MDS™ TD220MAX

Robust Communications for Positive Train Control

MDS 05-6906A01, Rev. R

DECEMBER 2018

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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 website: **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/bulletins**.

Antenna Gain vs. Minimum Safety Distance

(Based upon a 50% Duty Cycle, 0 dB Feedline Loss) Uncontrolled Environment Exposure limits

	Fixed/Mobile Antenna Gain		
	0-6 dBi	**6-10 dBi**	**10-16.5 dBi**
Safety Distance	1.78 meters	2.82 meters	5.01 meters

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.

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.

ESD Notice

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

Antenna Installation Warnings

1. A suitable lightning arrestor should be used when indicated by applicable standards or codes.
2. All antenna installation and servicing are to be performed by qualified technical personnel only. When servicing the antenna, or working at distances closer than those listed below, ensure the transmitter has been disabled.
3. Depending upon the application and the gain of the antenna, the total composite power could exceed 90 watts EIRP. For fixed/mobile configuration, the distances in the table below must be followed.

FCC Compliance Notice

This device is offered as a licensed transmitter per FCC Parts 80, 90 and 95. It is approved for use under the following conditions: Changes or modifications not expressly approved by GE MDS, LLC will void the user's authority to operate the equipment.

The TD220MAX is approved in the following FCC rule parts:

- FCC part 80, approved for operation from 216-220MHz, 28 watts
- FCC part 90, approved for operation from 217-220MHz, 1.66 watts
- FCC part 90, approved for operation from 220-222MHz, 27.5 watts
- FCC part 95F, approved for operation from 218-219MHz, 20 watts

Please refer to your FCC spectrum license to ensure you are in compliance with the appropriate radiated power levels.

For FCC Part 95, the Effective Radiated Power (ERP) must be less than or equal to 4 Watts for mobile use and 20 Watts for fixed use. This can be accomplished by adjusting the output power of the radio and selecting an antenna with appropriate gain. Consult the following table for assistance in setting the output power and selecting an antenna to maintain compliance. The table provides examples, however other combinations can be used.

Effective Radiated Power vs Radio Power		
Radio Power Setting	ERP	Maximum Antenna Gain
2 W	4 W	3 dBd (5.2 dBi)
4 W	4 W	0 dBd (2.2 dBi)
2 W	20 W	10 dBd (12.2 dBi)
10 W	20 W	3 dBd (5.2 dBi)
20 W	20 W	0 dBd (2.2 dBi)

1.0 INTRODUCTION

This manual is for users of the MDS TD220MAX Transceiver shown in Figure 1. It contains an overview of installation planning data, specifications, troubleshooting, and instructions for using the radio's menu system. This manual is intended for technical personnel who perform network design, configuration, and troubleshooting of the equipment.

All product documentation can be downloaded free of charge from the GE MDS website at **www.gemds.com**. The website also contains links to Application Bulletins and other product information.

Figure 1. TD220MAX Transceiver

1.1 Key Product Features

- 25 Watt transmit power for long-haul coverage
- Cost-effective solution with no software license or maintenance fees
- Optimized TDMA MAC supports single-frequency operation reducing spectrum license requirements
- Provides patented Forward Error Correction scheme for robustness in high-speed rail applications
- Internal or external Communications Manager available
- Provides Ethernet interface for use with local or remote controllers and devices
- Meets environmental specs for rail applications
- Ethernet and Serial Ports via a single rugged DB-25 connector
- Supports SNMP
- Command Console via Serial or Telnet

1.1.1 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 any such features. In some cases, a feature upgrade may be available. Contact your sales representative for additional information.

1.2 Accessories and Spares

Table 1 lists common accessories and spare items for the transceiver.

Table 1. Accessories & Spare Items

| Accessory	Description	Part Number
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
Flat Mounting Bracket Kit	Brackets that attach to the bottom of the unit. Used for mounting to a flat mounting surface.	03-4123A13
Power Cable	Mates with power connector on radio case with 3-foot feedline.	03-1846A02
TD220 DB25 Adapter Board	Breakout board for the DB25 connector.	03-6139A01
PPS Cable for Adapter Board	Provides connection to the header on the adapter board	03-4152A01
Amplifier/Timing Cable	Connects to the PPS cable and carries the signal to the GPS connection and amplifier.	03-4224A01
DB9 to RJ11 Adapter	Custom MDS serial converter	73-2434A02
DB25 Ribbon Cable	6-inch DB25 straight cable to connect from the radio to the adapter board	03-3828A01
DB25 Adapter Kit	Contains adapter board, I/O cable, serial cable, ribbon cable, and DB9 adapters	03-4758A03

1.3 40-Watt Power Amplifier
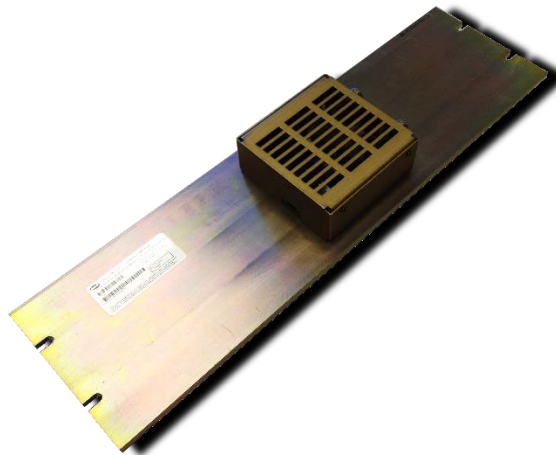
Figure 2. 220 eNETL2T/U Power Amplifier

The ENETL2T/U is an RF power amplifier designed for use in the 216-222 MHz frequency range at up to 40 Watts. It is intended to serve as a 100% duty cycle amplifier for MDS TD and other radios operating in point-to-multipoint repeater or base applications.

The power amplifier consists of an RF amplifier and PCB mounted to a heat sink, with a DC Power interface, power control interface, and input/output RF connections on the sidewalls of the chassis. DC power is supplied to the amplifier from a regulated and filtered DC source capable of supplying 10-16 VDC at a maximum current of 8 Amperes. The DC power source should be current limited or have a protective fuse or circuit breaker.

For additional details on the power amplifier, please contact your local sales representative.

2.0 PRODUCT DESCRIPTION

The GE MDS TD220MAX is a 25-Watt 220 MHz GMSK data radio intended for bridging messages over the air between locomotives and wayside devices in rail applications or between ship and shore in maritime applications. The data interface is Ethernet and uses the UDP/IP-based Simple Timeslot/Frequency/Power Protocol (STFP), defined elsewhere. STFP can support various payload protocols.

A time division channel access method is used by the TD220MAX for wireless communication. Each second is divided into 8, 133-byte time slots. The radio further defines a multi-second epoch to allow the effective number of time slots to be scaled according to system design. All radios in a system must be configured with the same epoch size.

Precise synchronization of timing amongst radios is necessary for operation. Each radio can be configured to use one of three timing sources: GPS, Precision Time Protocol (PTP), and over-the-air (OTA). While system design can be flexible, a base radio installation typically uses either GPS or PTP timing and a mobile radio typically uses OTA to synchronize to the wireless transmissions of a base radio. Radios configured for GPS timing must be connected to an external GPS unit to receive NMEA sentence information and the PPS signal. Radios configured for PTP timing will interact with a PTP Grandmaster Clock over the Ethernet port using IEEE 1588 (PTPv2). Radios configured for OTA timing use messages received wirelessly in the first timeslot of each second to maintain timing.

With its time slot definition and variable epoch size, the TD220MAX provides a generic TDMA implementation that can be used by an external Communication Manager (CM) to support a variety of TDMA schemes. A CM is responsible for making decisions regarding timeslot, frequency, power, and payload organization. The TD220MAX is responsible for requesting data from a CM for upcoming timeslots, forwarding messages received wirelessly to a CM, and wirelessly transmitting messages received from a CM using the specified timeslot, frequency, and power. All communication between the TD220MAX and a CM is done using STFP.

2.1 Front Panel Connectors and Indicators

Figure 3 shows the transceiver's front panel connectors and indicators. These items are referenced in the installation steps and in various other locations in the manual. The transceiver's LED functions are described in Table 6 on Page 12.
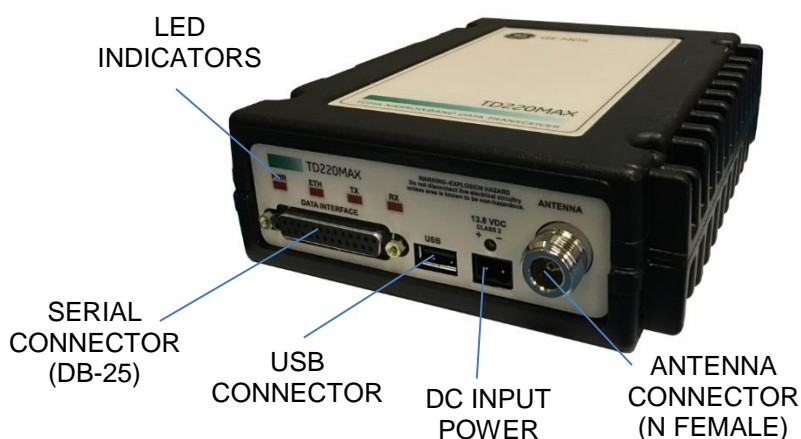
Figure 3. Front Panel Connectors & Indicators

3.0 INSTALLATION PLANNING

This section covers pre-installation factors that should be considered when installing the transceiver in the field. Careful planning will help achieve optimal performance from the transceiver. The specific details at an installation site may vary, but there are four main requirements for installing the transceiver in all cases:

- Adequate and stable primary power
- An efficient and properly installed antenna system
- Ethernet connection to local network
- Proper connections to a time source (PTP, GPS, Over-The-Air)

3.1 Chassis Dimensions

Figure 4 shows the external chassis dimensions of the TD220MAX Transceiver.
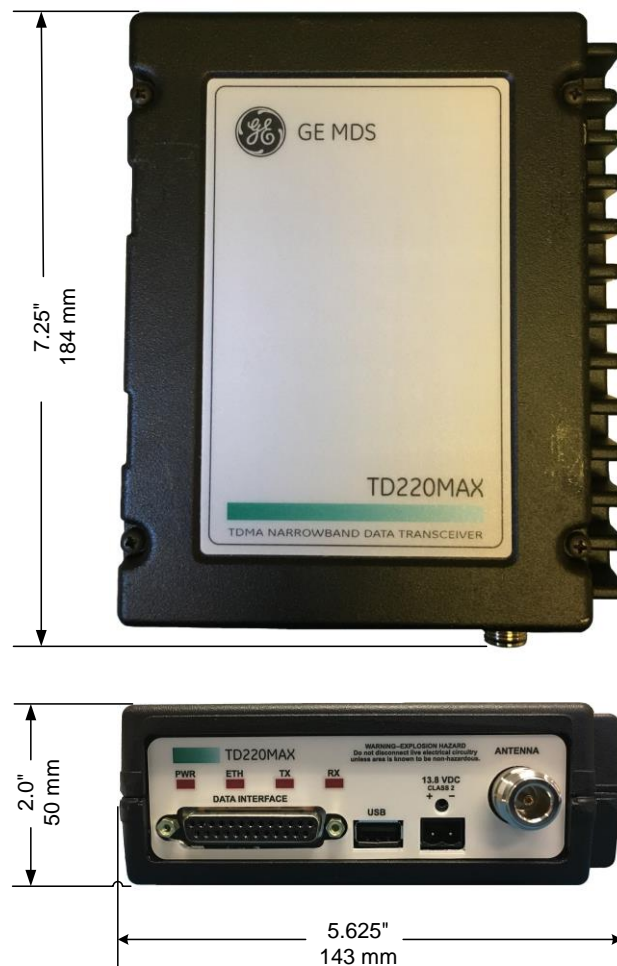
Figure 4. Transceiver Dimensions

3.2 Mounting Bracket Options

The transceiver is normally provided with flat mounting brackets attached to the bottom of the radio as shown in Figure 5. An optional 35 mm DIN rail mounting bracket is also available and is described below.

Figure 5. 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.

The figure above shows the mounting brackets at the furthest in (shortest distance) apart. The standard mounting brackets can be mounted with the second pair of holes to increase the distance. The new width of the radio with the mounting brackets would be 8.5 inches (216 mm).

3.2.1   Optional DIN Rail Mounting

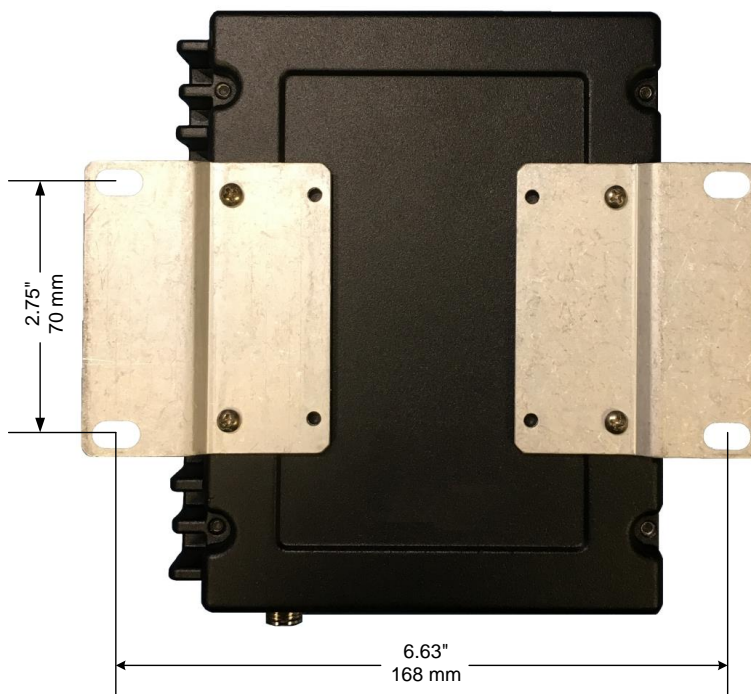The unit may be mounted with an optional 35 mm DIN Rail Mounting Bracket Kit (Part No. 03-4125A04). Equipment cabinets and racks of modern design often employ this type of mounting. Once the DIN bracket is attached to the radio, it allows for quick installation and removal of the radio from its mounting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

The DIN Rail bracket attaches to the unit's case along the left side of the transceiver (DB25 connector side) with two screws. Ensure that the pull tab is located towards the back of the radio. The entire assembly then attaches to the mounting rail with the connectors facing upwards.

3.3   Antennas and Feedlines

3.3.1   Antennas

The transceiver may be used with several different antennas. The exact style and gain factor depend on the physical size and layout of your system. Connection is made to the radio via a N coaxial connector. Contact your factory representative for details for Antennas available from GE MDS for this radio.

3.3.2   Feedlines

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

The table which follows, shows the approximate losses that will occur when using various lengths and types of coaxial cable in 200 MHz band. 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 Meters)	50 Feet (15 Meters)	100 Feet (30.5 Meters)	200 Feet (61 Meters)
RG-8A/U	0.26 dB	1.27 dB	2.50 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

3.4 Power

The transceiver may be operated from any well-filtered 10 to 16 VDC Power source; 13.8 VDC Nominal. The supply must be capable of providing up to 7 Amps maximum, and 2.5 Amp consistently. With each radio, an 03-1846A02 cable (as shown in Figure 6 below) is shipped, providing the matching power connector on a 3-foot power cable. Ensure to tighten the connector securely to the radio. A surge protection device such as a Transtector 1101-624 should be employed.

Figure 6. DC Power Cable (P/N 03-1846A02)

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

Consult the following table to determine how much current is required for receiving or transmitting vs. input voltage and RF power output. Duty cycle is a function of how many time slots of the 8 per second are used for transmission. The STFP protocol used by the communications manager to send data into the radio for transmission over the air specifies what time slot to use for each. If the communications manager uses all 8 slots, the duty cycle is 100%. If four are used every second, the duty cycle is 50%. If 7 are used every 3 seconds (24 slots), the duty cycle is 29% (roughly 30%). Many other duty cycles are possible depending on the epoch size and number of transmissions within each epoch. All MPE RF safety calculations are based on the highest ERP levels.

Table 3. Current Consumption vs Input Power and Duty Cycle

Voltage (V)	RF Power Out (W)	Duty Cycle (%)	Current Required (A)	Thermal Dissipation (W)
12	0 (RX)	0	0.3	3.6
12	2	100	1.4	14
12	10	30	3.6	14
12	25	30	6.3	15
13.8	0 (RX)	0	0.3	4
13.8	2	100	1.2	14
13.8	10	30	3.2	14
13.8	25	30	5.5	15

3.5 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. All grounds and cabling must comply with applicable codes and regulations.

3.6 Data Interface (DB-25)

The Data Interface has several ports integrated into one connector: Ethernet, COM1 and COM2 Serial Ports, and GPS signaling.
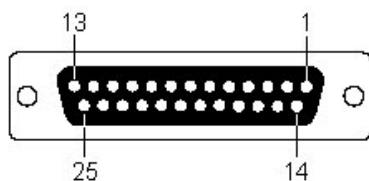
Figure 7. COM Connector (DB-25F)
As viewed from outside the unit

Table 4. DB25 Serial Interface Pinouts

| DB-25 Pin	Signal	Direction WRT MDS Equipment	Notes
1	Not Connected	N/A	Reserved
2	COM2_TXD	Input	GPS NMEA Port
3	COM2_RXD	Output	GPS NMEA Port
4	COM2_RTS	Input	GPS NMEA Port
5	COM2_CTS	Output	GPS NMEA Port
6	Not Connected	N/A	Reserved
7	GND	Input/Output	Ground
8	EXT_ALARM	Output	See *External Alarm Sense* in section 5.3
9	Not Connected	N/A	Reserved
10	Not Connected	N/A	Reserved
11	Not Connected	N/A	Reserved
12	Not Connected	N/A	Reserved
13	GND	Input/Output	Ground
14	ETH_TX_H	Output	Ethernet
15	ETH_TX_L	Output	Ethernet
16	ETH_RX_H	Input	Ethernet
17	ETH_RX_L	Input	Ethernet
18	EXT_KEY	Output	Reserved – Power Amplifier
19	EXT_DET	Input	Reserved – Power Amplifier
20	COM2_DTR	Input	GPS NMEA Port
21	Not Connected	N/A	Reserved
22	GPS_PPS_L	Input	Not Connected
23	GPS_PPS_H	Input	TTL level 1PPS signal input. 0 to 5 VDC nominal.
24	COM1_RXD	Input	Console
25	COM1_TXD	Output	Console

3.6.1 Adapter Board

GE MDS has available a breakout adapter board that separates the DB25 connector into an Ethernet port, PPS port, as well as three COM connectors. This board is for controlled environment applications only. For additional details regarding the adapter board, view the "TD_RCL" adapter board instruction sheet located here http://www.gegridsolutions.com/app/resources.aspx?prod=td-series&type=9.
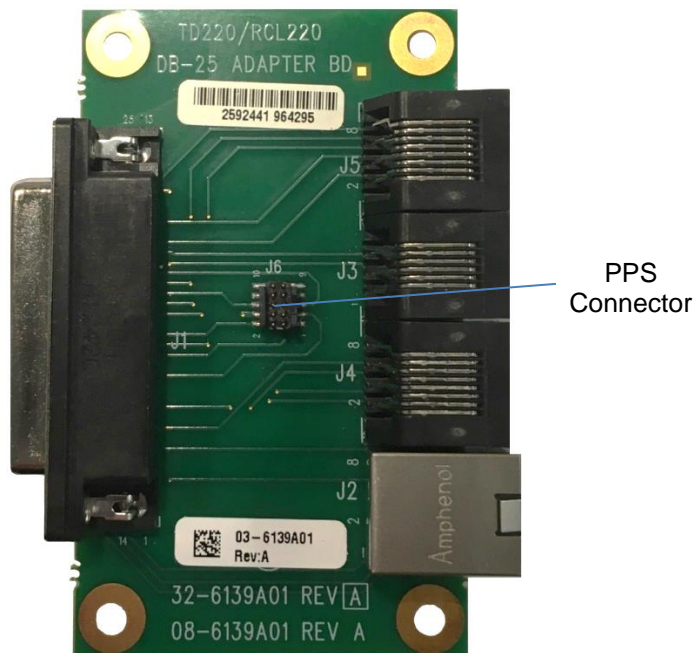
Figure 8. 03-6139A01 Adapter Board Top View
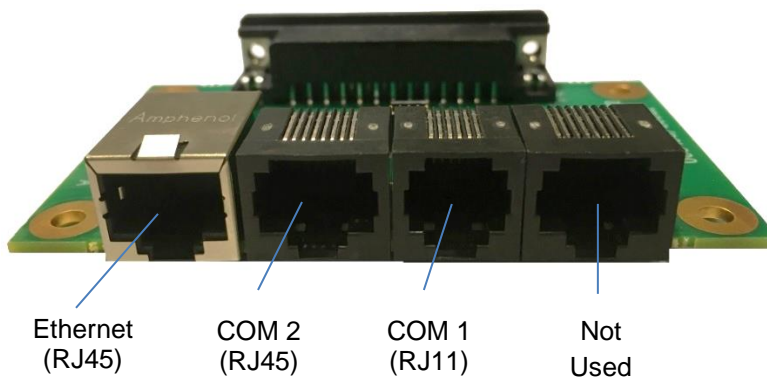
Figure 9. 03-6139A01 Adapter Side View

3.7   USB

The radio provides a USB Port conforming to version 1.1 of the USB standard. This port is provided for features such as logging STFP messages to text files on a memory stick. Consult GE MDS for information on this feature. The pinout for this connector is given in the table below.

Table 5. USB Port Pinout

Pin	Signal Name	Description
1	PC_USB_+5V	+5 VDC
2	USBD-	USB Data Minus
3	USBD+	USB Data Plus
4	GROUND	Ground

3.8 Antenna Connector

The Antenna Connector is a type N female connector with 50-Ohm characteristic impedance. A suitable lightning arrestor such as a Polyphaser VHF50HN should be employed when indicated by applicable standards or codes.

4.0 STEP-BY-STEP INSTALLATION

In most cases, the steps given here are sufficient to install the transceiver.

1. **Mount the transceiver**. Attach the mounting brackets to the bottom of the transceiver case (if not already installed), using the four 6-32 x 1/4-inch (6 mm) screws supplied. Mounting bracket dimensions are shown in Figure 5 on Page 5. 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 7.)
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 radio(s).
3. **Connect primary power.** Input power must be within 10 to 16 VDC and capable of providing up to 7 Amperes maximum.

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.

4. **Configure Basic Settings.** Connect a PC to the radio and access the radio's menu system. See the following section on details in communicating with the radio.

4.1   Logging On

The radio has a menu system that can be accessed in one of two ways:

- Terminal Emulator—Use a terminal emulator program on your PC, such as HyperTerminal or PuTTy, connected directly to the TD220MAX COM1 port via a serial cable.
- Telnet—Text-based access to the menu system through a network connection.

The serial console is typically used to configure the network parameters prior to connecting to the radio via Telnet remotely. Each radio is assigned a default IP Address, a Netmask, and a Gateway IP Address. These are as follows;

- IP Address: 192.168.1.1
- IP Netmask: 255.255.255.0
- IP Gateway: 0.0.0.0.

The IP Address and Netmask should be chosen carefully. The radio will network directly with other equipment with IP Addresses that are on a common Subnet. IP Addresses that begin with the same numerical IP address bits where the Netmask is one will be on the same Subnet. For example, if the IP Address is 10.4.100.1 and the Netmask is 255.255.0.0, the radio will attempt direct Ethernet communication with any node whose IP Address begins with 10.4. If a message is bound for a node outside of the 10.4 network, it will be sent to the Gateway IP address instead so that it can be placed from the radio's subnet onto another subnet.

4.1.1   Serial Console

For accessing the COM1 console, use a serial terminal emulator program such as HyperTerminal or PuTTy. The default settings are: baud rate 19200, no parity, 8 data bits, and 1 stop bit. The pins for this port are listed in Section 3.6. The serial console is typically used to configure the network parameters to connect to the radio via Telnet remotely.

1. Log in to the radio on its COM1 console using a serial terminal emulator program.
2. If you wish to change the default IP settings, go to the IP Configuration menu.
   - Set the IP address, the Netmask and the Gateway.
3. Verify network connectivity by going to the Maintenance/Tools Menu and select the Ping Utility.
   - Enter the IP address of a known node on the network.
4. Execute the Ping and observe the results. If the network interface is working properly, Ping responses should be received.

4.1.2 Telnet Console

On newer computers, the default telnet function on Windows machines may be disabled. This can be fixed by following step by step instructions located online. To either confirm that the telnet function is enabled or properly turned on;

1. Use a program that has a telnet function built in or launch a Windows DOS window.
2. Enter the command **telnet** <radio IP address>.
   i.   If the connection fails, perform a ping to the radio's IP address to confirm connectivity. If pings succeed, the telnet feature may not be enabled.
   ii. If pings fail, then use the serial console to check settings and connectivity.
   iii. If the telnet functions, login to the radio.

4.2 Initial Startup & Checkout

In-service operation of the transceiver is completely automatic. Once the unit has been properly installed and configured as described above, 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.
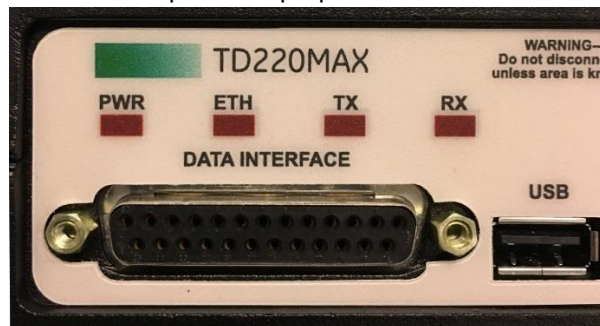
Table 6. LED Status Indicators

LED Name	Description
PWR	• Continuous — Power applied, no problems detected. • Rapid flash (5 times-per-second) — Alarm indication
ETH	• Flashing/On — Data is being transmitted and received. • Off — Ethernet signals not detected
TX	When lit, indicates data transfer between the Base and Mobile Radios.
RX	When lit, indicates data transfer between the Base and Mobile Radios.

4.3 Upgrade the Firmware

4.3.1 Introduction

From time-to-time MDS will offer upgrades to the TD220MAX firmware. Uploading new firmware into the radio does not require that the radio be taken off-line until you want to operate the radio from the new firmware image.

Firmware images are provided free-of-charge on the MDS Web site at: www.gemds.com. Use the product lookup to search for TD Series.

4.3.2 Installing TD220MAX Firmware by TFTP

To use this function the user will need:
- A PC with a TFTP server running.
- The IP address of the PC running the TFTP server.

If you do not know your computer's address on a Windows PC, you can use the RUN function from the Start menu and enter ipconfig to determine your local PC's IP address. The IP address of the radio can be found on the *Starting Information Screen* (see Page 16).

4.3.3 Reprogramming Procedure

To upload a new firmware file (TDM-krmd-X_Y_Z.mpk) into the TD220MAX unit use the following procedure:

1. Launch a TFTP server on a PC connected either directly or via a LAN to the Ethernet port (LAN) of the radio. Set the TFTP server's outgoing path to the directory containing the firmware image file.
2. Connect to the radio's menu system by whichever means is convenient: Telnet via the LAN or Terminal emulator via the COM1 port.
3. Go to the *Reprogramming Menu* (See *Reprogramming Menu* for more detailed information).
4. Fill in the information for the:
    - **TFTP Host Address** – IP Address of the server (host computer) running the TFTP server.
    - **Firmware Filename** – Name of the file (TDM-krmd-X_Y_Z.mpk) to be pulled from the TFTP server holding the firmware file.
5. Select **Retrieve File** to start the reprogramming and receive the firmware file through the TFTP server.

NOTE The uploaded firmware image file replaces the "inactive image" file and will be automatically verified.

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6. Check the FW version shown for the inactive image to verify that the download has completed successfully
7. Reboot the TD220MAX radio to the inactive image which now contains the newly downloaded firmware.
8. Test the radio for normal operation.
9. End of procedure.

4.4 Set Up a GPS Base Unit

1. Connect the RS-232 NMEA serial data output from the GPS receiver to the Base Radio via the radio's COM2 port. Drive serial data into the radio on DB-25 pin 2.
2. Connect the GPS's PPS output to the Base Radio. Drive TTL into the radio on DB-25 pin 23.
3. Log in to the radio.
4. Go to the *GPS Configuration Menu*.
    a. Verify/modify the GPS NMEA baud rate and PPS polarity to match the connected GPS.
5. Go to the *System Configuration Menu*.
    a. Set the timing source to GPS and allow the radio to reboot.
6. Logging in again after the reboot, verify that the radio's Device Status is **OPERATIONAL** as shown on the *Starting Information Screen*. If not, enter 'A' to get a list of the current alarms and correct the alarm condition.
7. Go to the *STFP Configuration Menu* (Under the *System Configuration Menu*)
    a. Set the STFP radio ID from the default 0 (it's recommended).

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    b. Set the IP Port on which the base will receive STFP messages from the Communication Manager.

    c. Set the IP Address of the Communication Manager to which timing markers and messages received from mobiles should be sent.

    d. Set the IP Port of the Communication Manager to which timing markers and messages received from mobiles should be sent.

    e. Set the epoch size to match the same value configured on the neighboring radios and reboot if necessary.

    f. Set the STFP slot delay as necessary. This number, multiplied by 125ms, represents the slot delay allowed from when a timing marker is sent to the Communication Manager to when a data message must be received from the Communication Manager. For most cases the default value of 3 should suffice.

8. Go to the *Ping Utility Menu* (Under the *Maintenance/Tools Menu*).

    a. Verify the Ethernet link using the Ping utility.

9. Begin sending STFP data.

10. Verify the TX LED illuminates and the radio begins transmitting over the air.

4.5 Set Up a PTP Base Unit

1. Install and configure a PTP Grandmaster Clock. The clock must be accessible to the Base Radio through the Ethernet Link. The base may interface to an external Communication Manager using the Ethernet Link; therefore, an external switch or router may be required.

2. Log in to the radio.

3. Go to the *PTP Configuration Menu*.

    a. Choose the PTP Profile for the Base to match with the settings on the Grandmaster Clock.

    b. If Telecom profile is selected in step a, set PTP Unicast Master to the IP address of the Grandmaster Clock.

4. Go to the *System Configuration Menu*.

    a. Set the timing source to PTP and allow the radio to reboot.

5. Logging in again after the reboot, verify that the radio's Device Status is **OPERATIONAL** as shown on the *Starting Information Screen.* If not, enter 'A' to get a list of the current alarms and correct the alarm condition.

6. Go to the *STFP Configuration Menu* (Under the *System Configuration Menu*).

    a. Set the STFP radio ID from the default 0 (it's recommended).

    b. Set the IP Port on which the Base will receive STFP messages from the Communication Manager.

    c. Set the IP Address of the Communication Manager to which timing markers and messages received from mobiles should be sent.

    d. Set the IP Port of the Communication Manager to which timing markers and messages received from mobiles should be sent.

    e. Set the epoch size to match the same value configured on the neighboring radios and reboot if necessary.

    f. Set the STFP slot delay as necessary. This number, multiplied by 125ms, represents the slot delay allowed from when a timing marker is sent to the Communication Manager to when a data message must be received from the Communication Manager. For most cases the default value of 3 should suffice.

7. Go to the *Ping Utility Menu* (Under the *Maintenance/Tools Menu*).

    a. Verify the Ethernet Link using the Ping utility.

8. Begin sending STFP data.

9. Verify the TX LED illuminates and the radio begins transmitting over the air.

4.6 Set Up an OTA Mobile Unit

1. Log in to the radio.
2. Go to the *System Configuration Menu*.
3. Set the timing source to OTA and allow the radio to reboot (factory-new units default to OTA, so this step may be skipped).
4. Logging in again after the reboot, verify that the radio's Device Status is **OPERATIONAL** as shown on the *Starting Information Screen*. If not, type 'A' to get a list of the current alarms and correct the alarm condition.
5. Go to the *STFP Configuration Menu* (Under the *System Configuration Menu*)
   a. Set the STFP radio ID from the default 0. (It's recommended.)
   b. Set the IP Port on which the mobile will receive STFP messages from the Communication Manager.
   c. Set the IP Address of the Communication Manager to which timing markers and messages received from bases should be sent.
   d. Set the IP Port of the Communication Manager to which timing markers and messages received from bases should be sent.
   e. Set the epoch size to match the same value configured on the neighboring radios and reboot if necessary.
   f. Set the STFP slot delay as necessary. This number, multiplied by 125ms, represents the slot delay allowed from when a timing marker is sent to the Communication Manager to when a data message must be received from the Communication Manager. For most cases the default value of 3 should suffice.
6. Go to the *Ping Utility Menu* (Under the *Maintenance/Tools Menu*).
   a. Verify the Ethernet Link using the Ping utility.
7. Ensure at least one base is present in the neighborhood of this radio so that it can detect beacons and synchronize timing.
8. Begin sending STFP data.
9. Verify the TX LED illuminates and the radio begins transmitting over the air.

4.7 Key the Transmitter

1. Log in to the radio on its COM1 console using a serial terminal emulator program.
2. Go to the *Maintenance / Tools Menu* and then to the *Radio Test Menu*.
3. Select the frequency for the test transmission.
4. Select the RF Output Power to use.

NOTE Power levels greater than 2 Watts will timeout after a 20-second period by default. Ensure ventilation with supplemental forced airflow if longer durations are desired.

---

5. Select the type of test to **Force Key**.
6. Enable test mode.
7. When finished, disable test mode or escape the test menu.

NOTE When in the Radio Test Menu, all STFP communications to this radio will be temporarily ignored. STFP communications will resume upon exiting the menu.

4.8 Perform Test Polling

This manual does not cover how to configure and send STFP messages. Please see document **STFP Polling with TD** radios in the Support Documents section of the website; https://www.gegridsolutions.com/app/Resources.aspx?prod=td-series&type=9.

5.0 Menu Interface

The menu interface can be reached via two ways; serially via the DB25 connector or by Telnet via the Ethernet Interface. This section will describe the different menus available on the radio.

Configurable settings are followed by information in brackets. The information includes a comma-separated list of possible values then a semicolon and the default value. For example, a setting followed by **[disabled, enabled; disabled]** means the possible values are **disabled** or **enabled** and the default value is **disabled**." In some cases, the parameter may be freeform for a customer to enter information. In that case, the minimum and maximum of characters the parameter can take will be listed.

Login with the administrator user name and password. When logged in, the Starting Information Screen is displayed.

```
                      MDS TD 220MAX
                 Starting Information Screen
-=============================================================-


              Device Name        Device Name

              IP Address         192.168.1.2

              Device Status      Operational

              Location           Location

              Serial Number      2781042

              Uptime             00 hrs, 01 min

              Current Firmware   1.2.14

              Current User       admin




                 Press 'G' to go to Main Menu
```

Figure 10. Starting Information Screen

- **Device Name** – User-configured name for this radio. Set this from the *Device Names* menu.
- **IP Address** – IP address for this radio. Set this from the *IP Configuration* menu.
- **Device Status** – This is a display of the status of the radio and can be the following;
    - **Initializing** – appears during startup and/or internal RF deck reprogramming.
    - **Operational** – when functioning properly.
    - **Alarmed** – when an error condition(s) exists. Click the letter "A" on the keyboard to view the alarm.
- **Location** – User-configured location for this radio. Set this from the *Device Names* menu.
- **Serial Number** – The manufacturer's serial number for this radio. Set by the factory and cannot be changed.
- **Uptime** – The elapsed time since the radio was started.
- **Current Firmware** – The version number of the currently operating firmware.
- **Current User** – The current user's login level.

5.1 Main Menu

The next screen, the Main Menu is the entryway to all user-controllable features. The transceiver's **Device Name** appears at the top of this and all other screens as a reminder of the unit that is currently being controlled.
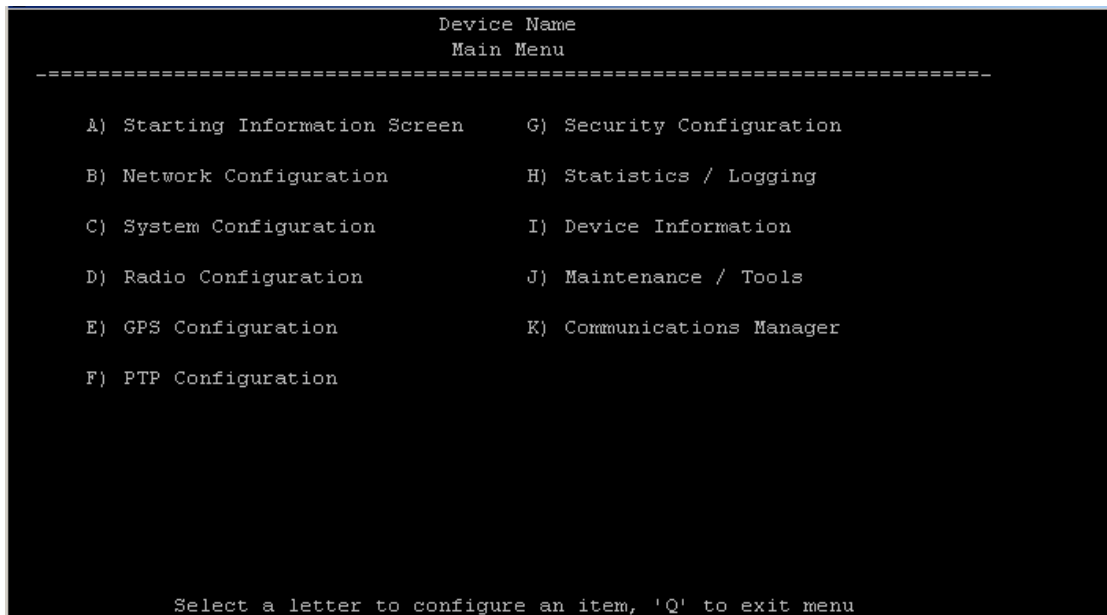
```
                          Device Name
                          Main Menu
-================================================================-

    A) Starting Information Screen    G) Security Configuration

    B) Network Configuration          H) Statistics / Logging

    C) System Configuration           I) Device Information

    D) Radio Configuration            J) Maintenance / Tools

    E) GPS Configuration              K) Communications Manager

    F) PTP Configuration




          Select a letter to configure an item, 'Q' to exit menu
```

Figure 11. Main Menu

- **Starting Information Screen** – Select this item to return to the start-up screen.
- **Network Configuration** – Tools to configure the data network layer of the transceiver.
- **System Configuration** – Tools to configure the transceiver's timing source and other application-specific operating parameters.
- **Radio Configuration** – Tools to configure the radio's frequencies, RF power, and other radio specific parameters.
- **GPS Configuration** – Tools to configure the radio's GPS NMEA and PPS connections.
- **PTP Configuration** – Tools to configure the Precision Time Protocol (PTP) settings.
- **Security Configuration** – Tools to configure the security services available with the transceiver's environment.
- **Statistics/Logging** – Tools to obtain historical and current statistics about the radio's payload performance, and access STFP Logging configuration.
- **Device Information** – Top level user-specific and definable parameters, such as the device name.
- **Maintenance/Tools** – Tools to use configuration files, change firmware and use Authorization Keys to change unit capabilities.
- **Communications Manager** – Tools to configure the internal message scheduler.

5.2   Network Configuration Menu

Figure 12. Network Configuration Menu

- **IP Configuration** – Access to set the IP address, netmask, and gateway IP address of the radio.
- **SNMP Agent Configuration** – Access to set SNMP configuration parameters.
- **Ethernet Address** – Display only hardware address of the unit's Ethernet port.

5.2.1   IP Configuration Menu

Figure 13. IP Configuration Menu

- **IP Address** – The IPv4 address that this radio will use for its Ethernet interface. **[Any valid IP address; 192.168.1.2]**
- **IP Netmask** – The IPv4 local subnet mask. **[Any valid IP netmask; 255.255.255.0]**
- **IP Gateway** – The IPv4 address of the gateway that will pass traffic from the radio's subnet to nodes on other networks. **[Any valid IP Gateway; 0.0.0.0]**

NOTE   The IP Address and the IP Gateway must be on the same subnet or a Network Interface Error will occur.

5.2.2 SNMP Agent Configuration Menu

```
                        Device Name
              SNMP Agent Configuration Menu
 -==============================================================================-

A) SNMP Read Community      ********

B) SNMP Write Community     ********

C) SNMP Trap Community      ********

D) SNMP v3 Auth Password    ********

E) SNMP v3 Priv Password    ********

F) SNMP Mode                disabled    J) SNMP Trap Manager #1  0.0.0.0

G) Trap Version             v1 traps    K) SNMP Trap Manager #2  0.0.0.0

H) Auth Trap Enable         disabled    L) SNMP Trap Manager #3  0.0.0.0

I) SNMP v3 Password Mode    manager     M) SNMP Trap Manager #4  0.0.0.0


      Select a letter to configure an item, <ESC> for the previous menu
```

Figure 14. SNMP Agent Configuration Menu

- **SNMP Read Community** – SNMP community string used for SNMPv1/SNMPv2c read access. This string can be up to 30 alphanumeric characters.
- **SNMP Write Community** – SNMP community string used for SNMPv1/SNMPv2c write access. This string can be up to 30 alphanumeric characters.
- **SNMP Trap Community** – SNMP community string used for SNMPv1/SNMPv2c trap access. This string can be up to 30 alphanumeric characters.
- **SNMP v3 Auth Password** – Authentication password stored in flash. Will be used when Agent is managing passwords locally or initially for all cases on reboot. This is the SNMPv3 password used for Authentication. This string can be between 8 and 30 alphanumeric characters.

NOTE Only MD5 authentication is supported for SNMPv3

- **SNMP v3 Priv Password** – Privacy password stored in flash. Will be used when Agent is managing passwords locally or initially for all cases on reboot. This is the SNMPv3 password used for Privacy (DES encryption). This string can be between 8 and 30 alphanumeric characters.
- **SNMP Mode** – The mode of operation of the SNMP Agent. Choices are disabled, **v1_only**, **v2_only**, **v3_only**, **v1-v2**, and **v1-v2-v3**. If the mode is disabled, then the Agent will not respond to any SNMP traffic. If the mode is **v1_only**, **v2_only**, or **v3_only**, then the Agent will only respond to that version of SNMP traffic. If the mode is **v1-v2**, or **v1-v2-v3**, then the Agent will respond to the specified version of SNMP traffic. **[v1_only, v2_only, v3_only, v1-v2, v1-v2-v3; v1-v2-v3]**.
- **Trap Version** – This specifies what version of SNMP will be used to encode the outgoing traps. The different versions of SNMP will include different information in the traps. The choices are **v1_traps**, **v2_traps**, and **v3_traps**. When **v3_traps** are selected, v2-style traps will be sent but with a v3 header. **[v1_traps, v2_traps, v3_traps; v1_traps]**
- **Auth Trap Enable** – Indicates whether or not traps will be generated for login events. **[disabled, enabled; disabled]**
- **SNMP v3 Password Mode** – Determines whether v3 passwords are managed locally or via an SNMP Manager. The different behaviors of the Agent depending on the mode specified here are described above for Auth and Priv Password. **[manager, local; manager]**
- **SNMP Trap Manager #1 - #4** – Specifies an SNMP Manager on the network that traps will be sent to. **[Any valid IP address; 0.0.0.0]**

5.3 System Configuration Menu

Figure 15. System Configuration Menu (Base)

Figure 16. System Configuration Menu (Mobile)

- **Timing Source** – The timing source used by the radio to precisely determine current time and the start of each second. Mobile radios are configured for OTA to synchronize with a base radio running GPS and/or PTP. **[GPS, PTP, GPS w/ PTP fallback, PTP w/ GPS fallback, OTA; OTA].**
- **Send OTA Beacon** – *Base Radios Only* – This parameter requests the radio to transmit beacons in the first timeslot of each second when no message is received from the Communication Manager for the time slot. Beacons are required to maintain OTA timing of mobiles. **[disabled, enabled; disabled]**
- **STFP Configuration** – Access the STFP Configuration menu to set the STFP operating parameters.
- **Timing Signal Timeout** – If the selected timing input is missing for this duration, the radio asserts an alarm. **[2-255 seconds; 60 seconds]**

- **External Alarm Sense** – Configures the external alarm line (see Table 4. DB25 Serial Interface Pinouts) to be either HIGH or LOW when the radio is in an alarmed state. **[Alarm High, Alarm Low; Alarm High]**
- **Free Run** – *Base Radios Only* – Allow over the air transmission despite the Time Synchronization Invalid alarm. This setting is intended for bench testing a radio and is not persistent. It will reset to disabled upon a reboot. **[enabled, disabled; disabled]**

5.3.1 STFP Configuration Menu

Figure 17. STFP Configuration Menu

- **STFP Radio ID** – Uniquely identifies the radio to the Communication Manager. **[0-65535; 0]**
- **STFP Receive Port** – This IP Port is used to receive STFP messages from the Communication Manager. **[0-65535; 50011]**
- **STFP Tx/Mcast Address** – This is the IP Address of the Communication Manger. **[Any valid IP address; 192.168.143.19]**
- **STFP Transmit Port** – This is the IP port used by the Communication Manager to receive STFP messages from the radio. **[0-65535; 51011]**
- **STFP Epoch Size** – This is the number of seconds constituting an epoch. Valid values are **1, 2, 3, 4, 5, 6, 10, 12, 15, 20,** and **30**. The number of timeslots equals 8 times the epoch size chosen. **[default: 6 seconds]**

NOTE This parameter must match for all radios communicating.

- **STFP Slot Delay** – This is the number of slots (125ms each) in advance that the radio will request data from the Communication Manager. This delay encompasses the time needed for timing markers to transit the network, processing by the Communication Manager, and resulting payload messages to transit the network. **[0-10; 3]**

5.4   Radio Configuration Menu

Figure 18. Radio Configuration Menu

- **Enable External PA** – If enabled, the radio ignores per message power values specified by STFP and forces transmissions at a lower power level suitable for driving the external PA (around 200 mW). **[disabled, enabled; disabled]**
- **Transmit Frequency** – The initial frequency that the radio uses for over the air transmissions upon booting. **[216.00625-221.9875 MHz; 220.106250]**

NOTE STFP messages specify the frequency to be used when transmitting. This parameter is ignored once an STFP message has been received.

- **Receive Frequency** – The initial that the radio uses for receiving over the air transmissions upon booting. **[216.00625-221.9875 MHz; 220.106250]**

NOTE STFP messages specify the frequency to be used when receiving. This parameter is ignored once an STFP message has been received.

- **Output Power** – The RF Output Power from which the radio transmits. **[2-25 W; 2 W]**

NOTE STFP messages specify the power to be used when transmitting. This parameter is ignored once an STFP message has been received.

- **Duty Cycle Power Limit** – Maximum output power the radio will transmit in response to a STFP request. Radio will be able to transmit at equal to or less than the configured power value. **[2-25 W; 25 W]**

5.5 GPS Configuration Menu

Figure 19. GPS Configuration Menu

- **GPS NMEA Baud Rate** – This is the baud rate used on the radio port to receive NMEA sentences. **[1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200; 9600 bps]**
- **GPS PPS Polarity** – Indicates if the TTL PPS Pulse is Active High (**Positive Pulse**) or Active Low (**Negative Pulse**). **[Negative Pulse, Positive Pulse; Negative Pulse]**
- **Use Legacy GPS Timing** – Enable to allow the radio to work with existing/legacy TD220X or TD220MAX systems. Disable in new deployments so that GPS Bases will work seamlessly with PTP units. **[enabled, disabled; disabled]**

NOTE A mobile radio will transition from a system where the Legacy GPS Timing is enabled to a system where it is disabled (or vice-versa) without a problem.

5.6 PTP Configuration Menu

Figure 20. PTP Configuration Menu - PTP Profile: None

```
                              Device Name
                         PTP Configuration Menu
-=================================================================================-

       A) PTP Profile             ITU-T G.8265.1 (Telecom profile)

       B) Profile Domain Number   4

       C) PTP Unicast Master      192.168.1.1

       D) PTP Unicast Lease       300 sec

       E) PTP Unicast Event Rate  16 /sec




       Select a letter to configure an item, <ESC> for the previous menu
```

Figure 21. PTP Configuration Menu - PTP Profile: Telecom

- **PTP Profile** – Choose either **None** or **ITU-T G.8265.1 (Telecom profile)** as the PTP profile. **None** uses multicast messaging. The **ITU-T G.8265.1 (Telecom profile)** uses unicast messaging with the clock specified by PTP Unicast Master. **[None, ITU-T G.8265.1 (Telecom profile); None]**
- **Profile Domain Number** –The logical domain the radio should join. **[0-255; 0 for None Profile, 4-23; 4 for ITU-T G.8265.1 (Telecom profile)]**
- **PTP Unicast Master** – the IP address of the PTP grandmaster clock which the radio will send PTP messages when using the **ITU-T G.8265.1 Telecom** profile. **[Any valid IP address; 192.168.1.1]**
- **PTP Unicast Lease** – The time in seconds for the lease to the grandmaster clock before requesting a new lease. **[60-1000; 300 seconds]**
- **PTP Unicast Event Rate** – Controls how many requests are sent between the grandmaster clock and the radio. For cases where the network is congested, decreasing this number will help reduce the number of messages sent over the network. **[2, 4, 8, 16, 32 /seconds; 16 /seconds]**
- **PTP Delay Mechanism** – *None Profile Only* – choose either **End-to-End (E2E)** or **Peer-to-Peer (P2P)** to correspond to your network infrastructure. **[End-to-End (E2E), Peer-to-Peer (P2P); End-to-End (E2E)]**

5.7   Security Configuration Menu

Figure 22. Security Configuration Menu

- **Telnet Access** – If "enabled", the radio allows user to Telnet to the radio via Ethernet. If "disabled", users must manage the radio via SNMP or the serial console. **[enabled, disabled; enabled]**
- **User Passwords** – Menu that allows modification of the admin, guest, and integrator logins.
- **SNMP Mode** – The mode of operation of the SNMP Agent. Choices are disabled, **v1_only**, **v2_only**, **v3_only**, **v1-v2**, and **v1-v2-v3**. If the mode is disabled, then the Agent will not respond to any SNMP traffic. If the mode is **v1_only**, **v2_only**, or **v3_only**, then the Agent will only respond to that version of SNMP traffic. If the mode is **v1-v2**, or **v1-v2-v3**, then the Agent will respond to the specified versions of SNMP traffic. **[disabled, v1_only, v2_only, v3_only, v1-v2, v1-v2-v3; disabled]**.

5.7.1 User Passwords Menu
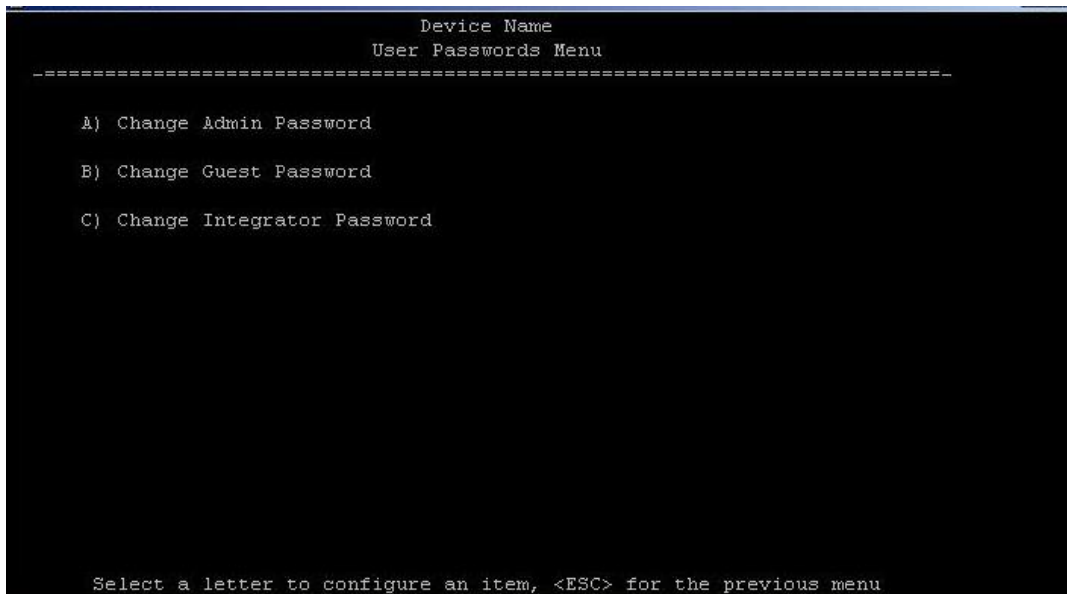
Figure 23. User Passwords Menu

- **Change Admin Password** – Change the password for the Admin level user. This string can be between 8 and 30 alphanumeric characters.
- **Change Guest Password** – Change the password for the Guest level user. This string can be between 8 and 30 alphanumeric characters. This password can only be changed when logged in as the admin user.
- **Change Integrator Password** – Change the password for the Integrator level user. This string can be between 8 and 30 alphanumeric characters. This password can only be changed when logged in as the admin user.

NOTE It is recommended to change the default value of the passwords for security. However, once passwords have been changed, they can never return to the default values unless the radio is sent back to GE MDS for service.

Console/Telnet Lockout Security

TD220MAX release 1.2.15 introduces a lockout on serial and telnet console logins after repeated attempts fail. If an invalid login attempt is repeated 3 times on either console type, the console will no longer display the login prompt for 5 minutes.

During this time, both serial and Telnet console logins are disabled (no matter which console was being attacked) but existing console sessions will operate normally. If SNMP traps are enabled and/or a Syslog server is configured, events recording the lockout will be sent to alert personnel to this possible attack. After 5 minutes, both serial and Telnet consoles present the login prompt once again.

5.8 Statistics/Logging Menu

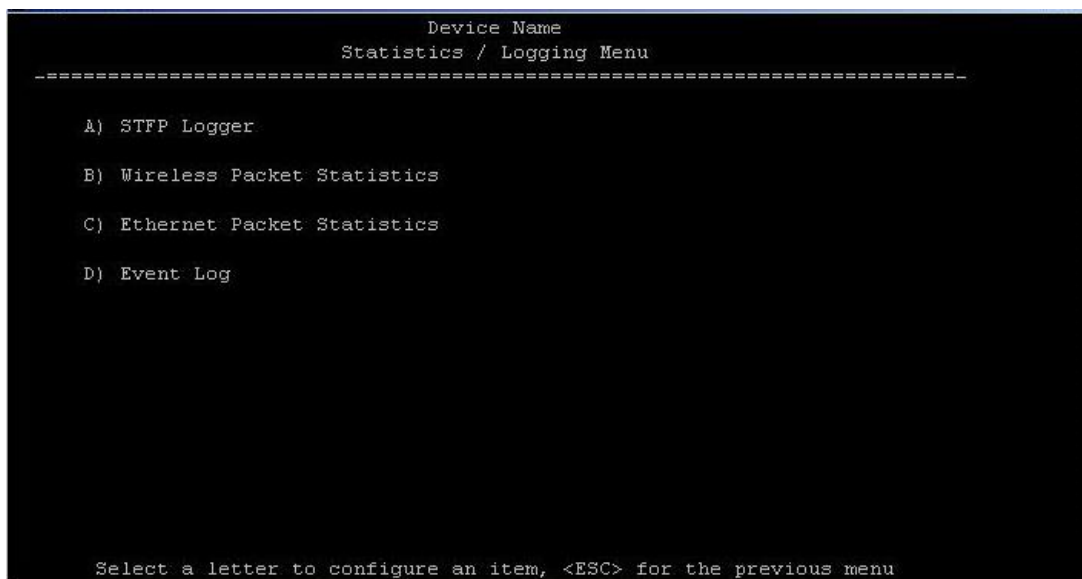

Figure 24. Statistics / Logging Menu - Base Radio

Figure 25. Statistics / Logging Menu - Mobile Radio

- **STFP Logger –** Access the STFP Logger Menu.
- **Wireless Packet Statistics –** Access the Wireless Packet Statistics Menu to view the number of messages passed over the air.
- **Ethernet Packet Statistics –** Access the Ethernet Packet Statistics Menu to view the number of messages passed via Ethernet.
- **Event Log –** Access the Event Log Menu to view the radio's log of system events and alarms.
- **GPS Status –** *Base Radio Only* – Access the GPS Status Menu to view the satellite fix status and the radio's location coordinates.
- **Clock Source Status** – *Base Radio Only* – Access the Clock Source Status Menu for details on the currently active timing source and to manually switch sources if fallback is enabled.

5.8.1 STFP Logger Menu

Figure 26. STFP Logger Menu

- **STFP Log Enable –** If "enabled", the radio will send UDP messages to a log server. **[enabled, disabled; disabled]**
- **STFP Log Server –** The IP address to send UDP messages for logging STFP traffic. **[Any valid IP address; 192.168.1.1]**
- **STFP Log Server Port –** The IP port number to send UDP messages for logging STFP traffic. **[0-65535; 777]**
- **Transmitter Serial Number –** Enabling this feature will put the serial number of the transceiver (space permitting) in the over the air message so the receiver can identify the transmitter for each message via the STFP log. **[enabled, disabled; disabled]**

5.8.2 Wireless Packet Statistics Menu

Figure 27. Wireless Packet Statistics Menu

- **Tx Beacons –** The number of beacon messages transmitted over the air. Beacons are messages sent in the first timeslot of a second that contain no payload. If a message with payload is sent during the first-timeslot of a second, it is still used by OTA radios to synchronize time, but it is not included in this statistic.
- **Tx Payloads –** The number of packets containing payload transmitted over the air.
- **Tx Configs –** The number of STFP configuration messages processed by the radio. STFP configuration messages are used to change the radio receive and transmit frequencies.
- **Tx Crc Errors** – The number of packets to be transmitted over the air that were dropped by the radio before sending because the STFP CRC did not match.
- **Rx Beacons –** The number of beacon messages received over the air. Beacons are messages sent in the first timeslot of a second that contain no payload.
- **Rx Payloads –** The number of packets containing payload received over the air.
- **Rx Errors –** The number of packets received over the air for which the radio detected an error that could not be compensated for using forward error correction. This will match the number of STFP error messages generated by the radio.
- **Tx Last Frequency –** The frequency of the last message transmitted.
- **Tx Last Power** – The power level of the last message transmitted.
- **Tx Payload Bytes –** The number of bytes for all packets containing payload transmitted over the air.
- **Tx Dropped –** The number of packets to be transmitted over the air that were dropped by the radio before sending. There can be various reasons for this. For example, an STFP message could not be properly decoded by the radio, or a message could not be transmitted because the radio is in an alarm state. Reference the "Dropped Packet Statistics Screen" for detailed information.
- **Tx Dropped Dc –** The number of packets to be transmitted over the air that were dropped by the radio before sending for exceeding the Duty Cycle. Make sure that the Duty Cycle Power Limit on the *Radio Configuration Menu* is set properly.
- **Rx Last Frequency –** The frequency of the last message received.
- **Rx Payload Bytes –** The number of bytes for all packets containing payload received over the air.
- **Rx Last RSSI** – The RSSI of the last message received.
- **Clear Statistics** – Resets all the statistics to zero.
- **Dropped Packet Statistics** – Access the Dropped Packet Statistics Menu

---

5.8.3 Dropped Packet Statistics Menu

Figure 28. Dropped Packet Statistics Sub Menu

- **Tx Dropped** – The number of packets to be transmitted over the air that were dropped by the radio before sending. There can be various reasons for this. For example, an STFP message could not be properly decoded by the radio, or a message could not be transmitted because the radio is in an alarm state. Reference below for detailed information.
- **Header Bad** – The number of packets to be transmitted over the air that were dropped by the radio due to a bad STFP message header. The message may have a bad version or other invalid field.
- **Invalid Slot** – The number of packets to be transmitted over the air that were dropped by the radio due to a bad Timeslot being specified. Valid timeslot values are 0 to N-1 where N is 8 times the number of seconds in an epoch.
- **Too Long** – The number of packets to be transmitted over the air that were dropped by the radio due to a payload length that was too long. The maximum payload length is 133 without FEC, 117 with FEC.
- **Bad Freq** – The number of packets to be transmitted over the air that were dropped by the radio due to an invalid RX or TX frequency. Either the frequency was outside of the frequency range of the radio (216.00625 to 221.9875 MHz) or the frequency has a bad step size.
- **In Alarm** – The number of packets to be transmitted over the air that were dropped by the radio while the radio was in alarm.
- **Msg Replaced** – The number of packets to be transmitted over the air that were dropped by the radio due to a later STFP message placing a new payload into that timeslot. This can be done any time before the payload is queued up for transmission.
- **Too Old** – The number of packets to be transmitted over the air that were dropped by the radio because they were older than the configured Max Message Age. (Deprecated in release 1.2.8).
- **Force Key** – The number of packets to be transmitted over the air that were dropped by the radio because the radio was in Forced Key mode.

5.8.4 Ethernet Packet Statistics Menu

```
                         Device Name
                Ethernet Packet Statistics Menu
-=============================================================================-


              Packets Received       0
              Packets Sent           0
              Bytes Received         0
              Bytes Sent             0
              Packets Dropped        0
              Receive Errors         0
              Lost Carrier Detected  0

                   A) Clear Statistics






         Select a letter to configure an item, <ESC> for the previous menu
```

Figure 29. Ethernet Packet Statistics Menu

- **Packets Received** – The number of packets received over Ethernet.
- **Packets Sent** – The number of packets transmitted over Ethernet.
- **Bytes Received** – The number of bytes for all packets received over Ethernet.
- **Bytes Sent** – The number of bytes for all packets transmitted over Ethernet.
- **Packets Dropped** – The number of packets that were dropped due to the Ethernet interface being busy.
- **Receive Errors** – The number of messages received over Ethernet that did not decode properly.
- **Lost Carrier Detected** – The number of times a message could not be sent over Ethernet because the cable was unplugged.
- **Clear Statistics** – Resets all the statistics to zero.

5.8.5 Event Log Menu

```
                        Device Name
                      Event Log Menu
-=============================================================================-

    A> Current Alarms

    B> View Event Log

    C> Clear Event Log

    D> Send Event Log

    E> Event Log Host Address      0.0.0.0

    F> Event Log Filename          eventlog.txt

    G> Transfer Options

    H> Syslog Server Address       127.0.0.1



    Select a letter to configure an item, <ESC> for the previous menu
```

Figure 30. Event Log Menu

- **Current Alarms** – Displays a list of the alarms currently active within the radio.
- **View Event Log** – Opens the Event Log to view the historical list of radio events and alarms.
- **Clear Event Log** – Erase all history of the radio's events and alarms.
- **Send Event Log** – Begin a TFTP transfer of the historical list of the radio's events and alarms from the last clearing to the present.
- **Event Log Host Address** – The IP Address of the TFTP server to send the event log to. **[Any valid IP address; 0.0.0.0]**
- **Event Log Filename** – The filename on the server for the event log. **[default: eventlog.txt]**
- **Transfer Options** – Access the Transfer Options menu to manage transfer characteristics.
- **Syslog Server Address –** As events and alarms occur in real time, send them via the standard SYSLOG protocol (RFC 3164) to the server at this IP Address. **[Any valid IP address; 127.0.0.1]**

5.8.6 View Event Log Menu

Figure 31. Event Log Submenu

- This screen displays the event number, date and time, and event or alarm for each occurrence. Besides the cursor keys indicated, the letter keys u, d, p, n, h, and e may be used for navigating (U)p, (D)own, (P)g-Up, Pg-D(n), (H)ome, and (E)nd.

5.8.7 Transfer Options Submenu

Figure 32. Transfer Options Submenu

- **TFTP Timeout** – Timeout in seconds for a TFTP connection or transfer operation. **[10-120 seconds; 30 seconds]**
- **TFTP Block Size** – Block size in bytes for TFTP transfers. **[512, 1024, 2048, 4096, 8192 bytes; 1024 bytes**

5.8.8 GPS Status Menu (Base Radios Only)

Figure 33. GPS Status Menu

- **GPS Fix Status** – When the status is "Fix" the information onscreen is up-to-date, otherwise the information is stale.
- **Number of Satellites** – Total satellites reported by the GPS receiver.
- **Latitude** – Current Latitude reported by the GPS receiver.
- **Longitude** – Current Longitude reported by the GPS receiver.
- **Altitude** – Current Altitude reported by the GPS receiver

5.8.9 Clock Source Status Menu (Base Radios Only)

Figure 34. Clock Source Status Menu

- **Timing Source** – The value of the System Configuration -> Timing Source setting.
- **Active Timing Source** – The currently active timing source.
- **Switch Clock Source** – When in fallback mode, manually cause a switch between time sources.

5.9 Device Information Menu

```
                         Device Name
                   Device Information Menu
-=================================================================-

                  Model          MDS TD 220MAX

                  Serial Number  2614845

                  Uptime         00 hrs, 13 min


   A> Date          02 Feb 2017    D> Console Baud Rate  19200

   B> Time          10:20          E> UTC Time Offset    0 hrs

   C> Date Format   Generic        F> Device Names




   Select a letter to configure an item, <ESC> for the previous menu
```

Figure 35. Device Information Menu

- **Model** – The model type of the radio.
- **Serial Number** – The factory-assigned unique radio serial number.
- **Uptime** – The number of elapsed hours, minutes, and seconds since the radio last rebooted.
- **Date** – The date from the active timing source (Base) or real-time clock (Mobile).
- **Time** – The time from the active timing source (Base) or real-time clock (Mobile).
- **Date Format** – Change how the date and time are displayed. **[Generic, US, European; Generic]**
- **Console Baud Rate** – The serial port rate the console will communicate at. **[1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200; 19200 bps]**
- **UTC Time Offset** – The local offset from UTC time; set this to display the time in the event log and configuration scripts as local time. **[-12 to + 12 hrs.; 0 hrs.]**
- **Device Names** – Access the Device Names submenu to modify the user-programmable name strings for this radio.
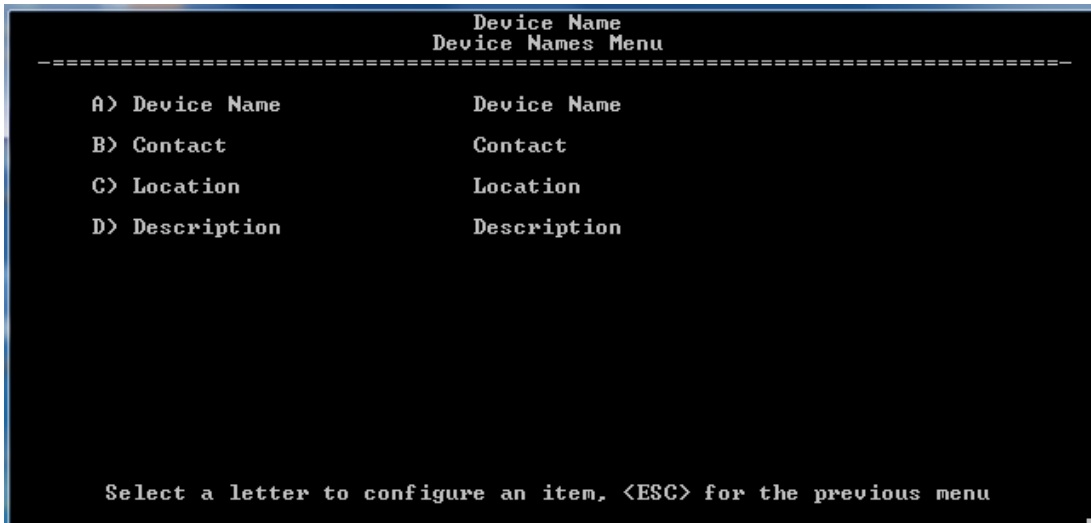
5.9.1 Device Names Submenu


```
                           Device Name
                        Device Names Menu
-================================================================================-

       A) Device Name              Device Name

       B) Contact                  Contact

       C) Location                 Location

       D) Description              Description








       Select a letter to configure an item, <ESC> for the previous menu
```

Figure 36. Device Names Submenu

- **Device Name** – Free-form field to enter a nickname for this radio. **[40 characters max; Device Name]**
- **Contact** – Free-form field to indicate who to contact in case the radio needs service. **[40 characters max; Contact]**
- **Location** – Free-form field to describe the site at which the radio is installed. **[40 characters max; Location]**
- **Description** – Free-form field to enter details describing this radio. **[40 characters max; Description]**

5.10 Maintenance/Tools Menu

Figure 37. Maintenance / Tools Menu

- **Reprogramming** – Access the Reprogramming submenu to upgrade the radio's firmware.
- **Configuration Scripts** – Access the Configuration Scripts submenu to save and restore the radio's configuration to and from a text file via a TFTP server.
- **Ping Utility** – Access the Ping Utility submenu to verify Ethernet communications with one or more hosts.
- **Authorization Codes** – Access the Authorization Codes submenu to enable certain enhanced features.
- **Radio Test** – Submenu for running built-in radio tests like force key or polling.

5.10.1 Reprogramming Menu


```
                        Device Name
                     Reprogramming Menu
-===========================================================================-

     A)  TFTP Host Address    192.168.1.25

     B)  Firmware Filename    TDM-krmd-1_2_14.mpk

     C)  Transfer Options

     D)  Retrieve File

     E)  Image Verify

     F)  Image Copy

     G)  Reboot Device

        Current Firmware        Image 1: 1.2.10
                                Image 2: 1.2.14  (active)



     Select a letter to configure an item, <ESC> for the previous menu
```

Figure 38. Reprogramming Menu

- **TFTP Host Address** – The IP address of the TFTP server from which the new firmware image will be download. **[Any valid IP address; 127.0.0.1]**
- **Firmware Filename** – The filename for the firmware image. This file must exist on the server. **[40-character filename max; firmware.mpk]**
- **Transfer Options** – Access the Transfer Options menu to manage transfer characteristics. See *Transfer Options Submenu* for details.
- **Retrieve File** – Command the radio to request the firmware image from the TFTP server. Note that the retrieved file will be written to the inactive image.
- **Image Verify** – Command the radio to perform a check of the firmware image in memory.
- **Image Copy** – Command the radio to copy the active firmware image to the inactive position.
- **Reboot Device** – Command the radio to restart to either the active or inactive firmware image.
- **Current Firmware** – Shows the version number of the installed firmware images and notes the active firmware.

5.10.2 Configuration Scripts Menu

```
                            Device Name
                     Configuration Scripts Menu
  -===============================================================-

       A) TFTP Host Address    192.168.1.1

       B) Config Filename      config.txt

       C) Transfer Options

       D) Retrieve File

       E) Send File




      Retrieve may cause a reboot if settings like 'Timing Source' change.



        Select a letter to configure an item, <ESC> for the previous menu
```

Figure 39. Configuration Scripts Menu

- **TFTP Host Address** – The IP address of the TFTP server used for configuration script transfers. **[Any valid IP address; 127.0.0.1]**
- **Config Filename** – The configuration script filename to transfer. **[40-character filename max; cfgscript.txt]**
- **Transfer Options** – Access the Transfer Options menu to manage transfer characteristics. See *Transfer Options Submenu* for details.
- **Retrieve File** – Command the radio to get a configuration file from the TFTP server.
- **Send File** – Command the radio to send the configuration file to the TFTP server.

Exporting a configuration file saves the radio's settings as a text file. The file includes some read-only settings to help identify different radios Password settings are not exported for security reasons but may be imported. These are not exported for security. Upon import, the radio will parse the configuration file for changes. Any read-only parameters exported will be ignored on import, even if they are changed.

CAUTION: As noted on the menu screen; changes made to either the **Timing Source** or **STFP Epoch Size** parameters will cause the radio to automatically reboot after the configuration script is retrieved and processed. Changing these parameters requires a reboot to keep the radio in proper operation.

5.10.3 Ping Utility Menu

Figure 40. Ping Utility Menu

- **Address to Ping** – The IP address of the network host to send test messages. **[Any valid IP address; 127.0.0.1]**
- **Count** – The number of test messages to send. **[0-4294967295; 4]**
- **Packet Size** – The number of bytes each test message will contain. **[0-65535; 32]**
- **Ping** – Command the radio to begin the ping test.

5.10.4 Authorization Codes Menu

Figure 41. Authorization Codes Menu

- **Authorization Key** – Enter an alphanumeric key to enable features on this device.
- **Authorized Features** – The status of the features authorized for this device.

NOTE Contact GE MDS to obtain an authorization key to enable additional features.

5.10.5 Radio Test Menu


```
                          Device Name
                        Radio Test Menu
-=============================================================================-

     A)  Test State                disabled

     B)  Test Transmit Frequency   218.250000 MHz

     C)  Test Receive Frequency    218.250000 MHz

     D)  Output Power              2 W

     E)  Test To Run               Receive

         RSSI




     Select a letter to configure an item, <ESC> for the previous menu
```

Figure 42. Radio Test Menu

- **Test State** – Enable or disable the test. **[disabled, enabled; disabled]**
- **Test Transmit Frequency** – The transmit test frequency. **[216.00625-221.9875; 218.25 MHz]**
- **Test Receive Frequency** – The receive test frequency. **[216.00625-221.9875; 218.25 MHz]**
- **Output Power** – The test output power. **[2-25 W; 2]**
- **Test to Run** – The type of test to run. **[Receive, Force Key, Poll Base (Mobile only), Poll Mobile (Base only); Receive]**
- **RSSI** – Displays the RSSI of the type of test being run.

NOTE All STFP communication with the radio will be ignored while the Radio Test Menu is displayed. STFP processing will resume when the menu is exited.

5.11 Communications Manager Menu

Figure 43. Communications Manager Menu

- **CM Version** – Access the menu to view the current installed Communications Manager firmware revision.
- **CM Provisioning** – Access the menu to manage provisioning files for the Communications Manager.
- **CM Configuration** – Access the menu to manage the configuration files for the Communications Manager.
- **CM Process Status** – Access the menu to view the status of some of the radio's processes for debugging purposes.
- **CM Log** – Access the menu to view logs from the Communications Manager for debugging purposes.
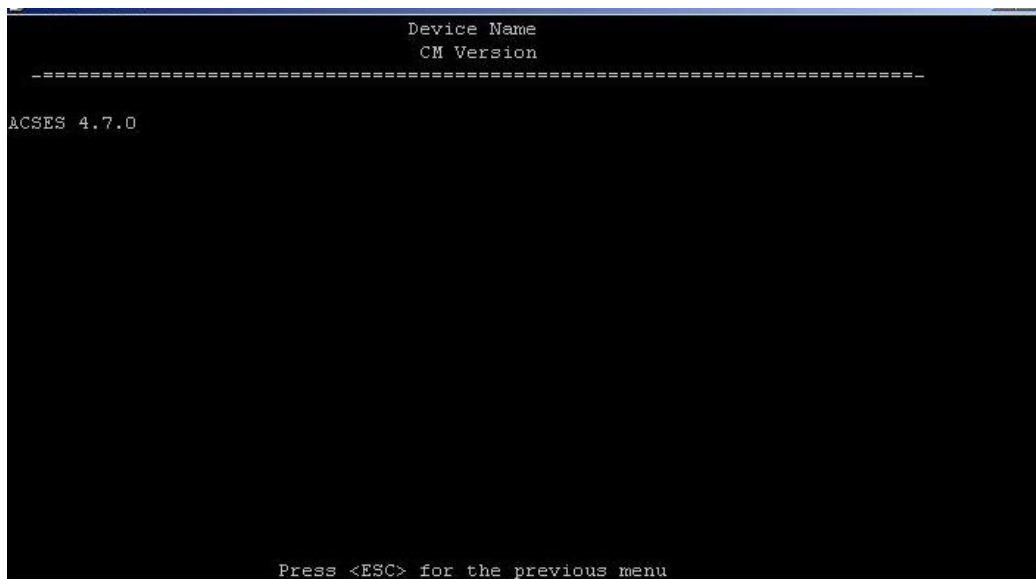
5.11.1 CM Version Menu

Figure 44. CM Version Menu

This menu will display the current installed Communication Manager firmware bundled in the radio's firmware.
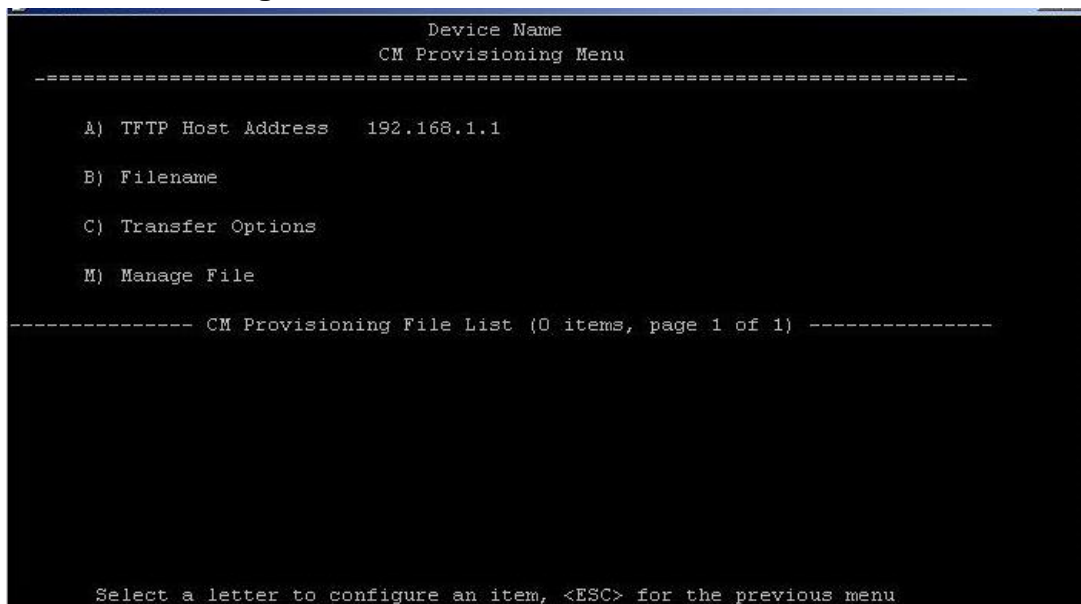
5.11.2 CM Provisioning Menu

Figure 45. CM Provisioning Menu

- **TFTP Host Address** – The IP address of the TFTP server used for provisioning file transfers. **[Any valid IP address; 127.0.0.1]**
- **Filename** – The filename of the provisioning file to manage. **[40 characters long; blank]**
- **Transfer Options** – Access the Transfer Options menu to manage transfer characteristics. See *Transfer Options Submenu* for details.
- **Manage File** – Provides options to manage a file. Options include: Add, Cksum (checksum), Delete, Send and View.
- **CM Provisioning File List** – Displays provisioning files installed on the radio.

5.11.3 CM Configuration Menu

Figure 46. CM Configuration Menu

- **TFTP Host Address** – IP address of the TFTP server located on the network. **[Any valid IP address; 127.0.0.1]**
- **Filename** – The filename of the configuration file to manage. **[40 characters long; blank]**
- **Transfer Options** – Access the Access the Transfer Options menu to manage transfer characteristics. See *Transfer Options Submenu* for details.
- **Manage File** – Provides options to manage a file. Options include: Add, Cksum (Checksum), Delete, Link, Rename, Send and View.
- **CM Configuration File List** – Displays configuration files installed on the radio.

5.11.4 CM Process Status Menu

Figure 47. CM Process Status Menu

This menu shows the state of certain processes that are on the radio. These processes can help assist in debugging purposes to determine the state of the Communications Manager.

5.11.5 CM Log Menu

Figure 48. CM Log Menu

- **TFTP Host Address** – IP address of the TFTP server used for log file transfers. **[Any valid IP address; 127.0.0.1]**
- **Filename** – The filename of the log file to manage. **[40 characters length]**
- **Transfer Options** – Access the Transfer Options menu to manage transfer characteristics. See *Transfer Options Submenu* for details.
- **Manage File** – Provides options to manage a file. Options include Add, Cksum (Checksum), Delete, Send and View.
- **CM Log File List** – Displays the logs available to be viewed to assist in debugging.

6.0 Troubleshooting

The following section is used to help determine the root cause of problems and offer a way to fix them.

6.1 Alarm/Event Conditions

The radio contains an alarm and event log to assist in the monitoring and troubleshooting day to day operation. An alarm is an event that affects performance and requires action. Typically, alarms are noticed due to the PWR LED blinking. Noted below, some alarms can be corrected by the user (noted with an asterisk (*)) while others may require returning the unit to GE MDS for diagnostics.

Many alarms and events also have an SNMP trap associated to them for use in applications using SNMP. For more information on the Alarm and Event Log, see *Event Log Menu*.

6.1.1 Alarms

Table 7. Alarm Conditions

Alarm Condition Reported	Event Log Entry	SNMP Trap
EVENT_IPADDR*	IP Address Invalid	ipAddress(1)
EVENT_MACADDR	MAC Address Invalid	macAddress(3)
EVENT_SYSTEM_ERROR *	System Error Please Reboot	systemError(4)
EVENT_BRIDGE	Network Interface Error	bridge(5)
EVENT_RADIO_SYNTH	Radio Synth Out of Lock	radiosynth(12)
EVENT_RADIO_CAL	Radio Not Calibrated	radiocal(13)
EVENT_FREQ *	Setting Frequency Failed	setfreq(15)
EVENT_OTA_SYNC *	OTA Sync Lost	otasync(18)
EVENT_PA_TEMP *	PA Temperature Too HOT	patemp(20)
EVENT_TOD *	Time Synchronization Invalid:	tod(21)
EVENT_HI_RFLCTD_PWR *	High Reflected Power Set	badswr(22)

6.1.2 Correcting Alarm Conditions

The following table provides insight on the causes of the events that inhibit the unit from operating and possible corrective actions.

Table 8. Correcting Alarm Conditions

Event Log Entry	Generating Condition	Clearing Condition or Action
IP Address Invalid	The default value of the IP address is still set.	• Change the IP address from 192.168.1.1.
MAC Address Invalid	Invalid MAC Address Programmed.	• Contact factory Technical Services for assistance.

Table 8. Correcting Alarm Conditions

Event Log Entry	Generating Condition	Clearing Condition or Action
System Error Please Reboot	Unit encounters something that causes a system error.	• Reboot the radio. If condition continues after reboot, contact factory Technical Services.
Network Interface Error	Ethernet interface fails to operate.	• Contact factory Technical Services for assistance.
Radio Synth Out of Lock	Internal alarm caused by the radio module.	• Contact factory Technical Services for assistance.
Radio Not Calibrated	Calibration failure on the radio.	• Contact factory Technical Services for assistance.
Setting Frequency Failed	Radio has failed to set configured frequencies.	• Toggle frequencies or reboot. If persistent contact Technical Services for assistance.
OTA Sync Lost	Mobile Radio has lost synchronization with the Base Radio.	• Ensure wireless connection is free of obstacles and antennas are properly installed. • Ensure that time synchronization is valid on the Base as synchronization lost on the Base will also cause this alarm to occur on the Mobile. • Ensure that STFP messages traffic is present or beacons are enabled on the Base.
PA Temperature Too HOT	Temperature of the PA exceeds limits.	• Ensure radio's environment is within specified range. • Ensure radio is installed with ventilation to allow for cooling.
Time Synchronization Invalid:	Radio cannot synchronize with a time source or configuration is invalid.	• If this is the first time booting up the radio, configure the necessary time source information. • Ensure that GPS/PTP configurations are properly configured. • Ensure that Ethernet/RF connections to the radio are correct.
High Reflected Power Set	SWR exceeds proper operational limits.	• Ensure proper antenna and equipment are installed.

6.1.3 Logged Events

The following events allow the transceiver to continue operation but do not make the PWR LED blink.

Table 9. Logged Events

Event Log Entry	Description	SNMP Trap
Time Synchronization Valid:	Displays the valid type of time source that the radio is actively synchronized to.	tod(21)
System Bootup	Self-explanatory	bootup(34)
User Selected Reboot	Self-explanatory	reboot(35)
Reprogramming Started	Self-explanatory	reprogStarted(36)
Reprogramming Complete	Self-explanatory	reprogCompleted(37)
Reprogramming Failed	Self-explanatory	reprogFailed(38)
Telnet User Logged In/Out	Self-explanatory	telnetLogin(39)
Event Log Cleared	Self-explanatory	logClear(41)
GPS PPS Ok/Not Available	Self-explanatory	gpspps(42)
GPS Signal OK/Inverted	Displays if the GPS signal matches the configured GPS PPS Polarity (OK) or not (Inverted)	ppsinverted(43)
NMEA Data – Valid/Invalid	Self-explanatory	nmeadata(44)
Console User Logged Out/In	Self-explanatory	consoleLogin(48)
Parameter Changed	Self-explanatory	parmChanged(50)
Configuration Script Generated/Received	Self-explanatory	cfgscript(51)
Auth Key Entered – Valid/Invalid	Self-explanatory	authKey(52)
Internal PTP Trigger Active/Not Active	Self-explanatory	ptppps(55)
Clock Source set to:	Displays the IP address of the time source (PTP) or connection to GPS.	clockSource(57)
Image Copy Started	Self-explanatory	imageCopyStarted(59)
Image Copy Complete	Self-explanatory	imageCopyComplete(60)
Image Copy Failed	Self-explanatory	imageCopyFailed(61)
Receiving NMEA True/False	Self-explanatory	rxingnmea(62)
GPS Fix Good/Bad	Self-explanatory	gpsfix(64)
File	Shows actions (add, delete, link, rename) done to files for the Communication Manager.	file(65)

Table 9. Logged Events

Event Log Entry	Description	SNMP Trap
Console Access Locked for 5 minutes	Self-explanatory	consoleLockdown(66)
Login Attempt Failed	Self-explanatory	loginFailed(67)

In some cases, along with alarms mentioned in the previous section, additional GPS events may assist in the corrective methods for proper radio operation.

Table 10. Logged Timing Events

Event Log Entry	Generating Condition	Clearing Condition or Action
GPS PPS Not Available	Either not connected or a problem exists with the PPS connected to the radio.	• Ensure connection to radio/adapter board is correct • Ensure configuration is correct.
NMEA Data Invalid	Either not connected or a problem exists with the NMEA connected to the radio.	• Ensure connection to radio/adapter board is correct • Ensure configuration is correct.
GPS Fix Bad	Despite having the proper PPS and NMEA connections, the radio is not able to synchronize with the GPS signal.	• Ensure connection to radio/adapter board is correct • Ensure configuration is correct.

6.2   Technical Specifications

GENERAL

Frequency Range

216-222 MHz, 12.5kHz bandwidth

RECEIVER

Maximum Usable Sensitivity

–114 dBm at 10% PER (FEC enabled, wide deviation)
–109 dBm at 10% PER (FEC enabled, narrow deviation)

TRANSMITTER

Carrier Power

2 – 25 Watts (33-44 dBm)

Note: 2 W max for FCC part 90 with frequencies under 220 MHz

Duty Cycle

25W / 30% Duty
10W / 30% Duty
2W / 100% Duty

Output Impedance

50 Ω

FCC ID

E5MDS-TD220MAX

PRIMARY POWER

Voltage

10.0 to 16 VDC (Negative ground only), 13.8 VDC Nominal

TX Supply Current *(Typical)*

7 A maximum @ 13.8 VDC at 25 W

RX Supply Current *(Typical)*

300 mA @ 13.8 VDC

ENVIRONMENTAL

Humidity

95%, non-condensing at 40°C

Temperature Range

–40 to 70 degrees C (–40°F to 158°F) (depending on Duty Cycle)

Duty Cycle

25W / 30% Duty: –40 to 60 degrees C (–40°F to 140°F)
10W / 30% Duty: –40 to 70 degrees C (–40°F to 158°F)
2W / 100% Duty: –40 to 70 degrees C (–40°F to 158°F)

Weight (nominal)

2.5 lbs. (1.13 kg)

Transceiver Dimensions

7.2" (18.29 cm) long, 5.2" (13.21 cm) wide, 2.0" (5.08 cm) in height

DIAGNOSTICS/DATA INTERFACE

Connection

Custom DB-25 Female
See Table 4. DB25 Serial Interface Pinouts for details

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

7.0 Acknowledgements

TD220MAX incorporates ptpd (https://github.com/ptpd/ptpd):

```
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*/

IN CASE OF DIFFICULTY...

Our 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 if servicing becomes necessary.

TECHNICAL ASSISTANCE

Technical assistance for GE MDS products is available from our Technical Support Department during normal business hours (8:30 A.M.–5:00 P.M. Eastern Time). When calling, please give the complete model number of the product, 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   **Web:** www.gemds.com

REPAIR 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 unit to its proper operating specifications.

If return of the equipment is necessary, you must obtain a return authorization number before shipment. This number helps expedite the repair so that the equipment can be returned to you as quickly as possible. Please be sure to include the 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 authorization number.

Return authorization 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 a number. A purchase order number or pre-payment 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 authorization number:

> **Telephone Number: 585-241-5540**
> **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**
> **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 department using the telephone, Fax, or E-mail information given above.