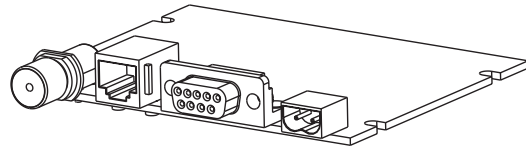


MDS TransNET 900“



TransNET 900“ Spread Spectrum Data Transceiver

MDS 05-2708A01 Rev. A
September 2001

QUICK START GUIDE

Below are the basic steps for installing the transceiver. Detailed instructions are given in **INSTALLATION** on page 24 of this guide.

1. Install and connect the antenna system to the radio

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

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

- ¥ Connection to the radio must be made with a DB-9 Male connector. Connections for typical systems are shown below.
- ¥ Connect only the required pins. Do not use a straight-through RS-232 cable with all pins wired.
- ¥ Verify the data equipment is configured as DTE. (By default, the radio is configured as DCE.)



3. Apply DC power to the radio

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

4. Verify proper operation by observing the LED display

- ¥ Refer to Table 4 on page 32 for a description of the status LEDs.
- ¥ Refine directional antenna headings for maximum receive signal strength using the RSSI command.

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

Operational Safety Notices

RF Exposure



The radio equipment described in this guide emits radio frequency energy. Although the power level is low, the concentrated energy from a directional antenna may pose a health hazard. **Do not allow people to come closer than 2 meters (6 feet) to the antenna when the transmitter is operating.**

This manual is intended to guide a professional installer in installing, operating and performing basic system maintenance on the described equipment.

ISO 9001 Registration

Microwave Data Systems adheres to the internationally-accepted ISO 9001 quality system standard.

MDS Quality Policy Statement

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

- ¥ We appreciate our customers patronage. They are our business.
- ¥ We promise to serve them and anticipate their needs.
- ¥ We are comitted 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 MDS TransNET 900™ When Approved

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.

FCC Part 15 Notice

The MDS TransNET 900[™] transceivers comply with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This device is specifically designed to be used under Section 15.247 of the FCC Rules and Regulations. Any unauthorized modification or changes to this device without the express approval of Microwave Data Systems may void the user's authority to operate this device.

Furthermore, this device is intended to be used only when installed in accordance with the instructions outlined in this manual. Failure to comply with these instructions may also void the user's authority to operate this device.

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.

Limited Modular Approval Notice

MDS TransNET radios are intended for use only inside an enclosure that is fully compliant to FCC Part 15 requirements. These enclosures have been tested with MDS radio products and meet the unintentional radiator requirements as set forth by the FCC. MDS certifies that any future enclosures offered with these products will meet the appropriate requirements and will not offer the products to end users as board-only solutions.

1.0 ABOUT THIS MANUAL

This guide presents installation and operating instructions for the MDS TransNET 900™ transceivers. Following installation, we suggest keeping this guide near the equipment for future reference.

2.0 PRODUCT DESCRIPTION

The transceiver, shown in [Figure 1](#), is a spread spectrum radio designed for license-free operation in the 900 MHz frequency band. Employing microprocessor control and Digital Signal Processing (DSP) technology, they are highly reliable for long-distance communications, even in the presence of weak signals or interference.

DSP technology also makes it possible to obtain information about radio operation and troubleshoot problems, without going to the remote radio site. Using the appropriate software at the master station, diagnostic data can be obtained on any DSP radio in the system, even while payload data is being transmitted.

DSP technology also makes it possible to obtain information about radio operation and troubleshoot problems, without going to the remote radio site. Using the appropriate software at the master station, diagnostic data can be obtained on any DSP radio in the system, even while payload data is being transmitted. The TransNET 900™ is housed in a compact and rugged die-cast aluminum case that need only be protected from direct exposure to the weather. It contains a single printed circuit board with all necessary components for radio operation. No jumper settings or adjustments are required to configure the radio for operation.



Figure 1. MDS TransNET 900 Transceiver

Transceiver Features

Listed below are several key features of the MDS TransNET 900™ transceivers. These are designed to ease the installation and configuration of the radio, while retaining the ability to make changes in the future.

- 1,028 frequencies over 902–928 MHz, subdivided into eight frequency zones
- Configurable operating zones to omit frequencies with constant interference
- 65,000 available network addresses

**THIS INFORMATION IS
SUBJECT TO CHANGE.**

**DO NOT USE FOR
PRODUCT ORDERING.**

- Network-wide configuration from the master station; eliminates most trips to remote sites
- Data transparency—ensures compatibility with virtually all asynchronous SCADA system RTUs
- Peak-hold RSSI, averaged over eight hop cycles
- Operation at up to 115,200 bps continuous data flow
- Same hardware for master or remote configuration
- Data latency typically less than 10 ms
- Supports EIA-232 (formerly called RS-232) and RS-485 user interface
- Low current consumption—5 mA or less average draw in “sleep” mode.

Model Configuration Codes

The radio model number is printed on the end of the radio enclosure, and provides key information about how the radio was configured when it left the factory. See [Figure 2](#) for an explanation of the model number characters.

Graphic is pending.

Figure 2. MDS TransNET 900™ transceiver model configuration codes

2.1 Spread Spectrum Radios—How Are They Different?

The main difference between a traditional (licensed) radio system and the MDS TransNET 900™ transceivers is that these units “hop” from channel to channel many times per second using a specific hop pattern applied to all radios in the network. A distinct hopping pattern is provided for each of the 65,000 available network addresses, thereby minimizing the chance of interference with other spread spectrum systems. In the USA, and certain other countries, no license is required to install and operate this type of radio system.

2.2 Typical Applications

Multiple Address Systems (MAS)

This is the most common application of the MDS TransNET 900™ transceivers. It consists of a central control station (master) and two or more associated remote units, as shown in [Figure 3](#). An MAS network provides communications between a central host computer and remote terminal units (RTU’s) or other data collection devices. The operation of the radio system is transparent to the computer equipment. When used in this application, the transceiver provides an excellent alternative to traditional (licensed) MAS radio systems.

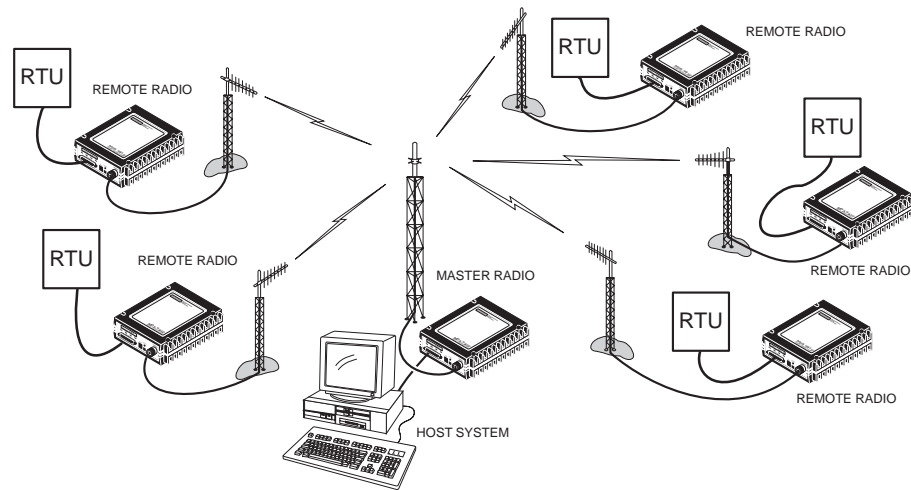


Figure 3. Typical MAS network

Simplex “Peer-to-Peer”

Peer-to-peer communication is possible using the transceiver’s simplex mode. With this arrangement (Figure 4), two or more remote units can share information by direct communication with each other in addition to communicating with a central master radio. This is possible because the transmit and receive frequencies for each hop channel are the same at each radio when simplex mode is enabled. If adequate transmission paths exist, each radio can communicate with all other units in the network. Additional details for peer-to-peer systems are provided in Section 5.2 (Page 16).

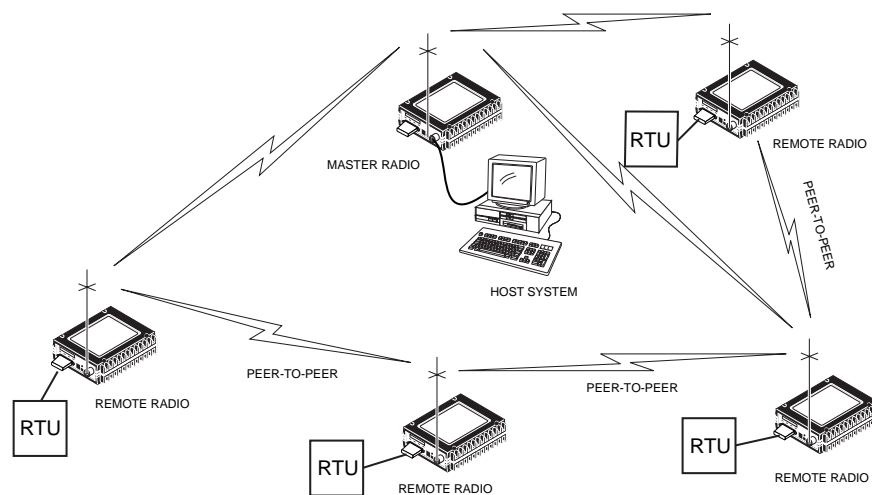


Figure 4. Typical simplex “peer-to-peer” network

Point-to-Point System

A point-to-point configuration (Figure 5) is a simple arrangement consisting of just two radios—a master and a remote. This provides a simplex or half-duplex communications link for the transfer of data between two locations.

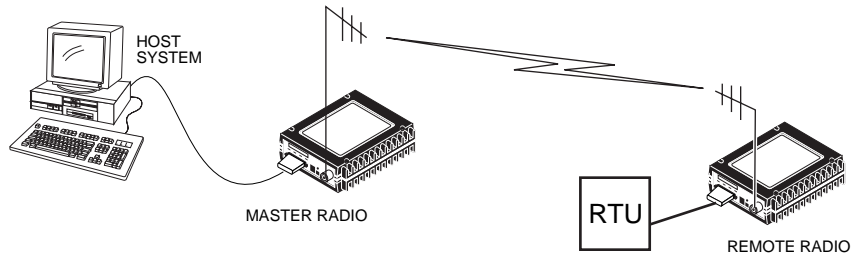


Figure 5. Typical point-to-point link

Tail-End Link (MAS Extension)

A tail-end link can be used to extend the range of a traditional (licensed) MAS system. This might be required if an outlying site is blocked from the MAS master station by a natural or man-made obstruction. In this arrangement, an MDS TransNET 900™ radio links the outlying remote site into the rest of a licensed MAS system by sending data from that site to an associated MDS TransNET 900™ installed at one of the licensed remote sites. (See Figure 6).

As the data from the outlying site is received at the licensed remote site, it is transferred to the licensed radio (via a local cable connection) and is then transmitted to the MAS master station in the usual manner. Additional details for tail-end links are given in Section 5.3 (Page 17).

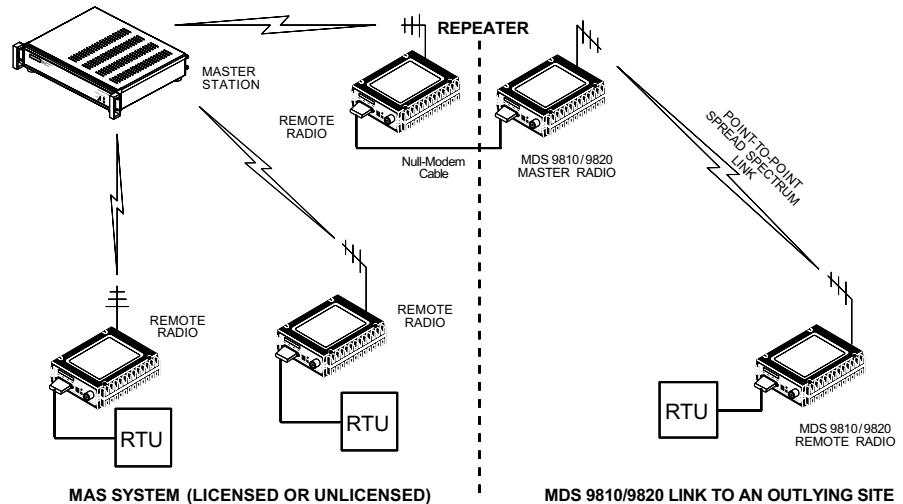


Figure 6. Typical tail-end link arrangement

Repeater System—Traditional

Although the range between MDS TransNET 900™ radios is typically 10 miles over average terrain, it is possible to extend the range considerably by connecting two units together at one site in a “back-to-back” fashion to form a repeater, as shown in Figure 7. Additional details for repeater systems are given in Section 5.4 (Page 17).

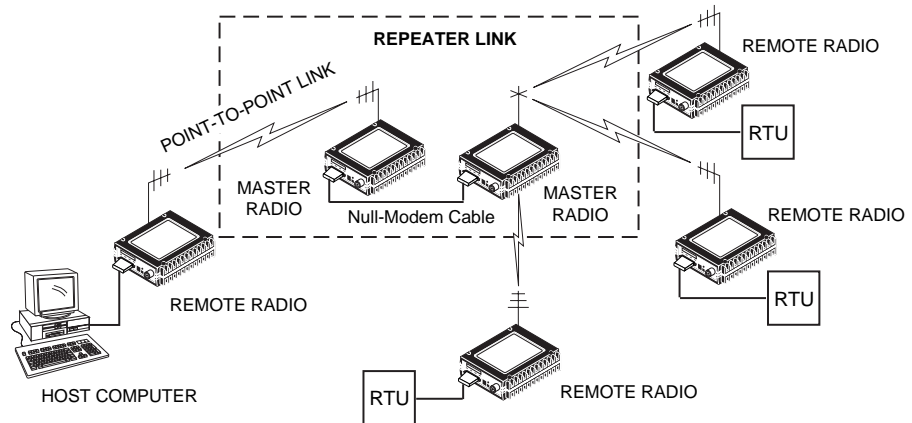


Figure 7. Typical repeater system configuration

2.3 Accessories

The MDS TransNET 900™ transceivers can be used with one or more of the accessories listed in [Table 1](#). Contact the factory for ordering details.

Table 1. Accessories

Accessory	Description	MDS P/N
RTU Simulator	Test unit that simulates data from a remote terminal unit. Comes with polling software that runs on a PC. Useful for testing radio operation.	03-2512A01
EIA-232 to EIA-422 Converter	External adapter that converts the radio's DATA INTERFACE connector to EIA-422 compatible signaling. May be required for long cable runs (over 50 feet/15 meters).	03-2358A01

3.0 GLOSSARY OF TERMS

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

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

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

Bits-per-second—See BPS.

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

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

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

Data Circuit-terminating Equipment—See DCE.

Data Communications Equipment—See DCE.

Data Terminal Equipment—See DTE.

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

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

DCE—Data Circuit-terminating Equipment (or Data Communications Equipment). In data communications terminology, this is the “modem” side of a computer-to-modem connection. By default, MDS TransNET 900™ transceivers are set as DCE devices.

Digital Signal Processing—See DSP.

DSP—Digital Signal Processing. In the MDS TransNET 900™ transceivers, the DSP circuitry is responsible for the most critical real-time tasks; primarily modulation, demodulation, and servicing of the data port.

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

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

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

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

Frequency Hopping—The spread spectrum technique used by the MDS TransNET 900™ transceivers, where two or more associated radios change their operating frequencies several times per second using a set pattern. Since the pattern appears to jump around, it is said to “hop” from one frequency to another.

Frequency Zone—The transceivers use up to 1,028 discrete channels in the 902 to 928 MHz spectrums. A group of 16 channels is referred to as a zone. The transceivers use five to eight frequency zones.

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. [Figure 3 on page 3](#) shows an example of an MAS system.

Master (Station)—The one radio transceiver in a spread spectrum network that automatically provides synchronization information to one or more associated remote transceivers. A radio may be programmed for either master or remote mode using software commands. See [Section 7.0, *TRANCEIVER PROGRAMMING*](#) (beginning on page 22).

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

Microcontroller Unit—See MCU.

Mode—This refers to the programmed function of an MDS spread spectrum radio—master or remote. (See also Remote Station and Master Station.)

Multiple Address System (MAS)—See Point-Multipoint System.

Network Address—User-selectable number between 1 and 65000 that is used to identify a group of transceivers that form a communications network. The master and all remotes within a given system must have the same network address.

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

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

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

Remote Radio—A radio in a spread spectrum network that communicates with an associated master station. A radio may be programmed for either master or remote mode using software commands. See [Section 7.0, *TRANCEIVER PROGRAMMING*](#) (beginning on page 22).

Remote Terminal Unit—See RTU.

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.

Standing Wave Ratio—See SWR.

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 ($\approx 2:1$ SWR).

Zone—See Frequency Zone.

4.0 INSTALLATION PLANNING

The installation of the radio 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 an antenna system, and reducing the chance of harmful interference.

4.1 General Requirements

There are three main requirements for installing the radio—adequate and stable primary power, a good antenna system, and the correct interface between the transceiver and the data device.

Figure 8 shows a typical remote station arrangement. At a remote station, a directional antenna is normally used, and a Remote Terminal Unit (RTU) or other telemetry equipment replaces the host computer normally used in a master station.

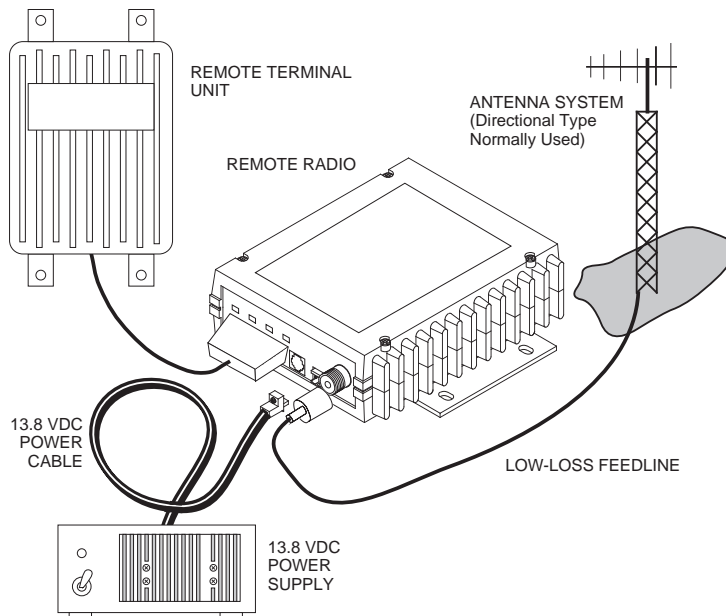


Figure 8. Typical remote station arrangement

4.2 Site Selection

For a successful installation, careful thought must be given to selecting proper sites for the master and remote stations. Suitable sites should provide:

- Protection from direct weather exposure
- A source of adequate and stable primary power
- Suitable entrances for antenna, interface or other required cabling
- Antenna location that provides an unobstructed transmission path in the direction of the associated station(s)

These requirements can be quickly determined in most cases. A possible exception is the last item—verifying that an unobstructed transmission path exists. 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 discussion below will provide helpful background.

Terrain and Signal Strength

While the 900 MHz band offers many advantages over VHF and lower UHF frequencies for data transmission, it is also more prone to signal attenuation from obstructions such as terrain, foliage or buildings in the transmission path.

A line-of-sight transmission path between the master station and its associated remote site(s) is highly desirable and provides the most reliable communications link. A line-of-sight path can often be achieved by mounting the station antenna on a tower or other elevated structure that raises it to a level sufficient to clear surrounding terrain and other obstructions.

The importance of a clear transmission path relates closely to the distance to be covered by the system. If the system is to cover only a limited geographic area, say up to 3 miles (4.8 km) for the MDS TransNET 900™, then some obstructions in the transmission path can usually be tolerated with minimal impact. For longer range systems, any substantial obstruction in the transmission path could compromise the performance of the system, or block transmission entirely.

Much depends on the minimum signal strength that can be tolerated in a given system. Although the exact figure will differ from one system to another, a Received Signal Strength Indication (RSSI) of -90 dBm or stronger will provide acceptable performance in many systems. While the equipment will work at lower signal strengths, this provides a “fade margin” to account for variations in signal strength which may occur from time-to-time.

Conducting a Site Survey

If you are in doubt about the suitability of the radio sites in your system, it is best to evaluate them before a permanent installation is begun. This can be done with an on-the-air test (preferred method); or indirectly, using path-study software.

An on-the-air test is preferred because it allows you to see firsthand the factors involved at an installation site and to directly observe the quality of system operation. Even if a computer path study was conducted earlier, this test should be done to verify the predicted results.

The test can be performed by first installing a radio and antenna at the proposed master station site and then visiting each remote site with a transceiver and a hand-held antenna. (An RTU simulator—MDS Part No. 03-2512A01—can be connected to each radio in the network to simulate data during this test.)

With the hand-held antenna positioned near the proposed mounting spot, a technician can check for synchronization with the master station (shown by a lit SYNC lamp on the front panel) and measure the reported RSSI value. 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. To prepare the equipment for an on-the-air test, follow the general installation procedures given in this guide and become familiar with the operating instructions given in Section 6.0, beginning on Page 20.

If time is short, and a site survey is impractical, a computer path study is a good alternative. Factors such as terrain, distance, transmitter power, receiver sensitivity, and other conditions are taken into account to predict the performance of a proposed system. Contact MDS for more information on path study services.

4.3 A Word About Radio Interference

The MDS TransNET 900™ transceivers share frequency spectrums with other services and other Part 15 (unlicensed) devices in the USA. As such, near 100% error free communications may not be achieved in a given location, and some level of interference should be expected. However, the radio's flexible design and hopping techniques should allow adequate performance as long as care is taken in choosing station location, configuration of radio parameters and software/protocol techniques.

In general, keep the following points in mind when setting up your communications network:

1. Systems installed in rural areas are least likely to encounter interference; those in suburban and urban environments are more likely to be affected by other devices operating in the license-free frequency band and by adjacent licensed services.
2. If possible, use a directional antenna at remote sites. Although these antennas may be more costly than omnidirectional types, they confine the transmission and reception pattern to a comparatively narrow lobe, which minimizes interference to (and from) stations located outside the pattern. (The use of a directional antenna may not be possible in a simplex peer-to-peer network, where all remotes are designed to communicate with one another.)
3. If interference is suspected from a nearby licensed system (such as a paging transmitter), it may be helpful to use horizontal polarization of all antennas in the network. Because most other services use vertical polarization in this band, an additional 20 dB of attenuation to interference can be achieved by using horizontal polarization.
4. Multiple MDS TransNET 900™ systems can co-exist in proximity to each other with only very minor interference as long as they are each assigned a unique network address. Each network address has a different hop pattern.
5. If constant interference is present in a particular frequency zone, it may be necessary to “lock out” that zone from the radio's hopping pattern. The radio includes built-in software to help users remove blocked frequency zones from its hopping pattern. Refer to the discussion of the **SKIP** (Page 33) command for more information.
6. If interference problems persist even after removing blocked zones, try reducing the length of data streams. Groups of short data streams have a better chance of getting through in the presence of interference than do long streams.
7. The power output of all radios in a system should be set for the lowest level necessary for reliable communications. This lessens the chance of causing unnecessary interference to nearby systems.

4.4 Antenna & Feedline Selection

Antennas

The equipment can be used with a number of antennas. The exact style used depends on the physical size and layout of a system. Contact your MDS representative for specific recommendations on antenna types and hardware sources.

In general, an omnidirectional antenna (Figure 9 and Figure 10) is used at the master station site in an MAS system. This provides equal coverage to all of the remote sites.

NOTE: Antenna polarization is important. If the wrong polarization is used, a signal reduction of 20 dB or more will result. Most systems using a gain-type omnidirectional antenna at the master station employ vertical polarization of the signal; therefore, the remote antenna(s) must also be vertically polarized (elements oriented perpendicular to the horizon).

When required, horizontally polarized omnidirectional antennas are also available. Contact your MDS representative for details.

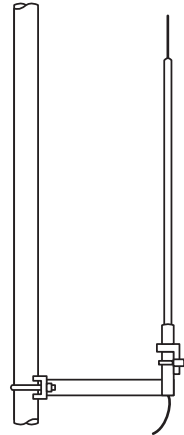


Figure 9. Omnidirectional antenna for MDS TransNET 900™ transceiver

At remote sites and point-to-point systems, a directional Yagi antenna (Figure 10), is generally recommended to minimize interference to and from other users. Antennas are available from a number of manufacturers.

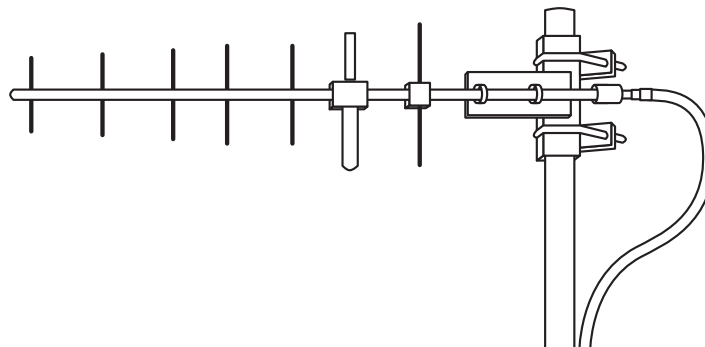


Figure 10. Typical Yagi antenna (mounted to mast)

Feedlines

The choice of feedline used with the antenna should be carefully considered. Poor-quality coaxial cables should be avoided, as they will degrade system performance for both transmission and reception. The cable should be kept as short as possible to minimize signal loss.

**MDS TransNET
900™ Transceiver**

For cable runs of less than 20 feet (6 meters), or for short range transmission, an inexpensive type such as Type RG8A/U may be acceptable. Otherwise, we recommend using a low-loss cable type

suited for 900 MHz, such as HeliAx®.

Table 2 lists several types of feedlines and indicates the signal losses (in dB) that result when using various lengths of each cable at 900 MHz. The choice of cable will depend on the required length, cost considerations, and the amount of signal loss that can be tolerated.

Table 2. Length vs. loss in coaxial cables at 900 MHz

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

4.5 How Much Output Power Can be Used?

The transceiver is normally supplied from the factory set for a nominal +30 dBm (1 Watt) RF power output setting; this is the maximum transmitter output power allowed under FCC rules. The power must be decreased from this level if the antenna system gain exceeds 6 dBi. The allowable level is dependent on the antenna gain, feedline loss, and the transmitter output power setting. Power considerations for point-to-multipoint and point-to-point systems using the MDS TransNET 900™ transceivers are discussed in the next sections.

NOTE: In some countries, the maximum allowable RF output may be limited to less than 1 watt (e.g., 100 mW /+20 dBm). Be sure to check for and comply with the requirements for your area.

For All MDS TransNET 900™ Systems

To determine the maximum allowable power setting of the radio, perform the following steps:

1. Determine the antenna system gain by subtracting the feedline loss (in dB) from the antenna gain (in dBi). For example, if the antenna gain is 9.5 dBi, and the feedline loss is 1.5 dB, the antenna system gain would be 8 dB. (If the antenna system gain is 6 dB or less, no power adjustment is required.)
2. Subtract the antenna system gain from 36 dBm (the maximum allowable EIRP). The result indicates the maximum transmitter power (in dBm) allowed under the rules. In the example above, this is 28 dBm.
3. If the maximum transmitter power allowed is less than 30 dBm, use the **PWR** command (described on Page 30) to set the power accordingly.

For convenience, [Table 3](#) lists several antenna system gains and shows the maximum allowable power setting of the radio. Note that a gain of 6 dB or less entitles you to operate the radio at full power output—30 dBm (1 watt).

Table 3. Antenna system gain vs. power output setting (USA)

Antenna System Gain (Antenna Gain in dBi* minus Feedline Loss in dB†)	Maximum Power Setting (in dBm)	EIRP (in dBm)
6 (or less)	30	36
8	28	36
10	26	36
12	24	36
14	22	36
16	20	36

* Most antenna manufacturers rate antenna gain in dBd in their literature. To convert to dBi, add 2.15 dB.

† Feedline loss varies by cable type and length. To determine the loss for common lengths of feedline, see [Table 2 on page 12](#) for the MDS TransNET 900™ transceiver.

5.0 INSTALLATION

[Figure 11](#) shows a typical transceiver product shipment (board versions of OEM shipments will differ). 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 and save all packing materials for possible re-shipment.

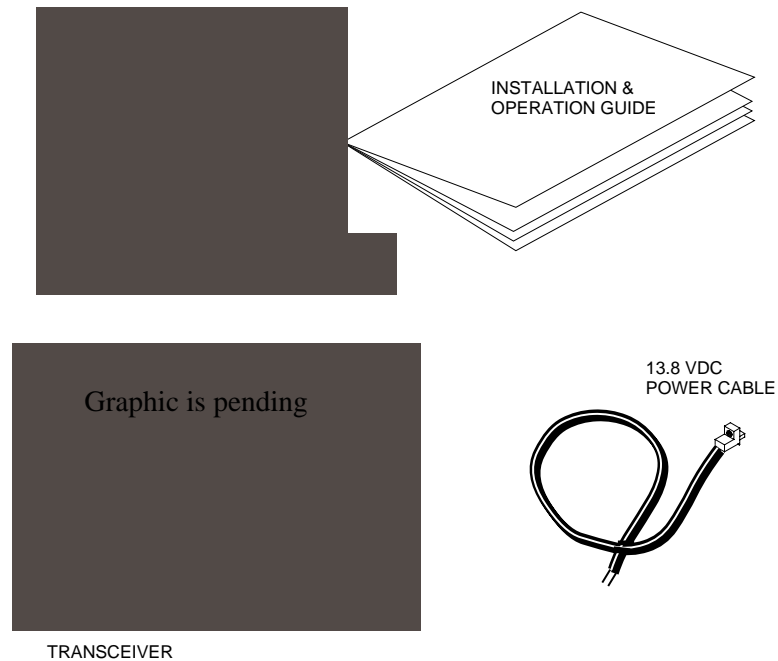


Figure 11. Typical Transceiver shipment

Below are the basic steps for installing the MDS TransNET 900™ transceivers. In most cases, these steps alone will be sufficient to complete the installation. Should further information be required, contact the factory at the number given on the inside back cover of this manual.

If you are installing a peer-to-peer or tail-end link systems, you should also review Sections 5.2 (Page 16) and 5.3 (Page 17) for important details on antennas, cabling and software settings.

NOTE: It is recommended that the master station be installed first. In this way, it will be possible to quickly check the operation of each associated remote station as it is placed on the air.

5.1 Transceiver Installation

1. Mount the transceiver to a stable surface using the brackets supplied with the radio. (Fasteners/anchors are not supplied.) Figure 12 shows the dimensions of the transceiver case and its mounting bracket. If possible, choose a mounting location that provides easy access to the connectors on the end of the radio and an unobstructed view of the LED status indicators.



Figure 12. Transceiver mounting dimensions

CAUTION
POSSIBLE
EQUIPMENT
DAMAGE

The screws holding the brackets to the radio are $\frac{5}{16}$ inch (8 mm) long so as not to damage the radio's PC board when tightened. If these screws are replaced for any reason, the new screws must not exceed this length.

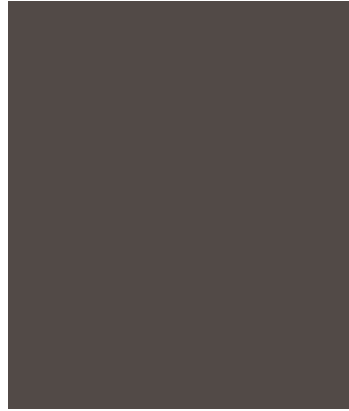
2. Install the antenna and antenna feedline for the station. Antennas should be mounted in the clear and in accordance with the manufacturer's instructions.

Additional information on antennas and feedlines is contained in Section 4.4 (Page 10).

NOTE: Strong fields near the antenna can interfere with the operation of the low level RTU circuits and change the reported values of the data being monitored. For this reason, the antenna should be mounted at least 10 feet (>3 meters) from the radio, RTU, sensors and other components of the system.

3. Connect the data equipment to the transceiver's DATA INTERFACE connector. Use only the required pins for the application—. Typical applications require the use of Pin 2 (received data—RXD), Pin 3 (transmit data—TXD) and Pin 7 (Request to send—RTS). Figure 13 shows a detailed view of the DATA INTERFACE connector.

If hardware flow control is desired, Pin 4 (Sleep) and Pin 5 (signal ground) are also required. A detailed chart of pin functions is provided in Table 11 on page 39.



**Figure 13. Transceiver interface connector pins
As viewed from outside the radio**

NOTE: The data cabling between the transceiver and the connected device should be kept as short as possible. Cable runs over 50 feet (15 meters) may require the use of EIA-422 signaling. Consult the factory for details.

4. Measure and install the primary power for the transceiver. It must be within 5–24 Vdc* and be capable of furnishing up to 500 mA. Be sure to observe proper polarity. The red wire on the power cable is the positive lead; the black is negative.
-

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

The power supply used with the transceiver should be equipped with overload protection (NEC Class 2 rating), to protect against a short circuit between its output terminals and the transceiver power connector.

5.2 Peer-to-Peer Systems

Peer-to-peer systems allow remote radios to communicate with each other as well as with the master station. The paragraphs below describe two types of peer-to-peer systems—simplex and repeater assisted.

Simplex Peer-to-Peer

A simplex peer-to-peer system is one in which all radios use the same transmit and receive frequencies. This is also known as single-frequency operation. A simplex arrangement is the simplest configuration for peer-to-peer systems, but it usually has limited transmission range because of the need for all stations to use omnidirectional antennas.

With a simplex peer-to-peer system, there are three key items to remember:

Programming

To program a system for simplex operation, the master radio must be set to **SIMPLEX ON** (Page 33). This setting is automatically applied to all remote radios as soon as they become synchronized with the master radio.

Antennas

Omnidirectional antennas are normally required at all stations in a simplex system. The transmission range may be significantly reduced as compared with stations using directional antennas, so it is especially important that sites be chosen to allow sufficient signal strength between all units. A discussion of site selection is provided in Section 4.2.

5.3 Tail-End Links

A tail-end link is established by connecting an MDS TransNET 900™ radio “back-to-back” with another radio such as a licensed MDS 2300/4300 series transceiver. This can be used to link an outlying remote site into the rest of an MAS network. Here are some specific requirements for tail-end link systems:

Interface Wiring

The connection between the two radios in a tail-end link system must be made as shown in Figure 14.



Figure 14. Data interface cable wiring for tail-end links

5.4 Repeaters—Traditional Method

Two MDS TransNET 900™ radios (or another MDS spread spectrum radio) may be connected “back-to-back” using a null-modem cable to form a repeater station. This is sometimes required in a network that includes a distant remote station that would otherwise be unable to communicate with the master station due to distance or terrain.

A repeater works by re-transmitting data from the outlying remote site to the master station and vice versa. It introduces a small amount of end-to-end transmission delay, but this is not a problem in most systems.

The geographic location of a repeater station is especially important. A site must be chosen that allows good communication with both the master and the outlying remote site. This is often on top of a hill, or other elevated terrain from which both sites can be “seen” by the repeater station antennas. A detailed discussion on the effects of terrain is given in Section 4.2, *Site Selection* (beginning on page 8).

The following paragraphs contain specific requirements for repeater systems.

Antennas

Two antennas are required at repeater stations—one for each radio. Measures must be taken to minimize the chance of interference between these antennas. One effective technique for limiting interference is to employ vertical separation. In this arrangement, one antenna is mounted directly over the other, separated by at least 10 feet (3 Meters). This takes advantage of the minimal radiation exhibited by most antennas directly above and below their driven elements.

Another interference reduction technique is to cross-polarize the repeater antennas. If one antenna is mounted in the vertical plane, and the other in the horizontal plane, an additional 20 dB of attenuation can be achieved. (Remember that the corresponding stations must use the same antenna orientation when cross-polarization is used.)

System Addresses

The two radios that are wired together at the repeater site must have different system addresses. To set or view the system address, see “ADDR [1..65000]” on page 26.

Interface Wiring

A null-modem cable (Figure 15) is required between the DATA INTERFACE connectors of the two radios forming a repeater station. This allows them to freely exchange data even though they are both configured as DCE devices.



Figure 15. Data interface cable wiring for null-modem cable (used for traditional repeater)

Interface Wiring

A single-radio repeater is formed by connecting TXD (Pin 2) and RXD (Pin 3) on the DATA INTERFACE connector together as shown in Figure 16.

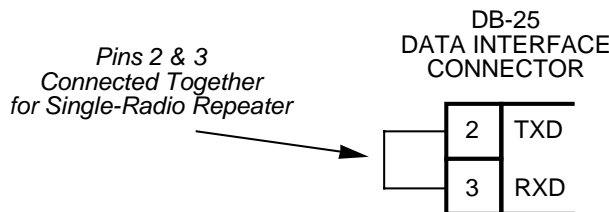


Figure 16. Data interface cable wiring for single-radio repeater

Software Programming (TDD Command)

As with other repeater systems, the network must be configured for TDD operation by programming the master radio with **TDD ON**. This places the DATA INTERFACE port in time division duplex (sometimes called “simulated full-duplex”) mode.

Although a single radio can never actually transmit and receive RF data at the same time, the **TDD ON** command enables the radio to simulate full-duplex at the data port, by designating alternate channel hops as transmit or receive hops, and buffering data when transmission is not permitted.

Limitations of Single-Radio Repeaters

Diagnostics

As of the date of publication, over-the-air diagnostics is not fully supported in repeater systems. Diagnostic data from these systems may be unavailable or unreliable. This is particularly true if a repeater radio is configured as the “root” in a diagnostics scheme. Better success might be achieved by picking a standard remote to use as the root.

Data Throughput Delay

When **TDD** is set to **ON**, there will be a significant delay in data throughput and an increase in latency (see Glossary of Terms). In general, the data throughput will be cut in half, and worst case latency will be increased by two hop times.

5.5 Using the Radio’s Sleep Mode

In some installations, such as at solar-powered sites, it may be necessary to keep the transceiver’s power consumption to an absolute minimum. This can be accomplished using Sleep Mode. In this mode, power consumption is reduced to less than 5 milliamperes.

Sleep Mode can be enabled under RTU control by asserting a ground (or EIA-232 low) on Pin 4 of the radio’s DATA INTERFACE connector. The radio stays in Sleep Mode until the low is removed, and all normal functions are suspended. As a status indication, the radio’s PWR LED flashes once every four seconds to indicate that it is in Sleep Mode.

The radio can be “woken up” by your RTU every minute or so to verify synchronization with the master station. When Pin 4 is opened (or an EIA-232 high is asserted), the radio will be ready to receive data within 75 milliseconds.

It is important to note that power consumption will increase significantly as communication from the master station degrades. This is because the radio will spend a greater period of time “awake,” looking for synchronization messages from the master radio.

Sleep Mode Example

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

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

6.0 OPERATION

6.1 Initial Start-up

In-service operation of the MDS TransNET 900™ transceiver is completely automatic. Once the unit has been properly installed and configured, operator actions are limited to observing the LED status indicators for proper operation.

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

1. Apply primary power to the radio.
2. Observe the transceiver LED status panel (Figure 17) for the proper indications. Table 4 provides a complete explanation of the LED functions.

In a normally operating system, the following LED indications will be seen within 16 seconds of start-up:

- PWR lamp lit continuously
- SYNC lamp lit continuously
- Remote radio(s) transmitting data (TXD) and receiving data (RXD) with the master station



Figure 17. LED status indicators

Table 4. LED status indicators

LED Name	Description
PWR	<ul style="list-style-type: none"> • Continuous—Power is applied to the radio; no problems detected. • Flashing 5 times per second—Fault indication. See Section 8.0, <i>TROUBLESHOOTING</i> (beginning on page 34). • Flashing once every 4 seconds—radio is in Sleep mode.
SYNC	Lights continuously to indicate the radio is receiving/sending synchronization frames. Normally, within 10 seconds of power-up, this LED should be lit continuously.
TXD	Indicates EIA-232 space (logic high) signal input to the DB-9 connector.
RXD	Indicates EIA-232 space (logic high) signal output from the DB-9 connector.

6.2 Performance Optimization

After the basic operation of the radio has been checked, you may wish to optimize its performance using some of the suggestions given here. The effectiveness of these techniques will vary with the design of your system and the format of the data being sent.

Complete instructions for using the software commands referenced herein are provided in Section 7.0, *TRANCEIVER PROGRAMMING* (beginning on page 22).

Antenna Aiming

For optimum performance of directional antennas, they must be accurately aimed in the direction of desired transmission. The easiest way to do this is to point the antenna in the approximate direction, then use the remote radio's built-in Received Signal Strength Indication (RSSI) feature to further refine the heading for maximum received signal strength.

In an MAS system, RSSI readings are only meaningful when initiated from a remote station. This is because the master station typically receives signals from several remote sites, and the RSSI would be continually changing as the master receives from each remote in turn.

Antenna SWR Check

It is necessary to briefly key the transmitter for this check by placing the radio in the **SETUP** mode (Page 32) and using the **KEY** command. (To unkey the radio, enter **DKEY**; to disable the setup mode and return the radio to normal operation, enter **Q** or **QUIT**.)

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The SWR of the antenna system should be checked before the radio is put into regular service. For accurate readings, a wattmeter suited for 1000 MHz is required. One unit meeting this criteria is the Bird Model 43™ directional wattmeter with an 5J element installed.

The reflected power should be less than 10% of the forward power ($\approx 2:1$ SWR). Higher readings usually indicate problems with the antenna, feedline or coaxial connectors.

Data Buffer Setting

The default setting for the data buffer is ON to accommodate virtually any data format. However, if the system can operate satisfactorily with the buffer OFF, we recommend doing so using the **BUFF OFF** command (Page 27). This allows the radio to operate with the lowest possible latency and improves channel efficiency.

Hoptime Setting

The default hop time setting is 7. An alternate setting of 28 is used when the data rate is 115,200 bps.

A detailed explanation of the **HOPTIME** command, and a table listing the available selections and the channel efficiency associated with each, can be found on Page 29.

Baud Rate Setting

The default baud rate setting is 9600 bps to accommodate most systems. If your system will support a higher data rate, you should increase the radio's transmission speed using the **BAUD xxxxx abc** command (Page 27). It should be set to the highest speed that can be sent by the data equipment in the system. (The transceiver supports 1200 to 115200 bps)

Radio Interference Checks

The radio operates in eight frequency zones. If interference is found in one or more of these zones, the **SKIP** command (Page 33) can be used to omit them from the hop pattern. You should also review *Section 4.3, A Word About Radio Interference* (beginning on page 10), when dealing with interference problems.

7.0 TRANCEIVER PROGRAMMING

There are no manual adjustments on the transceiver. Programming and control is performed through a PC connected to the Data Interface connector on the transceiver.

NOTE: The Diagnostic port (RJ-11 connector) uses 8 data bits, 1 stop bit, and no parity. It can automatically configure itself to function at 1200, 2400, 4800, 9600, 38400, 57600, and 115200 baud.

7.1 Programming Methods

1. Using a Terminal Interface

A PC may 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. Connect a PC to the Data Interface connector on the transceiver. Once connected, communication (baud rate) is established through the command interface. To access the command interface, an escape character, followed by one or more ENTER keystrokes (delivered at one second intervals), until the “>” prompt is displayed. The terminal communication parameters must be set to 9600 bps, with 8 data bits, and 1 stop bit (8N1).

2. Using PC Configuration Software

PC-based Radio Configuration software is available for use with the radio (MDS P/N pending). On-line instructions are included with the configuration software.

7.2 Keyboard Commands

Table 5 is a reference chart of software commands for the transceiver. See Section 7.3 for detailed command descriptions.

Entering Commands

The proper procedure for entering commands is to type the command, followed by an **[ENTER]** keystroke. For programming commands, the command is followed by **[SPACE]** and the appropriate information or values, then **[ENTER]**.

Table 5. Command summary

	COMMAND	DESCRIPTION
NETWORK CONFIGURATION These programming commands can only be set at the master radio.	BUFF [ON,OFF] <i>Details Page 27</i>	ON = Seamless data, OFF = Fast byte throughput.
	HOPTIME <i>Details Page 35</i>	Displays hop time
	SEND [n, -n, +n] <i>Details Page 31</i>	Sets/displays re-send count for data packets. Useful in areas with heavy radio interference.
	SKIP[NONE,1...8] <i>Details Page 33</i>	Select combination of frequency operating zones to avoid.

Table 5. Command summary (Continued)

	COMMAND	DESCRIPTION
SET/PROGRAM COMMANDS	ADDR[1...65000] <i>Details Page 26</i>	Program network address
	AMASK [0000 0000-FFFF FFFF] <i>Details Page 27</i>	Sets alarm response. Default is FFFF FFFF.
	ASENSE [HI/LO] <i>Details Page 27</i>	Changes the sense of the alarm output. Default sense is HI.
	BAUD [xxxxx abc] <i>Details Page 27</i>	Set data communication parameters
	CTS [0-255] <i>Details Page 28</i>	Program CTS delay in milliseconds. (A value of 0 returns CTS immediately)
	CTSHOLD[0-6000] <i>Details Page 28</i>	Set/display "hold time" that CTS remains present following last character transmission from DD-25 port.
	DEVICE [DCE, CTS KEY] <i>Details Page 28</i>	Set device behavior; DCE (normal) or CTS Key (Repeater)
	MODE[M,R,R-M] <i>Details Page 30</i>	Program operating mode, where M = Master, R = Remote, R-M = Remote-Master (Remote radio programmed to operate on Master frequencies)
	OWM [xxxxx] <i>Details Page 30</i>	Program owner's message (30 characters maximum)
	OWN [xxxxx] <i>Details Page 30</i>	Program owner's name (30 characters maximum)
	PWR [xx-30] <i>Details Page 30</i>	Program forward power output in dBm.
	RTU[ON/OFF/0-80] <i>Details Page 31</i>	Re-enables or disables the radio's internal RTU simulator and sets the RTU address.
	RXTOT [NONE, 0-1440] <i>Details Page 31</i>	Specifies max. duration (in minutes) to wait before issuing a time-out alarm. Default is OFF.
	SEND [n, -n, +n] <i>Details Page 31</i>	Sets/displays re-send count for data packets. Useful in areas with heavy radio interference.
UNIT[10000-65000] <i>Details Page 34</i>	Program unit address. Used to set a unique address for network-wide diagnostics.	

Table 5. Command summary (Continued)

	COMMAND	DESCRIPTION
DISPLAY OPERATING STATUS	ADDR[1...65000] <i>Details Page 26</i>	Network address (1-65000)
	AMASK [0000 0000-FFFF FFFF] <i>Details Page 27</i>	Sets alarm mask (response). Default is FFFF FFFF.
	ASENSE [HI/LO] <i>Details Page 27</i>	Changes the sense of the alarm output. Default sense is HI.
	BAUD [xxxxx abc] <i>Details Page 27</i>	Display data communication parameters. Example: BAUD 9600 8N1
	BUFF [ON, OFF] <i>Details Page 27</i>	Data buffering mode: ON = seamless data OFF = fast byte throughput
	CTS [0-255] <i>Details Page 28</i>	CTS delay in ms (0-255 ms)
	DEVICE [DCE, CTS KEY] <i>Details Page 28</i>	Device behavior (DCE, or CTS KEY)
	HOP-TIME <i>Details Page 29</i>	Show hop time in milliseconds (ms).
	HREV	Hardware revision level
	MODE [M, R, R-M] <i>Details Page 30</i>	Show operating mode: M = Master, R = Remote, R-M = Remote-Master (remote oper. on master freqs.)
	OWM	Owner's message or site name
	OWN	Owner's name or system name
	PWR [xx-30] <i>Details Page 30</i>	Forward power output setting in dBm
	RSSI <i>Details Page 30</i>	Received signal strength in dBm (continuously updated). Not available at master radio unless SETUP is enabled.
	RXTOT [NONE, 0-1440] <i>Details Page 31</i>	Specifies amount of time (in seconds) to wait before issuing a time-out alarm. Default is NONE.
	SEND [n, -n, +n] <i>Details Page 31</i>	Sets/displays re-send count for data packets. Useful in areas with heavy radio interference.
	SER	Serial number of radio
	SHOW [PORT, DC, PWR] <i>Details Page 33</i>	Show active port, DC voltage or measured RF power (dBm)
	SKIP [NONE, 1...8] <i>Details Page 33</i>	Simplex/half-duplex selection ON = Simplex, OFF = half-duplex
SKIP [NONE, 1...8] <i>Details Page 33</i>	Skip a frequency operating zone	

Table 5. Command summary (Continued)

	COMMAND	DESCRIPTION
DISPLAY OPERATING STATUS (CONTINUED)	SSNR <i>Details Page 33</i>	Signal-to-noise ratio. Expressed in dB.
	SREV <i>Details Page 34</i>	Display transceiver firmware revision level
	STAT <i>Details Page 34</i>	Show current alarm status
	TTEMP <i>Details Page 34</i>	Transceiver's internal temperature (°C)
	UNIT[10000–65000] <i>Details Page 34</i>	Show programmed unit address for network-wide diagnostics
DIAGNOSTIC/TEST	KEY	Enables the transmitter. (Radio must be in Setup mode.)
	DKEY	Disables the transmitter. (Radio must be in Setup mode.)
	TX [xxxx] <i>Details Page 34</i>	Set/display transmit test frequency. (Radio must be in Setup mode.)
	RX [xxxx] <i>Details Page 31</i>	Set/display receive test frequency. (Radio must be in Setup mode.)
	SETUP <i>Details Page 32</i>	Enables Setup mode. Times out after 15 minutes. Press "Q" to quit.

7.3 Detailed Command Descriptions

The essential commands for most applications are Network Address (**ADDR**), Mode, (**MODE**) and Baud Rate (**BAUD**). However, proper use of the additional commands allows you to tailor the transceiver for a specific use, or to conduct basic diagnostics on the radio. This section gives more detailed information for many of the user commands listed in [Table 5](#).

Most of the commands below can be used in two ways. First, you can type only the command name (for example, **ADDR**) to view the currently programmed data. Second, you can set or change the existing data by typing the command, followed by a space, and then the desired entry (for example, **ADDR 1234**). In the list below, allowable programming variables, if any, are shown in brackets [] following the command name.

ADDR [1...65000]

This command sets or displays the radio's network address. The network address can range from 1 to 65000.

Network address must be programmed at the time of installation and must be common across each radio in a given network. Radios are typically shipped with the network address unprogrammed. This causes the address to display as **NONE**. This leaves the system in an invalid state and prevents operation.

NOTE: It is recommended that the last four digits of the master radio's serial number be used for the network address (or chassis serial number if the radio is installed in a P-20 redundant chassis).

ALARM

Table and information pending.

AMASK [0000 0000–FFFF FFFF]

This command sets the alarm bits that cause the alarm output signal to be triggered. The PWR LED will still flash for all alarms, but the alarm output signal will only be activated for those alarms that have the corresponding mask bit set. The hex value for the mask aligns directly with the hex value for the **ALARM** command. The default is **FFFF FFFF**. Through proper use of the **AMASK** command, it is possible to tailor the alarm response of the radio. Contact the factory for more information on configuring the alarm mask.

A sense [HI/LO]

This command is used to set or display the sense of the alarm output at Pin 25 of the DATA INTERFACE connector. The default for transceivers is active **HI**.

BAUD [xxxxx abc]

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

The first parameter (**xxxxx**) is baud rate. Baud rate is specified in bits-per-second and must be one of the following speeds: 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 at any hop rate. If hop time is set to **NORMAL** or **LONG**, baud rates of up to 19200 bps with continuous unlimited data transmission are possible. (See **HOPTIME** command.)

The second parameter of the **BAUD** command (**abc**) is a 3-character block indicating how the data is encoded. The following is a breakdown of each character's meaning:

- 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 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]

This command sets or displays the received data handling mode of the radio. The command parameter is either **ON** or **OFF**. (The default is **ON**.) The setting of this parameter affects the timing of 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 25 to 50 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.

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.

Changes to the **BUFF** setting may only be made at the master radio. This is because the master radio broadcasts the buffer setting for the entire network. At remote radios, the buffer setting may be read when the radio is in synchronization with the master, but it may not be changed.

CLOS

Table and information pending.

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, 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 always be asserted (unless the radio is attempting to throttle back data as part of normal flow control operation).

For CTS Key operation (see the **DEVICE** command), the timer specifies how long to wait after asserting the CTS line 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 in effect from other radio operating parameters.)

CTSHOLD [0-6000]

Used in **DEVICE CTS KEY** mode, this command sets the amount of time in milliseconds that CTS remains present following transmission of the last character out the RXD pin of the DATA INTERFACE port. This “hold time” can be used to prevent squelch tail data corruption when interworking with other radios.

The **CTSHOLD** setting can range from 0 to 6000 (i.e., 6 seconds). The default value is 0, which means that CTS will drop immediately after the last character is transmitted. If the command is entered when the radio is in **DEVICE DCE** mode, the response **CTSHOLD N/A** will be 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 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.)

Following transmission of the last byte of data, CTS will remain asserted for the duration specified by the **CTSHOLD** command. **CTSHOLD** should be set sufficiently high.

DMGAP [xx]

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

HOPTIME

The **HOPTIME** command sets or displays the hop time setting. The command is one of eight keywords whose parameters and related efficiencies are shown in [Table 6](#).

Although the default setting is **7**, transmission efficiency can usually be improved by using a **setting of 28** when data rate exceeds 115200 bps. This is because there will be less frequent channel hops when using this setting, contributing to a smoother flow of transmitted data.

Table 6. Hoptime parameters

Hop Time Keyword	Time per Hop	Max. Bytes per Hop	Channel Efficiency
XSHORT	10 ms	9	32.1%
16	16 ms	21	46.7%
20	20 ms	30	53.6%
25	25 ms	39	55.7%
32	32 ms	57	63.3%
SHORT	40 ms	72	64.3%
NORMAL	80 ms	162	72.0%
LONG	160 ms	336	74.5%

Other hop times can be used to customize performance based on SEND count settings and payload data poll length.

The only time shorter settings (**SHORT** through **XSHORT**) should be considered is when the message size is very small and strong interference of a persistent nature is occurring on many frequencies. In these cases, a shorter hop time may improve the chances of a message getting through—but at the cost of reduced channel efficiency.

Changes to the **HOPTIME** setting may only be made at the master radio. (This is because the master radio establishes the hop time setting for the entire network.) At remote radios, the hop time setting may be read when the radio is in synchronization with the master, but it may not be changed.

MODE [M, R, R-M]

The **MODE** command sets or displays the operating mode of the radio. A master radio is designated by an **M**; a remote is designated by an **R**.

R-M indicates that the transceiver has been programmed to the special remote-master mode (remote radio operating on master frequencies) This is used in repeater-assisted peer-to-peer systems; see *Section 2.2, Typical Applications (beginning on page 2)* for details. The **R-M** mode denotes a remote radio operating on master frequencies. In all other respects, a remote-master behaves the same as a normal remote.

All units default to remotes; other modes must be specifically programmed with the **MODE** command.

OPTION!

Table and information pending.

OWM [xxxxx]

The **OWM** command sets or displays an optional owner's message, such as the system name. The entry can contain up to 30 characters.

OWN [xxxxx]

The **OWN** command sets or displays an optional owner's name, such as the site name. The entry can contain up to 30 characters.

PWR [xx-30]

This command displays or sets the desired RF forward output power setting of the radio. The **PWR** command parameter is specified in dBm and can range from 20 dBm (MDS TransNET 900™ transceiver) through 30 in 1 dBm steps. The default setting is 30 dBm (1 watt). 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 4.5, How Much Output Power Can be Used? (beginning on page 12)* contains a detailed discussion of this topic.

RSSI

This command displays the radio's Received Signal Strength Indication in dBm (decibels relative to 1 mW). The output can range from -50 dBm to -110 dBm. Command availability and results depend on the mode of operation (master or remote). The closer to 0 dBm, the stronger the signal, thus a reading of -70 dBm is stronger than -80 dBm.

For a remote radio, under normal operation, RSSI is based on the average signal strength of the SYNC message received in each of the eight frequency zones. (RSSI is sampled each time a SYNC message is received—every 1.6 seconds.) When using the RSSI reading to align a directional antenna, it is important to make changes slowly so that the RSSI reading will provide meaningful results. It will take several seconds to indicate a change in signal level. The radio stays in RSSI mode until **[ENTER]** is pressed.

For a master radio, under normal operation, entering the RSSI command causes the response **NOT AVAILABLE** to be returned. This is because a master is normally receiving signals from several remote stations and an RSSI reading would be continually changing. The only exception is when the **SETUP** command has been asserted. This disables hopping and allows reading a “raw” RSSI signal level in real time from a master or remote radio.

NOTE: RSSI Readings are not accurate for incoming signals stronger than -50 dBm.)

RTU [ON/OFF/0-80]

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

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

RX [xxxx]

This command sets or displays the test receive frequency used in place of hopping whenever the radio is in Setup mode. The test receive frequency can be reprogrammed to any value between 927.975 MHz and 902.025 MHz (MDS TransNET 900™), inclusive. The factory default settings are listed below and have been selected to be non-intrusive to normal operation.

Default Receive Frequencies		
	Master	Remote
MDS TransNET 900™	927.975 MHz	902.025 MHz

RXTOT [NONE, 0–1440]

This command sets or displays the amount of time (in minutes) to wait for the next received data packet before issuing a receiver time-out alarm. The default is **NONE**.

SEND [n, -n, +n]

The **SEND** command selects or displays the number of times that a radio will re-transmit data. This command is associated with “robust” or “bulletproof” operation of the radio and is intended for use in areas with heavy radio interference.

When the **SEND** command is issued without parameters, the cumulative retransmission count is shown. A value of 1 represents the default selection, meaning “normal, non-robust operation.” Values greater than 1 successively improve the chance of successful data delivery in spectrally harsh environments. (Note that the **SEND** count for a remote radio is only viewable when the remote is synchronized with its master station.)

There are two formats for entering the **SEND** command. One format (**SEND n**) can be used only at the master station, and selects the base transmission count for the entire network. The other format (**SEND +n** or **-n**) can be used at any radio in the network, and provides a means to customize the transmission count locally at each radio, as a delta (amount of change) from the base.

For both formats, **n** represents number between 1 and 10; for the “delta” format a value of zero is also permitted. The net transmission count for a particular radio is determined by adding the local “delta” (**+n** or **-n**) to the base transmission count for the network. The net transmission count is automatically bounded to the range 1..10, irrespective of the delta. The combination of the two formats provides a means to highly customize the retransmission behavior of network.

Higher retransmission counts come at the cost of increased latency and reduced data throughput. With **BUFF ON**, the radio maintains seamless operation based on timing derived from the network **SEND** value. The use of any tailored **SEND** values (e.g. **SEND +/-x**) within the system may disrupt seamless operation. This is because the increased latency makes seamless mode impractical. Table 2 lists the maximum cumulative **SEND** count for continuous operation, at some typical data rates.

Table 7. Baud Rate vs. Maximum SEND Count

BAUD RATE (BPS)	XSHORT (max. send count)	16 ms (max. send count)	20 ms (max. send count)	25 ms (max. send count)	32 ms (max. send count)	SHORT (max. send count)	NORMAL (max. send count)	LONG (max. send count)
1200	3	8	10	10	10	10	10	10
2400	N/A	4	5	5	5	7	8	8
4800	N/A	2	2	2	2	3	4	4
9600	N/A	N/A	N/A	N/A	N/A	N/A	2	2

SETUP

This command sets up the transceiver for checking antenna SWR or transmitter power with external measuring equipment. Do not use this mode during normal operation.

When the **SETUP** command is entered, the prompt changes to **SETUP>**, and:

- Hopping is disabled.
- Synthesizer frequencies are reset to the test frequencies specified by the **TX** and **RX** commands.
- The radio can be keyed using the **KEY** command. **DKEY** is used to unkey the radio. (If the radio is left in a keyed state it is automatically unkeyed after several minutes.)
- The **RSSI** is sampled in a raw, continuous fashion regardless of whether the unit is a master or a remote.

Entering **Q** or **QUIT** returns the system to normal operation.

A timer keeps the Setup mode from accidentally leaving the system disabled. After 10 minutes the system behaves as if **Q** or **QUIT** had been entered, returning to normal operation.

SHOW [PORT, DC, PWR]

The **SHOW** command displays three types of information based on the command variables. These are:

- **PORT**—Displays which connector port (RJ-11 or DB-9) 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.

SKIP [NONE, 1...8]

This command sets or displays which, if any, of the eight 3.2 MHz TransNET 900™ (128 frequency) zones will be skipped from the radio's hopping sequence. Skipping zones is one way of dealing with constant interference on one or more frequencies. See Section 4.3 (Page 10) for more information on dealing with interference.

Figure 18 shows the frequency range covered by each zone. The command parameter is either the keyword **NONE** or an undelimited string of up to seven digits where each digit 1...8 represents a corresponding zone to skip. (For zone parameter input, the digits can appear in any order and can be optionally separated by a blank space.) The **SKIP** command is read-only at remote radios. (Remotes must be synchronized with the master radio to read the skip status.)

MDS TransNET 900™ TRANSCEIVER

ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6	ZONE 7	ZONE 8
902.200 to 905.375	905.400 to 908.575	908.600 to 911.775	911.800 to 914.975	915.000 to 918.175	918.200 to 921.375	921.400 to 924.575	924.600 to 927.775

Figure 18. Frequency zones for MDS TransNET 900™ transceivers

SSNR

This command displays the signal-to-noise ratio of the received signal expressed in dB. As used in this guide, the 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 frame addressed for the receiving radio.) SNR is updated and latched for each valid frame received. A filter in the DSP tempers the effect of any sudden changes in the value.

SNR 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. For remote radios, a value of 0 is reserved to mean “no signal”; it is displayed whenever a remote is not in synchronization with the master station.

When the **SNR** command is used, it causes the DIAG(NOSTIC) port to enter an update mode, and it will provide an updated signal-to-noise ratio every 1.6 seconds. It stays in this mode until the **ENTER** key is pressed.

SREV

This command displays the software version currently loaded into the transceiver.

A display of **06-3111A01, 3.5.1** is an example of the software version identifier.

STAT

This command is used to check alarm status.

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

If more than one alarm exists, the word **MORE** appears at the bottom of the screen and additional alarms are viewed by pressing the **[ENTER]** key. Detailed descriptions of the alarm codes are provided in [Table 9 on page 36](#).

TTEMP

This command displays the internal temperature of the transceiver in degrees Celsius. (Note that the radio is specified to operate in an environment between –30 C° and +60 C°). This internal reading may be higher than the outside temperature by several degrees.

TX [xxxx]

This command sets or displays the test transmit frequency used in place of hopping whenever the radio is in Setup mode. The test transmit frequency can be reprogrammed to any value between 902.025 MHz and 927.975 MHz TransNET 900™, inclusive. The factory default settings are listed below and have been selected to be non-intrusive to normal system operation.

Default Transmit Frequencies		
	Master	Remote
MDS TransNET	927.975 MHz	902.025 MHz
900™	2400.08 MHz	2483.44 MHz

UNIT [10000–65000]

This command sets the unit addressing for network-wide diagnostics. The unit address is factory programmed to the last four digits of the serial number. If re-programmed in the field, the entry must consist of five digits between 10000 and 65000.

8.0 TROUBLESHOOTING

Successful troubleshooting of an MDS transceiver system is not difficult, but 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 instructions and synchronization data. If the master station has problems, the operation of the entire network will be affected.

When communication problems are found, it is good practice to begin by checking the simple things. All radios in the network must meet these basic requirements:

- Adequate and stable primary power
- An efficient and properly aligned antenna system
- Secure connections (RF, data & power)
- Proper programming of the radio's operating parameters, especially Mode selection (**MODE**), Network Address (**ADDR**), and interface Baud Rate (**BAUD**)
- The correct interface between the radio and the connected data equipment (proper cable wiring, data format and timing).

8.1 LED Indicators

The LED status indicators are an important troubleshooting tool and should be checked whenever a problem is suspected. [Table 8](#) describes the function of each status LED.



Table 8. LED status indicators

LED Name	Description
PWR	<ul style="list-style-type: none"> • Continuous—Power is applied to the radio, no problems detected. • Flashing 5 times per second—Fault indication. See Section 8.0, TROUBLESHOOTING (beginning on page 34). • Flashing once every 4 seconds—Radio is in Sleep Mode.
SYNC	Lights continuously to indicate the radio is receiving/sending synchronization frames. Within 16 seconds of start-up, this LED should be lit continuously.
TXD	Indicates EIA-232 space signal (logic high) input to the DB-9 connector.
RXD	Indicates EIA-232 space signal (logic high) output from the DB-9 connector.

8.2 Alarm Codes

When an alarm condition exists, the transceiver creates an alarm code. These codes can be very helpful in resolving many system difficulties.

Checking for Alarms—STAT command

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

If an alarm does exist, a two-digit alarm code (00–31) is displayed, and it is identified as a major or minor alarm. A brief description of the alarm is also given. Alarm codes and their meanings are listed in [Table 9](#).

If more than one alarm exists, the word **MORE** appears at the bottom of the screen; additional alarms can be viewed by pressing **ENTER**.

Major Alarms vs. Minor Alarms

Major alarms report serious conditions that generally indicate a hardware failure, or other abnormal condition that will prevent (or seriously hamper) further operation of the transceiver.

With the exception of alarm code 00 (network address not programmed), major alarms generally indicate the need for factory repair. Contact MDS for further assistance.

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

Alarm Code Definitions

Table 9 contains a listing of all event codes that may be reported by the transceiver.

Table 9. Alarm codes

Alarm Code	Alarm Type	Description
00	Major	The network address is not programmed.
01	Major	Improper software detected for this radio model.
02, 03	--	Reserved for factory use.
04	Major	One or more of the programmable synthesizer loops is reporting an out-of-lock condition.
05	--	Reserved for factory use.
08	Major	The system is reporting that it has not been calibrated. Factory calibration is required for proper radio operation.
09	--	Reserved for factory use.
10	Major	The microcontroller unit (MCU) was unable to properly program the system to the appropriate defaults. A hardware problem may exist.
11	--	Reserved for factory use.
12	Major	Receiver time-out alarm.
13-15	--	Reserved for factory use.
16	Minor	The unit address is not programmed.
17	Minor	A data parity fault has been detected on the DATA INTERFACE connector. This usually indicates a parity setting mismatch between the radio and the RTU.
18	Minor	A data framing error has been detected on the DATA INTERFACE connector. This may indicate a baud rate mismatch between the radio and the RTU.
19–24	--	Reserved for factory use.
27, 28	--	Reserved for factory use.
29	Minor	RF output power fault detected. (Power differs by more than 2 dB from set level.) Often caused by high antenna system SWR. Check antenna, feedline and connectors.
30	Minor	The system is reporting an RSSI reading below –105 dBm. Bit errors are likely to be present in the data.
31	Minor	The transceiver's internal temperature is approaching an out-of-tolerance condition. If the temperature drifts outside of the recommended operating range, system operation may fail.

8.3 Troubleshooting Chart

Table 10 provides suggestions for resolving system difficulties that may be experienced in the radio system. If problems persist, contact the factory for further assistance. Refer to the inside back cover of this guide for contact information.

Table 10. Troubleshooting chart

Difficulty	Recommended System Checks
Unit is inoperative.	<ul style="list-style-type: none"> a. Check for the proper supply voltage at the power connector. b. The transceiver's internal resettable fuse may have tripped. To reset it, momentarily remove and re-apply power to the radio.
Interference is suspected.	<ul style="list-style-type: none"> a. Verify that the system has a unique network address. Nearby systems with the same address will cause interference. b. Check for interference by locking out affected zone(s) using the SKIP command (Page 33). c. If omnidirectional antennas are used on remote stations, consider changing to directional antennas. This will often limit interference to and from other stations.
No synchronization with master, or poor overall performance.	<ul style="list-style-type: none"> a. Check for secure interface connections at the radio and the connected device. b. Check the antenna, feedline and connectors. Reflected power should be less than 10% of the forward power reading (SWR \approx2:1 or lower). c. If the remote radio is in synchronization, but performance is poor, check the received signal strength using the RSSI command (Page 30). If RSSI is low, it may indicate antenna problems, or misalignment of directional antenna headings. d. Verify proper programming of system parameters: mode, network address, data interface baud rate, transmitter power, CTS delay, etc. e. Check for alarms using the STAT command (Page 34)

9.0 TECHNICAL REFERENCE

The following section contains material that is not essential to using the radio, but may prove helpful in diagnosing performance problems or in gaining a better understanding of the unit's operation.

9.1 Technical Specifications

GENERAL

Frequency Hopping Range:	Up to 1028 frequencies within: MDS TransNET 900™: 902–928 MHz, configurable in 3.2 MHz zones
Hop Pattern:	Based on network address
Frequency Stability:	\pm 1.5 ppm
Simplex Operation:	User selectable
Half-Duplex Operation:	MDS TransNET 900™: \pm 1.6 MHz TX/RX split
Network Addresses:	65,000
Temperature Range:	-30°C to $+60^{\circ}\text{C}$
Humidity:	<95% at $+40^{\circ}\text{C}$; non-condensing

Primary Power:	13.8 Vdc (10.5–30 Vdc range)* * Units shipped prior to the year 2000 may be configured for 25 Vdc maximum DC input.
Supply Current (typical):	
Transmit:	MDS TransNET 900™: 400 mA @ 13.8 Vdc
Receive:	MDS TransNET 900™: 125 mA @ 13.8 Vdc
Sleep Mode:	<5 mA @ 13.8 Vdc
Size (excluding mtg. hardware):	
Enclosed Version:	5.30" x 3.50" x 1.40" 135 x 89 x 36 mm
: Board Version:	4.00"W x 3.25" x 0.50"
:	102 x 83 x 13 mm
Case:	Die-cast aluminum
Pending Approvals:	<ul style="list-style-type: none"> • FCC Part 15.247 • Industry Canada RSS-210 and RSS-139 • ETSI ETS 300 328 • UL/FM Class 1, Div. 2; Groups A, B, C and D hazardous locations • UL Listed • CE Mark • Contact MDS for information on availability and governmental approvals in other countries

DATA CHARACTERISTICS

Data Interface:	TTL/RS-232/RS-485
Interface Connector:	DB-9 female
Data Rate:	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps asynchronous
Data Latency:	<5 ms typical (buffer off)
Byte Length:	10 or 11 bits
Maximum Data Transmission:	Continuous up to 115200 bps

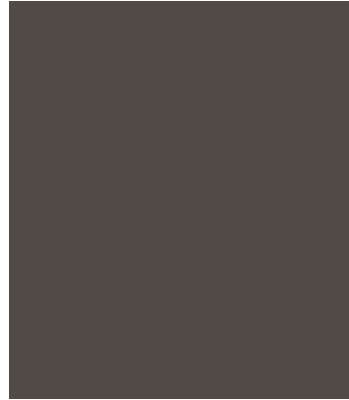
RF CHARACTERISTICS

TRANSMITTER:	
Power Output (at antenna connector):	MDS TransNET 900™: 0.1 to 1.0 watt (+20 dBm to +30 dBm) ±1.0 dB, set by user
Duty Cycle:	Continuous
Modulation Type:	Binary CPFSK
Output Impedance:	50 Ohms
Spurious:	-60 dBc
Harmonics:	-80 dBc
RECEIVER	
Type:	Double conversion superheterodyne
Bit-Error Rate:	MDS TransNET 900™: Less than 1x10 ⁻⁶ at -105 dBm
Intermodulation:	MDS TransNET 900™: 59 dB minimum (EIA)
Desensitization:	MDS TransNET 900™: 75 dB
Spurious:	70 dB minimum
Bandwidth:	MDS TransNET 900™: 200 KHz
Interference Ratio (BER degraded by 10 ⁻¹):	Co-channel:-10 dB Adjacent channel:+30 dB Two channels away:+50 dB Three channels away:+60 dB
Time Required to Synchronize with Master Radio:	Less than 10 seconds (typical)

9.2 Data Interface Connections (DB-9)

The DATA INTERFACE connector is used to connect the radio to an external DTE data terminal that supports the EIA-232 format. The radio supports data rates of 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 bps (asynchronous data only).

The DATA INTERFACE connector mates with a standard DB-9 plug that is available from many electronics parts distributors. Figure 19 shows the layout of the DATA INTERFACE connector. Table 11 lists each pin on the connector and describes its function.



**Figure 19. Data interface connector (DB-9) pins
As viewed from outside the radio**

Table 11. Data interface connector (DB-9) pin descriptions

Pin Number	Input/ Output	Pin Description
1	OUT	DCD—Data Carrier Detect A “high” indicates hopping synchronization.
2	OUT	RXD—Received Data Supplies received data to the connected device.
3	IN	TXD—Transmitted Data Accepts TX data from the connected device.
4	IN	Sleep Mode A ground on this pin turns off most circuits in the radio, including transmit, receive, modem, and diagnostic functions. This allows for greatly reduced power consumption, yet preserves the radio’s ability to be quickly brought on line. See Section 5.6, Using the Radio’s Sleep Mode (beginning on page 31) for details.
5	IN	Protective Ground Connects to ground (negative supply potential) on the radio’s PC board and chassis.

Table 11. Data interface connector (DB-9) pin descriptions(Continued)

Pin Number	Input/ Output	Pin Description
6	OUT	Alarm Output A logic low (less than 0.5 volts) on this in indicates normal operation. A logic high (greater than 4 volts) indicates that an alarm condition is present. This pin can be used as an alarm output, provided the internal series resistance of 1 kW is considered. DSR—Data Set Ready Provides a +6 Vdc DSR signal through a 2.5 kΩ resistor.
7	IN --	RTS—Request-to-Send Input Signal Ground Connects to ground (negative supply potential) at the radio's PC board.
8	OUT	CTS—Clear-to-Send Output Goes "high" after the programmed CTS delay time has elapsed (DCE), or keys an attached radio when RF data arrives (CTS KEY). DCD—Data Carrier Detect A "high" indicates hopping synchronization.
9	--	Unused.

9.3 dBm-Watts-Volts Conversion Chart

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

Table 12. dBm-Watts-Volts conversion—for 50 ohm systems

dBm	V	Po	dBm	V	Po	dBm	mV	Po	dBm	μV	Po
+53	100.0	200W	0	.225	1.0mW	-49	0.80		-98	2.9	
+50	70.7	100W	-1	.200	.80mW	-50	0.71	.01μW	-99	2.51	
+49	64.0	80W	-2	.180	.64mW	-51	0.64		-100	2.25	.1pW
+48	58.0	64W	-3	.160	.50mW	-52	0.57		-101	2.0	
+47	50.0	50W	-4	.141	.40mW	-53	0.50		-102	1.8	
+46	44.5	40W	-5	.125	.32mW	-54	0.45		-103	1.6	
+45	40.0	32W	-6	.115	.25mW	-55	0.40		-104	1.41	
+44	32.5	25W	-7	.100	.20mW	-56	0.351		-105	1.27	
+43	32.0	20W	-8	.090	.16mW	-57	0.32		-106	1.18	
+42	28.0	16W	-9	.080	.125mW	-58	0.286				
+41	26.2	12.5W	-10	.071	.10mW	-59	0.251		dBm	nV	Po
+40	22.5	10W	-11	.064		-60	0.225	.001μW	-107	1000	
+39	20.0	8W	-12	.058		-61	0.200		-108	900	
+38	18.0	6.4W	-13	.050		-62	0.180		-109	800	
+37	16.0	5W	-14	.045		-63	0.160		-110	710	.01pW
+36	14.1	4W	-15	.040		-64	0.141		-111	640	
+35	12.5	3.2W	-16	.0355					-112	580	
+34	11.5	2.5W				dBm	μV	Po	-113	500	
+33	10.0	2W	dBm	mV	Po	-65	128		-114	450	
+32	9.0	1.6W	-17	31.5		-66	115		-115	400	
+31	8.0	1.25W	-18	28.5		-67	100		-116	355	
+30	7.10	1.0W	-19	25.1		-68	90		-117	325	
+29	6.40	800mW	-20	22.5	.01mW	-69	80		-118	285	
+28	5.80	640mW	-21	20.0		-70	71	.1nW	-119	251	
+27	5.00	500mW	-22	17.9		-71	65		-120	225	.001pW
+26	4.45	400mW	-23	15.9		-72	58		-121	200	
+25	4.00	320mW	-24	14.1		-73	50		-122	180	
+24	3.55	250mW	-25	12.8		-74	45		-123	160	
+23	3.20	200mW	-26	11.5		-75	40		-124	141	
+22	2.80	160mW	-27	10.0		-76	35		-125	128	
+21	2.52	125mW	-28	8.9		-77	32		-126	117	
+20	2.25	100mW	-29	8.0		-78	29		-127	100	
+19	2.00	80mW	-30	7.1	.001mW	-79	25		-128	90	
+18	1.80	64mW	-31	6.25		-80	22.5	.01nW	-129	80	.1fW
+17	1.60	50mW	-32	5.8		-81	20.0		-130	71	
+16	1.41	40mW	-33	5.0		-82	18.0		-131	61	
+15	1.25	32mW	-34	4.5		-83	16.0		-132	58	
+14	1.15	25mW	-35	4.0		-84	11.1		-133	50	
+13	1.00	20mW	-36	3.5		-85	12.9		-134	45	
+12	.90	16mW	-37	3.2		-86	11.5		-135	40	
+11	.80	12.5mW	-38	2.85		-87	10.0		-136	35	
+10	.71	10mW	-39	2.5		-88	9.0		-137	33	
+9	.64	8mW	-40	2.25	.1μW	-89	8.0		-138	29	
+8	.58	6.4mW	-41	2.0		-90	7.1	.001nW	-139	25	
+7	.500	5mW	-42	1.8		-91	6.1		-140	23	.01fW
+6	.445	4mW	-43	1.6		-92	5.75				
+5	.400	3.2mW	-44	1.4		-93	5.0				
+4	.355	2.5mW	-45	1.25		-94	4.5				
+3	.320	2.0mW	-46	1.18		-95	4.0				
+2	.280	1.6mW	-47	1.00		-96	3.51				
+1	.252	1.25mW	-48	0.90		-97	3.2				

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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
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.

175 Science Parkway, Rochester, New York 14620
General Business: +1 (716) 242-9600
FAX: +1 (716) 242-9620
World Wide Web: <http://www.mdsroc.com>

175 Science Parkway, Rochester, New York 14620
General Business: +1 (716) 242-9600
FAX: +1 (716) 242-9620
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