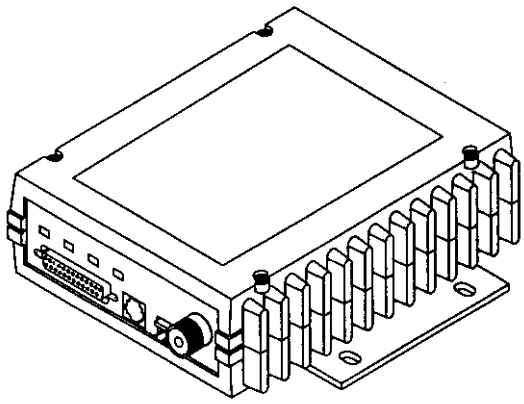
MDS 2710A/D



Data Transceiver

MDS 05-3447A01, REV. A.1
MARCH 1999

PRELIMINARY

CALIFORNIA MICROWAVE
MICROWAVE DATA SYSTEMS

Installation and Operation Guide

QUICK START GUIDE

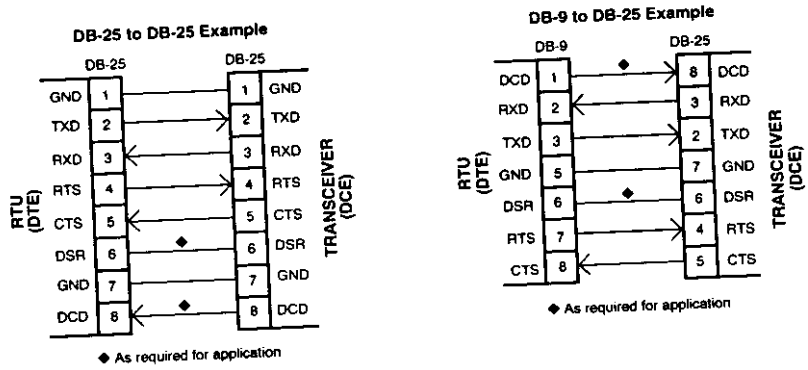
Below are the basic steps for installing the transceiver. Detailed instructions are given in "Installation Steps" on page 9 of this guide.

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.)



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 4 on page 16 for a description of the status LEDs.
- Refine directional antenna headings for maximum receive signal strength using the **RSSI** command.

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Copyright Notice

Operational Safety Notices

RF Exposure

The radio equipment described in this guide uses radio frequency transmitters. Although the power level is low, the concentrated energy from a directional antenna may pose a health hazard. Do not allow people to come in close proximity to 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' adherence to this internationally accepted quality system standard provides one of the strongest assurances of product and service quality available.

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.

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

1.1 Introduction

This guide presents installation and operating instructions for MDS 2710A (220-240 MHz) and MDS 2710D (220-222 MHz) digital radio transceivers.

These transceivers (Figure 1) are data telemetry radios designed to operate in a point-to-multipoint environment, such as electric utility Supervisory Control and Data Acquisition (SCADA) and distribution automation, gas field automation, water and wastewater SCADA, and on-line transaction processing applications. They use microprocessor control and Digital Signal Processing (DSP) technology to provide highly reliable communications even under adverse conditions.

MDS 2710A/D radios use continuous-phase frequency (CPFSK) modulation with root duo-binary filtering (the sum of two Nyquist-shaped, root-raised cosine responses). Demodulation uses a Virterbi decoder and equalization with soft decision decoding.

Modulation and demodulation is accomplished using Digital Signal Processing (DSP). DSP adapts to differences between components from unit to unit, and ensures consistent and repeatable performance in ambient temperatures from –30 to +60 degrees Centigrade. The use of Digital Signal Processing eliminates the fluctuations and variations in modem operation that degrade operation of analog circuits.

The transceiver is designed for trouble-free operation with data equipment provided by many other manufacturers, including Remote Terminal Units (RTUs), programmable logic controllers (PLCs), flow computers, lottery terminals, automatic teller machines, and others.

NOTE: Some features may not be available on all radios, based on the options purchased and the applicable regulations for the region in which the radio will operate.

1.2 Differences Between Models

The MDS 2710A and MDS 2710D are very similar in appearance and functionality. The major differences are in operating bandwidth and frequency coverage. The "A" model is designed to operate in a 12.5 kHz channel from 220 to 240 MHz, while the "D" model occupies a narrower 5 kHz channel in the frequency band of 220 to 222 MHz.

In addition, the over-the-air modem speed of the two models differ. The MDS 2710A is capable of 9600 bps transmission, while the MDS 2710D is capable of 3200 bps. This does *not* affect the local Data Interface port speed, however. Both models will accept asynchronous data between 300 and 38.4 kbps.

Finally, there are some hardware and software differences between the two models. The operating software is *not* interchangeable between "A" and "D" models.

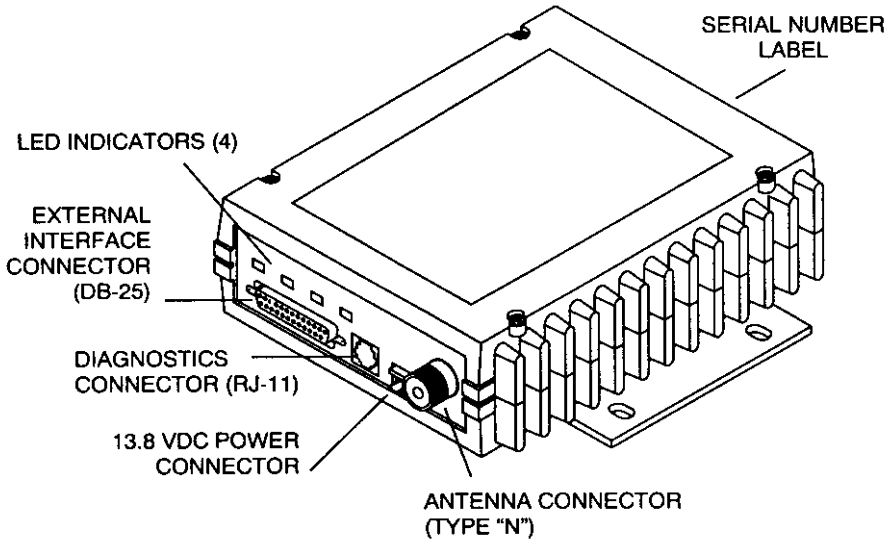

Figure 1. Transceiver Connectors and Indicators

1.3 Applications

Point-to-Multipoint, Multiple Address Systems (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.

Often, a radio system consists of many widely separated remote radios. A point-to-multipoint or SCADA (Supervisory Control and Data Acquisition) system may be a new installation for automatic, remote monitoring of gas wells, water tank levels, electric power distribution system control and measurement, etc.

The radio system may replace a network of remote monitors currently linked to a central location via leased telephone line. At the central office of such a system, there is usually a large mainframe computer and some means of switching between individual lines coming from each remote monitor. In this type of system, there is a modulator/demodulator (modem) at the main computer, and at each remote site, usually built into the remote monitor itself. Since the cost of leasing a dedicated-pair phone line is quite high, radio is often used as an alternative communication medium.

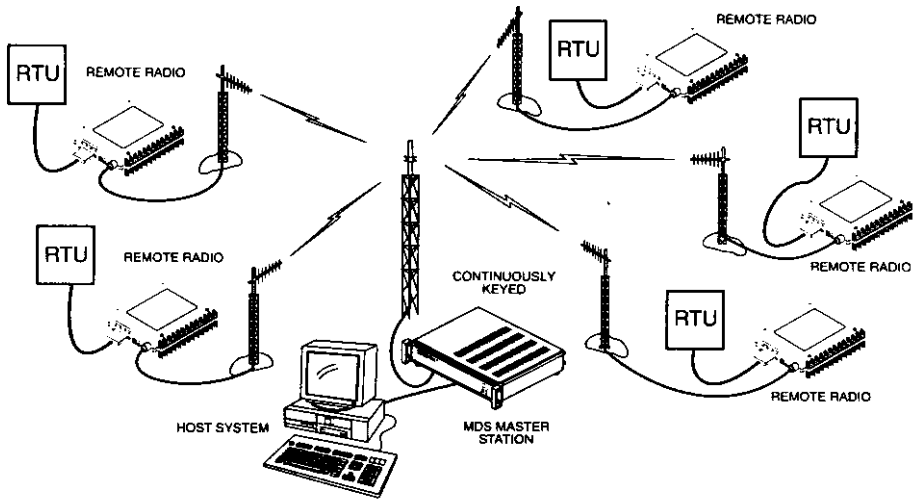

Figure 2. Typical MAS Point-to-Multipoint Network

Point-to-Point System

Where permitted, the transceiver may also be used in a point-to-point arrangement. A point-to-point system consists of just two radios—one serving as a master and the other as a remote—as shown in Figure 3. It provides a simplex or half-duplex communications link for the transfer of data between two locations.

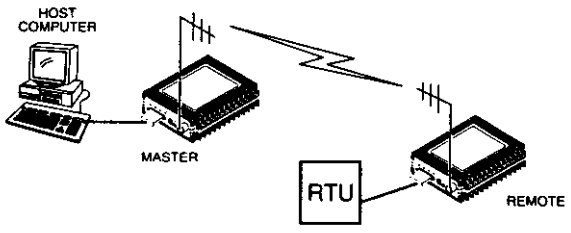

Figure 3. Typical Point-to-Point Link

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. 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 many MAS systems, and is shown in Figure 2. This is useful for high-speed polling applications.

NOTE: 2710A/D remotes do not support full-duplex operation.

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

Single Frequency (Simplex) Operation

Single frequency operation (also known as simplex) is a special case of switched carrier operation. 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.

1.4 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.

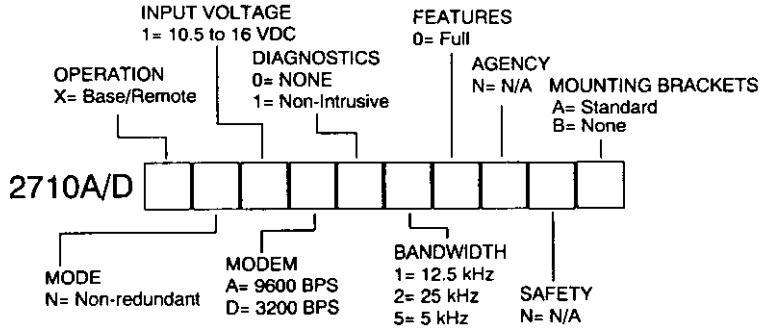

Figure 4. 2710A/D Model Number Codes

1.5 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 2710A/D 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
RJ-11 to DB-9 adapter	Used to connect a PC to the radio's DIAG. port	03-3246A01
EIA-232 to EIA-422 Converter Assembly	External adapter plug that converts the radio's DATA INTERFACE connector to EIA-422 compatible signaling.	03-2358A01
TTL Converter Assembly	External adapter plug that converts the radio's DATA INTERFACE connector to TTL compatible signaling.	03-2223A01
Radio Configuration Software	Provides diagnostics of the transceiver (Windows-based PC required.)	03-3156A01

2.0 GLOSSARY OF TERMS

If you are new to digital radio systems, some of the terms used in this guide may be unfamiliar. The following glossary explains many of these terms and will prove helpful in understanding the operation of the transceiver.

Active Messaging—This is a mode of diagnostic gathering that may interrupt SCADA system polling communications (contrast with *passive messaging*). Active (or intrusive) messaging is much faster than passive messaging because it is not dependent upon the RTU polling cycle.

Antenna System Gain—A figure, normally expressed in dB, representing the power increase resulting from the use of a gain-type antenna. System losses (from the feedline and coaxial connectors, for example) are subtracted from this figure to calculate the total antenna system gain.

Bit—The smallest unit of digital data, often represented by a one or a zero. Eight bits (plus start, stop, and parity bits) usually comprise a byte.

Bits-per-second—See *BPS*.

BPS—Bits-per-second. A measure of the information transfer rate of digital data across a communication channel.

Byte—A string of digital data usually made up of eight data bits and start, stop and parity bits.

Decibel (dB)—A measure computed from the ratio between two signal levels. Frequently used to express the gain (or loss) of a system.

Data Circuit-terminating Equipment—See *DCE*.

Data Communications Equipment—See *DCE*.

Data Terminal Equipment—See *DTE*.

dBi—Decibels referenced to an "ideal" isotropic radiator in free space. Frequently used to express antenna gain.

dBm—Decibels referenced to one milliwatt. An absolute unit used to measure signal power, as in transmitter power output, or received signal strength.

DCE—Data Circuit-terminating Equipment (or Data Communications Equipment). In data communications terminology, this is the "modem" side of a computer-to-modem connection. The MDS 2710A/D is a DCE device.

Digital Signal Processing—See *DSP*.

DSP—Digital Signal Processing. In the MDS 2710A/D transceiver, the DSP circuitry is responsible for the most critical real-time tasks; primarily modulation, demodulation, and servicing of the data port.

DTE—Data Terminal Equipment. A device that provides data in the form of digital signals at its output. Connects to the DCE device.

Equalization—The process of reducing the effects of amplitude, frequency or phase distortion with compensating networks.

Fade Margin—The greatest tolerable reduction in average received signal strength that will be anticipated under most conditions. Provides an allowance for reduced signal strength due to multipath, slight antenna movement or changing atmospheric losses. A fade margin of 20 to 30 dB is usually sufficient in most systems.

Frame—A segment of data that adheres to a specific data protocol and contains definite start and end points. It provides a method of synchronizing transmissions.

Hardware Flow Control—A transceiver feature used to prevent data buffer overruns when handling high-speed data from the RTU or PLC. When the buffer approaches overflow, the radio drops the clear-to-send (CTS) line, which instructs the RTU or PLC to delay further transmission until CTS again returns to the high state.

Host Computer—The computer installed at the master station site, which controls the collection of data from one or more remote sites.

Intrusive Diagnostics—A mode of remote diagnostics that queries and commands radios in a network with an impact on the delivery of the system "payload" data. See *Active messaging*.

Latency—The delay (usually expressed in milliseconds) between when data is applied to TXD (Pin 2) at one radio, until it appears at RXD (Pin 3) at the other radio.

MAS—Multiple Address System. A radio system where a central master station communicates with several remote stations for the purpose of gathering telemetry data.

Master (Station)—Radio which is connected to the host computer. It is the point at which polling enters the network.

MCU—Microcontroller Unit. This is the processor responsible for controlling system start-up, synthesizer loading, and key-up control.

Microcontroller Unit—See *MCU*.

Multiple Address System—See *MAS*.

Network-Wide Diagnostics—An advanced method of controlling and interrogating MDS radios in a radio network.

Non-intrusive diagnostics—See *Passive messaging*.

Passive messaging—This is a mode of diagnostic gathering that does not interrupt SCADA system polling communications. Diagnostic data is collected non-intrusively over a period of time; polling messages are carried with SCADA system data (contrast with *active messaging*).

Payload data—This is the application's user communication data which is sent over the radio network. It is the transfer of payload data that is the primary purpose of the radio communications network.

Point-Multipoint System—A radio communications network or system designed with a central control station that exchanges data with a number of remote locations equipped with terminal equipment.

Poll—A request for data issued from the host computer (or master PLC) to a remote radio.

PLC—Programmable Logic Controller. A dedicated microprocessor configured for a specific application with discrete inputs and outputs. It can serve as a host or as an RTU.

Programmable Logic Controller—See *PLC*.

Remote (Station)—A radio in a network that communicates with an associated master station.

Remote Terminal Unit—See *RTU*.

Redundant Operation—A station arrangement where *two* transceivers and two power supplies are available for operation, with automatic switchover in case of a failure.

RTU—Remote Terminal Unit. A data collection device installed at a remote radio site. An internal RTU *simulator* is provided with 4710/9710 radios to isolate faults to either the external RTU or the radio.

SCADA—Supervisory Control And Data Acquisition. An overall term for the functions commonly provided through an MAS radio system.

Standing Wave Ratio—See *SWR*.

Supervisory Control And Data Acquisition—See *SCADA*.

SWR—Standing Wave Ratio. A parameter related to the ratio between forward transmitter power and the reflected power from the antenna system. As a general rule, reflected power should not exceed 10% of the forward power (≈ 2:1 SWR).

3.0 INSTALLATION

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

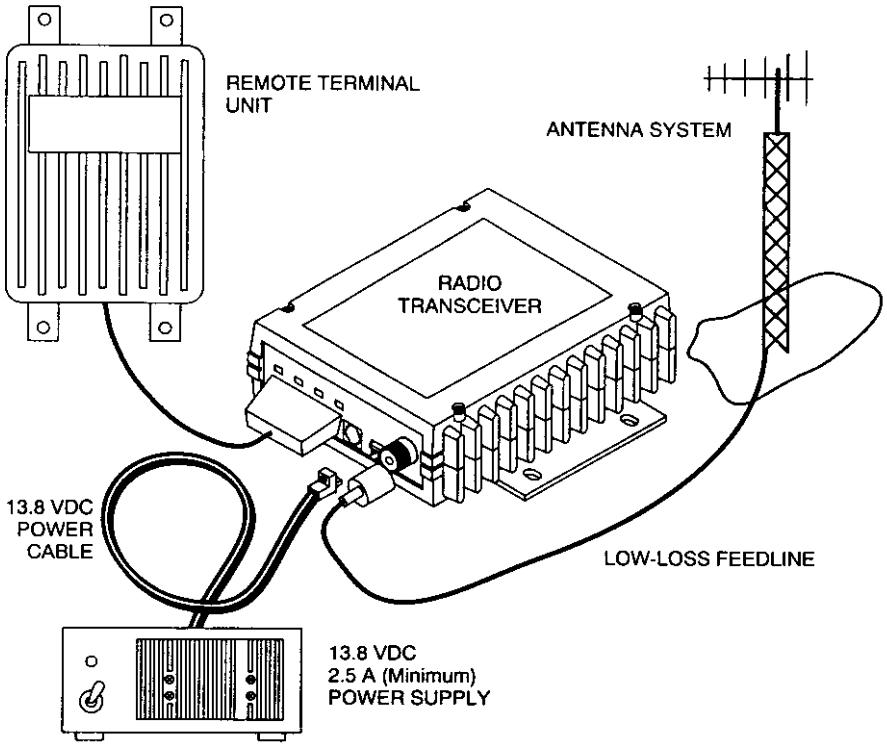

Figure 5. Typical Remote Station Arrangement

3.1 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. Preset directional antennas in the desired direction.

3. Connect the data equipment to the transceiver's DATA INTERFACE connector. Use only the required pins for the application—Do *not* use a fully pinned (25 conductor) cable. Basic applications may require only the use of Pin 2 (transmit data—TXD), Pin 3 (Received Data—RXD) and Pin 7 (signal ground). The radio can be keyed with the use of the **DATAKEY** command.

   Additional connections may be required for some installations. Refer to the complete list of pin functions provided in Table 3 on page 14.

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: Use the radio in negative ground systems only.

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 or verified 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.

6. Connect a hand-held terminal (HHT) to the DIAG. connector. When the HHT beeps, press [ENTER] to receive the ready ">" prompt.

   a. Set the operating frequencies using the **TX xxx.xxxx** (transmit) and **RX xxx.xxxx** (receive) commands.

      Press [ENTER] after each command. After programming, the HHT reads **PROGRAMMED OK** to indicate successful entry.

3.2 Transceiver Mounting

Figure 6 shows the mounting dimensions of the transceiver.

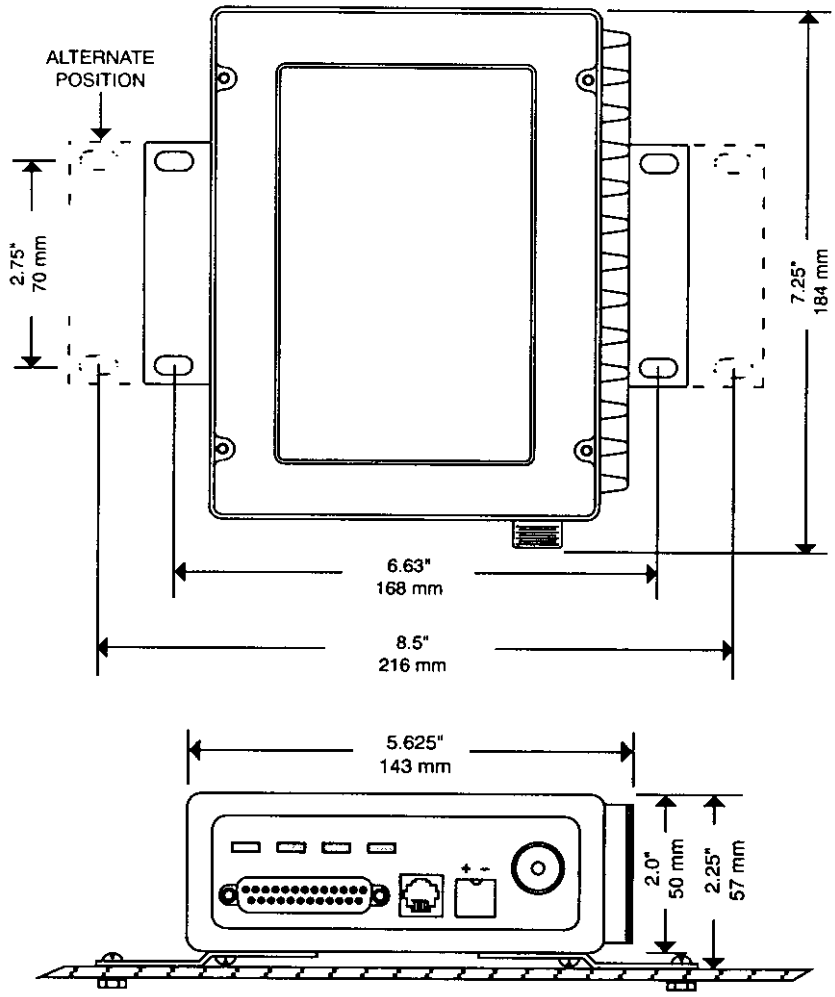

Figure 6. Transceiver Mounting Dimensions

3.3 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.

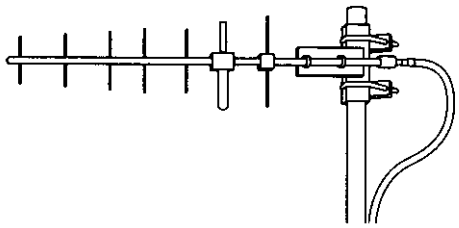

Figure 7. Typical Yagi Antenna (mounted to mast)

Feedlines

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 shows the losses that will occur when using various lengths and types of cable at 200 MHz. Regardless of the type of cable used, it should be kept as short as possible to minimize signal loss

Table 2. Length vs. Loss in Coaxial Cables at 200 MHz

Cable Type	3 Meters (10 Feet)	15 Meters (46 Feet)	30 Meters (91 Feet)	150 Meters (525 Feet)
RG-8A/U	0.32 dB	1.6 dB	3.2 dB	16 dB
1/2 inch HELIAX	0.10 dB	0.49 dB	0.98 dB	4.9 dB
7/8 inch HELIAX	0.05 dB	0.27 dB	0.54 dB	2.7 dB
1-1/4 inch HELIAX	0.04 dB	0.20 dB	0.40 dB	2.0 dB
1-5/8 inch HELIAX	0.03 dB	0.17 dB	0.33 dB	1.65 dB

3.4 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.

3.5 Data Interface Connections

The transceiver's DATA INTERFACE connector is used to connect the transceiver to an external DTE data terminal that supports the EIA-232 (formally RS-232) format. The transceiver supports asynchronous data rates of up to 38400 bps. The data rate at the DATA INTERFACE connector may differ from the data rate used over the air.

Table 3 lists each pin on the DATA INTERFACE connector and describes its function.

CAUTION
USE ONLY REQUIRED PINS

Do not use a 25 wire (fully pinned) cable for connection to the DATA INTERFACE connector. Use *only* the required pins for the application. Damage may result if improper connections are made. Typical applications require the use of *only* Pins 1 through 8 for EIA-232 signaling.

3.6 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 (nominal).

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

When Pin 12 is opened (or an EIA-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, except for a quick flash every 5 seconds.

Sleep Mode 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 EIA-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.

Table 3. 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 is at logic high.
5	OUT	**CTS—Clear-to-Send Output.** Goes "high" after the programmed CTS delay time has elapsed (DCE) or keys an attached radio when RF data arrives (CTS KEY).
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 "high" when the modem detects a data carrier from the master station.
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.
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.
12	IN	**Radio Inhibit (Sleep).** 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 online.
13	--	Do not connect—Reserved for future use.
14	IN	**PTT—Push to Talk.** This line is used to key the radio with an active-high signal of +5 Vdc.

Table 3. DATA INTERFACE Connector Pinouts *(Continued)*

Pin Number	Input/ Output	Pin Description
15	OUT	**Remote RTU Reset.** Do not connect—Reserved for future use.
16	IN	**$\overline{\text{PTT}}$—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 8 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 DIAG. 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.

4.0 OPERATION

In-service operation of the transceiver is completely automatic. Once the unit has been properly installed and configured, operator actions are limited to observing the front panel LED status indicators for proper operation.

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 4).

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 DIAG. connector.—See *Section 5.0, TRANSCEIVER PROGRAMMING.* This can also be done with a DC voltmeter as described in *Section 4.2, RSSI Measurement.*

4.1 LED Indicators

Table 4 describes the function of each status LED.

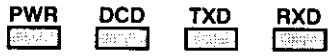

Table 4. LED Status Indicators

LED Name	Description
PWR	• Continuous—Power is applied to the radio, no problems detected. • Rapid flash (five times-per-second)—Fault indication. • Flashing once every 5 seconds—Radio is in Sleep mode.
DCD	• Flashing—Indicates the radio is receiving intermittent data frames. • Continuous—Radio is receiving a data signal from a continuously keyed radio.
TXD	An EIA-232 mark signal is being received at the DATA INTERFACE connector.
RXD	An EIA-232 mark signal is being sent out from the DATA INTERFACE connector.

4.2 RSSI Measurement

As an alternative to using an HHT, the radio's received signal strength (RSSI) may be read with a DC voltmeter connected to Pin 21 of the DATA INTERFACE connector. Figure 8 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.)

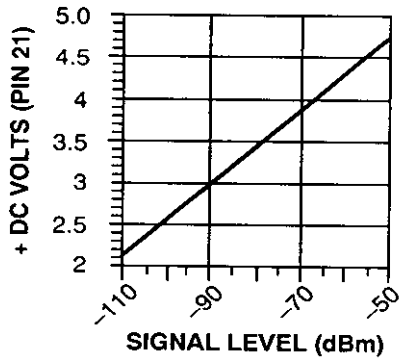

Figure 8. RSSI vs. Vdc (Typical)

5.0 TRANSCEIVER PROGRAMMING

Programming and control of the transceiver is performed through the radio's RJ-11 DIAG. (Diagnostics) connector with an MDS Hand-Held Terminal (MDS P/N 02-1501A01). This section contains a reference chart (Table 6) followed by detailed descriptions for each user command.

NOTE: In addition to HHT control, Windows-based software is available (MDS P/N 03-3156A01) to allow diagnostics and programming using a personal computer. An installation booklet and on-line instructions are included with the software. Contact MDS for ordering information.

5.1 Hand-Held Terminal Connection & Startup

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 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 5.2, Hand-Held Terminal Setup* for setup details.

Follow these steps to connect the HHT:

1. Connect the HHT's coiled cord to the DIAG. (RJ-11) jack on the radio as shown in Figure 9. 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 DIAG. jack. With this arrangement, Pin 23 of the HHT cable must be grounded to enable the diagnostic channel. (See Table 3.)

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

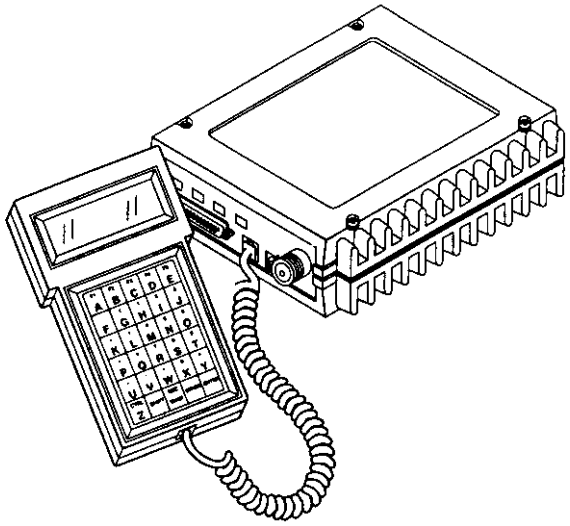

Figure 9. Hand-Held Terminal Connected to the Transceiver

5.2 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 DIAG. connector. Enable the setup mode by pressing the [SHIFT], [CTRL] and [SPACE] keys in sequence. The display shown in Figure 10 appears.

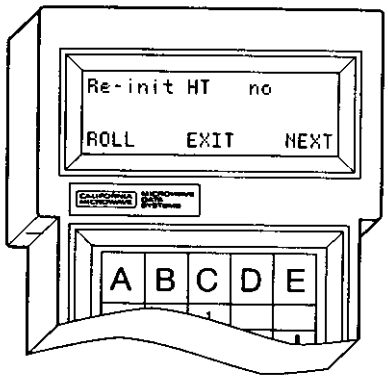

Figure 10. HHT Setup Display

2. The first of 15 menu items is displayed. Settings are reviewed by pressing the NEXT function controlled by the E key. Parameter settings are changed by pressing the ROLL function controlled by the A key.

3. Set up the HHT as listed in Table 5.

Table 5. HHT Operational Settings

Parameter	Setting	Parameter	Setting
Re-init HT	NO	Scroll On	33rd
Baud Rate	9600	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		

5.3 Keyboard Commands

Table 6 is a reference chart of software commands for the transceiver. Programmable information is shown in brackets [ ] following the command name. See *Section 5.4, Detailed Command Descriptions* for detailed command descriptions.

Entering Commands

To enter a command, 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.

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.
- Use the ESC/BKSP key to edit information or commands entries.
- The flashing square cursor (▪) indicates that letter mode is selected.
- The flashing superscript rectangular cursor (▫) indicates that number mode is selected.

Error Messages

Listed below are some possible error messages that may be encountered when using the HHT:

UNKNOWN COMMAND—The command was not recognized. Refer to the command description for command usage information.

INCORRECT ENTRY—The command format or its associated values were not valid. Refer to the command description for command usage information.

COMMAND FAILED—The command was unable to successfully complete. This may indicate an internal software problem.

NOT PROGRAMMED—Software was unable to program the internal radio memory or the requested item was not programmed.This is a serious internal radio error. Contact MDS for assistance.

TEXT TOO LONG—Response to **OWN** or **OWM** command when too many characters have been entered. Refer to the command description for command usage information.

NOT AVAILABLE—The entered command or parameter was valid, but it referred to a currently unavailable choice. Refer to the command description for command usage information.

ACCESS DENIED—The command is unavailable to the user. Refer to the command descriptions for command information.

EEPROM FAILURE— The **INIT** command was unable to write to EEPROM. This is a serious internal radio error. Contact MDS for assistance.

Table 6. Command summary

Command name	Function
AMASK [0000 0000–FFFF FFFF] *Details page 23*	Set or display hex code identifying which events trigger an alarm.
ASENSE [HI/LO] *Details page 24*	Set or display the state of the alarm output signal to ACTIVE HI or ACTIVE LO.
BAUD [xxxxx abc] *Details page 24*	Set or display the DATA INTERFACE data rate and control bits.
BUFF [ON, OFF] *Details page 24*	Enables or disables the internal radio data buffer.
CTS [0–255] *Details page 25*	Set or display the Clear-to-Send delay in seconds.
CKEY [ON–OFF] *Details page 25*	Enables or disables the continuously keyed mode. Note: Remotes cannot receive when keyed.
DATAKEY [ON, OFF] *Details page 25*	Toggles between key-on-data and key-on-RTS.
DKEY *Details page 26*	Dekey the radio (transmitter OFF). This is generally a radio test command.
DLINK [ON/OFF/xxxx] *Details page 26*	Configures local diagnostic link protocol.
DMGAP [xx] *Details page 26*	(*Diagnostics*) Sets the amount of time to wait after the receipt of a character before interpreting the next received character as the start of a new message.
DTYPE [NODE/ROOT] *Details page 26*	(*Diagnostics*) Sets up a radio as a root or node radio.
DUMP *Details page 27*	Display all programmable settings.
HREV *Details page 27*	Display the Hardware Revision level.
INIT *Details page 27*	Set radio parameters to factory defaults.
INIT [2710] *Details page 27*	Restores certain transceiver defaults before using the **INIT xx20** command.
INIT [2710] *Details page 27*	Configure radio for use with an MDS model P-20 chassis.
KEY *Details page 28*	Key the radio (transmitter ON). This is generally used for radio testing.
MODEL *Details page 28*	Display the model number of the radio.
MODEM [xxxx, NONE] *Details page 28*	Set the modem characteristics of the radio.
OWM [XXX...] *Details page 28*	Set or display the owner's message.

Table 6. Command summary *(Continued)*

Command name	Function
OWN [XXX...] *Details page 28*	Set or display the owner's name.
PTT [0–255] *Details page 28*	Set or display the Push-to-Talk delay in milliseconds.
PWR [20–37] *Details page 28*	Set or display the transmit power setting.
RSSI *Details page 29*	Display the Received Signal Strength Indication.
RTU [ON/OFF/0-80] *Details page 29*	Enables or disables the radio's internal RTU simulator and sets the RTU address.
RX [xxx.xxxx] *Details page 29*	Set or display receiver frequency.
RXTOT [NONE, 1-255] *Details page 29*	Set or display the value of the receive time-out timer.
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 30*	Display the DC voltages, diagnostics port, and transmit power level.
SREV *Details page 30*	Display the Software Revision Level.
STAT *Details page 30*	Display radio status and alarms.
TEMP *Details page 30*	Display the internal temperature of the radio in degrees Celsius.
TOT [1-255, ON, OFF] *Details page 31*	Set or display the Time-out Timer delay in milliseconds.
TX [xxx.xxxx] *Details page 31*	Set or display the transmit frequency.
UNIT [10000...65000] *Details page 31*	Set or display the transceiver's unit address.

5.4 Detailed Command Descriptions

The only *critical* commands for most applications are transmit and receive frequencies (**RX xxx.xxxx,TX xxx.xxxx**). However, proper use of the additional commands allows you to tailor the transceiver for a specific use, or conduct basic diagnostics on the radio. This section gives more detailed information for the user commands previously listed in Table 6.

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.

AMASK [0000 0000–FFFF FFFF]

The **AMASK** (alarm mask) command displays or sets which events cause the alarm output signal to be active. Normally, the mask is **FFFF FFFF**, meaning that any of the 32 possible events will activate the alarm output signal.

Entering the **AMASK** command alone displays the current setting of alarm events in hexadecimal format.

Entering the **AMASK** command followed by an eight-digit hexadecimal number reprograms the specified events to trigger an alarm.

The eight-digit hexadecimal number used as the command parameter is used to classify up to 32 events as alarm triggers, or disable alarm notification for an event. (See Table 7 below for a list of events.) The hex value for the mask corresponds to the hex value for the **STAT** command (see the **STAT** command description).

Each bit that is a '1' identifies the associated alarm condition as a major alarm. Each bit that is a '0' disables major alarm notification for that condition. If both the major and minor alarm bits are set to '0' for that condition, alarm notification is entirely disabled. For more information on configuring the alarm response, contact Microwave Data Systems and request Application Bulletin 98-002.

Table 7. Text messages of alarm event codes

Event Number	Text Message
01	Hardware mismatch
02	Model number not programmed
03	Authorization fault
04	Synthesizer is out-of-lock
07	Voltage regulator fault detected
08	Radio is not calibrated
09	DSP download fault
10	EEPROM write failure
11	Checksum fault
12	Receiver time-out
16	Unit address is not programmed
17	Data parity error

Table 7. Text messages of alarm event codes *(Continued)*

Event Number	Text Message
18	Data framing error
20	Configuration error
25	6V regulator output is not in valid range
26	DC input power is not in valid range
31	Internal Temperature is not in valid range

ASENSE [HI/LO]

The **ASENSE** command sets or displays the sense of the alarm output at Pin 25 of the DATA INTERFACE connector.

Entering the **ASENSE** command alone shows whether the alarm output is active high or low. Entering the **ASENSE** command followed by **HI** or **LO** resets the alarm output to active high or low.

BAUD [xxxxx abc]

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

The first parameter (**xxxxx**) is baud rate. Baud rate is specified in bits-per-second (bps) and must be one of the following speeds: 110, 300, 1200, 2400, 4800, 9600, 19200, or 38400.

The second parameter of the **BAUD** command (**abc**) is a three-character block indicating how the data is encoded:

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

The factory default setting is 19200 baud, 8 data bits, no parity, 1 stop bit (Example: **19200 8N1**).

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

BUFF [ON, OFF]

This command sets or displays the received data handling mode of the radio. The command parameter is either **ON** or **OFF**. The default is **ON**. The setting of this parameter affects the timing of how received RF data is sent out the INTERFACE connector. Outgoing (transmitted) data is not affected by this setting.

If data buffering is **OFF**, the radio operates with the lowest possible average latency. Data bytes are thus sent out the INTERFACE port as soon as an incoming RF data frame is disassembled. Average and typical latency will both be below 10 ms, but idle character gaps may be introduced into the outgoing data flow.

If data buffering is **ON**, the radio operates in seamless mode. Data bytes will be sent over the air as quickly as possible, but the receiver buffers (stores) the data until enough bytes have arrived to cover worst-case gaps in transmission. This mode of operation is required for protocols such as MODBUS™ that do not allow gaps in their data transmission.

Note that seamless mode (**BUFF ON**) is intended only for applications where the transmitter's baud rate is greater than or equal to the receiver's baud rate. Adherence to this rule is left up to the user.

CKEY [ON–OFF]

The **CKEY** command enables or disables the continuously-keyed function of the radio. When **CKEY** is set to **ON**, the radio is continuously keyed.

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 the radio asserts CTS and the DTE can transmit the data. A CTS value of zero keys the radio and asserts the CTS line immediately after the RTS line goes high.

For CTS Key operation (see **DEVICE** command), the timer specifies how long to wait after asserting the CTS, before sending data out the DATA INTERFACE port. A timer value of zero means that data will be sent out the data port without imposing a key-up delay. (Other delays may be present based on selected radio operating parameters.)

DATAKEY [ON, OFF]

The **DATAKEY** command sets or displays the ability of the radio to key the transmitter as data is received at the DATA INTERFACE connector. Asserting RTS keys the radio regardless of this command setting.

If **DATAKEY** is set to **ON**, the radio will key when a full data-character is received at the transceiver's DATA INTERFACE connector. If **DATAKEY** is set to **OFF**, the radio needs to be keyed by asserting either the RTS or PTT signal or with the **CKEY** or **KEY** command.

DEVICE [DCE, CTS KEY]

The **DEVICE** command sets or displays the device behavior of the radio. The command parameter is either **DCE** or **CTS KEY**.

The default selection is **DCE**. In this mode, CTS will go high following RTS, subject to the CTS programmable delay time. If the **DATAKEY** command is set to **ON**, keying can be stimulated by the input of characters at the data port. Hardware flow control is implemented by signaling the CTS line if data arrives faster than it can be buffered and transmitted.

If **CTS KEY** is selected, the radio is assumed to be controlling another radio. The RTS line is ignored and the CTS line is used as a keyline control for the other radio. CTS is asserted immediately following the receipt of RF data, but data will not be sent out the DATA INTERFACE port until after the CTS programmable delay time has expired. (This gives the other radio time to key.)

DKEY

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

DLINK [ON/OFF/xxxx]

This command is used to configure the local diagnostic link protocol used in network-wide diagnostics.

Entering **DLINK ON** enables the diagnostic link. Entering **DLINK OFF** disables the diagnostic link.

To change the diagnostic link, enter **DLINK** followed by one of the following baud rates: 1200, 2400, 4800, 9600, 19200 (default).

DMGAP [xx]

The **DMGAP** command sets the amount of time in milliseconds to wait after the receipt of a character before interpreting the next received character as the start of a new message. When data port baud rates are slow, the gap between characters within a poll may be so long that the radio interprets the next character as the start of a new poll. When diagnostics is being performed using passive messaging (see *Performing Network-Wide Remote Diagnostics* on page 35), this command may be used to change this behavior.

DTYPE [NODE/ROOT]

This command establishes the local radio as a root radio or node radio for network-wide diagnostics. Entering **DTYPE NODE** configures the radio as a node radio. Entering **DTYPE ROOT** configures the radio as a root radio. Entering the **DTYPE** command alone displays the current setting. See "Performing Network-Wide Remote Diagnostics" on page 35.

DUMP

This command displays all the programmed settings of the radio. 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.

HREV

This command displays the transceiver's hardware revision level.

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** is set to 0
- **DATAKEY** is set to **ON**
- **DEVICE** is set to **DCE**
- **PTT** is set to 0
- **SCD** is set to 0
- **TOT** is set to 30 seconds and set to **ON**
- **PWR** is set to +37 dBm (5 watts)

All other commands stay at their previously established settings.

INIT [2710]

This command sets the transceiver for operation *outside* the MDS model P-20 chassis by setting the following parameters as shown.

ASENSE	**ACTIVE HI**
AMASK	**FFFF FFFF** (assert alarm output on all alarms)
RXTOT	**NONE** (receive time-out timer disabled)

This command can be used prior to using the **INIT 2720** command to restore the standard transceiver defaults.

INIT [2720]

This command sets the transceiver for operation *inside* the model P-20 chassis by setting the following parameters as shown.

ASENSE	**ACTIVE LO**
AMASK	**FFFF 0000** (trigger on major alarms)
RXTOT	**20** (20 minute time-out timer)

KEY

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

MODEL

This command displays the radio's model number code.

MODEM [xxxx, NONE]

This command selects the radio's modem characteristics. Enter 9600 for digital operation, or enter NONE to select analog operation.

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]

NOTE: This function may not be available, depending on certification requirements in a particular country.

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 7.6.

RSSI

This command continuously displays the radio's Received Signal Strength Indication (RSSI) in dBm units, until you press the Enter key. 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 also be helpful in isolating a problem to either the external RTU or the radio.

RX [xxx.xxxx]

This command selects or displays the radio's receive frequency in MHz. The frequency step size is 6.25 kHz.

If the customer frequency has not been programmed at the factory, a default frequency will be programmed in the radio near the center of the frequency band.

RXTOT [NONE, 1-255]

The **RXTOT** command selects or displays the receive time-out timer value in minutes. This timer triggers an alarm (event 12) if data is not detected within the specified time.

Entering the **RXTOT** command without a parameter displays the timer value in minutes. Entering the **RXTOT** command with a parameter ranging from 0 to 255 resets the timer in minutes. Entering the **RXTOT** command with the parameter **NONE** disables the timer.

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 will unkey the transmitter immediately after the removal of the keying signal.

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

SNR

This command continuously displays the signal-to-noise ratio of the received signal expressed in dB, until you press the Enter key. As used in this guide, the signal-to-noise measurement is based upon the signal level following equalization, for received frames.

The SNR is an indication of the received signal quality. The SNR indication ranges from 10 dB to 33 dB. A value of 10 dB represents a very poor signal. A value of 24 dB represents a very good signal.

When the SNR command is used, it causes the DIAG. port to enter an update mode, and the signal-to-noise ratio is updated and redisplayed every 2 seconds. The SNR continuously updates until the [ENTER] key is pressed.

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 event codes are provided in Table 8 on page 33.

TEMP

This command displays the internal temperature of the transceiver in degrees Celsius.

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.

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

TX [xxx.xxxx]

This command selects or displays the radio's transmit frequency in MHz. The frequency step size is 6.25 kHz.

If the customer frequency has not been programmed at the factory, a default frequency will be programmed in the radio near the center of the frequency band.

UNIT [10000...65000]

This command selects or displays the radio's unit address. The factory default setting is the last five digits of the transceiver's serial number. The unit address is used in network diagnostics. See MDS' Network-Wide Diagnostics System Handbook (MDS P/N 05-3467A01) for more informatiion.

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 and re-apply primary power to reset.
- Secure connections (RF, data and power)
- An efficient and properly aligned antenna system with a good received signal strength (at least –90 dBm). It is possible for a system to operate with weaker signals, but reliability will be degraded.
- Proper programming of the transceiver's operating parameters (see *Section 5.0, TRANSCEIVER PROGRAMMING*).

- The correct interface between the transceiver and the connected data equipment (correct cable wiring, proper data format, timing, etc.)

6.1 LED Indicators

The LED status indicators are an important troubleshooting tool and should be checked whenever a problem is suspected. Table 4 on page 16 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 DIAG. port. These codes can be very helpful in resolving many system difficulties. Refer to Table 8 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 11).

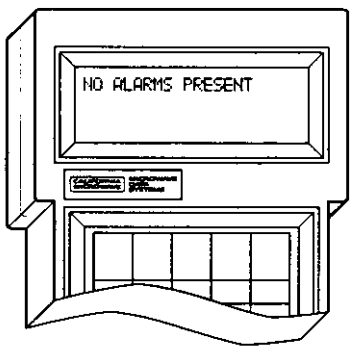

Figure 11. HHT Display in Response to STAT Command

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

If more than one alarm exists, the word **MORE** appears at the bottom of the screen. To view additional alarms, 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 degrade) 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 eventual system failure.

Event Code Definitions

Table 8 contains a listing of all event codes that may be reported by the transceiver.

Table 8. Event Codes

Event Code	Event Class	Description
01	Major	Improper software detected for this radio model.
02	Major	The model number of the transceiver is unprogrammed.
04	Major	One or both of the internal programmable synthesizer loops is reporting an out-of-lock condition.
06	Major	An unrecoverable fault was detected on the auto-D chip. The radio will not receive data.
07	Major	One or more of the radio's internal voltage regulators is reporting a failure. The radio will not operate.
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	--	Not used.
12	Major	Receiver time-out. No data received within the specified receiver time-out time.
13–15	--	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.
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 MDS 2710A/D Transceiver Specifications

TRANSMITTER SYSTEM SPECIFICATION

Operating Frequency:	See Transmitter Specifications
Frequency Stability:	±1.5 ppm
Adjacent Channel Power:	–65 dBc
Carrier Power Accuracy:	±2 dB

RECEIVER SYSTEM SPECIFICATION

Operating Frequency:	See Receiver Specifications
Maximum Usable Sensitivity:	–111 dBm for 1 x 10^{-6} BER
Co-Channel Rejection:	–12 dB

DATA CHARACTERISTICS

Signaling Standard:	EIA-232
Connector:	DB-25 Female
Data Interface Rates:	300 bps to 38.4 kbps1200, 2400, 4800, 9600 bps—asynchronous
Data Latency:	7 ms maximum
Byte Length:	10 or 11 bits

TRANSMITTER

Frequency Range:	220-240 MHz (MDS 2710A) 220-222 MHz (MDS 2710D)
Modulation Type:	Binary CPFSK
Carrier Power:	0.1 Watts to 5 Watts
Duty Cycle:	Continuous
Output Impedance:	50 ohms
Frequency Stability:	±1.5 ppm
Channel Spacing:	6.25 kHz steps
Transmitter Spurious Radiated Emissions:	–57 dBm, 30 MHz to 1 GHz –47 dBm, 1 GHz to 12.5 GHz
Harmonics:	
2nd harmonic:	57 dBc
3rd harmonic & higher:	57 dBc
Time-out Timer:	13 seconds, default (selectable with **TOT**)
Transmitter Keying:	Data activated or RTS

RECEIVER

Frequency Range:	220-240 MHz
Type:	Double conversion superheterodyne
Frequency Stability:	±1.5 ppm
Maximum Usable Sensitivity:	–111 dBm for 1 x 10^{-6} BER

Spurious Response Rejection:	70 dB
Intermodulation Response Rejection:	65 dB
Receiver Spurious Conducted Emissions:	–57 dBm, 9 kHz to 1 GHz –47 dBm, 1 GHz to 12.5 GHz
Receiver Spurious Radiated Emissions:	–57 dBm, 30 MHz to 1 GHz –47 dBm, 1 GHz to 12.5 GHz
Bandwidth:	12.5 kHz (MDS 2710A) 5 kHz (MDS 2710D)

PRIMARY POWER

Voltage:	13.8 Vdc Nominal (10.5 to 16 Vdc)
TX Supply Current:	2.5 amps max
RX Supply Current:	*Operational*—150 mA (nominal) *Standby (sleep)*—18 mA
Power Connector:	Integral part of Power/Interface connector
Fuse:	4 Amp Polyfuse, Self-Resetting, Internal (Remove Primary Power to Reset)
Reverse Polarity Protection:	Diode across primary input

ENVIRONMENTAL

Humidity:	95% at 40 degrees C
Temperature Range:	–30 to 60 degrees C (full performance) –40 to 70 degrees C (operational)
Weight:	1.6 kilograms
Case:	Die-cast Aluminum

DIAGNOSTICS INTERFACE

Signaling Standard:	EIA-232
Connector:	RJ-11 (may use DB-25 instead if Pin 23 is grounded to enable diagnostics channel)
I/O Devices:	MDS Hand Held Terminal or PC with MDS software

7.2 Performing Network-Wide Remote Diagnostics

Diagnostics data from a remote radio can be obtained by connecting a laptop or personal computer running MDS InSite diagnostics software to any radio in the network. Figure 12 shows an example of a setup for performing network-wide remote diagnostics.

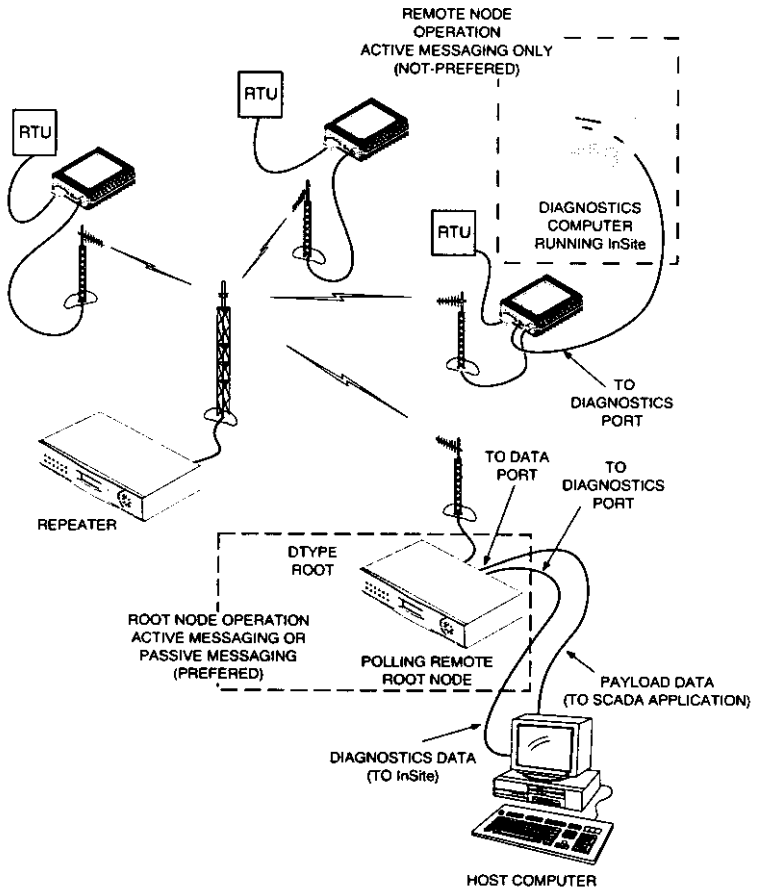

Figure 12. Network-Wide Remote Diagnostics Setup

If a PC is connected to any radio in the network, intrusive polling (polling which briefly interrupts payload data transmission) can be performed. To perform diagnostics without interrupting payload data transmission, connect the PC to a radio defined as the "root" radio. A radio is defined as a root radio using the **DTYPE ROOT** command locally, at the radio.

A complete explanation of remote diagnostics can be found in MDS' Network-Wide Diagnostics System Handbook (MDS P/N 05-3467A01). See the Handbook for more information about the basic diagnostic procedures outlined below.

1. Program one radio in the network as the root radio by entering the **DTYPE ROOT** command at the radio.

2. At the root radio, use the **DLINK ON** and **DLINK [baud rate]** commands to configure the diagnostic link protocol on the RJ-11 port.

3. Program all other radios in the network as nodes by entering the **DTYPE NODE** command at each radio.

4. Use the **DLINK ON** and **DLINK [baud rate]** commands to configure the diagnostic link protocol on the RJ-11 port of each node radio.

5. Connect same-site radios using a null-modem cable at the radios' diagnostic ports.

6. Connect a PC on which MDS InSite software is installed to the root radio, or to one of the nodes, at the radio's diagnostic port. (This PC may be the PC being used to collect payload data, as shown in Figure 12.)

   To connect a PC to the radio's DIAG. port, an RJ-11 to DB-9 adapter (MDS P/N 03-3246A01) is required. If desired, an adapter cable may be constructed from scratch using the information shown in Figure 13.

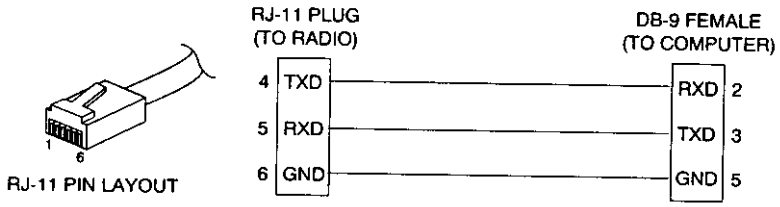

Figure 13. RJ-11 to DB-9 Adapter Cable

7. Launch the MDS InSite application at the PC. (See the MDS InSite User's Guide for instructions.)

7.3 Bench Testing Setup

Figure 14 shows a sample test setup that can be used to verify the basic operation of transceivers in a shop setting. The test can be performed with any number of remote radios by using a power divider with the required 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 using an IBM-compatible personal computer. The software reports the number of polls sent, polls received, and the number of errors detected.

As an alternative to using an external RTU simulator, the transceiver's internal RTU simulator may be used (see **RTU** command in Table 6 on page 21). (This will not provide as conclusive a test as an external simulator because it does not utilize the transceiver's data connector.)

NOTE: It is very important to use attenuation between all units in the test setup. The amount of attenuation required will depend 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 transceiver in the test setup.

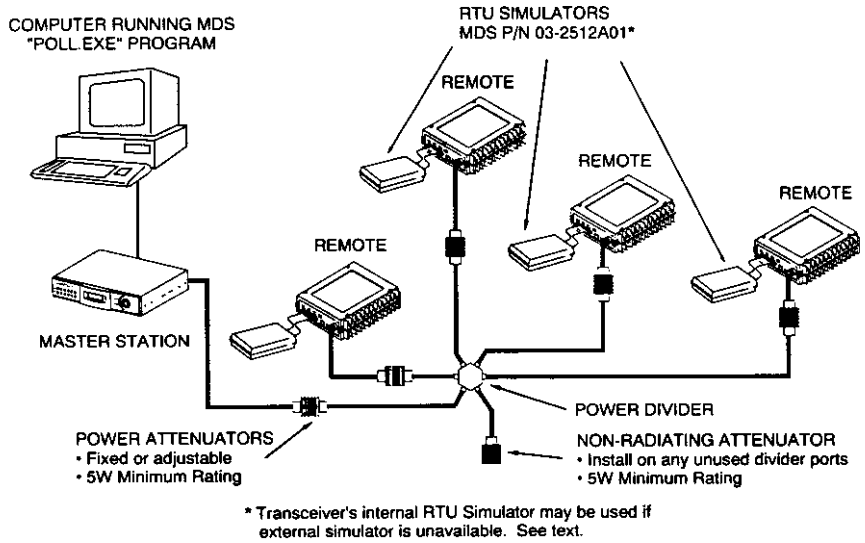

Figure 14. Typical setup for bench testing of radios

7.4 Helical Filter Adjustment

If the operating frequency of the radio is changed significantly, the helical filters should be adjusted for maximum received signal strength (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 15.

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

4. Measure the radio's RSSI using one of the following methods:
   - With an HHT (See *Section 5.0, TRANSCEIVER PROGRAMMING* on page 17).
   - With MDS Radio Configuration Software (See *Section 7.5, Upgrading the Radio's Software* on page 39).
   - With a voltmeter connected to Pin 21 of the DATA INTERFACE connector (See *Section 4.2, RSSI Measurement* on page 16).

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

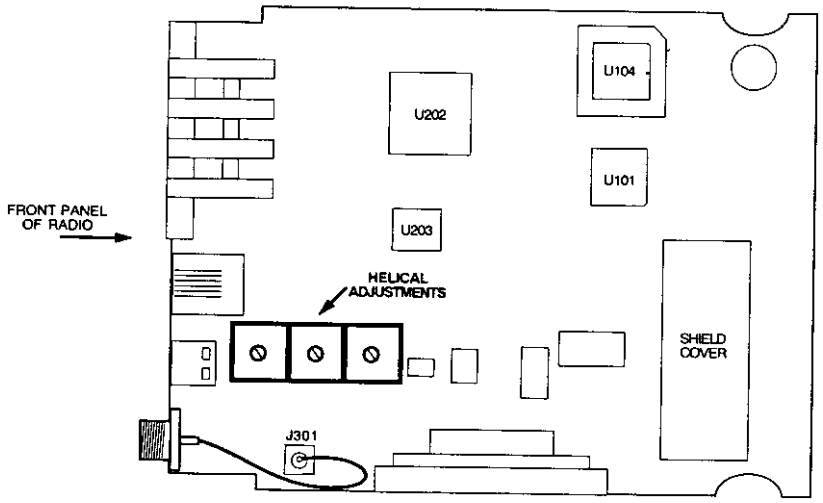

Figure 15. Helical Filter Location

7.5 Upgrading the Radio's Software

Windows-based Radio Configuration software is available (MDS P/N 03-3156A01) for upgrading the internal radio software when new features become available from Microwave Data Systems. Contact MDS for ordering information.

To connect a PC to the radio's DIAG. port, an RJ-11 to DB-9 adapter (MDS P/N 03-3246A01) is required. If desired, an adapter cable may be constructed from scratch using the information shown in Figure 13.

Using the Radio Configuration software, select **RADIO SOFTWARE UPGRADE** under the **SYSTEM** menu. Follow the prompts and online 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, 1 second off). This condition is only likely if a power failure occurred to the computer or radio during the downloading process. The download can be attempted again when the fault has been corrected.

7.6 dBm-Watts-Volts Conversion Chart

Table 9 is provided as a convenience for determining the equivalent wattage or voltage of an RF power expressed in dBm.

Table 9. 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

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
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.

CALIFORNIA MICROWAVE
MICROWAVE DATA SYSTEMS

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