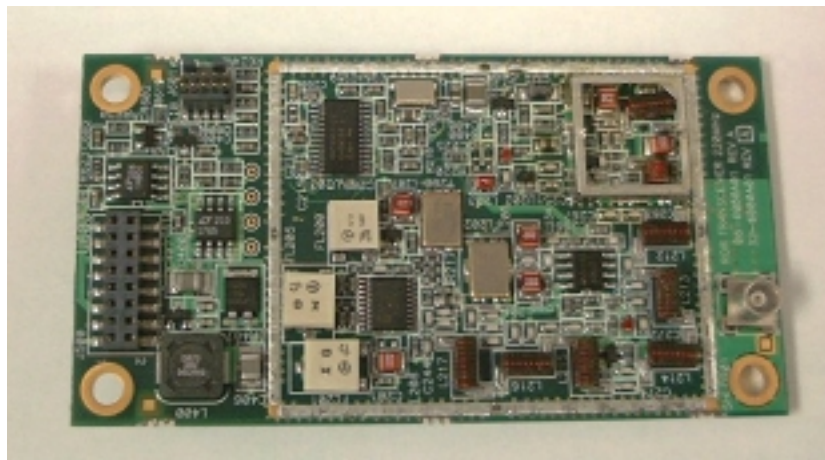


# Microwave Data Systems Inc.

## ROR Module



### 217-222 MHz Licensed OEM Transceiver

MDS 05-4132A01, Rev. A  
JANUARY 2004  
(PRELIMINARY)

industrial/wireless/performance








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# TABLE OF CONTENTS

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1.0 INTRODUCTION .....	7
1.1 Modem Speed versus Channel Bandwidth .....	7
1.2 Frequency Coverage .....	7
2.0 INSTALLATION DESIGN .....	8
2.1 Antennas and Feedlines .....	9
Antennas .....	9
Feedlines .....	10
2.2 Primary Power (6-12 Vdc) .....	10
DC Supply Connection .....	10
Sleep Mode (Energy Conservation) .....	10
Shutdown Mode (Power Supply Disabled) .....	11
2.3 Detailed Pin Descriptions .....	11
2.4 Transceiver Configuration and Diagnostic Commands .....	12
2.5 In-Service Operation—Radio & Data Configuration .....	14
2.6 Using the Evaluation Board (P/N 03-4051A01) .....	15
Connecting the Evaluation Board & Transceiver.....	16
2.7 Cable Connections for Benchtop Testing .....	17
Antenna Connection (J300 on the ROR module) .....	18
Diagnostic Connection (J4) .....	18
Data Connector (J5) .....	19
DC Power Connector (J3).....	20
Jumper Block J1 (DC Power Configuration) .....	21
2.8 Benchtop Power-Up & Configuration .....	21
3.0 TECHNICAL REFERENCE .....	22
3.1 Transceiver Specifications .....	22
3.2 dBm-Watts-Volts Conversion Chart .....	24
4.0 GLOSSARY OF TERMS.....	25

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## RF Exposure



Separation distances required for FCC RF Exposure compliance

## Antenna Installation Warnings

1. All antenna installation and servicing is to be performed by **qualified technical personnel** only. When servicing the antenna, or working at distances closer than those listed below, *ensure the transmitter has been disabled.*
2. Depending upon the application and the gain of the antenna, the total composite power could exceed 90 watts EIRP. For fixed/mobile configuration, the distances in the table below must be followed.

**Antenna Gain vs. Minimum Safety Distance**  
(Based on a 100% Duty Cycle, 0 dB Feedline Loss)

	Fixed/Mobile Antenna Gain		
	0–5 dBi	5–10 dBi	10–16.5 dBi
Minimum RF Safety Distance	0.58 meter	1.04 meters	2.19 meters

### Portable OCU Applications

For portable applications *only*, a directly-connected antenna is allowed. **This antenna must have a 0 dBi gain, and must operate with a separation distance of at least 5 cm from all persons.**

The Operator Control Unit (OCU) application uses a source-based, time-averaging duty factor not exceeding 4.26%, and the maximum time-averaged power output is 85 milliwatts or less. Reference FCC rules 2.1093 for portable applications.

### Enclosure Marking Requirements—FCC ID Label

When the ROR 220 module is to be used in portable/fixed/mobile applications, the outside of the OEM enclosure must be clearly marked with a durable label stating “**Contains E5MDS-ROR220**”.

## ISO 9001 Registration

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



## MDS Quality Policy Statement

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

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

## ESD Notice

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

## Manual Revision and Accuracy

While every reasonable effort has been made to ensure the accuracy of this manual, product improvements may result in minor differences between the manual and the product shipped to you. If you have additional questions or need an exact specification for a product, please contact our Customer Service Team using the information at the back of this guide. In addition, manual updates can often be found on the MDS Web site at [www.microwavedata.com](http://www.microwavedata.com).

## FCC Modular Approval Notice

This device is offered as a Modular Transmitter in per FCC Part 90. It is approved for use under the following conditions: (1) When this device is placed inside an enclosure, the enclosure must be clearly marked with a durable label stating "**Contains E5MDS-ROR220**".

(2) Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

## FCC Part 15 Notice

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to



radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try and correct the interference by one or more of the following measures:

- Reorient or locate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

## Industry Canada RSS-119 (Pending)

This Class B digital apparatus complies with Canadian RSS-119. Cet appareil numérique de la classe B est conforme à la norme RSS-119 du Canada.

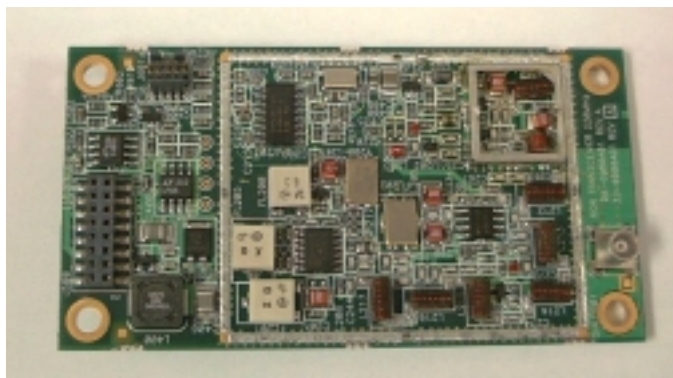
Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

## 1.0 INTRODUCTION

This guide presents installation and operating instructions for the ROR transceiver module. The unit is a compact, modular board intended for integration inside customer-designed equipment.

The module (Figure 1) is a wireless data transceiver designed to operate in an industrial environment. It employs two microprocessors—one for Digital Signal Processing (DSP) control of the unit's data port, and another for control of modulation functions at the diagnostic port. The module employs Gaussian-mean shift keying (GMSK) modulation. These features provide highly reliable communications, even under adverse conditions.



**Figure 1. ROR Transceiver Module**  
(Module shown with shield cover removed)

### 1.1 Modem Speed versus Channel Bandwidth

The module is factory configured for an over-the-air data baud rate (**BAUD**) of 9600 bps, Gaussian filtering (**BT=.3**), and a channel bandwidth (**BW**) of 12.5 kHz. This configuration may be verified by use of the **MODEM** command. These settings are independent of any other user-controllable parameter.

### 1.2 Frequency Coverage

The ROR module is designed for operation in the 217-222 MHz frequency band. Any combination of transmitter and receiver operating frequencies can be programmed, including a simplex (TX = RX) pair.

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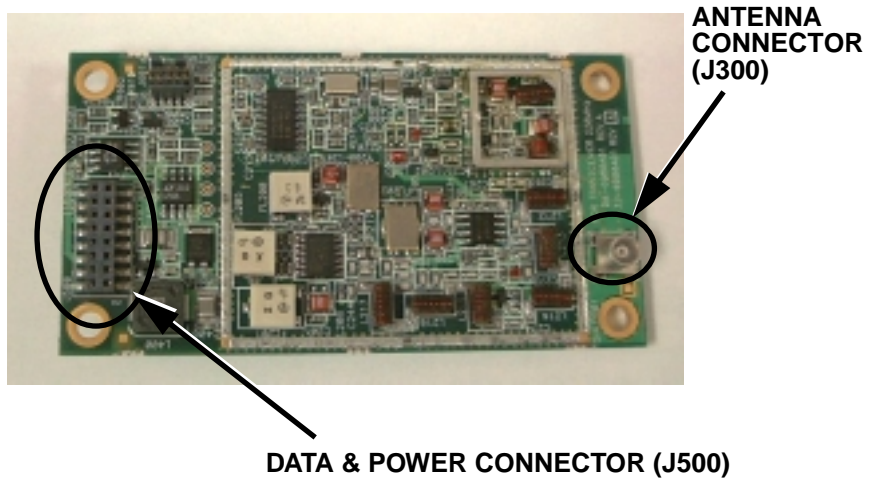
## 2.0 INSTALLATION DESIGN

The module is designed to be an integral part of another electronic device or system. It must be provided with adequate and stable primary power, a complementary data interface and a suitable antenna system. An antenna is the only external device that is needed for operation.

The module has just two connectors—one for data/power, and another for the antenna connection. Figure 2 shows the location of these connectors.

The data/power connector (J500) is a 16-pin dual-row header connector that mates with a Samtec TW Series, Part No. ASP 103812-01. This matching connector is provided on the OEM Test/Evaluation board, described later in this manual. Data signals and DC power are applied to the module through this board or another device to which the radio is attached.

The Antenna/RF Output connector (J300) is located at the lower right side of the module, and is a female MCX-type coaxial connector. A suitable RF load or antenna may be connected to this connector.



**Figure 2. Connections to the Transceiver Module**  
(Module shown with shield cover removed)

In its deliverable form, the module has all of its electronic circuitry enclosed in RF shields to minimize interaction with nearby electronic products. Careful selection and/or routing of the unit's antenna feedline line may be required to minimize RFI to other electronic devices mounted near the module. The module can be set to produce either 0.5 watt, or 2 watts of RF output using a connected terminal (requires use of **PWR** command).



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For optimal communication range and reliability, this unit must be provided with a good antenna system. A secondary benefit to an effective antenna system is the ability to run the system at the lowest possible power level, minimize primary power consumption, and reduce the chance for interference.

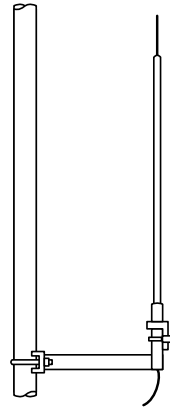
The data interface for the module supports TTL-type signaling. Use only the required pins for the application. Refer to the complete list of pin functions in Table 5 on Page 17.

## 2.1 Antennas and Feedlines

### Antennas

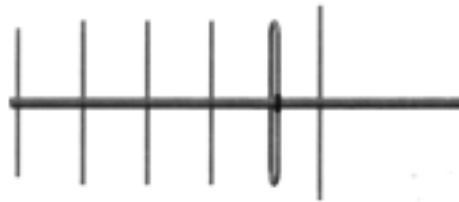
The module can be used with a variety of antennas, ranging from a directly-connected flexible type, to a highly directional array. The exact style depends on the physical size and layout of the radio system. Suitable antennas are available from several manufacturers, including Microwave Data Systems.

At master stations, omni-directional antennas (Figure 4) are typically used to provide equal coverage to all remote sites in the network.



**Figure 3. Typical Omni-directional Antenna for Master Stations  
(Shown mounted to mast)**

At remote sites, a directional Yagi (Figure 5) or corner reflector antenna is generally recommended to minimize interference to and from other users.



**Figure 4. Typical Yagi Antenna for Remote Sites**

**Feedlines**

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

Table 2 shows the losses that occur when using various lengths and types of cable at 200 MHz. Regardless of the type of cable used, it should be kept as short as possible to minimize signal loss.

Preliminary

**Table 1. Length vs. Loss in Coaxial Cables at 200 MHz**

<b>Cable Type</b>	<b>10 Feet (3.05 Meters)</b>	<b>50 Feet (15.24 Meters)</b>	<b>100 Feet (30.48 Meters)</b>	<b>500 Feet (152.4 Meters)</b>
RG-8A/U	0.32dB	1.6 dB	3.2 dB	16 dB
1/2 inch HELIAX	0.10 dB	0.49 dB	0.98 dB	4.9 dB
7/8 inch HELIAX	0.05 dB	0.27 dB	0.54 dB	2.7 dB
1-1/4 inch HELIAX	0.04 dB	0.20 dB	0.40 dB	2.0 dB
1-5/8 inch HELIAX	0.03 dB	0.17 dB	0.33 dB	1.65 dB

**2.2 Primary Power (6-12 Vdc)**

**DC Supply Connection**

The transceiver can be operated from any well-filtered 6-12 Vdc power source through the DATA INTERFACE connector. The power supply must be capable of providing at least 1.5 Amperes and provide current limiting even if you intend to operate the radio at low power (0.5 Watts).

**CAUTION**

**POSSIBLE  
EQUIPMENT  
DAMAGE**

NOTE: The radio is designed for use in *negative* ground systems only. There is no fuse or reverse polarity protection provided on the module's PCB assembly.

**Sleep Mode (Energy Conservation)**

In some installations, such as at solar-powered sites, it may be necessary to keep the transceiver's power consumption to an absolute minimum. This can be accomplished by configuring the host device to ground Pin 6 on the DATA INTERFACE connector, which powers down the radio until



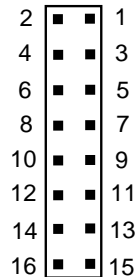
communication with other stations is needed. All radio and microprocessor activity is disabled when the radio is in Sleep Mode. When the ground is removed from Pin 6, the radio is ready to operate within 75 milliseconds.

### Shutdown Mode (Power Supply Disabled)

The Shutdown Mode completely turns off the ROR Module’s power supply. It is asserted by placing a ground on Pin 8 of the DATA INTERFACE connector. With this pin grounded, all radio functions cease.

## 2.3 Detailed Pin Descriptions

Table 3 provides detailed pin functions for the transceiver’s 16-pin header connector shown in Figure 6.



**Figure 5. 16-pin Header Connector (J500) on Transceiver Module**

**Table 2. Transceiver Data/Power Connector Pinouts (Payload data TTL; Diagnostic data TTL)**

Pin No.	Input/Output	Signal Type	Name/Description
1	IN	--	<b>Ground</b> —Connects to ground (negative supply potential).
2	OUT	TTL, 3 Vdc	<b>Diagnostic TXD</b> —Supplies received diagnostic/administrative data to the connected device.
3	OUT	TTL, 3 Vdc	<b>Alarm condition</b> —A low indicates normal operation. A high indicates an alarm. (See ASENSE [HI/LO] command for more information.)
4	IN	TTL, 3 Vdc	<b>Diagnostic RXD</b> —Accepts diagnostic/administrative data from the connected device.
5	IN	--	FCC 6-12 Vdc version: <b>DC Input (6-12 Vdc)</b> —Supply Source must be capable of furnishing at least 7.5 watts. Non-FCC 3 Vdc version: <b>Do not connect</b>
6	IN	TTL, 3 Vdc	<b>Sleep Mode Input</b> —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 <b>Sleep Mode (Energy Conservation)</b> on Page 12 for details.
7	OUT	TTL, 3 Vdc	Reserved—Do not connect.
8	IN	TTL, 3 Vdc	<b>Power Supply Shutdown Control</b> —A ground on this pin causes the OEM module’s power supply to shut down.

Preliminary



**Table 2. Transceiver Data/Power Connector Pinouts**  
(Payload data TTL; Diagnostic data TTL) (Continued)

9	--	--	Non-FCC 3 Vdc version: <b>DC Input (Regulated 3.3 Vdc)</b> —Supply Source must be capable of furnishing at least 7.5 watts.  FCC 6-12 Vdc version: <b>Do not connect</b>
10	IN	TTL, 3 Vdc	<b>Transmitted Data (TXD)</b> —Accepts payload data from the connected device.
11	IN	--	FCC 6-12 Vdc version: <b>DC Input (6-12 Vdc)</b> —Supply Source must be capable of furnishing at least 7.5 watts.  Non-FCC 3 Vdc version: <b>Do not connect</b>
12	IN	TTL, 3 Vdc	Reserved—Do not connect.
13	--	--	Reserved—Do not connect.
14	OUT	TTL, 3 Vdc	<b>Received Data (RXD)</b> —Supplies received payload data to the connected device.
15	IN	--	<b>Ground</b> —Connects to ground (negative supply potential).
16	OUT	TTL, 3 Vdc	Reserved—Do not connect.



Some pins on the DATA INTERFACE connector are used for factory testing. Use *only* the required pins for the application. Damage may result if improper connections are made.

## 2.4 Transceiver Configuration and Diagnostic Commands

The transceiver’s configuration and diagnostics are performed through the radio’s DATA INTERFACE connector through a terminal interface—either a personal computer or dedicated data terminal. An EIA/RS-232 to TTL converter circuit may be required depending on your installation design. Configuration and diagnostic activities may be performed with the module removed from the user equipment or as an installed module in your design.

If you choose to setup the module before its final installation, you may find it convenient to use the OEM Evaluation Board. (See *Using the Evaluation Board (P/N 03-4051A01)* on Page 16 for more detail.)

Table 4 lists each command entry and a brief description of its purpose. Programmable information is shown in brackets [ ] following the command name.



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

**Table 3. Command Summary**

Command	Function
DKEY	<b>Unkey Transmitter Test Carrier</b>
KEY	<p><b>Transmitter Carrier Key</b></p> <ul style="list-style-type: none"> <li>• Test command for technicians to key the radio with an unmodulated carrier.</li> <li>• Use DKEY command to cease transmission</li> </ul> <p>NOTES:</p> <ul style="list-style-type: none"> <li>• Use only for test purposes.</li> <li>• No time-out timer on this function.</li> </ul>
MODEM	<p><b>MODEM—Data Configuration</b></p> <p>Response indicates:</p> <p>Payload data rate (<b>BAUD</b>)                      + Gaussian Bandwidth x Data Rate (<b>BT</b>)                      + Channel Spacing (<b>BW</b>)</p> <p>For example: <b>9.6Kbps BT=.3 12.5 KHz.</b></p> <p>NOTE: Provides only a read-only display. The command cannot be used to change the settings.</p>
PWR [x]	<p><b>RF Power Output Level</b></p> <p>Options:</p> <p><b>H</b> = High Power (2 Watts)  <b>L</b> = Low Power (0.5 Watts)</p>
RSSI	<p><b>Received Signal Strength Indicator</b></p> <ul style="list-style-type: none"> <li>• Displays the current received RF signal level</li> <li>• One measurement per request by command</li> <li>• Reading is accurate to within 3 dB from -100 dBm to -60 dBm</li> </ul> <p>NOTE: A continuous RSSI signal is available during receive state on the DATA INTERFACE connector (J500).</p>
SREV [xxx]	<b>Software Revision of installed firmware</b>
SER	<b>Serial Number of the module</b>
RX [xxx.xxxxx]	<p><b>Receive RF Frequency</b></p> <ul style="list-style-type: none"> <li>• The frequency must be within the operating range for the unit.</li> <li>• Up to 5 digits can be entered after the decimal point. Trailing zeros are not required.</li> <li>• Frequencies can be in either 5 or 6.25 kHz increments.</li> </ul>
TX [xxx.xxxxx]	<p><b>Transmit RF Frequency</b></p> <ul style="list-style-type: none"> <li>• The frequency must be within the operating range for the unit.</li> <li>• Up to 5 digits can be entered after the decimal point. Trailing zeros are not required.</li> <li>• Frequencies can be in either 5 or 6.25 kHz increments.</li> </ul>

Preliminary



Preliminary

## 2.5 In-Service Operation—Radio & Data Configuration

Below are the basic steps for setting up of the transceiver once it is installed in the host device. In many cases, these steps alone are sufficient to complete the installation. This procedure assumes the module has been installed in your system/product and suitable connections have been provided for a terminal interface and antenna.

3. Install the antenna and antenna feedline for the station. Preset directional antennas in the desired direction of transmission and reception.
4. Connect a terminal (computer with emulations software) to the module through the user's product interface. (Asynchronous @ 38400 bps w/8N1)
5. Enable the configuration mode for the module. **DIAGNOSTICS OPEN** will appear on the terminal screen terminal once diagnostics communication with the radio is established.
6. Review the existing configuration parameters through a series of terminal commands.
  - **MODEM—Data Configuration**  
 Response indicates:  
 Payload data rate (**BAUD**)  
 Gaussian Bandwidth x Data Rate (**BT**)  
 Channel Spacing (**BW**)  
 For example: **9.6Kbps BT=.3 12.5KHz.**
  - **PWR—RF Power Output**  
 Responses: **H** = 2 Watts, **L** = 0.5 Watts
7. Check and set the radio transmit and receive frequencies.

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**NOTE:** The operating frequencies are typically not set at the factory. Determine the transmit and receive frequencies to be used, and follow the steps below to program them. The module must be programmed for the frequencies for which you hold a valid license.)

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- a. Set the transmit frequency with the **TX xxx.xxxxx** command.  
 Press **ENTER** after the command.
- b. Set the receive frequency with the **RX xxx.xxxxx** command.  
 Press **ENTER** after the command.



Preliminary

- c. After programming any parameter, **PROGRAMMED OK** will be displayed to indicate a successful entry.
- 8. Review and reprogram any other parameters as necessary to complement your system requirements. (See Table 4 on Page 14 for a list of all user commands.)
- 9. Optimize the antenna installation by measuring the received signal strength of the other station with which this station will be communicating. Monitor the module's RSSI level. Rotate the station antenna until the signal is the strongest. The less negative the value, the stronger the incoming radio signal.

The received signal should be at least -90 dBm. This value will provide a safety margin (fade margin) to prevent loss of communications through signal reduction caused by weather conditions, changes in station location if mobile, or other obstructions temporarily positioned between communicating stations.

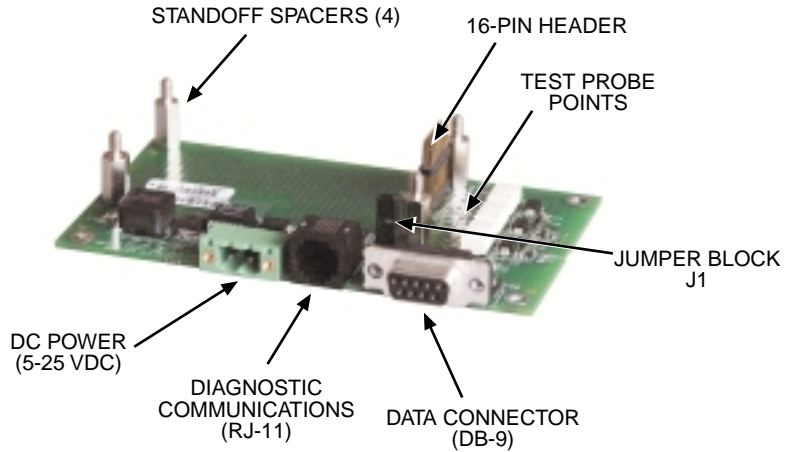
- 10. Disconnect the terminal interface and the ground from the DATA INTERFACE connector.
- 11. Connect the data equipment to the transceiver's DATA INTERFACE connector and test for normal operation.

## 2.6 Using the Evaluation Board (P/N 03-4051A01)

The Evaluation Board (Figure 7) is designed to assist integrators and testers who will work with the transceiver in a benchtop setting. It contains a 16-pin header connector (J2) that mates with female connector J500 on the transceiver board. It carries all signals (except RF) onto the Evaluation Board. Table 5 lists the basic pin functions of J2. For more detailed pinout information, refer to Section 2.5 on Page 12.

The Evaluation Board provides convenient connection points for diagnostics, payload data, and DC power. Each of these connectors are discussed in this section. The board also includes a series of test probe points to the left of J2. These may be used for monitoring logic signal activity with a multimeter or oscilloscope. The probe points are identified by printed markings on the board.

The module's RF/Antenna connection is *not* brought onto the Evaluation Board by the 16-pin header. The antenna connection is always made at J300 on the transceiver module using a male MCX-type connector.



**Figure 6. OEM Evaluation Board (P/N 03-4051A01)**

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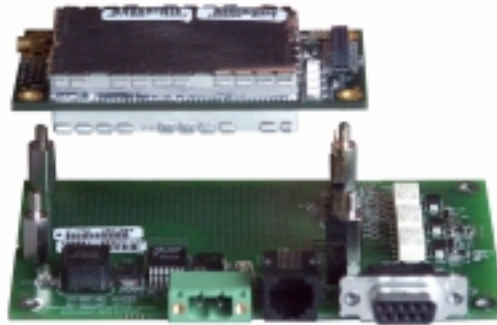
**Table 4. Basic Pin Functions of J2 (16-Pin Header Connector)**

Pin No.	Pin Function
1	Ground
2	Diagnostic TXD
3	Alarm Condition
4	Diagnostic RXD
5	DC Input
6	Sleep Mode Input
7	Reserved—Do not connect.
8	Power Supply Shutdown Control
9	Reserved—Do not connect.
10	Transmitted Payload Data (TXD)
11	DC Input
12	Reserved—Do not connect.
13	Reserved—Do not connect.
14	Received Payload Data (RXD)
15	Ground
16	Reserved—Do not connect.

**Connecting the Evaluation Board & Transceiver (Figure 8)**

To connect the Evaluation Board to the radio, carefully align the pins of the 16-pin header with J3 on the transceiver module and press down firmly. The radio PC board should seat solidly on the four standoff spacers. Use nuts to secure the board to the standoffs.





**Figure 7. Connecting the Evaluation Board and ROR Module**

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**CAUTION:** Take care to avoid short-circuiting the underside of the Evaluation board. The bottom of the board is *not* insulated, and contact with metallic objects on the work surface could cause damage to the board or connected equipment.

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Preliminary

## 2.7 Cable Connections for Benchtop Testing

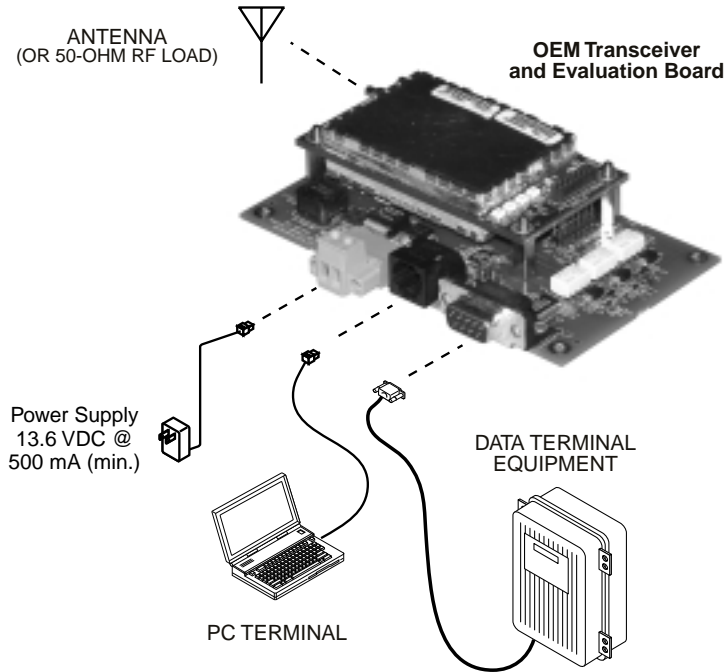
There are four basic requirements for operating the transceiver and evaluation board in a benchtop environment. They are:

- Adequate and stable primary power
- A proper antenna system or RF load (50 Ohms)
- The correct interface wiring between the transceiver and the connected DTE device
- A connected PC terminal to read/set transceiver parameters

Figure 9 shows a typical setup for bench testing an OEM Transceiver. Two such setups will be required if you intend to establish over-the-air communications with another transceiver.



Preliminary



**Figure 8. Typical Test Setup**

**Antenna Connection (J300 on the ROR module)**

The Antenna connector is located at the lower right corner of the transceiver module and is a female MCX-type coaxial connector. Connect an antenna or other suitable RF load to this connector.

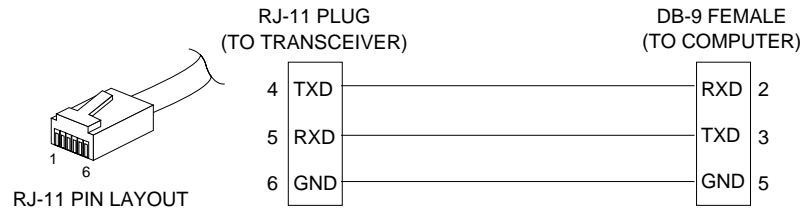
**CAUTION**  
POSSIBLE  
EQUIPMENT  
DAMAGE

Do not apply DC power to the transceiver without first attaching a proper RF load, or the transceiver may be damaged.

**Diagnostic Connection (J4)**

J4 is an RJ-11-6 modular connector used to connect the evaluation board/transceiver to an MCU module for programming and interrogation. An RJ-11 to DB-9 Adapter Cable (Part No. 03-3246A01) is required for this connection. If desired, a cable may be constructed for this purpose as shown in Figure 10. Only Pins 4, 5, and 6 of the RJ-11 connector should be used. (Pins 1, 2, and 3 are reserved for factory test purposes.)

The data parameters of the DIAGNOSTICS port are as follows: 38400 bps, 8 data bits, 1 stop bit, and no parity.



**Figure 9. RJ-11 to DB-9 Diagnostic Cable—Wiring Details**  
*(A pre-constructed cable is also available, Part No. 03-3246A01)*

**Diagnostic Communication with a PC**

You establish a terminal session with the radio by connecting the diagnostic cable (Figure 10) between the PC and radio, and then starting a communications program, such as HyperTerminal. Commands are issued as plain text strings. A list of radio commands appears in the section titled *Transceiver Configuration and Diagnostic Commands* on Page 13.

Preliminary

**Data Connector (J5)**

J5 on the Evaluation Board (Figure 11) is the data interface for the transceiver. It connects to the radio’s DSP module and does not directly control keying or modulation. It is used to connect the transceiver to an external DTE terminal supporting the EIA/RS-232 or EIA/RS-485 format, depending on how the radio hardware was configured at the factory. The data connector supports interface data rates of 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 bps (asynchronous only). The connector mates with a standard DB-9 plug available from many electronic parts suppliers.

**Data Wiring Connections**

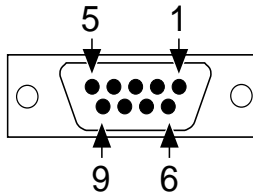
The connections made to J5 will depend on the requirements of the DTE device being used with the transceiver, and the operating functions that you require. Only the required pins for the application should be used. Do not use a straight through “computer” type cable that is wired pin-for-pin.

Typical RS/EIA-232 applications require the use of Pin 2 (receive data—RXD) and Pin 3 (transmit data—TXD). Additionally, some systems may require the use of Pin 7 (Request-to-send—RTS). If hardware flow control is desired, Pin 7 (RTS) and Pin 8 (CTS) may also need connection.

Table 6 gives pin details for radios configured for RS/EIA-232 service.



**NOTE:** Radios equipped with a payload TTL interface are presented as RS-232 mode from the Evaluation Board.



**Figure 10. DATA Connector (DB-9F)**  
As viewed from outside the device

**Pin Descriptions—  
RS/EIA-232 Mode**

Table 6 lists the DATA connector pin functions for radios configured to operate in RS/EIA-232 mode.

**Table 5. J5 DATA Connector Pinouts—RS/EIA-232**

Pin Number	Input/Output	Pin Description
1	--	Reserved—Do not connect.
2	OUT	<b>Received Data (RXD)</b> —Supplies received payload data to the connected device.
3	IN	<b>Transmitted Data (TXD)</b> —Accepts payload data from the connected device.
4	IN	<b>Sleep Mode Input</b> —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 <b>Sleep Mode (Energy Conservation)</b> on Page 12 for details.
5	IN	<b>Ground</b> —Connects to ground (negative supply potential).
6	OUT	<b>Alarm condition</b> —A low indicates normal operation. A high indicates an alarm. (See ASENSE [HI/LO] command for more information.)
7	--	Reserved—Do not connect.
8	---	Reserved—Do not connect.
9	--	Reserved—Do not connect.

Preliminary

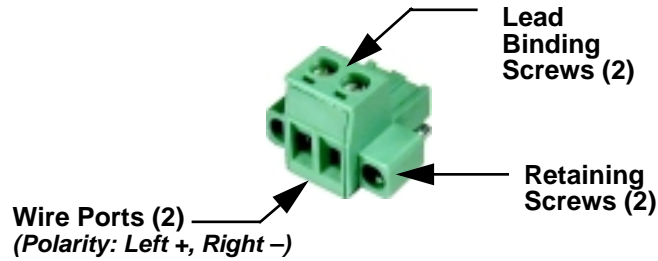
**DC Power Connector (J3)**

This connector accepts operating power for the transceiver. A wall-style AC adapter (Part No. 01-3862A02) is recommended for this service.

DC connection is made with a 2-pin polarized plug, MDS Part No. 73-1194A39. Be sure to observe proper polarity. **The left terminal is positive (+) and the right is negative (-).** (See Figure 12).



The transceiver must be used only with negative-ground systems. Make certain that the polarity of the power source is correct.



**Figure 11. DC Power Connector (P/N 73-1194A39)**

**WARNING:** Although the power connector used on the OEM Evaluation Board resembles those used by some earlier MDS transceivers, such as the MDS 9810 and x710 family, the connectors are *not* equal and the use of the wrong plug will provide unreliable connections and possible sparking. Only the power connector shown in [Figure 12](#) with screw terminals and two retainer screws should be used with the OEM Evaluation Board.

### Jumper Block J1 (DC Power Configuration)

*Jumper J1 does not normally require any change by the user. The jumper is used to configure the board for the proper voltage level applied to the transceiver module.*

*Both jumper plugs are normally installed on J1. The plug connecting Pins 3 and 4 may be temporarily removed to insert an ammeter in series with the DC power line going to the transceiver. This provides a convenient way to measure the transceiver's current draw during bench testing.*

## 2.8 Benchtop Power-Up & Configuration

When all of the cable connections described in Section 2.9 have been made, the transceiver is ready for initial power-up. Operation begins as soon as power is applied, and there are no manual adjustments or settings required.

To place the transceiver into operation:

1. Ensure that all cable connections are properly wired and secure. Verify that no metallic objects are touching the underside of the Evaluation Board which might cause a short-circuit.
2. Apply DC power.
3. Using a connected PC terminal, configure the unit with the proper mode (master or remote), network address and data parameters. See [Section 2.6, Transceiver Configuration and Diagnostic Commands](#) for programming details.
4. Verify that the transceiver is transmitting and receiving data (TXD, RXD).



## 3.0 TECHNICAL REFERENCE

### 3.1 Transceiver Specifications

#### RADIO TYPE

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Synthesized, half duplex or simplex, 6.25 and 5.0 kHz channel spacing

#### ENVIRONMENTAL

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Temperature Range: -30 to +60 degrees C  
 Humidity: 0 to 95% at 40 degrees C  
 Board Dimensions: 2.75" W x 0.4" H x 1.75" D  
 7.0 cm W x 1.10 cm H x 4.4 cm D  
 Weight: x.x oz. (x.x kg)  
 Enclosure: None. PCB with digital/RF circuit shielding

#### TRANSMITTER

---

Frequency Range: 217-222 MHz  
 Frequency Increments: 6.25 and 5.0 kHz  
 Frequency Stability: 1.5 ppm, -30 to +60 degrees C  
 Channel Spacing: 6.25 and 5.0 kHz  
 Modulation Type: GMSK (Gaussian-mean Shift Keying) B.T.= .3  
 Carrier Power: 0.5 W, 2 W programmable  
 (+27 DBM, +33 dBm)  
 Duty Cycle: 50%  
 Output Impedance: 50 ohms  
 RF Connection: MCX coaxial connector  
 Spurious and Harmonics: -65 dBc  
 Transmitter Keying: On reception of data  
 Key-up Time: 2 ms  
 Data Rate Over-the-Air : 9600 bps

#### RECEIVER

---

Type: Double conversion superheterodyne  
 (45 MHz IF)  
 Frequency Range: 217-222 MHz  
 Frequency Increments: 6.25 and 5.0 kHz  
 Frequency Stability: 1.5 ppm, -30 to +60 degrees C  
 Spurious and Image Rejection: -70 dB  
 Sensitivity: 12 dB SINAD @ -119 dBm @ 9600 bps  
 Intermodulation Rejection: -70 dB minimum  
 Selectivity: 60 dB typical at adjacent channel (EIA)  
 Bandwidth: 12.5 kHz

#### DATA INTERFACE

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Connector: 16 Pin dual header  
 Signaling: TTL  
 Data Rate—Over-the-air: 9600 bps  
 Data Rate—Diagnostics: 38400 bps asynchronous  
 Data Latency: < 20 ms typical

Preliminary



**PRIMARY POWER**

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Voltage: 6-12 Vdc via Data Interface connector  
 RX Current at 10 Vdc (typical): 100 mA  
 TX Current at 10 Vdc (typical): 690 mA @ high power (2W)  
 530 mA @ low power (0.5W)  
 Current Limit/Polarity Protection: External; User-provided

**AGENCY APPROVALS (Pending)**

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FCC Part 15 (Pending)  
 FCC Part 90 (Pending)  
 Industry Canada RSS-119 (Pending)

Preliminary



### 3.2 dBm-Watts-Volts Conversion Chart

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

**Table 6. dBm-Watts-Volts Conversion—for 50 Ohm Systems**

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

Preliminary





Preliminary

## 4.0 GLOSSARY OF TERMS

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

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

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

**Bits-per-second**—See *BPS*.

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

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

**Data Circuit-terminating Equipment**—See *DCE*.

**Data Communications Equipment**—See *DCE*.

**Data Terminal Equipment**—See *DTE*.

**dB<sub>i</sub>**—Decibels referenced to an “ideal” isotropic radiator in free space. Frequently used to express antenna gain.

**dB<sub>m</sub>**—Decibels referenced to one milliwatt. An absolute unit used to measure signal power, as in transmitter power output, or received signal strength.

**DCE**—Data Circuit-terminating Equipment (or Data Communications Equipment). In data communications terminology, this is the “modem” side of a computer-to-modem connection. The ROR Module is a DCE device.

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

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



Preliminary

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

**Gaussian-Mean Shift Keying (GMSK) Modulation**—A form of continuous-phase FSK, in which the phase is changed between bits to provide a constant envelope.

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

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

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

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

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

**Multiple Address System**—See *MAS*.

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

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

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

**Programmable Logic Controller**—See *PLC*.

**Received Signal Strength Indication**—See *RSSI*.

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



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

**Remote Terminal Unit**—See *RTU*.

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

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

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

**Supervisory Control And Data Acquisition**—See *SCADA*.

Preliminary



# Preliminary

# IN CASE OF DIFFICULTY...

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

## FACTORY TECHNICAL ASSISTANCE

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

Please use the following telephone numbers for product assistance:

716-242-9600 (Phone)

716-242-9620 (Fax)

## FACTORY REPAIRS

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

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

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

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

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

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

**industrial/wireless/performance**



175 Science Parkway, Rochester, New York 14620  
General Business: +1 (585) 242-9600  
FAX: +1 (585) 242-9620  
Web: [www.microwavedata.com](http://www.microwavedata.com)