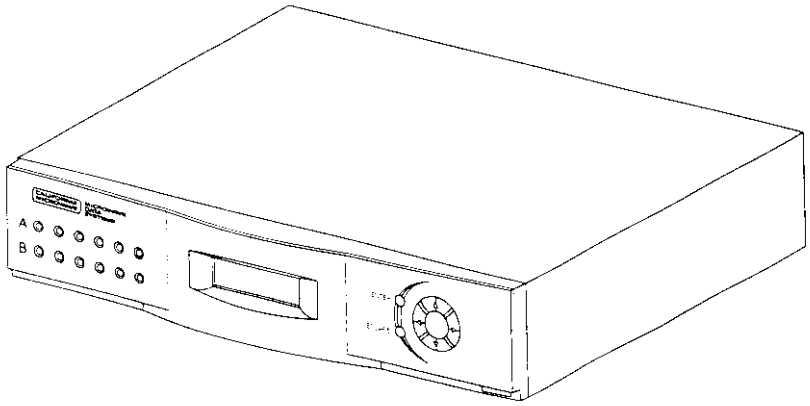
Exhibit C
Installation & Operation Manual

MDS 9790



900 MHz Multiple Address System Master Station Radio

MDS 05-3438A01, REV. 01
DECEMBER 1998

PRELIMINARY

CALIFORNIA MICROWAVE
MICROWAVE DATA SYSTEMS

Installation and Operation Guide

QUICK START GUIDE

1. Install and connect the antenna system to the radio. (Page 18)

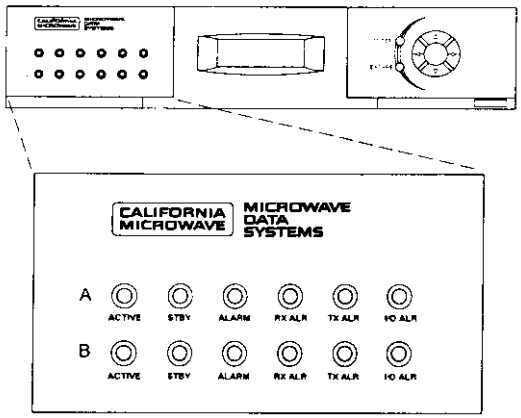
- Use a directional antenna aimed at the associated station.
- Use low loss feedline suited for 400 MHz. Keep the feedline as short as possible.

2. Connect the host computer to the rear panel DATA connector.

3. Verify proper mains voltage level, connect mains to the radio and set the power switch to ON.

4. Measure Received Signal Strength

5. Observe Front Panel Indicators for proper operation.



ACTIVE (green)—This transceiver board (A or B) is the selected unit.

STBY (yellow)—This transceiver board (A or B) is the standby unit (Protected version only).

ALARM (red)—General fault not covered by the other alarm categories (RX ALR, TX ALR, I/O ALR).

RX ALR (red)—Difficulty receiving. May be due to an antenna problem, receiver fault, or other condition causing a low received signal level.

TX ALR (red)—Fault with the transmit circuitry, or the transmitter is unkeyed.

I/O ALR (red)—The data rate or format of data at the data interface connector is incompatible with the radio settings.

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Copyright Notice

Operational Safety Notices

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.

RF Exposure

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 INTRODUCTION

This guide presents installation and operating instructions for the MDS 9790 master station radio. It begins with an overall description of the radio's features and is followed by the steps required to install the radio and place it into normal operation.

Additionally, the guide contains troubleshooting tips for resolving system difficulties that may be encountered. After you install the radio, keep this guide near the radio for future reference.

2.0 PRODUCT DESCRIPTION

The MDS 9790 (Figure 1) is a full-duplex data telemetry radio suitable for use as a master in a Multiple Address System (MAS) and Supervisory Control and Data Acquisition (SCADA) applications. The MDS 9790 uses microprocessor control and Digital Signal Processing (DSP) technology to provide highly reliable communications even under adverse conditions.

The MDS 9790 operates between 800 MHz and 960 MHz, and is intended to be used in systems with MDS 9710 remote radios. The radio is available in either a redundant configuration or a non-redundant configuration. Refer to Section 2.1, *Redundant versus Non-redundant*, on page 2 for further description.

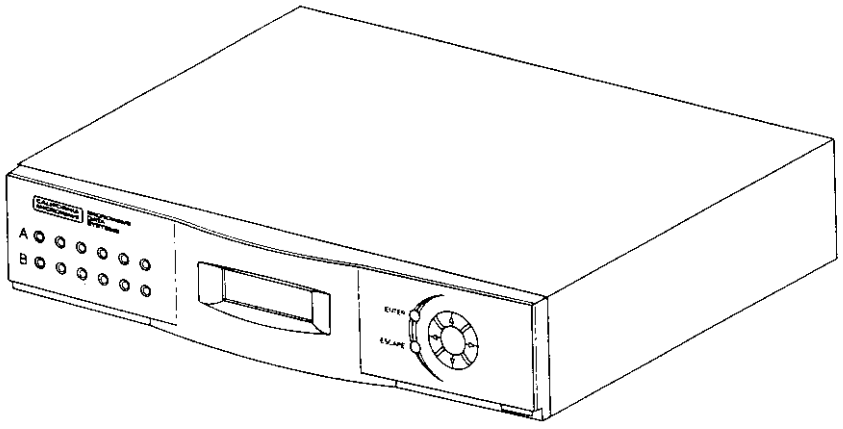


Figure 1. MDS 9790 master station

All radio assemblies, including the duplexer and power supply, are contained in the radio's compact (2RU high) enclosure. The radio's compact size allows it to fit into most existing systems, in either tabletop or rack-mounting arrangements. Connectors are provided on the rear panel for easy connection of power, antenna, data, alarm and diagnostic functions.

2.1 Redundant versus Non-redundant

A redundant configuration means that the master station has two complete transceiver systems installed in the enclosure. In the event of a primary transceiver system failure, the controlling logic causes a switch-over to the stand-by transceiver system. The redundant transceiver configuration has a stand-by transceiver that is constantly operating and its operational readiness is monitored. However, the transmitter power amplifier in the stand-by transceiver is not operating when it is in stand-by mode.

In a non-redundant configuration, there is only one transceiver system installed in the enclosure, and back-up transceiver operation is not possible.

2.2 Applications

The MDS 9790 is designed for point-to-multipoint data transmission in oil and gas pipeline communications, lottery systems and telecommunications systems. 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.

Basic MAS Master Station Operation

Figure 2 shows a typical point-to-multipoint system using an MDS 9790 radio.

The most basic system consists of a central master station and several associated remote units, as shown in Figure 2.

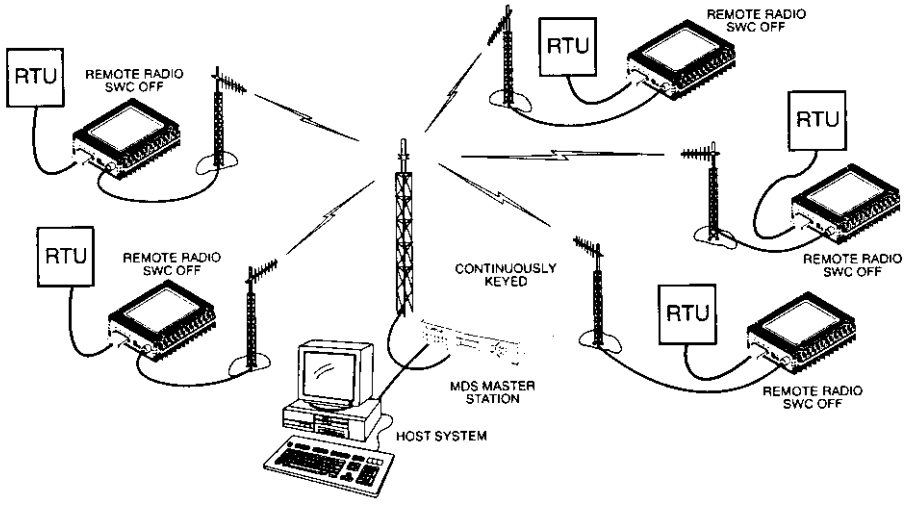


Figure 2. Typical MAS network

Repeater and Polling Remote Operation

An MAS system using repeater and polling-remote radios is shown in Figure 3. Notice that the polling remote radio is operating in half-duplex mode and the repeater is operating in full-duplex mode.

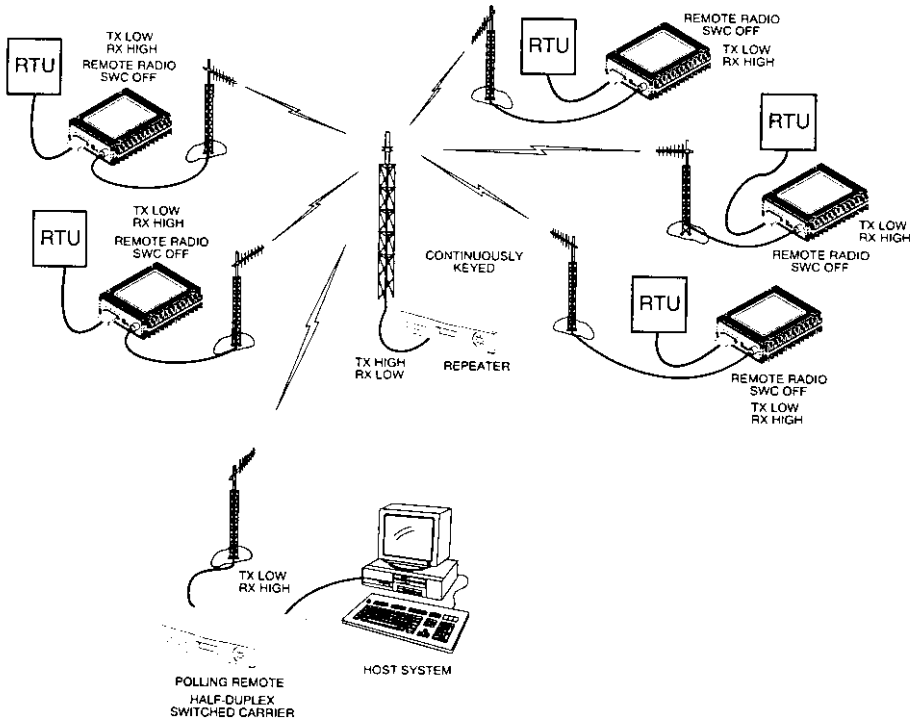


Figure 3. Typical repeater and polling-remote network

Simplex and Switched Carrier Operation

System-wide simplex operation is achieved by switching the master station carrier on to transmit, then off to receive. The same frequency is used for both transmit and receive.

Switched carrier, half-duplex mode is also achieved by switching the master station carrier on to transmit, then off to receive. However, different frequencies are used for transmit and receive.

2.3 Features

Reliability is a hallmark of the MDS 9790 design. The radio employs a one-piece transceiver board which minimizes RF losses and eliminates the need for inter-board cabling. This also allows easy plug-in replacement should servicing become necessary.

In addition, the optional redundant version of the radio includes redundant transceiver boards and power supply modules that automatically become active in the event of a failure in either of the transceivers or power supplies. This ensures continued operation in the event of most radio failures.

The following list highlights many of the radio's key features. For a full listing of specifications, see Section 8.1, *Technical Specifications*, on page 74.

- Operation from 24, 48 Vdc or 110 to 240 Vac mains
- Built-in diagnostics (local and remote)
- Front panel configuration of all operating parameters
- Time stamping of alarms and major events
- Software available for PC diagnostics and control (including firmware upgrade capability)
- Flexible mounting with connectors on front or rear

2.4 Accessories

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

Table 1. Transceiver accessories

Option	Description	MDS P/N
Diagnostics and Control Software	Computer software that allows PC control of the radio for diagnostics, control and software upgrades.	Contact MDS
Diagnostic and Control Interface Cable	Allows connection of a PC for diagnostics and control of the radio (DB-9 to DB-9).	97-1971A04
Auxiliary Front Panel Mounting Bracket	Allows rack mounting of the detachable front panel.	82-3189A01

2.5 Model Number Codes

The radio model number is printed on the serial number label, which is affixed to the radio chassis. Figure 4 shows the significance of the characters in the model number string for standard models. Contact MDS for specific information on optional configurations of the radio.

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

To be supplied

Figure 4. Model number codes

2.6 Terms and Abbreviations

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

BERT—Bit-error rate test. The results of a BERT are normally expressed as a ratio (power of 10) of the number of bits received in error compared to the total number received.

BER—Bit-error rate. See also BERT.

Bit—Binary digit. The smallest unit of digital data, often represented by a one or a zero. Eight bits usually comprise a byte.

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

Byte—A digital "word" usually made up of eight bits.

dBi—Decibels of gain relative to an isotropic radiator. (A hypothetical antenna which radiates equally in all directions.) Used to express antenna gain.

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

DCE— Data (circuit terminating) Communications Equipment. In data communications terminology, this is the "modem" side of a computer-to-modem connection. The transceiver is a DCE device which is designed to connect to a DTE device.

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

DSP—Digital Signal Processing. Advanced circuit technique to increase radio performance, primarily in modulation and demodulation.

DTE—Data Terminal Equipment. In data communications terminology, this is the computer side of a computer-to-modem connection. (Connects to the DCE device.)

Fade Margin—The maximum tolerable reduction in received signal strength which still provides an acceptable signal quality. This compensates for reduced signal strength due to multipath, slight antenna movement or changing atmospheric losses. Expressed in decibels.

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.

Fresnel Zone—A point of maximum width or girth of the transmitted radio signal. Obstructions in this region (the "first Fresnel zone") can have a detrimental effect on reception quality. As a general rule, 60 percent of the first Fresnel zone should be free of obstructions in a well-designed system. (Additional considerations are also required when planning a microwave path. A detailed discussion of the subject is presented in Section 8.2, *RF Propagation Planning*, on page 75.)

Half-Power Beamwidth—The customary way of measuring the width of a directional antenna's radiation pattern. This beamwidth is measured in degrees between the half-power points (the point at which the power is reduced 3 dB with respect to the main beam).

kbps—Kilobits-per-second.

Multipath Fading—Signals arriving at the receiver out of phase, which have a tendency to cancel each other. It is caused by reflections of the transmitted wave and results in distortion at the receiver or weak received signal strength.

RSSI—Received signal strength indication. Expressed in dBm.

SNR—Signal-to-noise ratio. Expressed in decibels (dB).

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 guideline, reflected power should not exceed 10% of the forward power (≈ 2:1 SWR).

3.0 INSTALLATION PLANNING

The installation of the transceiver is not difficult, but it does require some planning to ensure station reliability and efficiency. This section provides tips for selecting an appropriate site, choosing antennas and feedlines, and minimizing the chance of interference. This material should be reviewed before beginning equipment installation.

3.1 General Requirements

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 station arrangement.

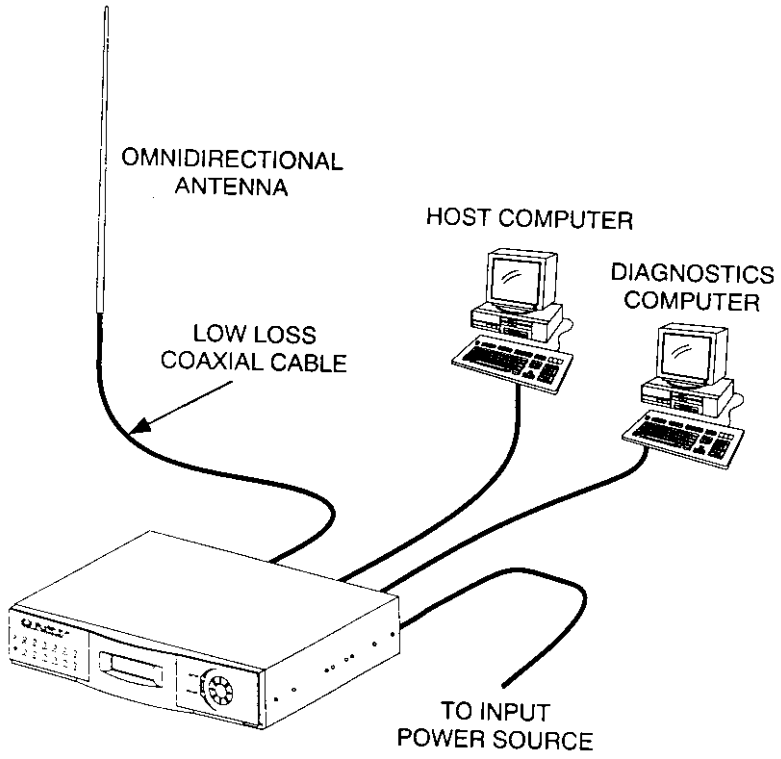


Figure 5. Typical station arrangement

Site Selection

For a successful installation, careful thought must be given to selecting the site for the master station and the remote radios. Suitable sites should offer:

- An antenna location that provides an unobstructed path to all the remote radios in the system
- A source of adequate and stable primary power
- Suitable entrances for antenna, interface or other required cabling.

These requirements can be quickly determined in most cases. A possible exception is the first item—verifying that an unobstructed transmission path exists. Microwave radio signals travel primarily by line-of-sight, and obstructions between the sending and receiving stations will affect system performance.

If you are not familiar with the effects of terrain and other obstructions on radio transmission, the following discussion will provide helpful background.

Terrain and Signal Strength

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

The requirement for a clear transmission path depends on the distance to be covered by the system. If the system is to cover only a limited distance, say 5 km (3.1 miles), then some obstructions in the transmission path may be tolerable. For longer range systems, any obstruction could compromise the performance of the system, or block transmission entirely.

The signal strength at the receiver must exceed the receiver sensitivity by an amount known as the fade margin (defined on page 6) to provide reliable operation under various conditions.

Section 8.2, *RF Propagation Planning*, on page 75 includes a detailed discussion of path planning, and should be reviewed before beginning an installation. Computer software is also available for this purpose that can greatly simplify the steps involved in planning a path.

On-the-Air Test

If you've analyzed the proposed transmission path and feel that it is acceptable, an on-the-air test of the equipment and path should be conducted. This not only verifies the path study results, but allows you to see firsthand the factors involved at each installation site.

The test can be performed by installing a radio at each end of the proposed link and checking the RSSI value reported at the front panel LCD screen of the radio. (See *Front Panel Indicators* on page 20 for procedures.) If adequate signal strength cannot be obtained, it may be necessary to mount the station antennas higher, use higher gain antennas, or select a different site for one or both stations.

To prepare the equipment for an on-the-air test, follow the general installation and operation procedures given in this guide and become familiar with the operating instructions given in Section 5.0, *START-UP AND OPERATION*, on page 20.

A Word About Interference

Interference is possible in any radio system. However, since the MDS 9790 is designed for use in a licensed system, interference is less likely because geographic location and existing operating frequencies are normally taken into account when allocating frequencies.

The risk of interference can be further reduced through prudent system design and configuration. Allow adequate separation between frequencies and radio systems.

Keep the following points in mind when setting up your radio system:

1. Systems installed in lightly populated areas are least likely to encounter interference; those in urban and suburban environments are more likely to be affected by other devices operating in the 900 MHz frequency band and adjacent services.

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

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

3.2 Antenna and Feedline Selection

Antenna System

The antenna system is perhaps the most crucial part of the system design. An antenna system that uses poor quality feedline, or is improperly aligned with the companion site, will result in poor performance, or no communication at all.

Generally speaking, an omni-directional antenna is used at the master station site and the remote radios use directional antennas.

Microwave Data Systems can also furnish antennas for use with the transceiver. Consult your MDS representative for details.

Feedline Selection

For maximum performance, a good-quality feedline must be used to connect the radio to the antenna. For short-range transmission, or where very short lengths of cable are used (up to 8 meters [26 feet]), an inexpensive coax cable such as Type RG-213 may be acceptable.

For example, 100 feet (30 meters) of RG-58A/U cable (commonly used for frequencies below 100 MHz) has an insertion loss of 5 dB at 450 MHz. A 500 milliwatt transmitter operating into such a feedline would produce only 160 milliwatts at the antenna; a similar loss in receiver sensitivity would result, and no amount of gain within the receiver can recover the signal lost in the feedline.

On the other hand, a 100 foot (30 meters) length of 1⅝ inch cable has a loss of 0.52 dB at the same frequency, but its cost is many times greater than RG-58A/U.

For systems covering short distances, feedline loss is relatively unimportant, and 6 dB or more of loss may be completely acceptable. For systems designed for maximum range however, each dB of loss directly affects signal-to-noise ratio at the receiver. It is good practice to keep feedline losses as low as possible and certainly under 3 dB. Remember that for each 3 dB of feedline loss, half the transmitter power is lost, and twice the receive signal power is needed to produce the same signal-to-noise ratio.

RG-8A/U is a widely available and inexpensive feedline that is suitable for systems with short ranges or those with short feedlines. For longer feedlines and lower losses, Andrew HELIAX™ semi-rigid coaxial cable or similar products are a good choice. Table 2 shows the length of various types of cable and the resulting degradation in signal strength.

Mount the antenna and feedline securely to the supporting structure to avoid damage from wind and ice loading. Refer to the instructions provided by the antenna and feedline manufacturers to ensure a safe and reliable installation.

Table 2. Feedline loss chart (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
½ in. HELIAX	0.23 dB	1.15 dB	2.29 dB	11.45 dB

Table 2. Feedline loss chart (900 MHz) *(Continued)*

Cable Type	10 Feet (3.05 Meters)	50 Feet (15.24 Meters)	100 Feet (30.48 Meters)	500 Feet (152.4 Meters)
7/8 in. HELIAX	0.13 dB	0.64 dB	1.28 dB	6.40 dB
1 1/4 in. HELIAX	0.10 dB	0.48 dB	0.95 dB	4.75 dB
1 5/8 in. HELIAX	0.08 dB	0.40 dB	0.80 dB	4.00 dB

4.0 INSTALLATION PROCEDURES

This section presents the steps necessary for installing the radio and connecting it to associated equipment. After completing these steps, the radio will be ready for in-service operation.

4.1 Unpacking and Inspection

Figure 6 shows a typical transceiver shipment. Check the contents against the packing list secured to the outside of the shipping box. Accessories and spare parts kits, if any, are wrapped separately. Inspect all items for signs of damage. Save all packing materials in case you need to ship the radio in the future.

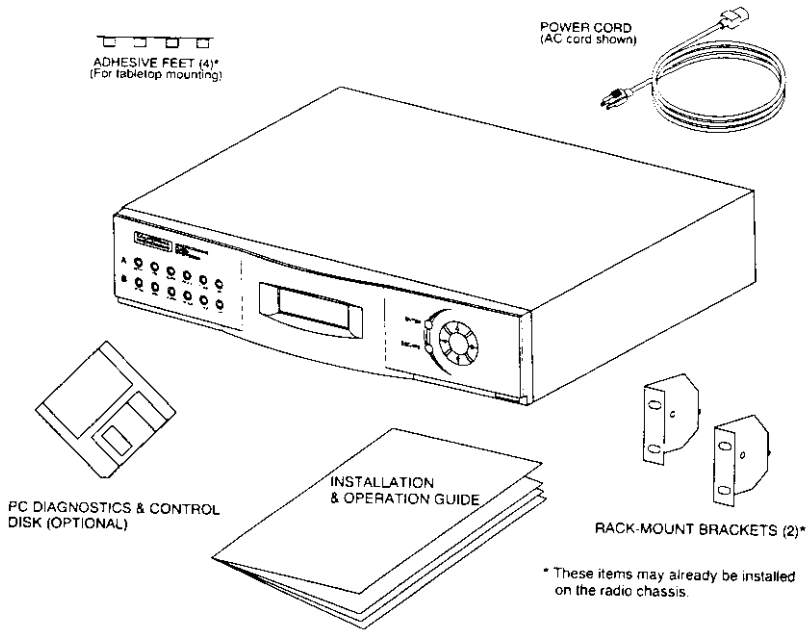


Figure 6. Typical shipment contents

4.2 Mounting the Radio

The radio should be located in a relatively clean, dust-free environment that allows easy access to the rear panel connectors as well as the front panel controls and indicators. Air must be able to pass freely over the heatsink on the rear panel.

Figure 7 shows the mounting dimensions of the radio. Most commonly, it is installed in a 2U 3.5 inch (88.90 mm) rack-mount configuration, but it can also be installed in a simple tabletop arrangement if desired.

Rack Mounting

To rack-mount the radio, use the supplied mounting brackets (MDS P/N 82-3184A01) to secure the chassis to the rack cabinet. The brackets can be attached at any of four points on the sides of the enclosure—front, back, middle facing front, and middle facing back (see Figure 7). This flexibility ensures compatibility with most rack mounting arrangements.

Tabletop Mounting

As an alternative to rack mounting, the radio can be placed on any sturdy shelf or tabletop that will support the weight of the unit. Adhesive-backed rubber feet are provided with the radio for use in tabletop installations. These should be placed underneath the chassis near each corner to prevent scratching of the mounting surface.

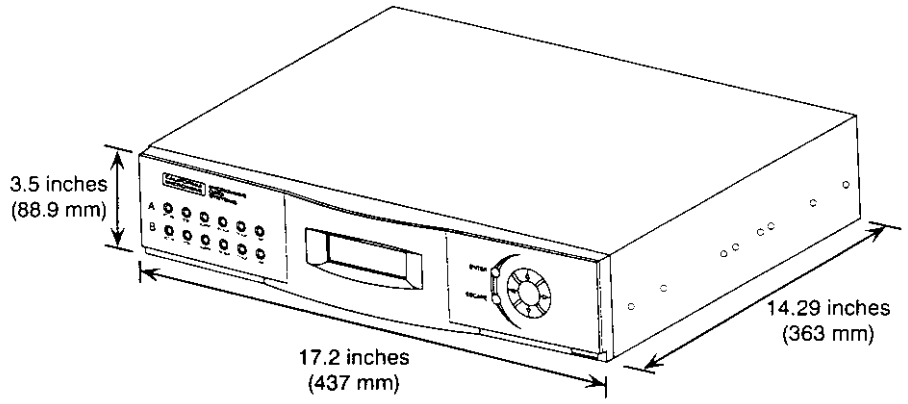


Figure 7. Mounting dimensions and bracket details

Remote Front Panel Mounting—*Optional Configuration*

If desired, the front panel can be detached from the radio and mounted separately to the rack cabinet. This option is needed in rack-mount installations where all connections and control will be performed from one side of the unit. An Auxiliary Mounting Plate (P/N 82-3189A01) is available for this type of mounting.

To remove the front panel from the radio and re-mount it to the Auxiliary Mounting Plate, follow these steps:

1. Detach the panel from the radio by grasping it firmly along its bottom edge and pulling away from the radio chassis (Figure 8).

2. Release the modular connector and cable from the back of the panel.

3. Plug the connector into an in-line splice connector (MDS P/N 73-1155A09).

4. Snap the splice connector into the front of the chassis at the square cut-out.

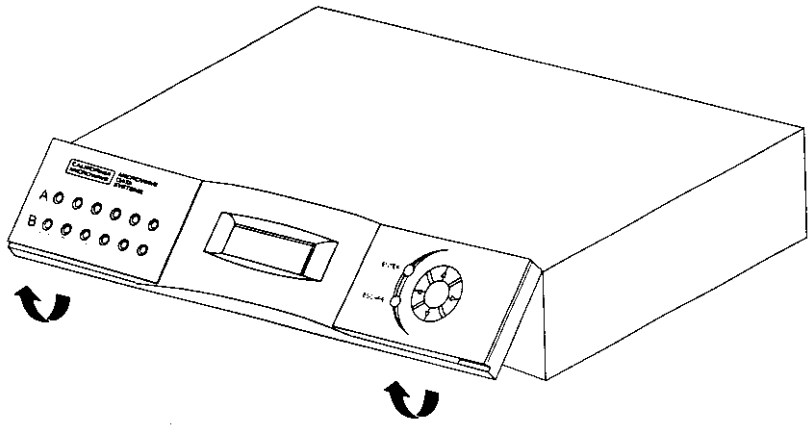


Figure 8. Front panel removal

5. Snap the front panel onto the Auxiliary Mounting Plate in the same way it was attached to the main radio chassis.

6. Mount the Auxiliary Mounting Plate to the rack cabinet just above (or below) the radio chassis.

7. Attach the extension cable (MDS P/N 03-2198A04) between the front panel modular connector and the in-line splice connector on the radio chassis.

4.3 Primary Power

CAUTION
POSSIBLE EQUIPMENT DAMAGE

Before connecting primary power to the radio, verify that power source matches the power supply operating range and type of service (AC or DC). Improper voltages may damage the equipment. The radio has either a nominal 24 volt DC, 48 volt DC, or a 110/220 Vac power supply module (see "Technical Specifications" on page 74 for voltage ranges). The input voltage is marked on the module at the rear of the radio.

AC-Powered Units

AC-powered radios are designed to operate from 100 to 240 Vac (50/60 Hz) primary power. No special configuration is required to operate the radio anywhere within the input voltage range. An AC power cord is supplied with these units. If the radio is equipped with the 110–240 Vac power supply option, the unit can be powered from a DC source between 120 Vdc to 370 Vdc as well.

DC-Powered Units

Figure 9 shows a rear view of the DC power supply. Connection to the DC power supply is made with a three-conductor plug-in terminal strip. The radio can be operated in either a positive or negative ground configuration. The center pin of the connector is not connected in the radio.

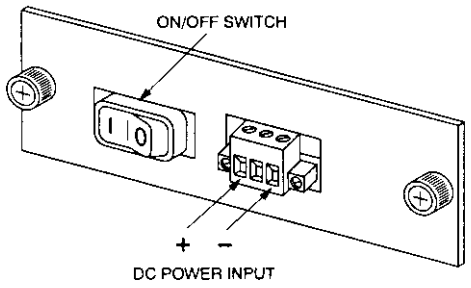


Figure 9. Rear view showing DC power supply

4.4 Antenna System

Antenna Installation

The antenna manufacturer's installation instructions should be followed for proper operation of the antenna. Using the proper mounting hardware and bracket ensures a secure mounting arrangement with no pattern distortion or detuning of the antenna.

Regardless of the antenna make, mount the antenna in the clear, as far away as possible from obstructions such as buildings, metal objects and dense foliage. Choose a location that provides a clear path in the direction of the associated station.

NOTE: Strong fields near the antenna can interfere with the operation of low-level circuits and change the values of the data being received. For this reason, the antenna should be mounted at least 3 meters (10 feet) from the radio and other electronic equipment.

Feedline Installation

A low-loss feedline is recommended for use with the radio. Section 3.2, *Antenna and Feedline Selection*, on page 9 provides suggestions for choosing the correct feedline for your installation. Whatever cable is used, it should be kept as short as possible to keep signal losses to a minimum.

When installing the feedline, take care not to kink, twist or stretch the cable. After installation, fasten the cable securely to the antenna tower or other supporting structure.

A Type N connector is required to connect the feedline to the radio. The feedline connectors must be installed in accordance with the manufacturer's instructions. Follow the manufacturer's recommendations for weatherproofing connectors that will be installed outdoors.

If large-diameter, semi-rigid coaxial cable is used for the feedline, insert a short length of 1/4 inch Superflex™ Cable (MDS P/N 97-1677A28) or other low-loss flexible cable between the radio and the feedline. This flexible interface eliminates tight bends in the feedline and reduces stresses on the feedline and connectors. The flexible section also allows the radio to be mounted on slides and pulled out without placing undue stress on the transmission line.

4.5 Interface Wiring Connections

All connections to the radio are made at the rear panel (Figure 10). In addition to the power and antenna connections already discussed, there are three interface connectors: J1–Diagnostic Port, J2–Alarm, and J3–E1 Data.

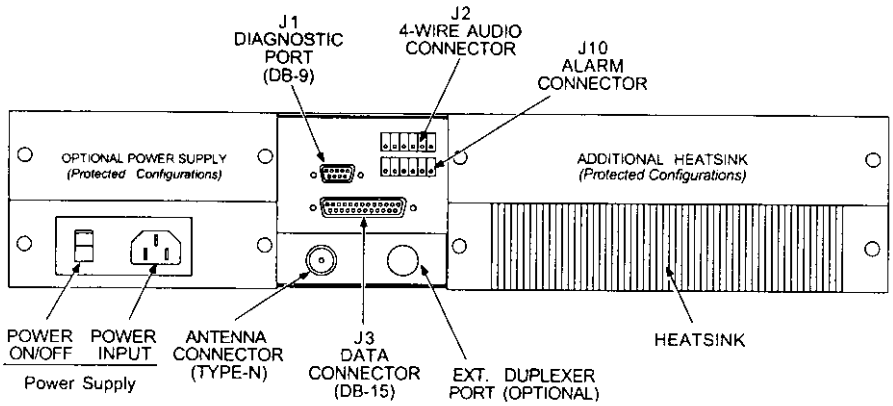


Figure 10. Rear panel of MDS 9790

Data Connector

The data connector (available on the rear of the radio) is the main system data interface and typically connects to the host computer.

Refer to Figure 11 and Table 3.

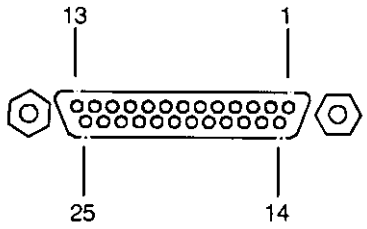


Figure 11. Data connector

Table 3. Data interface pinouts

Pin Number	Input/ Output	Pin Description
1	--	**Protective Ground.** Connects to ground (negative supply potential) on the radio's PC board.
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.** 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.

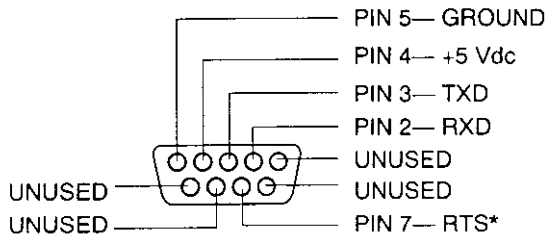
Table 3. Data interface pinouts *(Continued)*

Pin Number	Input/ Output	Pin Description
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	**No Connection**
10	OUT	**No Connection**
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	**No Connection**
13	--	**No Connection**
14	--	**No Connection**
15	OUT	Do not connect—Reserved for future use.
16	--	**No Connection**
17	--	Do not connect—Reserved for future use.
18	IN/OUT	**No Connection**
19	OUT	**14.0 Vdc Output.** Provides a source of regulated voltage at 1.5 amperes for low-power accessories.
20	--	**No Connection**
21	OUT	**No Connection**
22	--	**No Connection**
23	IN	**No Connection**
24	--	Do not connect—Reserved for future use.
25	OUT	**No Connection**

Diagnostics

There is a 9-pin D-type port on the rear panel of the radio that provides radio system diagnostics information. The DIAGNOSTIC PORT is used to control and perform diagnostics on the radio system from a connected computer. The communication speed between the computer and radio is 9600 bps.

Figure 12 shows the EIA-574 (9-pin EIA-232) pin functions of the DIAGNOSTIC PORT as viewed from the rear panel of the radio. Connection to J1 can be made with a DB-9 male connector, available from many electronics distributors.



* Used when reprogramming the radio firmware with a PC.

Figure 12. J1 pin connections

Alarm Contacts and Battery Back-up Connections

J10 is a plug-in terminal strip that provides connections for optional alarm circuits. Figure 13 shows the function of each terminal as viewed from the rear panel.

Terminals 1 and 2 provide relay contacts that close when a minor alarm is encountered. Terminals 3 and 4 provide relay contacts that close when a major alarm is encountered.

The contacts are rated for 1 ampere at 60 V ac or dc.

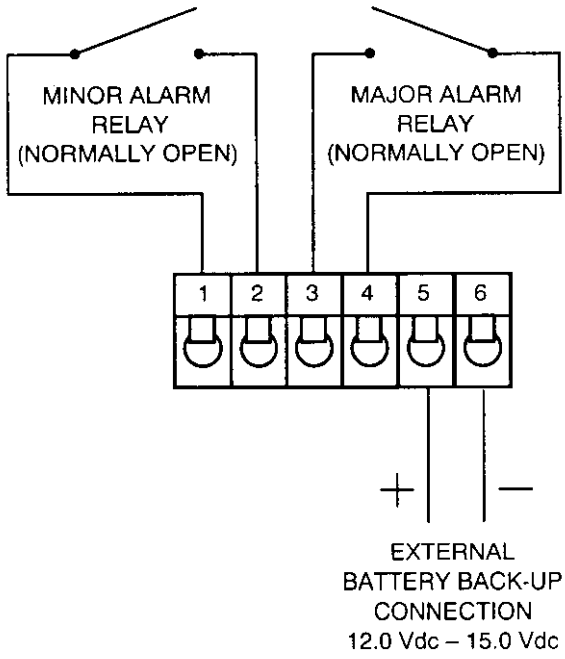


Figure 13. Alarm relay connections

4-Wire Audio Connector

J2 is a plug-in terminal strip that provides connections for 4-wire audio circuits. Figure 14 shows the function of each terminal as viewed from the rear panel.

Terminals 1 and 2 are for transmit audio input with a nominal 600 Ω impedance. Terminals 3 and 4 provide a receive audio output with a nominal 600 Ω impedance. Pins 5 and 6 provide a source for an external keying source. Connecting pins 5 and 6 together keys the radio.

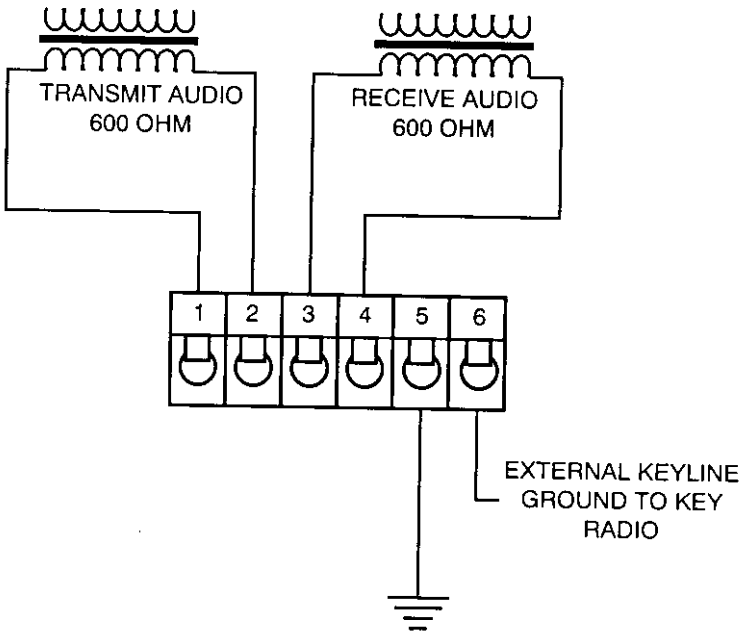


Figure 14. 4-wire audio connections

4.6 Post Installation Checks

Before applying power to the radio, verify that:

- All connections are properly wired and secure
- Input voltage matches that of the installed power supply
- Antenna heading is preset in the direction of the associated station.

This completes the installation of the radio. Section 5.0, *START-UP AND OPERATION*, describes the unit's indicators and gives initial startup procedures.

5.0 START-UP AND OPERATION

The transceiver is designed for continuous, unattended operation. Under normal conditions, the only time operator intervention is required is to power the unit up or down, or to change an operating parameter. This section explains the use of the radio's indicators and provides steps for initial startup of the equipment.

5.1 Initial Startup

NOTE: The MDS 9790 is normally continuously keyed, and the radio transmits when the power is switched on. Ensure there is a suitable load on the antenna connector before switching the power on.

Operation of the radio can be started by simply connecting primary power to the unit and setting the rear panel POWER switch to ON.

Normal Indications

When power is first applied, the following events occur in a normally working unit:

- All indicators light briefly and a beep is emitted
- The LCD (liquid-crystal display) shows the start-up screen, similar to Figure 17
- The ACTIVE LED for the selected transceiver lights. (In a protected version, the STBY LED also lights for the stand-by unit.)

Maximizing RSSI

Since the master station almost always uses an omni-directional antenna, maximizing signal strength is done at the remote sites where directional antennas are typically used.

5.2 Front Panel Indicators

Refer to Figure 15 and the following text for an explanation of the front panel indicators. The control buttons are described in Section 6.4, *Configuration and Programming using the Front Panel*, on page 52.

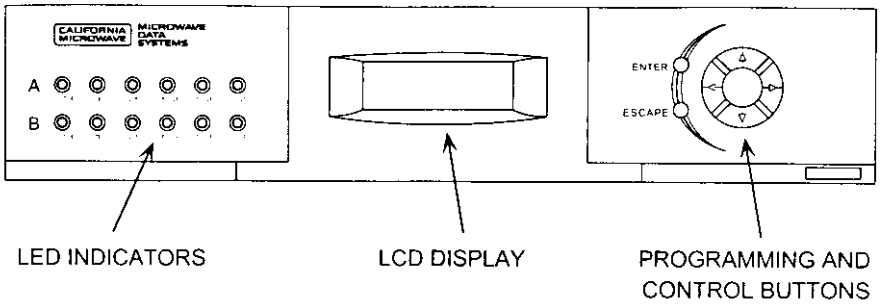


Figure 15. Front panel controls and indicators

LED Indicators

The basic operation of the transceiver can be checked by viewing the LED Indicator panel. The top row of indicators shows the status of the "A" transceiver; the bottom row shows the status of the "B" transceiver. In a non-redundant master station, Transceiver B is the only radio installed. On a redundant radio (spare transceiver and power supply installed), the references given here apply equally to Transceiver A and B.

Normally, only the green ACTIVE LED (and one of the yellow STBY LEDs in protected radios) should be lit. All other red LEDs are alarm indicators. If lit, they indicate a potential problem in the radio system.

Refer to Figure 16 and the text that follows for a detailed explanation of the LED indicators.

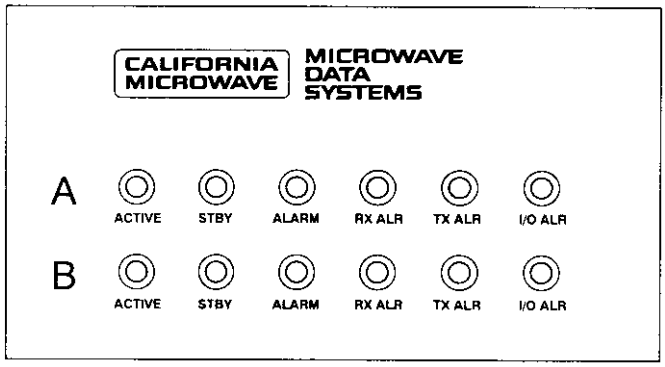


Figure 16. LED indicators

Table 4. Explanation of front panel LEDs

LED Name	Color	Meaning When Lit
ACTIVE	Green	Transceiver board (A or B) is the selected unit.
STBY	Yellow	Transceiver board (A or B) is currently in stand-by mode. (Functional on Protected version only.)
ALARM	Red	General fault not covered by the alarm categories below (RX ALR, TX ALR, I/O ALR)
RX ALR	Red	Difficulty receiving—may be due to an antenna problem, receiver fault, or other condition causing no or a weak received signal level.
TX ALR	Red	Fault with the transmit circuitry, or the transmitter is unkeyed.
I/O ALR	Red	The data rate or format of data at the data interface connector is incompatible with the radio settings.

LCD Display

The LCD (liquid-crystal) display is used with the front panel controls to view the radio's operating parameters. It may also be used to change parameters, or to perform diagnostic functions to evaluate radio system operation; but these functions are normally accomplished by connecting a PC to the radio and running communications software (see Section 6.0, *DIAGNOSTICS AND CONTROL*, on page 25).

At initial power-up, the LCD display shows the start-up screen (Figure 17). After a period of time without any activity, the LCD display darkens. The display can be restored by pressing any of the front panel buttons.

Figure 17. Start-up screen (typical)

The start-up screen displays the owner's name and message. Customers typically use these fields to display the system name and site name.

The start-up screen is one of many screens that can be displayed by the radio. Figure 18 is an overview of the LCD screens. Each screen displays a single radio function. The screens are divided into configuration, diagnostics, and event log functions. Individual screens are described in more detail in Section 6.5, *Screen Descriptions*, on page 54.

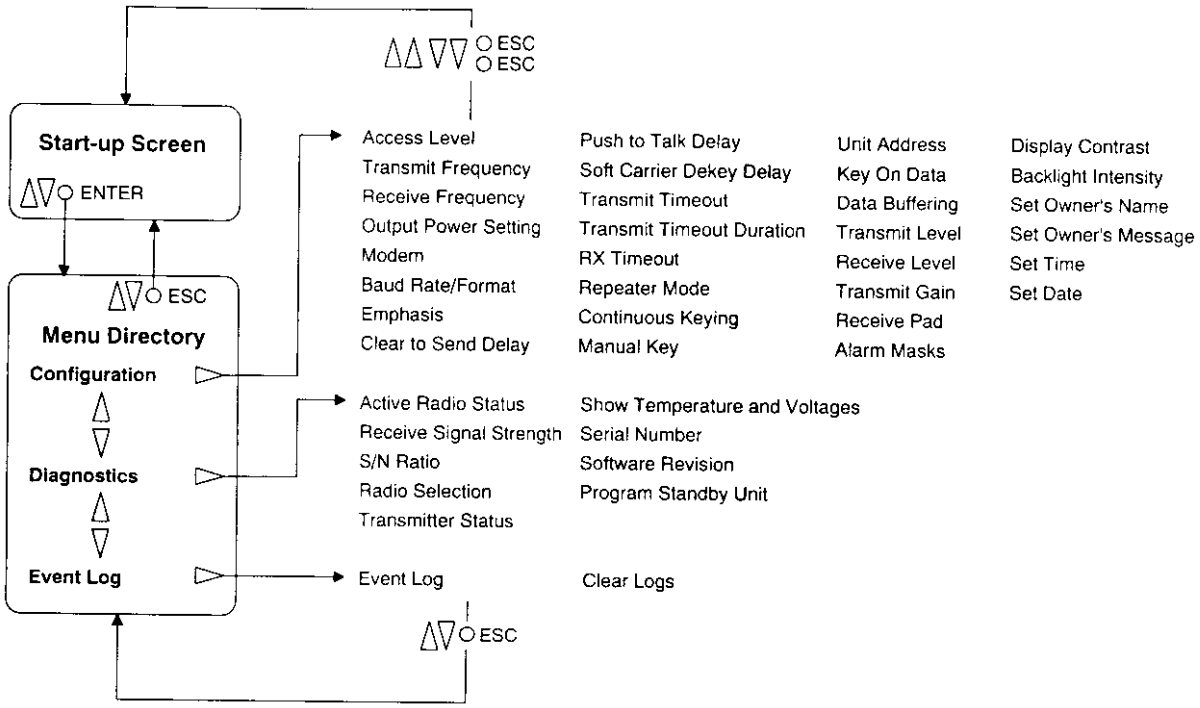


Figure 18. LCD menu flowchart

The LCD display has two modes: radio status (display only), and radio configuration. These modes are changed by defining the user access level. When the radio is powered on, the LCD is in display-only mode. The LCD mode, and the brightness and contrast of the LCD display, are the only changes that can be made to the radio in display-only mode. The LCD display reverts to display-only mode after a period of time has elapsed without a button press, and whenever the radio is powered back on.

Navigation through the screens to display radio status is described in the following section. Changing the LCD to radio configuration mode, and using the LCD screens to configure the radio, is described in *Switching LCD to Radio Configuration Mode* on page 52 and *Making changes to radio functions* on page 53.

Programming and Control Buttons

The programming and control buttons are located at the far right side of the front panel. They are used to navigate through the LCD screens and, when the LCD is in radio configuration mode, to make changes to radio operating parameters. Figure 19 shows a detailed view of these controls.

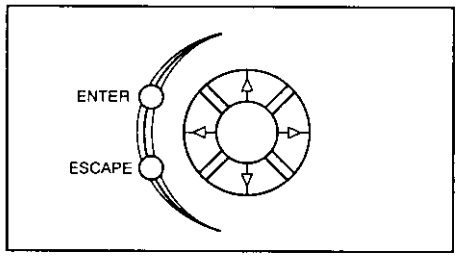


Figure 19. Programming and control buttons

- **ENTER**—When the start-up screen is displayed, pressing this button displays the Menu Directory screen. Otherwise, the ENTER button has no effect in display-only mode. Its use in radio configuration is described in *Use of Control Buttons in Radio Configuration Mode* on page 53.
- **ESCAPE**—Displays the previous screen in the menu hierarchy (start-up screen or menu directory). Its use in radio configuration is described in *Use of Control Buttons in Radio Configuration Mode* on page 53.
- **Up/down arrow buttons** (△ ▽)—On the start-up screen, pressing the up or down arrow button displays the menu directory. On the menu directory screen, the up and down arrow buttons cycle a selection arrow (⇨) through the main menu items. On the individual menu screens, in display-only mode, pressing the up or down arrow buttons displays the menu directory.

- **Left/right arrow buttons** (◁ ▷)—The left and right arrow buttons cycle the display through the selected menu's screens.

Navigating Through the LCD Screens

Figure 18 shows the menu hierarchy, as well as the button presses used to display the start-up and menu directory screens. (Navigation between individual screens is done using the right or left arrow buttons.)

Displaying the menu directory

To display the menu directory (Figure 20) when the start-up screen is displayed, press the ENTER, up, or down arrow button once. The menu directory lists the three main menus—**Configuration**, **Diagnostics**, and **Event Log**.

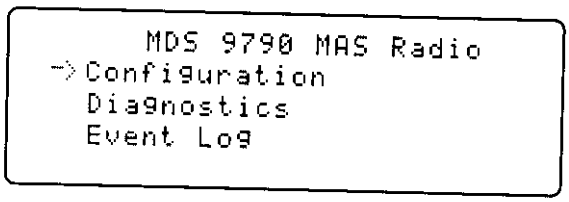


Figure 20. Menu directory screen

Selecting a main menu item

Pressing the up or down arrow buttons cycles the selection arrow:

->

through the main menu items.

Displaying the individual menu screens

When the selection arrow points to the desired menu, press the right or left arrow buttons to cycle the display through the screens of that menu. Each button press displays a new screen, until the entire menu has been traversed and the menu directory is redisplayed.

To return to the menu directory from any menu screen, press the ESCAPE, up or down arrow button once. Pressing any of these buttons twice displays the start-up screen.

6.0 DIAGNOSTICS AND CONTROL

Configuration, control and diagnostics of the 9790 Master Station is performed by connecting a Windows PC to a diagnostic port on the rear panel of the unit (Figure 21). Many of the same functions provided by this interface are available through the front panel interface, described in Section 6.4, *Configuration and Programming using the Front Panel*, on page 52.

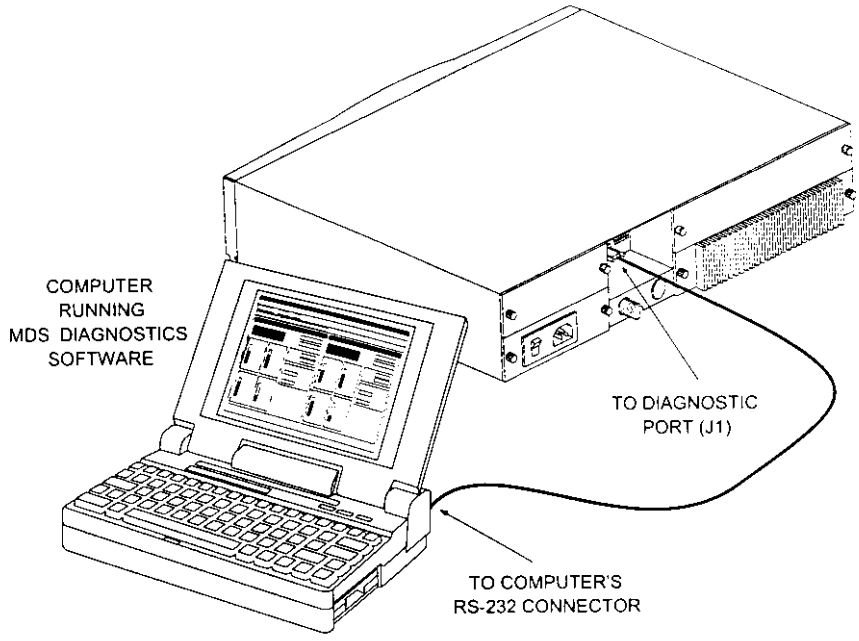


Figure 21. PC connected to the master station

This section explains how to connect a PC to the master station, and describes the commands that can be used for programming and diagnostics.

6.1 PC Connection

1. Connect a DB-9 to DB-9 cable (Figure 22) between the PC and the radio's rear panel DIAGNOSTIC PORT (Figure 23).

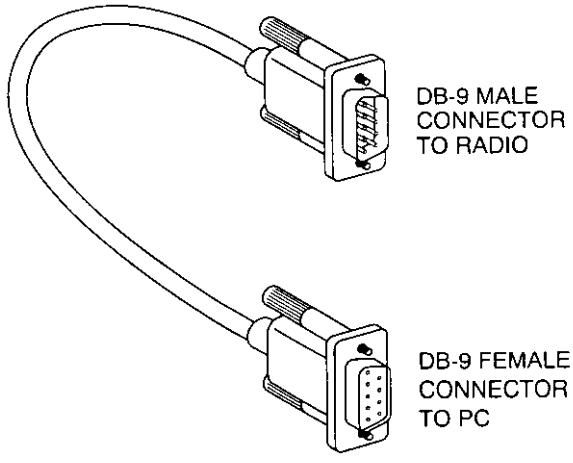


Figure 22. PC Diagnostic Port cable (DB-9 to DB-9)

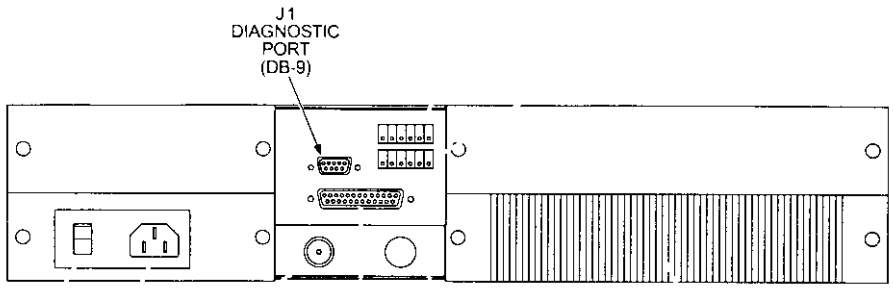


Figure 23. Diagnostic Port (rear panel)

2. Install a terminal emulation program, such as ProComm Plus or MDS diagnostics software (MDS P/N 03-3156A01), if such a program is not already installed. Follow the on-line prompts and instructions.

3. Launch the terminal program or diagnostics software.

   The diagnostic port automatically detects the baud rate. The port will work at 2400, 4800, 9600, 19.2K, and 38.4K baud.

4. Press the Enter key several times, at one-second intervals, until the > prompt is displayed, indicating that the command interface is ready to accept input. See Tables 5 through 7 beginning on page 29 for a list of commands.

5. Type the command, then press the Enter key.

   Command input is case-independent.
   Use the Backspace key to delete characters.

   The system displays one or more lines in confirmation. These responses are listed in Tables 5 through 7 beginning on page 29.

6. After exiting from the communication program, disconnect the PC from the master station, as it may cause interference????

6.2 Command Summaries

The only critical commands for most applications are...?????????? However, proper use of the additional commands allows you to tailor the transceiver for a specific use, or conduct basic diagnostics on the radio.

Tables 5 through 7 summarize master station commands.

- Table 5 (page 29) summarizes commands for setting radio operating parameters and displaying status and other information.
- Table 6 (page 31) summarizes diagnostic and testing commands.
- Table 7 (page 31) summarizes commands for obtaining information about the unit.

See Section 6.3 on page 32 for detailed command descriptions.

Most commands can be used in two ways. Typing *only* the command (for example, **MODE**) displays the current information. Typing the command, followed by a space and a parameter (for example, **MODE R**), changes a radio setting.

The following conventions are used in the table:

- Command parameters, if any, are shown in brackets [ ] following the command name.
- A string of lower-case "x"s in a command parameter stands for a letter or number key.
- "xxx.xxxxx" stands for a decimal number. (The decimal point position may vary.)
- "mm," "dd," and "yyyy" stand for month, day and year, respectively. (The number of characters used for month and year may vary.)
- "hh," "mm," and "ss" stand for hours, minutes and seconds, respectively.

Table 5. Operating parameter commands summary

COMMAND	LCD SCREEN	DESCRIPTION
ALARM *Details Page 32*	**Active Radio Status** *Details Page 66*	Display current alarm status in hexadecimal format
AMASK [0000 0000–FFFF FFFF] *Details Page 34*	**Alarm Masks** *Details Page 64*	Set or display the major alarm mask
ASENSE [HI/LO] *Details Page 34*	**Alarm Masks** *Details Page 64*	Set or display the sense of the alarm bits (active high or active low)
BAUD [xxxxx abc]/[xxxxx] S *Details Page 35*	**Baud Rate/Format** *Details Page 59*	Set or display communication attributes for data interface port xxxxx=Baud rate (110, 300, 1200, 2400, 4800, 9600, 19200, 38400) a=7 or 8 data bits b=N for none, O for odd, E for even parity c=1 or 2 stop bits S=Synchronous mode
BUFF [ON/OFF] *Details Page 36*	**Data Buffering** *Details Page 62*	Enables or disables received data buffering ON=Seamless data OFF=Fast byte throughput
CKEY [ON/OFF] *Details Page 36*	**Continuous Keying** *Details Page 61*	Enable or disable continuous keying ON=Continuous keying enabled OFF=Continuous keying disabled
CTS [0-255] *Details Page 37*	**Clear To Send Delay** *Details Page 60*	Set or display CTS delay. Setting a value of 0 keeps CTS normally asserted.
DATAKEY [ON/OFF] *Details Page 37*	**Key On Data** *Details Page 62*	Toggles between key-on-data and key-on-RTS ON=Key-on data OFF=Key-on RTS
DATE [mmm dd yyyy] *Details Page 38*	**Set Date** *Details Page 65*	Set or display the current date
DEVICE [DCE/CTS KEY] *Details Page 38*	**Continuous Keying** *Details Page 61*	*(A/E versions only)* Set or display device behavior DCE=behaves like a DCE device (default) CTS KEY=behaves like a repeater
DUMP *Details Page 39*		Display all settings
EMP [ON/OFF] *Details Page 40*	**Emphasis** *Details Page 59*	Enable or disable emphasis and de-emphasis
INIT *Details Page 40*		Set all operating parameters to default settings
LNA *Details Page 41*		Display low-noise amplifier current consumption
LOG [CLR] *Details Page 41*	**Event Log** *Details Page 68,* **Clear Logs** *Details Page 68*	Display or clear the event log
MODE [M/R] *Details Page 42*		Set or display operating mode M=Master R=Remote
MODEM [NONE, BELL, 4800B, 9600B, MPT1411] *Details Page 43*	**Modem** *Details Page 59*	Set or display the radio's modem type, or specify analog input

Table 5. Operating parameter commands summary *(Continued)*

COMMAND	LCD SCREEN	DESCRIPTION
NMASK [0000 0000–FFFF FFFF] *Details Page 44*		Set or display the minor alarm mask
OPT! *Details Page 44*		Display a list of available options and the current status of each: Diagnostics: OFF Premium Options: OFF 1200 Baud: OFF 4800 Baud: OFF 9600 Baud: OFF
PTT [0-255] *Details Page 45*	**Push to Talk Delay** *Details Page 60*	Set or display PTT delay
PWR [20–37] *Details Page 45*	**Output Power Setting** *Details Page 58*	Set or display forward power output setting
RADIO [A/B] *Details Page 46*	**Radio Selection** *Details Page 66*	Set or display the active radio
REPEATER [ON/OFF] *Details Page 46*	**Repeater Mode** *Details Page 61*	Enable or disable repeater mode
RSSI, RSSI! *Details Page 46*	**Receive Signal Strength** *Details Page 66*	Display received signal strength indication <-50 dBm to -120 dBm>
RX [xxx] *Details Page 47*	**Receive Frequency** *Details Page 58*	Set or display receive frequency
RXLEVEL [–20-7] *Details Page 47*	**Receive Level** *Details Page 63*	Set or display the analog audio receive level in dBm
RXPAD [ON/OFF] *Details Page 47*	**Receive Pad** *Details Page 64*	Enable or disable RX pad
SCD [0-255] *Details Page 47*	**Soft Carrier De-key Delay** *Details Page 60*	Set or display soft carrier dekey delay
SHOW [PORT/DC/PWR] *Details Page 48*		Display various items SHOW PORT CONNECTED TO RJ11 SHOW DC DC IN xx.x V DC OUT x.x V SHOW PWR RF POWER xx DBM
SNR, SNR! *Details Page 48*	**S/N Ratio** *Details Page 66*	Display signal-to-noise ratio (from DSP's channel equalizer) Range: 0 dB or 10-33 dB
STAT *Details Page 49*	**Active Radio Status** *Details Page 66*	Display current alarm event descriptions

Table 5. Operating parameter commands summary *(Continued)*

COMMAND	LCD SCREEN	DESCRIPTION
TEMP *Details Page 50*	**Show Temperature and Voltages** *Details Page 67*	Display internal radio temperature
TIME [TIME hh:mm:ss AM/PM] *Details Page 50*	**Set Time** *Details Page 65*	Set or display the current time
TOT [0-255] *Details Page 51*	**Transmit Timeout** *Details Page 60,* **Transmit Timeout Duration** *Details Page 61*	Set or display time-out timer delay
TX [xxxx] *Details Page 51*	**Transmit Frequency** *Details Page 58*	Set or display transmit frequency
TXGAIN [ON/OFF] *Details Page 51*	**Transmit Gain** *Details Page 63*	Enable or disable TX gain
TXLEVEL [–20-3, AUTO] *Details Page 52*	**Transmit Level [–20-3, AUTO]** *Details Page 63*	Set or display the analog audio transmit level in dBm

Table 6. Diagnostic and test commands summary

COMMAND	LCD SCREEN	DESCRIPTION
CLOS *Details Page 36*		Close diagnostics
DKEY *Details Page 38*	**Manual Key** *Details Page 62*	Disable transmitter
KEY *Details Page 41*	**Manual Key** *Details Page 62*	Enable transmitter
OPEN *Details Page 44*		Open diagnostics
PROG *Details Page 45*		Initiate reprogramming of the radio's internal software

Table 7. Owner and radio information commands summary

COMMAND	LCD SCREENS	DESCRIPTION
OWM [xxxxx] *Details Page 45*	**Set Owner Message** *Details Page 65*	Set or display owner message such as system name
OWN [xxxxx] *Details Page 45*	**Set Owner Name** *Details Page 64*	Set or display owner name or site name
HREV *Details Page 40*		Display hardware revision number
MODEL *Details Page 42*		Display model number (includes TX/RX band characteristics)
SER *Details Page 48*	**Serial Number** *Details Page 67*	Display serial number
SREV *Details Page 49*	**Software Revision** *Details Page 67*	Display software revision information
UNIT [10000–65000] *Details Page 52*	**Unit Address** *Details Page 62*	Display unit address

6.3 Detailed Command Descriptions

This section gives more detailed information for most of the commands listed in the previous tables. The commands are cross-referenced to descriptions of corresponding commands entered using the front panel LCD display and control buttons using this symbol:

Data Buffering command, page 62

Most commands can be used in two ways. Typing *only* the command (for example, **MODE**) displays the currently programmed data. Typing the command, followed by a space and a parameter (for example, **MODE R**), changes a radio setting. In this section, command parameters, if any, are shown in brackets [ ] following the command name.

ALARM

Active Radio Status command, page 66

The **ALARM** and **STAT** commands report on current alarms. **ALARM** provides alarm information in concise, two-line format; alarm codes are summarized in hexadecimal format. **STAT** (described on page 49) includes a text message describing each alarm.

The first line of the response to the **ALARM** command is a simple message indicating whether or not alarms are present. The second line is a hexadecimal numeric code representing the system alarm state. Examples of responses are:

```
NO ALARMS PRESENT
CODE: 0000 0000

MINOR ALARMS PRESENT
CODE: xxxx xxxx

MAJOR ALARMS PRESENT
CODE: xxxx xxxx
```

Each bit of the hexadecimal response code represents a unique alarm event. The first 4-digit number indicates major alarm conditions; if there are no major alarms, this number is 0000. The second 4-digit number represents minor alarm conditions; if there are no minor alarms, this number is 0000.

Code values for individual **major** alarm conditions are given below:

Table 8. Hexadecimal values for major alarm conditions

Alarm Code	Event Number	Description
4000 ----	1	The hardware configuration disagrees with the software. For example, this may be caused by attempting to run MDS 2790/9790 software in an MDS 9810 radio.
0800 ----	4	One or both of the programmable synthesizers is reporting an "out of lock" condition.
0100 ----	7	One or more of the radio's internal voltage regulators is reporting a failure. The radio will not work.
0080 ----	8	The system has not been calibrated. Factory calibration is required for proper operation of the system.
0040 ----	9	The MCU was unable to properly program the DSP. (This message will not normally be seen, because the system will reboot.)
0020 ----	10	The MCU was unable to properly program the system to the appropriate EEPROM defaults. There may be a hardware problem.
0010 ----	11	A verification procedure performed at start-up failed. There may be a digital hardware problem.

Code values for individual **minor** alarm conditions are given below:

Table 9. Hexadecimal values for minor alarm conditions

Alarm Code	Event Number	Description
---- 8000	16	The unit address has not been programmed.
---- 4000	17	A data parity fault has been detected on the DB25. This usually means there is a parity setting mismatch between the radio and the RTU.
---- 2000	18	A data framing error has been detected on the DB25. This sometimes means there is a baud rate mismatch between the radio and the RTU.
---- 0040	25	The 5.6 volt power regulator output is out of tolerance. If the voltage is too far out-of-tolerance, the radio may not work.
---- 0020	26	The DC input supply voltage is out of tolerance. If the supply voltage is too far out of tolerance, the radio may not work.
---- 0001	31	The transceiver's internal temperature is approaching an out-of-tolerance condition. If the temperature drifts outside of the recommended operating range, the radio may not work.

AMASK [0000 0000–FFFF FFFF]

Alarm Masks command, page 64

The **AMASK** and **NMASK** (page 44) commands display or set which alarms are classified as major and minor, respectively.

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

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

The **AMASK** command can be used to tailor a radio's alarm response. For example, a major alarm at a Redundant Station causes switch-over to the other transceiver. By reconfiguring a minor alarm as a major alarm, switch-over can be forced at the occurrence of a (formerly) minor alarm condition.

The eight-digit hexadecimal number used as the command parameter is used to classify up to 32 events as major or minor alarms, or disable alarm notification for an event. (See Table on page 49 for a list of events.) The hex value for the mask corresponds to the hex value for the **ALARM** command (see the **ALARM** 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.

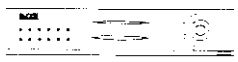
ASENSE [HI/LO]

Alarm Masks command, page 64

The **ASENSE** command displays or sets 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. The default for transceivers is active high. The default for Redundant Stations is low, and must remain so for the automatic switch-over feature of the radio to function properly.

BAUD [xxxxx abc]/[xxxxx] S



Baud Rate/Format command, page 59

The **BAUD** command displays or sets the communication attributes for the DATA INTERFACE port. (The command has no effect on the RJ-11 DIAG(NOSTICS) port.)

Entering the **BAUD** command alone displays the baud rate along with asynchronous data attributes or "S" for synchronous operation. Entering the **BAUD** command followed by one or more parameters:

BAUD xxxxx abc

or

BAUD xxxxx S

resets the data port attributes. The first parameter, **xxxxx**, is baud rate. Baud rate is specified in bits-per-second, and must be one of the following speeds: 110, 300, 1200, 2400, 4800, 9600, 19200, or 38400. In the worst case, the radio will always accept a minimum of 500 data bytes in a single continuous data transmission. At baud rates of 4800 bps or less, the radio can support unlimited continuous data transmission.

The second parameter of the **BAUD** command is either a 3-character block specifying asynchronous data attributes:

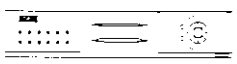
a = Data bits (**7** or **8**)
b = Parity (**N** for None, **O** for Odd, **E** for Even)
c = Stop bits (**1** or **2**)

or a single letter "S," specifying synchronous operation.

The factory default setting is 4800 baud, 8 data bits, no parity, 1 stop bit (Example: **4800 8N1**).

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

BUFF [ON/OFF]



Data Buffering command, page 62

This command displays or sets the received data handling mode. Entering the **BUFF** command alone shows whether the mode is seamless (**ON**), or fast byte throughput (**OFF**). Entering the **BUFF** command followed by a parameter resets the received data handling mode. The **ON** parameter sets the radio to seamless data mode. The **OFF** parameter sets the radio to fast byte throughput mode. The default is seamless data mode.

The setting of this parameter affects the timing of *received* data sent out the DATA INTERFACE connector. Data transmitted over the air by the radio is unaffected by the **BUFF** setting.

If data buffering is set to **OFF**, the radio will operate with the lowest possible average latency. Data bytes are sent out the DATA 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 will operate in a seamless mode. That is, data bytes will be sent over the air as quickly as possible, but the receiver will buffer the data until enough bytes have arrived to cover worst case gaps in transmission. The delay introduced by data buffering may range from ?????????? to ?????????? ms, but the radio will not create any gaps in the output data stream. 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. Enforcement of this rule is left up to the user.

CKEY [ON/OFF]

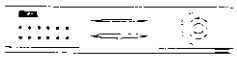
Continuous Keying command, page 61

The **CKEY** command enables or disables continuous keying, and instructs the remote transceivers to synchronize with the master radio. When **CKEY** is enabled (**ON**), the radio is continuously keyed. The **CKEY** command is normally enabled when the radio is in a full-duplex master configuration.

CLOS

This command ends a diagnostics session. (See also *OPEN* on page 44.)

CTS [0-255]



Clear To Send Delay command, page 60

This command displays or sets the timer value associated with the CTS line response. Entering the **CTS** (Clear-to-Send) command without a parameter displays the timer value in milliseconds. Entering the **CTS** command with a parameter ranging from 0 to 255 sets the timer value in milliseconds. The timer value function depends on the radio's operating mode (DCE or CTS Key). See the **DEVICE** command for more information about these operating modes.

When the radio is in DCE mode, 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 go high immediately following RTS.

When the radio is in CTS Key mode, 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, depending on how other operating parameters are configured.)

DATAKEY [ON/OFF]

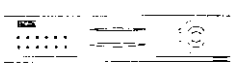
Key On Data command, page 62

This command displays or sets the key-on-data mode. In key-on-data mode, the radio will automatically key itself whenever input data arrives on the DB25 port. In key-on-RTS mode, the radio will only key in response to an RTS or PTT signal (or the **KEY** command).

Entering the **DATAKEY** command alone shows whether the key-on-data mode is key-on-data (**ON**) or key-on-RTS (**OFF**). Entering the **DATAKEY** command followed by a parameter controls whether or not the radio will automatically key on receipt of data. The **ON** parameter sets the radio to key-on-data mode. The **OFF** parameter sets the radio to key-on-RTS mode. The default mode is key-on-data.

Note that key-on-data mode is only applicable when the input data source is digital. When the input data source is analog, the **DATAKEY** setting is irrelevant.

DATE [mmm dd yyyy]



Set Date command, page 65

This command sets or displays the date. (See also *TIME [TIME hh:mm:ss AM/PM]* on page 50.) Enter the command without any parameters to display the date. Enter the command in the following format to reset the date:

DATE mmm dd yyyy

where *mmm* is a three-character abbreviation of the month:

Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec

dd is a two-digit number from 01 to 31 representing the date, and

yyyy is the year.

DEVICE [DCE/CTS KEY]

Continuous Keying command, page 61

This command sets or displays the radio's device behavior — DCE mode, or CTS Key mode. Entering the **DEVICE** command without a parameter displays "DCE" or "CTS KEY." Entering the **DEVICE** command followed by the parameter **DCE** or **CTS KEY** resets the radio's behavior.

The default device behavior is **DCE**. In this mode, CTS will go high following RTS, subject to the **CTS** programmable delay time. Keying is stimulated by the input of characters at the data port. Hardware flow control is implemented by dropping the CTS line if data arrives faster than it can be transmitted.

If **CTS KEY** is selected, the radio is assumed to be controlling another radio, such as in a repeater system. The RTS line is ignored, and the CTS line is used as a keyline control for the other radio. CTS is asserted immediately after 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

Manual Key command, page 62

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

DUMP

The **DUMP** command displays programming and status information in one quick step. Entering the **DUMP** command produces the same results as entering this series of display commands:

Table 10. List of DUMP command outputs

Command	Description
ALARM	Display current alarm code
MODEL	Display model number
TX	Display transmit frequency
RX	Display receive frequency
UNIT	Display unit address
MODE	Display operating mode: master or remote
BUFF	Display data buffering mode (ON/OFF)
BAUD	Display data port communication settings
DEVICE	Display device behavior
PWR	Display RF power output setting
DATAKEY	Display key-on-data mode setting (ON/OFF)
CKEY	Display CKEY setting (ON/OFF)
CTS	Display CTS response delay time
PTT	Display Push-to-Talk delay time
SCD	Display Soft Carrier De-key delay time
TOT	Display time-out timer setting
SER	Display serial number
HREV	Display hardware revision code
SREV	Display software revision level
OWN	Display owner name (system name)
OWM	Display owner message (site name)
RSSI!	Display received signal strength indication
SNR!	Display signal-to-noise ratio
SHOW PWR	Display RF output power
SHOW DC	Display DC supply and 5.6V regulator output
SHOW RADIO	Display radio setting (A/B/AUTO)
RADIO	Display current radio (A/B)
TEMP	Display temperature

The output format is identical to what you would see if you had entered the individual commands one after another:

```
>command
command output
>command
command output
...
```

EMP [ON/OFF]

Emphasis command, page 59

This command is used to enable or disable emphasis and de-emphasis on the analog input and output signals.

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.

ON indicates that emphasis and de-emphasis are enabled, and **OFF** indicates that emphasis and de-emphasis are disabled.

HREV

Displays the hardware revision level.

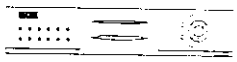
INIT

This command resets customer-programmable settings back to factory defaults:

- DCE device behavior
- 37 dBm (5 watts) RF output power
- 0ms CTS delay (that is, CTS is continuously asserted)
- 0ms PTT delay
- 0ms SCD delay
- Time-out Timer (maximum continuous key duration) is enabled and set to 30 seconds
- DB25 port set to 4800 baud, 8 data bits, no parity, 1 stop bit
- Key-on-data is enabled
- Diagnostic test outputs are disabled
- Transmit Audio Level is set to **AUTO**
- Receive Audio Level is set to -10 dBm
- Repeater Mode is disabled

- Pre/De-emphasis control is disabled
- Receive Time-out Timer is disabled
- TX Gain and RX Pad are disabled
- Major Alarm Mask is set to 0xFFFF 0000
- Minor Alarm Mask is set to 0x0000 FFFF
- Alarm sense is set to ACTIVE HI
- Vox time-out time is set to 500ms
- Remote maintenance eepot settings are reset
- Switched carrier mode is disabled
- LCD display and brightness are both set to mid-level
- Diagnostics level is disabled

KEY



Data Buffering command, page 62

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

LNA

This command displays the low-noise amplifier current consumption in mA.

LOG [CLR]

Event Log command, page 68

Clear Logs command, page 68

This command displays or clears a list of the last 800 operating changes, called "system events." These events include system problems, *as well as normal operator actions such as turning the power on or off.* In many cases, the events leading up to a failure can be reviewed to help determine the cause of a problem.

Entering the **LOG** command without any parameters displays the entire event history. Entering **LOG CLR** or **LOG CLEAR** clears all current events from the log history.

MODE [M/R]

The **MODE** command displays the radio's operating configuration — master or remote. Entering **MODE M** configures the radio as a master; entering **MODE R** configures the radio as a remote. All units default to remotes; other modes must be specifically programmed with the **MODE** command.

The mode command is not applicable to x810 radios at present.

MODEL

This command displays the radio's model number, which provides information about its product family (MDS 2790 or 9790) and TX/RX band operating range. The model number syntax is shown in below.

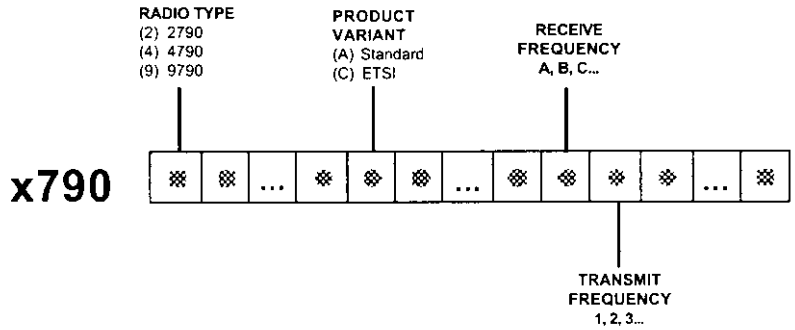


Figure 24. Radio model number syntax

The first character identifies the radio type (2790 or 9790).

The receive and transmit frequencies depend on the specific radio model:.

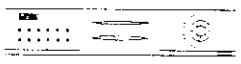
Table 11. Receive and transmit frequencies by radio model

MDS 2790 Standard Radio			
R =	RX Frequency Range	T =	TX Frequency Range
B	860.000 - 900.000 MHz	2	880.000 - 960.000 MHz
C	900.000 - 960.000 MHz		
MDS 2790 ETSI Radio			
A	871.000 - 871.850 MHz	1	800.000 - 880.000 MHz
B	916.000 - 916.850 MHz	2	880.000 - 960.000 MHz
MDS 4790 Standard Radio			
A	380.000 - 400.000 MHz	1	380.000 - 400.000 MHz
B	400.000 - 420.000 MHz	2	400.000 - 450.000 MHz
C	420.000 - 450.000 MHz	3	450.000 - 512.000 MHz
D	450.000 - 480.000 MHz		

Table 11. Receive and transmit frequencies by radio model

MDS 2790 Standard Radio			
E	480.000 - 512.000 MHz		
MDS 4790 ETSI Radio			
MDS 9790 Standard Radio			
A	800.000 - 860.000 MHz	1	800.000 - 860.000 MHz
B	860.000 - 900.000 MHz	2	860.000 - 900.000 MHz
C	900.000 - 960.000 MHz	3	900.000 - 960.000 MHz
MDS 9790 ETSI Radio			
A	871.000 - 871.850 MHz		
B	916.000 - 916.850 MHz		

MODEM [NONE, BELL, 4800B, 9600B, MPT1411]



Modem command, page 59

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.

NONE—No modem. The radio operates as an analog transceiver using Transmit Audio Input (Pin 9) and Receive Audio Output (Pin 11). Refer to Table ... for DATA INTERFACE connector pinouts.

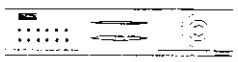
BELL—Bell 202T type of analog modem that is compatible with the MDS 1000μ, MDS 2310, or the MDS 4310 series of radio products equipped with a 1200 bps Bell 202T modem. All baud rates up to 1200 are automatically supported as data is received. The **BAUD** command setting is irrelevant.

4800B—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.

9600B—9600 bps modem modulation compatible with the MDS 1000μ, MDS 2310, or the MDS 4310 series of radio products equipped with a 9600 bps modem. When **9600B** is selected, the **BAUD** command is automatically set to 9600 bps.

MPT1411—Analog mode used with external modems compliant with the United Kingdom's MPT 1411 radio standard. The MPT 1411 modem option is only available on the MDS 4710 radio.

NMASK [0000 0000–FFFF FFFF]



Data Buffering command, page 62

The **AMASK** (page 34) and **NMASK** commands designate which alarms are to be classified as major and minor, respectively.

Entering the **NMASK** command alone displays the current setting of minor alarm conditions in hexadecimal format.

Entering the **NMASK** command followed by an eight-digit hexadecimal number reprograms the specified alarm conditions to trigger minor alarms.

The **NMASK** command can be used to tailor a radio's alarm response. For example, a major alarm at a Redundant Station causes switch-over to the other transceiver. By reconfiguring a major alarm as a minor alarm, switch-over can be avoided.

The eight-digit hexadecimal number used as the command parameter represents the 32 possible alarm bits. The hex value for the mask corresponds to the hex value for the **ALARM** command (see the **ALARM** command description). Each bit that is a '1' will cause the particular alarm field that it represents to be classified as a minor alarm. For more information on configuring the alarm response, contact Microwave Data Systems and request Application Bulletin 98-002.

OPEN

This command starts a diagnostics session. (See also *CLOS* on page 36.)

OPT!

The **OPT!** command lists each upgradable option and shows whether it is installed (**ON**) or not installed (**OFF**). Other accepted formats for this command include **OPTION!** and **OPTIONS!**.

The output format is as follows (note that OFF represents the current setting - this value could be either ON or OFF):

```
Diagnostics     : OFF
Premium Options: OFF
1200 Baud       : OFF
4800 Baud       : OFF
9600 Baud       : OFF
```

OWM [xxxxx]

Set Owner Message command, page 65

The **OWM** command allows for display or entry of an optional text message such as the system name. The entry can contain up to 30 characters.

OWN [xxxxx]

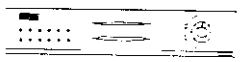
Set Owner Name command, page 64

The **OWN** command allows for display or entry of an optional text message such as the site name. The entry can contain up to 30 characters.

PROG

This command initiates an upgrade of the radio's internal software. See the on-line documentation provided with the MDS diagnostics and configuration software for instructions.

PTT [0-255]

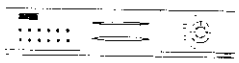


Push to Talk Delay command, page 60

This command sets or displays the amount of time to wait after the radio receives a key-up signal from either the PTT or RTS lines before actually keying up. Entering the **PTT** (Push-to-Talk) command without a parameter displays the timer value associated with the key-up delay selection. Entering the **PTT** command with a parameter ranging from 0 to 255 sets the timer value in milliseconds. A timer value of zero means that the radio will key-up immediately following the key-up signal.

The command is applicable for DCE operation, when the radio is keyed either by the PTT signal or by RTS. *The command is not applicable when the radio is keyed by data or keyed by the* **KEY** *command.*

PWR [20–37]



Output Power Setting command, page 58

This command sets or displays the master station's RF forward output power setting. Entering the **PWR** command without a parameter displays the forward output power in dBm. Entering the **PWR** command with a parameter ranging from 20 to 37 (inclusive) sets the forward output power in dBm. The default setting is 37 dBm, which is equivalent to 5 Watts.

To read the actual (measured) power output of the radio, use the **SHOW PWR** command.

In the USA, maximum allowable power is governed by FCC limits on Effective Isotropic Radiated Power output (EIRP). The EIRP limit of +36 dBm means that any user with a net antenna gain greater than 6 dBi must decrease the **PWR** setting accordingly. Section XXXXX????? contains a detailed discussion of this topic.

RADIO [A/B]

Radio Selection command, page 66

This command sets or displays the active radio. Entering the **RADIO** command without a parameter shows whether the A or B radio is the active radio. Entering the **RADIO** command with a parameter of **A** or **B** resets the active radio to the A or B radio.

REPEATER [ON/OFF]

Repeater Mode command, page 61

This command sets or displays the radio's configuration as a repeater. Entering the **REPEATER** command without a parameter displays whether or not the radio is configured as a repeater (**ON**=repeater; **OFF**=not a repeater). Entering the **REPEATER** command followed by **ON** configures the radio as a repeater; entering **REPEATER OFF** returns a repeater to stand-alone operation.

RSSI, RSSI!

Receive Signal Strength command, page 66

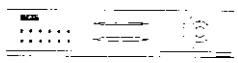
These commands display the Received Signal Strength Indication in dBm units. The output can range from –50 dBm to –120 dBm.

RSSI is a "raw" signal level indicator, continuously updated in real time at about a 1 second interval. The RSSI command causes the diagnostic port to enter an RSSI update mode. The diagnostic port will display an updated RSSI output line at roughly a 2 second interval refresh rate. The diagnostic port will stay in this mode until you press the Enter key at the PC or HHT.

The RSSI! command is a "computer friendly" version of RSSI. It provides a one-time reading and display of RSSI at the diagnostic port.

Note that an RSSI reading is only valid if the unit has been properly calibrated.

RX [xxx]



Receive Frequency command, page 58

This command sets or displays the radio's receive frequency. Entering the **RX** command without a parameter displays the receive frequency in MHz. Entering the **RX** command with a value from the frequency table below resets the receive operating frequency to the specified value.

The factory default for RX frequency is "NONE". This means that RX frequency must be explicitly programmed before the radio can operate.

The frequency must be an integer multiple of the reference frequency and must be within the valid range. The range of valid receive frequencies depends on the specific model and operating bands of the radio; see Table 11 on page 42.

RXLEVEL [–20-7]

Receive Level command, page 63

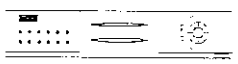
The **RXLEVEL** and **TXLEVEL** (page 52) commands control the audio level settings when the radio is operating in analog mode. When used alone, the **RXLEVEL** command displays the receive level in dBm. Entering the **RXLEVEL** command followed by a number between –20 and 7 resets the audio level in dBm.

RXPAD [ON/OFF]

Receive Pad command, page 64

This command enables or disables the receive attenuator for the receive audio level???????????. Entering the **RXPAD** command without a parameter shows whether the attenuator is **ON** (enabled) or **OFF** (disabled). Entering the **RXPAD** command followed by **ON** enables the receive attenuator; entering **OFF** disables it.

SCD [0-255]



Soft Carrier De-key Delay command,

This command sets or displays the amount of time to wait after a de-key request before actually de-keying the radio. Entering the **SCD** command without a parameter displays the timer value in milliseconds. Entering the **SCD** command with a parameter ranging from 0 to 255 resets the timer in milliseconds. The default setting is 0, which means that the radio will de-key immediately following removal of a keying signal.

SER

Serial Number command, page 67

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

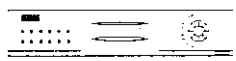
SHOW [PORT/DC/PWR]

The **SHOW** command displays one of three pieces of information, depending on the command parameter entered. These are:

- **PORT**—Displays which connector port (RJ-11 or DB-25) is *currently active* for diagnostics and control.
- **DC**—Displays DC input/output voltages.
- **PWR**—Displays the actual (measured) RF power output in dBm. Unlike the **PWR** command, this command shows the *actual* level being measured, not the programmed RF power setting.

Sample Input	Sample Response
SHOW PORT	CONNECTED TO RJ11
SHOW DC	DC IN xx.x V DC OUT x.x V
SHOW PWR	RF POWER nn dBm

SNR, SNR!



S/N Ratio command, page 66

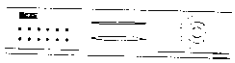
These commands display the signal-to-noise ratio in dB. MDS' definition of signal-to-noise is based upon the signal level following equalization, for valid frames only. A valid frame is defined as containing no more than one bit error, and belonging to a packet addressed for the receiving radio. SNR is updated and latched for each valid packet received. A filter in the DSP tempers the effect of any sudden changes in the value.

Output ranges from 10 dB to 33 dB. A value of 10 dB represents little or no signal. A value of 24 dB represents a very strong signal.

The **SNR** command causes the diagnostic port to enter an SNR update mode. The diagnostic port will display an updated SNR output line at roughly a 2 second interval refresh rate. The diagnostic port will stay in this mode until the Enter key is pressed at the PC or HHT.

The **SNR!** command is a "computer friendly" version of **SNR**. It provides a one-time reading and display of SNR at the diagnostic port.

SREV

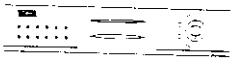


Software Revision command, page 67

SREV displays the release number, revision and build date of the MCU software, as shown below:

```
06-3251A01
1.0.0     ddMmmyy
```

STAT



Active Radio Status command, page 66

The **STAT** command provides a user-friendly, interactive way to get alarm status. (The **ALARM** command (page 32) summarizes alarm codes in hexadecimal format.)

If no alarm event conditions are active, the message **NO ALARMS PRESENT** is displayed. If alarms are present, they are displayed in ascending order starting with the lowest event number:

```
Event: 26 (MINOR)
DC input power is not in
valid range
```

Major alarms are displayed first, then minor ones.

The command output displays the event number, major/minor status, and a one- or two-line text message, respectively. If additional alarm events are active, the **MORE>** prompt is displayed.

- Press the Enter key to display the next alarm event
- Enter **QUIT**, **Q**, or . (period) to return to the command prompt.

The table below gives the text message displayed by the **STAT** command for each associated alarm event:. *(Continued)*

Table 12. Text messages of alarm event codes

Event Number	Text Message
01	Hardware mismatch
02	Model number not programmed
03	Authorization fault
04	Synthesizer out-of-lock
07	Voltage regulator fault detected
08	Radio not calibrated

Table 12. Text messages of alarm event codes

Event Number	Text Message
09	DSP download fault
10	EEPROM write failure
11	Checksum fault
12	Receiver time-out
16	Unit address not programmed
17	Data parity error
18	Data framing error
20	Configuration error
25	6V regulator output not in valid range
26	DC input power is not in valid range
31	Internal Temperature not in valid range

TEMP

Show Temperature and Voltages command, page 67

This command displays the internal temperature of the transceiver in degrees Centigrade. Note that the radio is designed to operate in a range from –30 C° to +60 C°, and may fail at temperatures outside this range. This internal reading may be higher than the outside temperature by several degrees.

TIME [TIME hh:mm:ss AM/PM]

Set Time command, page 65

This command sets or displays the time. Enter the command without any parameters to display the time. Enter the command in the following format to reset the time:

TIME hh:mm:ss AM

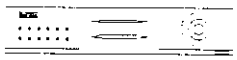
or

TIME hh:mm:ss PM

where *hh* is a two-digit number from 01-12 representing the hour, *mm* is a two-digit number from 00 to 59 representing the minute, and *ss* is a two-digit number from 00 to 59 representing the second. (Also see *DATE [mmm dd yyyy]* on page 38.)

TOT [0-255]

Transmit Timeout command, page 60

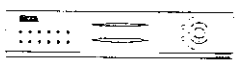


Transmit Timeout Duration command, page 61

The **TOT** command selects or displays the "time-out timer" value. This timer limits the time that a radio can remain continuously keyed. If a radio remains keyed for longer than the time-out timer duration, the transmitter is automatically de-keyed. The radio must then see a transition back to the de-keyed state before a new key-up request is allowed.

Entering the **TOT** command without a parameter displays the timer value in seconds. Entering the **TOT** command with a parameter ranging from 0 to 255 resets the timer in seconds. The default setting is 0, which disables the time-out timer. The default is 30 seconds.

TX [xxxx]



Transmit Frequency command, page 58

This command sets or displays the radio's transmit frequency. Entering the **TX** command without a parameter displays the transmit frequency in MHz. Entering the **TX** command with a value from the frequency table below resets the transmit operating frequency to the specified value. The factory default for TX frequency is "NONE". This means that TX frequency must be explicitly programmed before the radio can operate.

The frequency must be an integer multiple of the transmit frequency and must be within the valid range. The range of valid receive frequencies depends on the specific model and operating bands of the radio; see Table 11 on page 42.

TXGAIN [ON/OFF]

Transmit Gain command, page 63

This command enables or disables the transmit audio boost for the transmit audio level???????????. Entering the **TXGAIN** command without a parameter shows whether the audio boost is **ON** (enabled) or **OFF** (disabled). Entering the **TXGAIN** command followed by **ON** enables audio boost; entering **OFF** disables it.

TXLEVEL [–20-3, AUTO]

Transmit Level [–20-3, AUTO] command,

The **TXLEVEL** and **RXLEVEL** (page 47) commands are used to control the audio level settings when using the analog mode. When used alone, the **TXLEVEL** command displays the transmit level in dBm. Entering the **TXLEVEL** command followed by a number between –20 and 3 resets the audio level in dBm. Entering the **TXLEVEL** command followed by **AUTO** causes the transmit level to be set automatically.

UNIT [10000–65000]

Unit Address command, page 62

This command sets or displays the unit address of a radio, which uniquely identifies a single radio within a network. It is used primarily for diagnostics.

When the radio first powers up, unit address is unprogrammed. Unit address can range from 0...65000, but can only be manually programmed from 10000...65000. (Addresses in the 0...9999 range only occur when they are assigned as default values following factory programming of the serial number.)

6.4 Configuration and Programming using the Front Panel

This section explains how to use the radio's LCD display to change the radio's configuration. Cross-references to the corresponding PC-based commands are included. Basic navigation through the LCD screens was described in Section 5.2, *Front Panel Indicators*, on page 20.

Switching LCD to Radio Configuration Mode

As explained in Section 5.2, the LCD has two modes, display-only and radio configuration. The LCD is normally in display-only mode. To activate radio configuration mode:

1. From the start-up screen, press the down arrow button to display the menu directory.

2. On the menu directory screen, press the right arrow button to display the Set Access Level screen. (If this screen does not appear, the LCD is already in radio configuration mode.)

3. Press the ENTER button to initiate a change to radio operation.

4. Press the down arrow button to display the other access level, **USER**.

5. Press the ENTER button to save the change.

Use of Control Buttons in Radio Configuration Mode

In radio configuration mode, the control buttons have additional functions:

- **ENTER**—Starts and ends a change to radio functionality (enables arrow buttons to be used for selections instead of navigation).
- **ESCAPE**—Cancels the current radio functionality selection before the ENTER button is pressed a second time.
- **Up/down arrow buttons** (△ ▽)—Cycles through a display of available choices. Pressing the ENTER button when a particular choice is displayed reconfigures the radio using that setting.

Making changes to radio functions

1. When an individual menu screen is displayed, press the ENTER button. The message **change pending** appears at the bottom of the screen. This tells the system that the next series of arrow button presses are to make on-screen selections, not display menu screens.

2. Most options are either words ("enabled," "disabled") or numerals. The instructions below apply in most situations; if not, the method for choosing an option is detailed in the screeen description.

   Word options. To display all choices when the options are words, press the up or down △ ▽ arrow button.

   Numeric options. If the option is more than one digit, first select the digit to change: press the left or right arrow ◁ ▷ button to move the underscore (_) under the digit to be changed. (For example, to change "30" to "40," move the underscore under the "3.")

   Then press the up or down △ ▽ arrow buttons to increase or decrease the number. Or hold down the arrow button to scroll choices more rapidly.

3. Press the ENTER button again when the desired choice is displayed. (Or press the ESCAPE button to cancel the change.) The message **done** appears, indicating that the change was successfully made.

6.5 Screen Descriptions

This section describes each of the LCD display screens. The commands are cross-referenced to descriptions of corresponding commands entered from a connected PC using this symbol:

TX [xxxx] command, page 51

These screens are presented in four major groups:

Group 1—Startup Screen and Menu Directory (page 57)

These screens are starting points for all programming and viewing activities.

Group 2—Configuration Screens (page 58)

The Configuration screens are used to view or define the transceiver's operating parameters. They include:

- Set/display access level (LCD mode)
- Set/display transmit and receive frequency
- Set/display output power
- Set/display modem speed
- Set/display data port baud rate and parity
- Enable/disable emphasis
- Set/display Clear to Send (CTS) delay
- Set/display Push to Talk (PTT) delay
- Set/display soft carrier dekey delay
- Enable/disable Transmit Timeout Timer
- Set/display Transmit Timeout Timer delay
- Enable/disable RX Timeout Timer
- Enable/disable Repeater mode
- Enable/disable Continuous keying/DCE operation
- Key/dekey radio manually
- Set/display unit address
- Enable/disable key on data/key on RTS
- Enable/disable data buffering
- Set/display transmit and receive audio level
- Enable/disable transmit gain and receive pad
- Display major and minor alarm masks
- Set/display LCD display contrast and intensity

- Set/display owner name and message
- Set/display time and date

Group 3—Diagnostic Screens (page 66)

The Diagnostic screens display important status information for the local and remote radio, as well as run several tests useful in locating system problems. The Diagnostic screens include:

- Display active radio status
- Display receive signal strength
- Display S/N ratio
- Set/display active radio selection
- Display transmitter state (keyed, dekeyed)
- Display internal temperature and voltages
- Display radio serial number
- Display software revision level
- Program the stand-by unit

Group 4—Event Log (page 68)

The event log displays up to 800 of the most recent operating changes. These events include system problems, *as well as normal operator actions such as turning the power on or off.* The screens in this group are:

- Display event log entries
- Clear event log

LCD SCREEN	PC COMMAND	DESCRIPTION
Access Level *Details Page 58*		Enable or disable radio configuration mode
Active Radio Status *Details Page 66*	**STAT** *Details Page 49*	Display alarm conditions
Alarm Masks *Details Page 64*	**AMASK [0000 0000–FFFF FFFF]** *Details Page 34,* **NMASK [0000 0000–FFFF FFFF]** *Details Page 44*	Set or display alarm masks
Backlight Intensity *Details Page 64*		Set or display LCD background brightness
Baud Rate/Format *Details Page 59*	**BAUD [xxxxx abc]/[xxxxx] S** *Details Page 35*	Set or display data interface port communication attributes
Clear Logs *Details Page 68*	**LOG [CLR]** *Details Page 41*	Clear event log
Clear To Send Delay *Details Page 60*	**CTS [0-255]** *Details Page 37*	Set or display time to wait after RTS is asserted by host computer before asserting CTS line

LCD SCREEN	PC COMMAND	DESCRIPTION
Continuous Keying *Details Page 61*	**CKEY [ON/OFF]** *Details Page 36*	Select continuous keying or DCE behavior
Data Buffering *Details Page 62*	**BUFF [ON/OFF]** *Details Page 36*	Enable or disable data buffering
Display Contrast *Details Page 64*		Set or display LCD foreground character intensity
Emphasis *Details Page 59*	**EMP [ON/OFF]** *Details Page 40*	Enable or disable emphasis and de-emphasis
Event Log *Details Page 68*	**LOG [CLR]** *Details Page 41*	Display events logged by the active transceiver
Key On Data *Details Page 62*	**DATAKEY [ON/OFF]** *Details Page 37*	Select key-on-data or key-on-RTS
Manual Key *Details Page 62*	**DKEY** *Details Page 38,* **KEY** *Details Page 41*	Manually key or dekey the transmitter
Menu Directory *Details Page 57*		Select diagnostic, configuration, or event log commands
Modem *Details Page 59*	**MODEM [NONE, BELL, 4800B, 9600B, MPT1411]** *Details Page 43*	Set or display internal modem speed
Output Power Setting *Details Page 58*	**PWR [20–37]** *Details Page 45*	Set or display transmit power output
Program Standby Unit *Details Page 67*		Upgrade standby radio's internal software
Push to Talk Delay *Details Page 60*	**PTT [0-255]** *Details Page 45*	Set or display amount of time to wait after host computer asserts RTS before keying radio and beginning transmittal
Radio Selection *Details Page 66*	**RADIO [A/B]** *Details Page 46*	Set or display active transceiver; enable or disable automatic switch-over
Receive Frequency *Details Page 58*	**RX [xxx]** *Details Page 47*	Set or display receive frequency
Receive Level *Details Page 63*	**RXLEVEL [–20-7]** *Details Page 47*	Set or display radio's audio transmit level when radio is operating in analog mode
Receive Pad *Details Page 64*	**RXPAD [ON/OFF]** *Details Page 47*	Enable or disable receive attenuator for receive audio level
Receive Signal Strength *Details Page 66*	**RSSI, RSSI!** *Details Page 46*	Display received signal strength in dBm
Repeater Mode *Details Page 61*	**REPEATER [ON/OFF]** *Details Page 46*	Enable or disable repeater mode
RX Timeout [0-1440] *Details Page 61*		Set or display amount of time to wait without data receipt before generating an alarm and switching to the stand-by radio
S/N Ratio *Details Page 66*	**SNR, SNR!** *Details Page 48*	Display signal-to-noise ratio in dBm
Serial Number *Details Page 67*	**SER** *Details Page 48*	Display active transceiver board's serial number (not the radio serial number)
Set Date *Details Page 65*	**DATE [mmm dd yyyy]** *Details Page 38*	Set or display the date
Set Owner Message *Details Page 65*	**OWM [xxxxx]** *Details Page 45*	Set or display the owner message or site name
Set Owner Name *Details Page 64*	**OWN [xxxxx]** *Details Page 45*	Set or display the owner name or system name
Set Time *Details Page 65*	**TIME [TIME hh:mm:ss AM/PM]** *Details Page 50*	Set or display the time

LCD SCREEN	PC COMMAND	DESCRIPTION
Show Temperature and Voltages *Details Page 67*	**TEMP** *Details Page 50*	Display radio's internal temperature and voltages
Soft Carrier De-key Delay *Details Page 60*	**SCD [0-255]** *Details Page 47*	Set or display amount of time to wait after a de-key request before actually de-keying the radio
Software Revision *Details Page 67*	**SREV** *Details Page 49*	Display internal software part number and version number
Start-up Screen *Details Page 57*		Display radio name, owner name, owner message, and any alarms
Transmit Frequency *Details Page 58*	**TX [xxxx]** *Details Page 51*	Set or display transmitter frequency
Transmit Gain *Details Page 63*	**TXGAIN [ON/OFF]** *Details Page 51*	Enable or disable transmit audio boost for transmit audio level
Transmit Level [–20-3, AUTO] *Details Page 63*	**TXLEVEL [–20-3, AUTO]** *Details Page 52*	Set or display radio's audio transmit level when radio is in analog mode
Transmit Timeout *Details Page 60*		Enable or disable Transmit Timeout timer (time to wait before disabling the transmitter to prevent unnecessary use of the frequency)
Transmit Timeout Duration *Details Page 61*		Set or display Transmit Timeout duration (time to wait before disabling the transmitter to prevent unnecessary use of the frequency)
Transmitter Status *Details Page 67*		Display transmitter state (keyed or dekeyed)
Unit Address *Details Page 62*	**UNIT [10000–65000]** *Details Page 52*	Set or display radio's unit address

GROUP 1—MAIN SCREENS

Start-up Screen

```
MDS 9790 MAS Radio

OWNERS NAME
OWNERS MESSAGE
```

When the radio is first powered on, or after a period of time has elapsed after the last button press, the LCD display shows the start-up screen. The start-up screen displays the product model number, as well as the owner's name and message. (Typically, customers use the owner name and message fields to display the system and site name.)

The screen dims after a period of time has elapsed without any activity; brightness can be restored by pressing any button.

For information on how to set what is displayed on this screen, see *Set Owner Name* on page 64 and *Set Owner Message* on page 65.

Press ENTER, or the up or down arrow button, to display the Menu Directory screen.

Menu Directory

```
MDS 9790 MAS Radio
->Configuration
  Diagnostics
  Event Log
```

This screen is used to access three screen display cycles: **Configuration, Diagnostics,** and **Event Log**. The right-pointing arrow points to the currently selected menu.

Press the up/down arrow buttons to move the arrow to the desired menu, then press the right/left arrow buttons to display each of that menu's screens in succession.

GROUP 2—CONFIGURATION

Access Level

```
Set Access Level
      User
```

This screen is used to set the LCD display to radio configuration mode by selecting a level of access. There are two levels:

NONE—This is the default setting upon power-up. All radio settings can be viewed, the access level can be changed, and the LCD brightness and contrast can be changed. All other settings are for display only, and cannot be changed.

USER—Changes can be made to any radio parameter.

To select the **USER** access level, press ENTER, press the down arrow button to display the word "User," then press ENTER again to make the change.

The radio returns automatically to display-only mode (access level: **NONE**) after a period of time has elapsed without a button press, or if the radio is powered off and then on.

Transmit Frequency

```
Transmit Frequency
  400.00000 MHz
```

This screen is used to display or set the transmitter frequency. Valid frequencies are listed in Table on page 42.

To change this value, press ENTER, then use the left/right arrow buttons to select a digit. Then use the up/down arrow buttons to increase or decrease the number. Press ENTER to make the change.

If the transmit frequency is changed by more than 1 MHz, the duplexer must be replaced or retuned. Refer to *Duplexer and Helical Filter Retuning* on page 80 for information on retuning the duplexer and helical filters.

TX [xxxx] command, page 51

Receive Frequency

```
Receive Frequency
  400.00000 MHz
```

This screen is used to display or set the receive frequency. Valid frequencies are listed in Table on page 42.

To change this value, press ENTER, then use the left/right arrow buttons to select a digit. Then use the up/down arrow buttons to increase or decrease the number. Press ENTER to make the change.

If the receive frequency is changed by more than 1 MHz, the duplexer must be replaced or retuned. If the receive frequency is changed by more than 5 MHz, helical filter adjustments must be made. Refer to *Duplexer and Helical Filter Retuning* on page 80 for information on retuning the duplexer and helical filters.

RX [xxx] command, page 47

Output Power Setting

```
Output Power Setting
       30 dBm
```

This screen is used to set or display the transmit power output setting. Power output may be set between +37 dBm and +20 dBm.

To change this value, press ENTER, then use the left/right arrow buttons to select a digit. Then use the up/down arrow buttons to increase or decrease the number. Refer to Table to convert dBm to watts if necessary. Press ENTER to make the change.

PWR [20–37] command, page 45

(Continued)

Table 13. dBm versus Watts

dBm	Watts	dBm	Watts
+37 dBm	5.0 watts	+27 dBm	500 milliwatts
+35 dBm	3.2 watts	+25 dBm	320 milliwatts
+33 dBm	2.0 watts	+23 dBm	200 milliwatts
+31 dBm	1.25 watts	+20 dBm	100 milliwatts
+29 dBm	800 milliwatts		

Modem

```
Modem
4800
```

This screen is used to set or display the internal modem speed for compatibility with the modem in the central host computer.

To change the modem speed, press ENTER, then use the up/down arrow buttons to display available modem speeds. Press ENTER to make the change.

MODEM [NONE, BELL, 4800B, 9600B, MPT1411] command, page 43

Baud Rate/Format

This screen is used to set or display the communication attributes for the DATA INTERFACE port. For a description of the communication attributes, see BAUD [xxxxx abc]/[xxxxx] S command, page 35.

To change the baud rate, press ENTER, then press the left arrow button to move the underscore under the baud rate. Then use the up/down arrow buttons to select a new baud rate.

To change the data format, press ENTER, then press the right arrow button one or more times to move the underscore (_) under the character to change. Then use the up/down arrow buttons to change the character. Repeat for the other characters in the data format if necessary. Press ENTER to make the change.

BAUD [xxxxx abc]/[xxxxx] S command, page 35

Emphasis

```
Emphasis
enabled
```

This screen is used to enable or disable emphasis and de-emphasis on the analog input and output signals.

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.

To enable or disable emphasis, press ENTER, then use the up/down arrow buttons to display ENABLED or DISABLED. Press ENTER to make the change.

EMP [ON/OFF] command, page 40

Clear To Send Delay

```
Clear to Send Delay
  0 milliseconds
```

This screen is used to set or display the Clear-to-Send Delay. This is the amount of time to wait after RTS is asserted by the host computer on the data port before asserting the CTS line. When the delay is 0, data will be sent out the data port without imposing a key-up delay.

To change the delay, press ENTER, then use the left/right arrow buttons to select the digit to change. Then use the up/down arrow buttons to increase or decrease the digit. Repeat for the other digits if necessary. Press ENTER again to make the change.

CTS [0-255] command, page 37

Push to Talk Delay

```
Push to Talk
    Delay
0 milliseconds
```

This screen is used to set or display the Push-to Talk Delay. This is the amount of time to wait after RTS is asserted by the host computer before the radio is keyed and begins to transmit. When the delay is 0, the radio will key up immediately following the key-up signal.

To change the delay, press ENTER, then use the left/right arrow buttons to select the digit to change. Then use the up/down arrow buttons to increase or decrease the digit. Repeat for the other digits if necessary. Press ENTER again to make the change.

PTT [0-255] command, page 45

Soft Carrier De-key Delay

```
Soft Carrier De-key
  0 milliseconds
```

This screen is used to set or display the Soft-Carrier Dekey Delay. This is the amount of time to wait after a de-key request before actually de-keying the radio. When the delay is 0, the radio will de-key immediately following removal of a keying signal.

To change the delay, press ENTER, then use the left/right arrow buttons to select the digit to change. Then use the up/down arrow buttons to increase or decrease the digit. Repeat for the other digits if necessary. Press ENTER again to make the change.

SCD [0-255] command, page 47

Transmit Timeout

```
Transmit Timeout
    enabled
```

This screen is used to display the Transmit Timeout setting, and to enable or disable this timer. When this timer is enabled, it disables the transmitter after a set period of time to prevent unnecessary use of the frequency. If the radio is set to continuous keying, the Transmit Timeout Timer is automatically disabled.

To enable or disable the timer, press ENTER, then use the up/down arrow buttons to display ENABLED or DISABLED. Press ENTER to make the change.

See the following command to change the timer delay.

TOT [0-255] command, page 51

Transmit Timeout Duration

```
Transmit Timeout
30 seconds
```

This screen is used to set or display theTransmit Timeout duration. This is the amount of time to wait before disabling the transmitter to prevent unnecessary use of the frequency. If the radio is set to continuous keying, Transmit Timeout is automatically disabled.

To change the duration, press ENTER, then use the left/right arrow buttons to select the digit to change. Then use the up/down arrow buttons to increase or decrease the digit. Repeat for the other digit if necessary. Press ENTER again to make the change.

TOT [0-255] command, page 51

RX Timeout [0-1440]

```
RX Timeout
none
```

This screen is used to set or display the RX Timeout Timer duration. This is the amount of time to wait (in minutes) after the last data receipt before switching over to the stand-by radio and generating an alarm.

To change the duration, press ENTER, then use the left/right arrow buttons to select the digit to change. Then use the up/down arrow buttons to increase or decrease the digit. Repeat for the other digit if necessary. Press ENTER again to make the change.

To disable the Receive Timeout Timer, set the duration to 0.

Repeater Mode

```
Repeater Mode
enabled
```

This screen is used to set or display the radio's operation as a repeater. When the radio is set to operate as a repeater, the screen displays "enabled" (repeater mode is enabled). When the radio is a non-repeater, the screen displays "disabled" (repeater mode is disabled).

To change the operating mode, press ENTER, then use the up/down arrow buttons to select ENABLE (repeater mode) or DISABLE (non-repeater mode). Press ENTER again to make the change.

REPEATER [ON/OFF] command, page 46

Continuous Keying

```
Continuous Keying
enabled
```

This screen is used to set or display the radio's keying mode (continuous keying, or DCE behavior). Typically, a master station is set for continuous keying.

To change the keying mode, press ENTER, then use the up/down arrow buttons to select ENABLE (continuous keying) or DISABLE (DCE behavior). Press ENTER again to make the change.

CKEY [ON/OFF] command, page 36

Manual Key

```
Manual Key
disabled
```

This screen is used to manually key or dekey the transmitter. The transmitter state can be displayed by selecting **Transmitter Status** from the **Diagnostics** menu (page 67).

To key the transmitter, press ENTER, then use the up/down arrow buttons to select ENABLE (manual keying). Press ENTER again to key the transmitter.

To dekey the transmitter, press ENTER, then use the up/down arrow buttons to select DISABLE (manual dekeying). Press ENTER again to dekey the transmitter.

KEY command, page 41

DKEY command, page 38

Unit Address

```
Unit Address
2067
```

This screen is used to set or display the radio's unit address, which uniquely identifies a single radio within a network. It is used primarily for diagnostics.

When the radio first powers up, unit address is unprogrammed. Unit address can range from 0...65000, but can only be manually programmed from 10000...65000. (Addresses in the 0...9999 range only occur when they are assigned as default values following factory programming of the serial number.)

To change the unit address, press ENTER, then use the left/right arrow buttons to select the digit to change. Then use the up/down arrow buttons to increase or decrease the digit. Repeat for other digits as necessary. Press ENTER again to make the change.

UNIT [10000–65000] command, page 52

Key On Data

```
Key On Data
enabled
```

This screen is used to set or display the radio's keying mode (key-on-data, or key-on-RTS). In key-on-data mode, the radio will automatically key itself whenever input data arrives on the DB25 port. In key-on-RTS mode, the radio will only key in response to an RTS or PTT signal.

To set the radio to key-on-data mode, press ENTER, then use the up/down arrow buttons to select ENABLE. Press ENTER again to make the change. To set the radio to key-on-RTS mode, press ENTER, then use the up/down arrow buttons to select DISABLE. Press ENTER again to make the change.

Note that key-on-data mode is only applicable when the input data source is digital. When the input data source is analog, this setting is irrelevant.

DATAKEY [ON/OFF] command, page 37

Data Buffering

```
Data Buffering
enabled
```

This screen is used to enable or disable data buffering. If data buffering is enabled, the radio operates in seamless mode, where the data is sent over the air as quickly as possible. However, the receiver will buffer (hold) 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.

If data buffering is disabled, the radio operates with the lowest possible data latency (average). Data bytes are sent out the data 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.

To enable or disable data buffering, press ENTER, then use the up/down arrow buttons to display ENABLE or DISABLE. Press ENTER again to make the change.

BUFF [ON/OFF] command, page 36

Transmit Level [–20-3, AUTO]

```
Transmit Level
    -1 dBm
```

This screen is used to set or display the radio's audio transmit level when the radio is operating as an analog device. The audio transmit level can be set between –20 and 3 dBm, or it can be set to adjust automatically.

To change the audio transmit level, press ENTER. ***You do not need to use the left/right arrow buttons to select a digit.*** Instead:

To increase the transmit level, press the up or left arrow button (△ ▷).

To decrease the transmit level, press the down or right arrow button (▽ ◁).

Press ENTER again to make the change.

TXLEVEL [–20-3, AUTO] command, page 52

Receive Level

```
Receive Level
    -1 dBm
```

This screen is used to set or display the radio's audio receive level when the radio is operating as an analog device. The audio receive level can be set between –20 and 7 dBm.

To change the audio receive level, press ENTER. ***You do not need to use the left/right arrow buttons to select a digit.*** Instead:

To increase the receive level, press the up or left arrow button (△ ▷).

To decrease the receive level, press the down or right arrow button (▽ ◁).

Press ENTER again to make the change.

RXLEVEL [–20-7] command, page 47

Transmit Gain

```
Transmit Gain
   disabled
```

This command enables or disables the transmit audio boost for the transmit audio level???????????.

TXGAIN [ON/OFF] command, page 51

Receive Pad

```
Receive Pad
disabled
```

This screen is used to enable or disable the receive attenuator for the receive audio level???????????.

RXPAD [ON/OFF] command, page 47

Alarm Masks

```
Alarm Masks
Major FFFF 0000
Minor 0000 FFFF
Alarm Sense is HI
```

This screen is used to display hexadecimal codes which identify which alarms are classified as major or minor, or for which alarm notification is disabled. The screen also displays the alarm sense setting. For an explanation, or to change the alarm masks, see the following PC commands:

AMASK [0000 0000–FFFF FFFF] command, page 34

ASENSE [HI/LO] command, page 34

Display Contrast

```
Display Contrast
0        50       100
■■■■■■■■■■
```

This screen is used to set the intensity of the LCD display's foreground characters. Making the characters darker may aid the clarity of the LCD display when viewed from an angle.

The bar display indicates the relative intensity of the foreground characters, with '0' being faint characters and '100' being dark characters.

To change the selection, press ENTER, then use the left/right arrow buttons to move the bar display to the desired setting. The screen changes dynamically to show the effects of the change. Press ENTER again to set the change.

Backlight Intensity

```
Backlight Intensity
0        50       100
■■■■■■■■■■
```

This screen is used to set the brightness of the LCD display's background. Making the screen background brighter or dimmer may aid the clarity of the LCD display when viewed under different light conditions.

The bar display indicates the relative brightness of the screen background, with '0' being dim and '100' being very bright.

To change the selection, press ENTER, then use the left/right arrow buttons to move the bar display to the desired setting. The screen changes dynamically to show the effects of the change. Press ENTER again to set the change.

Set Owner Name

```
Set Owner Name
^
_!"#$%&'()*+,-./0123
```

This screen is used to set or display text (up to 20 characters) to appear on the radio's start-up screen, such as the system name.

Press ENTER to display a scrollable line of characters at the bottom of the screen. An underscore (_) is used to select a character for the owner name (Figure 25). A caret (^) shows the current character position.

- Press the ***up arrow*** △ button to move the underscore to the **left** until it is under the first character of the owner name. As you scroll to the left, the character under the underscore appears above the caret.
- Press the ***right arrow*** ▷ button once to move the caret to the next character position to the right.
- Press the up or down △ ▽ arrow buttons to move the underscore to the next character.

- Continue in this way, using the up/down arrow buttons to move the underscore to a character, then pressing the right arrow button to move to the next character position.
- Press ENTER to save the owner name.

OWN [xxxxx] command, page 45

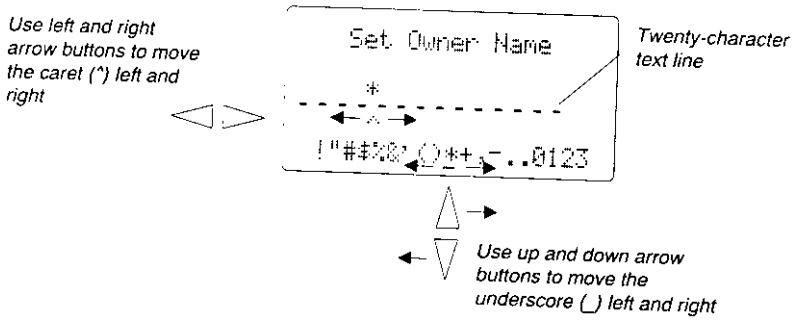
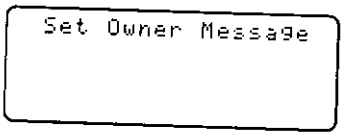


Figure 25. Setting the owner name and message

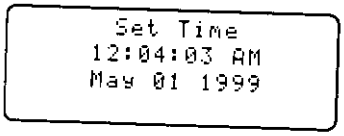
Set Owner Message



This screen is used to set or display text (up to 20 characters) to appear on the radio's start-up screen, such as the site name. See the Set Owner Name command and Figure 25 above for instructions.

OWM [xxxxx] command, page 45

Set Time

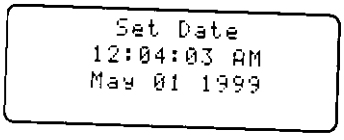


This screen is used to set or display the time set in the radio. The accuracy of the date and time are important, because event codes are "stamped" with the date and time.

To change the time, press ENTER, then use the left/right arrow buttons to select the hour, minute, second, or AM/PM. Then use the up/down arrow buttons to increase or decrease the digit, or toggle between AM and PM. Repeat for other characters if necessary. Press ENTER again to make the change.

TIME [TIME hh:mm:ss AM/PM] command, page 50

Set Date



This screen is used to set or display the date set in the radio. The accuracy of the date and time are important because event codes are "stamped" with the date and time.

To change the date, press ENTER, then use the left/right arrow buttons to select

the month, day, or year. Then use the up/down arrow buttons to increase or decrease the day or year, or set the month. Repeat for other characters if necessary. Press ENTER again to make the change.

DATE [mmm dd yyyy] command, page 38

GROUP 3—DIAGNOSTICS

Active Radio Status

```
Active Radio Status
  Alarms present
(enter for details)
```

```
Event: 20 (MINOR)
Configuration error
```

This screen is used to display alarm conditions, if any.

If alarms are indicated, press ENTER to display the first alarm. To scroll through the list of alarms, press the right ▷ or down ▽ arrow button. Press ESCAPE to return to the Active Radio Status screen.

STAT command, page 49

Receive Signal Strength

```
Rx Signal Strength
     -120 dBm
```

This screen displays the received signal strength in dBm.

In a typical master station configuration, the received signal strength is read from each of the remote transceivers that transmit to the master station in turn.

RSSI, RSSI! command, page 46

S/N Ratio

```
S/N Ratio
```

This screen displays the current signal-to-noise ratio in dBm.

SNR, SNR! command, page 48

Radio Selection

```
Radio Selection
      AUTO
Radio A is active
```

This screen is used to set or display the active transceiver system inside the master station. When the radio selection is:

AUTO—switch-over to the inactive transceiver system will occur if a fault condition occurs on the active transceiver system.

A—transceiver A is set as the active transceiver system and switch-over will not occur if an error condition is detected in the radio.

B—transceiver B is set as the active transceiver system and switch-over will occur if an error condition is detected in the radio.

To change which transceiver system is active, or to enable automatic switch-over, press the ENTER key, then use the up/down arrow buttons to select **AUTO**, **A** or **B**. Press ENTER again to make the change.

RADIO [A/B] command, page 46

Transmitter Status

```
Transmitter Status
      keyed
```

This screen displays the transmitter state. "Keyed" means the transmitter is set to transmit; "dekeyed" means the transmitter is prevented from transmitting. The transmitter can be keyed or dekeyed by selecting **Manual Key** from the **Configuration** menu (page 62). This setting is used when working on the radio, and the radio must be keyed to evaluate transmitter output power.

Show Temperature and Voltages

```
Show Temp/Voltage
   37° Celsius
11.2 Volts Input
5.8 Volts Output
```

This screen displays the radio's internal temperature and voltages.

The input voltage is the voltage that connects to the transceiver board and is unregulated. This voltage is essentially the output from the power supply assembly.

The output voltage is read after a 5.6 Vdc regulator on the transceiver board.

TEMP command, page 50

Serial Number

```
Serial Number
   00755959
```

This screen displays the serial number of the active transceiver *board*. This number will not match the serial number on the serial number label on the radio.

SER command, page 48

Software Revision

```
Software Revision

   06-3321A02
0.0.0    5Aug1998
```

This screen displays the internal software part number and version number.

SREV command, page 49

Program Standby Unit

```
Program Standby Unit
   Are you sure?
        No
  (change pending)
```

This screen is used to initiate a software upgrade at the standby radio. A PC must be connected to the radio via the radio's serial port, and a disk containing the software upgrade must be in one of the PC's drives.

To program the standby unit, press ENTER. The screen displays the prompt "Are you sure?" Use the up/down arrow buttons to change "No" to "Yes." Press ENTER again to program the standby unit.

GROUP 4—EVENT LOG

Event Log

```
Log     1 of     1
5/ 1/1998 12:00:00
   System Boot
```

This screen shows the events logged on the *active* transceiver board. In many cases, however, the events leading up to a failure can be reviewed to help determine the cause of a problem. The event log number, date and time of the event, and a description of the event are shown.

This screen shows the most recent log when first entered. Use the up/down arrow buttons to scroll through the stored history of events.

LOG [CLR] command, page 41

Clear Logs

```
Clear Logs
Are you sure?
No
(change pending)
```

LOG [CLR] command, page 41

7.0 TROUBLESHOOTING

The majority of radio operation problems are due to the failure of components outside of the radio, out in the elements—usually a poor or broken feedline or antenna connection. This section will help you determine whether the problem is outside or inside the radio; and, if in the radio, how to restore operation as quickly as possible.

MDS does not recommend component-level repair of the transceiver in the field. However, the major assemblies of the transceiver may be replaced without the need for tools or test equipment. Section 7.4, *Replacing Assemblies*, on page 72 covers this in detail.

If you are unable to solve a system problem with the information provided here, technical assistance is also available from Microwave Data Systems. Refer to the inside back cover of this guide for contact information.

NOTE: Before starting any detailed troubleshooting, check the basic requirements at both ends of the link: primary power, secure cable connections, and proper antenna heading. In many cases, one of these things may be at fault and cause poor operation or a complete loss of link service.

7.1 Troubleshooting with LED Indicators

The first indication of a problem is usually an illuminated Alarm LED on the front panel. In normal operation, only the green (ACTIVE) LED should be lit (and, in a protected radio, one of the yellow STBY LEDs).

In a redundant master station, the LEDs show the state of the A and B radios. In a non-redundant master station, the LEDs show the state of the B radio.

Refer to Figure 26 and the text that follows for an explanation of the LED indicators.

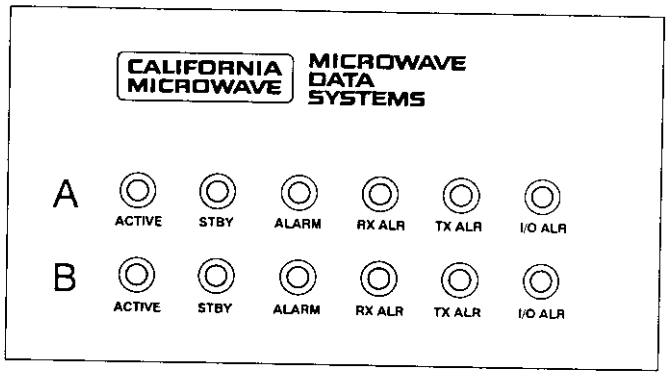


Figure 26. LED indicators

Table 14. Explanation of front panel LEDs

LED Name	Color	Meaning When Lit
ACTIVE	Green	Transceiver board (A or B) is the selected unit.
STBY	Yellow	Transceiver board (A or B) is currently in stand-by mode. (Functional on Protected version only.)
ALARM	Red	General fault not covered by the alarm categories below (RX ALR, TX ALR, I/O ALR).
RX ALR	Red	Difficulty receiving—may be due to an antenna problem, receiver fault, or other condition causing no or a weak received signal level.
TX ALR	Red	Fault with the transmit circuitry, or the transmitter is unkeyed.
I/O ALR	Red	The data rate or format of data at the data interface connector is incompatible with the radio settings.

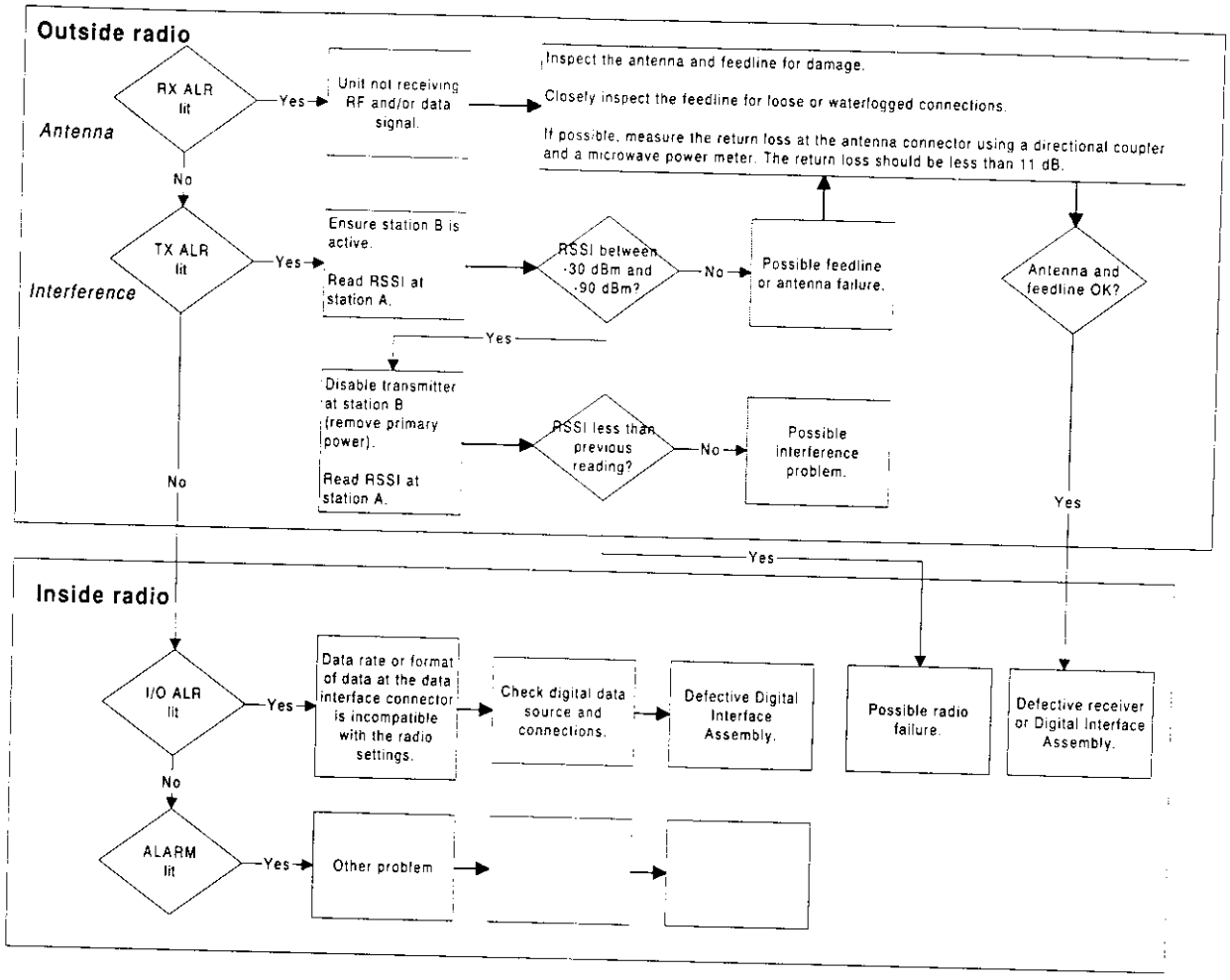


Figure 27. Troubleshooting decision flowchart

7.2 Troubleshooting Using a Connected PC

Determination of radio status and reprogramming is normally done from a PC connected to the master station. For troubleshooting suggestions and procedures, see the MDS InSite program's on-line manual (05-xxxxxxx).

7.3 Troubleshooting Using the LCD Display

Diagnostic Tests

The radio includes several useful tools in the **Diagnostics** menu that can be used to identify system problems. These include local and remote status screens, loopback configurations, and other internal tests?????????? Brief descriptions of these tools are given below. Refer to Section 6.5, *Screen Descriptions* for detailed information.

Local and Remote Status Screens

The local and remote status screens can be used to gather important information about both ends of the radio link, including signal strength, BER, signal-to-noise ratio and power output.

Loopback Configurations

The radio supports several types of loopback tests that can be performed with external equipment. These tests are very helpful in evaluating the overall RF and data performance of the system. A detailed description of the loopback tests is covered in Section 6.5, *Screen Descriptions*.

Other Tests

The **Run Tests** screen in the **Diagnostics** menu can be used to perform eight sequential tests on the transceiver's internal circuitry.

Event Codes

Event codes are another helpful way of identifying system problems. The radio stores recent events in a log that can be reviewed using the **Event Log** screen (for a full description, see Section 6.5, *Screen Descriptions*). In addition to on-site troubleshooting, the event log messages are also helpful when calling MDS for technical assistance.

Not all events are considered to be problems. For example, an intentional action such as turning the primary power on will be recorded as an event even though it is not a true error condition. In many cases, however, the events leading up to a failure can be reviewed to help determine the cause of a problem.

- **Major alarms** generally indicate a hardware failure or other abnormal condition that will prevent (or hamper) further operation of the radio link. Generally speaking, major alarms trigger a switch-over of internal transceiver assemblies on a protected model.

  Connections to a relay that is actuated by these alarms are provided on the rear panel ALARM connector. (See Figure 13 on page 18.)

- **Minor alarms** generally will not prevent operation of the radio link, but may impair performance. This includes out-of-tolerance conditions, low signal-to-noise ratios, etc. The cause of a minor alarm should be investigated and corrected to prevent an eventual system failure.

  Connections to a relay that is actuated by these alarms are provided on the rear panel ALARM connector. (See Figure 13 on page 18.)

7.4 Replacing Assemblies

Component-level repair of the transceiver in the field is *not* recommended due to the complex nature of the circuitry and the use of surface-mount technology throughout the radio. Malfunctioning assemblies should be returned to the factory (or authorized service center) for repair or replacement.

One approach to field-level servicing is to have spare modules available for the three easily replaced assemblies of the transceiver—the Main Transceiver Board, Power Supply, and Front Panel. In this way, a defective assembly can be quickly removed and replaced with a working unit. The following instructions describe the removal and installation of these assemblies.

CAUTION
POSSIBLE EQUIPMENT DAMAGE

The primary power to the radio must be disconnected before removing or installing transceiver or power supply assemblies.

Transceiver Board and Power Supply Assemblies

To remove either of these assemblies, loosen the two captive thumbscrews at each side of the module, and slide the unit straight out as shown in Figure 28. (There are no cables to disconnect, as the modules are fitted with in-line connectors.)

To re-install these modules, make sure that the slides are properly aligned with the guide slots on the chassis, and push straight in. Tighten the thumbscrews to secure the assembly.

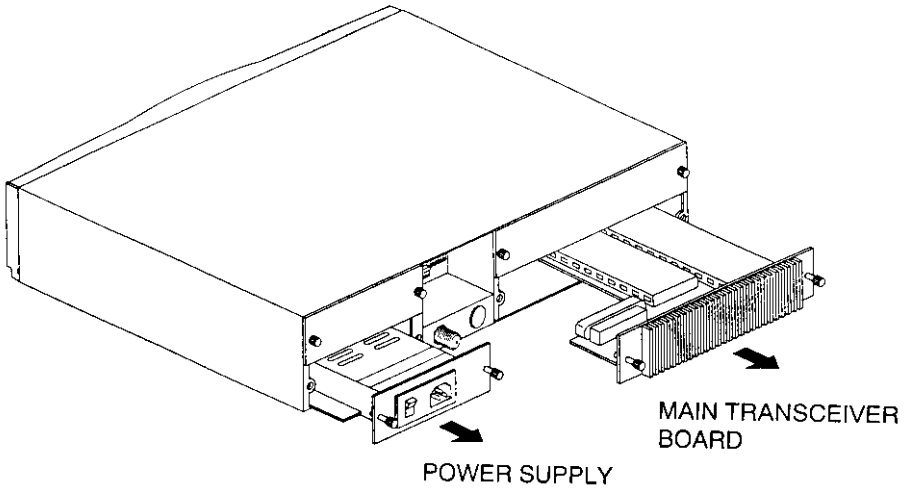


Figure 28. Main transceiver and power supply removal

Front Panel

The front panel is secured to the chassis with spring-loaded latches. To remove the panel, simply pull out at the bottom edge until it is free from the chassis (Figure 29). You will also need to disconnect the modular cable from the back of the panel. Reverse these steps to re-install the front panel on the chassis.

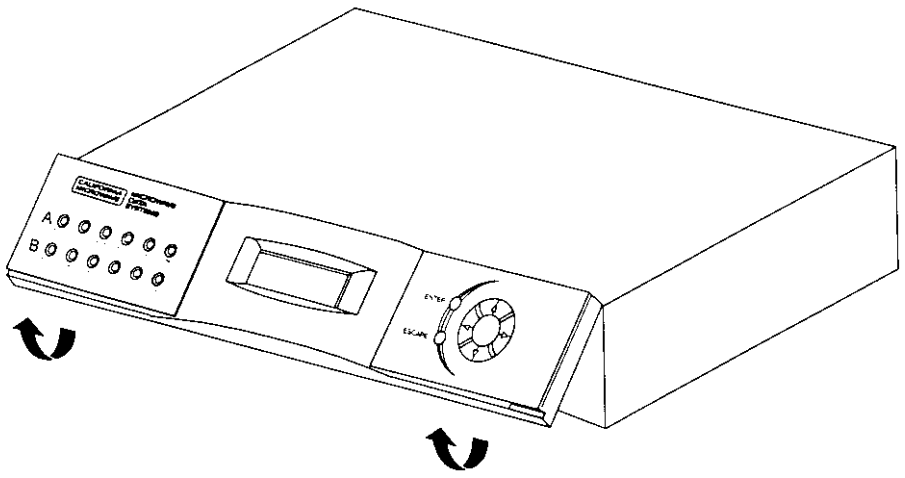


Figure 29. Front panel removal/replacement

8.0 TECHNICAL REFERENCE

8.1 Technical Specifications

Table 15. Technical specifications

GENERAL	
Size:	2RU (88.90 mm/3.5 inch) high 363 mm (14.3 in) deep 437 mm (17.2 in) wide —includes duplexer and power supply
Weight:	9 kg (19.8 lbs.)
Frequency Range:	800–960 MHz Front panel programmable, duplexer, and helical filters may require retuning. *(Refer to Figure 4 on page 5 for hardware band limits)*
T/R Separation:	
RF Occupied Bandwidth:	
Antenna Impedance:	50 Ω
Data Rates:	300, 1200, 2400, 4800, 9600, 19200, 38400 bps asynchronous
Data Interface:	EIA-232
Modulation Type:	
Temperature Range:	0 to 50°C guaranteed operation
Humidity:	95% non-condensing
Environmental:	
EMC:	
System Gain:	110 dB
Voltage Ranges:	19.4 to 37 Vdc
24 Vdc Power Supply	36 to 75 Vdc
48 Vdc Power Supply	
110/220 Vac Power Supply	
Power Consumption:	30 Watts
Data Latency:	7 ms maximum at 9600 bps
DIAGNOSTIC FUNCTIONS	
Local Indicators:	Active, stand-by, General Alarm, TX Fault, RX Fault, I/O Fault
Remote Indicators:	Minor and major alarm relay contacts (Available on rear panel)
Measurements:	RSSI, Power, S/N, BER, Alarms
Remote Readings:	Remote RSSI, S/N, BER and alarms via embedded diagnostic data stream (RS-232-type port at rear panel)

Table 15. Technical specifications *(Continued)*

Loopback:	Local digital loopback, Local RF loopback, Remote digital loopback
RECEIVER	
Sensitivity:	–89 dBm for 1 x 10^{-6} BER –92 dBm for 1 x 10^{-3} BER
Residual BER:	1 x 10^{-10}
Dynamic Range:	From sensitivity to –30 dBm better than 1 x 10^{-6} BER
TRANSMITTER	
Power Output:	+27 dBm (500 mW) out of duplexer (approx. +28.5 dBm out of transmitter)
Frequency Stability:	1.5 ppm
Spurious Outputs:	Less than –60 dBm
Duty Cycle:	Continuous/100%

8.2 RF Propagation Planning

Establishing a reliable point-to-point radio link requires system planning and design. It is helpful to have an understanding of the physical parameters affecting propagation. The following material discusses these factors and will assist you in designing a dependable transmission path for your radio link.

NOTE: This section is intended for use as a guideline when planning transmission paths. It does not consider all of the local conditions that may be present, nor does it guarantee that adequate signal strength will be obtained in a given system. There is no substitute for an on-the-air test to verify the predicted path results, and to check the overall operation of the radio system.

To ensure a highly reliable path, a line of sight between both ends of the link is desirable. For short paths (up to 5 kilometers/3.1 miles), some obstructions may be acceptable, but the performance of a blocked path is always less predictable than a clear path.

Fresnel Zone Clearance

As the distance spanned by a link gets longer, it is necessary to have more than just a grazing path between the two ends; the path must clear the ground or other obstacles by some percentage of a Fresnel zone.

The Fresnel zone corresponds to the width or girth of the radio signal. There are first, second, and third Fresnel zones, but the first zone is the only one that has substantial effects on signal strength.

The first Fresnel zone can be visualized as an oval-shaped volume between two station antennas (Figure 30). As the width of the radio wave front gets blocked by obstructions, less of the signal can get to the receiver antenna.

In addition to blocking the signal, obstructions in the first Fresnel zone may also cause multipath interference due to reflective and refractive signal paths. The reflected or refracted signal may arrive at the receiver out of phase with the desired signal and cause a cancelling effect.

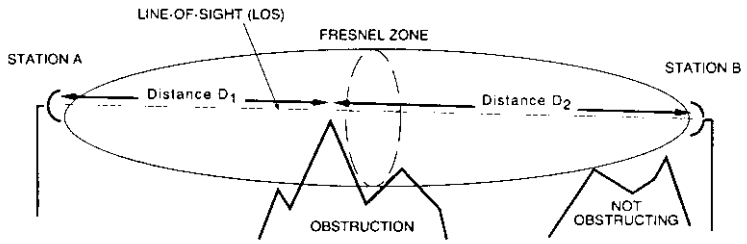


Figure 30. Fresnel zone obstructions

As a matter of practice, 60 percent of the first Fresnel zone must be clear of obstructions (0.6 x F) to allow a clear, unobstructed microwave path.

Remember, the first Fresnel zone calculation is only one parameter determining path quality.

Earth Curvature

As the distance of a communication link increases, the clearance problem is compounded by the earth's curvature. Radio waves traveling through typical atmospheric conditions bend slightly, which is represented by treating the earth as though it were slightly flatter than it actually is. Experience has shown that if we consider the earth's radius to be 4/3rds of its actual size, we get good agreement between theory and measured propagation results.

Figure 31 shows a representation of the 4/3 earth "radio horizon." This figure shows that under normal radio propagation conditions, a station with its antenna 15 meters above flat terrain will have a radio horizon approximately 15 kilometers away, well beyond the visual horizon.

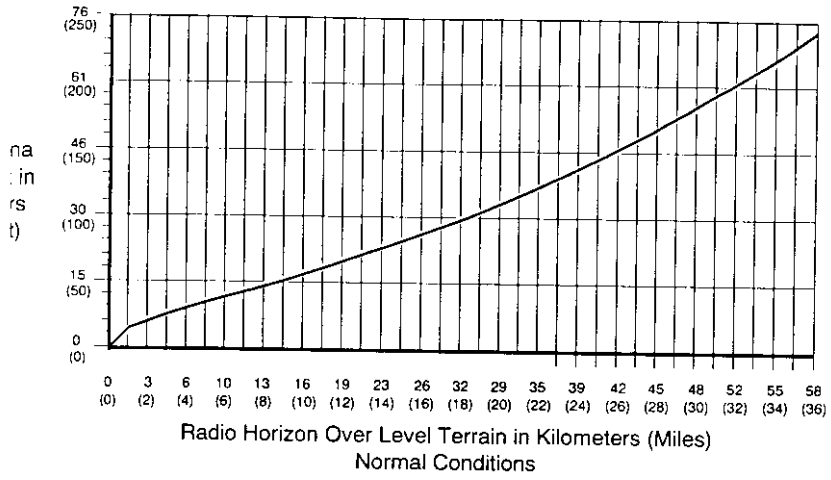


Figure 31. Antenna height vs. theoretical radio horizon

Fade Margins

Variations in the temperature and humidity of the atmosphere with elevation cause the signals to bend more or less, resulting in fading at the receiver. The longer the path is, the more likely that deep fades will occur, hence the greater the fade margin required.

Different parts of the world have differing propagation conditions, which can be categorized as favorable, average, or adverse. In general, mountainous areas have favorable propagation conditions, while tropical areas and those near large bodies of water have adverse conditions.

Calculating Path Loss

Assuming that we have satisfied the line-of-sight and first Fresnel zone clearance requirements, we can calculate the path loss. At 450 MHz, the loss between two isotropic radiators (0 dBi antennas) that are 1 km apart is 86 dB. For every doubling of distance, the loss increases by an additional 6 dB. Knowing this, the output power (+25 dBm), and the receiver sensitivity (–90 dBm), we can calculate antenna size and tower height requirements to cover any desired distance.

8.3 Formulas for System Planning

The following standard formulas are provided for assistance in determining system installation parameters.

Free Space Path Loss

$$\alpha_{fs} = 92.4 + 20\log_{10} f + 20\log_{10} d$$

Where:

α_{fs} = free space loss in dB
d = path distance in kilometers
f = frequency in GHz

Parabolic Antenna Gain

$$G = (20)\log_{10}(7.4Df)$$

Where:

G = antenna gain in dBi
D = dish diameter in meters
f = frequency in GHz

This formula assumes a typical 50 percent antenna illumination efficiency, and is representative of a full parabolic antenna.

Fresnel Zone Boundary

$$F_n = 17.3\sqrt{\frac{nd_1 \cdot d_2}{fD}}$$

Where:

F_n = Fresnel zone boundary in meters
d_1 = distance from one end of the path to the Fresnel zone boundary (in kilometers)
d_2 = distance from the other end of the path to the Fresnel zone boundary (in kilometers)
D = total path distance (d_1+d_2) in kilometers
f = frequency in GHz
n = Fresnel zone, 1 (for 1st) is used here

Theoretical Signal Strength

$$RSSI = EIRP - \alpha_{fs} + G_{ra} - L_{rfl}$$

Where:

RSSI = signal strength at the receiver in dBm
EIRP = RF power output in dBm + G_{ta} –L_{tfl}
α_{fs} = free-space path loss in dB
G_{ra} = receive antenna gain in dBi
L_{rfl} = receive feedline loss in dB
L_{tfl} = transmit feedline loss in dB

G_{ta} = transmit antenna gain in dBi

Probability of System Fading

$$FProb = a \times b \times 6.0 \times 10^{-7} \times f \times d^3 \times 10^{(-F)/10}$$

Where:

$FProb$ = probability of fading more than F

a = terrain factor
- 4 is used for very smooth terrain, such as over water
- 1 is used for average terrain, with moderate roughness
- 0.25 is used for mountainous or very rough terrain

b = climate factor
- 0.5 is used for a hot, humid climate
- 0.25 is used for temperate or northern areas
- 0.125 is used for a very dry climate

f = frequency in GHz

d = path length in km

F = fade margin in dB

8.4 Bench Testing Setup

Figure 32 shows a sample test setup that can be used to verify the basic operation of the MDS 9790 radio. 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. 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 DIAGNOSTIC 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.

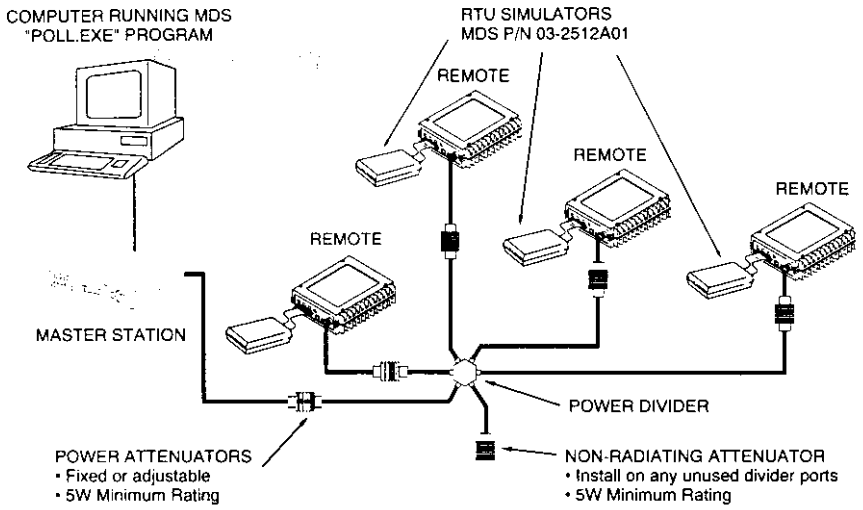


Figure 32. Bench test setup

8.5 Duplexer and Helical Filter Retuning

To be supplied.

8.6 dBm-Watts-Volts Conversion Chart

Table 16 is provided as a convenience for determining the equivalent voltage or wattage of an RF power expressed in dBm.

Table 16. dBm-Volts-Watts conversion chart

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 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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Rochester, New York 14620, USA
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FAX—All Services: +1 (716) 242-9620

World Wide Web: http://www.mdsroc.com/