ITCR 1.1 Wayside Radio Installation and Field Service Guide

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Revision History

Revision	Date	Summary of Changes
1.0	10/11/2012	FRA release.

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1. Overview

The *ITCR Wayside Radio Installation and Field Service Guide* provides important radio-frequency safety information, installation procedures, and servicing instructions for the Meteorcomm Interoperable Train Control (ITC) Wayside radio model 63010.

1.1 Audience

This guide provides essential information for personnel who are working with the Wayside radios. It is intended for users who will perform some or all of the following tasks on Wayside radios:

- Install or replace them.
- Diagnose common problems.
- Adjust radio characteristics.
- Make simple repairs.
- Perform routine maintenance.

Prerequisites for users of this guide include:

- The ability to work with standard radio-frequency (RF) test equipment, including knowledge of how to prevent damage to equipment and injury to oneself.
- The ability to measure basic transceiver performance including RF power, frequency, and receiver sensitivity and the knowledge to analyze RF performance.
- A working knowledge of XtermW, a Meteorcomm application used to configure radios and install downloads in Meteorcomm ITC Wayside, Base, and Locomotive radios.
- Familiarity with means to limit RF exposure from antennas and familiarity the Meteorcomm RF Energy Exposure Guide.

1.2 Specifications for model 63010 Wayside radios

General	
FREQUENCY RANGE:	220 – 222 MHz
CHANNEL SPACING:	25kHz
TEMPERATURE RANGE: OPERATING STORAGE	 -40°C to +70°C -55°C to +85°C
HUMIDITY, OPERATING:	0% to 95% non-condensing; Test per S-5702, clause 3.2.3.2
FREQUENCY STABILITY	±1.5ppm over operating temperature range (+25°C reference)
DC INPUT VOLTAGE RANGE:	10.9-15.5V Damage limit 17VDC
DC CURRENT DRAIN (13.6VDC input): Transmit: Receiver:	 10A max into 50 ohm load, 7.5A typical 1A max while receiving
DC POWER CONNECTOR:	Wago p/n 231-833/001-000
HEIGHT:	15.5 in.
WIDTH:	9.5 in.
DEPTH:	2.0 in.
WEIGHT:	6.9 lbs. (3.1 kg)
ANTENNA CONNECTOR:	Type N female
GPS RECEIVER:	Antenna power 3.3V 50mA max Antenna connector TNC Female
Antenna	Active or passive
EXTERNAL INTERFACE: Ethernet (2) 10/100 MBPS	 Data Network port – Type RJ-45 Maintenance port - Type RJ-45
CONFIGURATION INTERFACE MODULE:	SD Card

DISPLAY:	Activity / Diagnostic LEDs on Front Panel
TRANSMITTER:	
RF POWER OUTPUT:	25W PEP Adjustable 7.5W to 25W PEP
OUTPUT IMPEDANCE:	50 ohms Operating VSWR < 3:1
MODULATION WAVEFORMS:	16kbps π/4DQPSK (linear)
OCCUPIED BANDWIDTH:	Meets 47CFR90.210 (f), five aggregated channels
CONDUCTED SPURIOUS EMISSIONS:	-25dBm max
MAX DUTY CYCLE RATING:	10%
EMISSION DESIGNATOR:	16kbps π/4DQPSK 8K90DXW
REGULATORY APPROVALS:	63010: FCC ID BIB63010
RECEIVER:	
MAXIMUM USABLE SENSITIVITY, STATIC, BER<10-4:	16kbps PI/4DQPSK -111dBm 32kbps PI/4DQPSK -108dBm
ADJACENT CHANNEL SELECTIVITY:	70dB @ 25kHz offset
SPURIOUS RESPONSE REJECTION:	70dB
INTERMODULATION RESPONSE REJECTION:	65dB
HIGH INPUT LEVEL (-7dBm):	BER<10^{-4}
BLOCKING, 1MHz OFFSET:	80dB
NUMBER OF CHANNELS SIMULTANEOUSLY RECEIVED:	2 One (1) 16kbps π/4DQPSK One (1) Auto 16kbps/ 32 kbps π/4DQPSK
DIVERSITY SUPPORT:	No

Specifications are subject to change without notice.

1.3 Acronyms

The following table contains the acronyms used in this guide and their descriptions.

Acronym	Description
A	Amp
AWG	American Wire Gauge
CIM	Configuration Information Module
cm	Centimeter, approximately 0.4 inches (slightly less than a half inch)
dB	Decibel
dBi	Decibel isotropic
dBm	Decibel milliwatt
DC	Direct current
DOP	Dilution of precision
DQPSK	Differential quaternary phase-shift keying
EVM	Error vector magnitude
FCC	Federal Communications Commission
GPS	Global Positioning System
IC	Industry Canada
ITC	Interoperable Train Control
ITCR	Interoperable Train Control-Radio
LAN	Local area network
LOS	Line of sight
m	Meter
MCC	Meteorcomm LLC
MED	Medium Earth Orbit
MHz	Megahertz, a unit of frequency measurement
MPE	Maximum permitted exposure

Acronym	Description
MSGPS	Multi-satellite GPS
mW	Milliwatt
NIC	Network interface card
PEP	Peak envelope power
POST	Power-on self-test
PPM	Parts per million
PTC	Positive Train Control
RF	Radio frequency
SAR	Specific absorption rate
SD card	Secure Digital card
SMA	SubMiniature, version A, a type of connector
TCP/IP	Transmission Control Protocol/Internet Protocol
TNC	Threaded Neill-Concelman, a type of connector
VDC	Voltage, direct current
W	Watt
XtermW	Meteorcomm terminal emulation application used for configuring and operating Positive Train Control (PTC) radios.

1.4 Related documents

Each of the following documents serves a unique purpose. Brief overviews of each document follow their title. Familiarity with all documents is strongly encouraged for any personnel handling the radios.

- *ITCR Base Radio Installation and Field Service Guide*

  This document provides essential information for personnel who are working with Base radios.

- *ITCR Locomotive Radio Installation and Field Service Guide*

This document provides essential information for personnel who are working with Wayside radios.

- *ITCR Radio Configuration Guide*

  This document provides information on how to configure a radio to operate properly in the network after boot, values for the radio's configurable parameters that must be defined with specific site, device identification, and RF, network, and security information.

- *ITCR CLI Reference for Administration and Service*

  This document provides information on commands in the radio user interface for network system administrators and service personnel. The command line interface allows entry of commands to initiate actions, configure parameters, and retrieve status information. The HELP command gives concise descriptions of the syntax, while the CLI Reference provides descriptions, details, and examples.

- *ITCR Getting Started with XtermW*

  This document provides information on the XtermW program. XtermW is a Microsoft Windows-based terminal control program for use with the Base, Locomotive, and Wayside radios.

- *ITCR RF Energy Exposure Guide*

  This document provides information on RF energy exposure awareness and control information, and operational instructions for FCC/IC occupational use requirements.

1.5 How to get help

Please contact our Service Desk (https://support.meteorcomm.com/home) if you have any questions regarding this release.

2. Follow your established safety guidelines

Your employer has created safety guidelines that apply to your work environment and tasks. Please follow them. If you have questions about general on-the-job safety concerns, please consult your employer's established safety guidelines.

2.1 Electrical safety

To reduce the risk of electric shock:

- Follow your employer's established electrical-safety guidelines.
- Disconnect power from radio before removing the cover.
- Be aware that removing the radio cover may expose you to dangerous voltages or other risks. Avoid making internal adjustments to the radio when you are alone.
- Avoid contact with a radio's electrical components. Electric shock from voltages present with the radio are potentially fatal.
- Reassemble radios correctly. Incorrect reassembly of a radio can cause a harmful electric shock to radio handlers.

3. Important information for the user

3.1 Limiting RF exposure

Caution: Please refer to the *ITCR RF Energy Exposure Guide* that is packaged with each radio for specific information regarding safe distances that must be maintained between personnel and energized transmitting antennas.

The information in the *ITCR RF Energy Exposure Guide* is determined from FCC and Industry Canada rules that, when followed, limit human exposure to radio frequency energy to acceptable levels. Note that although the base station is expected to be sited, installed, and maintained only by professionals in a controlled-exposure environment, the *ITCR RF Energy Exposure Guide* lists the larger lateral safe distances

for an uncontrolled environment. Obeying these limits will protect both railroad employees and the general public.

The transmitter is intended to be operated with a fixed antenna in an Occupational/Controlled Exposure environment per FCC OET 65 or Controlled Use Environment per IC RSS-102. The Maximum Permitted Exposure (MPE) limit for devices in the presence of the general public in the 100-300 MHz range is 0.2 mW/cm2 = 2 W/m2 vs. 10 W/m2 in a controlled-exposure environment.

This radio is intended for use by railroad employees who have full knowledge of their exposure and can exercise control over their exposure to meet FCC and IC limits. This radio device is not intended for use by consumers or the general population. Base station antennas must be positioned on towers or non-residential buildings that are generally unoccupied except while servicing the equipment therein.

The table in the *ITCR RF Energy Exposure Guide* lists the calculated lateral distances to be maintained between the general public and an operational Base transmitter antenna for two antenna types suitable for fixed Base applications.

Note: RF exposure compliance at multiple transmitter sites must be addressed on a site-by-site basis. It is the responsibility of the licensee to ensure compliance with maximum exposure limits.

3.2 Fixed antenna guidelines

This section contains antenna information and additional notes regarding methods to limit RF exposure.

- The licensee is required to comply with limits on antenna location, power and effective antenna height per 47CFR Subpart T §90.701 et. seq., or Industry Canada SRSP-512 §6.3 as applicable. The section titled “Base-Radiated Power Limits,” below, provides additional information on how to comply with ERP limits.
- Refer to the *ITCR RF Energy Exposure Guide* for specific guidelines regarding the siting and installation of fixed antennas.

- Acceptable fixed-antenna types are listed in the lateral separation distance tables in the *ITCR RF Energy Exposure Guide*.
- Install antennas in accordance with the manufacturer's instructions.
- Disable the transmitter when installing or servicing its antenna or transmission line.

Maintain a safe distance from energized transmitting antennas. Refer to the table of safe distances for Base radios in the *ITCR RF Energy Exposure Guide*, which is packaged with each radio.

- Unauthorized antennas, equipment modifications, or attachments could invalidate any equipment warranty or authority to transmit. Modification could damage the radio and may violate FCC or IC regulations. Contact Meteorcomm before using other antennas.

3.3 RF interference to residential receivers

Notice to user: This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more the following measures:

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

3.4 Equipment modifications

Caution: Any changes or modifications to this equipment not expressly approved by the party responsible for compliance (in the respective country of use) could void the user's authority to operate the equipment.

4. Wayside transmitter operation

It is the responsibility of the licensee to operate this radio transmitter in compliance with FCC and Industry Canada service rules for 220-222 MHz, namely FCC Rules Part 90 Subpart T and Industry Canada SRSP-512.

4.1 Wayside radio channelization and frequency range

The Wayside radio can be configured to transmit on any one of 80 selectable 25-kHz spaced channels ranging from 220.0125 to 221.9875 MHz inclusive. The spectrum included corresponds to all 5-kHz wide FCC channels numbered from 1 at 220.0025 MHz to 400 at 221.9975 MHz. Each Wayside radio transmission occupies five of the FCC-defined 5-kHz channels. The lowest Wayside radio channel center frequency is in the center of FCC channel 3 and the next is FCC channel 8, then 13, 18, and so on, up to the highest in the center of channel 398.

4.2 Wayside channel restrictions

Section 90.715 of the FCC Rules lists the authorized frequencies of the 400 total 5-kHz-wide channels. According to §90.733(d), these can be aggregated into larger channel widths with the exception of FCC channels 161-170 and 181-185. Therefore, the Wayside radio may not transmit on those channels or their 221 MHz counterparts, 361-370 and 381-385. This corresponds to Wayside frequencies 220.8125, 220.8375, 220.9125, 221.8125, 221.8375, and 221.9125 MHz.

Please refer to Part 90 Subpart T and SRSP-512 for additional frequency use restrictions in Canadian and Mexican border areas.

4.3 Wayside radiated power limits

It is the responsibility of the licensee to comply with the effective radiated power limits based on operating frequency, geographic location, and effective antenna height set out in 47CFR Subpart T §90.701 et. seq., or Industry Canada SRSP-512 §6.3, as applicable.

Important: The following supplementary antenna system information discusses means for the licensee to determine effective radiated power (ERP) and comply with regulatory power limits.

Licensees must comply with the specific power and antenna height limitations for fixed-antenna stations per §90.729 or SRSP-512 §6.3. Note that U.S. and Canadian power limits vs. HAAT are not identical.

Licensees should note that all mobiles and also fixed installations transmitting between 221 and 222 MHz must limit effective radiated power (ERP) to 50W or 10*log(50) + 30 = 47dBm PEP referenced to the 2.15 dBi gain of a dipole, unless operating under a waiver of FCC rule §90.729(b) or SRSP-512 §6.3 as applicable. The EIRP for this case is 49.15 dBm. Also note that the maximum ERP on FCC/IC channels 196-200 at 220.975 to 221.000 MHz is 2 watts.

The allowable transmitter peak envelope power output in dBm is determined by subtracting the antenna gain in dBi from 49.15, then adding the loss from the antenna feedline and connectors. If the result is greater than or equal to 44.85 dBm = 14.85 dBW then the maximum power output of the Wayside transmitter can be used. If the value is less than 44.85 dBm, then the transmitter output power must be reduced to the calculated value.

Mobile Installation: As an example of a mobile installation, consider a vertical half wave ground plane on a vehicle metal rooftop. In an ideal installation the antenna gain = 2.4 dBd = 4.55 dBi. Ignoring connector losses, feedline loss is at least 0.6 dB for 10 feet of Times Microwave LMR-195 Ultra Flex coaxial cable. Transmitter power output limit = 47-2.4+0.6 = 45.2 dBm PEP and therefore the system is compliant with the 50W ERP limit. The actual ERP in this case is 10^(14.85+2.4-0.6) = 46.2 W. This installation is not allowed to transmit on FCC channels 196-200 because the maximum ERP is greater than 2 watts.

Fixed Installation: In a fixed installation, a common single-element exposed folded dipole antenna without reflector has 0 up to 2.9 dBd (2.1 to 5.0 dBi) azimuthal gain depending on the design.

Once the allowable ERP is determined by applying all power-restrictive rules from above and the antenna gain is known, the transmitter peak envelope power output feeding the transmission line is determined by subtracting the antenna gain in dBd from the ERP and adding the loss from the antenna feedline and connectors plus the loss from any external inline power sensors, combiners, filters or lightning arresters. If the net value is greater than or equal to 44.85 dBm, then the maximum power of the Wayside transmitter can be used. If the value is less than 44.85 dBm, then the transmitter output power must be reduced to the net value.

Example for the 50W ERP fixed case: Antenna gain = 2.9 dBd and feedline loss is at least 0.5 dB for 25 feet of Times Microwave LMR-400 coax plus 0.4 dB for inline lightning arrester and three connectors. Assuming no other losses, the transmitter power output limit = 47-2.9+0.9 = 45 dBm PEP. In this case, the actual Wayside ERP is 44.85+2.9-0.9 dBm = 46.85 dBm = 48.4 W PEP and therefore the system is compliant with the 50W ERP limit. This installation is not allowed to transmit on FCC channels 196-200 because the maximum ERP is greater than 2 watts.

5. Installation

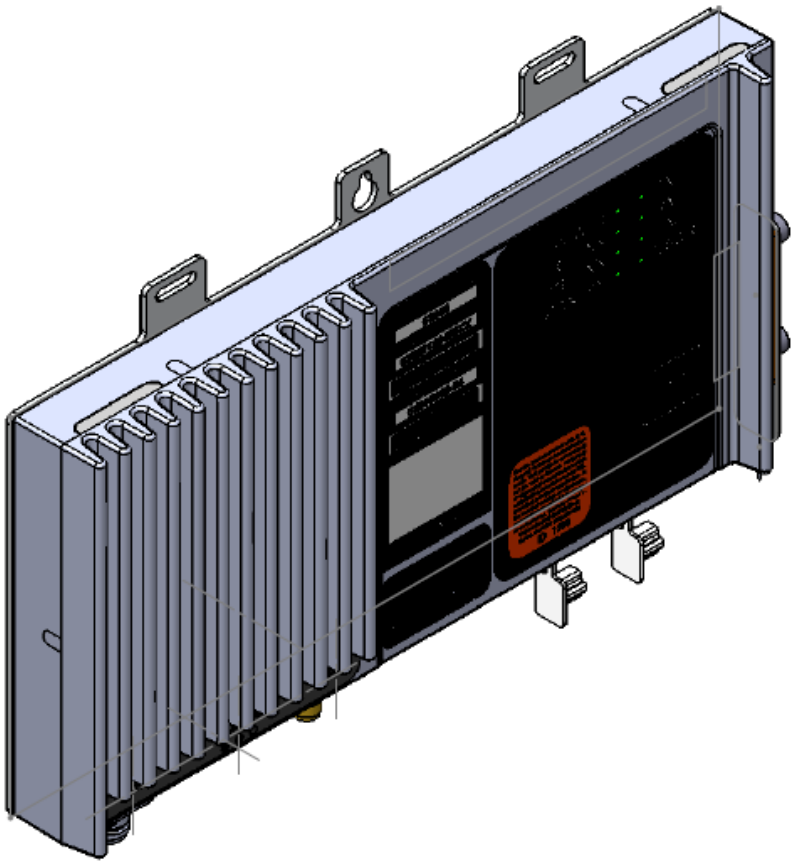
The Wayside radios are designed to satisfy the industry standard Interoperable Train Control (ITC) requirements as part of an integrated 220 MHz radio network supporting the implementation of Positive Train Control (PTC) systems. The Base radio, Locomotive radio, and Wayside radios form the transportation backbone on which a messaging application provides communication capabilities between railroad assets and their back offices. The Interoperable Train Control Radio (ITCR) is designed to provide communication in an inter-operable fashion enabling messaging to occur across railroad boundaries.

Wayside radios are housed in metal enclosures. The Wayside radio dimensions are approximately 15.5”W x 9.5”H x 2.0”D and weighs less than 8 pounds.

All input/output ports are grounded and/or shielded. In addition, internal shielding, unit assembly and PCB design are used in an effort to minimize potential sources of unwanted radiated emissions.

Warning: This radio requires an external isolated power supply to provide ground isolation between the radio and the site electronics. Failure to use an isolated power supply (for example, connecting unit directly to site batteries) would induce a ground fault at the site since the radio unit is grounded to the bungalow both through the ground lug as well as the GPS and 220 antennas.

Figure 1: Wayside radio



Radio installation consists of these steps:

- Unpack and inspect the radio
- Confirm the SD memory card is installed
- Mount the radio
- Connect the antennas
- Connect the Ethernet cable
- Ground the radio
- Install surge protection
- Connect the power cable
- Power on the radio
- View the power on self-test (POST) results

The following sections describe each of these steps in detail.

5.1 Required equipment

You need the following equipment to install, test, or service an ITC radio:

Table 1: Required equipment

Type	Model	Notes
Vector signal analyzer	Agilent E4438C or equivalent	Recommend option for 50 VDC, 50 W input protection of RF signal output port. Preprogrammed with DQPSK data packet and appropriate preamble required by Sprint release. See Appendix D - Program signal generator for DQPSK.
Vector signal analyzer	Agilent E9010A or equivalent	
10 MHz frequency standard	Standard Research Systems model FS725 or equivalent	Frequency adjustments require frequency standard accuracy to 0.01 ppm or better.

Type	Model	Notes
60 dB power attenuator/load		Consists of two pieces with 100 W and 2 W min. power rating
Constant voltage DC power supply		Verify unit supports voltage and current draw required by unit under test.
Host computer with at least one Ethernet port and Meteorcomm XtermW or equivalent terminal program installed		If the host computer's Ethernet port has not been configured then follow the instructions in the Configure the computer Ethernet ports to communicate with a radio.
Wilmore DC-DC Converter 1675-12-12-15 or equivalent		The radio must be grounded to a proper isolated converter.
Clip-on ammeter		
Antenna/VSWR test kit		
Cable ties as required		
Digital volt meter		
Network analyzer		
Portable power meter		
Site tester		

5.2 Unpack and inspect the radio

Unpack and inspect the radio. Note any damage that may have resulted from shipping including dents or loose parts. Also note any damage or discrepancies between the contents in the shipping container and the packing list.

Note: The radio is shipped with a power connector (MCC part number 010-031-0306). Please ensure it is connected to the radio and not left in the packing box.

If you detect damage or the contents do not match the invoice then make note of the defect and contact the radio manufacturer.

If you do not detect any damage and the shipping invoice matches the contents then continue with the installation.

5.3 Confirm the SD memory card is installed

To open the CIM card door to ensure the SD memory card is present:

1. Open the CIM card door to ensure the SD memory card is present.
2. Push the card once to release it.
3. Push the card again to ensure it is seated.
4. Once confirmed, close and secure the door.

Note: Make sure the card is installed in the orientation shown on the front of the radio.

Figure 2: CIM card door

5.4 Mount the radio

The radio cover is equipped with top and bottom mounting features. The Wayside radio should be mounted on a vertical surface for maximum heat dissipation.

Ensure that:

- Equipment that produces substantial heat is not installed below the radio.
- Each radio is secured with a minimum of two screws on the top and bottom.
- There is adequate room to access the SD memory card.
- There is adequate room for cable connections.
- Cables are restrained to prevent kinking, and stressing connectors.

Figure 3: Vertical mount

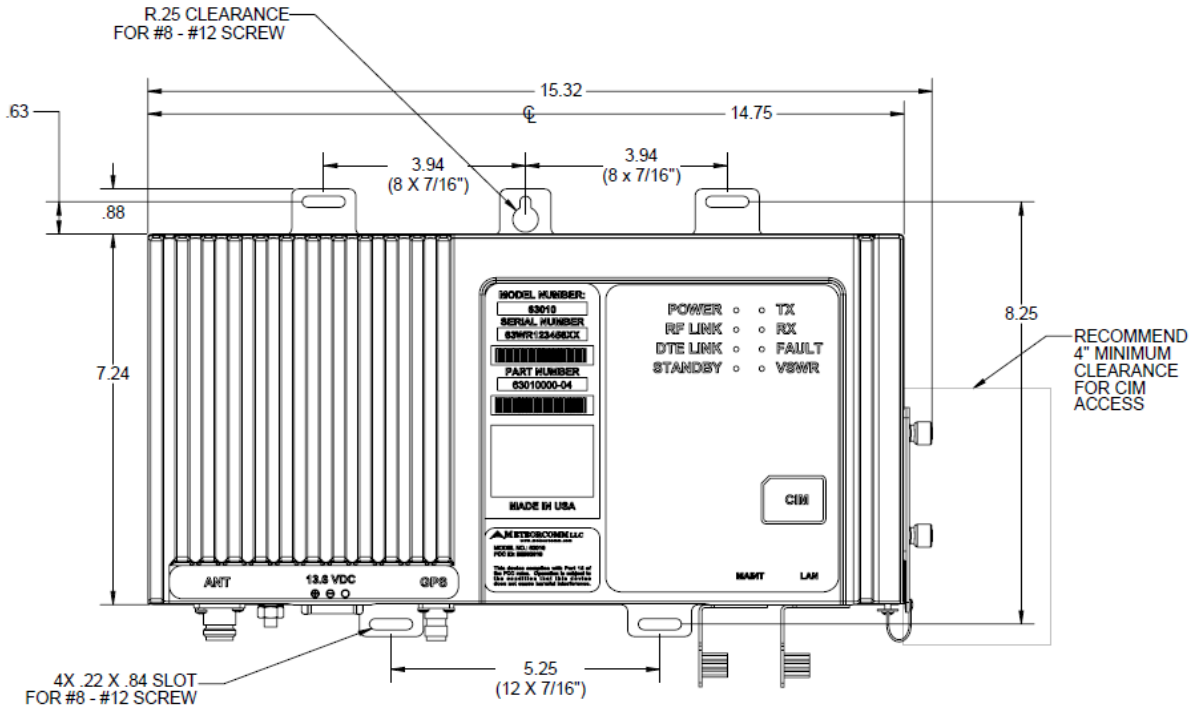
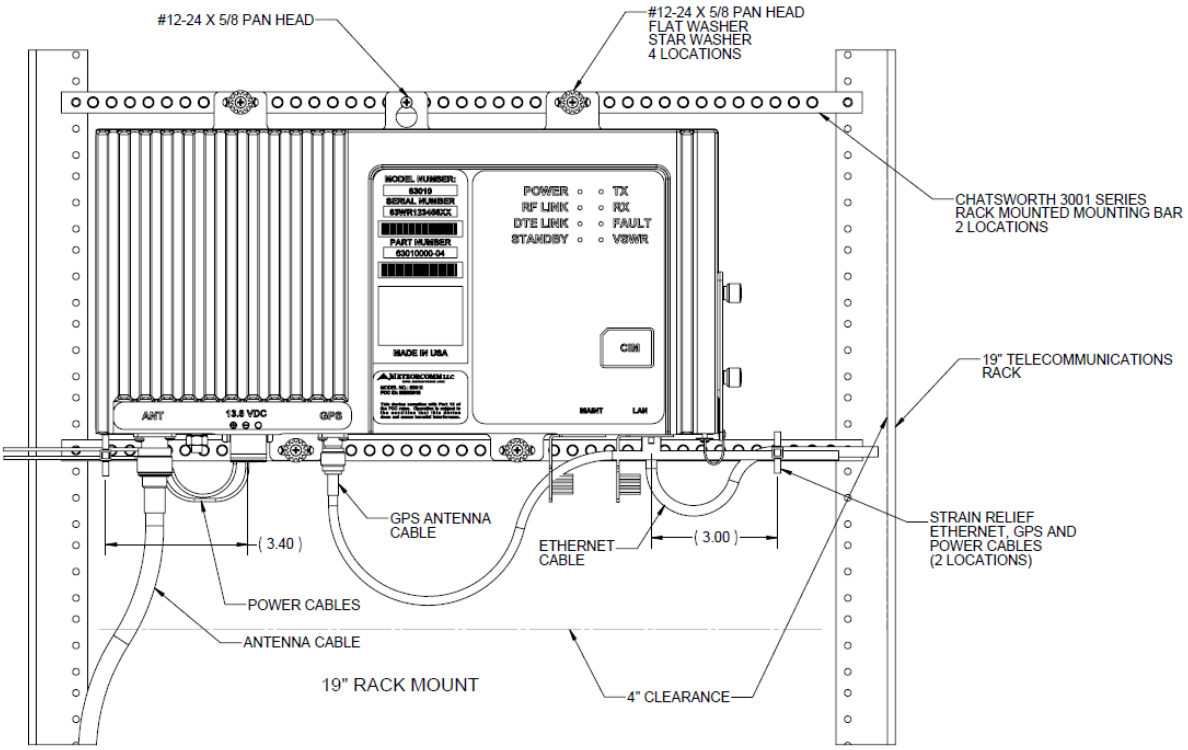


Figure 4: 19-inch rack mount



5.5 Connect the ITCR antenna

Note: Do not connect the radio to the antenna until the radio is configured for the proper frequencies for the site.

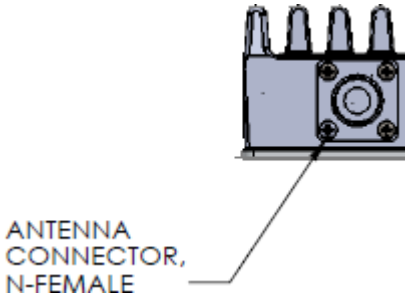
5.5.1 Antenna planning

The radio is designed to be properly terminated to 50 Ohm resistance load. Wayside radios have one antenna port.

5.5.2 Connect the cable

The Wayside radio is rated for 25W PEP. Sufficient termination is required to protect test equipment. The Wayside radio uses N-type connectors for narrowband RF antenna. For transmitter and receiver testing, connect the test equipment to the port labeled ANT.

Figure 5: Antenna connector



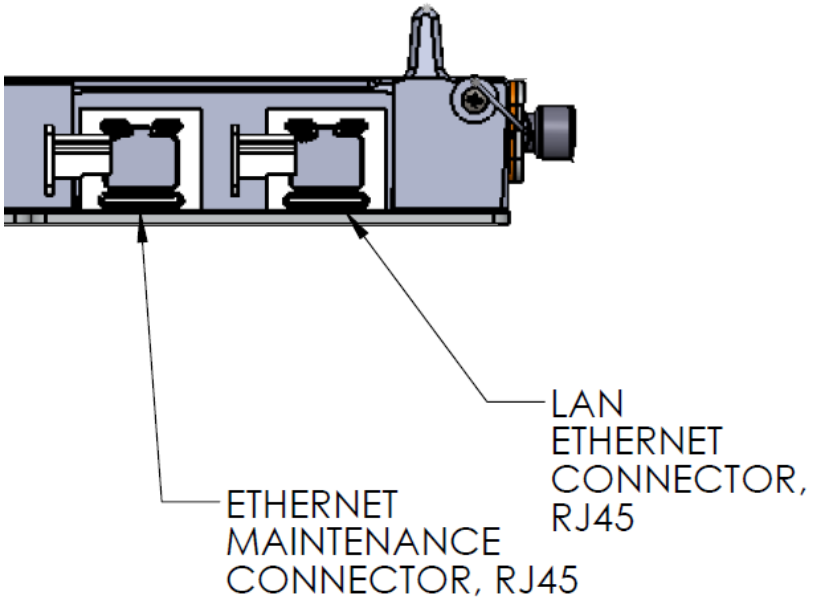
To connect the cable:

1. Perform or confirm a 220 MHz antenna VSWR test prior to connecting the antenna to the radio using an antenna/VSWR test set.
2. Slip the connector over the radio port and tighten.
3. Restrain all cables while observing the cable manufacturer's minimum bend radius requirements.

5.6 Connect the Ethernet cable

The Wayside radio uses a standard CAT5 Ethernet cable and two RJ-45 Ethernet I/O ports, each on its own network.

Figure 6: Ethernet connections



Insert the cable into the port marked LAN.

5.7 Connect the GPS antenna

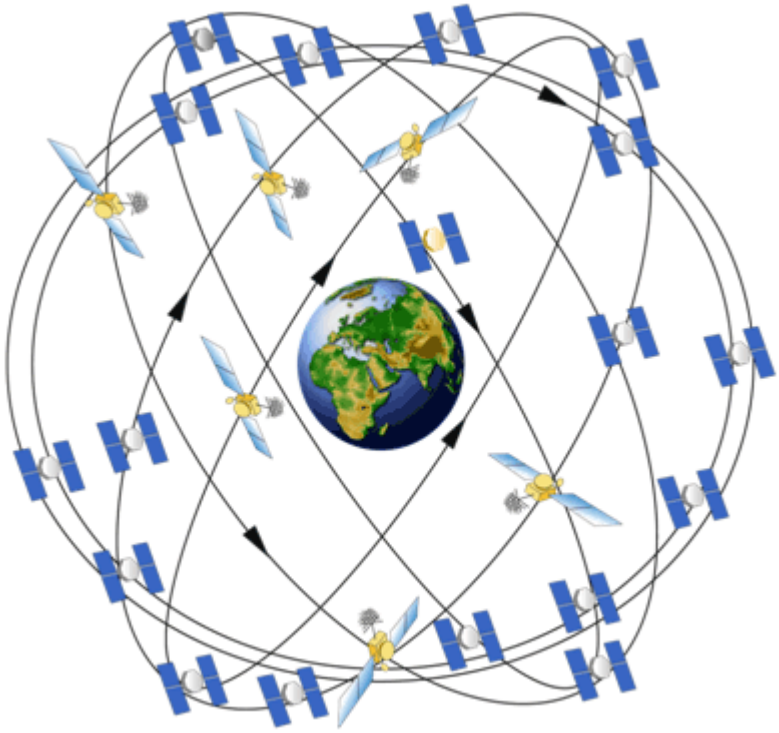
Position the GPS antenna to avoid strong interferers that could saturate the antenna low noise amplifier or the radio GPS receiver internal low noise amplifier. Combinations of strong interferers could mix and interfere directly with the GPS signal quality. Test the wayside radio GPS with any interference source active to qualify the antenna-antenna isolation of the GPS antenna position.

5.7.1 GPS antenna constellation overview

The current GPS satellite constellation is comprised of 30 active satellites in six inclined orbits, with several on-orbit spares. The GPS satellites operate in circular, ~11-hour, 58-minute orbits at an inclination of 55 degrees, at an altitude of 20,200 km.

This type of satellite is referred to as a MEO (Medium Earth Orbit). They are not in geo-stationary orbit. This is important, because unlike GEO satellites (Geostationary Orbits), which are located at an altitude of 35,790 km over the equator, MEO satellites move throughout most of the sky, so there is no significant preferential sky visibility sector when installing the GPS antennas at the site. The GPS antenna location selection must be optimized for as much sky visibility as possible, in all directions, not just South.

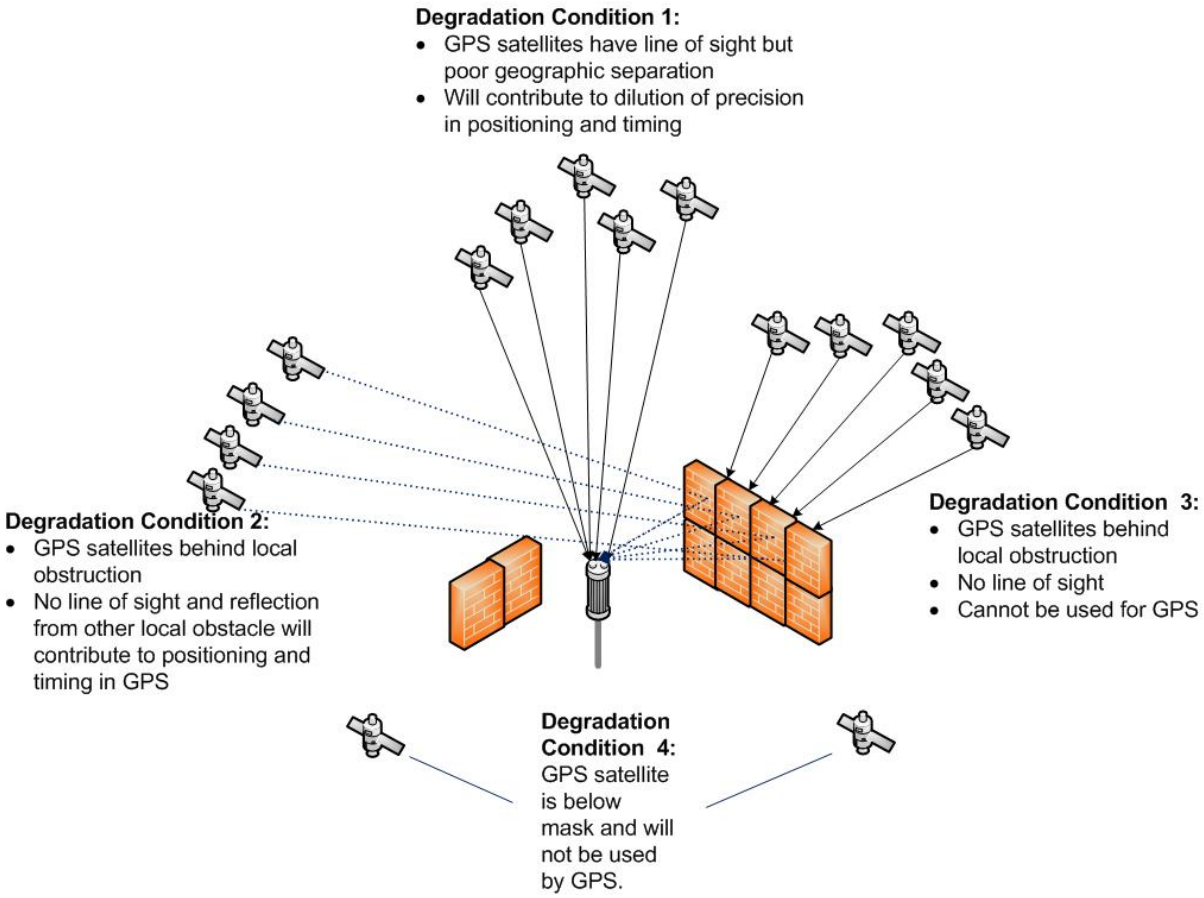
Figure 7: GPS satellite constellation



5.7.2 GPS antenna planning considerations

When determining antenna locations several factors should be taken into consideration. Figure 7: GPS antenna considerations illustrates four typical degradation conditions that a GPS antenna may face.

Figure 8: GPS antenna considerations



Degradation Condition 1: Some of the satellites have a direct view to the GPS antenna and as they move will fall behind various obstructions. There may be instances where the satellite constellation can provide replacement satellites that have unobstructed visibility. However, in the example shown, even the visible GPS satellites have a poor geographic separation and this will contribute to a poor DOP (Dilution of Precision).

Degradation Condition 2: Some satellites may only have an indirect view of the GPS antenna so that a reflected path that is longer than the direct path is all that is available. This will result in an artificially long path, and timing errors will be introduced, likely causing position errors during the self-survey and timing anomalies, depending on the distance of the reflecting object.

Degradation Condition 3: Satellites that are completely obstructed will have no view of the antenna and will be invisible to the antenna, even though they are in the GPS Almanac in the radio.

Degradation Condition 4: Satellites that are below the mask angle (~10 degrees) that is set in the radio will be ignored by the radio, even if they have perfect visibility of the antenna.

5.7.3 Minimize potential of GPS antenna issues

The intent is to optimize the GPS antenna installation to minimize the instances of intermittent timing anomalies.

The best way to minimize these types of problems is to:

- Install the antenna as high as is practical and as allowed by local, state, and federal laws.
- Reduce the obstruction angles by installing the antenna further from obstructions to reduce its apparent size from the perspective of the GPS antenna.
- Be aware of other, large structures that may block a significant portion of the sky from the GPS antenna's perspective.
- Be aware of transient obstructions that you may not immediately see.
- Always note the format of the GPS coordinates (for example, decimal degrees or decimal minutes).

5.7.4 Determine GPS coordinates

If you have not already determined the GPS coordinates through a field survey then it is possible to do so using the radio's internal GPS receiver. The GPS coordinates are of the GPS antenna and not the position of the radio.

GPS self-survey

GPS survey is a special, and important, case of configuration that does not fit neatly into any category. It is an installation procedure that affects configuration.

Base and Wayside radios are equipped with internal GPS receivers. The GPS provides the precise timing required to synchronize the network.

Meteorcomm recommends that the GPS configuration use timing mode since it provides the most precise and reliable timing possible. In timing mode, the GPS can provide timing signals with a single GPS satellite in view. However, timing mode requires that the radio provides a position to the GPS. There are two ways to provide position to the GPS:

- Use the command line to configure surveyed position obtained offline.
- Allow the GPS to determine its own position.

Surveyed position obtained offline

One way to configure the radios GPS is to obtain the survey position offline, then use the LOCATION command to provide the position and instruct the radio GPS to use that position information.

Using this method, the user:

- Must maintain a database of position coordinates for all fixed installations.
- May configure the GPS by issuing the command manually, or by including the command in a CIM script file.

The following example shows the use of the LOCATION command:

```
+LOCATION,47:28.381N,122:14.013W,15.7
+POS,SOURCE,MANUAL
+POS,TIMING,ON
+TIMESYNC,GPS
+
```

GPS determines its own position

The second method allows the GPS receiver to determine its own position. This method adds an additional step to the radio installation process. The advantages with this method include:

- No need to obtain position information as a separate procedure
- No need to maintain a database of position information for each fixed GPS antenna

Some disadvantages include:

- The self survey takes several minutes and may not complete for all sites all the time. For example, at certain times of the day, an antenna may not have a direct line of sight to a GPS satellite. The radio cannot obtain the timing needed to allow precision transmissions without the survey completing.
- The survey has to be repeated whenever the radio is swapped out.

Use the POS command to request the radio to survey its own position.

In the following example, `POS,TIMING,SURVEY,1,1` requests the GPS to survey its own position for at least one minute until it detects an *rms* error of 1 meter. When the survey is complete, the GPS operational mode is automatically changed to timing mode and stored. The survey is not complete until the POS command indicates that the timing mode is `TIMING` (not SURVEY). The example below highlights timing vs. survey mode indication:

```
+POS,SOURCE,SURVEY

+POS,TIMING,SURVEY,1,1

+TIMESYNC,GPS

+POS

 GPS Interval = 30, Tx format = TEXT, Input format = UBX

 19:18:42 47:28.380N 122:14.015W S000 H000 A00014 V1

 Position entered from GPS survey

 Precision: LOW  NSAT: 9  HDOP: OFF (0.93)

 HOLD: OFF  LOCK: OFF  DGPS-Age: 99 Seconds

 COPY Port: OFF

 SCALE rrc values: 0.0000

 RXDIFF: ON, ALL

 Timing mode: Requested: SURVEY     Actual: SURVEY

 Surveyed ECEF position: x=-230367548  y=-365342165  z= 467746427

 Survey parameters: fixed err=      1000  req err=   1000000  req
time=   60

+

+POS

 GPS Interval = 30, Tx format = TEXT, Input format = UBX
```

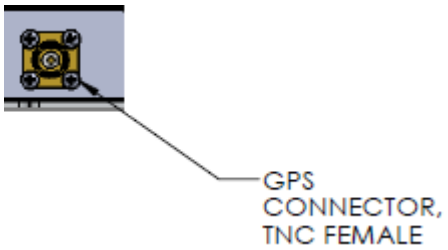
```
 19:19:45 47:28.381N 122:14.015W S000 H000 A00015 V1

 Position entered from GPS survey

 Precision: LOW  NSAT: 11  HDOP: OFF (99.99)

 HOLD: OFF  LOCK: OFF  DGPS-Age: 99 Seconds

 COPY Port: OFF

 SCALE rrc values: 0.0000

 RXDIFF: ON, ALL

 Timing mode: Requested: TIMING     Actual: TIMING

 Surveyed ECEF position: x=-230367629  y=-365342370  z= 467746792

 Survey parameters: fixed err=    993928  req err=   1000000  req
time=   60

+
```

Because it may take several minutes for the survey to complete, and completion should be verified, the survey should not be repeated unless a GPS antenna has been physically moved. Consequently this method is not recommended for inclusion in a CIM script file.

To connect the GPS antenna

The Wayside radio uses a TNC female connector and always provides an active antenna voltage. If the active antenna installed exceeds either the voltage or current ability of the radio then external power must be supplied to that antenna. A DC block must be used at the radio when the additional power is supplied to avoid damage to the radio.

Figure 9: GPS connector



1. Confirm the GPS antenna has been verified with a network analyzer.
2. Verify the power requirement of the GPS antenna and connect a DC block and tee in the case external power is necessary.

3. Connect the GPS antenna cable to the GPS antenna input connector on the radio and tighten securely but do not over tighten. Use caution to avoid cross threading the connector.

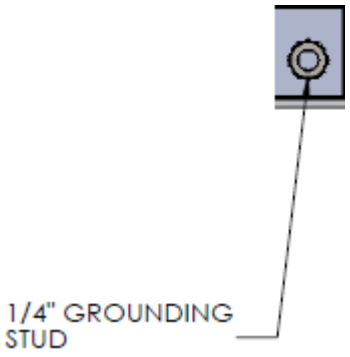
5.8 Ground the radio

Warning: This radio requires an external isolated power supply to provide ground isolation between the radio and the site electronics. Failure to use an isolated power supply (for example, connecting unit directly to site batteries) would induce a ground fault at the site since the radio unit is grounded to the bungalow both through the ground lug as well as the GPS and 220 antennas.

Warning: Ensure the radio is grounded. Not grounding the radio could result in possible bodily injury.

The Wayside radio has a ¼" grounding stud on the front of the radio.

Figure 10: Grounding stud



To ground the radio:

Note: The radio needs to be grounded to a proper isolated converter such as the Wilmore DC-DC isolated converter (P/N 1675-12-12-15) or equivalent.

1. Remove the nut and washer from the grounding stud.
2. Connect the ground wire ring lug to ground.

3. Replace the washer and nut and tighten to 65-75 in-lb for the ¼-20 nut.

5.9 Use current-limiting circuit protection

External circuit protection must be supplied to each radio. If necessary, always replace the fuse with a 10A/32V rated ATO fuse.

5.10 Connect the power cable

Warning: Applying an incorrect voltage to a radio can cause damage. Confirm the voltage of the power supply before applying power to the radio.

Warning: This radio requires an external isolated power supply to provide ground isolation between the radio and the site electronics. Failure to use an isolated power supply (i.e., connecting unit directly to site batteries) would induce a ground fault at the site since the radio unit is grounded to the bungalow both through the ground lug as well as the GPS and 220 antennas.

The Wayside radio operates from a 13.6 VDC nominal supply (10.9 to 15.5 VDC range) isolated from other electronic equipment using a DC-DC isolated converter such as the Wilmore Model 1675-12-12-15. The Wayside radio uses a Wago-type connector supplying 10.9 to 15.5 VDC.

Figure 11: Example of a typical power cable externally fused with 10A ATO

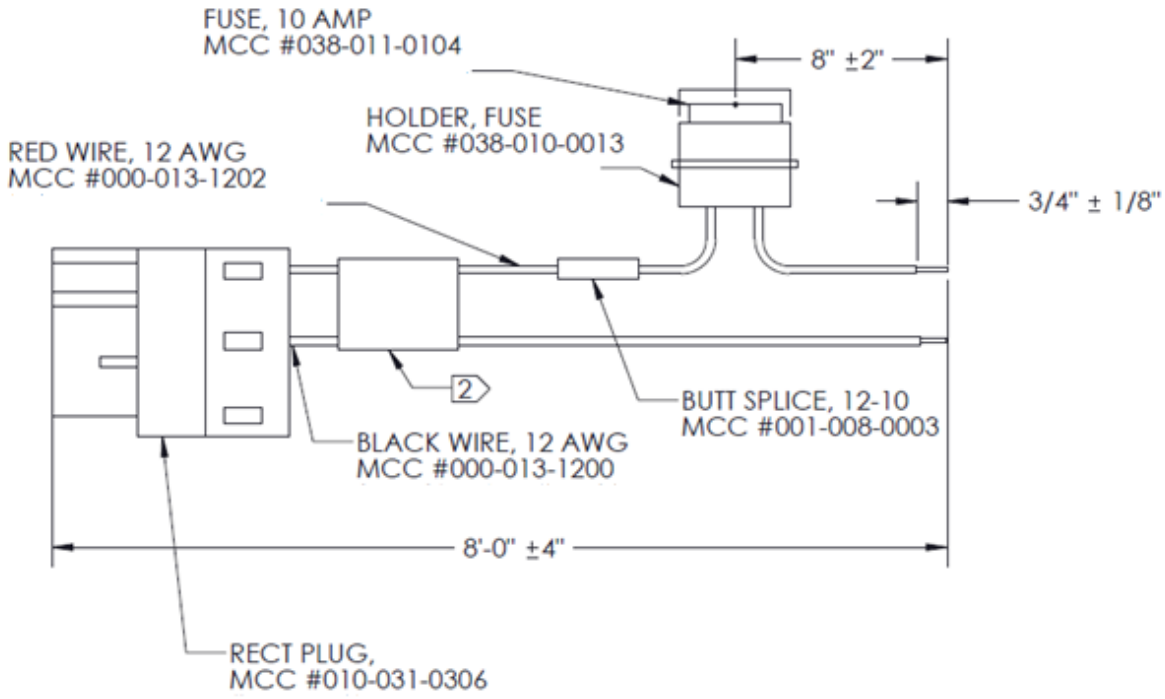
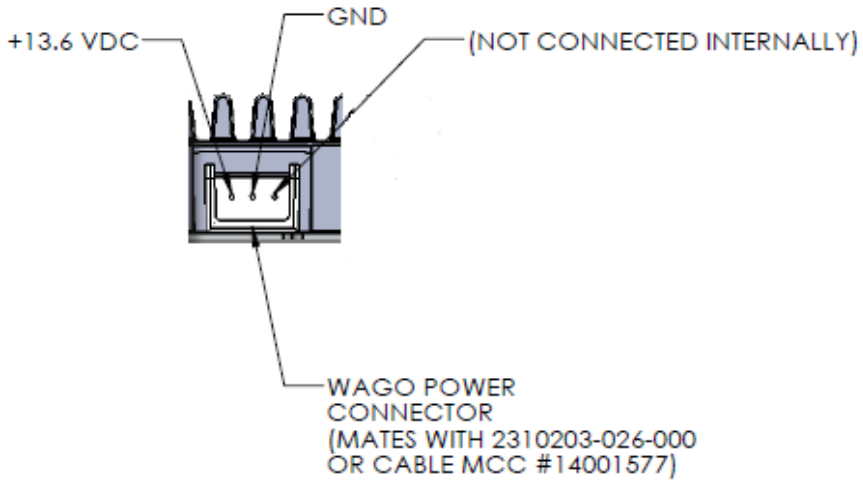


Figure 12: Power connector



1. The Wayside radio does not have a power switch. Verify the power is off before connecting the radio to a power source.
2. Insert the connector into the slot. The connector can only fit one way. Make sure the red wire is connected to the slot marked +.
3. Confirm proper grounding.

4. Verify the ground bond from the ground lug on the radio through external surge protection.
5. Confirm the ground lug connection has not bypassed the isolator converter.

5.11 Initial power on

Caution: Power should never be applied to any radio unless the user is acutely aware of his intentions and the environment in which the radio is operating. Applying power to an improperly terminated radio may result in damage to the radio, cause operator injury or violate regulatory laws regarding radio transmissions as radios will begin transmitting full rated power without any user intervention under certain conditions.

To power on the radio:

Make sure your computer network card has a fixed IP address of 192.168.255.200. See Configure the computer Ethernet interfaces to communicate with a radio for more information.

1. Confirm all connections are securely tightened.
2. Connect the laptop to the MAINT port with an Ethernet cable.
3. Start an XtermW session.

A flashing green POWER LED on the front panel indicates that the boot sequence has completed. Within approximately 10 seconds the Ethernet interface connection becomes active and allows you to run an XtermW session.

Table 2: Radio self test summarizes the self tests that occur at radio startup.

Table 2: Radio self test

Test	Description
RAM	Dynamic RAM is tested for correct operation. The amount of memory available is also detected.
Image	The firmware image is checked for corruption. Failure at this point can result in automatic rollback.
CONFIG	The internally stored configuration parameters are checked for corruption. Failure at this point will cause the radio to restore a factory default state.
CIM	A test is performed to ensure that the SD memory card is present and can be read. Radio configuration is also checked to ensure that it matches the CIM script file.
DC Voltage	Voltage levels of all internal power supplies are tested to ensure they are within the allowable range.
Firmware Operation	A hardware watchdog timer ensures that the firmware is running properly. If the radio fails to start up properly it will reset within 45 seconds. Failure subsequent to startup will also cause a reset.

If possible, any self tests that fail generate an alert and cause the front panel Fault LED to be illuminated (Table 3: Front panel LEDs).

Table 3: Front panel LEDs

Label	Description	Color	Indicates Normal Operation
POWER	A flashing green LED indicates that the radio is on.	Green	Flashing green
TX	Illuminated when the radio transmitter is keyed.	Red	On

Label	Description	Color	Indicates Normal Operation
VSWR	Illuminated when the VSWR of the TX port exceeds approximately 3:1. Illuminated if the TX forward power is not within 25% of the RF output power setting.	Red	Off
RX	Illuminated when the radio is receiving a valid 220 MHz PTC signal.	Amber	On
DTE LINK	Illuminated when the radio establishes a connection to a communication manager (CM) through the Ethernet network port.	Amber	On
RF LINK	Refers to RF Link. Illuminated when an RF link is established between two radios.	Amber	On
STANDBY	When illuminated, the radio is in standby mode and the TX is disabled.	Red	On
FAULT	When illuminated, it indicates a variety of fault conditions not indicated by other LEDs.	Red	Off

5.12 View the power-on self-test (POST) results

To run the POST and view results, disconnect and reconnect the DC power. The radio will automatically run internal diagnostics. A flashing POWER LED on the front panel indicates that the boot sequence has completed. Within approximately 10 seconds, the Ethernet interface connection becomes active.

Connect the computer to the MAINT port on the front of the radio. At the XtermW prompt type POST and press Enter. This returns the Host Post Log that contains general radio information and alarms. See Appendix D: Sample POST results from a properly functioning Wayside radio. If the SD memory card test fails then replace the radio or insert another card.

Make sure your computer network card has a fixed IP address of 192.168.255.200. See Configure the computer Ethernet interfaces to communicate with a radio for instructions.

To display the POST results:

1. Connect the computer to the radio MAINT port by using a CAT 5 Ethernet cable.
2. On the computer, open the XtermW application.
3. Click Send, click Command, and then type:

   POST
4. Click OK.
5. View the POST results list. See Appendix C: Sample POST results from a properly functioning Wayside radio.

6. Command security

User authentication identifies you as someone who is allowed to change the radio's configuration settings.

User-authentication tasks consist of:

- Logging on to a radio
- Logging off from a radio
- Changing your password
- Replacing a forgotten password

The following sections describe each task in detail.

6.1 Log on to a radio

The prerequisites for logging on to a radio are:

- Recommended: An SD card with a configuration information module (CIM) script is installed in the radio.

Note: You can log on without installing a CIM script. However, the radio will not transmit, and it will reboot after 5 minutes.

- The radio has powered on and booted up with the CIM script executing.
- A computer with its Ethernet interfaces configured to communicate with the radio is connected to the radio's MAINT port.
- The XtermW program is installed on the computer.
- You have permission to enter commands that can change configuration settings.

Without logging on, but with your computer connected to the radio, you can enter commands to get the radio's operational status only, such as SMS and IPCONFIG (without parameters). See the *ITCR Radio Management Guide* for more information.

Notes:

- The logon status defaults to logged off when the radio boots up. If you want to be logged on again, you have to re-enter your password after a reboot.
- You can make an unlimited number of logon attempts without being locked out of the radio.
- The default password is MCC-6300.
- You can have only one password.

To log on to the radio:

1. On the computer, open the XtermW application.
2. Click **Send**, click **Command**, and then type:

   `LOGON,password`

   Where:

   `password` is your current password

3. Click **OK** or press **ENTER**.

Note: If you enter the wrong password, you see the message "Incorrect password." If you are already logged on, you see the message "Already logged on."

6.2 Log off from a radio

After you log on to a radio, the radio logs you off automatically if it does not detect any activity from you for 10 minutes. You can also log off manually at any time.

To log off from a radio:

1. On the computer, open the XtermW application.
2. Click **Send**, click **Command**, and then type:

   `LOGOFF`

3. Click **OK** or press **ENTER**.

6.3 Change a password

Changing your password from the default password or a password you have been using for a while to a new password is a good way to improve radio security. If you are not sure of when to change your password, check with your company's established procedures for guidance.

The requirements for a password are:

- It can consist of any alphanumeric characters (a, b, c,… 1, 2, 3,…) plus the dash (-) character, in any combination.

  For example a password can consist of all letters, all numbers, or a combination of letters and numbers.

- It must be 3-20 characters long.

Passwords are not case sensitive.

To change your password:

1. Log on to the radio.
2. On the computer, open the XtermW application.
3. Click **Send**, click **Command**, and then type:

   `NEWPASSWORD,oldpassword,newpassword,newpassword`

   Where:

- `oldpassword` is your current password
- `newpassword` is the password you want to change to

4. Click **OK** or press **ENTER**.

6.4 Forget your password?

To replace a password that you have forgotten:

1. Ask an administrator who has permission to reset users' passwords to the default password, MCC-6300, to reset your password.
2. Change your password from the default password to one of your own choosing.

7. Troubleshooting

This section describes common radio problems, their probable causes, and likely solutions. It covers the following problems:

- Power
- SD card
- Antenna
- Transmission
- Receiver
- Ethernet connectivity
- RF link

In each of the following sections, a troubleshooting table lists solutions to these problems, in the order you should try them. Solutions that require more than one step are described in detail in Radio test and adjustment procedures.

7.1 Guidelines for troubleshooting common problems

Always check these items first when a radio problem occurs:

- **Check the physical radio connections**

  Make sure that all physical connections to the radio are secure. This includes: Power, Ethernet, Antenna(s), and GPS.

- **Check that the SD card is present**

  Make sure that there is an SD card with a valid CIM present in the SD card slot. Without a CIM, the radio will not transmit and will continually reboot every several minutes.

- **Check the LEDs**

  Use the LEDs to determine that state of the system and whether there is a fault condition. See Front panel LEDs: What they say about radio operation for more information.

- **Determine the software version each radio is running**

  Check the result of the REV command to determine what revision of radio software is running. All radios should be using a software version of 1.1.15.05 or later.

- **Check the POST log**

  Check the output of the POST command on the radio to ensure that no tests failed during the most recent power-on self-test. See View the results of the last POST for more information.

- **Check that the radio configuration is up to date**

  Run `INICHECK` to see if the radio configuration matches the current CIM script file. To run the CIM in the event that they are not the same, use:

  ```
  INICHECK,SCRIPT
  ```

7.1.1 Commonly used diagnostic commands

The following diagnostic commands provide information about the state of the radio, including current RF connections and software version information. They can be used to collect information that may be useful in determining why a radio connection is not performing as expected.

LINKSTAT

The LINKSTAT command displays the ITCnet radio statistics by link. On a remote radio, it also shows which Base radio is currently selected. A '~' to the left of the radio ID indicates that the remote radio is currently attempting to connect to the Base radio, and a '^' indicates that the remote radio is connected to the Base radio.

Example from a Wayside radio:

```
+linkstat 11/22/11 19:26:40
  NODE      CHAN TYPE     RXPKTS     TXPKTS     TXACKS     BCAST
B^00000222*  127 COMM          157          4          9          3
  BROADCST   000 SYSTM           0          0          0          0
  CMNBDCST   000 SYSTM           0          0          0          0

  NODE      CHAN TYPE     RXMSGS     TXMSGS     RXSEGS     TXSEGS
B^00000222*  127 COMM            2          2          4          4
  BROADCST   000 SYSTM           0          0          0          0
  CMNBDCST   000 SYSTM           0          0          0          0

  NODE      CHAN TYPE     BEACON   WAIT DTRF STAT   DIST DEG
B^00000222*  127 COMM            2 0000 -099 0000   0.00 216
  BROADCST   000 SYSTM           0 0000 -120
  CMNBDCST   000 SYSTM           0 0000 -120
```

REV

The REV command displays the current software version.

```
+REV 05/22/12 19:35:35 ETH1 port 4

     ITC PACKET DATA RADIO
(c) Copyright 2012 Meteorcomm LLC
      All Rights Reserved
S/W Part Number P63010-A17-01.01.15.06 ITC SVN r27917 Fri May 04 13:39:28 2012
S/W Part Number P63010-D06-01.01.15.06 DSP SVN r27892 Fri May 04 20:35:38 2012
S/W Part Number P63010-F06-01.01.15.06 FPGA SVN r27642 Fri Apr 27 17:42:15 2012
S/W Part Number P63000-C01 Flexbus CPLD Version 2.6 Fri Jun 03 17:47:32 2011
S/W Part Number P63000-B01 Boot Launcher Rev. 0.22.1 SVN 17525 2011-07-29
H/W Wayside Board
    ITC Role: Wayside
```

The software revision is highlighted above as 01.01.15.06.

STAT

The STAT,RF command displays the total number of packets transmitted and received over the air by the radio. Statistics are broken down by packet type. There are also several running totals included.

Example:

```
+stat,rf 19:28:54.282
 Bytes      Tx:      33213  Rx:       191
 Segments   Tx:          4  Rx:         4  Corr:           0  Bad:            0
 Packets    Tx:          2  Rx:        13
 AckedPkts  Ak:          2
 NonAckPkts Tx:       2340
 CtlPkt     Tx:       2285  Rx:         0
 Util       Out:       449  In:       104  HPCSMA:    105098  APCSMA:    105117
 QStatPkt   Tx:          0  Rx:         6
 BaseBeacon Tx:         35  Rx:         0
 AckPkt     Tx:          0  Rx:         2
 AcqPkt     Tx:          0  Rx:         1
 PosPkt     Tx:          0  Rx:         0
 TodPkt     Tx:         20  Rx:         0
 BcastShort Tx:          0  Rx:         0
 BcastLoc   Tx:          0  Rx:         0
 BcastComm  Tx:          0  Rx:         0
 UniLocal   Tx:          2  Rx:         4
 UniLocal   Ak:          2
 UniCommon  Tx:          0  Rx:         0
 UniCommon  Ak:          0
 UniBdcst   Tx:          0  Rx:         0
 OtherLocal Tx:          0  Rx:         0
 OtherLocal Ak:          0
 OtherComm  Tx:          0  Rx:         0
 OtherComm  Ak:          0
 Illegal                    Rx:         0
 Messages   Tx:          2  Rx:         2
```

STAT,HRX

The STAT,HRX command displays the HRX statistics. This command is useful for comparing how many of each type of message has been sent and received on the HRX host connection. See the *ITCR Radio Management Guide* for more information.

Example:

```
+stat,hrx 19:15:19.793
 HRX STATISTICS:       TX           RX
 --------------    ----------   ----------
 Bytes:                    24           78
 Messages:                  2            2
 Service Msgs:              2            1
 Data Messages:             0            1
 Short Broadcast:           0            0
 Long Broadcast:            0            0
 Unicast:                   0            0
 SH Code 0:                 0            0
 SH Code 1:                 0            0
 SH Code 2:                 0            0
 SH Code 3:                 0            0
 SH Code 4:                 0            0
 SH Code 5:                 0            0
 SH Code 6:                 0            0
 SH Code 7:                 0            0
 SH Code 8:                 0            0
 SH Code 9:                 0            0
 SH Code 10:                0            0
 SH Code 11:                0            0
 SH Code 12:                0            0
 SH Code 13:                0            0
 SH Code 14:                0            0
 SH Code 15:                0            0
 Unknown/Illegal:         ---            1
 ACK Messages:              0          ---
 NACK Messages:             1          ---
+
```

7.1.2 Front panel LEDs: What they say about radio operation

The front panel LEDs show the general operational status of the radio after the radio conducts a power-on self-test, or POST, which it does each time the radio boots up. Table 4: Front panel LEDs includes a description of the function of each LED as well as the color of each LED when the radio is functioning properly.

Note: If a problem occurs after a radio boots up, the front panel LEDs indicate the problem only after a re-boot of the radio provided the problem persists.

Read the description of each LED carefully. Some LEDs, such as the Power LED, indicate a problem when they are off. Other LEDs, such as the VSWR and Fault, indicate a problem when they are on.

Table 4: Front panel LEDs

Label	Description	Color	Indicates Normal Operation
POWER	A flashing green LED indicates that the radio is on.	Green	Flashing green
TX	Illuminated when the radio transmitter is keyed.	Red	On
VSWR	Illuminated when the VSWR of the TX port exceeds approximately 4:1 updated after a transmit. Illuminated if the TX forward power is not within 25% of the RF output power setting.	Red	Off
RX	Illuminated when the radio is receiving a valid 220 MHz PTC signal.	Amber	On
DTE LINK	Illuminated when the radio establishes a connection to a Communication Manager (CM) through the Ethernet network port.	Amber	On

Label	Description	Color	Indicates Normal Operation
RF LINK	Refers to RF Link. Illuminated when an RF link is established between two radios.	Amber	On
STANDBY	When illuminated, the radio is in standby mode and the TX is disabled.	Red	On
FAULT	When illuminated, it indicates a variety of fault conditions not indicated by other LEDs.	Red	Off

7.1.3 Boot up a radio

A radio boots up when it is powered on, the BOOT command is sent to it, or the software stops responding. During bootup, the radio:

- Resets the front panel LEDs. For example, if a defective SD card has been replaced, the Fault LED is off after bootup. If an SD card became defective after the last bootup, the Fault LED now illuminates.
- Runs a POST.

To boot up a radio:

Power on the radio by connecting it to a power supply that is at the correct voltage or send the BOOT command to the radio:

1. Connect the computer to the radio MAINT port by using the correct Ethernet cable.
2. On the computer, open the XtermW application.
3. Click **Send**, click **Command**, and then type:

   BOOT
4. Click **OK**.

If the radio problem has been solved, the front panel LED that indicated a problem should now indicate normal operation. If it still indicates a problem, continue troubleshooting.

7.1.4 View the results of the last power-on self-test (POST)

A POST is a series of several dozen tests that the radio quickly runs on itself each time it boots up, to determine if it has a problem or is missing critical information. The radio boots up when it is powered on or the BOOT command is issued at the command line. Entering post multiple times does not cause tests to be re-run since one execution of the tests are automatic each power-on.

POST results show whether the radio has passed a test, indicated by PASS, or failed a test, indicated by FAIL. The results do not appear on the radio, which has no display screen. Instead, you send a command to the radio and view the results on your computer monitor.

To view POST results:

1. Connect the computer to the radio MAINT port by using the correct Ethernet cable.
2. On the computer, open the XtermW application.
3. Click **Send**, click **Command**, and then type:

   POST
4. Click **OK** to view the POST results list.

7.2 Radio power problems

Problem indicators:

- There is no power to the radio.
- The POWER LED is off.
- The radio does not transmit.
- The POST results show that the internal voltages are low.

To troubleshoot radio power issues:

1. Make sure the power-cable connectors are securely connected to the power supply and to the radio.
2. Make sure the power-cable polarity is correct.
3. Check that the power supply is turned on. If it is off, then turn it on.
4. Adjust the power supply to within the rated operating voltage.

5. Measure the voltage at the power-cable connector to the radio.
6. Verify current limiting on the supply meets maximum current draw.
7. Replace the power cable.
8. Replace the radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

7.3 SD card and other problems indicated by a solid Fault LED

Problem indicators:

- The Fault LED is on.
- The POST results show that there is an SD card failure. See View the power-on self-test (POST) results.

Example showing the SD card portion of the POST results if the SD card is missing

HOST: SDCARD Present: FAIL

HOST: SDCARD Fail Pin: PASS

HOST: SDCARD Write Protect: OFF

HOST: SDCARD Access: FAIL

To troubleshoot SD memory card issues:

1. Check to make sure the SD memory card is present. See Confirm the SD memory card is installed. If it is missing or physically defective, install a new one. See Boot up a radio.

   If the SD card needs to be replaced then the CIM script file must be loaded to the new card. Please see the ITCR Radio Configuragion Guide for more information on CIM script files.

2. If the previous procedures do not turn off the Fault LED, or if the POST results list shows any other kinds of problems, then replace the radio.

7.4 Antenna problems

Problem indicators:

- Transmissions from or to the radio are poor or absent.
- The radio's VSWR LED is on.

To troubleshoot antenna issues:

1. Make sure the antenna-cable connectors are securely connected to the antenna and to the radio.
2. Check the antenna for any defects or breaks.
3. Issue the diagnostic command STAT to verify the VSWR and power output of the last transmission
4. Check the cable connector and radio connector for corrosion.
5. Check cable continuity
6. Disconnect the radio ANT connection and measure the antenna VSWR. Confirm it is within the VSWR operating requirement
7. Check the radio output power without the antenna connected.
8. Replace the cable or connector.
9. Replace the antenna.
10. Replace the radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

7.5 Transmission problems

Problem indicators:

- Transmissions from the radio are weak or intermittent.
- A radio in the network stops receiving expected communications from the radio.
- The TX LED is off.

To troubleshoot transmission issues:

1. Make sure the radio is turned on and the green POWER LED is blinking and no other FAULT's are present.

2. Issue the diagnostic command STAT to confirm the power output of the last transmission and VSWR.
3. Check the cable connector and radio connector for corrosion. If there is evidence of corrosion then replace the connector.
4. Check the temperature of the radio and confirm the PA temperature has not exceeded the over temperature threshold using the `txstat` diagnostic command. To follow are example results.

```
+txstat


Sniffer      - FALSE
CLI          - FALSE
Temperature  - FALSE
Voltage      - FALSE
CIM          - FALSE
Canned Msg   - FALSE
Test Mode    - FALSE
StartUp      - FALSE


Transmitter State - Available
```

5. With external test equipment verify the frequency accuracy of the radio transmission.
6. Make sure the antenna-cable connectors are securely connected to the antenna and to the radio.
7. Adjust the power output higher and lower to verify the transmission is controllable.
8. Monitor the current supplied by the power supply to confirm the typical transmit current is drawn and the radio is not current limited.
9. Issue a single tone or CW, which verifies the host processor to DSP communication if CW is present. If the CW works fine then the packet may not be communicated to the processor.
10. Check the antenna for any defects or breaks.

11. Adjust the power-supply voltage, if necessary. If the power-supply voltage is too low, the radio might stop transmitting.
12. Measure transmission power. See Create an MCC 63xx SDR connection profile.
13. Check the quality of the waveform and the frequency by using a spectrum analyzer.
14. Replace the cable or connector.
15. Replace the radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

7.6 Receiver problems

Problem indicators:

- A radio in the network stops receiving communications from another radio.
- The RX LED is off.

To troubleshoot receiver issues:

1. Make sure the radio is turned on and the green POWER LED is blinking.
2. Verify the transmit frequency is within limits.
3. Make sure the antenna-cable connectors are securely connected to the antenna and to the radio.
4. Check the cable connector and radio connector for corrosion. If there is evidence of corrosion then replace the connector.
5. Use a signal generator or a known good radio for a conducted receiver test to verify radio operation.
6. Make sure the radio is using the Auto channel control mode.
7. Make sure the Base radio has a local channel configured.
8. Replace the cable or connector.
9. Check the antenna for any defects or breaks.

10. Replace the radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

7.7 Ethernet connectivity problems

Problem indicators:

- The radio is disconnected from the network.
- The DTE Link LED is off.

To troubleshoot network connectivity issues:

1. If you cannot directly connect to the Maint port on the radio then contact your system administrator.
2. Check network activity, for example, by using Wireshark software and a computer. If the network is down, then the problem probably is not in the radio.
3. Make sure the Ethernet-cable is securely connected to the radio's LAN port.
4. Verify external network equipment is functioning properly.
5. Connect your computer to the radio's LAN port, send commands to the radio, and then see if the radio responds.

   Note: To connect the computer to the LAN port, the computer's Ethernet interfaces must be configured to communicate with the radio, and you must know the LAN Ethernet interface's IP address.

6. Replace the cable.
7. Replace the radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

7.8 RF Link problems

When the RF Link LED is on, it means that the Wayside radio has selected and connected to a Base radio. When the LED is off, it could mean that the Base radio has not communicated with the Wayside radio for a specified time.

Problem indicators:

- The RF Link LED is off.

To troubleshoot RF link issues:

1. Check the antenna for any defects or breaks.
2. Make sure the radio is turned on and the green POWER LED is blinking.
3. Make sure the antenna-cable connectors are securely connected to the antenna and to the radio.
4. Make sure there is a valid CIM script file loaded. At the XtermW prompt type `INICHECK,SCRIPT`.
5. In XtermW, run the `STAT,RF` command. This command displays the total number of packets transmitted and received by the radio. Statistics are broken down by packet type. There are also several running totals included.

Example:

```
+STAT,RF 19:28:54.282
 Bytes      Tx:      33213  Rx:       191
 Segments   Tx:          4  Rx:         4  Corr:           0  Bad:           0
 Packets    Tx:          2  Rx:        13
 AckedPkts  Ak:          2
 NonAckPkts Tx:       2340
 CtlPkt     Tx:       2285  Rx:         0
 Util       Out:       449  In:       104  HPCSMA:    105098  APCSMA:    105117
 QStatPkt   Tx:          0  Rx:         6
 BaseBeacon Tx:         35  Rx:         0
 AckPkt     Tx:          0  Rx:         2
 AcqPkt     Tx:          0  Rx:         1
 PosPkt     Tx:          0  Rx:         0
 TodPkt     Tx:         20  Rx:         0
 BcastShort Tx:          0  Rx:         0
 BcastLoc   Tx:          0  Rx:         0
 BcastComm  Tx:          0  Rx:         0
 UniLocal   Tx:          2  Rx:         4
 UniLocal   Ak:          2
 UniCommon  Tx:          0  Rx:         0
 UniCommon  Ak:          0
 UniBdcst   Tx:          0  Rx:         0
 OtherLocal Tx:          0  Rx:         0
 OtherLocal Ak:          0
 OtherComm  Tx:          0  Rx:         0
 OtherComm  Ak:          0
 Illegal                    Rx:         0
 Messages   Tx:          2  Rx:         2
```

6. Use the BBeacon command to ensure that the base beacons are configured for the common channel.
7. Verify the radio radio is transmitting. Use a signal source and perform a direct receiver test if necessary to isolate the problem.
8. Replace the radio.

8. Radio test and adjustment procedures

Some of the procedures you perform consist of a single, simple step, such as tightening a cable connection to fix a transmission problem. But several procedures consist of multiple steps. The multiple-step procedures are described in this section.

8.1 Required equipment

The tests and adjustments described in this section require service personnel to have the equipment listed in Required equipment as well as the skill and knowledge to use them.

Caution: Applying an incorrect voltage outside the rated voltage range of a Wayside radio can damage it. Confirm the voltage ratings of the radio and the power supply before applying power.

Table 5: Wayside radio input power parameters

Parameter	Value
Nominal DC Power Input Voltage	13.6 VDC
Operational Range	10.9-15.5 VDC (+14%/-20%)
Damage Limit	17 VDC
Current Drain (while transmitting rated power)	7.5 A typical while transmitting into 50 Ohm load, 10 A maximum

8.2 Configure the computer Ethernet interfaces to communicate with a radio

It is recommended that you use a computer with two Ethernet interfaces, Ethernet 1 and Ethernet 2, so that your computer can communicate with a radio's MAINT and LAN Ethernet ports at the same time. You need XtermW installed on the computer and have administrative rights to configure the Ethernet interfaces.

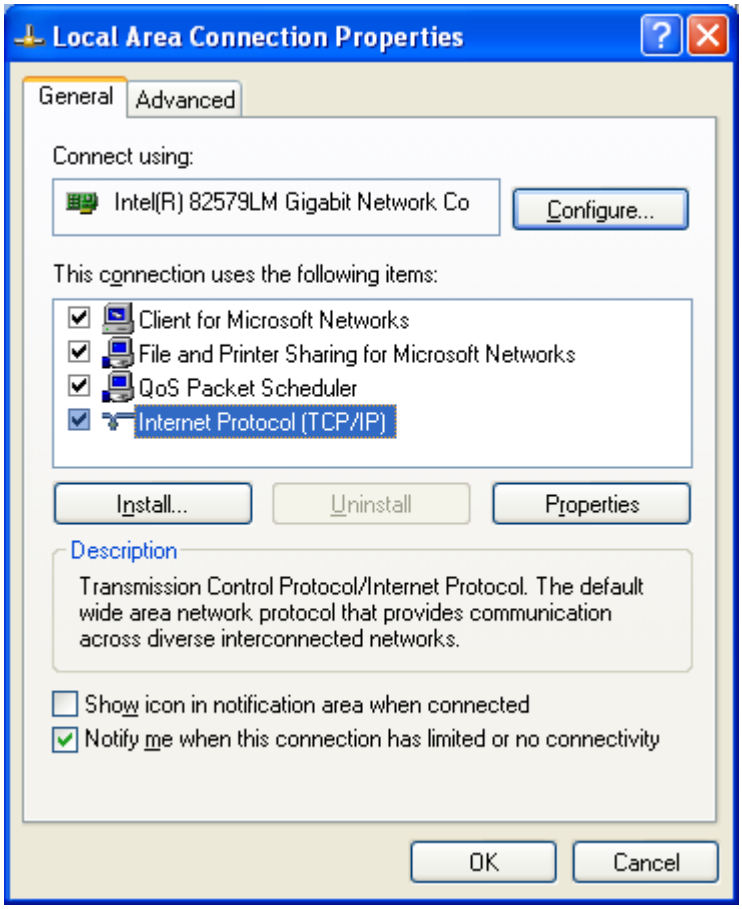
Notes:

1. The following configuration examples are for directly connecting to the radio and bypassing any network infrastructure. If direct access to the radio cannot be obtained then contact your network administrator for instructions.
2. If you are using the factory defaults then use the following examples. If you are not using the factory defaults then contact your network administrator for the appropriate IP settings.

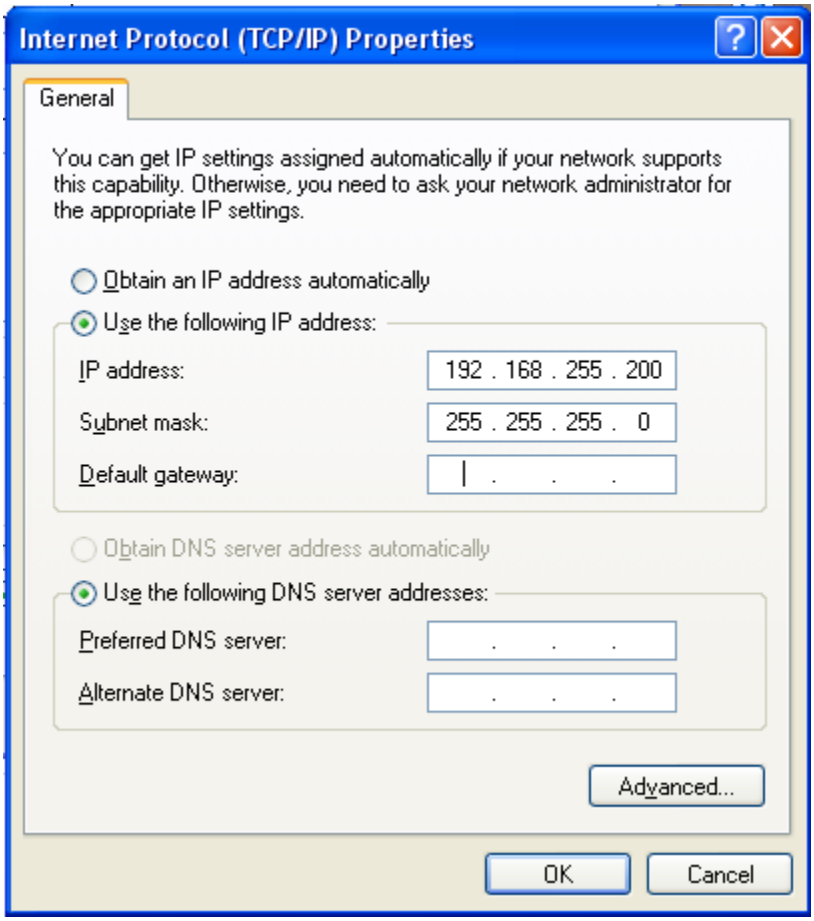
8.2.1 Configure a computer with two Ethernet interfaces

To configure the Ethernet 1 interface for the radio's MAINT port:

1. On the computer, click **Start**, **Control Panel**, **Network Connections**, and then **Local Area Connection**.
2. The **Local Area Network Connection Status** dialog box opens. Click **Properties**.
3. On the **General** tab, click to select the **Internet Protocol (TCP/IP)** check box, and then click **Properties**.

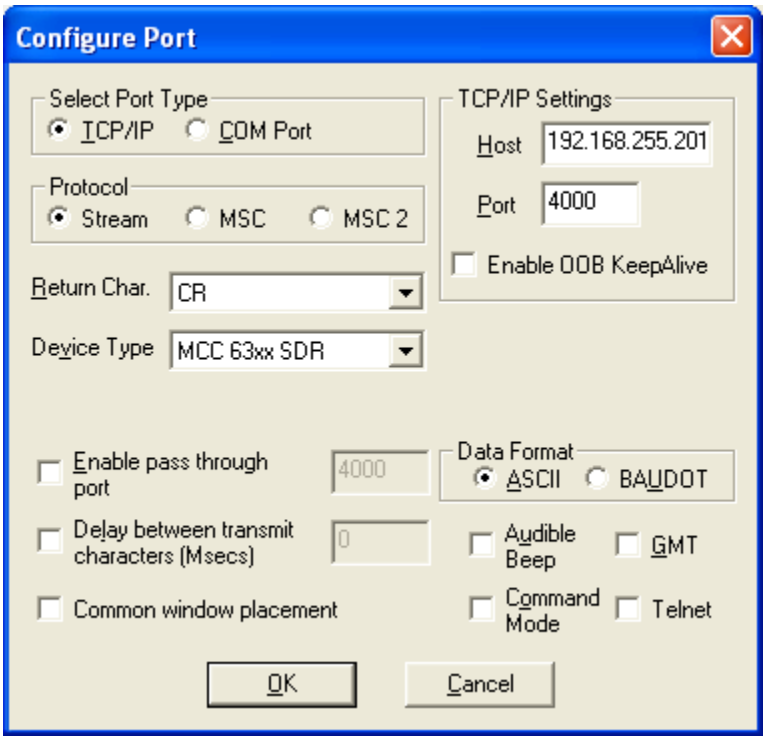


4. Click **Use the following IP Address**.



5. In the **IP address** box, enter **192.168.255.200**.
6. In the **Subnet mask** box, enter **255.255.255.0**.
7. Click **OK**.

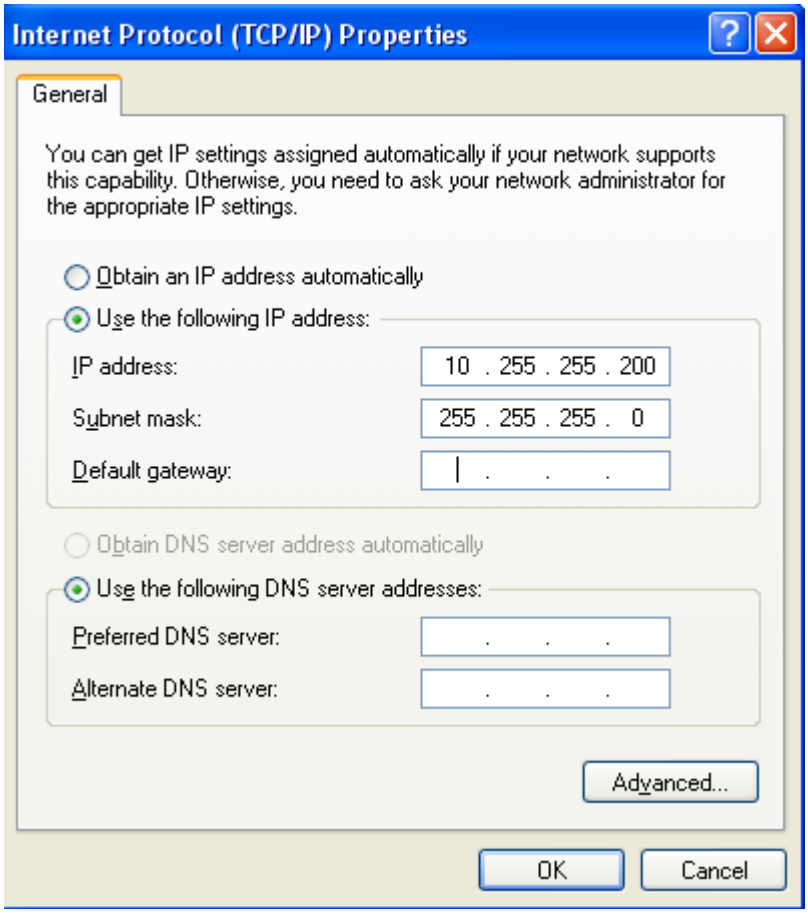
8. In XtermW, set the connection properties for the MAINT port connection as shown in the following figure.



To configure the Ethernet 2 interface for the Radio's LAN Port:

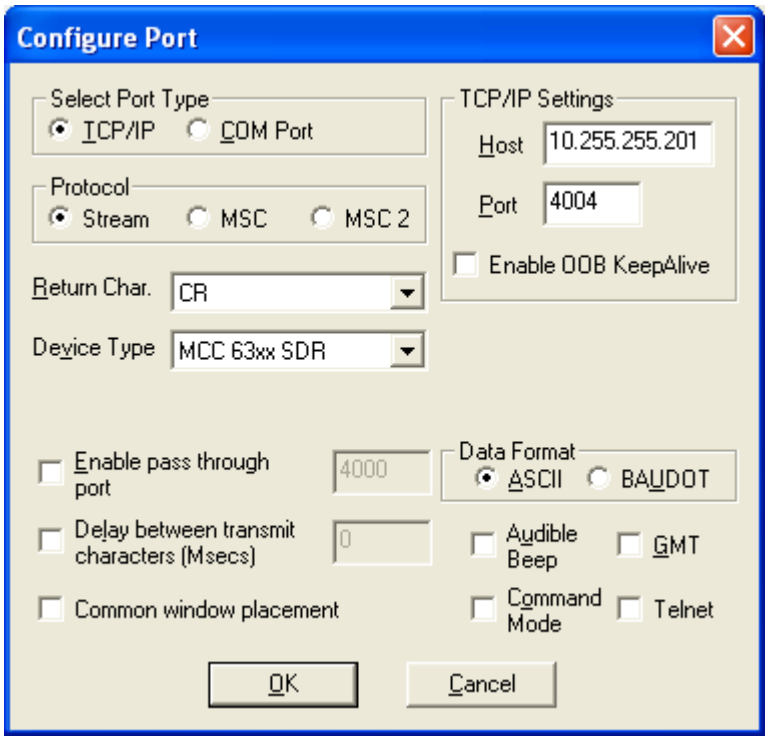
1. On the computer, click **Start**, **Control Panel**, **Network Connections**, and then **Local Area Connection**.
2. The **Local Area Network Connection Status** dialog box opens. Click **Properties**.

3. Click **Use the following IP address**.



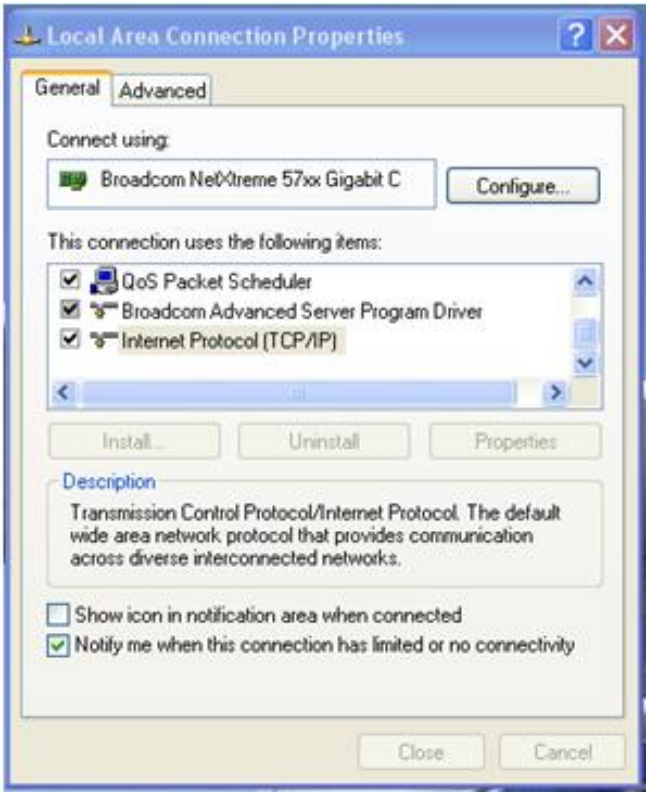
4. In the **IP address** box, enter **10.255.255.200**.
5. In the **Subnet mask** box, enter **255.255.255.0**.

6. In XtermW, set the connection properties for the LAN port connection as shown in the following figure:

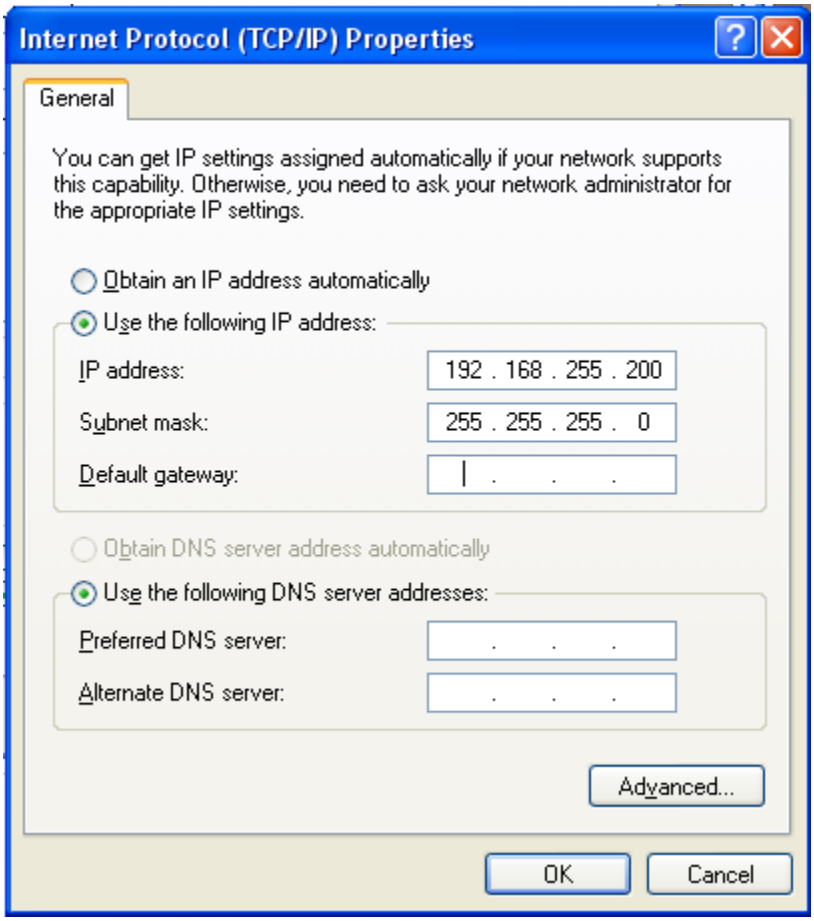


8.2.2 Configure a computer with one Ethernet interface

1. On the computer, click **Start**, **Control Panel**, **Network Connections**, and then **Local Area Connection**.
2. The **Local Area Network Connection Status** dialog box opens. Click **Properties**.

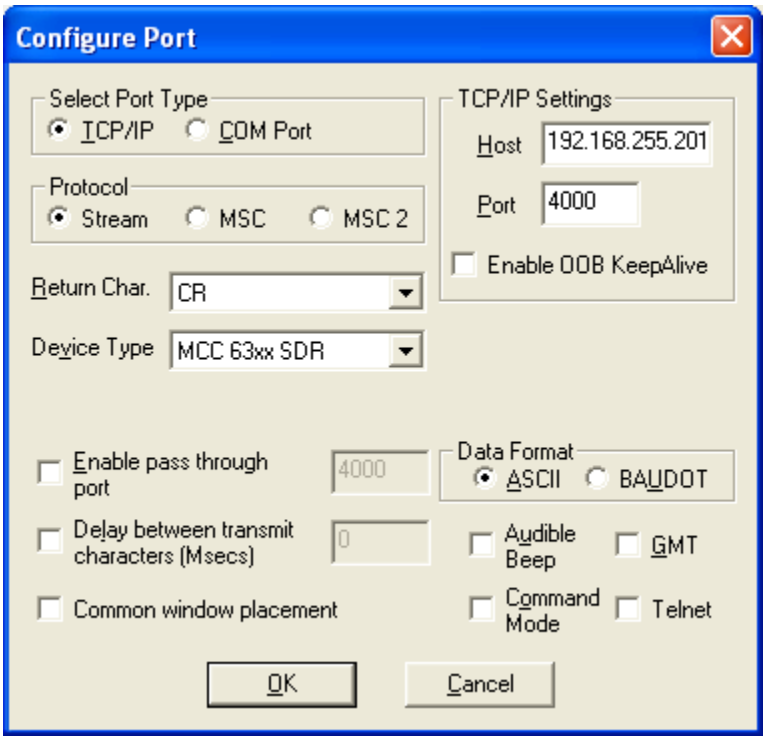


3. Click **Use the following IP Address**.



4. In the **IP address** box, enter **192.168.255.200**.
5. In the **Subnet mask** box, enter **255.255.255.0**.
6. Click **OK**.

7. In XtermW, set the connection properties for the MAINT port connection as shown in the following figure.

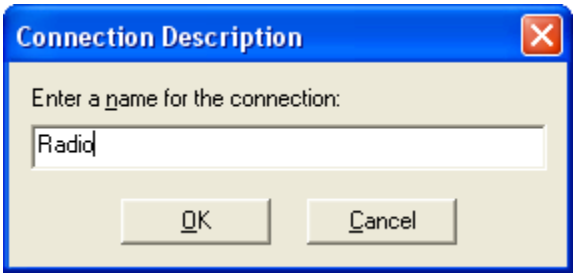


8.2.3 Create an MCC 63xx SDR connection profile

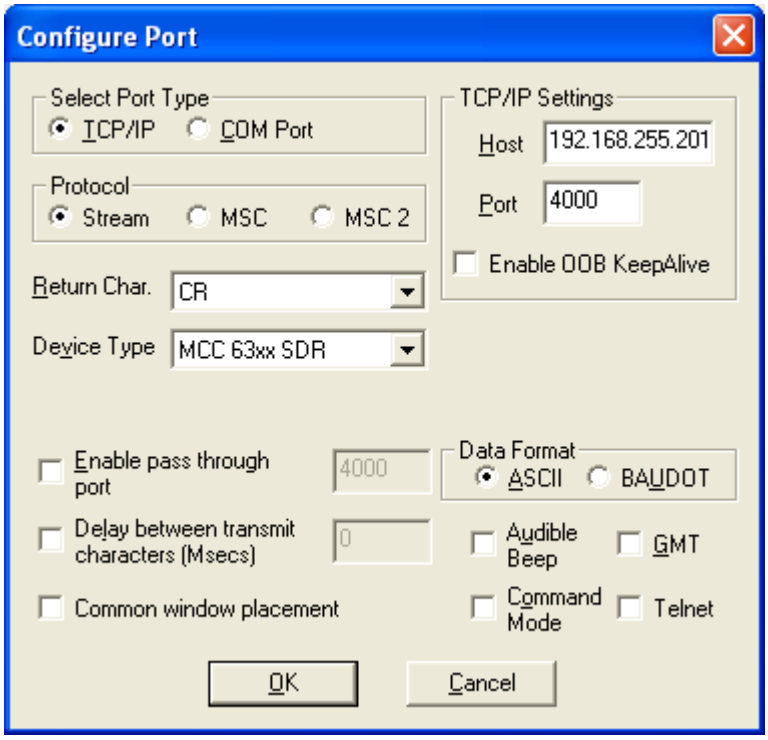
A connection profile is a group of settings created by XtermW when it is configured to make a new connection to an ITC radio.

To create an MCC 63xx SDR connection profile:

1. On the **File** menu select **New Connection.**



2. Enter a name for the connection and then click **OK**.
3. The **Configure Port** dialog box opens.



4. Set **Select Port Type** to **TCP/IP**.
5. Set **Protocol** to **Stream**.
6. Set **TCP/IP Host** and **Port** to the IP address and MAINT port of the radio.
7. Set the Device Type to MCC 63xx SDR.
8. Click **OK** to save and connect to the radio.

This connection profile can be reused in the future by selecting the menu item **File/Open Connection** and selecting the name of the connection profile or by selecting the connection profile from the recent profile list under the **File** menu.

8.3 Measure and adjust peak RF power output

8.3.1 Equipment used to measure and adjust peak RF power output

- A power supply capable of providing 13.6 VDC and a current of 10 amps
- 4 GHz spectrum analyzer that includes a DQPSK digital demodulation option

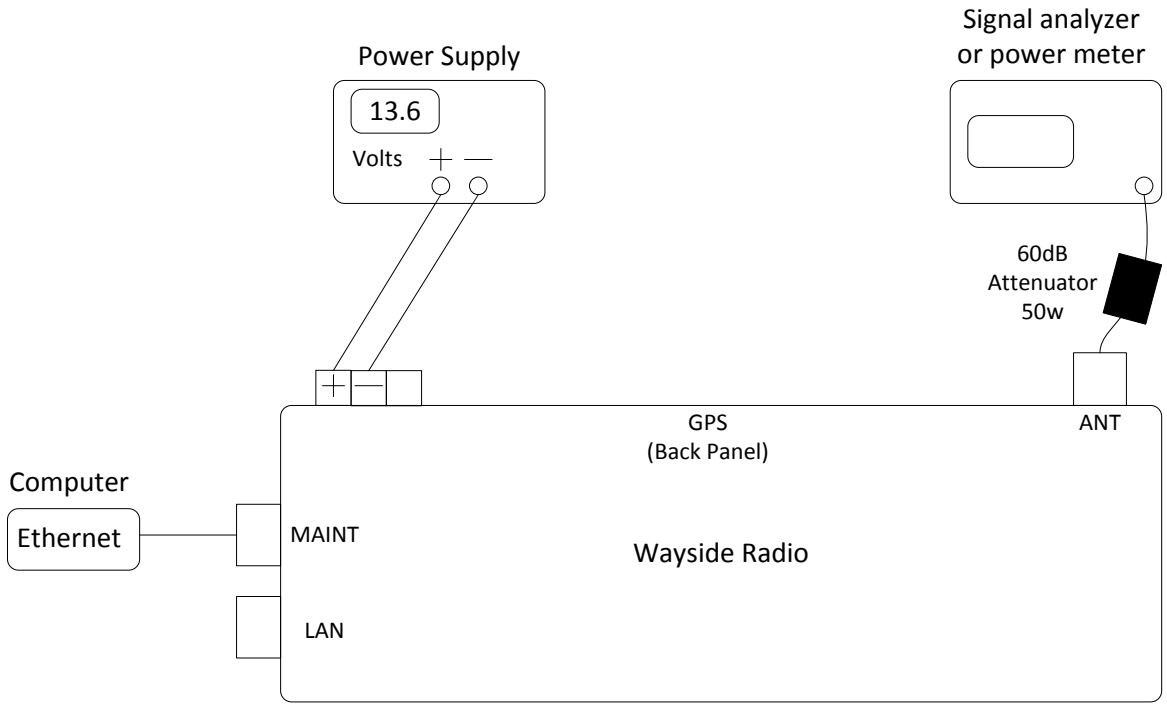
Or,

Agilent E4417A power meter to measure peak and average power or equivalent and Agilent E9325A Peak and Avg Power Sensor -65 to +20 dBm or equivalent

- 10 MHz signal reference
- 60 dB of attenuation rated at 50 W

8.3.2 System setup for measuring and adjusting RF power output

Figure 13: Wayside radio transmit setup



8.3.3 Expected peak RF power output

The expected peak RF power: 25 watts PEP

8.3.4 Measure RF peak power output

You measure RF peak power output by following these main steps:

- Calibrate the output power
- Measure peak power output with a power meter or with a spectrum analyzer
- Confirm peak envelope power (PEP) in band at the DDS Level

8.3.5 Radio transmission characteristics

The following spectrum analyzer images show typical radio transmission frequency and power spectrum characteristics, in half-DQPSK transmission modulation format. Using the commands in below in XtermW, key up the transmitter to half rate and observe radio performance:

To key up transmitter at π/4-DQPSK half rate:

1. At the XtermW prompt on the computer type:

```
STOP
SCHED,DEL,ALL
DSP_MODE,IDLE
DSP_MODE,TEST
L1_TEST,SET,TXFREQ,221137500
L1_TEST,SET,TXMOD,DQPSK_HALF
L1_TEST,TXDUTY,3500,300,0
```

Key off the transmitter using:

```
L1_TEST,STOP
```

Note: Each figure in this section shows a typical transmission spectrum or power measurement of a Wayside radio.

Figure 14: Typical transmission spectrum (HALF-DQPSK)

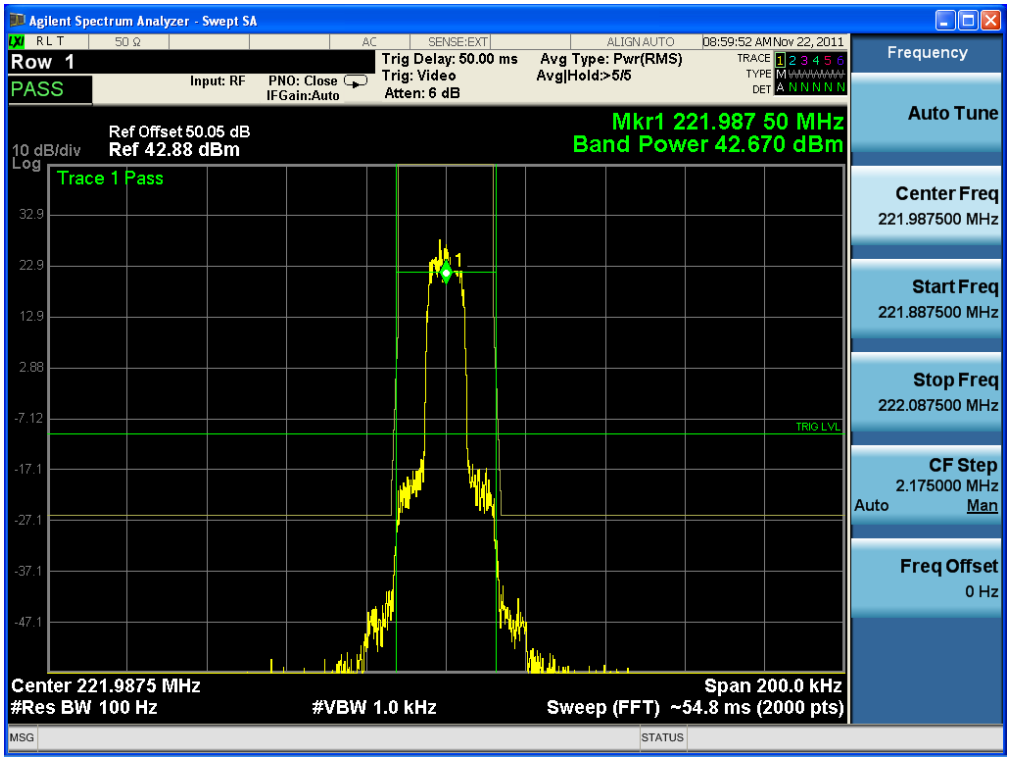
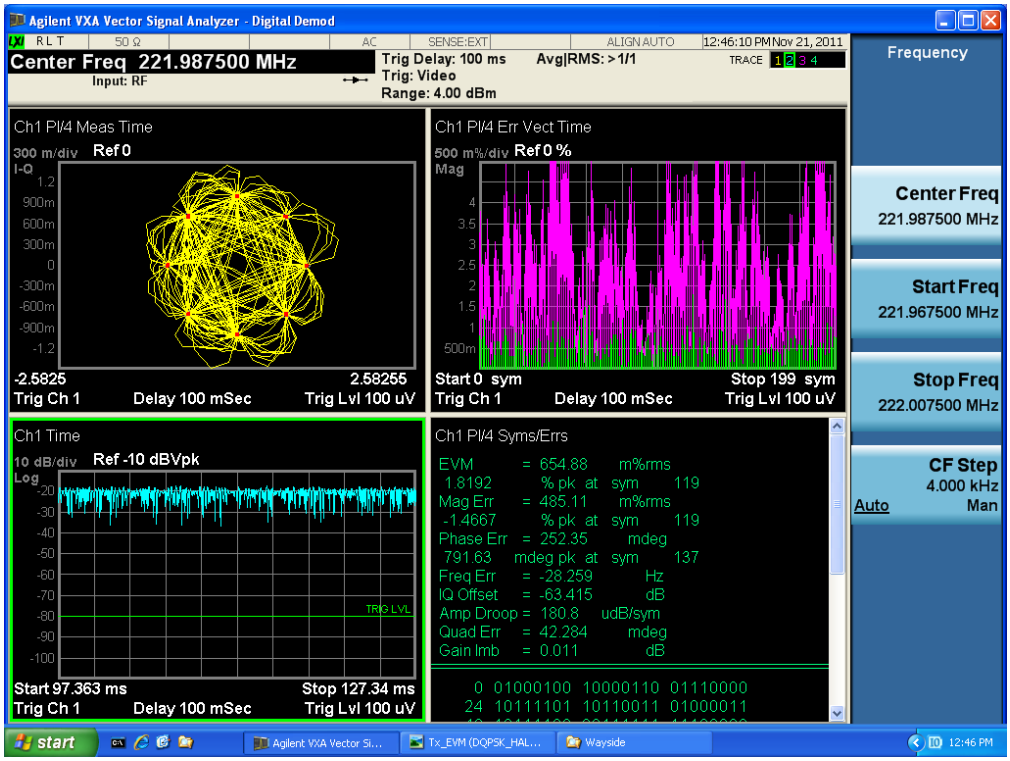


Figure 15: Typical transmission spectrum EVM (HALF-DQPSK)



8.3.6 Adjust RF power output

Wayside radios are rated for 25 W PEP. To achieve this power, radios are calibrated at the factory. If additional tuning is required, use the TXPOWER command to increase or decrease output power relative to the current power level.

Notes:

- You cannot adjust power above the factory-calibrated setting.
- π/4-DQPSK is a linear modulation technique.

To adjust RF output power:

1. Key up the transmitter for half-rate π/4-DQPSK modulation using the following commands in XtermW:

   ```
   STOP
   SCHED,DEL,ALL
   DSP_MODE,IDLE
   DSP_MODE,TEST
   L1_TEST,SET,TXFREQ,221137500
   L1_TEST,SET,TXMOD,DQPSK_HALF
   L1_TEST,TXDUTY,3500,300,0
   ```

2. To key off the transmitter, issue the following command:

   ```
   L1_TEST,STOP
   ```

3. With the transmitter keyed, monitor peak output power and make any necessary adjustments using the following command in XtermW:

   ```
   TXPOWER,value
   ```

   Where:

   `value` can be a positive (+) or negative (-) number, in dB (resolution to 1/10th of a dB), depending on whether you want to increase or decrease the power level.

4. If a TXPOWER level other than the default is permanently desired then you must save the setting. The procedure will vary depending on whether or not the `FACTORY,DEFAULT,INIT` command is included in the CIM file.

Note: If you do not know if the FACTORY,DEFAULT,INIT command is included in the CIM file then contact your network administrator.

- **If the** FACTORY,DEFAULT,INIT **command IS NOT set in the CIM**

  In XtermW type:

  SAVE

  This will result in a change sustained across power cycles.

- **If the** FACTORY,DEFAULT,INIT **command IS set in the CIM**

  The CIM script must include:

  TXPOWER,MAX

  TXPOWER,-nnn.nn

  where nnn.nn is the power reduction factor pre-determined by site survey technicians and is customized for each radio site operating at reduced transmit power levels.

  The TXPOWER,MAX command is required to ensure a known reference. The second command assigns a reduced level (in dB units) relative to that reference.

  This will result in a change sustained across power cycles.

Caution:

The following table shows the limits of the RF power output of the radios. Settings outside this range for operation into an antenna are out of FCC compliance.

It is the user's responsibility to confirm that settings are within compliance.

Table 6: Rated RF Power Output

Parameter	Wayside Radio	Locomotive Radio	Base Station
Conducted Carrier Output Power Rating	25W PEP nominal	50W PEP nominal	75W PEP nominal
Adjustment range	7.5 to 25W	15 to 50W PEP	10 to 75W PEP*
*7.5W PEP is +38.7dBm peak. Average power would be about 3dB less. The base range of 10 to 75W is less than a 9dB range.			

Note: Refer to the *ITCR Radio Configuration Guide* for more information on factory default settings and CIM script procedures.

8.4 Measure full-rate receiver sensitivity

8.4.1 ANT receiver measurement

To begin the test, make sure the E4438C signal generator is outputting the proper wave form into the ANT port on the radio. Next, issue the following commands using XtermW:

```
STOP
SCHED,DEL,ALL
DSP_MODE,IDLE
DSP_MODE,TEST
L1_TEST,SET,RXPATH,P
L1_TEST,SET,RXENABLE,3,ON
L1_TEST,SET,RXFREQ,value,3
L1_TEST,START,RX
SCHED,I,6,L1_TEST,GET,ERRCOUNTS,3,3
```

where:

`value` equals the desired frequency of operation.

To end the test, issue the stop command using XtermW:

```
L1_TEST,STOP
```

8.5 Put a trace on a feature

A trace enables you to monitor and capture a specific activity of an ITC radio. Examples of traceable activities are I/O port activity, RF link activity, and diagnostic information. You can save traces in a file.

Note: Heavy tracing can affect radio performance. Do not leave tracing on in the field.

Table 7: Brief descriptions of the available trace features

Feature	Description of traced data and notes
0-16	All activity on a selected I/O port
CLASC	Class C time and location messages
CLASD	Information about Class D messages
DEBUG	Variety of diagnostic data on ITC RADIO activity.
DLOG	Replaces “dsp_cmd, log, on/off” displays the DSP status log
DSP	Trace messages transferred from the DSP via the HPI interface
ETH	Information about Ethernet connection status
EVENT	Event activity
GPS	Activity in the GPS protocol device driver
HRX	Information about HRX messages
IDLE	Transmitted and received Base Beacons
ISMP	Information about ISMP messages
NOISE	Sampled (every second) and averaged (every five minutes) RF-noise levels
RF	Activity on the RF link
RSSI	Signal strength indicators

Feature	Description of traced data and notes
RX	Hex dump of data being received via the RF receivers
TX	Hex dump of transmit data being sent to the RF transmitter

To trace an activity:

1. Use an appropriate Ethernet cable to connect the correct computer Ethernet port to the radio's MAINT port.

   The Ethernet port must be configured to communicate with the MAINT port. See Configure the computer Ethernet ports to communicate with a radio.

2. On the computer, open the XtermW application.
3. Specify the radio port you want to communicate with: Click **Send**, click **Command**, and then type:

   `TRACE,PORT,MAINT`

   Where:

   - `TRACE` is the trace command
   - `PORT` is a subcommand
   - `MAINT` refers to the MAINT port

4. Click **OK**.
5. Select the trace feature and output destination: Click **Send**, click **Command**, and then **type**:

   `TRACE,level,feature,destination`

   Where:

   - `TRACE` is the trace command
   - `level` is a number from 0 to 7
   - `feature` is the name of the feature you want to trace
   - `destination` is the location of the trace output, which can be port, file, or both. If you do not enter the destination, the trace output is sent to the port only.

6. Click **OK**.

To suspend a trace:

1. In XtermW, click **Send**, click **Command**, and then type:

TRACE,suspend

2. Click **OK**.

To resume a trace:

1. In XtermW, click **Send**, click **Command**, and then type:

   TRACE,resume

2. Click **OK**.

To stop a trace:

1. In XtermW, click **Send**, click **Command**, and then type:

   TRACE,off

2. Click **OK**.

9. Managing software application images

From time to time, new functionality becomes available from the radio manufacturer in the form of a new software application image, or briefly, image. This new functionality is provided to the radio by updating the radio software.

All image management operations may be accomplished using operator commands. However, the radios also support the capability to perform some image management operations using ITC Systems Management (ITCSM) features via network connection from an application gateway. Refer to the *ITCR Radio Configuration Guide* for information about how to configure a radio for ITCSM connectivity.

Using ITCSM features involves creating a radio software kit, as well as sending the appropriate messages to the radio in order to perform the management operations. Consult with your Back Office support team or engineers for more information about ITCSM support of your radios.

This section explains how to:

- Obtain software image status information
- Update radio software application images
- Perform a manual software rollback
- Determine if automatic rollback has occurred
- Maintain multiple software images in the radio

9.1 Determining software image status

The APPS command displays a report containing the BootInfo information and a table of all installed application images.

The BootInfo includes information from the EEPROM boot record such as the BootInfo structure ID and Length, the bootlauncher version, the active image index and source, and the APPS Schedule report, the name, status, and file name of each image. The following table shows the image status codes.

Table 8: Software image status codes

Status code	Definition
RDY	Ready
NRDY	Not ready
SCHD	Scheduled
INV	Invalidated
FLTY	Faulty

Multiple software images can reside in the radio. However, the radio actively uses only one of them at a time, called the **active image**. The active image is the image that runs when the radio boots.

The following example output of the APPS command shows the BootInfo information, followed by the Apps Table, which shows image status. In this example:

- The radio is using bootlauncher version 0.22.1 SVN 17525 2011-07-29 (version).
- The radio has four (4) application images installed.
- Of the installed images, index number 2 (Inx), filename (Name) C:01011503.A18 is selected (Stat: RDY).
- C:01011503.A18 is the active image (Notes: ACTV).
- The active image has been launched (Lnch) two times.

```
APPS 04/09/12 23:34:20

** BEGIN *** BOOTINFO INFORMATION *****

---------------   ---------------------------

tag_id            3

length            254

version           0.22.1 SVN 17525 2011-07-29

reset_count       11

active_index      2

active_source     Flash1

active_user       USER_APP

schedule.enable   ON

schedule.status   BLANK

schedule.index    256

schedule.sched    256/00/2255 00:00

** END *** BOOTINFO INFORMATION *****

Inx Pri Stat Fail  Lnch  Date       Time      Size      Name           Notes Last
Status

--- --- ---- ----- ----- ---------- --------- --------- -------------- ----- ----
----------

  2  27  RDY     0     2 04/09/2012 05:10 PM    3364220 C:01011503.A18 ACTV
Success

  1   0 NRDY     0     0 04/09/2012 05:05 PM    3361028 D:01011401.A18

  3   0 NRDY     0     0 04/09/2012 05:03 PM    3346860 C:01011203.A18

  4   0 NRDY     0     0 04/09/2012 11:32 AM    3347544 D:01011101.A18
```

9.2 Updating software images

Updating the software means loading/installing the software image, selecting it to be active, and then activating/running it.

9.2.1 Updating Radio Software via command line

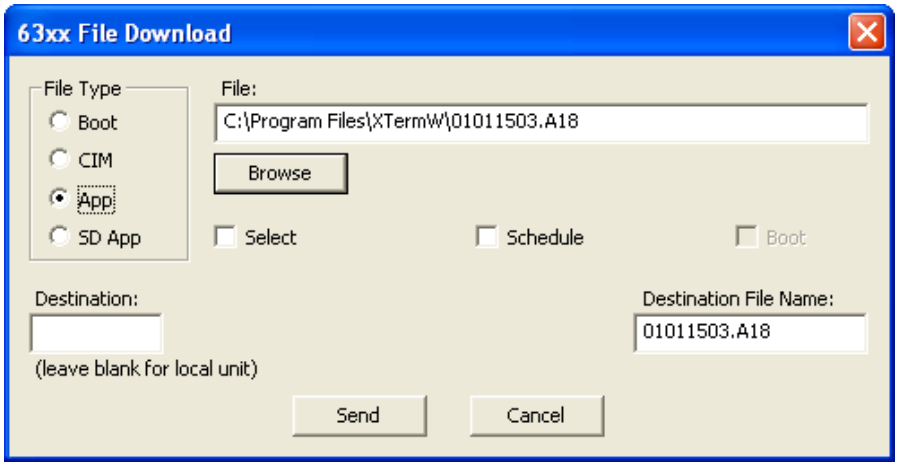
To update radio software:

1. Ensure that the new software image file is located on a computer drive accessible to the computer on which you launch XtermW.

2. Ensure that the destination file name is unique in the radio Apps table. Prior to performing the software update, check the names of existing files on the radio by using the *APPS* command to display a list of all installed application images.
3. Ensure that there is adequate space available on the non-active drive to store the file. If not, delete an unneeded image from the non-active drive using the *APPS,DELETE* command. (If the image to be deleted is RDY or NRDY, it must first be declared invalid via APPS,INVALIDATE command.)
4. Establish a connection from XtermW to the radio by using a connection profile that was created with Device Type set to MCC 63xx SDR.

   Note: The connection profile Device Type determines the kinds of menu options displayed, so it is important to use the proper connection profile. Refer to the XtermW User's Guide for more information about how to create an MCC 63xx SDR type connection profile.

5. To download the software image, on the Send menu, select 63xx File Download. You will see the following dialog box:



6. Under File Type, select App.
7. Click Browse, and then locate and select the software image file.
8. After you select the software image file:

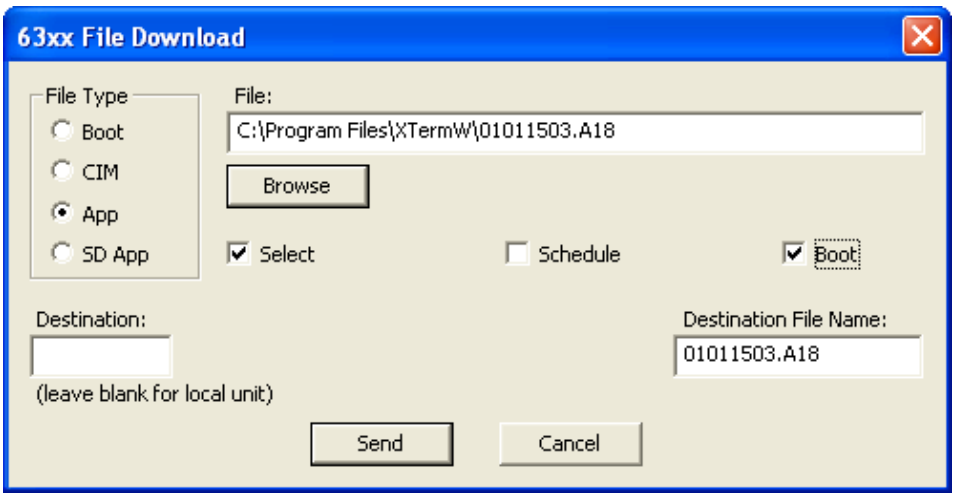
- The **Destination File Name** field is automatically populated with a file name derived from the selected image file name.

- Ensure that the destination file name meets the filename requirements.

9. To select this image immediately after it is downloaded, select the Select checkbox.

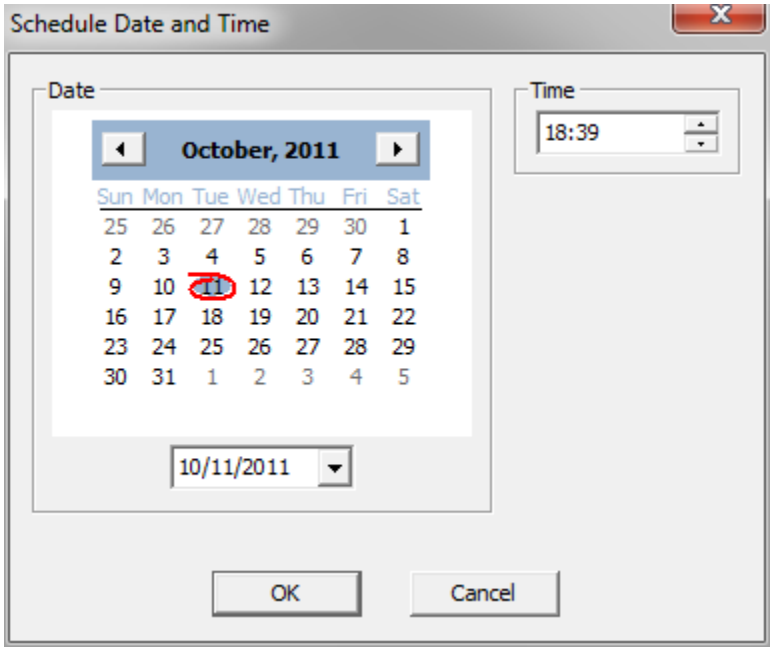
When you select the **Select** checkbox, XtermW automatically executes the `APPS,SELECT,<image-file>` command after the software image is downloaded. It also causes XtermW to enable the **Boot** checkbox.

The **Boot** checkbox is available only when you select the **Select** checkbox. When you select the **Boot** checkbox, XtermW automatically executes the `BOOT` command after the `APPS,SELECT,<image-file>` command, causing the newly downloaded image to become the active image after a reboot.

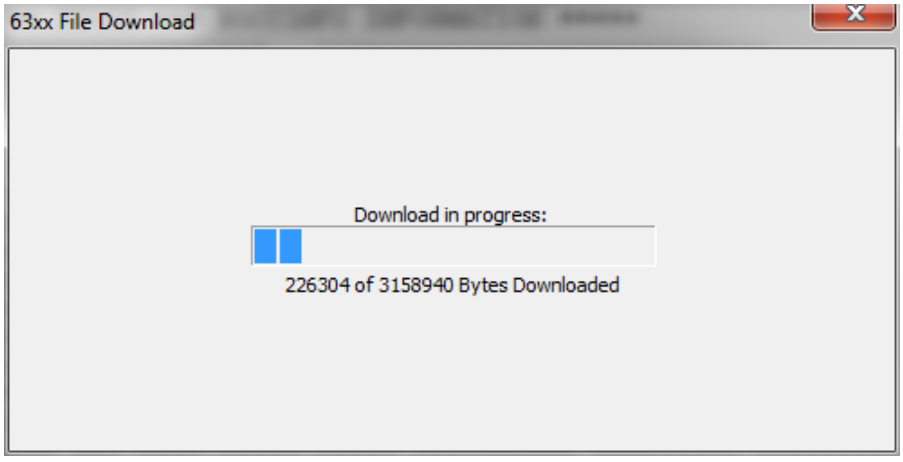


10. To execute a synchronized software update at a future time, select the Schedule checkbox. Choose the desired data and time in the popup, and then click **OK**.

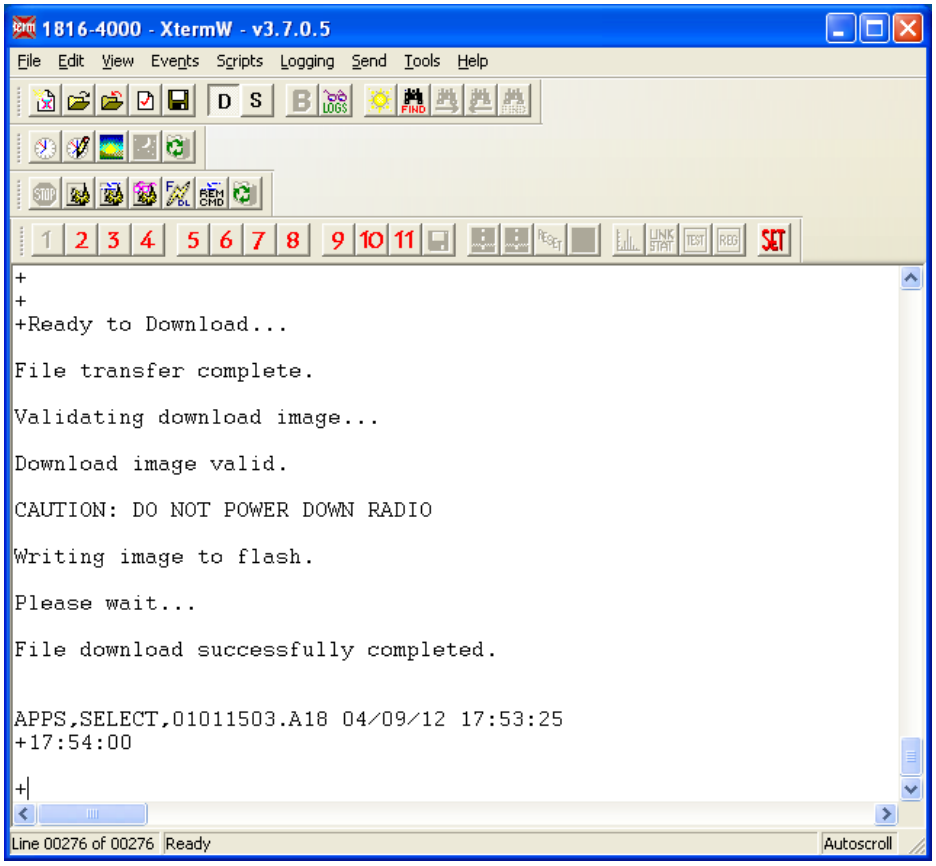
    When you select the **Schedule** checkbox, XtermW automatically executes the `APPS,SCHED,<date>,<time>,<image-file>` command after the software image is downloaded.



11. Click **Send** to begin the download.



12. After the installation finishes, you see the following text in the XtermW console window:



13. Execute the APPS command, and then observe the following:

- If the **Select** and **Boot** checkboxes were selected, the downloaded software image will be listed as ACTV (active image) after the reboot.
- If the **Select** checkbox was deselected, the downloaded software image will be listed with a status of NRDY.
- If the **Select** checkbox was selected, the downloaded software image will be listed in the top row of the Apps table with the highest priority and a status of RDY.
- If the **Schedule** checkbox was selected, the downloaded software image will be listed with a status of SCHD. The APPS,SCHED command displays a report of the software update schedule.

9.3 Rolling back an image

9.3.1 How automatic rollback occurs

Each time the active image fails to execute for longer than four (4) minutes due to unexpected power-cycles (the application fails or there is a power interruption), the failure counter of that image is incremented. When the active image executes longer than four (4) minutes, the failure counter of that image is reset.

In rare instances when the active image failure counter exceeds the failure counter threshold, the bootlauncher executes the following logic at power up:

Find **all** other images in the Apps table that have a RDY status.

If any RDY status images are found in the Apps table, then:

a. Select the image with the highest priority as the new active image.

b. Mark the previous active image as faulty (FLTY).

c. Launch the new active image. Automatic rollback has occurred. The previous image will display a FLTY status in the Apps report.

Else, if no other RDY status images are found then:

a. Update the failure counter of the current active image even if the failure counter exceeds the failure counter threshold.

b. Keep the current active image status as RDY.

c. Retry launching the current active image.

9.3.2 Determining if automatic rollback occurred

View the Apps report to determine if automatic rollback occurred.

To check if automatic rollback occurred:

Execute the APPS command.

Observe the status column of the Apps report:

- The previous active image will be listed with a status of FLTY and its failure counter will indicate a value greater than the failure counter threshold.
- Since the previous active image status is now FLTY, it is no longer manually selectable by the APPS,SELECT command, or by the Automatic rollback feature.

Note: You can manually delete the FLTY image by using the APPS,DELETE command. The FLTY image may also be automatically deleted when disk space is needed for new image downloads.

9.3.3 Rolling back an image via command line: APPS

You can manually rollback software when there are multiple software images installed in the radio.

To manually rollback a software image:

Execute the APPS command.

View the list of installed images.

In the sample APPS command output below, the following images are installed: C:01011503.A18, D:01011401.A18 and C:01011203.A18, where C:01011503.A18 is the active image.

```
Inx Pri Stat Fail  Lnch  Date       Time      Size      Name           Notes Last
Status

--- --- ---- ----- ----- ---------- --------- --------- -------------- ----- ----
----------

  3  27  RDY     1     2 04/09/2012 05:10 PM    3364220 C:01011503.A18 ACTV
Success

  2  26  RDY     0     2 04/09/2012 05:05 PM    3361028 D:01011401.A18
Success

  1  25  RDY     0     0 04/09/2012 05:03 PM    3346860 C:01011203.A18
```

If required, setup a CIM script association for each image to ensure that the proper CIM script executes when a particular image becomes the active image. Use the INISELECT command.

To manually rollback to D:01011401.A18, use the following commands:

```
APPS,SELECT, D:01011401.A18

BOOT
```

After the reboot, the Apps table should report D:01011401.A18 as the active image. Rollback is complete.

```
Inx Pri Stat Fail  Lnch  Date       Time      Size      Name           Notes Last
Status

--- --- ---- ----- ----- ---------- --------- --------- -------------- ----- ----
----------

  2  28  RDY     1     4 04/09/2012 05:05 PM    3361028 D:01011401.A18 ACTV
Success

  3  27  RDY     0     2 04/09/2012 05:10 PM    3364220 C:01011503.A18
Success

  1  25  RDY     0     0 04/09/2012 05:03 PM    3346860 C:01011203.A18
```

9.4 Maintaining multiple software images in the radio

9.4.1 Managing images via command line: APPS

The following table summarizes the actions that can be performed on software images using the APPS command.

Table 9: Software image actions

Action	Resulting image status
Install (using XtermW)	Different statuses depending on options selected during installation: NRDY if Select = No and Schedule = No RDY: if Select = Yes and Schedule = No SCHD if Schedule = Yes
Select	RDY The selected image is elevated to the highest priority of all installed images. The selected image is specified for activation at next power-up. Only images with the status of RDY, NRDY and INV are selectable.

Action	Resulting image status
Schedule	SCHD Only images with status of RDY or NRDY are eligible for scheduling.
Unschedule	NRDY Images with the status of SCHD may be unscheduled with the APPS,UNSCHED command
Demote	RDY Priority value swapped with next lower priority image with a RDY status Only images with a RDY status may be demoted
Deselect	NRDY Image is excluded from selection by the automatic rollback algorithm System requires at least one RDY image; the system will not allow deselection of the last remaining (only) RDY image.
Invalidate	INV Images with status INV are not selectable by the automatic software rollback algorithm. Images with status INV may be deleted by the APPS,DELETE command and by the automatic file-system cleanup during APPS downloading operations.
Delete	Images with the status NRDY, FLTY or INV can be deleted by the APPS,DELETE command. The image is removed from the Apps table and the file system

9.4.2 System events on installed software images

The radio may automatically perform the following actions on installed software images:

Table 10: System events on installed software images

Event	Description
Status change from RDY to FLTY	If the failure counter of the image with the highest priority exceeds the threshold, and there exists other RDY images, the automatic rollback algorithm changes the status of the image to FLTY, causing the next highest priority RDY image to become the active image
Status change from SCHD to RDY with highest priority	If APPS,SCHED is enabled and a schedule has expired, the radio will automatically select the scheduled image
Delete image	If an APPS download operation requires additional space, any image with the INV or FLTY status that resides on the target drive is deleted from the file system and the Apps table.

10. Routine maintenance

- Remove dust and obstructions from heat-sink fins.
- Ensure that the radio is free of excessive condensation and moisture.
- Make sure that the radio is securely mounted and supported.
- Make sure that the cables do not exceed the minimum bend radius.
- Restrain cables to prevent stress on connectors.
- Remove cables and inspect the pins do not have corrosion during a powered off maintenance cycle.
- Verify that cable insulation is not sliced, worn, or cracked.
- Make sure that the SD memory card door is securely closed.
- Keep the indicator-LEDs panel dust-free and viewable.
- Remove any animals or animal dwellings from the radio.

Appendix A: Parts list

The following part numbers are meant for reference only and are subject to change without notice.

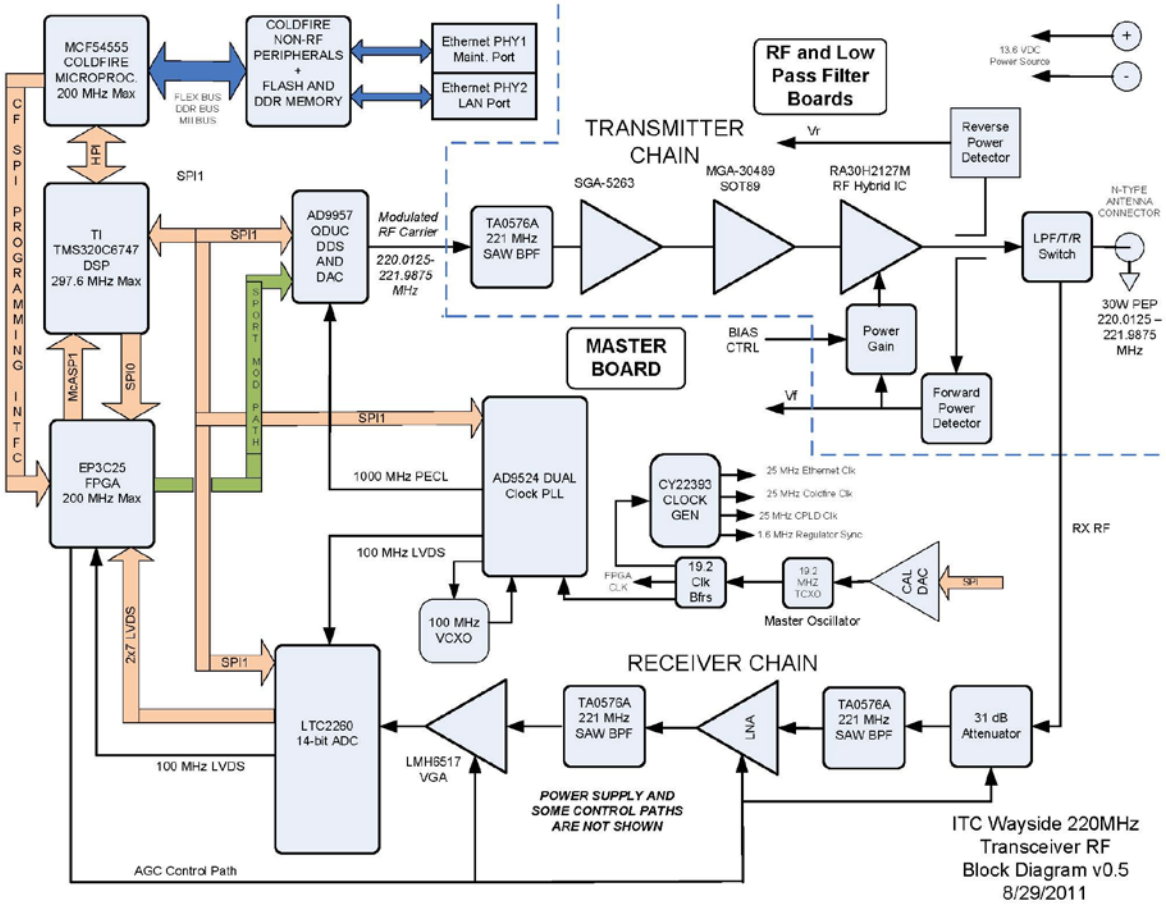
Table 11: Wayside radio parts and part numbers

Part name	Part number
Shipped assembly	WAYSIDE 63010901-PP2
Top-level assembly	WAYSIDE 63010000-05
TNC panel cable assembly	14001575-03
Ribbon cable assembly	14001601-02
RF MHF cable red assembly	14001618-03
RF MHF cable blue assembly	14001619-03
PA module shield	54508522-01
Cover assembly CIM Card	63010101-01
SD cover	63010505-01
SD gasket	63010512-01
PCA, RF & DC	63010308-02
PCA, T/R switch	63010309-01
PCA, master	63010311-02
PCB, Coupler	63010404-02
0-ring gasket	63010507-01
CIM card shield	63010511-01
Machined housing	63010515-02
WAGO dust shield	63010518-01
RJ45 gasket	63010522-01
Rear cover	63010103-01
Antenna label	63010527-01
LED and LEGENDS Label	63010530-01

Part name	Part number
Serial Number Label	63010531-01
Serial Number Label	63010535-01

Appendix B: Block diagram

Figure 16: 220 MHz Wayside tranceiver block diagram



Appendix C: Sample POST results from a properly functioning Wayside radio

```
+POST 05/22/12 19:35:36


*************** Host Post Log ***************

Board Type                    : Wayside
Hardware Revision             : F3
Serial Number                 : 63WR000278CA

HOST: DDR Address Line Test   : PASS
HOST: DDR Data    Line Test   : PASS
HOST: SPI                     : PASS
HOST: SDCARD Present          : PASS
HOST: SDCARD Fail Pin         : PASS
HOST: SDCARD Write Protect    : OFF
HOST: SDCARD Access           : PASS
HOST: I2C Controller          : PASS
HOST: RTC                     : PASS
HOST: BOOT FLASH (C:)         : PASS
HOST: BOOT FLASH (D:)         : PASS
HOST: DATA FLASH (E:)         : PASS
HOST: SEEPROM STAMP           : PASS
HOST: CALIBRATION PARAMETERS  : PASS
HOST: REG PARAMETERS          : PASS
HOST: ID PARAMETERS           : PASS
HOST: CHANNEL TABLE           : PASS
HOST: SITENAME                : PASS
HOST: DHCP CONTROL            : PASS
HOST: SERIAL NUMBER           : PASS
```

```
HOST: FPGA LOAD              : PASS
HOST: DSP  LOAD              : PASS
HOST: DSP RUNNING            : PASS
HOST: ETHERNET 0             : PASS
HOST: ETHERNET 1             : PASS
HOST: MAC 0                  : PASS
HOST: MAC 1                  : PASS
HOST: GPS                    : PASS
HOST: CIM                    : PASS
DSP:  CLOCK                  : PASS
DSP:  EDMA                   : PASS
DSP:  GPIO                   : PASS
DSP:  SPI                    : PASS
DSP:  MCASP                  : PASS
DSP:  PSC                    : PASS
DSP:  EXTERNAL CLOCK         : PASS
DSP:  DDS                    : PASS
FPGA: MEMORY                 : PASS
FPGA: Clocks                 : PASS
FPGA: Tx                     : PASS
HOST:  5.0v  Supply          : PASS :  4.988
HOST:  3.3v  Supply          : PASS :  3.288
HOST:  2.5v  Supply          : PASS :  2.502
HOST:  1.8v  Supply (Host)   : PASS :  1.862
HOST:  1.5v  Supply          : PASS :  1.486
HOST:  1.2v  Supply (Host)   : PASS :  1.246
HOST: External Supply        : PASS :  13.318
HOST:  6.0V Supply           : PASS :  5.966
HOST:  PA Temp               : PASS :  26.422
HOST:  Main Board Temp       : PASS :  26.867

boot loader version 0.22.1 SVN 17525 2011-07-29
reset_count         1
active_index        1
```

```
active_source       Flash1
active_user         USER_BOOT

Inx Pri Stat Fail  Lnch  Name           Notes Last Status
--- --- ---- ----- ----- -------------- ----- --------------
  1   6  RDY     1     0 C:01011506.A17 ACTV  Success
```

Appendix D - Program signal generator for DQPSK

How to set up an Agilent E4438C to test receivers with Sprints 18 to 23.02b

Step	Action	Button / Selection
1	Power cycle unit.	On/Off
2	Enter mode to program signal generator.	Mode
3	Select custom to define a custom waveform.	Custom
4	Select 'Real Time I/Q Baseband'.	Real Time I/Q Baseband
5	Define the modulation type.	Modulation Type
6	Select Pi/4-DQPSK.	Pi/4-DQPSK
7	Get ready to set the other parameters.	Mode Setup
8	Define the data stream by first selecting 'Data'.	Data
9	Define a custom user file.	User File
10	Create a user file.	Create File
11	Define the preamble bits using the numbered keypad.	1111 0011 0011 0111 1110 1110 1011 0110 0011 0111 0110 0110 0000 0110 0111 0010
12	Insert a PN9 sequence at the end of the preamble sequence.	INSERT
13	Select 'INSERT PN9'.	Insert PN9
14	Choose 'Insert PN9' (not 'Seed 1FF).	Insert PN9
15	Add a post- to the end of the sequence. Using the cursor keys (arrows), navigate the cursor to the end of the sequence just inserted.	→ / ↓
16	Complete a sequence of 528 bits by adding a '1'. Note: The final byte should read '1000 0001' or 1110 0001'.	1
17	Add 2 bytes of guard.	1111 1111
18	Press 'Return' twice.	Return Return
19	Press the 'Rename' button.	Rename

Step	Action	Button / Selection
20	Use the 'More' button to give the user file a useful name – 'DQPSK'.	D-Q-P-S-K or a suitable unused file name.
21	Save the user file.	Enter
22	Return to an upper level to define additional parameters.	Mode Setup
23	Select 'Filter'.	Filter
24	Choose 'Select.'	Select
25	Pick 'Root Nyquist'.	Root Nyquist
26	Define the filter alpha to be 0.35 by picking 'Filter Alpha'.	Filter Alpha
27	Use the numbered key pad to enter 0.35 then 'Enter'.	0.35 then Enter
28	Return to an upper level by hitting to define additional parameters.	Mode Setup
29	Select 'Symbol Rate'.	Symbol Rate
30	Using the numbered key pad enter 16 ksps for full rate testing or 8ksps for half rate testing	16ksps / 8ksps
31	Return to an upper level by pressing 'Mode Setup' to define additional parameters.	Mode Setup
32	Load the user defined data file just created.	Data
33	Pick 'User File'.	User File
34	User cursor keys to select 'DQPSK' and press 'Select File'.	Select File
35	Set 'Custom' to 'On'.	Custom
36	Save the file.	Save
37	Select a register that is not in use.	'Select Reg', and then '1' (or suitable unused register), and then 'Save Reg
38	Press 'preset' and now load the waveform.	Preset
39	Recall the waveform with 'Recall'.	Recall
40	Select the register using the numbered keypad and press 'Enter'.	'1' then 'Enter'

Step	Action	Button / Selection
41	Set the frequency, power level and be sure RF and Modulation are ON	Frequency: 220 MHz Amplitude: -80dBm Mod: ON RF: ON

How to set up an Agilent E4438C to test receivers with Sprint 23.03 and beyond

Step	Action	Button / Selection
1	Power cycle unit.	On/Off
2	Enter mode to program signal generator.	Mode
3	Select custom to define a custom waveform.	Custom
4	Select 'Real Time I/Q Baseband'.	Real Time I/Q Baseband
5	Define the modulation type.	Modulation Type
6	Select Pi/4-DQPSK.	Pi/4-DQPSK
7	Get ready to set the other parameters.	Mode Setup
8	Define the data stream by first selecting 'Data'.	Data
9	Define a custom user file.	User File
10	Create a user file.	Create File
11	Define the preamble bits using the numbered keypad.	1111 0011 0011 0111 1110 1110 1011 0110 0011 0111 0110 0110 0000 0110 0111 0010
12	Insert L1 Header bits using keypad	1000 0110 1101 0011 1001 1100 1101 1111 1100 1001 0010 1100

Step	Action	Button / Selection
12	Insert an FEC-encoded PN9 sequence at the end of the header sequence.	1111 1111 1100 0110 1000 1010 1011 1111 1000 0011 1101 0101 0001 0101 1010 0010 1101 1111 1100 0100 1010 0111 1100 0111 0001 0111 1100 0100 1110 1100 0101 1001 0011 0010 0100 0000 1001 0010 0110 0111 0000 1001 0010 0001 11011111 1000 1111 0100 1110 0001 1000 1001 0011 1011 1010 1101 0001 0100 1110 0101 0011 0000 1101 1110 0111 0101 0101 0011 0000 0110 1101 1100 1101 1000 0110 0001 1000 1101 1000 1000 1010 1111 0100 1100 1010 1100 1100 1001 0001 1101 1100 0011 0100 1110 1000 1100 0110 0001 1001 1010 1101 1111 1000 0111 0001 0110 1101 1010 0110 1111 1011 0001 1110 1011 0001 0101 0000 0100 1100 1000 1000 0001 1010 1101 0100 0000 0010
13	Insert end bits	1111 1111 1111 1111

Step	Action	Button / Selection
14	Press 'Return' twice.	Return Return
15	Press the 'Rename' button.	Rename
16	Use the 'More' button to give the user file a useful name – 'DQPSK'.	D-Q-P-S-K-2-3 or a suitable unused file name.
17	Save the user file.	Enter
18	Return to an upper level to define additional parameters.	Mode Setup
19	Select 'Filter'.	Filter
20	Choose 'Select.'	Select
21	Pick 'Root Nyquist'.	Root Nyquist
22	Define the filter alpha to be 0.35 by picking 'Filter Alpha'.	Filter Alpha
23	Use the numbered key pad to enter 0.35 then 'Enter'.	0.35 then Enter
24	Return to an upper level by hitting to define additional parameters.	Mode Setup
25	Select 'Symbol Rate'.	Symbol Rate
26	Using the numbered key pad enter 16 ksps for full rate testing or 8ksps for half rate testing	16ksps / 8ksps
27	Return to an upper level by pressing 'Mode Setup' to define additional parameters.	Mode Setup
28	Load the user defined data file just created.	Data
29	Pick 'User File'.	User File
30	User cursor keys to select 'DQPSK' and press 'Select File'.	Select File
31	Set 'Custom' to 'On'.	Custom
32	Save the file.	Save
33	Select a register that is not in use.	'Select Reg', and then '1' (or suitable unused register), and then 'Save Reg
34	Press 'preset' and now load the waveform.	Preset
35	Recall the waveform with 'Recall'.	Recall
36	Select the register using the numbered keypad and press 'Enter'.	'1' then 'Enter'

Step	Action	Button / Selection
37	Set the frequency, power level and be sure RF and Modulation are ON	Frequency: 220 MHz Amplitude: -80dBm Mod: ON RF: ON

Appendix E – Set up E4438C signal generator for MSGPS (multi-satellite GPS)

Step	Action	Button / Selection
1	Enter mode to program signal generator.	Mode
2	Select more at bottom of menu	More
3	Select GPS	GPS
4	Select Real Time MSGPS	Real Time MSGPS
5	Select Scenario	Scenario
6	Using arrow keys, highlight either Hawaii or SantaRosa	Arrow keys → / ↓
7	Select Scenario	Select Scenario
8	Select Number of Satellites (8)	Number of Satellites
9	Select more to go back to main GPS page	More
10	Select more	More
11	Verify GPS Ref (f0) = 1.023 Mcps	GPS Ref (f0)
12	Verify GPS Ref Clk = INT	GPS Ref Clk
13	Verify IQ Phase = Normal	IQ Phase
14	Select more	More
15	Select Frequency	Frequency
16	Set frequency to 1.575420 GHz	GHz
17	Select Real-time GPS = on	Real-time GPS (on)