1.0 INTRODUCTION

The transceiver, shown in Figure 1, is a spread spectrum radio designed for license-free operation. These units employ Digital Signal Processing (DSP) technology to provide highly-reliable long-distance communications, even in the presence of weak signals or interference.

The transceiver is housed in a compact and rugged die-cast enclosure 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 manual adjustments are required to configure the radio for operation.

In addition to these instructions, the *MDS TransNET Reference Manual* (05-2708A01) provides helpful guidance on TransNET systems. Electronic copies of all user documents and data sheets are available free of charge at **www.GEmds.com**.

1.1 Transceiver Features

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

- 902–928 MHz operation using the TransNET 900
- 2400–2482 MHz ISM band operation with the TransNET 2400
- User-selectable option to skip sub-bands with constant interference
- 65,000 available network addresses
- 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
- Store-and-Forward repeater operation
- Data latency typically less than 10 ms
- Same hardware for Master or Remote configuration
- Supports RS/EIA-232 and RS/EIA-485 user interface
- Low current consumption; typically less than 3 mA in “sleep” mode

Figure 1. MDS TransNET Series Transceiver

NOTE: Some radio features may not be available on all models, or limited by the options purchased, or the applicable regulatory constraints for the region in which the radio will operate.

1.2 Typical Applications

1.2.1 Multiple Address Systems (MAS)

This is the most common application of the transceiver. It consists of a central control station (Master) and two or more associated Remote units, as shown in Figure 2. An MAS network provides communications between a central host computer and remote terminal units (RTUs) or other data collection devices. The operation of the radio system is transparent to the computer equipment. When used in this application, the transceiver provides an excellent alternative to traditional (licensed) MAS radio systems.

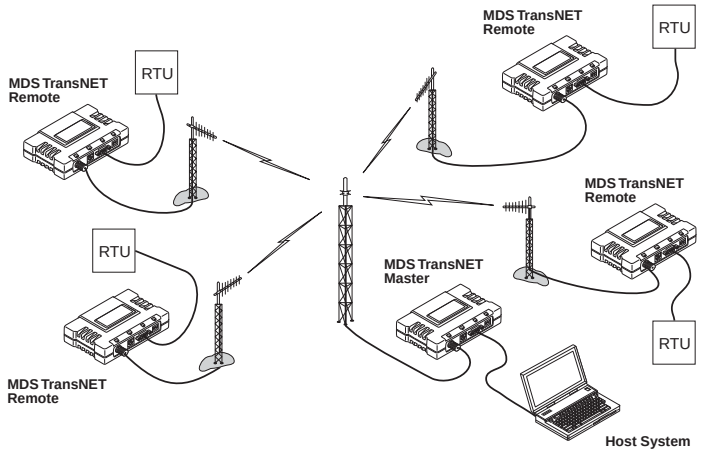

Figure 2. Typical MAS Network

1.2.2 Point-to-Point System

A point-to-point configuration (Figure 3) is a simple arrangement consisting of just two radios—a Master and a Remote. This provides a half-duplex communications link for the transfer of data between two locations.

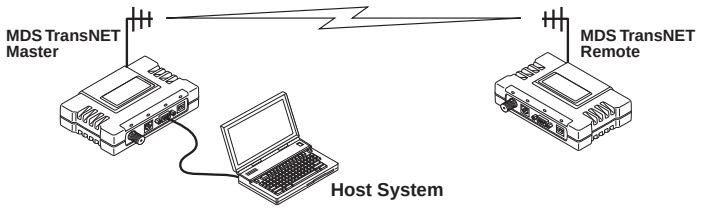

Figure 3. Typical Point-to-Point Link

1.2.3 Adding a Tail-End Link to an Existing Network

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, a TransNET radio links the outlying Remote site into the rest of a licensed MAS system by sending data from that site to an associated TransNET installed at one of the licensed Remote sites (see Figure 4 on Page 2).

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.

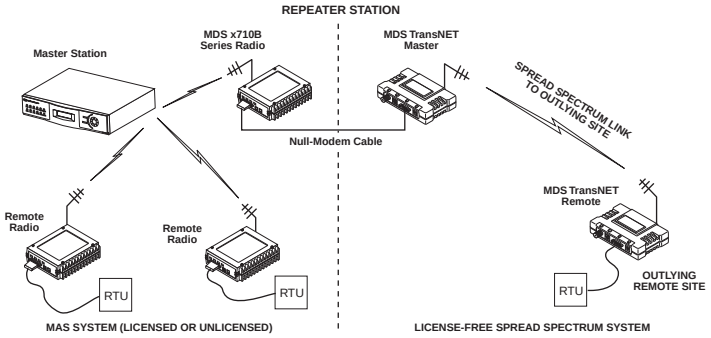

Figure 4. Typical Tail-End Link Arrangement

1.2.4 Extending a TransNET Network with a Repeater

Similar to a Tail-End Link, Store-and-Forward (SAF) offers a way to physically extend the network range, but in a simple and economical manner. SAF works by dividing a network into a vertical hierarchy of two or more sub-networks. Extension radios (designated as **MODE X**) serve as single-radio repeaters that link adjacent sub-networks, and move data from one sub-network to the next one.

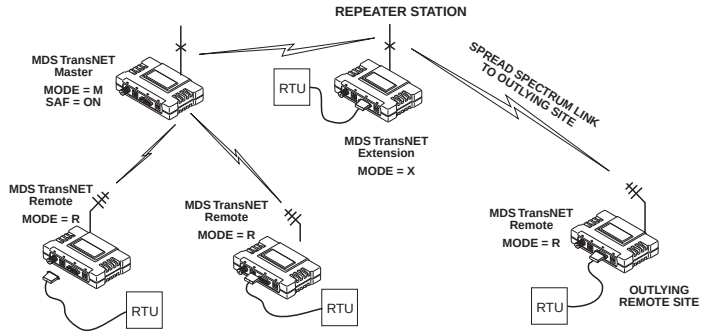

Figure 5. TransNET Repeater Network

1.3 Accessories

GE MDS offers an *Accessories Selection Guide* listing additional items that may be used with our products. Contact your factory representative or visit **www.GEmds.com** for the latest copy.

2.0 HARDWARE INSTALLATION

2.1 TransNET Installation

Figure 6 shows a typical Remote station arrangement. Master stations are similar, but an omni-directional antenna is normally used instead of a directional type, and a host computer replaces the data terminal equipment.

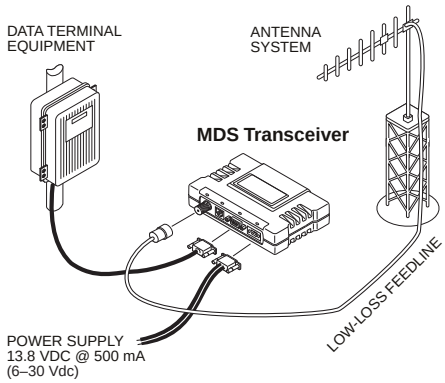

Figure 6. Typical Remote Station Arrangement

The following steps provide an overview of the installation procedure. For additional details, refer to the *MDS TransNET Reference Manual* (05-2708A01).

1. Select a site that provides stable power, protection from the weather, entrances for antenna and other cabling, and an antenna location with an unobstructed transmission path in the direction of the associated station(s).
2. Select and install an appropriate antenna and feedline for your system requirements.
3. Mount the transceiver to a stable surface using the brackets supplied with the radio (fasteners/anchors are not supplied).
4. Connect the data equipment to the transceiver's DATA connector. Use only the required pins for the application. Refer to Figure 7.
5. Measure and install the primary power for the transceiver. It must be within 6–30 Vdc (including transients) and be capable of providing 7.5 watts over this voltage range. (Typical current draw is 400 mA @13.8 Vdc; 0.9 A at 6 Vdc.) A power connector with screw-terminals is provided with each unit.

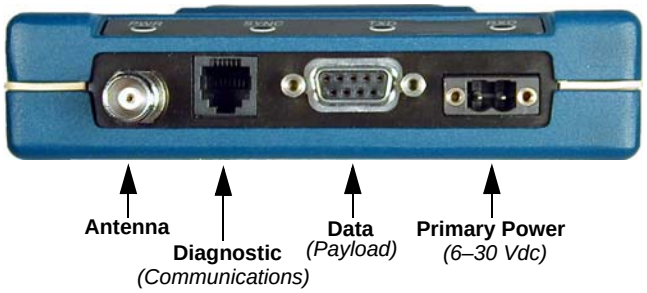

Figure 7. Interface Connector Functions

6. Set the radio's basic configuration with a PC terminal connected to the DIAG(nostics) connector via an RJ-11 to DB-9 adapter cable, MDS P/N 03-3246A01. For more information on connecting a PC terminal and preparing it for use, refer to the *MDS TransNET Reference Manual* (05-2708A01). Three essential settings for the transceiver are:
   - **Mode:** Master, Remote, or Extension
   - **Network Address:** A unique number from 1 to 65000
   - **Data Interface Parameters:** bps, data bits, parity, stop bits
7. Perform the initial start-up of the transceiver:
   a. Apply primary power.
   b. Observe the transceiver LED status panel for proper indications.

In a normally operating system, you will see the following indications 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.

8. Optimize the installation by checking:
   - Antenna aiming
   - Antenna SWR
   - Data buffer setting (Modbus protocol)
   - Hoptime setting
   - TotalFlow™ Protocol at 9600 with Sleep Mode
   - Operation at 115200 bps
   - Baud rate setting

- Radio interference checks

For more information on how to perform these optimization steps, refer to the *MDS TransNET Reference Manual* (05-2708A01).

3.0 RADIO PROGRAMMING

There are no manual adjustments on the radio. Programming and control is performed through a PC connected to the radio's **DIAG** connector. Programming is performed by either establishing a terminal connection to the radio (by using a terminal emulator such as HyperTerminal), or by connecting to the radio using *MDS TransNET Configuration Software* (P/N 06-4059A01). For more information, refer to the *MDS TransNET Reference Manual* (05-2708A01).

3.1 User Commands

The following tables provide brief descriptions of the various user commands for the transceiver. For more information, refer to the *MDS TransNET Reference Manual* (05-2708A01).

Table 1: Network Configuration—Master Station

COMMAND	DESCRIPTION
AT [ON, OFF]	Enables Master station to emulate a modem and respond to AT commands
BUFF [ON, OFF]	ON = Seamless data OFF = Fast byte throughput.
FEC [ON, OFF]	Sets/disables FEC (Forward Error Correction) setting.
HOPTIME [7, 28]	Displays hop-time or sets it to 7 or 28 ms.
LPM [1, 0]	Used at Master to set all associated stations in an energy-conservation mode. 1 = Low-power mode enabled network-wide 0 = Disable low-power mode (Default)
REPEAT	Sets/displays the fixed downstream re-send count.
RETRY [0–10]	Sets/displays the maximum upstream re-send count for ARQ (Automatic Repeat Request) operation
SAF [ON, OFF]	Enables/disables the store-and-forward function for the network controlled by this Master unit.
SKIP [NONE, 1...8]	Skip one or more frequency zones

Table 2: Network-Wide Diagnostics

COMMAND	DESCRIPTION
DLINK [xxxxx/ON/OFF]	Controls operation of diagnostic link function.
DTYPE [NODE/ROOT]	Set radio's operational characteristics for network-wide diagnostics

Table 3: Operational Configuration

COMMAND	DESCRIPTION
ADDR [1–65000]	Program network address
AMASK [0000 0000–FFFF FFFF]	Alarm response Default: FFFF FFFF
ASENSE [HI/LO]	Sense of the alarm output on Pin 6 of the DATA interface connector in the EIA-232 mode. Default: Alarm present = HI
BAND [A, B, C]	Selects one of three operating bands. *(2.4 GHz Model Only)*
BAUD [xxxxx abc]	Data communication parameters
CODE [NONE, 1...255]	Select the security/encryption setting in the radio
CSADDR [1–65000]	Used on a single Master/Remote network to support TDD-style simulated full-duplex.
CTS [0–255]	CTS delay in milliseconds (A value of 0 returns CTS immediately)
CTSHOLD [0–60000]	"Hold time" that CTS is present following last character from DATA port.
DEVICE [DCE, CTS KEY]	Device behavior: DCE (normal) or CTS Key
MODE [M, R, X]	Operating mode: M = Master, R = Remote, X = Extension
MRSSI [NONE, -40...-90]	Minimum RSSI level required to preserve synchronization with a Master radio for Remotes in mobile service.
OT [ON, OFF]	Enables a 1-second delay on delivery of RXD serial data.
OWN [xxxxx]	Owner's name, or alternate message (30 characters maximum)
PORT [RS232, RS485]	Data port (DATA connector) interface signaling mode: RS232 or RS485
PWR [20–30]	Power output in dBm
RXD [0–255]	Set RXD delay time for virtual seamless mode with low latency
RXTOT [NONE, 0–1440]	Maximum duration (in minutes) before time-out alarm. Default is OFF.
RTU [ON, OFF, 0–80]	Enable or Disable unit's built-in RTU simulator. Default is OFF. Set RTU address between zero and 80.
SLEEP [ON, OFF]	Enable or Disable the radio's energy-conservation Sleep mode function.
UNIT [10000–60000]	Unit address used for network-wide diagnostics. (Unique within associated network.)
XADDR [0–31]	This unit's Extended address Typically, the Master is set to zero (0).
XMAP [00000000–FFFFFFFF]	Included Extended units in MODE X. (Extensions and Remotes only)
XPRI [0–31]	Address of the primary Extended radio unit (Extension).

Table 3: Operational Configuration *(Continued)*

COMMAND	DESCRIPTION
XRSSI [NONE, -40...-120]	Minimum RSSI level required to preserve synchronization with a non-primary radio. (Only meaningful when XPRI is not NONE)
ZONE CLEAR	Reset zone data statistics

Table 4: Operating Status—Display Only

COMMAND	DESCRIPTION
ADDR	Network address
AMASK	Alarm mask (response)
ASENSE	Current sense of the alarm output.
BAUD	Data communication parameters. Example: BAUD 9600 8N1
BUFF	Data buffering mode: ON = seamless data, OFF = fast byte throughput
CODE	Security/encryption operational status. "NONE" (Inactive), or "ACTIVE"
CTS	CTS delay in milliseconds (0–255 ms)
CTSHOLD	"Hold time" that CTS is present following last character from DATA port.
DEVICE	Device behavior Alternatives: DCE and CTS KEY
HOPTIME	Hop-time value in milliseconds (ms).
LPMHOLD	Time (0-1000 ms) provided to give an RTU time to respond before the radio goes to sleep.
MODE	Current operating mode: M = Master R = Remote X = Extension (Repeater)
MRSSI	Minimum RSSI level required to preserve synchronization with a Master radio for Remotes in mobile service.
OWM	Owner's message or site name
OT	Status (ON/OFF) of the 1-second delay on delivery of RXD serial data.
OWN	Owner's name or system name
PORT	Current data port (DATA connector) interface signaling mode: RS232 or RS485
PWR	Forward power-output setting in dBm
REPEAT	The fixed downstream re-send count.
RETRY	The maximum upstream re-send count for ARQ (Automatic Repeat Request) operation.
RSSI	Received signal strength indicator (in dBm). Unavailable at Master unless SETUP is enabled.
RTU	RTU simulator's operational status (ON/OFF)
RXTOT	The amount of time (in seconds) to wait before issuing a time-out alarm.

Table 4: Operating Status—Display Only *(Continued)*

COMMAND	DESCRIPTION
SAF	Store-and-forward mode status in this unit. (ON/OFF)
SER	Serial number of radio
SHOW CON	Display virtual modem connection status
SHOW PWR	RF output power. Measured RF power in dBm.
SHOW SYNC	Information on synchronization source
SKIP	Frequency zones that are skipped
SLEEP	Radio's Sleep Mode setting. (At Remotes Only)
SREV	Transceiver firmware revision level
STAT	Current alarm status
TEMP	Transceiver's internal temperature (°C)
UNIT	Programmed unit address for network-wide diagnostics
XADDR	This unit's Extended address
XPRI	Address of the primary Extended radio unit (Extension).
XMAP	Included Extended units in MODE X. (Extensions and Remotes only).
XRSSI	Minimum RSSI level required to preserve synchronization with a non-primary radio. (Only meaningful when XPRI is not NONE)

Table 5: Diagnostic and Test Functions

COMMAND	DESCRIPTION
KEY	Enables the transmitter test. (must be in Setup mode).
DKEY	Turns off the transmitter test (must be in Setup mode).
TX [xxxx]	Set/display transmit test frequency (must be in Setup mode).
RX [xxxx]	Set/display receive test frequency. (must be in Setup mode).
SETUP	Enables Setup mode. Times out after 10 minutes. Press "Q" to quit.
ZONE DATA	Zone data statistics
ZONE CLEAR	Clears the Zone Data log

4.0 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 basics. 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 Operating Mode (MODE), Network Address (ADDR), and interface Baud Rate (BAUD). For TransNET 2400 check the sub-band (BAND).
- The correct interface between the radio and the connected data equipment (proper cable wiring, data format and timing).
- In store-and-forward systems there are several areas that should be checked or evaluated:
- Look for duplicate XADDR values on MODE M and MODE X radios. Duplicates will cause failures unless the radios are too far apart to hear each other.
- Check for errors in the synchronization qualifiers, XPRI and XMAP, on corresponding Remote radios.
- Verify SAF is enabled at the Master radio.

4.1 LEDs

Table 6 describes how to use the LEDs as a troubleshooting aid whenever you suspect a problem with the transceiver.

Table 6: LED Indicator Descriptions

Name	Description
PWR	• Continuous—Power is applied to the radio; no problems detected • Flashing (5 times-per-second)—Fault indication. See Section 4.0, *Troubleshooting*. • Off—Radio is unpowered or in Sleep mode
SYNC	Continuous—Radio is receiving/sending synchronization frames On within 10 seconds of power-up under normal conditions
TXD	Transmit data activity on the DB-9 DATA interface connector
RXD	Receive data activity on the DB-9 DATA interface connector

4.2 Alarm Codes

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

4.2.1 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 7.

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

Table 7: Alarm Codes

Alarm Code	Alarm Type	Description
00	Major	The network address is not programmed.
01	Major	Improper firmware detected for this radio model.
04	Major	One or more of the programmable synthesizer loops is reporting an out-of-lock condition.
08	Major	The system is reporting that it has not been calibrated. Factory calibration is required for proper radio operation.
10	Major	The DSP was unable to properly program the system to the appropriate defaults. A hardware problem may exist.
12	Major	Receiver time-out alarm.
16	Minor	The unit address is not programmed.
17	Minor	A data parity fault has been detected on the DATA 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 connector. This may indicate a baud rate mismatch between the radio and the RTU.
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.
31	Minor	The transceiver's internal temperature is approaching an out-of-tolerance condition. If the temperature drifts outside of the recommended operating range and the transceiver may fail.

4.2.2 Major Alarms versus 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.

4.3 Troubleshooting Chart

Table 8 provides suggestions for resolving system difficulties that may be experienced in the radio system. If problems persist, contact the factory for further assistance.

Table 8: Troubleshooting Guide

Difficulty	Recommended System Checks
Unit is inoperative	a. Check for the proper supply voltage at the power connector. b. The transceiver's internal fuse may have opened.
Interference is suspected	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. 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	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 ≈ 2:1 or lower). c. If the Remote radio is in synchronization, but performance is poor, check the received signal strength using the RSSI command. 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. For store-and-forward applications, also verify the following: **SAF** is **ON**; extended address is properly programmed at each extension; Remotes are using the proper values for **XPRI** and **XMAP**. e. Check for alarms using the **STAT** command.
BER is too high. Data throughput is spotty	a. The **RETRY** and **REPEAT** commands may be increased to deal with interference, or decreased to increase throughput and reduce latency. b. Try turning on FEC. FEC on gives some coding gain, but comes at the cost of reduced throughput.
Latency is too high	a. Reduce the **REPEAT** count. b. Turn **BUFF OFF**. **BUFF ON** ensures that no gaps occur in the data, but this comes at the cost of increased latency. c. Make sure **HOPTIME** is set to 7.

4.4 Technical Assistance

Factory technical assistance is available by contacting GE MDS during business hours (8:30 AM to 6:00 PM Eastern Time). Use one of the following means to contact the factory:

Telephone: (585) 241-5510
E-mail: GEmds.TechSupport@GE.com
Web: www.GEmds.com
FAX: (585) 242-8369

Part 15 Notice

This Equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case users will be required to correct the interference at their own expense.

This device complies 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.

Warning: Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

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