QUICK START GUIDE

Below are the basic steps for installing the transceiver. Detailed instructions are given in "Installation Steps" on page 6 of this guide.

1. Mount the transceiver (see Figure 6 or Figure 7 for mounting dimensions)

2. Install and connect the antenna system to the radio

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

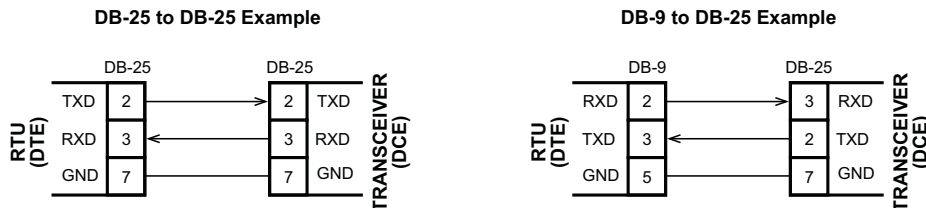## 3. Apply DC power to the radio (10–16 Vdc @ 2 A minimum)

- Measure the voltage source before connection.
- Observe proper polarity.
- Connect power to the power connector.

4. Set the radio's basic configuration with a terminal (PC or HHT) connected to the INTERFACE port

- Pin 23 of the INTERFACE port must be grounded to place the radio in the control and programming mode. (See **Figure 12 on page 16** for a cable wiring diagram.)
- Set the transmit frequency (**TX xxx.xxx**).
- Set the receive frequency (**RX xxx.xxx**).
- Set the network address (**ADDR xxx**). All radios in a given network must have the same address.
- Set/verify the data rate using the **BAUD** command. The default setting is **BAUD 9600 8N1**. (Refer to "TRANSCEIVER PROGRAMMING" on page 14 for command details.)

5. Connect the data equipment to the radio's INTERFACE connector

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

DB-25 to DB-25 Example   **DB-9 to DB-25 Example**

	DB-25		DB-25		
TXD	2	→	2	TXD	
RXD	3	←	3	RXD	
GND	7		7	GND	

RTU (DTE)   TRANSCEIVER (DCE)

	DB-9		DB-25		
RXD	2	→	3	RXD	
TXD	3	←	2	TXD	
GND	5		7	GND	

RTU (DTE)   TRANSCEIVER (DCE)

NOTE: Additional connections may be needed in some installations. See "Installation" for details.

6. Verify proper operation by observing the LED display

- See Table 5 on page 13 for a description of the status LEDs.
- Refine directional antenna headings for maximum receive signal strength using the **RSSI** command.

TABLE OF CONTENTS

Copyright Notice

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Antenna Installation Warning

1. All antenna installation and servicing is to be performed by **qualified technical personnel** only. When servicing the antenna, or working at distances closer than those listed below, *ensure the transmitter has been disabled.*

   Output is measured at the antenna terminal of the transmitter. The antenna(s) used for this transmitter must be fixed-mounted on outdoor permanent structures to provide the minimum separation distances described in this filing for satisfying RF exposure compliance requirements. When applicable, RF exposure compliance may need to be addressed at the time of licensing, as required by the responsible FCC Bureau(s), including antenna co-location requirements of section 1.1307(b)(3).

RF Exposure

Separation distances required for FCC RF Exposure compliance

2. Typically, the antenna connected to the transmitter is a directional (high gain) antenna, fixed-mounted on the side or top of a building, or on a tower. Depending upon the application and the gain of the antenna, the total composite power could exceed 90 watts EIRP. The antenna location should be such that only qualified technical personnel can access it, and that under normal operating conditions no other person can touch the antenna or approach within **2.3 meters** of the antenna.

Antenna Gain vs. Recommended Safety Distance (EL705 OEM 900 Series)

	Antenna Gain (EL705 OEMSeries)		
	0–5 dBi	5–10 dBi	10–18.65 dBi
Minimum RF Safety Distance	0.53 meter	0.94 meter	2.58 meters

ISO 9001 Registration

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

MDS Quality Policy Statement

We, the employees of Microwave Data Systems Inc., are committed to understanding and exceeding our customer's needs and expectations.

- We appreciate our customer's patronage. They are our business.
- We promise to serve them and anticipate their needs.
- We are committed to providing solutions that are cost effective, innovative and reliable, with consistently high levels of quality.
- We are committed to the continuous improvement of all of our systems and processes, to improve product quality and increase customer satisfaction.

FM/UL/CSA Notice

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

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

FM/UL/CSA Conditions of Approval:

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

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

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

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

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

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

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

ESD Notice *(Board version only)*

To prevent malfunction or damage to this product, which may be caused by Electrostatic Discharge (ESD), the radio should be properly grounded at the time of installation. In addition, the installer or maintainer should follow proper ESD precautions, such as touching a bare metal object to dissapate body charge, prior to touching components or connecting/disconnecting cables.

Cable Length Recomendation

MDS recommends a maximum cable length of 3.0 meters for *DC power* and *data* connections to this product.

Revision 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 OEM Series™ of radio transceivers. The radios can be purchased as compact, modular boards for direct mounting inside remote terminal units (RTUs), programmable logic controllers (PLCs), automatic teller/banking machines, or similar equipment. They are also available as standalone units packaged in their own enclosures (see lower cover illustration).

Although this manual focuses on the board-level product, the operating specifications and user connections are identical for both versions of the radio. Only the visual appearance and mounting details differ between the two. These differences are explained in the text where necessary.

The transceiver (Figure 1) is a data telemetry radio designed to operate in a point-to-multipoint environment, such as electric utility Supervisory Control and Data Acquisition (SCADA) and distribution automation, gas field automation, water and wastewater SCADA, and on-line transaction processing applications. The radio employs microprocessor control to provide highly reliable communications, even under adverse conditions.

MDS OEM Series™ radios use continuous-phase frequency shift keying (CPFSK) modulation with a 4-level modem.

NOTE: FINAL DESIGN WILL EMPLOY
A TWO-PIN, POLARIZED POWER
CONNECTOR.
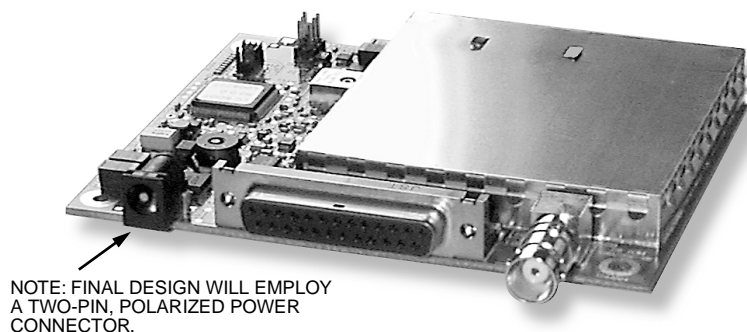
Figure 1. OEM Series™ Series Data Transceiver
(Board version shown—enclosed unit similar)

1.1 Differences Among Models

All OEM Series™ models are very similar in appearance and functionality. The major differences are over-the-air modem speed and frequency coverage.

Modem Speeds

Two modem speeds are available in the OEM 900 transceiver—standard 9600, and an optional 4800 bps. The latter provides 3 dB of extra receive sensitivity where greater range is required.

Changing the modem speed requires loading different software into the radio using MDS' Radio Configuration Software. See *Radio Programming Methods* on Page 14 for more information.

Frequency Coverage

The OEM 900 Series radio operates in the 900 MHz frequency band. The exact frequency coverage of each model is listed in the Specifications chart on Page 26.

NOTE: The radio's frequency range (band) cannot be set or changed by the user; it is set at the factory.

1.2 Applications

Point-to-Multipoint, Multiple Address Systems (MAS)

Point-to-multipoint (MAS) is the most common application of the transceiver. It consists of a central master station and several associated remote units as shown in Figure 2. An MAS network provides communications between a central host computer and remote terminal units (RTUs) or other data collection devices. The operation of the radio system is "transparent" to the computer equipment. That is, the radio system transports the data in its original form, making no changes to the data format.

Often, the radio system is used to replace a network of remote monitors currently linked to a central location by leased telephone lines. At the central office of such a system, there is usually a large mainframe computer and some means of switching between individual lines coming from each remote monitor. In this type of system, there is a modulator/demodulator (modem) at the main computer and at each remote site, usually built into the remote monitor itself. Since the cost of leasing a dedicated-pair telephone line is quite high, radio is frequently used as an alternative communication medium.
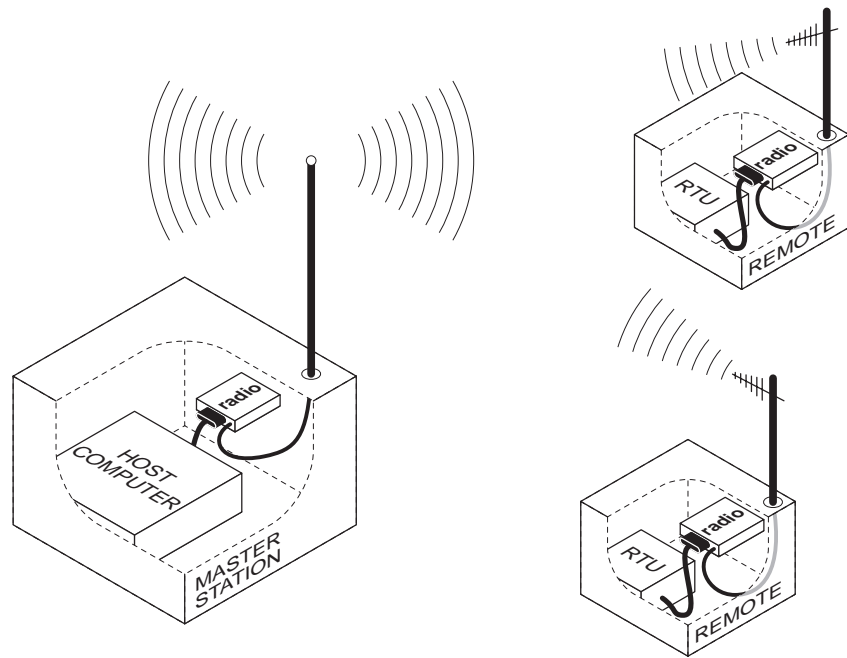
Figure 2. MAS Point-to-Multipoint Network
(Two remote stations shown—four or more are typically used)

Point-to-Point System

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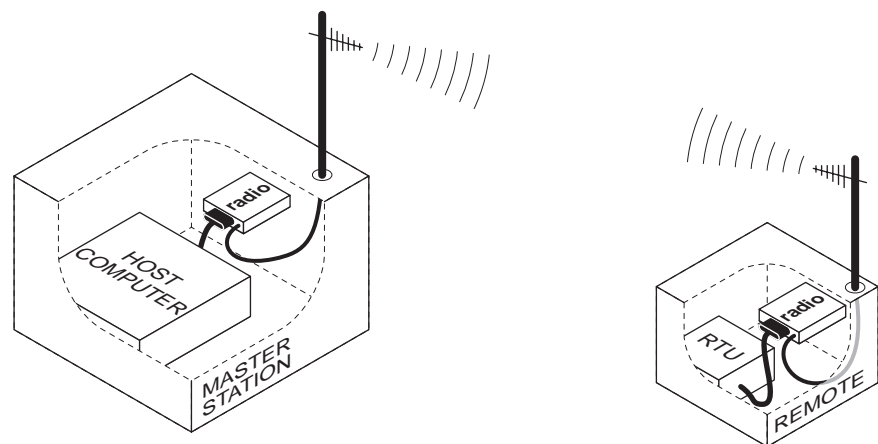

Figure 3. Typical Point-to-Point Link

Switched Carrier Operation

Switched Carrier operation is a half-duplex mode where the master station transmitter is keyed to send data and unkeyed to receive. MDS OEM Series™ radios operate in switched carrier mode and are keyed when data is present.

NOTE: MDS OEM Series™ radios do not support full-duplex operation (i.e., transmitting and receiving at the same time). For information on other MDS products that provide this capability, contact your sales representative.

Single Frequency (Simplex) Operation

Single frequency operation (also known as simplex) is a special case of switched carrier operation. Single frequency operation is *automatically* selected whenever the transmit and receive frequencies are set to the same value.

1.3 Model Number Codes

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

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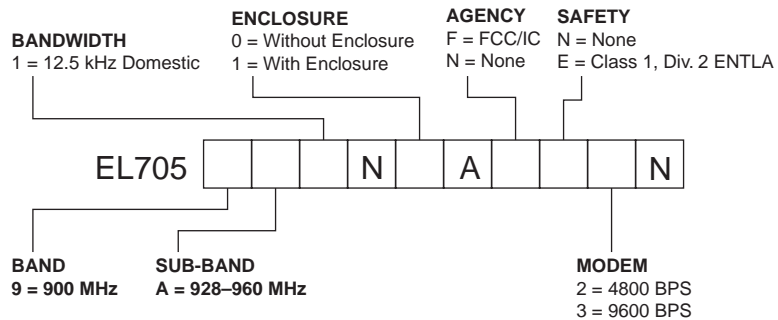
DO NOT USE FOR PRODUCT ORDERING.

Figure 4. MDS OEM Series™ Model Number Codes

1.4 Accessories

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

Table 1. Optional Accessories

Accessory	Description	MDS P/N
Hand-Held Terminal Kit (HHT)	Keypad terminal for programming, diagnostics, and control. Includes carrying case, cable set and an instruction booklet. (Accessory Power Adapter 03-3722A01 required for use with OEM radios—see below).	02-1501A01
Accessory Power Adapter	DB-25 male-to-female adapter that attaches to the radio's DATA INTERFACE connector. Provides regulated 10 Vdc for powering an HHT or other low power accessory. If not used, accessories could be damaged by excessive voltage (equal to the radio's DC input voltage).	03-3722A01
RTU Simulator Assy.	Test unit that simulates data from a remote terminal unit. Comes with polling software that runs on a PC. Used for testing OEM radio operation. (NOTE: Older MDS RTU Simulators will *not* work with the OEM radio as they require a higher input voltage.)	03-2094A01
DB-9 to DB-25 adapter	Used to connect a PC with a 9-pin serial port to the radio's DATA INTERFACE port.	01-3683A01
Radio Configuration Software (EL705)	Radio programming software for use with a Windows-based PC. This program is available on 3.5" disks, and is included on the MDS' InSite 6.4 (or higher) CD.	03-3649A01
PC Programming Adapter Kit	Required when programming the radio with a personal computer operating in terminal mode. The adapter asserts the auto-open signal (ground) on pin 23 of the DATA INTERFACE port. A scratch-built cable may also be used for this purpose (see Figure 12 on Page 16).	01-3683A01

2.0   INSTALLATION

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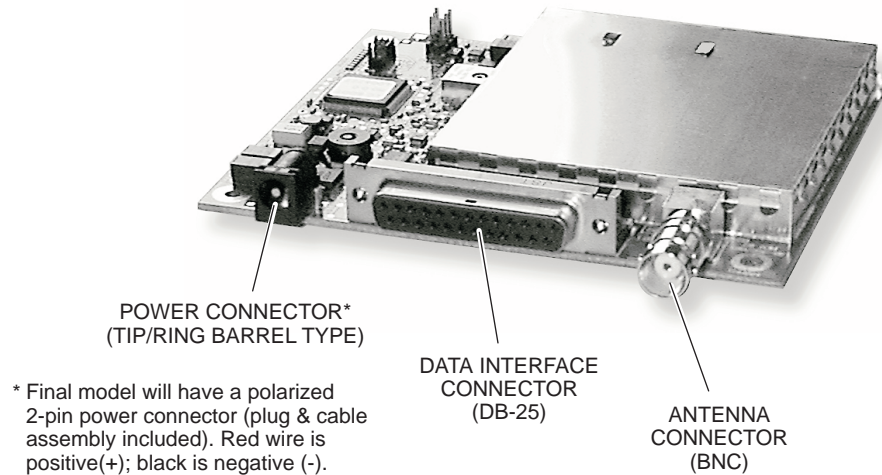

POWER CONNECTOR*
(TIP/RING BARREL TYPE)

DATA INTERFACE
CONNECTOR
(DB-25)

ANTENNA
CONNECTOR
(BNC)

* Final model will have a polarized
2-pin power connector (plug & cable
assembly included). Red wire is
positive(+); black is negative (-).

Figure 5. External Connections to the Transceiver Board
(Connector locations identical to enclosed radio)

2.1   Installation Steps

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

1. Mount the transceiver to a stable surface using the appropriate hardware.

2. Install the antenna and antenna feedline for the station. Preset directional antennas in the desired direction of transmission and reception.

3. Measure and install the primary power for the radio. The primary power must be between 10 and 16 Vdc and be capable of supplying at least 2 Amperes. (This requirement assumes a 5 watt RF output. Lower current consumption is possible if lower output power can be used in your application—see *OEM Series™ Transceiver Specifications* on Page 26 for details.)

NOTE: Use the radio in negative ground systems only.

4. Set the radio configuration. The transceiver is designed for quick installation with a minimum of software configuration in most cases. The selections that need to be verified for new installations are:

   - Transmit frequency
   - Receive frequency
   - Transmitter output power
   - Network address (factory default is **NONE**)

   The operating frequencies are not set at the factory unless they are specified at the time of order. Determine the transmit and receive frequencies to be used, and follow the steps below to program them.

5. Connect a terminal interface (personal computer or a hand-held terminal) to the DATA INTERFACE connector. (See *PC Connection and Startup* on Page 14 for details.)

6. Press ENTER to receive the ready ">" prompt.

   a. Set the transmit frequency with the **TX xxx.xxx** command.

      Press ENTER after the command.

   b. Set the receive frequency with the **RX xxx.xxx** command.

      Press ENTER after the command.

   c. Set the network address with the **ADDR xxx** command.

      Press ENTER after the command. After programming, the terminal interface reads **PROGRAMMED OK** to indicate successful entry.

7. Disconnect the terminal interface from the DATA INTERFACE connector.

8. Connect the data equipment to the transceiver's DATA INTERFACE connector. Use only the required pins for the application—do *not* use a fully pinned (25 conductor) cable. Basic applications often require only the use of Pin 2 (Transmitted Data—TXD), Pin 3 (Received Data—RXD), and Pin 7 (Signal Ground).

   Additional connections may be required in some installations. Refer to the complete list of pin functions in Table 3 on Page 11.

2.2 Mounting the Transceiver

Transceiver Board

Figure 6 shows the mounting dimensions of the transceiver PC board. The board should be secured to the mounting surface using the holes provided at each corner of the assembly. (Fasteners are not supplied.) Note that the lower left mounting hole in the board is a threaded ferrule.
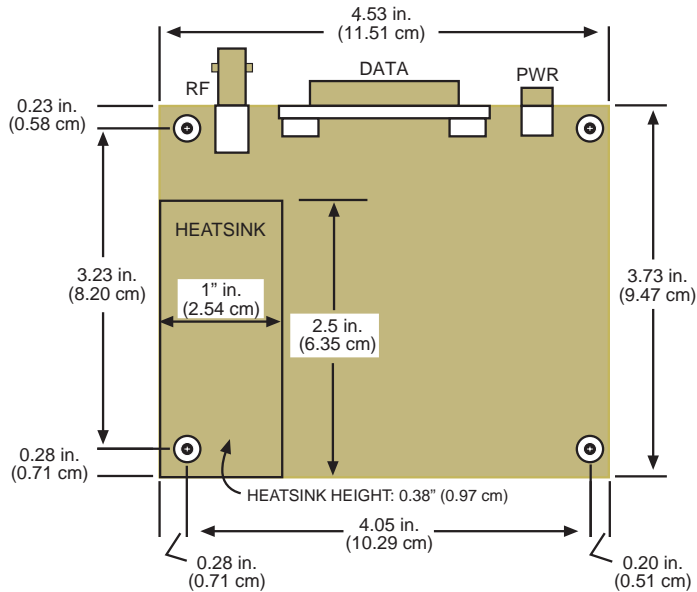

Figure 6. Transceiver Mounting Dimensions (Board Version)

Enclosed Transceiver

Figure 7 shows the mounting dimensions of the enclosed transceiver. Two cutout slots are provided on each side of the enclosure for mounting screws. (Fasteners are not supplied.)
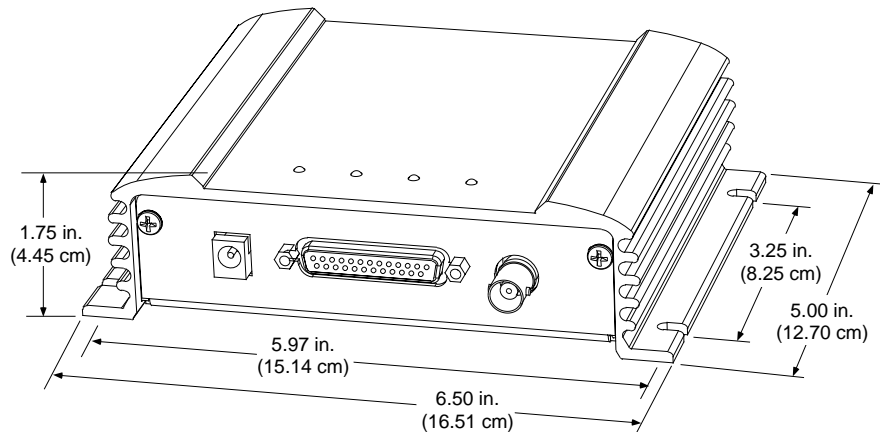

Figure 7. Transceiver Mounting Dimensions (Enclosed Version)

![MDS Microwave Data Systems Inc.]

2.3 Antennas and Feedlines

Antennas

The transceiver can be used with a number of antennas. The exact style depends on the physical size and layout of the radio system. Suitable antennas are available from several manufacturers, including MDS.

At master stations, omni-directional antennas (Figure 8) are typically used to provide equal coverage to all remote sites in the network.
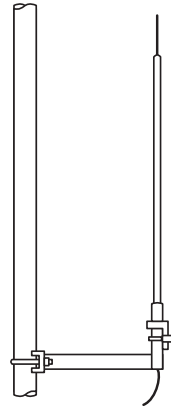
Figure 8. Typical Omni-directional Antenna for Master Stations
(Shown mounted to mast)

At remote sites, a directional Yagi (Figure 9) or corner reflector antenna is generally recommended to minimize interference to and from other users.

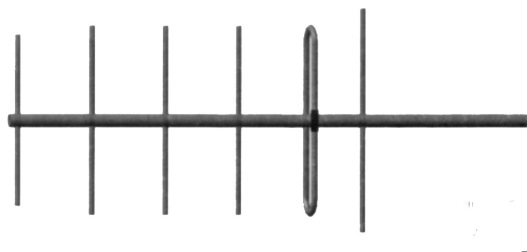**Figure 9. Typical Yagi Antenna for Remote Sites**

Feedlines

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

Table 2 shows the losses that occur when using various lengths and types of cable in the 900 MHz band. Regardless of the type of cable used, it should be kept as short as possible to minimize signal loss.

Table 2. Length vs. Loss in Coaxial Cables at 900 MHz

Cable Type	3 Meters (10 Feet)	15 Meters (50 Feet)	30 Meters (100 Feet)	150 Meters (500 Feet)
RG-8A/U	0.85 dB	4.27 dB	8.54 dB	42.70 dB
1/2 inch HELIAX	0.23 dB	1.15 dB	2.29 dB	11.45 dB
7/8 inch HELIAX	0.13 dB	0.64 dB	1.28 dB	6.40 dB
1-1/4 inch HELIAX	0.10 dB	0.48 dB	0.95 dB	4.75 dB
1-5/8 inch HELIAX	0.08 dB	0.40 dB	0.80 dB	4.00 dB

2.4 Power Connection

The transceiver can be operated from any well-filtered 10 to 16 Vdc power source. The power supply must be capable of providing at least 2 Amperes if 5 watt output is planned from the transceiver. Supply the power to the power connector (see Figure 5 on Page 6).

CAUTION

POSSIBLE EQUIPMENT DAMAGE

Do *not* apply power to the radio through Pin 18 of the DB-25 Interface connector. This pin does not provide over-current input protection, and is intended only as an auxiliary *output* for powering a low-current (1.0 Amp max.) device, such as an RTU.

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

Conservation (Sleep Mode)

In some installations, such as at solar-powered sites, it may be necessary to keep the transceiver's power consumption to an absolute minimum. This can be accomplished by configuring the data device (RTU, PLC, etc.) to ground Pin 12 of the DATA INTERFACE connector, which removes power from the radio. When the ground is removed, the radio is ready to operate within 75 milliseconds.

2.5 Data Interface Connections

The transceiver's DATA INTERFACE connector is configured as a DCE (modem) and is normally connected to an EIA-232 device. The transceiver supports over-the-air asynchronous data rates up to 19200 bps. Refer to Figure 10 and Table 3 for a detailed description of each pin on the DATA INTERFACE connector.

CAUTION

USE
ONLY REQUIRED
PINS

Do not use a 25 wire (fully pinned) cable for connection to the DATA INTERFACE connector. Use *only* the required pins for the application. Damage may result if improper connections are made. For EIA-232 signaling, typical applications require the use of Pins 2, 3, and 7 *only*.
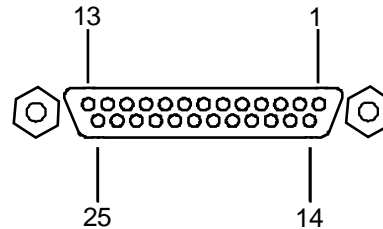

Figure 10. Data Interface Connector Pinouts
(As viewed from the front of the radio)

Table 3. DATA INTERFACE Connector Pinouts

Pin Number	Input/ Output	Pin Description
1	--	**Protective Ground.** Connects to ground (negative supply potential) on the radio's PC board and chassis.
2	IN	**TXD—Transmitted Data.** Accepts TX data from the connected device.
3	OUT	**RXD—Received Data.** Outputs received data to the connected device.
4	IN	**RTS—Request-to-Send Input.** Causes CTS to go "high."
5	OUT	**CTS—Clear-to-Send Output.** Behavior depends on DEVICE command setting: When DEVICE is set to DCE, this pin follows RTS and will provide "buffer full" flow control. When DEVICE is set to CTS KEY, this pin provides a keyline output when receive data is present.
6	OUT	**DSR—Data Set Ready.** Active when radio is powered on.
7	--	**Signal Ground.** Connects to ground (negative supply potential) at radio's PC board.
8	OUT	**DCD—Data Carrier Detect.** Active when receiving data from another OEM Series radio with the same network address.
11	OUT	**Receive Audio Output.** For test purposes only.

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

Pin Number	Input/ Output	Pin Description
12	--	**Sleep Mode.** A logic low on this pin removes power from the radio. The radio is ready to operate 75 milliseconds after the ground is removed.
18	IN/OUT	**Accessory Power.** Unregulated Output. Provides a source of output power for low current (1 Amp max.) accessories. Excessive drain on this connection causes the on board fuse (2 ampere) to open. The voltage at this pin matches the input voltage to the transceiver. *Do not use this pin for powering the radio.*
19	OUT	**5.8 Vdc Regulated Output.** Provides a source of regulated voltage at 100 mA for low power accessories.
23	IN	**Auto-Open.** A logic low (less than 0.5 volts or ground) on this pin opens the diagnostic channel and disables normal data operation. A logic high (greater than 4 volts or open) enables the DATA INTERFACE for normal data operation.
25	OUT	**Alarm.** A logic low (less than 0.5 volts) on this pin indicates normal operation. A logic high (greater than 4 volts) indicates that some alarm condition is present. This pin can be used as an alarm output, provided the internal series resistance of 1 kΩ is considered.

3.0   OPERATION

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

3.1   Initial Startup

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

1. Apply DC power to the transceiver.

2. Observe the LED status panel for the proper indications (see Table 4).

3. If not done earlier, refine the antenna heading of the station to maximize the received signal strength (RSSI) from the master station. Use the **RSSI** command from a terminal interface connected to the radio's DATA INTERFACE connector.—See *Section 4.0, TRANSCEIVER PROGRAMMING*.

3.2   LED Indicators

The transceiver includes four status LEDs visible from the top of the unit, behind the Data Interface connector (or on the front panel in enclosed units). Table 4 describes the function of each status LED.

PWR	DCD	TXD	RXD
◉	◉	◉	◉

Table 4. LED Status Indicators

LED Name	Description
PWR (Power)	• Continuous—Power is applied to the radio, no problems detected. • Rapid flash (five times-per-second)—Fault indication. • Flashing once every second—Unit is not programmed. Radio is in Bootloader mode.
DCD (Data Carrier Detect)	Flashing—Indicates another radio (with the same network address) is transmitting at the radio's receive frequency.
RXD (Receive Data)	Receive data is present on DATA INTERFACE connector.
TXD (Transmit Data)	Transmit data is present on DATA INTERFACE connector.

4.0 TRANSCEIVER PROGRAMMING

Programming and set-up of the transceiver is performed through the radio's DATA INTERFACE connector with a terminal interface—either a personal computer or a hand-held terminal (HHT). This section contains a reference chart of commands (Table 5) followed by detailed descriptions for each entry.

4.1 Radio Programming Methods

❶ PC with Radio Configuration Software

PC-based Radio Configuration software is available for use with the radio (MDS P/N 03-3649A01). This software is normally supplied on 3.5" disks, but can also be found on the MDS InSite disk (version 6.4 or higher) under the title of "EL705." On-line instructions are included with the configuration software.

NOTE: When using radio configuration software, click on the opening screen or press a key to activate the program.

---

❷ PC in Terminal Mode

A PC may also be used *without* the Radio Configuration software by operating it in a basic terminal mode (e.g., HyperTerminal session) and entering the radio commands listed in Table 5. **The terminal communication parameters must be set to 9600 bps, with 8 data bits, no parity, and 1 stop bit (8N1).**

❸ Handheld Terminal (HHT)

A Hand-Held Terminal kit (MDS P/N 02-1501A01) may be used to enter the radio commands listed in Table 5. **The HHT communication parameters must be set to 9600 bps, with 8 data bits, no parity, and 1 stop bit (8N1).**

4.2 PC Connection and Startup

Follow the steps below to prepare the radio for PC programming. For information about connecting and setting up a hand-held terminal, refer to the instructions provided with each HHT kit.:

1. Connect a PC to the radio's DATA INTERFACE port as shown in Figure 11. Pin 23 of the interface cable must be grounded to activate the control and programming mode. This can be done with a Programming Adapter (MDS P/N 01-3683A01), or with a scratch-built cable as shown in Figure 12.
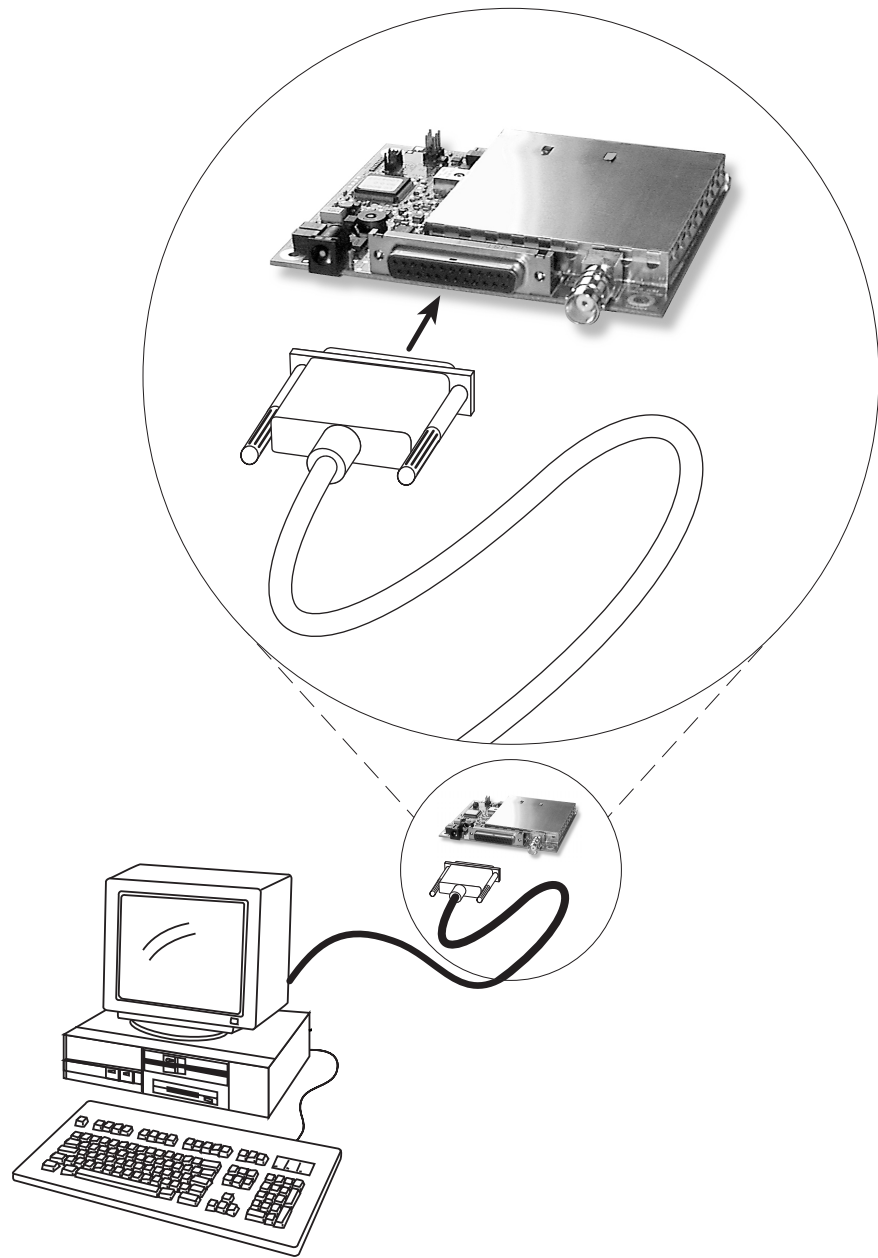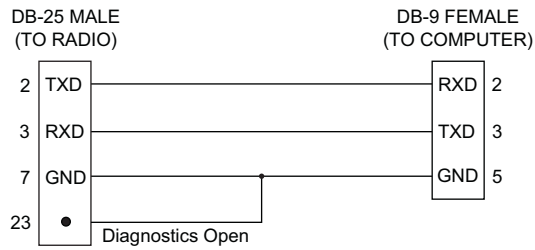
2. Press ENTER to obtain the ready ">" prompt.

Figure 11. Terminal Interface (PC) Connected to the Transceiver
(Pin 23 on cable must be grounded—see Figure 12)

Figure 12. DB-25 to DB-9 Adapter Cable
(For PC control and programming)

4.3 Keyboard Commands

Table 5 is a reference chart of software commands for the transceiver. Programmable information is shown in brackets [ ] following the command name. See section 4.4 following the table for detailed command descriptions.

Entering Commands

To enter a command, type the command, followed by an ENTER keystroke. For programming commands, the command is followed by SPACE and the appropriate information or values, then ENTER .

Error Messages

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

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

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

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

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

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

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

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

EEPROM FAILURE— The **INIT** command was unable to write to EEPROM. This usually indicates a hardware error. Contact MDS for assistance.

Table 5. Command summary

Command name	Function
**ADDR [NONE	1–255]** *Details page 18*	Set or display the network address of the radio.
AMASK [0000 0000–FFFF FFFF] *Details page 18*	Set or display hex code identifying which events trigger an alarm.
BAUD [xxxxx abc] *Details page 19*	Set or display the DATA INTERFACE data rate and format.
CTS [0–255] *Details page 19*	Set or display the Clear-to-Send delay in milliseconds.
CTSHOLD [0–60000] *Details page 19*	Set or display the delay, in milliseconds, at the end of a CTS line response; CTS Key operation only.
**DEVICE [DCE	CTS KEY]** *Details page 20*	Set or display the CTS options.
DKEY *Details page 20*	Dekey the radio (transmitter OFF) following a KEY command.
INIT *Details page 20*	Set radio parameters to factory defaults.
KEY *Details page 21*	Key the radio (transmitter ON). Provides a carrier for testing.
OWM [XXX...] *Details page 21*	Set or display the owner's message.
OWN [XXX...] *Details page 21*	Set or display the owner's name.
**PWR [L	M	H]** *Details page 21*	Set or display the transmit power setting.
RSSI and RSSI! *Details page 22*	Display the Received Signal Strength Indication.
RX [xxx.xxx] *Details page 22*	Set or display the receive frequency.
**RXTOT [NONE	1–255]** *Details page 22*	Set or display the value of the receive time-out timer.
SER *Details page 22*	Display the radio serial number.
SREV *Details page 22*	Display the software revision level.

Table 5. Command summary *(Continued)*

Command name	Function
STAT *Details page 22*	Display the current alarm status.
TOT [1–255 | ON | OFF] *Details page 23*	Set or display the time-out timer status and the timer delay in milliseconds.
TX [xxx.xxx] *Details page 23*	Set or display the transmit frequency.

4.4 Detailed Command Descriptions

The only essential commands for most applications are transmit frequency (**TX xxx.xxx**), receive frequency (**RX xxx.xxx**), and network address (**ADDR xxx**). However, proper use of the additional commands allows you to tailor the transceiver for a specific use or conduct basic diagnostics on the radio. This section gives more detailed information for the user commands previously listed in Table 5.

In many cases, the commands shown here can be used in two ways. First, you can type *only* the command name to view the currently programmed data. Secondly, you can set or change the existing data by typing the command, followed by a space, and then the desired entry. In the list below, allowable data values, if any, are shown in brackets following the command name. The separator symbol (|) indicates that you can enter *one* of the values in the list.

ADDR [NONE | 1–255]

The **ADDR** command displays or sets the network address of the radio. In order for all the radios in a network to communicate, their network addresses must be identical, or set to **NONE**. (The radio is shipped from the factory with **ADDR** set to **NONE**.)

AMASK [0000 0000–FFFF FFFF]

The **AMASK** (alarm mask) command displays or sets which events cause the alarm output signal to be active. Normally, the mask is **FFFF FFFF**, meaning that any of the 32 possible events activate the alarm output signal. No special configuration is required for typical applications.

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

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

Each bit that is a '1' identifies an associated alarm condition that can trigger the alarm output status line. Each bit that is a '0' treats the associated alarm as irrelevant when deciding whether or not to assert the alarm output status line.

Thus, an eight-digit hexadecimal number can classify up to 32 events as alarm triggers for the alarm output status line. See Table 6 on Page 25 for a list of the event codes and their hex values. The hex value of the mask is simply the sum of the hex values of the event codes corresponding to the alarm triggering events.

BAUD [xxxxx abc]

This command sets (or displays) the communication attributes for the DATA INTERFACE port.

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

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

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

The factory default setting is 9600 baud, 8 data bits, no parity, 1 start bit, and 1 stop bit (Example: **9600 8N1**).

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

CTS [0–255]

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

For DCE operation (see **DEVICE** command), the timer specifies how long to wait after the RTS line goes high, before the radio asserts CTS. A **CTS** value of zero asserts the CTS line immediately after the RTS line goes high.

For CTS Key operation (see **DEVICE** command), the timer specifies how long to wait after asserting the CTS, before data becomes available. A timer value of zero means that data is available as soon as received

CTSHOLD [0–60000]

For CTS Key operation (see **DEVICE** command), the **CTSHOLD** command sets or displays the timer value associated with the end of a CTS line response. The timer value specifies the length of time that CTS remains active following the last byte from the RXD pin of the DATA INTERFACE port. The time is in milliseconds. The default value is 0, which means that CTS drops immediately after the last byte.

For DCE operation (see **DEVICE** command), this command has no effect. The response **CTSHOLD n/a** is displayed.

DEVICE [DCE | CTS KEY]

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

The default selection is **DCE**. In this mode, CTS goes high following RTS, subject to the CTS programmable delay time. Hardware flow control is implemented by signaling the CTS line if data arrives faster than it can be buffered and transmitted. The transceiver does not require an RTS/CTS handshake. Data is transmitted whenever there is data to send.

If **CTS KEY** is selected, the CTS line transforms to a Receive Data indicator (with programmable delays) in order to provide a control line for use by other devices. The RTS line is ignored. CTS is asserted immediately following the receipt of RF data, but data is not sent out the DATA INTERFACE port until the CTS programmable delay time has expired. (See **CTSHOLD** description for the delay available following the data.)

A typical use of **CTSKEY** is to provide a keyline (or RTS signal) for a half-duplex modem or other radio.

DKEY

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

NOTE: The **DKEY** and **KEY** commands are *not* intended for normal operation. They are tools for field testing and installation.

INIT

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

- **AMASK** is set to **FFFF FFFF**
- **BAUD** is set to 9600 baud, 8 data bits, no parity, and 1 stop bit (**9600 8N1**)
- **CTS** is set to **0**
- **CTSHOLD** is set to **0**
- **DEVICE** is set to **DCE**

- **PWR** is set to **H** [+37 dBm (5 watts)]
- **RXTOT** is set to **NONE**
- **TOT** is set to **OFF**

All other commands stay at their previously established settings.

KEY

This command activates the transmitter. The transmitter stays keyed until either the DKEY command is entered, or the transmitter time-out timer is enabled and times out. See also the **DKEY** and **TOT** commands.

NOTE: The **KEY** and **DKEY** commands are *not* intended for normal operation. They are tools for field testing and installation.

OWM [XXX...]

This is a command to display or set an owner's message. To program the owner's message, type **OWM** then the message, followed by ENTER. The maximum number of characters that can be entered is 30.

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

OWN [XXX...]

This is a command to display or set an owner's name. To program the owner's name, type **OWN** then the name, followed by ENTER. The maximum number of characters that can be entered is 30.

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

PWR [L | M | H]

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

This command displays or sets the desired RF forward output power setting of the radio. The **PWR** command parameter is specified as **L** (low), **M** (medium), or **H** (high). The default setting is **H**. The values of **L**, **M**, and **H** are:

> **L** = 24 dBm (250 mW)
> **M** = 30 dBm (1 W)
> **H** = 37 dBm (5 W)

RSSI and RSSI!

These commands continuously display the radio's Received Signal Strength Indication (RSSI) in dBm units. Incoming signal strengths from –50 dBm to –120 dBm are displayed.

The **RSSI** command causes display of received signal strength, updated once every second. Press ENTER to terminate the display.

The **RSSI!** command displays a one-time reading of the RSSI at the diagnostic port.

RX [xxx.xxx]

This command sets or displays the radio's receive frequency in MHz. The frequency must be an integer multiple of the step size and must be in the valid range. If the entered frequency is invalid, the terminal interface displays the message **INCORRECT ENTRY**.

NOTE: The frequency must be in the valid range for the sub-band purchased, and may not be programmed "between" channels.

RXTOT [NONE | 1–255]

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

Entering the **RXTOT** command without a parameter displays the timer value in minutes. Entering the **RXTOT** command with a parameter ranging from 1 to 255 resets the timer in minutes. Entering the **RXTOT** command with the parameter **NONE** disables the timer.

SER

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

SREV

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

STAT

This command displays the current alarm status of the transceiver.

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

If an alarm does exist, a two-digit code (00–31) is displayed and the alarm is identified as **MAJOR** or **MINOR**. A brief description of the alarm code is also given. Detailed descriptions of event codes are provided in Table 6 on Page 25.

If more than one alarm exists, the word **MORE** appears at the bottom of the screen and additional alarms are viewed by pressing the ENTER key. Alarms are displayed in ascending order, major alarms before minor ones.

TOT [1–255 | ON | OFF]

This command sets or displays the transmitter time-out timer value (1–255 seconds), as well as the timer status (**ON** or **OFF**). The command parameter can be either the timer value or the status, but not both. The parameter **ON** enables the timer; **OFF** disables the timer.

If the timer is on, and the radio remains keyed for a longer duration than the **TOT** value, the transmitter is automatically unkeyed. When this happens, the radio must be commanded back to an unkeyed state before a new keying command is accepted.

By default the timer is **ON** and set to 30 seconds.

TX [xxx.xxx]

This command sets or displays the radio's transmit frequency in MHz. The frequency must be an integer multiple of the step size and must be in the valid range. If the entered frequency is invalid, the terminal interface displays the message **INCORRECT ENTRY**.

NOTE: The frequency must be in the valid range for the sub-band purchased, and may not be programmed "between" channels.

5.0   TROUBLESHOOTING

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

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

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

5.1   LED Indicators

The LED status indicators are an important troubleshooting tool and should be checked whenever a problem is suspected. Table 4 on Page 13 describes the function of each status LED.

5.2   Event Codes

When an alarm condition exists, the transceiver creates a code that can be read on a terminal connected to the DATA INTERFACE port. These codes can be very helpful in resolving many system difficulties. Table 6 lists the definitions of the event codes.

Checking for Alarms—*STAT command*

To check for alarms, enter **STAT** on the terminal interface. If no alarms exist, the message **NO ALARMS PRESENT** appears at the top of the display.

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

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

Major Alarms vs. Minor Alarms

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

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

Event Code Definitions

Table 6 contains a listing of the event codes that may be reported by the transceiver.

Table 6. Event Codes

Event Code	Hex Value	Event Class	Description	STATUS Message
00	0000 0000	--	No alarms present.	No Alarms Present
1–3	--	--	Not used.	--
04	0800 0000	Major	One or both of the internal programmable synthesizer loops is reporting an out-of-lock condition.	Synthesizer Out-of-Lock
5–7	--	--	Not used.	--
08	0080 0000	Major	The system is reporting that it has not been calibrated. Factory calibration is required for proper radio operation.	Radio Not Calibrated
09	--	--	Not used.	--
10	0020 0000	Major	The internal microcontroller was unable to properly program the system to the appropriate EEPROM defaults. A hardware problem may exist.	EEPROM Write Failure
11	--	--	Not used.	--
12	0008 0000	Major	Receiver time-out. No data received within the specified receiver time-out time.	Receiver time-out
13	0004 0000	Major	Transmitter time-out. The radio was keyed for a duration exceeding the time-out timer setting. (This alarm clears the next time the radio keys.)	Transmitter time-out
14–16	--	--	Not used.	--
17	0000 4000	Minor	A data parity fault has been detected on the DATA INTERFACE connector. This usually indicates a parity setting mismatch between the radio and the RTU.	Data Parity Error
18	0000 2000	Minor	A data framing error has been detected on the DATA INTERFACE connector. This may indicate a baud rate mismatch between the radio and the RTU.	Data Framing Error
19–30	--	--	Not used.	--

6.0 TECHNICAL REFERENCE

6.1 OEM Series™ Transceiver Specifications

MODELS

MDS OEM Series™ 900:	Licensed 900 MHz Transceiver

RADIO TYPE

Synthesized, half duplex, 12.5 kHz channel spacing, split frequency, or simplex

ENVIRONMENTAL

Temperature Range:	–30 to +60 degrees C
Humidity:	0 to 95% at 40 degrees C
Board Dimensions:	4.53″ W x 0.75″ H x 3.73″ D 11.51 cm W x 1.90 cm H x 9.47 cm D
Enclosed Dimensions:	6.5″ W x 1.75″ H x 5.00″ D 16.51 cm W x 4.45 cm H x 12.70 cm D
Weight:	(Board version) 4.5 oz. (0.13 kg) (Enclosed version) 1 lb. (0.45 kg)
RF Connector:	BNC
Enclosure Type (if furnished):	Aluminum

TRANSMITTER

Frequency Ranges (900 MHz):	928 to 960 MHz
Frequency Increments:	6.25 kHz (Standard) 5 kHz (Special)
Modulation Type:	4 level CPFSK
Carrier Power:	250 mW, 1 W, 5 W programmable (+24 DBM, +30 dBM, +37 dBm)
Duty Cycle:	50% (100% with additional heatsinking)
Output Impedance:	50 ohms
Frequency Stability:	1.5 ppm, –30 to +60 degrees C
Channel Spacing:	12.5 kHz
Spurious and Harmonics:	–60 dBc
Time-out Timer:	1 to 255 seconds
Transmitter Keying:	On data
Key-up Time:	2 ms

RECEIVER

Type:	Double conversion superheterodyne (45 MHz and 450 MHz IF)
Frequency Ranges (900 MHz):	928 to 960 MHz
Frequency Increments:	6.25 kHz (Standard) 5 kHz (Special)
Frequency Stability:	1.5 ppm, −30 to +60 degrees C
Spurious and Image Rejection:	−70 dB
Sensitivity:	12 dB Sinad @ −116 dBm
Data Performance:	1×10^{-6} @ −108 dBm (9600 bps) 1×10^{-6} @ −111 dBm (4600 bps)
Intermodulation Rejection:	−70 dB minimum
Selectivity:	50 dB typical at adjacent channel (EIA)
Bandwidth:	12.5 kHz

DATA INTERFACE

RS-232 through DB-25 Connector

Baud Rates at Interface Port:	1200, 2400, 4800, 9600, and 19200* bps
Over-the-Air Data Rate:	9600 bps 4800 bps
Data Latency:	< 20 ms typical

DIAGNOSTICS

Self Test:	Yes
Local RS-232 RSSI and Setup:	Yes
4 LED Display:	PWR, DCD, TXD, and RXD

PRIMARY POWER

Voltage:	10 to 16 Vdc through a 5.5 mm pin plug or 2-pin MDS connector
RX Current at 13.8 Vdc (typical):	75 mA
TX Current at 13.8 Vdc (typical):	1.75 A @ high power (5W) 700 mA @ medium power (1W) 400 mA @ low power (250 mW)
Circuit Protection:	2 amp fuse, surface mount
Reverse Polarity Protection:	Diode across primary input

* At 19200 bps, the radio operates in a buffered mode, storing 50 characters at a time.

6.2 Bench Testing Setup

Figure 13 shows a sample test setup that can be used to verify the basic operation of transceivers in a shop setting. The test can be performed with any number of remote radios by using a power divider with the required number of output connections.

The RTU simulator (MDS Part No. 03-2094A01) is a microcontroller that emulates a remote terminal unit operating at 1200, 2400, 4800, or 9600 bps. Custom software is supplied with the RTU simulator that allows continuous polling of remote radios using an IBM-compatible personal computer. The software reports the number of polls sent, polls received, and the number of errors detected.

NOTE: 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.

A maximum level of -50 dBm is recommended at each transceiver, because the radio's RSSI reporting will not be accurate above this level. In no case should a signal stronger than +10 dBm be applied to any transceiver in the test setup, or damage may result.
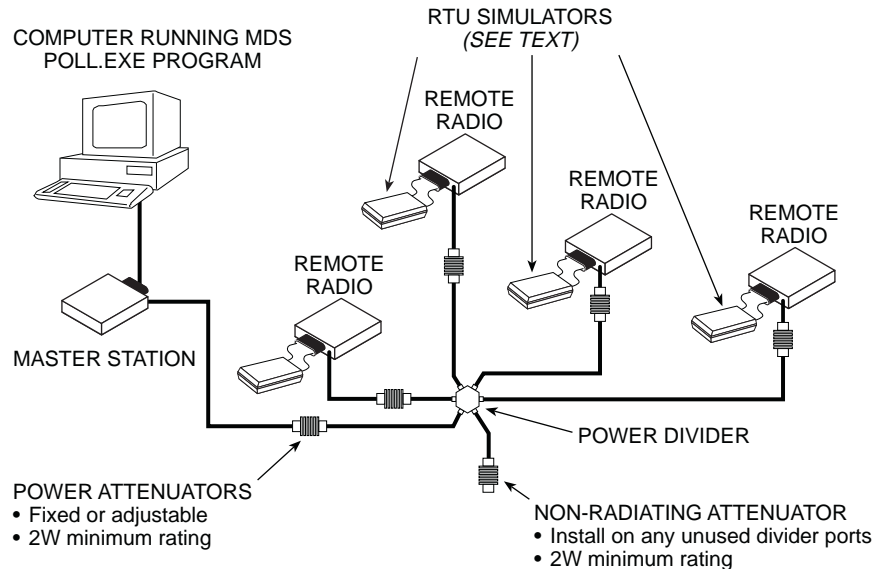
Figure 13. Typical setup for bench testing of radios

6.3 Helical Filter Adjustment

If the operating frequency of the radio is changed more than 10 MHz, the helical filters should be adjusted for maximum received signal strength (RSSI). If adjustment is required, follow these steps:

1. For enclosed units, remove the top cover from the transceiver by loosening the eight screws and lifting straight up.

2. Carefully remove the shield cover from the PC board.

3. Locate the helical filters. See Figure 14.

---

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

5. Measure the radio's RSSI using a terminal interface. See *Section 4.0, TRANSCEIVER PROGRAMMING* on Page 14.

6. With a non-metallic tool, carefully adjust each section of the helical filter for maximum RSSI. Repeat several times to work out any interactions. Re-install the cover to the transceiver.

HELICAL
ADJUSTMENTS

HELICAL
ADJUSTMENTS
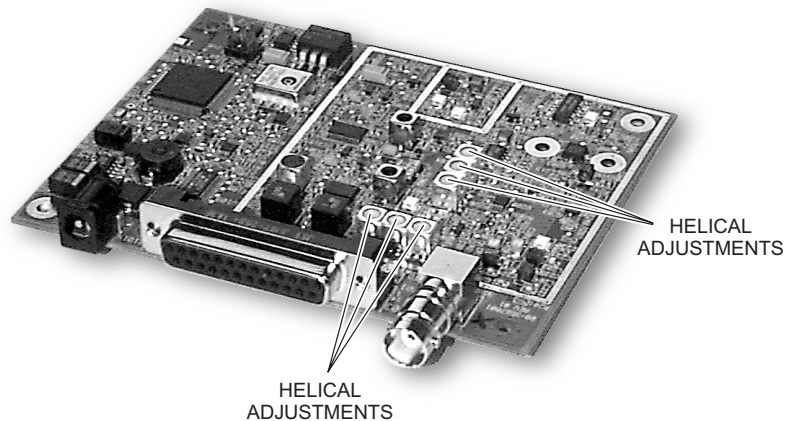
Figure 14. Helical Filter Location
(Shield cover removed)

6.4 Upgrading the Radio's Software

From time to time, new product features or software maintenance files become available from MDS. This section describes the steps necessary to install new software into the transceiver using a PC connected to the radio's DATA INTERFACE port.

When software upgrades become available, they can be obtained on the MDS Web site at **www.microwavedata.com**, or you can contact MDS to request radio software.

NOTE: Software upgrades are distributed as ASCII files with a ".S28" extension. These files use the Motorola S-record format.

Using Radio Configuration Software

If you already have software that you wish to download into the transceiver, Radio Configuration Software (MDS P/N 03-3649A01) may be used to perform the installation. (This software is referred to as "EL705" on the InSite 6.4 or higher CD.) To use this method, proceed as follows:

1. Connect a PC to the radio's DATA INTERFACE port via a DB-9 to DB-25 adapter (MDS P/N 01-3683A01 or equivalent). If desired, an adapter cable may be constructed from scratch using the wiring diagram shown in Figure 15.

```
DB-25 MALE                              DB-9 FEMALE
(TO RADIO)                              (TO COMPUTER)

2  TXD  ────────────────────────────  RXD  2

3  RXD  ────────────────────────────  TXD  3

7  GND  ────────────────────────────  GND  5
```
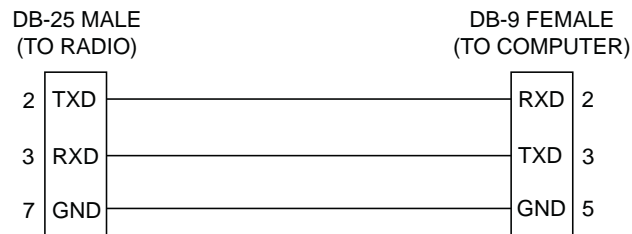
Figure 15. DB-25 to DB-9 Adapter Cable

2. Run the Radio Configuration software. (Click on the opening screen or press a key to activate the program.)

3. Under the **SYSTEM** menu, select **RADIO SOFTWARE UPGRADE**. Follow the prompts and online instructions to locate the desired software and complete the upgrade. The radio's PWR LED flashes rapidly to confirm that a download is in progress. The download takes about two minutes.

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

6.5 dBm-Watts-Volts Conversion Chart

Table 7 is provided as a convenience for determining the equivalent wattage or voltage of an RF power expressed in dBm.

Table 7. dBm-Watts-Volts Conversion—for 50 Ohm Systems

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

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

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

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

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

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

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

7.0   GLOSSARY OF TERMS

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

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

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

Bits-per-second—See *BPS*.

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

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

Data Circuit-terminating Equipment—See *DCE*.

Data Communications Equipment—See *DCE*.

Data Terminal Equipment—See *DTE*.

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

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

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

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

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

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

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

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

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

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

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

Multiple Address System—See *MAS*.

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

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

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

Programmable Logic Controller—See *PLC*.

Received Signal Strength Indication—See *RSSI*.

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

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

Remote Terminal Unit—See *RTU*.

RSSI—Received Signal Strength Indication. A measure, in dBm, of the strength of the signal received by a radio from an antenna. The radio must be properly calibrated for the RSSI value to be meaningful.

RTU—Remote Terminal Unit. A data collection device installed at a remote radio site.

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

Supervisory Control And Data Acquisition—See *SCADA*.

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IN CASE OF DIFFICULTY...

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

FACTORY TECHNICAL ASSISTANCE

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

Please use the following telephone numbers for product assistance:

716-242-9600 (Phone)

716-242-9620 (Fax)

FACTORY REPAIRS

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

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

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

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

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

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

MDS

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