MDS SD Series

Secure, Long Range Data Communications

Reference Manual

Covering Units Operating in x710 Mode
with Firmware Version 4.x

MDS 05-4670A01, Rev. E
MARCH 2015

Digital Energy
MDS

Need Quick-Start instructions for this product? Please refer to publication 05-4669A01.
All GE MDS user guides are available online at ***www.gemds.com***

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Copyright and Trademark

RF Safety Notice (English and French)

RF Exposure

Concentrated energy from a directional antenna may pose a health hazard to humans. Do not allow people to come closer to the antenna than the distances listed in the table below when the transmitter is operating. More information on RF exposure can be found online at the following web site: **www.fcc.gov/oet/info/documents/bulletins**.

l'exposition aux RF

Concentré d'énergie à partir d'une antenne directionnelle peut poser un risque pour la santé humaine. Ne pas permettre aux gens de se rapprocher de l'antenne que les distances indiquées dans le tableau ci-dessous lorsque l'émetteur est en marche. Plus d'informations sur l'exposition aux RF peut être trouvé en ligne à l'adresse suivante: www.fcc.gov/oet/info/documents et bulletins.

Antenna Gain vs. Minimum RF Safety Distance

	Antenna Gain		
	0–5 dBi	**5–10 dBi**	**10–16.5 dBi**
Safety Distance (SD4)	0.93 meter	1.66 meters	3.51 meters
Safety Distance (SD9)	0.72 meter	1.28 meters	2.71 meters
Safety Distance (SD1)	For SD1, maintain an RF safety distance of 2.02 meters for a 7 dBd (9.15 dBi) antenna. Use of higher gain antennas means increasing the distance accordingly.		
Safety Distance (SD2)	For SD2, maintain an RF safety distance of 1.89 meters for a 7 dBd (9.15 dBi) antenna. Use of higher gain antennas means increasing the distance accordingly.		
Safety Distance (Other SD models):	Consult factory prior to operation.		

FCC Part 15 Notice

Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Any unauthorized modification or changes to this device without the express approval of the manufacturer may void the user's authority to operate this device. Furthermore, this device is intended to be used only when installed in accordance with the instructions outlined in this manual. Failure to comply with these instructions may void the user's authority to operate this device.

Industry Canada Notice

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

Servicing Precautions

When servicing energized equipment, be sure to wear appropriate Personal Protective Equipment (PPE). During internal service, situations could arise where objects accidentally contact or short circuit components and the appropriate PPE would alleviate or decrease the severity of potential injury. When servicing radios, all workplace regulations and other applicable standards for live electrical work should be followed to ensure personal safety.

Manual Revision and Accuracy

This manual was prepared to cover a specific version of firmware code. Accordingly, some screens and features may differ from the actual unit you are working with. While every reasonable effort has been made to ensure the accuracy of this publication, product improvements may also 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 GE MDS using the information at the back of this guide. In addition, manual updates can be found on our web site at www.gemds.com

Environmental Information

The manufacture of this equipment has required the extraction and use of natural resources. Improper disposal may contaminate the environment and present a health risk due to hazardous substances contained within. To avoid dissemination of these substances into our environment, and to limit the demand on natural resources, we encourage you to use the appropriate recycling systems for disposal. These systems will reuse or recycle most of the materials found in this equipment in a sound way. Please contact GE MDS or your supplier for more information on the proper disposal of this equipment.

Battery Disposal—This product may contain a battery. Batteries must be disposed of properly, and may not be disposed of as unsorted municipal waste in the European Union. See the product documentation for specific battery information. Batteries are marked with a symbol, which may include lettering to indicate cadmium (Cd), lead (Pb), or mercury (Hg). For proper recycling return the battery to your supplier or to a designated collection point. For more information see: www.weeerohsinfo.com.

Product Test Data Sheets

Test Data Sheets showing the original factory test results for this unit are available upon request from the GE MDS Quality Leader. Contact the factory using the information at the back of this manual. Serial numbers must be provided for each product where a Test Data Sheet is required.

CSA/us Notice

This product is approved for use in Class 1, Division 2, Groups A, B, C & D Hazardous Locations. Such locations are defined in Article 500 of the National Fire Protection Association (NFPA) publication NFPA 70, otherwise known as the National Electrical Code. The transceiver has been recognized for use in these hazardous locations by the Canadian Standards Association (CSA) which also issues the US mark of approval (CSA/US). The CSA Certification is in accordance with CSA STD C22.2 No. 213-M1987.

CSA Conditions of Approval: The transceiver is not acceptable as a stand-alone unit for use in the hazardous locations described above. It must either be mounted within another piece of equipment which is certified for hazardous locations, or installed within guidelines, or conditions of approval, as set forth by the approving agencies. These conditions of approval are as follows: The transceiver must be mounted within a separate enclosure which is suitable for the intended application.The antenna feedline, DC power cable and interface cable must be routed through conduit in accordance with the National Electrical Code. Installation, operation and maintenance of the transceiver should be in accordance with the transceiver's installation manual, and the National Electrical Code. Tampering or replacement with non-factory components may adversely affect the safe use of the transceiver in hazardous locations, and may void the approval. A power connector with screw-type retaining screws as supplied by GE MDS must be used.

⚠ WARNING

EXPLOSION HAZARD!

Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous. Refer to Articles 500 through 502 of the National Electrical Code (NFPA 70) for further information on hazardous locations and approved Division 2 wiring methods.

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1.0 INTRODUCTION

This Reference Manual is one of two books provided for users of the MDS SD Series Transceiver (Figure 1) operating in x710 Mode. It contains an overview of common applications, installation planning data, technical specifications, troubleshooting, and a listing of software commands. This manual should be available to technical personnel who perform network design, configuration, and troubleshooting of the equipment.

A companion *Instruction Sheet* is also available (Part no. 05-4669A01). The scope of the Instruction Sheet is limited to installing the transceiver and placing it in service for the first time.

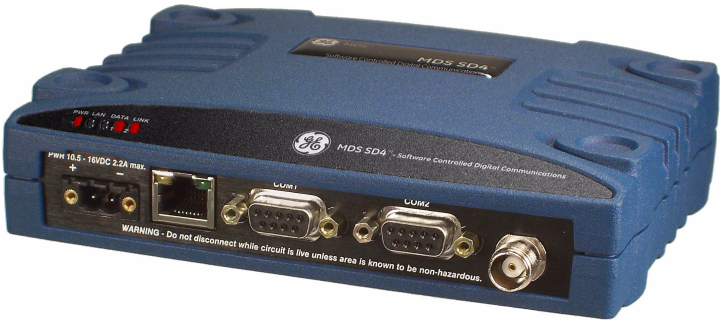


Figure 1. MDS SD Series Transceiver

1.1 Conventions Used in This Manual

Software Notations

This product is designed for software control using a connected PC. To indicate the names of software commands, keyboard entries, or other information shown on a PC screen, a distinctive, bolded font is used as follows:

Bolded font example (used for software commands and keyboard entries)

Model Number Notations

The term "SD" or "SD Series" is used in this manual to denote all models in the SD product line. Specific model numbers such as "MDS SD2" (216-235 MHz) "MDS SD4" (350-512 MHz) and MDS SD9 (928-960 MHz) are used only when necessary to reference model-specific features. This manual applies to *all* SD radios operating in x710 Mode.

Authorization Features

Some features of the radio are dependent on purchased options and applicable regulatory constraints. A "key" icon is shown near the heading of these features in this manual. If your radio is not currently authorized for a needed feature, contact your factory representative for information on obtaining a new authorization code/key.

1.2 Electronic Manuals

All SD Series manuals are available in printed or electronic form. Download electronic manuals from our web site at **www.gemds.com**. The web site also contains links to Application Bulletins and other product information.

2.0 PRODUCT DESCRIPTION

The SD Transceiver is a software-configurable, industrial radio for use in licensed data acquisition networks. It can be interfaced with a variety of data control equipment including remote terminal units (RTUs), programmable logic controllers (PLCs), flow computers, and similar devices. Data interface connections can be made for both serial (RS-232/RS-485) and local Ethernet protocols.

The radio's *x710 Mode* is designed primarily for use in serial MDS x710 radio networks where a central station communicates with each remote, one at a time, to convey data and control signals. For models operating in this mode, the radio offers direct, drop-in compatibility with existing, older x710 networks while providing additional functionality not found in MDS x710 radios. An SD Transceiver in x710 mode looks like an x710 with respect to over-the-air transmission and all serial user interface commands (plus some new SD-specific commands).

The transceiver employs digital signal processing (DSP) technology and a fully digital transmit and receive IF chain to provide robust communications even under adverse conditions. Digital signal processing also helps eliminate the effects of component variations or temperature swings, resulting in an optimized performance.

2.1 Front Panel Connectors and Indicators

Figure 2 shows the transceiver's front panel connectors and indicators. These items are referenced in various locations in this manual. The transceiver's LED functions are described in Table 10 on Page 19.

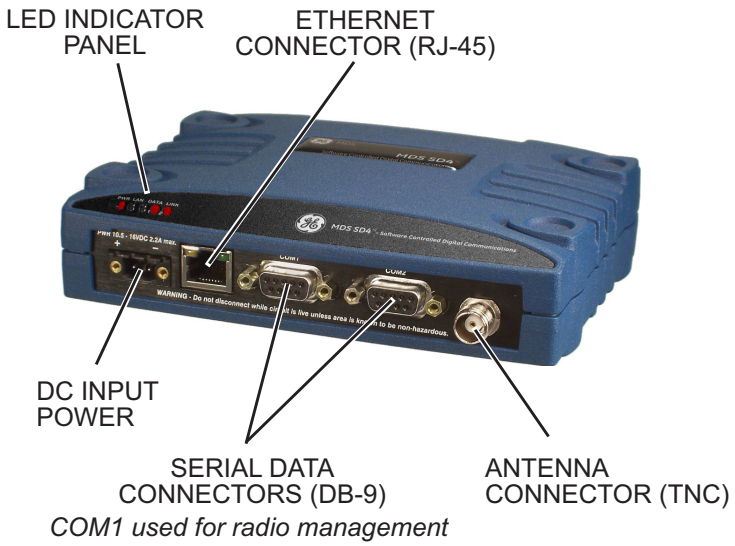


Figure 2. Front Panel Connectors & Indicators

2.2 Key Product Features

The transceiver is designed to meet the demanding needs of today's industrial wireless networks in a compact, rugged package. It offers an array of features in one hardware platform:

- Ethernet & serial interfaces—ideal for migration to IP networks
- Dual serial functionality (RS-232 and RS-485)
- Software configurable using the built-in interface, and Web management—no manual controls or adjustments. Supports Serial, Telnet, or web-based management.
- Over-the-air reprogramming—no unnecessary trips to radio sites
- Licensed 5-watt design, maximizes communications range with low interference risk from other users
- Configurable as a Remote or a Master unit
- Low power "sleep mode"—ideal for battery-powered solar sites
- Drop-in compatibility with MDS x710 radios (x710 mode)
- Supports a wide variety of modem speeds and bandwidths for regulatory compliance in virtually all regions of the world

NOTE: Some features might not be available on all units, depending on the options purchased and regulatory constraints for the region in which the radio will operate.

2.3 Model Offerings

The radio is available in three model configurations:

- **Ethernet**—All SD features and functionality
- **Standard**—All features *except* Ethernet functionality
- **x710**—Direct, drop-in compatibility for networks using a mix of SD and older MDS *x*710 radios. The Ethernet port is available for radio management in x710 mode, but not for payload.

Model Number Codes

The unit's complete model number is printed on the bottom label. Additional unit details are available through the **MODEL1** and **MODEL2** commands, described later in this manual.

2.4 Operating Modes and Applicable Manuals

SD Transceivers can be configured to operate in any one of three modes:

- **x710 Mode**—This mode provides direct, drop-in compatibility with MDS *x*710 (4710 or 9710) transceivers, and uses the same core command set as these radios. It is ideal for use in systems containing a mix of newer SD radios and legacy MDS *x*710 units. *This manual covers x710 Mode radios.*
- **Packet Mode (including Packet w/MAC)**—Payload data from the radio's serial or Ethernet ports is assembled into packets and transmitted over the air. Packet mode supports Ethernet Bridging, AES 128-bit encryption, and multihost operation. This mode is ideal for networks containing *all* SD radios. *This manual does **not** cover Packet Mode radios. See below for applicable manuals.*
- **Transparent Mode**—This mode is over-the-air compatible with MDS x710 transceivers, while supporting payload data on the Ethernet interface. This mode is ideal for mixed networks containing SD and MDS x710 radios. It allows currently deployed x710 networks to add the ability to support Ethernet data. *This manual does **not** cover Transparent Mode radios. See below for applicable manuals.*

For Packet Mode and Transparent Mode operation, refer instead to the following manuals for instructions:

- *Start-Up Guide*—Part No. 05-4847A01
- *Reference Manual*—Part No. 05-4846A01

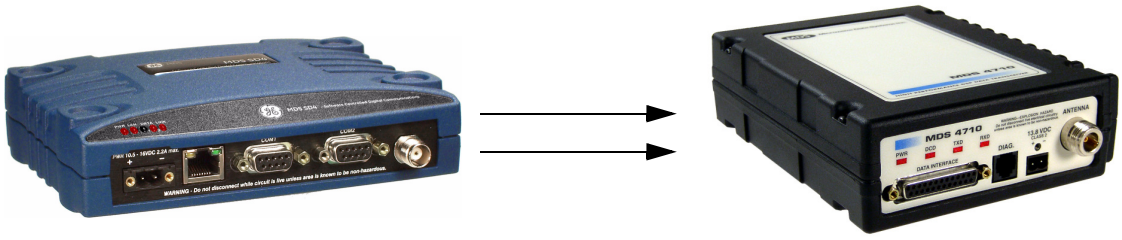


Figure 3. SD Transceivers offer compatibility with older MDS x710 Transceivers (right), and may be used for replacement or interoperability in these networks. A retrofit kit is available for connector conversion (see Table 1).

2.5 Accessories and Spares

Table 1 lists common accessories and spare items for the transceiver. GE MDS also offers an *Accessories Selection Guide* listing additional items that can be used with the product. Contact your factory representative or visit **www.gemds.com** to obtain a copy of the guide.

Table 1. Accessories & Ancillary Items

Accessory	Description	Part Number
Retrofit Kit, Digital	Contains adapters and connectors needed to facilitate the replacement of an existing MDS *x*710A/C/M digital transceiver.	03-4696A01
Retrofit Kit, Analog	Contains adapters and connectors needed to facilitate the replacement of an existing MDS *x*710A/C/M analog transceiver.	03-4697A01
DC Power Plug, 2-pin, polarized	Mates with power connector on radio case. Screw terminals provided for wires, threaded locking screws to prevent accidental disconnect.	73-1194A53
Instruction Sheet (for x710 Mode)	Describes the installation and setup of the transceiver. A companion to this Reference Manual.	05-4669A01
Flat Mounting Brackets (Standard)	Brackets that attach to the bottom of the unit. Used for mounting to a flat mounting service.	03-4123A14
DIN Rail Mounting Bracket Kit	Contains bracket for mounting the transceiver to standard 35 mm DIN rails commonly used in equipment cabinets and panels.	03-4125A04

3.0 APPLICATIONS

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

This is the most common application of the transceiver. It consists of a central master station and several associated remote units as shown in Figure 4. An MAS network provides communication between a central host computer and remote terminal units (RTUs) or other data collection devices. The operation of the radio system is transparent to the computer equipment.

Often, such a system is used to convey telemetry data to and from widely separated remote radios. Typical applications include automatic, remote monitoring of gas wells, water tank levels, electric power distribution systems, and similar control and measurement functions.

The radio system can replace a network of remote monitors currently linked to a central location using leased telephone lines or other hard-wired means. At the central office of such a system, there is usually a dedicated computer and some means of switching between individual

lines coming from each remote monitor. In this type of system, there is a modulator/demodulator (modem) at the main computer and at each remote site, usually built into the remote monitor itself. Since the cost of leasing a dedicated-pair phone line is quite high, wireless technology is often used as a cost-effective alternative.

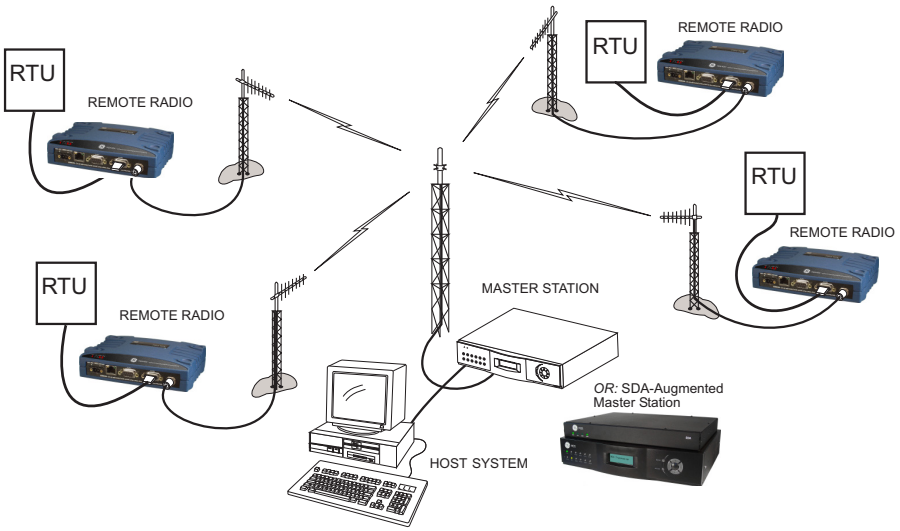


Figure 4. Typical MAS Point-to-Multipoint Network

Point-to-Point System

Where permitted, the transceiver can also be used in a point-to-point arrangement. A point-to-point system consists of just two radios—one serving as a Master and the other as a Remote (see Figure 5). It provides a simplex or half-duplex communications link for the transfer of data between two locations.

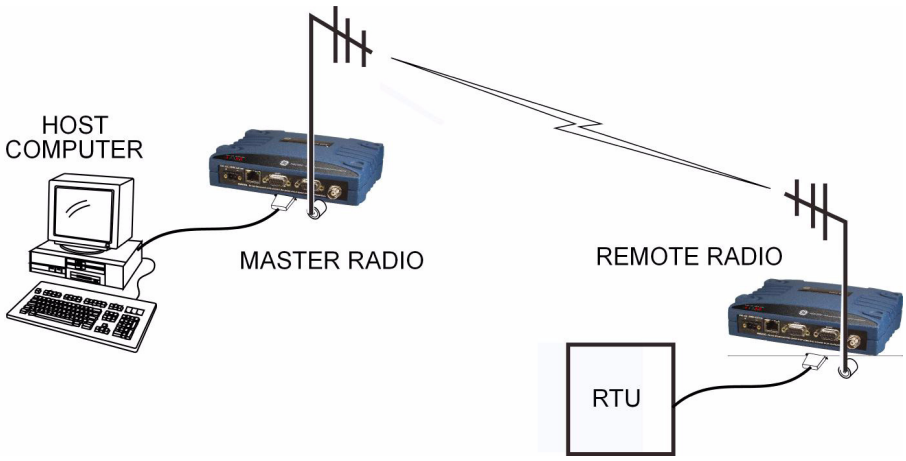


Figure 5. Typical Point-to-Point Link

Continuously-Keyed versus Switched-Carrier Operation

The keying behavior of the master station can be used to describe the operation of an MAS system.

Continuously-Keyed operation means the master station transmitter is always keyed and an RF carrier is always present, even when there is no data to send. The master station is always transmitting and receiving simultaneously. Different frequencies must be used for transmit and receive. This is the method used in many MAS systems, as is shown in Figure 4. This network arrangement is useful for high-speed polling applications.

NOTE: The SDx acting as a master does not support full-duplex operation.

Switched-Carrier operation is a half-duplex mode of operation where the master station transmitter is keyed to send data and unkeyed to receive.

Single-Frequency (Simplex) Operation

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

NOTE: Data turn-around times are increased when inter-working with an MDS x710 network. This restriction does *not* apply to homogeneous SD networks.

4.0 INSTALLATION PLANNING

Careful planning of the installation site helps achieve optimal performance from the transceiver. This section discusses pre-installation factors. After reviewing this section, refer to the step-by-step installation procedures beginning on Page 18.

4.1 Typical Installation

Figure 6 shows a typical station arrangement. Wiring connections and installation steps for the transceiver are provided in the sections that follow.

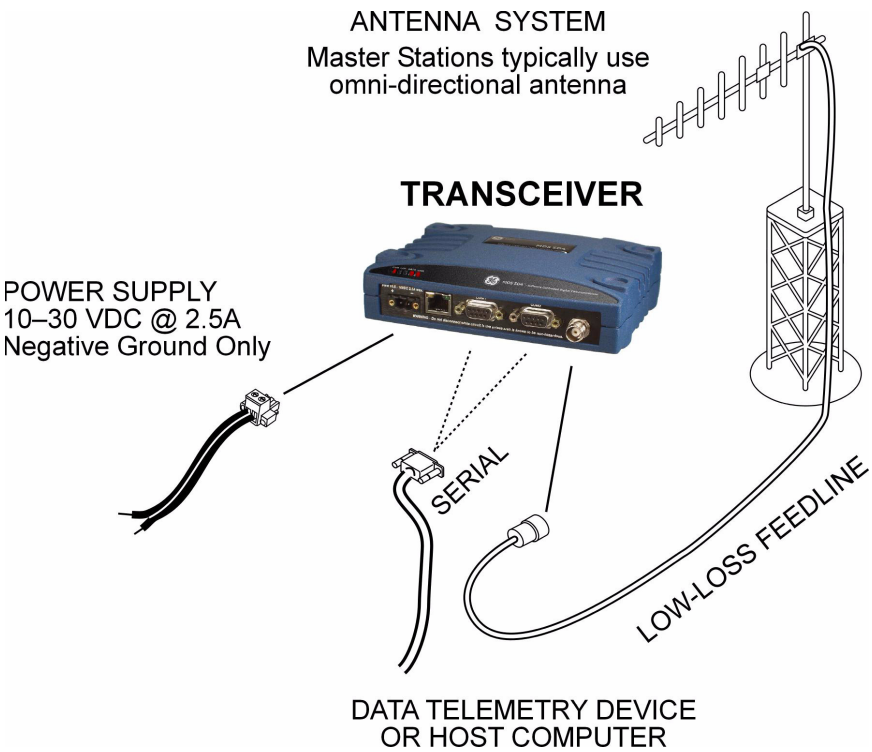


Figure 6. Typical Remote Station Arrangement

4.2 Mounting Options

The transceiver is normally provided with flat mounting brackets attached to the bottom of the radio as shown in Figure 7. An optional 35 mm DIN rail mounting bracket is also available. See “Optional DIN Rail Mounting” on page 10.

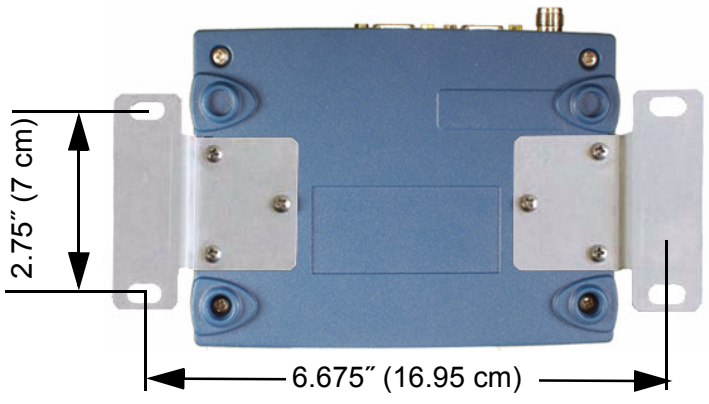


Figure 7. Mounting Bracket Dimensions

NOTE: To prevent moisture from entering the radio, do not mount the case with the cable connectors pointing up. Also, dress all cables to prevent moisture from running along the cables and into the radio.

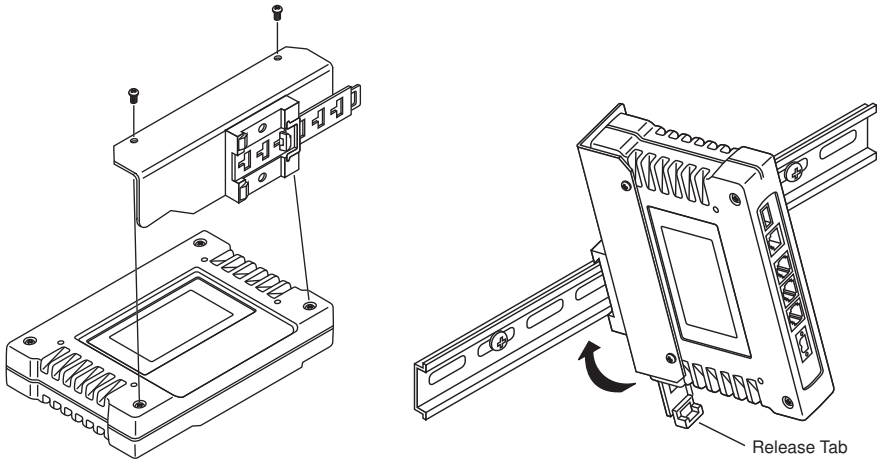
Transceiver dimensions are shown in Figure 8.

Figure 8. SD Transceiver Dimensions

Optional DIN Rail Mounting

The unit can be mounted with an optional 35 mm DIN Rail Mounting Bracket Kit (Part No. 03-4125A04). Equipment cabinets and racks of modern design often employ this type of mounting. Once the DIN bracket is attached to the radio, it allows for quick installation and removal of the radio from its mounting rail without the need for tools.

The DIN Rail bracket attaches to the unit's case as shown in Figure 9. The entire assembly then attaches to the mounting rail.



Step 1: *Attach the bracket using the two screws provided. (Attach to the end opposite the unit's connectors.)*

Step 2: *Clip the assembly onto the DIN Rail. Removal is performed by pulling down on the Release Tab.*

Figure 9. Attachment & Mounting of DIN Rail Bracket
(unit shown is for example only, and is not an SD Transceiver)

4.3 Antennas and Feedlines

Antennas

The transceiver can be used with a number of antennas. The exact style depends on the physical size and layout of your radio system. A directional Yagi (Figure 10) or corner reflector antenna is generally recommended at remote sites to minimize interference to and from other users. Antennas of this type are available from several manufacturers, including GE MDS. Contact your factory representative for details.

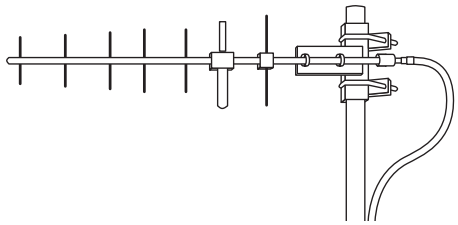


Figure 10. Typical Yagi Antenna (mounted to mast)

Feedlines

The selection of an antenna feedline is very important. Poor quality cable should be avoided as it will result in power losses that might reduce the range and reliability of the radio system.

Table 2, Table 3, and Table 4 show the approximate losses that will occur when using various lengths and types of coaxial cable in the 200, 400, and 900 MHz bands. Regardless of the type used, the cable should be kept as short as possible to minimize signal loss.

Table 2. Signal Loss in Coaxial Cables (at 200 MHz)

Cable Type	10 Feet (3.05 Meters)	50 Feet (15.24 Meters)	100 Feet (30.48 Meters)	200 Feet (60.96 Meters)
RG-8A/U	0.26 dB	1.27 dB	2.5 dB	5.07 dB
1/2 inch HELIAX	0.06 dB	0.38 dB	0.76 dB	1.60 dB
7/8 inch HELIAX	0.04 dB	0.21 dB	0.42 dB	0.83 dB
1-1/4 inch HELIAX	0.03 dB	0.16 dB	0.31 dB	0.62 dB
1-5/8 inch HELIAX	0.025 dB	0.13 dB	0.26 dB	0.52 dB

Table 3. Signal Loss in Coaxial Cables (at 400 MHz)

Cable Type	10 Feet (3.05 Meters)	50 Feet (15.24 Meters)	100 Feet (30.48 Meters)	200 Feet (60.96 Meters)
RG-8A/U	0.51 dB	2.53 dB	5.07 dB	10.14 dB
1/2 inch HELIAX	0.12 dB	0.76 dB	1.51 dB	3.02 dB
7/8 inch HELIAX	0.08 dB	0.42 dB	0.83 dB	1.66 dB
1-1/4 inch HELIAX	0.06 dB	0.31 dB	0.62 dB	1.24 dB
1-5/8 inch HELIAX	0.05 dB	0.26 dB	0.52 dB	1.04 dB

Table 4. Length vs. Loss in Coaxial Cables (at 900 MHz)

Cable Type	10 Feet (3.05 Meters)	50 Feet (15.24 Meters)	100 Feet (30.48 Meters)	200 Feet (60.96 Meters)
RG-8A/U	0.85 dB	4.27 dB	8.54 dB	17.08 dB
1/2 inch HELIAX	0.23 dB	1.15 dB	2.29 dB	4.58 dB
7/8 inch HELIAX	0.13 dB	0.64 dB	1.28 dB	2.56 dB
1-1/4 inch HELIAX	0.10 dB	0.48 dB	0.95 dB	1.90 dB
1-5/8 inch HELIAX	0.08 dB	0.40 dB	0.80 dB	1.60 dB

4.4 DC Power Connection

Power the transceiver from any well-filtered 10.0 to 30 Vdc power source. The supply must be capable of providing at least 2.5 A of continuous current.

NOTE: Early SD4 models supported 10.5 to 16 Vdc power, not 10 to 30 Vdc. Check the labeling above the power connector to confirm the operating range for your unit.

A power connector with screw terminals is provided with each unit (see Figure 11). Strip the wire leads to 6 mm (1/4 inch) and insert in the wire ports. Be sure to observe proper polarity as shown in Figure 11.

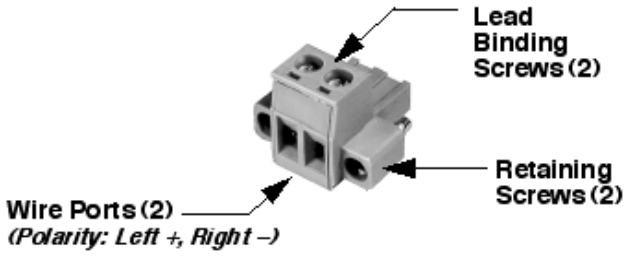


Figure 11. DC Power Connector (P/N 73-1194A39)

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

4.5 Grounding Considerations

To minimize the chance of damage to the transceiver and connected equipment, a safety ground (NEC Class 2 compliant) is recommended which bonds the antenna system, transceiver, power supply, and connected data equipment to a *single-point* ground, keeping all ground leads as short as possible.

Normally, the transceiver is adequately grounded if the supplied flat mounting brackets are used to mount the radio to a well-grounded metal surface. If the transceiver is not mounted to a grounded surface, it is recommended that a safety ground wire be attached to one of the mounting brackets or a screw on the transceiver's case.

The use of a lightning protector is recommended where the antenna cable enters the building. Bond the protector to the tower ground, if possible.

4.6 COM1 (Management) Connections

The radio's COM1 port is used to connect a PC for management or diagnostic purposes. Typically, a straight-through DB-9 cable can be used for this purpose. If desired, construct a cable as shown in Figure 13, connecting Pins 2 (RXD), 3 (TXD), and 5 (GND).

Other custom cables or adapter kits are only needed for analog operation or other special-use applications.

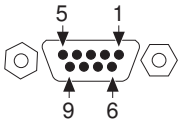


Figure 12. COM1 Connector (DB-9F)
As viewed from outside the radio

NOTE: To prevent unintended keying of the transmitter during management activities, set **PTTSIG** to **OFF**, or do not connect to Pin 6 of the COM1 port.

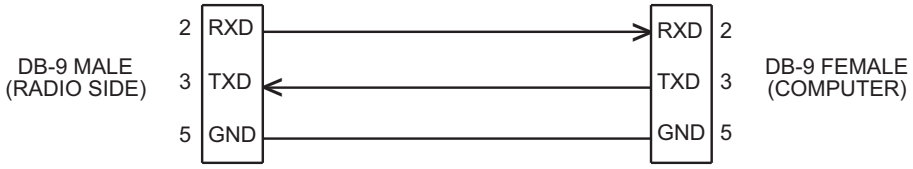


Figure 13. COM1 Wiring to Computer for Management

Table 5. COM1 Pin Descriptions

Pin Number	Input/ Output	Pin Description
1	--	No function
2	OUT	**RXD (Received Data)**—Supplies received data to the connected device.
3	IN	**TXD (Transmitted Data)**—Accepts TX data from the connected device.
4	--	No function
5	--	**Ground**—Connects to ground (negative supply potential) on chassis.
6	--	No function
7	--	No function in most applications—User I/O for special applications
8	---	No function
9	--	No function in most applications—User I/O for special applications

COM1 in Analog Operation

The COM1 port also supports connections for analog operation with an external modem. Pins 4, 5, 6, and 8 in Table 5 are used for analog operation. (Pins 7 and 9 are reserved for user I/O signals.) Refer to “Analog Operation of the Transceiver” on Page 46 for more information.

4.7 COM2 (Data) Connections

The COM2 port (Figure 14) is used to connect the radio to an external DTE telemetry device supporting the EIA/RS-232 or EIA/RS-485 (balanced) format, depending on how the radio is configured. Typically, a straight-through DB-9 cable is used to connect to COM2. The radio supports data rates of 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200 bps (asynchronous data only). The following data formats are supported:

Table 6. Data Formats

Character Bits	Parity	Stop Bits
8	No	1
8	No	2
8	Odd	1
8	Odd	2
8	Even	1
8	Even	2
7	No	1
7	No	2
7	Odd	1
7	Odd	2
7	Even	1
7	Even	2

Table 7 and Table 8 provide detailed pin descriptions for the COM2 data port in RS/EIA-232 mode and RS/EIA-485 mode, respectively.

NOTE: Make sure the PORT setting from the PORT command matches the type of interface you are using (RS-232 or RS-485). The default is RS-232.

NOTE: To prevent unintended keying of the transmitter on RTS, set **RTSKEY** to **OFF**, or do not connect to Pin 7 (RTS) of the COM2 port.

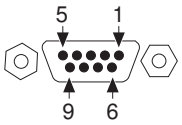


Figure 14. COM2 Connector (DB-9F)
As viewed from outside the radio

Pin Descriptions—RS/EIA-232 Mode

Table 7 lists the COM2 port pin functions when configured to operate in RS/EIA-232 mode.

NOTE: The radio is hard-wired as a DCE device.

Table 7. COM2 Pin Descriptions—RS/EIA-232 Mode

Pin Number	Input/ Output	Pin Description
1	OUT	**DCD (Data Carrier Detect/Link)**—A high (asserted) indicates signal received.
2	OUT	**RXD (Received Data)**—Supplies received data to the connected device.
3	IN	**TXD (Transmitted Data)**—Accepts TX data from the connected device.
4	IN	**Sleep Mode Input**—Grounding this pin places the radio in a low power consumption mode.
5	--	**Signal Ground—**Connects to ground (negative supply potential) on chassis.
6	OUT	**Alarm Output (DSR)—**Behavior is user-configurable. *Default behavior:* An RS-232 high/space (+5.0 Vdc) on this pin indicates an alarm condition. An RS-232 low/mark (–5.0 Vdc) indicates normal operation.
7	IN	**RTS (Request-to-Send)**—Keys the transmitter.
8	OUT	**CTS (Clear-to-Send)—**Goes “high” after the programmed CTS delay time has elapsed (DCE), or keys another connected radio when RF data arrives (CTS KEY).
9	--	Reserved—User I/O for special applications.

Pin Descriptions—RS/EIA-422/485 Mode

Table 8 lists the COM2 port pin functions for radios configured to operate in RS/EIA-422/485 mode. See Figure 15 for wiring schemes.

Table 8. COM2 Connector Pin Descriptions—RS/EIA-422/485 Mode

Pin Number	Input/ Output	Pin Description
1	OUT	**Carrier Detect/Link**—A high indicates signal received.
2	OUT	**TXD-/TXA** (Transmitted Data -)—Inverting driver output. Supplies received payload data to the connected device.
3	IN	**RXD-/RXA** (Received Data -)—Inverting receiver input. Accepts payload data from the connected device.
4	IN	**Sleep Mode Input**—Grounding this pin places the radio in a low power consumption mode.
5	--	**Ground**—Connects to ground (negative supply potential) on the radio’s PC board.
6	OUT	**Alarm Output**—Behavior is user-configurable. *Default behavior:* A high on this pin indicates an alarm condition; a low indicates normal operation.
7	IN	**RXD+/RXB** (Received Data +)— Non-inverting receiver input
8	OUT	**TXD+/TXB** (Transmitted Data +)**—**Non-inverting driver output.
9	--	Reserved—User I/O for special applications

COM2 PORT NOTES:

- RXD+ / RXB and RXD– / RXA are data sent to the radio to be transmitted
- RXD+ / RXB is positive with respect to RXD– / RXA when the line input is a “0”
- TXD+ / TXB and TXD– / TXA are data received by the radio and transmitted
- TXD+ / TXB is positive with respect to the TXD– / TXA when the line output is a “0”

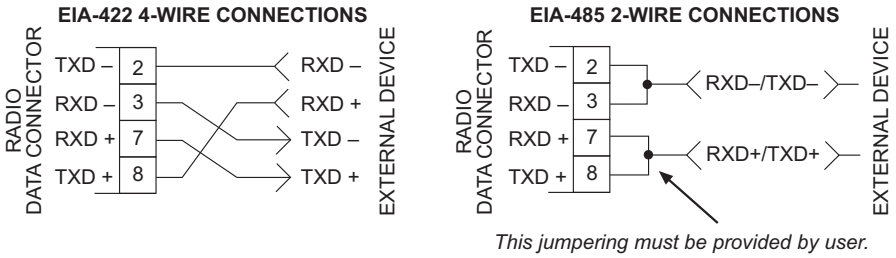


Figure 15. EIA-422/485 Wiring Arrangements

4.8 Ethernet Interface (RJ-45)

In x710 mode, the transceiver’s Ethernet Port is used for radio management only. The port has built-in MDIX (auto-sensing) capability, allowing either a straight-through or crossover cable to be used. Figure 16 and Table 9 show pinout data for the Ethernet port.

The Ethernet port can be used to support Telnet or web-based radio management. Telnet provides the same user interface available with COM1.

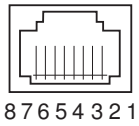


Figure 16. Ethernet Port (RJ-45) Pinout
(As viewed from the outside of the unit)

Table 9. Ethernet Port (IP/Ethernet) Pinouts

Pin	Functions	Ref.
1	Transmit Data (TX)	High
2	Transmit Data (TX)	Low
3	Receive Data (RX)	High
4	Unused	
5	Unused	
6	Receive Data (RX)	Low
7	Unused	
8	Unused	

5.0 STEP-BY-STEP INSTALLATION

In most cases, the steps given here are sufficient to install the transceiver. Refer to "INSTALLATION PLANNING" on Page 8 for additional details.

1. **Mount the transceiver**. Attach the mounting brackets to the bottom of the transceiver case (if not already attached), using the four 6-32 x 1/4 inch (6 mm) screws supplied. Mounting bracket dimensions are shown in Figure 7 on page 9. Secure the brackets to a flat, grounded surface. (If a grounded surface is not available, run a separate ground wire to the transceiver—see "Grounding Considerations" on Page 13.)

2. **Install the antenna and feedline.** The antenna used with the radio must be designed to operate in the radio's frequency band, and be mounted in a location providing a clear path to the associated station(s). At Remote sites, aim directional antennas toward the master unit. Use low-loss coaxial feedline, and keep the feedline as short as possible.

3. **Connect the data equipment.** Make the connection using Serial protocols (RS-232/RS-485).

   Connect a serial device to COM2 on the front panel. The radio is hardwired as a DCE device. Use a straight-through cable for most applications.

4. **Connect primary power.** Input power must be within the range printed above the power connector, and capable of providing at least 2.5 A. A power connector with screw-terminals is provided with the unit (see Figure 11 on page 12). Strip the wire leads to 1/4 inch (6 mm) and insert them into the wire ports. Be sure to observe proper polarity. Tighten the binding screws securely.

CAUTION
POSSIBLE EQUIPMENT DAMAGE

The unit is designed for use with negative-ground systems only. The power supply should be equipped with overload protection (NEC Class 2 rating), to protect against a short circuit between its output terminals and the radio's power connector.

NOTE: To comply with IEC61850-3, paragraph 5.7.1.2, surge suppression must be used across the power supply for Class 3 and 4 severity levels as defined by IEC 61000-4-5 Annex A.

5.1 Initial Startup & Checkout

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

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

1. Apply DC power.

2. Observe the LED status panel for proper indications (Table 10).

3. If not done earlier, refine the antenna heading of the station to maximize the received signal strength (RSSI) from the Master Unit. The **RSSI** command can be used to display signal strength. Turn the antenna heading slowly so that the RSSI display can be updated.

NOTE: The RSSI function limits the maximum displayed signal strength to –60 dBm.

Table 10. LED Status Indicators
(LED labeling may vary on early units; functionality remains as described below)

LED Name	Description
PWR	• Continuous—Power applied, no problems detected. • Rapid flash (5 times-per-second)—Alarm indication, or RX/TX frequencies not set.
LAN	• Flashing—Data is being transmitted and received. • Off—Ethernet signals not detected
DATA 1/DATA 2	These LEDs show data activity on the DB-9 serial payload ports (COM1 and COM2).
LINK	When lit, indicates that a communication link exists with the Master Unit.

5.2 Initial Software Configuration

This section provides the steps necessary to program the radio for its first on-air operation. There are numerous settings that go beyond basic configuration, and you may wish to access these later. A full description of commands is provided in “TRANSCEIVER MANAGEMENT” on Page 21.

Serial vs. Telnet Access, and the Device Manager

There are three methods available to communicate with the transceiver for configuration and management purposes: **Serial** (COM1 DB9 connector), **Telnet** (ETHERNET RJ-45 connector), and the web-based **Device Manager**. Both serial and telnet present identical screens, but the method of access is different for each. The Device Manager provides a web interface using the transceiver's built-in web server, and is the newest configuration interface, although all three options accomplish the same results.

NOTE: Firmware reprogramming is best handled using the Device Manager.

The focus of this section is on Serial access, but Telnet may also be used by following these additional points, which replace Steps 1-3 below:

- Connect to the radio with a PC that is on the same IP network as the transceiver. Launch a Telnet program, and connect to the radio using its programmed IP address.
- The default IP address for an SD is 192.168.1.1. If you do not know the IP address of the radio, follow the serial configuration instructions below, where you can determine the radio's address and continue configuration of the radio, or ask your network administrator.

Connecting a PC & Setting Basic Parameters

Follow these steps to configure the transceiver for its first use:

1. Connect a PC to the radio's COM1 serial port as shown in Figure 17. (Maximum recommended cable length: 50 ft./15 m)

NOTE: Not all PCs include a serial port. If one is not available, a USB port may be used, along with a USB-to-Serial adapter (with appropriate driver software). Adapters are available from many manufacturers.

NOTE: If COM1 has been configured to boot into data mode, pressing **ENTER** within 10 seconds of boot-up switches it into console (management) mode. Console mode is required for the following steps.

2. Launch a terminal communications program, such as HyperTerminal (included with many Windows®-based PCs) with the following communication parameters: **8 bits, no parity, one stop bit (8N1), flow control disabled, VT100 emulation.** The radio's COM1 port automatically determines the connected baud rate (within the range of 1200–115200 bps). The preferred baud rate is 9600 bps.

3. Press the **ENTER** key several times at half-second intervals to choose and select the correct baud rate. This will result in the **>** prompt.

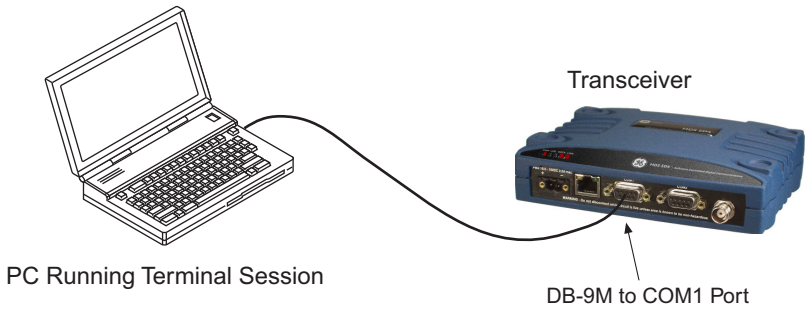


Figure 17. PC Connection to Transceiver

NOTE: TX and RX frequencies might not be set when the radio is shipped from the factory, depending on ordering options. If frequencies have not been set, the PWR LED will flash, indicating an alarm condition. The alarm will clear after the frequencies are set. In *all* cases, users should verify that the frequencies are properly set in accordance with the station license.

6.0 TRANSCEIVER MANAGEMENT

To perform transceiver management, connect a PC as described in Section 5.1, Initial Startup & Checkout and obtain the **>** prompt.

6.1 Software Commands

Table 11 is a reference chart of software commands for the transceiver. Programmable information is shown in brackets [ ] following the command name. See Section 6.2, Detailed Command Descriptions (Page 21) for detailed command descriptions.

Entering Commands

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

Table 11. Command Summary

Command name	Function
AK ***Details Page 25***	The Authorization Key and a list of authorized features.
ALARM ***Details Page 25***	Read current operating condition of radio.
AMASK [0000 0000–FFFF FFFF] ***Details Page 25***	Set/display hex code identifying which events trigger an alarm.

Table 11. Command Summary *(Continued)*

Command name	Function
ASENSE [HI, LO] ***Details Page 25***	Set/display the state of the alarm output signal to ACTIVE HI or ACTIVE LO.
AUDIO [ON, OFF] ***Details Page 26***	Set/display the receive audio monitor mode for modems.
BAUD [xxxxx abc] ***Details Page 26***	Set/display the DATA INTERFACE data rate and format.
BIN [DATA, CLEAR] ***Details Page 26***	Display or clear data counters.
BOOT ***Details Page 26***	Used to initiate a software reboot.
BUFF [ON, OFF] ***Details Page 26***	Enables or disables the internal radio data buffer.
CKEY [ON–OFF] ***Details Page 27***	Enables or disables the continuously keyed mode. Note: Remotes cannot receive when keyed.
CTS [0–255] ***Details Page 27***	Set/display the Clear-to-Send delay in seconds.
CTSHOLD [0–60000] ***Details Page 27***	Set/display Clear-to-Send hold delay.
DATAKEY [ON, OFF] ***Details Page 28***	Enables or Disables key-on-data mode (ON = key-on-data or RTS, OFF = key-on-RTS).
DEV ***Details Page 28***	Set/display modem control deviation.
DEVICE [DCE, CTS KEY] ***Details Page 28***	Set/display device mode.
DKEY ***Details Page 28***	Dekey the radio (transmitter OFF). This is generally a radio test command.
DLINK [ON/OFF/xxxx] ***Details Page 28***	Configures local diagnostic link protocol.
DTYPE [NODE/ROOT] ***Details Page 29***	(*diagnostics*) Sets up a radio as a root or node radio.
DUMP ***Details Page 29***	Display all programmable settings.
EMP [ON/OFF] ***Details Page 29***	Set/display TX audio pre-emphasis for analog mode.
ETHADDR ***Details Page 29***	Displays Ethernet MAC address (non-configurable).
FORCEALARM [ON or OFF] ***Details Page 29***	Generates a test alarm for 10 sec.
FORCEDCD [ON or OFF] ***Details Page 29***	Forces Data Carrier Detect (DCD) to always be asserted.
HELP ***Details Page 29***	Shows available commands.
INIT ***Details Page 30***	Set radio parameters to factory defaults for the radio *outside* the P-20 Protected Network Chassis.
INIT [SDx] ***Details Page 30***	Configure radio for use *outside* of the Protected Network Chassis (SDxP). Restores certain transceiver defaults changed by the **INIT P-20** command.

Table 11. Command Summary *(Continued)*

Command name	Function
INIT [P-20] ***Details Page 30***	Configure radio for service *within* a P-20 Protected Network Chassis.
IPCONFIG ***Details Page 31***	Ethernet interface configuration.
KEY ***Details Page 31***	Key the radio (transmitter ON). This is generally a radio test command.
MENU ***Details Page 31***	Activates the radio's menu-based program (if supported).
MODEL1 ***Details Page 31***	Shows configuration order entry string associated with the radio. Programmed at the factory.
MODEL2 ***Details Page 31***	Shows an identifier string associated with the radio's hardware bill of materials and revision. Programmed at the factory.
MODEM [xxxx] ***Details Page 31***	Set the modem characteristics of the radio.
OWM [XXX...] ***Details Page 33***	Set/display the owner's message.
OWN [XXX...] ***Details Page 33***	Set/display the owner's name.
PORT [RS232, RS485] ***Details Page 34***	Set/display COM2 data port interface settings.
PTT [0–255] ***Details Page 34***	Set/display the Push-to-Talk delay in milliseconds.
PTTSIG [OFF, LOW, HI] ***Details Page 34***	Set/display push-to-talk configuration.
PWR [20–37] ***Details Page 34***	Set/display the transmit power setting.
RESTORECONFIG ***Details Page 34***	Restores a saved user configuration.
RESTOREDEFAULTS ***Details Page 34***	This command restores the original factory configuration.
RMODE [X710, TRANSPARENT, PACKET, CMAC, HELP] ***Details Page 34***	Allows the reconfiguration of the SD operating mode.
RSSI ***Details Page 34***	Display the Received Signal Strength Indication.
RTSKEY [ON, OFF] ***Details Page 35***	Set/display how the radio responds to RTS keying. Default is RTSKEY OFF, to prevent undesired keying of the transmitter when RTS is raised by a terminal program.
RTU [ON/OFF/0-80] ***Details Page 35***	Re-enables or disables the radio's internal RTU simulator and sets the RTU address.
RX [xxx.xxxx] ***Details Page 35***	Set/display receiver frequency.
RXATTN [ON or OFF] ***Details Page 35***	Enables or disables receive attenuation.
RXLEVEL [–20 to 0] ***Details Page 35***	Set/display the receive audio input level.

Table 11. Command Summary *(Continued)*

Command name	Function
RXTOL [NORMAL or CUSTOM] ***Details Page 36***	Set/display the custom receive tolerance to accommodate issues experienced with some x790 masters.
RXTOT [NONE, 1-1440] ***Details Page 36***	Set/display the value of the receive time-out timer.
SAVECONFIG ***Details Page 36***	Saves a user configuration.
SCD [0-255] ***Details Page 36***	Set/display the Soft-Carrier Dekey delay in milliseconds.
SER ***Details Page 36***	Display the radio serial number.
SHOW [DC, PWR] ***Details Page 36***	Display the DC voltages and transmit power level.
SNR ***Details Page 36***	Signal-to-Noise Ratio, expressed in dB.
SPECTRUM [xxx.xx] ***Details Page 37***	Display the transceiver's built-in spectrum analyzer, where xxx.xx denotes center frequency.
SQUELCH [AUTO, BYPASSED] ***Details Page 37***	Set/display analog squelch bypass.
SREV ***Details Page 37***	Display the Software Revision Level.
STAT ***Details Page 38***	Display radio status and alarms.
SWC [ON, OFF] ***Details Page 38***	Switched Carrier configuration.
TFTP ***Details Page 38***	Set/display all TFTP settings.
TEMP ***Details Page 38***	Display the internal temperature of the radio in degrees C.
TOT [1-255, ON, OFF] ***Details Page 39***	Set/display the Time-out Timer delay in seconds.
TX [xxx.xxxx] ***Details Page 39***	Set/display the transmit frequency.
TXLEVEL [–20 to 0, AUTO] ***Details Page 39***	Set/display the transmit audio input level.
UNIT [10000...65000] ***Details Page 39***	Set/display the transceiver's unit address.
UPTIME ***Details Page 39***	Displays time since last system reboot.
VERSION ***Details Page 39***	Displays firmware package information.

6.2 Detailed Command Descriptions

The only critical commands for most applications are transmit and receive frequencies (**TX xxx.xxxx, RX xxx.xxxx**) and Modem configuration (**MODEM xxxx**) settings. However, proper use of the additional commands allows you to tailor the transceiver for a specific use, or conduct basic diagnostics on the radio. This section provides detailed information for the user commands previously listed in Table 11 (Page 21).

In many cases, the commands shown here can be used in two ways:

- Type *only* the command name to view the currently programmed data.
- Set or change the existing data by typing the command, followed by a space, and then the desired entry.

In the list below, allowable programming variables, if any, are shown in brackets following the command name.

Authorization Key

AK

The transceiver's feature set may be expanded (if all features are not currently enabled) by entering a new authorization key, which can be purchased from GE MDS. Contact the factory to obtain a new Authorization Key.

ALARM

Alarm Summary

The **ALARM** command displays a summary of the radio's current operating condition. An eight-digit code is presented which can be decoded as described in "Major Alarms vs. Minor Alarms" on Page 41.

AMASK [0000 0000–FFFF FFFF]

Alarm Mask

The **AMASK** command displays or sets which events cause an alarm output signal to be active. Normally, the mask is **FFFF FFFF**, meaning that any of the 32 possible events will activate the alarm output signal.

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

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

The eight-digit hexadecimal number used as the command parameter specifies 0 to 32 events that can trigger the external alarm output. (See Table 14 on Page 41 for a list of events.) The hex value for the mask corresponds to the hex value for the **STAT** command (Page 38). Each bit that is a '1' identifies an alarm condition that can trigger the external output. For more information on configuring the alarm response, contact GE MDS.

ASENSE [HI, LO]

Alarm Sense

The **ASENSE** command sets or displays the sense of the alarm output at Pin 6 of the COM2 port.

Entering the **ASENSE** command alone shows whether the alarm output is active high or low. Entering the **ASENSE** command followed by **HI** or **LO** resets the alarm output to active high or low.

AUDIO [ON, OFF]

Audio Monitor/ Orderwire Status

Used to set or display Audio Monitor/Orderwire functionality (on or off). If **AUDIO ON** is selected, the radio's transmit functionality will switch to analog whenever PTT is asserted.

BAUD [xxxxx abc]

Data Interface Port Baud Rate

This command sets (or displays) the communication attributes for the DATA INTERFACE port (COM2). It has no effect on the COM1 management port.

The first parameter (**xxxxx**) is baud rate. Baud rate is specified in bits-per-second (bps) and must be one of the following speeds: 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200 bps.

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

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: **9600 8N1**).

BIN [DATA, CLEAR]

Data Counters

Used to display or clear the data counters. Use **BIN DATA** to display. Use **BIN CLEAR** to clear the counters.

BOOT

Software Reboot

Used to initiate a software reboot. Use **BOOT** alone to reboot the currently running firmware image. Use **BOOT 1**, **BOOT 2**, or **BOOT OTHER** to reboot to a specific firmware image.

BUFF [ON, OFF]

RX Data Buffer

This command sets or displays the received data handling mode of the radio. The command parameter is either **ON** or **OFF**. The default is **ON**. The setting of this parameter affects the timing of how received RF data is sent from the DATA INTERFACE connector. Outgoing (transmitted) data is not affected by this setting.

If data buffering is **OFF**, the radio operates with the lowest possible average latency. Data bytes are sent from the DATA INTERFACE port as soon as an incoming RF data frame is disassembled. Average and typical latency will be minimized, but idle character gaps may be introduced into the outgoing data flow.

If data buffering is **ON**, the radio operates in seamless mode. Data bytes are sent over the air as quickly as possible, but the receiver buffers (stores) the data until enough bytes have arrived to cover worst-case gaps in transmission. This mode of operation is required for protocols such as MODBUS™ that do not allow gaps in their data transmission.

NOTE: Seamless mode (**BUFF ON**) is intended only for applications where the transmitter's baud rate is greater than or equal to the receiver's baud rate. Enforcement of this rule is the user's responsibility.

CKEY [ON–OFF]

Key TX Continuously

The **CKEY** command enables or disables the continuously-keyed function of the radio. When **CKEY** is set to **ON**, the radio is continuously keyed and the Timeout Timer is disabled.

CTS [0–255]

Clear-to-Send Time

The **CTS** (clear-to-send) command selects 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 the radio asserts CTS and the DTE can transmit the data. A CTS value of zero keys the radio and asserts the CTS line immediately after the RTS line goes high.

For CTS Key operation (see **DEVICE** command), the timer specifies how long to wait after asserting the CTS, before sending data from the DATA INTERFACE port. A timer value of zero means that data will be sent from the data port without imposing a key-up delay. (Other delays might be present based on selected radio operating parameters.)

CTSHOLD [0–60000]

Clear-to-Send Hold Time

Used in **DEVICE CTS KEY** mode, this command sets the amount of time in milliseconds that CTS remains present after transmission of the last character from 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 ms (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** is shown.

DATAKEY [ON, OFF]

Key on Data Activity

The **DATAKEY** command enables or disables the ability of the radio to key the transmitter as data is received at the DATA INTERFACE connector. Asserting RTS keys the radio regardless of this command setting.

If **DATAKEY** is set to **ON**, the radio will key when a full data-character is received at the transceiver's DATA INTERFACE connector. If **DATAKEY** is set to **OFF**, the radio needs to be keyed by asserting RTS.

DEV

Modem Deviation

Displays modem control deviation in Hertz (Hz). This is a read-only command, and cannot be changed in the field.

DEVICE [DCE, CTS KEY]

Data Device Mode

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

In **DCE** mode (the default setting), CTS will go high following RTS, subject to the CTS programmable delay time. If the **DATAKEY** command is set to **ON**, keying can be stimulated by the input of characters at the data port. Hardware flow control is implemented by signaling the CTS line if data arrives faster than it can be buffered and transmitted.

In **CTS KEY** mode, the SD is assumed to be controlling another radio. The SD will still key based on the RTS line, but the CTS line is used as a key-line control for the other radio. CTS is asserted immediately following the receipt of RF data, but data will not be sent out the DATA INTERFACE port until after the CTS programmable delay time has expired. (This gives the other radio time to key.)

DKEY

Unkey Transmitter

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

DLINK [ON/OFF/xxxx]

Diagnostic Link

Use this command to configure the local diagnostic link protocol used in network-wide diagnostics.

Entering **DLINK ON** enables the diagnostic link. Entering **DLINK OFF** disables the diagnostic link.

To change the diagnostic link, enter **DLINK** followed by one of the following baud rates: 1200, 2400, 4800, 9600, 19200 (default), 38400, 57600, 115200.

NOTE: The radio is configured by default to be in DLINK mode. The COM1 port automatically determines the connected baud rate (within the range of 1200–115200 bps). Enter a series of Return Key presses about a half second apart until the **>** prompt appears. This indicates that the radio is ready to receive commands.

DTYPE [NODE/ROOT]

Unit's Diagnostics Type

This command establishes the local radio as a root radio or node radio for network-wide diagnostics. Entering **DTYPE NODE** configures the radio as a node radio. Entering **DTYPE ROOT** configures the radio as a root radio. Entering the **DTYPE** command alone displays the current setting.

DUMP

Read Current Unit Profile

This command causes all of the programmed settings to be displayed.

EMP [ON/OFF]

Modem TX Audio Pre-Emphasis

This command displays or sets the TX pre-emphasis and RX De-Emphasis when the radio is operating with the analog mode and the radio's MODEM is turned off (**MODEM NONE**). It should be set to match the other radios in the system. The use of pre- and de-emphasis can help reduce the detrimental influence of high frequency audio noise.

ETHADDR

Ethernet Address

Displays programmed Ethernet MAC address (set at the factory).

FORCEALARM [ON or OFF]

Force Alarm

Generates a test alarm for 10 sec. Use to test alarm outputs and switch-over in redundant systems.

FORCEDCD [ON or OFF]

Force DCD

Forces Data Carrier Detect (DCD) to always be asserted. Use when connecting to equipment that requires a constant DCD indication.

HELP

User Help

Show available commands.

INIT

Initialize EEPROM Defaults

The **INIT** command is used to re-initialize the radio's operating parameters to the factory defaults. This can be helpful when trying to resolve configuration problems that might have 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. The following changes to the radio are made when **INIT** is entered:

- **CTS** is set to 0
- **DATAKEY** is set to **ON**
- **DEVICE** is set to **DCE**
- **PTT** is set to 0
- **SCD** is set to 0
- **TOT** is set to 30 seconds and set to **ON**
- **PWR** is set to +37 dBm (5 watts)

All other commands remain as previously set.

INIT [SD*x*]

(Where "x" denotes SD radio model)

Initialization (for standalone radio)

This command sets the transceiver for "normal" operation *outside* the P-20 chassis by setting the following parameters to the values shown below:

ASENSE	**ACTIVE HI**
AMASK	**FFFF FFFF** (assert alarm output on all alarms)
RXTOT	**NONE** (receive time-out timer disabled)

Use this command to restore these three parameters to the standard transceiver defaults if it was previously used in a P-20 package.

INIT [P-20]

Initialization for P-20 Implementation

This command sets the transceiver for service inside a P-20 redundant chassis by setting the following parameters to the values shown below:

ASENSE	**ACTIVE LO**
AMASK	**FFFF 0000** (trigger on major alarms)
RXTOT	**20** (20 minute receive time-out timer)

IPCONFIG

Ethernet Configuration

Ethernet interface configuration. This command is used to display or change the configuration of the Ethernet interface. The command can be used in several ways:

- **IPCONFIG** alone displays all current network settings.
- **IPCONFIG DHCP [ON/OFF]** is used to switch between DHCP and static addressing.
- **IPCONFIG IP [ipaddr]** is used to set a static IP address.
- **IPCONFIG NET [netmask]** and **IPCONFIG GW [Gateway]** are used to set subnet mask and gateway, respectively.

KEY

TX Key

This command activates the transmitter. See also the **DKEY** command.

MENU

Menu Activate

Activates the menu-based program within the transceiver (when supported), used for reprogramming the unit's firmware.

MODEL1

Displays the factory software configuration of the radio.

MODEL2

Displays the hardware configuration bill of material identifier.

Model Number Information

See Table 11 on Page 21 for information on these pre-programmed fields.

MODEM [xxxx]

Analog/Digital Modem Selection

This command selects the radio's modem characteristics. For digital operation enter **MODEM xxxx**, where **xxxx** equals the modem selection of the radio. Table 12 shows the supported modem types.

NOTE: For compatibility with an existing MDS x710 system, make sure to select the matching **MODEM** type. See Table 11.

Table 12. Modem Selection vs. Speed, Bandwidth & Sensitivity

Modem Type Selection	Over-the-air Speed (bps)	B/W (kHz)	Approximate Sensitivity[5]
Modem 9600[1]	9600	12.5	-112 dBm
Modem 4800[1, 2]	4800	12.5	-112 dBm
Modem 3200[1, 3]	3200	5.00	-108 dBm
Modem 9600M[1, 2]	9600	12.5	-106 dBm

Table 12. Modem Selection vs. Speed, Bandwidth & Sensitivity

Modem Type Selection	Over-the-air Speed (bps)	B/W (kHz)	Approximate Sensitivity[5]
Modem 4800F	4800	6.25	-108 dBm
Modem 9600B[1]	9600	12.5	-106 dBm
Modem 4800B[1]	4800	12.5	-110 dBm
Modem BELL[1]	1200	12.5	-110 dBm
Modem V23	1200	12.5	-110 dBm
Modem 19200N	19200	12.5	-100 dBm
Modem 19200E[2]	19200	12.5	-96 dBm
Modem 9600N	9600	6.25	-98 dBm
Modem 19200	19200	25.0	-105 dBm
Modem 38400N	38400	25.0	-99 dBm
Modem 65000[4]	65000	50.0	-102 dBm
Modem NONE	For analog operation with an external modem. See text.		

1) For MDS x710-compatible operation.
2) For ETSI compliance.
3) 3200 bps not applicable to SD4.
4) Only available for SD2 and SD9 units with wide bandwidth hardware option. Sensitivity is -104 dBm for SD2 and -100 dBm for SD9.

5) SD1 sensitivity may be up to 2 dB less, due to MDS 1710 interoperability constraints.

For analog operation with an external modem, enter **NONE** for this parameter. When the **MODEM** is set to **NONE**, the analog TX Input and RX Audio outputs of the DATA INTERFACE are used to interface with the connected external modem, and digital operation is disabled. These levels must be set to complement the audio signal level requirements of the external modem. See “RXLEVEL [–20 to 0]” on page 35 and “TXLEVEL [–20 to 0, AUTO]” on Page 39 for details on setting these levels.

When the transceiver is used to replace an existing MDS x710 radio, it is important to verify that the modem selection is compatible with the unit replaced. Table 13 lists SD modem type selections and the compatible x710 models they can be used with.

Table 13. Modem Compatibility with MDS x710 Radios

SD Modem Type Selection	Compatible with MDS x710 Models
Modem 9600	2710A, 4710A, 9710A
Modem 4800	4710E, 9710E
Modem 3200	2710D
Modem 9600M	4710M, 9710M
Modem 4800F	--
Modem 9600B	4710B, 9710B
Modem 4800B	4710B, 9710B
Modem BELL	4710B, 9710B
Modem V23	--
Modem 19200N	--
Modem 19200E	--
Modem 9600N	--
Modem 19200	2710C, 4710C, 9710C
Modem 38400N	--
Modem 65000	--
Modem NONE	x710A / x710C / x710E "modem none"
MPT1411	x710M "modem none"

OWM [XXX...]

Owner's Message

This is a command to show or program an owner's message. To program the owner's message, type **OWM** then the message, followed by **ENTER**.

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

OWN [XXX...]

Owner's Name

This is a command to show or program an owner's name. To program the owner's name, type **OWN** then the name, followed by **ENTER**.

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

PORT [RS232, RS485]

COM2 Settings

Set or show COM2 data port interface settings.

Push-to-Talk Delay

PTT [0–255]

This command sets or shows the key-up delay in milliseconds.

This timer specifies how long to wait after the radio receives a key signal, before actually keying the radio.

Push-to-Talk Configuration

PTTSIG [OFF, LOW, HI]

Used to set or show the configuration of the push-to-talk signal. This signal is used for analog operation.

TX RF Power Output Level

PWR [20–37]

NOTE: This function might be restricted due to regulatory constraints.

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 through 37. The default setting is 37 dBm (5 watts). To read the actual (measured) power output of the radio, use the **SHOW PWR** command. A dBm-to-watts conversion chart is provided in Section 8.6 (Page 55).

RESTORECONFIG

Restore Configuration

This command restores a user configuration. Command is timed and aborts in 3 sec if no response is provided.

RESTOREDEFAULTS

Restore Defaults

This command restores the original factory configuration. Command is timed and aborts in 3 sec if no response is provided.

RMODE [X710, TRANSPARENT, PACKET, CMAC, HELP]

Radio Mode

Allows the reconfiguration of the SD operating mode. An “MS” radio model normally ships with x710 mode and provides the command interface documented in this manual. Changing to a mode other than x710 causes the radio to exit the x710 command emulation interface and prompt for a user login.

RSSI

Received Signal Strength Indicator

This command continuously displays the radio’s Received Signal Strength Indication (RSSI) in dBm, until you press the Enter key. Incoming signal strengths up to -60 dBm can be read.

NOTE: The RSSI samples the incoming signal for one to two seconds before providing an average reading to the connected PC.

RTSKEY [ON, OFF]

RTS Keying Behavior

Used to set/display how the radio responds to RTS keying. The default setting is **RTSKEY OFF**. **RTSKEY ON** causes the radio to respond to RTS by keying the transmitter. When **RTSKEY OFF** is selected, key-on-RTS is suppressed.

NOTE: Terminal emulators such as HyperTerminal and Procomm typically initiate the RTS signal continuously upon the start of a connection. When connected to the radio's COM2 payload port, this typically causes the transmitter to remain constantly keyed. In such cases, **RTSKEY OFF** allows a terminal emulator to be connected to the radio's COM2 port without the need for special cables or a break-out box.

RTU [ON/OFF/0-80]

RTU Emulator

This command 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 testing. It can be helpful in isolating a problem to either the external RTU or the radio.

RX [xxx.xxxx]

Receive Frequency

This command selects or shows the radio's receive frequency in MHz. The frequency step size is 125 Hz.

If the customer frequency has not been programmed at the factory, a default frequency will be programmed in the radio near the center of the frequency band. For a list of frequency bands per radio model, refer to " Technical Specifications" on Page 43.

RXATTN [ON or OFF]

Receive Attenuation

Enables or disables receive attenuation. Enable receive attenuation when a remote is in close proximity to a master (such as on a test bench).

RXLEVEL [–20 to 0]

RX Audio Output Level

The **RXLEVEL command** selects or shows the desired receive audio output level. For more information, refer to the detailed description of analog operation beginning on Page 46.

RX Tolerance

RXTOL [NORMAL or CUSTOM]

The **RXTOL** command allows custom configuration of the receive tolerance, to improve performance with legacy radios (x790, x310, and so on).

RXTOT [NONE, 1-1440]

Loss of RX Data Alarm Time

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

Entering the **RXTOT** command without a parameter shows the timer value in minutes. Entering the **RXTOT** command with a parameter ranging from 0 to 1440 resets the timer in minutes. (1440 minutes equals 24 hours.) Entering the **RXTOT** command with the parameter **NONE** disables the timer.

SAVECONFIG

Save Configuration

Saves a user configuration. Command is timed and aborts in 3 sec if no response is provided.

SCD [0-255]

Soft-Carrier Dekey

This command shows or changes the soft-carrier dekey delay in milliseconds.

This timer specifies how long to wait after the removal of the keying signal before actually releasing the transmitter. A value of 0 milliseconds will unkey the transmitter immediately after the removal of the keying signal.

SER

Radio Serial Number

This command shows the radio's serial number as recorded at the factory (non-configurable).

SHOW [DC, PWR]

Show Power Settings

The **SHOW** command shows different types of information based on the command variables. The different parameters are:

- **DC**—Display DC input/output voltages
- **PWR**—Display RF power output

SNR

RX Signal-to-Noise Ratio

This command continuously shows the signal-to-noise ratio of the received signal expressed in dB, until you press the Enter key. As used in this guide, the signal-to-noise measurement is based upon the signal level following equalization, for received frames.

The SNR is an indication of the received signal quality. A value of 10 dB represents a very poor signal. A value of 24 dB represents a very good signal.

When the SNR command is used, it causes the DIAG. port to enter an update mode, and the signal-to-noise ratio is updated and redisplayed every 2 seconds. The SNR continuously updates until the ENTER key is pressed.

SPECTRUM [xxx.xx]

Internal Spectrum Analyzer

Activates the built-in spectrum analyzer tool (see Figure 18) that can be shown on a connected PC. This tool is helpful in diagnosing interference problems on or near your channel frequency.

Access the spectrum analyzer by entering **spectrum** at the command prompt. A display appears showing detected signals on your *current channel*.

Optionally, you can specify a frequency at the command prompt to view the surrounding spectrum of that frequency. To do this, enter **spectrum xxx.xx**, where **xxx.xx** is the frequency in MHz.

A typical spectrum analyzer display is shown in Figure 18. The display creates a received signal strength indication (RSSI) vs. frequency plot for the frequency and surrounding signals. By analyzing the display, you can determine the presence of other signals near the transceiver's operating frequency. This information can be helpful in troubleshooting interference problems.

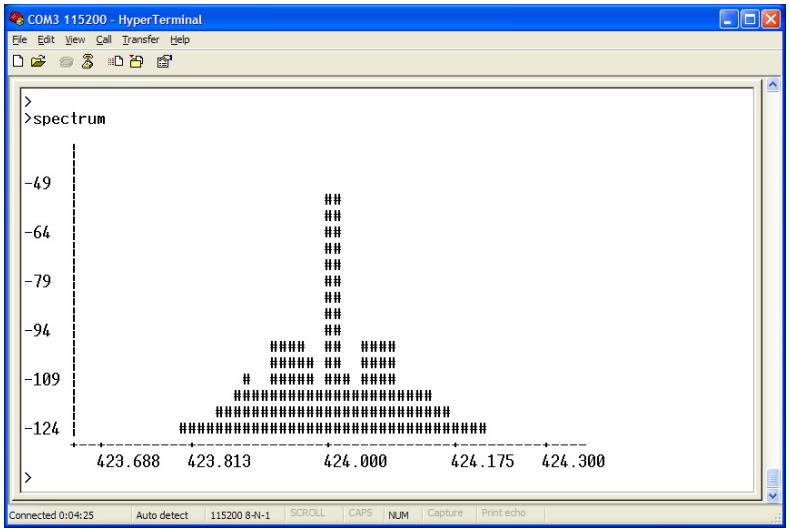


Figure 18. Internal Spectrum Analyzer Display

SQUELCH [AUTO, BYPASSED]

Squelch Operation

Set or show analog squelch bypass.

SREV

Software/Firmware Revision Level

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

STAT

Alarm Status

This command shows the current alarm status of the transceiver.

If no alarms exist, the message **NO ALARMS PRESENT** appears.

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

If more than one alarm exists, the word **MORE** appears at the bottom of the screen, and additional alarms are viewed by pressing the **ENTER** key. Detailed descriptions of event codes are provided in Table 14 on Page 41.

SWC [ON, OFF]

Switched Carrier

How you configure this command is based on whether or not the transceiver is listening to a continuously keyed master. If the master is not continuously keyed, then the master is operating in switched carrier mode and the transceiver's SWC setting should be ON. If the master is continuously keyed, the transceiver's SWC setting should be OFF. For B modem operation only. SWC should be OFF for A modems.

NOTE: **SWC** must be set to **ON** for switched carrier operation.

TFTP

TFTP Settings

Used to set/show all TFTP settings for upgrading the radio's firmware through the Ethernet port using TFTP transfer. The command can be used in several different ways:

- **TFTP HOST [ipaddr]** sets the IP address of the TFTP server hosting the firmware.
- **TFTP FILE [filename]** specifies the filename of the firmware to downloaded.
- **TFTP GET** is used after the above commands to begin the TFTP transfer.
- **TFTP STATUS** can be used to check on the progress of the download.

TEMP

Internal Temperature

This command shows the internal temperature of the transceiver in degrees Celsius.

TOT [1-255, ON, OFF]

TX Timeout-Timer

This command sets or shows the transmitter Time-out Timer value (1–255 seconds), as well as the timer status (**ON** or **OFF**). If the timer is on, and the radio remains keyed for a longer duration than the **TOT** value, the transmitter is automatically unkeyed.

When this happens, the radio must be commanded back to an unkeyed state before a new keying command is accepted. The default timer value is 30 seconds.

TX [xxx.xxxx]

TX Frequency

This command selects or shows the radio's transmit frequency in MHz. The frequency step size is 125 Hz.

If the customer frequency has not been programmed at the factory, a default frequency will be programmed in the radio near the center of the frequency band.

TXLEVEL [–20 to 0, AUTO]

TX Audio Input Level

The **TXLEVEL command** selects or shows the expected transmit audio input level from an external modem. For more information, refer to the detailed description of analog operation beginning on Page 46.

For optimum performance, set this parameter to match the external modem level. For example **TXLEVEL –10**. **TXLEVEL AUTO** is also available (default setting: –10 dBm).

UNIT [10000...65000]

Unit Address

The unit address is the radio's unique identity for the network's diagnostic activities. The unit responds to a request for a diagnostics code broadcast by the Master Station to all Remotes in an MAS network, if its unit address matches the number broadcast. The default number is programmed by the factory to the last four digits of the radio's serial number.

UPTIME

Up Time

Displays time since last system reboot.

VERSION

Firmware Version

Displays package version information for each firmware image.

7.0 TROUBLESHOOTING

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

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

- Adequate and stable primary power. The radio contains an internal self-resetting fuse (5 A). Remove primary power to reset.
- Secure cable connections (RF, data and power).
- An efficient and properly aligned antenna system with a received signal strength of at least –90 dBm (it is possible for a system to operate with weaker signals, but reliability might be degraded).
- Proper programming of the transceiver's operating parameters (see Section 6.0, TRANSCEIVER MANAGEMENT on Page 21), especially the TX/RX frequency and MODEM type selections.
- The correct interface between the transceiver and the connected data equipment (correct cable wiring, proper data format, timing, etc.)

7.1 LED Indicators

The LED status indicators are an important troubleshooting tool and should be checked whenever a problem is suspected. Table 10 on Page 19 describes the function of each status LED.

7.2 Event Codes

When an alarm condition exists, the transceiver creates a code that can be read on a connected PC. These codes can be very helpful in resolving many system difficulties. Refer to Table 14 (Page 41) for a definition of the event codes.

Checking for Alarms—*STAT command*

To check for alarms, enter **STAT** on the PC. If no alarms exist, the message **NO ALARMS PRESENT** appears.

If an alarm does exist, a two-digit alarm code (01–31) is shown and the event is identified as a Major or Minor Alarm. A brief description of the alarm is also given.

Major Alarms vs. Minor Alarms

Major Alarms (1-16)—report serious conditions that generally indicate a hardware failure, or other abnormal condition that will prevent (or seriously hamper) further operation of the transceiver. Major alarms generally indicate the need for factory repair. Contact your Technical Service representative for further assistance.

Minor Alarms (17-32)—report conditions that, 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.

Event Code Definitions

Table 14 contains a listing of event codes that can be reported by the transceiver. The codes shown are a subset of a larger pool of codes used for various GE MDS products. For this reason, the table does not show a sequential listing of all code numbers. Only the codes applicable to this product are shown, and this list is subject to change with product revision.

Table 14. Event Codes

Event Code	Event Class	Description
02	Major	Frequency not programmed.
03	Major	Authorization fault detected.
04	Major	The RF synthesizer 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.
09	Major	DSP download fault.
12	Major	Receiver time-out. No data received within the specified receiver time-out time.
13	Major	Transmitter time-out detected.
14	Major	Alarm test.
16	Minor	Unit address not programmed.
26	Minor	The DC input voltage approaching an out-of-tolerance condition. If the voltage is too far out of tolerance, operation may fail.
29	Minor	Output power not in valid range.
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 might fail.
37	Minor	Unexpectedly executing APP 1.
38	Minor	Unexpectedly executing APP 2.
39	Minor	Boot error. Active image unknown.
42	Minor	Reprogramming error.

Table 14. Event Codes *(Continued)*

Event Code	Event Class	Description
64	Minor	A socket operation failed.
70	Minor	AP not available.
41	Status	Forced restart of Ethernet interface.
43	Status	Reprogramming in progress.
44	Inform	Firmware update successful.
45	Inform	Reprogramming aborted.
46	Inform	Remote rebooted.

8.0 TECHNICAL REFERENCE

8.1 Technical Specifications

GENERAL

Frequency Range:

SD1: 150-174 MHz

SD2: 216-235 MHz in one of the bands listed below:
Band A—216 to 220 MHz
Band B—220 to 222 MHz
Band C—220 to 235 MHz
Band D—216 to 220 MHz (50 kHz)

SD4: 300–512 MHz in one of 4 bands as follows:
Band A—350 to 400 MHz
Band B—400 to 450 MHz
Band C—450 to 512 MHz
Band D—300 to 360 MHz

SD9: 820–960 MHz
Band A—820 to 870 MHz
Band C—928 to 960 MHz
Band D—928 to 960 MHz (50 kHz)
Band E—880 to 915 MHz
Band F—880 to 915 MHz (50 kHz)
Band G—850 to 960 MHz/926 to 936 MHz TX Lo
Band H—850 to 960 MHz/926 to 936 MHz TX Hi

Specific frequency authorizations are dependent on the type-approval of the radio. Consult the factory for details.

Bandwidths:

SD1: 3.0, 6.25, 9.0, 12.5 kHz
SD2: 2.0, 3.0, 5.0, 6.25, 8.0, 9.0, 12.5, 15.0, 16.0, 25.0, 48.0, 50.0 kHz
SD4: 6.25, 11.0, 12.5, 20.0, 25.0 kHz
SD9: 4.0, 7.0, 10.0, 12.5, 16.0, 18.0, 25.0, 30.0, 50.0 kHz

NOTE: This information subject to change depending on specific modem configuration. For emission designator information, consult the FCC web site for latest "GE MDS" grants: **http://transition.fcc.gov/oet/ea/fccid/**. Emission designators are subject to change pending new FCC additions and approvals.

RECEIVER

Maximum Usable Sensitivity: –112 dBm at $1x10^{-6}$ BER (9600 BPS)

NOTE: Typical sensitivity rating at 9600 BPS. See Table 12 on Page 31 for detailed listings by modem type.

TRANSMITTER

Carrier Power: 0.1 Watts to 5 Watts

Power Measurement Accuracy: +/- 1.5 dB

NOTE: RF output is limited to 2 watts for SD2 radios operating in Band B (220-222 MHz).

Duty Cycle:	Variable up to 100%, dependent on application. Continuous key operation not recommended.
Output Impedance:	50 Ω

Product	FCC ID	IC ID
SD1	E5MDS-SD1	101D-SD1
SD2	E5MDS-SD2 E5MDS-SD2-1	101D-SD2
SD4	E5MDS-SD4 E5MDS-SD4-1	101D-SD4 101D-SD4-1
SD9	E5MDS-SD9 E5MDS-SD9-1	101D-SD9

:

DATA CHARACTERISTICS

Signaling Types:	RS-232/485; DB-9 Female connector Ethernet 10/100 Mbps; RJ-45F connector
COM2 Data Rates:	300–115200 bps, asynchronous
Data Latency:	11 ms to 12 ms typical (transparent)

PRIMARY POWER

Voltage:	10.0 to 30 Vdc (Negative ground only)

NOTE: Early SD4 models supported 10.5 to 16 Vdc power, not 10 to 30 Vdc. Check the labeling above the power connector to confirm the operating range for your unit.

TX Supply Current *(Typical)*:	2.5 A maximum @ 5 W RF Output
RX Supply Current *(Typical)*:	*Operational*—150 mA, Nominal *Sleep*—<15 mA typical @ 13.8 Vdc
Fuse:	5 A, internal

ENVIRONMENTAL

Humidity:	**SD1**: 95% at 70°C (158°F), non-condensing **SD2**: 95% at 40°C (104°F), non-condensing **SD4**: 95% at 70°C (158°F), non-condensing **SD9**: 95% at 40°C (104°F), non-condensing
Temperature Range:	–40 to 70°C (–40°F to 158°F)
Weight (nominal):	1.22 lbs. (0.55 kg)
Transceiver Dimensions:	6.5” long (16.51 cm) 4.625” wide (11.75 cm) 1.5” High (3.81 cm)

DIAGNOSTICS INTERFACE

Signaling Standard:	RS-232 (COM1) RS-232/RS-485 (COM2)
Connector:	COM1—DB-9F COM2—DB-9F

All specifications are subject to change without notice or obligation to any party.

8.2 Performing Network-Wide Remote Diagnostics

Diagnostics data from a remote radio can be obtained by connecting a laptop or personal computer running compatible NMS software, such as Element Manager or InSite,to any radio in the network. Figure 19 shows a sample arrangement for performing network-wide remote diagnostics.

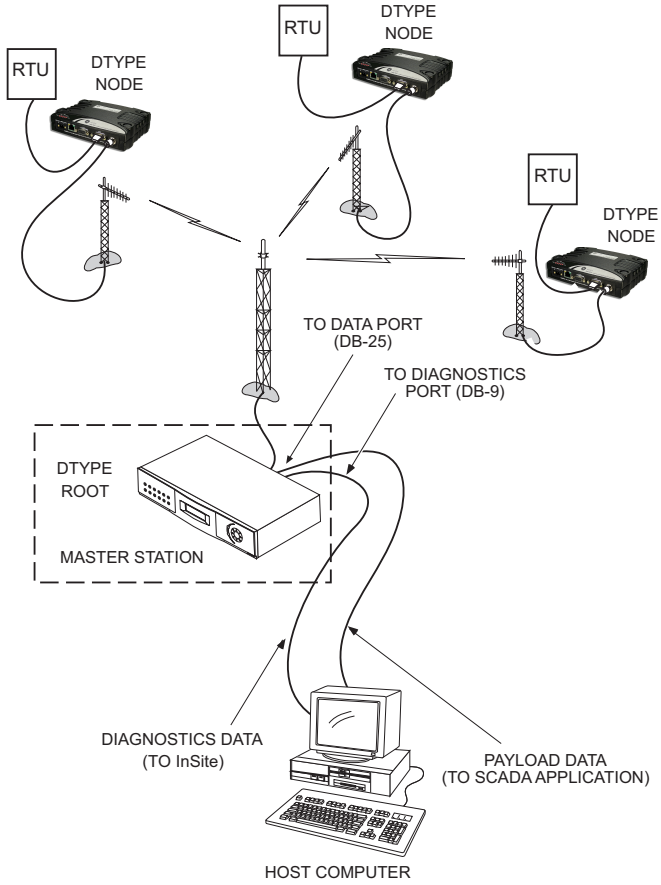


Figure 19. Network-Wide Remote Diagnostics Setup

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). See the Handbook for more information about the basic diagnostic procedures outlined below.

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 Management 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 Management Port of each node radio.

5. Connect same-site radios using a null-modem cable at the radios' diagnostic ports.

6. Connect a PC running the management software to the root radio, or to one of the nodes, using the radio's COM1 port. This PC can also be the PC used to collect payload data, as shown in Figure 19.

7. Launch the diagnostic program at the PC.

8.3 User-Programmable I/O Functions - *Pending*

8.4 Analog Operation of the Transceiver

The transceiver is designed for full digital modulation, while offering analog support to those systems that require it. Operation is compatible with the MDS x710 family of products, but some SD radio-specific command configuration and wiring might be necessary based on differences in SD hardware. This section provides important information for using the radio in analog service.

Physical Interface

The physical interface for analog operation utilizes pins on the radio's COM1 (management) connector. This connector is multiplexed with the serial data lines used for software commands. The applicable pins of the DB-9 are as follows:

- **Pin 4**—Transmit Audio
  (-20 dBm to 0 dBm, as set by TXLEVEL command)
- **Pin 5**—Ground (negative supply potential)
- **Pin 6**—Push-to-Talk (3 V TTL, 5 V tolerant)
- **Pin 8**—Receive Audio
  (-20 dBm to 0 dBm, as set by RXLEVEL command)

Operational Characteristics

Analog operation is available in two general modes: *Analog-only* or *Mixed Analog/Digital*.

Analog-only operation is typically useful when interfacing with external analog modems. Operation is selected by specifying **MODEM NONE**. In this mode, RX and TX Audio are both always active; Carrier Detect output and the LINK LED are asserted based on the receiver unsquelching. Key sources automatically assume the use of TX Audio as the input source. In analog-only mode, carrier detect is based on squelch status.

Mixed analog/digital operation is useful for orderwire application, or for analog systems that need to make use of GE MDS Network-Wide Diagnostics. Operation is enabled by selecting a digital modem type (*for example,* **MODEM 9600**) and selecting **AUDIO ON**. In this mode RX Audio is always active, but TX Audio only becomes active when the Push-to-Talk (PTT, Pin 6) input signal is asserted. All other key sources use digital modulation automatically. In this mode, Carrier Detect output and the LINK LED are asserted based only on detection of digital modulation.

The PTT "asserted" condition is defined by the **PTTSIG** command. Entering **PTTSIG HI** configures the system for an active high Push-to-Talk signal. Entering **PTTSIG LO** configures the system for an active low Push-to-Talk signal. Entering **PTTSIG OFF** disables the Push-to-Talk input—useful for RX audio monitoring of the channel when no TX analog transmission is desired.

Analog operating characteristics (selected either by PTT assertion or the **MODEM NONE** command) vary based on channel type.

As a simple rule, SD characteristics associated with **MODEM NONE** are driven by the last digital modem selection. For example, if **MODEM 9600** is selected followed by **MODEM NONE**, the characteristics for analog operation match the corresponding 12.5 kHz FCC/IC channel constraints. If

MODEM 9600M is selected followed by **MODEM NONE**, analog operation conforms to the channel constraints for a 12.5 kHz ETSI-compliant channel. Table 15 defines the relationship between digital modem selection and analog operation.

Table 15. Relationship Between Digital Modem Selection and Analog Operation

Command		Command	Agency Compliance	Analog Chan. Size	Peak Deviation
MODEM 19200	*followed by...*	**MODEM NONE**	FCC/IC	25.0KHz	5.0 kHz
MODEM 9600	*followed by...*	**MODEM NONE**	FCC/IC	12.5KHz	2.5 kHz
MODEM 9600M	*followed by...*	**MODEM NONE**	ETSI	12.5KHz	2.0 kHz
MODEM 4800	*followed by...*	**MODEM NONE**	ETSI	12.5KHz	2.0 kHz

Modem transmission/reception characteristics are further qualified by the **EMP** (emphasis) command. When **EMP ON** is entered, pre-emphasis is applied on the transmitter and de-emphasis is applied on the receiver. This setting is typically used in operation with voice radios. To disable emphasis, select **EMP OFF**.

Audio signal levels are governed by the **RXLEVEL** and **TXLEVEL** commands. Both commands support a range from -20 dBm to 0 dBm. For RX operation, this means that a received signal at the peak deviation will be scaled to the specified **RXLEVEL**. For TX operation, this means that a transmit input signal of the specified **TXLEVEL** will translate into the specified peak deviation for transmit. Note that **TXLEVEL** can also be set to **AUTO** to automatically scale the input to the target deviation. Values outside the expected range will cause clipping of the RF signal.

By default, built-in squelch thresholds automatically mute the receive audio when a signal is not present. To bypass the squelch controls, enter the command **SQUELCH BYPASSED**. To restore normal operation, enter the command **SQUELCH AUTO**.

8.5 Upgrading the Radio's Firmware

From time to time, GE MDS releases new firmware for its radio products to take advantage of engineering improvements or to add operational features. New firmware can be installed into existing radios in the field, bringing them up to date with the firmware shipped with new units.

Firmware files are available free of charge online at:
www.gemds.com/app/support/downloads

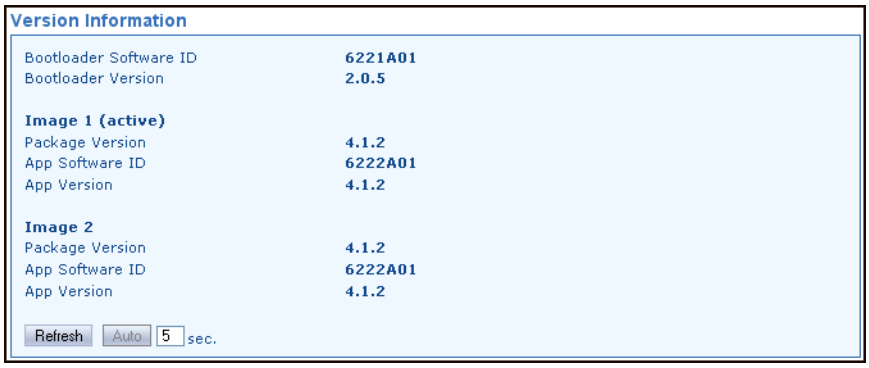
NOTE: Only firmware specifically designed for this model of radio can be installed in the unit.

Three methods can be used to load new firmware into the radio: **Web reprogramming**, **TFTP**, and **Serial Transfer**. Firmware reprogramming is best handled using the web-based Device Manager. Instructions for these methods of transfer are given below, beginning with Web programming.

Web Method

Determining Current Firmware Version

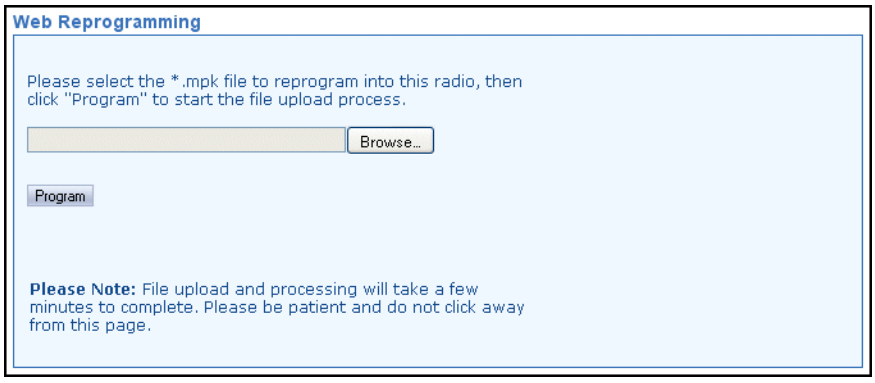
This screen shows Bootloader version information and indicates which firmware image (1 or 2) is currently active, as well as the firmware version of each image. The information on this screen is read-only.



- **Refresh**—Clicking this button updates the displayed information on demand.
- **Auto**—Initiates automatic updating of the information. A time (in seconds) may be entered in the box provided, to specify how often the display is updated.

NOTE: The latest firmware version for this product can be obtained at www.gemds.com.

Web Reprogramming



In the space provided, enter the ***.mpk** file to reprogram into this radio, then click **Program** to start the file upload process. Do not click away from this page until the upload has finished processing.

TFTP Method

What You Will Need

To install firmware by TFTP, you will need:

1. A valid firmware file (see web address above). This will be a file with a **.mpk** extension.

2. A PC equipped with Telnet, *and* a TFTP server running on the same computer where the **.mpk** file is located (a Windows-based TFTP server can be downloaded from the GE MDS Web site at: **www.gemds.com/Resources/TechnicalSupport**).

3. The IP address of the PC running the TFTP server. If you do not know your computer's IP address, use the **RUN** function from the **Start** menu and enter **cmd** to invoke the Windows Command Interpreter. At the **>** prompt, enter **ipconfig** to determine the address.

4. The IP address of the radio (the radio's IP address can be found by entering the **ipconfig** command with a serial command line session at the radio).

Connecting the Transceiver for Firmware Upgrade

There are several alternatives to connecting the transceiver for firmware upgrade. Figure 20 and Figure 21 show two common methods. *It is essential that all of the equipment be on the same subnet.*

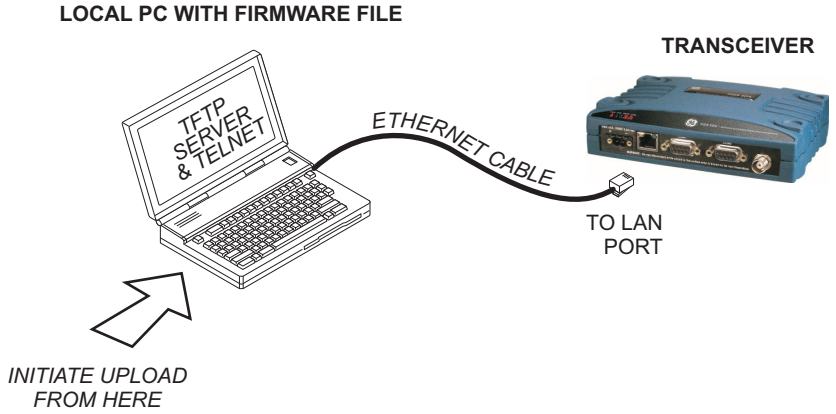


Figure 20. Firmware Upgrade Setup—Option 1
(TFTP Server and Firmware File Must Reside on Same Computer)

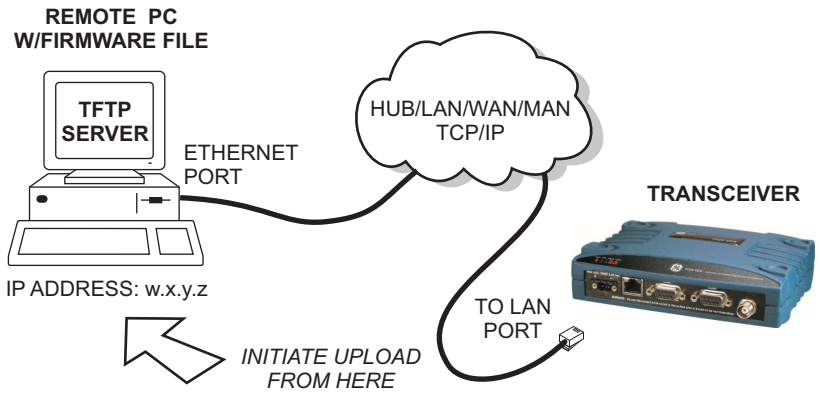


Figure 21. Firmware Upgrade Setup—Option 2
(TFTP Server and Firmware File Must Reside on Same Computer)

Upgrade Procedure (TFTP)

To load a new firmware file (**filename.mpk**) into the transceiver via TFTP, follow these steps:

1. Connect an Ethernet cable between the radio's LAN port and the PC (refer to Figure 20 or Figure 21, as applicable). Verify that the yellow LED on the radio's LAN port lights and stays lit. This verifies that the network is functioning.

2. Launch the TFTP server on the PC. If using the GE MDS TFTP Server, click the **Options** tab (A in Figure 22 below) and modify the **Outgoing path** (B) using your browser to point to the folder where the reprogramming package (**.mpk** file) is located. The path (C) will be displayed once the operation is completed. Leave the application running until reprogramming on the radio is complete.

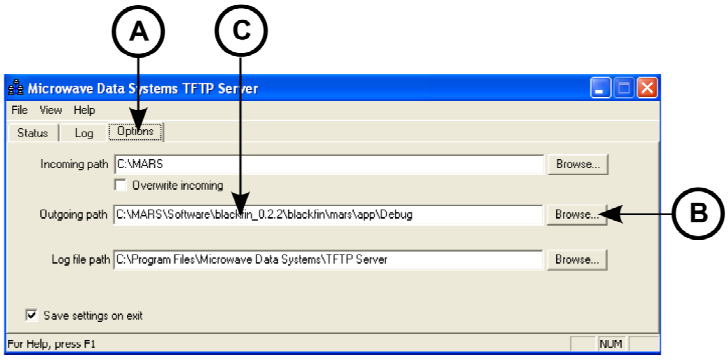


Figure 22. TFTP Server Screen
(GE MDS Server shown)

3. Launch a Telnet session and connect to the radio using its programmed IP address (the radio and PC must be on the same IP network to connect via Telnet).

4. Use the **tftp** command to configure the IP host and file to program. For example:
   >tftp host 10.4.147.63
   >tftp file SDx-3_0_0

5. Enter **tftp get** to begin reprogramming. The file is loaded into the radio's *inactive* image. A series of progress messages display every few seconds indicating the reprogramming status, followed by **Reprogramming Complete** when the process is finished.

6. Reboot the radio to the other image using the **boot other** command. (At the **Are you sure?** message, make sure to enter **y** within 5 seconds or the operation will be cancelled and you will be returned to the **>** prompt.) After **y** is pressed, the message **Rebooting to image...** will be shown.

NOTE: Rebooting ends the current Telnet session. Reestablish a new Telnet connection and proceed with the step below.

7. Enter the **SREV** command to verify the radio is running the new application image. This completes the TFTP upgrade procedure.

NOTE: If a firmware installation fails, the radio is left with the original active image intact, and the inactive image will be unusable. Reprogramming should be attempted again.

Serial Transfer Method

Firmware upgrade via serial transfer is an alternative method which takes longer to complete than TFTP, but accomplishes the same result. This method is typically used when an Ethernet connection to a PC is not available.

What You Will Need

To install firmware by serial transfer, you will need:

1. A valid firmware file (see web address given under "Upgrading the Radio's Firmware" on Page 48). This will be a file with an **.s28** extension.

2. A PC equipped with a terminal program, such as HyperTerminal (included with many pre-Vista PCs).

Connecting the Transceiver for Firmware Upgrade

Connect a PC to the radio's COM1 Serial connector as shown in Figure 23 to prepare for firmware upgrade.

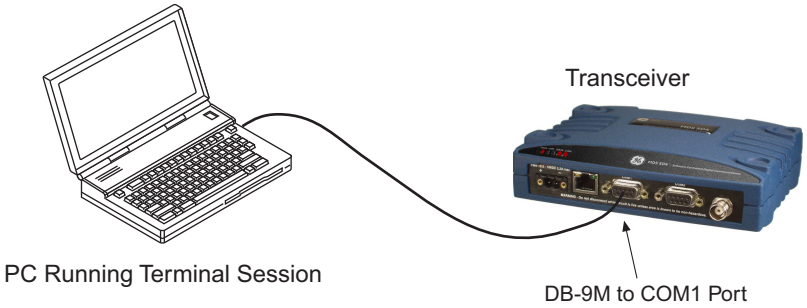


Figure 23. PC Connection to Transceiver (Serial)

Follow the steps below for serial transfer upgrade.

NOTE: Serial reprogramming takes several minutes at 115200 bps baud rate (the recommended speed), but reprogramming is possible at lower baud rates.

---

1. Launch a terminal session to the radio with the following communications parameters: Baud 115200, 8 data bits, no parity, one stop bit (8N1), XON/XOFF flow control, and VT100 emulation.

2. At the **>** prompt, enter **program**. At the **ARE YOU SURE?** prompt, enter **yes**.

3. At the **LOADER>** prompt, enter **erase**. The response **ERASED OK** is returned.

4. At the **LOADER>** prompt, enter **program**. Do not type any more characters at the prompt.

5. From the terminal program, quickly select **Transfer->Send Text File** and choose the correct file/file folder on the PC where the **.s28** firmware file is located.

   This process initiates the file transfer and causes the radio to reprogram the *inactive* image. When using HyperTerminal to perform reprogramming, no status indication is available.

6. Programming is complete when **PROGRAMMED OK** appears at the prompt. The active image has now been changed to the new package. If this message is not seen, reprogramming did not complete successfully and must be attempted again.

7. Reboot the unit by typing the **exit** command at the **LOADER>** prompt. This completes the serial upgrade procedure. To verify that the radio is running the newly loaded firmware image, enter the **srev** command after rebooting.

NOTE: If a firmware installation fails, the radio is left with the original active image intact, and the inactive image will be unusable. Reprogramming should be attempted again.

Error Messages During File Transfers

It is possible to encounter errors during a file transfer. In most cases errors can be quickly corrected by referring to Table 16.

Table 16. Common Errors During TFTP Transfer

Error Message	Likely Cause/Corrective Action
Invalid File Type	Indicates that the file is not a valid firmware file. Locate proper file and re-load.
File not found	Invalid or non-existent filename on TFTP server
Invalid file path	Invalid or non-existent file path to TFTP server
Timeout	TFTP transfer time expired. Increase the timeout value.
Bad CRC	Cyclic Redundancy Check reporting a corrupted file. Attempt to re-load, or use a different file.
Version String Mismatch	Invalid file detected. Attempt to re-load, or use a different file.

8.6 dBm-Watts-Volts Conversion Chart

Table 17 is provided as a convenience for determining the equivalent wattage or voltage of an RF power expressed in dBm.

Table 17. dBm-Watts-Volts Conversion—for 50 Ohm Systems

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

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

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

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

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

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

dBm	nV	Po
-107	1000	
-108	900	
-109	800	
-110	710	.01pW
-111	640	
-112	580	
-113	500	
-114	450	
-115	400	
-116	355	
-117	325	
-118	285	
-119	251	
-120	225	.001pW
-121	200	
-122	180	
-123	160	
-124	141	
-125	128	
-126	117	
-127	100	
-128	90	
-129	80	.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

9.0 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 will prove helpful in understanding the operation of the transceiver.

Active Messaging—This is a mode of diagnostic gathering that may interrupt SCADA system polling communications (contrast with *passive messaging*). Active (or intrusive) messaging is much faster than passive messaging because it is not dependent upon the RTU polling cycle.

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

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

Bits-per-second—See *BPS*.

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

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

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

Data Circuit-terminating Equipment—See *DCE*.

Data Communications Equipment—See *DCE*.

Data Terminal Equipment—See *DTE*.

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

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

DCE—Data Circuit-terminating Equipment (or Data Communications Equipment). In data communications terminology, this is the "modem" side of a computer-to-modem connection. The transceiver described in this manual is hardwired as a DCE device.

Digital Signal Processing—See *DSP*.

DSP—Digital Signal Processing. The transceiver's DSP is the core operating unit of the transceiver through which nearly all functions depend.

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

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

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

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

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.

Intrusive Diagnostics—A mode of remote diagnostics that queries and commands radios in a network with an impact on the delivery of the system "payload" data. See *Active messaging*.

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*.

Network-Wide Diagnostics—An advanced method of controlling and interrogating GE MDS radios in a radio network.

Non-intrusive diagnostics—See *Passive messaging*.

Passive messaging—This is a mode of diagnostic gathering that does not interrupt SCADA system polling communications. Diagnostic data is collected non-intrusively over a period of time; polling messages are carried with SCADA system data (contrast with *active messaging*).

Payload data—This is the application's user communication data which is sent over the radio network.

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

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

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

Programmable Logic Controller—See *PLC*.

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

Remote Terminal Unit—See *RTU*.

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

RTU—Remote Terminal Unit. A data collection device installed at a remote radio site. An internal RTU *simulator* is provided with the transceiver to isolate faults to either the external RTU or the radio.

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

Standing Wave Ratio—See *SWR*.

Supervisory Control And Data Acquisition—See *SCADA*.

SWR—Standing Wave Ratio. A parameter related to the ratio between forward transmitter power and the reflected power from the antenna system. As a general guideline, reflected power should not exceed 10% of the forward power (≈ 2:1 SWR).

NOTES

IN CASE OF DIFFICULTY...

GE 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.

TECHNICAL ASSISTANCE

Technical assistance for GE MDS products is available from our Technical Support Department during business hours (8:30 A.M.–6:00 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	E-Mail: gemds.techsupport@ge.com
FAX: 585 242-8369	Web: www.gemds.com

FACTORY SERVICE

Component level repair of this 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 must obtain a Service Request Order (SRO) number. This number helps 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.

SRO numbers are issued online at www.gedigitalenergy.com/Communications.htm. On the left side of the page, click “Login to my MDS” and once logged in, click “Service Request Order”. Your number will be issued immediately after the required information is entered. Please be sure to have the model number(s), serial number(s), detailed reason for return, “ship to” address, “bill to” address, and contact name, phone number, and fax number available when requesting an SRO number. A purchase order number or prepayment will be required for any units that are out of warranty, or for product conversion.

If you prefer, you may contact our Product Services department to obtain an SRO number:

Phone Number: 585-241-5540
Fax Number: 585-242-8400
E-mail Address: gemds.productservices@ge.com

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:

GE MDS, LLC
Product Services 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 using the telephone, Fax, or E-mail information given above.

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