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 tools to help users do this. Refer to the discussion of the **SKIP** command (Page 49) for more information. In the USA, a maximum of four zones may be skipped, per FCC rules. Check the regulatory requirements for your region.
6. Interference can also come from out-of-band RF sources such as paging systems. Installation of a bandpass filter, such as Part No. 20-2822A02 in the antenna system may provide relief from this type of interference.
7. Proper use of the **RETRY** and **REPEAT** commands may be helpful in areas with heavy interference.

   The **RETRY** command sets the maximum number of times (1 to 10) that a radio will re-transmit upstream data over the air. Values greater than 1 successively improve the chances of a message getting through when interference is a problem.

   The **REPEAT** command sets a fixed number of unconditional retransmissions for downstream data.
8. The RF 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 and keeps power consumption to a minimum.

10.0 PROGRAMMING REFERENCE

All programming and control of the transceiver is performed through a PC terminal connected to the radio or the Evaluation Board DIAG connector. There are no manual adjustments or jumper settings used for configuration. This section explains how to establish terminal communication, and provides a complete list of user commands.

10.1 Programming Methods

Terminal Interface Mode

A PC may be used by operating it in a basic terminal mode (e.g., a HyperTerminal session) and entering the radio commands listed in the tables contained in this section. The PC must be connected to the radio via its 16-pin header connector, or, if using the Evaluation Board, via the modular diagnostics connector. In the latter case, an RJ-11 to DB-9 Adapter Cable (Part No. 03-3246A01) is required. A cable of this type may be constructed using the information shown in Figure 10 on Page 11.

Once a PC terminal is connected, communication (baud rate) is automatically established through the command interface. To access the command interface, press the **ESCAPE** key, followed by one or more **ENTER** keystrokes (delivered at about half-second intervals), until the ">" prompt is displayed.

NOTE: The diagnostic interface uses 8 data bits, 1 stop bit, and no parity. It automatically configures itself to function at 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 bps.

If the **DLINK** setting is **ON**, the interface will start out in Diagnostic Link mode. This is a special protocol used to support Network-Wide Diagnostics. The process described in the paragraph above causes the radio to exit diagnostic link mode and enter command mode. If there is no input in command mode for 5 minutes, the interface will revert back to diagnostic link mode.

PC-Based Configuration Software

The Windows™-based *TransNET Configuration Software* (P/N 06-4059A01) is designed for use with the OEM Transceiver. This software provides access to all of the radio's capabilities with the benefit of context-sensitive help. The program is shipped as part of the TransNET Support Package CD included with every order.

10.2 User Commands

A series of tables begin on the next page listing the various user commands for the OEM transceiver. The tables provide abbreviated command descriptions. Complete descriptions follow in Section 9.3.

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, the appropriate information or values, and then ENTER.

Table 11. Network Configuration—Master Station

COMMAND	DESCRIPTION
BAND [abc] *Details, page 41*	Selects which of three frequency ranges the transceiver will operate in.
BUFF [ON, OFF] *Details, page 42*	ON = Seamless data OFF = Fast byte throughput.
FEC [ON, OFF] *Details, page 44*	Sets/disables FEC (Forward Error Correction) setting.
HOPTIME [7, 28] *Details, page 44*	Displays hop-time or sets it to 7 or 28 ms.
REPEAT [0–10] *Details, page 47*	Sets/displays the fixed downstream re-send count.
RETRY [0–10] *Details, page 47*	Sets/displays the maximum upstream re-send count for ARQ (Automatic Repeat Request) operation
SAF [ON, OFF] *Details, page 49*	Enables/disables the store-and-forward function for the network controlled by this Master unit.
SKIP [NONE, 1...8] *Details, page 49*	Skip one or more frequency zones

Table 12. Network-Wide Diagnostics

Command	Description
DLINK [xxxxx/ON/OFF] *Details, page 43*	Controls operation of diagnostic link function.
DTYPE [NODE/ROOT] *Details, page 44*	Set radio's operational characteristics for network-wide *diagnostics*

Table 13. Operational Configuration—Set/Program

Command	Description
ADDR [1–65000] *Details, page 40*	Program network address
AMASK [0000 0000–FFFF FFFF] *Details, page 41*	Sets alarm response. Default: FFFF FFFF
ASENSE [HI/LO] *Details, page 41*	Sense of the radio's alarm output in the EIA-232 mode. Default: Alarm present = HI.
BAND [abc] *Details, page 41*	Selects which of three frequency ranges the transceiver will operate in.
BAUD [xxxxx abc] *Details, page 41*	Data communication parameters
CODE [NONE, 1…255] *Details, page 42*	Select the security/encryption setting in the radio.
CTS [0–255] *Details, page 43*	CTS delay in milliseconds. (A value of 0 returns CTS immediately)
CTSHOLD [0–60000] *Details, page 43*	"Hold time" that CTS is present following last character from DATA port.
DEVICE [DCE, CTS KEY] *Details, page 43*	Device behavior: DCE (normal) or CTS Key
LEDS [ON, OFF] *Details, page 45*	Enables/disables transceiver LEDs
MODE [M, R, X] *Details, page 45*	Operating mode: where M = Master, R = Remote
OWM [xxxxx] *Details, page 46*	Owner's message, or alternate message (30 characters maximum)
OWN [xxxxx] *Details, page 46*	Owner's name, or alternate message (30 characters maximum)
PORT [RS232, RS485] *Details, page 46*	Data port (DATA connector) interface signaling mode: RS232 or RS485
PWR *Details page 47*	Forward power-output setting in dBm
REPEAT [0–10] *Details, page 47*	Forward power output in dBm.
RXTOT [NONE, 0–1440] *Details, page 48*	Maximum duration (in minutes) before time-out alarm. Default is OFF.

Table 13. Operational Configuration—Set/Program *(Continued)*

Command	Description
RTU [ON, OFF, 0-80] *Details, page 48*	Enable or Disable unit's built-in RTU simulator. Default is OFF. Set RTU address between zero and 80.
SLEEP [ON, OFF] *Details, page 50*	Enable or Disable the radio's Sleep mode function.
UNIT [10000–65000] *Details, page 51*	Unit address used for network-wide diagnostics. (Unique within associated network.)
XADDR [0–31] *Details, page 51*	This unit's Extended address Typically, the Master is set to zero (0).
XPRI [0–31] *Details, page 51*	Address of the primary Extended radio unit (Extension).
XMAP [00000000-FFFFFFFF] *Details, page 51*	Included Extended units in MODE X. (Extensions and Remotes only).
XRSSI [NONE, –40...–120] *Details, page 51*	Minimum RSSI level required to preserve synchronization with a non-primary radio. (Only meaningful when XPRI is not NONE)
ZONE CLEAR *Details, page 51*	Reset zone data statistics

Table 14. Operating Status—Display Only

Command	Description
ADDR *Details page 40*	Network address
AMASK *Details page 41*	Alarm mask (response)
ASENSE *Details page 41*	Current sense of the alarm output.
BAND *Details page 41*	Shows which of three frequency ranges the transceiver is set to operate in (A, B, or C)
BAUD *Details page 41*	Data communication parameters. Example: BAUD 9600 8N1
BUFF *Details page 42*	Data buffering mode: ON = seamless data, OFF = fast byte throughput
CODE *Details page 42*	Security/encryption operational status. "NONE" (Inactive), or "ACTIVE"

Table 14. Operating Status—Display Only *(Continued)*

Command	Description
CTS *Details page 43*	CTS delay in milliseconds (0–255 ms)
CTSHOLD *Details page 43*	"Hold time" that CTS is present following last character from DATA port.
DEVICE *Details page 43*	Device behavior Alternatives: DCE and CTS KEY
HOPTIME *Details page 44*	Hop-time value in milliseconds (ms).
HREV *Details, page 45*	Hardware revision level
LEDS [ON, OFF] *Details, page 45*	Enables/disables transceiver LEDs
MODE *Details page 45*	Current operating mode: M = Master R = Remote X = Extension (Repeater)
OWM *Details page 46*	Owner's message or site name
OWN *Details page 46*	Owner's name or system name
PORT *Details page 46*	Current data port (DATA connector) interface signaling mode: RS232 or RS485
PWR *Details page 47*	Show forward power-output setting in dBm
REPEAT *Details page 47*	The fixed downstream re-send count.
RETRY *Details page 47*	The maximum upstream re-send count for ARQ (Automatic Repeat Request) operation.
SAF *Details page 49*	The store-and-forward function status.
SKIP *Details page 49*	Table of frequency zones programmed to be skipped
RSSI *Details page 48*	Received signal strength indicator (dBm). Unavailable at Master unless SETUP is enabled.

Table 14. Operating Status—Display Only *(Continued)*

Command	Description
RXTOT *Details page 48*	The amount of time (in seconds) to wait before issuing a time-out alarm.
RTU *Details page 48*	RTU simulator's operational status (ON/OFF)
SAF *Details page 49*	Store-and-forward mode status in this unit. (ON/OFF)
SER *Details page 49*	Serial number of radio
SHOW PWR *Details page 49*	Show measured RF output power in dBm
SHOW SYNC *Details page 49*	Information on synchronization source and depth
SKIP *Details page 49*	Frequency zones that are skipped
SLEEP *Details page 50*	Radio's Sleep Mode setting. (At Remotes Only)
SREV *Details page 50*	Transceiver firmware revision level
STAT *Details page 50*	Current alarm status
TEMP *Details page 50*	Transceiver's internal temperature (°C)
UNIT *Details page 51*	Programmed unit address for network-wide diagnostics
XADDR *Details page 51*	This unit's Extended address
XPRI *Details page 51*	Address of the primary Extended radio unit (Extension).
XMAP *Details page 51*	Included Extended units in MODE X. (Extensions and Remotes only).
XRSSI *Details page 51*	Minimum RSSI level required to preserve synchronization with a non-primary radio. (Only meaningful when XPRI is not NONE)

Table 15. Diagnostic and Test Functions

Command	Description
KEY *Details, page 45*	Enables the transmitter test. (Radio must be in Setup mode.)
DKEY *Details, page 44*	Turns off the transmitter test. (Radio must be in Setup mode.)
TX [xxxx] *Details, page 50*	Set/display transmit test frequency. (Radio must be in Setup mode.)
RX [xxxx] *Details, page 48*	Set/display receive test frequency. (Radio must be in Setup mode.)
SETUP *Details, page 49*	Enables Setup mode. Times out after 10 minutes. Press “Q” to quit.
ZONE DATA *Details, page 51*	Zone data statistics
ZONE CLEAR *Details, page 51*	Clears the Zone Data log

10.3 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 the commands listed above in section 9.2.

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.

A 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, causing the address to display as **NONE**. If the address is not set (or is set to a wrong value) it leaves the system in an invalid state, preventing operation and generating an alarm.

NOTE: It is recommended that the last four digits of the master radio’s serial number be used for the network address. This helps avoid conflicts with other users.

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.

ASENSE [HI/LO]

This command is used to set the sense of the radio's alarm output at Pin 3 of the 16-pin header connector. The default setting is HI which means an alarm exists when an RS-232 high is on Pin 3.

BAND [abc]

The **BAND** command is used to select one of three frequency ranges that the transceiver will operate in (A, B, or C). All transceivers in a given network *must* have the same band setting or communication will not be possible. Conversely, radios may be set to different bands to enable up to three separate radio networks to operate in the same vicinity, without cross-network interference.

Each frequency band is approximately 26 MHz wide, and contains eight "zones" within. These zones are described in more detail under the **ZONE DATA** command (see Page 51). The frequency ranges for each band are as follows:

Band A: 2.4016–2.4270 GHz
Band B: 2.4272–2.4526 GHz
Band C: 2.4528–2.478.2 GHz

BAUD [xxxxx abc]

This command sets or displays the communication attributes for the normal payload communications through the DATA 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, 38400, 57600, or 115200. At baud rates of 19200 bps or less, the radio can support unlimited continuous data transmission at any hop rate.

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 9600 baud, 8 data bits, no parity, 1 stop bit (Example: **19200 8N1**).

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

BUFF [ON, OFF]

This command sets or displays the received data handling mode of the radio. The command parameter is either **ON** or **OFF**. (The default is **OFF**.) The setting of this parameter affects the timing of received data sent out the DATA 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 port as soon as an incoming RF data frame is processed. 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 the entire packet has been collected. The delay introduced by data buffering is variable and depends on message size and the number of retransmissions required, 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.

Seamless mode (**BUFF ON**) is intended only for applications where the message size is 256 characters or less. Enforcement of this rule is left up to the user. If more than 256 characters are transmitted data delivery will not be seamless and data may be lost.

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.

CODE [NONE, 1…255]

The **CODE** command is used to select or display the security/encryption setting in the radio.

The default is **CODE NONE**. Setting **CODE** to a value other than **NONE** provides an extra level security beyond that provided by the Network Address (**ADDR**). The disadvantage is increased complexity in managing the network.

The **CODE** command takes an argument **1…255,** or "**NONE**". Entering **CODE** without an argument will display either "**NONE**" or "**ACTIVE**". **ACTIVE** means that security/encryption has been enabled, but the radio *will not* display the security argument.

When a **CODE** value is active, *all radios in the system must use the same code value*. If the code value is not properly programmed, a remote radio will not synchronize with the master.

CAUTION: Record the **CODE** value and store it in a safe place. If the code is later forgotten, and a unit is to be added to the system, all radios in the network must be set to **NONE** and then reprogrammed to a new value.

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 be asserted immediately following the assertion of RTS.

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 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 [0–60000]

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 port. This "hold time" can be used to prevent squelch tail data corruption when communicating with other radios.

The **CTSHOLD** setting can range from 0 to 60000 (i.e., 60 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 or tail-end link 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 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.

DLINK [xxxxx/ON/OFF]

DLINK ON enables use of *Diagnostic Link* mode and establishes it as the default protocol on the RJ-11 DIAG port. *Diagnostic Link* mode is a special protocol used to support Network-Wide Diagnostics. **DLINK** must be set to **ON** to support connection to *InSite* or to support chained diagnostics between radio networks. **DLINK OFF** disables this feature. The default setting is **ON**.

The following **DLINK** baud rates selections are allowed:

- 1200 • 4800 • 9600 • 19200 (default)
- 38400 • 57600 • 115200

Example: **DLINK 4800** sets the RJ-11 DIAG port to operate at 4800 bps when diagnostics is "closed". This setting will not affect the port's autobaud operation. Use only of **DLINK ON,** will enable the use 19200 or the most recently programmed value. The default is **DLINK 19200** and **DLINK ON**.

NOTE: The same baud rate must be entered into the InSite Equipment List's **BAUD** field.

NOTE: The DLINK rate must match the rate of any connected device to the diagnostic port. This may be either another radio's diagnostic port, the InSite computer, or another data link device that eventually connects to the InSite computer.

DKEY

Disables the transmitter when it is keyed. See also **KEY** command.

DTYPE [NODE/ROOT]

The **DTYPE** command specifies the radio's operational characteristics for network-wide diagnostics. The transceiver uses the following types:

- **NODE**–The most common setting, and the default. This is the basic system radio device-type. Typically, the radio network is comprised of nodes and one root. Intrusive diagnostics can originate from any node. However, non-intrusive diagnostics can only be conducted from the root node.
- **ROOT**–Always one, and only one, per network (including units associated through Extension units.) The root is the focal point of network-wide diagnostics information. Intrusive diagnostics can originate from any radio, including the root. However, the root is the *only* radio through which non-intrusive diagnostics can be conducted.

FEC [ON, OFF]

This command is used to view the FEC setting, or turn it on or off. The default setting is **FEC ON**. (It needs to be turned off when throughputs exceed 57,600 bps.) FEC is set at the master and is automatically passed on to all of the remotes in a network.

Setting FEC to **ON** improves sensitivity at the cost of reduced throughput. Typical SCADA/telemetry applications use low data rates and, as such, the FEC setting is normally transparent to them.

HOPTIME [7, 28]

The **HOPTIME** command is used to set or display the hop-time setting. The command is a digit corresponding to the hop-time setting in milliseconds. The default **HOPTIME** setting is **7**. A setting of **28** must be used when throughputs exceed 57,600 bps.

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.

INIT

The **INIT** command is used to reset the radio's operating parameters to the factory defaults listed in Table 16 on Page 46. This may be helpful when trying to resolve configuration problems that resulted from the entry of one or more improper command settings. If you are unsure of which command setting caused the problem, this command allows you to get back to a known working state.

NOTE: Caution should be exercised when using the **INIT** command on radios in a system employing the Store-and-Forward feature. Settings relating to the use of Extension services will be lost and will need to be re-entered. Inventory and record the settings for **XADDR**, **XPRI** and **XMAP** before using the **INIT** command.

SPECIAL NOTE: Installing firmware of Revision 2.0 or later into a radio with Revisions 1.x firmware will preserve the radio's compatibility with other radios running Revision 1.x firmware. If updating the radio's firmware is part of a system-wide upgrade, the last step should be to use the **INIT** command at the Master station. Use of the **INIT** command causes the changes shown in Table 16 on Page 46 to be applied

HREV

Shows the Hardware revision of the radio.

KEY

Enables the transmitter. (Radio must be in Setup mode.) See also **DKEY** command.

LEDS [ON, OFF]

This command is used to view the LED setting, or to enable/disable LED operation. In power-critical applications (battery/solar powered sites, for example), it may be desirable to turn off the LEDs.

MODE [M, R, X]

The **MODE** command sets or displays the operating mode of the radio. A master radio is set by **MODE M**; a remote set by **MODE R**, and an Extension is set by **MODE X**.

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

If **MODE X** is used, the **MODE X** radio should be programmed with an Extended Address (**XADDR**). Units that need to hear this **MODE X** radio must be programmed with an appropriate **XPRI** and/or **XMAP** value.

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.

PORT [RS232, RS485]

Select or identify the current data interface signaling mode: **RS232** or **RS485**. This is the port though which the payload data will pass. Pin descriptions for EIA-232 are on Page13 and EIA-485 can be found on Page13. Note: This command will always show **TTL** if the radio is only equipped for TTL service—see model number configuration code on Page 3.

PWR [17–21]

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 through 27 in 1 dBm steps. The default setting is 27 dBm (0.5 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 10 dBi must decrease the **PWR** setting accordingly.

Table 16. INIT Command Generated Defaults

Parameter	Default Setting	Corresponding Command
For all radios		
Device operation	DCE	**DEVICE DCE**
CTS delay	0 (CTS is continuously asserted)	**CTS 0**
CTS hold-time	0	**CTSHOLD 0**
DATA Interface port	• 9600 baud • 8 data bits • none (no parity) • 1 stop bit	**BAUD 9600 8N1**
Alarm Mask	FFFF FFFF	**AMASK**
Alarm Output Sense	RS-232 High (+5.0 Vdc)	**ASENSE**
RX Time-out-Timer	None/Disable	**RXTOT**
Transmitter test frequency	2.4xx GHz	**TX xxx**

Table 16. INIT Command Generated Defaults *(Continued)*

Parameter	Default Setting	Corresponding Command
Receiver test frequency	2.4xx GHz	**RX xxx**
Sleep Enable	OFF	**SLEEP OFF**
Data Port Setting	RS/EIA-232	**PORT RS232**
Primary Extension Radio Address	0 (Master)	**XPRI 0**
Synchronization Source Map	None	**XMAP 0**
Extended Address	0	**XADDR 0**
For MASTER radios		
Skipped frequencies	None (radio will hop across all frequencies)	**SKIP NONE**
Hop-time	7 ms	**HOPTIME 7**
Buffer mode	OFF	**BUFF OFF**
Retry Count	10 (max. 10 repeats for ARQ)	**RETRY 10**
Repeat Count	3 (downstream repeats)	**REPEAT 3**
Forward Error Correction	ON	**FEC ON**

REPEAT [0–10]

The **REPEAT** command affects “downstream” data. The command causes a Master or Extension to always repeat transmissions for the specified number of times (range is 0 to 10; default selection is 3). Unlike the **RETRY** command, there is no acknowledgment that a message has been received. To display the current setting, use the **REPEAT** command without entering a value.

RETRY [0–10]

The **RETRY** command affects upstream data. The command selects, or displays, the maximum number of times (0 to 10) that a remote radio will re-transmit data. The default setting is 10.

This command is associated with ARQ (Automatic Repeat Request) operation of the radio and is intended for use in areas with heavy radio interference.

When the **RETRY** command is issued without parameters, the maximum retransmission count is shown. A value of 0 represents no retries, while values of 1 or greater successively improve the chance of data delivery in spectrally harsh environments (at the expense of possibly increased latency). The **RETRY** value is only settable at the Master. It is readable by a synchronized Remote.

RSSI

This command displays the radio's Received Signal Strength Indication in dBm (decibels relative to 1 mW). The output can range from –40 dBm to –120 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.) 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 will not indicate signals stronger than –40 dBm.

RTU [ON, OFF, 0-80]

This command re-enables or disables the radio's internal RTU simulator, which runs with proprietary polling programs such as 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. The default RTU setting is **OFF**.

RX [xxxx]

This command sets or displays the test receive frequency used in place of hopping when the radio is in **SETUP** mode. The test receive frequency can be reprogrammed to any value between 2.4016 GHz and 2.4782 GHz, inclusive. The factory default setting is 2.42420 GHz.

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 setting is **NONE**.

SAF [ON, OFF]

This command enables/disables the operation of the Store-and-Forward services. It can be set only at the network's Master station, but will effect all radios in the associated network. The default setting is OFF. See related commands: "XADDR [0–31]" on Page 51, "XPRI [0–31]" on Page 51, and "XMAP [00000000-FFFFFFFF]" on Page 51.

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 described earlier.
- 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.

SER

Displays the Serial Number of the radio.

SHOW PWR

The **SHOW PWR** command 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.

SHOW SYNC

When used at a Remote station, this command will display **Extended Address** and **Unit Address** of the Master or Extension radio to which the Remote is synchronized. The network depth at the remote, defined as the number of downstream links from the Master, is displayed in parentheses.

SKIP [NONE, 1...8]

This command sets or displays which, if any, of the eight 3.2 MHz-wide 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 "DEALING WITH INTERFERENCE" on Page 32 for more information on dealing with interference.

The command parameter is either the keyword **NONE** or an undelimited string of up to four 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 display-only at remote radios. (Remotes must be synchronized with the master radio to display the skip status.)

In the USA, a maximum of four zones may be skipped, per FCC rules. Check the regulatory requirements for your region before deleting zones.

SLEEP [ON, OFF]

This command is used to set or display the radio's Sleep Mode setting. The default setting is **SLEEP OFF**. When this mode is enabled (ON), a ground or logic low on Pin 6 of the 16-pin header connector (J3) suspends all normal radio functions, and power consumption is reduced to approximately 8 mA. The radio remains in this state until the low is removed. This function cannot be turned on for a Master or Extension radio.

SREV

This command displays the version of the firmware currently loaded into the transceiver.

A display of **06-4040A01, 2.0.0** is an example of the firmware version identifier—part number followed by release/version number.

STAT

This command is used to check the alarm status of the radio. If no alarms exist, the message **NO ALARMS PRESENT** is returned.

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

If more than one alarm exists, the word **MORE** appears, and additional alarms may be viewed by pressing the ENTER key. Detailed descriptions of the alarm codes are provided in Table 17 on Page 54.

TEMP

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 2.4016 GHz and 2.4782 GHz, inclusive. The factory default setting is 2.42420 GHz.

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.

XADDR [0–31]

Display or program the Extended Address of this radio that will serve as a common address for the sub-network synchronized to this Master or Extension. This value can be listed in the **XPRI** parameter of associated Extension or Remote radios to allow them to synchronize to this radio. We recommend setting the Master to zero (0). It is easy to remember, and is the default address when the INIT command is used. (Programmed only in Master and Extension radios.)

XMAP [00000000-FFFFFFFF]

XMAP is a 32-bit hex entry where the least significant bit represents XADDR 0 and the most significant bit represents XADDR 31. The full 32-bit hex value represents the entire list of extensions with which the radio will be allowed to communicate. (Remotes and Extensions only.)

This parameter is easily programmed through the *TransNET Configuration Software's* **Store and Forward Settings** panel.

XPRI [0–31]

Display or program the extended address of a primary radio with which this radio will attempt to synchronize and communicate. A setting of **NONE** will allow the unit to synchronize with any Master or Extension in the **XMAP** list. (Parameter only meaningful for a Remote or Extension.)

XRSSI [NONE, –40...–120]

The XRSSI command is used to set the RSSI minimum signal level required to preserve synchronization with a non-primary Extension radio. This parameter will be ignored if XPRI is set to NONE.

ZONE CLEAR

The **ZONE CLEAR** command clears the zone data for *all* zones in the Zone Data Log, resetting the count to 0. (Zone data is also cleared automatically upon reboot.)

ZONE DATA

The transceiver divides its frequency operating spectrum into eight 3.2 MHz-wide zones. (These are the same zones referenced by the **SKIP** command described earlier.) Data frame statistics are maintained for each zone to indicate the transmission quality of data through the network. This information is useful for identifying zones where significant interference exists.

Zone quality information can be accessed using the **ZONE DATA** command. For each zone (1–8), it shows you the number of data frames sent, the number received, and the number received with errors. If an excessive number of errors are seen in one or more frequency zones, it may indicate interference, and you should consider "skipping" those zones using the **SKIP** command.

Note: If a frequency zone has been skipped, all counts for that zone will be zeros.

The **ZONE DATA** format is displayed as follows:

1:TX TOTAL 00000000

1:RX TOTAL 00000000

1:RX ERROR 00000000

x:

x:

x:

8:TX TOTAL 00000000

8:RX TOTAL 00000000

8:RX ERROR 00000000

All data is based on payload packets. Incoming network data may be divided up into multiple packets for over-the-air transfers. The number before the colon represents the zone. **TX TOTAL** is the transmit packet total. **RX TOTAL** is the receive packet total. **RX ERROR** is the total number of received packets with CRC errors. All zone data is reset with the **ZONE CLEAR** command.

11.0 TROUBLESHOOTING

Successful troubleshooting of the radio 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).
- In store-and-forward systems there are several areas that must be carefully evaluated:

- Duplicate **XADDR** values on **MODE M** and **MODE X** radios will cause failures unless the radios are far enough apart to not hear each other.
- Errors in the synchronization qualifiers, **XPRI** and **XMAP**, on corresponding Remote radios.
- **SAF** must be enabled at the Master

11.1 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 17.

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 your factory representative 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 17 contains a listing of all event codes that may be reported by the transceiver.Additional alarm codes may be used in future firmware releases or are used by the factory.

Table 17. 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, system operation may fail.

11.2 LED Indicators

The LED indicators on the transceiver board (CR3, CR-4, CR-5 and CR-6) are an important troubleshooting tool and should be checked whenever a problem is suspected. Table 18 describes the function of each status LED.

Table 18. LED indicator descriptions

LED Name	Description
RXD (CR3) Receive Data	Serial receive data activity. Payload data from connected device.
TXD (CR4) Transmit Data	Serial transmit data activity. Payload data to connected device.
DCD (CR5) Data Carrier Detect	Continuous—Radio is receiving/sending synchronization frames On within 10 seconds of power-up under normal conditions
GP (CR6) General Purpose	• Continuous—Power is applied to the radio; no problems detected • Flashing (5 times-per-second)—Fault indication. See “TROUBLESHOOTING” on Page 52 • Off—Radio is unpowered or in Sleep mode

11.3 Troubleshooting Chart

Table 19 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 19. Troubleshooting chart

Difficulty	Recommended System Checks
Unit is inoperative.	a. Check for the proper supply voltage at the transceiver, J3 Pins 5 and11. b. If using the Evaluation Board, the surface mount fuse may have opened. Refer to Section 4.3 below for replacement instructions.
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 and lockout any affected zone(s) using the **SKIP** command (Page 49). 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 (Page 48). 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 (Page 50)
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 insures that no gaps occur in the data, but this comes at the cost of increased latency. c. Make sure **HOPTIME** is set to 7.

11.4 Network-Wide Remote Diagnostics

Diagnostics data from a remote radio can be obtained by connecting a laptop or personal computer running *InSite* diagnostics software (V6.6 or later) at any radio in the network.

NOTE: The diagnostics feature may not be available in all radios. The ability to query and configure a radio via Network-wide Diagnostics is based on the feature options purchased in the radio being polled.

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

A complete explanation of remote diagnostics can be found in the *Network-Wide Diagnostics System Handbook* (Part No. 05-3467A01).

Table 20. Network-Wide Diagnostics Commands

Command	Description
DLINK [xxxxx/ON/OFF] *Details, page 43*	Set baud rate of diagnostics link
DTYPE [NODE/ROOT] *Details, page 44*	Set radio's operational characteristics for network-wide diagnostics

1. Program one radio in the network as the root radio by entering the **DTYPE ROOT** command at the radio.
2. At the root radio, use the **DLINK ON** and **DLINK [baud rate]** commands to configure the diagnostic link protocol on the RJ-11 port.
3. Program all other radios in the network as nodes by entering the **DTYPE NODE** command at each radio.
4. Use the **DLINK ON** and **DLINK [baud rate]** commands to configure the diagnostic link protocol on the RJ-11 port of each node radio.
5. Connect a PC on which *InSite* software is installed to the root radio, or to one of the nodes, at the radio's diagnostics port.

   To connect a PC to the radio's DIAG port, an RJ-11 to DB-9 adapter (Part No. 03-3246A01) is required. If desired, an adapter cable may be constructed from scratch, using the information shown in Figure 10 on Page 11.
6. Launch the InSite program at the PC. (Refer to the InSite user's manual for details.)

12.0 FIRMWARE UPGRADES

From time to time, the factory releases new firmware for its radio products. An upgraded file can be installed in existing radios to take advantage of engineering improvements or additional features.

12.1 Obtaining new firmware

The latest firmware for each radio type may be obtained free of charge from our website: **www.microwavedata.com/service/technical/support/downloads/.**

Firmware is also available on disks from the factory that are bundled with an installation utility (*Radio Software Upgrade*—upgrade.exe) for transferring the firmware file on the disk to the radio.

Saving a Web-site firmware file to your PC

Firmware upgrades are distributed as a plain-text (ASCII) file with a ".S28" extension. Browse to find the desired ".S28" file for your radio on the factory website at **www.microwavedata.com**. After finding your selection, use the right mouse button to select a path on your computer on which to save the file. (If this isn't done, your browser may display the firmware file contents as text on the screen instead of downloading it to your local hard drive.)

After the ".S28" file has been saved to your computer, you may use either *TransNET Configuration Software* or *Radio Software Upgrade programs* to install this firmware in your radios.

12.2 Installing firmware in your radio

1. Connect a PC to radio's diagnostic interface.
2. Start the *TransNET Configuration Software*. Open diagnostics port to the radio. The program will automatically read the radio's profile.
3. From the **File** menu select **Radio Firmware Upgrade** and follow the prompts to install the new firmware into the radio. Do not press the **Cancel** button once the installation has started or it will leave the radio without any code. When the installation is complete, another radio may be connected to your PC and programmed.

NOTE: If a firmware installation fails, the radio is left unprogrammed and inoperative. This is indicated by the PWR LED flashing slowly (1 second on/1 second off). This condition is only likely to occur if there is a power failure to the computer or radio during the installation process. The installation should be attempted again.

13.0 Security

Today, the operation and management of an enterprise is becoming increasing dependent on electronic information flow. An accompanying concern becomes the security of the communication infrastructure and the security of the data itself. We take this matter seriously, and provide several means for protecting the data carried over our wireless products.

Our radios address this issue primarily through the use of the following items:

1) A proprietary modem/data link layer—Data signals are processed using code and hardware specifically designed by the manufacturer.
2) A unique Network Address—This provides a unique identifier for each radio in a network. A radio is not addressable unless this unique code is included in the data string.
3) An optional encryption value (code)—Setting an encryption code requires the use of the **CODE** command. This command scrambles the radio's hop pattern and encrypts payload data content. A radio requires the correct Network Address (**ADDR**) and **CODE** value in order to synchronize. When the **CODE** command is used, the same value must be programmed into all radios in the network. See "CODE [NONE, 1…255]" on Page 42 for more details.

   The effective combination of **CODE** and **ADDR** discourage the use of an exhaustive search to gain access to a system.

The items described above provide sufficient security for most systems. For highly-sensitive applications, system designers should consider employing application level encryption into their polling protocols to further protect their systems. Third party software tools are available for adding encryption, and these should be considered as part of any advanced encryption scheme.

14.0 Product Specifications

GENERAL

Frequency Hopping Range:	Up to xx frequencies within each band: 2.4016–2.4270 GHz (Band A) 2.4272–2.4526 GHz (Band B) 2.4528–2.478.2 GHz (Band C) Above are configurable in 3.2 MHz zones.
Hop Pattern:	Based on network address
Frequency Stability:	±1.5 ppm
Half-Duplex Operation:	±1.6 MHz TX/RX split
Network Addresses:	65,000
Temperature Range:	–40° C to +70° C
Humidity:	<95% at +40° C; non-condensing
Primary Power:	13.8 Vdc (5–25 Vdc range)
Current Draw (typical):	 Transmit: 510 mA @ 13.8 Vdc Receive: 115 mA @ 13.8 Vdc Sleep Mode: 8 mA @ 13.8 Vdc
Physical Dimensions:	1.81"W x 3.45"L x 0.63"H (46 x 87.5 x 16 mm)
Agency Approvals (pending):	• FCC Part 15.247 (E5MDS-EL806-2.4) • FCC Limited Modular Approval (LMA) • Industry Canada RSS-210 and RSS-139 (CAN 3738A-MDSEL806-2.4)

DATA CHARACTERISTICS

Data Interface:	RS-232/422/485
Interface Connector:	16 pin header, female
Data Rate:	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps asynchronous
Data Latency:	7 ms (typical)
Byte Length:	10 or 11 bits
Maximum Data Transmission:	Continuous up to 115200 bps

RF CHARACTERISTICS

TRANSMITTER:	
Power Output (at antenna connector):	50 mW to 0.5 Watt (+17 to +27 dBm) Refer to Table 7 on Page 24
Duty Cycle:	Continuous
Modulation Type:	Binary CPFSK
Output Impedance:	50 Ohms
Spurious:	–60 dBc
Harmonics:	–55 dBc
RECEIVER:	
Type:	Double conversion superheterodyne
Sensitivity:	–108 dBm @ 1 x 10^{-6} BER
Intermodulation:	54 dB minimum (EIA)
Desensitization:	75 dB
Spurious:	70 dB minimum
Bandwidth:	200 kHz
Interference Ratio (SINAD degraded by 3dB):	Co-channel:–10 dB Adjacent channel:+30 dB Two channels away:+40 dB Three channels away:+48 dB
Time Required to Synchronize with Master Radio:	0.5 seconds (typical)

:14.1 Detailed Pin Descriptions

The tables in this section give detailed pin functions for the transceiver's 16-pin header connector, J3 (see Figure 21). The tables are organized according to the available signaling configurations of the OEM transceiver. (Figure 2 on Page 3 may be used to determine which configuration you have.) Signaling configuration is hardware fixed at the time of manufacture and will be one of the following:

- TTL signaling for *both* Payload and Diagnostic data
- Payload data TTL; Diagnostic data RS-232
- Payload data RS-232/RS-485 selectable; Diagnostic data RS-232

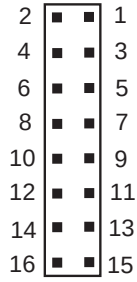

Figure 21. 16-pin Header Connector (J3) on OEM Transceiver Board

(See parts list (Page18) for information on matching connector)

Table 21. Transceiver Connector J3 Pinouts
(Payload data TTL; Diagnostic data TTL)

Pin No.	Input/ Output	Signal Type	Name/Description
1	IN	--	**Ground—**Connects to ground (negative supply potential).
2	OUT	TTL, 3 Vdc	**Diagnostic TXD—**Supplies received diagnostic/administrative data to the connected device.
3	OUT	TTL, 3 Vdc	**Alarm condition—**A low indicates normal operation. A high indicates an alarm. (See ASENSE [HI/LO] command for more information.)
4	IN	TTL, 3 Vdc	**Diagnostic RXD—**Accepts diagnostic/administrative data from the connected device.
5	IN	--	FCC 6-18 Vdc version: **DC Input (5-25 Vdc)—** Supply Source must be capable of furnishing at least 7.5 watts. Non-FCC 3 Vdc version: **Do not connect**
6	IN	TTL, 3 Vdc	**Sleep Mode Input—**A ground on this pin turns off most circuits in a remote radio. This allows for greatly reduced power consumption, yet preserves the radio's ability to be brought quickly back on line. See "Sleep Mode Operation (Remote units only)" on Page 31 for details.
7	OUT	TTL, 3 Vdc	**Data Carrier Detect (DCD)—**A low indicates hopping synchronization has been achieved.
8	IN	TTL, 3 Vdc	**Power Supply Shutdown Control—**A ground on this pin causes the OEM module's power supply to shut down.
9	--	--	Non-FCC 3 Vdc version: **DC Input (Regulated 3.3 Vdc)—**Supply Source must be capable of furnishing at least 7.5 watts. FCC 6-18 Vdc version: **Do not connect**

Table 21. Transceiver Connector J3 Pinouts
(Payload data TTL; Diagnostic data TTL) (Continued)

10	IN	TTL, 3 Vdc	**Transmitted Data (TXD)—**Accepts payload data from the connected device.
11	IN	--	FCC 6-18 Vdc version: **DC Input (5-25 Vdc)—** Supply Source must be capable of furnishing at least 7.5 watts. Non-FCC 3 Vdc version: **Do not connect**
12	IN	TTL, 3 Vdc	**Request to Send (RTS)—**A high causes CTS to follow after the programmed CTS delay time has elapsed (DCE).
13	--	--	Reserved—Do not connect.
14	OUT	TTL, 3 Vdc	**Received Data (RXD)—**Supplies received payload data to the connected device.
15	IN	--	**Ground—**Connects to ground (negative supply potential).
16	OUT	TTL, 3 Vdc	**Clear to Send (CTS)—**Goes high after the programmed CTS delay time has elapsed (DCE), or keys an attached radio when RF data arrives (CTS KEY).

Table 22. Transceiver Connector J3 Pinouts
(Payload data TTL; Diagnostic data RS-232)

Pin No.	Input/ Output	Signal Type	Name/Description
1	IN	--	**Ground—**Connects to ground (negative supply potential).
2	OUT	RS-232	**Diagnostic TXD—**Supplies received diagnostic/administrative data to the connected device.
3	OUT	TTL, 3 Vdc	**Alarm condition—**A low indicates normal operation. A high indicates an alarm. (See ASENSE [HI/LO] command for more information.)
4	IN	RS-232	**Diagnostic RXD—**Accepts diagnostic/administrative data from the connected device.
5	IN	--	FCC 6-18 Vdc version: **DC Input (6-18 Vdc)—** Supply Source must be capable of furnishing at least 7.5 watts. Non-FCC 3 Vdc version: **Do not connect**

Table 22. Transceiver Connector J3 Pinouts
(Payload data TTL; Diagnostic data RS-232) (Continued)

6	IN	TTL, 3 Vdc	**Sleep Mode Input—**A ground on this pin turns off most circuits in a remote radio. This allows for greatly reduced power consumption, yet preserves the radio's ability to be brought quickly back on line. See "Sleep Mode Operation (Remote units only)" on Page 31 for details.
7	OUT	TTL, 3 Vdc	**Data Carrier Detect (DCD)—**A low indicates hopping synchronization has been achieved.
8	IN	TTL, 3 Vdc	**Power Supply Shutdown Control—**A ground on this pin causes the OEM module's power supply to shut down.
9	--	--	Reserved—Do not connect.
10	IN	TTL, 3 Vdc	**Transmitted Data (TXD)—**Accepts payload data from the connected device.
11	IN	--	FCC 6-18 Vdc version: **DC Input (6-18 Vdc)—** Supply Source must be capable of furnishing at least 7.5 watts. Non-FCC 3 Vdc version: **Do not connect**
12	IN	TTL, 3 Vdc	**Request to Send (RTS)—**A high causes CTS to follow after the programmed CTS delay time has elapsed (DCE).
13	--	--	Reserved—Do not connect.
14	OUT	TTL, 3 Vdc	**Received Data (RXD)—**Supplies received payload data to the connected device.
15	IN	--	**Ground—**Connects to ground (negative supply potential).
16	OUT	TTL, 3 Vdc	**Clear to Send (CTS)—**Goes high after the programmed CTS delay time has elapsed (DCE), or keys an attached radio when RF data arrives (CTS KEY).

Table 23. Transceiver Connector J3 Pinouts
(Payload data RS-232; Diagnostic data RS-232)

Pin No.	Input/ Output	Signal Type	Name/Description
1	IN	--	**Ground—**Connects to ground (negative supply potential).
2	OUT	RS-232	**Diagnostic TXD—**Supplies received diagnostic/administrative data to the connected device.
3	OUT	TTL, 3 Vdc	**Alarm condition—**A low indicates normal operation. A high indicates an alarm. (See ASENSE [HI/LO] command for more information.)
4	IN	RS-232	**Diagnostic RXD—**Accepts diagnostic/administrative data from the connected device.
5	IN	--	FCC 6-18 Vdc version: **DC Input (6-18 Vdc)—** Supply Source must be capable of furnishing at least 7.5 watts. Non-FCC 3 Vdc version: **Do not connect**
6	IN	TTL, 3 Vdc	**Sleep Mode Input—**A ground on this pin turns off most circuits in a remote radio. This allows for greatly reduced power consumption, yet preserves the radio's ability to be brought quickly back on line. See "Sleep Mode Operation (Remote units only)" on Page 31 for details.
7	OUT	TTL, 3 Vdc	**Data Carrier Detect (DCD)—**A low indicates hopping synchronization has been achieved.
8	IN	TTL, 3 Vdc	**Power Supply Shutdown Control—**A ground on this pin causes the OEM module's power supply to shut down.
9	--	--	Reserved—Do not connect.
10	IN	RS-232, +/- 5 Vdc	**Transmitted Data (TXD)—**Accepts payload data from the connected device.
11	IN	--	FCC 6-18 Vdc version: **DC Input (6-18 Vdc)—** Supply Source must be capable of furnishing at least 7.5 watts. Non-FCC 3 Vdc version: **Do not connect**
12	IN	RS-232, +/- 5 Vdc	**Request to Send (RTS)—**A high causes CTS to follow after the programmed CTS delay time has elapsed (DCE).

Table 23. Transceiver Connector J3 Pinouts
(Payload data RS-232; Diagnostic data RS-232) (Continued)

13	--	--	Reserved—Do not connect.
14	OUT	RS-232, +/- 5 Vdc	**Received Data (RXD)—**Supplies received payload data to the connected device.
15	IN	--	**Ground—**Connects to ground (negative supply potential).
16	OUT	RS-232, +/- 5 Vdc	**Clear to Send (CTS)—**Goes high after the programmed CTS delay time has elapsed (DCE), or keys an attached radio when RF data arrives (CTS KEY).

Table 24. Transceiver Connector J3 Pinouts
(Payload data RS-485; Diagnostic data RS-232)

Pin No.	Input/ Output	Signal Type	Name/Description
1	IN	--	**Ground—**Connects to ground (negative supply potential).
2	OUT	RS-232	**Diagnostic TXD—**Supplies received diagnostic/administrative data to the connected device.
3	OUT	TTL, 3 Vdc	**Alarm condition—**A low indicates normal operation. A high indicates an alarm. (See ASENSE [HI/LO] command for more information.)
4	IN	RS-232	**Diagnostic RXD—**Accepts diagnostic/administrative data from the connected device.
5	IN	--	FCC 6-18 Vdc version: **DC Input (6-18 Vdc)—** Supply Source must be capable of furnishing at least 7.5 watts. Non-FCC 3 Vdc version: **Do not connect**
6	IN	TTL, 3 Vdc	**Sleep Mode Input—**A ground on this pin turns off most circuits in a remote radio. This allows for greatly reduced power consumption, yet preserves the radio's ability to be brought quickly back on line. See "Sleep Mode Operation (Remote units only)" on Page 31 for details.
7	OUT	TTL, 3 Vdc	**Data Carrier Detect (DCD)—**A low indicates hopping synchronization has been achieved.
8	IN	TTL, 3 Vdc	**Power Supply Shutdown Control—**A ground on this pin causes the OEM module's power supply to shut down.
9	--	--	Reserved—Do not connect.

Table 24. Transceiver Connector J3 Pinouts
(Payload data RS-485; Diagnostic data RS-232) (Continued)

10	IN	Differential	**RXD+/RXA (Transmitted Data+)—**Non-inverting receiver input. Accepts payload data from the connected device.
11	IN	--	FCC 6-18 Vdc version: **DC Input (6-18 Vdc)—** Supply Source must be capable of furnishing at least 7.5 watts. Non-FCC 3 Vdc version: **Do not connect**
12	IN	Differential	**RXD-/RXA (Transmitted Data-)—**Inverting receiver input.
13	--	--	Reserved—Do not connect.
14	OUT	Differential	**TXD+/TXA (Received Data+)—**Non-inverting driver output. Supplies received payload data to the connected device.
15	IN	--	**Ground—**Connects to ground (negative supply potential).
16	OUT	Differential	**TXD-/TXA (Received Data-)—**Inverting driver output.

15.0 dBm-Watts-Volts Conversion Chart

Table 25 is provided as a convenience for determining the equivalent voltage or wattage of an RF power expressed in dBm with 50 Ohms load.

Table 25. dBm-Watts-Volts Conversion Chart

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

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

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

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

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

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

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

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.

CUSTOMER ASSISTANCE

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 one of the following means for product assistance:

Phone: 585 241-5510
FAX: 585 242-8369
E-Mail: techsupport@microwavedata.com
Web: www.microwavedata.com

FACTORY SERVICE

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 Service Request Order (SRO) number. The SRO 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 SRO 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 SRO 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
Product Service Department
(SRO 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. To inquire about an in-process repair, you may contact our Product Services Group at 585-241-5540 (FAX: 585-242-8400), or via e-mail at ProductServices@microwavedata.com.

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