often ignored, part of the communication system. A good antenna system will increase range, increase throughput, and increase reliability. You can use directional gain antennas when operating in a point-to-point configuration.

8.2.2. Three-wire Interface

When using a three-wire RS232 interface (TX, TX, GND), you must disable RTS/CTS flow control. You may enable the XON/XOFF protocol if software flow control is required. Refer to Section 5.7.2.

8.2.3. Hardware Flow Control

Many programs disable the use of hardware data flow control signals. If this is the case, the RTS/CTS flow control must be disabled. To ensure that the NL6000's internal data buffers do not overflow, you may use the XON/XOFF flow control. Refer to section 5.7.2.

8.2.4. Use a Fully-Wired RS-232 Cable

Some RS-232 cables, especially those hand-made, may not have all of the flow control wires connected. If your application supports hardware flow control (RTS/CTS), then ensure that the cable connecting the NL6000 to the host device has all of the wires connected. Refer to section 4.3.

8.2.5. Use a Slower Baud Rate

If the input baud rate is higher than the over-the-air bit rate, long strings of data are going into the serial port, and flow control is not used, the NL6000 buffers may fill up and lose data. Lower the NL6000's baud rate and the host device baud rate to as slow as practical.

8.2.6. Use a Faster Baud Rate

If system time-outs, caused by a remote site not responding fast enough, are a problem, you may consider increasing the serial baud rate at both ends of the radio link. High baud rates along with hardware flow control should yield a fast, reliable system.

8.2.7. Unit Does Not Enter Programming Mode

If you forget what baud rate the NL6000 is set to, you will not be able to get into the programming mode with the …/// command without trying all baud rates on your terminal. Instead, if you enter three break characters within 10 seconds on the terminal, the modem goes into programming mode at 9600 baud. From this point you can reset the baud rate with the **Baud Rate** parameter on the Serial menu.

Make sure you use a cable that connects RTS and CTS from the modem to the computer, not just RX and TX. You need this cable connection before trying the three break characters that enter programming mode.

Appendix A – Diagnosing and Correcting Performance Problems

Factory technicians use the procedures in this section for initial modem alignment. After installation, a qualified electronic technician can use these procedures to diagnose and correct performance problems. Only an electronic technician with training in RF radio alignment should perform these procedures.

Always perform these procedures using calibrated test equipment. Use the following test equipment for these procedures:

- A calibrated service monitor (IFR) capable of generating and analyzing narrow- band FM signals in the frequency band of the radio being tested.

- DC power supply capable of supplying at least 1 amp of current at 10-12V DC.

- A computer terminal capable of 9600 Baud wired as a DTE.

- A cable to connect the modem antenna output to the connector on the IFR.

Setting the Power Value

1. Set the IFR to receive at the radio's transmit frequency.

2. From the terminal emulator, enter programming mode.

3. Select the active channel for the radio as follows:
   - Select **Radio** ä **Select Active Channel**.

   - Enter the active channel assignment for the radio. The value must be a number in the range 01 – 64.

   - Press **ESC** to return to the **Main Menu**.

4. Select **Diagnostics** ä **Transmit Continuous Random Data**.

5. Set the power value as follows:
   - Select **Power** from the **Diagnostics** menu.

   - While watching the power gauge, change the power value and check the gauge to see that the power value registers correctly. The value must be a number in the range 0 – 1023.

6. Select **None** from the **Diagnostics** menu to stop the data transmission.

Setting the Frequency Trim (includes setting Power)

The power setting affects the frequency trim in the NL6000, so part of setting the frequency trim is setting the power.

1. Set the IFR to receive at the radio's transmit frequency.

2. From the terminal emulator, enter programming mode.

3. Select the active channel for the radio as follows:
   - Select **Radio** ä **Select Active Channel**.

- Enter the active channel assignment for the radio. The value must be a number in the range 01 – 64.

- Press **ESC** to return to the **Main Menu**.

4. Select **Diagnostics** ä **Transmit Continuous Random Data**.

5. Set the power value as follows:
   - Select **Power** from the **Diagnostics** menu.

   - While watching the power gauge, change the power value and check the gauge to see that the power value registers correctly. The value must be a number in the range 0 – 1023.

   - Press **ESC** to return to the **Diagnostics** menu.

6. Set the frequency trim as follows:
   - Select **Frequency Trim** from the **Diagnostics** menu.

   - While watching the Frequency Error gauge on the IFR, change the frequency trim value on the **Frequency Trim** window until the needle on the gauge is centered.

7. Select **None** from the **Diagnostics** menu to stop the data transmission

Setting the Deviation and Balance

To properly set the deviation and balance, you must perform the following procedure twice – once near each "edge" of the transmit frequency band. In this procedure, an edge is defined as approximately 2.5 MHz from one end of the band range.

1. From the terminal emulator, enter programming mode.

2. Select one "edge" of the transmit frequency as follows:
   - Select **Radio** Ä **Transmit Frequency for Active Channel**.

   - Enter a frequency that is on one "edge" of the frequency for the active radio channel. The value must be a number in the format **nnn.nnnn**.

   - Press **ESC** to return to the **Main Menu**.

3. Set the IFR to receive at the transmit frequency you set in Step 2.

4. Select **Diagnostics** ä **Transmit 100 Hz Square Wave**.

5. Set the balance value as follows:
   - Select **Balance** from the **Diagnostics** menu.

   - While watching the square wave on the IFR, enter **1-Increase Balance 0.125 dB** or **2-Decrease Balance 0.125 dB** until the corners of the wave are at a 90 ˚ angle.
   - Press **ESC** to return to the **Diagnostics** menu.

6. Select **None** from the **Diagnostics** menu to stop the square wave.

7. Select **Transmit Continuous Random Data** from the **Diagnostics** menu.

8. Set the deviation value as follows:
   - Select **Deviation** from the **Diagnostics** menu.

   - While watching the deviation gauge on the IFR, enter **1-Increase Deviation 0.25 dB** or **2-Decrease Deviation 0.25 dB** until the deviation gauge measures 2.5 kHz for a low data rate or 4 kHz for a high data rate.

   - Press **Ctrl-A** or **Ctrl-B** to save the balance and deviation values as the first or second reference point.

   - Press **ESC** to return to the **Diagnostics** menu.

   - Select **None** from the **Diagnostics** menu to stop the data transmission.

10. Repeat Steps 1-7 for the opposite "edge."

Setting the Receive Gain

Use this procedure to set the receive packets at the best level for this modem.

1. From the terminal emulator, enter programming mode.

2. Enable the Receive Diagnostic Mode as follows:
   - Select **Diagnostics** ä **Receive Diagnostic Mode**.

   - Select **1-Enable**.

   - Press **ESC** twice to return to the **Main Menu**.

   - Select **Exit** to save the Receive Diagnostic Mode setting and enter operating mode.

3. Set up another modem to send data to the modem. The terminal emulator will display the receive level correction value. Make note of this value.

4. From the terminal emulator, enter programming mode.

5. Set the receive gain level as follows:
   - Select **Diagnostics** ä **Receive Gain**.

   - Enter the receive level correction value, using the **1-Increase Gain 0.25 dB** or **2-Decrease Gain 0.25 dB** options.

   - Press **ESC** twice to return to the **Main Menu**.

   - Select **Exit** to save the Receive Gain value and enter operating mode.

6. Repeat steps 3-5 to ensure the receive level remains near zero (±0.5 dB) after your correction.

7. Disable the Receive Diagnostic Mode as follows:
   - Select **Diagnostics** ä **Receive Diagnostic Mode**.

   - Select **2-Disable**.

- Press **ESC** twice to return to the **Main Menu**.

- Select **Exit** to save the Receive Diagnostic Mode setting and enter operating mode.

Appendix B - Factory Default Parameters

The following chart lists the default values set for each parameter at the factory. Use the last column to record any custom values you need to set.

Category	Parameter	Default Value	Custom Value
Radio	Unit Type	Remote	
	MYID	1234	
	TOID	FFFF	
	Active Channel	1	
	Rx Frequency on Active Channel	464.5500 MHz	
	Tx Frequency on Active Channel	464.5500 MHz	
Serial	Baud Rate	9600	
	Data Bits	8	
	Stop Bits	1	
	Transmit Character Timeout	100	
	Transmit Character Timeout	None	
	DCD Mode	Disabled	
	Pre-Data DCD Time	500 msec	
	Post-Data DCD Time	500 msec	
	Diagnostic Programming Mode	Disabled	
Data	Maximum Packet Size	300	
	Packet Mode	Enhanced Telem	
	Data Rate	12000 bps	
	ACKs	Disabled	
	Contention	CSMA	
Repeater Entry	Trigger	MYID	
	ID	0000	
	Transmit Channel	1	
	Transmit Delay (ms)	0	

Table 5: Factory Default Values

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