



ITC 220 Base Station, Locomotive & Wayside RADIO TRANSCEIVER FOR RAILROAD PTC



Field Service Guide
ITC 220 Transceivers
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REVISION HISTORY

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A	August 2012	Initial release. Part number 0046300120.

Important Notice

Because of the nature of wireless communication, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e. have errors), or be totally lost. Significant delays or losses of data are rare when wireless devices such as CalAmp provides are used in a normal manner with a well-constructed network. These products should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury or death, or loss of property. CalAmp accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the ITC 220 Base Station, Locomotive, or Wayside Transceiver, or for failure to transmit or receive such data.

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RF Exposure Compliance Requirements



RF Exposure

The ITC 220 Base Station, Locomotive, and Wayside Transceivers are intended for use in the railroad industry as Interoperable Train Control (ITC) Radio (ITCR), which is an important component of Positive Train Control (PTC). The ITC 220 Base station, Locomotive, and Wayside Transceiver units must be professionally installed and must ensure a minimum separation distance between the antenna or radiating structure and any person. Refer to Table 1 and 2 on pages 3 and 4 of the *RF Energy Exposure Guide for ITC 220 Base Station, Locomotive, and Wayside Transceivers Installed in Vehicles or at Fixed Sites* for

recommended minimum lateral distance, as applicable for the antenna application, type of antenna, and transmitting power.

Radio Transceiver Model	Antenna application	Section and applicable table
ITC 220 Base Station Transceiver	Fixed installation	Section 6 Fixed Installations; Table 2 on Page 5
ITC 220 Locomotive Transceiver	Mobile installation	Section 4 Mobile Installations; Table 1 on Page 3
ITC 220 Wayside Transceiver	Fixed installation	Section 6 Fixed Installations; Table 2 on Page 5
ITC 220 Wayside Transceiver	Mobile installation	Section 4 Mobile Installations; Table 1 on Page 3

It is the responsibility of the user to guarantee compliance with the FCC MPE regulations when operating this device in a way other than described above. The installer of this equipment must ensure the antenna is located or pointed such that it does not emit an RF field in excess of Health Canada limits for the general population.

ITC 220 Base Station, Locomotive, and Wayside Transceivers use a low power radio frequency transmitter. The concentrated energy from an antenna may pose a health hazard. People should not be in front of the antenna when the transmitter is operating.

Recommended safety guidelines for the human exposure to radio frequency electromagnetic energy are contained in the Canadian Safety Code 6 (available from Health Canada), the Federal Communications Commission (FCC) Bulletin 65 and the Council of the European Union's Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (1999/519/EC).

Any changes or modifications not expressly approved by the party responsible for compliance (in the country where used) could void the user's authority to operate the equipment.

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1 OVERVIEW

This *ITC 220 Radio Transceiver Field Service Manual* provides important electrical safety and radio-frequency compliance information, and field service information for CalAmp ITC 220 Base Station, Locomotive, and Wayside Transceivers.

This manual provides essential information for personnel who perform the following on ITC 220 Radio Transceivers, including:

- Field Service maintenance, minor repair, or replacement
- Verification or transceiver operation, software settings, and radio characteristics
- Advanced troubleshooting

Prerequisites for users of this manual who perform the above include:

- Ability to work with standard radio-frequency (RF) test equipment, including knowledge of how to prevent personal injury and equipment damage.
- Ability to measure RF power, frequency, and other quantities, and analyze RF performance.
- Working knowledge of the XtermW terminal emulation application that is used to configure and install updates in the radio transceivers.
- Familiarity with means to limit RF exposure from antennas and familiarity with the *RF Energy Exposure Guide for ITC Base Station, Locomotive, and Wayside Transceivers Installed in Vehicles or at Fixed Sites*.
- Familiarity with installation procedures in the Installation Guides for the Base Station, Locomotive, and Wayside Transceivers.

Related Documents

Other documents related to this *ITC 220 Radio Transceiver Field Service Guide* include:

- *ITC 220 Base Station Transceiver Installation Guide*; CalAmp PN 133991
- *ITC 220 Locomotive Transceiver Installation Guide*; CalAmp PN 133971
- *ITC 220 Wayside Transceiver Installation Guide*; CalAmp PN 133981
- *RF Energy Exposure Guide for ITC 220 Base Station, Locomotive, and Wayside Transceivers Installed in Vehicles or at Fixed Sites*; CalAmp PN 134069

Because installation of each type of radio transceiver is covered in the above-listed Installation Guides, installation instructions are not repeated in this Field Service Guide. This Field Service Guide covers field service and advanced troubleshooting topics beyond the scope and purpose of the Installation Guides.

1.1 GENERAL DESCRIPTION

Positive Train Control (PTC) is a technology solution that prevents train-to-train collisions, over-speed derailments, movement of a train through a switch left in the wrong position, and incursion of trains into maintenance of way work limits. Interoperable Train Control (ITC) defines industry-standard messaging and communication protocols that support PTC and ensure interoperability between components.

CalAmp's line of ITC 220 Radio Transceivers for locomotive, base station, and wayside applications are manufactured specifically for use by North American Railroads for PTC applications. Operating between 217.6 to 222 MHz, these multi-channel software-defined radio transceivers meet railroad requirements for ITC and are designed to meet relevant railroad specifications for operation in the harshest environments. With high power capacity, CalAmp's ITC

220 Radio Transceivers provide wireless packet data transport between locomotives, base stations, and wayside locations.

Base Station Transceivers are installed at fixed locations and provide RF connectivity between back office and remote applications. The backhaul between the Base radio transceiver and the Back Office is typically in the range of 56 kbps to 1 Mbps. Base Station Transceivers provide radio coverage to all wayside and operational locomotive transceivers in the system.

Locomotive Transceivers are remote radios installed in the cab of locomotives and are the mobile element of the ITC 220 network. A Locomotive Transceiver communicates with the Back Office through a Base Station over a 220 MHz RF link. To establish this link, a Locomotive transceiver registers with the Base transceiver. As long as the Base is the best link available, the locomotive will continue to communicate with the Back Office through that Base.

Wayside Transceivers are typically installed at waysides as remote, fixed location radios. In this application they provide wayside signal status, switch position, and track integrity information to locomotives and must communicate with locomotives even when there is no Base Radio coverage. Wayside radios enable wayside sites to communicate with the Back office for maintenance and other purposes. Some wayside radios may have access to the Back Office through a broadband connection.

The Base Station Transceiver, Locomotive Transceiver, and Wayside Transceiver form the transportation backbone on which a messaging application provides communication capabilities between railroad assets and their back offices.

ITC 220 Base Station, Locomotive, and Wayside Transceivers are designed to meet the following specifications:

- AAR Standard S-5702
- ANSI/TIA-603-C-2004
- MIL-STD-810E

1.2 OPERATIONAL CHARACTERISTICS

ITC 220 radio transceivers are designed to satisfy industry-standard ITC requirements as part of an integrated 220 MHz radio (ITCR) network supporting the implementation of PTC systems. These transceivers are designed to provide communication in an interoperable fashion enabling messages to occur across railroad boundaries.

Base Station Transceivers are available in two configurations, one of which requires +24 VDC nominal input power, and the other requires +48 VDC nominal input power. Both models are almost identical, with the exception of their nominal input power requirements.

ITC 220 radio transceivers have the following operational characteristics, with differences noted where they appear for each of the three types of transceivers, and for +24 VDC and +48 VDC models of the Base Station Transceivers. (Specifications are subject to change without notice.)

General

Frequency Range:	217.6-222.0 MHz
Channel Spacing:	25 kHz
Temperature Range:	Operating: Base Station: -30°C to +70°C; Locomotive & Wayside -40°C to +70°C Storage: -55°C to +85°C (Base Station, Locomotive & Wayside)
Operating Humidity:	0 - 95% non-condensing

Frequency Stability:	Base Station: +/- 0.1 ppm over operating temperature range; Locomotive & Wayside: +/- 1.5 ppm over operating temperature range
DC Input Voltage	Base Station 48 V model: 42-54 VDC; Damage limit 60 VDC Base Station 24 V model: 21-27 VDC; Damage limit 30 VDC Locomotive: 45–100 VDC, Damage limit 120 VDC Wayside: 10.9–15.5 VDC, Damage limit 17 VDC
DC Current Draw:	Base Station 48 V model: Transmit: 6 A (peak) max. into 50 ohm load; 4 A typical; Receive: 0.6 A max. while receiving Base Station 24 V model: Transmit: 11 A (peak) max. into 50 ohm load; 7.5 A typical; Receive: 1.2 A max. while receiving Locomotive: Transmit: 4 A (peak) max. into 50 ohm load, 1.8 A typical; Receive: 0.5 A max. while receiving Wayside: Transmit 10 A (peak) max. into 50 ohm load, 7.5 A typical; Receive: 1 A max. while receiving
DC Power Connector:	Base Station: Threaded 5/16-18 studs for ring lug connection Locomotive: MS 3102 A18-4P or equivalent Wayside: Wago p/n 231-833/001-000
Size:	Base Station: 19.2 in. width × 17.8 in. depth × 7 in. height (4U) (Occupies 5U max. when installed with a vented shelf in a 19" EIA rack) Locomotive: 6.2 in. (5×MCU) width × 12.8 in. depth × 9.2 in. height (Occupies 5×MCU when installed in an LSI rack) Wayside 15.5 in. width × 9.5 in. height × 2.0 in. depth (Lugged back-plate allows mounting to 19" EIA rack horizontal bars)
Weight:	Base Station: 27 lbs. (12 kg) approximate; <40 lbs. (18 kg) rack w/vented shelf Locomotive: < 22 lbs. (10 kg) Wayside: < 8 lbs. (5.5 kg)
Antenna Connector:	Base Station: Three (3) Type N female: One (1) TX/RX (single antenna install), One (1) RX1 (multi-antenna RX only), One (1) RX2 (diversity RX only) Locomotive: Two (2) Type N female: One (1) TX/RX1 (transmit / primary receive), One (1) RX2 (diversity) Wayside: One (1) Type N female (TX/RX, no diversity support)
GPS Receiver:	Base Station & Wayside: Active or passive antenna; Antenna power: 3.3 V 50 mA max; Antenna connector: TNC female Locomotive: None (GPS function is separate from the ITC 220 Locomotive Transceiver)
External Interface:	Base Station & Wayside: Two (2) Ethernet 10/100 Mbps: One (1) data network port, RJ-45; One (1) maintenance port, RJ-45 Locomotive Two (2) Ethernet: One (1) data network port, M12 – 8 pin female; One (1) maintenance port, M12 - 8 pin female
Configuration Interface Module (CIM):	SD Card
Display:	Activity and diagnostic LEDs on front panel
Regulatory:	Base Station & Locomotive: Complies with FCC Parts 2, 15, and 90; Industry Canada SRSP-512 Wayside: Complies with FCC Parts 2, 15, and 90

Transmitter

RF Power Output:	Base Station:	75 W PEP; adjustable to 10-75 W PEP
	Locomotive:	50 W PEP; adjustable to 15-50 W PEP
	Wayside:	25 W PEP; adjustable to 7.5-25 W PEP
Output Impedance:	50 ohms; Operating VSWR < 3:1	
Modulation Waveforms:	Base & Locomotive:	16 kbps pi/4DQPSK (linear); 32 kbps pi/4DQPSK (linear)
	Wayside:	16 kbps pi/4DQPSK (linear)
Occupied Bandwidth:	Meets 47CFR90.210 (f), five aggregated channels	
Modulation Designators:	Base & Locomotive:	16 kbps: 8K90DXW; 32 kbps: 17K8DXW
	Wayside:	16 kbps: 8K90DXW
Conducted Spurious Emissions:	– 25 dBm max.	
Max. Duty Cycle Rating:	Base Station:	50 %
	Locomotive:	30 %
	Wayside:	10 %

Receiver

Maximum Usable Sensitivity, Static BER<10 ⁻⁴ :	16 kbps -111 dBm; 32 kbps -108 dBm
Adjacent Channel Selectivity:	70 dB at 25 kHz offset
Spurious Response Rejection:	70 dB
Intermodulation Response Rejection:	65 dB
High Input Level (-7 dBm)	Locomotive only: BER < 10 ⁻⁴
Blocking (1 MHz offset)	80 dB
Number of Simultaneous Receiver Channels:	
Base Station (24V & 48V) and Locomotive:	Sixteen (16) paired as: eight (8) diversity; seven (7) 16 kbps; one (1) auto 16 kbps/32 kbps
Wayside:	Two (2) (no diversity support): One (1) 16kbps; one (1) auto 16 kbps/32 kbps

1.3 PHYSICAL DESCRIPTION

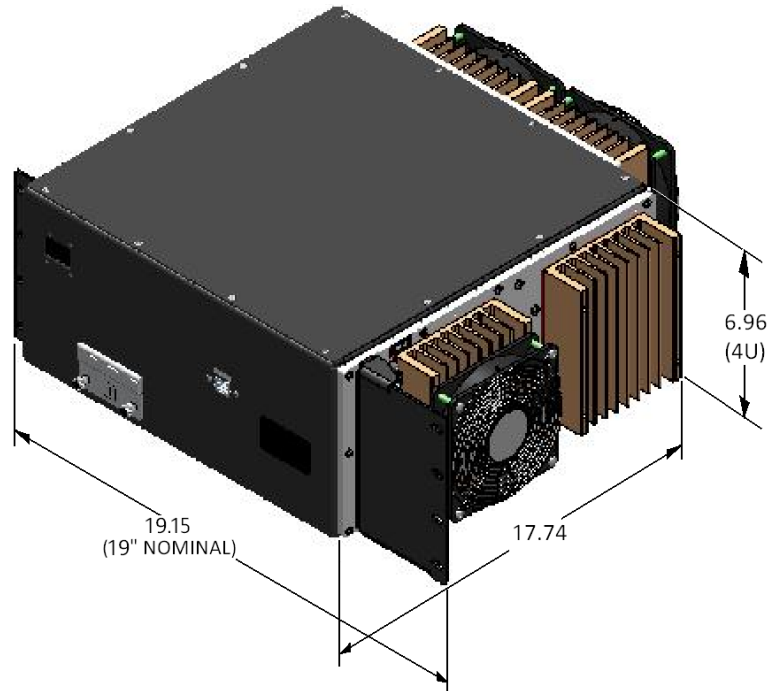
1.3.1 BASE STATION TRANSCEIVER

The ITC 220 Base Station Transceiver is housed in a 4 unit-height (allow 5 unit height to mount with a vented shelf underneath), 19-inch rack-mountable sheet metal chassis. Repositionable brackets allow for mounting the chassis in forward or mid-plane positions in 19-inch channel-rack installations.

1.3.1.1 BASE STATION TRANSCEIVER DIMENSIONS

Overall dimensions of the ITC 220 Base Station Transceiver are 19.15 in. width × 17.74 in. depth × 6.96 in. (4U) height, as shown in Figure 1, which follows.

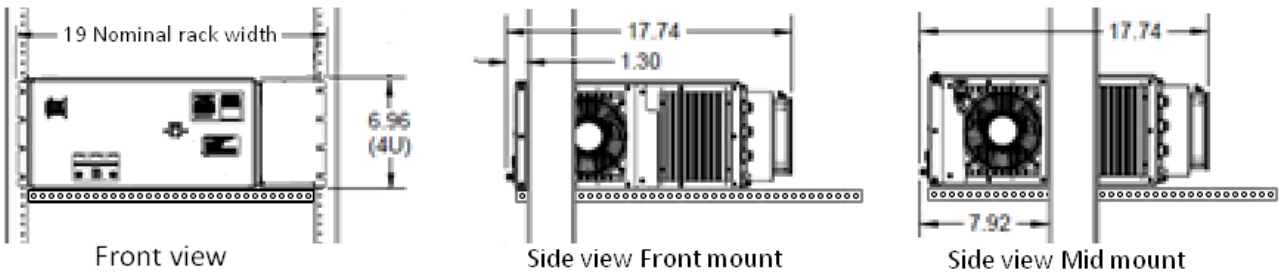
Figure 1 ITC 220 Base Station Transceiver overall dimensions



(Dimensions shown are in inches.)

Reconfigurable mounting brackets allow the Base Station Transceiver to be front mounted or mid mounted in EIA 19" rack applications. Dimensions of the unit as mounted in either of these configurations are shown in Figure 2 below. (Dimensions shown are in inches.)

Figure 2 Base Station Transceiver overall dimensions in front mount and mid mount configurations in EIA 19" rack



1.3.1.2 BASE STATION TRANSCEIVER CONNECTIONS

All physical connections and interfaces are located on either the front or rear panel of the Base Station Transceiver.

1.3.1.2.1 BASE STATION TRANSCEIVER FRONT PANEL CONNECTIONS

The following figure and table illustrate the interface connections on the front panel of the Base Station Transceiver.

Figure 3 Base Station Transceiver front panel interface connections

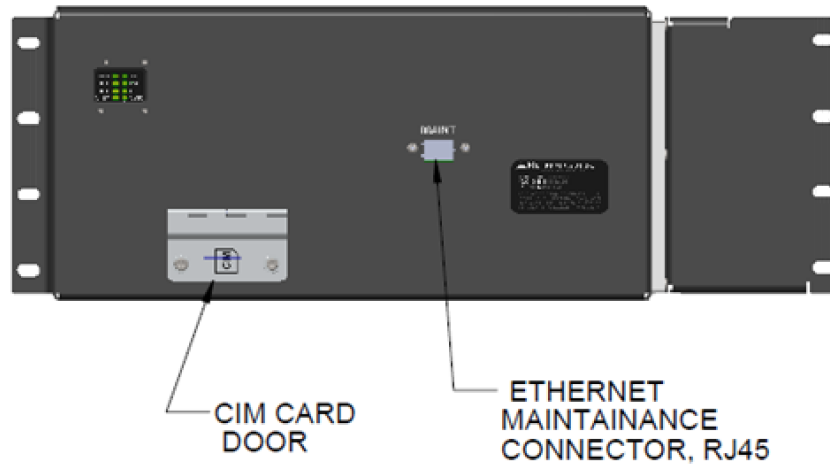


Table 1 Base Station Transceiver front panel interface connections

Interface	Connector Type	Label
Maintenance Ethernet	RJ-45	MAINT
CIM socket	SD memory card receptacle	CIM

1.3.1.2.2 BASE STATION TRANSCEIVER REAR CONNECTORS

The following figure and table illustrate connectors at the rear of the Base Station Transceiver.

Figure 4 Connectors at rear of Base Station Transceiver

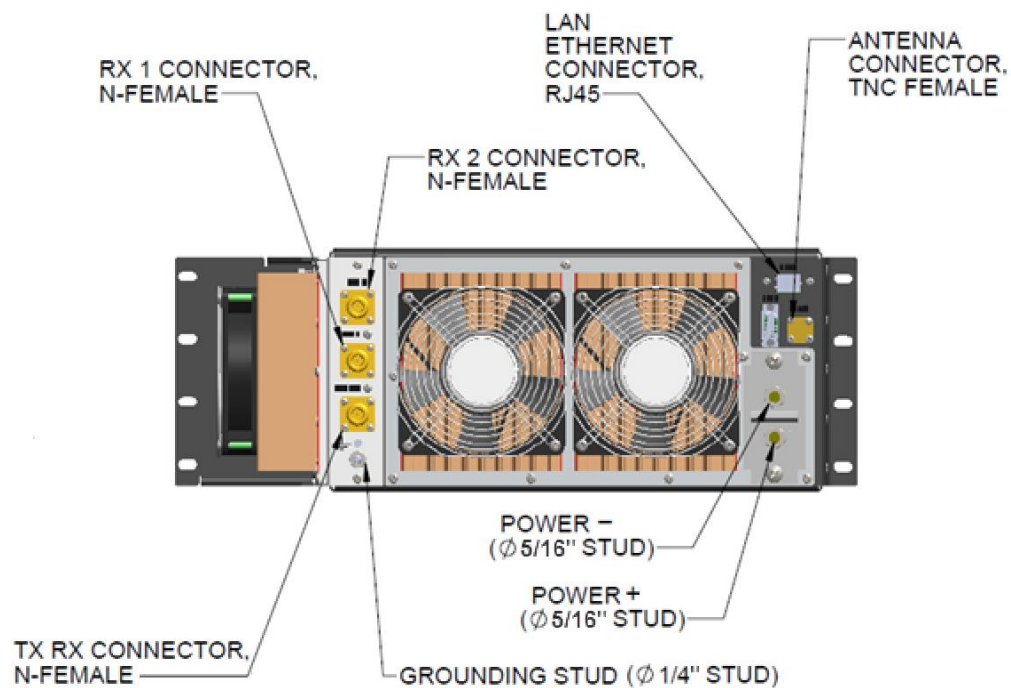


Table 2 Connectors at rear of Base Station Transceiver

Interface	Connector Type	Label
TX Antenna	Type N female	TX/RX
RX1 Antenna	Type N female	RX1
RX2 Antenna	Type N female	RX2
GPS Antenna	TNC female	GPS
DC Power Input	Threaded posts (studs) for ring lug connection	+24 VDC or +48 VDC
Data Network Ethernet	RJ-45	LAN
Ground connection	Threaded post (stud) for ring lug connection	⏏

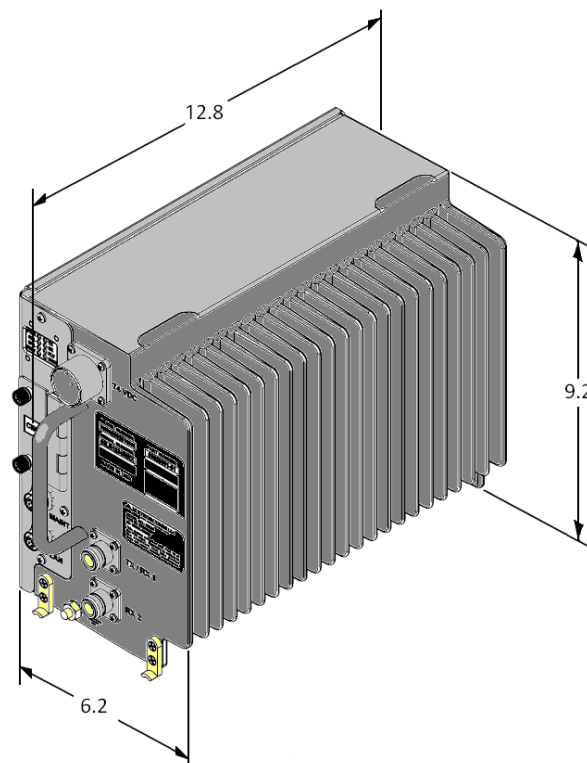
1.3.2 LOCOMOTIVE TRANSCEIVER

The ITC 220 Locomotive Transceiver is housed in a 5×MCU LSI rack-compatible chassis.

1.3.2.1 LOCOMOTIVE TRANSCEIVER DIMENSIONS

Overall dimensions of the ITC 220 Locomotive Transceiver are 6.2 in. width × 9.2 in. height × 12.8 in. depth, as shown in Figure 1, which follows.

Figure 5 ITC 220 Locomotive Transceiver overall dimensions



(Dimensions shown are in inches.)

1.3.2.2 LOCOMOTIVE TRANSCEIVER CONNECTIONS

All physical connections and interfaces are located on the front panel of the Locomotive Transceiver.

The following figure and table illustrate the ports and connectors on the Locomotive Transceiver front panel.

Figure 6 Locomotive Transceiver ports and connectors

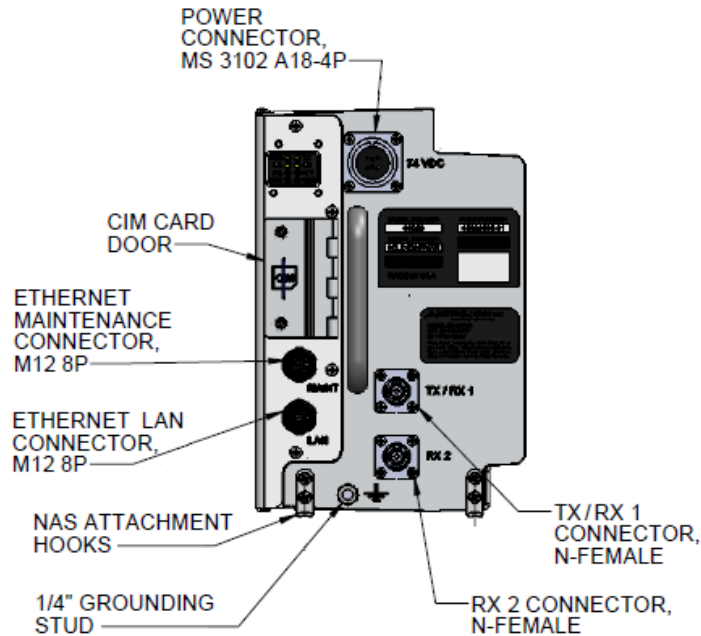


Table 3 Locomotive Transceiver front panel interface connections

Interface	Connector Type	Label
TX/RX1 Antenna	Type N female	TX/RX1
Diversity RX Antenna	Type N female	RX2
DC Power Input	MS-3102 A18-4P or equivalent	74 VDC PWR IN
Data Network Ethernet	M12 - 8 pin female, A-coded	LAN
Maintenance Ethernet	M12 - 8 pin female, A-coded	MAINT
CIM socket	SD memory card receptacle	CIM
Ground connection	Threaded post (stud) for ring lug connection	⏏

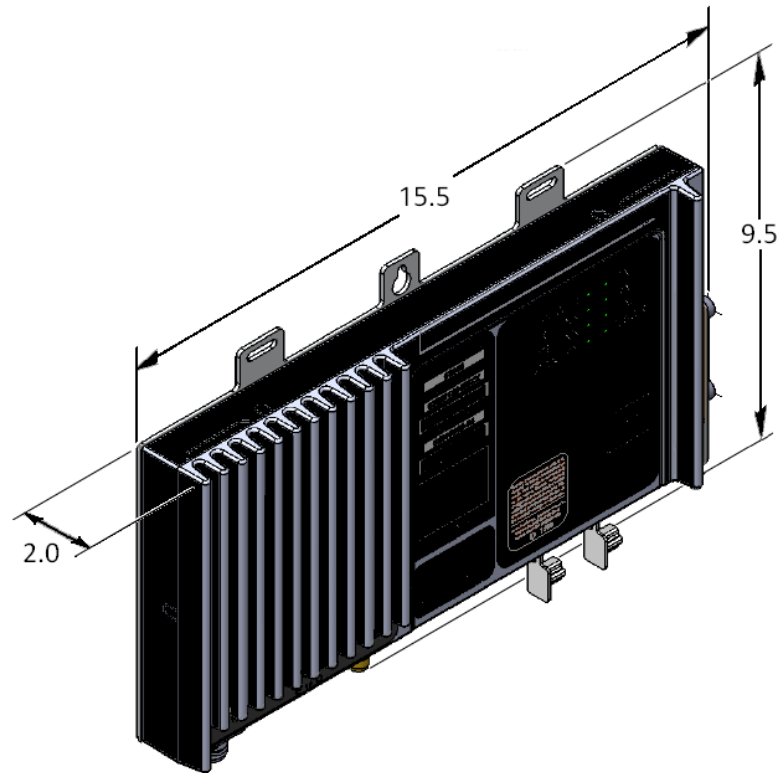
1.3.3 WAYSIDE TRANSCEIVER

The ITC 220 Wayside Transceiver is housed in a die-cast metal chassis. Mounting lugs at top and bottom of the chassis allow for a variety of mounting options, including in 19-inch channel-rack installations.

1.3.3.1 WAYSIDE TRANSCEIVER DIMENSIONS

Overall dimensions of the ITC 220 Wayside Transceiver are approximately 15.5 in. width × 9.5 in. height × 2.0 in. depth, as shown in Figure 1 below.

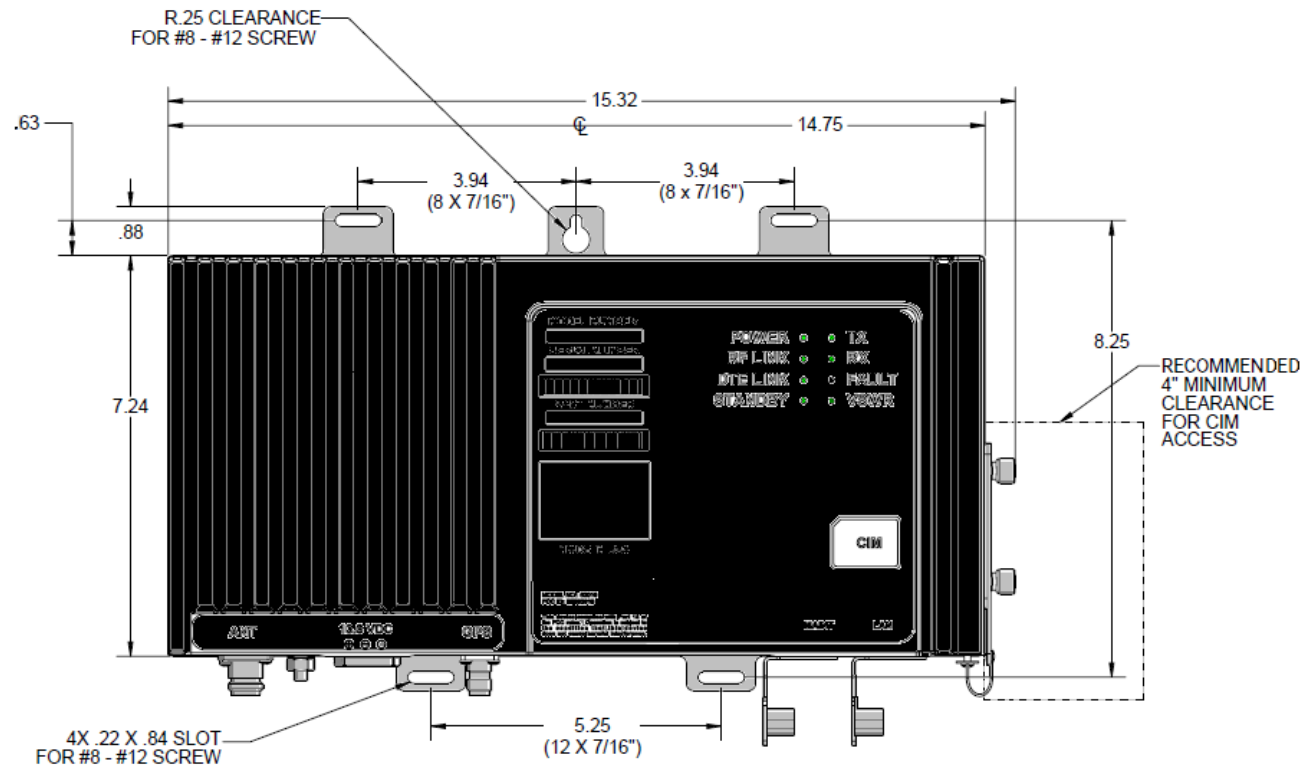
Figure 7 ITC 220 Wayside Transceiver overall dimensions



(Dimensions shown are in inches.)

The Wayside Transceiver may be mounted vertically or horizontally, providing that the unit is mounted such that the cooling fins, CIM card door, and cable connections are unobstructed. When mounting the unit, choose an orientation that provides clear visibility of the status LEDs. Dimensions of mounting lugs for mounting the unit are shown in Figure 2, which follows.

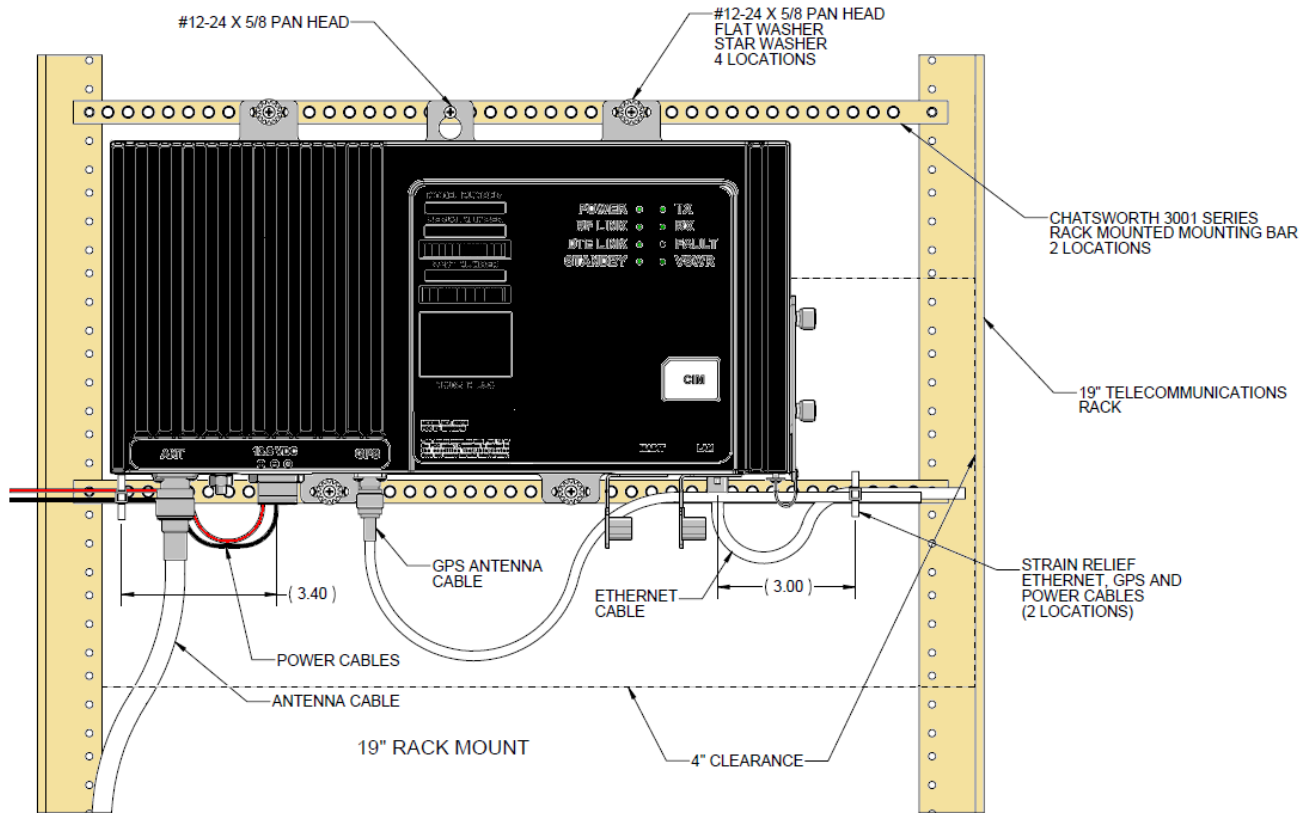
Figure 8 Wayside Transceiver mounting lug dimensions



(Dimensions shown are in inches.)

Spacing of mounting lugs and slotted holes provide versatility for mounting the Wayside Transceiver. Figure 9, which follows, shows the recommended method of installing the Wayside Transceiver in a typical EIA 19" telecommunications rack application.

Figure 9 Wayside Transceiver mounted in a typical EIA 19" rack application



(Dimensions shown are in inches.)

1.3.3.2 WAYSIDE TRANSCEIVER CONNECTIONS

All physical connections and interfaces are located at the bottom (as viewed with the unit mounted vertically) of the Wayside Transceiver, except the CIM card slot, the door for which is in the right side of the unit (as viewed mounted vertically).

The following figure and table illustrate the interface connections at the bottom panel of the unit.

Figure 10 Wayside Transceiver bottom panel interface connections

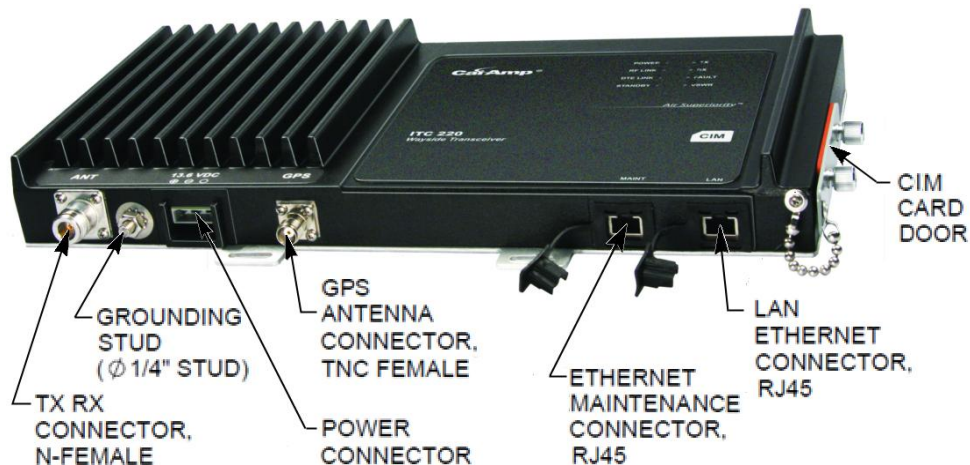


Table 4 Wayside Transceiver bottom panel interface connections

Interface	Connector Type	Label
TX RX Antenna	Type N female	ANT
DC Power Input*	Wago p/n 231-833/001-000	13.6 VDC
GPS Antenna	TNC female	GPS
Data Network Ethernet	RJ-45	LAN
Maintenance Ethernet	RJ-45	MAINT
CIM socket	SD memory card receptacle	CIM
Ground connection*	Threaded post (stud) for ring lug connection	

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

2 FOLLOW 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 the transceiver before removing the cover.
- Be aware that removing the cover of the radio transceiver may expose you to dangerous voltages or other risks. Avoid making internal adjustments to the radio transceiver when you are alone.
- Avoid contact with a radio's electrical components. Electric shock from voltages present with the radio transceiver are potentially fatal.
- Reassemble radio transceivers correctly. Incorrect reassembly of a radio transceiver can cause a harmful electric shock to anyone who handles it.

3 IMPORTANT INFORMATION FOR THE USER

3.1 TRANSMITTER WARM-UP PERIOD (BASE STATION TRANSCEIVER ONLY)

The transmitter of the Base Station Transceiver uses a precision oven-controlled crystal oscillator (OCXO). The OCXO warm-up period is one minute minimum after application of input power before any transmission should commence.

Locomotive and Wayside Transceivers use temperature-compensated crystal oscillators (TCXO), which do not require warm-up time before the transmitter can be used.

3.2 LIMITING RF EXPOSURE



Caution – Please refer to the *RF Energy Exposure Guide for ITC 220 Base Station, Locomotive, and Wayside Transceivers Installed in Vehicles or at Fixed Sites* that is packaged with each transceiver for specific information regarding safe distances that must be maintained between personnel and energized transmitting antennas.

The information in the *RF Energy Exposure Guide for ITC 220 Base Station, Locomotive, and Wayside Transceivers Installed in Vehicles or at Fixed Sites (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 transceivers and antennas are expected to be sited, installed, and maintained only by professionals in a controlled-exposure environment, the *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.

Radio transceivers are 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 $0.2 \text{ mW/cm}^2 = 2 \text{ W/m}^2$ vs. 10 W/m^2 in a controlled-exposure environment.

Radio transceivers are 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. These radio devices are not intended for use by consumers or the general population. Base station antennas must be positioned on towers or nonresidential buildings that are generally unoccupied except while servicing the equipment therein.

Tables in the *RF Energy Exposure Guide* list the calculated lateral distances to be maintained between the general public and an operational transmitter antenna for antenna types suitable in fixed and mobile 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

3.3 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 “[Transceiver-Radiated Power Limits](#),” below, provides additional information on how to comply with ERP limits.
- Refer to the *RF Energy Exposure Guide*, which is packaged with each Base Station and Locomotive Transceiver and available online or by request, for specific guidelines regarding placement and installation of fixed antennas.
- Acceptable fixed-antenna types are listed in the Rated Power and Recommended Lateral Distance tables in the *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 *RF Energy Exposure Guide*.
- Unauthorized antennas, equipment modifications, or attachments could invalidate any equipment warranty or authority to transmit. Modification could damage the radio transceiver and may violate FCC or IC regulations. Contact CalAmp before using other antennas.

3.4 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 of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment to 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.

3.5 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 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 TRANSCEIVER CHANNELIZATION AND FREQUENCY RANGE

Transceivers 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 Base Station transmission occupies five of the FCC-defined 5 kHz channels. The lowest radio channel center frequency is in the center of FCC channel 3 and the next is centered on FCC channel 8, then 13, 18, and so on, up to the highest, which is centered with FCC channel 398.

4.2 BASE 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 exceptions of FCC channels 161-170 and 181-185. Therefore, the radio may not transmit on those channels or their 221 MHz counterparts, 361-370 and 381-385. This corresponds to 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 TRANSCEIVER-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 specified 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 to comply with regulatory power limits.

Licensees must comply with specific power vs. antenna height above average terrain (HAAT) limitations for fixed-antenna stations per §90.729 or SRSP-512 §6.3 unless operating under an explicit waiver of the applicable rule. Note that U.S. and Canadian power vs. antenna HAAT limitations are not identical and differ in this regard.

Licensees should also note that fixed and mobile installations transmitting between 221 and 222 MHz must limit effective radiated power (ERP) to 50 W or $10\log(50) + 30 = 47$ dBm PEP referenced to the 2.15 dBi gain of a dipole. 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.

Base Station:

- Common single element fixed station antennas typically exhibit 2.1 to 5 dBi (0 to 2.9 dBd) gain and being vertically polarized, are usually omnidirectional. Multi-element antennas are designed to concentrate RF radiated power toward the horizon and away from the sky and the earth and, depending on the design criteria, provide azimuthal gain directivity that decreases ERP in the direction of other base stations or increases ERP in a specific direction. They may also be used to make up for large losses between transmitter and antenna. The isotropic gain of a commonly-used two-element exposed dipole antenna is typically 7 to 8 dBi.
- 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 (PEP) output feeding the transmission line is determined by subtracting the antenna gain in dBi from the EIRP and adding the loss from the antenna feedline and connectors plus the loss from any combiners, cavity filters or lightning arresters. If the net value is greater than or equal to 48.75 dBm, then the 75 W maximum power of the Base transmitter can be used. If the value is less than 48.75 dBm, then the transmitter output power should be reduced to the net value. Example for the 50 W ERP case: Antenna gain = 8 dBi, feedline and connector loss = 2 dB. Assuming no other losses, the transmitter power output limit = $49.15 - 8 + 2 = 43.15$ dBm PEP or 20.7 W PEP. In this case, the Base RF output power should be adjusted to 20.7 W PEP or less.
- If the calculated transmitter power limit is less than the minimum Base rated power of 10W PEP = 40 dBm PEP, then an external RF attenuator would be inserted in the feed line to increase the loss between transmitter and antenna to achieve compliance.

Locomotive

- Antennas designed for locomotives at 220 MHz generally use a rugged cast aluminum body and are top-loaded vertically polarized requiring a metal cab roof for a ground plane. They are necessarily electrically shorter than one-fourth wavelength due to vertical space limitations. Maximum antenna gain is expected to be at 0 dBd – 2.15 dB.
- FCC rule §90.729(b) limits mobile operation at 220-222 MHz to 50 W ERP, which is calculated relative to a free-space dipole with 0 dBd = 2.15 dBi gain. Since the locomotive antenna has a maximum gain equal to a dipole and the rated maximum transmitter output power is 50 W PEP, compliance with the 50 W ERP limit is assured.
- The actual power will be less than 50 W ERP when the feedline and filter losses between transmitter and antenna are taken into account. Minimum feedline loss is expected to be 0.5 dB and an inline 160 MHz reject filter adds 0.7 dB loss for a total loss of 1.2 dB. The actual ERP is therefore $47 - 1.2 = 45.8$ dBm = 38 watts. The transmitter installation cannot be operated on FCC channels 196-200 due to the 2 W limitation.

Wayside:

- 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 output power output limit = $47 - 2.4 + 0.6 = 45.2$ dBm PEP and therefore the system is compliant with the 50 W ERP limit. The actual ERP in this case is $10^{(44.85 + 2.4 - 0.6)} = 46.2$ 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 dBi from the EIRP 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 50 W ERP 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 = $47 - 2.9 + 0.9$ dBm = 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 50 W ERP limit. This installation is not allowed to transmit on FCC channels 196-200 because the maximum ERP is greater than 2 watts.

5 TRANSCIVER SERVICE

Service technicians should be familiar with installation instructions provided in Installation Guides for Base Station, Locomotive, and Wayside Transceivers. Installation procedures are summarized only briefly as they relate to service procedures in this chapter. Refer to the Installation chapter of the Installation Guides for radio transceiver installation details.

5.1 RECOMMENDED EQUIPMENT

Following is a list of test equipment required to perform tests and adjustments described in this Field Service Guide. It is expected the user is familiar with the pieces of test equipment listed below. Instructions on how to use the following equipment are beyond the scope of this document.

Table 5 Recommended equipment

Type	Model	Notes
24 VDC power supply		For testing 24 V Base Station Transceiver—constant voltage DC power supply with precision current output display, capable of 10 A at 24 VDC
48 VDC power supply		For testing 48 V Base Station Transceiver—constant voltage DC power supply with precision current output display, capable of 5 A at 48 VDC
74 VDC power supply		For testing Locomotive Transceiver—constant voltage DC power supply with precision current output display, capable of 4A at 74 VDC
13.6 VDC power supply		For testing Wayside Transceiver—constant voltage DC power supply with precision current output display, capable of 10 A at 13.6 VDC
Vector signal generator	Agilent E4438C or equivalent	Recommended 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 G— Program Signal Generator for DQPSK .
Vector signal analyzer	Agilent E9010A or equivalent	
Handheld RF spectrum analyzer	Anritsu or equivalent	
10 MHz frequency standard	Standard Research Systems model FS725 or equivalent	Base frequency adjustments require frequency standard accuracy to 0.01 ppm or better.
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 XtermW or equivalent terminal program installed		If the host computer's Ethernet port has not been configured, then follow the instructions in 5.4 Configure Computer Ethernet Ports to Communicate with the Transceiver .

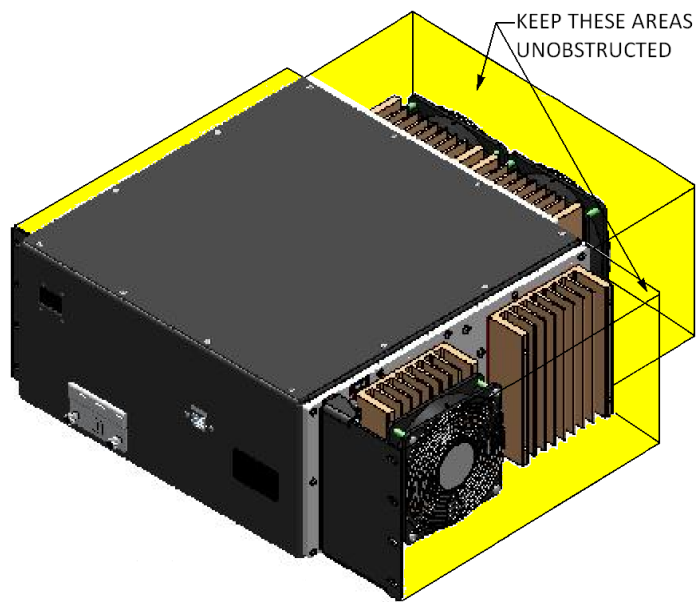
Type	Model	Notes
Ethernet cable(s)	Category 5 or better	One Ethernet cable for each computer Ethernet port. Standard Ethernet cable terminated with RJ-45 connectors.
Clip-on ammeter		
Antenna / VSWR test kit		
Cable ties as required		
Digital volt meter		
Network analyzer		
Power (Watt) meter		
Site tester		
7/16" and 1/2" open-end wrenches		7/16" wrench for 1/4" hex nut on grounding stud, on all transceivers; 1/2" wrench for 5/16" hex nuts on power terminals, Base Station Transceiver only
#2 Phillips head screwdriver		
Torque wrench with 100 in.-lb. capacity		
Crimping tool		For assembling power cable(s), if required

5.2 ROUTINE MAINTENANCE

Transceivers require the following routine maintenance. The user (or person responsible for the equipment on site) should check transceivers periodically to verify that each transceiver and cables are maintained and remain securely supported, clear of dust and obstructions, and away from potential causes of overheating.

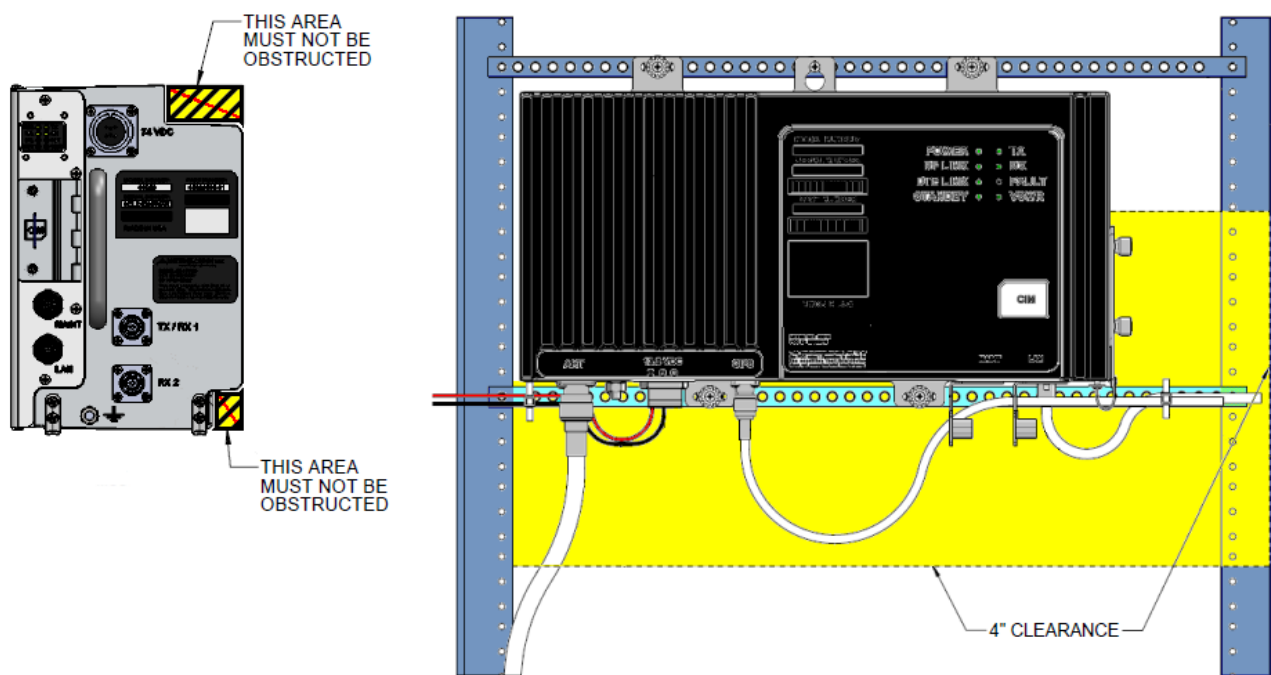
- Remove dust and obstructions from heat-sink fins.
- Ensure that the unit is not subjected to excessive heat from adjacent equipment.
- Make sure that the unit is securely mounted and supported.
- Restrain cables to prevent stress on connectors.
- Make sure that the SD memory card (CIM) door is securely closed.
- Keep the indicator-LED panel dust-free and LEDs viewable.
- For Base Station Transceivers, check fan operation and make sure the fans are not obstructed. More advanced information about checking fan operation is provided later in this chapter. The following figure illustrates the areas to keep unobstructed.

Figure 11 Base Station Transceiver — areas must not be obstructed



- For Locomotive and Wayside Transceivers, verify clearances specified in installation instructions are maintained.

Figure 12 Locomotive and Wayside Transceiver — areas must not be obstructed



5.3 VISUAL INSPECTION

Visually inspect the transceiver and note any dents or damage or missing or loose parts. Also verify heat-sink fins are clear of dust and debris, that potential sources of excessive heat are not mounted near the transceiver, and that the bullet points described in [Routine Maintenance](#) have been followed.

If you detect damage or missing parts, you will need to determine whether the transceiver is repairable or if it should be replaced. Depending on what you determine, you may need to order replacement parts or a replacement transceiver accordingly.

5.3.1 CONFIRM SD MEMORY CARD (CIM) IS INSTALLED AND SEATED

Note: The SD memory card must be inserted in the orientation shown on the door.

To confirm the CIM card is installed and seated:

- Open the CIM door to ensure the SD memory card is present in the CIM socket.
- Push the SD memory card once to release it.
- Push the SD memory card again to ensure it is seated in the socket.
- Once confirmed, close and secure the CIM door.






5.3.2 LED DIAGNOSTICS




The front panel LEDs show the general operational status of the transceiver after it has conducted a POST, which it does each time it boots up. [Table 6 Front panel LEDs](#) includes a description of the function of each LED as well as the color of each LED when the transceiver is functioning properly.

Note: If a problem occurs *after* the transceiver boots up, the front panel LEDs indicate the problem only after a reboot of the transceiver (provided the problem persists).

Read the description of each LED carefully. Some LEDs, such as the PWR LED, indicate a problem when they are off. Other LEDs, such as the FLT (Fault) and SWR, indicate a problem when they are lit. A time-stamped entry will be written to the ALARM.LOG file on the CIM SD card and will be displayed onscreen when connected in XtermW whenever the FLT or SWR LEDs are illuminated.

Table 6 Front panel LEDs

Label	Description	Color
PWR	Power — Blinking green LED indicates that the unit is on.	Green 
TX	Illuminates when the radio transmitter is keyed.	Red 
SWR	Illuminates when the VSWR of the TX port exceeds approximately 3:1. Illuminates if the TX forward power is not within 25% of the RF output power setting. (A time-stamped entry specifying the cause will be entered in the ALARM.LOG file and will display in the XtermW window when connected.)	Red 
RX	Illuminates when the transceiver is receiving a valid 220 MHz PTC signal.	Amber 
DTL	DTE Link — Illuminates when the transceiver establishes a connection to a Communication Manager (CM) through the Ethernet network port.	Amber 

Label	Description	Color
RFL	RF Link — Illuminates when an RF link is established between two radios.	Amber 
STBY	Standby — Illuminates when the transceiver is in standby mode, indicating TX is disabled.	Red 
FLT	<p>Fault — When illuminated, it indicates a variety of fault conditions not indicated by other LEDs.</p> <p>Possible faults indicated by the Fault LED include:</p> <ul style="list-style-type: none"> • One or more internal radio supply voltages are below the minimum threshold. • The extended DC voltage to the transceiver is outside of the acceptable range. • One or more of the transceiver's internal sensors is indicating a temperature exceeding the allowable threshold. • The transceiver failed one or more self tests at power on. • TX forward power is not within 25% of the RF output power setting. • The CIM script file is not present or has invalid or corrupt data. <p>If the Fault LED illuminates, a time-stamped entry will display in XtermW specifying the cause and will be entered in the Alarm.log file.</p>	Red 

A flashing PWR (Power) LED on the front panel indicates that the boot sequence has completed. The Ethernet port connection becomes active within 10 seconds, allowing you to start an **XtermW** session.

The above indicators assist in troubleshooting common problems provided the LEDs are operational. If an LED is burnt out or damaged, however, it will not be able to provide any indication when an error condition may exist. For this reason, more advanced information about verifying that the LEDs are operational is provided later in this chapter.

5.4 CONFIGURE COMPUTER ETHERNET PORTS TO COMMUNICATE WITH THE TRANSCEIVER

It is recommended that you use a computer with two Ethernet interfaces so that your computer can communicate with a transceiver'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:

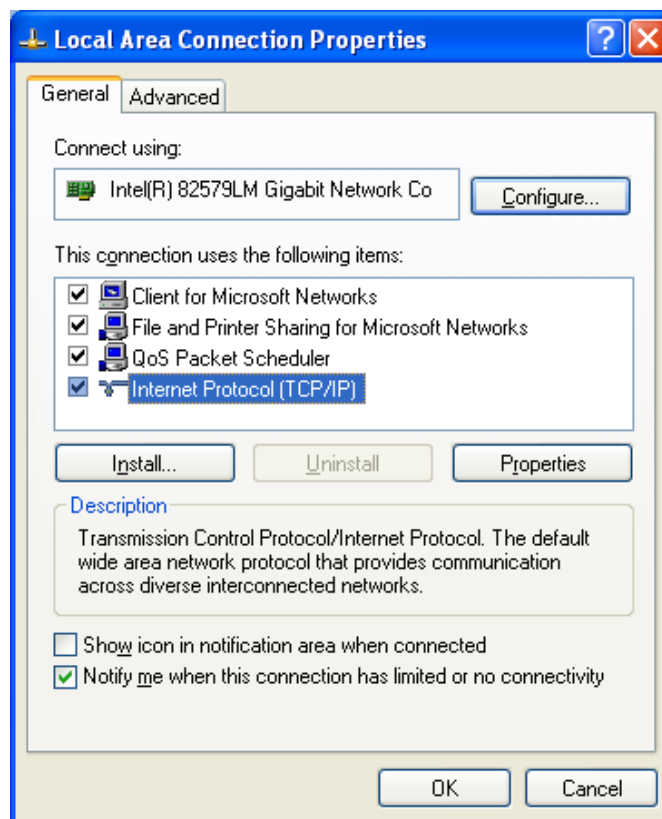
- The following configuration examples are for directly connecting to the transceiver and bypassing any network infrastructure. If direct access to the transceiver cannot be obtained, then contact your network administrator for instructions.
- If you are using the factory defaults, then use the following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

For these examples, Ethernet 1 refers to the computer's first Ethernet port and is used for communication with the transceiver MAINT port, and Ethernet 2 refers to the computer's second Ethernet port and is used for communication with the transceiver LAN port. It is possible to communicate with the radio transceiver using a computer with a single Ethernet port, but you will only be able to communicate with one port at a time, and you will need to reconfigure the port each time to use the appropriate IP address for the transceiver port you are connecting to.

5.4.1 TO CONFIGURE THE COMPUTER ETHERNET 1 INTERFACE FOR COMMUNICATION WITH THE TRANSCEIVER MAINT PORT

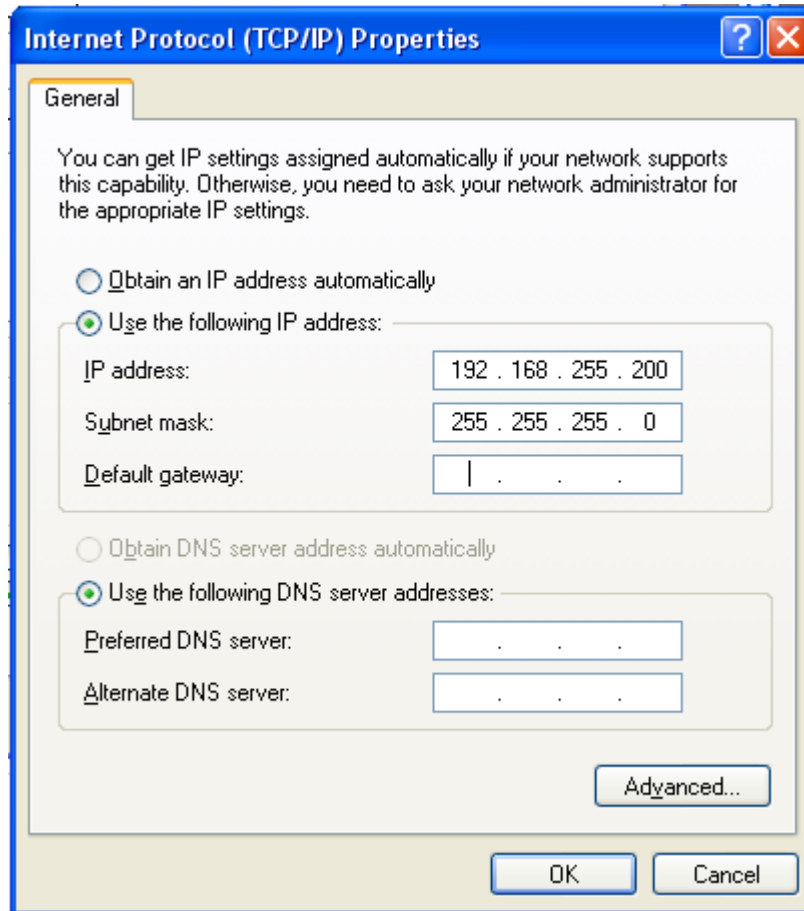
1. On the computer, click **Start, Control Panel, Network Connections**, and then **Local Area Connection**.
 - There will be one **Local Area Connection** icon for each Ethernet port on the computer. Click the **Local Area Connection** icon that corresponds to the first Ethernet port.
2. The **Local Area Network Connection Status** window opens. Click **Properties** and the **Local Area Connection Properties** window for the first Ethernet connection opens.

Figure 13 Local Area Connection Properties window for Ethernet 1 connection



3. On the **General** tab, click on **Internet Protocol (TCP/IP)** to select it (you may have to scroll down in the items list to see it—do not remove the check mark), and then click **Properties**.

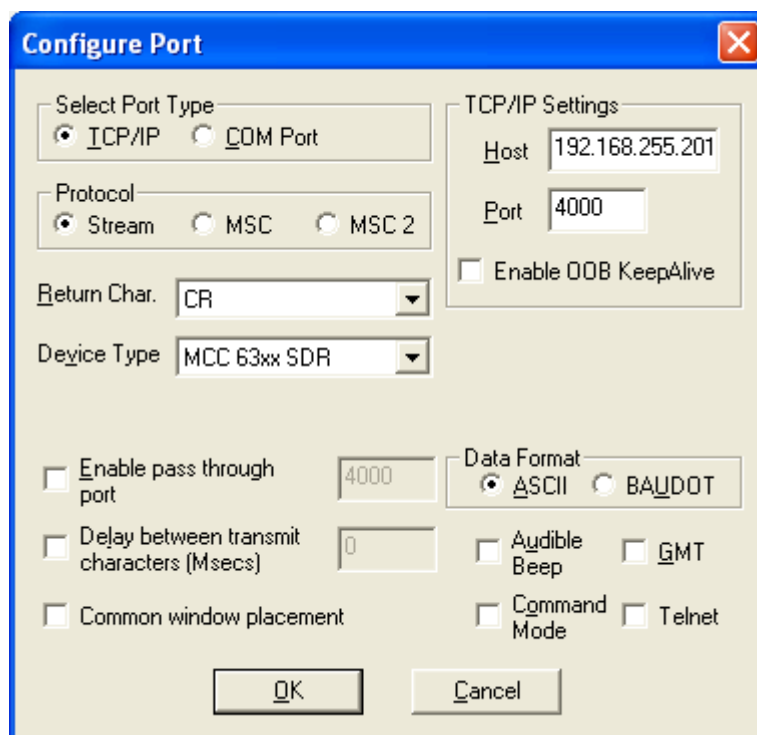
Figure 14 Internet Protocol (TCP/IP) Properties window for Ethernet 1 connection



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.

Figure 15 XtermW Configure Port window with settings for MAINT port

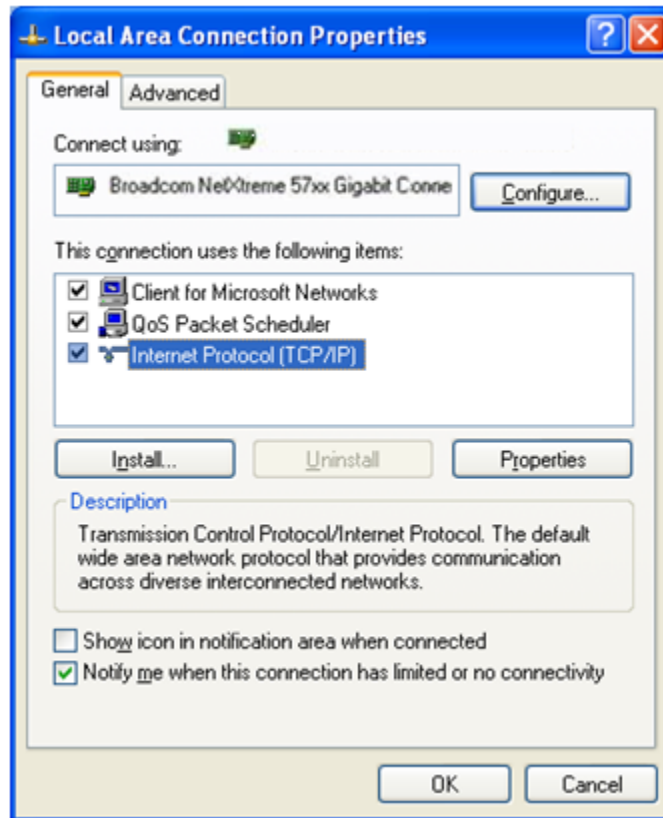


Note TCP/IP Settings for Host on the **MAINT** port is configured for IP address **192.168.255.201**.

5.4.2 TO CONFIGURE THE COMPUTER ETHERNET 2 INTERFACE FOR COMMUNICATION WITH THE TRANSCEIVER LAN PORT

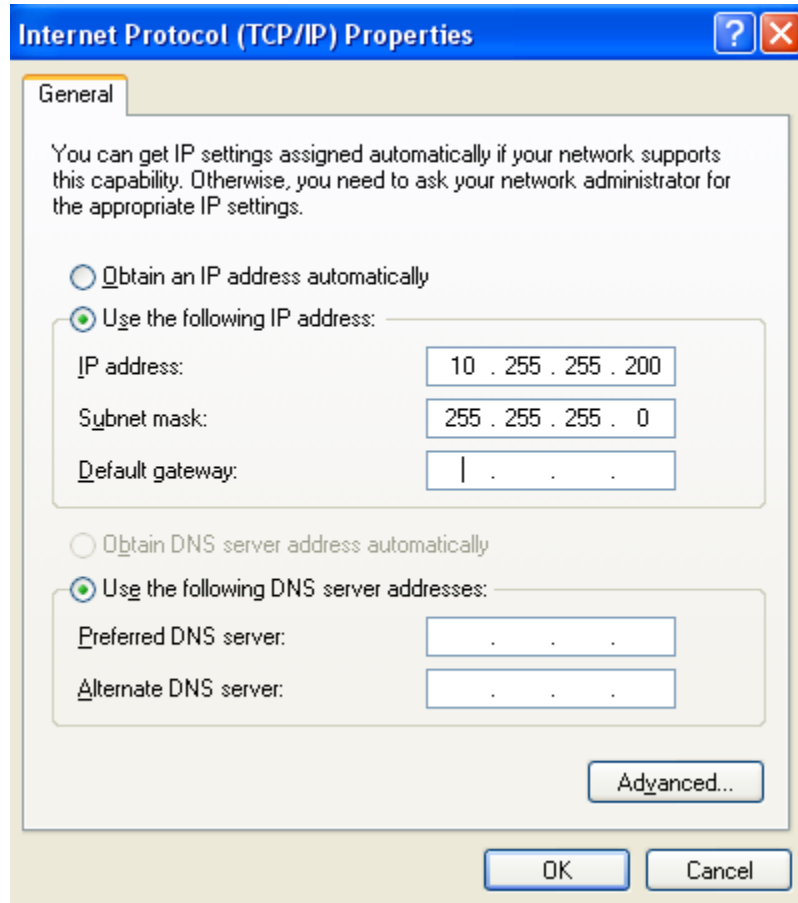
1. On the computer, click **Start, Control Panel, Network Connections**, and then **Local Area Connection**.
 - There will be one **Local Area Connection** icon for each Ethernet port on the computer. Click the **Local Area Connection** icon that corresponds to the second Ethernet port.
2. The **Local Area Network Connection Status** window opens. Click **Properties** and the **Local Area Connection Properties** window for the second Ethernet connection opens.

Figure 16 Local Area Connection Properties window for Ethernet 2 connection



3. On the **General** tab, click on **Internet Protocol (TCP/IP)** to select it (you may have to scroll down the items list to see it—do not remove the check mark) and then click **Properties**.

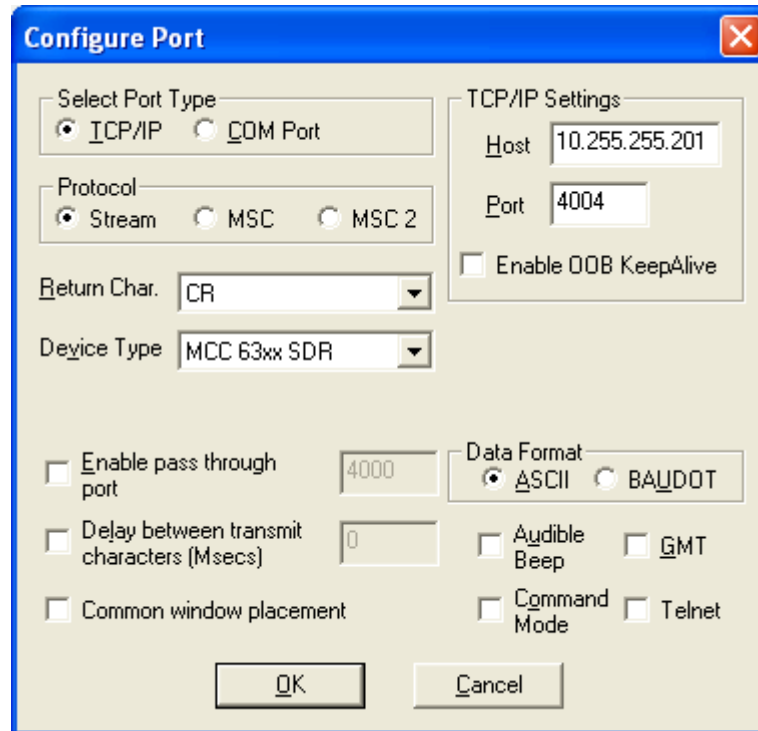
Figure 17 Internet Protocol (TCP/IP) Properties window for Ethernet 2 connection



4. Click **Use the following IP address**.
5. In the **IP address** box, enter **10.255.255.200**.
6. In the **Subnet mask** box, enter **255.255.255.0**.
7. Click **OK**.

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

Figure 18 XtermW Configure Port window with settings for LAN port



Note TCP/IP Settings for Host on the **LAN** port is configured for IP address **10.255.255.201**.

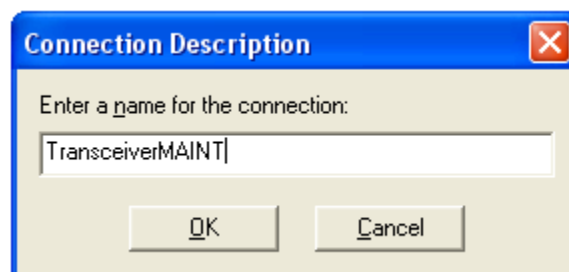
5.4.3 CREATING AN XTERMW CONNECTION PROFILE

A connection profile is a group of configuration settings created in XtermW and saved to use again for convenience when connecting to an Ethernet port using the same settings.

To create an XtermW connection profile

1. Open **XtermW** if it is not already open.
2. From the **File** menu, select **New Connection** and the **Connection Description** window opens.

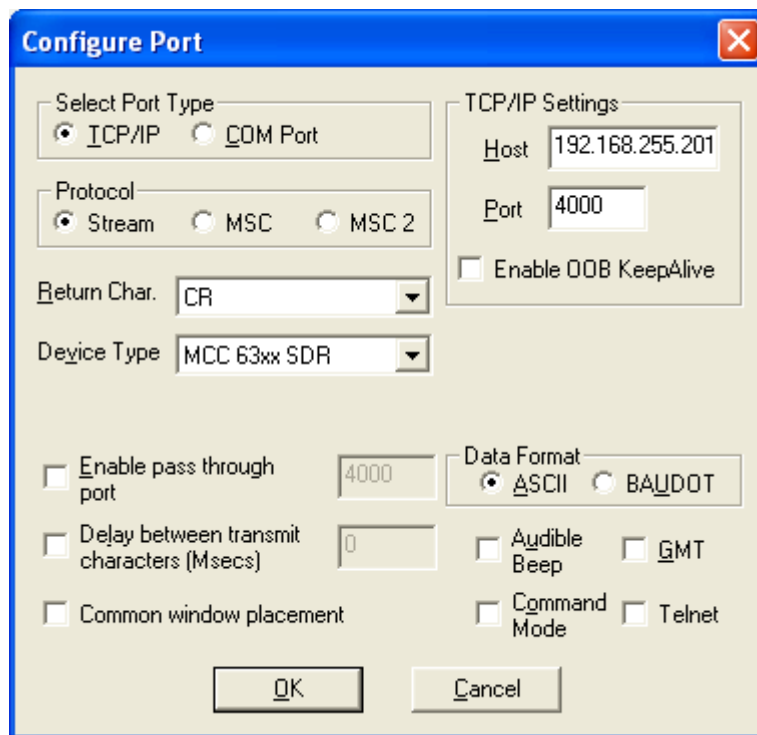
Figure 19 Connection Description window



3. Enter a name for the connection and then click **OK**.

4. The **Configure Port** dialog window opens.

Figure 20 XtermW Configure Port window with settings for the MAINT port



5. Set **Select Port Type** to **TCP/IP**.
6. Set the **Protocol** to **Stream**.
7. Set **TCP/IP Host** and **Port** to the IP address and port for the Ethernet port you are connecting to.
 - The default IP address for the Transceiver **MAINT** port is **192.168.255.201**.
 - The default IP address for the Transceiver **LAN** port is **10.255.255.201**.
8. Set the **Device Type** and the rest of the settings in the window as shown in the figure.
9. Click **OK** to save the connection profile and connect to the specified Ethernet port.

To use a previously-saved connection profile in the future, open **XtermW**, and from the **File** menu, select **Open**, and then select the connection profile to use.

5.4.4 VERIFY THAT THE MAINT AND LAN ETHERNET PORTS ARE OPERATIONAL

Use the preceding procedures to configure Ethernet ports of the test computer for connection to the Transceiver MAINT and LAN ports, and connect the test computer to each these ports. The test computer should display an active network connection on both ports (indicated in the System Tray in Windows XP) within 60 seconds.

5.5 REVIEW THE POWER ON SELF-TEST (POST) RESULTS

A POST is a series of several dozen tests that the transceiver 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 the POST command multiple times does not cause the tests to be re-run since one execution of the tests are automatic at each power on.

POST results show whether the transceiver has passed a test, indicated by PASS, or failed a test, indicated by FAIL. The results do not appear on the transceiver, 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, remove and reconnect DC power. The transceiver will automatically run internal diagnostics. A flashing green PWR LED on the front panel indicates that the boot sequence has completed. Within 10 seconds the Ethernet port becomes active.

Note — For the Base Station Transceiver, the transmitter is disabled for approximately 30 seconds after power is applied. This delay allows the oven-controlled crystal oscillator to warm up enough to ensure the accuracy of the transmitter frequency.

The computer must be configured and connected to the radio transceiver MAINT port, as explained in the previous section. (Make sure your computer network card connected to the MAINT port has a fixed IP address of 192.168.255.200.)

To display the POST results:

1. If it is not already connected, connect the computer to the transceiver **MAINT** port, using a Category 5 or better Ethernet cable.
2. On the computer, open the **XtermW** application, if it is not already open.
3. Click **Send**, click **Command**, and then type:
POST
4. Click OK.
5. View the POST results listing. See [APPENDIX F— Sample POST Results Typical for Properly Functioning Transceiver](#).

5.6 VERIFY FRONT PANEL LEDS ARE OPERATIONAL (ALL TRANSCEIVER TYPES) AND VERIFY COOLING FANS ARE OPERATIONAL (BASE STATION TRANSCEIVERS ONLY)

This section provides instructions to verify that all front-panel LEDs are operational and, for Base Station Transceivers, to verify that the cooling fans are operational. (Only Base Station Transceivers are equipped with cooling fans.)

5.6.1 VERIFY ALL FRONT-PANEL LEDS ARE OPERATIONAL

Front-panel LEDs must be operational to be useful in diagnosing transceiver problems. When not operational, they can result in misleading information when attempting to troubleshoot problems.

To test the transceiver front-panel LEDs:

1. If it is not already connected, connect the computer to the transceiver **MAINT** port, using a Category 5 or better Ethernet cable.
2. On the computer, open the **XtermW** application, if it is not already open.
3. Click **Send**, click **Command**, and then type:
`IOD, 0xFE0`
4. Click **OK**.
5. Verify that all LEDs illuminate, except the power LED (PWR) which will blink (as it does in normal operation when power is applied to the transceiver).
6. Click **Send**, click **Command**, and then type:
`IOD, 0x000`
7. Click **OK**.
8. Verify that all LEDs turn off, except the power LED which will continue to blink as in normal operation.

To test LEDs individually, use values from the following table with the **IOD** command to illuminate the associated LED.

Table 7 Front Panel LEDs and IOD values arranged by IOD value

LED Label	IOD Value	LED Label	IOD Value
TX (Transmit link)	0x0020	STBY (Standby)	0x0400
SWR (VSWR)	0x0040	FLT (Fault)	0x0800
RX (Receive link)	0x0080		
DTL (DTE Link)	0x0100	All On (except Power)*	0xFE0
RFL (RF Link)	0x0200	All Off (except Power)*	0x000

*The PWR LED blinks; it does not illuminate solid on.

NOTE — Be sure to **Send** the **Command** `IOD, 0x000` (then click **OK**) to the transceiver when you have finished testing the LEDs, to turn off all LEDs (except Power, which will blink), or alternatively restart the transceiver (using the **BOOT** command, for example) to return all LEDs to normal operation.

Table 8 Front Panel LED IOD values arranged to panel LED arrangement

IOD Value	LED Label	LED Panel	LED Label	IOD Value
(none)	Power		Tx Transmit	0x0020
0x200	RF Link		Rx Receive	0x0080
0x100	DTE Link		Fault	0x0800
0x400	Standby		VSWR	0x0040
0xFE0	All On (except Power)*			
0x000	All Off (except Power)*			

*The PWR LED blinks; it does not illuminate solid on.

5.6.2 VERIFY COOLING FANS ARE OPERATIONAL (BASE STATION TRANSCEIVERS ONLY)

Base Station Transceivers rely on the cooling fans being operational to help prevent overheating conditions. The Base Station Transceiver has three cooling fans: one cooling fan is located on heat-sink fins on the right side of the transceiver chassis, and two cooling fans are located on heat-sink fins at the rear of the unit.

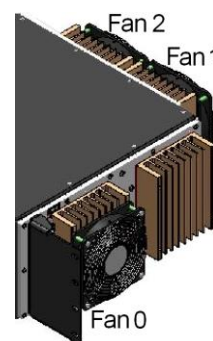
To test the Base Station Transceiver cooling fans:

1. If it is not already connected, connect the computer to the transceiver **MAINT** port, using a Category 5 or better Ethernet cable.
2. On the computer, open the **XtermW** application, if it is not already open.
3. Turn on the first fan, located on heat-sink fins at the right side of the transceiver:
 - a. Click **Send**, click **Command**, and then type:
`FANS, ON, 0`
 - b. Click **OK**.
4. Verify that the first fan turns on and runs.
5. Turn on the second fan, located on the rear set of heat-sink fins to the right:
 - a. Click **Send**, click **Command**, and then type:
`FANS, ON, 1`
 - b. Click **OK**.
6. Verify that the second fan turns on and runs.
7. Turn on the third fan, located on the rear set of heat-sink fins to the left:
 - a. Click **Send**, click **Command**, and then type:
`FANS, ON, 2`
 - b. Click **OK**.
8. Verify that the third fan turns on and runs.
9. Turn each of the fans off, verifying that each turns off soon after clicking OK:
 - a. Click **Send**, click **Command**, and then type:
`FANS, OFF, 0`
 - b. Click **OK**. The right-side fan turns off.
 - c. Click **Send**, click **Command**, and then type:
`FANS, OFF, 1`
 - d. Click **OK**. The right rear fan turns off.
 - e. Click **Send**, click **Command**, and then type:
`FANS, OFF, 20`
 - f. Click **OK**. The left rear fan turns off.

Use values from the following table with FANS command to turn fans on and off.

Table 9 Commands turning on and off Base Station Transceiver fans

To do this	Located on the set of heat-sink fins	Issue Command
Turn the first fan on	at the right side of the transceiver	FANS,ON,0
Turn the first fan off	at the right side of the transceiver	FANS,OFF,0
Turn the second fan on	to the right at the rear of the transceiver	FANS,ON,1
Turn the second fan off	to the right at the rear of the transceiver	FANS,OFF,1
Turn the third fan on	to the left at the rear of the transceiver	FANS,ON,2
Turn the third fan off	to the left at the rear of the transceiver	FANS,OFF,2



NOTE — Be sure to **Send** the **Command** FANS , OFF , *n* (where *n* represents the fan number, and then click **OK**) to the transceiver for each fan you turn on to turn fans off when you have finished testing them, or alternatively restart the transceiver (using the **BOOT** command, for example) to return all fans to normal operation.

5.7 VERIFY SETTINGS THAT ALLOW THE TRANSCEIVER TO TRANSMIT

The transceiver will not transmit if calibration is not locked or if the transceiver is uncommissioned. If the transceiver boots up normally and everything else appears normal except that the transmitter will not transmit, check these settings to verify they have been set correctly.

5.7.1 VERIFY TRANSCEIVER CALIBRATION IS LOCKED

With the computer connected to the transceiver MAINT port, use the CALIBRATION or CAL command to determine whether radio calibration is locked and if not to lock it.

To determine if the transceiver calibration is locked and if necessary lock the transceiver calibration:

1. If it is not already connected, connect the computer to the transceiver **MAINT** port using a Category 5 or better Ethernet cable.
2. On the computer, open the **XtermW** application.
3. Click Send, click Command, and then type:
CAL
4. Click **OK**.

The transceiver will return a Calibration status of either “CAL Params are LOCKED” or “CAL Params are UNLOCKED.”

- If the transceiver returns a status of “CAL Params are LOCKED,” the transceiver calibration is locked and you can continue on to the next procedure.
- If the transceiver returns a status of “CAL Params are: UNLOCKED,” do the following to lock the transceiver calibration parameters:

1. You will need the calibration random (CALRAND) number that the transceiver creates at power-up.
Click **Send**, click **Command**, and then type:

CALRAND

2. Click **OK**.

The transceiver will return a number that appears to be a random decimal number, *calrand number*.
Make note of this number because you will need to provide it in the next command.

3. Click **Send**, click **Command**, and then type:

CAL, LOCK, *calrand number*

Where *calrand number* represents the random number obtained from issuing the CALRAND command.

4. Click **OK**.

The transceiver will lock the calibration parameters and return a status message "CAL Params are LOCKED."

5.7.2 VERIFY THE TRANSCEIVER IS COMMISSIONED

The transceiver will not transmit if it is in uncommissioned mode. With the computer still connected to the transceiver **MAINT** port, use the COMMISSION command to determine whether the radio is commissioned and if not to commission it.

To determine the Commission status of the transceiver and if necessary commission the transceiver:

1. If it is not already connected, connect the computer to the transceiver **MAINT** port using a Category 5 or better Ethernet cable.
2. On the computer, open the XtermW application.
3. Click **Send**, click **Command**, and then type:

COMMISSION

4. Click **OK**.

The transceiver will return a Commission status of either "Radio State: COMMISSIONED" or "Radio State: UNCOMMISSIONED."

- If the transceiver returns a status of "Radio State: COMMISSIONED," the transceiver has been commissioned and you can continue on to the next procedure.
- If the transceiver returns a status of "Radio State: UNCOMMISSIONED," do the following to commission the transceiver:

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

COMMISSION, COMMISSIONED

2. Click **OK**.

The transceiver will return the status of "Radio State: COMMISSIONED." The transceiver has been commissioned.

5.8 DETERMINE AND VERIFY OR SET GPS COORDINATES (BASE STATION AND WAYSIDE TRANSCEIVERS ONLY)

Base Station and Wayside Transceivers, because it is generally known where each will be installed, may have default GPS coordinates already entered as part of system planning and configured before shipment. For the most part, this works to the advantage of the installer. A hidden risk where this can become problematic though, is where a replacement transceiver is used to replace a non-working unit or where a transceiver intended for installation at one location is substituted for another at a different location. In these cases, if a GPS location has been programmed into the system, it is most likely wrong. In any case, because being configured with the correct global position of the transceiver is essential to its proper function, it is important to determine and verify—and if necessary correct—the GPS coordinates configured in the transceiver.

[APPENDIX E— GPS Satellite Constellation Overview and Antenna Planning Considerations](#) provides a general overview of GPS as it relates to the system. If you are not familiar with the concepts, it is good reference material. The sections that are important here are those contained in [E.2.2 Determine GPS Coordinates](#).

- If the GPS coordinates of the Wayside Transceiver location are known use the instructions and example contained in [Surveyed position obtained offline](#) to enter the GPS coordinates and configure the transceiver to use GPS Manual mode.
- If the GPS coordinates are not known or the transceiver will be used in a mobile application, use instructions and example contained in [GPS determines its own position](#), to configure the transceiver to use Survey mode.

Note: If you choose to have the Wayside Transceiver continue to use Survey mode (for example where the transceiver will be used in a mobile application), DO NOT enter GPS coordinates in the CIM script.

5.9 TRANSCEIVER TEST AND ADJUSTMENT PROCEDURES

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

5.9.1 REQUIRED EQUIPMENT

The tests and adjustments described in this section require service personnel to have equipment listed in the [Recommended Equipment](#) section, as well as the skill and knowledge to use them.

Note: Base Station Transceivers come in two versions that differ only in their voltage requirements: 24 VDC or 48 VDC. The table below describes the power supply requirements for each type. Locomotive and Wayside Transceivers have different voltage requirements (74 VDC and 13.6 VDC) as noted below.



Caution – Applying an incorrect voltage to the Base Station Transceiver can cause damage. Confirm the voltage rating of the Transceiver and power source before applying power.

Table 10 Base Station Transceiver input power parameters

Parameter	24 VDC version	48 VDC version
Nominal DC Power Input Voltage	24 VDC	48 VDC
Operational range	21-27 VDC (+/-12.5%)	42-54 VDC (+/-12.5%)
Damage limit	30 VDC	60 VDC
Current draw (while transmitting rated power)	7.5 A – typical while transmitting into 50 Ohm load	4.0 A — typical while transmitting into 50 Ohm load

Table 11 Locomotive Transceiver input power parameters

Parameter	Value
Nominal DC Power Input Voltage	74 VDC
Operational range	45-100 VDC (+35%/-40%)
Damage limit	120 VDC
Current draw (while transmitting rated power)	1.8 A – typical while transmitting into 50 Ohm load

Table 12 Wayside Transceiver 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 draw (while transmitting rated power)	7.5 A – typical while transmitting into 50 Ohm load, 10 A maximum

5.9.2 MEASURE AND ADJUST PEAK RF POWER OUTPUT

Equipment used to measure and adjust peak RF power output

1. A power supply capable of providing:
 - 24 VDC Base Station Transceiver: 24 VDC and a current of 11 Amperes
 - 48 VDC Base Station Transceiver: 48 VDC and a current of 6 Amperes
 - Locomotive Transceiver: 45-100 VDC and a current of 4 Amperes
 - Wayside Transceiver: 13.6 VDC and a current of 10 Amperes
2. 4 GHz spectrum analyzer that includes a DQPSK digital demodulation option

Or

1. Agilent #4417A power meter to measure peak and average power or equivalent and Agilent E9325A Peak and Average Power Sensor -65 to +20 dBm or equivalent
2. 10 MHz signal reference

3. 60 dB of attenuation rated at 100 W for Base Station or Locomotive Transceivers; 60 dB of attenuation rated at 50 W for Wayside Transceivers.

System setup for measuring and adjusting RF power output

Figures that follow illustrate the setup required to measure the RF output power for Base Station, Locomotive, and Wayside Transceivers.

Figure 21 Base Station transmitter power output measurement and adjustment setup

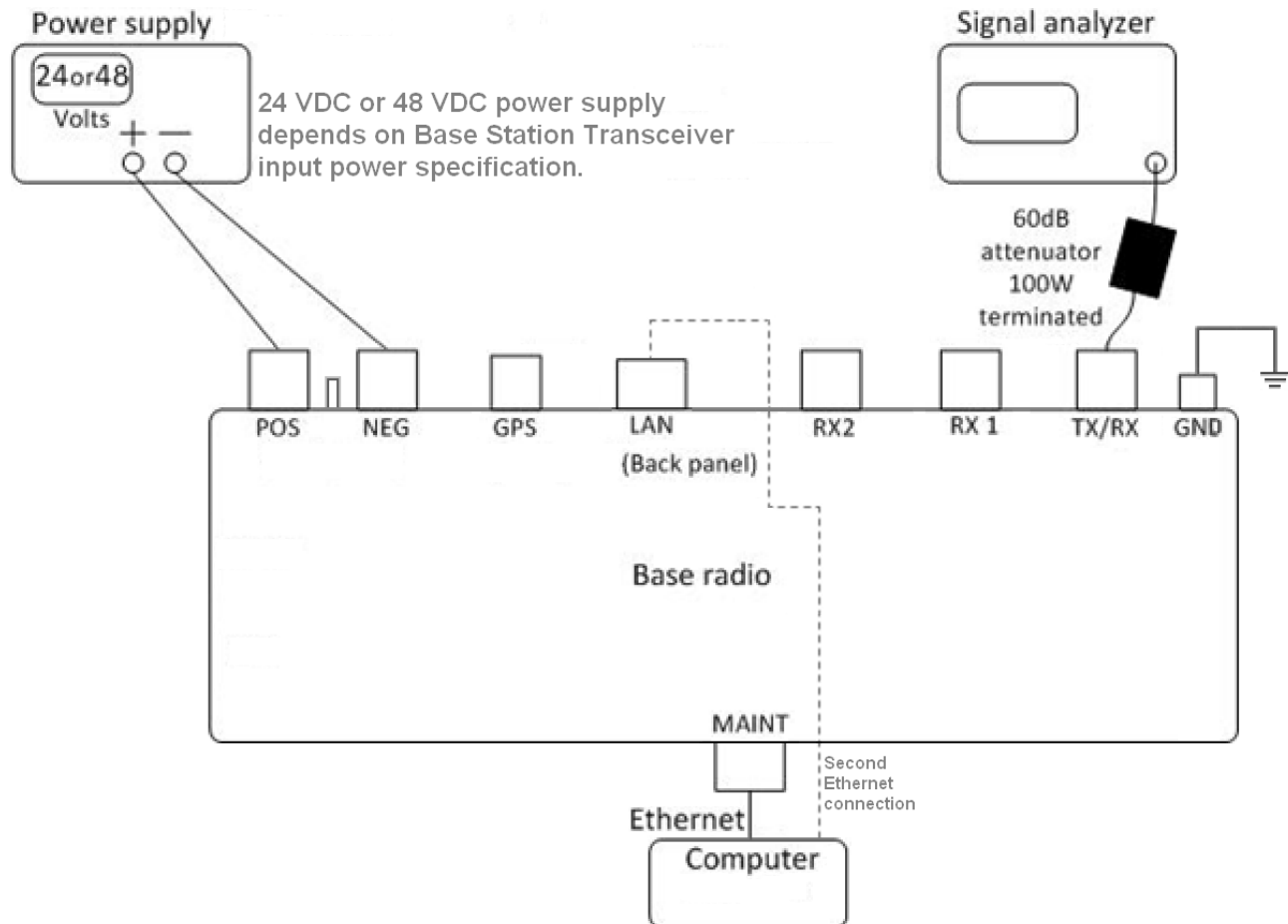


Figure 22 Locomotive transmitter power output measurement and adjustment setup

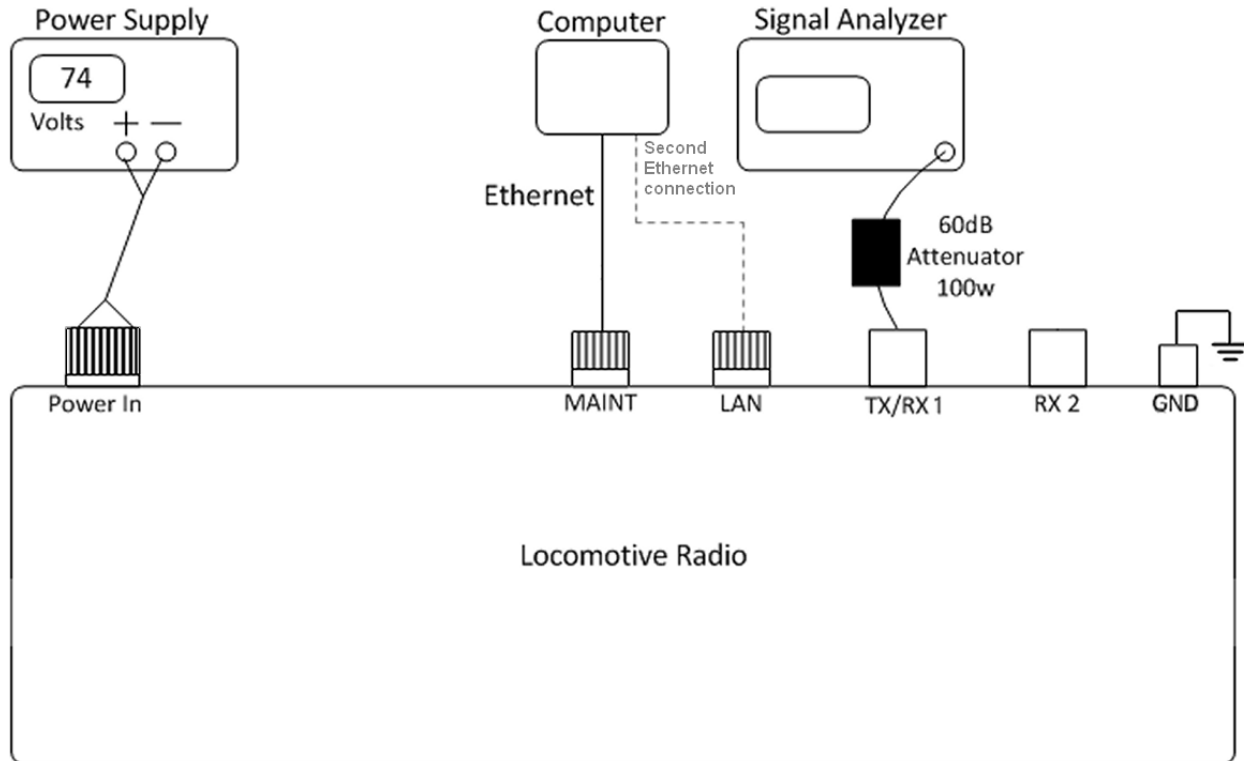
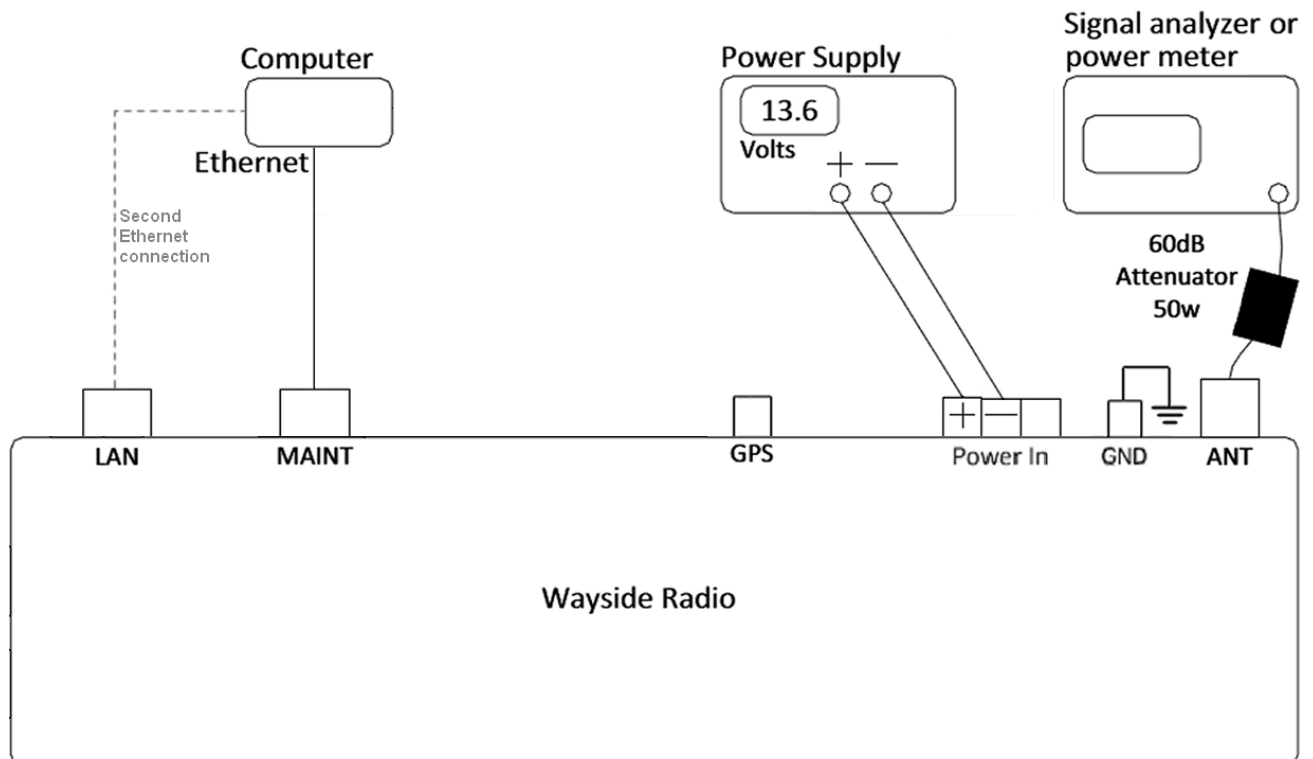


Figure 23 Wayside transmitter power output measurement and adjustment setup



Configure the Agilent E4417A power meter

Use these settings:

Select Channel

- Sensor Mode: Normal
- Range: Auto
- Filter: Auto
- Duty Cycle: Off
- Offset On: Use offset from cable and attenuator
- Frequency: 221.137 MHz
- CF Table: Off
- FDO Table: Off
- Video Avg: Off
- Video B/W: Low
- Step Detect: On
- Gates
 - Gate Start: 3 ms
 - Gate Length: 97 ms
- Trace Setup
 - Start: 1 ms
 - Length: 99 ms
- Trigger
 - Cont Trig
- Measure Setup
 - Upper Window: AVG
 - Lower Window: Peak
 - Rel/Offset: both Off
- Meas Display – Resolution 3 digits

Expected peak RF power output

- The expected peak RF power for the Base Station Transceiver (24 VDC or 48 VDC model) is 75 watts PEP.
- The expected peak RF power for the Locomotive Transceiver is 50 watts PEP.
- The expected peak RF power for the Wayside Transceiver is 25 watts PEP.

Radio transmission characteristics

Spectrum analyzer images, which follow, show typical radio transmission frequency and power spectrum characteristics in DQPSK transmission modulation format.

Note — Only Base Station and Locomotive Transceivers are capable of transmitting at $\pi/4$ DQPSK full rate. The Wayside Transceiver is capable of transmitting only at $\pi/4$ DQPSK half rate.

Use the commands below in XtermW, to key up the transmitter at either $\pi/4$ DQPSK full rate (Base Station or Locomotive only) or half rate (Base Station, Locomotive, or Wayside) and observe radio performance.

To key up a Base Station or Locomotive transmitter at $\pi/4$ DQPSK full rate:

(Base Station and Locomotive only)

1. In **XtermW** type the following commands:

STOP

SCHED, DEL, ALL

DSP_MODE, IDLE

DSP_MODE, TEST

L1_TEST, SET, TXFREQ, value

L1_TEST, SET, TXMOD, DQPSK

L1_TXDUTY, 1000, 300, 0

where:

value equals the desired frequency of operation in Hz.

Note: The ratio of 300/1000 denotes a 30% transmit duty cycle.

2. Once observation of radio performance is complete, turn off transmit operations by typing:

L1_TEST, STOP

To key up a Base Station or Locomotive transmitter at $\pi/4$ DQPST half rate:

(Base Station or Locomotive only)

1. In **XtermW** type the following commands:

STOP

SCHED, DEL, ALL

DSP_MODE, IDLE

DSP_MODE, TEST

L1_TEST, SET, TXFREQ, value

L1_TEST, SET, TXMOD, DQPSK_HALF

L1_TXDUTY, 1000, 300, 0

where:

value equals the desired frequency of operation in Hz.

Note: The ratio of 300/1000, specified for Base Station and Locomotive Transceivers, denotes a 30% transmit duty cycle. (The maximum transmit duty cycle for Wayside Transceivers must be held to less than 10%. The ratio of 300/3500, you will see specified for the Wayside Transceiver in the next section, denotes approximately a 9% transmit duty cycle.)

2. Once observation of radio performance is complete, turn off transmit operations by typing:

L1_TEST, STOP

Note — The two following figures in this section show a typical transmission spectrum or power measurement of a Locomotive Transceiver at Full DQPSK.

Figure 24 Typical transmission spectrum (Full DQPSK)

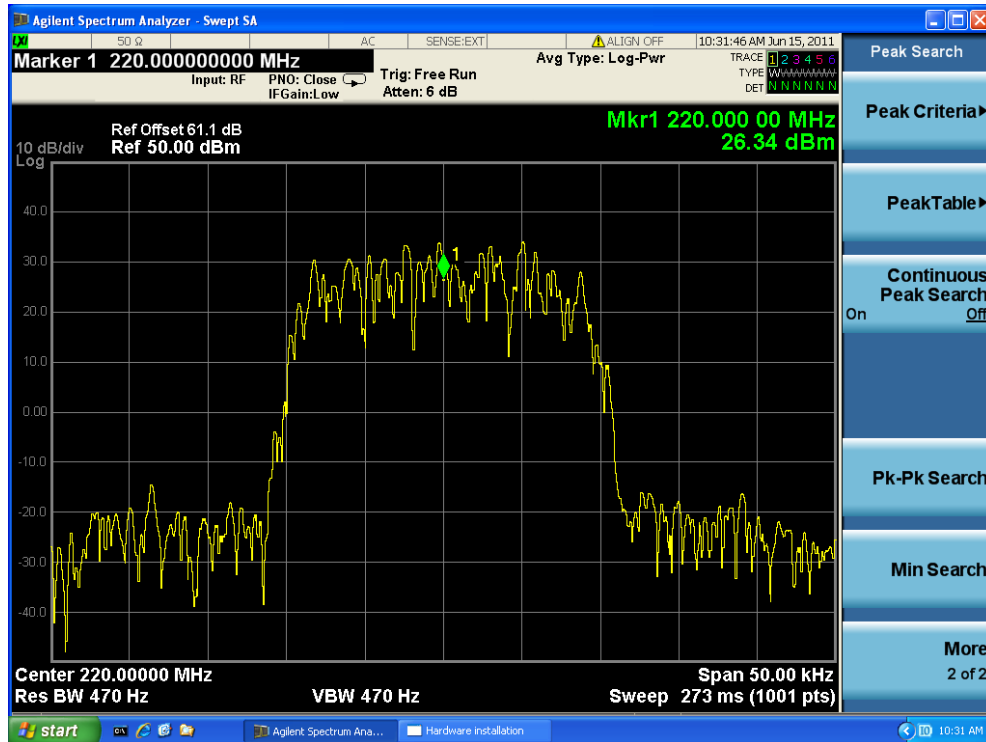
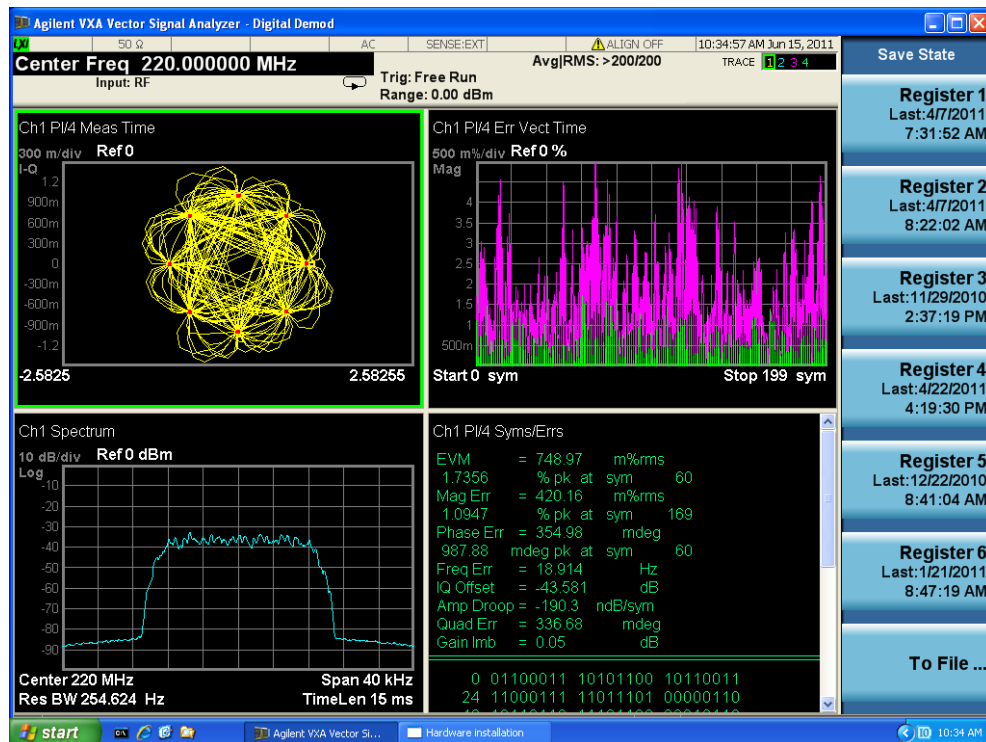


Figure 25 Typical transmission spectrum EVM (Full DQPSK)



To key up a Wayside transmitter at $\pi/4$ DQPSK half rate:

1. In **XtermW** type the following commands:

STOP

SCHED, DEL, ALL

DSP_MODE, IDLE

DSP_MODE, TEST

L1_TEST, SET, TXFREQ, value

L1_TEST, SET, TXMOD, DQPSK_HALF

L1_TXDUTY, 3500, 300, 0

where:

value equals the desired frequency of operation in Hz.

Note: The ratio of 300/3500, specified for Wayside Transceivers, denotes approximately a 9% transmit duty cycle. (The maximum transmit duty cycle for Wayside Transceivers must be held to less than 10%.)

2. Once observation of radio performance is complete, turn off transmit operations by typing:

L1_TEST, STOP

Note — The two following figures in this section show a typical transmission spectrum or power measurement of a Wayside Transceiver at Half-DQPSK.

Figure 26 Typical transmission spectrum (Half-DQPSK)

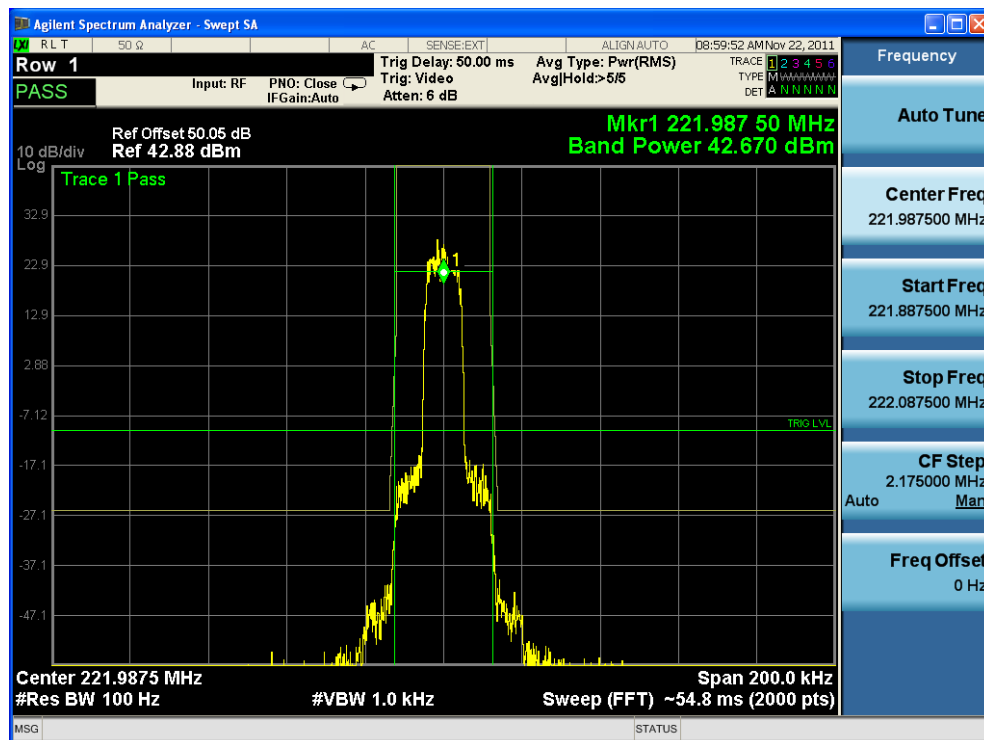
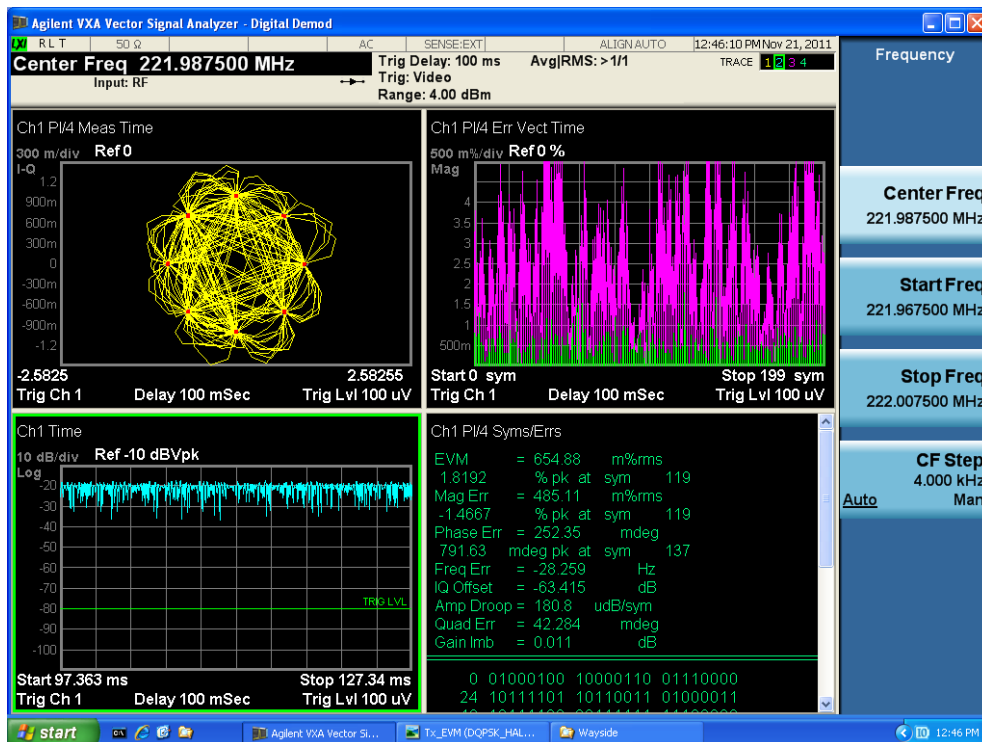


Figure 27 Typical transmission spectrum EVM (Half-DQPSK)



5.9.2.1 ADJUST RF POWER OUTPUT

Base station transceivers are rated for 75 W PEP, Locomotive transceivers are rated for 50 W PEP, and Wayside transceivers are rated for 25 W PEP. To achieve rated power, transceivers 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.
- $\pi/4$ DQPSK is a linear modulation technique.

To adjust RF output power for a Base Station or Locomotive Transceiver

Base Station and Locomotive Transceivers can operate at full-rate $\pi/4$ DQPSK modulation and a maximum duty cycle of 50% for Base Station and 30% for Locomotive Transceivers. (Wayside Transceivers operate only at half-rate $\pi/4$ DQPSK modulation and the maximum transmit duty cycle for Wayside Transceivers must be held to less than 10%.)

- Key up the transmitter for full-rate $\pi/4$ DQPSK modulation using the following commands in XtermW:

STOP

SCHED, DEL, ALL

DSP_MODE, IDLE

DSP_MODE, TEST

L1_TEST, SET, TXFREQ, value

L1_TEST, SET, TXMOD, DQPSK

L1_TXDUTY, 1000, 300, 0

where:

value equals the desired frequency of operation.

Note: The ratio of 300/1000 denotes a 30% transmit duty cycle. (The maximum transmit duty cycle for Wayside Transceivers must be held to less than 10%. The ratio of 300/3500, you will see specified for the Wayside Transceiver in the next section, denotes approximately a 9% transmit duty cycle.)

2. 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 $1/10^{\text{th}}$ of a dB), depending on whether you want to increase or decrease the power level.

3. Once observation of radio performance is complete, turn off transmit operations by typing:

L1_TEST, STOP

To adjust RF output power for a Wayside Transceiver

Wayside Transceivers operate at half-rate $\pi/4$ DQPSK modulation and are rated for a maximum duty cycle of 10%.

1. Key up the transmitter for half-rate $\pi/4$ 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_TXDUTY, 3500, 300, 0

where:

221137500 equals the desired frequency of operation in Hz.

Note: The ratio of 300/3500, specified for Wayside Transceivers, denotes approximately a 9% transmit duty cycle. (The maximum transmit duty cycle for Wayside Transceivers must be held to less than 10%.)

2. 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.

3. Once observation of radio performance is complete, turn off transmit operations by typing:

L1_TEST, STOP

To make power settings persistent across power cycles (all transceivers)

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 radio transceivers. Settings outside this range for operation for an antenna are out of FCC compliance. It is the user's responsibility to confirm that settings are within compliance.

Table 13 Rated RF Power Output

Parameter	Wayside Transceiver	Locomotive Transceiver	Base Station
Conducted Carrier Output Power Rating	25 W PEP nominal	50 W PEP nominal	75 W PEP nominal
Adjustment range	7.5 to 25 W	15 to 50 W PEP	10 to 75 W PEP*

*7.5 W PEP is +38.7 dBm peak. Average power would be about 3 dB less. The base range of 10 to 75 W is less than a 9 dB range.

5.9.3 MEASURE FULL-RATE RECEIVER SENSITIVITY

5.9.3.1 PRIMARY/RX1 OR ANT RECEIVER MEASUREMENT (ALL TRANSCEIVERS)

To begin the test, make sure the E4438C signal generator is outputting the proper wave form into the RX1 port (for Base Station and Locomotive) or ANT port (for Wayside) on the transceiver. Next, issue the applicable set of commands in XtermW.

Commands for Base Station Transceiver:

```
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
DSP_CMD, SET, BER, RAW
L1_TEST, START, RX
DSP_CMD, BAC, 3
SCHED, I, 6, L1_TEST, GET, ERRCOUNTS, 3, 3
```

where:

value equals the desired frequency of operation.

Once observation of radio performance is complete, turn off transmit operations by typing:

```
L1_TEST, STOP
```

Commands for Locomotive or Wayside Transceiver:

```
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
DSP_CMD, SET, BER, RAW
L1_TEST, START, RX
SCHED, I, 6, L1_TEST, GET, ERRCOUNTS, 3, 3
```

where:

value equals the desired frequency of operation.

Once observation of radio performance is complete, turn off transmit operations by typing:

L1_TEST, STOP

5.9.3.2 DIVERSITY/RX2 RECEIVER MEASUREMENT (BASE STATION AND LOCOMOTIVE)

To begin the test make sure the E4438C signal generator is outputting the proper wave form into the RX2 port on the transceiver. Next, issue the applicable set of commands in XtermW.

Commands for Base Station Transceiver:

```
STOP
SCHED, DEL, ALL
DSP_MODE, IDLE
DSP_MODE, TEST
L1_TEST, SET, RXPATH, D
L1_TEST, SET, RXENABLE, 3, ON
L1_TEST, SET, RXFREQ, value, 3
DSP_CMD, SET, BER, RAW
L1_TEST, START, RX
DSP_CMD, BAC, 2
SCHED, I, 6, L1_TEST, GET, ERRCOUNTS, 3, 3
```

where:

value equals the desired frequency of operation.

Once observation of radio performance is complete, turn off transmit operations by typing:

L1_TEST, STOP

Commands for Locomotive Transceiver:

```
STOP
SCHED, DEL, ALL
DSP_MODE, IDLE
DSP_MODE, TEST
L1_TEST, SET, RXPATH, D
L1_TEST, SET, RXENABLE, 3, ON
L1_TEST, SET, RXFREQ, value, 3
```

```
DSP_CMD, SET, BER, RAW
```

```
L1_TEST, START, RX
```

```
SCHED, I, 6, L1_TEST, GET, ERRCOUNTS, 3, 3
```

where:

value equals the desired frequency of operation.

Once observation of radio performance is complete, turn off transmit operations by typing:

```
L1_TEST, STOP
```

5.9.3.3 ALTERNATE/TX-RX RECEIVER MEASUREMENT (BASE STATION TRANSCEIVER ONLY)

To begin the test, make sure the E4438C signal generator is outputting the proper wave form into the TXRX port on the transceiver. Next, issue the following commands in 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
```

```
DSP_CMD, SET, BER, RAW
```

```
L1_TEST, START, RX
```

```
DSP_CMD, BAC, 2
```

```
SCHED, I, 6, L1_TEST, GET, ERRCOUNTS, 3, 3
```

where:

value equals the desired frequency of operation.

Once observation of radio performance is complete, turn off transmit operations by typing:

```
L1_TEST, STOP
```

5.9.4 PUT A TRACE ON A FEATURE

A trace enables you to monitor and log a specific activity of a ITC radio transceiver. Examples of traceable activities are port activity, RF link activity, and forward-error-correction (FEC) activity. You can save traces in a log file.

Note: Heavy tracing can affect radio performance. Do not leave traces running at the site.

Table 14 Brief descriptions of 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 and displays the DSP status log
DSP	Trace messages transferred from the DSP via the HPI interface
ETH	Information about the Ethernet connection status
EVENT	Event activity
GPS	Activity in the GPS protocol device driver
HRX	Information about the 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
RX	Hex dump of data being received through the RF receivers
TX	Hex dump of transmit data being sent to the RF transmitter

To trace an activity:

1. Use Category 5 or better Ethernet cable to connect the correct computer Ethernet port to the transceiver's **MAINT** port.
2. The Ethernet port must be configured to communicate with the **MAINT** port. [See To Configure the Computer Ethernet 1 Interface for Communication with the Transceiver MAINT Port.](#)
3. On the computer, open the **XtermW** application.
4. Specify the transceiver 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

5. Click **OK**.
6. 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 a destination, the trace output is sent to the port only.

7. 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**.

5.10 MANAGING SOFTWARE APPLICATION IMAGES

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

All image management operations may be accomplished using operator commands. However, the transceivers also support the capability to perform some image management operations using ITC Systems Management (ITCSM) features via a network connection from an application gateway.

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 transceiver.

This section explains how to:

- Obtain software image status information
- Update transceiver software application images
- Perform a manual software rollback
- Determine if automatic roll back has occurred

- Maintain multiple software images in the radio

5.10.1 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 15 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 transceiver. However, the transceiver 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 the image status.

In this example:

- The radio is using bootlauncher version 0.22.1 AVN 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 2-1011-07-29
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			

5.10.2 UPDATING SOFTWARE IMAGES

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

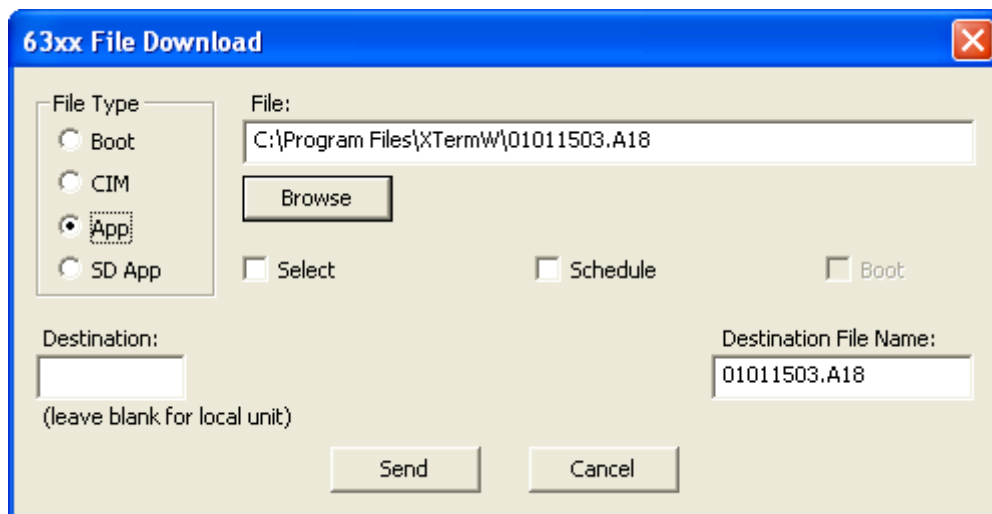
5.10.2.1 UPDATING TRANSCEIVER SOFTWARE USING THE COMMAND LINE

To update transceiver software:

1. Ensure that the new software image file is located on a computer drive accessible to the computer on which you run 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 transceiver 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 using the APPS ,INVALIDATE command.)
4. Establish a connection from **XtermW** to the transceiver using a connection profile that was created with the **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.

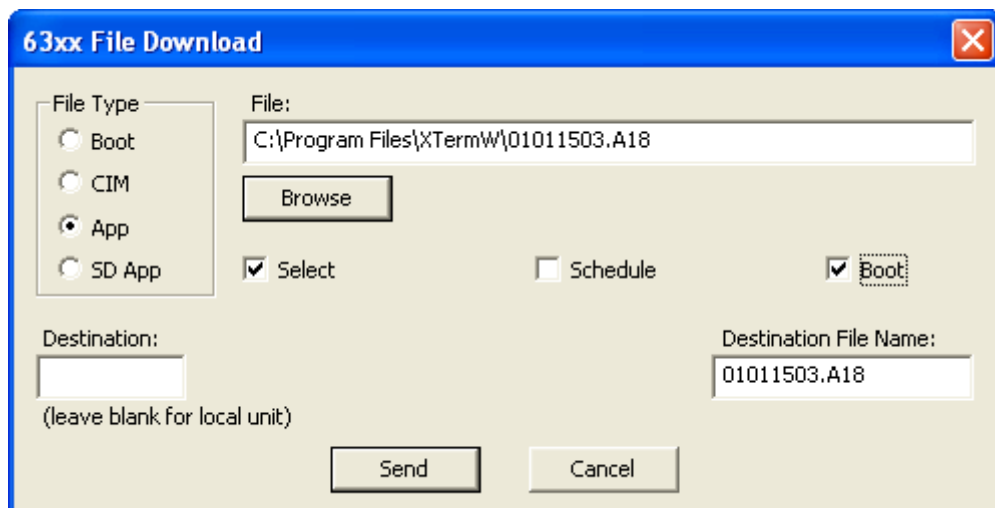
5. To download the software image, on the **Send** menu, select **63xx File Download**. You will see a dialog window like the following:



6. Under **File Type**, select **App**.
7. Click **Browse**, 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 8.3 filename requirements, meaning that the filename can have at most eight alphanumeric characters, followed by a period and extension of at most three alphanumeric characters. A few special characters are also allowed (namely, ! # \$ % & ' () - @ ^ _ ` { } and ~) Alphabetical characters are treated as case-insensitive.
9. To select this image immediately after it is downloaded, select the **Select** check box.

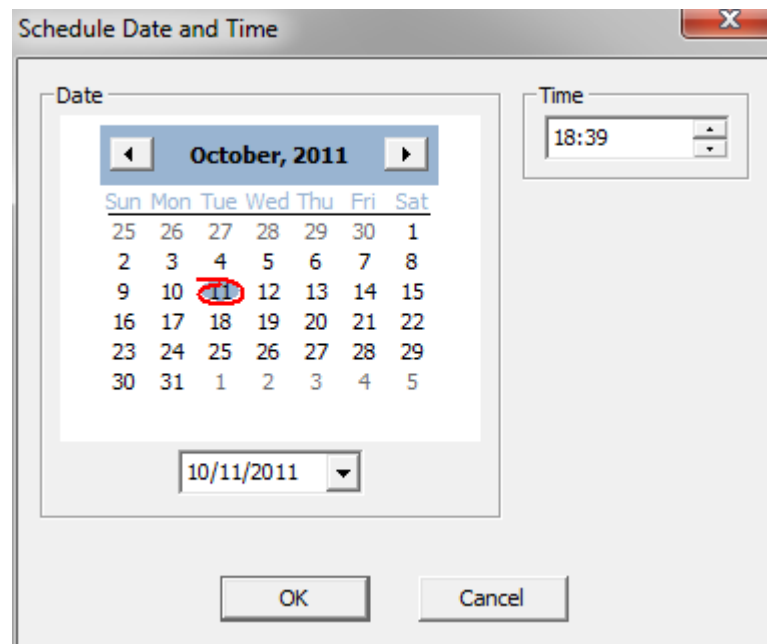
When you select the Select check box, XtermW automatically executes the **APPS, SELECT, image-file** command after the software image is downloaded. It also causes XtermW to enable the **Boot** check box.

The **Boot** check box is available only when you select the Select check box. When you select the **Boot** check box, 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.

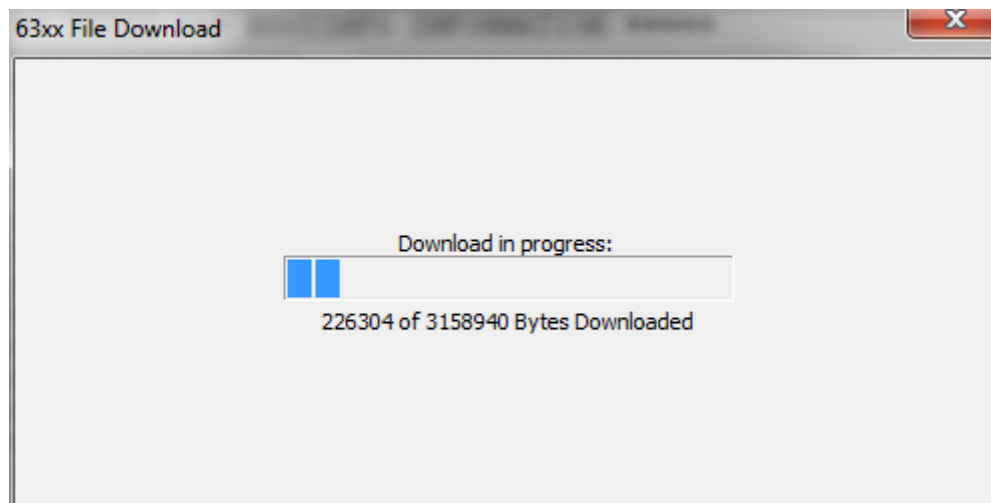


10. To execute a synchronized software update at a future time, select the **Schedule** check box. Choose the desired date and time in the pop-up window, and then click **OK**.

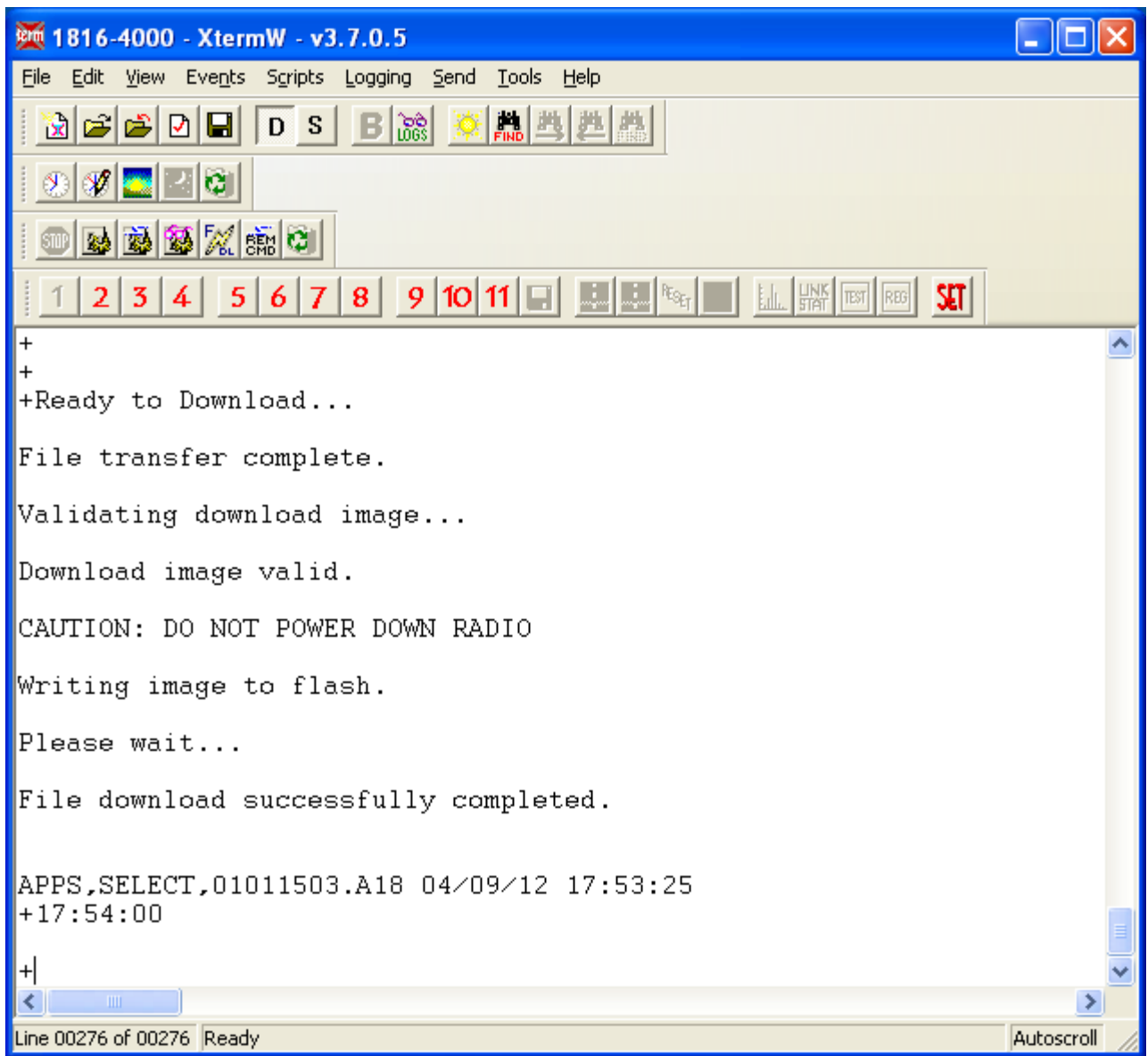
When you select the **Schedule** check box, XtermW automatically executes the `APPS,SCHED,date,time,image-file` command after the software image is downloaded.



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 check boxes were selected, the downloaded software image will be listed as ACTV (active image) after the reboot.
- If the Select check box was cleared, the downloaded software image will be listed with the status of NRDY.
- If the Select check box 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 check box 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.

5.10.3 ROLLING BACK AN IMAGE

5.10.3.1 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 as RDY.
- c. Retry launching the current active image.

5.10.3.2 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.

5.10.3.3 ROLLING BACK AN IMAGE VIA THE COMMAND LINE: APPS

You can manually roll back software when there are multiple software images installed in the transceiver.

To manually roll back 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 roll back 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	2	04/09/2012	05:05 PM	3361028	D:01011401.A18	ACTV		Success
3	27	RDY	0	2	04/09/2012	05:10 PM	3364420	C:01011503.A18			Success
1	25	RDY	0	0	04/09/2012	05:03 PM	3346860	D:01011203.A18			

5.10.4 MAINTAINING MULTIPLE SOFTWARE IMAGES IN THE TRANSCEIVER

5.10.4.1 MANAGING IMAGES VIA THE COMMAND LINE: APPS

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

Table 16 Software image actions

Action	Resulting image status
Install (using XtermW)	Different statuses depending 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 NIV are selectable.
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 a 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.

5.10.4.2 SYSTEM EVENTS ON INSTALLED SOFTWARE IMAGES

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

Table 17 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 SCHED to RDY with highest priority	If APPS, SCHED is enabled and a schedule has expired, the transceiver 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.

6 TROUBLESHOOTING

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

- Power
- SD memory 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 Transceiver test and adjustment procedures.

6.1 GUIDELINES FOR TROUBLESHOOTING COMMON PROBLEMS

Always check these items first when a transceiver problem occurs.

- **Check physical connections.**
Make sure that all physical connections to the transceiver are secure. This includes: Ethernet (LAN port), power, narrowband RF antennas, and GPS.
- **Check that the SD card is present, seated, and contains a valid CIM script file.**
Make sure that there is an SD card installed and seated that contains a valid CIM script file. Without an SD card present and without a valid CIM script, the transceiver will not transmit and will continually reboot every few minutes.
- **Check the LEDs.**
Use the LEDs to determine the state of the system and whether there is a fault condition. See LED Diagnostics for more information.
- **Determine the version of software each transceiver is running.**
Check the results of the REV command to determine what revision of software is running. All transceivers should be running software version 1.1.15.05 or later.
- **Check the POST results.**
Review the output of the POST command on the transceiver to ensure that no tests failed during the most recent power-on self test. See [Review the Power On Self-Test \(POST\) Results](#) for more information.
- **Check that the transceiver configuration is up to date.**
Run INICHECK to see if the transceiver configuration matches the current CIM script file. To run the CIM script in the event that they are not the same, use:
INICHECK, SCRIPT

6.2 POWER PROBLEMS

Problem indicators:

- There is no power to the transceiver — as indicated by the PWR (Power) LED does not illuminate or blink.
- The transceiver does not transmit.
- The POST results show that internal voltages are low.

To troubleshoot transceiver power issues:

1. Make sure the power cable connectors are securely connected to the power supply and to the transceiver.
2. Make sure the power cable polarity is correct: the wire for positive connection is connected to the unit's positive (+) terminal and the wire for negative connection is plugged into the negative (–) terminal. See the power cable diagram that is applicable to the radio transceiver in [D.1 Transceiver Power Cables](#).
3. Check that the power supply is turned on. If it is off, then turn it on. Verify that the breaker does not trip on power up.
4. Adjust the power supply to within the rated operating voltage.
5. Verify that the current limit on the power supply meets the maximum current draw. Refer to the applicable Input Power Parameters table in the [Required Equipment](#) section.
6. Replace the power cable.
7. Replace the transceiver. When replacing a transceiver, if the SD card contains a valid CIM script, remove the SD memory card from the nonworking transceiver and insert and seat it in the replacement transceiver. The replacement transceiver will use the CIM script on the SD memory card and its configuration will be the same as the original transceiver.

6.3 SD MEMORY CARD PROBLEMS

SD memory card problems are one type of problem that can cause the Fault LED to illuminate.

You can determine the specific problem that causes the Fault LED to illuminate by viewing the results of the POST, which occurs each time the transceiver boots up.

The POST results will show if there is an SD memory card failure. See [Review the Power On Self-Test \(POST\) Results](#).

The following shows what you will see in the SD memory card portion of the POST results if the SD memory 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 SD Memory Card \(CIM\) is Installed and Seated](#). If it is missing or defective, replace it with a new one that has a valid CIM script file.

2. If the transceiver reboots every few minutes, replace the SD memory card with one that contains a valid CIM script.
3. If the previously-described procedures to not turn off the Fault LED, or if the POST results listing shows any other kinds of problems, then replace the transceiver.

6.4 ANTENNA PROBLEMS

Antenna problem indicators:

- Transmissions from or to the transceiver are poor or absent.
- The transceiver's SWR LED illuminates.

To troubleshoot antenna issues:

1. Make sure the antenna cable connectors are securely connected to the antenna and to the transceiver. Make sure any unused antenna connectors are properly terminated.
2. Check the antenna and antenna cable for any defects or breaks.
3. Check the cable connector and radio connector for corrosion.
4. Issue the diagnostic command STAT to verify the VSWR and power output of the last transmission.
5. Check cable continuity.
6. Replace the cable or connector.
7. Replace the antenna.
8. Check the radio output power without the antenna connected.
9. View the Standing Wave Ratio measurements. At the XtermW prompt, type VSWR and press Enter. This displays the SWR indicator. Values are OK greater than 3:1. Examples of output from issuing the VSWR command might look like either of the following.

```
+VSWR 03:05:46.253
VSWR Ok.
```

Or

```
+VSWR 03:05:31.417
VSWR > 3:1
```

10. Replace the transceiver. When replacing a transceiver, if the SD card contains a valid CIM script, remove the SD memory card from the nonworking transceiver and insert and seat it in the replacement transceiver. The replacement transceiver will use the CIM script on the SD memory card and its configuration will be the same as the original transceiver.

6.5 TRANSMISSION PROBLEMS

Problem indicators:

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

To troubleshoot transmission issues:

1. Make sure the transceiver is turned on and the green PWR LED illuminates and blinks.
2. Issue the diagnostic command STAT to confirm the power output of the last transmission and VSWR.
3. Check the cable connector and the 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 (Power Amplifier) temperature has not exceeded the over-temperature threshold using the TXSTAT command to query the transmitter status.

+txstat

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

Transmitter State - Available

5. Inspect the SD memory card to ensure it is seated properly in the CIM socket in the orientation shown and is not damaged.
6. Make sure there is a valid CIM script file loaded from the SD card. At the XtermW prompt, enter INICHECK, SCRIPT.
7. Make sure the antenna cable connectors are securely connected to the antenna and to the radio connectors.
8. Adjust the power output higher and lower to verify the transmission is controllable.
9. Monitor the current supplied by the power supply to confirm the typical transmit current is drawn and the radio is not current limited.
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 transceiver might stop transmitting.
12. Adjust the power level, if necessary. The transceiver might stop transmitting if the voltage is too low.
13. Replace the cable or connector.
14. Replace the transceiver. When replacing a transceiver, if the SD card contains a valid CIM script, remove the SD memory card from the nonworking transceiver and insert and seat it in the replacement transceiver. The

replacement transceiver will use the CIM script on the SD memory card and its configuration will be the same as the original transceiver.

6.6 RECEPTION PROBLEMS

Problem indicators

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

To troubleshoot receiver issues:

1. Make sure the transceiver is turned on and the PWR LED illuminates and blinks.
2. Verify the transmit frequency is within limits. See [Operational Characteristics](#).
3. Verify the antenna cable connectors are securely connected to the antenna and the transceiver.
4. Verify each antenna is connected to the appropriate antenna input connector at the rear of the unit and terminate unused connectors. (See [APPENDIX B— Possible RF Antenna Configurations](#) for more specific information, if necessary.)
5. Check the cable connector and transceiver connector for corrosion.
6. Replace the cable or connector.
7. Check the antenna for any defects or breaks.
8. Replace the transceiver. When replacing a transceiver, if the SD card contains a valid CIM script, remove the SD memory card from the nonworking transceiver and insert and seat it in the replacement transceiver. The replacement transceiver will use the CIM script on the SD memory card and its configuration will be the same as the original transceiver.

6.7 ETHERNET CONNECTIVITY PROBLEMS

Problem indicators:

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

To troubleshoot network connectivity issues:

If you cannot directly connect to the MAINT port on the transceiver, then contact your system administrator.

1. Check network activity, for example, by using Wireshark software (or equivalent) and a computer. If the network is down, persons responsible for the network administration will need to restore network operation.
2. Make sure the Ethernet cable is securely connected to the transceiver LAN port.
3. Verify external network equipment is functioning properly.

4. Connect your computer to the transceiver LAN port. [See To Configure the Computer Ethernet 2 Interface for Communication with the Transceiver LAN Port](#). Send a command to the transceiver LAN port and then see if the transceiver responds.

Note: To communicate with the transceiver's LAN port, the computer's connected Ethernet port must be configured to do so. You must know the LAN port's IP address. If you do not know the IP address, contact the system administrator.

5. Replace the Ethernet cable.
6. Replace the transceiver. When replacing a transceiver, if the SD card contains a valid CIM script, remove the SD memory card from the nonworking transceiver and insert and seat it in the replacement transceiver. The replacement transceiver will use the CIM script on the SD memory card and its configuration will be the same as the original transceiver.

6.8 RF LINK PROBLEMS

Base Station Transceiver

- When the RF Link LED illuminates on the Base Station transceiver, it means that the Base Station transceiver is connected to one or more Locomotive or Wayside transceivers.
- When the LED on the Base Station transceiver is off, it means that the Base Station transceiver is not currently connected to a Locomotive or Wayside transceiver.

Locomotive or Wayside Transceiver

- When the RF Link LED illuminates on the Locomotive or Wayside Transceiver, it means that the Locomotive or Wayside transceiver has selected and connected to a Base Station transceiver.
- When the LED is off for the Locomotive transceiver, it probably means that the Locomotive transceiver detects one or more Base Station transceivers but has not selected one.
- When the LED is off for the Wayside transceiver, it could mean that the Base Station transceiver has not communicated with the Wayside transceiver for a specified time.

Problem indicators:

- The RF Link LED is off.

To troubleshoot RF link issues:

1. Make sure the transceiver is turned on and the green PWR LED illuminates and blinks.
2. Make sure the antenna cable connectors are securely connected to the antenna and to the transceiver.
3. Inspect the SD memory card to ensure it is not damaged and is seated properly in the CIM socket.
4. Make sure there is a valid CIM script file loaded from the SD card. At the XtermW prompt, enter INICHECK, SCRIPT.
5. Use the BBEACON command to ensure that the base beacons are configured for the common channel.
6. Check the antenna for any defects or breaks.

- Verify the base radio is transmitting. 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				

- Replace the transceiver. When replacing a transceiver, if the SD card contains a valid CIM script, remove the SD memory card from the nonworking transceiver and insert and seat it in the replacement transceiver. The replacement transceiver will use the CIM script on the SD memory card and its configuration will be the same as the original transceiver.

6.9 A REMOTE TRANSCEIVER DOES NOT ESTABLISH AN RF CONNECTION TO THE BASE STATION TRANSCEIVER

Troubleshooting steps:

Check to make sure the remote transceiver is not already connected to a different Base Station Transceiver:

- Use the LINKSTAT command on the remote radio to make sure it is not connected to a different Base radio.
- A tilde (~) or caret (^) next to the radio ID in the XtermW device output window indicates that a Base radio is selected or connected.
- Check to see if the Base radio with the expected connection to the remote radio is listed.

Check the channel configuration:

- Use the CHANNEL command on each radio to make sure the radios are both using the same common channel.
- Make sure the remote radio is using the AUTO channel control mode.
- Check to make sure the Base radio has a local channel configured.

Check to make sure the base beacons are enabled:

- On the Base radio, use the BBEACON command and ensure that base beacons are configured for the common channel.

Check to make sure base beacons are transmitted and received:

- On both the Base radio and the remote radio, enable the IDLE trace by using the command TRACE , ON , IDLE.
- Ensure that you see an ITCBB trace from the Base radio at approximately the rate configured in the BBEACON command.
- Check that the remote is receiving the base beacons. They are shown with a similar trace.

Note: Heavy tracing can affect radio performance. Do not leave traces running at the site.

APPENDIX A — ABBREVIATIONS AND DEFINITIONS

A: Ampere, or Amp; measure of electric current

AWG: American Wire Gauge (a measure of wire diameter)

BER: Bit Error Rate

CIM: Configuration Interface Module

cm: Centimeter

Common Channel: A CSMA-operated channel common to all Base Station, Locomotive, and Wayside Transceivers in the system. Every radio transceiver in the system should have the same common channel.

CSMA: Carrier Sense Multiple Access

CW: Constant Wave

dB: Decibel

dBd: Decibel, dipole

dB_i: Decibel, isotropic

dBm: Decibel, referenced to one milliwatt

DC: Direct Current

DCE: Data Communication Equipment

DTDMA: Dynamic Time Division Multiple Access

DOP: Dilution of Precision

DQPSK: Differential Quaternary Phase-Shift Keying

EIA: Electronic Industries Alliance

EIRP: Equivalent Isotropically -Radiated Power

ERP: Effective Radiated Power

EVM: Error Vector Magnitude

FCC: Federal Communications Commission (U.S.)

FRA: Federal Railroad Administration (U.S.)

FTDMA: Fixed Time Division Multiple Access

GPS: Global Positioning System

HAAT: Height Above Average Terrain

IC: Industry Canada (Canada)

ITC: Interoperable Train Control

ITCR: Interoperable Train Control Radio

kbps: Kilobits per Second

LAN: Local Area Network

LOS: Line of Sight

Local Channel: A frequency assigned to each Base Transceiver (DTDMA and FTDMA) and Wayside Transceiver (FTDMA)

m: Meter

Mbps: Megabits Per Second

MEO: Medium Earth Orbit

MHz: Megahertz

MPE: Maximum Permissible Exposure

MSGPS: Multi-Satellite Global Positioning System

mW: Milliwatt

NIC: Network Interface Card or Network Interface Controller

OCXO: Oven-Controlled Crystal Oscillator

PC: Personal Computer

PCA: Printed Circuit Assembly

PCB: Printed Circuit Board

PEP: Peak Envelope Power

PER: Packet Error Rate

POST: Power On Self Test

PPM: Parts Per Million

PSK: Phase Shift Keying

PSWR: Power Standing Wave Ratio

PTC: Positive Train Control

Radio ID: Radio Identifier; A unique identifier assigned to each radio transceiver in the system

RF: Radio Frequency

RSSI: Received Signal Strength Indicator

RTCS: Radio Test Control Simulator

RX: Receive

SAR: Specific Absorption Rate

SD memory card: Secure Digital memory card

SMA connector: SubMiniature version A connector

SRSP: Standard Radio System Plan (Canada)

TCP/IP: Transmission Control Protocol / Internet Protocol

TCXO: Temperature-Compensated Crystal Oscillator

TNC connector: Threaded Neill-Concelman connector

TX: Transmit

U: Unit measure of height for rack-mounted equipment, defined 44.5 mm (approximately 1¾ in) for rack-mounted equipment that conforms to EIA 19-inch rack standards

UUT: Unit Under Test

VDC: Voltage, Direct Current

VSWR: Voltage Standing Wave Ratio

W: Watt

XtermW: The terminal-emulation application used for configuring and testing ITC 220 Transceivers

APPENDIX B — POSSIBLE RF ANTENNA CONFIGURATIONS

B.1 BASE STATION TRANSCEIVER

The ITC 220 Base Station Transceiver allows for three possible RF antenna configurations.

- **Single-antenna configuration**

The antenna is connected to the primary receive port, which is the TX/RX port. Terminate the other two ports, RX1 and RX2 each with 50 Ohm termination.

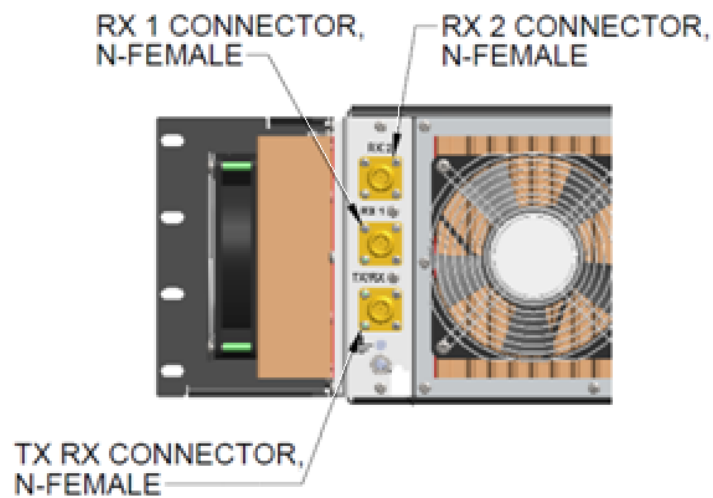
- **Two-antenna configuration**

One antenna is connected to the primary receive port, which is the TX/RX port. A second antenna is connected to the diversity port, RX2. Terminate the remaining port, RX1, which is unused, with 50 Ohm termination.

- **Three-antenna configuration**

One antenna is connected to the primary receive port, which in this configuration is RX1. A second antenna is connected to the TX/RX port. A third antenna is connected to the diversity port, RX2.

Figure 28 Narrowband RF antenna connections at the rear of the Base Station Transceiver



B.2 LOCOMOTIVE TRANSCEIVER

The ITC 220 Locomotive Transceiver allows for two possible RF antenna configurations.

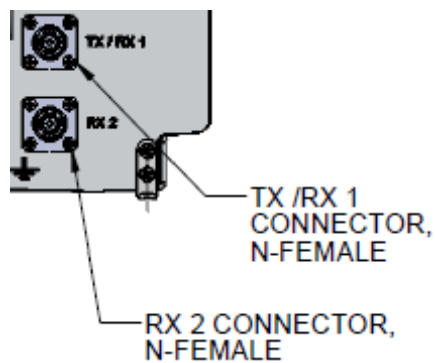
- **Single-antenna configuration**

The antenna is connected to the primary receive port, which is the TX/RX1 port. Terminate the other port RX2 with 50 Ohm termination.

- **Two-antenna configuration**

One antenna is connected to the primary receive port, TX/RX1. A second antenna is connected to the diversity port, RX2.

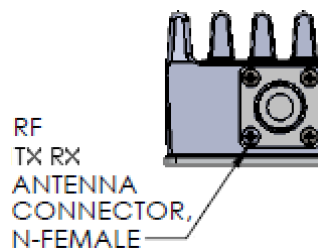
Figure 29 Narrowband RF antenna connections at the rear of the Locomotive Transceiver



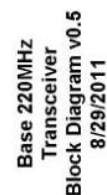
B.3 WAYSIDE TRANSCEIVER

The ITC 220 Wayside Transceiver only has a single antenna port for TX/RX and does not have diversity support.

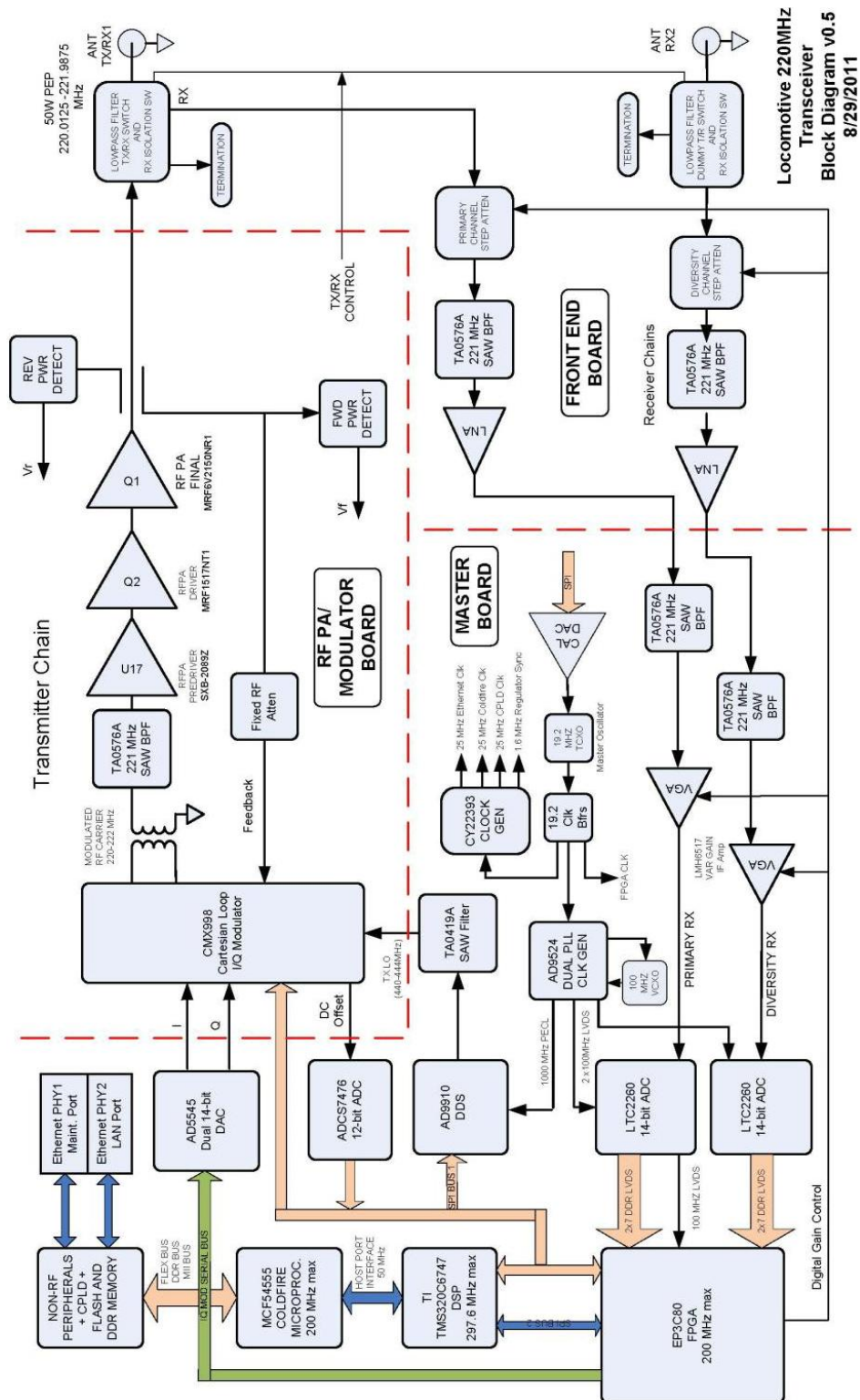
Figure 30 Narrowband RF antenna connector on the Wayside Transceiver



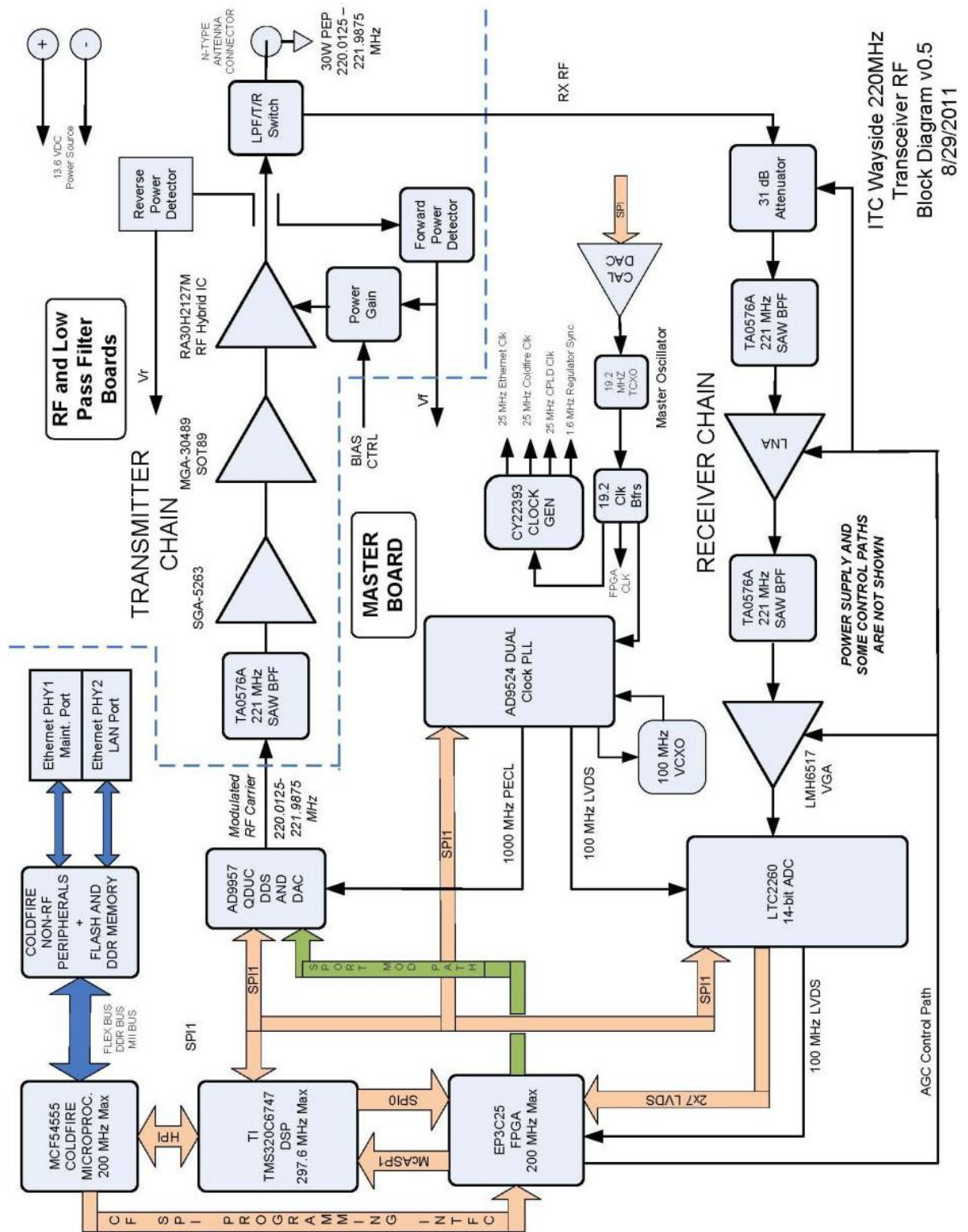
C.1 BASE STATION TRANSCEIVER



C.3 WAYSIDE TRANSCEIVER



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APPENDIX D — TRANSCEIVER CABLES

D.1 TRANSCEIVER POWER CABLES



Warning – Applying an incorrect voltage to a transceiver can cause damage. Confirm the voltage rating of the transceiver and power source before applying power.



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

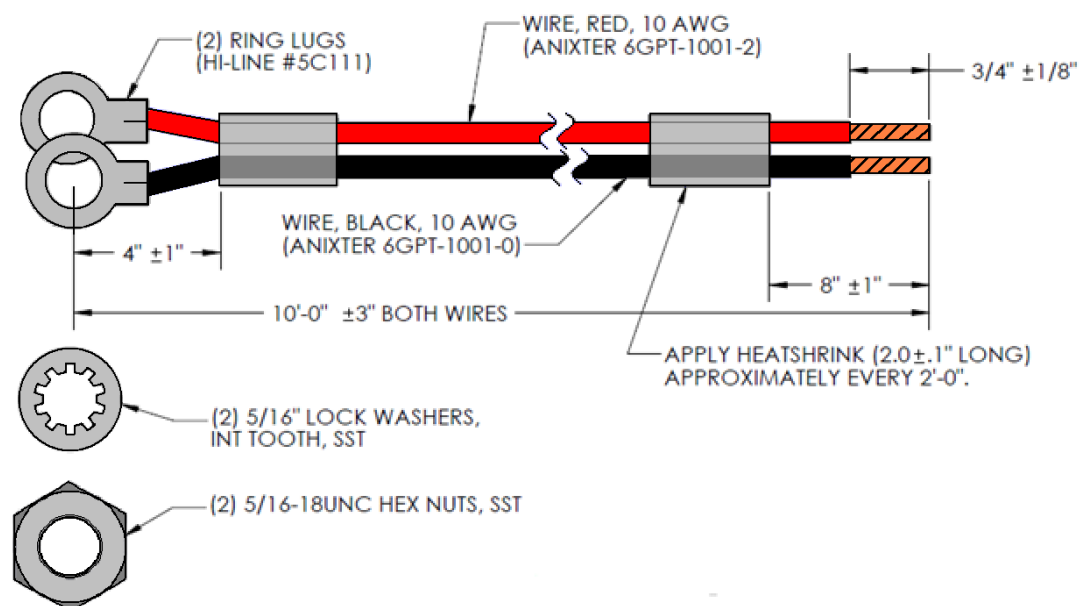
Important! Transceivers do not have a power switch. Applying power to the power port powers on the transceiver. Verify that the power is off before connecting the unit to a power source.

D.1.1 BASE STATION TRANSCEIVER POWER CABLE

The Base Station Transceiver has two 5/16-inch studs (marked + and –) to connect the 10 AWG power cables. The power connectors are threaded posts for ring lug terminals and are located on the rear panel of the unit.

The following figure shows recommended construction of a power cable and the lock washers and nuts required to connect the power cable to the Base Station Transceiver power terminals.

Figure 31 Power cable for Base Station Transceiver with attaching lock washers and nuts

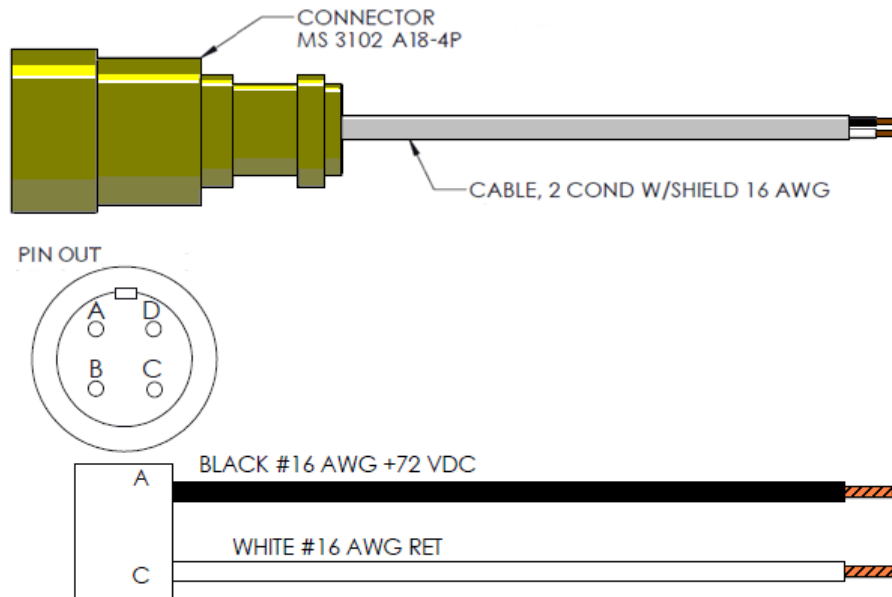


D.1.2 LOCOMOTIVE TRANSCEIVER POWER CABLE

Locomotive Transceivers operate nominally at 74 VDC with an input range of 45-100 VDC. The Locomotive Transceiver uses an MS 3102 A18-4P connector for power. Using shielded 16 AWG cable is suggested.

The following figure shows recommended construction of a power cable and wire connection pin out of the cable connector.

Figure 32 Power cable for Locomotive Transceiver with wire connection pin out



D.1.3 WAYSIDE TRANSCEIVER POWER CABLE



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

The Wayside Transceiver operates from a 13.6 VDC nominal power 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 Transceiver uses a Wago-type connector supplying 10.9 to 15.5 VDC.

The following figures show recommended construction of a power cable and the pin out of the Wayside Transceiver power connector.

Figure 33 Power cable for Wayside Transceiver externally fused with 10 A ATO.

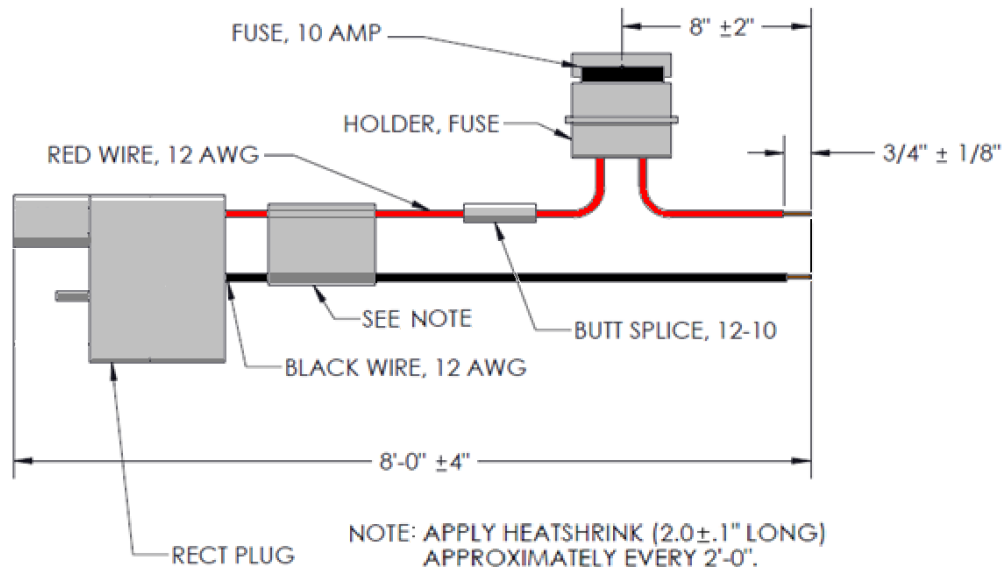
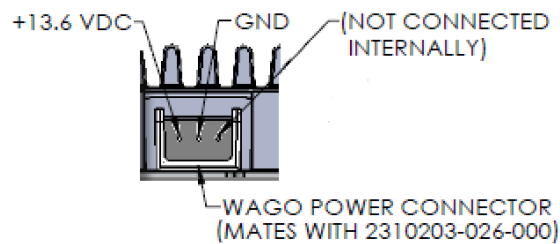


Figure 34 Wayside Transceiver power connector pin out



D.2 ETHERNET CABLES

BASE STATION AND WAYSIDE TRANSCEIVER ETHERNET CABLES

Base Station and Wayside Transceivers require shielded Category 5 (or better) Ethernet cables with an RJ-45 connector at each end. It is recommended that the cable length not exceed 100 meters. Receptacles for connecting into the MAINT and LAN ports of the transceivers are RJ-45 receptacles (jacks).

LOCOMOTIVE TRANSCEIVER ETHERNET CABLE

The Locomotive Transceiver features two 8-pole female M12 A-coded connectors for Ethernet. One is for LAN communications and the other is for the MAINT port of the transceiver. The LAN Ethernet connection is required for normal transceiver operation. The MAINT port is for performing maintenance on the unit.

The following figure shows the pin out of the 8-pole female M12-A cable connector used for Ethernet connection.

Figure 35 M12 Ethernet cable connection

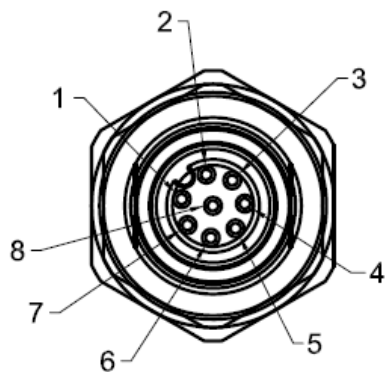


Table 18 M12 connector pinout

Pin	Purpose
1	Reserved
2	Reserved

Pin	Purpose
3	Reserved
4	Transmit –

Pin	Purpose
5	Receive +
6	Transmit +

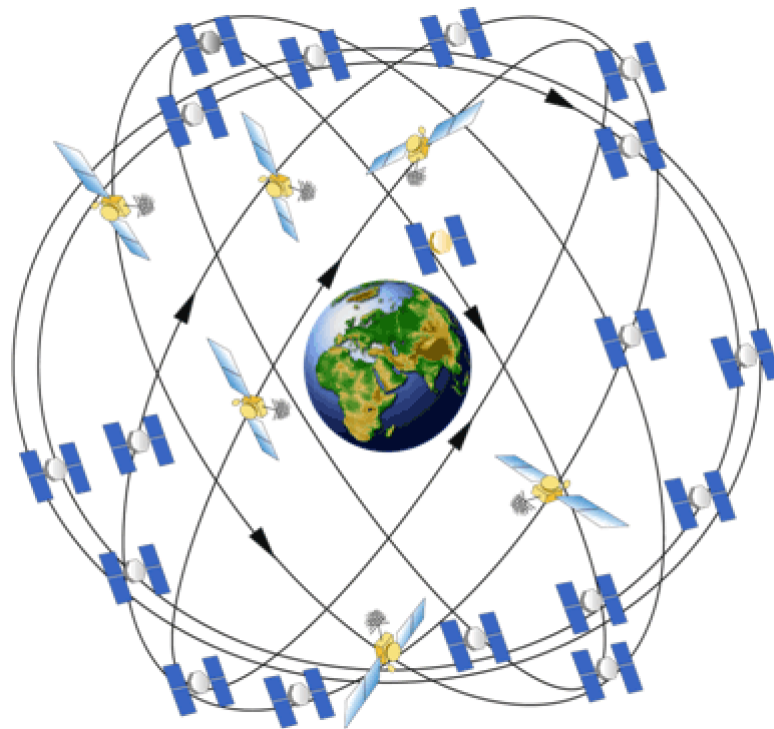
Pin	Purpose
7	Reserved
8	Receive –

APPENDIX E — GPS SATELLITE CONSTELLATION OVERVIEW AND ANTENNA PLANNING CONSIDERATIONS

E.1 GPS SATELLITE 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, approximately 11-hour and 58 minute orbits, at an inclination of 55 degrees at an altitude of 20,200 km.

Figure 36 — GPS satellite constellation

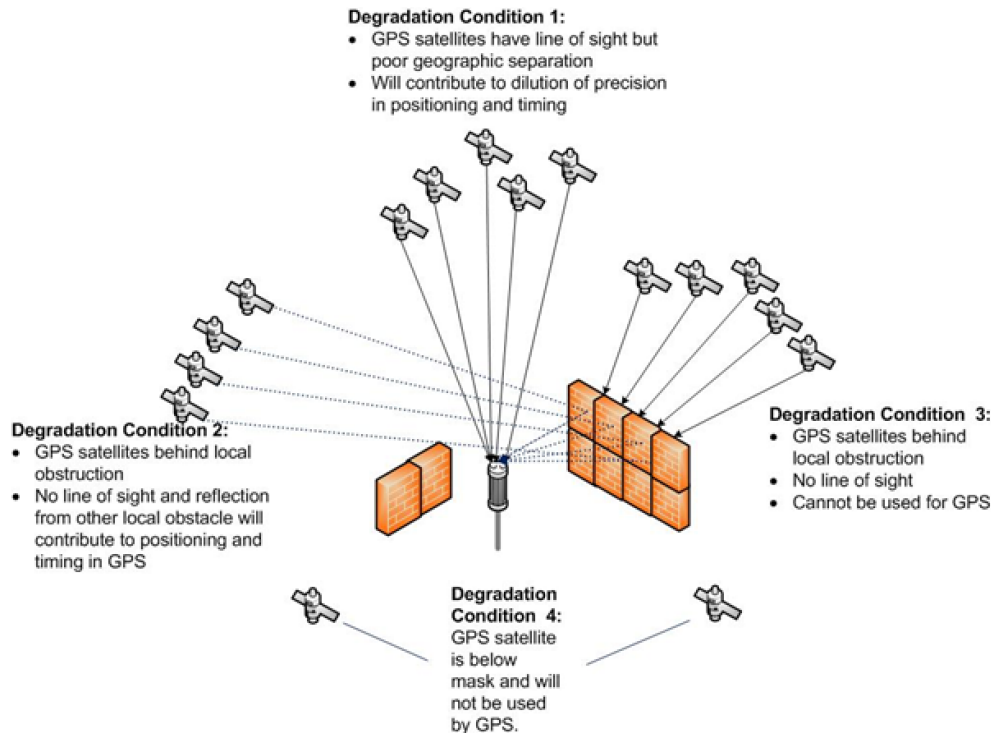


This type of satellite is referred to as an MEO (Medium Earth Orbit) satellite. They are not in geostationary orbit. This is important because unlike GEO (Geostationary Earth Orbit) satellites, which are located at an altitude of 37,790 km over the equator, MEO satellites move throughout most of the sky, so there is no significantly 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 to the South.

E.2 GPS ANTENNA PLANNING CONSIDERATIONS

When determining GPS antenna locations, several factors should be taken into consideration. Following is an explanation of four typical degradation conditions that may occur for GPS antennas.

Figure 37 — GPS antenna degradation conditions



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

Degradation condition 2: The GPS antenna may only have an indirect view of some satellites, 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: The GPS antenna will have no view of Satellites that are completely obstructed and they will be invisible to the antenna, even though they are in the GPS Almanac in the radio.

Degradation condition 4: The GPS radio will ignore satellites that are below the mask angle (~ 10 degrees) that is set in the radio, even if the antenna has perfect visibility of them.

E.2.1 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 any potential transient obstructions.
- Always note the format of the GPS coordinates (for example, decimal degrees or decimal minutes)

E.2.2 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 Station and Wayside Transmitters are equipped with internal GPS receivers. The GPS provides the precision timing required to synchronize the network.

Configure the GPS to 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 a position to the GPS:

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

The method used depends on which fits better into the user's workflow.

Surveyed position obtained offline

One way to configure the transceiver GPS is to obtain the survey position offline, then use the LOCATION command to provide the position and instruct the transceiver 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
+TIMESYNCH,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 transceiver installation process.

The advantages of 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 transceiver or GPS receiver 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
+TIMESYNCH, 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.

APPENDIX F — SAMPLE POST RESULTS TYPICAL FOR PROPERLY FUNCTIONING TRANSCEIVERS

+POST 05/22/12 19:34:46

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

Board Type	: Base	(or Locomotive or wayside)
Hardware Revision	: F2	(or F3, etc.)
Serial Number	: 20024	(may be many digits and letters)

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: I2C Mux	: PASS	(Not applicable for wayside)
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: FAN CONTROLLER	:	PASS	(Base Station Transceiver only)
HOST: ETHERNET 0	:	PASS	
HOST: ETHERNET 1	:	PASS	
HOST: MAC 0	:	PASS	
HOST: MAC 1	:	PASS	
HOST: GPS	:	PASS	(Not applicable for Locomotive)
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: IQ MIXER	:	PASS	(Not applicable for wayside)
DSP: RX ADC	:	PASS	(Not applicable for wayside)
DSP: TX NULL ADC	:	PASS	(Not applicable for wayside)
DSP: DDS	:	PASS	
FPGA: MEMORY	:	PASS	
FPGA: Clocks	:	PASS	
FPGA: Tx	:	PASS	
HOST: 28.0v Supply	:	PASS	: 28.915 (Not applicable wayside)
HOST: 11.5v Supply	:	PASS	: 11.432 (Not applicable wayside)
HOST: 5.0v Supply	:	PASS	: 5.022
HOST: 3.3v Supply	:	PASS	: 3.277
HOST: 2.5v Supply	:	PASS	: 2.490
HOST: 1.8v Supply (Host)	:	PASS	: 1.808
HOST: 1.8v Supply (DSP)	:	PASS	: 1.814 (Not applicable wayside)
HOST: 1.5v Supply	:	PASS	: 1.396 (Not applicable wayside)
HOST: 1.2v Supply (Host)	:	PASS	: 1.249
HOST: 1.25v Supply (DSP)	:	PASS	: 1.240 (Locomotive only)
HOST: External Supply	:	PASS	: 2.401
HOST: 12V Power Supply Temp	:	PASS	: 41.751 (Not applicable wayside)
HOST: 28V Power Supply Temp	:	PASS	: 39.702 (Not applicable wayside)

HOST: PA Temp : PASS : 32.200
 HOST: Main Board Temp : PASS : 26.867 (wayside only)
 HOST: Driver Temp : PASS : 32.200 (Not applicable wayside)
 HOST: PA Current : PASS : 0.000 (Not applicable wayside)
 HOST: Driver Current : PASS : 0.000 (Not applicable wayside)

boot loader version 0.22.1 SVN 17525 2011-07-29 (this line and output
 reset_count 3 below may differ)

active_index 2
 active_source Flash1
 active_user USER_BOOT

Inx	Pri	Stat	Fail	Lnch	Name	Notes	Last	Status
---	---	----	-----	-----	-----	-----	----	-----
2	42	RDY	1	2	D:01011506.A14		ACTV	Success

APPENDIX G — PROGRAM SIGNAL GENERATOR FOR DQPSK

G.1 PROGRAM AGILENT E4438C TO TEST TRANSCEIVERS WITH SPRINTS 18 TO 23.02B

Table 19 Steps for programming Agilent E4438C to test transceivers 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 numeric 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.	Arrow keys →/↓
16	Complete a sequence of 528 bits by adding a “1.” Note: the final byte should read “1000 0001” or “1110 0001.”	1
17	Press Return twice.	Return Return
18	Press the “Rename” button.	Rename
19	Use the “More” button to give the user file a useful name, “DQPSK.”	D-Q-P-S-K or a suitable unused file name.
20	Save the user file.	Enter
21	Return to an upper level by pressing “Mode Setup” to define additional parameters.	Mode Setup
22	Select “Filter.”	Filter
23	Choose “Select.”	Select
24	Pick “Root Nyquist.”	Root Nyquist
25	Define the filter alpha to be 0.35 by picking “Filter Alpha.”	Filter Alpha
26	Use the numeric keypad to enter 0.35 then “Enter.”	0.35 Enter
27	Return to an upper level by pressing “Mode Setup” to define additional parameters.	Mode Setup

Step	Action	Button / Selection
28	Select "Symbol Rate."	Symbol Rate
29	Using the numeric keypad, enter 16 ksps for full-rate testing or 8 ksps for half-rate testing.	16ksps / 8ksps
30	Return to an upper level by pressing "Mode Setup" to define additional parameters.	Mode Setup
31	Load the user-defined data file just created.	Data
32	Pick "User File."	User File
33	Use cursor keys to select "DQPSK" and press "Select File."	Select File
34	Set "Custom" to "On."	Custom
35	Save the file.	Save
36	Select a register that is not in use.	"Select Reg," and then "1" (or suitable unused register), and then "Save Reg"
37	Press "Preset" and now load the waveform.	Preset
38	Recall the waveform with "Recall."	Recall
39	Select the register using the numeric keypad and press "Enter."	1 Enter
40	Set the frequency and power level, and be sure RF and Modulation are ON.	Frequency: 220 MHz Amplitude: -80 dBm Mod: ON RF: ON

G.2 PROGRAM AGILENT E4438C TO TEST TRANSCEIVERS WITH SPRINT 23.03 AND UPWARD

Table 20 Steps for programming an Agilent E4438C to test transceivers with Sprint 23.03 and upward

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 numeric keypad.	1111 0011 0011 0111 1110 1110 1011 0110 0011 0111 0110 0110 0000 0110 0111 0010
12	Insert L1 Header bits using the keypad.	1000 0110 1101 0011 1001 1100 1101 1111 1100 10010010 1100
13	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 1101 1111 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

Step	Action	Button/Selection
		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
14	Insert end bits.	1111 1111 1111 1111
15	Press "Return" twice.	Return Return
16	Press the "Rename" button.	Rename
17	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.
18	Save the user file.	Enter
19	Return to an upper level by pressing "Mode Setup" to define additional parameters.	Mode Setup
20	Select "Filter."	Filter
21	Choose "Select."	Select
22	Pick "Root Nyquist."	Root Nyquist
23	Define the filter alpha to be 0.35 by picking "Filter Alpha."	Filter Alpha
24	Use the numeric keypad to enter 0.35 then "Enter."	0.35 Enter
25	Return to an upper level by pressing "Mode Setup" to define additional parameters.	Mode Setup
26	Select "Symbol Rate."	Symbol Rate
27	Using the numeric keypad, enter 16 ksps for full-rate testing or 8 ksps for half-rate testing.	16ksps / 8ksps
28	Return to an upper level by pressing "Mode Setup" to define additional parameters.	Mode Setup
29	Load the user defined data file just created.	Data
30	Pick "User File."	User File
31	Use cursor keys to select "DQPSK23" and press "Select File."	Select File
32	Set "Custom" to "On."	Custom
33	Save the file.	Save
34	Select a register that is not in use.	"Select Reg," and then "1" (or suitable unused register), and then "Save Reg"
35	Press "preset" and now load the waveform.	Preset
36	Recall the waveform with "Recall."	Recall
37	Select the register using the numeric keypad and press "Enter."	1 Enter
38	Set the frequency and power level, and be sure RF and Modulation are ON.	Frequency: 220 MHz Amplitude: -80 dBm Mod: ON RF: ON

G.3 PROGRAM F4438C SIGNAL GENERATOR FOR MSGPS (MULTI-SATELLITE GPS)

Table 21 Steps for programming an F4438C 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 return 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)

APPENDIX H — FORWARD ERROR-CORRECTION DATA-PACKET FORMAT TABLE

Offset	Hex	Binary
0	f3	11110011
	37	00110111
	ee	11101110
	b6	10110110
20	37	00110111
	66	01100110
	6	00000110
	72	01110010
40	86	10000110
	d3	11010011
	9c	10011100
	df	11011111
60	c9	11001001
	2c	00101100
	ff	11111111
	c6	11000110
80	8a	10001010
	bf	10111111
	83	10000011
	d5	11010101
A0	15	00010101
	a2	10100010
	df	11011111
	c4	11000100
C0	a7	10100111
	c7	11000111
	17	00010111
	c4	11000100
E0	ec	11101100
	59	01011001
	32	00110010
	40	01000000

Offset	Hex	Binary
100	92	10010010
	67	01100111
	9	00001001
	21	00100001
120	df	11011111
	8f	10001111
	4e	01001110
	18	00011000
140	93	10010011
	ba	10111010
	d1	11010001
	4e	01001110
160	53	01010011
	0d	00001101
	e7	11100111
	55	01010101
180	30	00110000
	6d	01101101
	cd	11001101
	86	10000110
1A0	18	00011000
	d8	11011000
	8a	10001010
	f4	11110100
1C0	ca	11001010
	cc	11001100
	91	10010001
	dc	11011100
1E0	34	00110100
	e8	11101000
	c6	11000110
	19	00011001

Offset	Hex	Binary
200	ad	10101101
	f8	11111000
	71	01110001
	6d	01101101
220	a6	10100110
	fb	11111011
	1e	00011110
	b1	10110001
240	50	01010000
	4c	01001100
	88	10001000
	1a	00011010
260	d4	11010100
	2	00000010
	ff	11111111

APPENDIX I — COMMAND SECURITY

User authentication is a way to identify yourself as someone who is allowed to change the radio's configuration settings.

User-authentication tasks consist of:

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

Following sections describe each task in detail.

I.1 LOG ON TO THE TRANSCEIVER

The prerequisites for logging on to a transceiver are:

- Recommended: an SD memory card with a configuration information module (CIM) script file installed in the transceiver.
Note: You can log on without installing a CIM script. However, the transceiver will not transmit and it will reboot after five minutes.
- The transceiver has been powered on and has booted up successfully executing the CIM script.
- A computer with Ethernet interfaces configured to communicate with the transceiver is connected to the transceiver **MAINT** port.
- The **XtermW** program is installed and running on the computer.
- You have permission to enter commands that can change the configuration settings.

You can enter some commands that allow you to get the transceiver's operational status only, such as SMS and IPCONFIG (without parameters), without logging on.

Notes:

- The login status defaults to logged-off when the transceiver boots up. If you want to log on again, you have to re-enter your password after each reboot.
- You can make an unlimited number of login attempts without being locked out of the transceiver.
- The default password for the transceiver is mcc-6300.
- You can have only one password at a time.

To log on to the transceiver:

1. On the computer, open **XtermW** if it is not already running.
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.”

I.2 LOG OFF FROM THE TRANSCEIVER

After you log on to a transceiver, it will log 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 **XtermW** if it is not already running.
2. Click **Send**, click **Command**, and then type:

LOGOFF
3. Click **OK** or press **Enter**.

I.3 CHANGE YOUR TRANSCEIVER PASSWORD

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

The requirements for a password are:

- Passwords 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 and dash characters.
- Passwords must be 3 to 30 characters.

Passwords are not case sensitive.

To change your password:

1. Log on to the transceiver.
2. In **XtermW**, click **Send**, click **Command**, and then type:

NEWPASSWORD,o1dpassword,newpassword,newpassword

Where:

o1dpassword is your current password

newpassword is your new password you want to change to

3. Click **OK** or press **Enter**.

I.3.1 FORGET YOUR PASSWORD?

To recover from a forgotten password:

- Ask an administrator who has permission to reset users' passwords to the default password to reset your password to the default.
- Change your password from the default password to your own password. See [I.3 Change Your Transceiver Password](#).

APPENDIX J — COMMONLY USED DIAGNOSTIC COMMANDS

The following diagnostic commands provide information about the state of the transceiver, 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.

INICHECK

The INICHECK command checks the validity of the current transceiver configuration against the CIM (configuration interface module) and optionally reconfigures the radio if the configuration is invalid. The CIM is a script file of configuration commands with a signature contained in a removable SD card. When the CIM script is run, the radio is configured by commands in the script and the CIM signature is stored in nonvolatile memory in the transceiver. When a user invokes commands that reconfigure the transceiver, the CIM signature in the transceiver is invalidated. The transceiver is reconfigured at startup if a CIM is found and the configuration is invalid. INICHECK allows a user to check the configuration manually at any time.

Syntax:

INICHECK or INICHECK, script

Returns:

+OK on success, or

+Bad Parameter on failure.

LINKSTAT

The LINKSTAT command displays link statistics by link. On a remote transceiver (locomotive or wayside), it also shows which Base Station Transceiver is currently selected. A minus-sign (–) to the left of the radio ID indicates that the remote transceiver is currently attempting to connect to it. A caret (^) indicates that the remote transceiver is connected to the Base transceiver. Below is an example of output from the LINKSTAT command on a Base Station Transceiver.

+linkstat 08/23/11 00:42:52

NODE	CHAN	TYPE	RXPKTS	TXPKTS	TXACKS	BCAST
BROADCAST	000	SYSTM	0	0	0	0
CMNBDCST	000	SYSTM	0	0	0	0
r^00000500 v	127	SDR1	7	21	0	0

NODE	CHAN	TYPE	RXMSGs	TXMSGs	RXSEGS	TXSEGS
BROADCAST	000	SYSTM	0	0	0	0
CMNBDCST	000	SYSTM	0	0	0	0
r^00000500 v	127	SDR1	1	1	4	44

NODE	CHAN	TYPE	BEACON	WAIT	DTRF	STAT	DIST	DEG
BROADCAST	000	SYSTM	0	0000	0000			
CMNBDCST	000	SYSTM	0	0000	0000			
r^00000500 v	127	SDR1	0	0000	–099	0000		+

REV

The REV command displays the current software version running on the transceiver unit. Below is an example of output from the REV command.

```
+REV 05/22/12 19:34:46 ETH1 port 4
```

ITC PACKET DATA RADIO

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S/W Part Number P63020-A14-01.01.15.06 ITC SVN r27917 Fri May 04 13:39:28 2012

S/W Part Number P63020-D03-01.01.15.06 DSP SVN r27892 Fri May 04 20:29:15 2012

S/W Part Number P63020-F03-01.01.15.06 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 Base Board

ITC Role: Base

The software revision is highlighted above and is 01.01.15.06 in this example.

STAT,RF

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.

```
+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 over the air by radio.

+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	---

ABOUT CALAMP

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