ITC 220 Base Station Transceiver

HIGH PERFORMANCE WIRELESS FOR RAILROAD PTC

CalAmp®

Installation Guide
PN 133991 Rev. A
Revised July 2012

REVISION HISTORY

REV	DATE	REVISION DETAILS
A	July 2012	Initial release. Part number 133991.

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.

Copyright Notice

RF Exposure Compliance Requirements

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.

TABLE OF CONTENTS

1 OVERVIEW

This *ITC 220 Base Station Transceiver Installation Guide* provides important electrical safety and radio-frequency compliance information, operation and routine maintenance instructions, and installation and troubleshooting procedures for CalAmp ITC 220 Base Station Transceivers.

This manual provides essential information for personnel who perform the following on the Base Station Transceiver:

- Operation and routine maintenance (Chapters 1–5; Appendix A)
- Installation and verification of operation (Chapters 1–6; Appendices A–C)
- Advanced troubleshooting and verification of equipment settings (Chapters 1–7; Appendices A–J)

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 220 Base Station, Locomotive, and Wayside Transceivers Installed in Vehicles or at Fixed Sites*.

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 and 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. 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.

Experience the advantage of high performance reliability designed to meet:

- AAR Standard S-5702
- ANSI/TIA-603-C-2004
- MIL-STD-810E
- American Recovery and Reinvestment Act – Buy American Provision

1.2 OPERATIONAL CHARACTERISTICS

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

All input and output ports are grounded or shielded. Internal shielding is used within the unit assembly and PCB design minimizes potential sources of unwanted radio emissions.

CalAmp ITC 220 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.

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

General

Frequency Range:	217.6-222.0 MHz
Channel Spacing:	25 kHz
Temperature Range:	Operating: -30°C to +70°C
	Storage: -55°C to +85°C
Operating Humidity:	0 - 95% non-condensing
Frequency Stability:	+/- 0.1 ppm over operating temperature range
DC Input Voltage Range:	48 V model: 42-54 VDC; Damage limit 60 VDC
	24 V model: 21-27 VDC; Damage limit 30 VDC
DC Current Drain:	48 V model: Transmit: 6 A (peak) max. into 50 ohm load; 4 A typical;
	Receive: 0.6 A max. while receiving
	24 V model: Transmit: 11 A (peak) max. into 50 ohm load; 7.5 A typical;
	Receive: 1.2 A max. while receiving
DC Power Connector:	Threaded 5/16-18 studs for ring lug connection
Size:	EIA 19" rack compatible, 4U (7") height, occupies 5U (8.75") max. w/vented shelf
Weight:	27 lbs. (12 kg) approximate; <40 lbs. (18 kg) rack w/vented shelf (recommended)
Antenna Connector:	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)
GPS Receiver:	Active or passive antenna; Antenna power: 3.3 V 50 mA max;
	Antenna connector: TNC female
External Interface:	Two (2) Ethernet 10/100 Mbps:
	One (1) data network port, RJ-45;
	One (1) maintenance port, RJ-45
Configuration Interface Module (CIM):	SD Card
Display:	Activity and diagnostic LEDs on front panel
Regulatory:	Complies with FCC Parts 2, 15, and 90; Industry Canada SRSP-512

Transmitter

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

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
Blocking (1 MHz offset)	80 dB
Number of Simultaneous Receiver Channels: (24V and 48V)	Sixteen (16) paired as eight (8) diversity; seven (7) 16 kbps; one (1) auto 16 kbps/32 kbps

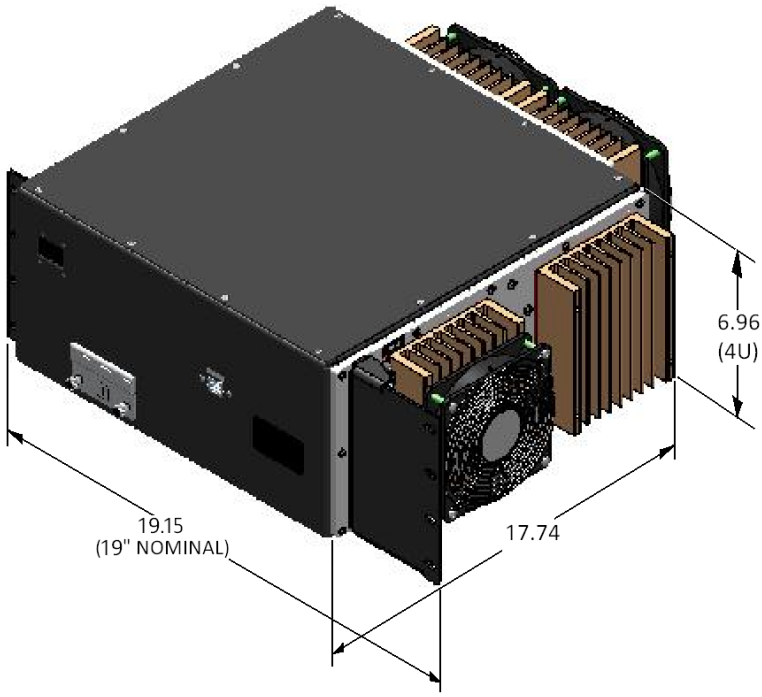
1.3 PHYSICAL DESCRIPTION

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 for simple installation. Repositionable brackets allow for mounting the chassis in forward or mid-plane positions in 19-inch channel-rack installations. The unit is designed to operate in an extended temperature range and provide worry-free operation.

1.3.1 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.

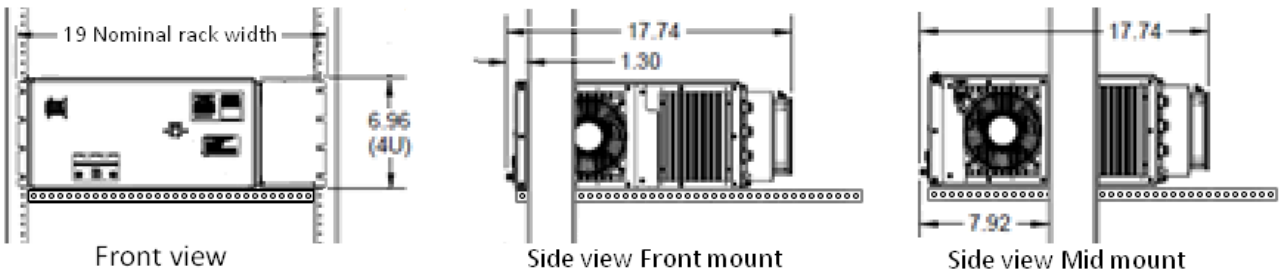
Figure 1 ITC 220 Base Station Transceiver overall dimensions



(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



1.3.2 CONNECTIONS

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

1.3.2.1 FRONT PANEL

The following figure and table illustrate the interface connections on the front panel.

Figure 3 Base Station Transceiver front panel interface connections

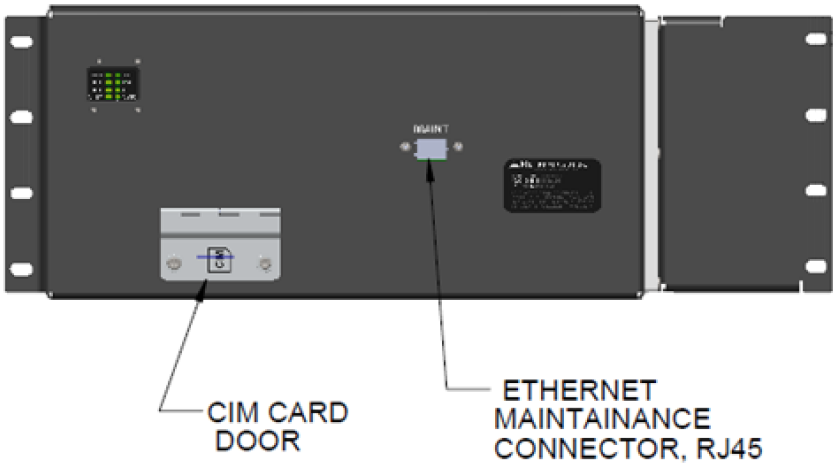


Table 1 Base Station Transceiver front panel interface connections

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

1.3.2.2 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

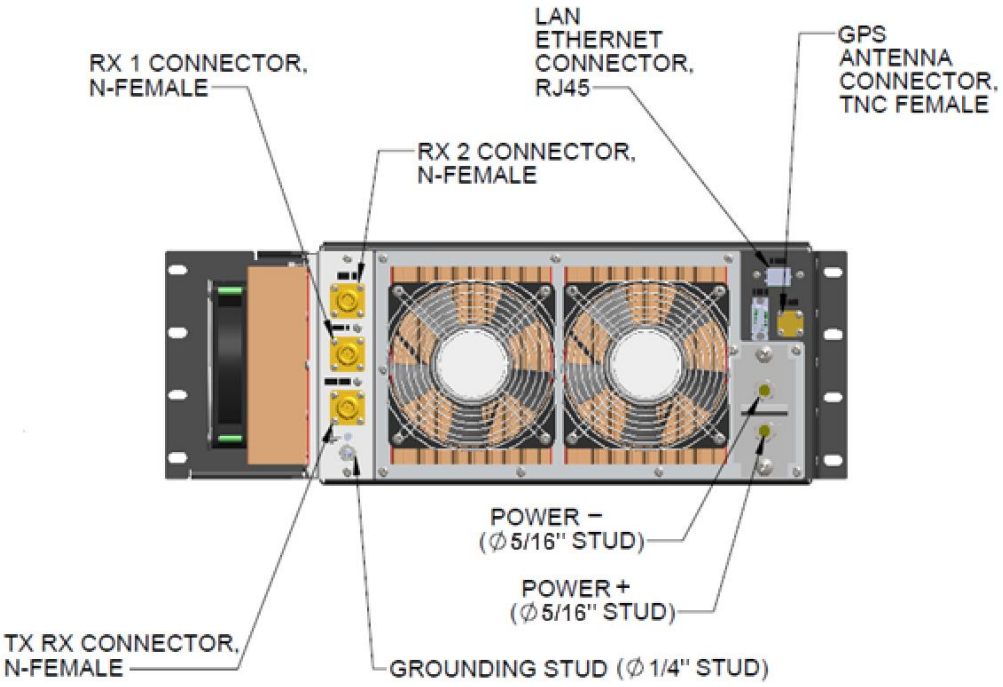


Table 2 Connectors at rear of Base Station Transceiver

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	⏚

1.4 RELATED DOCUMENTS

Other documents related to this *ITC 220 Base Station Transceiver Installation Guide* include:

- *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

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 WARMUP PERIOD

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

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 Base Station and Locomotive Transceiver and available online or by request 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 form FCC and Industry Canada rules that, when followed, limit human exposure to radio frequency energy to acceptable levels. Note that although the Base station is expected to be sited, installed, and maintained only by professionals in a controlled-exposure environment, the *RF Energy Exposure Guide* lists the larger lateral safe distances for an uncontrolled environment. Obeying these limits will protect both railroad employees and the general public.

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

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

Table 2 in Section 6 of the *RF Energy Exposure Guide* lists the calculated lateral distances to be maintained between the general public and an operational Base transmitter antenna for two antenna types suitable for fixed Base applications.

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

3.3 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 "Base-Radiated Power Limits," which follows, 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 BASE 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 BASE STATION TRANSCEIVER CHANNELIZATION AND FREQUENCY RANGE

The Base Station Transceiver 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 BASE-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. HAAT limitations for fixed-base stations unless operating under an explicit waiver of the applicable rule. U.S. and Canadian power limits differ in this regard.

Licensees should also note that fixed installations transmitting between 221 and 222 MHz must limit effective radiated power (ERP) to 50 W or 10log(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.

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.

5 ROUTINE MAINTENANCE

The Base Station Transceiver requires the following routine maintenance.

- 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.
- Check fan operation and make sure the fans are not obstructed.

6 INSTALLATION

The Base Station Transceiver is housed in a sheet metal enclosure that is designed to be mounted in a 19-inch rack that conforms to EIA standards. It has a-design height of four rack units (4 U) and together with a vented shelf, which is recommended for mounting, will occupy 5 U max. It weighs approximately 27 lbs. (12 kg), which together with the vented shelf, required mounting hardware, termination, and cabling, will add less than 40 lbs. (18 kg) rack weight, total.

Installation of the Base Station Transceiver consists of these steps:

1. Unpack and inspect the unit (section 6.2).
2. Confirm the SD memory card (CIM) is installed and seated (section 6.3).
3. Mount the unit (section 6.4).
4. Ground the unit (section 6.5).
5. Install current-limiting protection (section 6.6).
6. Connect the narrowband RF antennas (section 6.7).
7. Connect the GPS antenna (section 6.8).
8. Connect the Ethernet cable (section 6.9).
9. Connect the power cable (section 6.10).
10. Power on the unit (section 6.11).

At the conclusion of installation, you will verify that the Base Station Transceiver is operational by doing the following:

1. Observe the operation of the LEDs in the transceiver front panel (section 6.11.1).
2. Review the power on self-test (POST) results (section 6.11.2).
3. Verify that the radio transceiver is commissioned (section 6.11.3).
4. Verify that the LAN Ethernet port is operational (section 6.11.4).

Following sections describe each of the above steps in detail. This guide also contains a brief Troubleshooting chapter for help with common problems that may occur when installing a Base Station Transceiver.

6.1 REQUIRED EQUIPMENT

Following is a list of test equipment required to perform all of the tests described in this document. 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 3 Required equipment

Type	Model	Notes
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 reqired by Sprint release. See APPENDIX F— Program Signal Generator for DQPSK.
Vector signal analyzer	Agilent E9010A 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 APPENDIX D— Configure the Computer Ethernet Ports to Communicate with the Transceiver.
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" wrenches		7/16" wrench for 1/4" hex nut on grounding stud; 1/2" wrench for 5/16" hex nuts on power terminals.
#2 Phillips head screwdriver		
Torque wrench with 100 in.·lb. capacity		
Crimping tool		

6.2 UNPACK AND INSPECT THE UNIT

Unpack and inspect the Base Station Transceiver. Note any damage that may have resulted from shipping, including dents or loose parts. Note any damage or discrepancies between the contents in the shipping container and the packing list.

- If you detect damage or if the contents do not match the invoice, then note the defect and contact the manufacturer.
- If you do not detect any damage and the shipping invoice matches the contents, then continue with installation.

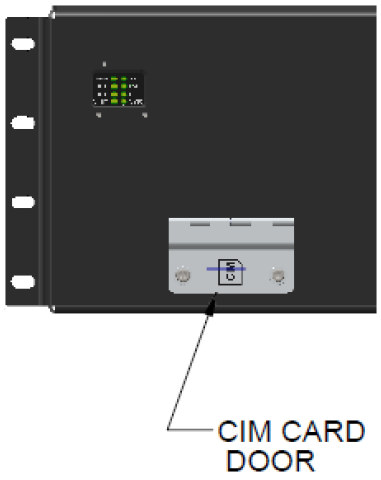
6.3 CONFIRM SD MEMORY CARD (CIM) IS INSTALLED AND SEATED

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.

Figure 5 CIM card door on a Base Station Transceiver



6.4 MOUNT THE BASE STATION TRANSCEIVER

The Base Station Transceiver is installed in an EIA standard 19-inch rack. For open-frame channel-rack installations, relocate the mounting brackets near the unit center of gravity.

Caution – We recommend the Base Station Transceiver be installed only in a 19-inch rack.

Caution – If you relocate the flanges (and dust cover), then be sure to keep the associated mounting screws with each. The screws are partnered with the brackets and dust cover.

As noted in the caution message above, the brackets and dust cover are partnered with screws. Screws are partnered with their Bracket or dust cover regardless of whether the transceiver is installed using the front-mount or mid mount bracket configuration. Use of any incorrect screws may result in damage to the transceiver chassis. See the following table for details about which screws are partnered with each bracket and with the dust cover.

Table 4 Mounting brackets, dust cover, and partnered mounting screws

Description	Appearance	Partnered fastener description	Quantity
Left bracket		Machine screw, 8-32 × 3/8" Flat head, Phillips, stainless steel	5 screws
Unused mounting location	No image	Machine screw, 8-32 × 3/8" Pan head, Phillips, stainless steel	5 screws
Right bracket		Machine screw, 6-32 × 1/4" Pan head, Phillips, stainless steel	5 screws
Dust cover		Machine screw, 6-32 × 1/4" Pan head, Phillips, stainless steel	2 screws

Figure 6 Base Station Transceiver in 19-inch rack mount

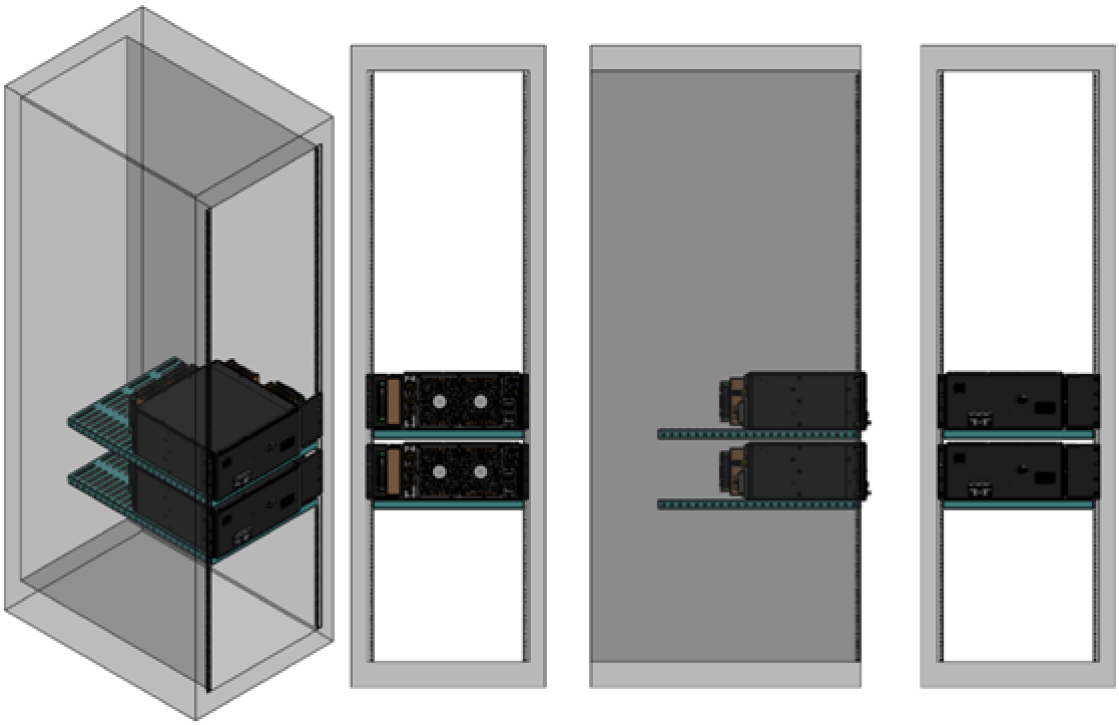


Figure 7 Channel rack installation with mounting brackets in mid-plane position

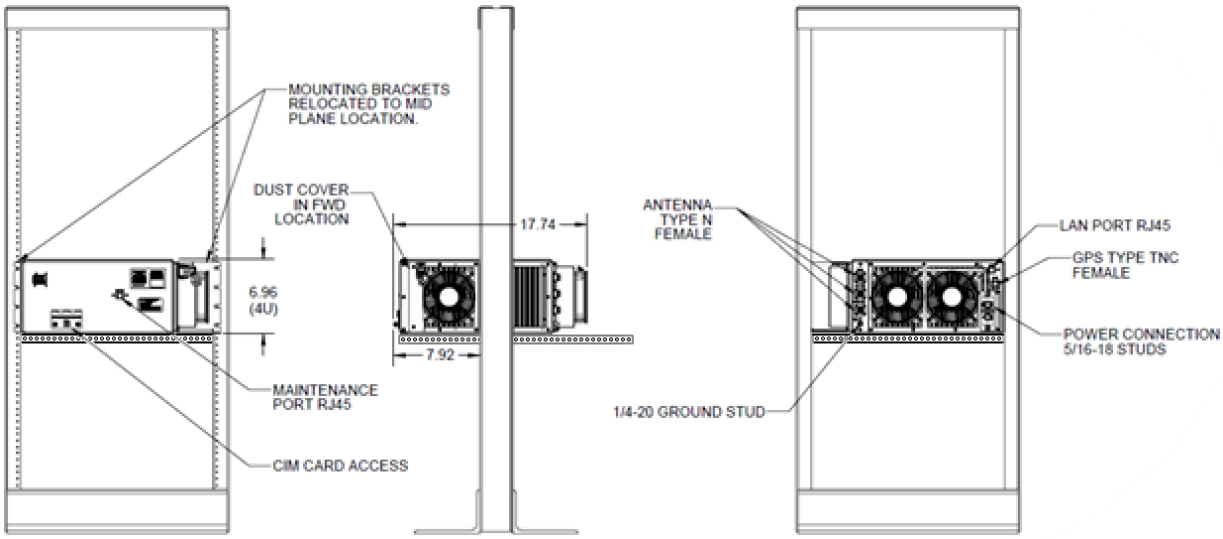
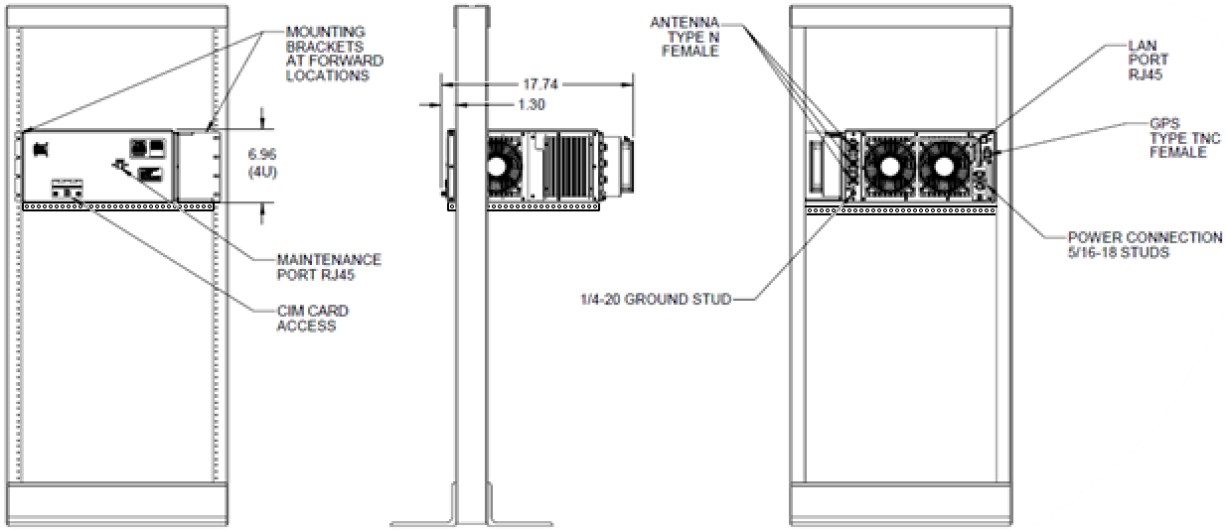


Figure 8 Channel rack installation with mounting brackets at forward position



Warning – Anchor the rack according to your local building codes and standards.

To mount the Base Station Transceiver

1. Place the unit on the vented cabinet shelf.
2. Secure the unit with four screws on each side.

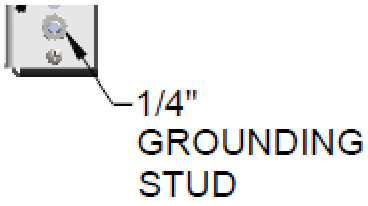
After mounting, ensure that:

- Equipment that produces substantial heat is not installed below the Base Station Transceiver.
- Each unit is secured with four screws on each side.
- There is adequate space to access the CIM (SD memory card).
- There is adequate space for cable connections.
- The unit is resting on a vented cabinet shelf.
- Cables are restrained to prevent kinking and stressing connectors.

6.5 GROUND THE RADIO TRANSCEIVER CHASSIS

The Base Station Transceiver has a ¼ inch grounding stud at the rear of the unit (located below the bottom Type N female connector for TX RX antenna connection).

Figure 9 Grounding stud



To ground the Base Station Transceiver:

1. Remove the nut and internal-tooth lock washer from the grounding stud.
2. Connect a 12 AWG stranded wire with ring lugs from the grounding stud to the building ground.
3. Reinstall the internal-tooth lock washer and nut, removed earlier, and tighten outer nut to a maximum torque of 65-75 in.·lbs. for the ¼-20 nut.

6.6 CONNECT CURRENT-LIMITING CIRCUIT PROTECTION

Use current-limiting circuit protection. Current-limiting circuitry must be externally supplied to the Base Station Transceiver. For installations using fuses or breakers, limits of 15 A for the 24 VDC and 10 A for the 48 VDC version of the Transceiver are recommended. Follow the manufacturer's instructions. T he table below describes power supply requirements, operational ranges, and damage limits for each version.

Table 5 Base Transceiver input power parameters with operational ranges and damage limits

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

6.7 CONNECT RF ANTENNAS

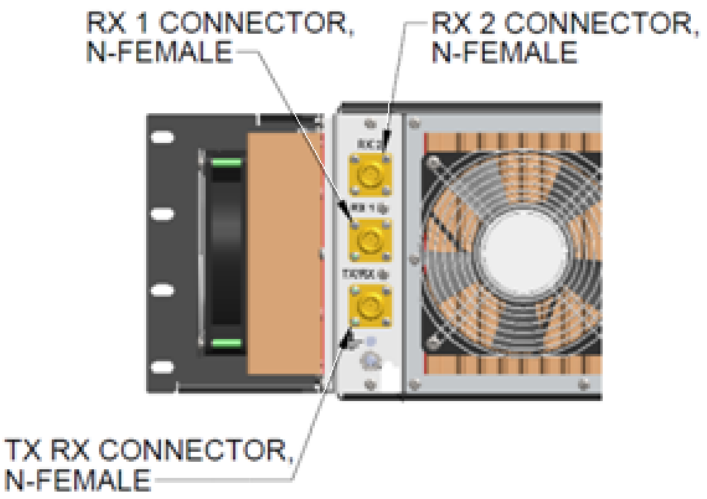
6.7.1 ANTENNA PLANNING

Antenna planning for each site takes place before installation begins. You should already know how many antennas have been installed at the site. The Base Station Transceiver is designed to be properly terminated to a 50 Ohms resistance. Base Station Transceivers can have three possible antenna configurations. See Appendix B— Possible RF Antenna Configurations for more information.

6.7.2 CONNECT ANTENNA CABLE(S) FOR NARROWBAND RF ANTENNA(S)

The Base Station Transceiver is rated for 75 W peak envelope power (PEP). Base Station Transceivers have one combined TX/RX port and two additional ports for receiving only, all of which have Type N female connectors for narrowband RF antennas.

Figure 10 Narrowband RF antenna connections at the rear of the Base Station Transceiver



To connect the cables:

1. Perform or confirm the 220 MHz antenna VSWR before connecting the antenna(s) to the unit. The VSWR should not exceed 1.5.
2. Run the cables into the rack.
3. Connect each antenna cable 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.) Tighten securely, but **do not over-tighten**. Use caution to avoid cross-threading the connector.
4. Terminate and cover unused ports with 50 Ohms termination.

6.8 CONNECT THE GPS ANTENNA

Position the GPS antenna to avoid strong interference that could saturate the antenna low-noise amplifier or the radio GPS receiver low-noise amplifier. Combinations of strong interferers could mix and interfere directly with the GPS signal quality. Test the transceiver GPS with any interference source active to qualify the antenna-antenna isolation of the GPS antenna position. See APPENDIX C— GPS Satellite Constellation Overview and Antenna Planning Considerations, if necessary, for reference. Because GPS satellites are not stationary, but move throughout the sky, install the GPS antenna where it will have clear visibility to as much of the entire sky as possible. (Not just the southern sky, as for geosynchronous satellite reception.)

The GPS antenna connection is a TNC female connector and always provides an active antenna voltage. If the active antenna installed exceeds either the voltage or current ability of the transceiver, then external power must be supplied to the antenna. A DC block must be used at the transceiver when the additional power is supplied, to avoid damage to the transceiver. It is recommended that the cable length not exceed 30 meters.

6.9 CONNECT THE ETHERNET CABLE

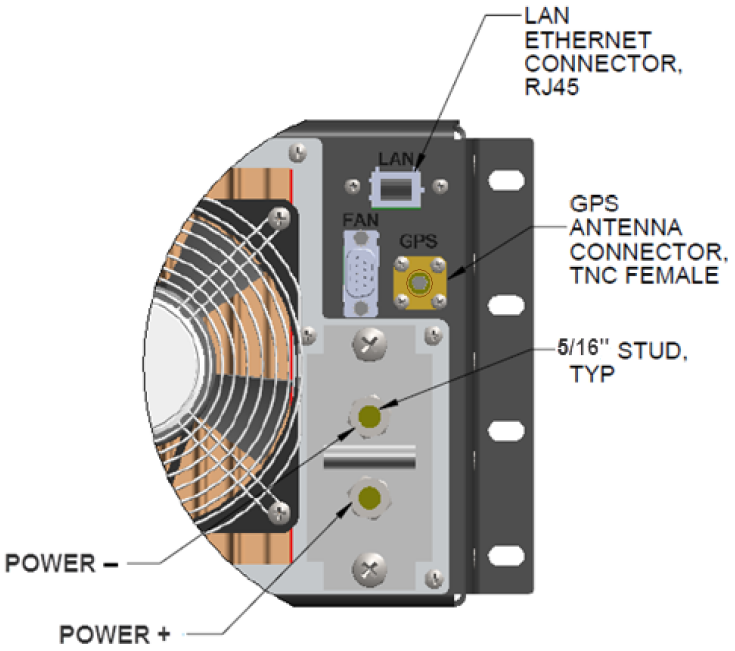
The Base Station Transceiver requires a shielded Category 5 (or better) Ethernet cable with an RJ-45 connector. It is recommended that the cable length not exceed 100 meters. Insert the RJ-45 connector into the LAN port on the back of the unit above the GPS antenna connector.

6.10 CONNECT THE POWER CABLE

Warning – 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.

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.

Figure 11 Power connector studs on the rear panel of the Base Station Transceiver

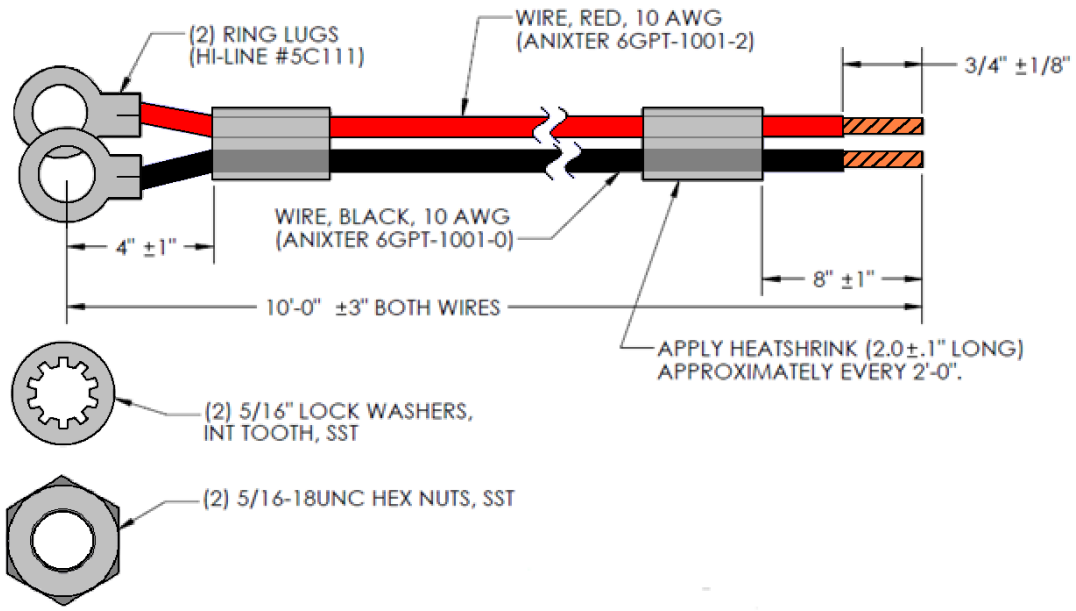


The power connectors are threaded posts for ring lug terminals and are located on the rear of the unit.

Important! The transceiver does not have a power switch. Applying power to the threaded posts on the rear panel of the Base Station Transceiver powers it on. Do not connect the transceiver to power until instructed to do so later in these instructions. Verify that the power is off before connecting the unit to a power source.

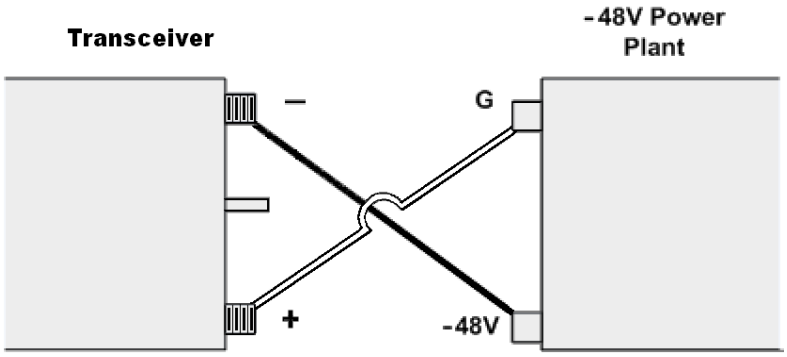
Figure 12, which follows, shows recommended construction of a power cable and the lock washers and nuts required to connect the power cable to the unit.

Figure 12 Power cable with attaching lock washers and nuts



Note: If installing the Base Station Transceiver at a site with - 48 V power plant, then connect ground (G) on the power plant to the positive connection on the transceiver and -48 VDC from the power plant to the negative connection on the transceiver.

Figure 13 Transceiver installation with - 48 VDC power plant



To connect the power cable:

1. The Base Station Transceiver does not have a power switch. Verify that the power is off before connecting the unit to a power source.
2. Run power cables into the rack and route them through the rack to the rear of the unit.
3. Remove the outer nut on both studs.
4. Place the lock washers over the inner nut on both studs.
5. Place the ring lugs of the power cable onto the studs: positive to the lower stud; negative to the upper stud.
6. Reinstall outer nuts on both studs and tighten to a maximum torque of 100 in.·lbs.
7. Restrain the cables, observing the cable manufacturer's minimum bend radius requirements.

6.11 POWER ON THE TRANSCEIVER

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.

To power on the radio transceiver:

Make sure your computer network card is configured with a fixed IP address of 192.168.255.200. See Appendix D— Configure the Computer Ethernet Ports to Communicate with the Transceiver for more information.

1. Connect the computer through the MAINT port on the radio transceiver with an Ethernet cable.
2. Start an XtermW session.
3. Confirm that all radio transceiver connections are secure.
4. Power on the transceiver.
5. Ensure the breaker did not trip on startup.

Caution – Take care to not power-cycle the transceiver off and on repeatedly within four minutes of powering it on. Subjecting the transceiver to three or more successive power cycles within four minutes can cause a reboot error. If a reboot error occurs, remove power, replace the SD card, and then apply power and allow the transceiver to boot up normally without power interruptions.

6.11.1 LED DIAGNOSTICS

A blinking 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 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 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 display in the XtermW window.)	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
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	Fault — When illuminated, it indicates a variety of fault conditions not indicated by other LEDs. Possible faults indicated by the Fault LED include: • 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. If the Fault LED illuminates, a time-stamped entry will display in XtermW specifying the cause.	Red

6.11.2 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 blinking green PWR LED on the front panel indicates that the boot sequence has completed. Within 10 seconds the Ethernet port becomes active.

Note: The transmitter is disabled for approximately 30 seconds after power is applied. This delay allows the oven-controlled oscillator (OCXO) to warm up enough to ensure the accuracy of the transmitter frequency.

Make sure your computer network card has a fixed IP address of 192.168.255.200. See APPENDIX D — Configure the Computer Ethernet Ports to Communicate with the Transceiver for instructions.

To display the POST results:

1. 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:

   POST
4. Click OK.
5. View the POST results list. See APPENDIX E— Sample POST Results from a Properly Functioning Base Station Transceiver.

6.11.3 VERIFY THE TRANSCEIVER IS COMMISSIONED

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 step Verify LAN Ethernet Port is Operational.
   - 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,COMMISSION
     2. Click **OK**.

        The transceiver will return the status of "Radio State: COMMISSIONED." The transceiver has been commissioned and you can continue on to the next step Verify LAN Ethernet Port is Operational.

6.11.4 VERIFY LAN ETHERNET PORT IS OPERATIONAL

Configure the Ethernet port (or second Ethernet port) of the test computer for connection to the Transceiver LAN port, then connect an Ethernet cable to connect these ports. The test computer should display an active network connection on the port (indicated in the System Tray in Windows XP) within 60 seconds.

7 TROUBLESHOOTING

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

- Power
- SD memory card
- Antenna
- Transmission
- Reception
- 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.

7.1 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. (A time-stamped entry will display in XtermW if the Fault or SWR LEDs illuminate.)

- **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`

7.2 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 red wire is connected to the unit's positive (+) terminal and the black wire is plugged into the negative (–) terminal. See Figure 12 Power cable with attaching lock washers and nuts.
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. See Table 10 Base Transceiver input power parameters.
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.

7.3 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 SD card that contains 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 do not turn off the Fault LED, or if the POST results listing shows any other kinds of problems, then replace the transceiver.

7.4 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.

7.5 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 transceiver 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.

7.6 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.

7.7 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 D.2 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.

7.8 RF LINK PROBLEMS

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

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.
7. 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              0   Rx:     0
 Messages     Tx:     2   Rx:     2
```

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.

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

dBi: 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

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

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

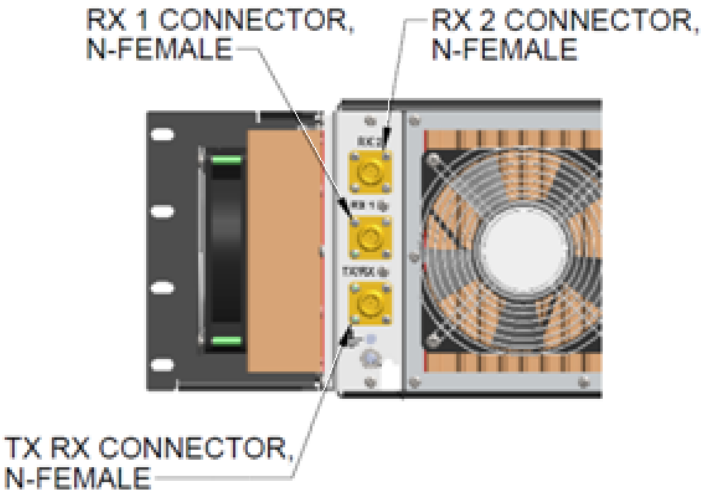
The ITC 220 Base Station Transceiver allows for three possible RF antenna configurations.

- **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 14 Narrowband RF antenna connections at the rear of the Base Station Transceiver

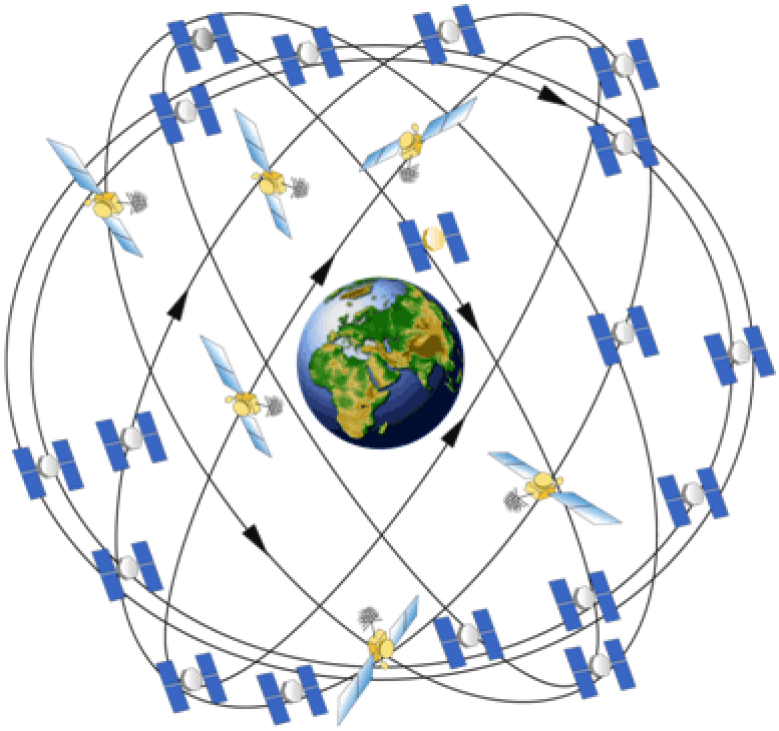


APPENDIX C — GPS SATELLITE CONSTELLATION OVERVIEW AND ANTENNA PLANNING CONSIDERATIONS

C.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 15 — GPS satellite constellation

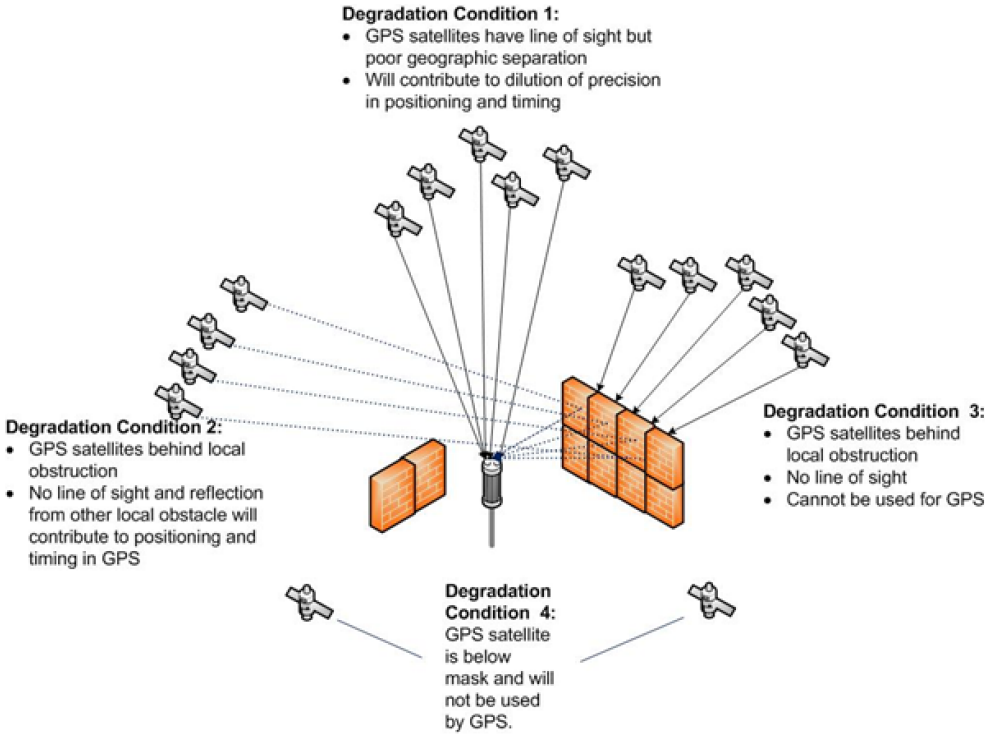


This type of satellite is referred to as an MEO (Medium Earth Orbit) satellite. They are not in geostationary orbit. This is important because unlike GEO (Geostationary Earth Orbit) satellites, which are located at an altitude of 37,790 km over the equator, MEO satellites move throughout most of the 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.

C.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 16 — 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.

C.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)

C.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 D — CONFIGURE THE 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.

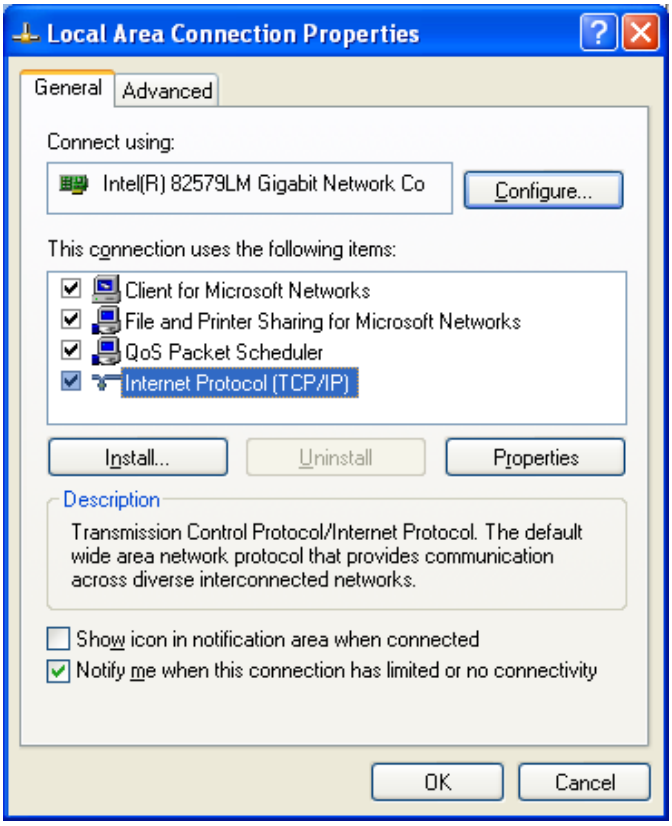
D.1 TO CONFIGURE THE COMPUTER ETHERNET 1 INTERFACE FOR COMMUNICATION WITH THE TRANSCEIVER MAINT PORT

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.

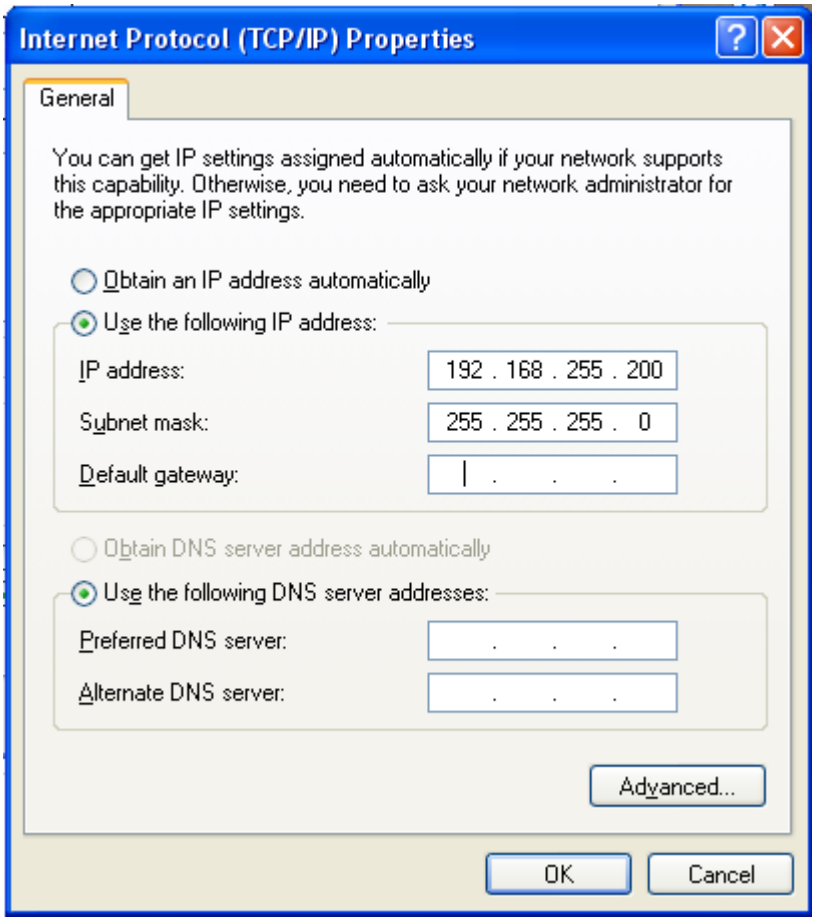
2. The **Local Area Network Connection Status** window opens. Click **Properties** and the **Local Area Connection Properties** window for the first Ethernet connection opens.

Figure 17 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**.

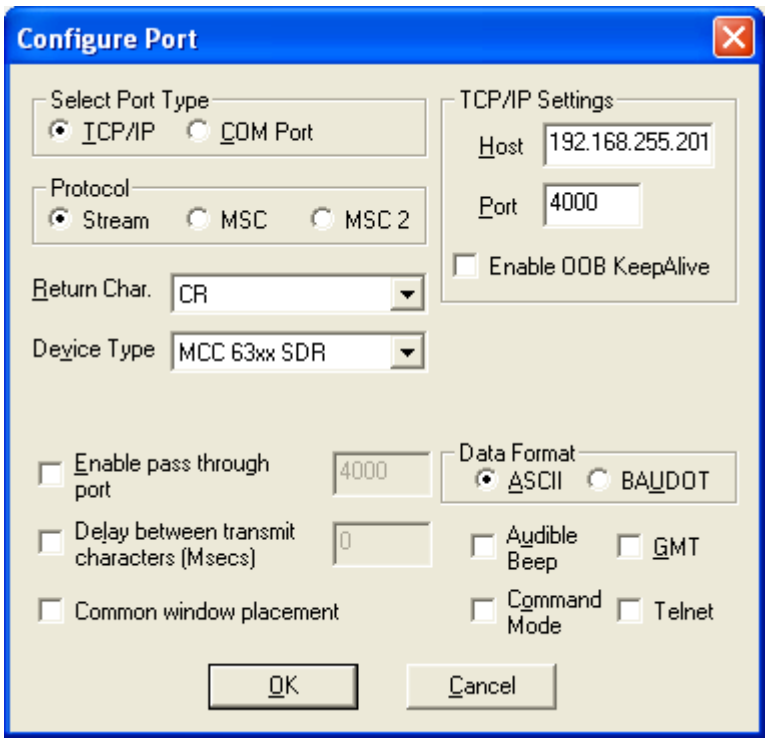
Figure 18 Internet Protocol (TCPIP) Properties Window for Ethernet 1 connection



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 19 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**.

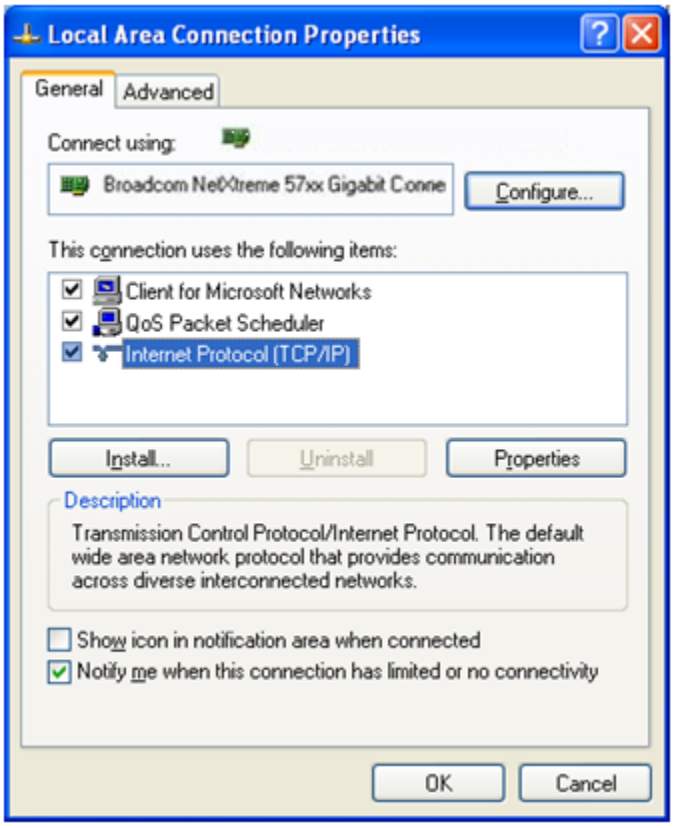
D.2 TO CONFIGURE THE COMPUTER ETHERNET 2 INTERFACE FOR COMMUNICATION WITH THE TRANSCEIVER LAN PORT

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.

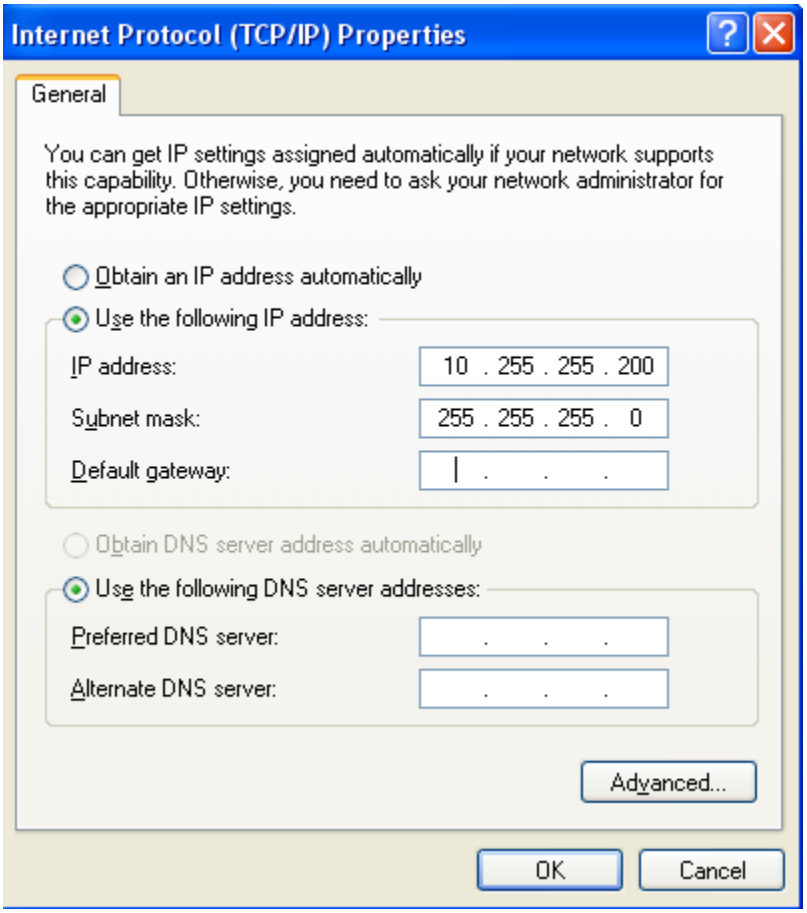
2. The **Local Area Network Connection Status** window opens. Click **Properties** and the **Local Area Connection Properties** window for the second Ethernet connection opens.

Figure 20 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**.

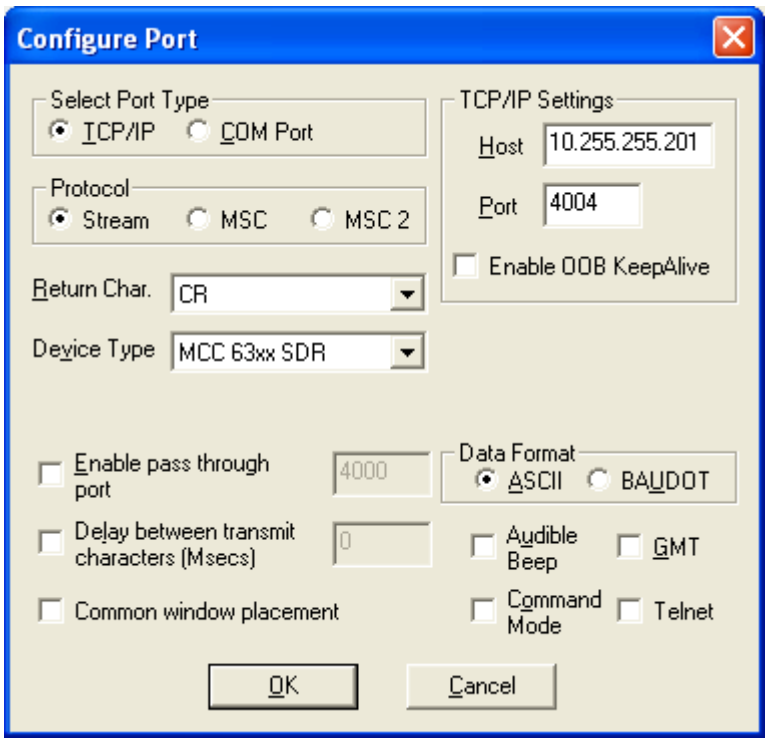
Figure 21 Internet Protocol (TCP/IP) Properties window for Ethernet 2 connection



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 22 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**.

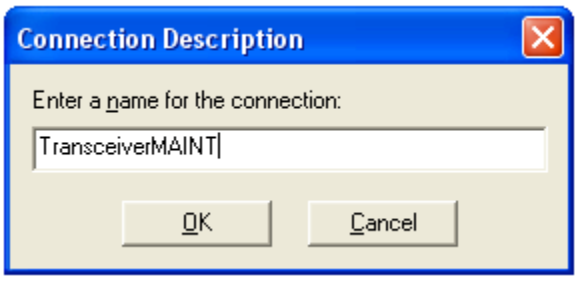
D.3 CREATING AN XTERMW CONNECTION PROFILE

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

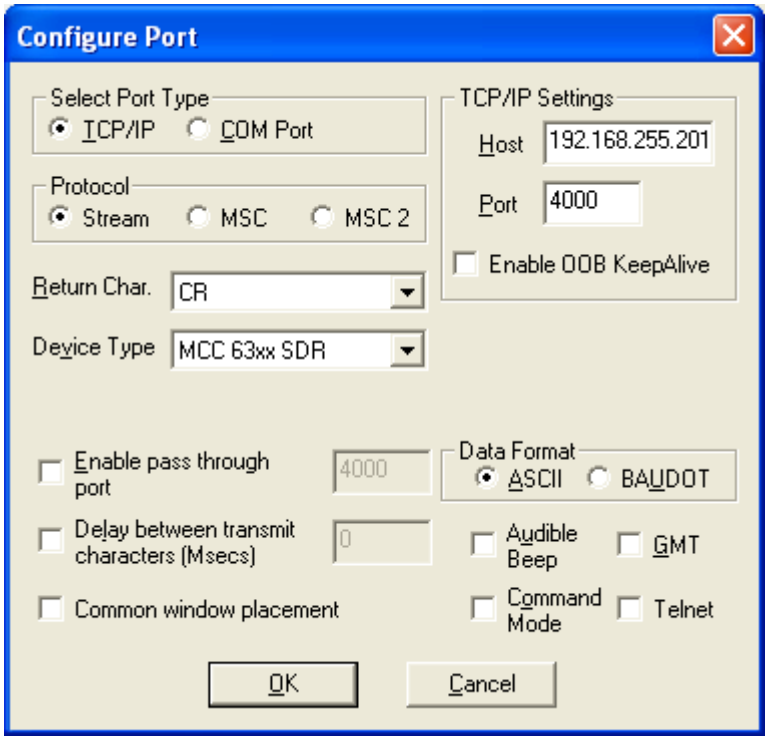
1. Open **XtermW** if it is not already open.
2. From the **File** menu, select **New Connection** and the **Connection Description** window opens.

Figure 23 Connection Description window



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

Figure 24 XtermW Configure Port window with settings for MAINT port



5. Set **Select Port Type** to **TCP/IP**.
6. Set the **Protocol** to **Stream**.
7. Set **TCP/IP Host** and **Por**t 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.

APPENDIX E — SAMPLE POST RESULTS FROM A PROPERLY FUNCTIONING BASE STATION TRANSCEIVER

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


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

Board Type                    : Base
Hardware Revision             : F2
Serial Number                 : 20024

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
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
HOST: ETHERNET 0              : PASS
HOST: ETHERNET 1              : PASS
HOST: MAC 0                   : PASS
HOST: MAC 1                   : PASS
HOST: GPS                     : PASS
HOST: CIM                     : PASS
DSP:  CLOCK                   : PASS
DSP:  EDMA                    : PASS
DSP:  GPIO                    : PASS
DSP:  SPI                     : PASS
DSP:  MCASP                   : PASS
DSP:  PSC                     : PASS
DSP:  EXTERNAL CLOCK          : PASS
DSP:  IQ MIXER                : PASS
DSP:  RX ADC                  : PASS
DSP:  TX NULL ADC             : PASS
DSP:  DDS                     : PASS
FPGA: MEMORY                  : PASS
FPGA: Clocks                  : PASS
FPGA: Tx                      : PASS
HOST:  28.0v   Supply         : PASS :  28.915
HOST:  11.5v   Supply         : PASS :  11.432
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
HOST:   1.5v   Supply         : PASS :  1.396
HOST:   1.2v   Supply (Host)  : PASS :  1.249
HOST: External Supply         : PASS :  2.401
HOST: 12V Power Supply Temp   : PASS :  41.751
```

```
HOST: 28V Power Supply Temp   : PASS :  39.702
HOST: PA Temp                 : PASS :  32.200
HOST: Driver Temp             : PASS :  32.200
HOST: PA Current              : PASS :  0.000
HOST: Driver Current          : PASS :  0.000

boot loader version 0.22.1 SVN 17525 2011-07-29
reset_count          3
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 F — PROGRAM SIGNAL GENERATOR FOR DQPSK

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

Table 7 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

Step	Action	Button / Selection
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
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

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

Table 8 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

Step	Action	Button/Selection
		1100 0110 0001 1001 1010 1101 1111 1000 0111 0001 0110 1101 1010 0110 1111 1011 0001 1110 1011 0001 0101 0000 0100 1100 1000 1000 0001 1010 1101 0100 0000 0010
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

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

Table 9 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.	Rea;-time GPS (on)

APPENDIX G — 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.

G.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."

G.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**.

G.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,oldpassword,newpassword,newpassword

   Where:

   oldpassword is your current password
   newpassword is your new password you want to change to
3. Click **OK** or press **Enter**.

G.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 G.3 Change Your Transceiver Password.

APPENDIX H — 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
   BROADCST     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
   BROADCST     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
   BROADCST     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
(c) Copyright 2012 CalAmp Inc.
     All Rights Reserved
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             ---
```

APPENDIX I — 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.

I.1 REQUIRED EQUIPMENT

The tests and adjustments described in this section require service personnel to have equipment listed in the Required 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.

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 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

I.2 MEASURE AND ADJUST PEAK RF POWER OUTPUT

Equipment used to measure and adjust peak RF power output

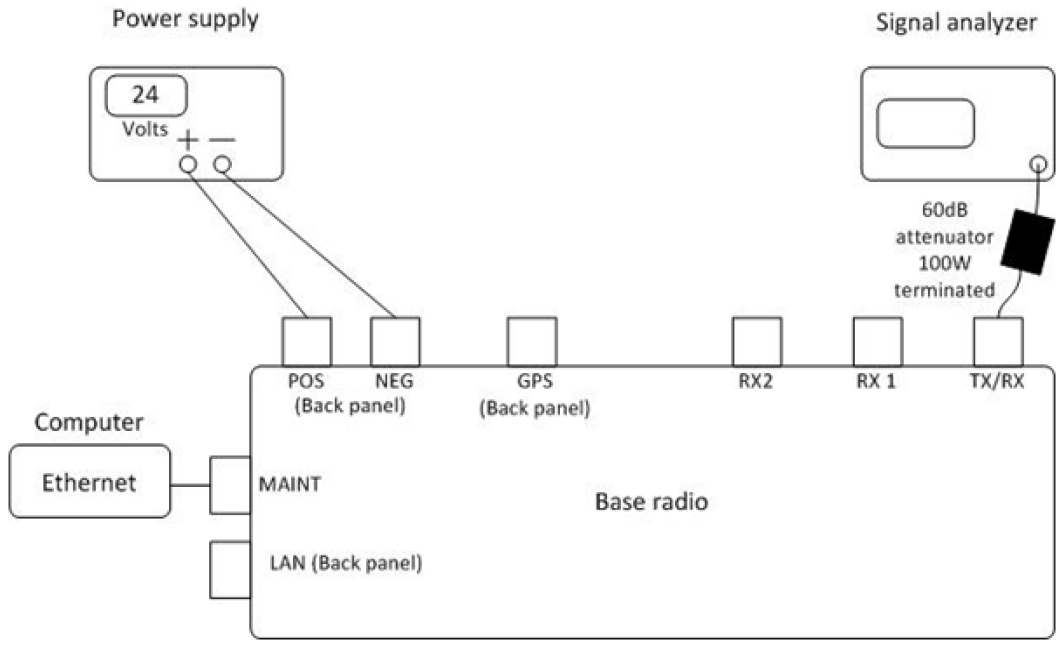
1. A power supply capable of providing:
   - 24 VDC Base Station Transceiver: 24 VDC and a current of 11 Amperes
   - 48 VDC Base Station Transceiver: 48 VDC and a current of 6 Amperes
2. 4 GHz spectrum analyzer that includes a DQPSK digital demodulation option

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

System setup for measuring and adjusting RF power output

Figure 25 Base Station 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 24 VDC Base Station Transceiver or the 48 VDC Base Station Transceiver is 75 watts PEP.

Radio transmission characteristics

The following spectrum analyzer images show typical radio transmission frequency and power spectrum characteristics in DQPSK transmission modulation format. Using the commands below in XtermW, key up the transmitter at either π/4DQPSK full or half rate and observe radio performance.

To key up transmitter at π/4DQPSK full 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

   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.

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

   L1_TEST,STOP

To key up transmitter at π/4DQPST 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,1000,300,0

where:

value equals the desired frequency of operation.

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

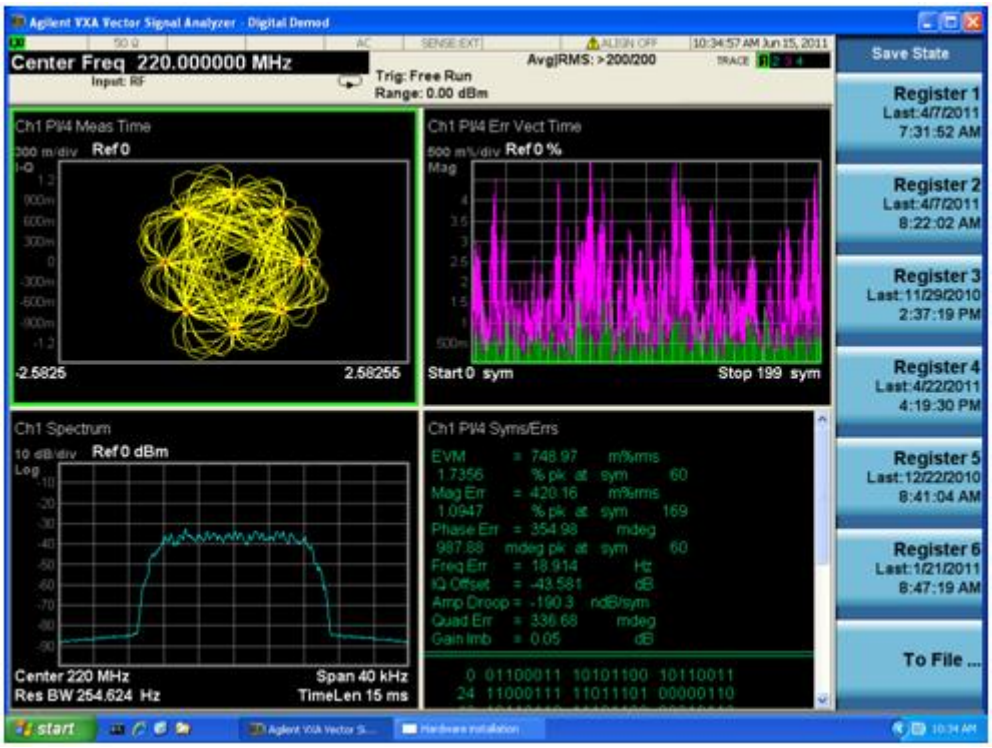
2. Once observation of radio performance is complete, turn off transmit operations by typing:

L1_TEST,STOP

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

Figure 26 Typical transmission spectrum (DQPSK)

Figure 27 Typical transmission spectrum EVM (DQPSK)



I.2.1 ADJUST RF POWER OUTPUT

Base station transceivers are rated for 75 W PEP. To achieve this power, radios are calibrated at the factory. If additional tuning is required, use the TXPOWER command to increase or decrease output power relative to the current power level.

Notes:

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

To adjust RF output power:

1. Key up the transmitter for full-rate π/4DQPSK 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.

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

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 11 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.

I.3 MEASURE FULL-RATE RECEIVER SENSITIVITY

I.3.1 PRIMARY/RX1 RECEIVER MEASUREMENT

To begin the test, make sure the E4438C signal generator is outputting the proper wave form into the RX1 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,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
```

I.3.2 DIVERSITY/RX2 RECEIVER MEASUREMENT

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 following commands in XtermW:

```
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
```

I.3.3 ALTERNATE/TX-RX RECEIVER MEASUREMENT

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
```

I.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 12 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 date 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 D.1 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, and
   `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, and
   `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**.

APPENDIX J — 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 t 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

J.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 13 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
```

J.2 UPDATING SOFTWARE IMAGES

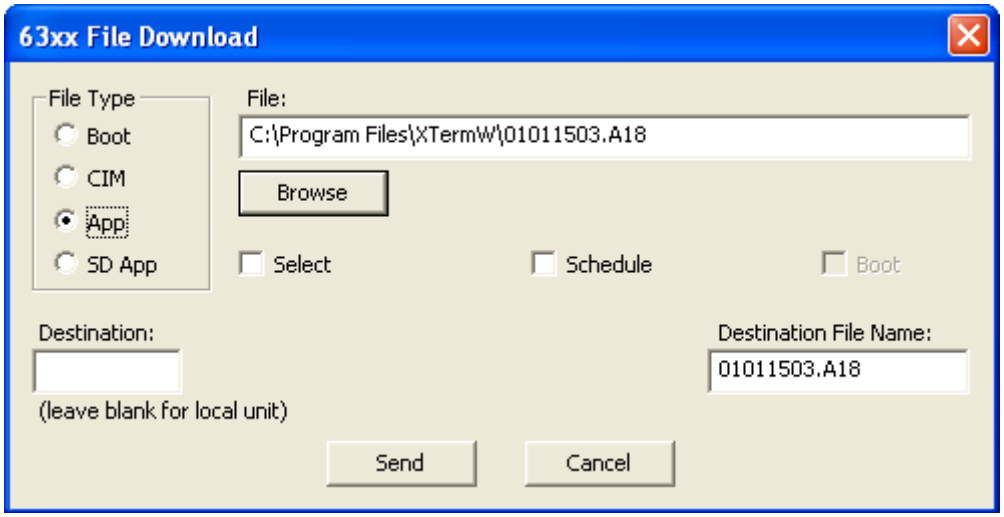
Updating the software means loading/installing the software image, selecting it to be active, and then activating/running it.

J.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:

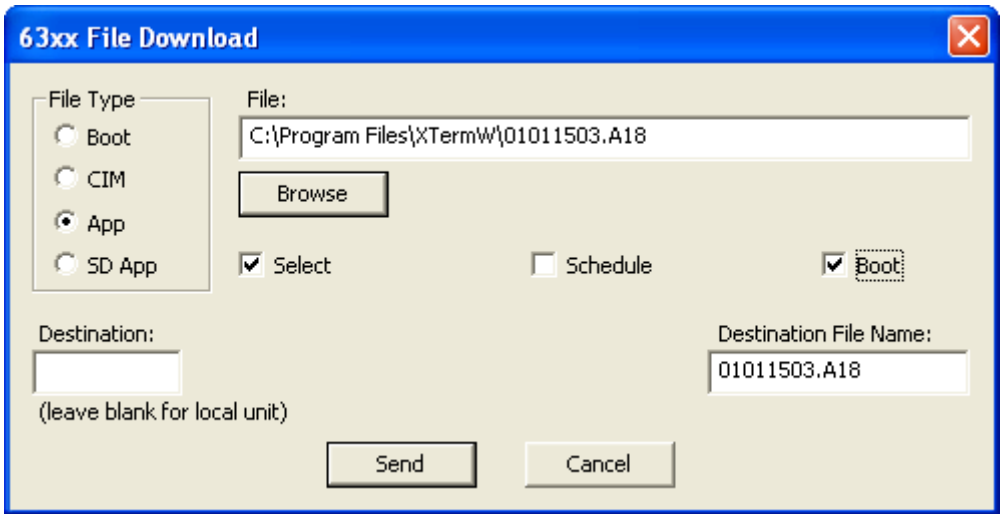


6. Under **File Type**, select **App**.
7. Click **Browse**, then locate and select the software image file.

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.

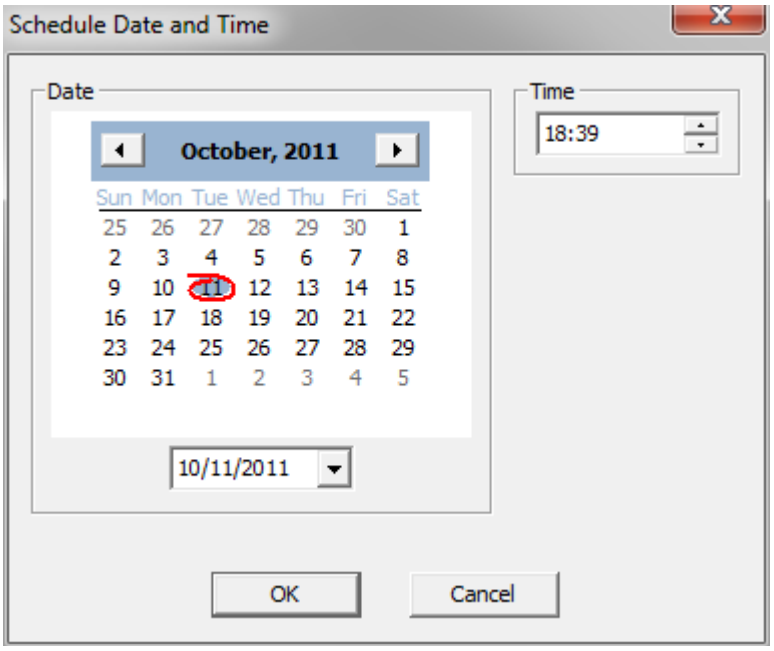
   When you select the Select check box, XtermW automatically executes the `APPS,SELECT,image-file` command after the software image is downloaded. It also causes XtermW to enable the **Boot** check box.

   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.

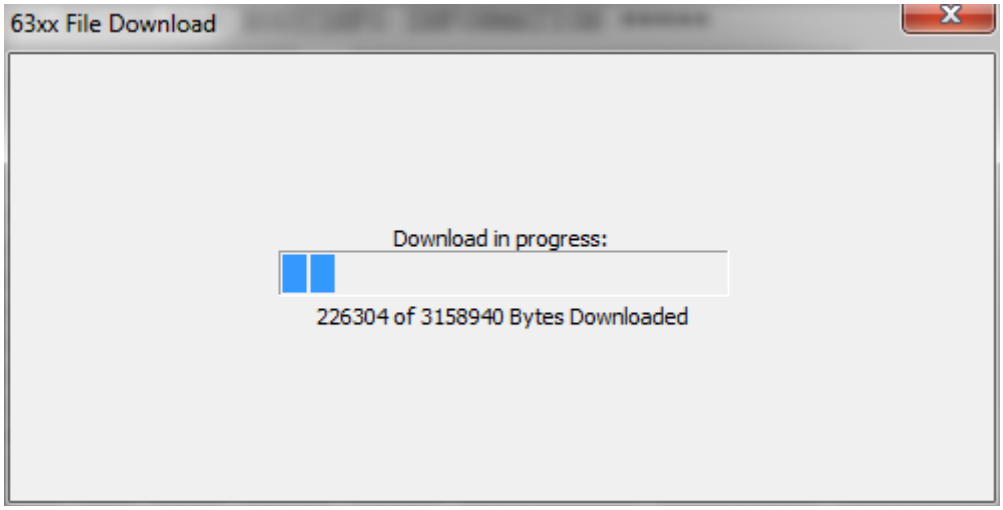


10. To execute a synchronized software update at a future time, select the Schedule check box. Choose the desired date and time in the pop-up window, and then click **OK**.

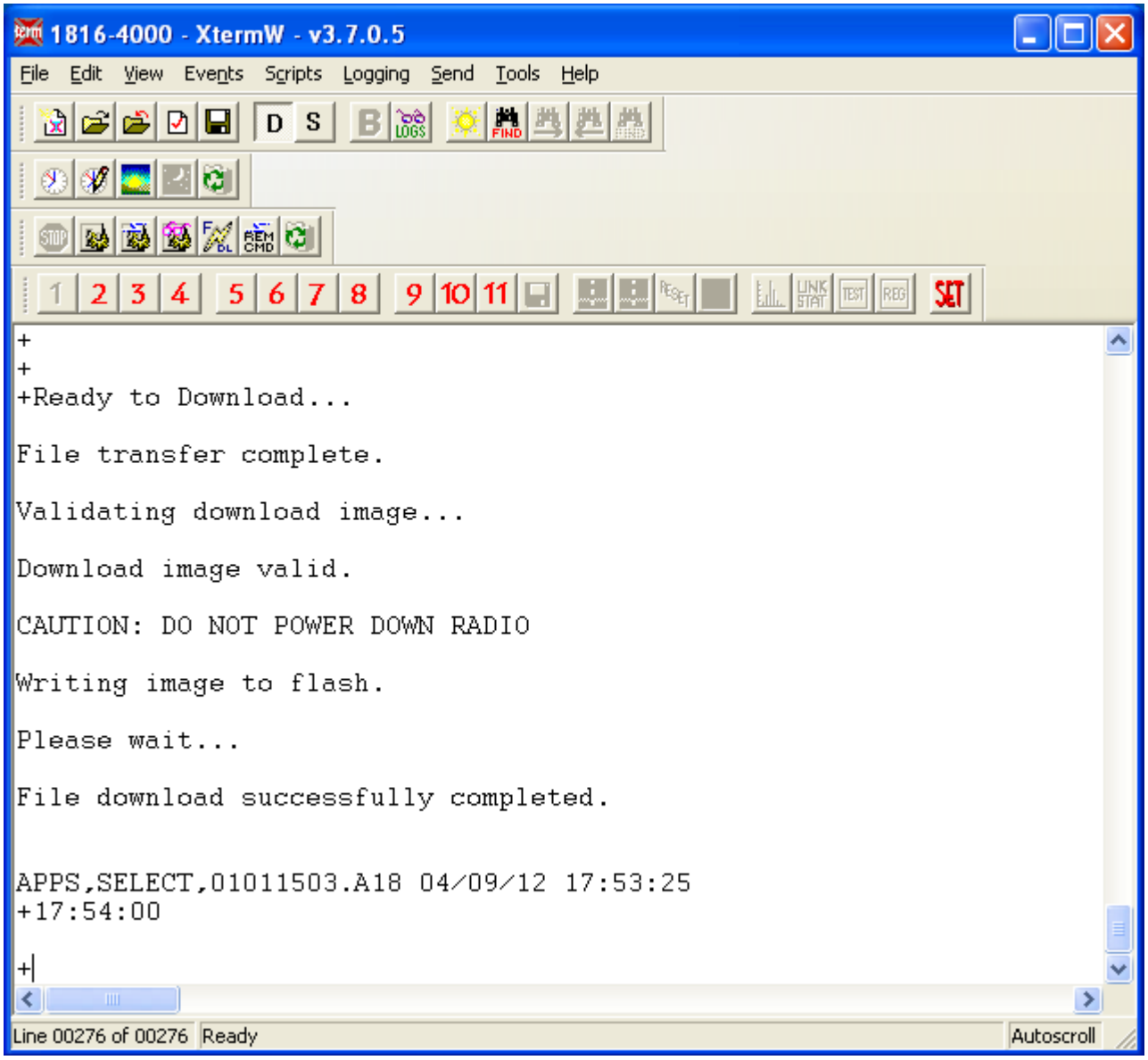
When you select the **Schedule** check box, XtermW automatically executes the `APPS,SCHED,date,time,image-file` command after the software image is downloaded.



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.

J.3 ROLLING BACK AN IMAGE

J.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.

J.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.

J.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
```

J.4 MAINTAINING MULTIPLE SOFTWARE IMAGES IN THE TRANSCEIVER

J.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 14 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.

J.4.2 SYSTEM EVENTS ON INSTALLED SOFTWARE IMAGES

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

Table 15 System events on installed software images

Event	Description
Status change from RDY to FLTY	If the failure counter of the image with the highest priority exceeds the threshold and there exists other RDY images, the automatic rollback algorithm changes the status of the image to FLTY, causing the next highest priority RDY image to become the active image.
Status change from SCHD to RDY with highest priority	If APPS , SCHED is enabled and a schedule has expired, the 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.

ABOUT CALAMP

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