*IP*Series

M64450G25
High Speed Mobile Radio
Product Owner's Manual

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The term “IC”: before the radio certification number only signifies that Industry of Canada technical specifications were met.

Operation is subject to the following two (2) conditions: (1) this devise may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of this device.

The following U.S. Patents apply to this product:

U.S. Patent numbers 5,640,695,6,018,647,6,243,393

Information contained in this document is subject to change without notice.

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Product Description

The M64450G25 Mobile Radio works within a frequency range of 450-506 MHz and requires a 1/4-wavelength antenna.

The *IP*Series High Speed Mobile Radios are intelligent devices designed for the challenging requirements of mobile data applications. Mounted in vehicles, other intelligent devices may connect to the serial or Ethernet ports for connectivity back to the Internet Protocol Network Controller (IPNC) and other such servers. It provides the mobile link to land-based wired networks.

Figure 1: *IP*Series High Speed Mobile Radio (Front View)

Product Functionality

The IPSeries High Speed Mobile Radio utilizes a high-performance, 4-level Frequency-Shift Keying (FSK) wireless data modem for 32 kbps operation, 16-level FSK for 64 kbps in 25 kHz channels; a multi-layered approach to signal reliability. It features low power consumption, high performance integrated GPS receiver. Embedding this technology in the mobile radio lowers the cost of acquiring GPS data from vehicles and ensures optimal performance.

The mobile radio technology includes Diversity Reception (DR) capability. DR reduces the effects of fades in a multi-path environment. With the use of two (2) antennae mounted at a calculated distance on the roof of the vehicle the Diversity Reception System (DRS) minimizes the effects of fading by intelligently selecting the receiver with a better signal.

Diversity is most effective when the vehicle is in motion.

External Features

As seen in the figure below, the mobile radio technology is enclosed in a compact and sturdy aluminum case. The external features consist of a series of connectors and ports as described in this section.

The product warranty becomes immediately void if an uncertified or unauthorized individual removes the mobile radio cover.

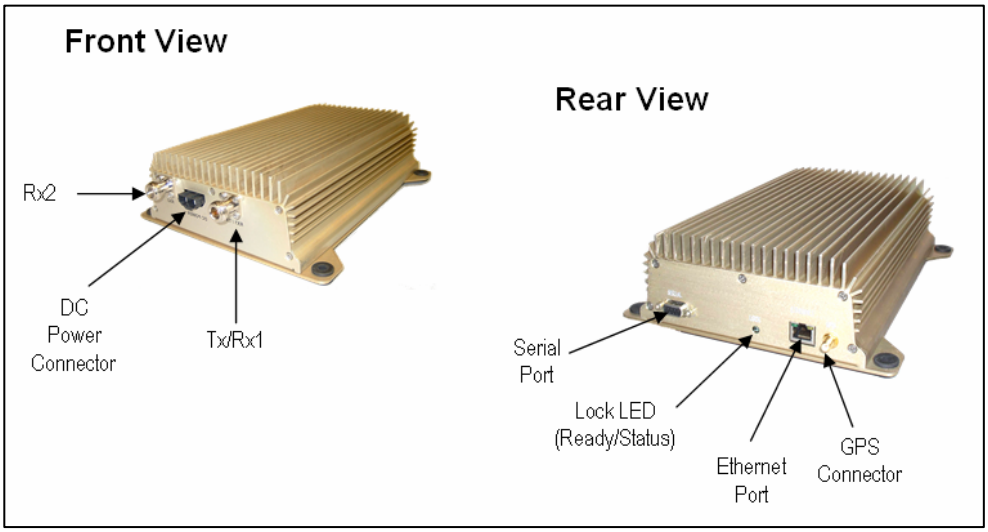


Figure 2: *IP*Series High Speed Mobile Radio (External Features)

The mobile radio external features consist of the following connectors and ports:

TABLE 1: EXTERNAL FEATURES

FEATURE	DESCRIPTION
TX/RX1	Transmitter / Receiver 1 antenna connection
RX2	Receiver 2 antenna connection
Power Connector	13.8 VDC mobile radio power connector
Lock LED	Unit 'Ready' Status Indicator LED (light emitting diode)
GPS	GPS antenna (SMA) connector
Serial Port	RS232 Serial Line Internet Protocol (SLIP) interface port
Ethernet Port	10 Base T Ethernet interface port

Mobile Radio-to-Mobile Computer Setup and Configuration

The following section describes the setup and configuration method for the mobile radio in a vehicle.

Mobile Radio-to-Mobile Computer Setup

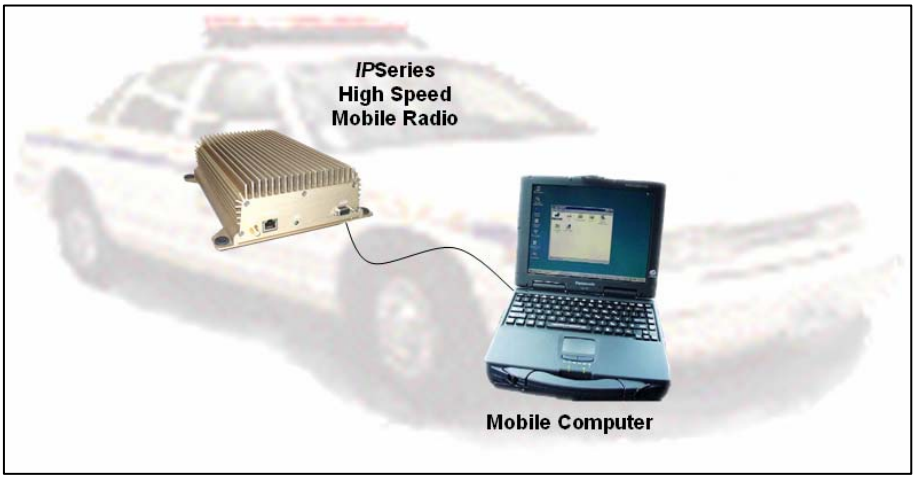


Figure 3: High Speed Mobile Radio-to-Mobile Computer Setup

Additional components are required to setup a mobile radio-to-mobile computer configuration, and are listed in the following table:

TABLE 2: HIGH SPEED MOBILE RADIO-TO-MOBLE COMPUTER COMPONENTS REQUIRED FOR INSTALLATION

QTY	DESCRIPTION
1	IPSeries High Speed Mobile Radio
1	Mobile Computer
1	20-foot serial cable (DB9F – DB9M)
1	*IP*MobileNet SLIP Port Driver Installation file (SLIP2IPMN.exe)

If using the mobile radio's Ethernet feature an Ethernet crossover cable is required to replace the 20-foot serial cable.

To configure the mobile radio and computer for this type of setup, follow the instructions on pages 2 through 17 in the ***Mobile Computer Setup for Communication with the Mobile Radio Installation Guide*** (IPMN p/n: 516.80310.IG) available on the Product Documentation CD.

Installation Overview

This chapter provides the basic steps involved in the installation process of an *IP*Series High Speed Mobile Radio into a vehicle. This chapter includes wire routing and connections between the mobile radio, other components, and the vehicle's power.

To prevent personal injury and vehicle damage, exercise extreme caution throughout the installation process and follow the reminders listed below.

- Follow safety precautions for handling wiring, tools, and a vehicle's engine.
- Handle the vehicle's battery with extreme caution to avoid burns.
- **Do not** alter the components listed in the 'Installation Requirements' section below, unless substitutions are noted within this section.
- Once the antennae are installed, as directed within this user manual, all persons must maintain a distance of no less than 39 inches from the antennae while the mobile radio is in the transmit mode.

Installation Requirements

The table below lists the documents required to successfully install the mobile radio and connect to the various components within the vehicle:

TABLE 3: DOCUMENTS REQUIRED FOR HIGH SPEED MOBILE RADIO INSTALLATION

DESCRIPTION	PART NUMBER
▪ M64450G25 High Speed Mobile Radio Product Owner's Manual	516.80528.POM
▪ Installation Guide for Mobile Computer Setup for Communication with the Mobile Radio (available on the Product Documentation CD, IPMN p/n: 480.0001.001).	516.80310.IG

The table below lists components that are available for purchase through *IP*MobileNet, Inc.

TABLE 4: MOBILE INSTALLATION ACCESSORIES

QTY	DESCRIPTION	IPMN PART NUMBER
4	Screws, Self Tapping #10 X 5/8	37040010-10
1	EMI Filter	127.0020.002
1	Timer, 2 hours	150.0127.004
1	Relay	128.0117.001
1	Relay Socket	128.0116.001
2	Butt Connectors #8 AWG	120.0256.001
1	Terminal, Ring #8 AWG, #10 Screw Insulated	120.0127.001
4	Terminal, Ring #18-22 AWG, #10 Screws Insulated	120.0250.004
4	Terminal, Ring #10-12 AWG, #10 Screws Insulated	120.0250.005
4	Terminal, Disconnect #14-16 F	120.0244.002
18	Terminal, Disconnect #10-12 F	120.0244.003
2	Disconnect Tab, Quad Male	200.1377.001
1	Wire, 12 AWG Black, order 5 ft.	156.0242.001
1	Wire, 12 AWG Red, order 44 ft.	156.0242.003
1	Fuse, 15 AMPS ATO	122.0042.003
2	Fuse, 30 AMPS ATO	122.0042.001
3	Fuse Holder, 12 AWG	120.0253.001
1	Switch, Toggle DPST	144.0136.001
1	Diagram, Mobile Installation (included in this manual)	502.80259.52
1	Diagram, Diversity Antenna Mobile Installation Detail (Typical Install)	DT450-10-0201

The table below lists the auxiliary equipment required to complete the installation process.

TABLE 5: AUXILIARY EQUIPMENT

QTY	DESCRIPTION	IPMN PART NUMBER
1	Serial Cable (DB9MF), 20 ft.	156.0245.020
1	Wire, 8 (133/29) AWG VW-1 Red, by foot, order 19.5 ft.	156.0243.003
1	Wire, 8 (133/29) AWG VW-1 Black, by foot, order 19.5 ft.	156.0243.001
2	Mounting Kit, Permanent Hole (MB8UN)	124.0601.001
2	Antenna, Radome Type, 410-430 MHz, 3dB Gain (requires 1MB8XN for each antenna)	102.0206.001
2	Antenna, Radome Type, 430-450 MHz, 3dB Gain (requires 1MB8XN for each antenna)	102.0206.002
2	Antenna, Radome Type, 458-470 MHz, 3dB Gain (requires 1MB8XN for each antenna)	102.0206.003
2	Antenna, Radome Type, 470-490 MHz, 3dB Gain (requires 1MB8XN for each antenna)	102.0206.004
2	Antenna, 5/8 Wave, 490-512 MHz, 3dB Gain (requires 1MB8XN for each antenna)	102.0199.006

Installation Instructions

Pre-Installation Guidelines

Prior to installing new equipment, perform the following steps:

1. Remove existing equipment and all related components to include stock clips on radio wiring harness and antenna.

2. As shown in the figure below, mounting of the mobile radio, delay timer, relay, and EMI filter (noise filter) will take place in the trunk compartment, unless installing in a vehicle without a trunk.

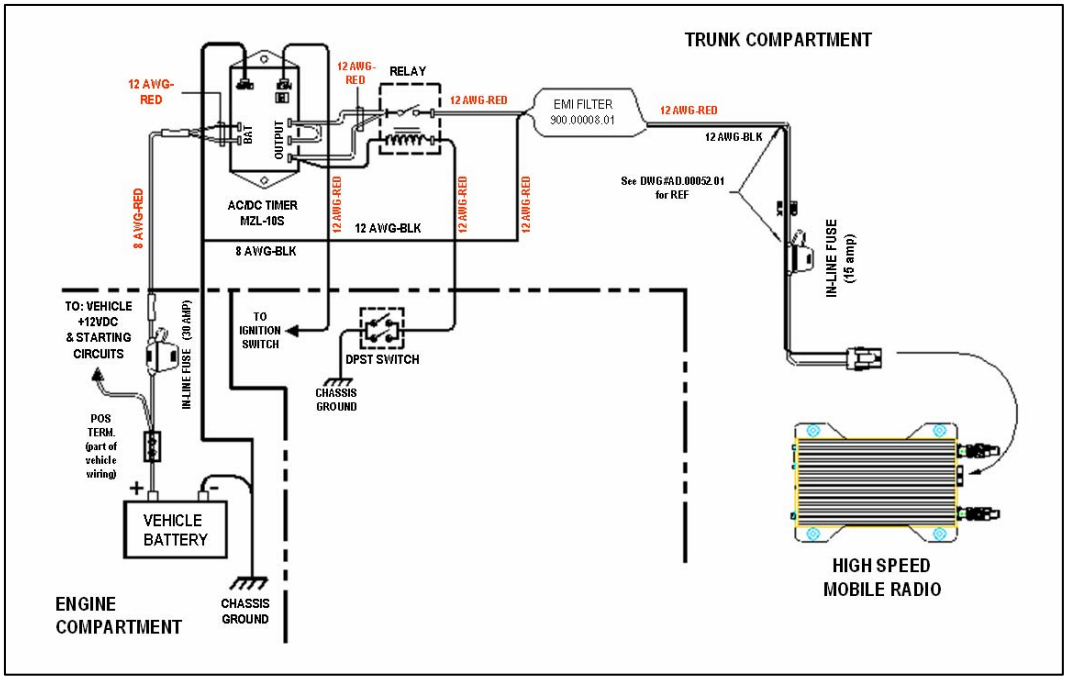


Figure 4: Trunk Compartment Installation

Removal of seats, rubber mats, and other obstructions from inside the driver compartment may be necessary to facilitate routing of wires to the engine and trunk compartments.

3. To ensure appropriate cable and wire routing, exercise the following precautions:

   - Route cables away from sharp edges that can penetrate cable insulation and damage wires.
   - Protect wires with silicone rubber grommets when routing through the engine compartment firewall or through other holes with sharp edges.
   - Use high-quality electrical tape when covering exposed wires in the engine compartment.
   - Avoid routing cables through areas exposed to extreme heat, such as the exhaust.
   - Keep wires routed through the engine compartment away from hot and/or moving parts.

4. Prior to drilling holes in the engine compartment firewall, inspect both sides to avoid obstructions.

5. For grounding point, use the engine block or the negative (-) terminal of the vehicle battery. Ground connection surfaces must be free of paint, rust, and other corrosion to maximize performance and avoid damage. Do not tie to the vehicle chassis.

6. To simplify troubleshooting problems, label all connecting points and wires.

Mounting the High Speed Mobile Radio

To mount the mobile radio, perform the following steps:

Step 1 As shown in the figure below, secure the mobile radio into the trunk compartment. Insert four (4) sheet metal screws in the mobile radio brackets.

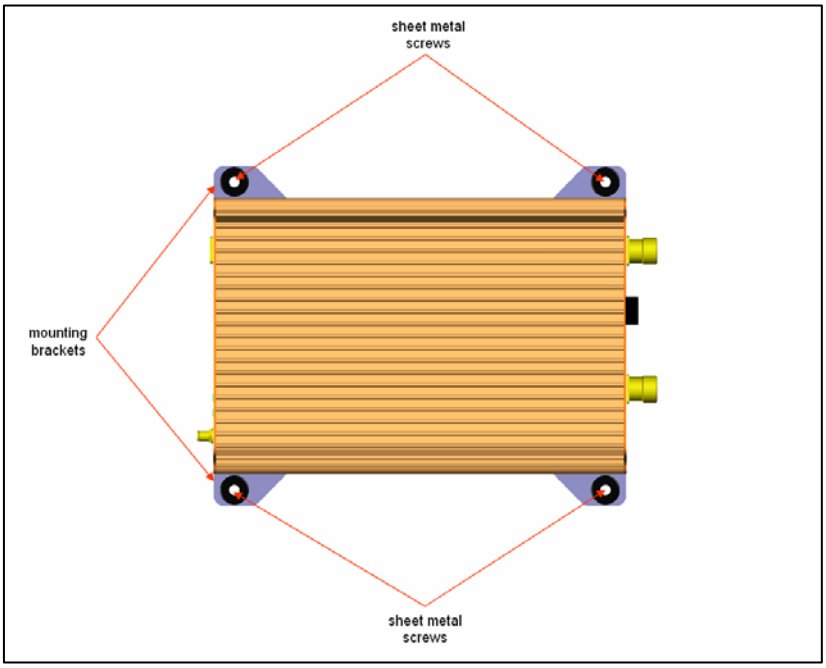


Figure 5: High Speed Mobile Radio Mounting

If less than four (4) screws are used, the mobile radio can become loose in the trunk compartment. This may cause the mobile radio not to function properly.

When inserting screws, be careful not to disturb the vehicle's gas tank.

Serial Cable Connection and Routing

The serial cable connects the mobile radio to the mobile computer located in the driver compartment.

To connect the serial cable, perform the following steps:

Step 1 Attach the 20-foot serial cable male connector (DB9M) to the mobile radio.

Figure 6

Step 2 Route the female connector (DB9F) to the driver compartment and connect to the serial port located on the rear of the mobile computer.

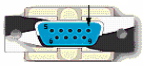


Figure 7

✎ Route the serial cable to minimize foot pressure and other potential stresses. Use split loom tubing and nylon cable ties for cable protection.

Ethernet Setup

The user also has the option to connect the mobile radio and the mobile computer via Ethernet.

To connect the Ethernet cable, perform the following steps:

Step 1 Attach the Ethernet cable (minimum 20 feet) to the Ethernet port on the rear of the mobile radio.

Step 2 Route the other end of the Ethernet cable to the driver compartment and connect to the Ethernet port located on the rear of the mobile computer.

✎ Route the cable to minimize foot pressure and other potential stresses. Use split loom tubing and nylon cable ties for cable protection.

Delay Timer Installation

To install the Delay Timer, perform the following steps:

Step 1 Secure Delay Timer to the trunk compartment of the vehicle inserting screws in the appropriate locations using care not to puncture the vehicle's gas tank.

Step 2 Route the black wire (#12 AWG) from ground connection on the Delay Timer to the vehicle chassis (see Figure 8).

Step 3 Route and wire the red wire (#8 AWG) from the positive (+) terminal connection on the vehicle battery connection via the in-line fuse toward the battery connection on the Delay Timer.

Connect the red wire (#8 AWG) to the two red wires (#12 AWG). Route and wire the red (#12 AWG) wires to the two (2) battery connections on the Delay Timer.

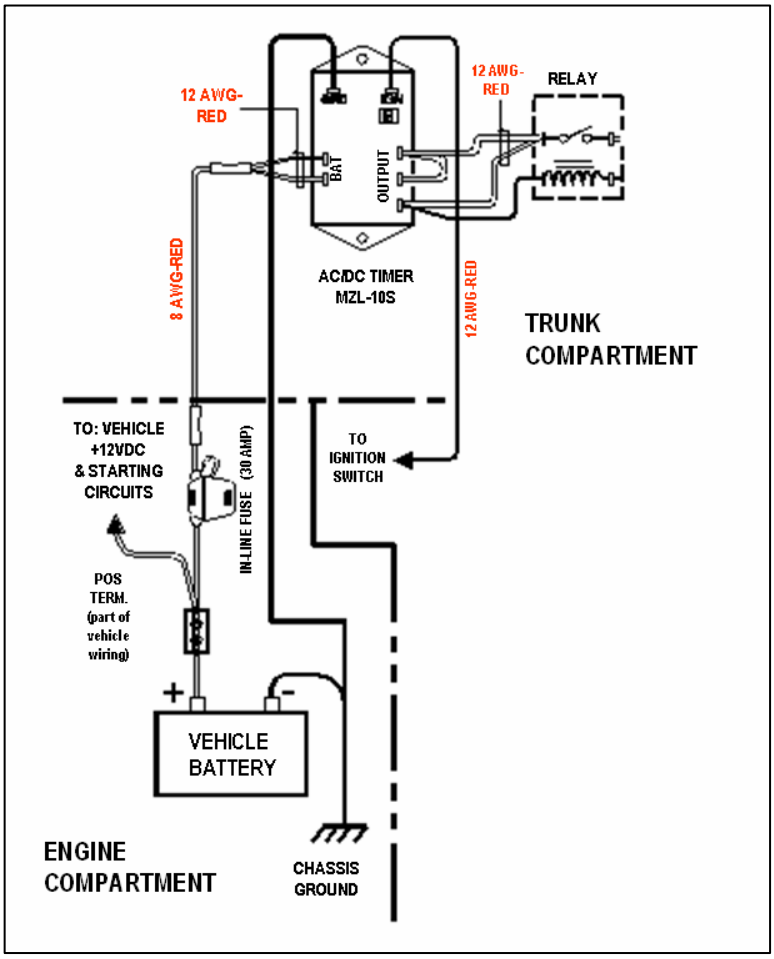


Figure 8: Delay Timer Installation

Step 4 Route a red wire (#12 AWG) from the ignition connection on the Delay Timer to the ignition switch in the driver compartment (see the figure above). The ignition wire should be fused with 2A fuse.

Step 5 Route a red wire (#12 AWG) from the first and last output connections on the Delay Timer to the Automotive Power Relay.

Step 6 Route and wire a red (#12 AWG) wire from the second output connection on the Delay Timer to the last output connection on the Delay Timer.

Step 7 Route and wire a red (#12 AWG) wire from the last output connection on the Delay Timer to the Automotive Power Relay coil at the position shown in the figure above.

Step 8 Route and wire a black (#8 AWG) wire from the junction (negative battery post group) in the trunk compartment to the negative (-) terminal on the vehicle battery.

Step 9 Wire the red (#12 AWG) wire to the battery input on the Delay Timer and route the black (#8 AWG) portion of the wire to the positive terminal on the battery via an in-line fuse (30 AMP).

Switch Installation (DPST Heavy Duty Toggle)

To install the switch, perform the following steps:

Step 1 Mount the switch in the selected location.

Step 2 Route and wire a red wire (#12 AWG) from the switch to the Automotive Power Relay (see the figure below).

Step 3 Ground the switch by routing and wiring a black wire from the switch to the chassis ground.

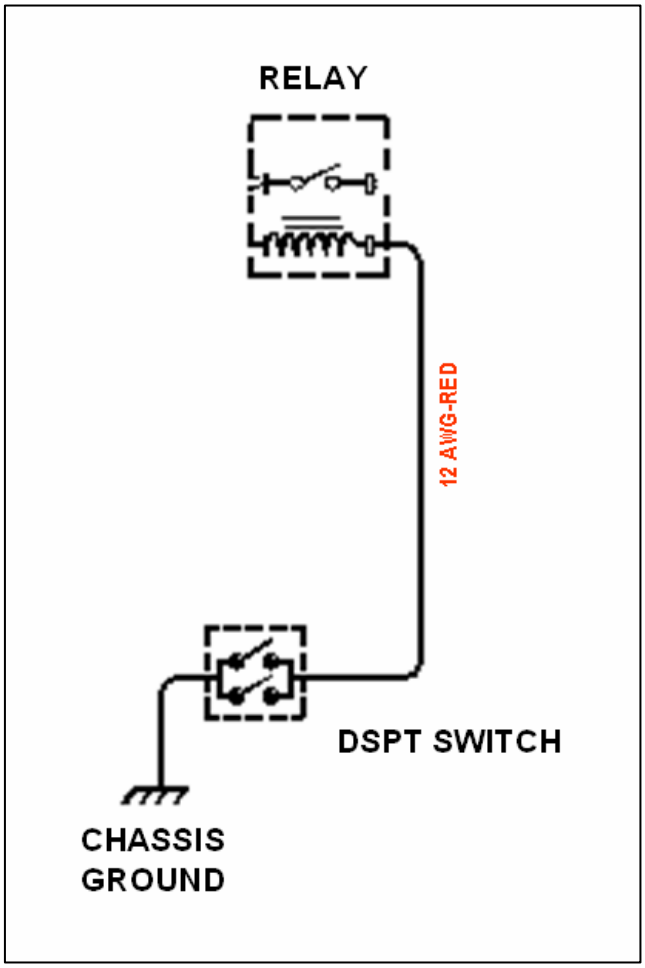


Figure 9: Carling Switch Installation

Mobile Radio Power Supply Installation

To install the mobile radio power connection, perform the following steps:

Step 1 Route and connect the power cable to the EMI filter, as shown in the figure below.

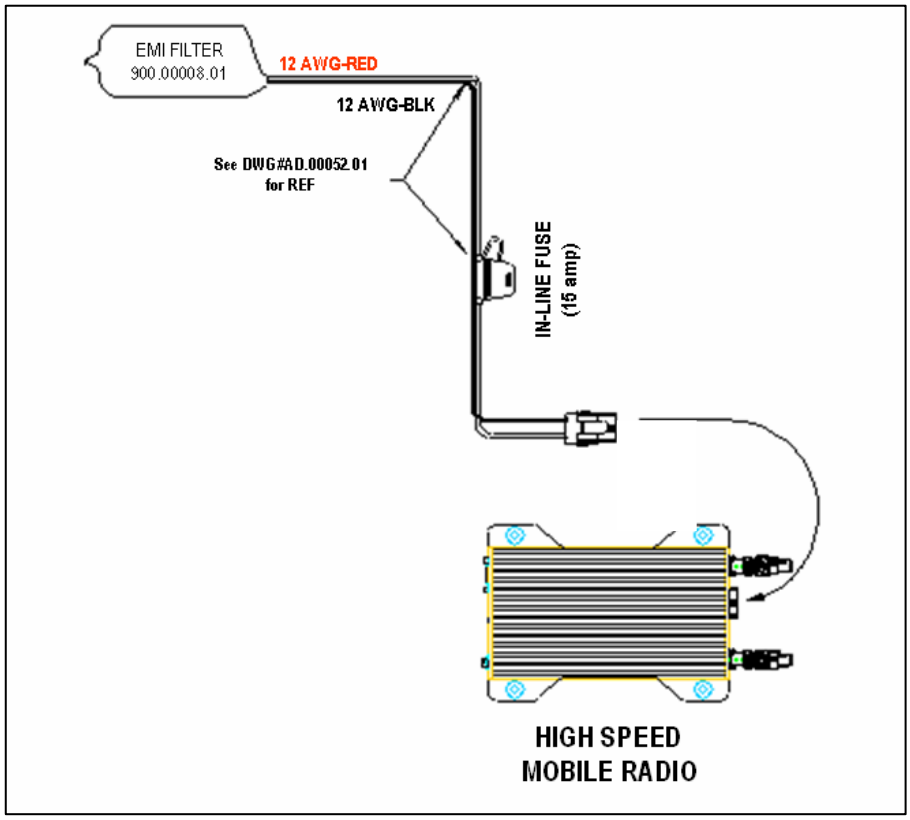


Figure 10: Power Supply Installation

Step 2 Route and connect the other end of the power cable to the rear of the mobile radio to the power connector (13.8 VDC) connection.

WARNING! **Do not** connect power before installing and connecting proper antenna or dummy load on the TX/RX1 port. The mobile radio must never be allowed to transmit without a suitable output load.

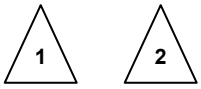
Step 3 Install the GPS antenna. The GPS antenna is required for the mobile radios and the base stations.

Antenna Configuration

Two (2) antennae are mounted and installed on the roof of the vehicle using specific measurements for distance.

To mount and install the antennae, perform the following steps:

Step 1 Install antennae (see the figure below).



Observe correct separation between antennae (refer to Table 7: Mobile Antenna Distance Matrix). This table provides midpoint distance calculations and minimum and Near-Field Exclusion Zone (NFEZ) for proper diversity reception.

The NFEZ distance is an absolute minimum. The greater the distance between the antennae to any other surfaces will result in improved performance.

Step 2 Cut a mounting hole in the roof of the vehicle using an electric drill or hole saw.

The antenna-mounting hole provides ground connection to the antenna. Ensure that a metal-to-metal connection between the antenna shields exists.

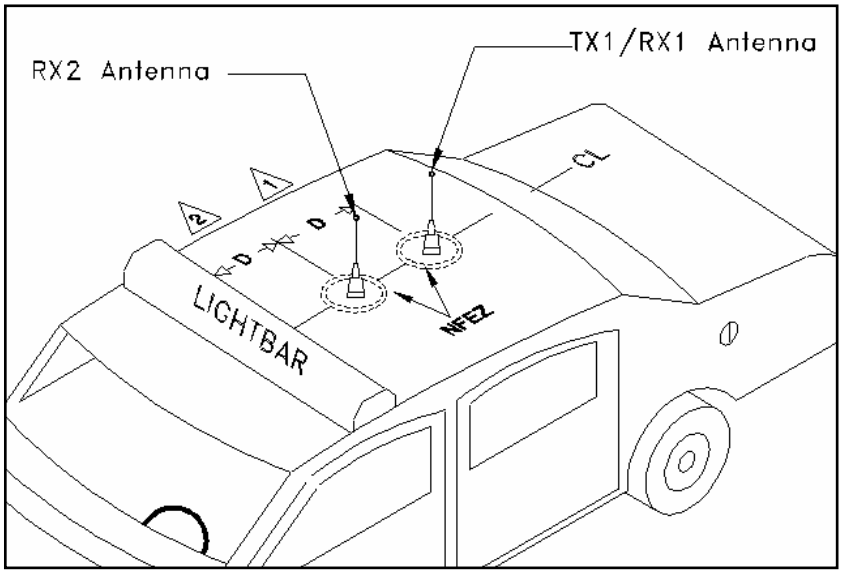


Figure 11: Antenna Distance Configuration

The previous figure represents the recommended front-to-rear antenna installation. The receiver antenna (RX2) should be the antenna nearest to the light bar.

Step 3 All antenna mounts must be environmentally tight. Install or use O-rings to seal the antenna base to the rooftop of the vehicle.

Step 4 Route the coaxial cables to the mobile radio through one of the hollow spaces in the roof supports into the trunk compartment where the mobile radio is mounted.

Both antennae should be checked and tested to ensure they are functioning properly.

If these installation guidelines are followed, it will be safe for persons to stand at a distance no less than 39 inches from the antennae while the mobile radio is in transmit mode.

Measuring Return Loss

The following test is performed without any power, thus can be performed immediately after the installation of the coax and antenna, following the installation of the N-type connector on the coax.

To measure Return Loss, perform the following steps:

Step 1 Select the appropriate Antenna Analysts to perform the test.

Step 2 Connect the antenna to be tested to the Antenna Analyst.

Step 3 Turn on the Antenna Analyst and the Return Loss (RETL) is displayed in dB to the left of the Voltage Standing Wave Ratio (VSWR) curve.

The Return Loss Specification is –14 dBm or greater (with good antennae the typical range will be between –14 dBm and –28 dBm).

Measuring Voltage Standing Wave Ratio

To measure the Voltage Standing Wave Ratio (VSWR) Reflected Power, perform the following steps:

Step 1 After selecting the appropriate Analyst and connecting the antenna to be tested, press **F1** to access the Analyst Menu.

Step 2 Press **F1** again to access the Display (DSPLY) menu, which lists the modes.

Step 3 Press **F2** to select the VSWR display mode. Plotting will resume and the VSWR value is highlighted.

The VSWR Reflected Power Specification should be at a ratio of approximately 1.6 to 1.

Measuring Insertion Loss

To measure Insertion Loss of an unterminated length of coax, perform the following steps:

Step 1 Connect the antenna to be tested to the appropriate Antenna Analyst.

Step 2 Turn on the Antenna Analyst and the Return Loss is displayed in dB to the left of the VSWR curve.

✎ To switch from the RETL mode to VSWR mode, refer back to the previous set of instructions.

Step 3 Divide the result by two (2).

Post Installation Checklist

Table 6 lists the tasks that should be performed upon completing installation.

TABLE 6: POST INSTALLATION CHECKLIST

NO.	CHECKLIST ITEM	☑
1	Scope out the entire vehicle setup to locate any obvious problem areas.	☐
2	Check wiring for safety concerns.	☐
3	Use tie wraps to ensure that all wires routed in parallel are bundled together.	☐
4	Check to see if any wires are exposed.	☐
5	If any wires are exposed, use electrical tape to cover. ✎ When covering wires in the engine compartment, use high-quality electrical tape.	☐
6	Perform appropriate testing as described in this manual to ensure mobile radio works properly.	☐

Once installation is completed, remove all debris and restore dismantled parts and rubber mats to appropriate locations.

Mobile Installation Layout Diagrams

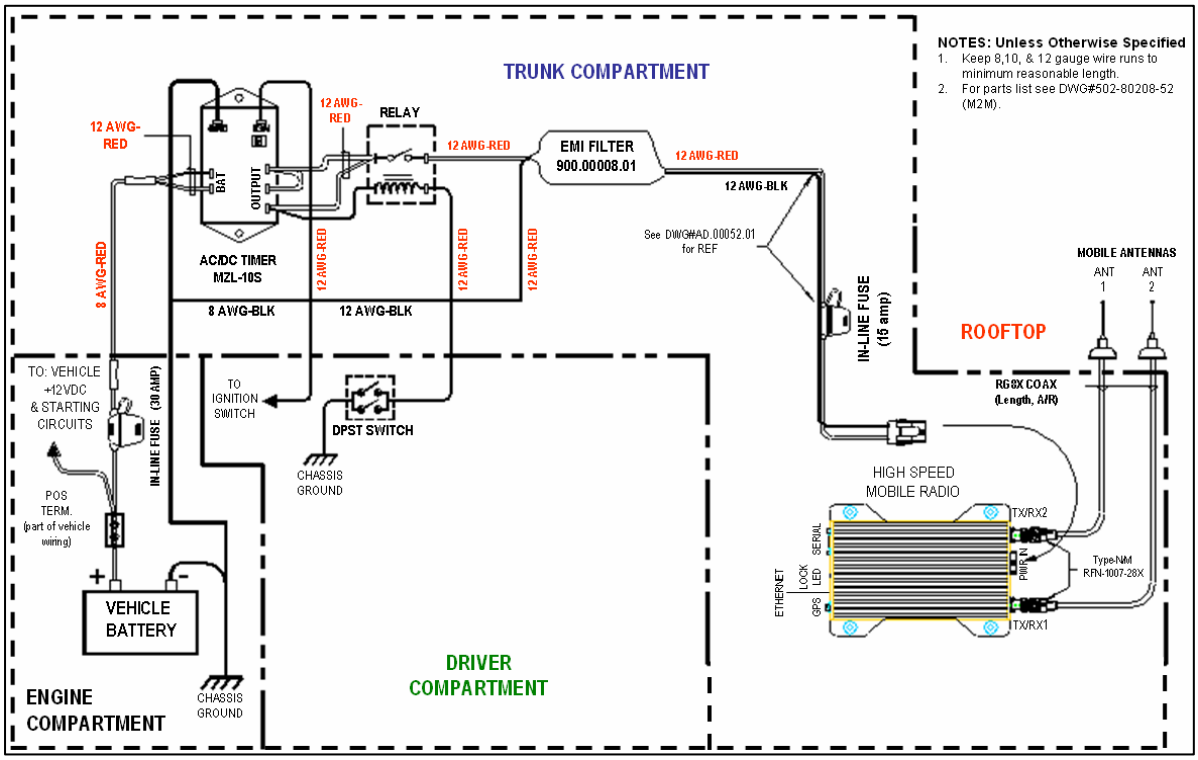


Figure 12 Vehicle Unit Wiring Interconnection Layout

Table 7 lists the mobile radio antenna distances by frequency band.

TABLE 7: MOBILE ANTENNA DISTANCE MATRIX

Frequency Band in MHz	Center Frequency in MHz	Antenna Spacing for ¼ Wave Ant (inches)	Wavelength (inches)	Near-Field Exclusion Zone* (inches)	¼ Wave Length (inches)
130-140	135	65.4	87.3	10.9	21.8
140-150	145	61.2	81.4	10.2	20.4
150-160	155	57.0	76.2	9.5	19.0
160-174	167	53.1	70.7	8.9	17.7
450-470	460	19.2	25.7	3.2	6.4
470-490	480	18.6	24.6	3.1	6.2
490-512	501	17.7	23.6	2.9	5.9
764-784	774	11.4	15.26	1.91	3.81
784-804	794	11.2	14.88	1.86	3.72
806-821	814	10.8	14.5	1.8	3.6

*NFEZ = Minimum Near-Field Exclusion Zone

**Round antenna spacing to the nearest ⅛”

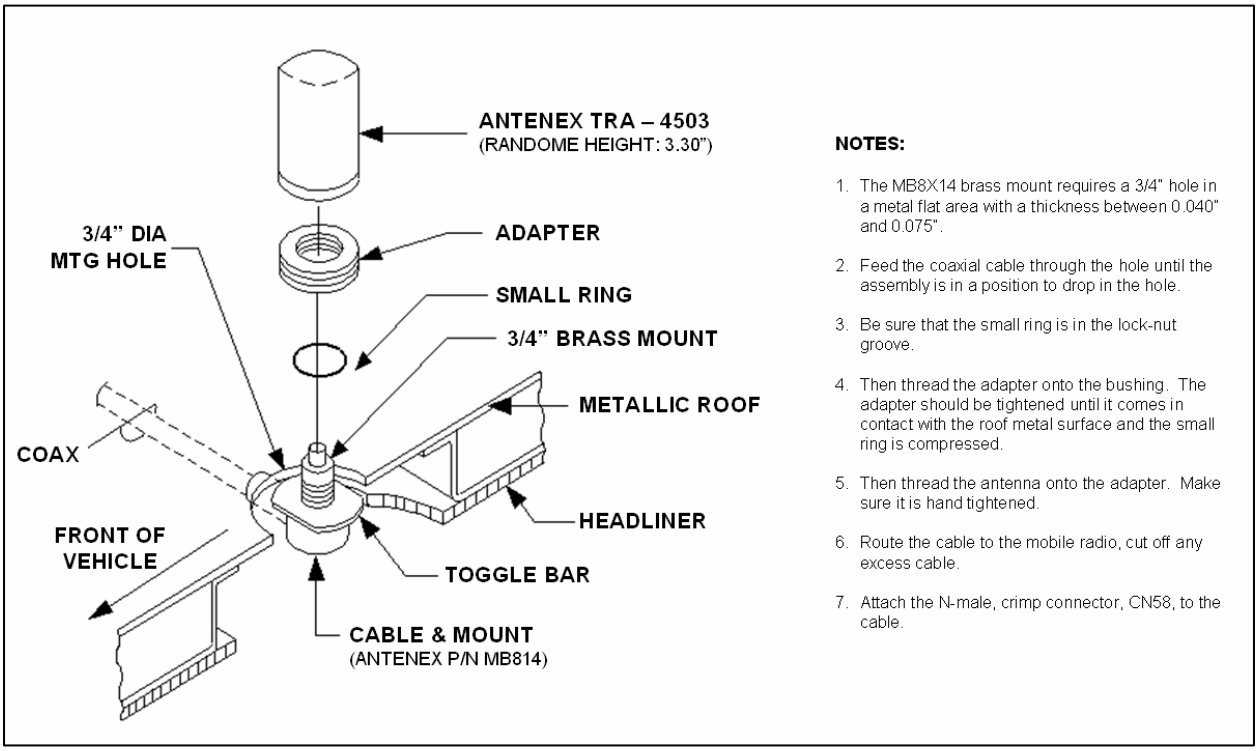


Figure 13 Diversity Antenna Mobile Installation Detail (Typical Installation)

Preliminary Testing and Troubleshooting

This section provides a functional preliminary test for the mobile radio once installed. It is used to determine the condition of new mobile radios before being placed into service.

Checklist of Required Material

The table below provides a checklist of the tools and equipment required to perform the preliminary test procedure.

TABLE 8: CHECKLIST OF REQUIRED MATERIAL TO PERFORM PRELIMINARY TESTING

NO.	REQUIRED TOOLS/EQUIPMENT	☑
1	*IP*Series High Speed Mobile Radio installed in the vehicle as previously described in this section	☐
2	A laptop with an available serial communication port and Microsoft Windows 98 or greater installed	☐
3	*IP*MobileNet Dial-Up Networking and *IP*Message software loaded onto the laptop (SLIP2IPMN.exe)	☐
4	DC power supply with ammeter, 13.8V, 12 amps or more (Astron VS12M or equivalent)	☐
5	Corresponding calibrated *IP*Series Base Station	☐
6	Internet Protocol Network Controller (IPNC)	☐
7	Two antennae (generic mag mounts) tuned to frequency of transceiver	☐
8	Serial cable DB9M – DB9F connectors (IPMN p/n: 156.0245.020)	☐
9	RF Attenuator 10-20 dB with appropriate wattage rating for transceiver	☐

Base Station Setup for Testing

The system must be programmed with the customer's parameters before any tests are made on the mobile radio.

To prepare the base station to be used in the mobile radio test, perform the following steps:

Step 1 On the laptop at the Windows desktop, click on the **Start** button and select **Accessories**, **Communications**, and **HyperTerminal**.

Step 2 Power up the base station.

First-time users must enter the customer's operating parameters into the base station with *HyperTerminal* (*refer to the IPSeries High Speed Base Station System Manual for instructions and the client's system documentation for parameters*).

Ensure that the calibrated base station and the mobile radio antennae are separated by at least 10 feet. If the antennae are too close, the mobile radio receivers may be overloaded by the transmitters resulting in intermittent communications and high data errors.

Preliminary Test Procedure and Troubleshooting

Prior to performing this procedure, the IPNC IP address must be known. Note taking during preliminary testing is crucial to ensure necessary information is gathered to use for additional testing or if the mobile radio needs to be submitted for repair.

To test mobile radio functionality, perform the following steps:

Step 1 Perform a visual inspection of the mobile radio and its connections. Validate that all connectors and power cables are in good condition and all chassis screws are in place.

Step 2 Connect the mobile radio as shown in the figure below.

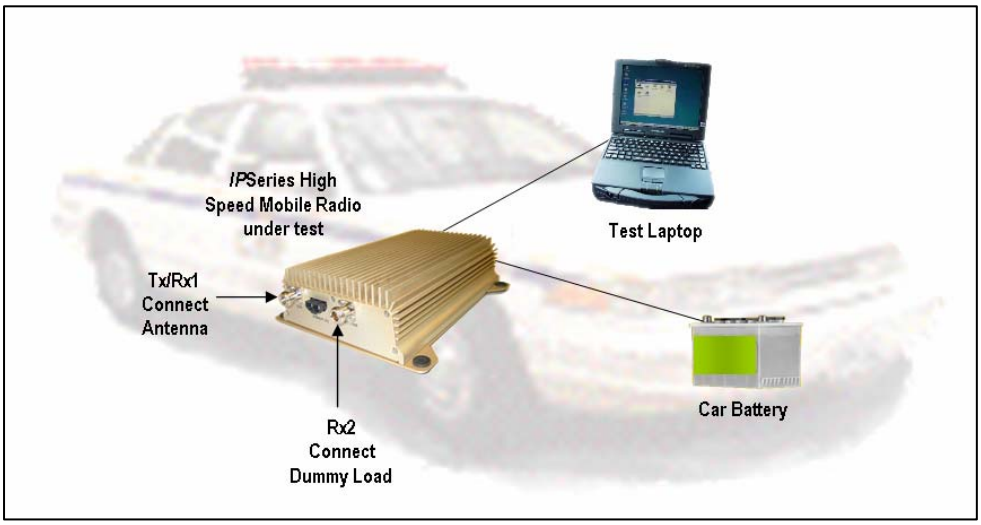


Figure 14 High Speed Mobile Radio Connection for Testing

Step 3 Power on the mobile radio and the test laptop. The power supply ammeter must read 1.0 amp or less with a 13.8 VDC output.

Step 4 At the desktop, run the dial-up connection setup to use Serial Line Internet Protocol (SLIP) by double clicking on the **SLIP2IPMN** shortcut.

The SLIP2IPMN dial-up network shortcut displays as an icon on the laptop's desktop. If the SLIP2IPMN shortcut is not available on the desktop, consult the ***Mobile Data Computer for Communication with the Mobile Radio Installation Guide*** (IPMN p/n: 516-80310.IG) for instructions on how to set up the connection.

Step 5 At the desktop, run the *IP*Message Utility by double clicking on the ***IP*Msg** shortcut. The *IP*Message window displays.

🛠 *If a message window appears indicating the connection was unsuccessful, perform the following troubleshooting steps:*

1. *Ensure the serial and power cables are properly connected.*
2. *Verify that the mobile radio lock LED (light emitting diode) is on, indicating the mobile radio has power.*
3. *Ensure that the SLIP2IPMN dial-up connection is running.*
4. *If problem persists after retrying, replace the serial cable with one that is known to be working properly.*

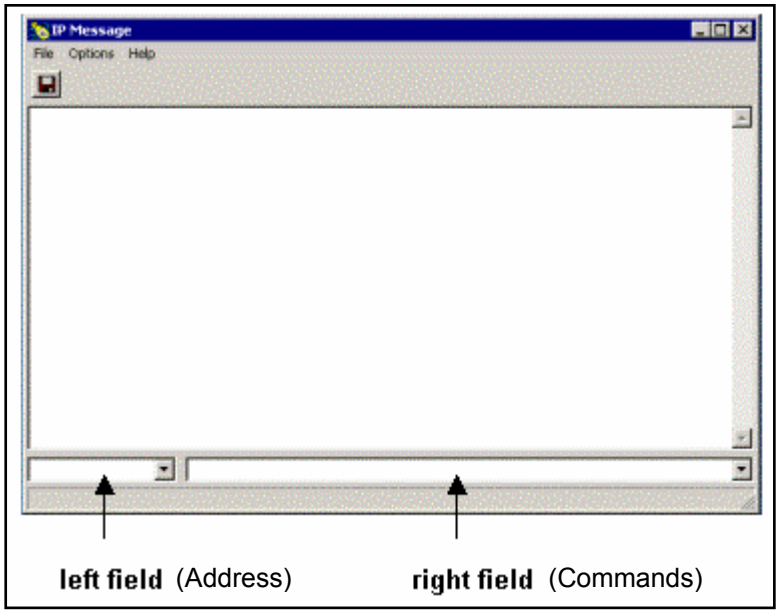


Figure 15*IP*Message Window

Step 6 In the *IP*Message window in the left field, enter the mobile radio's IP address and press the **[TAB]** button. If the mobile radio IP address is not known, enter 255.255.255.255 in the left field.

Step 7 In the right field type a **?** and click the **[ENTER]** button. A list of mobile radio configuration parameters appears in the upper message window. This verifies that the IP address is correct, the mobile radio's serial interface is live, and that the mobile radio's microcontroller section is active.

🛠 *If the upper message window only displays **"To [IP address] ?"**, communication has not been established. Validate the IP address.*

Step 8 At the desktop, click on the **Start** button and select **Programs** and **MS-DOS Prompt**. The MS-DOS window displays.

Step 9 Ping the IPNC commanding the transmitter to send 25 messages of 500 characters each to the IPNC as well as a response through Receiver 1 back to the laptop or desktop PC by typing in the following command at the MS-DOS prompt replacing NNN.NNN.NNN.NNN with the IPNC IP address:

Ping NNN.NNN.NNN.NNN –n 25 –l 500 –w 4000

After entering the command, press **[ENTER]** to continue.

✎ When entering a command, pay special attention to the spaces and the characters being typed.

🛠 *If the calibrated base station does not respond, check the syntax of the Ping command and verify the IP address is correct.*

If the ping command runs but high packet loss figures are shown, perform the following:

1. *Verify that the calibrated base station and mobile radio antennae are separated by at least 10 feet. If the antennae are too close, the mobile radio receivers can be overloaded by the transmitters resulting in intermittent communication and high data errors.*

2. *Verify the calibrated base station parameters are correct for the mobile radio. Such parameters include IP addresses and complementary RX/TX frequencies.*

3. *Check to ensure the data and power cables are connected correctly.*

4. *If the Ping command continues to fail, test using a mobile radio that is known to be working properly.*

Step 10 Check the test laptop and verify that the Packets Lost Percentage is zero to 1% packet loss. Greater losses may indicate a problem with the transmitter/receiver 1, or modem circuitry.

Step 11 Change the antenna on the mobile radio to the RX2 antenna input.

Step 12 Connect the RF attenuator to the mobile radio's TX/RX1 antenna input.

Step 13 Connect the second antenna to the RF attenuator. In the *IP*Message window, enter **receiver=2**. This will allow the mobile radio to only receive via Receiver 2.

Step 14 Type the following command at the MS-DOS prompt replacing NNN.NNN.NNN.NNN with the IPNC IP address:

Ping NNN.NNN.NNN.NNN –n 25 –l 500 –w 4000

After entering the command, press **[ENTER]** to continue**.**

Step 15 Check the test laptop and verify that the Packets Lost Percentage is zero to 1% packet loss. Greater losses may indicate a problem with the receiver 2, or modem circuitry.

Confirming High Speed Mobile Radio Receiver Sensitivity

This set of instructions provides the user with a list of required equipment and steps needed to confirm mobile radio Receiver sensitivity.

Requirements

- *IP*Series High Speed Mobile Radio
- DC power supply, 13.8V, 12 amps or more (Astron VS 12M or equivalent)
- Desktop or laptop computer with *IP*Message installed
- Agilent HP 8920A or B Service Monitor
- Serial cable DB9M – DB9F connectors (generic)

To confirm mobile radio receiver sensitivity, perform the following steps:

Step 1 Connect the mobile radio to the recommended power supply, the desktop or laptop computer, and the service monitor.

Step 2 Turn on the mobile radio.

Step 3 Connect the serial cable or Ethernet interface to the mobile radio and the desktop or laptop computer.

Step 4 Start the connection to the mobile radio.

Step 5 Start the *IP*Message utility.

Step 6 At the *IP*Message window, enter the mobile radio IP address and press **[ENTER]**.

Step 7 At the *IP*Message window, enter **unlock=password** (entering the assigned password) and press **[ENTER]**.

Step 8 Send the following test mode command at the *IP*Message window, by entering **testmode=1** and press **[ENTER]** to continue.

Step 9 Generate an on frequency, modulated (1000 Hz @ 5 kHz dev) signal to Receiver 1 at –100 dBm.

Step 10 At the *IP*Message window, type **noise** and press **[ENTER]** to continue.

Step 11 Confirm that the noise level for Receiver 1 is +/- 2dB of the –100 dBm level.

Repeat the same steps for Receiver 2.

Equipment List

The following table lists the equipment required to perform the M64450G25 Mobile Radio Factory Test Procedure:

TABLE 9: EQUIPMENT REQUIRED TO PEREFORM FACTORY TEST PROCEDURE

QTY	DESCRIPTION	MANUFACTURER	MODEL
2	PC's One for Mobile One for Base	Windows 9X w/ *IP*Message AVR	
1	Service Monitor – Communication Test Set	HP	HP8920B or equivalent
1	Digital multimeter	Tektronix Fluke	77 or equivalent
1	DC power supply w/ ammeter, 13.8V, 20 Amps or more	Astron	RM35A
1	4-Channel Scope	Tektronix	TDS 460A
1	IPSeries High Speed Mobile Radio		M64450G25
1	Calibrated IPSeries High Speed Base Station		B64450G25
1	Internet Protocol Network Controller (IPNC)		
1	100 watt dummy load/attenuator	Pasternack	PE7021-40 or equivalent
2	UHF Antennae (generic mag mount)		
1	Serial cable DB9M-DB9F connectors		IPMN p/n: 156-0245-020
1	IP power cable		IPMN p/n: 502-82017-52
1	3-foot RF jumper cable with type N connectors (generic)		
1	High Frequency Probe		
1	Ceramic tuning tool		IPMN p/n: 44010006
1 ea	#0, #1, and #2 Phillips screwdrivers (generic)		

Programming and Configuring Mobile Radio

Once the appropriate equipment for performing the factory test are gathered, perform the following steps to program and configure an M64450G25 Mobile Radio:

Step 1 Enter the mobile radio serial number, date test being performed, and tester's name on the ***Test Data Sheet (see Appendix B)***.

Step 2 Program the radio to the current Firmware revision using the AVR programming utility.

Step 3 Connect a PC to the radio and launch the *IP*Message program. In the *IP*Message window, type **`factory default`**, press **[ENTER]**, and the radio displays the radio's default values.

Step 4 Enter the appropriate values for the radio's frequency band. The following values were used for a 450-506 MHz mobile radio:

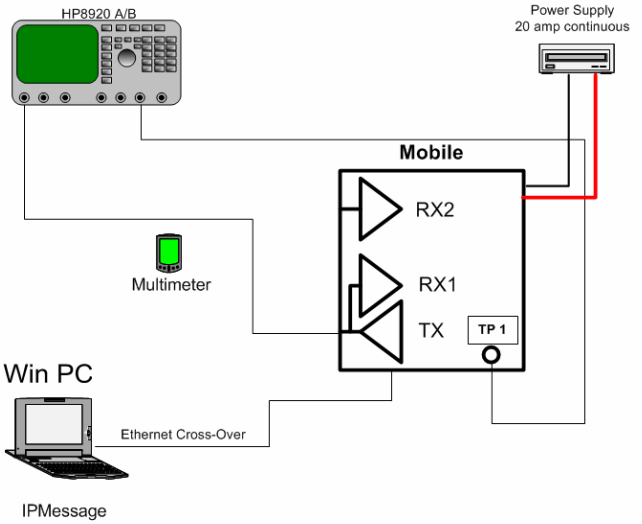
```
[From: 172.16.22.10] Host serial = 115200,N,8,1, timeout=200
[From: 172.16.22.10] Model = HS800
[From: 172.16.22.10] Host framing = Ethernet, no status messages
[From: 172.16.22.10] Channel = 0
[From: 172.16.22.10]        Channel      Tx freq          Rx freq          Inj freq
[From: 172.16.22.10] Frequency= 0, 450.000000, 463.000000, 418.000000
[From: 172.16.22.10] IP Address = 172.16.22.10, Netmask = 255.255.255.0 (VIU = 0.0.0.0, PC = 172.16.20.10)
[From: 172.16.22.10] IPNC = 255.255.255.255
[From: 172.16.22.10] PC netmask = 255.255.255.0
[From: 172.16.22.10] Radio MAC Address = 00:08:ce:00:00:00
[From: 172.16.22.10] Injection = LOW SIDE,   45.0000 MHz
[From: 172.16.22.10] Serial number: undefined
[From: 172.16.22.10] TX Power = 150
[From: 172.16.22.10] TX quiet time = 5
[From: 172.16.22.10] TX sync time = 12 milliseconds
[From: 172.16.22.10] TX tail time = 5
[From: 172.16.22.10] Tx delay = 2 slots
[From: 172.16.22.10] Radio data rate = 32000
[From: 172.16.22.10] PLL load to txkey delay = 2 milliseconds
[From: 172.16.22.10] Carrier detect delay time = 7 milliseconds
[From: 172.16.22.10] roam status time = 1800 seconds, type = 1
[From: 172.16.22.10] roam lost time = 60 seconds
[From: 172.16.22.10] Polarity = TX-, RX-
[From: 172.16.22.10] RSSI step = 12   (=234mV)
[From: 172.16.22.10] num timeslots = 24
[From: 172.16.22.10] timeslot period = 984ms
[From: 172.16.22.10] timeslots per voice packet = 4
[From: 172.16.22.10] noise = -117dBm, -117dBm
[From: 172.16.22.10] receiver = auto
[From: 172.16.22.10] Receiver Hysteresis = 0
[From: 172.16.22.10] diversity speed = 4
[From: 172.16.22.10] 12dB SINAD = -117dBm (63 on RX0)
[From: 172.16.22.10] 12dB SINAD = -117dBm (9 on RX1)
[From: 172.16.22.10] 30dB S/N = -106dBm (96 on RX0)
[From: 172.16.22.10] 30dB S/N = -102dBm (93 on RX1)
[From: 172.16.22.10] 40dB S/N = -100dBm (110 on RX0)
[From: 172.16.22.10] 40dB S/N = -94dBm (128 on RX1)
[From: 172.16.22.10] -40dBm = (225 on RX0)
[From: 172.16.22.10] -40dBm = (227 on RX1)
[From: 172.16.22.10] Modem FEC = on
[From: 172.16.22.10] Suspend Tx = 90 seconds
[From: 172.16.22.10] DHCP Client disabled
[From: 172.16.22.10] DHCP Server enabled
[From: 172.16.22.10] diag message level = 2
[From: 172.16.22.10] TFTP options = 256 (block size), 3 (interval)
[From: 172.16.22.10] Reference Frequency =   16.800000 MHz
[From: 172.16.22.10] MTU = 1480
[From: 172.16.22.10] 06 Feb 2036 22:28:30 (PST), calibration=-236
[From: 172.16.22.10] uptime = 0h:00m:14s
[From: 172.16.22.10] Radio Firmware Rev. 35-01.000.003, Sep  7 2004 - 17:33:10
[From: 172.16.22.10] Temp period = 2s
[From: 172.16.22.10] Temp Maximum = 80C
[From: 172.16.22.10] Comparison Frequency = 400000 Hz
[From: 172.16.22.10] Reflected power limit = 20
```

Test Connections

Test Equipment Setup

The test equipment should be configured as shown in the figure below:

Figure 1. Standard Bench Test Setup for Mobile



Mobile Radio Connections

Perform the following steps to connect the mobile radio properly:

Step 1 Connect the GPS antenna.

Step 2 Connect a serial cable and launch IPMessage.

Step 3 Connect a load to the transmitter antenna port.

Step 4 Connect the power cable to a voltage source of 13.8 VDC able to deliver 25 amps of continuous current.

Step 5 Apply power to the mobile radio.

Step 6 Verify the IPMessage connection by entering the **"?"** in the IPMessage command field and pressing **[ENTER]**.

Receiver Alignments and Tests

TCXO Operation

Perform the following steps to check the operation of the TCXO:

Step 1 In IPMessage, type "**status = pps, cal**" in the command field and press **[ENTER]**.

Step 2 Read the reported error values for the TCXOs.

Step 3 Continue using the "status = pps, cal" command, until GPS is acquired.

Step 4 Repeat the command observing the error values.

Step 5 Observe that the TCXO "error ppb" continues to adjust until it settles at +/-200.

Step 6 Enter the "error ppb" data onto the Tune and Align Data Sheet.

Receiver Injection

Perform the following steps to make sure the receiver injection is locked on frequency:

Step 1 Connect a coaxial cable from the Service Monitor "RF Input" port to the "RX2" port on the mobile radio.

Step 2 Place the Service Monitor in the "Tx" mode.

Step 3 Set the Service Monitor to the base station's Receiver Injection frequency.

Step 4 Adjust the squelch on the Service Monitor until the frequency error is displayed.

Step 5 When the injection frequency stabilizes record the frequency error on the Tune and Align Data Sheet.

✎ At this time the Operator is able to proceed with the other adjustments and alignments.

45 MHz Filters Waveform

Perform the following steps to set the Waveform for the 45 MHz filters:

Step 1 Set the Service Monitor with the following selections:

- Select the spectrum analyzer function
- Set the center frequency for 45 MHz
- Set the amplitude to -20 dBm
- Set the Span to 100 kHz
- Choose "Controls…RF Gen"
- Set to "Track" to enable the tracking generator
- Set the "RF Gen Freq" to equal the radio receive frequency minus 45 MHz
- Set "Amplitude" to -30 dBm
- Set the "Output Port" to "DUPL" to select the duplex out port

Step 2 Connect a High Frequency Probe to "Ant In" port on the Service Monitor.

Step 3 Adjust Receiver 1 filters.

- Connect an RF cable from the “Duplex Out” port to Receiver 1
- Probe U64 pin 1 with the High Frequency Probe
- Adjust CV12, CV5, and CV8 for the correct waveform as shown in the figure below

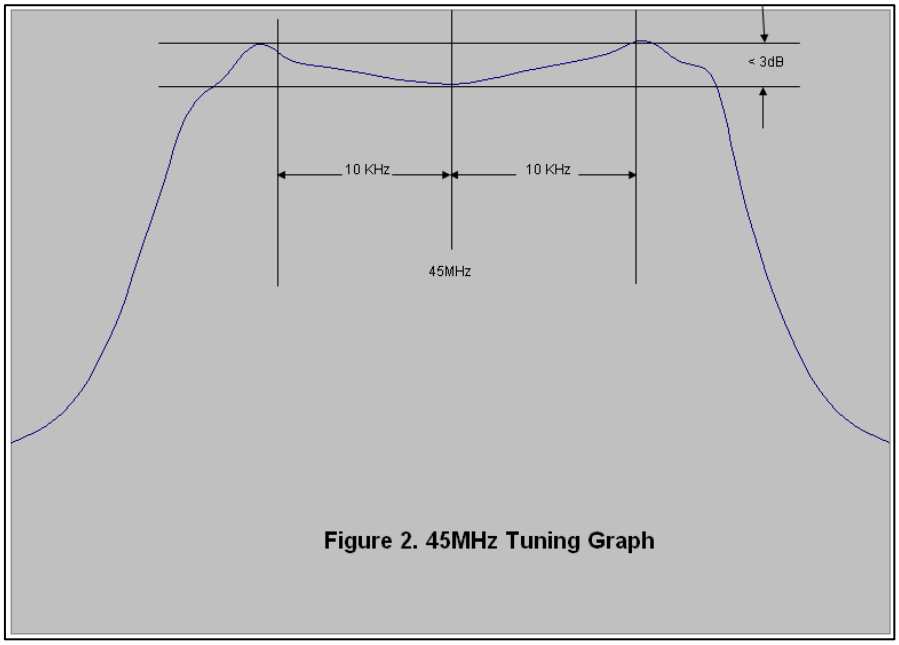


Figure 2. 45MHz Tuning Graph

Step 4 Adjust Receiver 2 filters.

- Connect an RF cable from the “Duplex Out” port to Receiver 2
- Probe U48 pin 1 with the High Frequency Probe
- Adjust CV9, CV2, and CV7 for the correct waveform as shown in the figure above

Reciever 12 dB SINAD

Perform the following steps to adjust Receiver 12 dB SINAD:

Step 1 Set the Service Monitor, as follows:

- Select the “RX” function
- Set “RF Gen Freq” to the receive frequency of the mobile radio under test
- Set the Service Monitor to display SINAD readings
- Set other values as follows:

Amplitude: *Varies*	AFGen1 Freq: 1.000 kHz	AFGen2 Freq: 1.000 kHz
Atten Hold: Off	AFGen to: FM 5 KHz	AFGen2 to: Off
Output Port: RF Out		Ext Load R: 600 ohm
Filter 1: 300 Hz HPF		
Filter 2: 3 kHz LPF		

Step 2 Test Receiver 1, as follows:

- Connect an RF cable from the Service Monitor's "RF Out" port to the antenna port of Receiver 1
- At the Service Monitor, reduce the "Amplitude" until the SINAD meter indicates 12 dB SINAD

The amplitude must be -115 dBm or less. If necessary, adjust CV12 slightly to improve 12 dB SINAD reading.

Step 3 Test Receiver 2, as follows:

- Connect an RF cable from the Service Monitor's "RF Out" port to the antenna port of Receiver 2
- At the Service Monitor, reduce the "amplitude" until the SINAD meter indicates 12 dB SINAD

The amplitude must be -115 dBm or less. If necessary, adjust CV9 slightly to improve 12 dB SINAD reading.

Receivers Minimum Distortion

Perform the following steps to adjust the receivers for minimum distortion:

Step 1 Set the Service Monitor, as follows:

- Select the "RX" function
- Set the "RF Gen Freq" to the receive frequency of the mobile radio under test
- Set the Service Monitor to display distortion readings
- Set other values as follows:

Amplitude: -80 dBm	AFGen1 Freq: 1.000 kHz	AFGen2 Freq: 1.000 kHz
Atten Hold: Off	AFGen to: FM 5 KHz	AFGen2 to: Off
Output Port: RF Out		Ext Load R: 600 ohm
Filter 1: 300 Hz HPF		
Filter 2: 3 kHz LPF		

Step 2 Adjust Receiver 1, as follows:

- Connect an RF cable from the Service Monitor's "RF Out" port to the antenna port of Receiver 1
- Observe the Service Monitor while adjusting CV4 for minimum distortion – Distortion must read 3.0% or less
- Record the distortion on the Tune and Align Data Sheet

Step 3 Adjust Receiver 2, as follows:

- Connect an RF cable from the Service Monitor's "RF Out" port to the antenna port of Receiver 2
- Observe the Service Monitor while adjusting CV1 for minimum distortion – Distortion must read 3.0% or less
- Record the distortion on the Tune and Align Data Sheet

Data Quality and Message Success Rate

Perform the following steps to adjust receiver data quality and Message Success Rate (MSR):

Step 1 Connect the base station to an IPNC via SLIP cable (an Ethernet connection will be used during Message Success Rate Testing).

Step 2 Connect a mobile radio with known good transmitter data quality in the test set up. Allow the mobile radio to connect to the base station.

Step 3 Run IPLinkView or ping the mobile radio from the IPNC.

Step 4 Set the uplink RSSI at -93 +/- 3dBm.

Step 5 Connect the mobile test setup receive cable to each of the two (2) receivers in turn.

Step 6 On each receiver, run a minimum of 50 packets in IPLinkView or 50 pings.

✎ The Data Quality of each receiver must average at least 220 over 50 contiguous samples.

Step 7 For Receiver 1, if necessary adjust CV8 slightly to improve Data Quality.

Step 8 For Receiver 2, if necessary adjust CV7 slightly to improve Data Quality.

Step 9 Calculate the Message Success Rate (MSR) over the 50 consecutive packets on each of the receivers.

✎ The MSR shall be greater than 94%. If MSR does not meet 94% proceed with Hardware Time Verification for trouble shooting.

Step 10 Record the Data Quality and the MSR on the Tune and Align Data Sheet.

Audio AC and DC Voltages and Balances

Perform the following steps to adjust the Receiver Audio AC and DC voltages and balance:

Step 1 Set the Service Monitor, as follows:

- Select the "RX" function
- Set "RF Gen Freq" to the receive frequency of the mobile radio under test
- Set the Service Monitor to display DC volts and AC Volts
- Connect an oscilloscope 1x probe from TP1 on the base station control board to the “audio in” connector on the Service Monitor
- Set other values as follows:

Amplitude: -80 dBm	AFGen1 Freq: 1.000 kHz	AFGen2 Freq: 1.000 kHz
Atten Hold: Off	AFGen to: FM 5 KHz	AFGen2 to: Off
Output Port: RF Out		Ext Load R: 600 ohm
Filter 1: 300 Hz HPF		
Filter 2: 3 kHz LPF		

Step 2 Adjust Receiver 1, as follows:

- Connect an RF cable from the Service Monitor's RF Out port to the antenna port of Receiver 1
- In IPMessage, type the command “receiver = 1” and observe that Receiver 1 is selected
- At TP1, measure AC and DC volts
- Adjust RV5 for an AC reading of 400 mVAC +/- 1mVAC
- Adjust RV6 for a DC reading of 2.500 mVDC +/- 1mVDC
- Record AC and DC levels on the Tune and Align Data Sheet

Step 3 Adjust Receiver 2, as follows:

- Connect an RF cable from the Service Monitor's RF Out port to the antenna port of Receiver 2
- In IPMessage, type the command “receiver = 2” and observe that Receiver 2 is selected
- At TP1, measure AC and DC volts
- Adjust RV3 for an AC reading of 400 mVAC +/- 1mVAC
- Adjust RV4 for a DC reading of 2.500 mVDC +/- 1mVDC
- Record AC and DC levels on the Tune and Align Data Sheet

Receiver Calibration

Each receiver must be calibrated at four (4) points to ensure the proper operation of Intelligent Diversity Reception and to provide the IPNC with correct information about the signal strength of received mobile data.

Step 1 Connect a coaxial cable from the Service Monitor “RF Input” port to a receiver port on the base station

Step 2 Set the Service Monitor

Step 3 Select the "RX" function

Step 4 Set the "RF Gen Freq" to the receive frequency of the mobile radio under test

Step 5 Connect an oscilloscope 1x probe from TP1 on the base station control board to the “audio in” connector on the Service Monitor

Step 6 Set other values as follows:

Amplitude: *varies*	AFGen1 Freq: 1.000 kHz	AFGen2 Freq: 1.000 kHz
Atten Hold: Off	AFGen to: FM 5 KHz	AFGen2 to: Off
Output Port: RF Out		Ext Load R: 600 ohm
Filter 1: 300 Hz HPF		
Filter 2: 3 kHz LPF		

Step 7 Calibrate Receiver 1, as follows:

- Connect an RF cable from the Service Monitor's RF Out port to the antenna port of Receiver 1
- In IPMessage, type the command “receiver = 1” and observe that Receiver 1 is selected
- Set the Service Monitor to measure 12db SINAD
- Reduce signal amplitude on the Service Monitor until 12dB SINAD is reached. Record this value
- In IPMessage, type the command “12DB SINAD = “ and the recorded value
- Set the Service Monitor to measure SNR
- Increase signal amplitude until reaching a level of 30dB SNR
- Record the amplitude
- In IPMessage, type the command “30DB S/N = “ and the recorded value
- Increase signal amplitude until reaching 40dB SNR
- Record the amplitude
- In IPMessage, type the command “40DB S/N = “ and the recorded value
- Set the signal amplitude to -40dBm
- In IPMessage, type the command “-40DBM = -40“

Step 8 Calibrate Receiver 2, as follows:

- Connect an RF cable from the Service Monitor's RF Out port to the antenna port of Receiver 2
- In IPMessage, type the command “receiver = 2” and observe that Receiver 2 is selected
- Set the Service Monitor to measure 12db SINAD
- Reduce signal amplitude on the Service Monitor until 12dB SINAD is reached
- Record the value
- In IPMessage, type the command “12DB SINAD = “ and the recorded value
- Set the Service Monitor to measure SNR
- Increase signal amplitude until reaching a level of 30dB SNR.
- Record the amplitude
- In IPMessage, type the command “30DB S/N = “ and the recorded value
- Increase signal amplitude until reaching 40dB SNR
- Record the amplitude
- In IPMessage, type the command “40DB S/N = “ and the recorded value
- Set the signal amplitude to -40dBm
- In IPMessage, type the command “-40DBM = -40“

Step 9 Test Receiver Calibration, as follows:

- Inject a signal with an amplitude of -95dBm into the Receiver 1 antenna port
- In IPMessage, type the command “noise”. The result must -95 dBM +/- 2.
- Next, inject -105dBM into the receiver and type “noise”. The result must be -95 dBM +/- 2.

  ✎ Result must be within 2dBm. If the noise figure is not within 2dBm of the injected signal level, return to receiver calibration and recalibrate the receivers.

- Repeat the tests for the other Receiver
- Record the noise readings on the Tune and Align Data Sheet

Transmitter Alignment Tests

Transmitter Output

Step 1 Set the Service Monitor to measure the transmitter frequency of the base station.

Step 2 Set the Service Monitor filters to "<20 Hz HPF" and "15 kHz HPF".

✎ Ensure the Service Monitor can handle the full power transmission of the base station otherwise attach an attenuator to the output of the base station transmitter antenna port before transmitting into the Service Monitor.

Step 3 Connect a coaxial cable from the output of the base station (or connected attenuator) to the Service Monitor's RF In port.

Step 4 In IPMessage, type the command "symbol sync time = 5000".

✎ This will provide a steady modulated tone from which frequency error can be measured.

Step 5 When ready to transmit, in IPMessage, type the command "X = 1" - The transmitter frequency will be modulated with a 3.9 kHz tone.

Step 6 On the Service Monitor read the frequency error.

Step 7 Record the transmit frequency error on the Tune and Align Data Sheet - Transmitter frequency error is controlled by the processor and cannot be adjusted manually.

Transmitter Modulation

Step 1 Set the Service Monitor to measure the transmitter frequency of the base station.

Step 2 Set the Service Monitor filters to "<20 Hz HPF" and "15 kHz HPF"

✎ Ensure the Service Monitor can handle the full power transmission of the base station otherwise attach an attenuator to the output of the base station transmitter antenna port before transmitting into the Service Monitor.

Step 3 Connect a coaxial cable from the output of the base station (or connected attenuator) to the Service Monitor's RF In port.

Step 4 In IPMessage, type the command "symbol sync time = 5000". This will provide a steady modulated tone from which frequency error can be measured.

Step 5 When ready to transmit, in IPMessage, type the command "X = 1". The transmitter frequency will be modulated with a 3.9 kHz tone.

Step 6 On the Service Monitor read the deviation. Use RV2 to set the deviation between 4.7 and 4.9 kHz.

Step 7 Record the Transmit Deviation on the Tune and Align Data Sheet.

Transmitter Power

Step 1 Set the Service Monitor to measure the transmitter frequency of the base station.

Step 2 Set the Service Monitor filters to "<20 Hz HPF" and "15 kHz HPF".

✎ Ensure the Service Monitor can handle the full power transmission of the base station otherwise attach an attenuator to the output of the base station transmitter antenna port before transmitting into the Service Monitor.

Step 3 Connect a coaxial cable from the output of the base station (or connected attenuator) to the Service Monitor's RF In port.

Step 4 In IPMessage, type the command "X = 1400,20". The base station will transmit 20 packets of 1400 bytes each. This continuous transmission will last approximately 10 seconds.

Step 5 On the Service Monitor note the transmitter power at the beginning of the transmission and observe whether the transmitter power drops over the course of the transmission.

Step 6 Transmitter Power Output must begin at a level between 20 and 35 watts and must not drop by more then 5 watts over the course of the "X = 1400,20" command.

Step 7 To change the transmitter output power use "TXpower" command in IPMessage.

Step 8 Record the Transmit Power on the Tune and Align Data Sheet.

Transmitter Data Quality and Message Success Rate

Step 1 Connect a base station to an IPNC via SLIP cable or Ethernet.

Step 2 Connect the mobile radio under test in the test set up.

Step 3 Allow the mobile radio to connect to the base station.

Step 4 Run IPLinkView or ping the mobile from the IPNC.

Step 5 Set the downlink and uplink RSSI to -90 +/- 2dBm.

Step 6 Observe the data quality reported by the base station on the uplink.

Step 7 Adjust RV1 in the mobile for the maximum data quality on the uplink.

Step 8 Data Quality must average 220 or better over the course of 50 consecutive packets or pings.

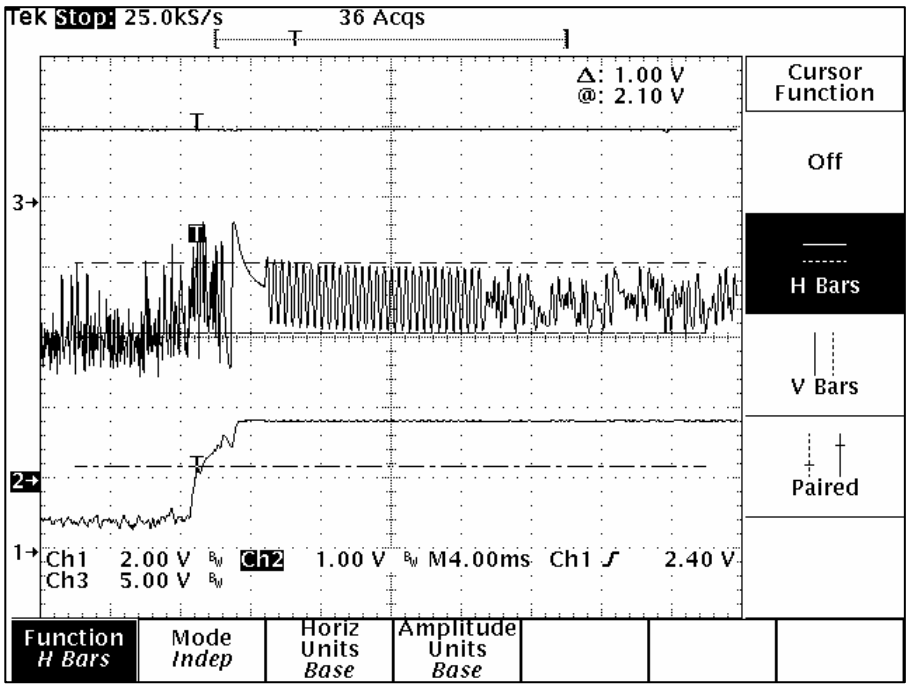
Step 9 Calculate the Message Success Rate over the 50 Consecutive packets. The MSR shall be greater that 94%.

Step 10 Record the Data Quality and the MSR on the Tune and Align Data Sheet. If MSR does not meet 94% proceed with Hardware Time Verification for trouble shooting.

Step 11 After completion of Data Quality and MSR tuning, record Firmware Settings. File the Tune and Align Data Sheet with the Firmware setting in the IPMN Network.

Hardware Timing Troubleshooting

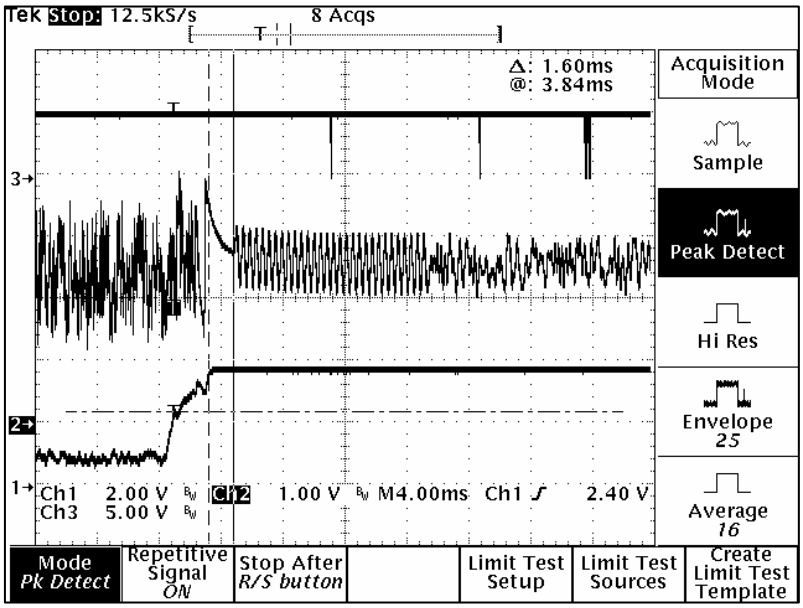
For trouble shooting data quality and MSR failures hardware timing can be verified as follows. The figure below is an oscilloscope plot of a down-link data message from the base station to the mobile. Channel 1 is connected to the mobile's RSSI test point, Channel 2 is connected to the mobile's recovered modulation (TP1), and Channel 3 is connected to the mobile's modem chip select line. The scope's acquisition mode is high-resolution.



As can be seen from this plot, the base station's transmit carrier has ramped up to full power (Channel 1) in just a few milliseconds. The recovered modulation (Channel 2) is stable by this time. There follows a few milliseconds of quiet time followed by 12 milliseconds of symbol sync time.

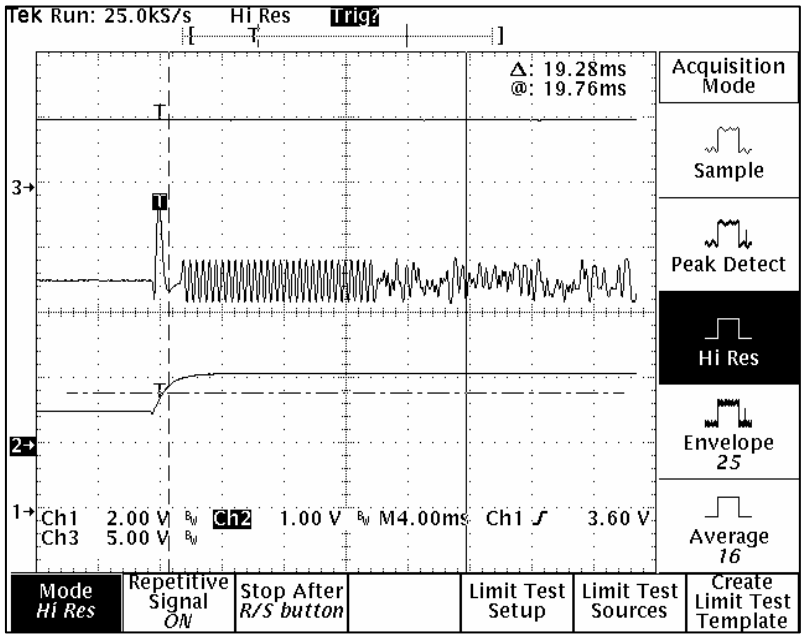
The recovered modulation from a base station should look similar to this plot. The recovered modulation signal should be approximately 1.0 Volts peak-to-peak and should be centered at approximately 2.5 VDC as is indicated in the figure above.

Below is another oscilloscope plot of an up-link data message from the mobile radio to the base station. As in the last plot, Channel 1 is connected to the mobile's RSSI test point, Channel 2 is connected to the mobile's recovered modulation test point (TP1), and Channel 3 is connected to the mobile's modem chip select line. The scope's acquisition mode is now in the peak detect mode. This enables the mobile's modem CS (Chip Select) line to be viewed.

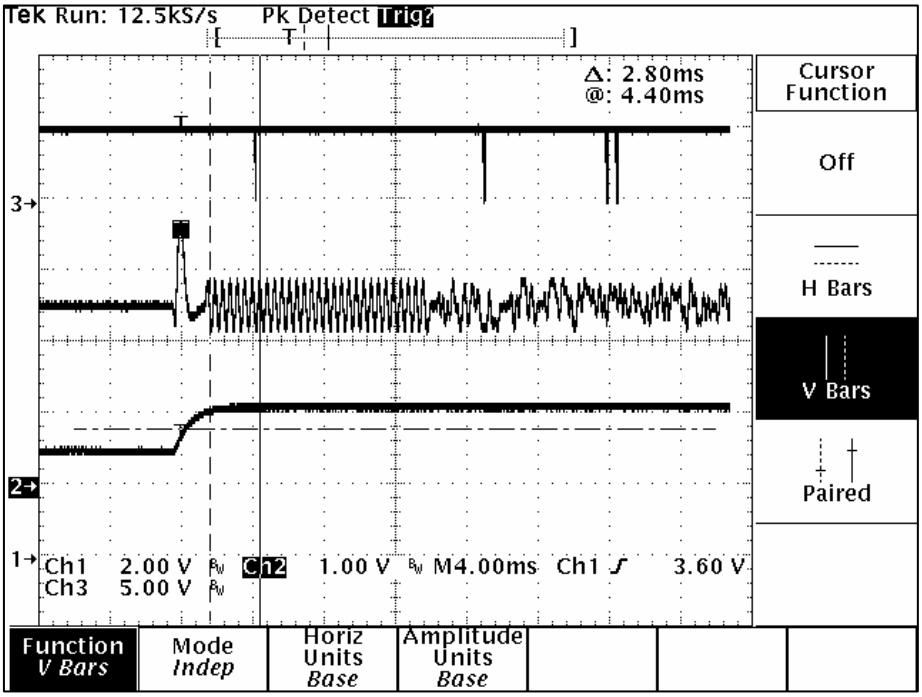


The mobile radio's microcontroller, upon detecting a step response in the RSSI (caused by the base station's transmitter coming up to power), waits a period of time equal to the programmed value of the mobile's carrier detect delay time. The microcontroller then instructs the modem to search for the modem synchronization preamble. When the base station instructs the modem to look for sync tones the modem's CS line transitions low. This can be seen in the above plot. Approximately 10 milliseconds after the base station's transmitter causes a step increase in the mobile's RSSI, the CS signal goes low momentarily. As can be seen, the sync tones are stable by this time and the modem quickly establishes synchronization.

The figure below is a plot of the down-link timing characteristics. Channel 1 is connected to RSSI, Channel 2 is connected to recovered audio, and Channel 3 is connected to the modem CS pin. The scope is in the high resolution acquisition mode. Note there is a very short period of quiet time (no modulation) followed by approximately 12 milliseconds of modem synchronization time (sync time).



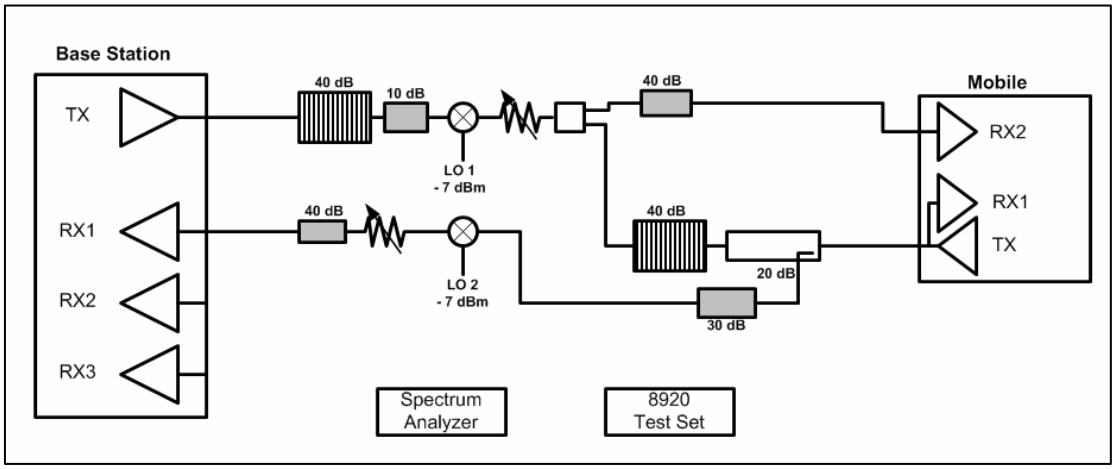
The next plot is the same as before but now the scope is in the peak detect acquisition mode. After the mobile radio detects a step response in the RSSI (caused by a down-link transmission), the mobile radio's microcontroller waits an amount of time equal to the programmed value of the "carrier detect delay time" then instructs the modem to look for frame sync. When the microcontroller instructs the modem to look for frame sync, it asserts the modem's CS line (active low). In this plot, the modem's CS line can be seen to transition low approximately 3 milliseconds after the base station's transmitter has come up to full power.



The recovered modulation should be centered at approximately 2.5 VDC and should have the amplitude of approximately 800 mV peal-to-peak as indicated in the plot above.

Message Success Rate Testing and Burn-In

After completion of the alignment and testing, the base station shall undergo Burn In and Final Testing. Install the mobile radio in the MSR screen room as shown in the figure below.



Sequence Tests

Step 1 In IPMessage, verify latest version of the mobile radio firmware by entering the 'version' command.

Step 2 Verify the serial number and MAC I.D. – match the label on the unit by typing 'serial number' and 'radio mac address'.

Step 3 Modify firmware settings as needed and run IPLinkView on the mobile radio on the highest and lowest frequencies programmed in the mobile radio.

Step 4 Run IPLinkView until a GPS connection is established.

Step 5 Run 'firmware check' for the specific Customer.

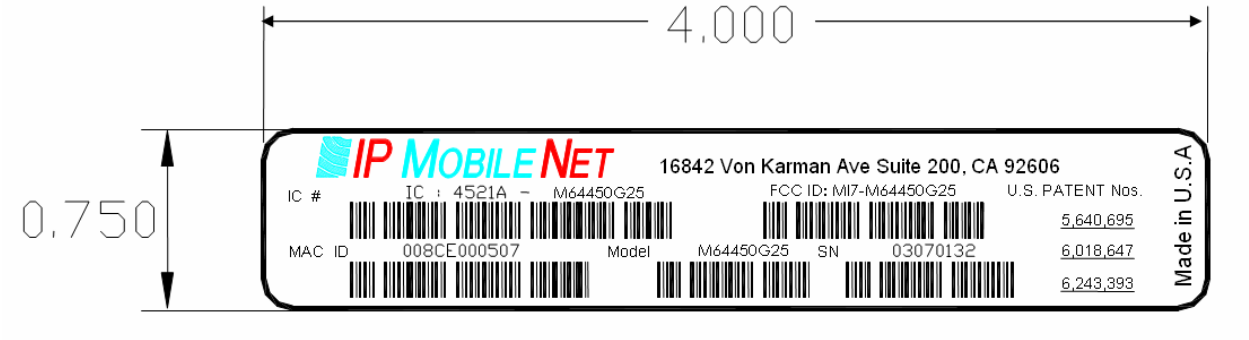
Final Inspection

The final inspection of the mobile radio is a critical step that translates directly into confidence in the product. Several areas must be checked on every base station before it can be shipped:

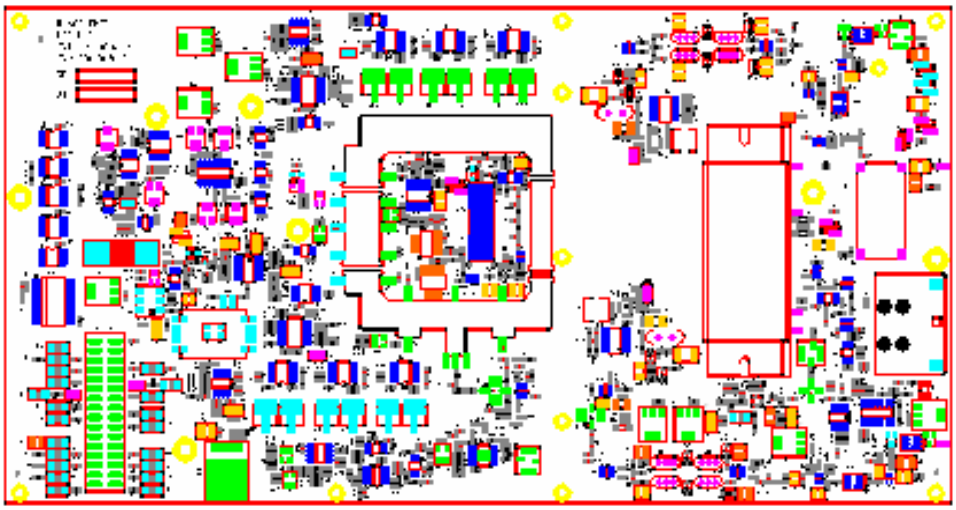
- Screws- every screw hole must have the proper screw tightened the proper amount. The screws must be new and cannot have rounded shoulders. Screw heads must be flush to the case.
- Connectors- all screws must be tight and the internal portions of each connector must not be damaged.
- Covers and panels must not be dented or unduly scratched.
- Initial traveler after completion of Final Inspection.

M64450G25 Data Transceiver FCC Label Placement

M64450G25 Data Transceiver FCC Label



M64450G25 IPSeries High Speed Mobile Radio Circuit Board



APPENDIX B: M64450G25 TEST DATA SHEET

Date: _____
Serial Number: _____
Firmware Revision: _____
End User: _____
Tester: _____

Adjustment / Alignment Procedures

TCXO Frequency Error

Parameter	Specification	Using GPS as freq ref	Cal Value
TCXO freq error ppb	**≤1 PPM**		

Receiver Injection

Parameter	Specification	Measured
Injection Frequency Error at RX Antenna Port	**±400 Hz**	

Set 45MHz Filter Waveform

Parameter	Initial
Waveform set	

Receiver SINAD

Parameter	Specification	Receiver 1 Measured	Receiver 2 Measured
12dB SINAD at TP1	**≤ -116dBm**		

Receiver Distortion

Parameter	Specification	Receiver 1 Measured	Receiver 2 Measured
Distortion	**≤3.0%**		

Receiver Data Quality

Parameter	Specification	Receiver 1 Measured	Receiver 2 Measured
Data Quality	**≥ 220**		

Audio Voltages and balance

Parameter	Specification	Receiver 1 Measured	Receiver 2 Measured
Audio AC voltage at TP1	**400 mVAC +/- 1mV**		
Audio DC voltage at TP1	**2.500 vDC +/- 1mV**		

APPENDIX B: M64450G25 TEST DATA SHEET

Receiver Calibration

Parameter	Specification	Receiver 1 Measured	Receiver 2 Measured
"Noise" value reported with -95dBm signal injected	**-95 ±2 dBm**		
"Noise" value reported with -105dBm signal injected	**-105 ± 2 dBm**		

Transmitter Output

Parameter	Specification	Measured
Transmitter Frequency Error (Frequency controlled by software; record measured value)	**± 400 Hz**	
Transmitter Modulation (Deviation)	**4.8 kHz ±75 Hz**	
Output Power at 13.8 vDC	**40 watts**	

Transmitter Data Quality

Parameter	Specification	Measured
Data Quality	**≥ 220 for 50 contiguous plots**	
Message Success Rate	**≥ 94% for 50 contiguous plots**	

Final Inspection

Item to check	Check for	Initials
Receiver selection function	Correct Rx LED lights when receiving on its port	
Visual inspection	Screws, connectors, jack screws, switches, overlay, no rattle	
LED	Lock light illuminates when power is applied	
Attach copy of all firmware settings	Completed	