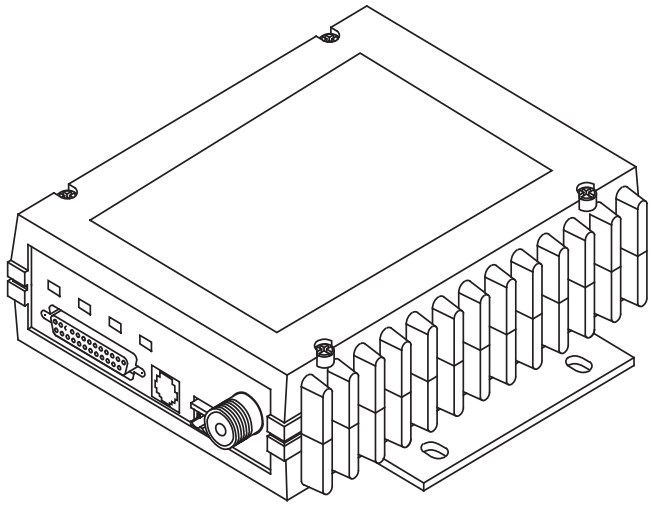
MDS 4710B/9710B



Data Transceiver

MDS 05-3316A01, REV. E
SEPTEMBER 2000

Microwave Data Systems Inc.

Installation and Operation Guide

QUICK START GUIDE

Below are the basic steps for installing the transceiver. Detailed instructions are given in “INSTALLATION” on page 5 of this guide.

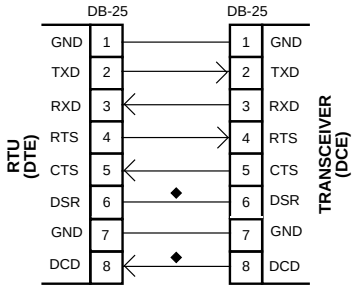
1. Install and connect the antenna system to the radio

- Use good quality, low loss coaxial cable. Keep the feedline as short as possible.
- Preset directional antennas in the direction of desired transmission.

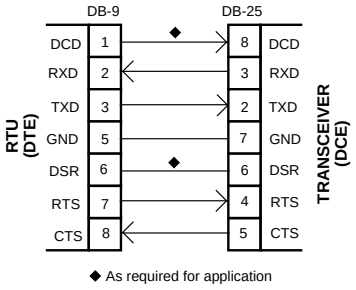
2. Connect the data equipment to the radio’s INTERFACE connector

- Connection to the radio must be made with a DB-25 Male connector. Connections for typical systems are shown below.
- Connect only the required pins. Do not use a straight-through RS-232 cable with all pins wired.
- Verify the data equipment is configured as DTE. (By default, the radio is configured as DCE.)

DB-25 to DB-25 Example



DB-9 to DB-25 Example



3. Apply DC power to the radio (10.5–16 Vdc @ 2.5 A minimum)

- Observe proper polarity. The red wire is the positive lead; the black is negative.

4. Set the radio’s basic configuration with a Hand-Held Terminal (HHT)

- Set the transmit frequency (**TX xxx.xxxxx**).
- Set the receive frequency (**RX xxx.xxxxx**).
- If the transceiver will be listening to a switched carrier master station, set switched carrier mode operation with the **SWC** command.
- *If the modem is 9600 bps,* set the data interface parameters as follows. Use the **BAUD 9600 abc** command, where **9600** is the data rate and **abc** are the communication parameters as follows:
  a = Data bits (7 or 8)
  b = Parity (N for None, O for Odd, E for Even
  c = Stop bits (1 or 2)
  (Example: **BAUD 9600 8N1**)

  NOTE: 7N1, 8E2 and 8O2 are invalid parameters and are not supported by the transceiver.

5. Verify proper operation by observing the LED display

- Refer to Table 6 on page 13 for a description of the status LEDs.
- Refine directional antenna headings for maximum receive signal strength using the **RSSI** command.

TABLE OF CONTENTS

Copyright Notice

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Microwave Data Systems reserves its right to correct any errors and omissions in this publication.

Operational Safety Notices

RF Exposure

The radio equipment described in this guide emits radio frequency energy. Although the power level is low, the concentrated energy from a directional antenna may pose a health hazard. Do not allow people to come within 6 meters of the front of the antenna when the transmitter is operating.

This manual is intended to guide a professional installer to install, operate and perform basic system maintenance on the described radio.

ISO 9001 Registration

Microwave Data Systems adheres to this internationally accepted quality system standard.

MDS Quality Policy Statement

We, the employees of Microwave Data Systems, are committed to achieving total customer satisfaction in everything we do.

Total Customer Satisfaction in:

- Conception, design, manufacture and marketing of our products.
- Services and support we provide to our internal and external customers.

Total Customer Satisfaction Achieved Through:

- Processes that are well documented and minimize variations.
- Partnering with suppliers who are committed to providing quality and service.

- Measuring our performance against customer expectations and industry leaders.
- Commitment to continuous improvement and employee involvement.

FM/UL/CSA Notice

This product is available for use in Class I, Division 2, Groups A, B, C & D Hazardous Locations. Such locations are defined in Article 500 of the National Fire Protection Association (NFPA) publication NFPA 70, otherwise known as the National Electrical Code.

The transceiver has been recognized for use in these hazardous locations by three independent agencies —Underwriters Laboratories (UL), Factory Mutual Research Corporation (FMRC) and the Canadian Standards Association (CSA). The UL certification for the transceiver is as a Recognized Component for use in these hazardous locations, in accordance with UL Standard 1604. The FMRC Approval is in accordance with FMRC Standard 3611. The CSA Certification is in accordance with CSA STD C22.2 No. 213-M1987.

FM/UL/CSA Conditions of Approval:

The transceiver is not acceptable as a stand-alone unit for use in the hazardous locations described above. It must either be mounted within another piece of equipment which is certified for hazardous locations, or installed within guidelines, or conditions of approval, as set forth by the approving agencies. These conditions of approval are as follows:

1. The transceiver must be mounted within a separate enclosure which is suitable for the intended application.

2. The antenna feedline, DC power cable and interface cable must be routed through conduit in accordance with the National Electrical Code.

3. Installation, operation and maintenance of the transceiver should be in accordance with the transceiver's installation manual, and the National Electrical Code.

4. Tampering or replacement with non-factory components may adversely affect the safe use of the transceiver in hazardous locations, and may void the approval.

5. When installed in a Class I, Div. 2, Groups A, B, C or D hazardous location, observe the following:
   WARNING —EXPLOSION HAZARD— Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

Refer to Articles 500 through 502 of the National Electrical Code (NFPA 70) for further information on hazardous locations and approved Division 2 wiring methods.

Notice

While every reasonable effort has been made to ensure the accuracy of this manual, product improvements may result in minor differences between the manual and the product shipped to you. If you have additional questions or need an exact specification for a product, please contact our Customer Service Team using the information at the back of this guide. In addition, manual updates can often be found on the MDS web site at www.microwavedata.com.

1.0 GENERAL

This guide presents installation and operating instructions for the MDS 9710B (900 MHz) and MDS 4710B (400 MHz) radio transceiver. For brevity, the model number "MDS x710B" is used in this guide to represent both models, except where it is necessary to distinguish between the two.

The transceiver (Figure 1) is a data telemetry radio suitable for Multiple Address System (MAS) and Supervisory Control and Data Acquisition (SCADA) operation. It uses microprocessor control and Digital Signal Processing (DSP) technology to provide highly reliable communications even under adverse conditions.

These radios are designed for over-the-air compatibility with earlier MDS remote transceivers such as the MDS 2300 and MDS 4300 Series as well as the MDS 1000µ. The radios will operate in systems using MDS 2100 and 4100 master stations.

An MDS 4710 is also available which is adherent to the United Kingdom's MPT1411 specifications for radio performance and frequency assignment criteria. The MPT1411 compliant version of the MDS 4710 is covered in MDS manual 05-3634A01.

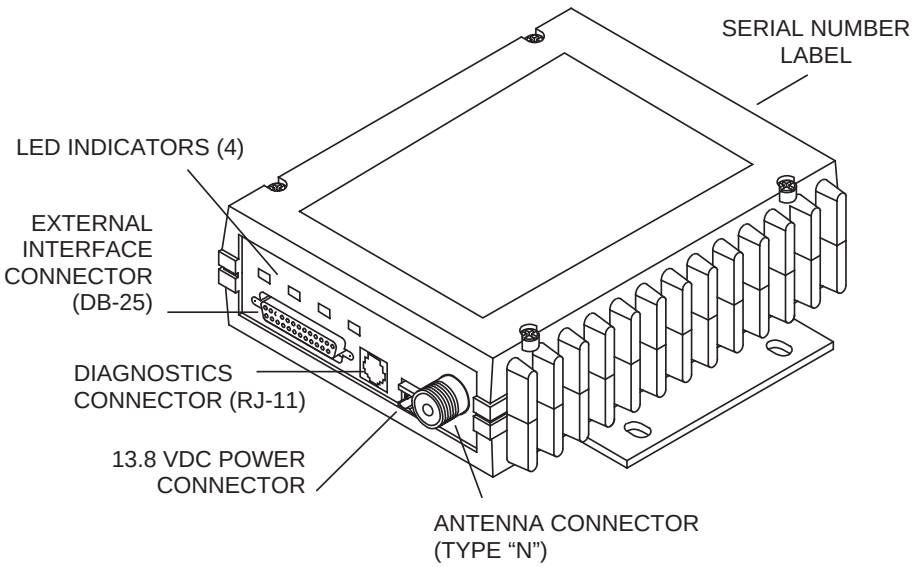

Figure 1. Transceiver connectors & indicators

1.1 Applications

Multiple Address System (MAS)

This is the most common application of the transceiver. It consists of a central master station and several associated remote units as shown in

Figure 2. An MAS network provides communications between a central host computer and remote terminal units (RTUs) or other data collection devices. The operation of the radio system is transparent to the computer equipment.

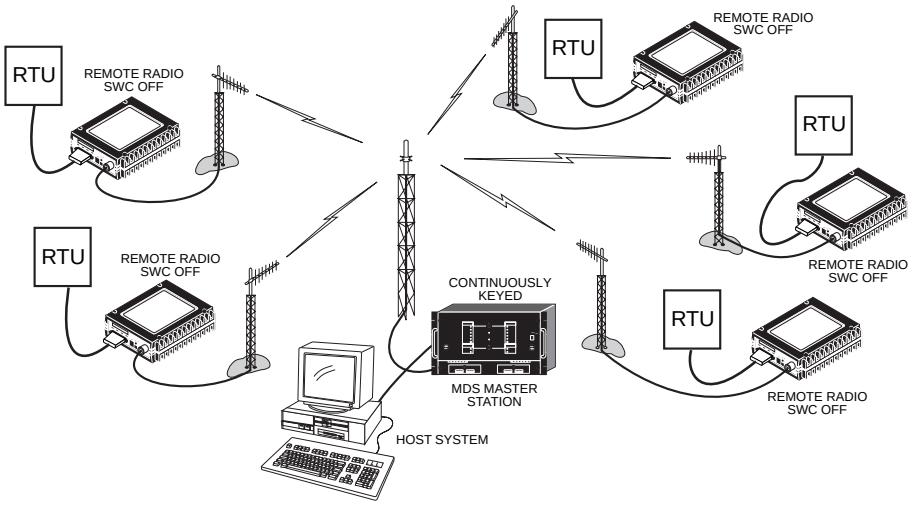

Figure 2. Typical MAS network

Point-to-Point System

Where permitted, the transceiver may also be used in a point-to-point arrangement as shown in Figure 3. A point-to-point system consists of just two radios. It provides a simplex or half-duplex communications link for the transfer of data between two locations. Refer to *Continuously Keyed versus Switched Carrier Operation on page 2* for additional information.

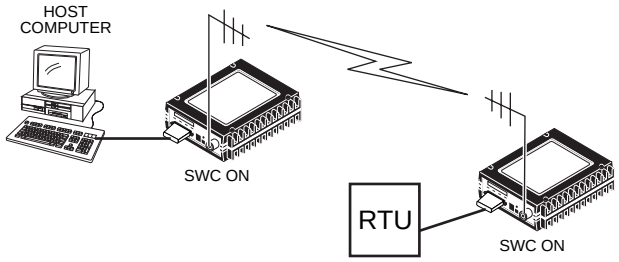

Figure 3. Typical point-to-point link

Continuously Keyed versus Switched Carrier Operation

The keying behavior of the master station can be used to describe an MAS system.

Continuously Keyed operation means the master station transmitter is always keyed and an RF carrier is always present, even when there is no data to send. Continuously keyed operation is inherently full duplex. The master station is always simultaneously transmitting and continuously listening. Different frequencies must be used for transmit and receive. This is the method used in most MAS systems and is shown in Figure 2.

Switched Carrier operation is a half-duplex mode of operation where the master station transmitter is keyed to send data and unkeyed to receive.

For proper operation, x710B radios must be specifically configured to listen to either a continuously keyed or switched carrier master. The **SWC** command is used to select whether or not a radio is listening to a switched carrier master. The default setting is **SWC OFF**, for communications with a continuously keyed master.

MDS x710B radios always transmit using switched carrier operation. If a radio system is configured with an x710B as the master, all radios (master and remotes) must be configured with **SWC ON**. This situation is shown in a point-to-point system in Figure 3.

Single Frequency (Simplex) Operation

Single frequency operation (also known as simplex) is a special case of switched carrier operation. The **SWC** command must be set to **ON**. Single frequency operation is automatically selected whenever the transmit and receive frequencies are set to the same value. Note that data turn-around times are increased when a single frequency configuration is used.

1.2 Model Number Codes

The radio model number is printed on the end of the radio enclosure, and provides key information about how the radio was configured when it was shipped from the factory. See Figure 4 for an explanation of the model number characters.

THIS INFORMATION IS SUBJECT TO CHANGE. DO NOT USE FOR PRODUCT ORDERING.

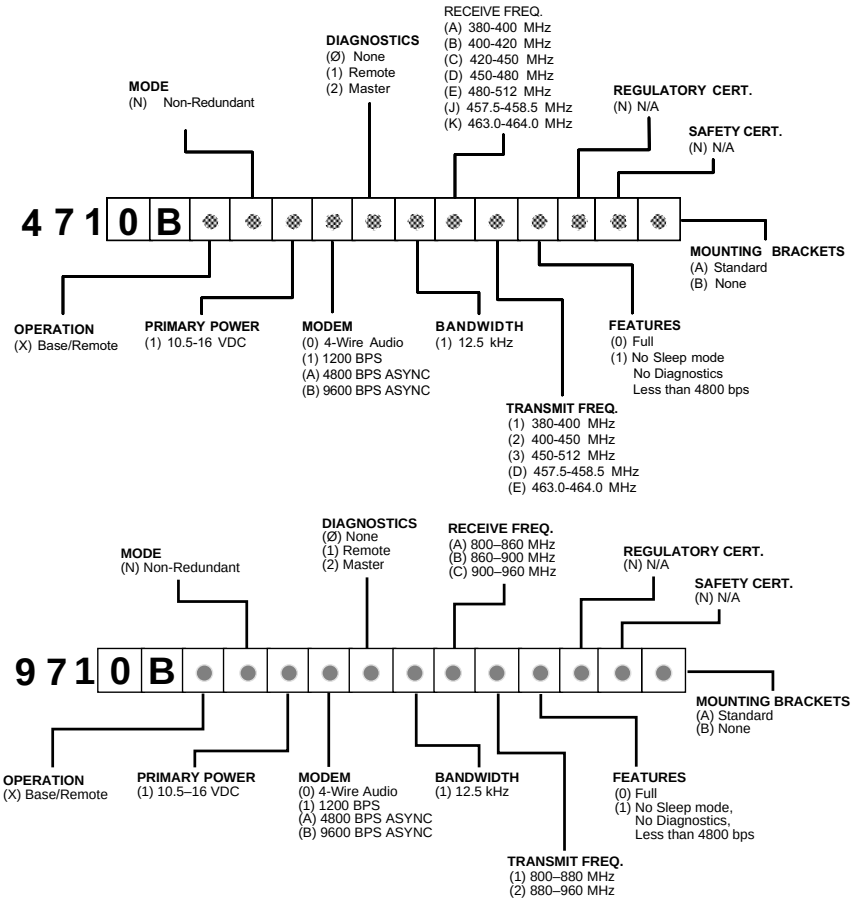

Figure 4. Model number codes

1.3 Accessories

The transceiver can be used with one or more of the accessories listed in Table 1. Contact Microwave Data Systems for ordering information.

Table 1. MDS x710B optional accessories

Accessory	Description	MDS P/N
Hand-Held Terminal Kit (HHT)	Terminal that plugs into the radio for programming, diagnostics & control. Includes carrying case and cable set.	02-1501A01
RTU Simulator	Test unit that simulates data from a remote terminal unit. Comes with polling software that runs on a PC. Useful for testing radio operation.	03-2512A01
Order Wire Module	External device that allows temporary voice communication. Useful during setup & testing of the radio system.	02-1297A01
Order Wire Handset	Used with Order Wire Module (above).	12-1307A01

Table 1. MDS x710B optional accessories *(Continued)*

Accessory	Description	MDS P/N
RJ-11 to DB-9 adapter	Used to connect a PC to the radio's DIAGNOSTICS port	03-3246A01
RS-232 to RS-422 Converter Assembly	External adapter plug that converts the radio's DATA INTERFACE connector to RS-422 compatible signaling.	03-2358A01
Radio Configuration Software	Provides diagnostics of the transceiver (Windows-based PC required.)	03-3156A01
Synchronous to Asynchronous Data Converter	Allows synchronous operation of the x710 transceiver.	Contact MDS

2.0 INSTALLATION

There are three main requirements for installing the transceiver—adequate and stable primary power, a good antenna system, and the correct interface between the transceiver and the data device. Figure 5 shows a typical remote station arrangement.

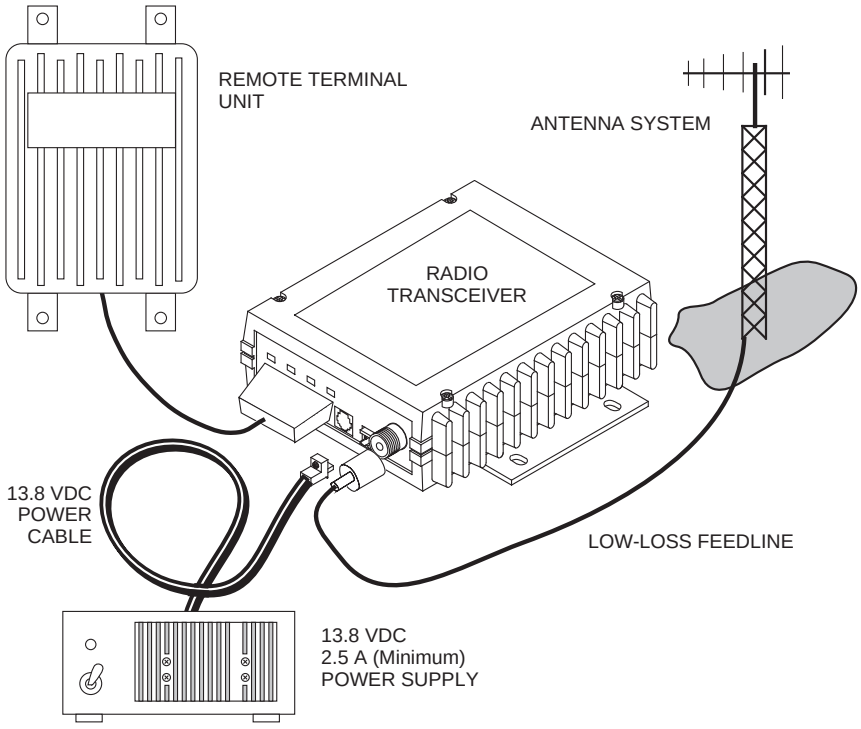

Figure 5. Typical remote station arrangement

2.1 Installation Steps

Below are the basic steps for installing the transceiver. In most cases, these steps alone are sufficient to complete the installation. More detailed explanations appear at the end of these steps.

1. Mount the transceiver to a stable surface using the brackets supplied with the radio.

2. Install the antenna and antenna feedline for the station. Connect the feedline to the radio and preset directional antennas in the appropriate direction.

3. Connect the data equipment to the transceiver's INTERFACE connector. Typical applications require the use of *only* Pins 1 through 8 for RS-232-type signaling. When using an external modem (4-wire audio arrangement), only Pins 7, 9, 11 and 16 are typically required.

   Additional connections may be required for some installations. Refer to the complete list of pin functions provided in Table 5 on page 11.

4. Measure and install the primary power for the radio. The red wire on the power cable is the positive lead; the black is negative.

NOTE: The radio is designed for use only in negative ground systems.

---

5. Set the radio configuration. The transceiver is designed for quick installation with a minimum of software configuration required in most cases. The selections that *must* be made for new installations are:

   - Transmit frequency
   - Receive frequency

   The operating frequencies are not set at the factory unless they were specified at the time of order. Determine the transmit and receive frequencies to be used, and follow the steps below to program them. It is always best to verify the frequencies using the steps below. (See Figure 4 on page 4 for the frequency range of your radio.)

   a. Connect a hand-held terminal (HHT) to the DIAGNOSTICS connector. When the HHT beeps, press **ENTER** to receive the ready ">" prompt.

   b. Set the operating frequencies using the **TX xxx.xxxxx** (transmit) and **RX xxx.xxxxx** (receive) commands. Press **ENTER**. After programming, the HHT reads **PROGRAMMED OK** to indicate successful entry.

6. Refine the antenna heading of the station to maximize the received signal strength (RSSI) from the master station.

   Use the **RSSI** command from an HHT connected to the radio's DIAGNOSTICS connector.—See *TRANSCEIVER PROGRAMMING on page 15*. This can also be done with a DC voltmeter as described in *3.3 RSSI Chart*

2.2 Using the Radio's Sleep Mode

In some installations, such as at solar-powered sites, it may be necessary to keep the transceiver's power consumption to an absolute minimum. This can be accomplished using the Sleep Mode. In this mode, power consumption is reduced to less than 16 milliamperes.

Sleep mode can be enabled under RTU control by asserting a ground (or RS-232 low) on Pin 12 of the radio's DATA INTERFACE connector.

When Pin 12 is opened (or an RS-232 high is asserted), the radio will be ready to receive data within 75 milliseconds.

All normal functions are suspended while the radio is in sleep mode. The PWR LED will be off.

System Example

The following example describes Sleep Mode implementation in a typical system. Using this information, you should be able to configure a system that will meet your own particular needs.

Example:

> Suppose you need communications to each remote site only once per hour. Program the RTU to raise an RS-232 line once each hour (DTR for example) and wait for a poll and response before lowering it again. Connect this line to Pin 12 of the radio's DATA INTERFACE connector. This will allow each RTU to be polled once per hour with a significant savings in power consumption.

2.3 Transceiver Mounting

Figure 6 shows the mounting dimensions of the transceiver.

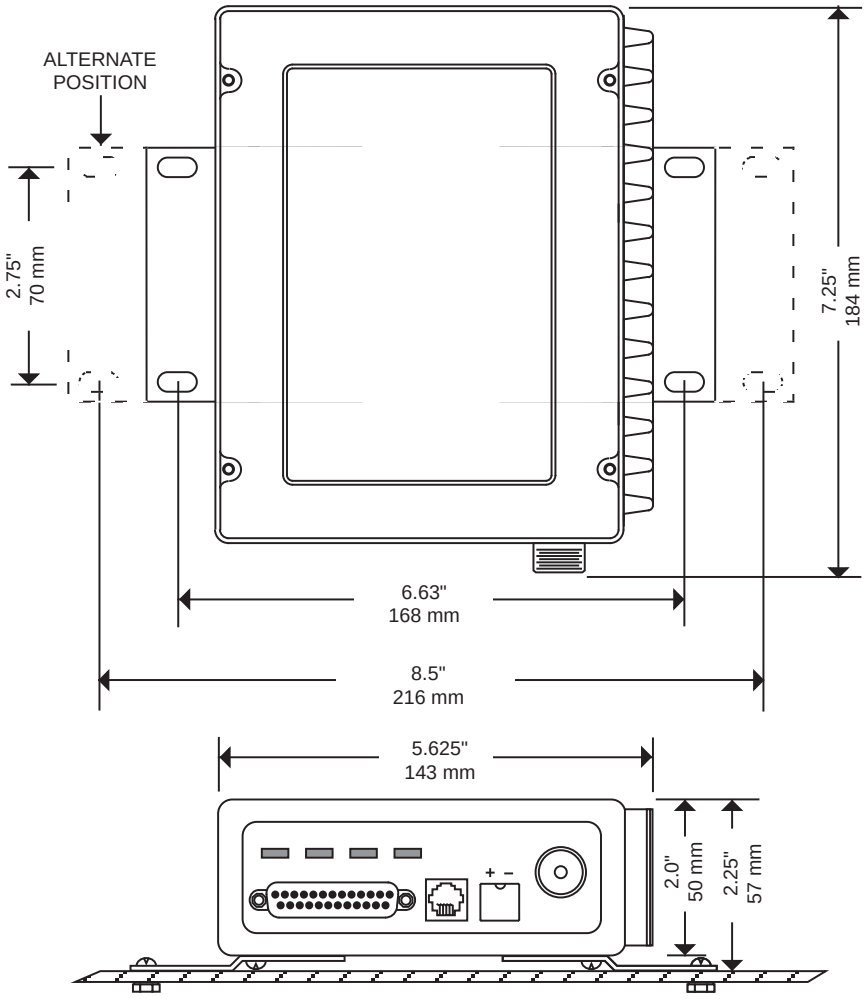

Figure 6. Transceiver mounting dimensions

2.4 Power Connection

The transceiver can be operated from any well-filtered 10.5 to 16 Vdc power source. The power supply should be capable of providing at least 2.5 amperes of continuous current.

The red wire on the power cable is the positive lead; the black is negative.

NOTE: The radio is designed for use only in negative ground systems.

2.5 Antennas and Feedlines

Antennas

The transceiver can be used with a number of antennas. The exact style depends on the physical size and layout of the radio system. A directional Yagi (Figure 7) or corner reflector antenna is generally recommended at remote sites to minimize interference to and from other users. Antennas of this type are available from several manufacturers.

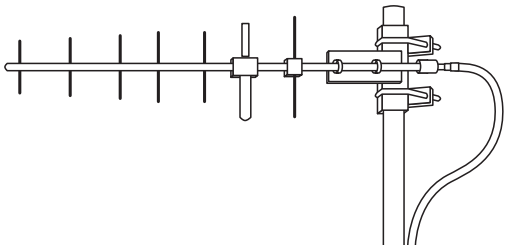

Figure 7. Typical Yagi antenna (mounted to mast)

The selection of antenna feedline is very important. Poor quality cables should be avoided as they will result in power losses that may reduce the range and reliability of the radio system.

Table 2 and Table 3 show the losses that will occur when using various lengths and types of cable at 400 and 900 MHz, respectively. Regardless of the type used, it should be kept as short as possible to minimize signal loss.

Table 2. Length vs. loss in coaxial cables at 400 MHz

Cable Type	10 Feet (3.05 Meters)	50 Feet (15.24 Meters)	100 Feet (30.48 Meters)	500 Feet (152.4 Meters)
RG-8A/U	0.51dB	2.53 dB	5.07 dB	25.35 dB
1/2 inch HELIAX	0.12 dB	0.76 dB	1.51 dB	7.55 dB
7/8 inch HELIAX	0.08 dB	0.42 dB	0.83 dB	4.15 dB
1 1/4 inch HELIAX	0.06 dB	0.31 dB	0.62 dB	3.10 dB
1 5/8 inch HELIAX	0.05 dB	0.26 dB	0.52 dB	2.60 dB

Table 3. Length vs. loss in coaxial cables at 900 MHz

Cable Type	10 Feet (3.05 Meters)	50 Feet (15.24 Meters)	100 Feet (30.48 Meters)	500 Feet (152.4 Meters)
RG-8A/U	0.85 dB	4.27 dB	8.54 dB	42.70 dB
1/2 inch HELIAX	0.23 dB	1.15 dB	2.29 dB	11.45 dB
7/8 inch HELIAX	0.13 dB	0.64 dB	1.28 dB	6.40 dB
1 1/4 inch HELIAX	0.10 dB	0.48 dB	0.95 dB	4.75 dB
1 5/8 inch HELIAX	0.08 dB	0.40 dB	0.80 dB	4.00 dB

2.6 Data Interface Connections

The transceiver's DATA INTERFACE connector is used to connect the transceiver to an external DTE data terminal that supports the RS-232-type format. The transceiver supports asynchronous data rates of up to 9600 bps, depending on the radio's modem setting. (See Table 4.) The data interface speed may differ from the data rate used over the air.

If synchronous data transmission is required, an external synchronous-to-asynchronous converter is required. Contact MDS for additional information.

Table 4. Modem type versus speed

Modem Type	Data Speeds Supported
1200 bps (Bell)	Up to 1200 bps
4800 bps	Up to 4800 bps
9600 bps	9600 bps

Table 5 lists each pin on the DATA INTERFACE connector and describes its function.

CAUTION

USE ONLY THE REQUIRED PINS!

Do not use a 25 wire (fully pinned) interface cable for connection to the DATA INTERFACE connector. Use *only* the required pins for the application. Damage will result if improper connections are made. Typical applications require the use of *only* Pins 1 through 8 for RS-232-type signaling. When using an external modem (4-wire audio arrangement), only Pins 7, 9, 11 and 16 are typically required.

Table 5. Data interface connector pinouts

Pin Number	Input/ Output	Pin Description
1	--	**Protective Ground.** Connects to ground (negative supply potential) on the radio's PC board and chassis.
2	IN	**TXD—Transmitted Data.** Accepts TX data from the connected device.
3	OUT	**RXD—Received Data.** Outputs received data to the connected device.
4	IN	**RTS—Request-to-Send Input.** Keys the transmitter when RTS asserted.
5	OUT	**CTS—Clear-to-Send Output.** Is active after the programmed CTS delay time has elapsed.
6	OUT	**DSR—Data Set Ready.** Provides a +6 Vdc DSR signal through a 2.5 kΩ resistor.
7	--	**Signal Ground.** Connects to ground (negative supply potential) at radio's PC board.
8	OUT	**DCD—Data Carrier Detect.** Goes active when the radio detects an on-frequency signal.
9	IN	**Transmit Audio Input.** Connects to the audio output of an external (AFSK) modem. The input impedance is 600 Ω. Use Pin 7 for the modem's return lead. The audio level can be adjusted using the *TXLEVEL [–20...+3, AUTO]* command.
10	OUT	**RUS—Receiver Unsquelched Sensor.** Not used in most installations, but is available as a convenience. Provides +8 Vdc through a 1 kΩ resistor whenever the receiver squelch is open, and drops to less than 1 Vdc when the squelch is closed.
11	OUT	**Receive Audio Output.** Connects to the audio input of an external (AFSK) modem. The output impedance is 600 Ω, and the level is factory set to suit most installations. Use Pin 7 for the modem's return lead. The audio level can be adjusted using the *RXLEVEL [–20...+3]* command.
12	IN	**Radio Inhibit.** A ground on this pin places the radio into the "sleep" mode. It turns off most circuits in the radio, including transmit, receive, modem and diagnostic functions. This allows for greatly reduced power consumption, yet preserves the radio's ability to be quickly brought on-line.
13	--	Do not connect—Reserved for future use.
14	--	**PTT—Push to Talk.** This line is used to key the radio with an active-high signal of +5 Vdc.

Table 5. Data interface connector pinouts *(Continued)*

Pin Number	Input/ Output	Pin Description
15	OUT	**Remote RTU Reset.** This line can be used to reset an RTU from a command issued remotely with MDS InSite software. See “Remote RTU Reset” on page 14 for additional information. This pin can be toggled remotely, using InSite software or locally using the radio configuration software. The required signal levels are either a nominal +10 Vdc or –10 Vdc and the signal source must be capable of supplying 20 ma.
16	--	**$\overline{\text{PTT}}$—Push to Talk.** This line is used to key the radio with an active-low signal of 0 Vdc.
17	--	Do not connect—Reserved for future use.
18	IN/OUT	**Accessory Power.** Unregulated Input/Output. Provides a source of input power for low current accessories. Excessive drain on this connection will trip self-resetting fuse F1 on the transceiver PC board. The voltage at this pin will match the input voltage to the transceiver.
19	OUT	**9.9 Vdc Regulated Output.** Provides a source of regulated voltage at 100 mA for low power accessories.
20	--	Do not connect—Reserved for future use.
21	OUT	**RSSI—Received Signal Strength Indication.** A DC voltmeter may be connected to this pin to read the relative strength of the incoming signal. Figure 9 is a chart showing RSSI vs. DC voltage.
22	--	Do not connect—Reserved for future use.
23	IN	**Diagnostic Channel Enable.** A ground on this pin causes the radio’s microcontroller to open the DB-25 DATA INTERFACE for diagnostics and control instead of the normal RJ-11 diagnostics connection.
24	--	Do not connect—Reserved for future use.
25	OUT	**Alarm.** A logic low (less than 0.5 volts) on this pin indicates normal operation. A logic high (greater than 4 volts) indicates that some alarm condition is present. This pin can be used as an alarm output, provided the internal series resistance of 1 kΩ is considered.

3.0 OPERATION

This section contains procedures and information regarding the setup and configuration of the transceiver.

3.1 Initial Start-up

If all parameters are correctly set, operation of the radio can be started by following these steps:

1. Apply DC power to the transceiver.

2. Observe the LED status panel for the proper indications (Table 6).

3. If not done earlier, refine the antenna heading of the station to maximize the received signal strength (RSSI) from the master station.

   Use the **RSSI** command from an HHT connected to the radio's DIAGNOSTICS connector.—See *TRANSCEIVER PROGRAMMING on page 15*. This can also be done with a DC voltmeter as described in *3.3 RSSI Chart*

3.2 Reading LED Status Indicators

Table 6 describes the function of each status LED.

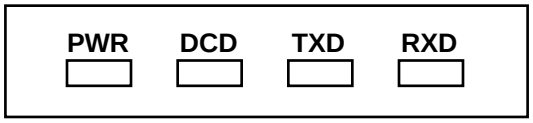

Figure 8. LED Status Indicators

Table 6. LED status indicators

LED Name	Description
PWR	• Continuous—Power is applied to the radio, no faults detected. • Rapid flash (five times-per-second)—Fault indication. Refer to *Checking for Alarms—STAT command on page 32* • Moderate flash (one time-per-second)—Internal firmware error. Refer to *Upgrading the Radio's Software on page 37* • Off—No power is applied to the radio or the radio is in Sleep mode. Refer to *Using the Radio's Sleep Mode on page 7*
DCD	• Flashing—Indicates the radio is receiving valid data frames. • Continuous—Radio is receiving a data signal from a continuously keyed radio.
TXD	An RS-232 mark signal is being received at the DATA INTERFACE.
RXD	An RS-232 mark signal is being sent out from the DATA INTERFACE.

3.3 RSSI Chart

As an alternative to using an HHT, the radio's RSSI may be read with a DC voltmeter connected to Pin 21 of the DATA INTERFACE connector. Figure 9 shows the relationship between received signal level and the DC voltage on Pin 21 of the DATA INTERFACE connector. (Note: Readings are not accurate for incoming signal strengths above –50 dBm.)

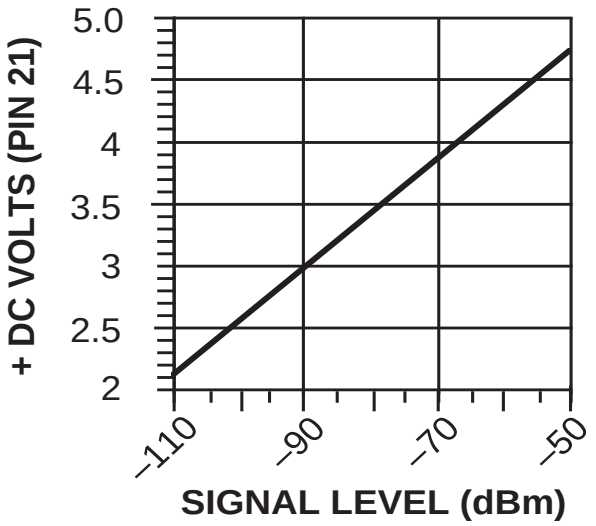

Figure 9. RSSI versus DC voltage (typical)

3.4 Remote RTU Reset

Using MDS InSite software (version 4.1 or later), a command can be issued remotely to toggle Pin 15 of the DATA INTERFACE connector.

From InSite:

1. Select the **SYSTEM** (Network) **DIAGNOSTICS POLLING** from the main menu.

2. Open the pull down menu **DIAGNOSTICS POLLING MODE** and select **REMOTE MAINTENANCE.**

3. Click on the particular remote radio that needs the RTU reset. The **REMOTE MAINTENANCE** screen appears.

4. Click on **RTU RESET LINE** to set pin 15 to High or Low.

3.5 Remote Maintenance and Diagnostics Levels

There are three levels of internal radio diagnostics supported in the x710B transceivers that are set with the **DIAGLEV** command. The three levels of diagnostics are compatible with the corresponding diagnostics levels available in the MDS 2300 and 4300 series transceivers. The diagnostics levels are as follows:

- Mode 1—Loopback
- Mode 2—Advanced Diagnostics
- Mode 3—Remote Maintenance

Set the **DIAGLEV** to mode 3 unless compatibility with a lower level of diagnostics is required in the system.

Mode 1—Loopback

A radio set to **DIAGLEV 1** responds to a diagnostics poll containing a four-digit number (loopback code). When the remote radio decodes its loopback code transmitted by an MDS master station, it responds by keying its transmitter for several seconds with a continuous modulating tone. The radio's signal strength and deviation can then be measured by the master station.

Mode 2—Advanced

A radio set to **DIAGLEV 2** provides critical radio diagnostics information over-the-air with MDS InSite or MDS 2000 software.

Mode 3—Remote Maintenance

A radio set to **DIAGLEV 3** provides all the diagnostics information available with Mode 2 enabled and also allows adjustment of several parameters over-the-air with MDS InSite or MDS 2000 software.

4.0 TRANSCEIVER PROGRAMMING

Programming and control of the transceiver is performed through the radio's RJ-11 DIAGNOSTICS connector with an MDS Hand-Held Terminal (MDS P/N 02-1501A01). This section contains a reference chart (Table 8) and detailed descriptions for each user command.

NOTE: In addition to HHT control, Windows-based software is available. *REMOTE* Radio Configuration Software (MDS P/N 03-3156A01) allows the transceiver to be programmed using a personal computer. An installation booklet and on-line instructions are included with the software.

4.1 Hand-Held Terminal Connection & Start-up

This section gives basic information for connecting and using the MDS Hand-Held Terminal. For more information about the terminal, refer also to the instructions included with each HHT kit.

The steps below assume that the HHT has been configured for use with the MDS x710B Transceiver (80 character screen display). If the HHT was previously used with a different model transceiver, or if its default settings have been changed, refer to Section 4.2 for setup details.

Follow these steps to connect the HHT:

1. Connect the HHT's coiled cord to the DIAGNOSTICS (RJ-11) jack on the radio as shown in Figure 10. This automatically places the radio into the control and programming mode.

   As an alternative, the DATA INTERFACE (DB-25) connector may be used for programming instead of the DIAGNOSTICS jack. With this arrangement, Pin 23 of the HHT cable must be grounded to enable the diagnostic channel. (See Table 5.)

2. When the HHT is connected, it runs through a brief self-check, ending with a beep. After the beep, press **ENTER** to receive the ready ">" prompt.

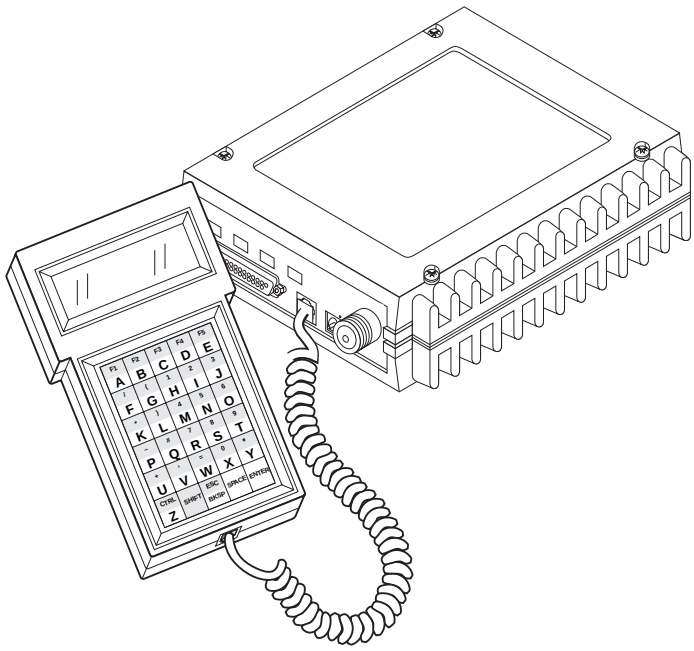

Figure 10. Hand-held terminal connected to the transceiver

4.2 Hand-Held Terminal Setup

The following is a set of instructions for re-initializing an HHT for use with the transceiver. These steps may be required if the HHT was previously used with a different radio, or if the HHT default settings have been inadvertently altered.

1. Plug the HHT into the DIAGNOSTICS connector. Enable the setup mode by pressing the SHIFT, CTRL and SPACE keys in sequence. The display shown in Figure 11 appears.

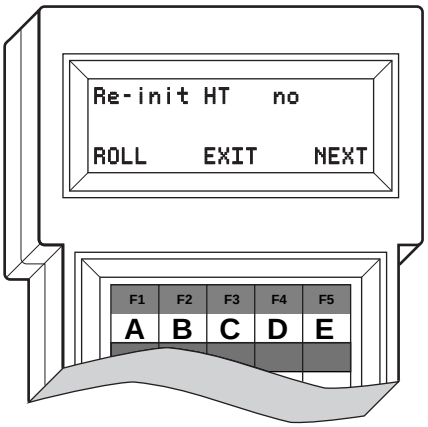

Figure 11. HHT set-up display

2. The first of 15 menu items will be displayed. Settings can be reviewed by pressing the NEXT function controlled by the E key. Parameter settings can be changed by pressing the ROLL function controlled by the A key. Exit this setup mode by pressing the C key.

3. Set up the HHT as listed in Table 7.

Table 7. HHT Operational Settings

Parameter	Setting	Parameter	Setting
Re-init HT	NO	Scroll On	33rd
Baud Rate	1200	Cursor	ON
Comm bits	8,1,n	CRLF for CR	OFF
Parity Error	OFF	Self Test	FAST
Key Repeat	OFF	Key Beep	ON
Echo	OFF	Screen Size	80
Shift Keys	YES	Menu Mode	LONG
Ctl Chars	PROCS		

5.0 TRANSCEIVER COMMANDS

Table 8 is a reference chart of software commands for the transceiver. Programmable information is shown in brackets [ ] following the command name. See Section 5.4 for detailed command descriptions. Some of the commands and functions are optional. Therefore, the transceiver may not have all of the following commands and functions available.

5.1 General Command Information

The proper procedure for entering commands is to type the command, followed by an **ENTER** keystroke. For programming commands, the command is followed by **SPACE** and the appropriate information or values, then **ENTER**. Many commands will display the current setting if the command is entered without the value.

Example:

1. Type **PWR 27 ENTER**. This sets the power output to +27 dBm.

2. Type **PWR ENTER**. The HHT displays **PWR 27 dBm**.

Here are some additional points to remember when using the HHT:

- Use the **SHIFT** key to access numbers; press again to return to letter mode.
- Flashing square cursor (▫) – letter mode is selected.
- Flashing superscript rectangular cursor (▫) – number mode is selected.
- Use **ESC/BKSP** key to edit information or commands entries.

Error Messages

Listed below are some of the most common error messages encountered when using the HHT:

UNKNOWN COMMAND—The command was not recognized.

INCORRECT ENTRY—The command format or the values entered were not valid.

COMMAND FAILED—The requested action could not be completed. There may be a problem with the software; contact MDS.

NOT PROGRAMMED—The software was unable to program the EEPROM, or the requested display item was not programmed. This is a serious internal radio error; contact MDS.

TEXT TOO LONG—Too many characters were entered.

NOT AVAILABLE—The entered command or parameter was valid, but it referred to a currently unavailable choice.

PASSWORD INVALID—The entered password was invalid, and was not accepted.

ACCESS DENIED—The command is invalid for the current password level.

EEPROM FAILURE—The **INIT** command is unable to write to EEPROM. This is a serious internal error; contact MDS.

5.2 Command Summary

Table 8 is a command list applicable to the MDS x710 radios. Table 9 is a list of the Local Maintenance commands that can be used to adjust items such as operating frequency. These tables are summaries only. Refer to *5.4 Detailed Command Descriptions* for more comprehensive information regarding the use of each command.

Table 8. Operating parameter commands

Command name	Function
BAUD [9600 abc] *Details page 22*	Set or display the DATA INTERFACE data rate and control bits.
CTS [0–255] *Details page 23*	Set or display the Clear-to-Send delay in milliseconds.
DIAGLEV [OFF, 1,2,3] *Details page 23*	Set or display the diagnostics level compatible with the MDS 2300 and 4300 Series radios.
DKEY *Details page 24*	Dekey the radio (transmitter OFF). This is generally a radio test command.
DP *Details page 24*	Local maintenance command that decrements transmit power.
DSTE *Details page 24*	Disable the Squelch Tail Eliminator function.
DUMP *Details page 24*	Display all programmable settings.
EMP [ON, OFF] *Details page 24*	Display or change the emphasis/de-emphasis characteristics of the radio.
ESTE *Details page 24*	Enable the Squelch Tail Eliminator function.
HREV *Details page 25*	Display the Hardware Revision level.
INIT *Details page 25*	Set radio parameters to the default values
KEY *Details page 26*	Key the radio (transmitter ON), This is generally a radio test command.
LBC [xxxx] *Details page 26*	Set or display the loopback code of the radio.
MODEL *Details page 26*	Display the Model number of the radio.

Table 8. Operating parameter commands*(Continued)*

Command name	Function
MODEM [NONE, BELL, 4800B, 9600B] *Details page 26*	Set or display the modem type used in the radio. None indicates an analog input.
OWM [XXX...] *Details page 27*	Set or display the owner's message.
OWN [XXX...] *Details page 27*	Set or display the owner's name.
PTT [0–255] *Details page 27*	Set or display the Push-to-Talk delay in milliseconds.
PWR [20–37] *Details page 27*	Set or display the transmit power setting.
RSSI *Details page 28*	Display the Received Signal Strength Indication.
RTU [ON/OFF/0-80] *Details page 28*	Re-enables or disables the radio's internal RTU simulator and sets the RTU address.
RX [xxx.xxxxx] *Details page 28*	Set or display receiver frequency.
RXLEVEL [–20...+3] *Details page 28*	Set or display the analog audio receive level in dBm.
SCD [0-255] *Details page 29*	Set or display the Soft-carrier Dekey delay in milliseconds.
SER *Details page 29*	Display the radio serial number.
SHOW [DC, PORT, PWR] *Details page 29*	Display the DC voltages, diagnostics port, and transmit power level
SREV *Details page 29*	Display the Software Revision Level
STAT *Details page 29*	Display radio status and alarms
STE *Details page 30*	Display whether the Squelch-Tail Eliminator is ON or OFF.
SWC [ON, OFF] *Details page 30*	Set or display the master station carrier mode.
TEMP *Details page 30*	Display the internal temperature of the radio in degrees C.
TOT [1-255 ON/OFF] *Details page 31*	Set or display the Time-out Timer delay in seconds.
TX [xxx.xxxxx] *Details page 31*	Set or display the transmit frequency.
TXLEVEL [–20...+3, AUTO] *Details page 31*	Set or display the analog audio transmit level in dBm.

Table 9. Local maintenance commands

Command name	Function
DECF [0–100] *Details page 23*	Local maintenance command that decrements both the transmit and receive frequency by specified amount.
DECP [0–100] *Details page 23*	Local maintenance command that decrements transmit power by specified amount.
DF *Details page 23*	Local maintenance command that decrements frequency.
IF *Details page 25*	Local maintenance command that increments frequency.
INCF [1–99] *Details page 25*	Local maintenance command that increments both the transmit and receive frequency by the specified amount.
INCP [1–99] *Details page 25*	Local maintenance command that increments the transmit power by the specified amount.
IP *Details page 26*	Local maintenance command that increments the transmit power.
RMIS *Details page 27*	Local maintenance command that resets and stores the transmit power and frequency to mid-range.
RMOV *Details page 27*	Local maintenance command that resets the transmit power and frequency to previously values.
RMRD *Details page 28*	Local maintenance command that displays the transmit power and frequency.
RMST *Details page 28*	Local maintenance command that stores the transmit power and frequency.

5.3 Command Equivalents for Older Transceivers

There are several programming commands used with earlier transceivers that also function with the MDS x710B. Table 10 lists these commands along with cross references to their equivalents in the MDS x710B command set. In these instances, either the new or old command may be used.

Table 10. Command equivalents for older transceivers

Older Transceiver Command	MDS 4710B & 9710B Equivalent Command
PCTS	See **CTS [0–255]** *Details page 23*
PPTT	See **PTT [0–255]** *Details page 27*
PSCD	See **SCD [0-255]** *Details page 29*
FRQ	See **RX [xxx.xxxxx]** *Details page 28* and **TX [xxx.xxxxx]** *Details page 31*
PTX	See **TX [xxx.xxxxx]** *Details page 31*
PRX	See **RX [xxx.xxxxx]** *Details page 28*
PTOT	See **TOT [1-255 ON/OFF]** *Details page 31*
SV	See **SHOW [DC, PORT, PWR]** *Details page 29*
FPWR	See **SHOW [DC, PORT, PWR]** *Details page 29*

5.4 Detailed Command Descriptions

The only *critical* radio configuration for most applications is setting the operating frequencies (**RX xxx.xxxxx, TX xxx.xxxxx**) and setting the **SWC** command for switched carrier operation, if required. However, proper use of additional commands allow you to tailor the transceiver for a specific use, or conduct diagnostics on the radio. This section gives more detailed information for the user commands previously listed in Table 8.

In many cases, the commands shown here can be used in two ways. First, you can type *only* the command name to view the currently programmed data. Secondly, you can set or change the existing data by typing the command, followed by a space, and then the desired entry. In the list below, allowable programming variables, if any, are shown in brackets following the command name.

The **INIT** command can be used to set many commands to the default values.

BAUD [9600 abc]

This command is only valid for radios that have the **MODEM** command set to **9600B** and the only allowable baud rate is 9600 bps. However, the data format can be specified with this command.

This command sets (or displays) the communication attributes for the DATA INTERFACE port. It has no effect on the RJ-11 DIAGNOSTICS port.

Refer to *MODEM [NONE, BELL, 4800B, 9600B] on page 26* for additional information.

The first parameter (**9600**) is baud rate.

The second parameter of the **BAUD** command (**abc**) is a 3-character block indicating how the data is formatted.

a = Data bits (**7** or **8**)
b = Parity (**N** for None, **O** for Odd, **E** for Even)
c = Stop bits (**1** or **2**)

NOTE: 7N1, 8O2, and 8E2 are invalid communication settings and are not supported by the transceiver.

CTS [0–255]

The **CTS** (clear-to-send) command selects or displays the timer value associated with the CTS line response. The command parameter ranges from 0 to 255 milliseconds.

For DCE operation, the timer specifies how long to wait after the RTS line goes high, before asserting the CTS line. A timer value of zero means that the CTS line will be asserted immediately.

DECF [0–100]

The **DECF** (decrease frequency) is a local maintenance command that decreases both the transmit and receive frequency by the specified percentage of the adjustable range. This is a temporary setting until the **RMST** command is used to store the command.

DECP [0–100]

The **DECP** (decrease power) is a local maintenance command that decreases the transmit power by the percentage specified of the adjustable range. This is a temporary setting until the **RMST** command is used to store the command.

DF

The **DF** (decrement frequency) is a local maintenance command that decreases both the transmit and receive frequency by 1% of the adjustable range. This is a temporary setting until the **RMST** command is used to store the command.

DIAGLEV [OFF, 1,2,3]

This command sets the diagnostics level used in the transceiver. **OFF** indicates no diagnostics capabilities are available.

- Mode 1 (Standard Diagnostics) is indicated by **1**.
- Mode 2 (Advanced Diagnostics) is indicated by **2**.
- Mode 3 (Remote Maintenance) is indicated by **3**.

Set **DIAGLEV** to the diagnostics mode currently used in the radio system.

DKEY

This command deactivates the transmitter after it has been keyed with the **KEY** command.

DP

The **DP** (decrement power) command is a local maintenance command that decreases the transmit power by 1% of the adjustable range. This is a temporary setting until the **RMST** command is used to store the command.

DSTE

This command disables the radio's squelch tail eliminator (STE) circuit and is only applicable when the **MODEM** command is set to **BELL**. The squelch tail eliminator mutes the noise burst at the end of a transmit cycle which prevents the master station receiver from receiving the burst of noise as the squelch closes. The squelch-tail eliminator adds 5 ms to the transmission time. To enable the squelch tail eliminator use the **ESTE** command. Use the **STE** command to determine if the squelch tail eliminator is ON (enabled) or OFF (disabled). If the remote radio has **STE ON**, the master station receiver(s) must also have the **STE** set to **ON**.

DUMP

This command displays all the programmed settings with this one command. The HHT display is too small to list all the command settings at one time. Therefore, this command is most useful if the command is issued from a computer or full-screen terminal.

EMP [ON, OFF]

This command sets and displays whether the emphasis and de-emphasis of the analog input and output signals is enabled. **ON** indicates that emphasis and de-emphasis is enabled and **OFF** indicates that emphasis and de-emphasis is disabled.

Emphasis is a function used in older analog radios where the modulating signal is increased (at the transmitter) at the higher frequencies to increase system performance. De-emphasis compensates (at the receiver) for a signal that has had emphasis applied.

Emphasis and de-emphasis functions should *not* be enabled except when compatibility with older MDS analog radios is required.

ESTE

This command enables the radio's squelch tail eliminator (STE) circuit and is only applicable when the **MODEM** command is set to **BELL**. The squelch tail eliminator mutes the noise burst at the end of a transmit cycle which prevents the master station receiver from receiving the burst

of noise as the squelch closes. The squelch-tail eliminator adds 5 ms to the transmission time. To disable the squelch tail eliminator use the **DSTE** command. Use the **STE** command to determine if the squelch tail eliminator is ON (enabled) or OFF (disabled). If the remote radio has **STE ON**, the master station receiver(s) must also have the **STE** set to **ON**.

HREV

This command displays the transceiver's hardware revision level.

IF

The **IF** (increment frequency) command is a local maintenance command that increases both the transmit and receive frequency by 1% of the adjustable range. This is a temporary setting until the **RMST** command is used to store the command.

INCF [1–99]

The **INCF** (increase frequency) command is a local maintenance command that increases both the transmit and receive frequency by the specified amount of the adjustable range. This is a temporary setting until the **RMST** command is used to store the command.

INCP [1–99]

The **INCP** (increase power) command is a local maintenance command that increases the transmit power by the specified amount of the adjustable range. This is a temporary setting until the **RMST** command is used to store the command.

INIT

The **INIT** command is used to re-initialize the radio's operating parameters to the factory defaults. This may be helpful when trying to resolve configuration problems that may have resulted from the entry of one or more improper command settings. If you are unsure of which command setting may have caused the problem, this command allows you to get back to a known working state. The following changes to the radio are made when **INIT** is entered:

- **CTS** command is set to 10
- **PTT** command is set to 0
- **SCD** command is set to 0
- **TOT** command is set to 30 seconds and set to **ON**
- **PWR** command is set to +37 dBm (5 watts)

All other commands stay in the previously established setting.

IP

The **IP** (increment power) command is a local maintenance command that increases the transmit power by 1% of the adjustable range. This is a temporary setting until the **RMST** command is used to store the command.

KEY

This command activates the transmitter. See also the **DKEY** command.

LBC [xxxx]

This command programs or displays the loopback code of a radio. The loopback code provides a means to uniquely identify a single radio within a network. It is used primarily for diagnostic purposes, and is intended to be identical to the loopback code command of older transceivers.

By default it is set to the last 4 digits of the serial number. See **SER** command. Loopback codes can range from 0...9999.

MODEL

This command displays the radio's model number code. Refer to Figure 4 on page 4 for an explanation of the model number characters.

MODEM [NONE, BELL, 4800B, 9600B]

This command sets the signal type and modulation mode of the radio. The radio may not have all options available. Contact MDS if you need a modem that is currently unavailable on the radio.

A choice of **NONE** selects no modem and the radio operates as an analog transceiver using Transmit Audio Input (Pin-9) and Receive Audio Output (Pin-11). Refer to Table 5 for DATA INTERFACE connector pinouts.

A choice of **BELL** selects a Bell 202T type of analog modem that is compatible with the MDS 1000µ, MDS 2310, or the MDS 4310 series of radio products equipped with a 1200 bps Bell 202T modem. All baud rates up to 1200 are automatically supported as data is received. The **BAUD** command setting is irrelevant.

The choice of **4800B** selects a 4800 bps modem modulation compatible with the MDS 1000µ, MDS 2310, or the MDS 4310 series of radio products equipped with a 4800 bps modem. All baud rates up to 4800 are automatically supported as data is received. The **BAUD** command setting is irrelevant.

The choice of **9600B** selects a 9600 bps modem modulation compatible with the MDS 1000µ, MDS 2310, or the MDS 4310 series of radio prod-

ucts equipped with a 9600 bps modem. When **9600B** is selected, the **BAUD** command is automatically set to 9600 bps.

OWM [XXX...]

This is a command to display or program an owner's message. To program the owner's message, type **OWM** then the message, followed by **ENTER**.

To display the owner's message, type **OWM** then **ENTER**. The owner's message appears on the display.

OWN [XXX...]

This is a command to display or program an owner's name. To program the owner's name, type **OWN** then the name, followed by **ENTER**.

To display the owner's name, type **OWN** then **ENTER**. The owner's name appears on the display.

PTT [0–255]

This command sets or displays the key-up delay in milliseconds.

This timer specifies how long to wait after the radio receives a key signal from either the PTT or RTS lines (on the Data Interface), before actually keying the radio.

PWR [20–37]

This command displays or sets the desired RF forward output power setting of the radio. The **PWR** command parameter is specified in dBm and can range from 20 through 37. The default setting is 37 dBm (5 watts). To read the actual (measured) power output of the radio, use the **SHOW PWR** command. A dBm-to-watts conversion chart is provided in Section 7.5.

RMIS

This local maintenance command initializes the current settings to the midpoint or 50% for the following local maintenance settings.

- Power
- Frequency

RMOV

This command restores the old values (after the last **RMST** command) for the following remote maintenance settings.

- Power
- Frequency

RMRD

This command reads the current settings of the following remote maintenance settings.

- Power
- Frequency

RMST

This command stores the current settings of the following remote maintenance settings.

- Power
- Frequency

RSSI

This command displays the radio's Received Signal Strength Indication (RSSI) in dBm units. Incoming signal strengths from –50 dBm to –120 dBm can be read.

RTU [ON/OFF/0-80]

This command re-enables or disables the radio's internal RTU simulator, which runs with MDS' proprietary polling programs (poll.exe and rsim.exe). The internal RTU simulator is available whenever a radio has diagnostics enabled. This command also sets the RTU address that the radio will respond to.

The internal RTU can be used for testing system payload data or pseudo bit error rate testing. It can be helpful in isolating a problem to either the external RTU or the radio.

RX [xxx.xxxxx]

This command selects or displays the radio's receive frequency in MHz. The frequency step size is normally 6.25 kHz. However, other frequency step sizes are available on request. Refer to Figure 4 on page 4 for the allowable frequency range. Note: A large change in frequency (more than 5 MHz) requires adjustment of the receiver helical filters for maximum RSSI. See *7.2 Helical Filter Adjustment* for details.

RXLEVEL [–20...+3]

This command sets the analog output gain compatible with a received signal with 2.5 kHz deviation. The values are in dBm. This function is used when the radio is set in analog operating mode with the **MODEM NONE** command.

This setting is accurate to ±1 dBm.

The factory default is **RXLEVEL –10**.

SCD [0-255]

This command displays or changes the soft-carrier dekey delay in milliseconds.

This timer specifies how long to wait after the removal of the keying signal before actually releasing the transmitter. A value of 0 milliseconds unkeys the transmitter immediately after the removal of the keying signal. Some protocols require a delay before unkeying the transmitter after the data has been sent to indicate the end of transmission.

SER

This command displays the radio's serial number as recorded at the factory.

SHOW [DC, PORT, PWR]

The **SHOW** command displays different types of information based on the command variables. The different parameters are:

- **DC**—Display DC input/output voltages
- **PORT**—Display the connector port (RJ-11 or DB-25) that is active for diagnostics and control.
- **PWR**—Display RF power output

SREV

This command displays the software revision level of the transceiver firmware.

STAT

This command displays the current alarm status of the transceiver.

If no alarms exist, the message **NO ALARMS PRESENT** appears at the top of the HHT display.

If an alarm does exist, a two-digit code (00–31) is displayed and the alarm is identified as *Major* or *Minor.* A brief description of the alarm code is also given.

If more than one alarm exists, the word **MORE** appears at the bottom of the screen and additional alarms are viewed by pressing the **ENTER** key. Detailed descriptions of alarm codes are provided in Table 11 on page 33.

STE

This command displays the state of the squelch tail eliminator, either ON (enabled) or OFF (disabled). This function is only applicable when the **MODEM** command is set to **BELL**.

The squelch tail eliminator mutes the noise burst at the end of a transmit cycle which prevents the master station receiver from receiving the burst of noise as the squelch closes. The squelch-tail eliminator adds 5 ms to the transmission time. To disable the squelch tail eliminator use the **DSTE** command. To enable the squelch tail eliminator use the **ESTE** command.

If the remote radio has **STE ON**, the master station receiver(s) must also have the **STE** set to **ON**.

SWC [ON, OFF]

This command sets the master station carrier mode. If the transceiver is intended to be used with a master station that has the carrier switched on and off and is *not* continuously keyed, set **SWC** to **ON**. When the transceiver is used with a continuously keyed master station, **SWC** should be set to **OFF**. The default setting is **OFF**.

NOTE: If **SWC** is set to **ON** and the radio is being used with an MDS 2100 or 4100 series master station, it is important to set **CTS** to at least 20 milliseconds for proper system operation.

To use an MDS x710 as a master radio, set **SWC** to **ON**.

If the x710B radio is used in a system that has an x710B radio operating as a master, all radios in the system must have **SWC** set to **ON**.

Refer to *Continuously Keyed versus Switched Carrier Operation on page 2* and *Single Frequency (Simplex) Operation on page 3* for additional information.

TEMP

This command displays the internal temperature of the transceiver in degrees Celsius. Refer to Figure 12 for a Celsius to Fahrenheit conversion graph.

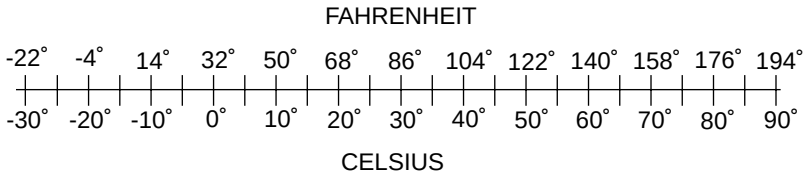

Figure 12. Celsius to Fahrenheit Conversion

TOT [1-255 ON/OFF]

This command sets or displays the transmitter Time-out Timer value (1–255 seconds), as well as the timer status (**ON** or **OFF**). If the timer is on, and the radio remains keyed for a longer duration than the **TOT** value, the transmitter is automatically unkeyed. This function prevents radios that are erroneously keyed from tying up the system frequency.

When this happens, the radio must be commanded back to an unkeyed state before a new keying command will be accepted. The default timer value is 30 seconds.

TX [xxx.xxxxx]

This command selects or displays the radio's transmit frequency in MHz. The frequency step size is normally 6.25 kHz. However, other frequency step sizes are available on request. Refer to Figure 4 on page 4 for the allowable frequency range.

The factory default for transmit frequency is set to the center of the operating band of the radio.

TXLEVEL [–20...+3, AUTO]

This command sets the analog input gain to modulate the transmitter at optimum peak deviation. The values are in dBm. If **AUTO** is selected, the input signal level is sensed and amplified as required to provide the radio's operating deviation. This function is used when the radio is set in analog operating mode with the **MODEM NONE** command.

This setting is accurate to ±1 dBm.

The factory default is **TXLEVEL AUTO**.

6.0 TROUBLESHOOTING

Successful troubleshooting of the radio system is not difficult, but it requires a logical approach. It is best to begin troubleshooting at the master station, as the rest of the system depends on the master for polling commands. If the master station has problems, the operation of the entire network can be compromised.

It is good practice to start by checking the simple things. For proper operation, all radios in the network must meet these basic requirements:

- Adequate and stable primary power. The radio contains an internal self-resetting fuse (4A). Remove primary power to reset.
- Secure connections (RF, data & power)
- An efficient and properly aligned antenna system with a good received signal strength of at least -90 dBm. (It is possible for a system to operate with weaker signals, but reliability may be degraded.)
- Proper programming of the transceiver's operating parameters (see *4.0 TRANSCEIVER PROGRAMMING*).
- The correct interface between the transceiver and the connected data equipment (correct cable wiring, proper data format, timing, etc.)

6.1 LED Status Indicators

The LED status indicators are an important troubleshooting tool and should be checked whenever a problem is suspected. Table 6 on page 13 describes the function of each status LED.

6.2 Event Codes

When an alarm condition exists, the transceiver creates a code that can be read on an HHT connected to the DIAGNOSTICS port. These codes can be very helpful in resolving many system difficulties. To check for the presence of alarms, enter **STAT** on the connected HHT. Refer to Table 11 for a definition of the event codes.

Checking for Alarms—*STAT command*

To check for alarms, enter **STAT** on the HHT. If no alarms exist, the message **NO ALARMS PRESENT** appears at the top of the display (Figure 13).

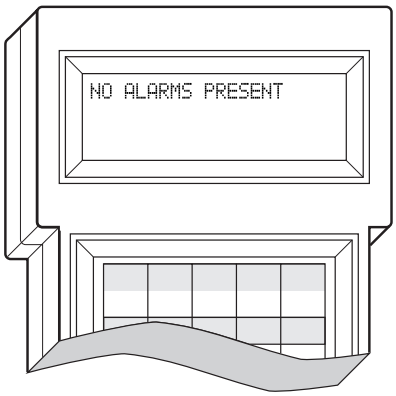

Figure 13. HHT display in response to STAT command

If an alarm does exist, a two-digit event code (00–31) is displayed and the event is identified as a Major or Minor Alarm. A brief description of the event is also given.

If more than one event exists, the word **MORE** appears at the bottom of the screen. To view additional events, press **ENTER**.

Major Alarms vs. Minor Alarms

Major Alarms—report serious conditions that generally indicate a hardware failure, or other abnormal condition that will prevent (or seriously hamper) further operation of the transceiver. Major alarms generally indicate the need for factory repair. Contact MDS for further assistance.

Minor Alarms—report conditions that, under most circumstances will not prevent transceiver operation. This includes out-of-tolerance conditions, baud rate mismatches, etc. The cause of these alarms should be investigated and corrected to prevent system failure.

Event Code Definitions

Table 11 contains a listing of all event codes that may be reported by the transceiver.

Table 11. Event codes

Event Code	Alarm Type	Description
01	Major	Improper software detected for this radio model.
02	Major	The model number of the transceiver is unprogrammed.
03	Major	Authorization fault. Contact MDS.
04	Major	One or both of the internal programmable synthesizer loops is reporting an out-of-lock condition.
07	Major	One or more of the radio's internal voltage regulators is reporting a failure. The radio will not operate.

Table 11. Event codes *(Continued)*

Event Code	Alarm Type	Description
08	Major	The system is reporting that it has not been calibrated. Factory calibration is required for proper radio operation.
09	--	Not used.
10	Major	The internal microcontroller was unable to properly program the system to the appropriate EEPROM defaults. A hardware problem may exist.
11–15	--	Not used.
16	Minor	Not used.
17	Minor	A data parity fault has been detected on the DATA INTERFACE connector. This usually indicates a parity setting mismatch between the radio and the RTU.
18	Minor	A data framing error has been detected on the DATA INTERFACE connector. This may indicate a baud rate mismatch between the radio and the RTU.
20	Minor	Configuration error. An invalid parameter configuration exists. This may be caused by an invalid modem choice.
19–24	--	Not used.
25	Minor	The 5.6 volt power regulator is out-of-tolerance. If the error is excessive, operation may fail.
26	Minor	The DC input voltage is out-of-tolerance. If the voltage is too far out of tolerance, operation may fail.
27, 28	--	Not used
31	Minor	The transceiver's internal temperature is approaching an out-of-tolerance condition. If the temperature drifts outside of the recommended operating range, system operation may fail.

7.0 TECHNICAL REFERENCE

7.1 Transceiver Specifications

TRANSMITTER

Frequency Range:	380–512 MHz (MDS 4710B) 800–960 MHz (MDS 9710B) *(See Figure 4 on page 4 for hardware band limits)*
Frequency Increments:	6.25 kHz or 5 kHz (Factory Configurable)
Modulation Type:	Binary CPFSK
Audio Input Level:	–20 to +5 dBm
Carrier Power:	Maximum: 5 watts (+37 dBm) Minimum: 0.1 watts (+20 dBm)
Duty Cycle:	Continuous
Output Impedance:	50 ohms (Ω)
Frequency Stability:	1.5 ppm, –30 to +60 degrees Celsius
Channel Spacing:	12.5 kHz
Spurious & Harmonic:	–65 dBc per EIA test specification
Time-out Timer:	1–255 seconds
Transmitter Keying:	RTS

Response Time:	5 ms
Max. FM modulation:	±2.5 kHz

RECEIVER

Type:	Double conversion superheterodyne
Frequency Range:	380–512 MHz (MDS 4710B) 800–960 MHz (MDS 9710B) *(See Figure 4 on page 4 for hardware band limits)*
Frequency Increments:	6.25 kHz or 5 kHz (Factory Configurable)
Frequency Stability:	1.5 ppm, –30 to +60 degrees Celsius
Sensitivity:	12 dB SINAD at –110 dBm
Spurious & Image Rejection:	85 dB minimum
Intermodulation Response Rejection:	75 dB minimum per EIA specification
Selectivity:	65 dB minimum at adjacent channel
Bandwidth:	12.5 kHz
Desensitization:	65 dB minimum, 12.5 kHz channel
Bit-Error Rates:	1200 bps: 1 x 10–6 at –110 dBm 4800 bps: 1 x 10–6 at –110 dBm 9600 bps: 1 x 10–6 at –108 dBm

PRIMARY POWER

Voltage:	13.8 Vdc Nominal (10.5 to 16 Vdc)
TX Supply Current:	1.8 A nominal, 2.5 A maximum
RX Supply Current:	150 mA (less than 16 mA in Sleep mode)
Power Connector:	2-pin polarized locking connector
Circuit Protector:	4 Amp, Self-Resetting Fuse, Internal *(Remove Primary Power to Reset)*
Reverse Polarity Protection:	Diode across primary input

DATA INTERFACE

Signaling Standard:	RS-232
Connector:	DB-25 (shared with data port), RJ-11 (separate)
Data Interface Rates:	Bell 202T (1200 bps) modem—up to 1200 bps 4800 bps modem—up to 4800 bps 9600 bps modem—9600 bps only
Data Latency:	10 milliseconds maximum

ENVIRONMENTAL

Humidity:	95% at 40 C
Temperature Range:	–30 to 60 C
Weight:	3.5 pounds (1.6 kilograms)
Size:	Refer to Figure 6.
Case:	Die-cast aluminum

7.2 Helical Filter Adjustment

If the receive frequency of the radio is changed more than 5 MHz, the helical filters should be adjusted for maximum received signal strength indication (RSSI). To adjust the filters, proceed as follows:

1. Remove the top cover from the transceiver by loosening the four screws and lifting straight up.

2. Locate the helical filters on the PC board. See Figure 14 (MDS 4710B) or Figure 14 (MDS 9710B) as appropriate.

3. Apply a steady signal to the radio at the programmed receive frequency (–80 dBm level recommended; no stronger than –60 dBm). This should be done with a signal generator.

4. Measure the radio's RSSI using one of the following methods:
   - With an HHT (See *4.0 TRANSCEIVER PROGRAMMING*).
   - With MDS Radio Configuration Software (See *7.3 Using PC Software with the Radio*).
   - With a voltmeter connected to Pin 21 of the INTERFACE connector (See *3.3 RSSI Chart*).

5. With a non-metallic adjustment tool, adjust each section of the helical filters for maximum RSSI. Re-install the cover to the transceiver.

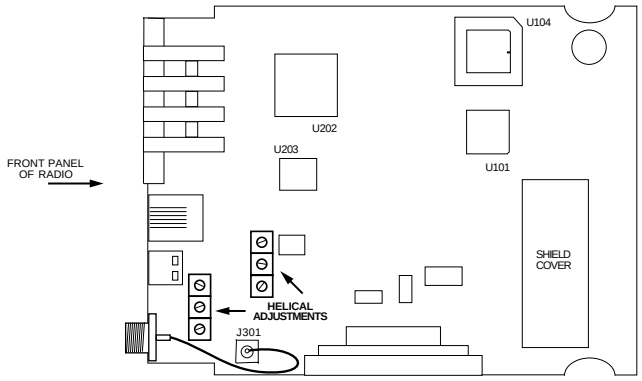

Figure 14. MDS 4710B helical filter locations

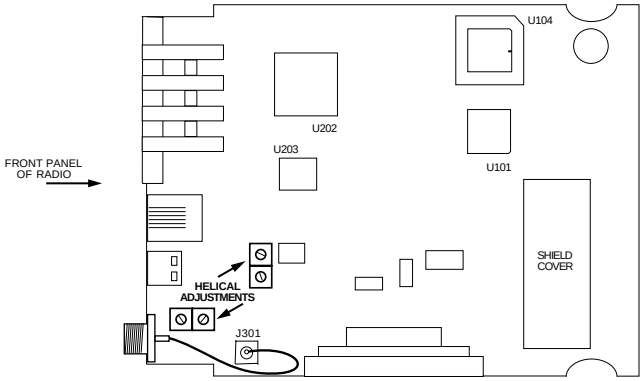

Figure 15. MDS 9710B helical filter locations

7.3 Using PC Software with the Radio

Windows-based Radio Configuration software is available (MDS P/N 03-3156A01) to allow diagnostics and control of the transceiver using a personal computer. The software package also allows you to upgrade the radio's internal software when new features become available from Microwave Data Systems.

The current software version includes functionality for MDS x710B Transceivers and includes on-line user instructions. An installation booklet is provided with the software package. Contact MDS for ordering information.

Connecting a PC

To connect a PC to the radio's DIAGNOSTICS port, an RJ-11 to DB-9 adapter (MDS P/N 03-3246A01) is required. If desired, an adapter cable may be constructed using the information shown in Figure 16.

Upgrading the Radio's Software

Using the Radio Configuration software, select **RADIO SOFTWARE UPGRADE** under the **SYSTEM** menu. Follow the prompts and on-line instructions to determine how to proceed.

Software upgrades are distributed as ASCII files with a ".S28" extension. These files use the Motorola S-record format. When the download is activated, the radio's PWR LED will flash rapidly confirming that a download is in process. The download takes about two minutes.

NOTE: If a download fails, the radio is left unprogrammed and inoperative. This is indicated by the PWR LED flashing slowly (1 second on and 1 second off). This condition is only likely if there were to be a power failure to the computer or radio during the downloading process. The download can be attempted again when the fault has been corrected.

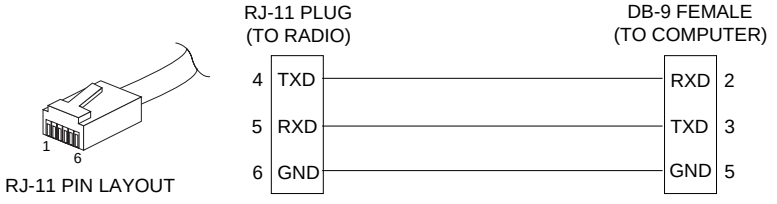

Figure 16. RJ-11 to DB-9 adapter cable
(for PC Diagnostics & Control)

7.4 Bench Testing Set-up

Figure 17 shows a sample test setup that can be used to verify the basic operation of MDS x710B radios. This test can be performed with any number of remote radios by using a power divider with the appropriate number of output connections.

The RTU simulator shown in the test setup (MDS Part No. 03-2512A01) is a microcontroller that emulates a remote terminal unit operating at 1200, 2400, 4800, or 9600 bps. Custom software is supplied with the RTU simulator that allows continuous polling of remote radios. The software reports the number of polls sent, polls received, and the number of errors detected. The software runs on an IBM-compatible personal computer connected to the DIAGNOSTICS port on the master station.

CAUTION

POSSIBLE EQUIPMENT DAMAGE

It is very important to use attenuation between all units in the test setup. The amount of attenuation required depends on the number of units being tested and the desired signal strength (RSSI) at each transceiver during the test. In no case should a signal greater than –50 dBm be applied to any radio in the test setup.

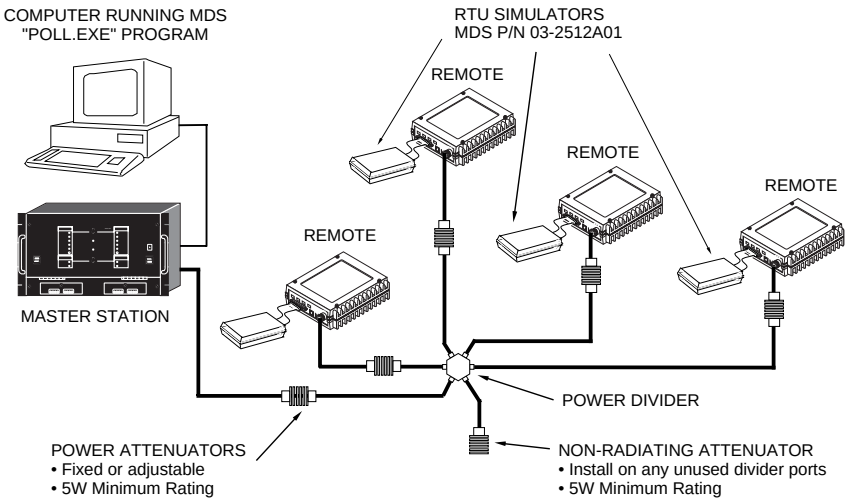

Figure 17. Bench test set-up

7.5 dBm-Watts-Volts Conversion Chart

Table 12 is provided as a convenience for determining the equivalent wattage or voltage of an RF power expressed in dBm.

Table 12. dBm-watts-volts conversion—for 50 ohm systems

dBm	V	Po
+53	100.0	200W
+50	70.7	100W
+49	64.0	80W
+48	58.0	64W
+47	50.0	50W
+46	44.5	40W
+45	40.0	32W
+44	32.5	25W
+43	32.0	20W
+42	28.0	16W
+41	26.2	12.5W
+40	22.5	10W
+39	20.0	8W
+38	18.0	6.4W
+37	16.0	5W
+36	14.1	4W
+35	12.5	3.2W
+34	11.5	2.5W
+33	10.0	2W
+32	9.0	1.6W
+31	8.0	1.25W
+30	7.10	1.0W
+29	6.40	800mW
+28	5.80	640mW
+27	5.00	500mW
+26	4.45	400mW
+25	4.00	320mW
+24	3.55	250mW
+23	3.20	200mW
+22	2.80	160mW
+21	2.52	125mW
+20	2.25	100mW
+19	2.00	80mW
+18	1.80	64mW
+17	1.60	50mW
+16	1.41	40mW
+15	1.25	32mW
+14	1.15	25mW
+13	1.00	20mW
+12	.90	16mW
+11	.80	12.5mW
+10	.71	10mW
+9	.64	8mW
+8	.58	6.4mW
+7	.500	5mW
+6	.445	4mW
+5	.400	3.2mW
+4	.355	2.5mW
+3	.320	2.0mW
+2	.280	1.6mW
+1	.252	1.25mW

dBm	V	Po
0	.225	1.0mW
-1	.200	.80mW
-2	.180	.64mW
-3	.160	.50mW
-4	.141	.40mW
-5	.125	.32mW
-6	.115	.25mW
-7	.100	.20mW
-8	.090	.16mW
-9	.080	.125mW
-10	.071	.10mW
-11	.064	
-12	.058	
-13	.050	
-14	.045	
-15	.040	
-16	.0355	

dBm	mV	Po
-17	31.5	
-18	28.5	
-19	25.1	
-20	22.5	.01mW
-21	20.0	
-22	17.9	
-23	15.9	
-24	14.1	
-25	12.8	
-26	11.5	
-27	10.0	
-28	8.9	
-29	8.0	
-30	7.1	.001mW
-31	6.25	
-32	5.8	
-33	5.0	
-34	4.5	
-35	4.0	
-36	3.5	
-37	3.2	
-38	2.85	
-39	2.5	
-40	2.25	.1µW
-41	2.0	
-42	1.8	
-43	1.6	
-44	1.4	
-45	1.25	
-46	1.18	
-47	1.00	
-48	0.90	

dBm	mV	Po
-49	0.80	
-50	0.71	.01µW
-51	0.64	
-52	0.57	
-53	0.50	
-54	0.45	
-55	0.40	
-56	0.351	
-57	0.32	
-58	0.286	
-59	0.251	
-60	0.225	.001µW
-61	0.200	
-62	0.180	
-63	0.160	
-64	0.141	

dBm	µV	Po
-65	128	
-66	115	
-67	100	
-68	90	
-69	80	
-70	71	.1nW
-71	65	
-72	58	
-73	50	
-74	45	
-75	40	
-76	35	
-77	32	
-78	29	
-79	25	
-80	22.5	.01nW
-81	20.0	
-82	18.0	
-83	16.0	
-84	11.1	
-85	12.9	
-86	11.5	
-87	10.0	
-88	9.0	
-89	8.0	
-90	7.1	.001nW
-91	6.1	
-92	5.75	
-93	5.0	
-94	4.5	
-95	4.0	
-96	3.51	
-97	3.2	

dBm	µV	Po
-98	2.9	
-99	2.51	
-100	2.25	.1pW
-101	2.0	
-102	1.8	
-103	1.6	
-104	1.41	
-105	1.27	
-106	1.18	

dBm	nV	Po
-107	1000	
-108	900	
-109	800	
-110	710	.01pW
-111	640	
-112	580	
-113	500	
-114	450	
-115	400	
-116	355	
-117	325	
-118	285	
-119	251	
-120	225	.001pW
-121	200	
-122	180	
-123	160	
-124	141	
-125	128	
-126	117	
-127	100	
-128	90	
-129	80	.1fW
-130	71	
-131	61	
-132	58	
-133	50	
-134	45	
-135	40	
-136	35	
-137	33	
-138	29	
-139	25	
-140	23	.01fW

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IN CASE OF DIFFICULTY...

MDS products are designed for long life and trouble-free operation. However, this equipment, as with all electronic equipment may have an occasional component failure. The following information will assist you in the event that servicing becomes necessary.

FACTORY TECHNICAL ASSISTANCE

Technical assistance for MDS products is available from our Customer Support Team during business hours (8:00 A.M.–5:30 P.M. Eastern Time). When calling, please give the complete model number of the radio, along with a description of the trouble symptom(s) that you are experiencing. In many cases, problems can be resolved over the telephone, without the need for returning the unit to the factory.

Please use the following telephone numbers for product assistance:

716-242-9600 (Phone)

716-242-9620 (FAX)

FACTORY REPAIRS

Component-level repair of radio equipment is *not* recommended in the field. Many components are installed using surface mount technology, which requires specialized training and equipment for proper servicing. For this reason, the equipment should be returned to the factory for any PC board repairs. The factory is best equipped to diagnose, repair and align your radio to its proper operating specifications.

If return of the equipment is necessary, you will be issued a Returned Material Authorization (RMA) number. The RMA number will help expedite the repair so that the equipment can be repaired and returned to you as quickly as possible. Please be sure to include the RMA number on the outside of the shipping box, and on any correspondence relating to the repair. *No equipment will be accepted for repair without an RMA number.*

A statement should accompany the radio describing, in detail, the trouble symptom(s), and a description of any associated equipment normally connected to the radio. It is also important to include the name and telephone number of a person in your organization who can be contacted if additional information is required.

The radio must be properly packed for return to the factory. The original shipping container and packaging materials should be used whenever possible. All factory returns should be addressed to:

Microwave Data Systems Inc.
Customer Service Department
(RMA No. XXXX)
175 Science Parkway
Rochester, NY 14620 USA

When repairs have been completed, the equipment will be returned to you by the same shipping method used to send it to the factory. Please specify if you wish to make different shipping arrangements.

Microwave Data Systems Inc.

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