RMX

RADIO MODEM TRANSCEIVER

Operating Manual

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DESCRIPTION

GENERAL

FTS Forest Technology Systems Limited RMX Radio Modem Transceiver is a radio telemetry device designed to provide access to data at remote weather station sites. The RMX utilizes conventional VHF or UHF radio frequencies for communications and is able to transfer data at rates up to 9600 bits/sec on a 25 kHz channel and 4800 bits/sec on a 12.5 kHz channel. Data throughput is maximized by the use of Reed-Solomon forward error correction algorithms and by implementation of selective repeat transmissions of corrupt data packets in the RMX. The RMX also employs dynamic baud rate selection and a CSMA (Carrier Sense Multiple Access) channel acquisition protocol to provide robust and reliable communications to ensure successful data retrieval. Maximum RF output power for the RMX is 6 Watts.

As the RMX is designed to operate under harsh field conditions, all configuration parameters are stored in non-volatile memory and are preserved during transport and power interrupts to allow the RMX to automatically reset and start-up. As well, each RMX monitors and stores its radio link communication statistics and has an integrated date and time stamped audit log. Front panel LEDs give clear RMX operating status indication and also indicate the status of the radio channel. The LEDs can also display which of the 8 pre-programmed user radio channels is currently selected.

A powerful diagnostic interface is available on either of the RMX front panel military style bayonet connectors (MODEM or DATALOGGER). The RMX diagnostic interface provides a PC com port (RS-232) connection that can be accessed locally via a cable or remotely via a phone modem. RMX network troubleshooting is simplified as the diagnostic interface can be used to communicate with a locally-connected or RF-linked RMX.

For maximum protection and survivability, the RMX is housed in the standard FTS, cast aluminum, O-ring sealed, modular, 5U waterproof case. This makes replacing an RMX in the field is as simple as disconnecting and connecting a few cables.

FRONT PANEL CONNECTORS

On the RMX front panel (see Figure 1) there are 4 user connection points: a RF ANTENNA connector; a MODEM connector; a DATALOGGER connector; and a POWER connector. Also present on the RMX front panel are 4 LEDs to display the status of the radio channel and a pushbutton switch for radio channel control. To prevent the possible entry of water into the RMX housing, the LEDs and pushbutton are built into the front panel label and all connectors are sealed even when not mated. In addition, the MODEM and DATALOGGER connectors are supplied with a tethered protective cap for added protection.

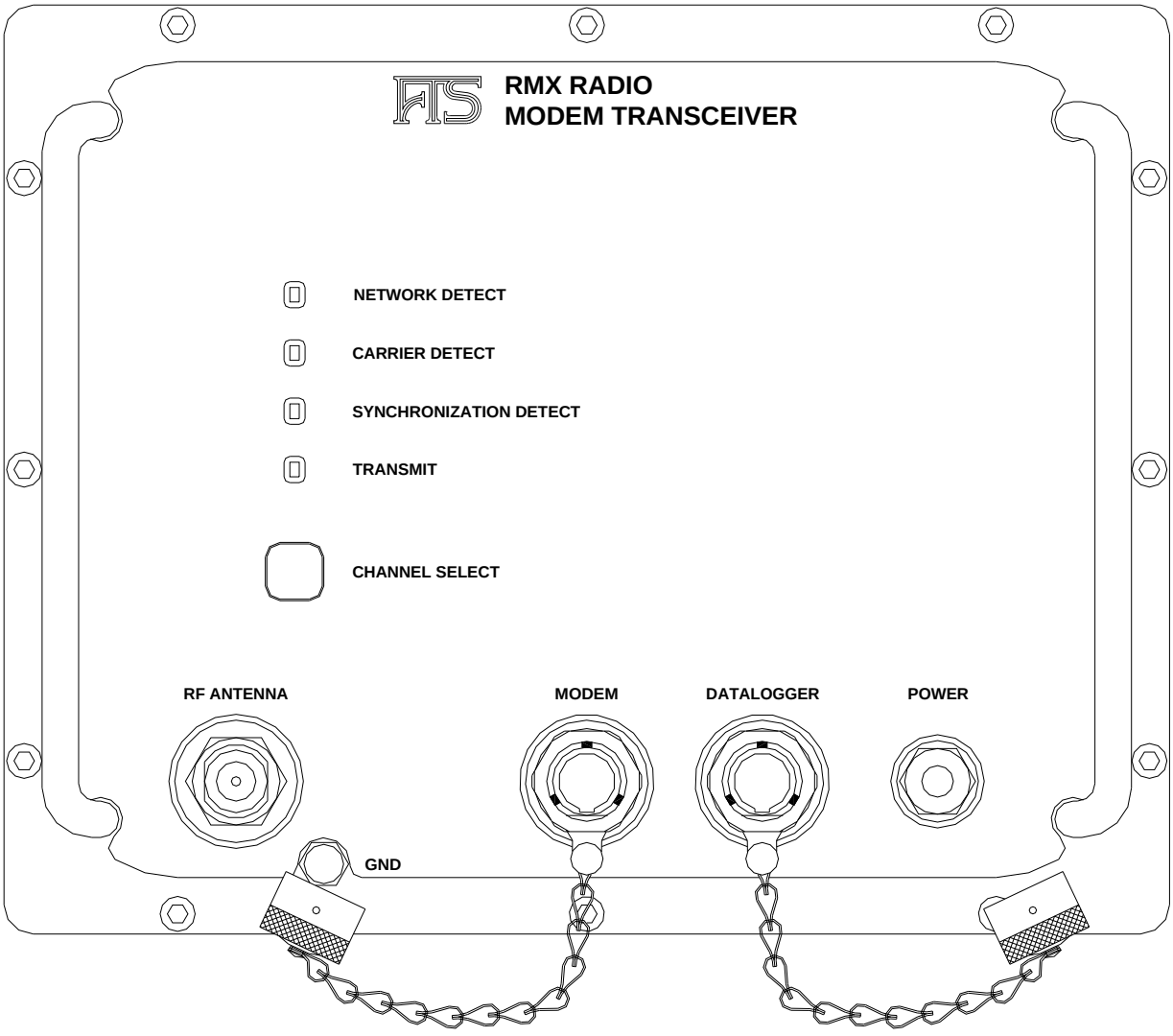


Figure 1: RMX Front Panel Diagram

RF Antenna

The front panel RF ANTENNA connector is a 50 ohm, N-type jack which is used to connect to the desired RF antenna. Bear in mind that the maximum RF output power from the RMX is 6W, so in order to minimize RF power losses, high quality connectors and low-loss RF coaxial cable should be used to connect to the RF antenna. Also, the cable length connecting the RMX to the antenna should be kept as short as possible.

Modem and Data Logger

The front panel MODEM and DATALOGGER ports are 14 contact, military-style, female bayonet connectors that are mainly used to connect to the desired modem or data logger. Either port can be used to connect to a personal computer (PC) for network polling, diagnostic, or programming purposes. When connecting a modem or a data logger to the RMX, a modem should always be connected to the MODEM connector and a data logger should always be connected to the DATALOGGER connector as flow control is implemented on the MODEM port but not on the DATALOGGER port.

Power

Power connection to the RMX is implemented as a cable harness with an integrated 2 contact female Deutsch connector which enters the front panel through a PG-7 gland. A second separate cable harness (male Deutsch connector to ring terminals) is also supplied with the RMX to allow easy connection to a 12 Vdc battery. RF antenna, modem, and data logger connections should be made prior to connecting power to the RMX.

FRONT PANEL INTERFACE

The RMX front panel is designed to give a simple, clear, visual indication of the RMX operating status. By examining four LEDs, the user can determine: start-up status; if an on-channel RF signal is being received; if the received signal follows the RMX on-air protocol; if the received signal is addressing this particular RMX; if the RMX is transmitting; and also, with the use of the built-in pushbutton, determine or change on which pre-programmed channel the RMX is currently operating. Normally all LEDs are turned off in order to minimize current consumption. Only when warranted will the appropriate LED be illuminated to indicate a particular action.

Network Detect LED

The top LED on the RMX front panel is labeled "NETWORK DETECT". This is a green LED which illuminates when the received on-air signal is addressing this specific RMX unit and while the unit transmits its reply.

This LED is also illuminated during the RMX power-on sequence (refer to the POWER-ON section of this manual for sequence details) and as part of the front panel channel display & selection process (refer to the CHANNEL DISPLAY & SELECTION section of this manual for process details).

Carrier Detect LED

The RMX front panel LED labeled "carrier detect" is a green LED which illuminates anytime an on-air signal is being received. Any on-frequency, in-band, RF signal that is strong enough to break the RMX receiver's squelch will illuminate this LED.

This LED is also illuminated during the RMX power-on sequence (refer to the POWER-ON section of this manual for sequence details) and as part of the front panel channel display & selection process (refer to the CHANNEL DISPLAY & SELECTION section of this manual for process details).

Synchronization Detect LED

The RMX front panel LED labeled “synchronization detect” is another green LED which illuminates anytime a received on-air signal conforms to the RMX on-air protocol. The received signal does not need to be addressing this specific RMX in order for the LED to illuminate.

This LED is also illuminated during the RMX power-on sequence (refer to the POWER-ON section of this manual for sequence details) and as part of the front panel channel display & selection process (refer to the CHANNEL DISPLAY & SELECTION section of this manual for process details).

Transmit LED

The bottom LED on the RMX front panel is labeled “transmit”. This is a red LED which illuminates anytime the RMX unit is transmitting.

This LED is also illuminated during the RMX power-on sequence (refer to the POWER-ON section of this manual for sequence details) and as part of the front panel channel display & selection process (refer to the CHANNEL DISPLAY & SELECTION section of this manual for process details).

Channel Select Pushbutton

The RMX unit is delivered with 8 pre-programmed RF channel frequencies (channel 1 through to channel 8). The red pushbutton on the RMX front panel labeled “channel select” is used to display or to change the currently used channel via a sequence of key presses (refer to the CHANNEL DISPLAY and SELECTION section of this manual for process details).

OPERATING CONFIGURATIONS

GENERAL

Figure 2 below shows the various equipment connection options for the RMX. The operating configuration (Base, Hub, Repeater or Remote) for an individual RMX is determined by which equipment is connected to the RMX and where the RMX is located in the cluster. A cluster is any group of interconnected RMX modems that are all operating on the same frequency. All RMX units are capable of seamlessly operating as a Base, Hub, Repeater or Remote station. Any RMX is capable of having an attached data logger regardless of its configuration or position in the cluster.

The RMX does not require special configuration in order to operate in a particular mode; however, each unit does require a unique Station Identification parameter (refer to the STATION IDENTIFICATION section of this manual for parameter details).

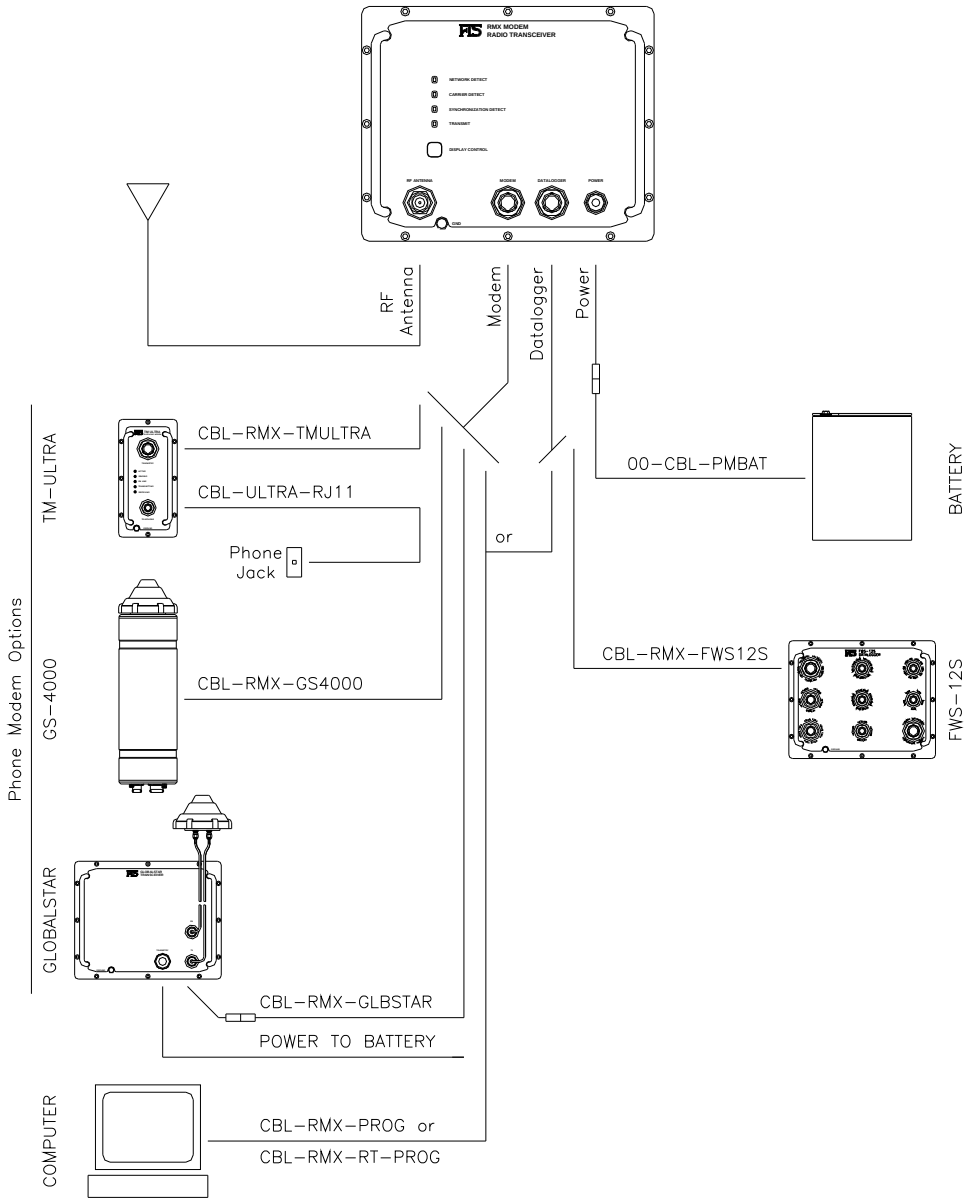


Figure 2: RMX Equipment Interconnect Matrix

TYPICAL CLUSTER CONFIGURATION

Figure 3 below shows a typical RMX radio network where 1 Hub RMX is interconnected with 2 Repeaters and 3 Remote sites. As can be seen, each RMX in the cluster has a unique Station Identification. Equipment required for each configuration is detailed in the following sections.

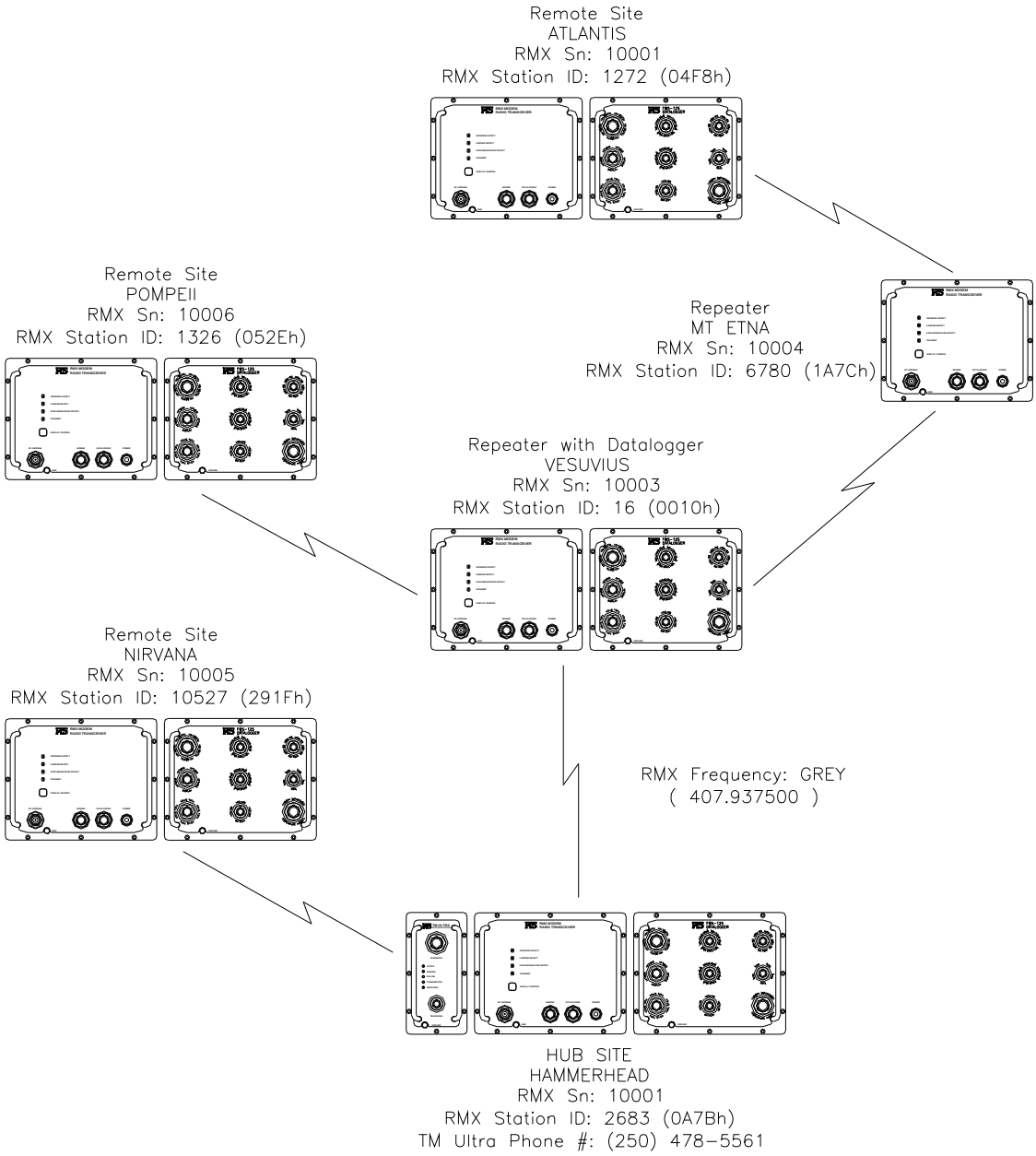


Figure 3: Typical RMX Cluster

HUB

When an RMX is operating as a Hub Station, the RMX will be connected via a phone modem to the public telephone system. The telephone connection provides the communications access point into the radio network. More than one Hub Station can exist in a cluster; however, this situation does not usually occur because of the added monthly charges for the redundant phone line. A Hub Station is used when the RF coverage of the RMX network does not extend to the office where the data collection PC is located. FTS provides two main types of phone modem equipment that are compatible with the RMX radio modem: a land-line based solution (TM Ultra); and a Globalstar satellite link solution (GS4000 or Fixed-Site Globalstar).

Hardware required for a RMX Hub Station configuration is as follows:

- RMX radio modem
- RF antenna and cable
- Power system
- Data logger, sensors, and interconnect cable (if desired)
- 1 of the modem connection choices offered below

TM Ultra Phone Modem Connection

The TM Ultra is an FTS designed field-hardened telephone modem that is compatible with the RMX radio modem. The TM Ultra is a perfect communications link solution when a land-line telephone connection is available at the RMX site as the TM Ultra will automatically answer in-coming phone calls and establish the telephone modem to telephone modem connection. Once the telephone link is connected, the TM Ultra provides a transparent link to the Hub RMX.

Hardware required to add a TM Ultra land-line link to an RMX Hub Station is as follows:

- TM Ultra telephone modem
- CBL-RMX-TMULTRA connection cable
- CBL-ULTRA-RJ11 phone jack connection cable

The RMX provides power to the TM Ultra so a separate TM Ultra power connection is not required.

Globalstar Satellite Modem Connection

The Globalstar satellite link solution is an alternative to a telephone land-line link when a land-line is not present or is cost prohibitive to install at the RMX site. FTS Globalstar modems are designed for field use in remote locations. The phone connection is provided using a Globalstar satellite communications link. All FTS Globalstar modems will automatically answer in-coming phone calls and establish the office phone modem to satellite phone modem connection. Once the phone link is connected, the Globalstar modem provides a transparent link to the Hub RMX.

Two packing options exist for the FTS Globalstar modems:

1/ a GS4000 modem (has an integrated Globalstar antenna) can be mounted on a pole external to the standard FTS weather station cabinet, or

2/ a Globalstar Fixed-site modem (supplied with an external Globalstar antenna) can be mounted inside the standard FTS weather station cabinet.

Although FTS Globalstar modems support “Direct Internet” mode (SMS calling), when using the Globalstar modem as a link to the RMX, the Globalstar modem must be operated as a standard modem (asynchronous calling). “Direct Internet” mode is not supported when communicating to an RMX.

Hardware required to add a Globalstar satellite modem link to an RMX Hub Station is as follows:

Option 1 – pole or mast mounted with integrated Globalstar antenna
- GS4000 satellite modem
- RMX to GS4000 connection cable

The RMX provides power to the GS4000 so a separate GS4000 power connection is not required.

Option 2 – weather station cabinet mounted with external Globalstar antenna
- Globalstar fixed-site satellite modem
- RMX to Globalstar connection cable
- Globalstar fixed-site power connection

BASE

When an RMX is operating as a Base Station (this configuration is not shown in Figure 3), the RMX is connected directly to a PC. This situation occurs when the RF coverage of the RMX network extends to the office where the data collection PC is located. The Base configuration is similar to a Hub except that a telephone modem is not required as the PC provides the communications access point into the radio network.

Hardware required for a Base Station configuration is as follows:
- Personal computer (user supplied)
- Data polling and management software such as FTS Fire Weather Plus or Terra Plus
- PC to RMX cable connection
- RMX radio modem
- RF antenna and cable
- Power system
- Data logger and sensors (if desired)

REMOTE

A Remote RMX always has an attached data logger and is defined as the last station in the RF path. All communications to a Remote RMX are via the RF link and originate from another RMX in the cluster.

Hardware required for a Remote Station is as follows:
- RMX radio modem
- RF antenna and cable
- Power system
- Data logger and sensors
- RMX to FWS-12S connection cable

REPEATER

An RMX Repeater Station is the same as a Remote Station except that the repeater is not the last station in the RF path and a repeater may or may not have an attached data logger. All communications to a Repeater RMX are via the RF link and originate from another RMX in the cluster.

INSTALLATION

PREPARATION

Preparation for any equipment installation is vitally important. This is especially true when installing an RMX weather station site due to the nature of RF communications and to the remote nature of the majority of the RMX sites. Proper site selection and an installation plan are key factors in ensuring successful operation of any remote installation.

Site Selection

Check that the selected site is suitable for its primary purpose and also that the site is functionally capable of supporting the intended application. For example, a Remote Station site must be suitable as a weather station site (its primary purpose); however, the site must also support a good RF path for suitable communications. It is up to the user to balance both issues when determining site suitability.

Installation Plan

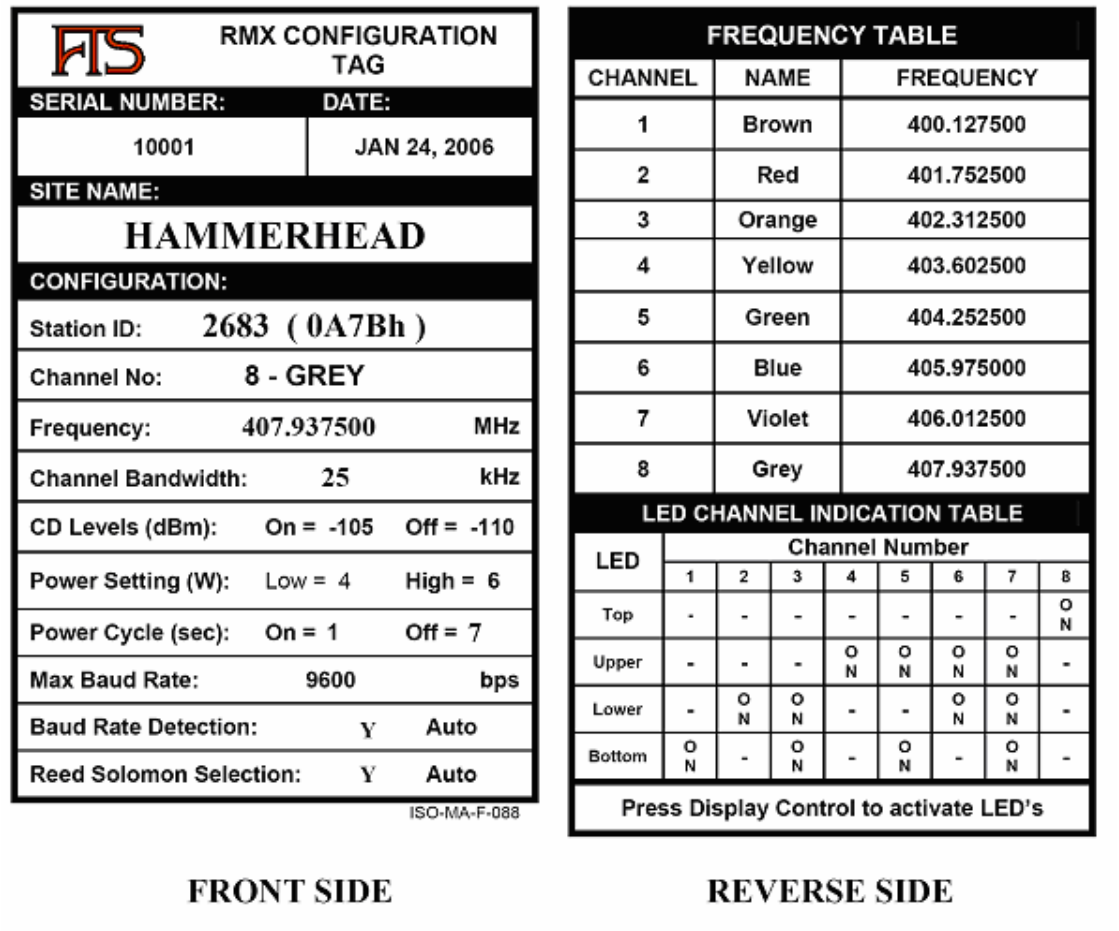
Once a site is selected, FTS recommends the following installation preparation procedure before installing the equipment into the field:

1) Create a Cluster Diagram, similar to Figure 3, which shows the RMX serial number and Station ID (decimal value and hexadecimal value – e.g. Station 1234d = 04D2h). The cluster diagram will be extremely helpful when performing radio link checks through the RMX diagnostic interface.
2) Make a check list of all equipment, equipment serial numbers, and cables required at the site. This includes cabinets, masts, antennas, cables, power systems, and mounting hardware plus any other special equipment required at the site.
3) Make a checklist of the tools and materials required to install the equipment.
4) Make a checklist of the software and cables needed to test the equipment.
    - FTS cable CBL-RMX-PROG to connect the PC to the RMX.
    - FTS cable CBL-RMX-RT-PROG to connect the PC to the RMX internal radio module.
    - Laptop computer with a com port running HyperTerminal and the RMX internal radio module programming software (Ritron DTX Plus radio module programming software: DTXP-PCPS 2.58.13).
5) Double-check the operation of the equipment for each site and confirm the configuration tag information.
6) Double-check that all of the test software is properly installed and running and that the cables are in working order.
7) If required, arrange for a coworker or FTS personnel to be available during the installation for remote troubleshooting or equipment polling purposes.
8) Leave an itinerary with a coworker to let them know where you are going and when you are expected back.

Configuration Tag

A Configuration Tag is delivered with each RMX unit. The Configuration Tag shows the settings of the various RMX parameters and the RF settings for the internal radio module. A sample tag is shown below in Figure 4 followed by an explanation of the parameter functionality.

Any changes to the RMX parameters should be recorded on the Configuration Tag.



RMX CONFIGURATION TAG

SERIAL NUMBER:	DATE:
10001	JAN 24, 2006

SITE NAME: HAMMERHEAD

CONFIGURATION:

Station ID:	2683 (0A7Bh)	
Channel No:	8 - GREY	
Frequency:	407.937500	MHz
Channel Bandwidth:	25	kHz
CD Levels (dBm):	On = -105	Off = -110
Power Setting (W):	Low = 4	High = 6
Power Cycle (sec):	On = 1	Off = 7
Max Baud Rate:	9600	bps
Baud Rate Detection:	Y	Auto
Reed Solomon Selection:	Y	Auto

ISO-MA-F-088

FREQUENCY TABLE

CHANNEL	NAME	FREQUENCY
1	Brown	400.127500
2	Red	401.752500
3	Orange	402.312500
4	Yellow	403.602500
5	Green	404.252500
6	Blue	405.975000
7	Violet	406.012500
8	Grey	407.937500

LED CHANNEL INDICATION TABLE

LED	Channel Number							
	1	2	3	4	5	6	7	8
Top	-	-	-	-	-	-	-	ON
Upper	-	-	-	ON	ON	ON	ON	-
Lower	-	ON	ON	-	-	ON	ON	-
Bottom	ON	-	ON	-	ON	-	ON	-

Press Display Control to activate LED's

FRONT SIDE REVERSE SIDE

Figure 4: RMX Configuration Tag Example

Station ID

The Station ID is a decimal value which determines the RMX address. The hexadecimal equivalent number is shown in brackets after the decimal Station ID value. The valid range for this parameter is from 1 to 65531 inclusive (0001h to FFFBh). An RMX will only respond to communications that have its address in the signal packet header; therefore, you will not be able to communicate with the site if the Station ID parameter is incorrectly set.

Channel Number

The Channel Number parameter indicates which of the eight pre-programmed internal radio module frequencies the RMX is currently using. This channel will be used by the RMX after a power cycle event.

Frequency

The frequency field indicates the actual RF frequency of the default Channel Number.

Channel Bandwidth

Channel Bandwidth indicates the RF bandwidth of the internal radio module. This parameter is not programmable.

CD (Carrier Detect) Levels

The CD (Carrier Detect) Threshold parameters are settings in the internal built-in radio module. This pair of settings controls the squelch of the radio module and determines at what RF signal level the radio will respond and shut-off. Factory default for these settings is approximately -105 dBm and -110 dBm respectively.

Power Setting

There are two power setting parameter values: one for a low power setting and one for a high power setting. These two values indicate the RF output power level for each setting. The RMX transmitter is always factory set to default to the high power setting.

Power Cycle

Power Cycle parameters Pon and Poff control the RMX modem power strobe settings. Factory default settings are one second on (Pon = 1) followed by seven seconds off (Poff = 7). Power strobing is employed to reduce the RMX average current consumption while balancing radio response times. These values should not be changed unless instructed to do so by FTS personnel.

Maximum Baud Rate

The default value and maximum possible baud rate for the RMX is 9600 bps on a 25 kHz radio channel; however, if desired, the user can set the maximum baud rate to 4800 bps. This could be done on a weak RF link where 9600 baud communications are unreliable and will most probably fail causing the RMX to auto-step down to 4800 baud to complete the communication. Note that the maximum baud rate is 4800 bps when operating on a 12.5 kHz channel.

Baud Rate Detection

If enabled, the Baud Rate Detection parameter allows the RMX to automatically step from 9600 bps to 4800 bps. The factory default is to have this feature enabled.

Reed Solomon Selection

If enabled, the Reed Solomon Selection parameter allows the RMX to automatically use a more powerful error correction code if communication attempts at 4800 bps have failed. Normally the RMX uses a (204,188) Reed Solomon code for error correction; however, the RMX will automatically switch to a (48,32) code in order to try to successfully complete the transmission. The factory default is to have this feature enabled.

Frequency Table

The tag also shows the eight pre-programmed channel frequencies and the default channel frequency number that was set at the factory. Users are able to change the default channel number through the front panel interface.

SET-UP

The FTS RMX Radio Modem is designed to be mounted in a standard FTS equipment enclosure on a keyway mount panel as shown in Figure 5; however, the RMX enclosure is completely weatherproof so an external enclosure is not required. If required, the RMX can be mounted directly on a mast or on a client supplied panel (e.g. piece of plywood).

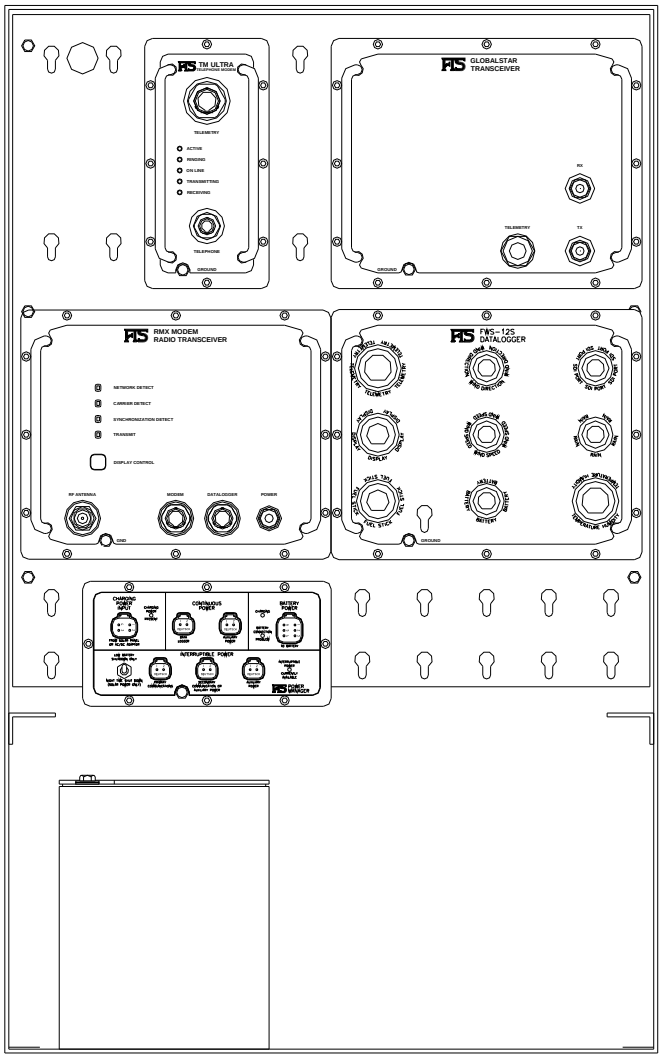


Figure 5: RMX Mounting Diagram

The RMX requires a tower or mast for the RF antenna and a 12 Vdc power source. A rechargeable starved electrolyte type battery with a solar power charging system is the recommended power source.

After the site preparations have been completed and the cabinet is ready to accept equipment, the set-up procedure for RMX installation is as follows. If you are using an FTS Power Manager, then disregard the battery related instructions in the following list and make the appropriate power connection to the Power Manager.

1) Disconnect any 00-CBL-PM-BAT cables from their associated equipment and then connect the 00-CBL-PM-Bat ring terminals to the battery. Attach the ring lug with the black wire to the battery's negative (-) terminal and the ring lug with the red wire to the battery's positive (+) terminal.

2) Mount the RF antenna on the tower or mast and connect the cable to the antenna. This critical connection should be wrapped with waterproof, self-vulcanizing tape, meltable wall heat shrink tubing, or equivalent to prevent the possible entry of water that could degrade the signal and cause corrosion to the connection.

3) Connect the charging system to the battery.

4) Mount the equipment into the cabinet as shown in Figure 5. If a Globalstar modem is present at the site, it must be mounted in the location shown on Figure 5 in order for the antenna cables to reach the antenna which is mounted on the cabinet roof.

5) Connect the antenna cable to the RMX RF ANTENNA connector.

6) If this is a Hub Site, connect the RMX MODEM port to the associated phone modem.
   - For a TM-Ultra - ensure the TM Ultra landline is connected.
   - For a GS4000 - ensure that the GS4000 is mounted with a clear view of the sky.
   - For a Globalstar Fixed-site - ensure that the Globalstar antenna has a clear view of the sky, that the antenna connections are secure and correct, and then connect power to the Globalstar unit.

7) If this site has a data logger, connect all sensors to the data logger and then connect the RMX datalogger port to the telemetry port (large green ring) on the FWS-12S data logger. If desired, connect power for the data logger to the FWS-12S battery port (small green ring); however, this connection is not required as the RMX will provide power to the data logger.

8) The final step is to connect power to the RMX by plugging the plastic power connector into the associated 00-CBL-PM-BAT cable or the FTS power manager and observe the RMX power-on sequence as described in the next section.

POWER-ON

When power is first applied to the RMX, the RMX will go through a processor boot sequence where only the front panel 'Transmit' LED is illuminated. After approximately four seconds, the boot sequence will complete and the RMX will then perform a check to determine whether a data logger or phone modem is connected to the RMX. During this check, which lasts approximately six seconds, the RMX will alternately illuminate the front panel TRANSMIT, SYNCHRONIZATION DETECT, CARRIER DETECT, and NETWORK DETECT LEDs. All front panel LEDs will be shutoff after the check is complete. The RMX is now fully operational.

RADIO LINK CHECK

After powering-up the RMX, it is suggested that the user perform a radio link check from the newly installed RMX to determine the suitability of the RF links between the local and neighbouring RMX units. RF links of the entire cluster can be examined from any of the RMX units. The radio link check is done using a PC running HyperTerminal connected to the RMX diagnostic interface. When on-site, a handheld radio programmed to the same frequency as the RMX is useful as an independent check of radio channel traffic.

Procedure

Steps for performing the radio link check are as follows (refer to the DIAGNOSTIC INTERFACE section of this manual for RMX Diagnostic Interface operation and for command details).

1) Start a HyperTerminal session on your PC and enable the text file capture feature to keep a log of all communications. This file is useful for future reference and recording the radio link test results.

2) Using FTS cable CBL-RMX-PROG, connect the PC to the RMX MODEM or DATALOGGER port depending on which port is free. If you are at a HUB site with a phone modem and a data logger then connect your PC in place of the phone modem to prevent an incoming call from disrupting your test.

3) Enable RMX communications to the PC by setting the appropriate monitor port via the ***'User Interface'*** command (ui=M for the MODEM port or ui=L for the DATALOGGER port).

4) Confirm RMX parameter settings using the ***'Configuration'*** command (CFG).

5) Capture the existing RMX audit log and quality log using the ***'Audit Log'*** command (AL) followed by the ***'Quality Log'*** command (QL).

6) Clear the RMX radio quality log using the ***'Quality Clear'*** command (QC).

7) Transmit a query to determine which other RMX units are within RF range of the locally connected RMX using the ***'Query Neighbours'*** command (QU) or refer to your network diagram for the neighboring RMX Station IDs. Observe the RMX front panel LEDs and listen to the channel on the handheld radio to confirm transmission of the query request and remote station replies.

   If no neighbours are reported by the RMX but the transmission and replies can be heard on the handheld unit, then the user can reduce the RMX squelch settings in order to try to receive the remote RMX signals. Bear in mind that lowering the squelch settings can degrade system performance as lower squelch settings will also make the RMX more sensitive to unwanted noise signals.

   Changing the RMX internal RF module squelch settings requires the use of third party software and the FTS CBL-RMX-RT-PROG cable. Refer to the RF TRANSCEIVER MODULE section for details on changing the internal module's squelch settings.

8) Using the neighbour query results or the network diagram, build the network table in the locally connected RMX to communicate with a specific RMX. The network table is constructed using the ***'Table'*** command (TBL)

9) Request the remote RMX configuration by using the ***'Remote Configuration'*** command (RCFG).

10) Using the ***'Quality Log'*** command (QL), examine the local radio quality logs for indication of radio link suitability.

11) If desired, initiate a radio quality test with the RMX specified in the routing table using the ***'Radio Quality Test'*** command (RQT) and examine the quality log for indication of radio link suitability.

12) Repeat steps 8 to 11 as desired for various remote RMX units in the cluster using the remote commands.

13) Be sure to reconnect the data logger and phone modem to the RMX if they had been disconnected during the above tests.

FUNCTIONAL BLOCKS

The RMX Radio Modem Transceiver electronics are comprised of a custom FTS designed control board interfaced to a commercially available, FCC and IC approved, OEM FM radio transceiver module. The transceiver module is responsible only for RF signal transmission and reception. The FTS designed control board provides all interface functionality, processing capability, and signal control for the RMX. A block diagram of the internal RMX structure is shown below in Figure 6.

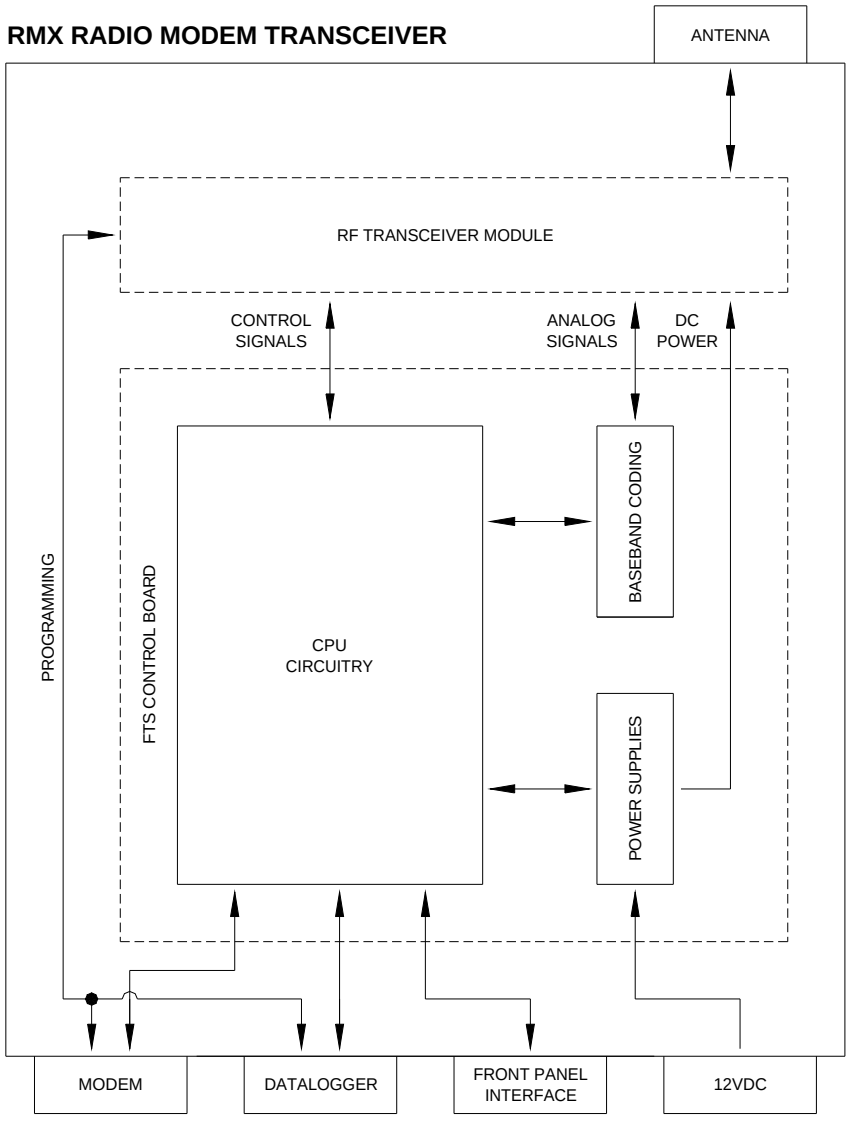


Figure 6: RMX Block Diagram

Radio Module

The FM radio module used in the RMX is manufactured by Ritron Incorporated. The DTX Plus module is capable of six Watts RF output and is available in multiple frequency bands with 12.5 kHz or 25 kHz RF channel bandwidth. The radio module can be pre-programmed with up to eight different user-selectable frequencies (selected through the Front Panel or Diagnostic Interface). Available frequency bands are:

- 136 to 162 MHz
- 148 to 174 MHz
- 400 to 420 MHz
- 450 to 470 MHz

The radio module comes pre-aligned (deviation levels, frequency, output power, squelch levels, etc.) from the factory as indicated on the RMX Configuration Tag; however, the user is able to alter these settings. Refer to the RF Transceiver Module section of this manual and the Ritron DTX Plus Maintenance and Operating Manual for instructions on altering the radio module settings.

> **WARNING!** Servicing the radio module or altering the radio module settings should only be performed by factory qualified personnel.

Control Board

The FTS designed Control Board is the heart of the RMX radio modem transceiver as it is responsible for all aspects of RMX operation. Control Board firmware enables the RMX to manage, process and control the following aspects of RMX operation.

- Parameter Management
- Power Distribution
- Baseband GMSK Coding
- Reed Solomon Error Correction
- CSMA Protocol
- Selective Packet Repeat
- Dynamic Baud Rate and Error Correction Selection
- RF Channel Control
- Modem and Data Logger Interface
- Diagnostic Interface
- Front Panel User Interface

Although the details of the above functions are complex, RMX operation is quite simple as after power-on the RMX has four basic operating modes: listen; receive; transmit; and diagnostic. RMX operating modes are independent of RMX functionality. This independence allows the RMX to seamlessly function as a Base, Hub, Repeater, or Remote.

Listen Mode

Listening mode is the lowest current operating mode. In this mode all front panel LEDs are off and the RMX processor periodically turns on the radio module to check if an RF signal is being received. The RMX immediately switches to Receive Mode if any RF signal is present on the selected radio channel. If no signal is detected then the RMX processor turns the radio module back off to minimize power consumption. The strobing duty cycle is controlled by the Diagnostic Interface factory Power Off (Poff) and Power On (Pon) parameters.

Receive Mode

Receive mode is entered when any RF signal (be it noise, voice, or data) that is strong enough to break the radio module's squelch threshold is received on the selected radio channel. In Receive mode, the three green front panel LEDs will illuminate depending on the nature of the received RF signal: the LED labeled CARRIER DETECT will always be illuminated to indicate that the RMX is receiving an on-channel RF signal; the LED labeled SYNCHRONIZATION DETECT will only be illuminated when the RMX determines that the received RF signal conforms to the RMX protocol; and the LED labeled NETWORK DETECT is illuminated to indicate that the received signal is addressing this specific RMX.

When the RMX enters Receive mode the following algorithm is followed:

1) The CARRIER DETECT front panel LED is illuminated.

2) The RMX Control Board processor begins to search for RMX protocol synchronization:
   a) the processor continues to check for synchronization as long as the RF signal is present.
   b) if the signal disappears the RMX will revert to Listen mode after a short time-out period.
   c) if the RF signal persists for longer than the RMX watchdog period, the RMX will reboot as a precaution in case of radio module lockup or RMX failure.

3) If RMX protocol synchronization is found, the SYNCHRONIZATION DETECT front panel LED is illuminated.

4) The RMX processor examines to see if the Station ID in the RF signal matches the internal Station ID parameter.

5) If the Station IDs match, the NETWORK DETECT front panel LED is illuminated and the RMX processes the command. After processing the command, the RMX will revert to Listen mode after a short time-out period. If the Station IDs do not match then the RMX ignores the communication and goes back to Step 2 (monitoring the signal for protocol synchronization).

Transmit Mode

Transmit mode is entered when the RMX responds to or initiates communications. In Transmit mode, the green front panel LED labeled NETWORK DETECT is always illuminated to indicate that the RMX is actively processing data or commands. The red front panel LED labeled TRANSMIT is only illuminated when the RMX is actually transmitting an RF signal.

When the RMX enters Transmit mode the following algorithm is followed:

1) The RMX Control Board processor checks to see if the radio channel is idle.

2) If the radio channel is busy, the processor waits for a short random time and then goes back to Step 1 (monitoring the radio channel). The processor repeats this loop several times and, if the channel is still busy, the RMX will report a "radio channel busy" error(1) and revert to Listen mode after a short time-out period.

   (1) Note: the RMX can only report an error if the RMX is a Hub or a Base. The RMX is unable to report this error message if it is a Repeater or a Remote since the radio channel is busy.

3) If the radio channel is idle then the RMX issues a Connect request every 540 ms to the remote RMX. The baud rate of the Connect request is determined by the RMX Baud Rate parameter (Diagnostic Interface BR command).

- if the Connect request is not acknowledged, the processor waits for a short random time and then goes back to Step 1 (monitoring the radio channel). The processor repeats this loop a maximum of M times.

  M = (Poff + Pon) / Z

  Where: Z: Connect Request Interval (540 ms)
  Poff: Listen mode Power Off Interval (7 s)
  Pon: Listen mode Power On Interval (1 s)

- if the Connect request is not acknowledged after M times and the initial baud rate was 9600 bps and the RMX Automatic Baud Rate parameter is enabled, the processor automatically reduces the baud rate to 4800 bps, waits for a short random time, goes back to Step 1 (monitoring the radio channel) and repeats this loop a maximum of M times.
- If the Connect Request is still not acknowledge after M times, the RMX processor waits for 10 seconds and repeats the entire Step 3 process one more time.
- if the RMX is still not able to Connect to the remote site, the processor will give-up, report a "failed to connect to remote" error, and revert back to Listen mode after a short time-out period.

4) If the Connect request is acknowledged, the RMX processor then transmits a Data request (the Data request can be a command or actual data) to the remote RMX.

- if the Data request is not acknowledged, the processor waits for a short random time and then retries the Data request. The processor repeats this loop a maximum of five times.
- if the Data request is not acknowledged after five times and the RMX Automatic Reed-Solomon Code parameter is enabled, the processor automatically switches the error correction code from an RS(204,188) to a more powerful RS(48,32) and then retries the Data request. The processor retries the Data request a maximum of six times.
- if the Data request is still not acknowledged, the processor will give-up, report a "failed to send data to remote" error, and revert back to Listen mode after a short time-out period.

5) if the Data request is acknowledged, the RMX processor then transmits the entire message as per the procedure in Step 4. After the message is successfully transmitted the RMX will revert back to Listen mode after a short time-out period.

Diagnostic Mode

Diagnostic mode is entered when the RMX responds to a Diagnostic Command received on one of the RMX ports (MODEM, DATALOGGER, or internal) or when the front panel CHANNEL SELECT pushbutton is pressed. When entering Diagnostic mode the RMX wakes up and goes from normal Listen mode (radio module strobing) to a Listen mode with the radio module always active (turned on).

If the RMX is responding to a Diagnostic Command, RMX front panel LED functionality does not change and the user is able to visually monitor communication activity. The RMX will go back to sleep (revert to normal Listen mode) after two minutes of command inactivity.

If the RMX is responding to a front panel key press, the RMX front panel LED functionality changes from indicating communication activity to indicating RMX channel selection. Refer to the following section for the channel display and selection procedure.

CHANNEL DISPLAY and SELECTION

The front panel CHANNEL SELECT pushbutton is used to indicate or alter which one of the eight pre-programmed channels the RMX is currently using for RF communications. The RMX uses a binary pattern on the four front panel LEDs to visually display the RMX channel setting (see Figure 7). The Channel Indication Table can also be found on the reverse side of the RMX Configuration Tag. In the table, the front panel NETWORK DETECT LED is labeled as 'Top' while the front panel TRANSMIT LED is labeled as 'Bottom'.

LED CHANNEL INDICATION TABLE

LED	Channel Number							
	1	2	3	4	5	6	7	8
Top	-	-	-	-	-	-	-	ON
Upper	-	-	-	ON	ON	ON	ON	-
Lower	-	ON	ON	-	-	ON	ON	-
Bottom	ON	-	ON	-	ON	-	ON	-

Press Display Control to activate LED's

Figure 7: RMX Channel Indication Table

Momentarily press the CHANNEL SELECT pushbutton to display the currently selected RMX channel. The four front panel LEDs will illuminate appropriately to indicate the current RMX channel setting. The LEDs will remain illuminated for approximately two seconds.

To change the current channel setting, follow the procedure below:

1) Press and hold the CHANNEL SELECT pushbutton until the LEDs begin to flash the current channel setting.

2) Repeatedly press the CHANNEL SELECT pushbutton to cycle to the desired channel number. The channel number LED patterns will continue to flash throughout this process.

3) To abort the channel changing process, simply let the RMX time-out by not touching the CHANNEL SELECT pushbutton for approximately six seconds. The front panel LEDs will turn off and the original channel setting will be retained.

4) To save the new desired channel number, ensure the LEDs are flashing the desired channel number pattern, then press and hold the CHANNEL SELECT pushbutton until the LEDs stop flashing. The RMX has saved the new channel number. Use the 'Display the Current Channel' procedure to confirm the new setting.

RMX - RM4000 COMPATIBILITY

The RMX telemetry interface is compatible with RM4000 commands; however, due to differing modulation schemes, the RMX on-air protocol is not compatible with the RM4000 on-air protocol. When replacing an RM4000 with an RMX, all RM4000 radio modems within the cluster must be replaced with RMX units. An RMX cannot communicate with an RM4000 or vice-versa.

DIAGNOSTIC INTERFACE

GENERAL

The Diagnostic Interface is a command line, text based interface used to configure RMX modems and to troubleshoot RMX networks. The Diagnostic Interface is available on either of the RMX MODEM or DATALOGGER ports and is accessed using an FTS CBL-RMX-PROG cable connected to a COM port of a personal computer running a communications program such as HyperTerminal. The required PC COM port settings are shown below in Figure 8. Diagnostic Interface commands are not case sensitive (e.g. the letters 'v' and 'V' will be interpreted as the same character).

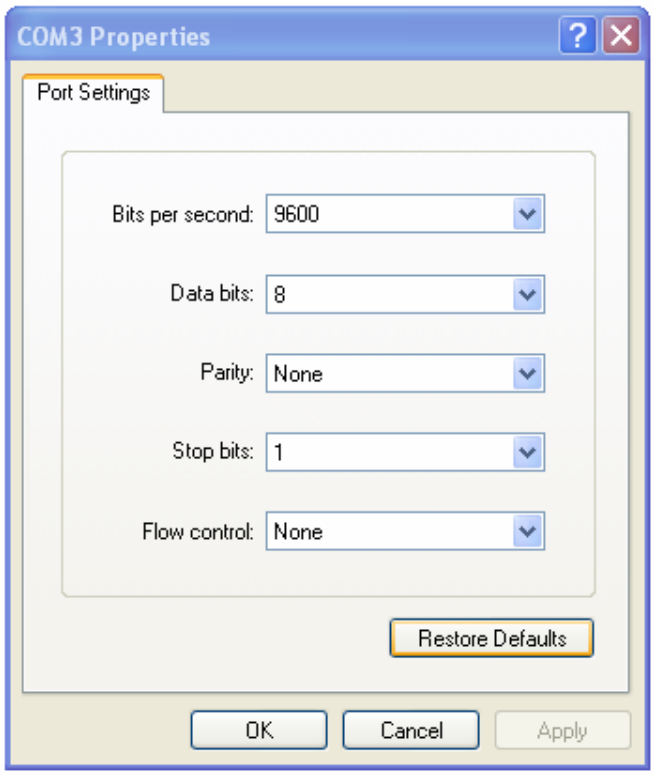


Figure 8: HyperTerminal User Interface Settings

IMPORTANT: The very first command issued in a Diagnostic Interface session MUST be the User Interface command. This command tells the RMX processor to which port (MODEM or DATALOGGER) the user is connected. Details for the “User Interface” command is given in the following Local Commands section.

LOCAL COMMANDS

Local commands refer to those commands that act upon the RMX modem connected (either directly with a cable or over a phone modem link) with a personal computer. Details and examples for each of the local commands are shown below.

User Interface

The User Interface command is used to set which RMX port, MODEM or DATALOGGER, will be used as the Diagnostic Interface. **This command must be the first command issued to the RMX** in order to use the Diagnostic Interface.

Command: **UI=(M, L or U)**

Where: M is the RMX MODEM port
L is the RMX datalogger port
U is the RMX internal monitor port (not user accessible)

To show:

```
>ui
Show message on monitor port
>
```

To set:

```
>ui=m
Show message on modem port
>
```

Save

The Save command is used to write the currently set parameters to the RMX's non-volatile memory (EEPROM). If a parameter value is changed to a new value but not saved, the new parameter value will not be retained through a power cycle. The Save command always writes all parameters to the EPROM so Save commands after each parameter change is not required as long as one Save command is issued after the desired parameters have been changed.

Command: **SA**

```
>sa
Saving - please wait
Values saved
Detecting modem... AT
not attached -- no response
>
```

Help

The Help command is used to view a list of RMX commands.

Command: **H=(<blank>, L, or R)**

Where: L lists only the local commands
R lists only the remote commands
If <blank> then all commands are listed

Version

The Version command is used to show the RMX hardware and firmware versions as well as the unit's serial number.

Command: **V**

```
>v
Firmware version v2.00
S/N: 000001
>
```

Audit Log Clear

The Audit Log Clear command is used to clear all messages from the RMX audit log.

Command: **AC**

```
>ac
All audit log information cleared
>
```

Audit Log

The Audit Log command is used to retrieve all messages from the RMX audit log. The RMX audit log is a circular buffer (approximately 8k bytes) that records messages from anomalous events.

Command: **AL**

```
>AL
2005/01/01 02:03:44 Audit log cleared by local user
>
```

Automatic Reed-Solomon Code

The Automatic RS Code command is used to enable or disable the auto-RS code feature. When enabled, the RMX will automatically step from 4800 baud with a (204,188) RS code to 4800 baud with a more powerful (48,32) RS code in order to try to successfully complete the requested communication. Auto-RS code selection only occurs when operating at 4800 baud.

Command: **ARS=(0,1)**

where: 0 disables the automatic RS code select feature
1 enables the automatic baud rate select feature

Factory Default Value: enabled

To show:

```
>ars
RS code switch: disabled
>
```

To set:

```
>ars=1
RS code switch: enabled
>
```

Note: Remember to issue the Save command after altering this parameter.

Automatic Baud Rate

The Automatic Baud Rate command is used to enable or disable the auto-baud feature. When enabled, the RMX will automatically step from 9600 baud to 4800 baud in order to try to successfully complete the requested communication. The starting baud rate is set by the Baud Rate command.

Command: **ABR=(0,1)**

where: 0 disables the automatic baud rate select feature
1 enables the automatic baud rate select feature

Factory Default Value: enabled

To show:

```
>abr
Baud rate detect: disabled
>
```

To set:

```
>abr=1
Baud rate detect: enabled
>
```

Note: Remember to issue the Save command after altering this parameter.

Baud Rate

The Baud Rate command is used to set the starting baud rate for RMX over-the-air communications.

Command: **BR=(0,1)**

Where: 0 selects 4800 baud
1 selects 9600 baud

Factory Default Value: 9600 baud for 25 kHz channels
4800 baud for 12.5 kHz channels

To show:

```
>br
Baud rate: 4800
>
```

To set:

```
>br=1
Baud rate: 9600
>
```

Note: Remember to issue the Save command after altering this parameter.

Configuration

The Configuration command is used to show the current RMX configuration settings.

Command: **CFG**

```
>cfg
1: ATZ
2: ATS0=1
3: ATE0
4:
5:
6:
7:
8:
9:
Station ID: 0141h=321d
Baud rate: 9600
Modem attached: None
Modem flow control: enabled
Logger port setting: FTS logger
Logger port device: Unknown
Power cycle: on/off=1/7 seconds
Baud rate detect: enabled
RS code switch: enabled
Transmitting power setting: high
Current channel:  4
Firmware version v2.00
S/N: 000001
Time: 2005/01/01 02:08:23
Show message on modem port
>
```

Channel

The Channel command is used to show or set which of the eight pre-programmed radio channels is currently being used by the RMX modem.

Command: **CH=(1..8)**

Where: 1..8 represent the channel number

To show:

```
>ch
Current channel:  4
>
```

To set:

```
>ch=1
Current channel:  1
>
```

Note: Remember to issue the Save command after altering this parameter.

Default

The Default command is used to set all RMX parameters to their factory default values.

Command: **DEFAULT**

```
>default
All are set to factory default
>
```

Note: Remember to issue the Save command after altering this parameter.

Station ID

The Station ID command is used to show or set the RMX Station ID number. The number can be entered as a decimal or hexadecimal value.

Command: **ID=(N)**

where: N represents the station id from 1 to 65531 (0001h to FFFBh) inclusive

To show:

```
>id
Station ID: 0141h=321d
>
```

To set:

```
>id=1234
Station ID: 04d2h=1234d
```

or

```
>id=A23Eh
Station ID: a23eh=41534d
>
```

Note: Remember to issue the Save command after altering this parameter.

Idle

The Idle command is used to clear all of the existing RMX tasks. This command will terminate all existing communications. This command will not affect RMX parameter values

Command: **IDLE**

```
>idle
Starting soft reset...
>Soft reset: OK

>
```

Data Logger Port Configuration

The Logger Port command is used to set what kind of device is connected to the RMX DATALOGGER port. Currently only the FTS FWS-12S data logger is supported.

Command: **LP=L(S,G,C)**

where: L selects a FTS data logger
S selects an SDI device (not implemented)
G selects a GPS (not implemented)
C selects a GPS (not implemented)

Factory Default Value: Logger

To show:

```
>lp
Logger port setting: FTS logger
>
```

To set:

```
>lp=L

Logger port setting: FTS logger

>
```

Note: Remember to issue the Save command after altering this parameter.

Modem AT Commands

The Modem AT Commands are used to send Hayes AT commands to the modem connected to the RMX MODEM port. Any AT command supported by the attached modem can be sent. This command can be used to ensure that the attached modem is operating properly. Modem AT Commands can only be sent when the user is connected to the RMX DATALOGGER port.

Command: **AT**

To show:

```
>ats0?
Sending AT command to modem port
>Network is passing to upper layer...
The response received:

001

OK

2005/01/01 16:28:03 Succeeded in relaying
```

Modem Initialization Command

The Modem Initialization Command is used to view all nine Hayes AT initialization commands that are sent to the modem connected to the RMX MODEM port when the RMX powers-up. Any AT command supported by the attached modem can be sent.

Command: **A**

To show:

```
>a
1: ATZ
2: ATE0
3: ATS0=1
4:
5:
6:
7:
8:
9:
>
```

To set an individual string:

```
>4=atv0
>
```

Note: Remember to issue the Save command after altering this parameter.

Power Setting

The Power Setting command allows the user to choose between the pre-programmed high and low RF output power settings. Typical factory settings are 4W (low) and 6W (high) RF output power.

Command: **PSET=(L,H)**

where: L selects low power
H selects high power

Factory Default Value: High

To show:

```
>pset
Transmitting power setting: low
>
```

To set:

```
>pset=h
Transmitting power setting: high
>
```

Note: Remember to issue the Save command after altering this parameter.

Quality Log Clear

The Quality Log Clear command is used to clear all information in the RMX radio quality log.

Command: **QC**

```
>qc
All quality log information cleared
>
```

Quality Log

The Quality Log command is used to retrieve all information in the RMX radio quality log. The RMX quality log is capable of recording communication statistics for up to 10 different RMX units.

Command: QL

```
>QL
The RF quality:
Quality not available now
>
```

or

```
>ql
Station 0142h(322) -> 0141h(321)
   <Rate = 4800bps>
   Accumulate quality:
     High time: 88%, S/N: 11.4dB
     Error/total(bytes)=0/3628, retried blocks: 0
   Last quality:
     S/N not available
     Error/total(bytes)=0/0, retried blocks: 0

   <Rate = 9600bps>
   Accumulate quality:
     High time: 80%, S/N: 10.3dB
     Error/total(bytes)=2/86036, retried blocks: 0
   Last quality:
     High time: 78%, S/N: 10.1dB
     Error/total(bytes)=0/900, retried blocks: 0
>
```

Note on Reported S/N

Reported S/N is only an estimate of the signal quality. This value is not an actual signal to noise measurement.

The S/N value should be used in conjunction with the "Error/total (bytes)" and "retried blocks" fields to determine the quality of the communications.

In general, S/N values above 6 dB should be observed for reliable communications.

Query Neighbours

The Query Neighbours command is used to determine what neighbouring RMX units are within communications range of the local RMX. This command will return the Station IDs of the units that can respond to the query.

Command: QU

```
>qu
The neighbor stations:
0142h=322  0146h=326  0133h=307
>
```

Quit

The Quit command is mainly used to put the RMX back into sleep mode. The Quit command is also used to stop certain factory test commands.

Command: QUIT

```
>quit
2006/03/14 13:35:03 Entering sleep mode
>
```

Reset

The Reset command is used to reboot the RMX. This command is similar to power cycling the RMX. This command will terminate all existing communications and restore RMX parameters to their default values.

Command: RST

```
>rst
RMX is rebooting...
>>AT
```

Status

The “Status command is used to determine the state of the RMX modem.

Command: ST

```
>st
Modem is idle
>
```

Time from User

The Time from User command is used to show or set the RMX internal clock. The RMX internal clock is used to time stamp audit log messages. Normally the RMX will try to set its clock from the attached data logger during the power-up sequence; however, in the case where a data logger is not attached, this command allows the user to set the time directly.

Command: TMU=(YYYY/MM/DD hh:mm:ss)

where: YYYY is the year
MM is the month
DD is the day
hh is the hour in 24 hour format
mm is the minute
ss is the second

To show:

```
>tmu
2005/01/01 22:48:22
>
```

To set:

```
>tmu=2006/02/03 14:45:30
2006/02/03 14:45:31
>
```

Time from Logger

The Time from Logger command is used to set the RMX internal clock to that of the attached data logger. Normally the RMX will set its clock from the attached data logger during the power-up sequence; however, this command allows the user to periodically resynchronize the RMX clock to the logger clock.

Command: TML

```
>tml

set time to 2006/02/08 06:56:45 from logger
>
```

User Routing Table

The User Routing Table command is used to show or set the RMX routing table. The routing table defines the signal path to a remotely located RMX unit. The first entry (index 00) and the last entry in the routing table must be FFFCh (defined RMX user ports). The table entries in between the first and last entry sequentially list the RMX Station IDs from the locally connected RMX to the desired remote site. Station IDs can be entered as a decimal or hexadecimal value. The routing table can support up to 10 unique RMX entries. The routing table is not stored in non-volatile memory and therefore is not maintained through a power cycle.

Command: **TBL=(X,N)**

Where: X is the table index
N is an RMX Station ID

To show:

```
>tbl
The routing table on the link:
 Index(d)  Station(h)
   00      fffch=65532(Monitor port)
   01      0001h=1
   02      0002h=2
   03      0003h=3
   04      fffch=65532(Monitor port)
>
```

To set:

```
>tbl=2,22
The routing table on the link:
 Index(d)  Station(h)
   00      fffch=65532(Monitor port)
   01      0001h=1
   02      0016h=22
   03      0003h=3
   04      fffch=65532(Monitor port)
>
```

To delete:

```
>tbl=4,0
 The routing table on the link:
 Index(d)  Station(h)
   00      fffch=65532(Monitor port)
   01      0001h=1
   02      0016h=22
   03      0003h=3
>tbl=3,FFFCh
The routing table on the link:
 Index(d)  Station(h)
   00      fffch=65532(Monitor port)
   01      0001h=1
   02      0016h=22
   03      fffch=65532(Monitor port)
>
```

REMOTE COMMANDS

Remote commands refer to those commands that act upon the last RMX modem that is defined in the User Routing Table. The last RMX modem listed in the User Routing Table is referred to as the 'remote RMX'. The Remote commands provide functions similar to their local counterparts. Details for each of the remote commands are given below.

Remote Save

The Remote Save command is used to write the currently set parameters to the remote RMX's non-volatile memory (EEPROM). If a parameter value in a remote RMX is changed, the new parameter value will not be retained through a power cycle of the remote RMX unless the remote RMX receives a Remote Save command. The Remote Save command always writes all parameters to the remote RMX's EEPROM so Remote Save commands after each parameter change is not required as long as one Remote Save command is issued after the desired parameters have been changed.

Command: **RSA**

>rsa

Remote Audit Log Clear

The Remote Audit Log Clear command is used to clear all messages from the remote RMX audit log.

Command: **RAC**

>rac

Remote Audit Log

The Remote Audit Log command is used to retrieve all messages from the remote RMX audit log.

Command: **RAL**

>RAL

Remote Baud Rate

The Remote Baud Rate command is used to set the starting baud rate for RMX over-the-air communications.

Command: **RBR=(0,1)**

Where: 0 selects 4800 baud
1 selects 9600 baud

Factory Default Value: *9600 baud for 25 kHz channels*
4800 baud for 12.5 kHz channels

Note: Remember to issue the Remote Save command after altering this parameter.

Remote Configuration

The Remote Configuration command is used to show the remote RMX configuration settings.

Command: **RCFG**

Remote Power Setting

The Remote Power Setting command allows the user to choose between the pre-programmed high and low RF output power settings. Typical factory settings are 4W (low) and 6W (high) RF output power.

Command: **RPSET=(L,H)**

where: L selects low power
H selects high power

Factory Default Value: High

Note: Remember to issue the Remote Save command after altering this parameter.

Remote Reset

The Remote Reset command is used to reboot the remote RMX. This command is similar to power cycling the RMX. This command will terminate all existing communications and restore remote RMX parameters to their default values.

Command: **RRST**

Remote Quality Log Clear

The Remote Quality Log Clear command is used to clear all information in the remote RMX radio quality log.

Command: **RQC**

Remote Quality Log

The Remote Quality Log command is used to retrieve all messages from the remote RMX quality log.

Command: **RQL**

Remote Query Neighbours

The Remote Query Neighbours command is used to determine what neighbouring RMX units are within communications range of the remote RMX. This command will return the Station IDs of the units that can respond to the query.

Command: **RQU**

Remote Time from User

The Remote Time from User command is used to show or set the remote RMX internal clock.

Command: **RTMU=(YYYY/MM/DD hh:mm:ss)**

Remote Time from Logger

The Remote Time from Logger command is used to set the RMX internal clock to that of the data logger attached to the remote RMX.

Command: **RTML**

Radio Quality Test

The Radio Quality Test command is used to check the RF link quality on the link defined in the User Routing Table. Multiple data packets are sent between the RMX units. Information on the link quality is returned in the 'Last quality' field.

Command: **RQT**

```
>rqt
Radio quality on the link:
  Station 0141h -> 0133h
    <Rate = 4800bps>
    Accumulate quality:
      High time: 83%, S/N: 10.8dB
      Error/total(bytes)=1/3975, retried blocks: 0
    Last quality:
      S/N not available
      Error/total(bytes)=0/0, retried blocks: 0
    <Rate = 9600bps>
    Accumulate quality:
      High time: 77%, S/N: 9.9dB
      Error/total(bytes)=36/288479, retried blocks: 0
    Last quality:
      High time: 75%, S/N: 9.7dB
      Error/total(bytes)=1/9756, retried blocks: 0

  Station 0133h(307) -> 0141h(321)
    <Rate = 4800bps>
    Accumulate quality:
      High time: 87%, S/N: 11.3dB
      Error/total(bytes)=4/6448, retried blocks: 14
    Last quality:
      S/N not available
      Error/total(bytes)=0/0, retried blocks: 0
    <Rate = 9600bps>
    Accumulate quality:
      High time: 77%, S/N: 9.9dB
      Error/total(bytes)=69/117664, retried blocks: 165
    Last quality:
      High time: 81%, S/N: 10.5dB
      Error/total(bytes)=2/9756, retried blocks: 0

2006/02/08 09:25:57 Radio link is idle
```

Send User Message

The User Message command is used to send a text message to the monitor port of the last RMX in the User Routing Table. All received characters are displayed in upper case. Use the Quit command to exit User Message mode.

Command: **UM**

```
>um
User Message >hello
User Message >how are you
User Message >quit
>
```

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RF TRANSCEIVER MODULE

GENERAL

As previously mentioned, the RMX has a built-in FCC and IC approved, OEM FM radio transceiver module which is responsible for all RF transmission and reception. The Ritron Incorporated DTX Plus radio module comes pre-aligned from the factory (e.g. deviation levels, audio levels, etc.) and should not require servicing or tuning. Servicing the radio module or altering the radio module settings should only be performed by factory qualified personnel.

The DTX Plus module has programmable squelch settings, eight pre-programmed frequency settings, and two pre-programmed RF output power settings. Normally FTS will program the user's desired settings before shipping RMX units; however, the user is able to alter these settings as required. Again, altering the pre-programmed module settings should only be performed by factory qualified personnel.

RADIO MODULE PROGRAMMING

Radio Module programming can be done without opening the RMX case. Access to the DTX Plus Radio Module programming pin is provided on the RMX front panel MODEM port and the DATALOGGER port. As the DTX Plus uses a one-wire programming protocol, a custom cable with an RS232 to one-wire interface PCB is required for PC communications.

Required Equipment

FTS cable CBL-RMX-RT-PROG and Ritron's DTXP-PCPS programming software (version 2.58 or newer) is required when programming the DTX Plus Radio Module. Both the cable and the software are provided when the FTS cable (part number CBL-RMX-RT-PROG) is ordered.

Procedure

It may be necessary for the user to modify the DTX Plus Radio Module squelch levels, channel frequencies, or output power levels. Follow the procedure outlined below in order to view or alter the module settings:

1) Connect the CBL-RMX-RT-PROG cable to the PC COM port and to either the RMX front panel MODEM or DATALOGGER port.

2) Momentarily press the RMX front panel CHANNEL SELECT pushbutton switch to ensure that the RMX control board is supplying power to the DTX Plus Radio Module. Power remains active to the DTX Plus module for 120 seconds after each press of the switch.

3) Run the DTXP-PCPS programming software and make the desired changes.

4) Exit the software.

5) Disconnect the cable from the RMX front panel.

6) Update the RMX Configuration Tag to reflect the current settings.

Channel Frequencies

The Radio Module can be programmed with up to eight different user-selectable frequencies which can be selected by the user through the RMX Front Panel or Diagnostic Interface (Channels 1 to 8). The pre-programmed frequencies are listed on the RMX Configuration Tag. When reprogramming the radio module frequency settings ensure that the Rx (receive) and Tx (transmit) frequencies within each channel are identical. This is required for proper RMX operation.

Output Power Levels

The radio module can be pre-programmed with a High and Low RF output power setting which can be selected through the RMX Diagnostic Interface (PSet parameter). The pre-programmed output power levels are listed on the RMX Configuration Tag. The RMX is shipped with the PSet parameter set at High power. The user can switch to Low power in order to minimize current consumption but should only do so if the RMX radio link is of sufficient quality that the reduced output power will not degrade communications. The radio module output power settings can be individually set for each frequency.

Refer to the *Ritron DTX Plus Maintenance and Operating Manual* for the TX High Power and Tx Low Power radio module setting details.

Squelch Levels

Squelch levels for the DTX Plus Radio Module are pre-programmed from the factory and are listed on the RMX Configuration Tag. The squelch levels can not be accessed or adjusted through the RMX Diagnostic Interface. The only way to alter the squelch levels is to reprogram the DTX Plus radio module.

Refer to the *Ritron DTX Plus Maintenance and Operating Manual* for the Carrier Detect On and Carrier Detect Off Radio Module setting details.

MAINTENANCE

GENERAL

The RMX Radio Modem should require no field maintenance other than a visual inspection for cable damage and loose connections. As with any RF system, the RF link should be monitored for indications of poor signal strength, off frequency operation, poor data quality, poor modulation, or incorrect transmissions which can indicate problems with the transmitter that must be repaired.

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SPECIFICATIONS

RMX RADIO MODEM TRANSCEIVER

Operating Voltage Range:	9 to 16 V
Current Consumption	
Sleep:	0.5 mA nominal
Receive:	70 mA nominal
Transmit:	1.5 A nominal at 6W
Sleep Time:	7 seconds (Poff = 7)
Receive Time:	1 second (Pon = 1)
Connectors	
Power:	Cable harness with integrated 2 contact Deutsch connector
RF Output:	N type jack, 50 ohm
Data Logger Port*:	14 contact FTS Telemetry bayonet style
Modem Port*:	14 contact FTS Telemetry bayonet style

* Data Logger or Modem Port can be used for RMX and system diagnostics

Serial Protocol:	RS-232 at 9600 bps
Over-the-Air Protocol:	GMSK with CSMA, RS error correction & selective ARQ
25 kHz Channel:	9600 bps with auto-stepdown to 4800 bps
12.5 kHz Channel:	4800 bps with auto-stepdown from RS(204,188) to RS(48,32)
Number of Channels:	8 (factory programmable, user selectable)
Transmit Power:	6 Watts maximum
Operating Temperature:	-30 to +60 C (-22 to +140F°)
Dimensions:	25 x 20 x13 cm (10 x 8 x 5 in)
Weight:	3.1 kgs (6.8 lbs)

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APPENDIX 1

BLANK CONFIGURATION TAG

RMX CONFIGURATION TAG		
SERIAL NUMBER:	DATE:	
SITE NAME:		
CONFIGURATION:		
Station ID:		
Channel No:		
Frequency:		MHz
Channel Bandwidth:		kHz
CD Levels (dBm):	On =	Off =
Power Setting (W):	Low =	High =
Power Cycle (sec):	On =	Off =
Max Baud Rate:		bps
Baud Rate Detection:		Auto
Reed Solomon Selection:		Auto

ISO-MA-F-088

FREQUENCY TABLE		
CHANNEL	NAME	FREQUENCY
1		
2		
3		
4		
5		
6		
7		
8		

LED CHANNEL INDICATION TABLE								
LED	Channel Number							
	1	2	3	4	5	6	7	8
Top	-	-	-	-	-	-	-	ON
Upper	-	-	-	ON	ON	ON	ON	-
Lower	-	ON	ON	-	-	ON	ON	-
Bottom	ON	-	ON	-	ON	-	ON	-

Press Display Control to activate LED's

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APPENDIX 2

RITRON DTX PLUS MAINTENANCE AND OPERATING MANUAL

< Insert FTS document 701-DTX-PLUS here >