ITCR 1.1 Locomotive Radio Installation and Field Service Guide

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Revision History

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

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1. Overview

The *ITCR Locomotive Radio Installation and Field Service Guide* provides important radio-frequency safety information, installation procedures, and servicing instructions for the Meteorcomm Interoperable Train Control (ITC) Locomotive radio model 63020.

1.1 Audience

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

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

Prerequisites for users of this guide include:

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

1.2 Specifications for model 63020 Locomotive radio

GENERAL	
FREQUENCY RANGE:	220-222 MHz
CHANNEL SPACING:	25kHz
TEMPERATURE RANGE: OPERATING: STORAGE:	 -40°C to +70°C -55°C to +85°C
HUMIDITY, OPERATING:	0% to 95% non-condensing; Test per S-5702, clause 3.2.3.2
FREQUENCY STABILITY:	±1.5ppm over operating temperature range (+25°C reference)
INPUT VOLTAGE RANGE:	45-100VDC Damage limit 120VDC
DC CURRENT DRAIN (74VDC input):	Transmit: 4A (peak) max 50 Ohm load 1.8A typical Receiver: 0.5A max while receiving
DC POWER CONNECTOR:	MS 3102 A18-4P or equivalent
SIZE:	LSI rack compatible, 5 x MCU max
WEIGHT:	21.2 lbs (9.6kg)
ANTENNA CONNECTORS: TX/RX1 (transmit/primary receive): RX2 (diversity):	 Type N female Type N female
EXTERNAL INTERFACE: Ethernet (2)	1. Data Network port, M12-8 female 2. Maintenance port, M12-8 female
CONFIGURATION INTERFACE MODULE:	SD Card
DISPLAY:	Activity / Diagnostic LEDs on Front Panel
TRANSMITTER:	
RF POWER OUTPUT:	50W PEP Adjustable 15W PEP to 50W 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:	30%
EMISSION DESIGNATORS:	16kbps π/4DQPSK 8K90DXW 32kbps π/4DQPSK 17K8DXW
REGULATORY APPROVALS:	FCC ID BIB63020 IC 1300A-63020
RECEIVER:	
MAXIMUM USABLE SENSITIVITY, STATIC, BER<10-4:	16kbps π/4DQPSK -111 dBm 32kbps π/4DQPSK -108 dBm
ADJACENT CHANNEL SELECTIVITY:	70dB @ 25kHz offset
SPURIOUS RESPONSE REJECTION:	70dB
INTERMODULATION RESPONSE REJECTION:	65 dB
HIGH INPUT LEVEL (-7dBm):	BER<10^{-4}
BLOCKING, 1MHz OFFSET:	80dB
NUMBER OF SIMULTANEOUS RECEIVER CHANNELS:	16 - paired as 8 diversity Seven (7) 16kbps π/4DQPSK One (1) Auto 16kbps/ 32 kbps π/4DQPSK

Specifications are subject to change without notice.

1.3 Acronyms

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

Acronym	Description
A	Amp
AWG	American Wire Gauge
CIM	Configuration Information Module
cm	Centimeter, approximately 0.4 inches (slightly less than a half inch)

Acronym	Description
dB	Decibel
dBi	Decibel isotropic
dBm	Decibel milliwatt
DC	Direct current
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
MHz	Megahertz, a unit of frequency measurement
MPE	Maximum permitted exposure
MSGPS	Multi-satellite GPS
mW	Milliwatt
PEP	Peak envelope power
POST	Power-on self-test
PPM	Parts per million
PTC	Positive Train Control
RF	Radio frequency
RU	Rack unit. Defined as a height of 44.5 mm.
SAR	Specific absorption rate
SD card	Secure Digital card
SMA	SubMiniature, version A, a type of connector
TCP/IP	Transmission Control Protocol/Internet Protocol
TNC	Threaded Neill-Concelman, a type of connector
VDC	Voltage, direct current

Acronym	Description
W	Watt
XtermW	Meteorcomm application used for developing and operating Positive Train Control (PTC) radios.

1.4 Related documents

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

- *ITCR Base Radio Installation and Field Service Guide*

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

- *ITCR Wayside Radio Installation and Field Service Guide*

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

- *ITCR Radio Configuration Guide*

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

- *ITCR Radio Management Guide*

  This document provides guidance about how to manage ITCnet® Base, Locomotive, and Wayside 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 is potentially fatal.
- Reassemble radios correctly. Incorrect reassembly of a radio can cause a harmful electric shock to radio handlers.

3. Important information for the user

3.1 Limiting RF exposure

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

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

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

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

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

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

3.2 Fixed antenna guidelines

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

- The licensee is required to comply with limits on antenna location, power and effective antenna height per 47CFR Subpart T §90.701 et. seq., or Industry Canada SRSP-512 §6.3 as applicable. The section titled "Base-Radiated Power Limits," below, provides additional information on how to comply with ERP limits.
- Refer to the *ITCR RF Energy Exposure Guide* for specific guidelines regarding the siting and installation of fixed antennas.
- Acceptable fixed-antenna types are listed in the lateral separation distance tables in the *ITCR RF Energy Exposure Guide*.
- Install antennas in accordance with the manufacturer's instructions.
- Disable the transmitter when installing or servicing its antenna or transmission line.
- Maintain a safe distance from energized transmitting antennas. Refer to the table of safe distances for Base radios in the *ITCR RF Energy Exposure Guide*, which is packaged with each radio.
- Unauthorized antennas, equipment modifications, or attachments could invalidate any equipment warranty or authority to transmit. Modification could damage the radio and may violate FCC or IC regulations. Contact Meteorcomm before using other antennas.

3.3 RF interference to residential receivers

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

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These

limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more the following measures:

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

3.4 Equipment modifications

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

4. Locomotive 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 Locomotive radio channelization and frequency range

The Locomotive 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 Locomotive radio transmission occupies five of the FCC-defined 5-kHz

channels. The lowest Locomotive 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 Locomotive 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 Locomotive radio may not transmit on those channels or their 221 MHz counterparts, 361-370 and 381-385. This corresponds to Locomotive radio 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 Locomotive-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 calculate effective radiated power (ERP) and how to comply with regulatory power limits.

Licensees should also note that mobile radios must limit effective radiated power (ERP) to 50W or 10*log(50) + 30 = 47dBm PEP referenced to the 2.15 dBi gain of a dipole. 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.

Antennas designed for locomotives at 220 MHz generally use a rugged cast aluminum body and are top-loaded vertically polarized requiring a metal cab roof for a ground plane. They are necessarily electrically shorter than

one-fourth wavelength due to vertical space limitations. Maximum antenna gain is expected to be 0 dBd = 2.15 dBi.

FCC rule §90.729(b) limits mobiles operating at 220-222 MHz to 50W ERP, which is calculated relative to a free-space dipole with 0 dBd = 2.15 dBi gain. Since the locomotive antenna has a max gain equal to a dipole and the rated maximum transmitter output power is 50W PEP, compliance with the 50 W ERP limit is assured.

The actual power will be less than 50W ERP when feedline and filter losses between transmitter and antenna are taken into account. Minimum feedline loss is expected to be 0.5 dB and an in-line 160 MHz reject filter adds 0.7 dB loss for a total loss of 1.2 dB. The actual ERP is therefore 47-1.2 = 45.8 dBm = 38 watts. The transmitter installation cannot be operated on FCC channels 196-200 due to the 2W limitation.

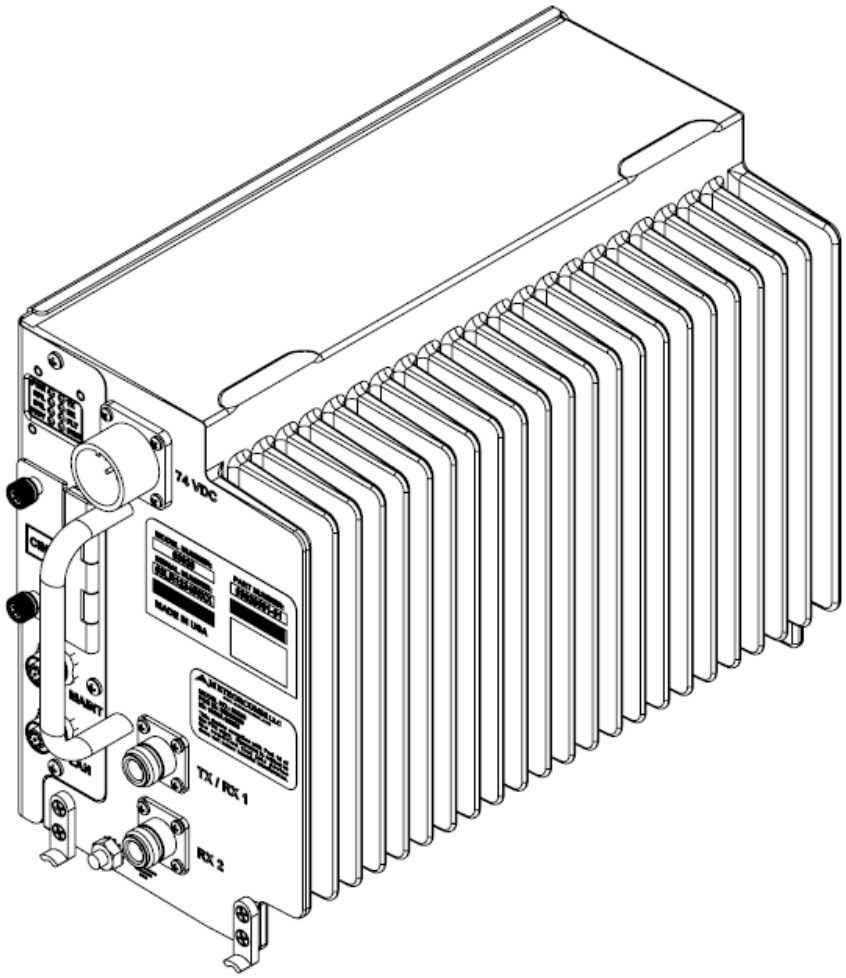
5. Installation

The Locomotive 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 Interoperable Train Control Radio (ITCR) is designed to provide communication in an inter-operable fashion enabling messaging to occur across railroad boundaries.

Locomotive radios are housed in die-cast chassis. The radio is LSI-rack compatible and is less than 6xMCUs. It weighs 22 pounds. The radio is 17.01”L x 19.15”W x 6.80”H.

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

Figure 1: Locomotive radio

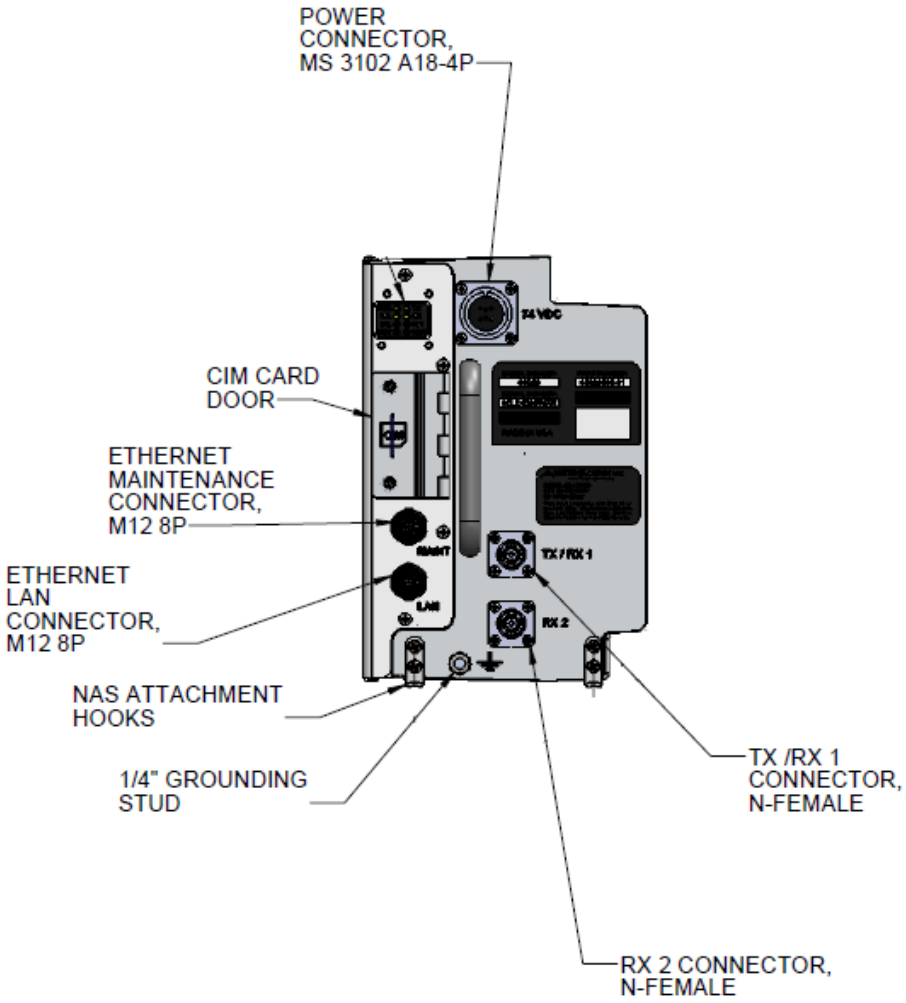


5.1 Radio connections

Table 1: Front panel Locomotive radio connectors

Interface	Connector Type	Label
TX/RX1 Antenna	Type N female	TX/RX1
Diversity RX Antenna	Type N female	RX2
DC Power Input	MS 3102 A18-4P or equivalent	74VDC/PWR IN
Data Network Ethernet	M12- 8 pin female, A-coded	LAN
Maintenance Ethernet	M12- 8 pin female, A-coded	MAINT
CIM Socket	SD memory card receptacle	CIM

Figure 2: Ports and connectors on the Locomotive radio front panel



Radio installation consists of these steps:

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

The following sections describe each of these steps in detail.

5.2 Required equipment

You need the following equipment to test or service an ITC radio. It is expected that the user is familiar with the pieces of test equipment listed below. Instructions on how to use the equipment below 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	Frequency adjustments require frequency standard accuracy to 0.01 ppm or better.
60 dB power attenuator/load		Consists of two pieces with 100 W and 2 W min. power rating
Constant voltage DC power supply		Verify unit supports voltage and current draw required by unit under test.
Host computer with at least one Ethernet port and Meteorcomm XtermW or equivalent terminal program installed		If the host computer's Ethernet port has not been configured then follow the instructions in Configure the computer Ethernet ports to communicate with a radio.
Clip-on ammeter		
Antenna/VSWR test kit		
Cable ties as required		
Digital volt meter		
Network analyzer		
Portable power meter		
Site tester		

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 make note of 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.

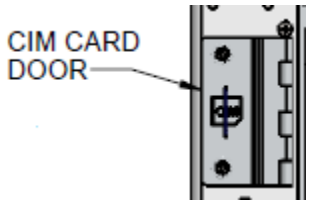
5.4 Confirm the SD memory card is installed

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

1. Push the card once to release it.
2. Push the card again to ensure it is seated.
3. Once confirmed, close and secure the door.

Note: Make sure the card is inserted in the orientation shown on the CIM card door.

Figure 3: CIM card door



5.5 Mount the radio

The Locomotive radio is installed in a standard LSI rack. The package includes mounting points for installation on flat surfaces.

Ensure that:

- The areas around the heat sink fins are not obstructed to allow for proper airflow. See Figure 4: Areas not to be obstructed.
- There is adequate room to access the SD memory card.
- There is adequate room for cable connections.
- Cables are restrained to prevent kinking and stressing connectors.

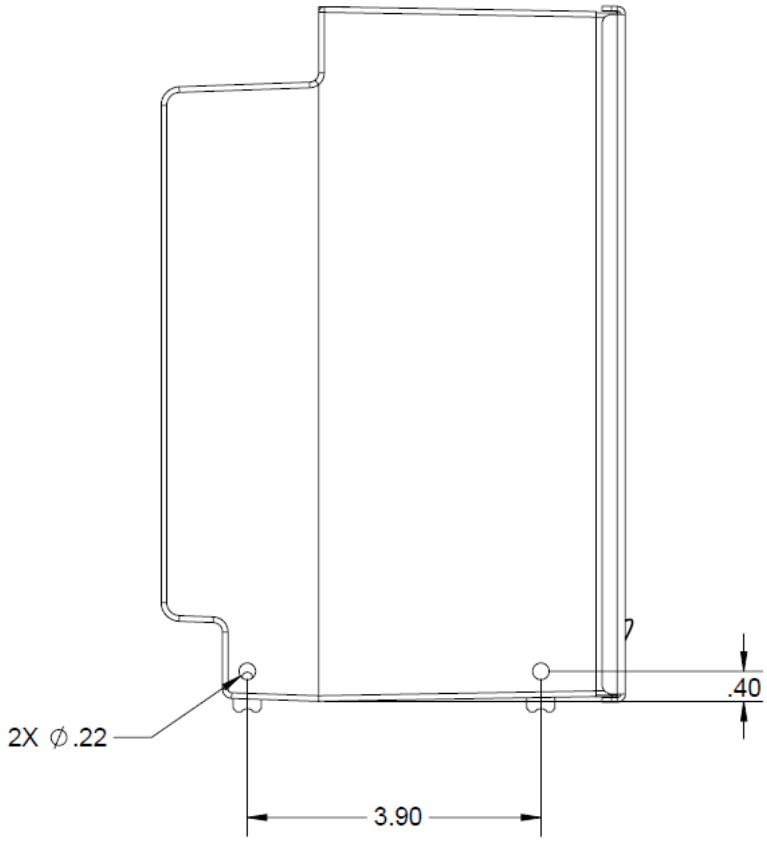
To mount the radio:

1. Slip the radio into the LSI rack tray with rear alignment dowels. Ensure the heat sink fins are not obstructed.

Figure 4: Areas not to be obstructed

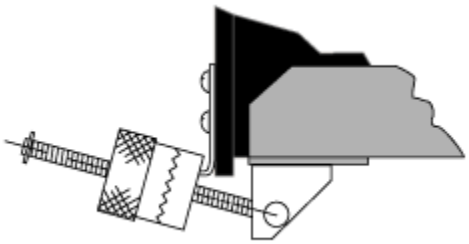
2. Make sure the back of the radio is secured by two tapered pins fitting into the radio attachment holes.

Figure 5: Back of radio



3. On the front of the rack, flip the thumbscrew hold downs up and onto the NAS attachment hooks on the front of the radio.

Figure 6: Hold downs on radio NAS attachment hook – side view



4. Securely tighten the hold downs.

5.6 Connect the antennas

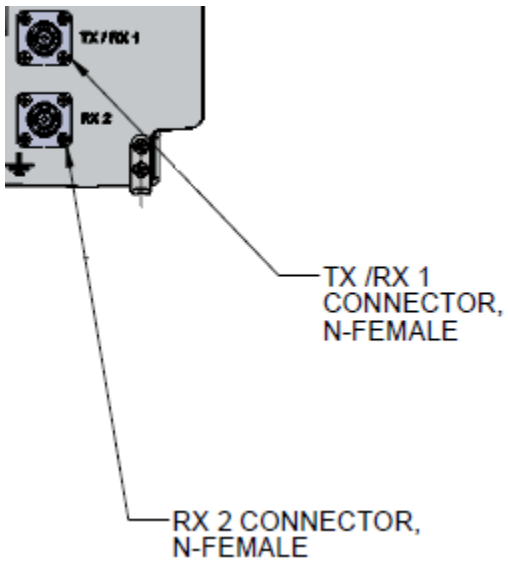
5.6.1 Antenna planning

You should already know how many antennas have been set up at the site. The radio is designed to operate into a 50 Ohm load. Locomotive radios can have two possible antenna configurations. See Appendix A: Possible antenna configurations for more information.

5.6.2 Connect the cable(s)

The Locomotive radio is rated for 50W PEP. Locomotive radios have one combined TX/RX port and one additional port for receiving only, both of which use Type N connectors for narrowband RF antennas. Keep any unused ports covered.

Figure 7: Antenna connectors



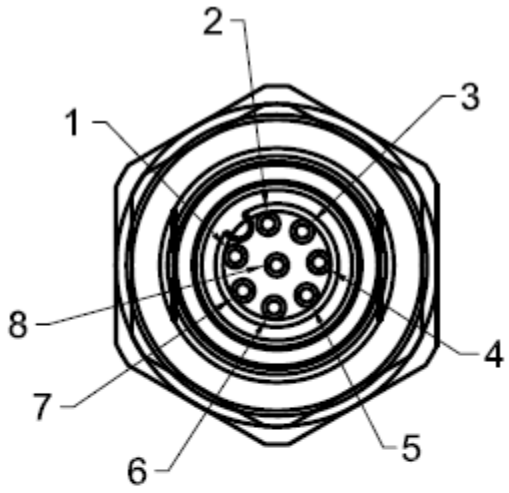
To connect the cables:

1. Run the cable(s) into the rack.
2. Thread the connector onto the radio port and hand tighten.
3. Cover any unused ports.
4. Restrain all cables while observing the cable manufacturer's minimum bend radius recommendations.

5.7 Connect the Ethernet cable

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

Figure 8: Ethernet cable end pinout



M12 connector pinout

Pin	Purpose
1	Reserved
2	Reserved
3	Reserved
4	Transmit -
5	Receive +
6	Transmit +
7	Reserved
8	Receive –

1. Insert the cable into the LAN connection port on the radio.
2. Rotate the whole connector until the locator pin engages its slot. It may help to check the orientation of the pin and slot beforehand. Carefully align the connectors and screw until finger-tight.

5.8 Ground the radio

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

Figure 9: Grounding stud

1. Remove the nut and washer from the grounding stud.
2. Slip the ground ring lug wire over the grounding stud and properly ground.
3. Replace the washer and nut and tighten to 65-75 inch per pound torque for a 1/4-20 nut.

5.9 Use of current-limiting circuit protection

You must provide circuit protection externally to each radio. We recommend a magnetic breaker with a DC voltage rating of >100V and 10A current rating. Follow the manufacturer's instructions.

5.10 Connect the power cable

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

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

Figure 10: Power connector

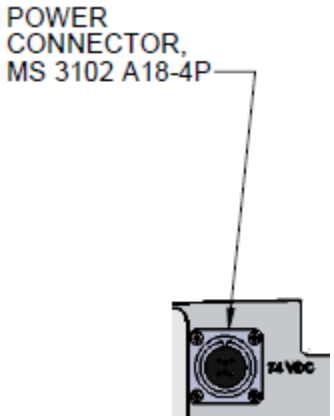
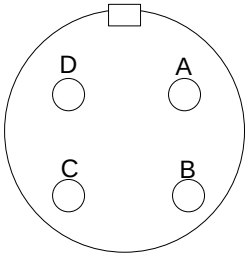


Figure 11: Power connector pin-out



To connect the power cable:

1. The radio does not have a power switch. Verify the power is off before connecting the radio to a power source. Verify the power is off.
2. Confirm proper grounding.
3. Verify the ground bond from the ground lug on the radio through external surge protection.
4. Run the power cable into the rack.
5. Slip the connector onto the radio port and hand tighten.

5.10.1 Power cable and pin-out

Figure 12: Power cable (MCC P/N 14001578)

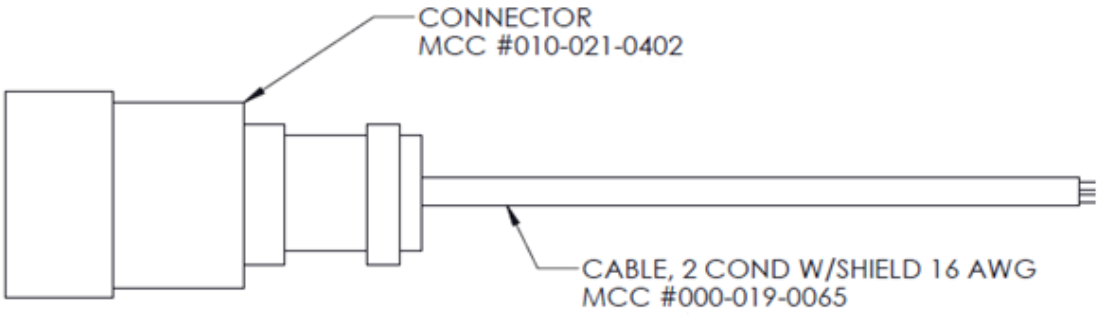
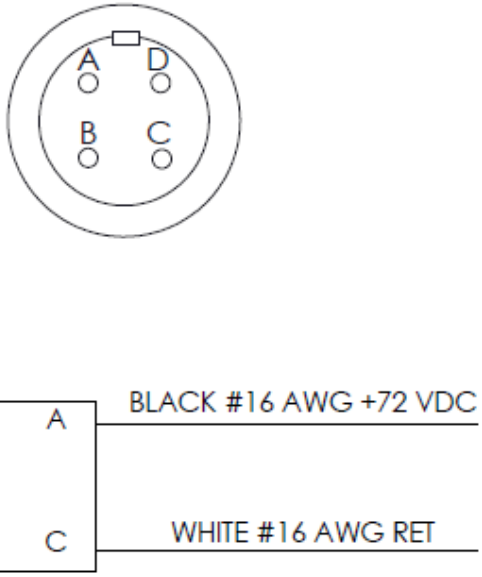


Figure 13: Power cable pin-out (MCC P/N 14001578)



5.11 Initial power on

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

To power on the radio:

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

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

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 and allows you to run an XtermW session.

Table 2 summarizes the power on self-tests (POSTs) that occur at radio startup.

Table 2: Radio power on self-tests

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

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. See Table 3: Front panel LEDs.

Table 3: Front panel LEDs

Label	Description	Color
PWR	Power – A 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 – Illuminated when the radio is in standby mode and the TX is disabled.	Red
FLT	Fault – Illuminated when one or more of a variety of fault conditions is detected but not indicated by other LEDs.	Red

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

Each time a radio is powered it conducts a POST, or Power On Self Test. This test serves as a snapshot of a radios performance at boot. To run the POST and view results, disconnect then reconnect DC power. A flashing green PWR LED on the front panel indicates that the boot sequence has been completed. Within Approximately 10 seconds the Ethernet port connection becomes active.

Connect the computer to the MAINT port on the front of the radio. At the XtermW prompt type POST and press **Enter**. This returns the Host Post Log that contains general radio information and alarms. See Appendix D: Sample POST results from a properly functioning Locomotive 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 card with a configuration information module (CIM) script is installed in the radio.

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

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

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

Notes:

- The logon status defaults to logged off when the radio boots up. To log 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**.

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**.

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:

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

7. Troubleshooting

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

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

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

7.1 Guidelines for troubleshooting common problems

Always check these items first when a radio problem occurs:

- **Check physical radio connections**

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

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

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

- **Check the LEDs**

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

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

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

- **Check the POST log**

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

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

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

  `INICHECK,SCRIPT`

  For more information on radio configuration see *the ITCR Radio Configuration Guide*.

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7.1.1 Commonly used diagnostic commands

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

LINKSTAT

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

Example from a Locomotive radio:

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

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

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

REV

The **REV** command displays the current software version.

```
+REV 05/22/12 19:33:19 ETH1 port 4

     ITC PACKET DATA RADIO
(c) Copyright 2012 Meteorcomm LLC
      All Rights Reserved
S/W Part Number P63020-A18-01.01.15.06 ITC SVN r27917 Fri May 04 13:39:28 2012
S/W Part Number P63020-D04-01.01.15.06 DSP SVN r27892 Fri May 04 20:31:15 2012
S/W Part Number P63020-F07-01.01.15.06 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 Locomotive Board
    ITC Role: Locomotive
```

The software revision is highlighted above as 01.01.15.06.

STAT

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

Example:

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

STAT,HRX

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

Example:

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

7.1.2 Front panel LEDs: What they say about radio operation

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

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

Read the description of each LED carefully. Some LEDs, such as the 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 – A 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 – Illuminated when the radio is in standby mode and the TX is disabled.	Red
FLT	Fault – Illuminated when one or more of a variety of fault conditions is detected but not indicated by other LEDs.	Red

7.1.3 Problems indicated by the FLT (Fault) LED

The FLT (Fault) LED differs from the 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 FLT LED are:

- One or more internal radio supply voltages are below their 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 is not present or it has invalid or corrupt data.

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

The specific problem causing the FLT LED to illuminate is determined by viewing the results of the last POST, which occurs each time the radio boots up.

7.1.4 View the results of the last POST

Power-on self test (POST) is a series of several dozen tests that the radio quickly runs on itself, each time it boots up, to determine if it has a problem or is missing critical information. The radio boots up when it is powered on or the BOOT command is issued at the command line.

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.

See Appendix D: Sample POST results from a properly functioning Locomotive radio.

To view POST results:

If the computer Ethernet interfaces have not yet been set up then see Configure the computer Ethernet interface(s) to communicate with a radio.

1. Connect the computer to the radio MAINT port by using a M12- 8 pin male, A-coded 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.

7.1.5 Boot up a radio

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

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

To boot up a radio:

1. 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:
2. Connect the computer to the radio MAINT port by using an M12- 8 pin male, A-coded Ethernet cable.
3. On the computer, open the XtermW application.
4. Click **Send**, click **Command**, and then type:

   BOOT
5. 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 PWR (Power) LED is off.
- The radio does not transmit
- The POST results show that the internal voltages are low.

To troubleshoot radio power issues:

1. Make sure the power-cable connectors are securely connected to the power supply and to the radio.
2. Make sure the power-cable polarity is correct. See Figure 13: Power cable pin-out (MCC P/N 14001578).
3. Check that the power supply is turned on. If it is off, then turn it on.
4. Measure the voltage at the power-cable connector to the radio. Adjust the power supply to within the rated operating voltage.
5. Verify current limiting on the supply meets maximum current draw.
6. Replace 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 FLT (Fault) LED

Problem indicators:

- The FLT (Fault) LED is on.
- The POST results show that there is an SD memory card failure. See View the results of the last POST.

The following is an 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 the SD memory card clicks into the connector. If it is missing or physically defective, then install a new one. See Boot up a radio.
2. If the previous procedures do not turn off the FLT 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. Check cable continuity.
5. Replace the cable or connector.
6. Replace the antenna.
7. Check the radio output power without the antenna connected(be sure to adequately attenuate and properly load the radio with an appropriate piece of test equipment capable of measuring RF output power).
8. 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
```

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

7.5 Transmission problems

Problem indicators:

- Transmissions from the radio are weak or intermittent.
- A radio in the network stops receiving expected communications from the radio.
- The TX LED never illuminates.

To troubleshoot transmission issues:

1. Make sure the radio is turned on and the green PWR LED is blinking.
2. Check the temperature of the radio and confirm the PA temperature has not exceeded the over-temperature threshold. This can be verified by booting up the radio and viewing the POST results.
3. Verify the frequency accuracy of the radio transmission.
4. Make sure the antenna-cable connectors are securely connected to the antenna and to the radio.
5. Check the cable connector and radio connector for corrosion.
6. Adjust the power output higher and lower to verify the transmission is controllable.
7. Monitor the current supplied by the power supply to the current drawn is consistent with a like radio under similar conditions.
8. Check the antenna for any defects or breaks.
9. Adjust the power-supply voltage, if necessary. If the power-supply voltage is too low, the radio might stop transmitting.
10. Measure the transmission power. See Measure and adjust peak RF power output.
11. Check the quality of the waveform and the frequency by using a spectrum analyzer.

12. 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 never illuminates

To troubleshoot receiver issues:

1. Make sure the radio is turned on and the green PWR LED is blinking.
2. Verify the transmit frequency is within limits.
3. Make sure the antenna-cable connectors are securely connected to the antenna and to the radio.
4. Check the cable connector and radio connector for corrosion.
5. Use a signal generator or a known good radio for a conducted receiver test to verify radio operation.
6. Replace the cable or connector.
7. Make sure the radio is using the auto channel mode. See the *ITCR Radio Configuration Guide* for more information on Channel mode.
8. Make sure the Base radio has a local channel configured. See the Channel assignments for Base radios section in the *ITCR Configuration Guide* for more information.
9. Check the antenna for any defects or breaks.
10. Replace the radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

7.7 Ethernet connectivity problems

Problem indicators:

- The radio is disconnected from the Ethernet network.

To troubleshoot network connectivity issues:

1. If you cannot directly connect to the Maint port on the radio then contact your system administrator.
2. Check network activity by using, for example, Wireshark software and a computer. If the network is down, then the problem probably is not in the radio.
3. Make sure the Ethernet-cable is securely connected to the radio's LAN port.
4. Verify external network equipment is properly functional.
5. Connect your computer to the radio's LAN port, send commands to the radio, and then see if the radio responds.
6. Note: To connect the computer to the LAN port, the computer's Ethernet ports 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 network administrator.
7. Replace the cable.
8. Replace the radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

7.8 RF Link problems

Note: When the RF Link LED is on, it means that the Locomotive radio has selected and connected to a Base radio. When the LED is off, it probably means that the Locomotive radio detects one or more Base radios but has not yet selected one.

Problem indicators:

- The RFL (RF Link) LED never illuminates.

To troubleshoot RF link issues:

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

   Example:

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

6. Use the **`BBeacon`** command to ensure that the base beacons are configured for the local channel.
7. Verify the base radio is transmitting. Use a signal source and perform a direct receiver test if necessary to isolate the problem.
8. Replace the radio. If the radio is replaced then the SD memory card can be removed from the original radio and inserted in the replacement

radio. The replacement radio uses the CIM on the SD memory card and is configured in the same way as the original radio.

8. Radio test and adjustment procedures

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

8.1 Required equipment

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

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

Table 5: Locomotive radio input power parameters

Parameter	Value
Nominal DC Power Input Voltage	74 VDC
Operational Range	45-100 VDC
Damage Limit	120 VDC
Current Drain (while transmitting rated power)	1.8 A @ 74 VDC typical while transmitting into 50 Ohm load

8.2 Configure the computer Ethernet interface(s) to communicate with a radio

It is recommended that you use a computer with two Ethernet interfaces, Ethernet 1 and Ethernet 2, so that your computer can communicate with a

radio's MAINT and LAN Ethernet ports at the same time. You need XtermW installed on the computer and have administrative rights to configure the Ethernet interfaces.

Notes:

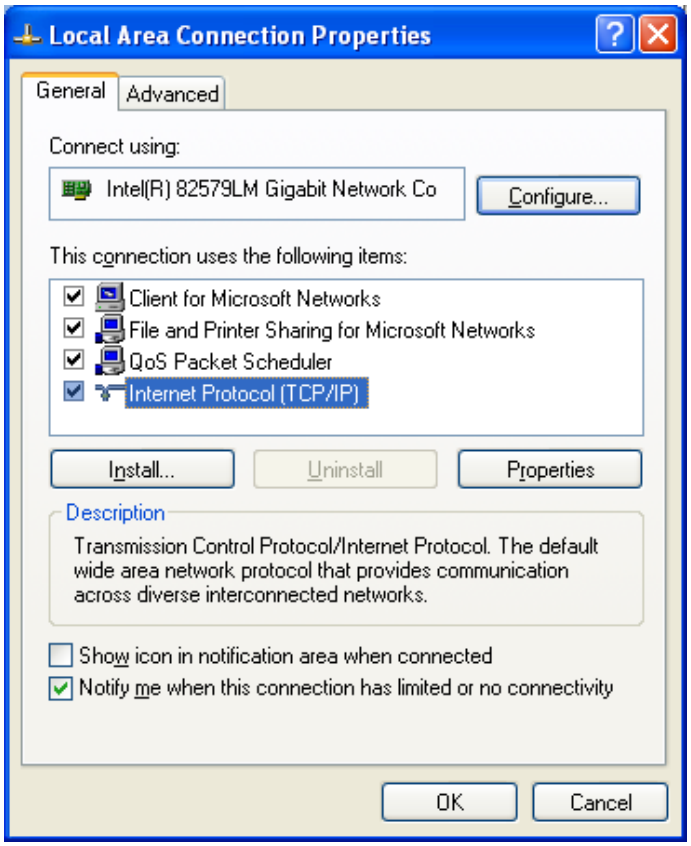
1. The following configuration examples are for directly connecting to the radio and bypassing any network infrastructure. If direct access to the radio cannot be obtained then contact your network administrator for instructions.
2. If you are using the factory defaults then use the following examples.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

8.2.1 Configure a computer with two Ethernet interfaces

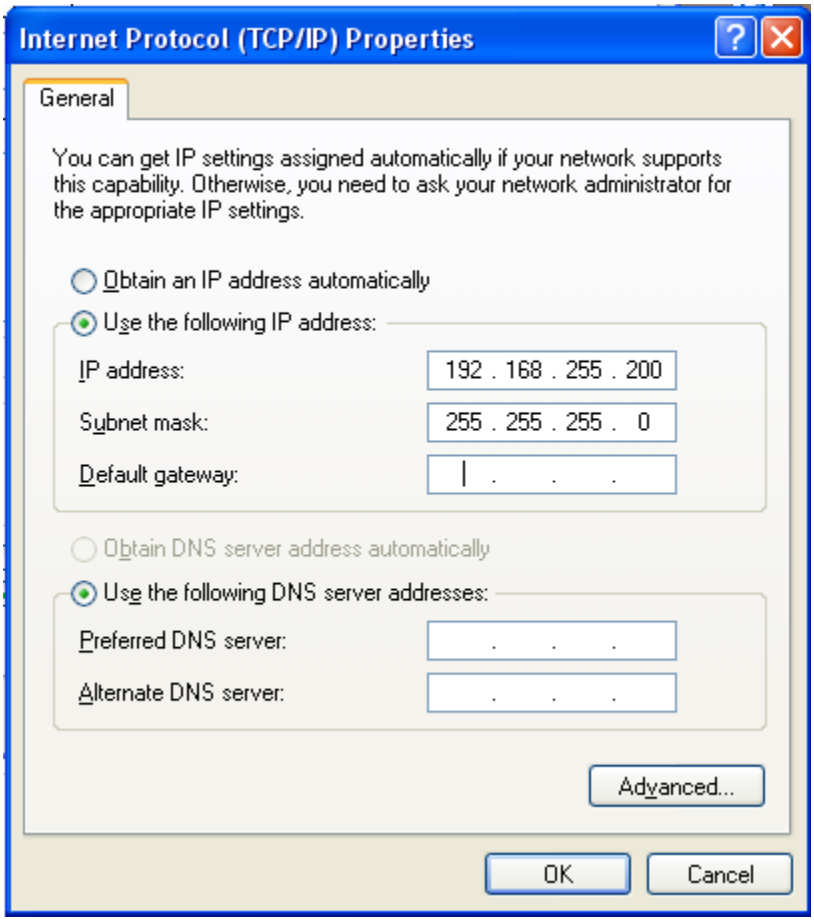
To configure the Ethernet 1 interface for the radio's MAINT port:

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

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

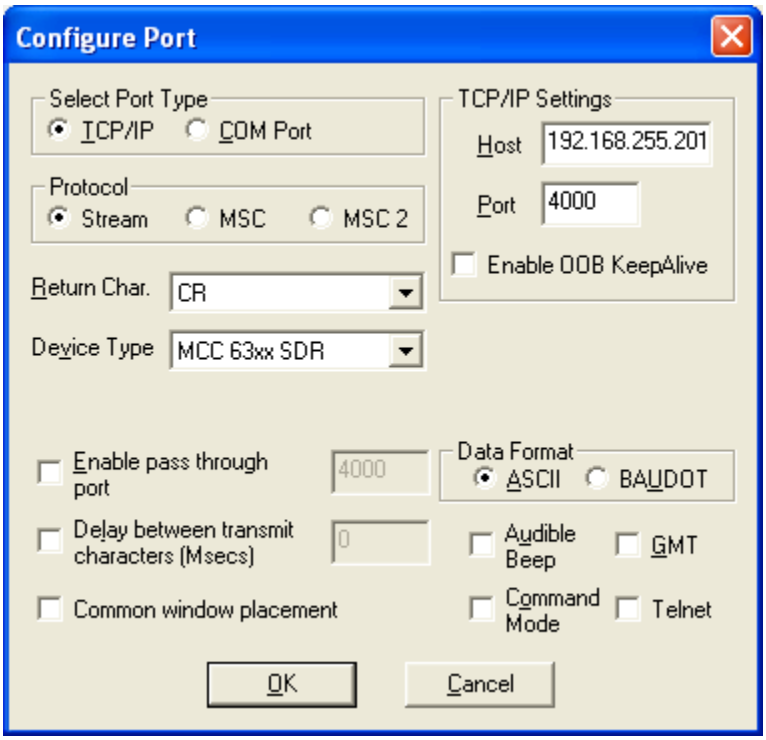


4. Click **Use the following IP Address**.



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

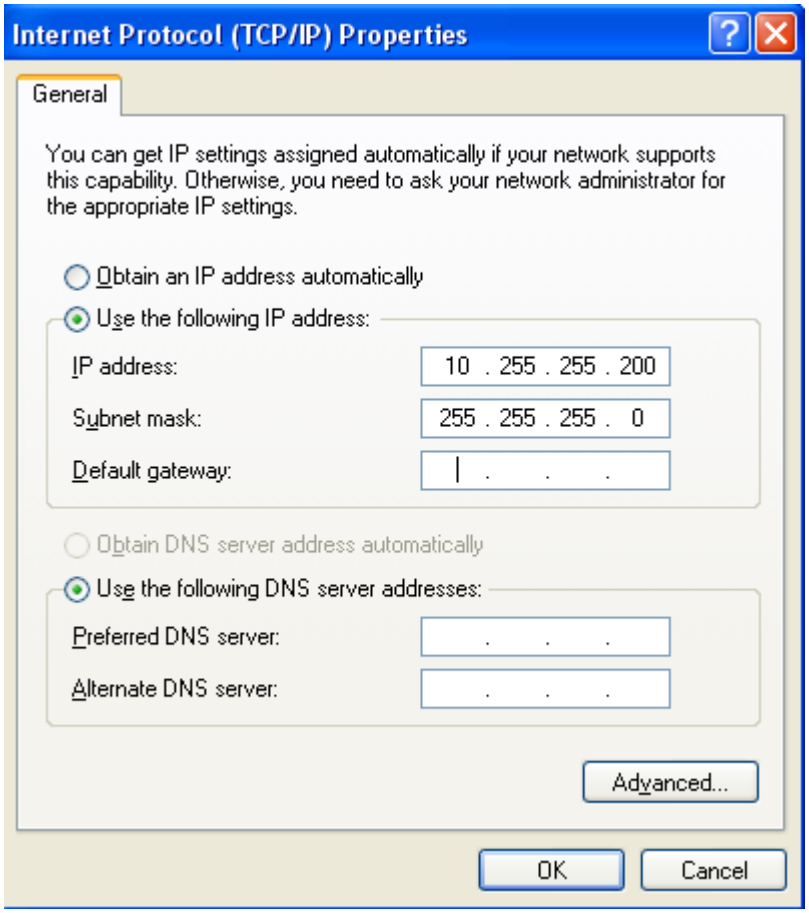
8. In XtermW, set the connection properties for the MAINT port connection as shown in the following figure.



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

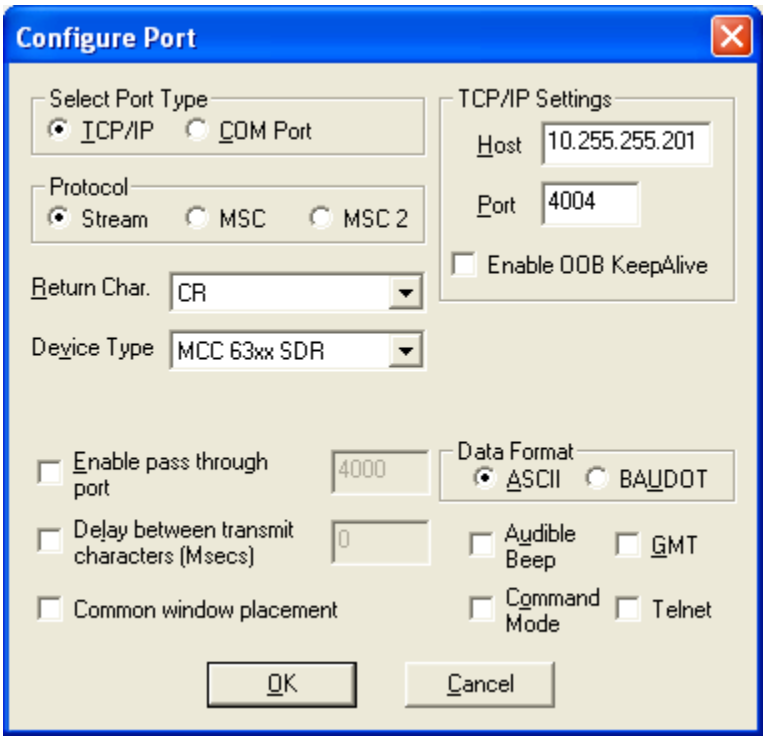
1. On the computer, click **Start**, **Control Panel**, **Network Connections**, and then **Local Area Connection**.
2. The **Local Area Network Connection Status** dialog box opens. Click **Properties**.

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



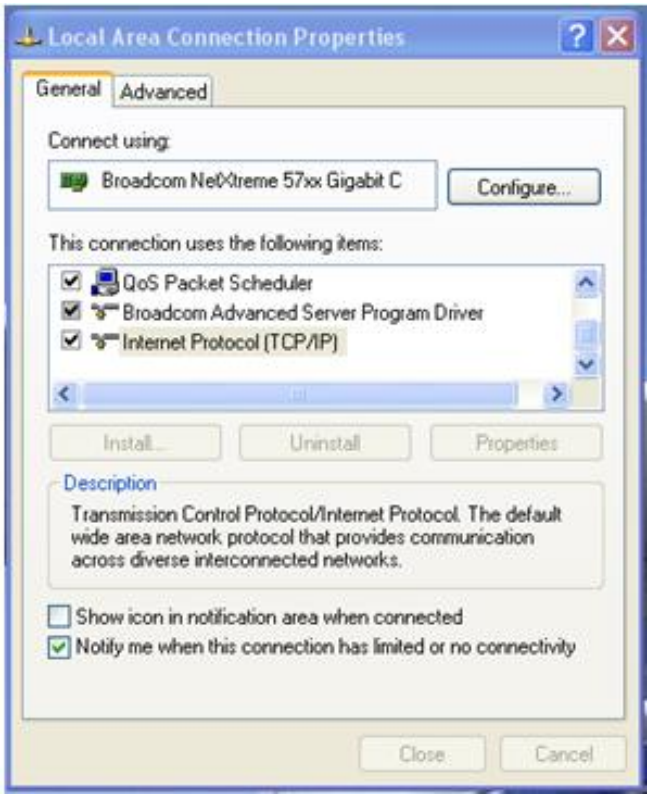
4. In the **IP address** box, enter **10.255.255.200**.
5. In the **Subnet mask** box, enter **255.255.255.0**.

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

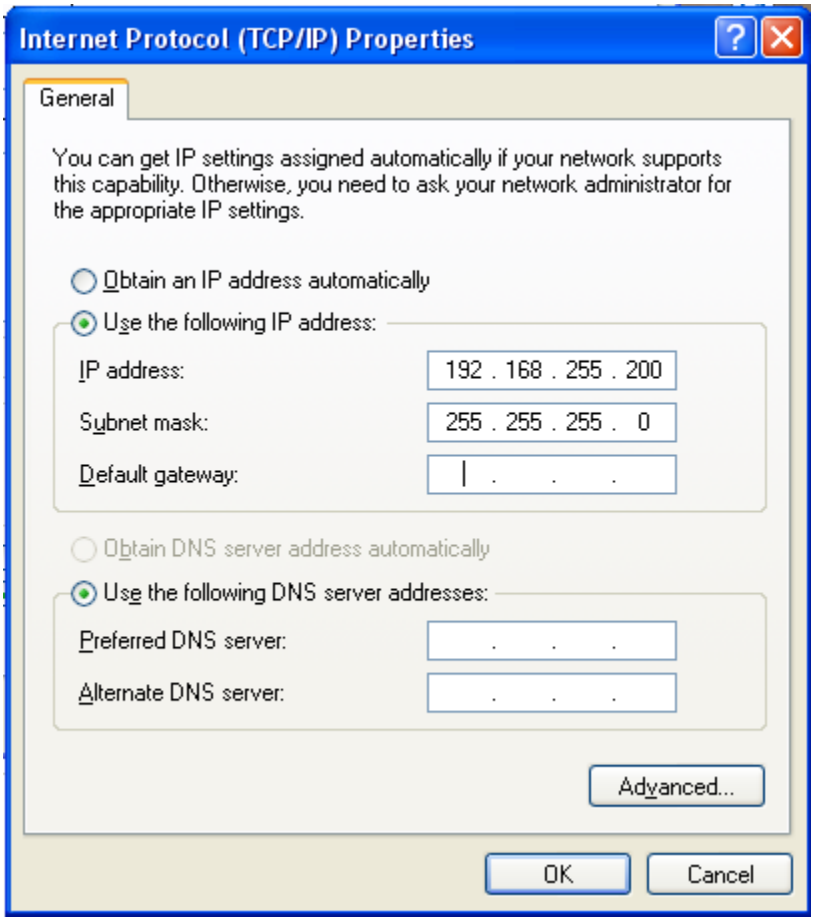


8.2.2 Configure a computer with one Ethernet interface

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

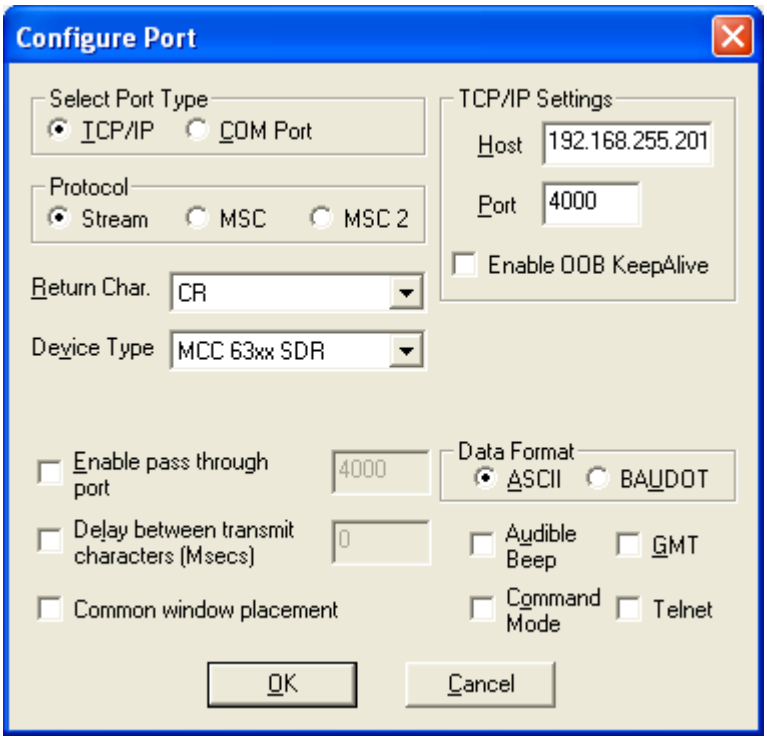


3. Click **Use the following IP Address**.



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

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

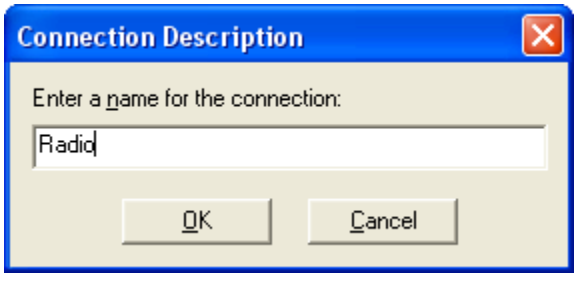


8.2.3 Create an MCC 63xx SDR connection profile

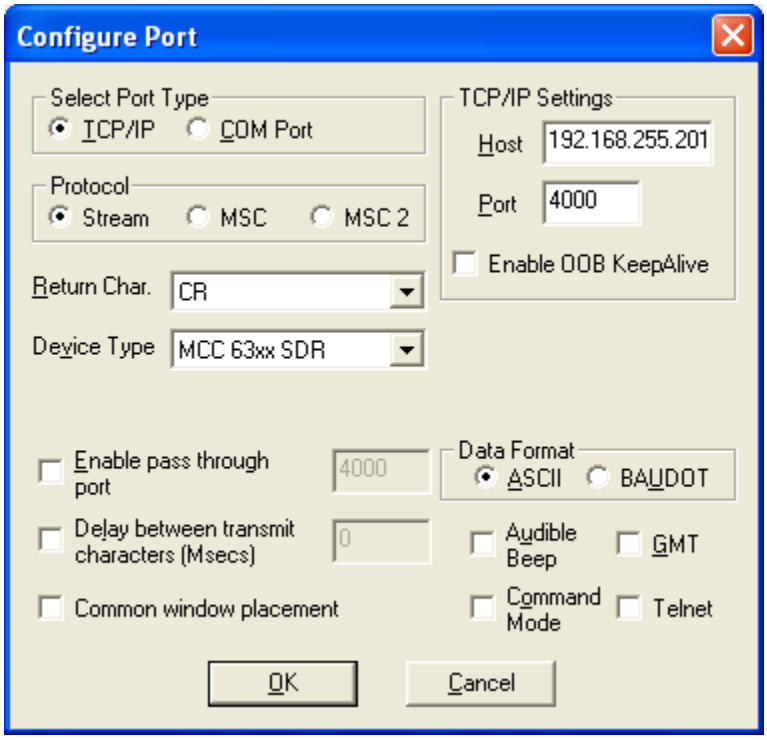
A connection profile is a group of settings created by XtermW when it is configured to make a new connection to an ITC radio.

To create an MCC 63xx SDR connection profile:

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



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



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

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

8.3 Measure and adjust peak RF power output

8.3.1 Equipment used to measure and adjust peak RF power output

- A power supply capable of providing 45-100 VDC and a current of 4 Amps
- 4 GHz spectrum analyzer that includes a DQPSK digital demodulation option

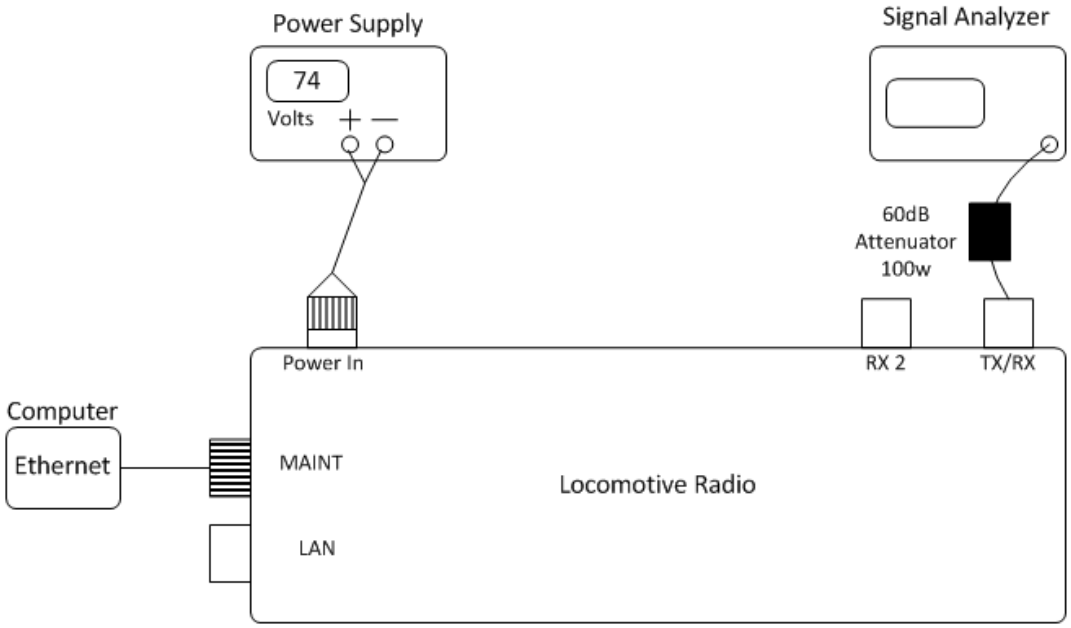
  Or,

  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 14: Locomotive radio transmit setup illustrates the setup required to measure the RF output power of the radio transmitter.

Figure 14: Locomotive radio transmit setup



8.3.3 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. At the XtermW prompt on the computer type:

   ```
   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 expressed in Hz.

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

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

   ```
   L1_TEST,STOP
   ```

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

1. At the XtermW prompt on the computer type:

   ```
   STOP
   SCHED,DEL,ALL
   DSP_MODE,IDLE
   DSP_MODE,TEST
   L1_TEST,SET,TXFREQ,value
   ```

```
L1_TEST,SET,TXMOD,DQPSK_HALF
L1_TXDUTY,1000,300,0
```

where:

`value` equals the desired frequency of operation.

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

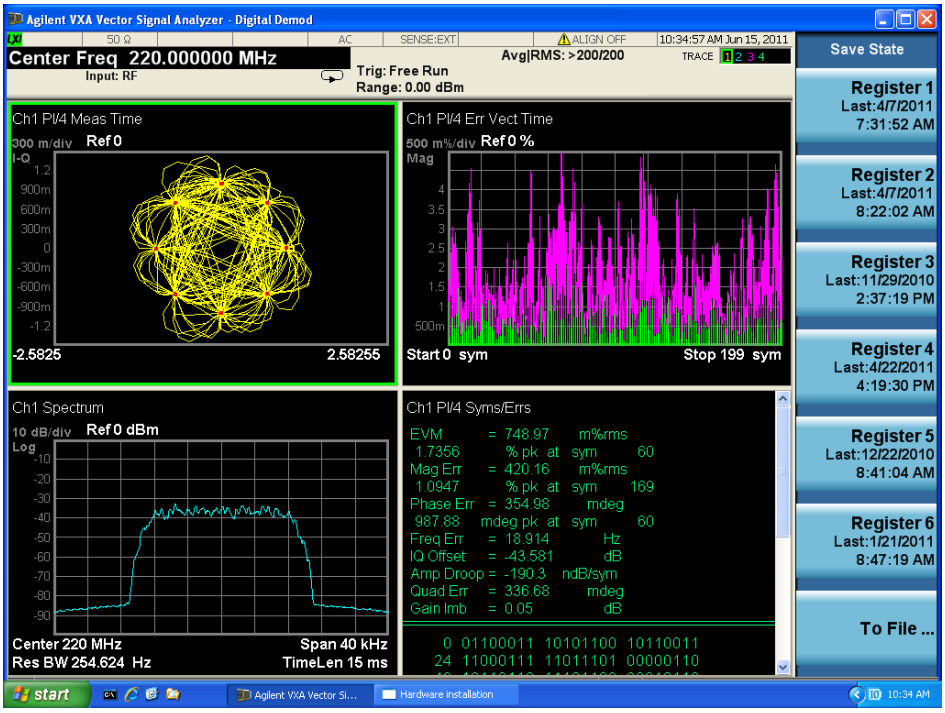
Once observation of radio performance is complete, turn off transmit operations by typing:

```
L1_TEST,STOP
```

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

Figure 15: Typical transmission spectrum (DQPSK)

Figure 16: Typical transmission spectrum EVM (DQPSK)



8.3.4 Adjust RF power output

Locomotive radios are rated for 50 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. Once observation of radio performance is complete, turn off transmit operations by typing:

   ```
   L1_TEST,STOP
   ```

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

   ```
   TXPOWER,value
   ```

   Where:

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

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

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

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

     In XtermW type:

     ```
     SAVE
     ```

This will result in a change sustained across power cycles.

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

  The CIM script must include:

  ```
  TXPOWER,MAX
  TXPOWER,-nnn.nn
  ```

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

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

  This will result in a change sustained across power cycles.

Caution:
The following table shows the limits of the RF power output of the radios. Settings outside this range for operation into an antenna are out of FCC compliance. It is the user's responsibility to confirm that settings are within compliance.

Table 6: Rated RF Power Output

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

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

8.4 Measure full-rate receiver sensitivity

8.4.1 Primary/RX1 receiver measurement

> **Warning:** Use caution when connecting any equipment to the TX/RX1 port as accidental keying of the transmitter can damage equipment if not properly protected.

To begin the test, make sure the E4438C signal generator is outputting the proper wave form into the TX/RX1 port on the radio. See Appendix E - Program Signal Generator for DQPSK for more information on setting up the signal generator. Next, issue the following commands using XtermW:

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

where:

`value` equals the desired frequency of operation.

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 Locomotive radio. Next, issue the following commands using 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
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 7: Brief descriptions of the available trace features

Feature	Description of traced data and notes
0-16	All activity on a selected I/O port
CLASC	Class C time and location messages

Feature	Description of traced data and notes
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 M12- 8 pin male, A-coded Ethernet cable to connect the computer’s Ethernet 1 port to the radio’s MAINT port.

   The Ethernet port must be configured to communicate with the MAINT port. See Configure the computer Ethernet interface(s) to communicate with a radio.

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

   `TRACE,PORT,MAINT`

   Where:

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

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

`TRACE,level,feature,destination`

Where:

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

6. Click **OK**.

To suspend a trace:

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

   `TRACE,suspend`

2. Click **OK**.

To resume a trace:

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

   `TRACE,resume`

2. Click **OK**.

To stop a trace:

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

   `TRACE,off`

2. Click **OK**.

9. Managing software application images

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

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

ITCR Radio Configuration Guide for information about how to configure a radio for ITCSM connectivity.

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

This section explains how to:

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

9.1 Determining software image status

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

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

Table 8: Software image status codes

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

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

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

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

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

9.2 Updating software images

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

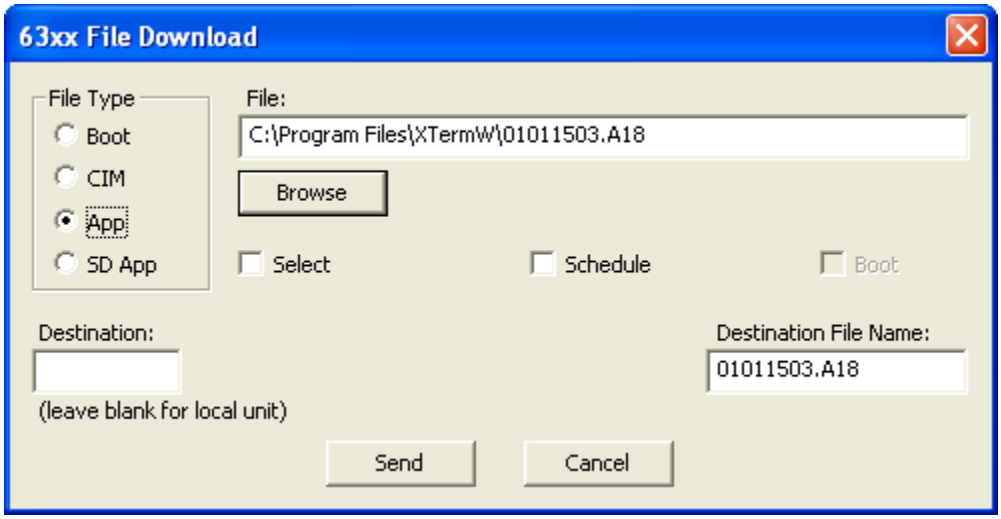
9.2.1 Updating radio software via command line

To update radio software:

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

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

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



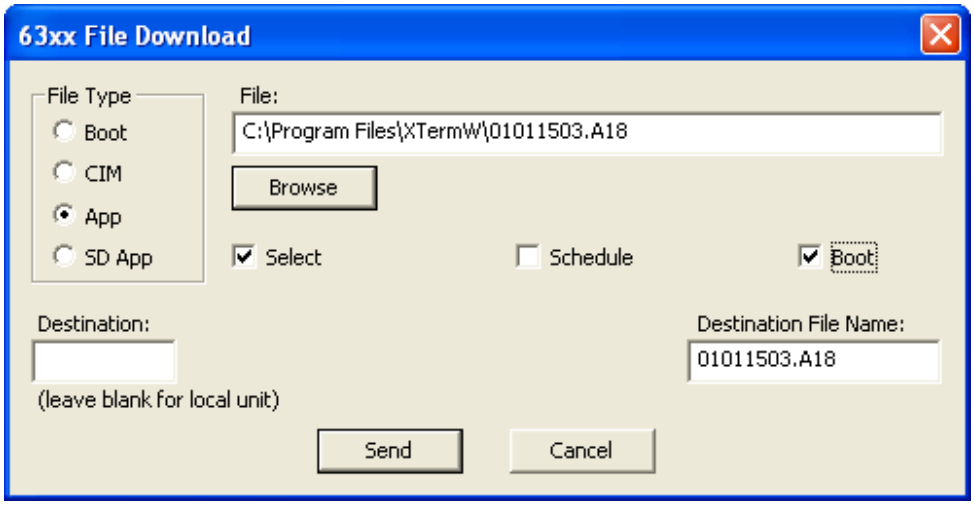
6. Under File Type, select App.
7. Click Browse, and then locate and select the software image file.
8. After you select the software image file:

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

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

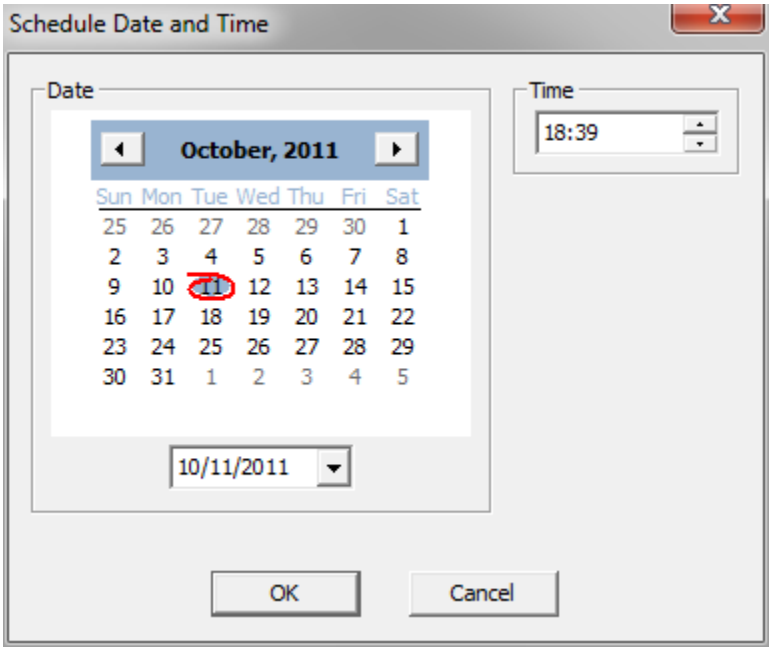
   When you select the **Select** checkbox, XtermW automatically executes the **`APPS,SELECT,<image-file>`** command after the software image is downloaded. It also causes XtermW to enable the **Boot** checkbox.

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

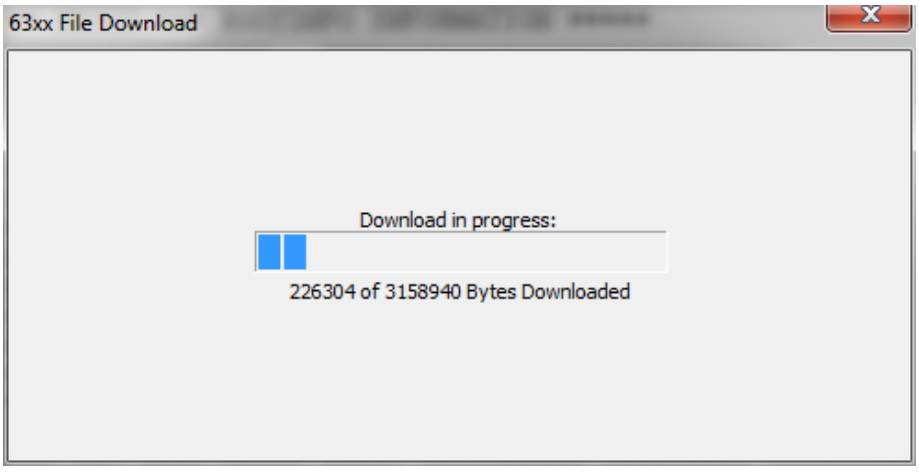


10. To execute a synchronized software update at a future time, select the Schedule checkbox. Choose the desired data and time in the popup, and then click OK.

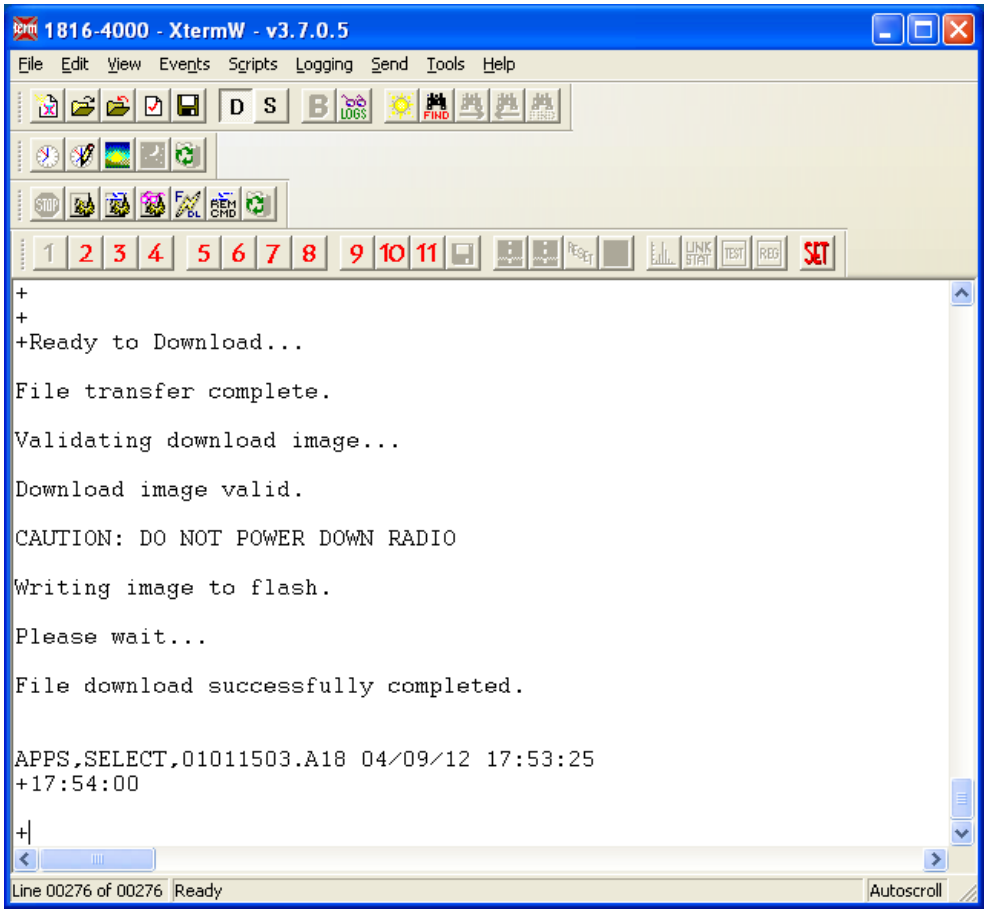
When you select the **Schedule** checkbox, XtermW automatically executes the **`APPS,SCHED,<date>,<time>,<image-file>`** command after the software image is downloaded.



11. Click Send to begin the download.



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



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

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

9.3 Rolling back an image

9.3.1 How automatic rollback occurs

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

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

1. 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:

1. Execute the **APPS** command.
2. 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:

1. Execute the **APPS** command.
2. 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
```

3. 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.

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

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

   BOOT
   ```

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

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

9.4 Maintaining multiple software images in the radio

9.4.1 Managing images via command line: APPS

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

Table 9: Software image actions

Action	Resulting image status
Install (using XtermW)	Different statuses depending on options selected during installation: NRDY if Select = No and Schedule = No RDY: if Select = Yes and Schedule = No SCHD if Schedule = Yes

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

9.4.2 System events on installed software images

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

Table 10: System events on installed software images

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

10. Routine maintenance

- Remove dust and obstructions from heat-sink fins.
- Make sure that the radio is securely mounted.
- Restrain cables to prevent stress on connectors.
- Make sure that the SD card door is securely closed.
- Keep the LED panel dust-free and viewable.

Appendix A: Possible antenna configurations

Single antenna configuration

An antenna is connected to the primary receive port, TX/RX1.

Two antenna configuration

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

Appendix B: Parts list

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

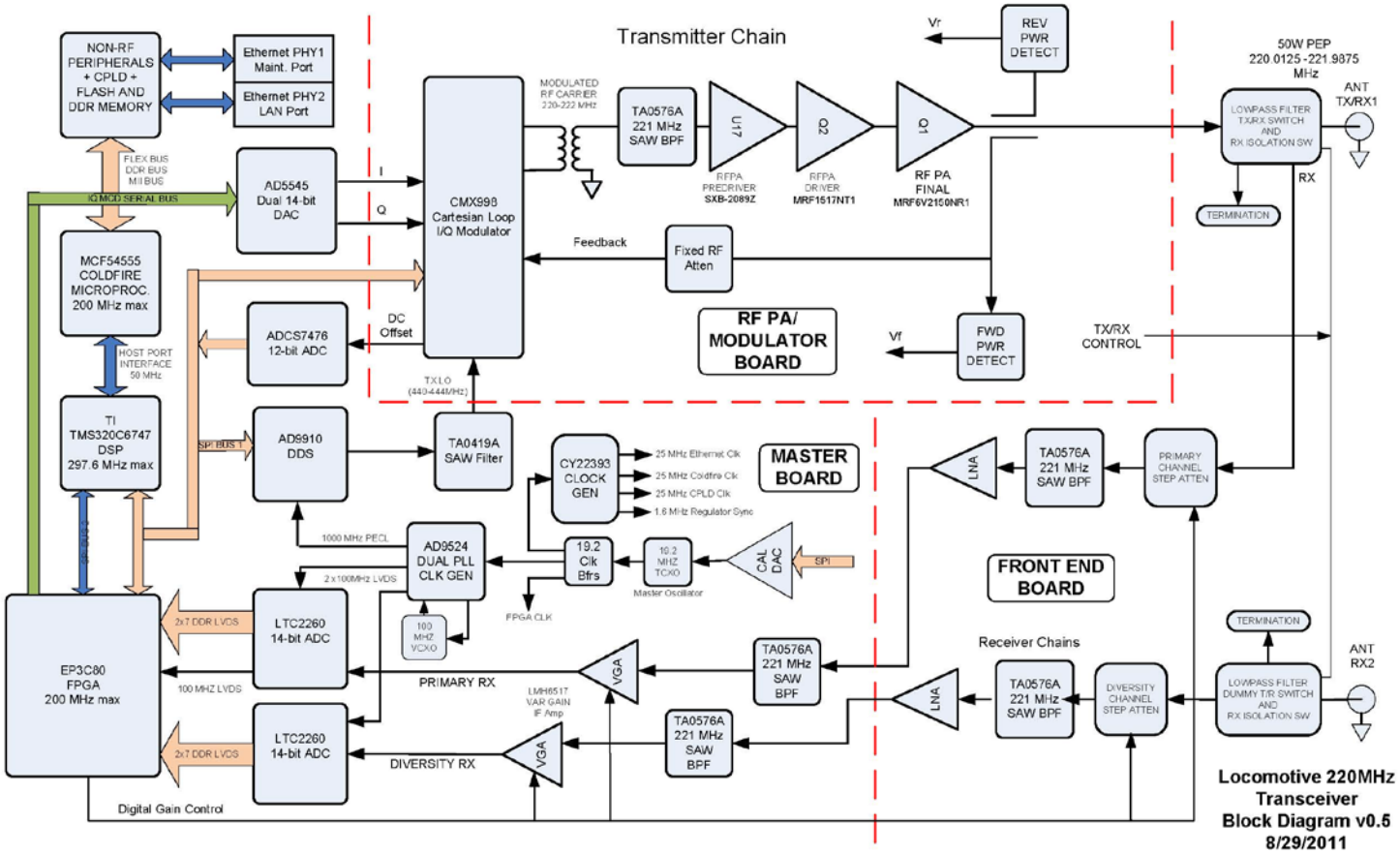
Table 11: Locomotive radio parts and part numbers

Part name	Part number
Shipped assembly	LOCO 63020901-01
Top level assembly	LOCO 63020001-01
DC power cable assembly	14001624-01
TX CTL cable assembly	14001625-01
RF antenna cable assembly	14001626-01
Ethernet cable assembly	14001627-01
Power supply cable assembly	14001628-01
Master board cable assembly	14001630-01
Power supply cable assembly	14001631-01
TXQ+ YEL/WHT cable assembly	14001644-01
TXQ- BLU/WHT cable assembly	14001645-01
TXI-BLU/GRN cable assembly	14001646-01
TXI+ GRN cable assembly	14001647-01
LO BLU/YEL cable assembly	14001648v-01
RX cable assembly	14001649-02
RX cable assembly	14001650-02
Side cover	63020101-02
PCA, PA/MOD	63020303-01
PCA, front end	63020304-02
PCA, power supply	63020306-01
PCA, Ethernet	63020308-01
PCA, LED	63020311-01
PCA, master	63020312-01
PCB, PA/MOD	63020403-01
PCB, front end	63020404-02
PCB, power supply	63020406-01
PCB, Ethernet	63020408-01
PCB, LED	63020411-01

Part name	Part number
PCB, master	63020412-01
EMI shield	63020506-01
SD card guide	63020508-01
LED overlay label	63020524-01
Machined housing	63020530-01
LED backing plate	63020535-01
Cable tie bracket	63020537-01
FPGA thermal pad	63020541-01
Bottom thermal spreader	63020545-01
Cover	63020547-01
DSP thermal pad	63020548-01
Regulators thermal pad	63020549-01
COLDFIRE thermal pad	63020550-01
FPGA thermal spreader	63020551-01
FCC label	63020552-01
ITC thermal pad heatsink	63030511-01
RF module heat slug	63030518-01
Thermal pad	63030519-01

Appendix C: Block diagram

Figure 17: 220 MHz Locomotive transceiver block diagram



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

```
+post 11/24/11 01:08:00
+POST 05/22/12 19:33:21



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


Board Type                    : Locomotive
Hardware Revision             : F3
Serial Number                 : 63LR000233CA


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: ETHERNET 0             : PASS
HOST: ETHERNET 1             : PASS
HOST: MAC 0                  : PASS
HOST: MAC 1                  : 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 :  28.969
HOST: 11.5v  Supply          : PASS :  11.408
HOST:  5.0v  Supply          : PASS :  5.046
HOST:  3.3v  Supply          : PASS :  3.320
HOST:  2.5v  Supply          : PASS :  2.473
HOST:  1.8v  Supply (Host)   : PASS :  1.799
HOST:  1.8v  Supply (DSP)    : PASS :  1.815
HOST:  1.5v  Supply          : PASS :  1.477
HOST:  1.2v  Supply (Host)   : PASS :  1.192
HOST:  1.25v Supply (DSP)    : PASS :  1.240
HOST: External Supply        : PASS :  2.401
```

```
HOST:  12V Power Supply Temp : PASS :  38.276
HOST:  28V Power Supply Temp : PASS :  39.167
HOST:  PA Temp               : PASS :  29.329
HOST:  Driver Temp           : PASS :  30.764
HOST:  Main Board Temp       : PASS :  34.978
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         2
active_index        2
active_source       Flash1
active_user         USER_BOOT

Inx Pri Stat Fail  Lnch  Name           Notes Last Status
--- --- ---- ----- ----- -------------- ----- --------------
  2  12  RDY     1     1 D:01011506.A18 ACTV  Success
```

Appendix E - Program Signal Generator for DQPSK

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

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

Step	Action	Button / Selection
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 8 ksps for half rate testing.	16ksps / 8ksps
30	Return to an upper level by pressing 'Mode Setup' to define additional parameters.	Mode Setup
31	Load the user defined data file just created.	Data
32	Pick 'User File.'	User File
33	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

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

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

Step	Action	Button / Selection
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
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

Step	Action	Button / Selection
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

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

Step	Action	Button / Selection
1	Enter mode to program signal generator.	Mode
2	Select more at bottom of menu.	More
3	Select GPS.	GPS
4	Select Real Time MSGPS.	Real Time MSGPS
5	Select Scenario.	Scenario
6	Using arrow keys, highlight either Hawaii or SantaRosa.	Arrow keys → / ↓
7	Select Scenario.	Select Scenario
8	Select Number of Satellites (8).	Number of Satellites
9	Select more to go back to the 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)