DL-3400
Synthesized Telemetry Link

Part Number 242-40X0-XX0

DL-3400 Synthesized Telemetry Link

Technical Manual

001-4000-101 Revision 007
March 2005

About Dataradio

Dataradio is a leading designer and manufacturer of advanced wireless data products and systems for mission critical applications. Our products are found at the heart of mobile data and SCADA networks around the world. With over 20 years dedicated to data technology and innovation, Dataradio is the premier source for wireless data solutions. Our products include mobile data products, telemetry devices, integrated wireless modems for fixed point-to-point and point to multi-point applications, and OEMs. Our product line is one of the broadest in the industry covering the most often-used frequency bands.

Dataradio COR Ltd.

Dataradio COR Ltd. designs and manufactures radios and integrated wireless modems to serve a wide variety of data communication needs. Dataradio produces equipment for the fixed data market including SCADA systems for utilities, petrochemical, waste and fresh water management markets and RF boards for OEM applications in the Radio Frequency Data Capture market.

Product Warranty

The manufacturer's warranty statement for this product is available in Appendix B.

www.dataradio.com

Dataradio provides product brochures, case studies software downloads and product information on our website.

Every effort is taken to provide accurate, timely product information in this technical manual. Product updates may result in differences between the information provided herein and the product shipped. The information in this document is subject to change without notice.

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Revision History

April 2005
Revision 007

Updated Section 1.3 Transceiver Identification, updated Section 1.6 Technical Support contact information. Section 2, Installation added mounting plate dimensions graphic. Updated Section 3, Programming with current screen shots. Removed references to 900 MHz product.

March 2003
Revision 006

Updated product dimensions, added revision history page

September 2002
Revision 005

Added interface cable wire colors to Table 2-1, page 2-3

November 2001
Revision 004

Updated to Windows-based Field Programming Software, added Appendix A

February 2001
Revision 003

Reformatted Connector Pin Table, page 2-3 to show last row of information, updated to new manual layout

November 2000
Revision 002

Added Band 7 information for VHF units

October 1999
Revision 001

Updated to DRL format, changed circuit description

October 1999
Revision 000

JDT manual release

SECTION 1

GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This service manual contains alignment and service information for Dataradio's DL-3400 Series Synthesized Telemetry Link.

1.2 EQUIPMENT DESCRIPTION

1.2.1 GENERAL DL-3400 TRANSCEIVER INFORMATION

Dataradio DL-3400 Series Analog Transceivers are synthesized data links that operate at 132-174 MHz VHF or 380-512 MHz UHF. Transmitter power output is 5 watts nominal at 13.3VDC in simplex or half-duplex modes.VHF versions of the DL-3400 have a frequency stability of 2.5 ppm. Frequency stability for UHF versions is 1.5 ppm.

The eight channel logic section performs synthesizer loading through an RS-232 DB-9 interface and has circuitry to provide electronic control of:

- Transmit/Receive data conditioning and gating
- Carrier Detect
- Power Control
- Preselector Tracking
- Modulation Flatness
- Audio/Data Filtering
- Sleep\Wake-up to minimize current consumption

and diagnostics that include:

- Supply Voltage
- Supply Current
- RSSI Voltage
- Forward/Reverse Power
- VSWR
- Temperature (F)
- Temperature (C)
- Carrier Detect
- Synth Locked

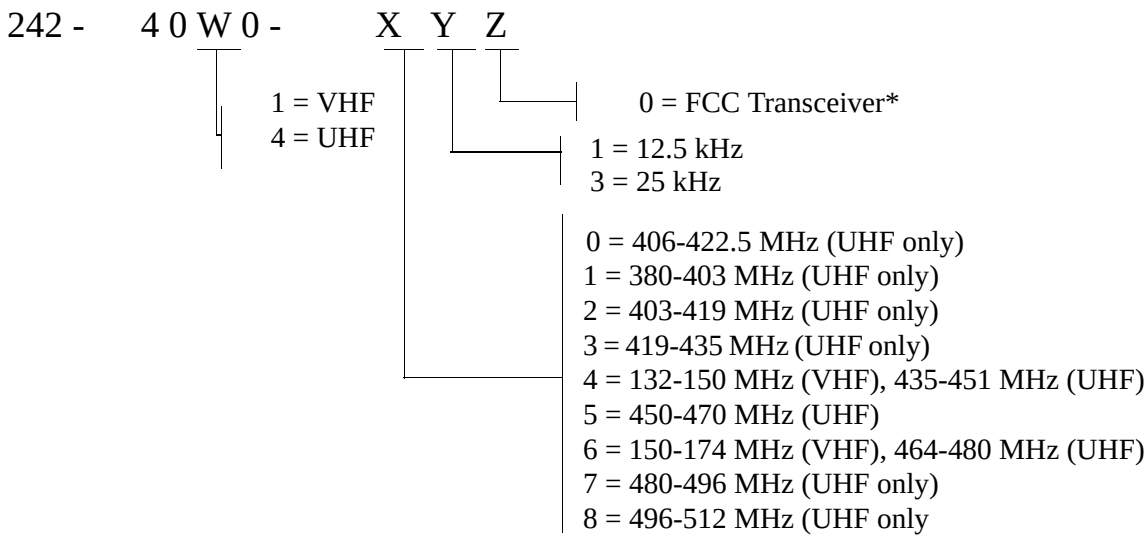
Gating circuits allow user selection of data filtering (standard or wide band.) Pre-emphasis/de-emphasis may be enabled or disabled.

The transceiver is programmed using a PC running Microsoft Windows® and the DL-3400 Field Programming Software (Part No. 250-4000-001). Programming information is stored in an EEPROM in the transceiver. Refer to Section 3.3 for programming information.

1.3 TRANSCEIVER IDENTIFICATION

The transceiver identification number is a random, unique serial number (SN) printed on the shipping box and the model label on the side of the transceiver.

1.4 PART NUMBER BREAKDOWN



***NOTE:** The Z character for the UHF 406-430 MHz range represents:
0 = Rx set LO (UHF 406-422 MHz only)
1 = Rx set HI (UHF 414-430 MHz only)

Figure 1-1 DL-3400 Part Number Breakdown

1.5 ACCESSORIES

TABLE 1-1 ACCESSORIES

Accessory	Part Number
Interface Cable	023-3410-109
DL-3282 1200 Baud Modem	250-3282-002
Factory Installed DL-3282 1200 Baud Modem	023-3282-002
DIN-rail Mounting Kit	250-5800-406
DL-3400 Programming Software	250-4000-001
Switching Power Converter	250-0300-133 (13.3 VDC V Out, 3 Amp)
Test Cable (separates RF and Loader board for easier tuning)	023-3472-007

1.6 TECHNICAL SUPPORT

The Technical Service Department of Dataradio COR Ltd. (DRL) provides customer assistance on technical problems and serves as an interface with factory repair facilities. They can be reached by mail, phone, and E-mail at:

Dataradio COR Ltd.
Technical Support Department
299 Johnson Avenue, Suite 110
Waseca, MN 56093-0833

Technical Service hours are: Monday to Friday 7:30 AM to 4:30 PM, Central Time

Phone: 1-800-992-7774 or 1-507-833-8819

Fax:1-507-833-6758
E-mail address: support@dataradio.com

1.7 PRODUCT WARRANTY

The warranty statement for the DL-3400 is available in the Appendix section.

1.8 REPLACEMENT PARTS

This product is not field serviceable, except by the replacement of complete units. Specialized equipment and training is required to repair logic boards and radio modules.

1.9 FACTORY REPAIR

Dataradio products are designed for long life and failure-free operation. If a problem arises, factory service is available. Contact the Technical Service Department before returning equipment. A service representative may suggest a solution eliminating the need to return equipment.

A Return Material Authorization (RMA) is required when returning equipment to Dataradio for repair. Contact the Technical Service Department at 800-992-7774, extension 6707 to request an RMA number. Be prepared to give the equipment model and serial number, your account number (if known), and billing and shipping addresses. Equipment return information is also available on our website at www.dataradio.com.

Include the RMA number, a complete description of the problem, and the name and phone number of a contact person with the returned units. This information is important. The technician may have questions that need to be answered to identify the problem and repair the equipment. The RMA number helps locate your equipment in depot repair if there is a need to contact Dataradio concerning the equipment. Units sent in for repair will be returned to the customer re-tuned to the current Dataradio Test and Tune Procedure and will conform to all specifications noted in this section

Customers are responsible for shipping charges (to Dataradio) for returned units in warranty. Units in warranty are repaired free of charge unless there is evidence of abuse or damage beyond the terms of the warranty. Dataradio covers return shipping costs for equipment repaired while under warranty.

Units out of warranty are subject to repair service charges. Customers are responsible for shipping charges (to and from Dataradio) on units out of warranty. Return shipping instructions are the responsibility of the customer.

The following are general specifications and are subject to change without notice.

DL-3400 Series VHF (4010) Specifications

GENERAL

Frequency Range	132-150 MHz/150-174 MHz
Frequency Control	Synthesized
IF Bandwidth	12.5/25 kHz
Frequency Resolution	5 kHz, 6.25 kHz, & 7.25 kHz (Range 4), 2.5 kHz (Range 6)
Mode of Operation	Simplex or Half Duplex
Operating Voltage	+13.3V DC nominal (10-16V DC operational)
RF Input/Output	SMA connector (female)
Operating Temperature	-30°C to +60°C (-22°F to +140°F)
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Humidity	95% maximum RH at 40°C, non-condensing
Maximum Dimensions	4.75" L x 3.25" W x 2.38" H with mounting plate 4.20" L x 3.25" W x 2.175" H without mounting plate
FCC Compliance DL-4010	Part 90, Part 15
FCC Identifier	NP42423422-007
Industry Canada Compliance	RSS119, Issue 5
Industry Canada Identifier	933 195 245

RECEIVER

Bandwidth	**132-150 MHz**: 18 MHz with electronic tuning 6 MHz without retuning from 132-150 MHz **150-174 MHz**: 24 MHz with electronic tuning 6 MHz without retuning from 150-174 MHz
Frequency Stability	±2.5 PPM from -30°C to +60°C (-22°F to +140°F)
Sensitivity - 12 dB SINAD	≤ 0.35 µV, -116 dBm psophometrically weighted (Wide DC Output)
RF Input Impedance	50 ohms
Selectivity	-70 dB for 25 kHz, 60 dB for 12.5 kHz
Spurious and Image Rejection	-70 dB
Conducted Spurious Emissions	< -57 dBm
Intermodulation	-70 dB
FM Hum and Noise	-45 dB, 25 kHz channels psophometrically weighted -40 dB, 12.5 kHz channels psophometrically weighted
Receive Attack Time	< 3 ms to $F_a \pm 1.0$ kHz @ 20 dB above 25 dB SINAD,
Rx Audio Mode	WB-DC J102, Pin 2
Audio	
Distortion	< 3% psophometrically weighted
Current Drain	100 mA maximum
Carrier Detect	
Attack Time	Within 2 ms of receiving an RF signal 20 dB greater than an RF signal which produces at least 25 dB SINAD before squelching
Dynamic Range	30 dB minimum -116 to -86 dBm
Audio Response	
FSK Output	+1/-3 dB from 65 Hz to 2.8 kHz (referenced to 1 kHz) -6dB/octave above 3 kHz
Audio Output	+1/-3 dB from a 6 dB/octave de-emphasis curve from 300-3000Hz referenced to 1 kHz (per TIA/EIA-603) -18 dB/octave above 3 kHz
Output Load	Load ≥ 600 ohm
Output Level	200-1600 mVRMS ±5% over voltage and temp variations at ±60% max system dev, 1 kHz tone

TRANSMITTER

Frequency Stability	±2.5 PPM from -30°C to +60°C (-22°F to +140°F)
Bandwidth	132-150 MHz: 18 MHz 150-174 MHz: 24 MHz
Maximum System Deviation	5 kHz (25 kHz), 2.5 kHz (12.5 kHz)
Distortion	< 3% at 60% of maximum system deviation, 1 kHz tone
Flatness	±0.5 dB DC- 5 kHz referenced to 1 kHz tone
RF Power Output	1-5W (User programmable via software, factory tuned to 5W)
Deviation Symmetry	5%
RF Output Impedance	50 ohms
Duty Cycle	50% (30 sec. max transmit) @ 5W
Adjacent Channel Power	-70 dB
Intermodulation Attenuation	-40 dB
Spurious and Harmonic FM	-37 dBm max.
FM Hum and Noise	-45 25 30 kHz, -40 dB 12.5 kHz psophometrically weighted
Current Drain	2.0 A maximum at 5.0 Watts (13.3 VDC)
Audio Response	
FSK Input	+1/-3 dB from 65 Hz to 2.5 kHz (referenced to 1 kHz) -30 dB/octave above 3 kHz
Audio Input	+1/-3 dB from a 6 dB/octave pre-emphasis from 300-3000Hz referenced to 1 kHz (per TIA/EIA-603) -42 dB/octave above 3 kHz
Modulation Capability	
Input	Adjustable, factory preset for 60% maximum rated system deviation with a 400 mVRMS, 1 kHz input
Audio Distortion	≤5% with 1 kHz tone at 60% maximum rated system deviation
Audio Input Impedance	≥40k ohm or 600 ohm, programmable

DL-3400 Series UHF (4040) Specifications

GENERAL	
Frequency Range	380-512 MHz
Frequency Control	Synthesized
IF Bandwidth	12.5/25 kHz
Frequency Resolution	5 kHz, 6.25 kHz, 10 kHz
Mode of Operation	Simplex or Half Duplex
Operating Voltage	+13.3V DC nominal (10-16V DC operational)
RF Input/Output	SMA connector (female)
Operating Temperature	-30°C to +60°C (-22°F to +140°F)
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Humidity	95% maximum RH at 40°C, non-condensing
Maximum Dimensions	4.75" L x 3.25" W x 2.38" H with mounting plate 4.20" L x 3.25" W x 2.175" H without mounting plate
FCC Compliance DL-4040	Part 90, Part 15 (403-512 MHz)
FCC Identifier	NP42423412-004
Industry Canada Compliance	RSS119, Issue 5
Industry Canada Identifier	933 195 238A
RECEIVER	
Bandwidth	20 MHz 450-470, 16 MHz all other bands
Frequency Stability	±1.5 PPM (-30°C to +60°C) (-22°F to +140°F)
Sensitivity - 12 dB SINAD	≤ 0.35 µV, -116 dBm psophometrically weighted (Wide DC Output)
RF Input Impedance	50 ohms
Selectivity	-70 dBfor 25 kHz, 60 dBfor 12.5 kHz
Spurious and Image Rejection	-70 dB
Conducted Spurious Emissions	<-57 dBm
Intermodulation	-70 dB
FM Hum and Noise	-40 dB 12.5 kHz, -45 dB 25 kHz psophometrically weighted
Receive Attack Time	< 3 ms to $F_a \pm 1.0$ kHz @ 20 dB above 25 dB SINAD, Rx Audio Mode: WB-DC J102, Pin 2
Audio	
Distortion	< 3% psophometrically weighted
Current Drain	115 mA maximum
Carrier Detect	
Attack Time	Within 2 ms of receiving an RF signal 20 dB greater than an RF signal which produces at least 25 dB SINAD before squelching
Dynamic Range	30 dB minimum -116 to -86 dBm
Audio Response	
FSK Output	+1/-3 dB from 65 Hz to 2.8 kHz (referenced to 1 kHz) -6dB/octave above 3 kHz
Audio Output	+1/-3 dB from a 6 dB/octave de-emphasis curve from 300-3000Hz referenced to 1 kHz (per TIA/EIA-603) -18 dB/octave above 3 kHz
Output Load	Load ≥ 600 ohm
Output Level	200-1600 mVRMS ±5% over voltage and temp variations at ±60% max system dev, 1 kHz tone

TRANSMITTER

Frequency Stability	±1.5 PPM (-30°C to +60°C) (-22°F to +140°F)
Bandwidth	16 MHz without tuning 20 MHz without tuning 406-430 and 450-470 MHz bands
Maximum System Deviation	5 kHz (25 kHz), 2.5 kHz (12.5 kHz)
Distortion	< 3% at 60% of maximum system deviation, 1 kHz tone
Flatness	±0.5 dB DC - 5 kHz referenced to 1 kHz tone
RF Power Output	1-5W (User programmable via software, factory tuned to 5W)
Deviation Symmetry	5%
RF Output Impedance	50 ohms
Duty Cycle	50% (30 sec. max transmit) @ 5 W
Adjacent Channel Power	-70 dB
Intermodulation Attenuation	-40 dB
Spurious and Harmonic FM	-37 dBm max.
FM Hum and Noise	-45 dB 25 kHz, -40 dB 12.5 kHz psophometrically weighted
Current Drain	2.5 A maximum at 5.0 Watts (13.3 VDC)
Audio Response	
FSK Input	+1/-3 dB from 65 Hz to 2.5 kHz (referenced to 1 kHz) -30 dB/octave above 3 kHz
Audio Input	+1/-3 dB from a 6 dB/octave pre-emphasis from 300-3000Hz referenced to 1 kHz (per TIA/EIA-603) -42 dB/octave above 3 kHz
Modulation Capability	
Input	Adjustable, factory preset for 60% maximum rated system deviation with a 400 mVRMS, 1 kHz input
Audio Distortion	≤5% with 1 kHz tone at 60% maximum rated system deviation
Audio Input Impedance	≥40k ohm or 600 ohm, programmable

WIDEBAND DATA SPECIFICATIONS

Note: User must apply for FCC certification when using Pin 1 to transmit wideband data.

TRANSMIT:

Audio Response	
Wideband Input	
DC Coupled	+1/-3 dB from DC to 5 kHz (referenced to 1 kHz)
AC Coupled	+1/-3 dB from 1 Hz to 5 kHz (referenced to 1 kHz)
Wideband Output Bias	
DC Coupled	2.5V DC ±1% temp compensated to ±100 mV. (must be supplied in Tx/Rx)
AC Coupled	2.5V DC ±1% temp compensated to ±100 mV. (supplied in Tx/Rx internally set)
Wideband Audio Input Impedance	≥ 40k ohm

RECEIVE:

Audio Response	
Wideband Out	
DC Coupled	+1/-3 dB from DC to 5 kHz (referenced to 1 kHz) 25 kHz units
AC Coupled	+1/-3 dB from 1 Hz to 5 kHz (referenced to 1 kHz) 12.5 kHz
Wideband Output Load	Load > 10k ohm
Wideband Output Level	100-200 mV RMS ±5% over voltage and temp variations at ±60% max system dev, 1 kHz tone 2.5 VDC ± 0.5 VDC
Wideband Distortion Output	≤ 3% with 1 mV RF input

SECTION 2

INSTALLATION

2.1 PRE-INSTALLATION CHECKS

Unpack the transceiver. Inspect the unit to ensure the transceiver was not damaged during shipment. Save the packing material and documentation. Field alignment is normally not necessary before transceiver is installed. Check the performance of the transceiver (following the performance tests in Section 4) to make sure no damage occurred during shipment.

2.1.1 CONNECTOR J102 USER INTERFACE

The data equipment interface is J102 on the transceiver. The programming interface is a universal RS-232 DB-9 connector (J104).

An interface cable diagram and also the connector pin designations for this configuration are shown in Figure 2-1. This cable is not included with the data transceiver and must be ordered separately.

2.1.2 J102 INPUT / OUTPUT SIGNAL DESCRIPTIONS

Pin 1 (Tx Wideband Data In) - DC coupling provides a response of +1/–3 dB from DC to 5 kHz (referenced to 1 kHz). AC coupling provides a response of +1/-3 dB from 2 Hz to 5 kHz (referenced to 1 kHz). When this input is used, a 2.5V DC ±1% temperature compensated to ±100 mV bias is required in DC coupling and is internally set in AC coupling. This bias is required because variations in voltage cause the frequency to change. ***Note: User must apply for FCC certification when using Pin 1 to transmit wideband data.*** For wideband specifications, see Section 1, General Specifications, page 1-11.

Pin 2 (Rx Wideband Data Out) - DC coupling provides a response of +1/–3 dB from DC to 5 kHz (referenced to 1 kHz). AC coupling provides a response of +1/-3 dB from 2 Hz to 5 kHz (referenced to 1 kHz). Load impedance should be >10k ohms. The data output level is 100-200 mV RMS ±5% over voltage and temperature variations at ±60% maximum system deviation (see Table 4-2) with a modulation signal of a 1 kHz tone. For wideband specifications, see Section 1, General Specifications, page 1-11.

Pin 3 (Frequency Select In) - A logic high level (no connections) selects Frequency 1 and a low (ground) level selects Frequency 2.

NOTE: If the preceding line is not connected, channel 1 is automatically selected because it is pulled high by an internal pull-up resistor.

Pin 4 (RSSI Out) - The Receive Signal Strength Indicator output provides a voltage that increases in proportion to the strength of the RF input signal.

Pin 5 (+13.3V DC In) - This voltage should be stabilized near +13.3V DC (+10V to +16V operational).

Pin 6 (PTT) - A programmable logic high / low level keys the transmitter and a programmable logic low / high level unkeys the transmitter.

Pin 7 (Carrier Detect Out) - This output goes active when the receive signal increases to the preset level. The active polarity is programmable.

Pin 8 (Tx Data In) - This audio input provides +1/ -3 dB from 6 dB/octave pre-emphasis from 300-3000 Hz referenced to 1 kHz (-42 dB/octave above 3 kHz). FSK input provides +1/-3 dB from 20 Hz to 2.5 kHz referenced to 1 kHz (-30 dB/octave above 3 kHz). When this input is used, a 2.5V DC ±1% temperature compensated to ±100 mV bias is required, this bias is internally set. This bias is required because variations in voltage cause the frequency to change. This pre-emphasis can be bypassed if desired.

Pin 9 (Ground) - Chassis ground.

Pin 10 (RX Data Out) - This audio output provides +1/-3 dB from a 6 dB/octave de-emphasis from 300-3000 Hz referenced to 1 kHz (-18 dB/octave above 3 kHz). FSK output provides +1/-3 dB from 20 Hz to 2.8 kHz referenced to 1 kHz (-6 dB/octave above 3 kHz. This de-emphasis can be bypassed if desired (see Section 3.3). Load impedance should be equal to or greater than 600 ohms. This output level is 200-1600 mV RMS ±5% over voltage and temperature variations at ±60% maximum system deviation with a modulation signal of a 1 kHz tone.

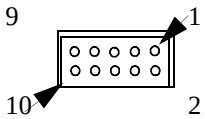


TABLE 2-1 J102 CONNECTOR PIN ASSIGNMENTS

Interface Cable Wire Color (023-3410-109)	Pin	Function
Brown	1	Tx Wideband Data In
Blue	2	Rx Wideband Data Out
Violet	3	Frequency Select In
Green	4	RSSI Out
Red	5	+13.3 V DC In
Orange	6	Tx Key (PTT) In
Gray	7	Carrier Detect Out
Yellow	8	Tx Data In
Black	9	Ground
White	10	Rx Data Out

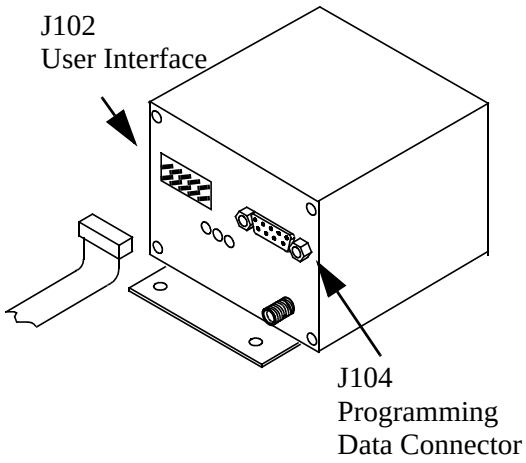
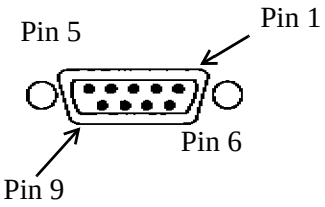


Table 2-2 J104 Programming User Interface Connector Pin Assignments

Pin	Assignment
Pin 1	Sleep/Wake-up
Pin 2	RS-232 Receive Data
Pin 3	RS-232 Transmit Data
Pin 4	Not Used
Pin 5	Ground
Pin 6	Channel Select 0
Pin 7	Not Used
Pin 8	Channel Select 1
Pin 9	Channel Select 2



(Universal RS-232)

Figure 2-1 Interface Cable Installation and Connector Pinout Descriptions

Table 2-3 Pins 9, 8, & 6 Channel Select Descriptions

Channel	Channel Select 2 (Pin 9)	Channel Select 1 (Pin 8)	Channel Select 0 (Pin 6)
1	High (No Connect)	High (No Connect)	High (No Connect)
2	High (No Connect)	High (No Connect)	Low (Ground)
3	High (No Connect)	Low (Ground)	High (No Connect)
4	High (No Connect)	Low (Ground)	Low (Ground)
5	Low (Ground)	High (No Connect)	High (No Connect)
6	Low (Ground)	High (No Connect)	Low (Ground)
7	Low (Ground)	Low (Ground)	High (No Connect)
8	Low (Ground)	Low (Ground)	Low (Ground)

Note: See Appendix A for 3282 modem connection.

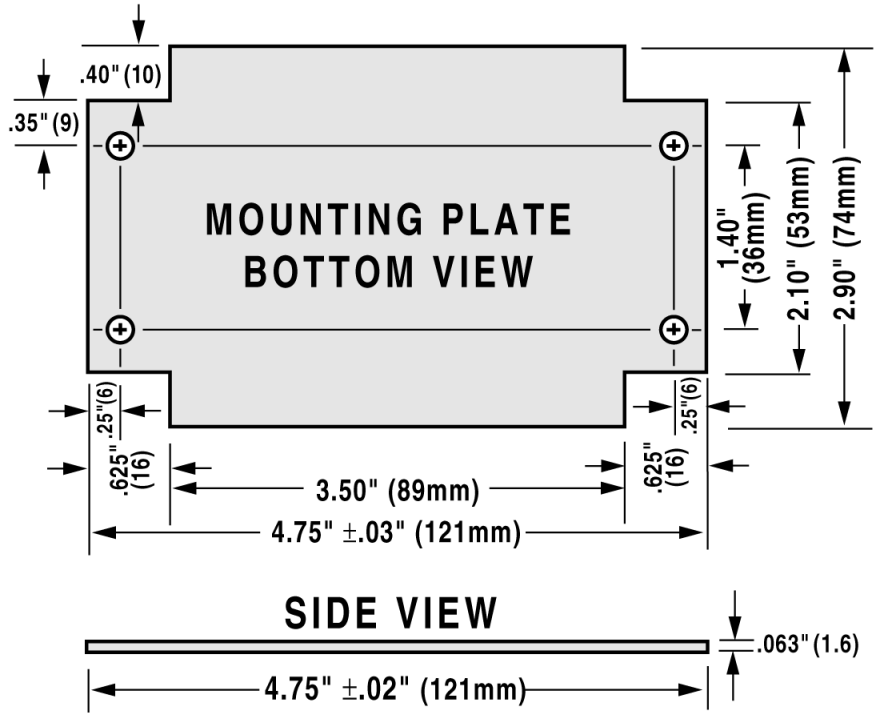


FIGURE 2-2 DL-3400 Mounting Plate Dimensions

SECTION 3

PROGRAMMING

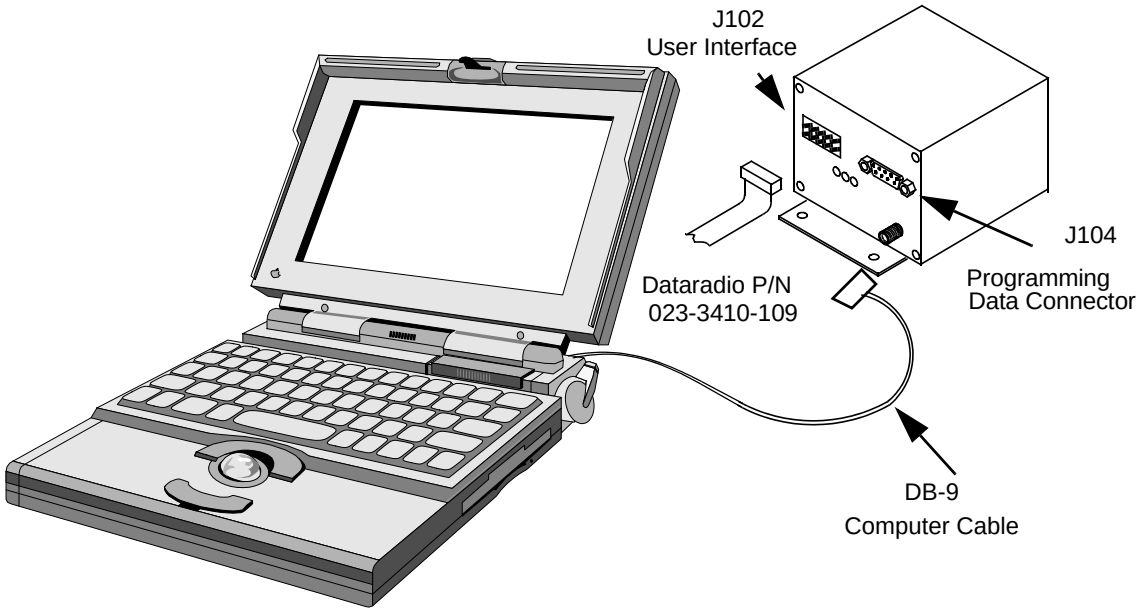


Figure 3-1 DL-3400 Programming Setup

3.1 INTRODUCTION

The DL-3400 Field Programming Software programs the eight channel frequency information into an EEPROM on the board. During power up, the microprocessor reads the information from the EEPROM and loads specific frequency information into the transceiver synthesizer IC.

The software also selects between DC and AC coupled wideband or filtered, inverted or non-inverted, pre-emphasized, and de-emphasized data/audio inputs and outputs. This information is stored in the EEPROM. Two channel selection is made via the frequency select pin in the front panel user interface connector (J102). Eight channel selection is made via three frequency select pins in the front panel programming interface connector (DB-9). Channels can be changed using the field programming software and a DB-9 computer serial cable. *Note: Disconnect Pin 3 (frequency select) of user interface (J102) 10-pin cable (023-3410-109) when using the DB-9 connector.*

3.2 PROGRAMMING INTERFACE CONNECTOR

The programming interface connector (J104) is a RS-232 universal 9-pin female DB-9 (See Table 2-2).

3.3 FIELD PROGRAMMING SOFTWARE

3.3.1 INTRODUCTION

The DL-3400 Field Programming Software package allows the user to program the Loader Board. This manual assumes the Programming Software has been installed on the user's PC with at least one operational serial COM port. DL-3400 programmable settings include:

- Frequencies
- Power Output
- Audio Modes
- Input Line Polarity
- Firmware Updates

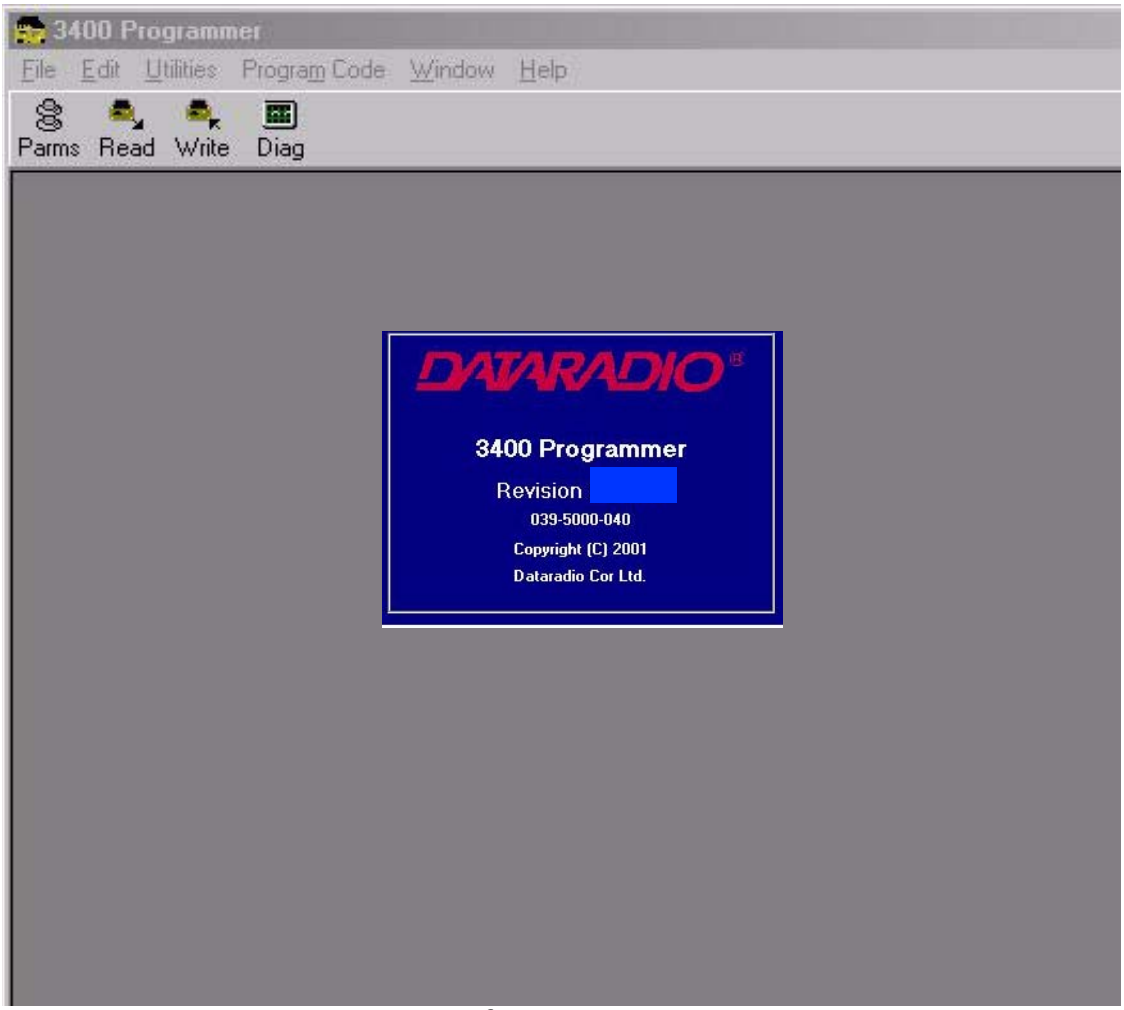


Figure 3-2 DL-3400 Programming Software Startup Screen

3.3.2 SETUP PARAMETERS

The Setup Parameters screen is used to configure the 3400 Loader user programmable options. User programmable parameters are saved in a data file (*.dat). If the parameters are edited, they must be programmed into the 3400 Loader using the Write Parameters menu selection in the Edit menu.

3.3.2.1 PARAMETERS

Figure 3-3 Setup Parameters Screen

Radio Type

Radio Type allows the user to select the transceiver type

- VHF (3412 or 3413 / 4010)
- UHF (3422 or 3423 / 4040)

Radio Range

Radio Range allows the user to select the RF range for the transceiver.

Freq Steps

Freq Steps allows the user to select the channel steps for the transceiver

- 2.50 kHz
- 5.00 kHz
- 6.25 kHz
- 7.50 kHz

Suggested Band Settings

VHF Range 4	VHF Range 6	UHF
7.50 kHz	2.50 kHz	6.25 kHz
6.25 kHz		
5.00 kHz		

Rx Audio Mode

Rx Audio Mode allows the user to select Audio Filtering for the Receive Signals. The following may be selected:

FSK - Flat Response
Inverted FSK - Inverted Flat Response
Audio - Audio Response, de-emphasis is applied
Inverted Audio - Inverted Audio Response, de-emphasis is applied
Wide AC - Wide Band AC coupled
Inverted Wide AC - Inverted Wide Band AC coupled
Wide DC - Wide Band CD coupled

See Section 1, General Specifications, Wideband Data Specifications (page 1-11).

Tx Audio Mode - Tx Audio Mode allows the user to select Audio Filtering for Transmit Signals

FSK - Flat Response (100 - 3300 Hz)
Inverted FSK - Inverted Flat Response (100-3300 Hz)
Audio - Audio Response (300-3300 Hz), pre-emphasis is applied
Inverted Audio - Inverted Audio Response (300-3300 Hz), pre-emphasis is applied
Wide AC - Wide Band AC coupled (20-10000 Hz) ****See FCC notice**
Inverted Wide AC - Inverted Wide Band AC coupled (20-10000 Hz) ****See FCC notice**
Wide DC - Wide Band CD coupled (0-10000 Hz) ****See FCC notice**

*****FCC Notice: Wideband settings will invalidate Dataradio FCC type approval of this product. The selected wideband mode will bypass DL-3400's baseband Tx modulation filtering. Use of the wideband setting requires user FCC type approval for this product.***

Rx Mute Control

The Rx Mute Control selects between Rx Audio mute - only when transmitting or Rx Audio mute when a Carrier is not present (squelch).

PTT Polarity

PTT Polarity allows the user to select between Active High or Active Low input for PTT (transmitting). ***Caution: Programming PTT for Active High will cause the transceiver to "key-up" (internal pull-up resistor). PTT line must be grounded to unkey transceiver or further programming will not be possible and could damage the transceiver.***

Carrier Detect Polarity

Carrier Detect Polarity allows the user to select between Active High or Active Low output for Carrier Sense.

Sleep Polarity

Sleep Polarity allows the user to choose between Active High or Active Low input for Low Power (Sleep) Mode. Active Low supplies an internal pullup. Pin 1 of the DB-9 connector should be left open for Active Low. If operating Active High, Pin 1 should be grounded and the interface circuit must be capable of sinking 600 to 700 uA (microamps). When the DL-3400 is put into Sleep mode, it draws approximately 15 mA.

LED Enable

LED Enable allows the user to enable or disable the LEDs for a current savings.

600 Ohm Input

600 Ohm Input allows to user to choose a 600 ohm impedance.

Tx Only

Tx Only allows the user to choose the transmit only option.

Tune Range

The Tune Range field shows the user if the unit is a UHF model that has been factory tuned for the low or high receive range (International only).

3.3.2.1 FREQUENCY

Frequency allows the user to program the Receive and Transmit Frequency for each of the DL-3400 Loader's eight programmable channels.To change frequency parameters (Rx CN, Tx CN, Tx Power and Tx Mod Flatness) from the Default Settings, click the Advanced Tab. This allows the user to override default parameters on a channel by channel basis.

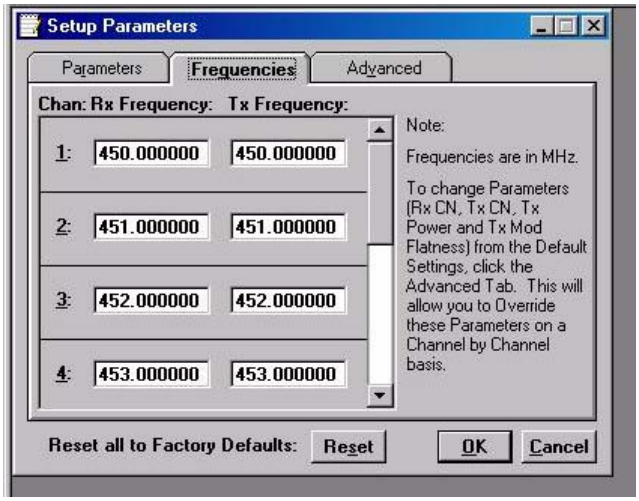


Figure 3-4 Setup Frequencies Parameters Screen

3.3.2.1 SETUP ADVANCED PARAMETERS

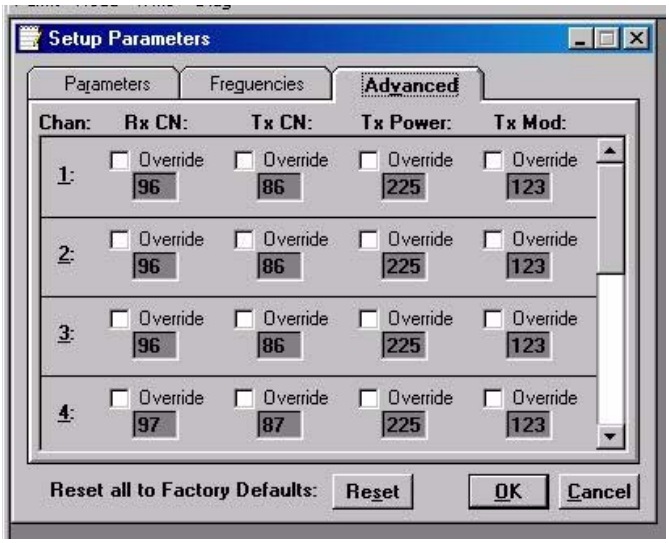


Figure 3-5 Setup Advanced Parameters Screen

The Advanced Parameters tab allows the user to override the factory tuned CN, power output and modulation balance settings for each of the eight programmed channels. ***It is strongly recommended these settings NOT be adjusted.***

Rx CN, TX CN - Parameters in Synthesizer IC to set charge pump currents. The values control lock times and phase-lock loop setting times. **Changing these values may cause an unstable system.**

TX Power - Transmit output power setting NOTE: When Tx Power is overridden, the new values must be entered, a Write performed (programmed) and power cycled for the new values to take effect.

TX Mod - Controls transmitter audio frequency response

3.3.3 VERSION REQUEST

The Version Request utility displays information about the 3400 Loader Firmware.

3.3.4 READ PARAMETERS

The Read Parameters utility reads the user programmable parameters that are currently programmed in the DL-3400 Loader's non-volatile EEPROM.

3.3.5 WRITE PARAMETERS

The Write Parameters utility writes (programs) the user programmable parameters into the DL-3400 Loader's non-volatile EEPROM.

3.3.6 PORT SETTINGS

Port Settings are used to configure the user PC's serial COM ports (Primary and Secondary).

3.3.6.1 PRIMARY/SECONDARY

The Primary port is the main port for the tools of Port Settings. The Secondary Port is used only for those tools requiring two COM ports. A modem is required to transmit and received data through the DL-3400.

COM Port

The COM Port drop down box allows the user to select the COM Port number (1-4) to use for the Primary and Secondary COM Ports.

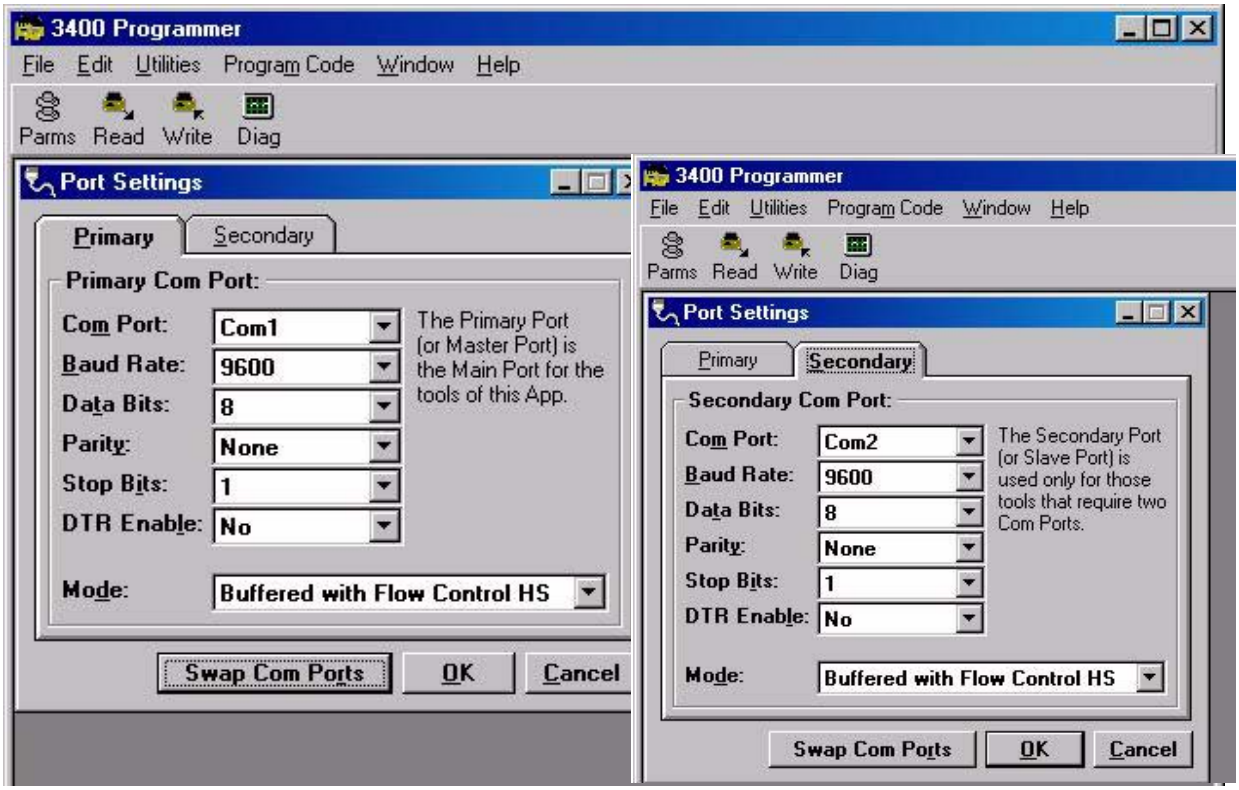


Figure 3-6 Port Settings Screen

Baud Rate

The Baud Rate drop down box allows the user to select the communication speed for the Primary and Secondary COM Ports.

Data Bits

The Data Bits drop down box allows the user to select the number of Data Bits (4-8) transmitted or received for the Primary and Secondary COM Ports.

Parity

The Parity drop down box allows the user to select Parity Bits (None/Odd/Even) transmitted or received for the Primary and Secondary COM Ports.

Stop Bits

The Stop Bits drop down box allows the user to select the number of Stop Bits (1 or 2) transmitted or received for the Primary and Secondary COM Ports.

DTR Enable

DTR Enable allows the user to select whether the DTR (Data Terminal Ready) line of the RS-232 port is asserted when the port is open for the Primary and Secondary COM Ports.

Mode

Mode allows the user to select the communications mode for the Primary and Secondary COM Ports.

Table 3-1 Communications Mode

Mode	**Description**
Sync/Esc with No HS	Send data using the Sync/Esc byte-stuffing protocol with no handshaking
Buffered with No HS	Send buffered data without handshaking
Sync/Esc with RTS/CTS HS	Send data using the Sync/Esc byte-stuffing protocol with RTS/CTS hardware handshaking
Buffered with RTS/CTS HS	Send buffered data with RTS/CTS hardware handshaking
Sync/Esc with Flow Control HS	Send data using the Sync/Esc byte-stuffing protocol with flow control handshaking
Buffered with Flow Control HS	Send buffered data with flow control hardware handshaking

Sync/Esc Framing

A typical Sync/Esc frame resembles the following character stream:

SYNC	ML	Data0	---	DataN	Chksum
8 bits	8 bits	8 bits	---	8 bits	8 bits

with the following definitions made:

Sync (8 bits) - marks the start of a frame when not preceded by an ESC character. When using a Sync/Esc (Framing) Mode, the Field Programming Software will stuff this character automatically.

ML (8 bits) - the length of the frame. ML is the number of characters left to be received including the checksum but excluding any ESC characters added as part of the protocol. When using a Sync/Esc (Framing) Mode, the Field Programming Software will stuff this character automatically based on the number of Data Characters.

Data 0 - N(8 bits each) - frame information

Chksum (8 bits) - the 8 bit 2s complement of the sum of the frame less the SYNC character and any additional ESC added characters ignoring the carryout of the high order bits. When using a Sync/Esc (Framing) Mode, the Field Programming Software will stuff this character automatically.

3.3.7 PORT STATISTICS

The Port Statistics utility displays statistics of the PC's serial COM Ports (Primary and Secondary).

RTS

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

DTR

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

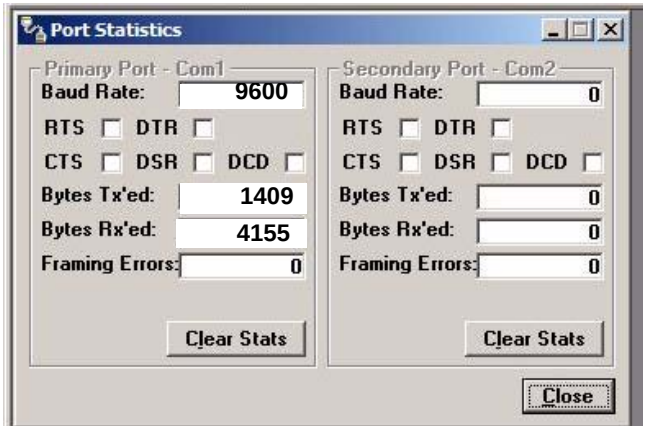


Figure 3-7 Port Statistics Screen

Baud Rate

Baud Rate shows the current data rate for the transceiver.

CTS

CTS shows the current state of the CTS (clear-to-send) line. CTS in 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 Tx'ed shows the number of bytes (characters) transmitted since the port was last opened.

Bytes Rx'ed

Bytes Rx'ed shows the number of bytes (characters) received since the port was last opened.

Framing Errors

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

Dribble Bytes

Dribble Bytes shows the number of extra (not expected) bytes (characters) received since the port was last opened.

3.3.8 DIAGNOSTICS

The diagnostics screen displays the current diagnostic information about the operating conditions of the DL-3400 Loader. Diagnostic parameters include:

- Supply Voltage in Volts (V)
- Supply Current in Amps (A)
- RSSI Voltage in Volts (V)
- Forward Power in Volts (V)
- Reverse Power in Volts (V)
- VSWR (ratio)
- Temperature in Fahrenheit (F)
- Temperature in Celsius (C)
- Carrier Detect (Found/Lost)
- Synth Locked (Locked/Unlocked)

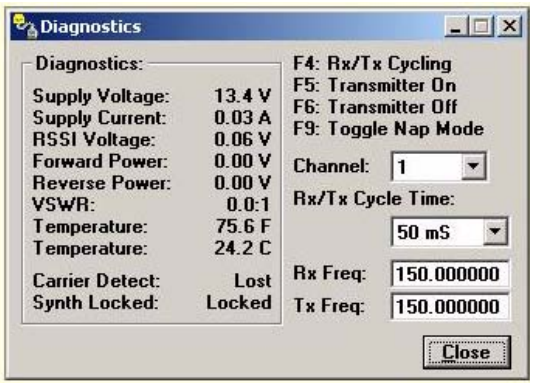


Figure 3-8 Diagnostics Screen

Rx/Tx Cycling (F4)

Pressing the F4 key will activate or deactivate Rx/Tx cycling.

Transmitter On (F5)

Pressing the F5 key will cause the DL-3400 Loader to transmit on the transmit frequency for the selected channel.

Transmitter Off (F6)

Pressing the F6 key will cause the DL-3400 Loader to stop transmitting and to the receive frequency for the selected channel.

Toggle Nap Mode (F9)

Pressing the F9 key will activate or deactivate Nap Mode in the DL-3400.

Channel

Channel allows the user to select any of the user programmable channels 1-8.

Rx/Tx Cycle Time

Rx/Tx Cycle Time allows the user to select a cycle time of 50mS or 500mS.

Rx Frequency

Rx Frequency shows the current receive frequency (in MHz) for the selected channel.

Tx Frequency

Tx Frequency shows the current transmit frequency (in MHz) for the selected channel.

3.3.9 ASCII / HEX TERMINAL

The ASCII / HEX Terminal Screens allow the user to select an ASCII or Hexadecimal Terminal Screen for the Primary and Secondary COM ports that were configured in the Port Settings screen. The data is sent according to the port configuration that was setup in the Port Settings Screen (see Section 3.3.6).
A modem is required to transmit and receive data through the DL-3400.

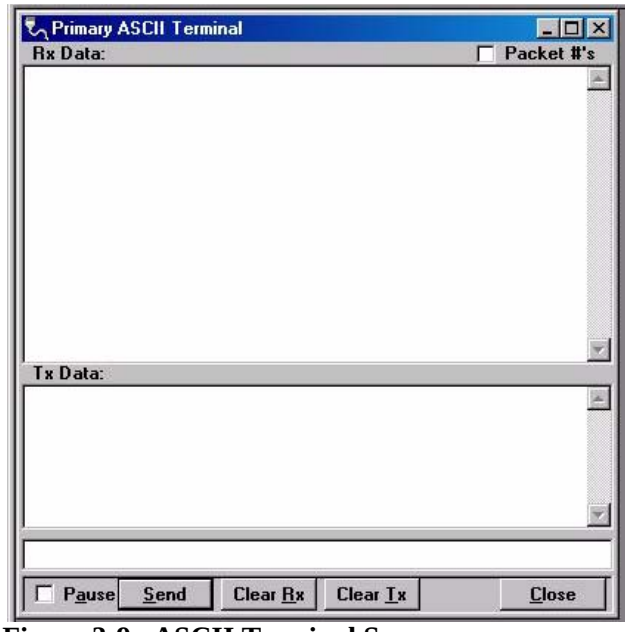


Figure 3-9 ASCII Terminal Screen

3.3.9.1 ASCII TERMINAL

Primary

Primary selects an ASCII Terminal screen to send and receive ASCII data on the primary COM port that was setup in the Port Setting screen.

Secondary

Secondary selects an ASCII Terminal screen to send and receive ASCII data on the secondary COM port that was setup in the Port Settings screen.

3.3.9.2 HEX TERMINAL

Primary

Primary selects a Hexadecimal Terminal screen to send and receive Hexadecimal data on the primary COM port that was setup in the Port Setting screen.

Secondary

Secondary selects an Hexadecimal Terminal screen to send and receive Hexadecimal data on the secondary COM port that was setup in the Port Settings screen.

Note: The following utilities should not be accessed without first consulting Technical Support (see Section 1.6).

3.3.10 PROGRAM CODE

The Program Code utility updates the DL-3400 Loader microcontroller firmware (*.s19).

3.3.11 SELECT BOOT CODE FILE

The Select Boot Code File utility allows the user to change the *.s19 (boot.s19) file that contains the 34XX Loader bootcode to be downloaded to program the non-volatile memory.

3.3.12 SELECT LOADER CODE FILE

The Select Loader Code File utility allows the user to change the *.s19 (ldr_3400.s19) file that contains the 3400 Loader firmware to be programmed into non-volatile memory.

3.3.13 HELP FILES

The DL-3400 Field Programming Software's online help files are accessed by the menu bar at the top of the Field Programming window.

Figure 3-10 DL-3400 Series Help Files

SECTION 4

ALIGNMENT AND TROUBLESHOOTING

4.1 GENERAL

4.1.1 PERIODIC CHECKS

This transceiver should be put on a regular maintenance schedule and an accurate performance record maintained. Important checks are receiver sensitivity, transmitter frequency, modulation, and power output. A procedure for these and other tests is located in Section 4.2.1. It is recommended that transceiver performance be checked annually even though periodic checks are not required by the FCC.

4.1.2 SERVICING

The majority of the components used on the printed circuit boards are surface mount devices. DL-3400 transceiver components are not field serviceable. Specialized training and equipment are required to service board level components. Equipment should be returned to the factory for repair.

4.2 PERFORMANCE CHECKS

4.2.1 TRANSMITTER PERFORMANCE

1. Connect a 1 kHz, 400 mV RMS sine wave to J102, pin 8.

2. Press F5 to key the transmitter. With pre emphasis (Audio Mode), the transmit deviation should be between ±50% and ±20% Maximum Rated System Deviation (see Table 4-2).

3. Input a 2.5 kHz, 4V RMS sine wave to J102, pin 8.

4. Press F5 to key the transmitter. Deviation should not exceed Maximum Rated System Deviation (see Table 4-2).

5. Press F6 to unkey the transmitter.

6. Input a 500 Hz, 400 mV RMS sine wave to J102, pin 8.

7. Press F5 to key the transmitter.

8. With pre emphasis (Audio Mode) the transmit deviation should be less than ±40% Maximum Rated System Deviation (see Table 4-2).

9. Press F6 to unkey the transmitter.

10. Cycle the Tx Audio Mode to FSK. Program the loader board with the following change:

- Tx Audio Mode = FSK

11. Press F5 to key the transmitter. Without pre emphasis (FSK Mode) the transmit deviation should be greater than ±50% Maximum Rated System Deviation (see Table 4-2).

12. Change the audio frequency to 1 kHz.

13. Press F5 to key the transmitter. Without pre emphasis (FSK Mode) the transmit deviation should be between ±50% and ±70% Maximum Rated System Deviation (see Table 4-2).

14. Press F6 to unkey the transmitter.

RF BOARD FEATURES

1. Read the diagnostic Forward Power and Reverse Power reading. They should both be less than 0.1V.

2. Press F5 to key the transmitter.

3. Read the diagnostic Forward Power and Reverse Power reading. The Forward Power reading must be ≥ 1V with the transmitter at full power, and the Reverse Power reading must be less than the Forward Power reading.

4. Press F6 to unkey the transmitter.

4.2.2 RECEIVER PERFORMANCE

1. Decrease the signal generator amplitude until the unit squelches. The Carrier Detect Amber LED (CR102) **must not** light. The signal generator level must be greater than the reference sensitivity for the receiver (12 dB SINAD).

2. Increase the RF signal generator to -90 dBm.

3. Read the diagnostic RSSI Voltage reading. The reading should be within ±10% of the voltage measured on J201, pin 12 (14-pin connector).

4. Increase the RF signal generator to -47 dBm. Reduce the modulating frequency to 500 Hz.

5. With de-emphasis (Audio Mode) the output level on J102, pin 10 should be > 1V RMS (2.83V P-P).

6. Cycle the Rx Audio Mode to FSK. Program the Loader board with the following change:

- Rx Audio Mode = FSK

Without de-emphasis (FSK Mode) the output level on J102, pin 10 should be 707 mV ±2 dB (between 562 mV and 890 mV).

4.2.3 DEVIATION AND SENSITIVITY LEVEL

1. Cycle the Tx Audio Mode to Audio.Program the Loader board with the following changes:

- Tx Audio Mode = Audio

2. Select a frequency near the high end of the band.

3. Connect a 1 kHz, 1V RMS sine wave to J102, pin 8. Set the Modulation Analyzer to 50 Hz-15 kHz filtering.

4. Set R453 (Input Level) to midrange.

5. Press F5 to key the transmitter.

6. Adjust R461 (Tx Deviation) to the Limited Deviation Level in Table 4-1 (set tolerance is +0 Hz/-100 Hz).

7. Press F6 to unkey the transmitter.

4.2.4 CARRIER DETECT AND RECEIVE LEVEL

1. Adjust R416 (Carrier Detect) fully clockwise.

2. Connect an RF signal generator to J501, set at the Receive frequency with 1 kHz modulation, ±60% Maximum Rated System Deviation (see Table 4-2) and -47 dBm RF input.

3. Adjust R409 (Receive Level) for 707 mV RMS (2V P-P) at J102, pin 10.

4. Adjust the signal generator for 25 dB SINAD.

5. Adjust R416 (Carrier Detect) counterclockwise until the audio is hard squelched.

6. Adjust R416 (Carrier Detect) clockwise until audio just unsquelches. The Carrier Detect Amber LED (CR102) **must** light.

Table 4-1 DEVIATION SETUP LEVELS

IF Bandwidth	Maximum Rated System Deviation	Limited Deviation Level Setting	Sensitivity Deviation Level Setting
12.5 kHz	± 2.500 kHz	± 1.90 kHz	± 1.500 kHz
25 kHz	± 5.000 kHz	± 4.40	± 3.000 kHz

Table 4-2 PERCENT DEVIATION REFERENCE GUIDE

IF Bandwidth	Deviations by Percent of Maximum Rated System Deviation (kHz)								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
12.5 kHz	0.250	0.500	0.750	1.000	1.250	1.500	1.750	2.000	2.250
25 kHz	0.500	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500

4.2.5 CHANNEL FREQUENCY

The transceiver frequency is controlled by a temperature compensated crystal oscillator (TCXO) which has a frequency stability of ± 2.5 parts per million for VHF transceivers and 1.5 ppm for UHF transceivers over a temperature range of -30 to + 60° C. When transmitting (for example) at 150 MHz, the output frequency should be 150 MHz ± 375 Hz over temperature. The operating frequency may be fine tuned. (An accessory Test Cable [023-3472-007] allows the separation of the Audio Loader and the RF Board for easier tuning/ testing. See page 1-2 for ordering information.) Remove the transceiver from the chassis. Connect the antenna port to a frequency counter or other frequency measurement instrument. Locate the Frequency Adjust Access Hole on the bottom side of the Loader Board (see Figure 4-2). Enable the transmitter and fine tune the TCXO for the desired transmit frequency (A tuning tool is available from Dataradio's Customer Service as part number 721-0015-142S) See Figure 4-1 for TCXO tuning location.

Caution: An RF attentuator may be required depending on the power handling capability of the measuring instrument.

4.2.6 RF OUTPUT POWER

The RF output power may be verified with an accurate power meter connected with a short 50 ohm cable to the Antenna Connector. From the factory, the transceiver typically provides 5 Watts ± 10% at 13.3 Vdc across the specified band. Transmitter alignment is performed in the factory and is not a recommended field adjustment.

NOTE: Transmit duty cycle must also be considered when making power measurements, see Section 1 for duty cycle specifications.

4.2.7 TRANSMIT DEVIATION LIMITING

Deviation limiting is a factory adjustment that ensures the transmitter is not over-modulated when audio input signal levels vary. Deviation limiting may be verified by applying a 1 kHz, 1 Vrms audio signal to the Tx Data In (pin 8 port of J102). Apply PTT and observe the frequency deviation on a modulation analyzer (or similar equipment). The peak deviation should be ± 2.5 kHz for 12.5 kHz channel transmitters and ± 5 kHz for 25 channel transmitters. If adjustment is required, locate R461 on the Loader Board (see Figure 4-2). Apply the previously mentioned signal and adjust R461 for a peak deviation of < 2.5 kHz or < 5 kHz (whichever is applicable).

4.2.8 TRANSMIT DEVIATION

Transmitter deviation is preset by the factory and is adjustable via R453 on the Loader Board (see Figure 4-2) when using the Tx Data In (pin 8) on the User Interface J102. Refer to General Information, Section 1 for specifications and levels.

4.2.9 RECEIVE AUDIO LEVEL

Receive audio levels are preset by the factory, refer to General Information, Section 1, for specifications and levels. The Rx Data Output can be programmed for de-emphasis or flat response (FSK), (refer to Programming, Section 3). The level may be adjusted via R409. Refer to Figure 4-2 for adjustment locations.

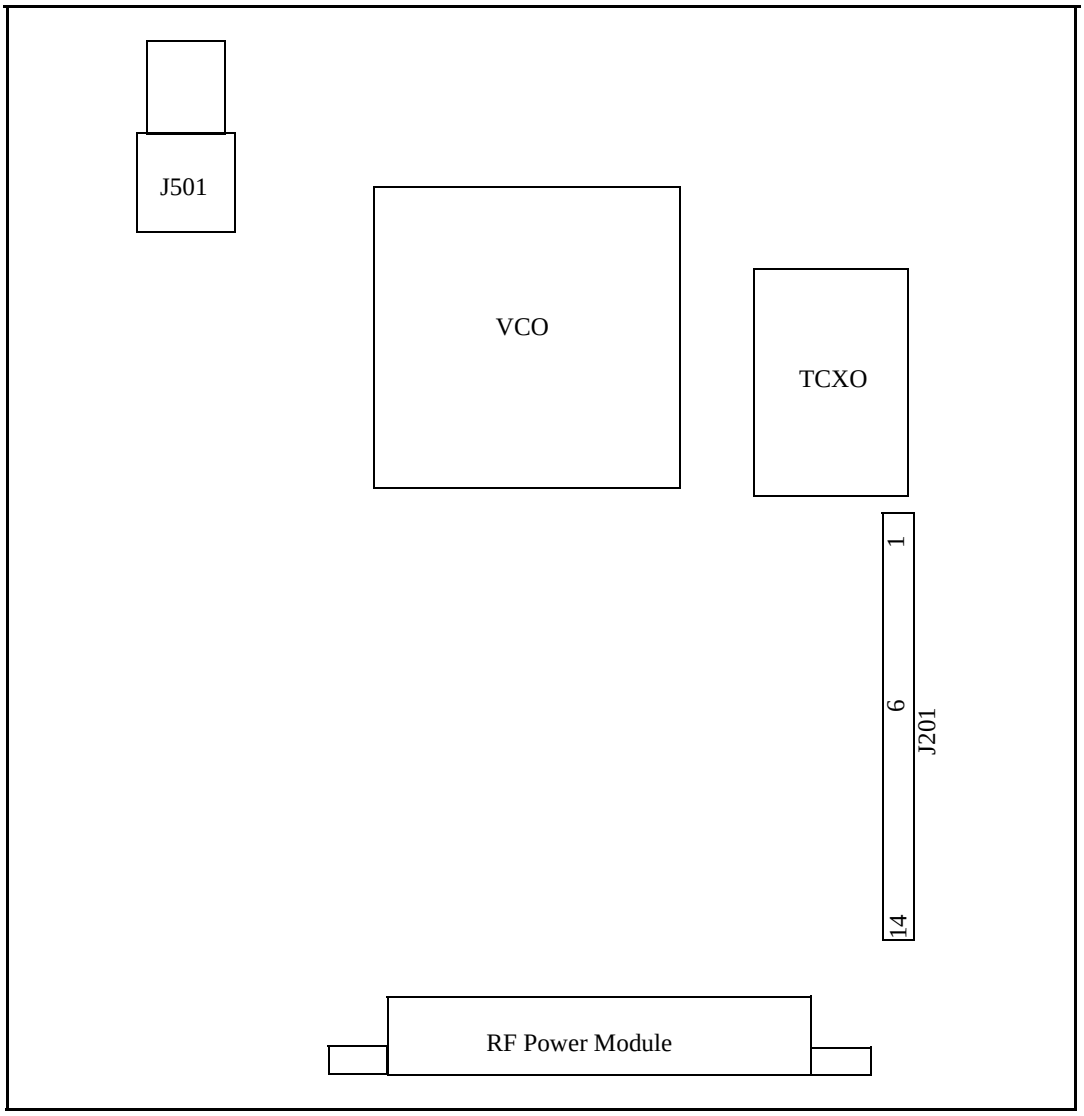


Figure 4-1 DL-3400 RF Board Adjustment Points

(NOTE: A tuning tool should be used to perform adjustments. This tool is available from Dataradio's Customer Service [see Section 1] as part number 721-0015-142S.)

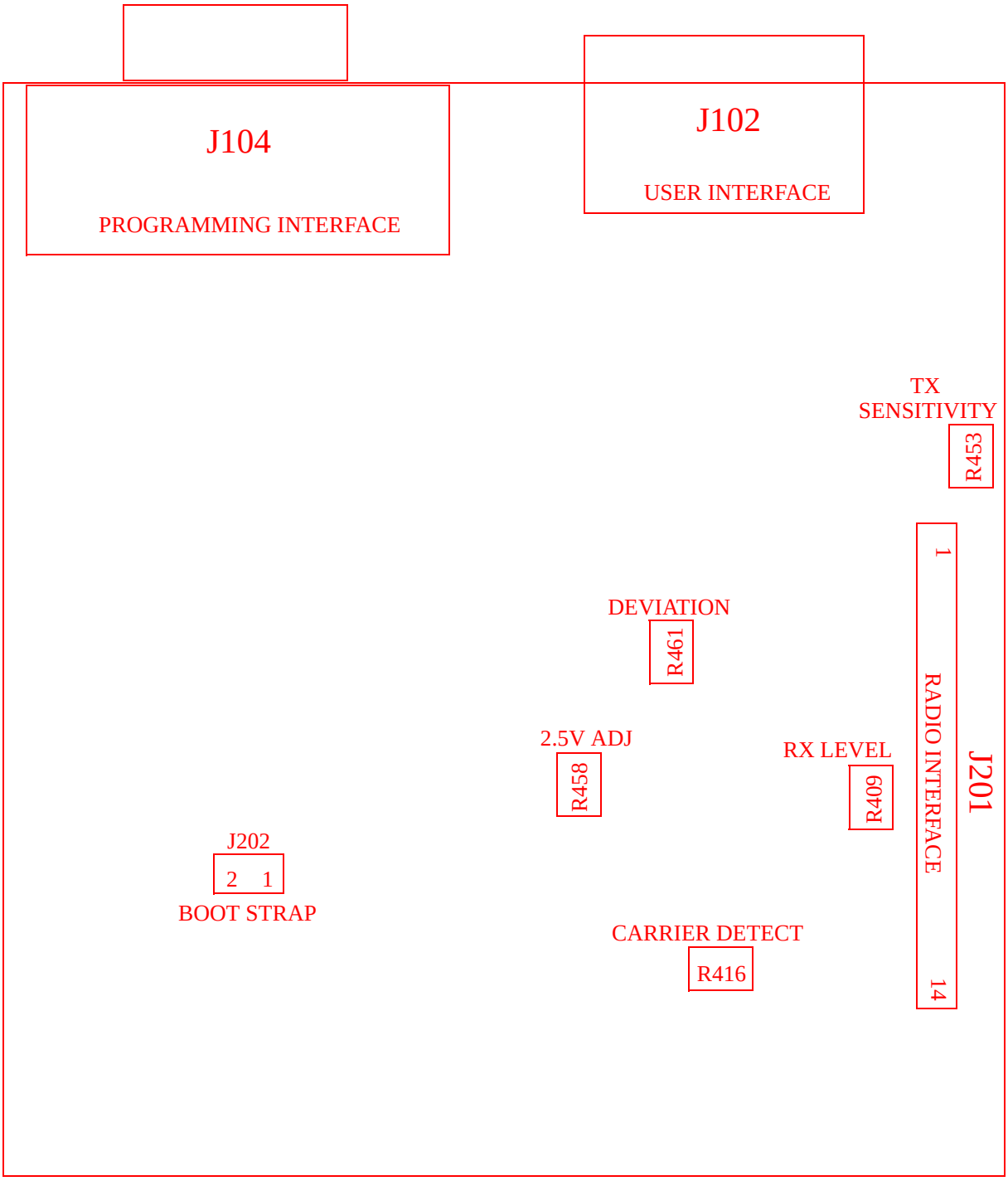


Figure 4-2 DL-3400 Loader Board Adjustment Points

(NOTE: A tuning tool should be used to perform adjustments. This tool is available from Dataradio's Customer Service [see Section 1] as part number 721-0015-142S.)

Technical Support Application Note

(TSAN006DL3400)
Dataradio COR Ltd. Technical Support
U.S.A. 1-800-992-7774 International 1-507-833-8819

Product: DL-3400 Series Analog Transceiver and DL-3282 Bell 202/103 Modem

Application: Provide technical information for connecting a DL-3400 Series Analog Transceiver to a DL-3282 Modem.

The DL-3400 transceiver family is designated as part numbers 242-40W0-XYZ, available in VHF (132-174 MHz), and UHF (380-512 MHz). The DL-3282 modem (part number 250-3282-002) and is configurable in Bell 202 or Bell 103 formats (DIP switch selectable).

Combined, the DL-3400 and DL-3282 provide a reliable 300 bps or 1200 bps RS-232 serial data system.

Modem Set-up: The DL-3282 modem does not require special programming for normal Bell 202 or Bell 103 operation. All data parameters are set using an eight position DIP switch located inside the modem. The functions of these switches are:

Position	Function	Factory Default
1. Normal/Loop	Normal Operation/ Loopback Test Mode	Off – Normal
2. Conventional	Normal Operation	Off – Conventional
3. Bell 202/103	Selects Modem Format	Off - Bell 202
4. Squelch Invert	Carrier Detect	Off - Active High
5. Half/Full-Duplex	Duplex Mode Determination	Off - Half Duplex
6. Option 1	Self-Test Mode	Off - Self-Test Off
7. RTS/CTS	Set RTS/CTS Delay	On – 240 mSec. Delay
8.	Timer	On

Radio Programming: The DL-3400 transceiver is computer programmable using Dataradio's Field Programming Software (part number 250-4000-001). Connection from the computer to the radio is through a standard DB-9 straight through serial cable.

Power for the radio connects to the 10-pin ribbon cable connection located on the front of the radio. Dataradio offers a cable assembly (part number 023-3410-125) that consists of two 10-pin connectors to three feet of wire with spade lug terminations. This cable applies power to the radio for programming and

connects the radio to the modem for application purposes. The red (B+) wire and black (B-) wire are for connection to a DC voltage supply of +10 to +15 VDC.

After the programming software is installed, the Field Programming Software start up screen displays a toolbar with several options.

Click on the Read button (Fig. 1) to download the parameters from the radio.

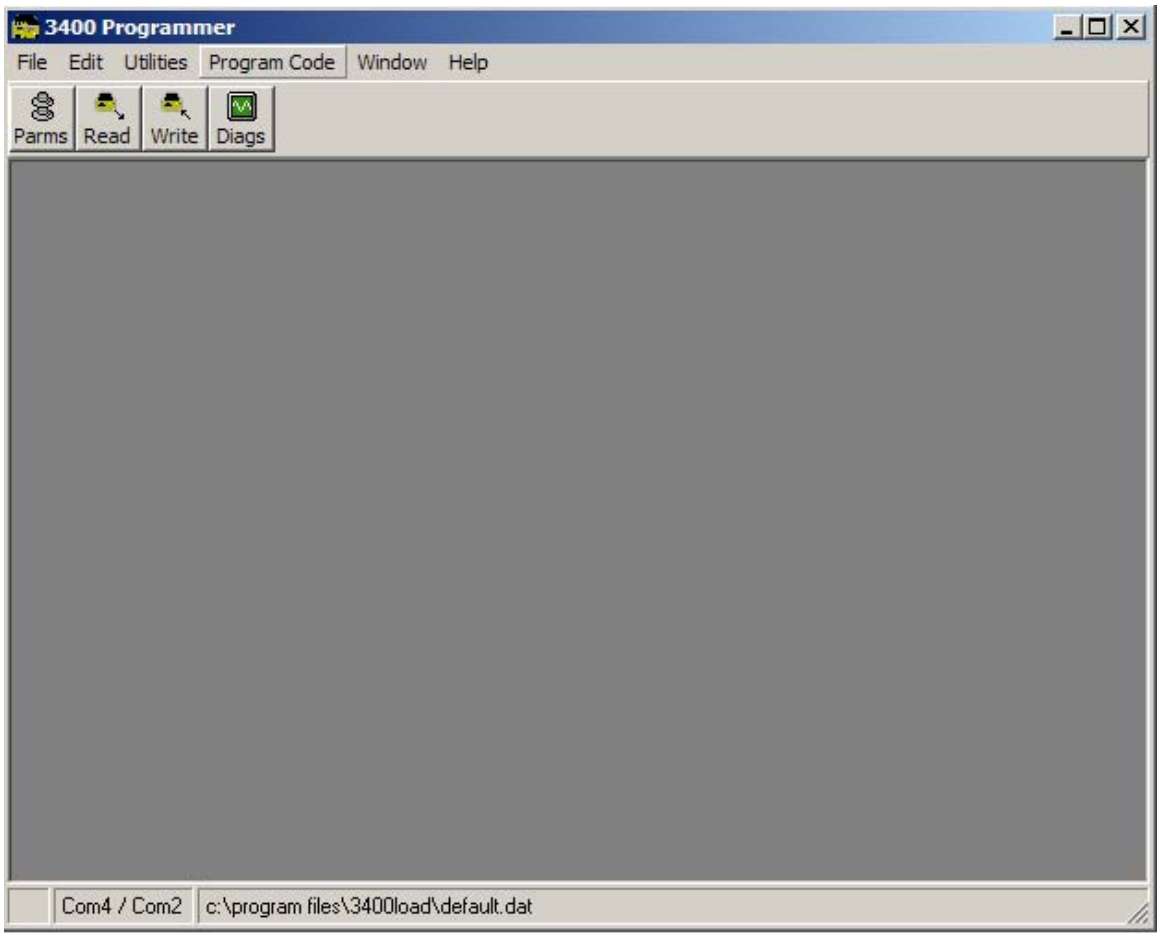


Fig. 1

Click on the Parameters tab (Fig. 2) and set the following items:

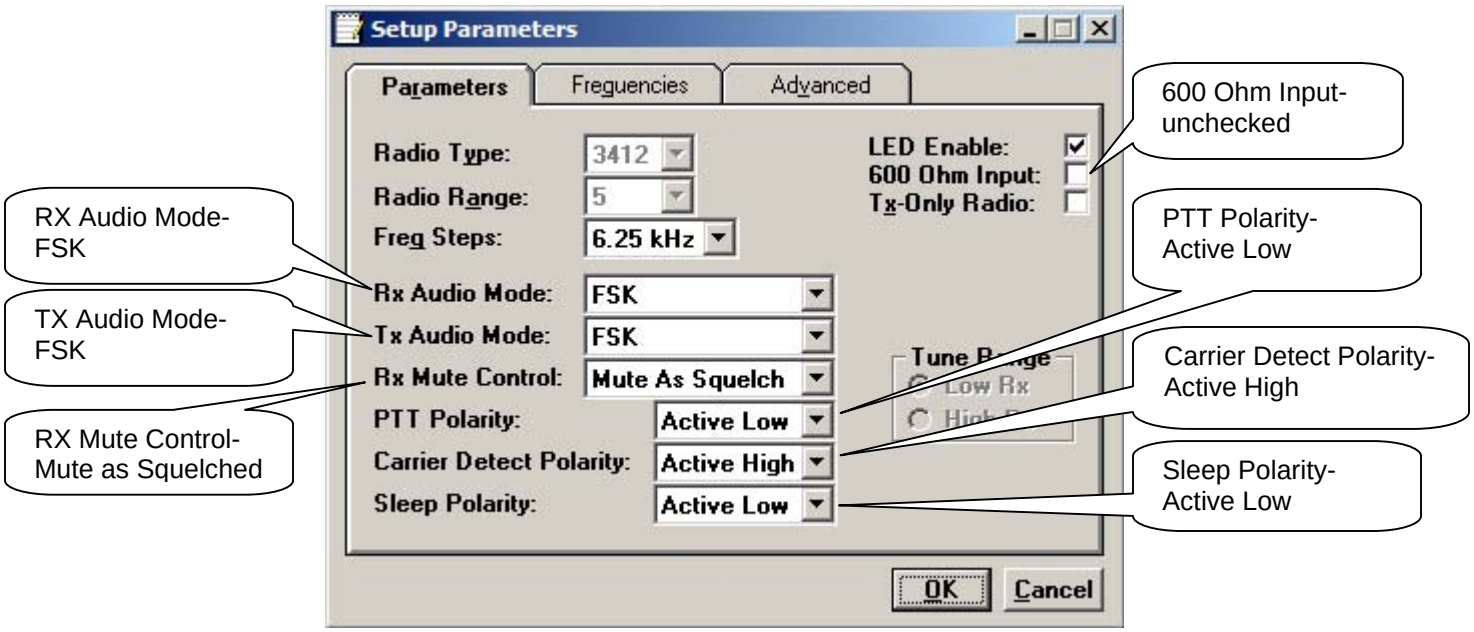


Fig. 2

Click on the Frequencies Tab (Fig 3):
Select Frequencies- highlight and type in the frequencies. We suggest that all 8 channels be programmed the same unless your application uses the channel select feature.

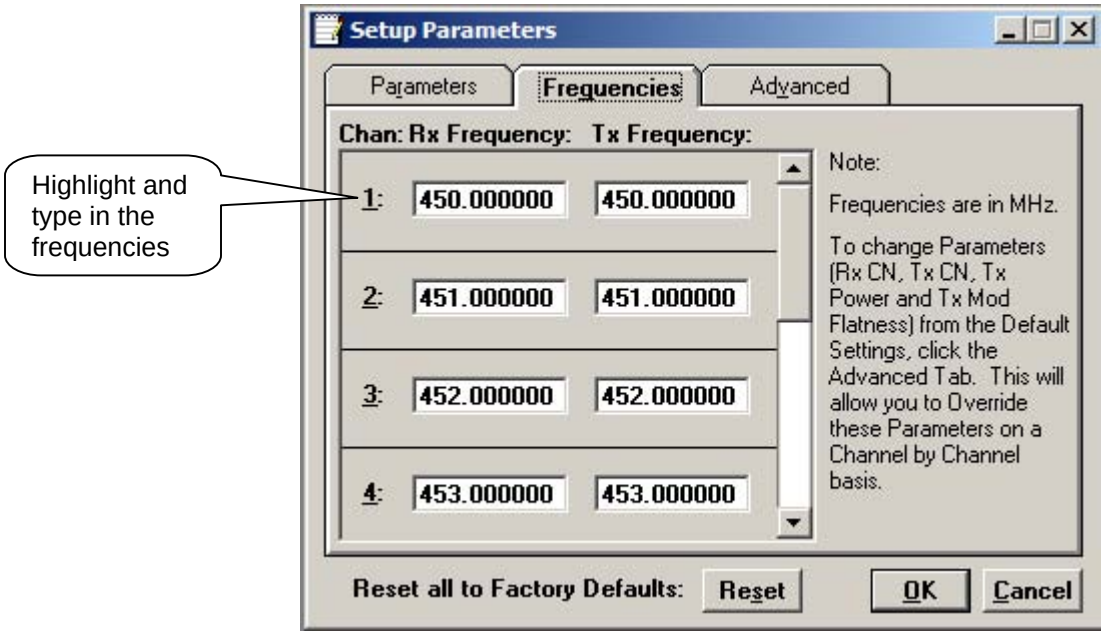
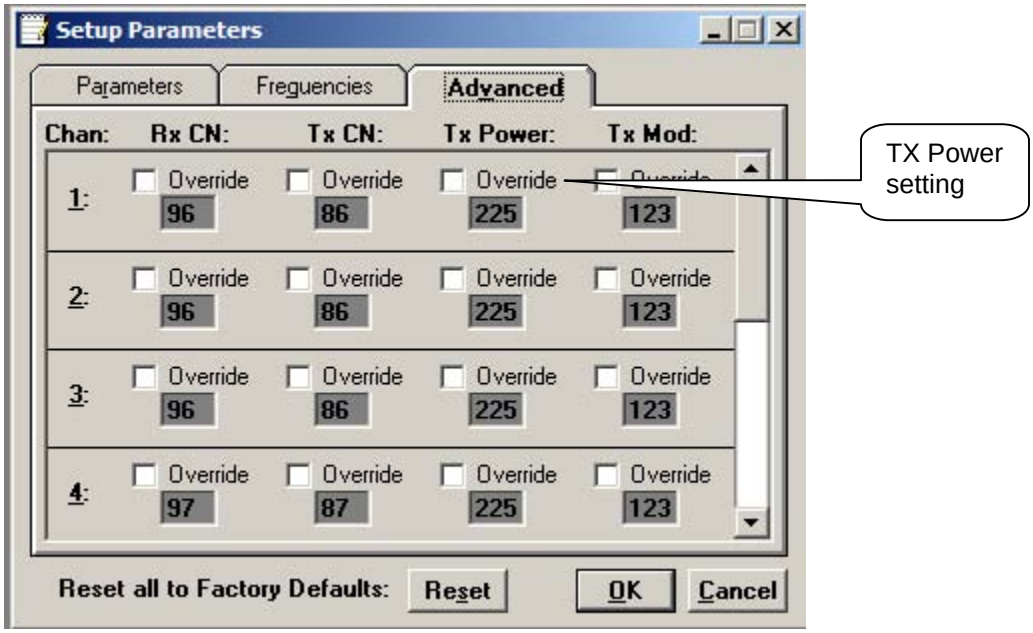


Fig. 3

Advanced Tab (Fig. 4): Unless the output power is to be set to a value lower than the factory set level, there is no need to access this tab.



IF making changes, click on the OK button and then click the WRITE button to write the new values into the radio. Then perform a READ to verify the changes have been programmed into the radio. *Note*: *The OK button is a "save and continue". It does not write the parameters to the radio.*

For further information, refer to the installation manuals for the DL-3400 transceiver (001-4000-101) and (001-3282-101) DL-3282 modem.

Connection: Figure 4 shows the connection between the DL-3400 transceiver and DL-3282 modem using Dataradio's ribbon cable assembly (023-3410-125) dual 10-pin cable. Figure 5 gives a pin-out description of the 10-pin connector. Figure 6 shows typical configuration and connection of the radio and modem.

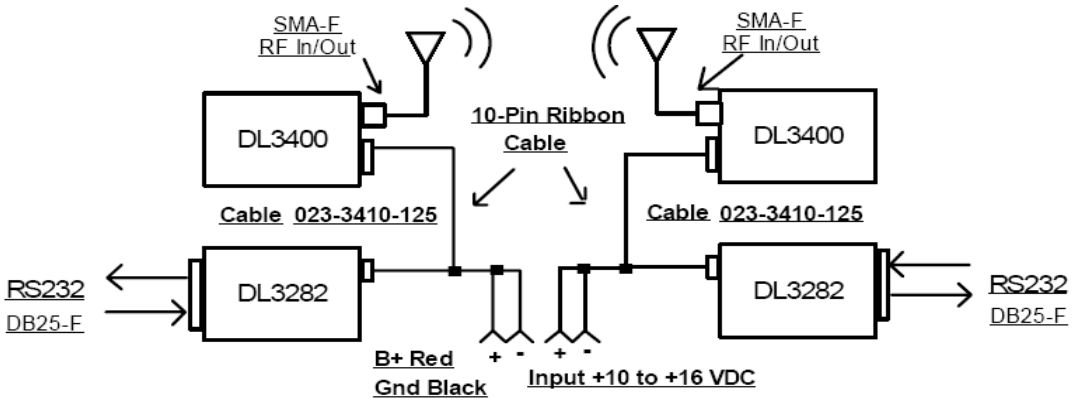
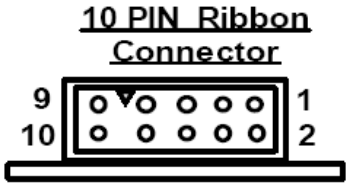


Fig. 4



Radio Connector
Pin Assignment

PIN	COLOR	FUNCTION
1	Brown	TX Wideband Data Out
2	Blue	RX Wideband Data In
3	Violet	Not Used
4	Green	Not Used
5	Red	Supply Voltage (+)
6	Orange	TX Key (PTT) Out
7	Gray	Carrier Detect In/Out
8	Yellow	TX Narrowband Data In/Out
9	Black	Ground (-)
10	White	RX Narrowband Data In/Out

Fig. 5

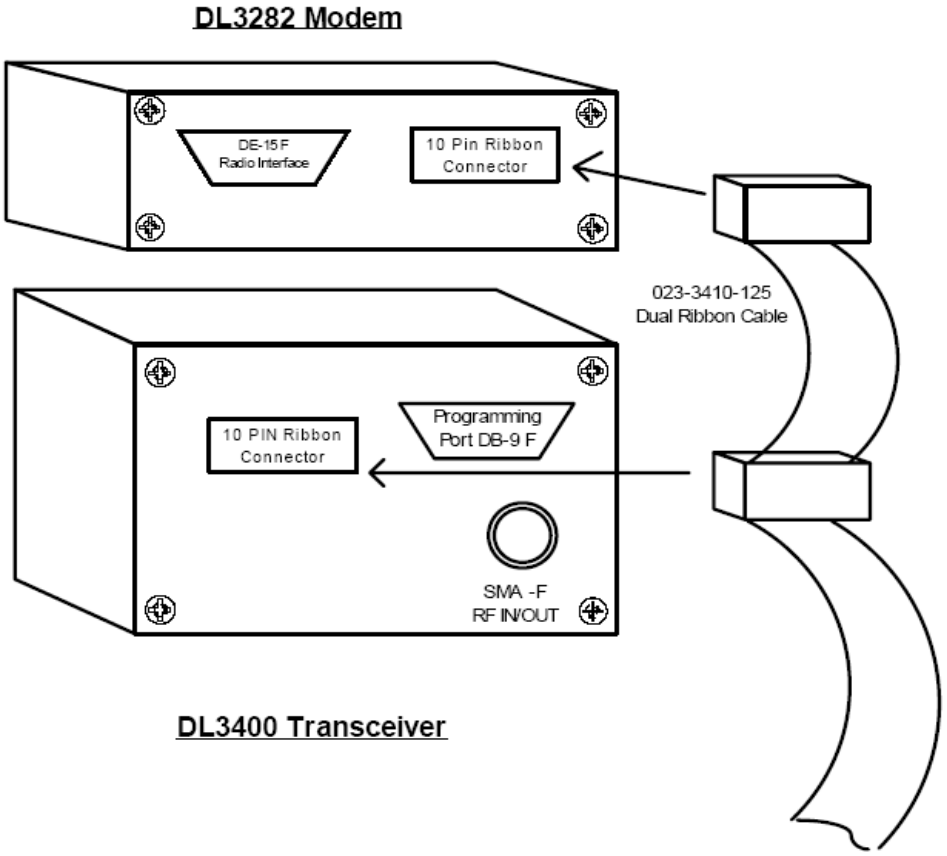


Fig. 6

DATARADIO®

TRUSTED WIRELESS DATA

DATA TELEMETRY PRODUCT WARRANTY

Dataradio COR Ltd. ("DRL") 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, two (2) years 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

ONE YEAR:	Labor to replace defective parts in repeaters or base stations
THIRTY DAY:	Tuning and adjustment of telemetry radios
NO WARRANTY:	Fuses, lamps and other expendable parts

Effective 01/2004