METEORCOMM LLC

ITCR 1.1 Base Radio Installation and Field Service Guide

Document Revision: 1.0
Document Number: 00002468-A

This work was funded in whole or in part by the Federal Railroad Administration, US Department of Transportation under U.S. Government Grant FR-TEC-0003-11-01-00, and is therefore subject to the following license: The Government is granted for itself and others acting on its behalf a paid-up, nonexclusive, irrevocable worldwide license in this work to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or behalf of the Government. All other rights are reserved by the copyright owner.

Document Number:00002468-A

Revision History

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

Table of Contents

Table of Figures

Table of Tables

1 Overview

The *ITCR Base Radio Installation and Field Service Guide* provides important radio-frequency safety information, installation procedures, and servicing instructions for Meteorcomm Interoperable Train Control (ITC) Base radio models 63030-24 and 63030-48. These two models are nearly identical in design and operation. The only difference is their nominal input power requirement: +24VDC and +48VDC, respectively.

1.1 Audience

This guide provides essential information for personnel who perform the following tasks on Base radios:

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

Prerequisites for users of this guide include:

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

1.2 Specifications for models 63030-24 and 63030-48 Base Station radios

GENERAL	
FREQUENCY RANGE:	220 – 222.0MHz
CHANNEL SPACING:	25kHz
TEMPERATURE RANGE:	
OPERATING	-30^{O}C to +70^{O}C
STORAGE	-55^{O}C to +85^{O}C
HUMIDITY, OPERATING	0% to 95% non-condensing; Test per S-5702, clause 3.2.3.2
FREQUENCY STABILITY:	+/-0.1ppm over operating temperature range (+25^{o}C reference)
DC INPUT VOLTAGE RANGE:	
Model 63030-24:	21 - 27VDC, Damage limit 30VDC
Model 63030-48:	42 - 54VDC, Damage limit 60VDC
DC CURRENT DRAIN	
Model 63030-24, 24VDC input:	Transmit: 11A (peak) max into 50 Ohm load, 7.5 A typical Receive: 1.2A max while receiving
Model 63030-48, 48VDC input	Transmit: 6A (peak) max into 50 Ohm load, 4A typical Receive: 0.6A max while receiving
DC POWER CONNECTOR:	Threaded 5/16 -18 studs for ring lug connection
SIZE:	EIA 19” rack compatible, 5U height (8.75”) max
WEIGHT:	26.8 lbs (12.2kg)
ANTENNA CONNECTORS: 3 x Type N female	1. TX/RX (single antenna install) 2. RX1 (multi-antenna – RX only) 3. RX2 (diversity – RX only)
GPS RECEIVER:	
Antenna:	Active or passive
Antenna power:	3.3V 50mA max
Antenna connector:	TNC Female
DISPLAY:	Activity / Diagnostic LEDs on Front Panel

EXTERNAL INTERFACE: Ethernet (2), 10/100 MBPS	Data Network port – Type RJ-45 Maintenance port - Type RJ-45
CONFIGURATION INTERFACE MODULE:	SD Card
TRANSMITTER	
RF POWER OUTPUT:	75W PEP. Adjustable 10W PEP to 75W PEP
OUTPUT IMPEDANCE:	50 Ohms
Operating VSWR	< 3:1
MODULATION WAVEFORMS:	16kbps π/4DQPSK (linear)
	32kbps π/4DQPSK (linear)
OCCUPIED BANDWIDTH:	Meets 47CFR90.210 (f), five aggregated channels
CONDUCTED SPURIOUS EMISSIONS:	< -25dBm
MAX DUTY CYCLE RATING:	50%
EMISSION DESIGNATORS:	16kbps π/4DQPSK 8K90DXW 32kbps π/4DQPSK 17K8DXW
REGULATORY APPROVALS:	63030-24: FCC ID BIB63030-24 IC 1300A-6303024 63030-48: FCC ID BIB63030-48 IC 1300A-630304
RECEIVER	
MAXIMUM USABLE SENSITIVITY, STATIC, BER<10^{-4}:	16kbps π/4DQPSK -111 dBm 32kbps π/4DQPSK -108 dBm
ADJACENT CHANNEL SELECTIVITY (Analog FM):	70dB @ 25kHz offset
SPURIOUS RESPONSE REJECTION:	70dB
INTERMODULATION RESPONSE REJECTION:	65dB
HIGH INPUT LEVEL (-7dBm):	BER<10^{-4}
BLOCKING, 1MHz OFFSET:	80 dB
MAX SIMULTANEOUS RECEIVER CHANNELS:	16 (8 diversity receivers)

Specifications are subject to change without notice.

1.3 Acronyms

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

Acronym	Description
A	Amp
AWG	American wire gauge. Unit of wire diameter.
CIM	Configuration information module
cm	Centimeter, approximately 0.4 inches (slightly less than a half inch)
dB	Decibel
dBi	Decibel isotropic
dBm	Decibel, referenced to one milliwatt
DC	Direct current
DOP	Dilution of precision
DQPSK	Differential quaternary phase-shift keying
EVM	Error vector magnitude
FCC	Federal Communications Commission
GPS	Global Positioning System
IC	Industry Canada
ITC	Interoperable Train Control
ITCR	Interoperable Train Control-Radio
LAN	Local area network
m	Meter
MCC	Meteorcomm LLC
MEO	Medium Earth Orbit
MHz	Megahertz, a unit of frequency measurement
MPE	Maximum permitted exposure
MSGPS	Multi-satellite GPS
mW	Milliwatt

Acronym	Description
NIC	Network interface card
PEP	Peak envelope power
POST	Power-on self-test
PPM	Parts per million. Typically used to indicate frequency tolerance.
PTC	Positive Train Control
RF	Radio frequency
RU	Rack unit. Defined as a height of 44.5 mm.
SAR	Specific absorption rate
SD memory card	Secure Digital memory card
SMA	SubMiniature, version A, a type of connector
TCP/IP	Transmission Control Protocol/Internet Protocol
TNC	Threaded Neill-Concelman, a type of connector
VDC	Voltage, direct current
W	Watt
XtermW	Meteorcomm terminal emulation application used for configuring and operating Positive Train Control (PTC) radios.

1.4 Related documents

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

- *ITCR Locomotive Radio Installation and Field Service Guide*

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

- *ITCR Wayside Radio Installation and Field Service Guide*

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

- *ITCR Radio Configuration Guide*

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

- *ITCR Radio Management Guide*

  This guide provides essential information for personnel who monitor and manage ITCnet Base, Wayside, and Locomotive radios.

- *ITCR CLI Reference for Administration and Service*

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

- *ITCR Getting Started with XtermW*

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

- *ITCR RF Energy Exposure Guide*

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

1.5 How to get help

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

2 Follow your established safety guidelines

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

2.1 Electrical safety

To reduce the risk of electric shock:

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

3 Important information for the user

3.1 Transmitter warm-up period

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

3.2 Limiting RF exposure

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

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

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

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

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

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

3.3 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," below, provides additional information on how to comply with ERP limits.

Refer to the *ITCR RF Energy Exposure Guide* for specific guidelines regarding the siting and installation of fixed antennas.

Acceptable fixed-antenna types are listed in the lateral separation distance tables in the ITCR RF Energy Exposure Guide.

Install antennas in accordance with the manufacturer's instructions.

Disable the transmitter when installing or servicing its antenna or transmission line.

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

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

3.4 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 the following measures:

- Reorient or relocation the receiving antenna.

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

3.5 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 radio channelization and frequency range

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

4.2 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 exception of FCC channels 161-170 and 181-185. Therefore, the Base radio may not transmit on those channels or their 221 MHz counterparts, 361-370 and 381-385. This corresponds to Base 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 set out in 47CFR Subpart T §90.701 et. seq., or Industry Canada SRSP-512 §6.3, as applicable.

Important: The following supplementary antenna system information discusses means for the licensee to comply with regulatory power limits.

Licensees must comply with the 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 10*log(50) + 30 = 47 dBm PEP referenced to the 2.15 dBi gain of a dipole. The EIRP for this case is 49.15 dBm. Also note that the maximum ERP on FCC/IC channels 196-200 at 220.975 to 221.000 MHz is 2 watts.

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 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 Equipment installation

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

Base radios are housed in a sheet metal enclosure. The Base radio mounts within a standard 19-inch rack and a height rack of four rack units (RUs). It weighs 26.8 lbs.

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

Figure 1: Base radio

Radio installation consists of these steps:

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

The following sections describe each of these steps in detail.

5.1 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 if familiar with the pieces of test equipment listed below. Instructions on how to use the following equipment are beyond the scope of this document.

Type	Model	Notes
Vector signal generator	Agilent E4438C or equivalent	Recommend option for 50 VDC, 50 W input protection of RF signal output port. Preprogrammed with DQPSK data packet and appropriate preamble required by Sprint release. See Appendix E - 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 2W min. power rating
Constant voltage DC power supply		Verify unit supports voltage and current draw required by unit under test.
Host computer with at least one Ethernet port and Meteorcomm XtermW or equivalent terminal program installed.		If the host computer's Ethernet port has not been configured then follow the instructions in the Configure the computer Ethernet ports to communicate with a radio.
Clip-on ammeter		
Antenna/VSWR test kit		
Cable ties as required		
Digital volt meter		

Type	Model	Notes
Network analyzer		
Portable power meter		
Site tester		
7/16" and 9/16" wrenches		
#2 Phillips-head screwdriver		
Torque wrench with 100 in-lbs capacity		
Ring lug		
Crimping tool		

5.2 Radio connections

All physical connections and radio interfaces are located on either the front or rear panel of the radio. The following tables and figures illustrate these interfaces.

Table 1: Connectors on the Base radio front panel

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

Figure 2: Connectors on the Base radio front panel

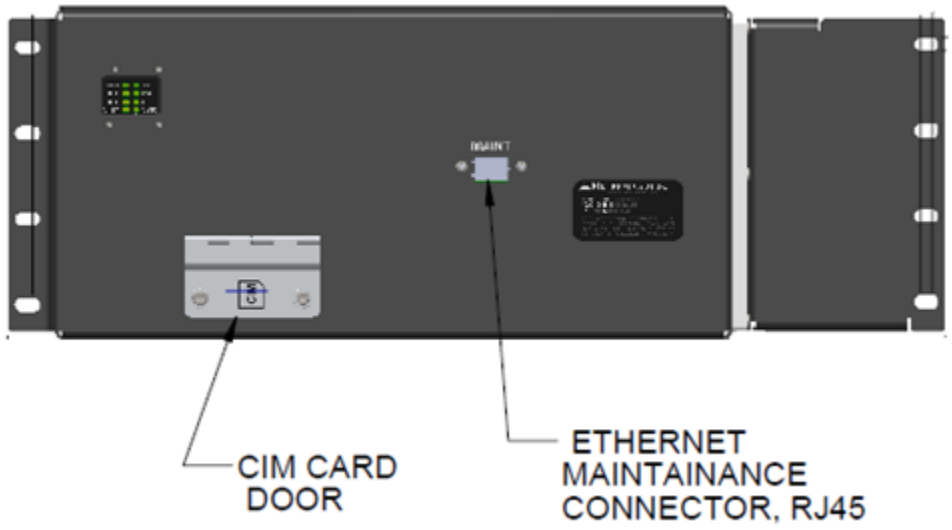
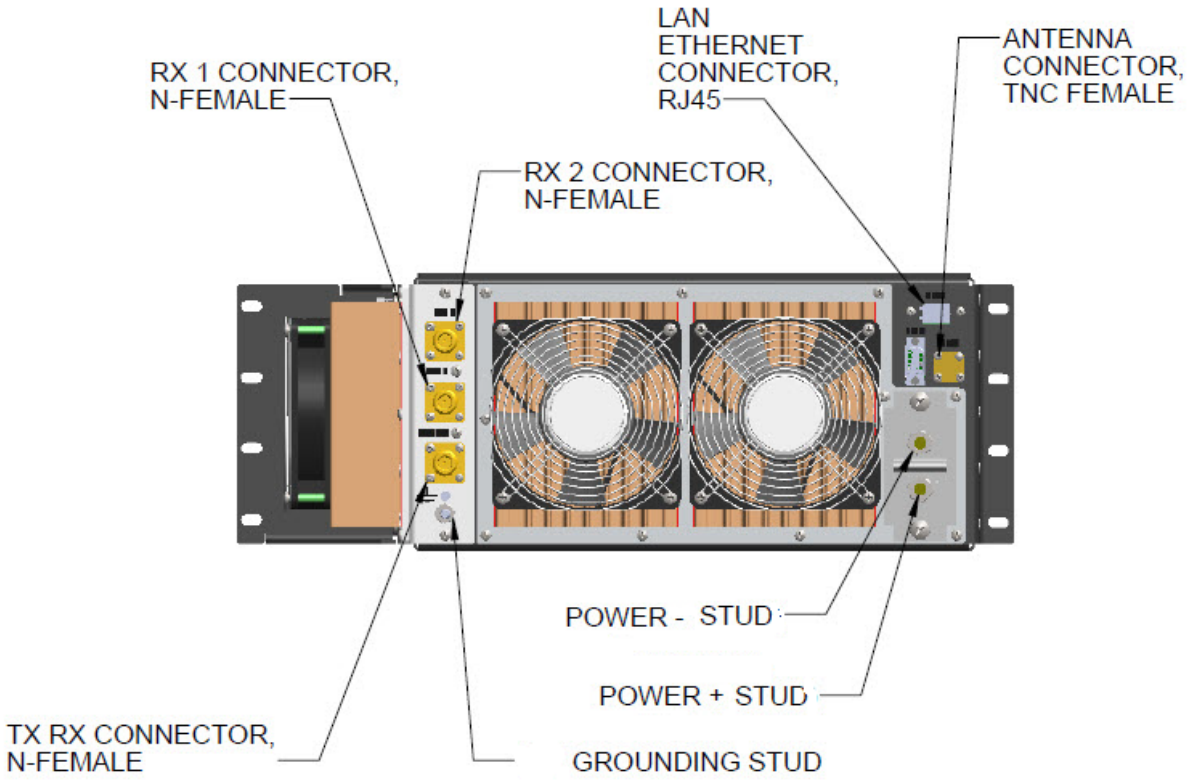


Table 2: Connectors on the Base radio rear panel

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 for ring lug connection	+24 VDC or +48 VDC
Data Network Ethernet	RJ-45	LAN

Figure 3: Connectors on the Base radio back panel



5.3 Unpack and inspect the radio

Unpack and inspect the radio. 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 the contents do not match the invoice, then note the defect and contact the manufacturer.

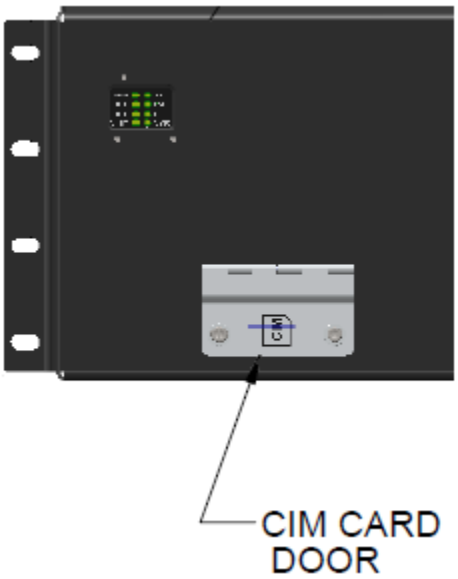
If you do not detect any damage and the shipping invoice matches the contents, then continue with the installation.

5.4 Confirm SD memory card

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

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

Figure 4: CIM card door on a Base radio



5.5 Mount the radio

The Base radio is installed in a standard 19-inch rack. For open-frame channel-rack installations, relocate the mounting brackets near the radio center-of-gravity.

Caution: We recommend the Base radio 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 by the caution above, the brackets and dust cover are partnered with screws. These bracket/dust cover and screw partnerships are independent of mid-point or front mount installations. Use of any incorrect screws may result in damage to the radio. See the following table for pairing details.

Table 3: Brackets, dust cover, and partnering mounting screws

Item	Image	Screws
Left bracket		5 pcs x 005-004-0106; Machine screw, 8-32 x 3/8”, Flat head, Philips, Stainless steel
Unused mount	N/A	5 pcs x 005-004-0006; Machine screw, 8-32 x 3/8”, Pan head, Philips, Stainless steel
Right bracket		5 pcs x 005-003-0004; Machine screw, 6-32 x 1/4”, Pan head, Philips, Stainless steel
Dust cover		2 pcs x 005-003-0004; Machine screw, 6-32 x 1/4”, Pan head, Philips, Stainless steel

Figure 5: 19-inch rack mount

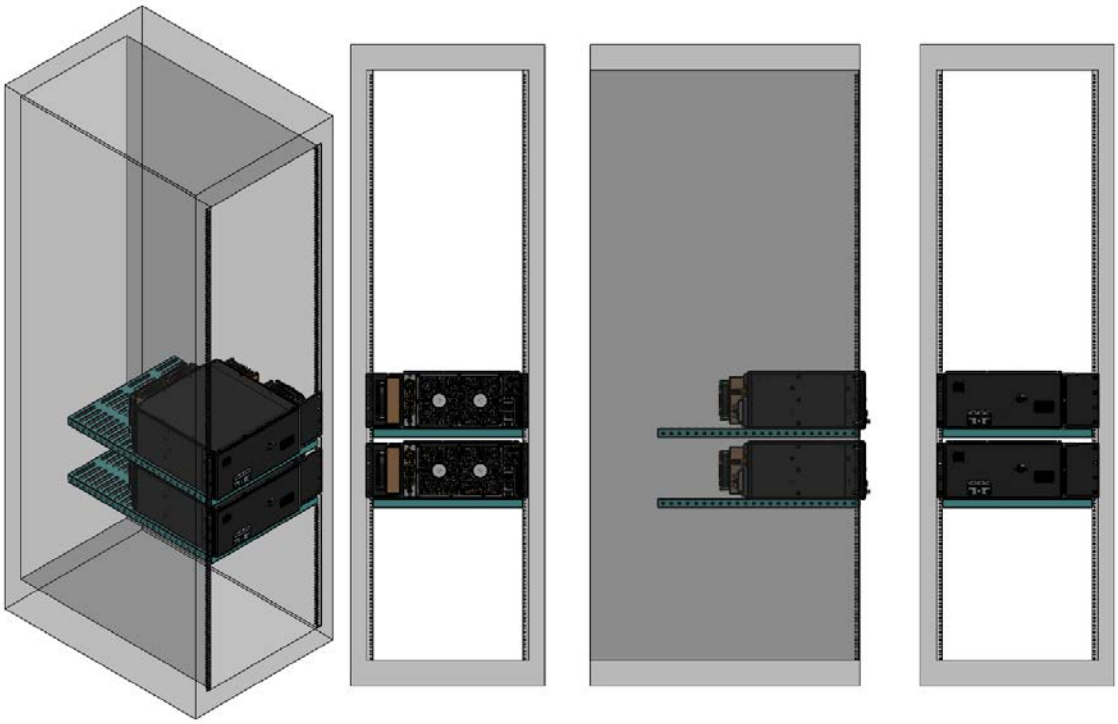


Figure 6: Channel-rack installation: Mounting brackets in mid-plane position

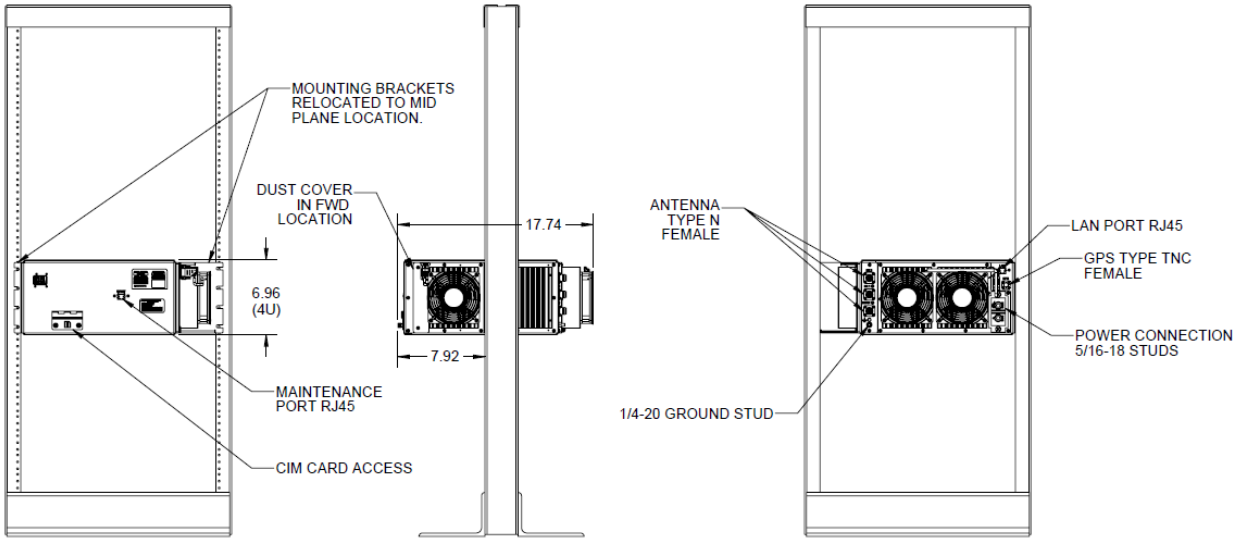
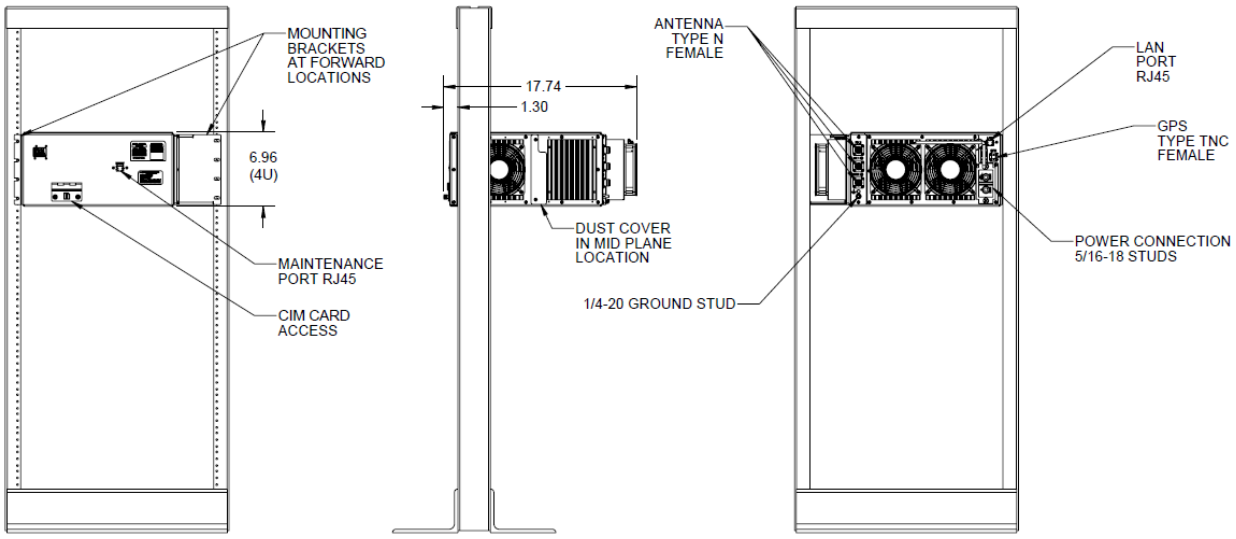


Figure 7: Channel-rack installation: Mounting brackets at forward position



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

To mount the radio:

1. Place the radio on the vented cabinet shelf (if installing in a 19-inch rack).
2. Secure the radio with four screws on either side.

After mounting, ensure that:

- Equipment that produces substantial heat is not installed below the radio.
- Each radio is secured with four screws on either side.
- There is adequate room to access the SD memory card.
- There is adequate room for cable connections.
- The radio is resting on a vented cabinet shelf (if installed in a 19-inch rack).
- Cables are restrained to prevent kinking and stressing connectors.

5.6 Connect the antennas

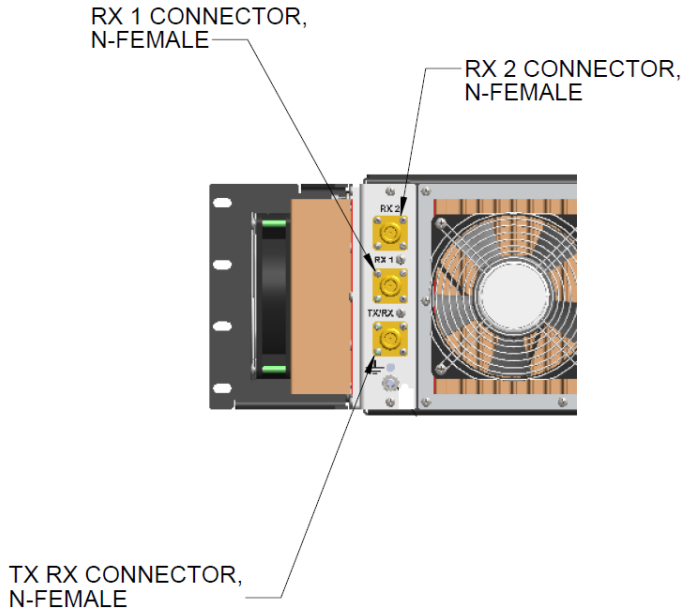
5.6.1 Antenna planning

You should already know how many antennas have been set up at the site. The radio is designed to be properly terminated to a 50 Ohms resistance. Base radios can have three possible antenna configurations. See Appendix A: Possible antenna configurations for more information.

5.6.2 Connect the cable(s)

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

Figure 8: Antenna connections on the Base radio rear panel



To connect the cables:

1. Perform or confirm the 220 MHz antenna VSWR prior to connecting the antenna to the radio. The VSWR should not exceed 1.5.
2. Run the cables into the rack.
3. Connect the antenna cable to the appropriate antenna input connector on the radio rear panel and tighten securely but do not over tighten. Use caution to avoid cross threading the connector.
4. Cover any unused ports.

5. Restrain all cables while observing the cable manufacturer's bend radius recommendations.

5.7 Ethernet connections

Base radios use a shielded CAT 5 Ethernet cable with an RJ-45 connector. It is recommended that the cable length not exceed 100 meters. Insert the cable into the LAN port on the back of the radio.

5.8 Connect the GPS antenna

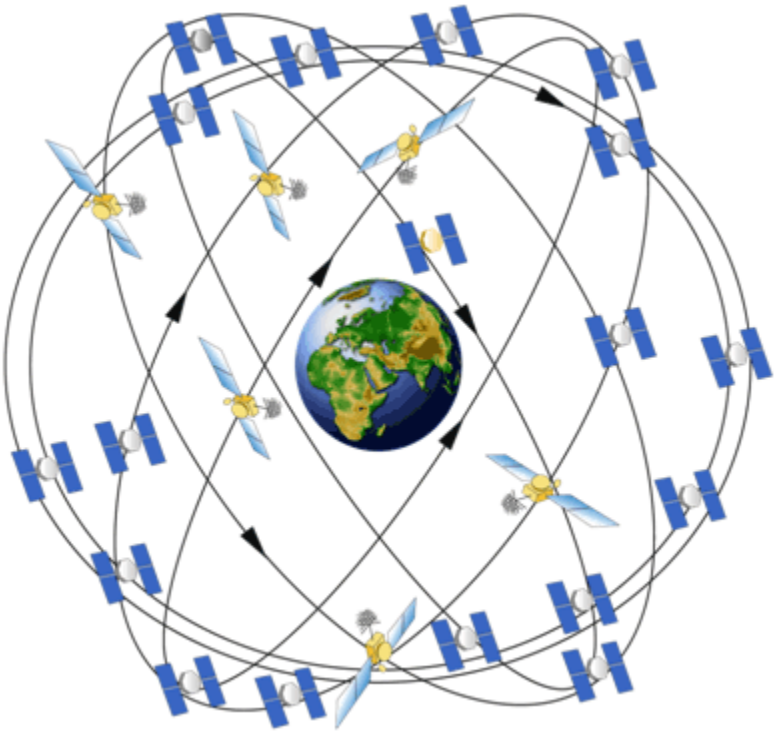
Position the GPS antenna to avoid strong interferers that could saturate the antenna low noise amplifier or the radio GPS receiver internal low noise amplifier. Combinations of strong interferers could mix and interfere directly with the GPS signal quality. Test the radio GPS with any interference source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

5.8.1 GPS antenna constellation overview

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

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

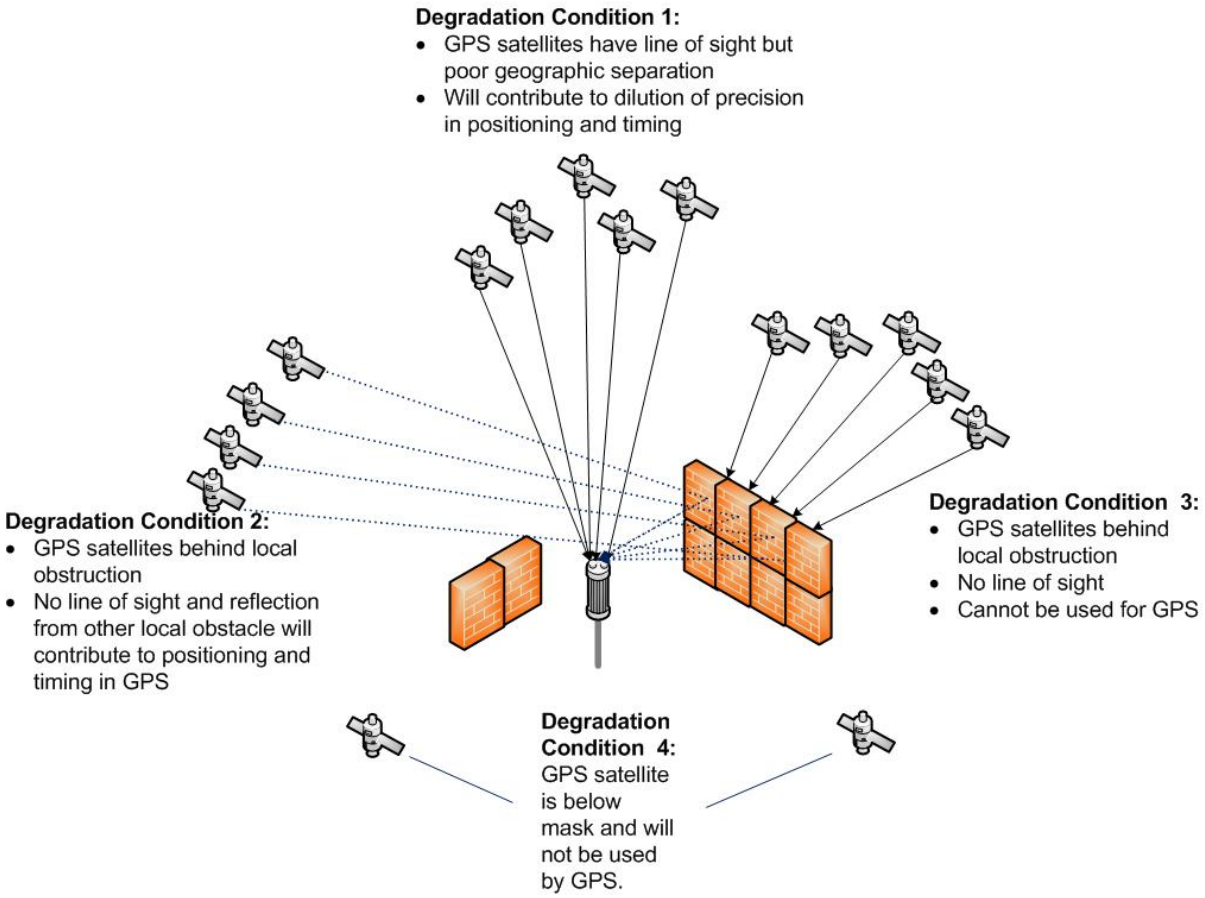
Figure 9: GPS satellite constellation



5.8.2 GPS antenna planning considerations

When determining antenna locations several factors should be taken into consideration. Figure 10: GPS antenna considerations illustrates four typical degradation conditions that a GPS antenna may face.

Figure 10: GPS antenna considerations



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

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

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

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

5.8.3 Minimize potential of GPS antenna issues

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

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

- Install the antenna as high as is practical and as allowed by local, state, and federal laws.
- Reduce the obstruction angles by installing the antenna further from obstructions to reduce its apparent size from the perspective of the GPS antenna.
- Be aware of other, large structures that may block a significant portion of the sky from the GPS antenna's perspective.
- Be aware of any potential transient obstructions.
- Always note the format of the GPS coordinates (for example, decimal degrees or decimal minutes).

5.8.4 Determine GPS coordinates

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

GPS self-survey

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

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

Meteorcomm recommends that the GPS configuration be configured 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 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 work flow.

Surveyed position obtained offline

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

Using this method, the user:

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

The following example shows the use of the LOCATION command:

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

GPS determines its own position

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

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

Some disadvantages include:

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

- The survey has to be repeated whenever the radio is swapped out.

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

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

```
+POS,SOURCE,SURVEY
+POS,TIMING,SURVEY,1,1
+TIMESYNC,GPS
+POS
 GPS Interval = 30, Tx format = TEXT, Input format = UBX
 19:18:42 47:28.380N 122:14.015W S000 H000 A00014 V1
 Position entered from GPS survey
 Precision: LOW  NSAT: 9  HDOP: OFF (0.93)
 HOLD: OFF  LOCK: OFF  DGPS-Age: 99 Seconds
 COPY Port: OFF
 SCALE rrc values: 0.0000
 RXDIFF: ON, ALL
 Timing mode: Requested: SURVEY     Actual: SURVEY
 Surveyed ECEF position: x=-230367548  y=-365342165  z=
467746427
 Survey parameters: fixed err=      1000  req err=   1000000
req time=   60
+
+POS
 GPS Interval = 30, Tx format = TEXT, Input format = UBX
 19:19:45 47:28.381N 122:14.015W S000 H000 A00015 V1
 Position entered from GPS survey
 Precision: LOW  NSAT: 11  HDOP: OFF (99.99)
```

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

 COPY Port: OFF

 SCALE rrc values: 0.0000

 RXDIFF: ON, ALL

 Timing mode: Requested: TIMING     Actual: TIMING

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

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

+
```

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

To connect the GPS antenna

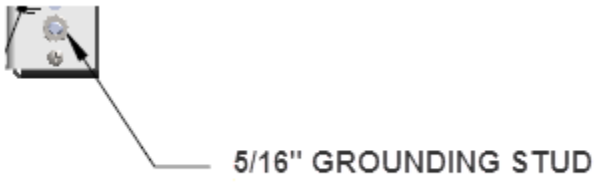
The GPS antenna connection is a TNC female connector and always provides an active antenna voltage. If the active antenna installed exceeds either the voltage or current ability of the radio then external power must be supplied to that antenna. A DC block must be used at the radio when the additional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

1. Confirm that the GPS antenna has been verified with a network analyzer.
2. Verify the power requirement of the GPS antenna and connect a DC block and tee in the case external power is necessary.
3. Run the cable into the rack.
4. Connect the GPS antenna cable to the GPS antenna input connector on the radio rear panel and tighten securely but do not over tighten. Use caution to avoid cross threading the connector.

5.9 Ground the radio

The Base radio has a 5/16" grounding stud on the front of the radio.

Figure 11: Grounding stud



To ground the radio:

1. Remove the nut and washer from the grounding stud.
2. Connect a 12 AWG stranded wire, with ring lugs, from the radio ground stud to the building ground.
3. Replace the washer and nut and tighten.

5.10 Use current-limiting circuit protection

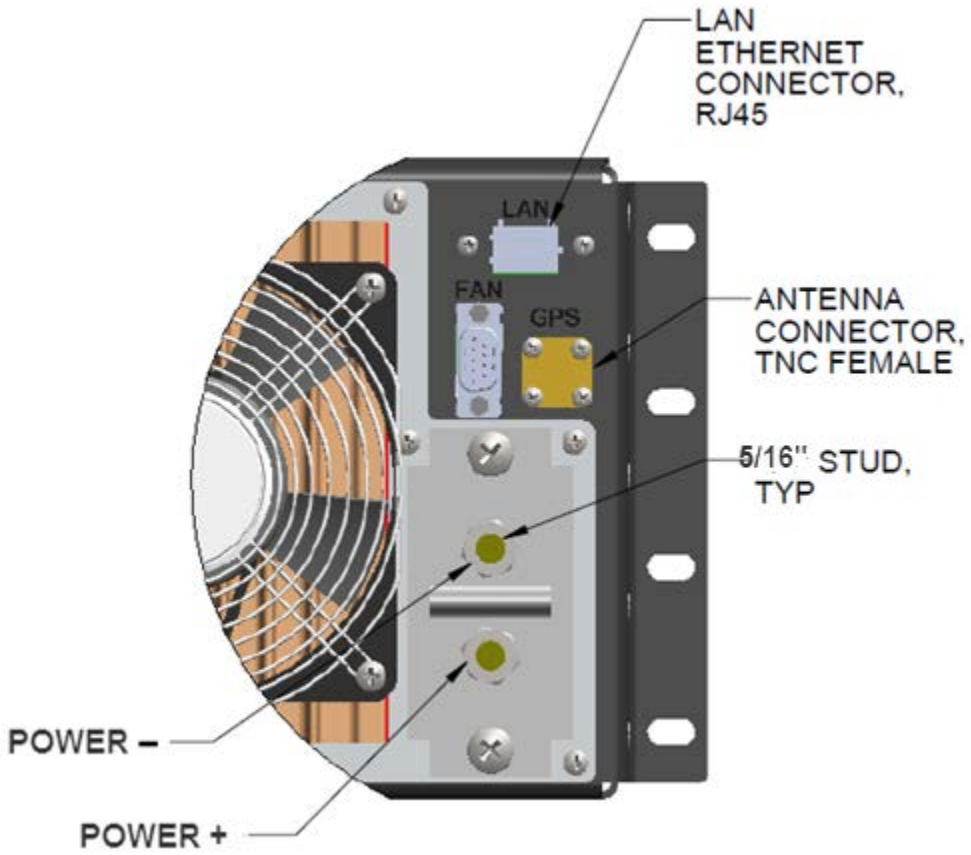
Current-limiting circuitry must be externally supplied to the radio. For installations using fuses or breakers, limits of 15 A for the 24VDC and 10 A for the 48VDC version of the radio are recommended. Follow the manufacturer's instructions.

5.11 Connect the power cable

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

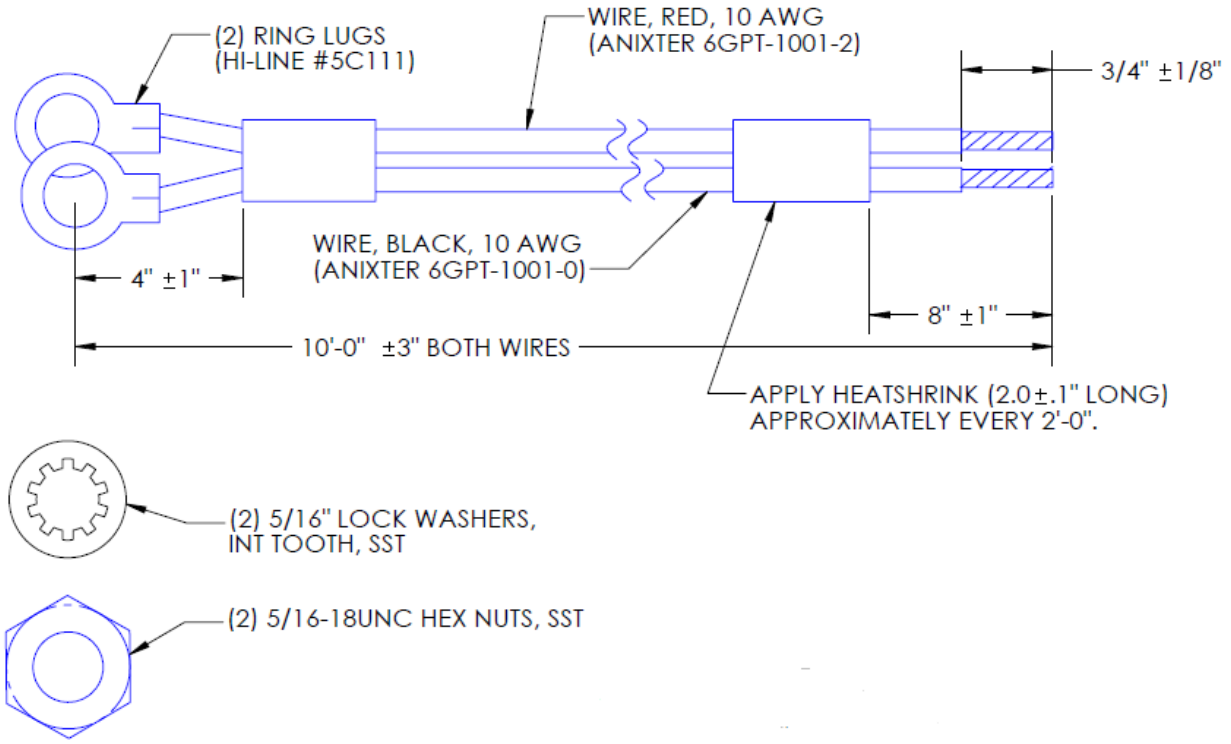
The Base radio has two 5/16" studs (marked **+** and **—**) to connect the 10 AWG power cables. The power connectors are threaded posts for ring lug terminals and are located on the radio rear panel.

Figure 12: Power connector studs on the rear panel of the Base radio



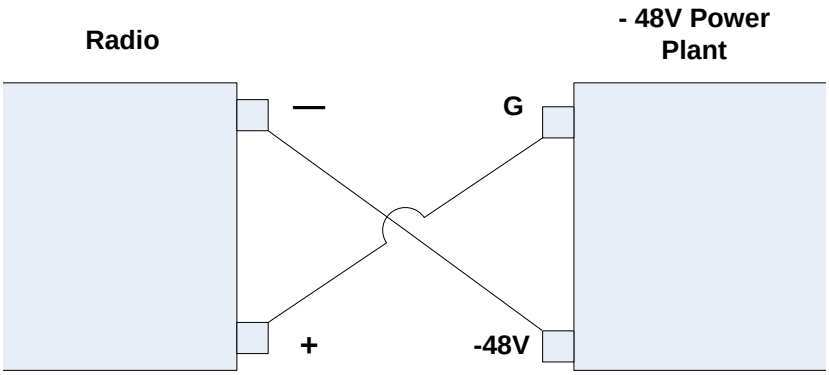
The power connectors are threaded posts for ring lug terminals and are located on the radio rear panel.

Figure 13: Power cable



Note: If installing a radio in a site with a -48V power plant then connect ground (G) on the power plant to the positive connection on the radio and the -48V on the power plant to the negative connection on the radio.

Figure 14: Radio installation at —48V power plant



To connect the power cable:

1. The Base radio does not have a power switch. Verify the power is off before connecting the radio to a power source.
2. Run the power cables into the rack.
3. Remove the hex nut and lock washer from each stud.
4. Place ring lugs of the power cable onto the studs – positive goes to the lower stud, negative to the upper stud.
5. Place the star (lock) washer over the ring lug.
6. Replace nuts on both studs and tighten to maximum torque of 100 in-lbs.
7. Restrain the cables while observing the cable manufacturer's minimum bend radius recommendations.

5.12 Initial power on

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

To power on the radio:

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

1. Connect the computer through the MAINT port on the radio with an Ethernet cable.
2. Start an XtermW session.
3. Confirm that all connections are secure.
4. Power on the radio.

5. Ensure the breaker did not trip on start up.

A flashing PWR LED on the front panel indicates that the boot sequence has completed. Within 10 seconds the Ethernet port connection becomes active allowing you to run an XtermW session.

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

Table 4: Front panel LEDs

Label	Description	Color
PWR	Power - Blinking green LED indicates that the radio is on.	Green
TX	Illuminated when the radio transmitter is keyed.	Red
SWR	Illuminated when the VSWR of the TX port exceeds approximately 3:1. Illuminated if the TX forward power is not within 25% of the RF output power setting.	Red
RX	Illuminated when the radio is receiving a valid 220 MHz PTC signal.	Amber
DTL	DTE Link - Illuminated when the radio establishes a connection to a Communication Manager (CM) through the Ethernet network port.	Amber
RFL	RF Link - Illuminated when an RF link is established between two radios.	Amber
STBY	Standby - When illuminated, the radio is in standby mode and the TX is disabled.	Red
FLT	Fault - When illuminated, it indicates a variety of fault conditions not indicated by other LEDs.	Red

5.13 Display the power-on self-test (POST) results

To view POST results, remove and re-apply DC power. The radio will automatically run internal diagnostics. A flashing green PWR LED on the front panel indicates that the boot sequence has completed. Within 10 seconds the Ethernet port connection becomes active.

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

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

To display the POST results:

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

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

6 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 radio
- Logging off from a radio
- Changing your password
- Replacing a forgotten password

The following sections describe each task in detail.

6.1 Log on to a radio

The prerequisites for logging on to a radio are:

- Recommended: An SD memory card with a configuration information module (CIM) script file is installed in the radio.
- **Note**: You can log on without installing a CIM script. However, the radio will not transmit, and it will reboot after 5 minutes.
- The radio has powered on and booted up with the CIM script executing.
- A computer with its Ethernet interfaces configured to communicate with the radio's MAINT port.
- The XtermW program is installed on the computer.
- You have permission to enter commands that can change configuration settings.

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

Notes:

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

To log on to the radio:

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

   `LOGON,password`

   - Where:

     `password` is your current password

3. Click OK or press ENTER.

DCN 00002468-A

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

6.2 Log off from a radio

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

To log off from a radio:

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

   `LOGOFF`

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

6.3 Change a password

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

The requirements for a password are:

- It can consist of any alphanumeric characters (a, b, c,… 1, 2, 3,…) plus the dash (-) character, in any combination.
- For example a password can consist of all letters, all numbers, or a combination of letters and numbers.
- It must be 3-20 characters long.

Passwords are not case sensitive.

To change your password:

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

   `NEWPASSWORD,oldpassword,newpassword,newpassword`

- Where:

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

4. Click **OK**.

6.4 Forget your password?

To replace a password that you have forgotten:

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

- See Change a password.

7 Troubleshooting

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

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

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

7.1 Guidelines for troubleshooting common problems

Always check these items first when a radio problem occurs:

Physical radio connections

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

Check that the SD card is present

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

Check the LEDs

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

Determine the software version each radio is running

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

Check the POST results

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

Check that the radio configuration is up to date

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

7.1.1 Commonly used diagnostic commands

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

LINKSTAT

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

Example from a Base radio:

```
+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.

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


     ITC PACKET DATA RADIO

(c) Copyright 2012 Meteorcomm LLC

      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 as 01.01.15.06.

STAT

The STAT,RF command displays the total number of packets transmitted and received over the air by the radio. Statistics are broken down by packet type. There are also several running totals included. See the *ITCR Radio Management Guide* for more information.

Example:

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

STAT,HRX

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

Example:

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

7.1.2 Front panel LEDs: What they say about radio operation

The front panel LEDs show the general operational status of the radio after the radio conducts a POST, which it does each time the radio boots up. Table 5: Front panel LEDs includes a description of the function of each LED as well as the color of each LED when the radio is functioning properly.

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

DCN 00002468-A

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 on.

Table 5: Front panel LEDs

Label	Description	Color
PWR	Power - Blinking green LED indicates that the radio is on.	Green
TX	Illuminated when the radio transmitter is keyed.	Red
SWR	Illuminated when the VSWR of the TX port exceeds approximately 3:1. Illuminated if the TX forward power is not within 25% of the RF output power setting.	Red
RX	Illuminated when the radio is receiving a valid 220 MHz PTC signal.	Amber
DTL	DTE Link - Illuminated when the radio establishes a connection to a Communication Manager (CM) through the Ethernet network port.	Amber
RFL	RF Link - Illuminated when an RF link is established between two radios.	Amber
STBY	Standby - When illuminated, the radio is in standby mode and the TX is disabled.	Red
FLT	Fault - When illuminated, it indicates a variety of fault conditions not indicated by other LEDs.	Red

7.1.3 View the results of the last POST

A POST is a series of several dozen tests that the radio quickly runs on itself, each time it boots up, to determine if it has a problem or is missing critical information. The radio boots up when it is powered on or the BOOT command 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 radio has passed a test, indicated by PASS, or failed a test, indicated by FAIL. The results do not appear on the radio, which has no display screen. Instead, you send a command to the radio and view the results on your computer monitor.

To view POST results:

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

   POST

4. Click OK.

View the POST results list. See Appendix D: Sample POST results from a properly functioning Base radio.

7.1.4 Boot up a radio

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

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

To boot up a radio:

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

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

   BOOT

4. Click **OK**.

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

7.2 Radio power problems

Problem indicators:

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

To troubleshoot radio power issues:

1. Make sure the power-cable connectors are securely connected to the power supply and to the radio.
2. Make sure the power-cable polarity is correct: the red wire is plugged into the radio's positive (+) terminal and the black wire is plugged into the minus (-) terminal. See Figure 13: Power cable.
3. Check that the power supply is turned on. If it is off, then turn it on.
4. Adjust the power supply to within the rated operating voltage.
5. Verify that the current limit on the power supply meets maximum current draw.
6. Replace the power cable.
7. Replace radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

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

The Fault LED differs from most of other front-panel LEDs in that it illuminates when the radio has a problem that is not indicated by any of the other LEDs.

Faults indicated by the Fault LED are:

- One or more internal radio supply voltages are below the minimum threshold.

- The external DC voltage to the radio is outside of the acceptable range.
- One or more of the radio's internal sensors is indicating a temperature exceeding the allowable threshold.
- The radio 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 it has invalid or corrupt data.

Note: A time-stamped entry is placed in the alert log whenever the Fault or SWR LEDs are illuminated.

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

The POST results show that there is an SD memory card failure. See View the results of the last POST.

Example showing 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 the SD memory card is installed. If it is missing or physically defective, install a new one. See the ITCR Configuration Guide for more information on CIM script files.
2. If the previous procedures do not turn off the Fault LED, or if the POST results list shows any other kinds of problems, then replace the radio.

7.4 Antenna problems

Problem indicators:

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

To troubleshoot antenna issues:

1. Make sure the antenna-cable connectors are securely connected to the antenna and to the radio.
2. Check the antenna for any defects or breaks.
3. 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 state of SWR indicator. Values are Ok or Greater than 3:1. To follow are examples of the results.

```
+VSWR 03:05:46.253

VSWR Ok.
```

```
+VSWR 03:05:31.417

VSWR > 3:1
```

10. Replace the radio.

7.5 Transmission problems

Problem indicators:

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

To troubleshoot transmission issues:

1. Make sure the radio is turned on and the green PWR LED is blinking.
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 temperature has not exceeded the over-temperature threshold using the proper diagnostic command.

```
+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 not damaged and is seated properly in the radio.
6. Make sure there is a valid CIM script file loaded. At the XtermW prompt type INICHECK,SCRIPT.
7. Make sure the antenna-cable connectors are securely connected to the antenna and to the radio.
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 radio might stop transmitting.

12. Adjust the power level, if necessary. The radio might stop transmitting if the voltage is too low. See Create an MCC 63xx SDR connection profile.
13. Replace the cable or connector.
14. Replace the radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

7.6 Receiver problems

Problem indicators:

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

To troubleshoot receiver issues:

1. Make sure the radio is turned on and the PWR LED is on, green, and blinking.
2. Verify the transmit frequency is within limits. See Specifications for models 63030-24 and 63030-48 Base Station radios.
3. Make sure the antenna-cable connectors are securely connected to the antenna and to the radio.
4. Check the cable connector and radio connector for corrosion.
5. Replace the cable or connector.
6. Check the antenna for any defects or breaks.
7. Replace the radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

7.7 Ethernet connectivity problems

Problem indicators:

- The radio 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 radio 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, then the problem probably is not in the radio.
2. Make sure the Ethernet cable is securely connected to the radio's LAN port.
3. Verify external network equipment is functioning properly.
4. Connect your computer to the radio's LAN port, send commands to the radio, and then see if the radio responds.
5. Note: To connect the computer to the LAN port, the computer's Ethernet interfaces must be configured to communicate with the radio, and you must know the LAN port's IP address. If you do not know the IP address then contact your system administrator.
6. Replace the cable.
7. Replace the radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

7.8 RF link problems

When the RF Link LED is on, it means that the Base radio is connected to one or more Locomotive or Wayside radios. When the LED is off, it means the Base radio is not currently connected to a Locomotive or Wayside radio.

Problem indicators:

- The RF Link LED is off.

To troubleshoot RF link issues:

1. Make sure the radio is turned on and the green PWR LED is green and blinking.
2. Make sure the antenna-cable connectors are securely connected to the antenna and to the radio.
3. Inspect the SD memory card to ensure it is not damaged and is seated properly in the radio.
4. Make sure there is a valid CIM script file loaded. At the XtermW prompt type 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                    Rx:         0
 Messages   Tx:          2  Rx:         2
```

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

8 Radio test and adjustment procedures

Some of the procedures you perform to solve a radio 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. The multiple-step procedures are described in this section.

8.1 Required equipment

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

Note: Base radios come in two versions that differ only in their voltage requirement: 24VDC or 48VDC. The table below describes the power supply requirements for each type.

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

Table 6: Base radio input power parameters

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

8.2 Configure the computer Ethernet interfaces to communicate with a radio

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

Notes:

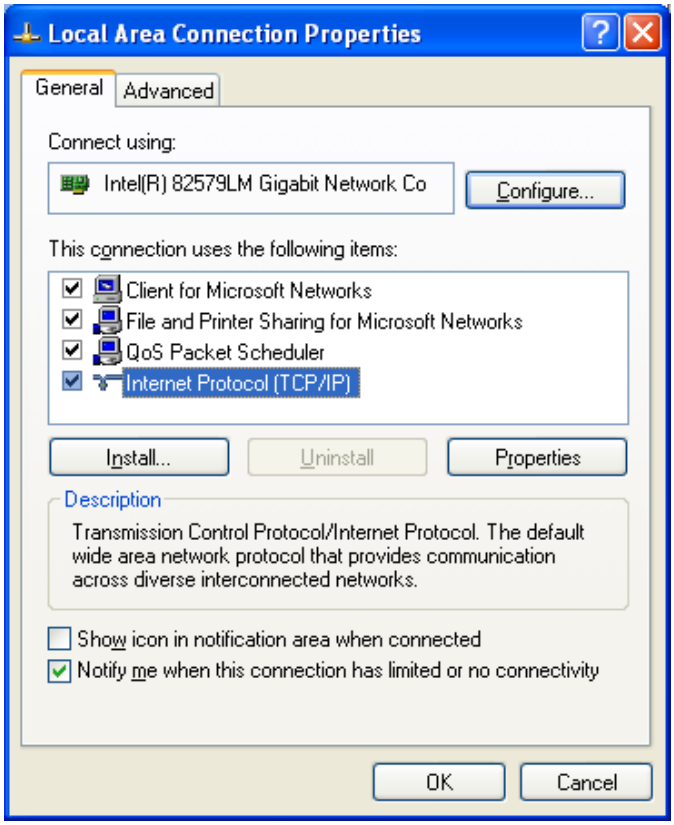
- The following configuration examples are for directly connecting to the radio and bypassing any network infrastructure. If direct access to the radio cannot be obtained then contact your network administration for instructions.
- If you are using the factory defaults then use the following examples.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

8.2.1 Configure a computer with two Ethernet interfaces

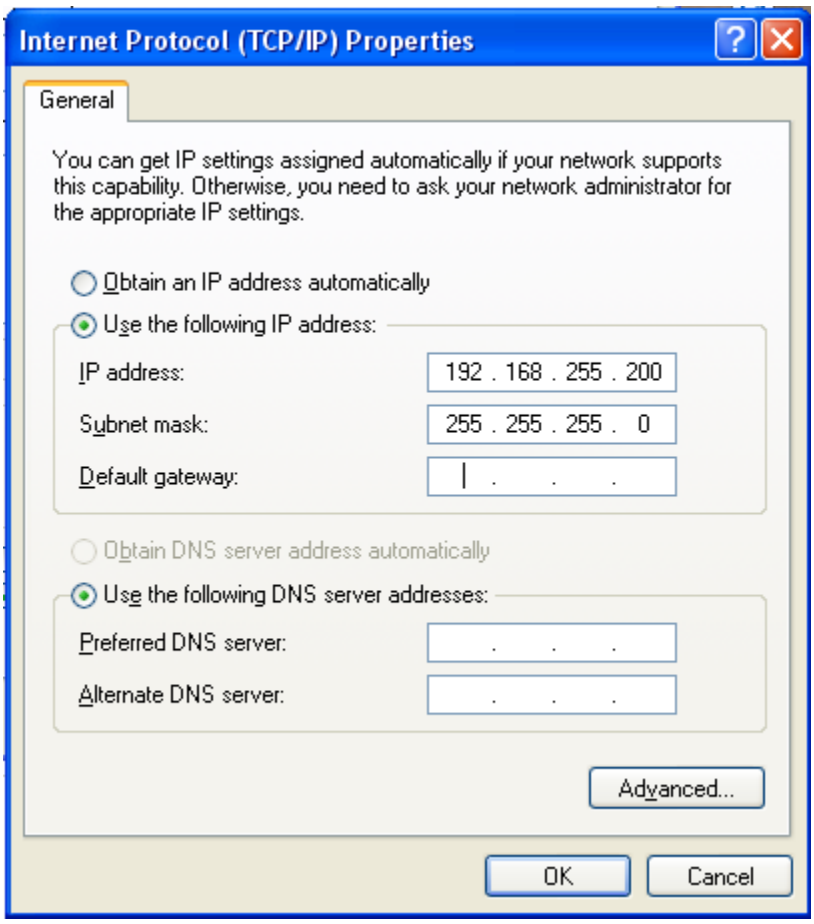
To configure the Ethernet 1 interface for the radio's MAINT port:

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

3. On the **General** tab, click to select the **Internet Protocol (TCP/IP)** check box, and then click **Properties**.

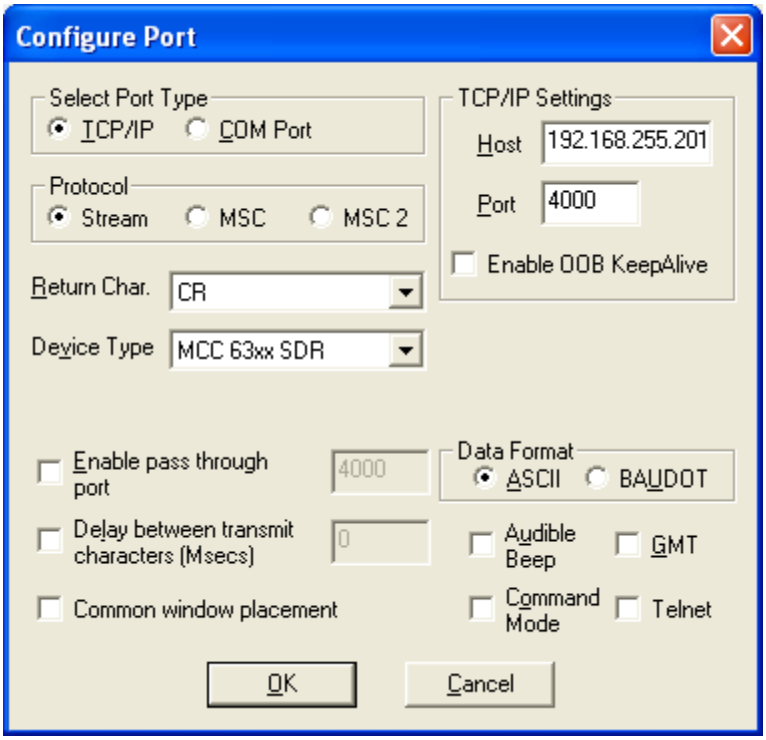


4. Click **Use the following IP Address**.



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

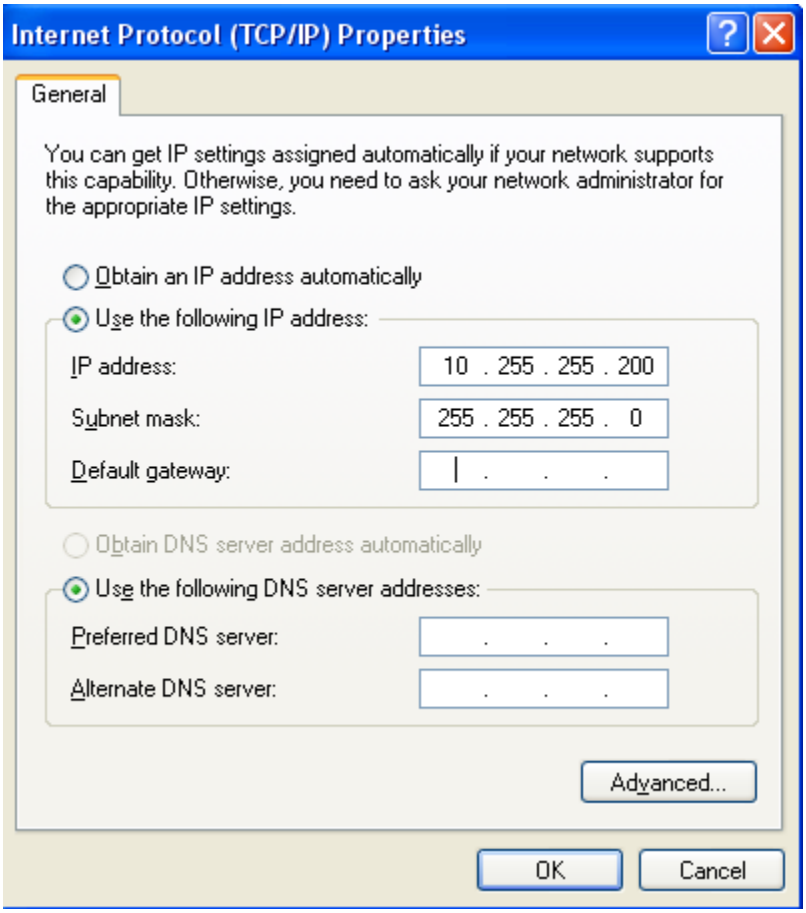
8. In XtermW, set the connection properties for the MAINT port connection as shown in the following figure.



To configure the Ethernet 2 interface for the radio's LAN port:

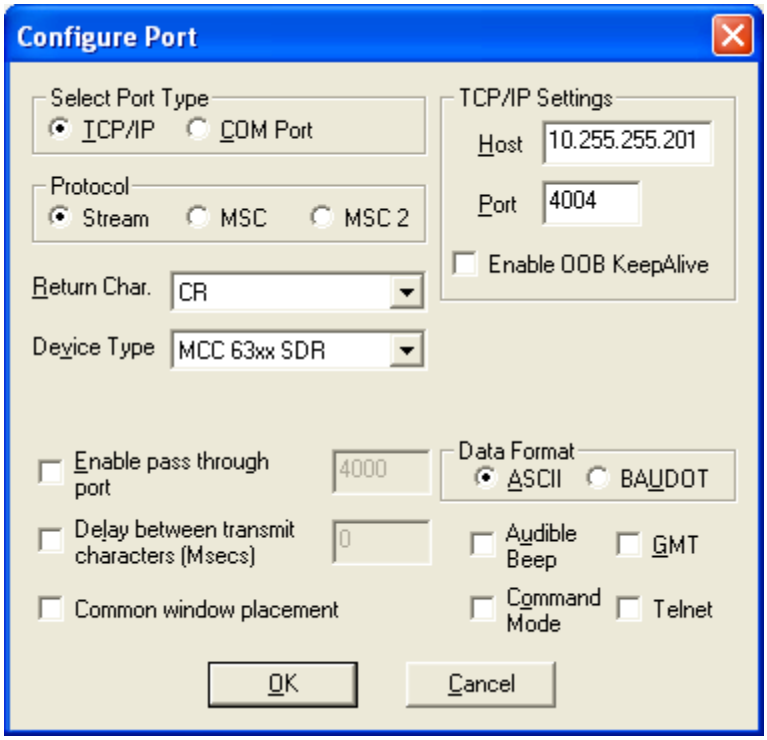
1. On the computer, click **Start**, **Control Panel**, **Network Connections**, and then **Local Area Connection**.
2. The **Local Area Network Connection Status** dialog box opens. Click **Properties**.

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



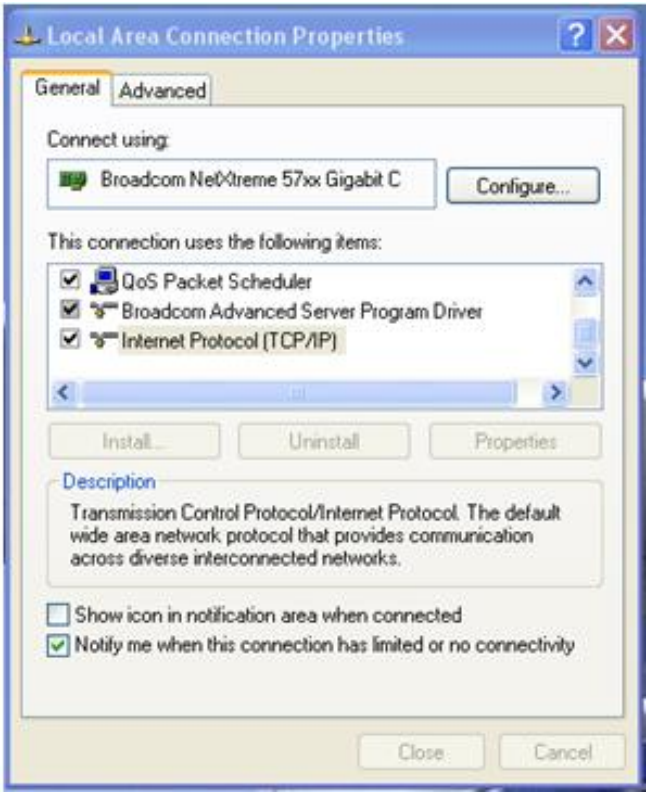
4. In the **IP address** box, enter **10.255.255.200**.
5. In the **Subnet mask** box, enter **255.255.255.0**.

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

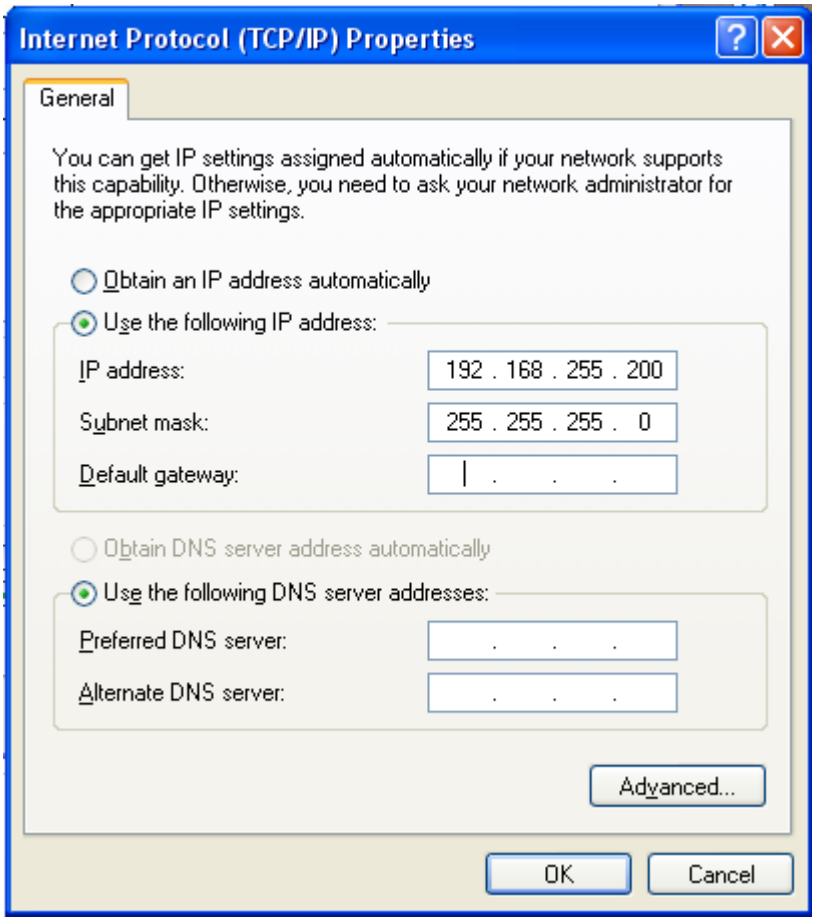


8.2.2 Configure a computer with one Ethernet interface

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

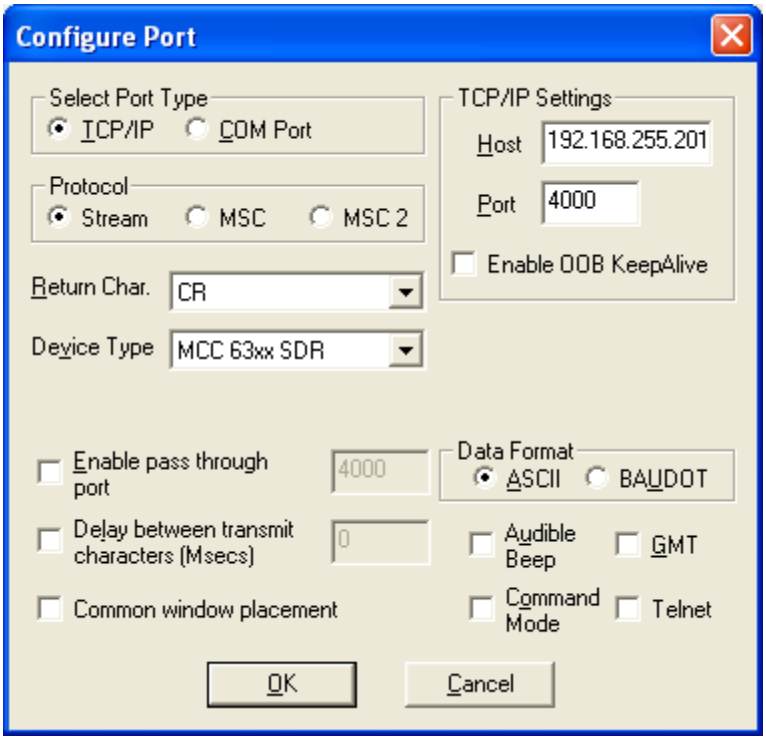


3. Click **Use the following IP Address**.



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

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

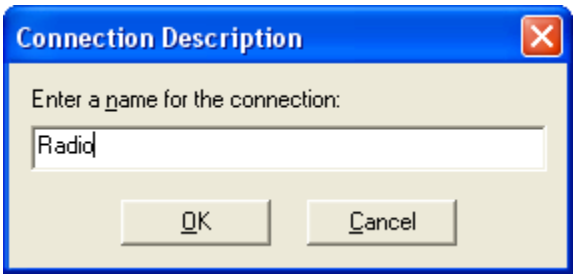


8.2.3 Create an MCC 63xx SDR connection profile

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

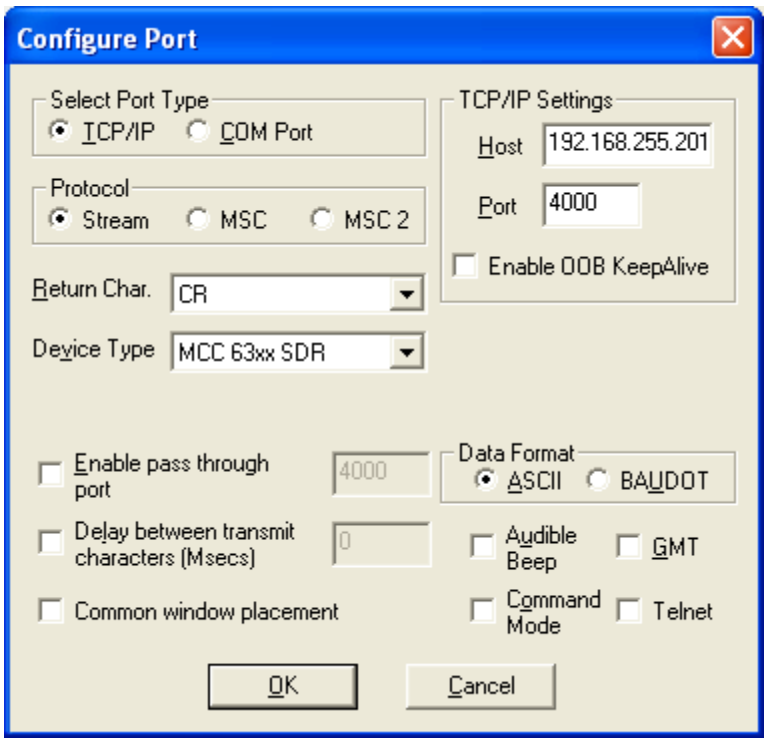
To create an MCC 63xx SDR connection profile:

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



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

3. The **Configure Port** dialog box opens.



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

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

8.3 Measure and adjust peak RF power output

8.3.1 Equipment used to measure and adjust peak RF power output

A power supply capable of providing:

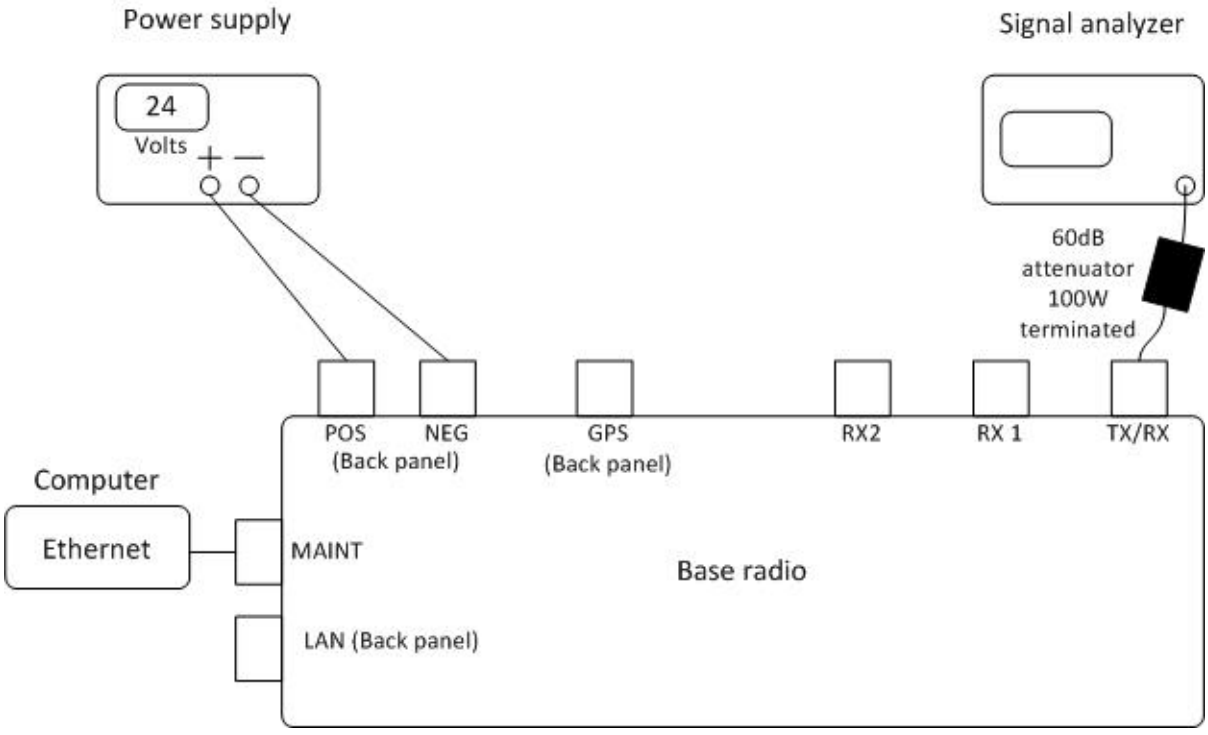
- 24V Base: 24V and a current of 11 amps
- 48V Base: 48V and a current of 6 amps
- 4 GHz spectrum analyzer that includes a DQPSK digital demodulation option

Or,

- Agilent E4417A power meter to measure peak and average power or equivalent and Agilent E9325A Peak and Avg Power Sensor -65 to +20 dBm or equivalent
- 10 MHz signal reference
- 60 dB of attenuation rated at 100 W

8.3.2 System setup for measuring and adjusting RF power output

Figure 15: Base radio transmit setup



8.3.3 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: 1ms
  - Length: 99 ms
- Trigger
  - Cont Trig
- Measure Setup
  - Upper Window: AVG
  - Lower Window: Peak
  - Rel/Offset: both Off
- Meas Display – Resolution 3 digits

8.3.4 Expected peak RF power output

The expected peak RF power for the 24VDC Base radio or the 48VDC Base radio is 75 watts PEP.

8.3.5 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/4-DQPSK full or half rate and observe radio performance:

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

1. In XtermW type the following commands:

   ```
   STOP
   SCHED,DEL,ALL
   DSP_MODE,IDLE
   DSP_MODE,TEST
   L1_TEST,SET,TXFREQ,VALUE
   L1_TEST,SET,TXMOD,DQPSK_HALF
   ```

```
L1_TXDURY,1000,300,0
```

where:

`value` equals the desired frequency of operation.

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

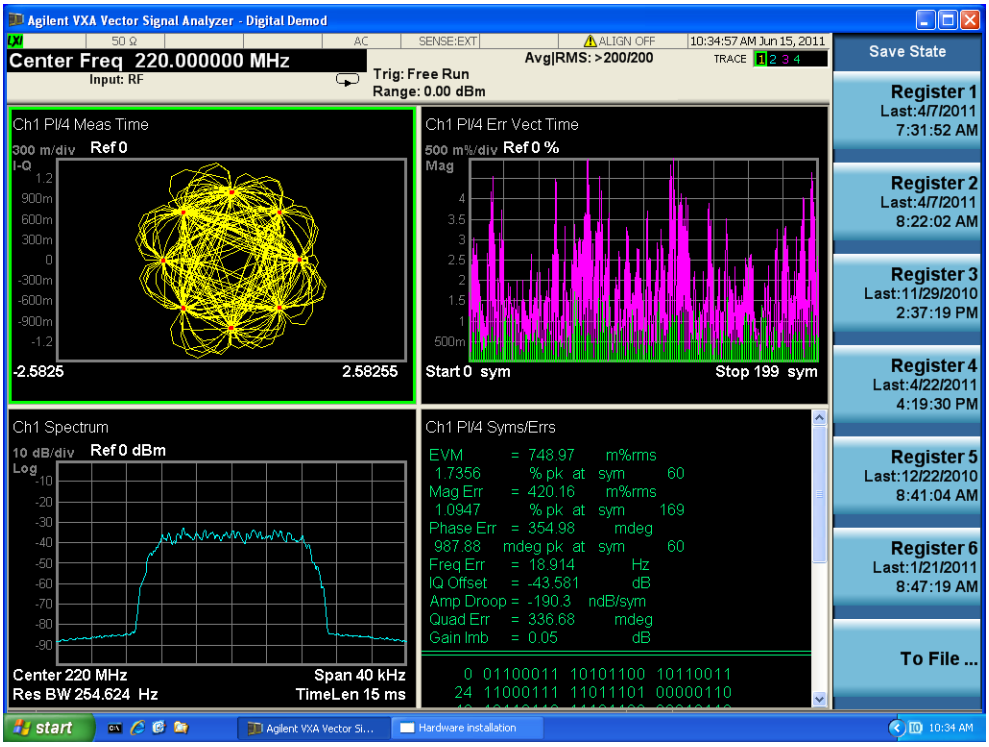
2. Once observation of radio performance is complete, turn off transmit operations by typing:

```
L1_TEST,STOP
```

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

Figure 16: Typical transmission spectrum (DQPSK)

Figure 17: Typical transmission spectrum EVM (DQPSK)



8.3.6 Adjust RF power output

Base radios 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/4-DQPSK is a linear modulation technique.

To adjust RF output power:

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

   ```
   STOP
   SCHED,DEL,ALL
   DSP_MODE,IDLE
   DSP_MODE,TEST
   L1_TEST,SET,TXFREQ,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 radios. Settings outside this range for operation into an antenna are out of FCC compliance.

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

Table 7: Rated RF Power Output

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

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

8.4 Measure full-rate receiver sensitivity

8.4.1 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 radio. Next, issue the following commands via 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.

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

```
L1_TEST,STOP
```

8.4.2 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 radio. Next, issue the following commands via 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.

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

```
L1_TEST,STOP
```

8.4.3 Alternate/TX-RX receiver measurement

To begin the test, make sure the E4438C signal generator is outputting the proper wave form into the TX RX port on the radio. Next, issue the following commands via 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.

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

```
L1_TEST,STOP
```

8.5 Put a trace on a feature

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

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

Table 8: Brief descriptions of the available trace features

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

To trace an activity:

1. Use a CAT 5 Ethernet cable to connect the correct computer Ethernet port to the radio’s MAINT port.
2. The Ethernet port must be configured to communicate with the MAINT port. See Configure the computer Ethernet interfaces to communicate with a radio.
3. On the computer, open the XtermW application.

4. Specify the radio port you want to communicate with: Click **Send**, click **Command**, and then type:

   `TRACE,port,maint`

- Where:

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

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

   `TRACE,level,feature,destination`

- Where:

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

9 Managing software application images

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

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

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

This section explains how to:

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

9.1 Determining software image status

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

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

Table 9: Software image status codes

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

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

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

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

```
APPS 04/09/12 23:34:20
** BEGIN *** BOOTINFO INFORMATION *****
----------------   ---------------------------
tag_id             3
length             254
version            0.22.1 SVN 17525 2011-07-29
reset_count        11
active_index       2
active_source      Flash1
active_user        USER_APP
schedule.enable    ON
schedule.status    BLANK
schedule.index     256
schedule.sched     256/00/2255 00:00
** END *** BOOTINFO INFORMATION *****
Inx Pri Stat Fail  Lnch  Date       Time      Size      Name           Notes Last Status
--- --- ---- ----- ----- ---------- --------- --------- -------------- ----- --------------
  2  27  RDY     0     2 04/09/2012 05:10 PM    3364220 C:01011503.A18 ACTV  Success
  1   0 NRDY     0     0 04/09/2012 05:05 PM    3361028 D:01011401.A18
  3   0 NRDY     0     0 04/09/2012 05:03 PM    3346860 C:01011203.A18
  4   0 NRDY     0     0 04/09/2012 11:32 AM    3347544 D:01011101.A18
```

9.2 Updating software images

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

9.2.1 Updating radio software via the command line

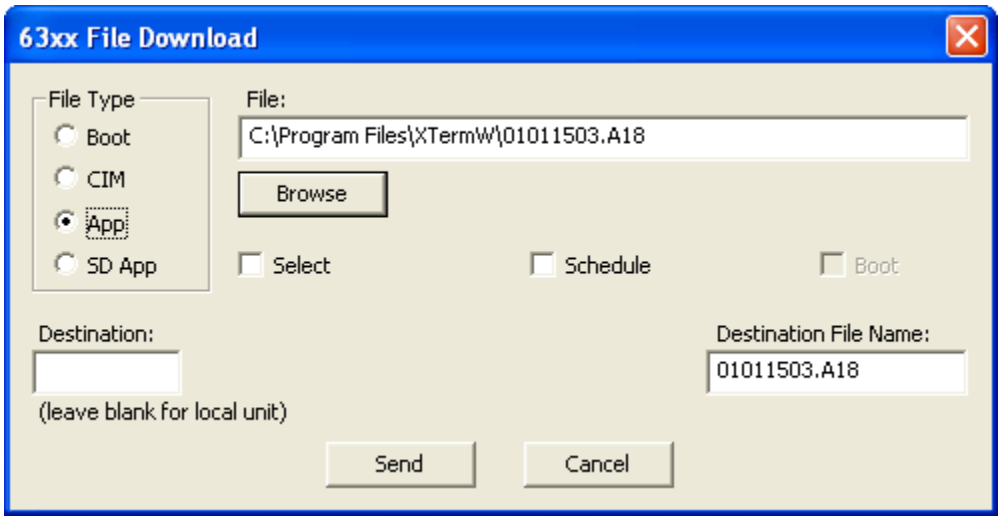
To update radio software:

1. Ensure that the new software image file is located on a computer drive accessible to the computer on which you launch XtermW.
2. Ensure that the destination file name is unique in the radio Apps table. Prior to performing the software update, check the names of existing files on the radio by using the APPS command to display a list of all installed application images.

3. Ensure that there is adequate space available on the non-active drive to store the file. If not, delete an unneeded image from the non-active drive using the APPS,DELETE command. (If the image to be deleted is RDY or NRDY, it must first be declared invalid via APPS,INVALIDATE command.)
4. Establish a connection from XtermW to the radio by using a connection profile that was created with **Device Type** set to **MCC 63xx SDR**.

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

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



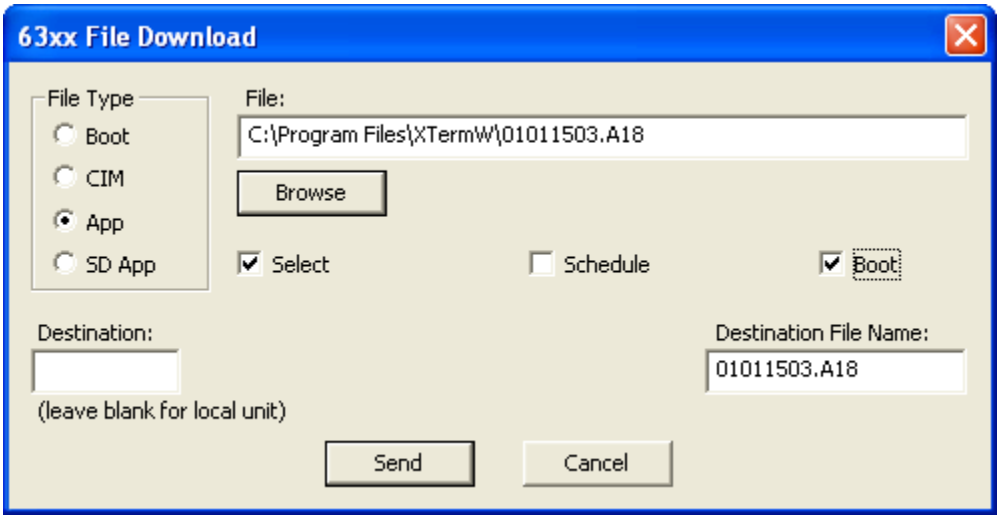
6. Under **File Type**, select **App**.
7. Click **Browse**, and then locate and select the software image file.
8. After you select the software image file:

   - The **Destination File Name** field is automatically populated with a file name derived from the selected image file name.
   - Ensure that the destination file name meets the filename requirements.

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

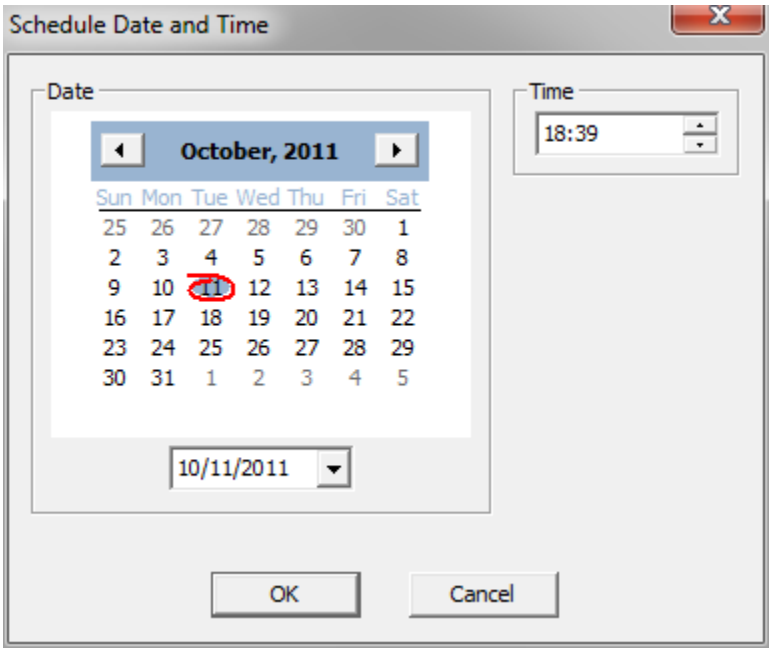
When you select the **Select** checkbox, XtermW automatically executes the `APPS,SELECT,<image-file>` command after the software image is downloaded. It also causes XtermW to enable the **Boot** checkbox.

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

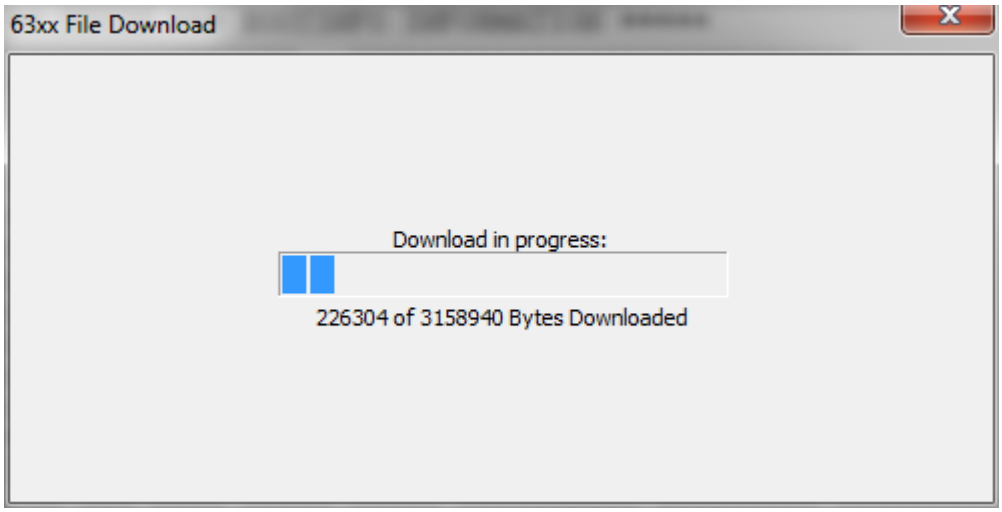


10. To execute a synchronized software update at a future time, select the Schedule checkbox. Choose the desired data and time in the popup, and then click OK.

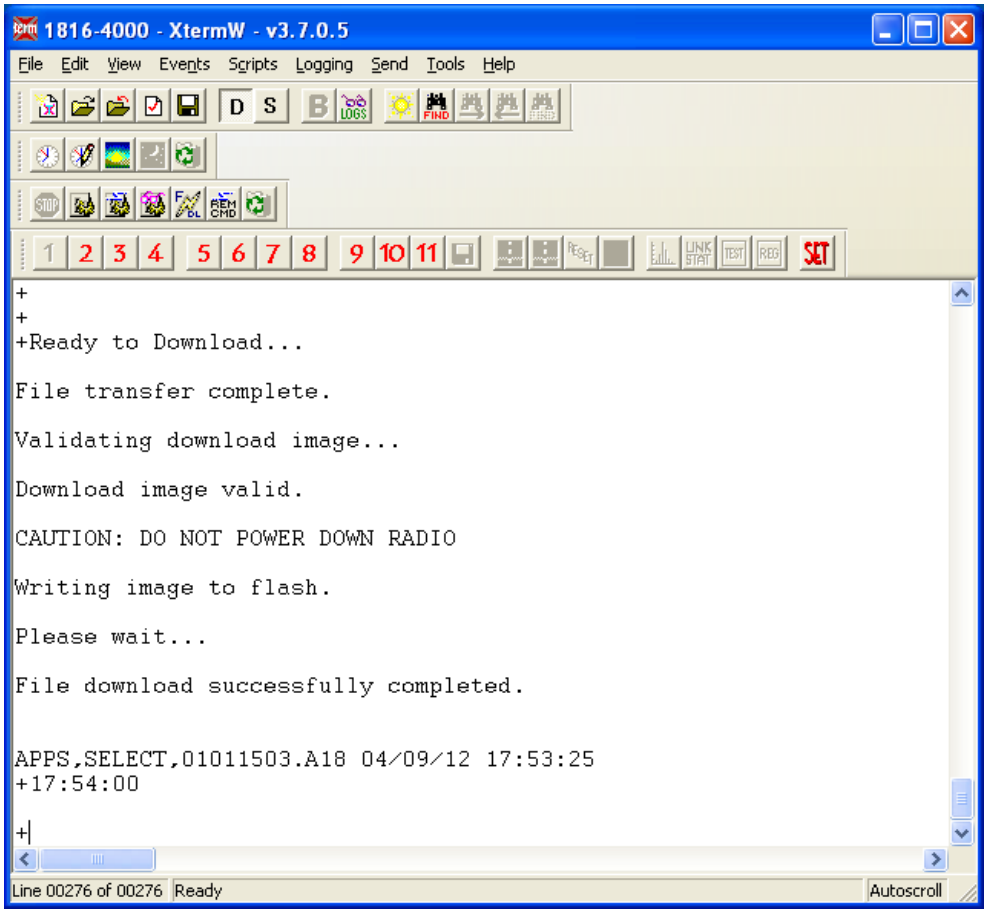
When you select the **Schedule** checkbox, XtermW automatically executes the APPS,SCHED,<date>,<time>,<image-file> command after the software image is downloaded.



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



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



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

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

9.3 Rolling back an image

9.3.1 How automatic rollback occurs

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

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

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

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

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

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

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

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

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

b. Keep the current active image status as RDY.

c. Retry launching the current active image.

9.3.2 Determining if automatic rollback occurred

View the Apps report to determine if automatic rollback occurred.

To check if automatic rollback occurred:

Execute the APPS command.

Observe the status column of the Apps report:

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

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

9.3.3 Rolling back an image via command line: APPS

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

To manually rollback a software image:

Execute the APPS command.

View the list of installed images.

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

```
 Inx Pri Stat Fail  Lnch  Date       Time      Size      Name           Notes Last Status
 --- --- ---- ----- ----- ---------- --------- --------- -------------- ----- --------------
   3  27  RDY     1     2 04/09/2012 05:10 PM    3364220 C:01011503.A18 ACTV  Success
   2  26  RDY     0     2 04/09/2012 05:05 PM    3361028 D:01011401.A18       Success
   1  25  RDY     0     0 04/09/2012 05:03 PM    3346860 C:01011203.A18
```

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

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

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

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

```
Inx Pri Stat Fail  Lnch  Date       Time      Size      Name           Notes Last Status
--- --- ---- ----- ----- ---------- --------- --------- -------------- ----- --------------
  2  28  RDY     1     4 04/09/2012 05:05 PM    3361028 D:01011401.A18 ACTV  Success
  3  27  RDY     0     2 04/09/2012 05:10 PM    3364220 C:01011503.A18       Success
  1  25  RDY     0     0 04/09/2012 05:03 PM    3346860 C:01011203.A18
```

9.4 Maintaining multiple software images in the radio

9.4.1 Managing images via command line: APPS

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

Table 10: Software image actions

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

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

9.4.2 System events on installed software images

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

Table 11: System events on installed software images

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

10 Routine maintenance

- Remove dust and obstructions from heat-sink fins.
- Ensure that the radio is not subjected to excessive heat from adjacent equipment.
- Make sure that the radio is securely mounted and supported.
- Restrain cables to prevent stress on connectors.
- Make sure that the SD memory card door is securely closed.
- Keep the indicator-LEDs panel dust-free and viewable.
- Check fan operation and make sure the fans are not obstructed.

Appendix A: Possible antenna configurations

There are three possible 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, the RX1 and the RX2 ports, each with a 50 Ohm termination.

Two-antenna configuration

One antenna is connected to the primary receive port, which is the TX/RX port. The second antenna is connected to the diversity port, the RX2 port.

Three-antenna configuration

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

Appendix B: Parts list

The following applies to the two Base radio models listed below, along with their regulatory identifiers. These two models differ only in their power supply input voltage and associated power supply circuits.

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

Radio model	Model number	FCC ID	IC ID
Base radio 24VDC	63030-24	BIB63030-24	1300A-6303024
Base radio 48VDC	63030-48	BIB63030-48	1300A-6303048

Table 12: Base radio parts and part numbers

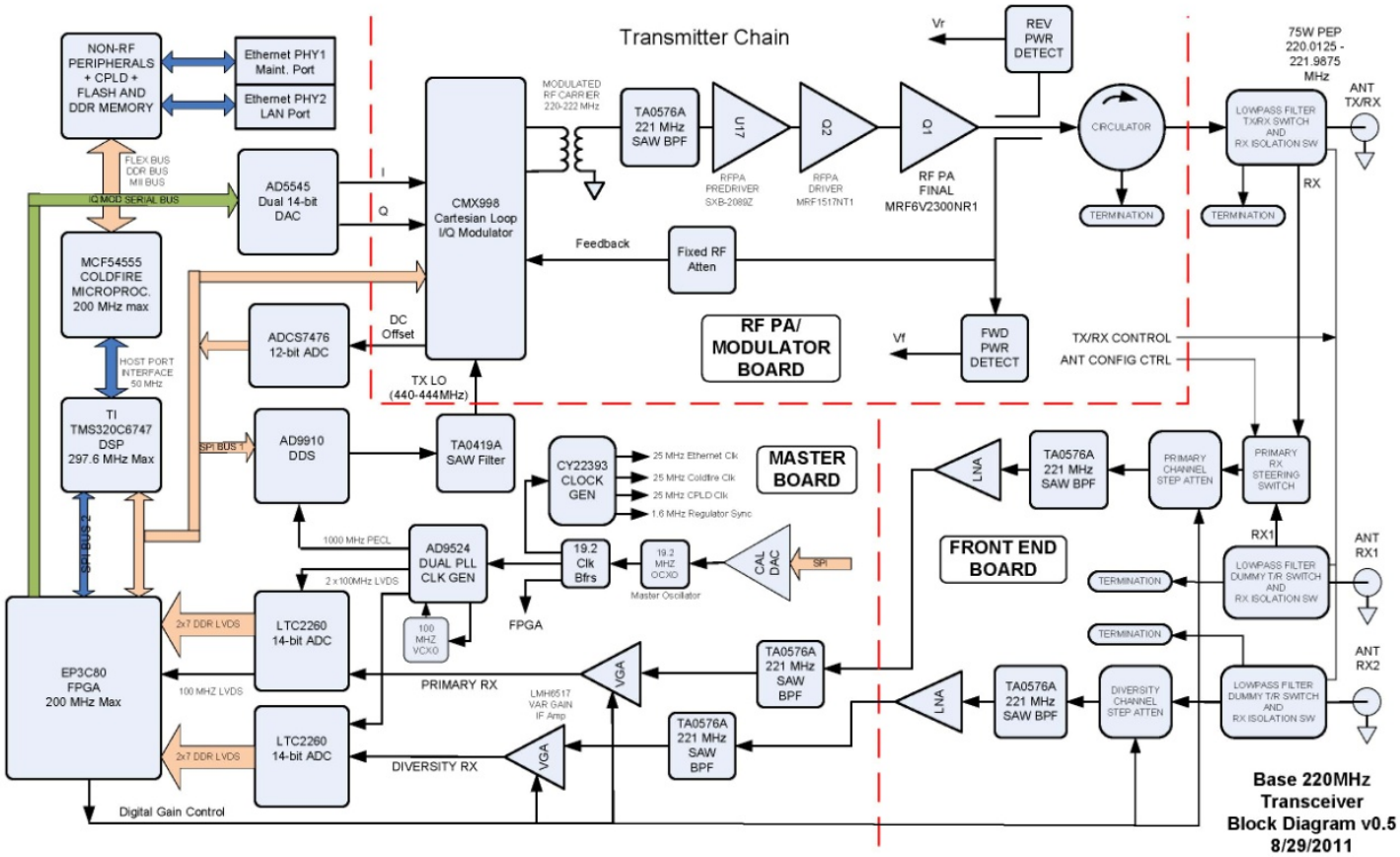
Part name	Part number
24V Shipped assembly	BASE 63030901-04
24V Top level assembly	BASE 63030001-04
24V Power supply sub-assembly	63030102-01
DC power cable assembly	14001637-01
DC power cable assembly	14001643-01
PCA, power supply 24V	63020307-01
PCB, power supply 24V	63020407-01
Power supply shield	63030505-01
ITC thermal pad heatsink	63030511-01
PS module baseplate	63030523-01
Heatsink	63030525-01
Heatsink thermal pad	63030526-01
RF module sub-assembly	63030104-01
RF antenna cable assembly	14001626-01
Master board cable assembly	14001630-01
PCA, PA/MOD	63020303-02
PCA, front end	63020305-02

Part name	Part number
PCB, PA/MOD	63020403-01
PCB, front end	63020405-01
RF module slug	63030518-01
RF module thermal pad	63030519-01
RF module baseplate	63030521-01
RF module mounting bracket	63030524-01
Heatsink	63030525-01
Heatsink thermal pad	63030526-01
Base sub-assembly	63030108-01
Master board cable assembly	14001630-01
Power supply cable assembly	14001631-01
Power supply cable assembly	14001634-01
MB to Ethernet cable assembly	14001636-01
Ethernet cable assembly	14001638-01
MFAN cable assembly	14001639-01
MFAN cable assembly	14001640-01
RX cable assembly	14001649-02
RX cable assembly	14001650-02
TXQ+ YEL/RED cable assembly	14001651-01
TXQ- RED/WHT cable assembly	14001652-01
TXI-RED/BLU cable assembly	14001653-01
TXI+ GRN/WHT cable assembly	14001654-01
Ribbon cable assembly	14001661-01
PCA, Ethernet	63020309-01
PCA, LED	63020311-01
PCA, master	63020312-02
PCB, Ethernet	63020409-01
PCB, LED	63020411-01

Part name	Part number
PCB, master	63020412-01
SD card guide	63020508-01
PCB MTG shield	63020518-01
Shield cover	63020519-01
LED overlay label	63020524-01
LED backing plate	63020535-01
FPGA thermal pad	63020541-01
Regulators thermal pad	63020549-01
COLDFIRE thermal pad	63020550-01
FPGA thermal spreader	63020551-01
Chassis assembly	63030109-01
Cover	63030502-01
RF shield	63030503-01
Dust shield bracket	63030509-01
Thermal spreader	63030527-01
Cover	63030529-01
Large mounting bracket	63030514-01
Small mounting bracket	63030515-01
FCC label	63030530-01
48V Shipped assembly	BASE 63030902-04
48V Top level assembly	BASE 63030002-04
48V Power supply sub-assembly	63030103-01
PCA, power supply 48V	63020307-02
PCB, power supply 48V	63020407-01

Appendix C: Block diagram

Figure 18: 220 MHz Base transceiver block diagram



Appendix D: Sample POST results from a properly functioning Base radio

```
+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 E - Program Signal Generator for DQPSK

Program an Agilent E4438C to test receivers with Sprints 18 to 23.02b

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

Step	Action	Button / Selection
22	Select 'Filter'.	Filter
23	Choose 'Select.'	Select
24	Pick 'Root Nyquist'.	Root Nyquist
25	Define the filter alpha to be 0.35 by picking 'Filter Alpha'.	Filter Alpha
26	Use the numbered key pad to enter 0.35 then 'Enter'.	0.35 then Enter
27	Return to an upper level by hitting to define additional parameters.	Mode Setup
28	Select 'Symbol Rate'.	Symbol Rate
29	Using the numbered key pad enter 16 ksps for full rate testing or 8ksps 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	User 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 numbered keypad and press 'Enter'.	'1' then 'Enter'
40	Set the frequency, power level and be sure RF and Modulation are ON	Frequency: 220 MHz Amplitude: -80dBm Mod: ON RF: ON

Program an Agilent E4438C to test receivers with Sprint 23.03 and beyond

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

Step	Action	Button / Selection
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 11011111 1000 1111 0100 1110 0001 1000 1001 0011 1011 1010 1101 0001 0100 1110 0101 0011 0000 1101 1110 0111 0101 0101 0011 0000 0110 1101 1100 1101 1000 0110 0001 1000 1101 1000 1000 1010 1111 0100 1100 1010 1100 1100 1001 0001 1101 1100 0011 0100 1110 1000 1100 0110 0001 1001 1010 1101 1111 1000 0111 0001 0110 1101 1010 0110 1111 1011 0001 1110 1011 0001 0101 0000 0100 1100 1000 1000 0001 1010 1101 0100 0000 0010
14	Insert end bits.	1111 1111 1111 1111
15	Press ‘Return’ twice.	Return Return

Step	Action	Button / Selection
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 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 numbered key pad to enter 0.35 then 'Enter'.	0.35 then Enter
25	Return to an upper level by hitting to define additional parameters.	Mode Setup
26	Select 'Symbol Rate'.	Symbol Rate
27	Using the numbered key pad enter 16 ksps for full rate testing or 8ksps 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	User cursor keys to select 'DQPSK' 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 numbered keypad and press 'Enter'.	'1' then 'Enter'
38	Set the frequency, power level and be sure RF and Modulation are ON.	Frequency: 220 MHz Amplitude: -80dBm Mod: ON RF: ON

Program an E4438C signal generator for MSGPS (multi-satellite GPS)

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