GUARDIAN™
HIGH SPEC RADIO MODEM

User Manual
PN 001-5006-000 Rev 0
Revised February 2010

REVISION HISTORY

REV	DATE	REVISION DETAILS
0	February 25, 2010	Initial Release as 001-5006-000.

IMPORTANT NOTICE

Because of the nature of wireless communication, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors), or be totally lost. Significant delays or losses of data are rare when wireless devices such as the Guardian are used in a normal manner with a well-constructed network. Guardian should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. CalAmp accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using Guardian, or for the failure of Guardian to transmit or receive such data.

RF EXPOSURE COMPLIANCE REQUIREMENTS

The Guardian radio is intended for use in the Industrial Monitoring and Control and SCADA markets. The Guardian unit must be professionally installed and must ensure a minimum separation distance listed in the table below between the radiating structure and any person. An antenna mounted on a pole or tower is the typical installation and in rare instances, a 1/2-wave whip antenna is used.

	Antenna Gain		
	5 dBi	**10 dBi**	**15 dBi**
Min Safety Distance (VHF @ max Power)	123cm	218.8cm	389cm
Min Safety Distance (UHF @ max Power)	105.7cm	188cm	334.4cm
Min Safety Distance (900 MHz @ max power)	63.8cm	115 cm	201.7 cm

Note: It is the responsibility of the user to guarantee compliance with the FCC MPE regulations when operating this device in a way other than described above.

The Guardian radio uses a low power radio frequency transmitter. The concentrated energy from an antenna may pose a health hazard. People should not be in front of the antenna when the transmitter is operating.

The installer of this equipment must ensure the antenna is located or pointed such that it does not emit an RF field in excess of Health Canada limits for the general population. Recommended safety guidelines for the human exposure to radio frequency electromagnetic energy are contained in the Canadian Safety Code 6 (available from Health Canada) and the Federal Communications Commission (FCC) Bulletin 65.

Any changes or modifications not expressly approved by the party responsible for compliance (in the country where used) could void the user's authority to operate the equipment.

REGULATORY CERTIFICATIONS

The Guardian radio is available in several different models each with unique frequency bands. Each model of Guardian may have different regulatory approval as shown in the table below.

Certifications					
Model Number	Frequency Range	FCC	IC (DOC)	European Union EN 300 113	Australia/New Zealand
140-5016-500	136 – 174 MHz	NP4-5016-500	773B-5016500		
140-5016-501	136 – 174 MHz	NP4-5016-500	773B-5016500		
140-5026-500	216 – 222 MHz	NP4-5026-500	773B-5026500		
140-5026-501	216 – 222 MHz	NP4-5026-500	773B-5026500		
140-5046-300	406 - 470 MHz	NP4-5046-500	773B-5046500		
140-5046-301	406 - 470 MHz	NP4-5046-500	773B-5046500		
140-5046-500	450 - 512 MHz	NP4-5046-500	773B-5046500		
140-5046-501	450 - 512 MHz	NP4-5046-500	773B-5046500		
140-5096-500	928 - 960 MHz	NP4-5096-500	773B-5096500		
140-5096-501	928 - 960 MHz	NP4-5096-500	773B-5096500		

UL Certification	
All models	UL approved when powered with a listed Class 2 source.

DECLARATION OF CONFORMITY FOR MODEL # 140-5046-400

This device (Guardian model #140-5046-400) is a data transceiver intended for commercial and industrial use in all EU and EFTA member states.

cs **Česky [Czech]**	CalAmp tímto prohlašuje, že tento rádio je ve shodě se základními požadavky a dalšími příslušnými ustanoveními směrnice 1999/5/ES.
da **Dansk [Danish]**	Undertegnede CalAmp erklærer herved, at følgende udstyr radio overholder de væsentlige krav og øvrige relevante krav i direktiv 1999/5/EF.
de **Deutsch [German]**	Hiermit erklärt CalAmp, dass sich das Gerät radio in Übereinstimmung mit den grundlegenden Anforderungen und den übrigen einschlägigen Bestimmungen der Richtlinie 1999/5/EG befindet.
et **Eesti [Estonian]**	Käesolevaga kinnitab CalAmp seadme raadio vastavust direktiivi 1999/5/EÜ põhinõuetele ja nimetatud direktiivist tulenevatele teistele asjakohastele sätetele.
en **English**	Hereby, CalAmp, declares that this radio is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.
es **Español [Spanish]**	Por medio de la presente CalAmp declara que el radio cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 1999/5/CE.
el **Ελληνική [Greek]**	ΜΕ ΤΗΝ ΠΑΡΟΥΣΑ CalAmp ΔΗΛΩΝΕΙ ΟΤΙ ΡΑΔΙΌΦΩΝΟ ΣΥΜΜΟΡΦΩΝΕΤΑΙ ΠΡΟΣ ΤΙΣ ΟΥΣΙΩΔΕΙΣ ΑΠΑΙΤΗΣΕΙΣ ΚΑΙ ΤΙΣ ΛΟΙΠΕΣ ΣΧΕΤΙΚΕΣ ΔΙΑΤΑΞΕΙΣ ΤΗΣ ΟΔΗΓΙΑΣ 1999/5/ΕΚ.
fr **Français [French]**	Par la présente CalAmp déclare que l'appareil radio est conforme aux exigences essentielles et aux autres dispositions pertinentes de la directive 1999/5/CE.
it **Italiano [Italian]**	Con la presente CalAmp dichiara che questo radio è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 1999/5/CE.
Latviski [Latvian]	Ar šo CalAmp deklarē, ka radio atbilst Direktīvas 1999/5/EK būtiskajām prasībām un citiem ar to saistītajiem noteikumiem.
Lietuvių	Šiuo CalAmp deklaruoja, kad šis radijo atitinka esminius reikalavimus ir kitas 1999/5/EB

[Lithuanian]	Direktyvos nuostatas.
Nederlands [Dutch]	Hierbij verklaart CalAmp dat het toestel radio in overeenstemming is met de essentiële eisen en de andere relevante bepalingen van richtlijn 1999/5/EG.
Malti [Maltese]	Hawnhekk, CalAmp , jiddikjara li dan tar-radju jikkonforma mal-ħtiġijiet essenzjali u ma provvedimenti oħrajn relevanti li hemm fid-Dirrettiva 1999/5/EC.
Magyar [Hungarian]	Alulírott, CalAmp nyilatkozom, hogy a rádió megfelel a vonatkozó alapvetõ követelményeknek és az 1999/5/EC irányelv egyéb elõírásainak.
Polski [Polish]	Niniejszym CalAmp oświadcza, że radio jest zgodny z zasadniczymi wymogami oraz pozostałymi stosownymi postanowieniami Dyrektywy 1999/5/EC.
Português [Portuguese]	CalAmp declara que este rádio está conforme com os requisitos essenciais e outras disposições da Directiva 1999/5/CE.
Slovensko [Slovenian]	CalAmp izjavlja, da je ta radio v skladu z bistvenimi zahtevami in ostalimi relevantnimi določili direktive 1999/5/ES.
Slovensky [Slovak]	CalAmp týmto vyhlasuje, že rádio spĺňa základné požiadavky a všetky príslušné ustanovenia Smernice 1999/5/ES.
Suomi [Finnish]	CalAmp vakuuttaa täten että radio tyyppinen laite on direktiivin 1999/5/EY oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen.
Svenska [Swedish]	Härmed intygar CalAmp att denna radio står I överensstämmelse med de väsentliga egenskapskrav och övriga relevanta bestämmelser som framgår av direktiv 1999/5/EG.
Íslenska [Icelandic]	Hér með lýsir CalAmp yfir því að útvarp er í samræmi við grunnkröfur og aðrar kröfur, sem gerðar eru í tilskipun 1999/5/EC.
Norsk [Norwegian]	CalAmp erklærer herved at utstyret radio er i samsvar med de grunnleggende krav og øvrige relevante krav i direktiv 1999/5/EF.

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1 GUARDIAN OVERVIEW

This document provides information required for the operation and verification of the CalAmp Guardian Narrowband Modem.

1.1 GENERAL DESCRIPTION

This DSP-based radio was designed for SCADA, telemetry and industrial applications in the 136-174 MHz, 215-240 MHz VHF, 406.1-512 MHz UHF, and 928-960 MHz frequency ranges.

Guardian supports serial Remote Terminal Units (RTU) and programmable logic controllers (PLC). The Guardian is compatible with any Dataradio Interoperability Standard (DI-OS) equipment and Bell 202/212 interface.

1.2 OPERATIONAL CHARACTERISTICS

The Guardian product has the following operational characteristics:

- Frequency range of 136-174 MHz, 215-240 MHz, 406.1-470 MHz, 450-512 MHz, or 928-960 MHz.

- User-selectable data rates

- Built-in transceiver adjustable from 1 to 10 watts (8 watts max for 900MHz)

- Wide input power range of 10 to 30 volts DC

- Online and Offline Diagnostics

- Supports up to 8 different frequency channel pairs (selectable through user interface port).

- Industrial operating temperature range of -30 to +60 C

- Rugged die-cast aluminum and steel case

These features provide system benefits that give users:

Rugged Packaging. Guardian is housed in a compact and rugged cast aluminum case. Built for industrial applications in a variety of environments, Guardian operates over an extended temperature range and provides worry-free operation in the roughest environments.

Simple Installation. Basic installation typically utilizes an omni-directional antenna at the master station or Relay Point and a directional antenna at each remote site not a Relay Point. See Section 2 for information on Site and Antenna Selection. For basic service, just hook up an antenna, apply primary power, check and set a few operating parameters and you are done.

Flexible Management. Configuration, commissioning, maintenance and troubleshooting can be done locally or remotely. There are no physical switches or adjustments. The Dual-Port Guardian provides a receive antenna connector allowing for unique customer applications requiring additional receive filtering, external PA(s), and other options.

Long Range. Narrowband configurations allow better coverage over harsh terrain.

1.3   PHYSICAL DESCRIPTION

Guardian consists of two logic PCBs, one that includes the modem circuitry and the other the radio module. Both are installed in a cast aluminum case. The unit is not hermetically sealed and should be mounted in a suitable enclosure when dust, moisture, and/or a corrosive atmosphere are anticipated.

The Guardian is designed for easy installation and configuration; the Guardian features no external or internal switches or adjustments. All operating parameters are set via the setup port.

1.3.1   FRONT PANEL

The front panel has the following connections:

- (1) 8-Pin user interface block connector

- (1) 50-ohm TNC female Antenna connector

- (1) 50-ohm SMA female receive antenna connector (Dual-Port models only)

- (1) Right-angle power connector (10-30 VDC)

- (2) DE-9F RS-232 ports

- For Dual-port Guardian connections, see Section 1.3.6.

1.3.2   LED PANEL

The LED panel has five Tri-Color LEDs. The functionality of each LED is shown in Table 1.1.

Table 1.1 Guardian LED Functionality

LED	Color	Definition
Power	Green	Guardian ready, normal operations
	Amber (Solid or Blinking)	Guardian is Programming
	Red	Guardian hardware fault
Status	Green	Guardian no faults, normal operations
	Red	Guardian has a fault condition, check unit status
	Amber (Solid or Blinking)	Guardian detects high background noise
Rx	Green	Receiving data
	Off	
Tx	Red	Transmitting data
	Blinking Amber	The unit wants to transmit, but is inhibited.
	Off	
Rd/Td	Green	Receive data is being sent out of the port
	Red	Transmit data is being received by the port

1.3.3   USER INTERFACE PORT

The user interface port is an 8 pin block receptacle, programmable to work with 1.8V to 5V levels. Table 1.2 shows pin-out descriptions for the RJ-45 port.

Table 1.2 Pin-out for User Interface Port Contacts

Contact	10 Base-T Signal
1	Tx Audio In
2	Rx Audio Out
3	PTT
4	RSSI Out
5	Ground
6	Channel Select 1
7	Channel Select 2
8	Channel Select 3

1.3.4   SETUP AND COM PORTS

The SETUP and COM serial connections are DE-9F RS-232 ports.

Serial port considerations:

- Guardian radio modem SETUP and COM ports are Data Communication Equipment (DCE) devices

- In general, equipment connected to the Guardian's SETUP / COM serial port is Data Terminal Equipment (DTE) and a straight-through cable is recommended.

  Note: If a DCE device is connected to the Guardian SETUP / COM port, a null modem cable/adapter is required.

The pin-out for the SETUP and COM ports are shown in Table 1.3.

Table 1.3 Pin-out for DCE SETUP and COM port, 9 Contact DE-9 Connector

Contact	EIA-232F Function	Signal Direction
1	DCD[1]	DTE ← DCE
2	RXD	DTE ← DCE
3	TXD	DTE → DCE
4	DTR	DTE → DCE
5	GND	DTE --- DCE
6	DSR[2]	DTE ← DCE
7	RTS[1]	DTE → DCE
8	CTS[1]	DTE ← DCE
9	RING [3]	DTE --- DCE
(1) Programmable.		
(2) Always asserted		
(3) For future use		

The DCD, DTR, RTS and CTS control lines are programmable. Refer to section 6.4 for serial port control line configurations.

1.3.5   POWER CONNECTOR

The Guardian is supplied with a right-angle power connector (10-30 VDC). Table 1.4 shows the pin-out of the power connector.

Table 1.4 Pin-out of the power connector

Contact # (Left to Right)	Color	Description
4		Fan Power Output (5V)
3	Black	Ground
2	Red	Positive (10-30) VDC
1	White	Enable

Note: The White Enable line must be tied to the red positive lead of the connector for the Guardian to function.

1.3.6 ANTENNA CONNECTOR

The standard Guardian has a 50-ohm TNC female antenna connector. This connection functions for both transmit and receive.

The Dual-Port Guardian has a 50-ohm TNC female antenna connector functioning for transmit (only) and a 50-ohm SMA female antenna connector functioning for receive (only). The separate receive antenna connector allows for unique customer applications that require additional receive filtering, external PA(s) and other options.

Warning: The transmit antenna port must not be connected directly to the receive antenna port of the Dual-Port Guardian. Excessive power into the receive antenna port will damage the radio. Input power to the receiver should not exceed 17 dBm (50mW).

To reduce potential interference, the antenna type and its gain should be chosen to ensure the effective isotropic radiated power (EIRP) is not more than required for successful communication.

1.3.7 CHASSIS DIMENSIONS

Figure 1.2 shows the dimensions of the Guardian Chassis and mounting plate.
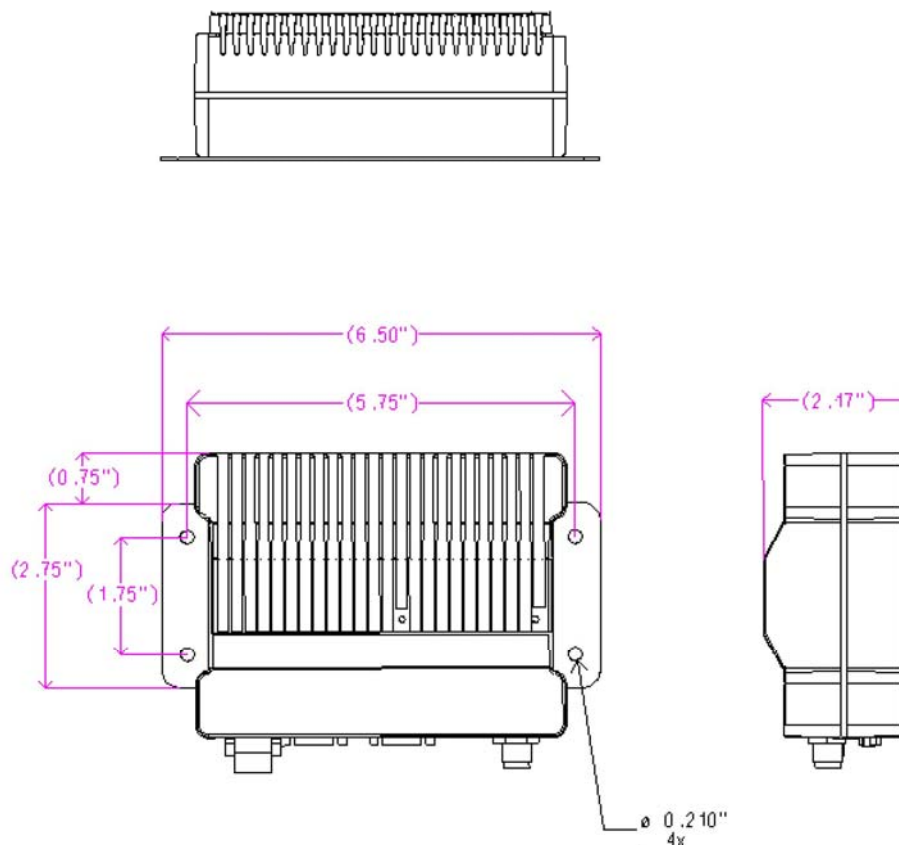
1.4   PART NUMBERS AND AVAILABILITY

1.4.1   GUARDIAN RADIO

Table 1.5 provides a breakdown of the Guardian part number 140-50X6-Y0Z.

Table 1.5 - Part Number Breakdown

Model Number	Description	Frequency Range
140-5016-500	Standard VHF Guardian	136 - 174 MHz
140-5026-502	Standard VHF Guardian-200	215 - 240 MHz
140-5046-300	Standard UHF Guardian Range 3	406.1 - 470 MHz
140-5046-500	Standard UHF Guardian Range 5	450 - 512 MHz
140-5096-500	Standard 900MHz Guardian	928 - 960 MHz
140-5016-501	Dual Port VHF Guardian	136 - 174 MHz
140-5026-503	Dual Port VHF Guardian-200	215 - 240 MHz
140-5046-301	Dual Port UHF Guardian Range 3	406.1 - 470 MHz
140-5046-501	Dual Port UHF Guardian Range 5	450 - 512 MHz
140-5096-501	Dual Port 900MHz Guardian	928 - 960 MHz

1.4.2   ACCESSORIES AND OPTIONS

Tables 1.6-1.8 list standard accessories (including antenna, feedline, and connectors) tested and approved for use with the Guardian.

Table 1.6 - Accessories

ITEM	PART NUMBER
Guardian Power Cable	897-5008-010
Guardian Demo Kit* – VHF - 136-174 MHz	250-5016-500
Guardian Demo Kit* – VHF 200 - 215-240 MHz	250-5026-502
Guardian Demo Kit* – UHF - 406-470 MHz	250-5046-300
Guardian Demo Kit* – UHF - 450-512 MHz	250-5046-500
Guardian Demo Kit* – 900 - 928-960 MHz	250-5096-500
Factory Installed Guardian Fan Kit	150-5008-001
Field Installed Guardian Fan Kit**	150-5008-002
TNC-Male to N-Male 18"	250-0697-103
TNC-Male to N-Male 48"	250-0697-104
TNC-Male to N-Male 72"	250-0697-105
TNC-Male to N-Female 18"	250-0697-106

The Guardian Demo Kit includes two of each of the following: Guardian, rubber duck antennas, adapters, attenuators, power cables, and power supplies.

** The field install Fan Kit is available for all VHF 200/UHF/900 Guardians (140-5026-XXX/140-5046-xxx/140-5096-xxx) but is only available for VHF models-(140-5016-xxx) with RF revision 0.3 or greater (shipping Fall 2008). Contact CalAmp Technical Support for more information.

Table 1.7 Antenna Kits

ITEM	PART NUMBER
Antenna Kit*: 138-143 MHz 6.5 dBd	250-0211-007
Antenna Kit*: 138-143 MHz 9.5 dBd	250-0211-010
Antenna Kit*: 143-148 MHz 6.5 dBd	250-0211-107
Antenna Kit*: 143-138 MHz 9.5 dBd	250-0211-110
Antenna Kit*: 148-152 MHz 6.5 dBd	250-0211-207
Antenna Kit*: 148-152 MHz 9.5 dBd	250-0211-210
Antenna Kit*: 152-157 MHz 6.5 dBd	250-0211-307
Antenna Kit*: 152-157 MHz 9.5 dBd	250-0211-310
Antenna Kit*: 157-163 MHz 6.5 dBd	250-0211-407
Antenna Kit*: 157-163 MHz 9.5 dBd	250-0211-410
Antenna Kit*: 163-169 MHz 6.5 dBd	250-0211-507
Antenna Kit*: 163-169 MHz 9.5 dBd	250-0211-510
Antenna Kit*: 169-174 MHz 6.5 dBd	250-0211-607
Antenna Kit*: 169-174 MHz 9.5 dBd	250-0211-610
Antenna Kit*: 216-222 MHz 6.5 dBd	250-0221-007
Antenna Kit*: 216-222 MHz 9.5 dBd	250-0221-010
Antenna Kit*: 450-470 MHz, 7 dBd	250-0241-507
Antenna Kit*: 450-470 MHz, 10 dBd	250-0241-510
Antenna Kit*: 890-960 MHz, 6.4 dBd	250-5099-011
Antenna Kit*: 890-960 MHz, 10 dBd	250-5099-021

*Kits include premium antenna, mounting bracket, surge protector, grounding kit, cable ties, 18" TNC male to N-male jumper cable and weather kit. UHF/900 kits include 25 feet of LMR400 antenna feedline. Feedline is available for VHF kits in 25 or 50 feet lengths.

Table 1.8 - Feedline and Connectors

ITEM	PART NUMBER
25 feet antenna feedline (LMR400), N-Male	250-0200-025
50 feet antenna feedline (LMR400), N-Male	250-0200-055
Barrel Connector, RF1 N type, Female	250-0200-100

1.5   PRODUCT WARRANTY

It is our guarantee that every Guardian Radio modem will be free from physical defects in material and workmanship for TWO YEARS from the date of purchase when used within the limits set forth in Appendix A: Specifications.

The manufacturer's warranty statement is available in Appendix B. If the product proves defective during the warranty period, contact our Customer Service Department to obtain a Return Material Authorization (RMA). BE SURE TO HAVE THE EQUIPMENT MODEL, SERIAL NUMBER, AND BILLING & SHIPPING ADDRESSES AVAILABLE WHEN CALLING. You may also request an RMA online at www.calamp.com/component/option,com_rma/

FACTORY AND TECHNICAL SUPPORT

M-F 7:30-4:30 CST

CalAmp Wireless DataCom

299 Johnson Ave., Ste 110, Waseca, MN 56093

Tel 507.833.8819; Fax 507.833.6758

Email imcsupport@calamp.com

1.6   RMA REQUEST

When returning a product, mark the RMA clearly on the outside of the package. Include a complete description of the problem and the name and telephone number of a contact person. RETURN REQUESTS WILL NOT BE PROCESSED WITHOUT THIS INFORMATION.

Contact Customer Service:

299 Johnson Ave., Ste 110

Waseca, MN 56093

Tel 1.507.833.8819

BE SURE TO HAVE THE EQUIPMENT MODEL AND SERIAL NUMBER, AND BILLING AND SHIPPING ADDRESSES ON HAND WHEN CALLING.

For units in warranty, customers are responsible for shipping charges to CalAmp Wireless DataCom. For units returned out of warranty, customers are responsible for all shipping charges. Return shipping instructions are the responsibility of the customer.

1.7   DOCUMENTATION AND DOWNLOADS

CalAmp reserves the right to update its products, software, or documentation without obligation to notify any individual or entity. Product updates may result in differences between the information provided in this manual and the product shipped. For access to the most current product documentation and application notes, visit www.calamp.com/home/download_library.html

2 SYSTEM ARCHITECTURE AND NETWORK PLANNING

This section briefly discusses network architecture (including basic network types), interfacing modems and DTE, data protocols for efficient channel operation, addressing, and repeaters.

Guardian is designed to replace wire lines in SCADA, telemetry and control applications. The RS-232 serial port allows direct connection to Programmable Logic Controllers (PLCs) or Remote Terminal Units (RTUs). A SCADA system is defined as one or more centralized control sites used to monitor and control remote field devices over wide areas. For example, a regional utility may monitor and control networks over an entire metropolitan area. Industry sectors with SCADA systems include energy utilities, water and wastewater utilities, and environmental groups.

The Guardian is intended for use in the Industrial Monitoring and SCADA market. The range of the Guardian is dependent on terrain, RF (radio frequency) path obstacles, and antenna system design. This section provides tips for selecting an appropriate site, choosing an antenna system, and reducing the chance of harmful interference.

2.1 SINGLE COVERAGE AREA

In a network topology with only a single coverage area (all units can talk to one another directly), there are several common system configurations.

The most common is for one unit to be designated as a master and the rest designated as remotes. Another system configuration is Report-by-Exception.

2.2 NETWORK ARCHITECTURE

2.2.1 POINT-TO-POINT

A point-to-point network is the most simple of all networks, and may be used for connecting a pair of PC's, a host computer and a terminal, a SCADA polling master and one remote, mobile applications (like in-vehicle GPS receivers and base stations) or a wide variety of other networking applications.

Figure 2.1 – Point-to-Point Network
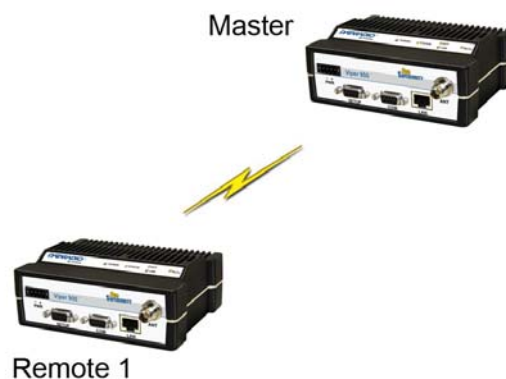
2.2.2 POINT-TO-MULTIPOINT

A Point-to-Multipoint network is a common network type used in SCADA or other polling systems. The single polling master station communicates with any number of remotes and controls the network by issuing polls and waiting for remote responses. Individual PLC/RTU remotes manage addressing and respond when their individual addresses are queried. PLC/RTU unit addresses are maintained in a scanning list stored in the host program or master terminal device at the SCADA host site. Communications equipment is transparent and does not interact with specific remotes; all data is coupled to the host on a single data line (such a network is commonly used with synchronous radio modems and asynchronous radio modems).

Figure 2.2 – Point to Multipoint Network
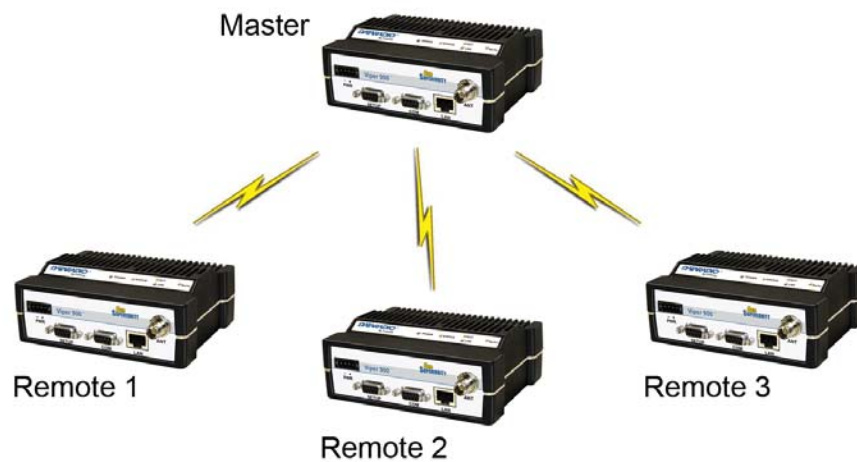
2.2.3 MULTIPLE POINT-TO-POINT

A multiple point-to-point is similar to the point-to-multipoint system except the SCADA host has multiple serial ports that are directed to different geographic areas in the SCADA system.

2.2.4 PEER-TO-PEER

A Peer-to-Peer network is generally used for device to device communications among a number of stations. This network requires full addressing capability on the part of the data equipment (DTE). If the distances involved for any link or links are too great for a single radio hop, they can be extended by means of repeaters without affecting the basic network design.

2.2.5 STORE AND FORWARD

Store and Forward is a common technique where a data transmission is sent from one device to a receiving device but first passes through a relaying device. The device is typically an RTU or PLC used by the message service to store the received message then it transmits the message to the intended recipient.

2.2.6 NETWORK USING A T-BASE

The Network Using a T-Base configuration has the following characteristics:

- Master station may be full duplex (duplexer required), half duplex, or simplex

- Online diagnostics are available using the Online Diagnostics utility without disrupting network activity

- Remote / local diagnostics and statistics / control are available using the Guardian Offline Diagnostics utility when connected to the Tx module (not Diag Port of T-Base)

- The T-Base provides output of Online Diagnostic information which can be processed by the Guardian Online Diagnostics utility or by a user-supplied network management program. Contact your sales representative for further information.

2.2.7 NETWORK USING A T-BASE REPEATER

The Network Using a T-Base Repeater has the following characteristics:

- Master station and all remotes must be half duplex

- Networks described in Section 1.10.2, 1.10.3, or 1.10.5 may be used with a T-Base repeater

- The RTS/CTS delays for each GUARDIAN in the system must be extended as shown in Table 2-6, RTS/CTS Delays

2.2.8 NETWORK USING A GUARDIAN FOR ONLINE DIAGNOSTICS

The Network Using a Guardian for Online Diagnostics configuration has the following characteristics:

- Master station may be half duplex or simplex

- Accumulated online diagnostics for a maximum of 15 stations are available at a monitoring site (monitoring site must be in range of all remotes)

- Online Diagnostics are available in real time at the monitoring site

- Remote Offline Diagnostics, statistics, and control are available from the monitoring site by temporarily disabling network activity (best if using a Master Station Antenna System)

Online Diagnostics are accumulated in the monitoring Guardian for the last 15 stations heard. This information may be viewed using the Online Diagnostics utility. For larger networks, the Guardian can output raw diagnostic data only which may be interpreted for network management by the Calamp Field Programming Software Online Diagnostics utility or by a user-supplied software program. Contact your sales representatives for more information.

2.3 EXTENDING THE COVERAGE AREA WITH A RELAY POINT

The Guardian has a Relay Point feature that allows a unit to relay data from one RF coverage area to another RF coverage area. When units are spread over two or more coverage areas, the user must identify the devices forming the backbone between coverage areas so any unit can talk to any other regardless of their locations. There can be multiple Relay Points in the system extending the coverage over several hops.

Figure 2.3 - Two Coverage Areas
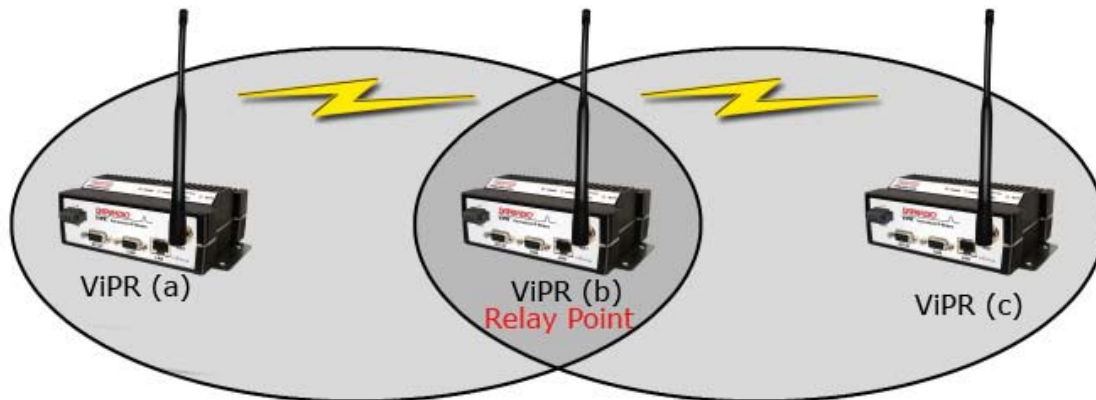
The unit forming the backbone between the coverage areas must be configured to repeat all necessary information from one coverage area to the next. This unit must have the Relay Point parameter enabled (See Section 6.1).

2.3.1 UNDERSTANDING RF PATH REQUIREMENTS

Radio waves are propagated when electrical energy produced by a radio transmitter is converted into magnetic energy by an antenna. Magnetic waves travel through space. The receiving antenna intercepts a very small amount of this magnetic energy and converts it back into electrical energy that is amplified by the radio receiver. The energy received by the receiver is called the Received Signal Strength Indication (RSSI) and is measured in dBm.

A radio modem requires a minimum amount of received RF signal to operate reliably and provide adequate data throughput. This is the radio's receiver sensitivity. In most cases, spectrum regulators will define or limit the amount of signal that can be transmitted and it will be noted on the FCC license. This is the effective isotropic radiated power (EIRP). Transmitted power decays with distance and other factors as it moves away from the transmitting antenna.

2.4   SITE SELECTION AND SITE SURVEY

2.4.1   SITE SELECTION

For a successful installation, careful thought must be given to selecting the site for each radio. Suitable sites should provide the following:

- Protection from direct weather exposure

- A source of adequate and stable primary power

- Suitable entrances for antenna, interface, or other cabling

- Antenna location with an unobstructed transmission path to all remote radios in the system

These requirements can be quickly determined in most cases.

2.4.2   SITE SURVEY

A Site Survey is an RF propagation study of the RF path between two points or between one point and multiple points. UHF radio signals travel primarily by line of sight and obstructions between the sending and receiving stations will affect system performance. Signal propagation is also affected by attenuation from obstructions such as terrain, foliage, or buildings in the transmission path. A Site Survey is recommended for most projects to determine the optimal RF paths for each link. This is especially true when more than one RF coverage area is required. A Site Survey will determine the best unit location for the Relay Points.

2.5   SELECTING ANTENNA AND FEEDLINE

The Guardian can be used with a variety of antenna types. The exact style used depends on the physical size and layout of a system. The Guardian device has been tested and approved with antennas having a maximum gain of 10 dBi.

2.5.1   ANTENNA GAIN

Antenna gain is usually measured in comparison to a dipole. A dipole acts much like the filament of a flashlight bulb: it radiates energy in almost all directions. One bulb like this would provide very dim room lighting. Add a reflector capable of concentrating all the energy into a narrow angle of radiation and you have a flashlight. Within that bright spot on the wall, the light might be a thousand times greater than it would be without the reflector. The resulting bulb-reflector combination has a gain of 1000, or 30 dB, compared to the bulb alone. Gain can be achieved by concentrating the energy both vertically and horizontally, as in the case of the flashlight and Yagi antenna. Gain can be also be achieved by reducing the vertical angle of radiation, leaving the horizontal alone. In this case, the antenna will radiate equally in all horizontal directions, but will take energy that otherwise would have gone skywards and use it to increase the horizontal radiation.

The required antenna impedance is 50 ohms. To reduce potential radio interference, the antenna type and its gain should be chosen to ensure the effective isotropic radiated power (EIRP) is not more than required for successful communication.

See Table 1.7 for a list of tested antenna recommendations. These antennas are FCC approved for use with the Guardian. Similar antenna types from other manufacturers are equally acceptable. It is important to follow the manufacturer's recommended installation procedures and instructions when mounting any antenna.

2.5.2   OMNI DIRECTIONAL ANTENNA

In general, an omni directional antenna should be used at a master station and Relay Points. This allows equal coverage to all of the remote locations. Omni directional antennas are designed to radiate the RF signal in a 360-degree pattern around the antenna. Short range antennas such as folded dipoles and ground independent whips are used to radiate the signal in a ball shaped pattern while high gain omni antennas, such as a collinear antenna, compress the RF radiation sphere into the horizontal plane to provide a relatively flat disc shaped pattern that travels further because more of the energy is radiated in the horizontal plane.

2.5.3   YAGI ANTENNA

At remote locations (not used as a Relay Point), a directional Yagi is generally recommended to minimize interference to and from other users.

2.5.4   VERTICAL DIPOLES

Vertical dipoles are very often mounted in pairs, or sometimes groups of 3 or 4, to achieve even coverage and to increase gain. The vertical collinear antenna usually consists of several elements stacked one above the other to achieve similar results.

Figure 2.4 - Antenna Types

Omni (Vertical Collinear)	Yagi	Vertical Dipole

2.5.5   FEEDLINE

The choice of feedline should be carefully considered. Poor quality coaxial cables should be avoided, as they will degrade system performance for both transmission and reception. The cable should be kept as short as possible to minimize signal loss. See Table 2.1 for a list of feedline recommendations.

Table 2.1 - Transmission Loss (per 100 Feet)

	Frequency Range		
Cable Type	VHF	UHF	900 MHz
LMR-400	1.5 dB	2.7 dB	3.9 dB
1/2" Heliax	0.68 dB	1.51 dB	2.09 dB
7/8" Heliax	0.37 dB	0.83 dB	1.18 dB
1 5/8" Heliax	0.22 dB	0.51 dB	0.69 dB

Outside cable connections should have a weather kit applied to each connection to prevent moisture. Feedline connections should be routinely inspected to minimize signal loss through the connection. A 3 dB loss in signal strength due to cable loss and/or bad connections represents a 50% reduction in signal strength.

2.5.6   RF EXPOSURE COMPLIANCE REQUIREMENTS

The Guardian radio is intended for use in the Industrial Monitoring and Control and SCADA markets. The Guardian unit must be professionally installed and must ensure a minimum separation distance listed in the table below between the radiating structure and any person. An antenna mounted on a pole or tower is the typical installation and in rare instances, a 1/2-wave whip antenna is used.

Table 2.2 – RF Exposure Compliance Minimum Safety Distances

	Antenna Gain		
	5 dBi	10 dBi	15 dBi
Min Safety Distance (VHF @ max power)	123cm	218.8cm	389cm
Min Safety Distance (UHF @ max power)	105.7cm	188cm	334.4cm
Min Safety Distance (900 MHz @ max power)	63.8cm	115 cm	201.7 cm

Note: It is the responsibility of the user to guarantee compliance with the FCC MPE regulations when operating this device in a way other than described above.

The Guardian radio uses a low power radio frequency transmitter. The concentrated energy from an antenna may pose a health hazard. People should not be in front of the antenna when the transmitter is operating.

The installer of this equipment must ensure the antenna is located or pointed such that it does not emit an RF field in excess of Health Canada limits for the general population. Recommended safety guidelines for the human exposure to radio frequency electromagnetic energy are contained in the Canadian Safety Code 6 (available from Health Canada) and the Federal Communications Commission (FCC) Bulletin 65.

Any changes or modifications not expressly approved by the party responsible for compliance (in the country where used) could void the user's authority to operate the equipment.

2.6   TERRAIN AND SIGNAL STRENGTH

A line of sight path between stations is highly desirable and provides the most reliable communications link in all cases. A line of sight path can often be achieved by mounting each station antenna on a tower or other elevated structure that raises it high enough to clear surrounding terrain and other obstructions.

The requirement for a clear transmission path depends on the distance to be covered by the system. If the system is to cover a limited distance, say 3-5 miles, then some obstructions in the transmission path may be tolerable. For longer-range systems, any obstruction could compromise the performance of the system, or block transmission entirely.

The signal strength (RSSI) at the receiver must exceed the receiver sensitivity by an amount known as the fade margin to provide reliable operation under various conditions. Fade margin (expressed in dB) is the maximum tolerable reduction in received signal strength, which still provides an acceptable signal quality. This compensates for reduced signal strength due to multi-path, slight antenna movement or changing atmospheric losses. CalAmp recommends a 30 dB fade margin for most projects.

Table 2.3 shows the RSSI versus Reliability.Table 2.3 RSSI Reliability

RSSI	Reliability
-100 dBm	Approximately 50% reliability. Fading may cause frequent data loss.
-90 dBm	Approximately 90% reliability. Fading will cause occasional data loss.
-80 dBm	Approximately 99% reliability. Reasonable tolerance to most fading.
-70 dBm	Approximately 99.9% reliability with high tolerance to fading.

2.7   RADIO INTERFERENCE

Interference is possible in any radio system. However, since the Guardian is designed for use in a licensed system, interference is less likely because geographic location and existing operating frequencies are normally taken into account when allocating frequencies.

The risk of interference can be further reduced through prudent system design and configuration. Allow adequate separation between frequencies and radio systems. Keep the following points in mind when setting up your radio system.

   a.   Systems installed in lightly populated areas are least likely to encounter interference, while those in urban and suburban areas are more likely to be affected by other devices.

b. Directional antennas should be used at the remote end of the link. They confine the transmission and reception pattern to a comparatively narrow beam, which minimizes interference to and from stations located outside the pattern.

c. If interference is suspected from another system, it may be helpful to use antenna polarization opposite to the interfering system's antennas. An additional 20 dB (or more) of attenuation to interference can be achieved by using opposite antenna polarization.

d. Check with your CalAmp sales representative or CalAmp Technical Services for additional options. The Technical Services group has qualified personnel to help resolve your RF issues.

3 SETUP AND CONFIGURATION

It is easy to set up a Guardian network to verify basic unit operation and experiment with network designs and configurations.

3.1 INSTALL THE ANTENNA

An RX/TX antenna is required for basic operation. For demo units only, connect the antenna as shown in Figure 3.1 to provide stable radio communications between demo devices.

Figure 3.1 -Demo Antenna Assembly

20 dB, 5 watt max. attenuator
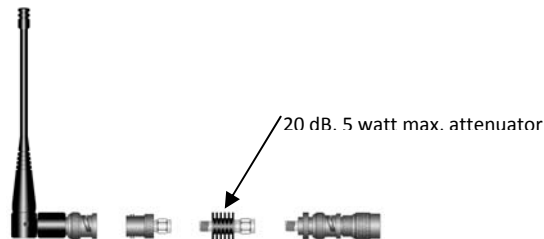
Note:

It is important to use attenuation between all demo units in the test network to reduce the amount of signal strength in the test environment.

3.2 MEASURE AND CONNECT PRIMARY POWER

Primary power for the Guardian must be within 10-30 VDC and be capable of providing a minimum of 10 watt supply for Tx @ 1W, 40 watt supply for Tx @ 5W, or 60 watt supply for Tx @ 10 W. (In Guardian Demo Kits, a power connector with screw-terminals is provided with each unit.) Observe proper polarity when connecting the cables to the Power Supply. (White wire must be connected to red wire.)

3.3 CONNECT GUARDIAN TO PROGRAMMING PC

Connection to a Guardian is established through an RS-232 cable connected to the setup port of the Guardian and the COM port of the PC

3.4 GUARDIAN FIELD PROGRAMMING SOFTWARE

Operating characteristics of the Guardian are configured by the Field Programming Software. Offline Diagnostics and Online Diagnostics give access to Offline Diagnostics and commands (local and remote) and online diagnostics monitoring (with or without a T-Base/R). Programming software is Windows® based and requires a Windows 95 or better operating system. Context sensitive help and printable help files are provided with this program.

The GUARDIAN requires the use of the Field Programming Software for configuration, adjustment and diagnostics.

4 UNIT STATUS

The Unit Status windows display device General and Diagnostic information.

4.1 UNIT IDENTIFICATION AND STATUS

Each Guardian has addressing capability which is used for diagnostics and remote commands **only**.

4.1.1.1 ID NUMBER

This value (maximum 1023) is assigned at the factory but may be modified using the Field Programming Software. The ID Number is used to uniquely identify the Guardian for remote commands and Offline Diagnostics. The ID Number may have values within the range of 1 to 4294967295 but **multiples of 1024 should not be used**

4.1.1.2 SHORT ID

This value (maximum 1023) is the low order 10 bits of the ID Number. It is used to identify online diagnostics only. It may not be modified directly using the Field Programming Software; it is always derived from the ID Number. All units within a network should have unique Short ID numbers to avoid ambiguity in Online Diagnostics reports.

The Guardian Field Programming Software may be used to check the value of the Short ID. When setting up a network, we recommend checking each unit to make sure there is no duplication of Short ID numbers. Duplications may be resolved by changing the Short ID Number.

If ID Numbers are set within the range of 1 to 1023, the ID Number and the Short ID will always have the same value (see Table 1-4).

4.2 DIAGNOSTICS

Guardian units continually monitor and report on their environmental and operating conditions.

4.2.1 ONLINE DIAGNOSTICS

Information is automatically sent by each unit at the beginning of every transmission.

May be disabled for back compatibility with Dataradio T-Modem 96 or Motorola RNet 9600. Online Diagnostics (statistics) require the use of a network configuration such as that specified in the "Network Using T-Base" or "Network Using GUARDIAN for Online Diagnostics" sections. Online diagnostics do not interfere with normal network operation. Online diagnostics provide four types of information:

- DC Input Voltage

- Transceiver Temperature

- PA Forward Power

- PA Reverse Power

4.2.2   OFFLINE DIAGNOSTICS

Offline diagnostics are statistics returned in response to a specific request to a particular station. The use of this feature requires temporary suspension of user network operation. Offline diagnostics provide information that is displayed via the Offline Diagnostics utility. Offline Diagnostics gather and displays five types of information:

- Supply Voltage

- Analog supply voltage

- Internal temperature

- Received signal strength (in dBm)

- Forward and reverse power in watts

- Preamble good & total

- Preamble DCD

4.2.3   REMOTE COMMANDS

Remote commands that may be sent using the Offline Diagnostics utility include:

- Get parameters (configuration) from remote unit

- Sample network statistics (monitoring online diagnostics)

- Get statistics (diagnostics)

5 GUARDIAN FIELD PROGRAMMING SOFTWARE

5.1 INTRODUCTION

The Guardian Field Programming Software provides programming and diagnostics for the Guardian wireless modem. The Field Programming Software allows the user to edit and program user programmable settings, interactively tune modem and RF parameters, and monitor diagnostic data from the Guardian. See Figure 5-1 for the Guardian Field Programming Software startup screen.

Figure 5.1 - Guardian Field Programming Software startup screen

This manual assumes the Field Programming Software has been installed on the user's PC with at least one operational serial COM Port available.

5.1.1 COM PORT SETTINGS

Guardian programming is done through the PC's Primary COM Port. Primary and secondary COM ports are configured with the Field Programming Software. The programming cable (included in the Programming Kit - DRL part number 250-4006-001) is connected from the Setup Port on the Guardian to the PC's COM port configured as the Primary Port.

The Port Settings screen of the Field Programming Software is accessed via the Utilities pull-down menu (see Figure 2-7). The Port Settings screens are used to configure the PC's serial COM Ports. COM Port parameters are defined in 2.5.2.1. COM Port assignments are displayed in the bottom status bar of the Guardian Field Programming Software screen.

5.1.2 COM PORT PARAMETERS

COM Port
Selects COM Port number (COM 1-4) for Primary and Secondary COM Ports (see Figure 2-6).

Baud Rate
Selects the communication speed for Primary and Secondary COM Ports.

Data Bits
Selects the number of data bits (4-8) transmitted or received for the Primary and Secondary COM Ports.

Parity
Selects transmission or reception of any Parity Bits for the Primary and Secondary COM Ports.

Stop Bits
Selects number of Stop Bits (1 or 2) transmitted or received for the Primary and Secondary COM Ports.

DTR Enable

Used to assert DTR (Data Terminal Ready) line of the RS232 Port when the port is open for the Primary and Secondary COM Ports.

Swap COM Ports

Selecting the Swap Com Ports button moves the Secondary COM Port settings to the Primary COM Port (and moves the Primary COM Port to the Secondary settings). Since Guardian programming is done through the Primary COM Port, this is useful when two units are connected to the Primary and Secondary COM Ports. A Swap COM Ports allows the second unit to be programmed without switching programming cables.

## 5.1.2.1   PRIMARY AND SECONDARY PORT SETTINGS COMMUNICATIONS MODES

The Mode drop down menu configures the communications mode for the Primary and Secondary PC Port. See Table 2-6 for Communication Modes configurations.

Table 5.1 - Communication Modes

Mode	Description
Sync/ESC with No HS	Sends data using Sync/byte-stuffing protocol without handshaking.
Buffered with No HS	Sends buffered data without handshaking (this mode required for DOX operation.)
Sync/Esc with RTS/CTS HS	Sends data using the Sync/Esc byte-stuffing protocol with RTS/CTS hardware handshaking.
Buffered with RTS/CTS HS	Sends buffered data with RTS/CTS hardware handshaking.
Sync/Esc with Flow Control HS	Sends data using the Sync/Esc byte-stuffing protocol with flow control handshaking.
Buffered with Flow Control HS	Sends buffered data with flow control hardware handshaking.

5.1.3 PORT STATISTICS

Figure 5.1 Port Statistics Screen
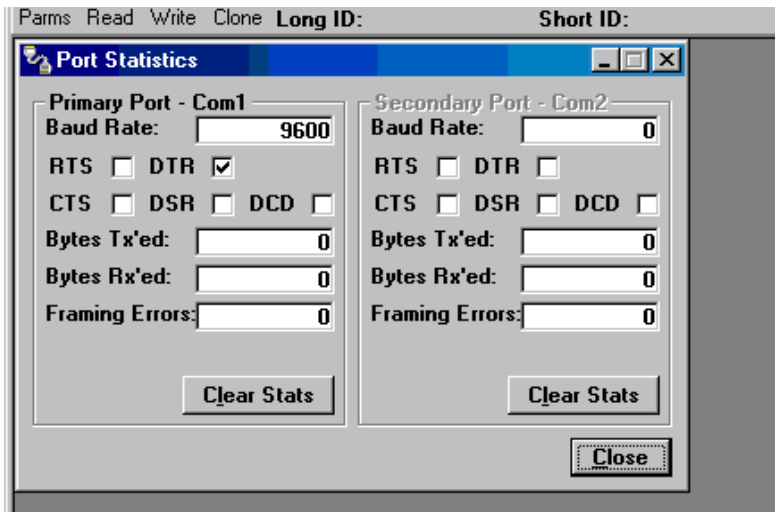
Port Statistics show current parameters of the PC's Primary and Secondary COM Ports.

Baud Rate
Baud Rate shows the current baud rate setting for the Primary and Secondary COM ports.

RTS
RTS shows the current state of the RTS (request to send) line. RTS is an output from the PC.

DTR
DTR shows the current state of the DTR (data terminal ready) line. DTR is an output from the PC.

CTS
CTS shows the current state of the CTS (clear to send) line. CTS is an input to the PC.

DSR
DSR shows the current state of the DSR (data set ready) line. DSR is an input to the PC.

DCD
DCD shows the current state of the DCD (data carrier detect) line. DCD is an input to the PC.

Bytes Tx'ed
Bytes Transmitted shows the number of bytes (characters) transmitted since the port was last opened or cleared.
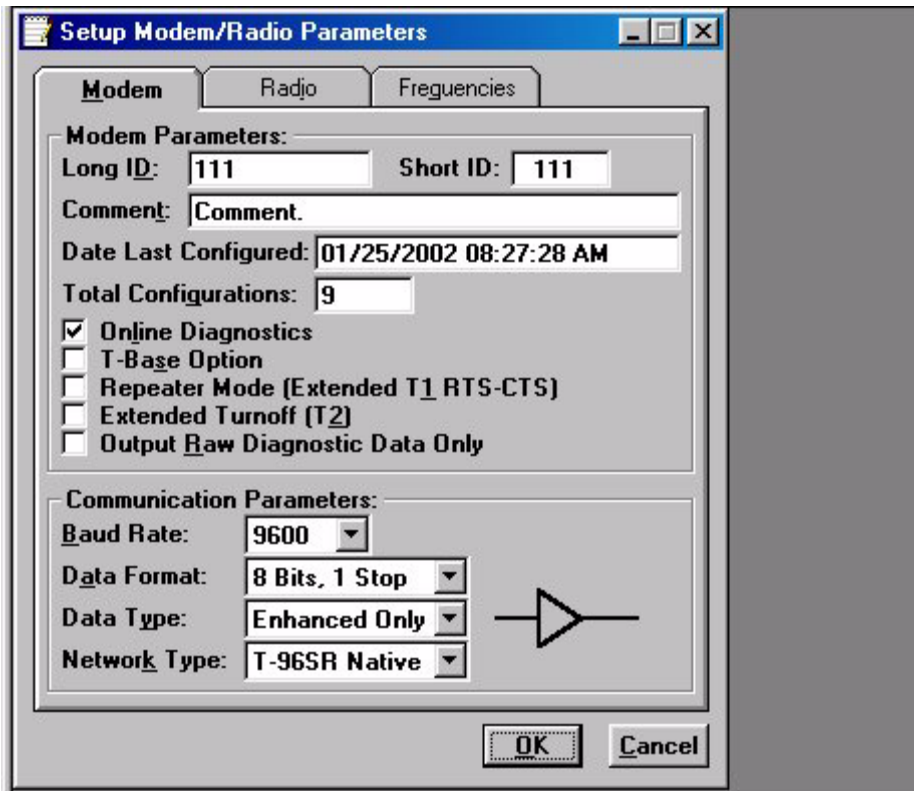
Bytes Rx'ed
Bytes Received shows the number of bytes (characters) received since the port was last opened or cleared.

Framing Errors
Framing Errors shows the number of Framing Errors received since the port was last opened or cleared.

5.1.4 SETUP MODEM/RADIO PARAMETERS

Figure 5.2 Setup Modem/Radio Screen

The Setup Modem/Radio Parameters screen is accessed from the Edit menu pull-down or from the Parms icon when the tool bar is visible.

5.1.4.1 MODEM OPERATING PARAMETERS

The Setup Modem/Radio Parameters allows the user to view and edit GUARDIAN's programmable parameters.

Programming parameters can be stored in a data file with the .DAT file extension. Programmable parameters are used by the Read/Write Parameters screen for programming into nonvolatile memory.

Parameter settings are modified from three screen tabs: the Modem tab, COM/Analog tab, and Radio tab.

When desired parameters in each tab window have been adjusted, select the OK button to store the parameter information into local PC memory and exit the parameter screen. Clicking the Default Parms button sets certain parameters back to factory default settings. Clicking Cancel exits the parameter screen without modifying any parameters currently stored in local PC memory.

Modem operating parameters include:

Long ID

The electronic ID Number is a unique number assigned at the factory. This number may be changed in the case of a duplication. The ID Number is used by the programmer for remote addressing and diagnostics.

The range of this field is 1 to 4294967295 but multiples of 1024 should not be used. A multiple of 1024 results in a Short ID of 0. If the ID Number is within the range of 1 to 1023, the Short ID will be the same.

NOTE: This ID is not the same as the printed serial number. Use the printed serial number to verify if the unit is under warranty.

Short ID

The Short ID is derived from the longer ID Number. It is used to identify units and minimizes the time required to transmit Online Diagnostics. The Short ID of each unit in a network must be unique if Online or

Offline Diagnostics will be used. Since the Short ID is derived from the ID Number, no entry is allowed in this field. The range of the Short ID is 1 to 1023.

Comment

The Comment field can be used as a notepad (i.e., customer name, location, technical info...etc can be entered in this field). Comments are text up to 39 characters including spaces.

Date Last Configured

The Date Last Configured field shows the date the unit was last programmed. The date is taken from the operating program. No entry is allowed in this field.

Total Configurations

The Total Configurations field shows the number of times a unit has been programmed. No entry is allowed in this field.

Online Diagnostics

If enabled, diagnostics information is sent at the beginning of each transmission. Diagnostics information is invisible to user data except for the increase in RTS/CTS delay of 11ms (at 9600 b/s). The default value is "Enabled" (checked).

All units in a network must use the same setting. Diagnostics from the last 15 stations heard are stored in each unit. These values are read using the Offline or Online Diagnostics screen.

Transmitted information includes:

- Short ID

- Supply Voltage (in Volts)

- Internal Temperature (in Celsius)

- Forward and Reverse Power (in Watts)

- Received Signal Strength (in dBm)

T-Base Option

Available when connected to a GUARDIAN Wireless Modem, the "T-Base Option" makes the necessary circuit changes to allow using the modem as a special diagnostic unit in the T-Base/R. The default value is "Disabled" (unchecked).

Repeater Mode (Extended T1 RTS-CTS refer to Table 2-8, page 2-13)

The Repeater Mode option extends transmitter turn-on time to allow use in a repeater network. The default value is "Disabled" (unchecked).

Extended Turn-off (T2)

The Extended Turn-off option extends transmitter turn-off time to enforce a quiet period at the end of each transmission. Select "Enabled" if data equipment does not clearly terminate each data frame and is susceptible to extraneous bits (dribble bits) at the end of data transmission. The default value is "Disabled" (unchecked).

Values are: 4800 b/s = 16 ms; 9600 b/s = 8 ms; 19200 b/s = 4 ms

An end-of-transmission quiet period approximately 8 characters long can be invoked on the GUARDIAN by holding its transmitter on briefly after RTS is dropped. This quiet period (which occurs between the last valid data character and any possible extraneous "noise" bits) may be of benefit to some DTE that would otherwise be adversely affected by the extraneous bits.

Output Raw Diagnostic Data Only

The Output Raw Diagnostic Data Only option instructs the modem to receive diagnostic information received from other modems only. Enabling this option disables user data delivery. This function is provided to use with the Diagnostic Unit incorporated in a T-Base or T-Base/R. The default value for this option is "Disabled" (unchecked).

Baud Rate

This field selects the RS-232 Interface and Network (over the air) baud rates. Table 5.3 lists programming possibilities for this field.

Table 5.2 RTS/CTS Delays

Data Format

The Data Format field selects the word length and number of stop bits for the data stream. The following options are available*:

a. 8 Data Bits, 1 Stop Bit

b. 8 Data Bits, 2 Stop Bits

c. 9 Data Bits, 1 Stop Bit

d. 9 Data Bits, 2 Stop Bits

Table 2-8 shows supported user formats and modem programming.

Note: A Yes in the Parity column indicates Even/Odd or Mark/Space Parity. A No in the Parity column indicates none. N/A means the combination is not available.

Table 5.3 RS-232 Interface and Network Baud Rates

Configuration Baud Rates

Full-Channel GUARDIAN in "GUARDIAN Native" network type 4800, 9600, 19200

Half-Channel GUARDIAN in "GUARDIAN Native" network type 4800, 9600

Full-Channel GUARDIAN in "T-96S/DL3276" network type 4800, 9600

Half-Channel GUARDIAN in "T-96S/DL3276" network type 4800

Full-Channel T-96S 1200, 2400, 4800, 9600

Table 5.4 Supported User Formats and Modem Programming

Data Bits Parity Stop Bits Modem*

7 No 1 N/A

7 Yes 1 a

7 No 2 a

7 Yes 2 b

8 No 1 a

8 Yes 1 b or c

8 No 2 b or c

8 Yes 2 d

9 No 1 c

9 Yes 1 d

9 No 2 d

9 Yes 2 N/A

RTS/CTS delay (normal) RTS/CTS delay (extended)

Product Mode

Speed diag. off diag. on diag. off diag. on

T-96S 4800 b/s 30 ms 54 ms 60 ms 85 ms

T-96S 9600 b/s 30 ms 41 ms 60 ms 75 ms

GUARDIAN 9600 b/s 20 ms 32 ms 40 ms 55 ms

GUARDIAN 19200 b/s 20 ms 28 ms 40 ms 50 ms

Note: If 9 Data Bits, 2 Stop Bits is selected, Remote Diagnostics or Commands are not supported and Online Diagnostics must be disabled for proper network data operation. *Important: All units in a network must use the same Data Format setting.*

5.1.4.2   DATA TYPE

Data Type behavior is dependent on the modem connected to the user PC.

- Connected to a GUARDIAN Modem operating in "GUARDIAN Native" network type: Enhanced Only Data Type

- Connected to a GUARDIAN Modem operating in "T-96S/DL3276" (or Crystal) network type: Enhanced **or** Compatible Data Type

Note: Choose "Compatible" if the modem is to be used with RNet 9600S (crystal) or T-Modem96 (crystal) units with serial numbers below 103500. The buffer icon to the right of his option will turn to an inverting buffer when "Compatible" is selected. Choose "Enhanced" for other applications to achieve better performance. *Important: All units in a network must use the same Data Format setting.*

5.1.4.3   NETWORK TYPE

Interdependent with Baud Rate and Data Type, Network Type allows over-the-air compatibility and varies according to the products used in the network. Network Type is dependent on the modem connected to the user PC.

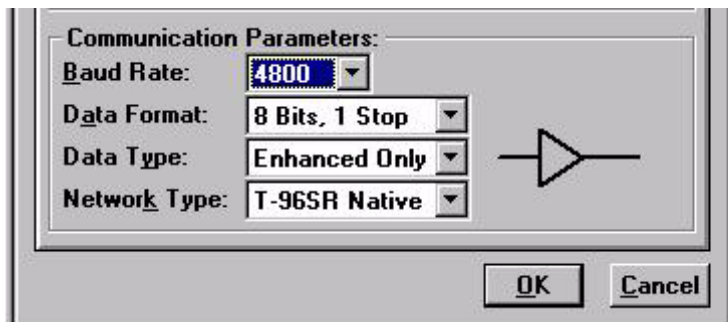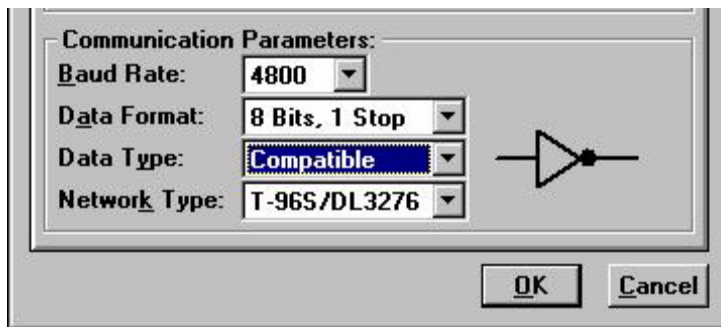Figure 5.3 Network Type Connected to a GUARDIAN Modem

Figure 5.4 Network Type Connected to T-96S/DL3276

Connected to a GUARDIAN Modem, Network Types include:

1. GUARDIAN Native: available Baud Rate options include 4800/9600/19200 for full-channel units or 4800/9600 for a half-channel units. Data Type is Enhanced Only

2. T-96S/DL3276: available Baud Rate options include 4800/9600 for full-channel units or 4800 for half-channel units. Data Type offers two options: Enhanced and Compatible. Compatible causes the buffer icon to change to an inverting buffer

3. Crystal: available Baud Rate options include 4800/9600 for full-channel units or 4800 for half-channel units. Data Type offer two options: Enhanced and Compatible. Compatible causes the buffer icon to change to an inverting buffer. Selecting this Network Type extends all RTS/CTS delays by **5 mS** for compatibility with crystal units.

**Connected to a T-96S/DL3276 Modem, Network Types include:**

1. T-96S/DL3276: available Baud Rate options include 1200/2400/4800/9600 for full-channel units or 1200/2400/4800 for half-channel units. Data Types offer two options: Enhanced and Compatible. Compatible causes the buffer icon to change to an inverting buffer

2. Crystal: available Baud Rate options include 1200/2400/4800/9600 for full-channel units or 4800 for half-channel units. Data Type offer two options: Enhanced and Compatible. Compatible causes the buffer icon to change to an inverting buffer. Selecting this Network Type extends all RTS/CTS delays by 5 ms for compatibility with crystal units.

Caution: The 9600 Baud Rate (full-channel) in GUARDIAN Native Network Type has faster modem timing and a higher deviation than the 9600 Baud Rate in the T-96S/DL3276 Network Type. The two are not interchangeable.

5.1.4.4   RADIO SETUP PARAMETERS

The Radio tab provides the interface for programming various radio operating parameters.

Figure 5.5 Radio Setup Parameters Screen
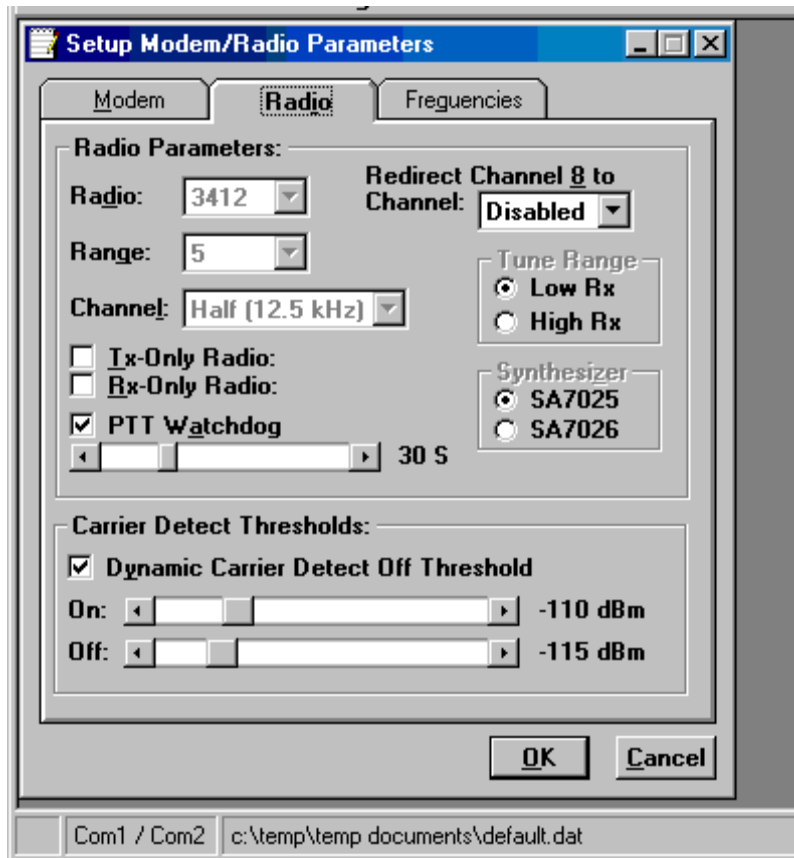
Radio

This field designates the radio model.

Range

This field designates radio frequency range.

Channel

This field specifies whether the unit is full- or half-channel (12.5 or 25 kHz).

Redirect Channel 8

The Redirect Channel 8 field allows Channel 8 to be directed to another programmed channel. The units' DIP switches must be set to the Channel 8 selection for channel redirection to function.

Tx Only Radio

The Tx Only Radio option disables the radio's receiver and any ability for the modem to receive data. This function is provided for use with the Tx unit incorporated into a T-Base or T-Base/R.

Rx Only Radio

The Rx Only Radio option disables the radio's transmitter and any ability for the modem to transmit data. This function is provided for use with the Rx unit incorporated into a T-Base or T-Base/R.

PTT Watchdog

The PTT Watchdog allows the user to set the maximum transmit time. This is used to protect against a 'stuck' transmitter. The time is selected by a slider bar. The range is 0 to 120 seconds with a default of 30 seconds. Warning: Transmissions longer than 30 seconds may exceed the duty cycle rating of the transmitter and lead to shortened life or transmitter failure. A factory-installed cooling fan is available for extended duty operations. For continuous-transmit applications, the PTT Watchdog feature can be disabled (unchecked).

Synthesizer

This field lists the synthesizer model used. This field is non-selectable and for reference only.

Dynamic Carrier Detect Off Threshold

The Dynamic Carrier Detect Off Threshold allows the modem to automatically adjust the Carrier Detect Off Threshold based on the RSSI while receiving data. If selected, the Carrier Detect Off level will automatically adjust to approximately 15 dB below the actual signal strength. This provides rapid detection of loss-of-carrier and minimizes or eliminates 'bit dribble' at the end of transmissions.

Recommendation: Keep Dynamic Carrier Detect Off Threshold enabled (checked) unless interference or variable signal strength (i.e., fading in a moving vehicle) causes problems.

Carrier Detect On Threshold

Carrier Detect On Threshold indicates RSSI level when a carrier is found. This level should be more than the Carrier Detect Off Threshold.
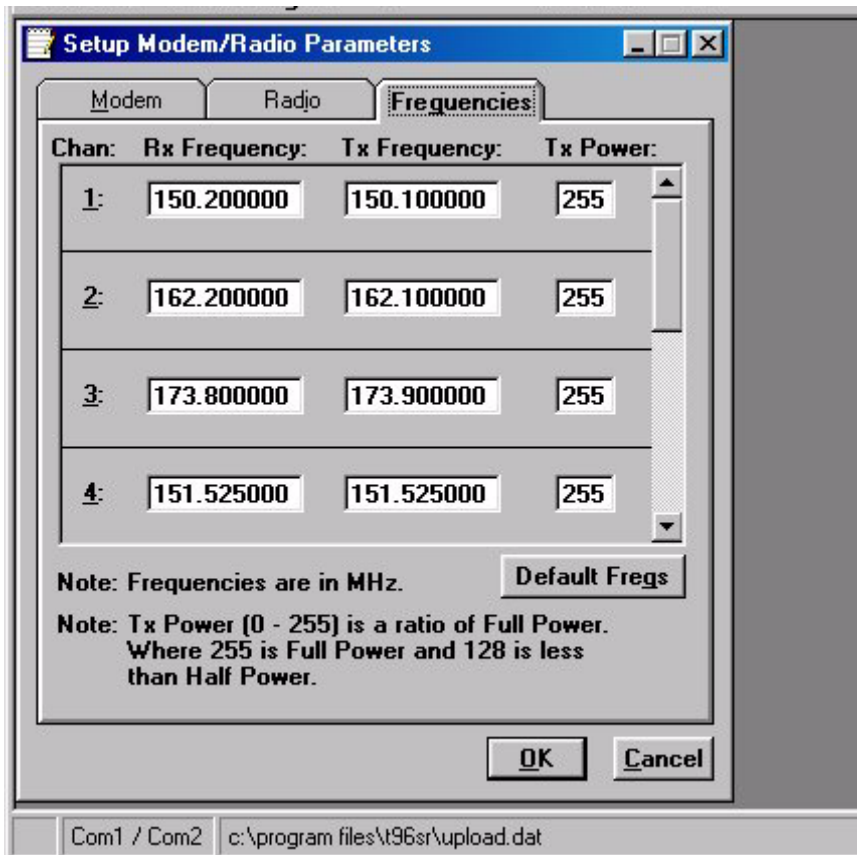
Carrier Detect Off Threshold

Carrier Detect Off Threshold indicates the RSSI level when a carrier is lost. This level should be less than the Carrier Detect On.

5.1.4.5   SETUP RADIO/MODEM FREQUENCIES

The Frequencies tab provides the interface to program frequency pairs and their corresponding power settings.

Figure 5.6 Setup Radio/Modem Frequencies Parameters

Chan

Chan displays the frequency channel pair.

Rx Frequency

Rx Frequency displays the receive frequency for the channel pair.

Tx Frequency

Tx Frequency displays the transmit frequency for the channel pair.

Power

Power displays the Power Output Adjust value for the channel pair. The default value is 255 (5 watts). This value should be left at the default value unless:

- a lower power is required to meet regulatory requirements or
- the user's application requires an increase in the transmit duty cycle

Default Freqs

The Default Freqs button forces the Rx and Tx Frequencies to their default values, based on radio type and range.

5.1.5 VERSION REQUEST

Selecting Version Request causes the GUARDIAN Field Programming Software to display information about the version of the GUARDIAN hardware and firmware.

Figure 5.7 Version Request Screen

## 5.1.6 WRITING/READING GUARDIAN PARAMETERS

After all radio parameters are setup, select the OK button to store the information into the PC's memory. To load parameters into the GUARDIAN, initiate a Write Programmable Settings from the Edit menu or select the Write icon from the Tool Bar. After the programmable parameters are loaded into the GUARDIAN, save the parameter information using the Save Data As option in the File pull-down menu. The name and location of the file (*.dat extension) will appear on the status bar at the bottom of the screen.

The Read Programmable Settings command will read parameters from the current GUARDIAN and store the information in local memory. The parameters can be viewed and/or edited with the Setup Modem/Radio Parameters screens.

Note: Dataradio recommends a Read be done anytime an initial connection is made to the GUARDIAN Setup Port before accessing the Setup Modem/Radio Parameters screen. This will help avoid writing erroneous parameters to the connected unit.

5.1.7 CLONE PROGRAMMABLE PARAMETERS

Figure 5.8 Clone Programmable Parameters Screen
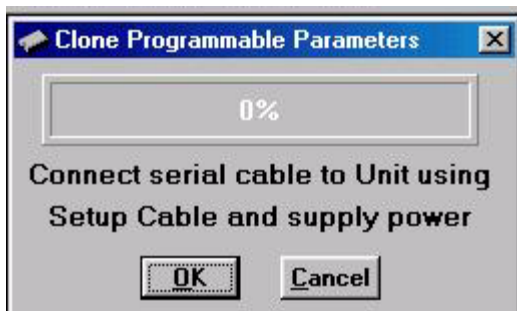
The Clone Programmable Settings writes the currently loaded settings (except the ID Number, Comment, and Number of Writes) to the EEPROM of the GUARDIAN. This option is used for programming the same Data File (.dat) into multiple modems.

5.1.8 DIAGNOSTIC IDS AND ALARMS

The Diagnostics IDs and Alarms screen allows the user to set up the ID List for use with the Offline Link Test and Offline and Online Diagnostics as well as the Alarms for use with Online Diagnostics.

Figure 5.9 Diagnostic IDs and Alarms Screen
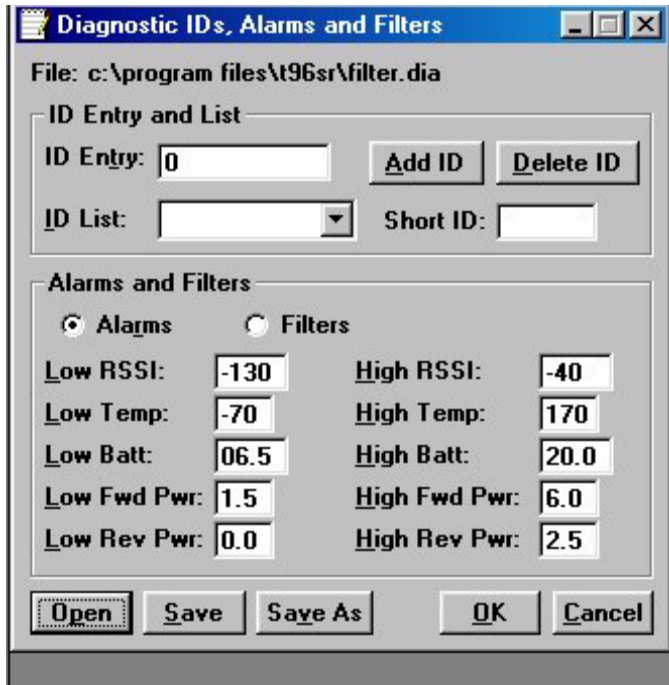
ID Entry and List

ID Entry allows the entry of a Long ID to be added to the ID List. The range of this field is 1 to 4294967295 but multiples of 1024 should not be used. A multiple of 1024 results in a Short ID of 0. If the Long ID is within the range of 1 to 1023, the Short ID will be the same or the resulting Short ID will be smaller than the Long ID and will be represented by a '+' character in front of the ID. A Long ID is added to the ID List by an 'Enter' or by pressing the Add ID button.

ID List: Allows the user to select a Long ID from the list to delete. A Long ID is deleted from the list by pressing the Delete ID button.

Short ID: Shows the converted Short ID from the selected Long ID of the ID List.

Alarms and Filters

Alarms and Filters are used with Online Diagnostics. When Online Diagnostics are received and a diagnostic field falls outside the Alarm limits, a "<"character will designate a value less than the low Alarm and a ">" character will designate a value greater than the High Alarm.

When Online Diagnostics are received and a diagnostic field falls outside the Filter Limits, the diagnostic information is considered invalid and is not displayed.

Low/High RSSI: Low/High RSSI represent the low and high limits for the RSSI diagnostics (in dBm).

Low/High Temp: The Low/High Temp represents the low and high limits for the temperature diagnostics (in degrees C).

Low/High Batt: Low/High Batt represents the low and high limits for the battery voltage diagnostics (in volts).

Low/High Fwd Pwr: Low/High Fwd Pwr represents the low and high limits for the forward power diagnostics (in watts).

Low/High Rev Pwr: Low/High Rev Pwr represents the low and high limits for the Reverse Power diagnostics (in watts).

Open

The Open button allows the user to restore Diagnostic IDs and Alarms from a previously saved file.

Save

The Save button allows the user to save the current Diagnostic IDs and Alarms to the current file.

Save As

The Save As button allows the user to save the current Diagnostic IDs and Alarms to a name different than the current file.

5.1.9   OFFLINE LINK TEST

The Offline Link Test is used to test the link between two units: the local unit interfaced to the computer and a remote unit. Blocks of data are transmitted to the remote unit and the remote unit decodes and returns them. The transmitted and received blocks of data are compared and the ratio of the results are calculated.

NOTE: An Offline Link Test requires suspension of user network operation.

Remote Select

Local ID

The Local ID is the Long ID of the unit connected to the computer. The Short ID is displayed.

Remote ID

The Remote ID combo box allows selection of the unit (by choosing its Remote ID) from which the Link Test information is gathered. Remote IDs are set up in the Diagnostic IDs and Alarms Screen. The Short ID is displayed.

An Offline Link Test returns the following statistics:

Figure 5.10 Offline Link Test Screen
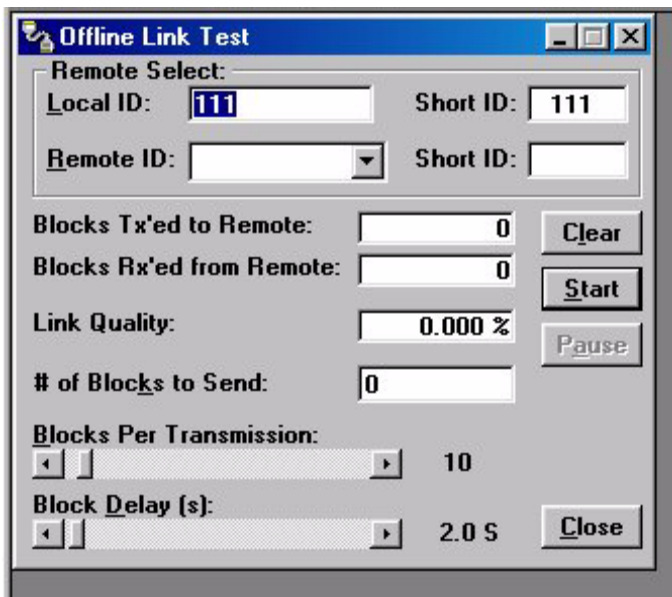
Blocks Tx'ed to Remote

Blocks Tx'ed to Remote displays the number of data blocks transmitted to the remote unit.

Blocks Rx'ed from Remote

Blocks Rx'ed from Remote displays the number of data blocks received from the remote unit.

Link Quality

Link Quality displays the ratio of data blocks received to data blocks transmitted (in %).

# of Blocks to Send

# of Blocks to Send allows the user to determine the number of blocks to send before stopping (with 0 being disabled).

Blocks Per Transmission

Allows the selection of the number of blocks per transmission (1 to 200 blocks).

Block Delay (s)

Block Delay (s) allows the user to determine the delay between the transmission of data blocks in 0.05 second intervals (0.00 to 120.00 seconds).

Clear

Clear allows the user to clear the display (blocks transmitted, blocks received and link quality).

Start

Start is used to begin the test.

Pause

Pause is used to pause the test and allows the user to resume the test at a later time.

5.1.10   OFFLINE DIAGNOSTICS

Offline Diagnostics are returned from a local or remote unit in response to a Get Diags request (see Figure 2-18). **An Offline Diagnostics request requires suspension of user network operation**.

Diagnostics

<u>Select</u>

Select allows the user to choose Current, Low or High Diagnostics. Current shows the value of the last requested parameters. Low or High displays the lowest or highest value of the parameters since the last Clear was performed or the last time power was removed.

Offline Diagnostics parameters include the following:

- Battery Voltage: supply voltage

- Analog Vcc: Analog Circuits Regulated 5V line

- Temperature: internal case temperature (in Celsius) *list continued on next page*

- RSSI Level: Received Signal Strength Indication (in dBm)

- Forward Power: Forward Power (in watts)

- Reverse Power: Reverse Power (in watts)

- Preamble Good: the number of correctly decoded transmissions received in the last 15. Used with Preamble Total, this serves as an indication of how well the unit is receiving data

- Preamble Total: the number of total transmissions detected, maximum is 15. Used with Preamble Good, this serves as an indication of how well the unit is receiving data

- Preamble DCD: this number shows a count of all received Carrier Detects

Figure 5.11 Offline Diagnostics Screen
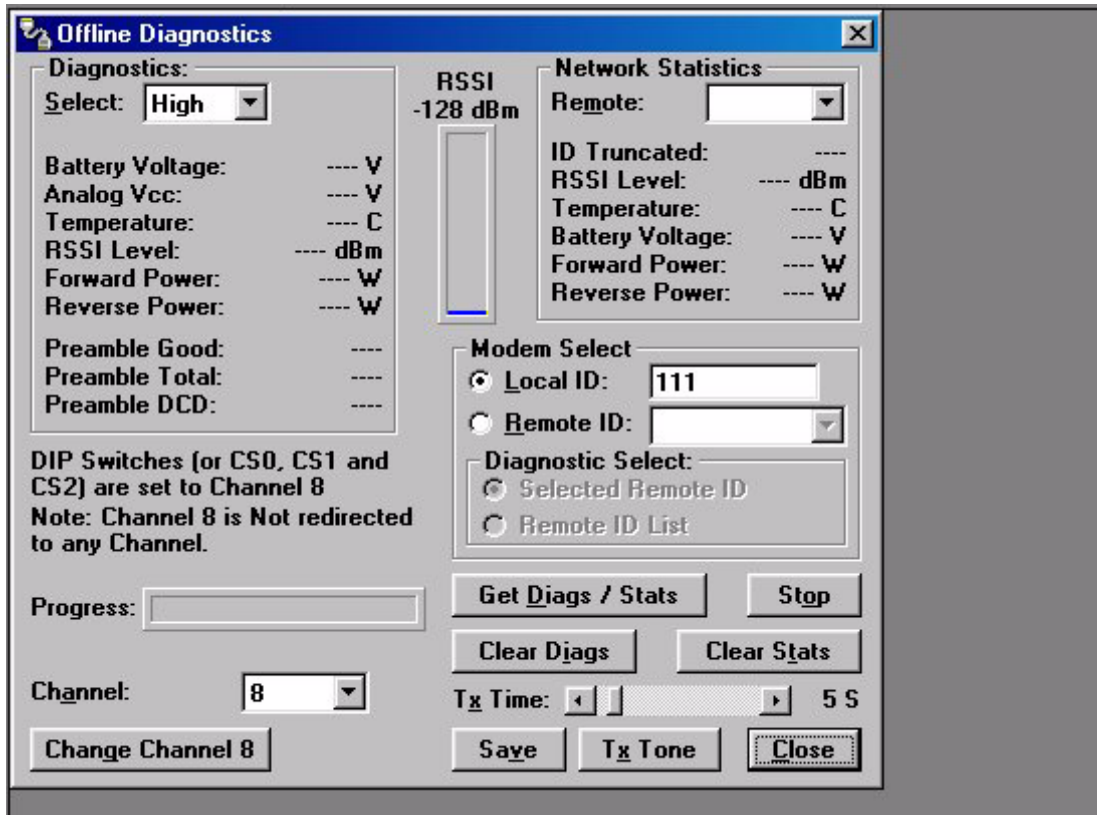
Network Statistics

Offline Network Statistics are only available when the 'Online Diagnostics' option is enabled for the network. Online Diagnostics are located on the Setup Modem/Radio Parameters screen. When enabled, diagnostic information is inserted at the beginning of each transmission from each unit in the network. While the network may remain online, the monitoring unit is in 'Setup' mode (flashing green LED).

Network Statistics include:

Remote

The Remote drop down allows the user to select (from the list Remotes) which network statistics to display.

ID Truncated

ID Truncated shows the user the Long and Short ID are not the same.

RSSI Level

The RSSI level shows the current RSSI level (in dBm) while the Local unit is receiving.

Temperature

Temperature shows the internal case temperature (in Celsius).

Battery Voltage

Battery Voltage shows the supply voltage (in Volts).

Forward Power

Forward Power shows forward power (in Watts).

Reverse Power

Reverse Power shows reverse power (in Watts).

RSSI Panel

The RSSI panel shows the current RSSI level (in dBm) while the local unit is receiving.

Modem Select

Local ID

The Local ID button allows the user to send commands to the local unit (the unit interfaced to the computer). The Short ID for this unit is shown.

Remote ID

The Remote ID button allows the user to send diagnostic commands to any specific remote unit and obtain its diagnostic information. The Remote ID is selected from the list of Remote IDs set up in the Diagnostic IDs and Alarms screen.

Diagnostic Select / Selected Remote ID

This button allows the user to gather Offline Diagnostics from the selected Remote ID only.

Diagnostic Select / Remote ID List

This button allows the user to gather Offline Diagnostics from all the IDs in the list of Remote IDs (including the local unit).

Progress

The Progress panel displays the progress of obtaining Remote Diagnostics.

Channel

Channel allows the user to select the programmed channel of operation. There are 8 programmed channels.

Change Channel 8

Change Channel 8 allows the user to redirect Channel 8 to another programmed channel. The unit's DIP switches must be set to the Channel 8 selection for channel re-direction to function.

Get Diags / Stats

The Get Diags button allows the user to send the command for Offline Diagnostics. The command is sent to the unit connected to the computer if the Local ID button is selected. The command is sent to the selected Remote ID if the Remote ID and Selected Remote ID buttons are selected. The command is sent to the list of Remote IDs if the Remote ID and Remote ID List buttons are selected.

Stop

The Stop button allows the user to stop any commands for Offline Diagnostics from being sent.

Clear Diags

Clear Diags clears the unit's online network statistics.

Tx Time

Tx Time allows the user to select the length of time the unit will transmit a tone (in seconds) when the Tx Tone button is pressed (1 to 60 seconds).

Save

The Save button allows the user to save the current Offline Diagnostics to a file.

Tx Tone

The Tx Tone button instructs the unit to transmit a tone for modulation on the programmed transmit frequency for a duration of Tx Time.

5.1.11   ONLINE DIAGNOSTICS

Online Diagnostics are transmitted by each unit in a network before the user's data is transmitted. All units must be programmed with the Online Diagnostics parameter found on the Setup Modem/Radio Parameters screen to receive Diagnostics from a system. The unit that the computer is interfaced with will output Online Diagnostics as they are received. This unit must have the Output Raw Diagnostic Data Only parameter programmed (found on the Setup Modem/Radio Parameters Screen). Using Online Diagnostics does not require suspension of network operation.

Online Diagnostics are subject to alarm and filter conditions defined in the Diagnostic IDs, Alarms and Filters screen (see Figure 2-15). When Online Diagnostics are received and a diagnostic field falls outside the alarm limits, a "<" character will designate a value less than the low alarm and a ">" character will designate a value greater than the high alarm. If Online Diagnostics are received and a diagnostic field falls outside the filter limits, the diagnostic information will be considered invalid and will not be displayed.

Figure 5.12 Online Diagnostics

The following Online Diagnostics are gathered:

Short ID

The Short ID displays the Short ID of the unit transmitting the diagnostics.

RSSI

RSSI (Received Signal Strength Indicator) displays the RSSI (in dBm) ID of the unit transmitting the

diagnostics. This is the RSSI sampled during the last transmission received.

Temp

Temp displays the internal case temperature (in Celsius) of the unit transmitting the diagnostics.

Batt

Batt displays the supply voltage (in volts) of the unit transmitting the diagnostics.

FwdP

FwdP displays the forward power (in watts) of the unit transmitting the diagnostics.

RevP

RevP displays the reverse (reflected) power (in watts) of the unit transmitting the diagnostics.

Time

Time is the time stamp when the diagnostics were received.

Filter

Filter allows the user to filter Short IDs. The following options are available:

- Off (All IDs): no IDs are filtered out

- ID List: only the IDs in the Filter ID List are shown

- Selected ID: only the selected ID in the Filter ID List is shown

Display

Display allows the user to format on screen data. The following options are available:

- Scroll (by time): displays the diagnostics as they are received

- Slotted (by ID): sorts the diagnostics by Short ID. Using this option, each Short ID will have one row of diagnostics, showing the most recent

Short ID Filter List

Filter ID List is a listing of Remote IDs setup in the Diagnostic IDs and Alarms Screen. This list is used for selecting a filter.

Progress

The Progress panel shows the sorting progress of the diagnostics if a filter was changed.

Pause

The Pause check box allows the user to pause the reception of the diagnostics for scrolling through the grid.
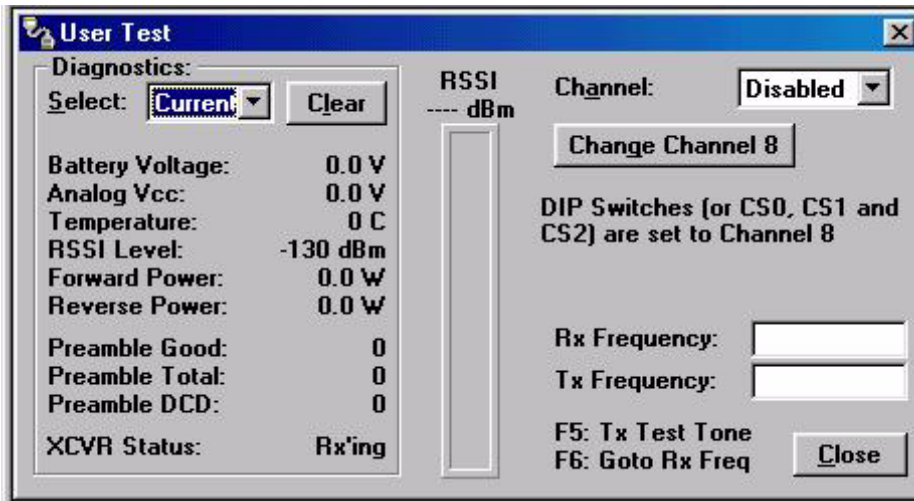
Clear

The Clear button allows the user to clear the display and current Online Diagnostics.

Save

The Save button allows the user to save the current Online Diagnostics to a file. A maximum of 4096 lines of data can be saved.

5.1.12 USER TEST

Figure 5.13 User Test Screen

The User Test utility is an Offline function and requires suspension of network operation. A User Test's diagnostic parameters include:

RSSI Level

Received Signal Strength Indication (in dBm)

Battery Voltage

Supply voltage (in volts)

Temperature

Internal temperature (in degrees Celsius)

Forward Power

Forward power (in watts)

Reverse Power

Reverse power (in watts)

Preamble Good

The number of correctly decoded transmissions received in the last 15. Used with Preamble Total, this serves as an indication of how well the unit is receiving data.

Preamble Total

The number of total transmissions detected, maximum is 15. Used with Preamble Good, this serves as an indication of how well the unit is receiving data.

RSSI

This panel shows the current RSSI level (in dBm) while the local unit is receiving.

Rx / Tx Frequency

Rx / Tx Frequency shows the current receive and transmit frequencies.

F5

Pressing the F5 key will cause the unit to transmit on the programmed transmit frequency.

F6

Pressing the F6 key will cause the unit to go to receive on the programmed receive frequency

5.1.13   PACKET TEST

Figure 2-20 Packet Test Screen
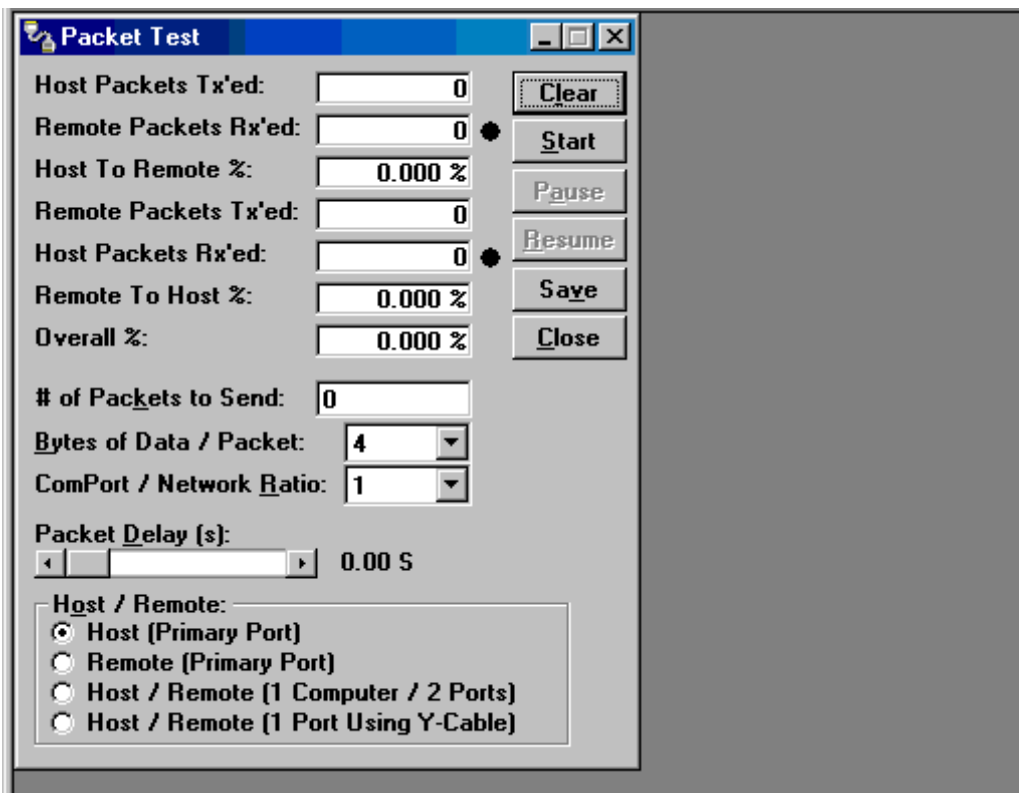
The Packet Test screen is used to simulate a Host/Remote polling environment. The Master unit will send out a packet to the Remote and the Remote will reply to the Master with the same packet information. This is a useful utility for testing modem communication.

Host Packets Tx'ed

Host Packets transmitted shows the number of data packets the Master has sent to the Remote.

Remote Packets Rx'ed

Host Packets received shows the number of data packets the Remote device has received from the Master.

Host to Remote %

Host to Remote percentage shows the percentage of packets the Host device has successfully sent to the Remote.

Remote Packets Tx'ed

Remote Packets transmitted shows the number of data packets that the Remote device has returned to the Host.

Host Packets Rx'ed

Host Packets received shows the number of data packets the Host device has received from the Remote.

Remote to Host %

Remote to Host percentage shows the number of packets the Remote device successfully sent to the Host.

Overall %

Overall percentage shows the percentage of Host received packets versus Host transmitted packets.

# of Packets to Send

Number of Packets to Send programs the number of packets the Host should send to the Remote before stopping.

Bytes of Data / Packet

Bytes of Data / Packet is the programmable number of data bytes in each packet the Host sends. The Remote will respond with the same number of packets.

COMPort/Network Ratio

COMPort/Network Ratio is the ratio of the COM port baud rate to network (over the air) baud rate of a modem. This is used if the network baud rate is slower than the COM port baud rate. If the COM port baud rate is 9600 and the network baud rate is 4800, set the ratio to 2. If the two are the same, set this field to 1.

Packet Delay (s)

Packet Delay (s) is the number of seconds for the Host to delay between sending each packet. This field ranges from 0.00 to 10.00 seconds (in 0.25 second intervals).

Host/Remote

Host/Remote is used to configure COM port options.

- Host (Primary Port) - Configures the primary COM port as the Host device (the device initiating packets to the Remote device.

- Remote (Primary Port) - Configures the primary COM port as the Remote device (the device responding to the packets from the Host device).

- Host/Remote (1 computer / 2 ports) - Configures the primary COM port as the Host device and the secondary COM port as the Remote device. This option requires a computer with 2 COM ports.
  Host/Remote (1 Port using a Y-cable) - Configures the primary COM port as the Host and Remote device.

A Y-cable is required for this option (with transmit connections split to the transmitting device and receive connections split to the receiving device). A computer with 1 COM port is utilized for this option

Table 2-10 Y-Cable Connections

Pin Name	DB-9	DB-29	Computer	Rx	Tx
DCD	1	8	X	X	-
RxD	2	3	X	X	-
TxD	3	2	X	-	X
DTR	4	20	-	-	-
GND	5	7	X	X	X
DSR	6	6	-	-	-
RTS	7	4	X	-	X
CTS	8	5	X	-	X
RI 9	2	2	-	-	-

X = Requires connection

- = No connection

5.1.14   ARRAY TEST

The Array Test screen is used to send programmable length test packets. Packets Tx'ed - total number of packets transmitted.

# of Packets to Send

# of Packets to Send allows the user to set the total number of packets to send before stopping (field range is 0 to unlimited)

Table 2-10 Y-Cable Connections

Pin Name DB-9 DB-29 Computer Rx Tx

DCD 1 8 X X -

RxD 2 3 X X -

TxD 3 2 X - X

DTR 4 20 - - -

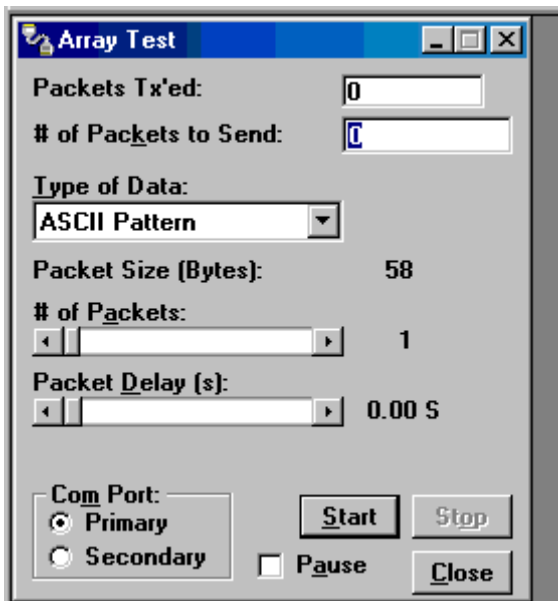GND 5 7 X X X

DSR 6 6 - - -

RTS 7 4 X - X

CTS 8 5 X - X

RI 9 22 - - -

X = Requires connection

- = No connection

Figure 2-21 Array Test Screen

Type of Data

Type of Data allows the user to select the data pattern for each packet. The size for each data pattern is listed in the pattern format explanations (packets are built using one of four possible patterns).

- ASCII Pattern - Packets are 58 characters in length and have a sequence number at the beginning of each string starting with 000, incrementing to 999 then wrapping around to 000 again

The pattern used to build the packets will have the following format (in ASCII):

000 ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz

001 ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz

---

998 ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz

999 ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz

000 ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz

001 ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz

- ASCII Number Pattern - The packets will be 58 characters in length and have a sequence number at the beginning of each string, starting at 000 and incrementing to 999, then wrapping around to 000 again.

The pattern used to build the packets will have the following format (in ASCII):

000 00 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

001 00 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

---

998 00 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

999 00 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

000 00 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

001 00 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

- Binary Pattern - The packets will be 16 characters in length and have a sequence number every 16 characters, starting at 0x00 and incrementing to 0xFF, then wrapping around to 0x00 again.

The pattern used to build the packets will have the following format (in Hex):

00 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

01 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

02 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

-- 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

FE 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

FF 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

00 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

01 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

02 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

-- 11 22 33 44 55 66 77 88 99 AA BB CC DD EE FF

- Random Binary Pattern - The packets will be 16 characters in length and contain random binary data.

# of Packets

# of Packets allows the user to set the number of packets in each transmission.

Packet Delay

Packet Delay allows the user to set the amount of time (in seconds) to delay between each packet transmission, ranging from 0.00 to 30.00 seconds (in 0.25 second intervals).
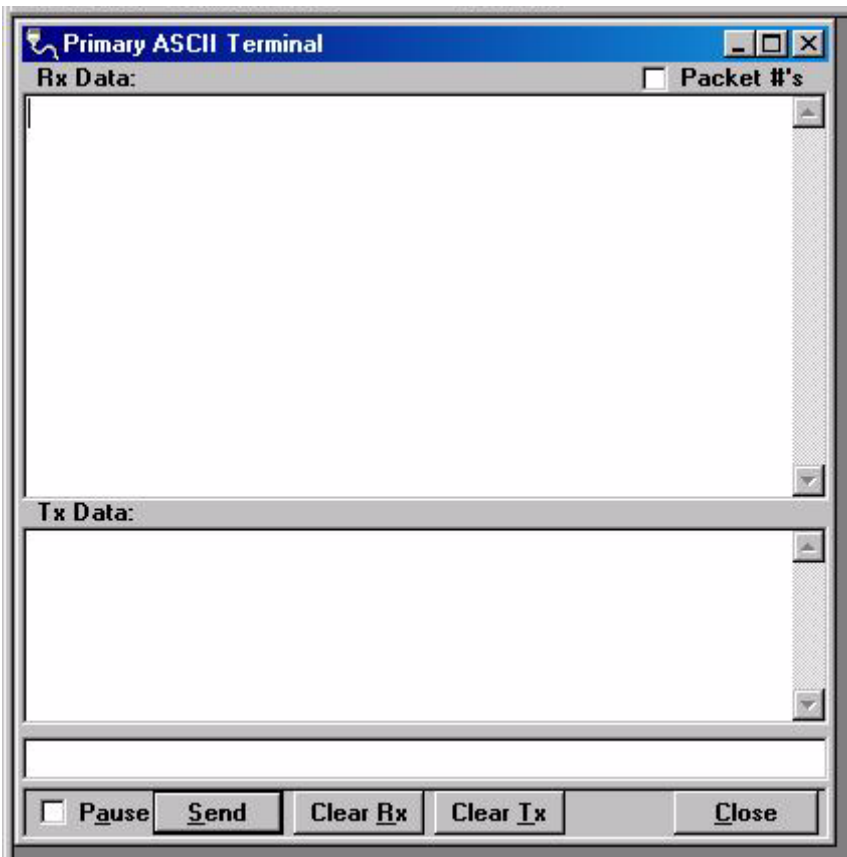
Com Port

Com Port allows the user to select the COM port (primary or secondary) for data transmission.

5.1.15   ASCII / HEX TERMINAL

Terminal Screens allow the user to select an ASCII or Hexadecimal Terminal Screen for the Primary and Secondary COM Ports (configured in the Port Settings screen - see Section 2.5.2.1) Data is sent according to the port configuration set up in the Port Settings screen.

ASCII / HEX TERMINAL Terminal Screens allow the user to select an ASCII or Hexadecimal Terminal Screen for the Primary and Secondary COM Ports (configured in the Port Settings screen - see Section 2.5.2.1) Data is sent according to the port configuration set up in the Port Settings screen.

Figure 2-22 ASCII Terminal Screen

5.1.15.1   ASCII TERMINAL

ASCII Terminal configurations include:

Primary

The Primary ASCII Terminal screen sends and receives ASCII data on the Primary COM Port (set up in the Port Settings screen).

Secondary

The Secondary ASCII Terminal screen sends and receives ASCII data on the Secondary COM Port (set up in the Port Settings screen).

5.1.15.2   HEX TERMINAL

Hex Terminal configurations include:

Primary

The Primary Hex Terminal screen selects a Hexadecimal Terminal screen to send and receive Hexadecimal data on the Primary COM Port (set up in the Port Settings screen).

Secondary

The Secondary Hex Terminal screen selects a Hexadecimal Terminal screen to send and receive Hexadecimal data on the Secondary COM Port (set up in the Port Settings screen).

5.1.16   PROGRAM CODE

The Program Code pull-down menu allows the user to update the GUARDIAN firmware (*.bin) with the Program Firmware option. Select Modem Code File allows the user to select the file to program the firmware in the GUARDIAN.

5.1.17   END TO END TEST

Two Dataradio GUARDIANs can be tested using the Dataradio GUARDIAN Field Programming Software. The Field Programming Software has several useful utilities embedded in the program that assist in testing the wireless modems. The testing setup requires a computer running the Field Programming Software attached to each user COM port on the GUARDIAN wireless modems. The Utilities will allow the user to send ASCII text or Hex characters through the GUARDIANs being tested.

The GUARDIANs must be setup so that they have the appropriate receive and transmit signal levels for the test. The signal strength will be much stronger if the units are tested on the bench compared to being tested in a field installation. These signals must be attenuated or the output power level adjusted if the units are being tested on the bench.

Under the "Utilities" menu choose the "ASCII Terminal". From the "ASCII Terminal" screen, choose the "Primary" selection. This will open an ASCII terminal window using the primary COM port of the computer. This procedure should be done for both GUARDIANs. The ASCII Terminal utility has provisions for transmitting the ASCII data, displaying received ASCII data and displaying ASCII transmitted data. Figure 2-23 shows the window for the Primary ASCII Terminal.

Figure 2-23 End to End Test: ASCII Terminal
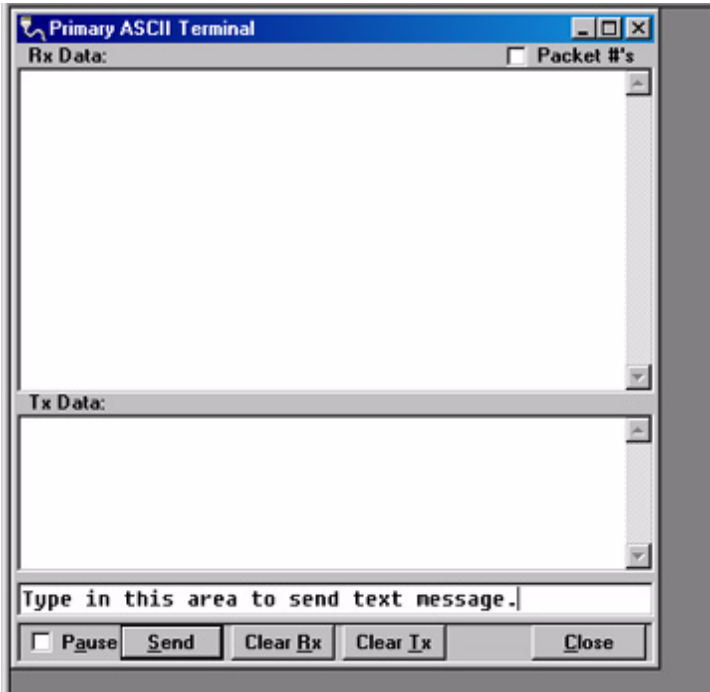
Figure 2-23 also shows the area that is used to send an ASCII text message. The ASCII data message is typed into this area. The ASCII text message is then sent out the first GUARDIAN through the computer's primary port once the "Send "button is clicked. The sent ASCII message is then displayed in the Tx Data area of the ASCII Terminal window as shown in Figure 2-24.

Figure 2-24 End to End Test: Text message sent
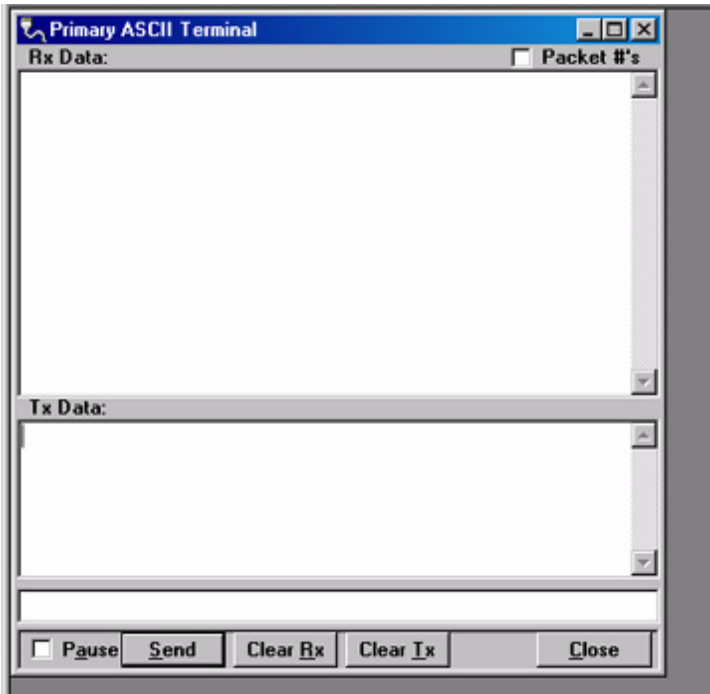
The ASCII message is transmitted to the other GUARDIAN. The ASCII terminal program will display the received ASCII message in the Rx Data area as shown Figure 2-25.

Figure 2-25 End to End Test: Text message received
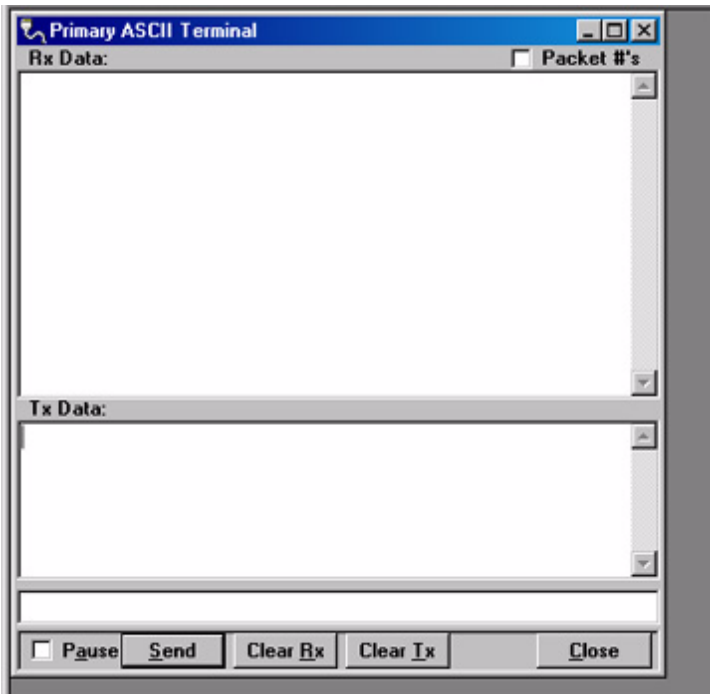
If the message was not displayed as typed, then a problem may exist in the system. Check all parameters and connections in the system. The signal level should also be checked again. The GUARDIAN's Link Test utility can be used to verify a communication path.

The previous procedure can also be used with the Hex Terminal utility. When the Hex Terminal is used, the information is entered as hex code. Figure 2-26 shows how the information will look when it is typed in and sent in hex.

Figure 2-26 Hex Terminal
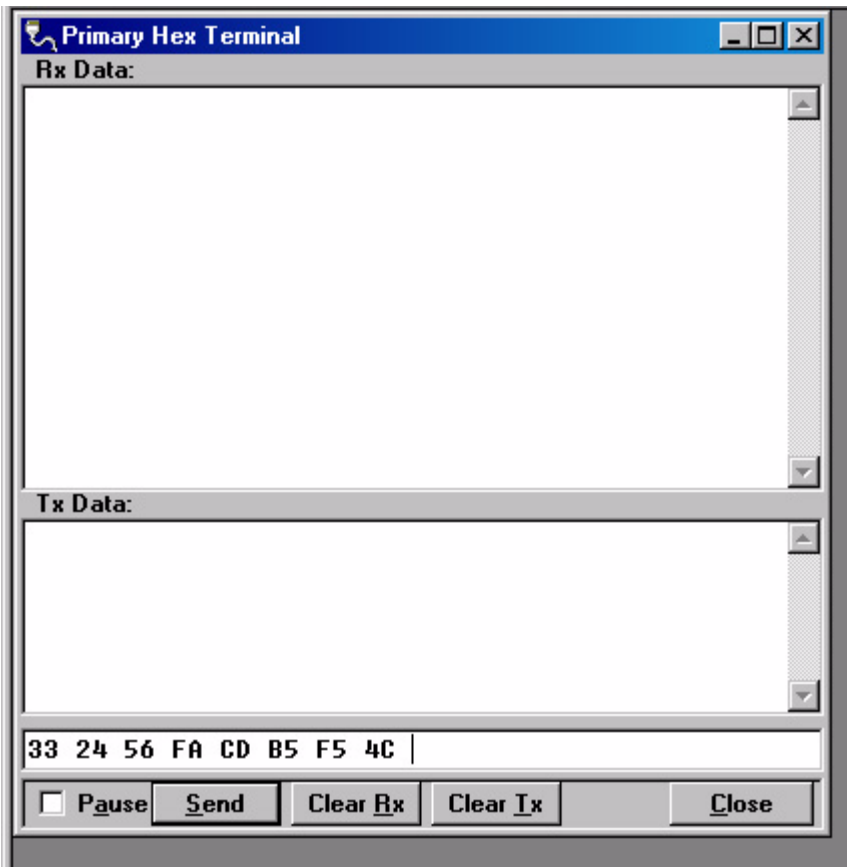
In the Hex Terminal mode, the program will not transmit ASCII information. It will only allow valid hex characters.

6 GUARDIAN SPECIFICATIONS

These specifications are typical and subject to change without notice.

GENERAL	VHF	UHF	900
Model Numbers	140-5016-50x 140-5026-50x	140-5046-30x 140-5046-400 (ETSI, AS/NZ) 140-5046-50x 140-5046-600 (AS/NZ)	140-5096-50x
Frequency Range (MHz)	136 – 174 MHz 215 – 240 MHz	406.125 – 470.000 MHz 406.125 – 470.000 MHz 450.000 - 511.975 MHz 450.000 - 511.975 MHz	928 – 960 MHz
Frequency Stability	1.0 ppm	1.0 ppm	1.0 ppm
Channel Bandwidth	12.5 kHz 25 kHz	12.5 kHz 25 kHz 12.5 kHz (ETSI, AS/NZ certified) 25 kHz (ETSI, AS/NZ certified)	12.5 kHz 25 kHz
Modes of Operation	Simplex, Half-Duplex, Full-Duplex		
Frequency Increment	1.25 kHz		
Power Source	10-30 VDC, Negative GND The Guardian is UL approved when powered with a listed Class 2 power supply.		
RF Impedance	50 Ω		
Operating Temperature	-30° to + 60° C		
Storage Temperature	-40° to + 85° C, 95% non-condensing RH		
Operating Humidity	5% to 95% non-condensing RH		
Rx Current Drain at 25°C		DC Input 10V	DC Input 20V	DC Input 30V
		520 mA (max) 450 mA (typ)	270 mA (max) 240 mA (typ)	190 mA (max) 170 mA (typ)
Tx Current Drain at 25°C	Power Out	DC Input 10V	DC Input 20V	DC Input 30V
	Max Pwr	5.8 A (max) 3.6 A (typ)	2.5 A (max) 1.8 A (typ)	1.6 A (max) 1.2 A (typ)
	30 dBm (1W)	1.6 A (max) 1.2 A (typ)	0.8 A (max) 0.6 A (typ)	0.6 A (max) 0.4 A (typ)
Cold start	20 seconds		
Nominal Dimensions	5.50" W x 2.125" H x 4.25" D (13.97 x 5.40 x 10.8 cm)		
Shipping Weight	2.4 lbs. (1.1 Kg)		
Mounting Options	Mounting plate/pattern & DIN Rail		
Fan Output	5VDC, 400mA max.		

TRANSMITTER	VHF	UHF	900
Tx Frequencies	136 - 174 MHz 215 – 240 MHz	406.125 – 470.000 MHz 450.000 - 511.975 MHz	928 - 960 MHz
Carrier Output Power	1-10 Watts Adjustable	1-10 Watts Adjustable	1-8 Watts Adjustable
Duty Cycle	100% (Power Foldback Allowed for High Temperatures)		
Radiated Spurious Emissions	Per FCC/Regulatory		
Conducted Spurious Emissions	Per FCC/Regulatory		
Transmitter Stability into VSWR:	> 10:1 (Power Foldback Allowed)		
RX to TX Time	< 2 ms (Standard) 4 ms (ETSI Versions)		
Channel Switching Time	< 15 ms (Band-End to Band-End)		

RECEIVER						
	Bandwidth Bit Rate	**140-5016-50x**	**140-5026-50x**	**140-5046-30x** **140-5046-50x**	**140-5096-50x**	**Units**
RX Frequencies		136 - 174	215 - 240	406.125 – 470.000 450.000 - 511.975	928 - 960	MHz
Data Sensitivity @ 10^{-6} Bit Error Rate (BER) Typical / **Max**	**12.5 kHz** 4.9 kbps 9.6 kbps					dBm
	25 kHz 4.8 kbps 9.6 kbps 19.2 kbps					dBm
Adjacent Channel Rejection (min)	12.5 kHz	60	60	60	60	dB
	25 kHz	75	70	75	70	dB
Spurious Response Rejection	All	> 75 dB				dB
Intermodulation Rejection	All	> 75 dB				dB
TX to RX Time	All	< 1 ms (Standard) 5 ms (ETSI Versions)				ms
Channel Switching Time	All	< 15ms (Band-End to Band-End)				ms
Receive Input Power	All	17 dBm (50mW) max.				dBm

MODEM/LOGIC			
	Model	**12.5 kHz**	**25 kHz**
Data Rate (Selectable)	140-5016-50x	4800 9600	4800 9600 19200
	140-5026-50x	4800 9600	4800 9600 19200
	140-5046-30x	4800 9600	4800 9600 19200
	140-5046-50x	4800 9600	4800 9600 19200
	140-5096-50x	4800 9600	4800 9600 19200
Modulation Type	2FSK		
Addressing	Serial		

SETUP and COM Port	
Interface	EIA-232F DCE
Data Rate	Setup Port: 300 – 19,200 bps (Default: 19.2 Kbps) Com Port: 300 – 115,200 bps (Default: 9.6 Kbps)

Display	
5 Tri-color status LEDs	Power, Status, Rx, Tx, RD/TD

Connectors	
Antenna Connector	TNC female (Tx/Rx), SMA female (Rx) – Full-duplex models only
Serial Setup Port	DE-9F
Serial Terminal Server	DE-9F
User Interface	I/O Right angle, 8 contacts (male)
Power - I/O	I/O Right angle, 4 contacts (male)Power Plug

Diagnostics	
Message Elements	Temp, Voltage, Local/Remote RSSI, Forward Power, Reverse Power, Message Quality

Domestic and International Certifications

Model Number	Frequency Range	FCC	IC (DOC)	European Union EN 300 113	Australia/New Zealand
140-5016-500	136 – 174 MHz	NP4-5016-500	773B-5016500		
140-5016-501	136 – 174 MHz	NP4-5016-500	773B-5016500		
140-5026-502	215 – 240 MHz	NP4-5026-502	Pending		
140-5026-503	215 – 240 MHz	NP4-5026-502	Pending		
140-5046-300	406.1 - 470 MHz	NP4-5046-300	773B-5046300		
140-5046-301	406.1 - 470 MHz	NP4-5046-300	773B-5046300		
140-5046-400	406.1 - 470 MHz			CE1588	Pending
140-5046-500	450 - 512 MHz	NP4-5046-300	773B-5046300		
140-5046-501	450 - 512 MHz	NP4-5046-300	773B-5046300		
140-5046-600	450 - 512 MHz				Pending
140-5096-500	928 - 960 MHz	NP4-5096-500	773B-5096500		
140-5096-501	928 - 960 MHz	NP4-5096-500	773B-5096500		

UL Certification

All models	UL approved when powered with a listed Class 2 source.

7   PRODUCT WARRANTY

PRODUCT WARRANTY

CalAmp warrants to the original purchaser for use ("Buyer") that data telemetry products manufactured by DRL ("Products") are free from defects in material and workmanship and will conform to DRL's published technical specifications for a period of, except as noted below, one (1) year from the date of shipment to Buyer. DRL makes no warranty with respect to any equipment not manufactured by DRL, and any such equipment shall carry the original equipment manufacturer's warranty only. DRL further makes no warranty as to and specifically disclaims liability for, availability, range, coverage, grade of service or operation of the repeater system provided by the carrier or repeater operator. Any return shipping charges for third party equipment to their respective repair facilities are chargeable and will be passed on to the Buyer.

If any Product fails to meet the warranty set forth above during the applicable warranty period and is returned to a location designated by DRL. DRL, at its option, shall either repair or replace such defective Product, directly or through an authorized service agent, within thirty (30) days of receipt of same. No Products may be returned without prior authorization from DRL. Any repaired or replaced Products shall be warranted for the remainder of the original warranty period. Buyer shall pay all shipping charges, handling charges, fees and duties for returning defective Products to DRL or DRL's authorized service agent. DRL will pay the return shipping charges if the Product is repaired or replaced under warranty, exclusive of fees and duties. Repair or replacement of defective Products as set forth in this paragraph fulfills any and all warranty obligations on the part of DRL.

This warranty is void and DRL shall not be obligated to replace or repair any Products if (i) the Product has been used in other than its normal and customary manner; (ii) the Product has been subject to misuse, accident, neglect or damage or has been used other than with DRL approved accessories and equipment; (iii) unauthorized alteration or repairs have been made or unapproved parts have been used in or with the Product; or (iv) Buyer failed to notify DRL or DRL's authorized service agent of the defect during the applicable warranty period. DRL is the final arbiter of such claims.

THE AFORESAID WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED AND IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. DRL AND BUYER AGREE THAT BUYER'S EXCLUSIVE REMEDY FOR ANY BREACH OF ANY OF SAID WARRANTIES IT AS SET FORTH ABOVE. BUYER AGREES THAT IN NO EVENT SHALL DRL BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL, SPECIAL, INDIRECT OR EXEMPLARY DAMAGES WHETHER ON THE BASIS OF NEGLIGENCE, STRICT LIABILITY OR OTHERWISE. The purpose of the exclusive remedies set forth above shall be to provide Buyer with repair or replacement of non-complying Products in the manner provided above. These exclusive remedies shall not be deemed to have failed of their essential purpose so long as DRL is willing and able to repair or replace non-complying Products in the manner set forth above.

This warranty applies to all Products sold worldwide. Some states do not allow limitations on implied warranties so the above limitations may not be applicable. You may also have other rights, which vary from state to state.

EXCEPTIONS

THIRTY DAY: Tuning and adjustment of telemetry radios

NO WARRANTY: Fuses, lamps and other expendable parts

ABOUT CALAMP

CalAmp is a leading provider of wireless communications products that enable anytime/anywhere access to critical information, data and entertainment content. With comprehensive capabilities ranging from product design and development through volume production, CalAmp delivers cost-effective high quality solutions to a broad array of customers and end markets. CalAmp is the leading supplier of Direct Broadcast Satellite (DBS) outdoor customer premise equipment to the U.S. satellite television market. The Company also provides wireless data communication solutions for the telemetry and asset tracking markets, private wireless networks, public safety communications and critical infrastructure and process control applications. For additional information, please visit the Company's website at www.calamp.com.