IPMOBILENET ™

*IP*Series

M64800D25
High Speed Mobile Radio
(806 to 824)

Product Owner's Manual

Date Released: September 12, 2006

Document #: 516.80546.POM
Revision: A

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.

Product Description

✎   The M64800D25 Mobile Radio works within a frequency range of 806-824 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 and voice 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. The high speed mobile radio circuit boards are built using surface mount technology (SMT) and through-hole components.
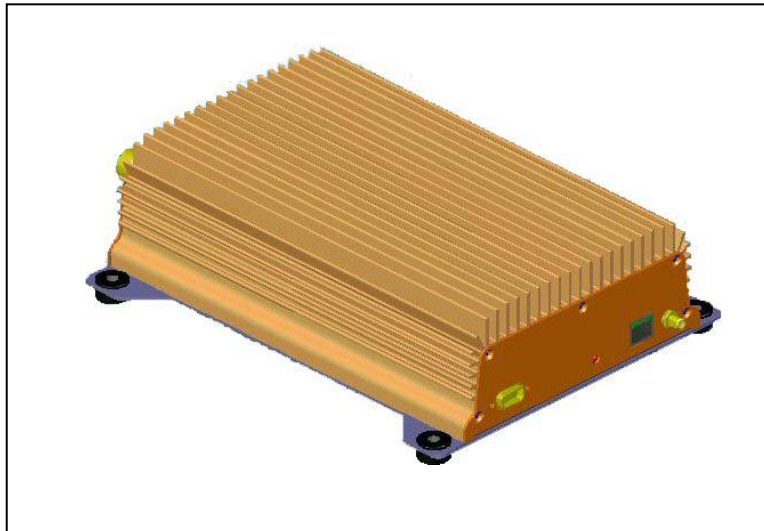
Figure 1: *IP*Series High Speed Mobile Radio (Front View)

Product Functionality

The high speed mobile radio utilizes a high-performance, 32-level QAM. Further it uses state-of-the-art OFDM technique. This new technique will enable the high speed mobile radio to transmit and receive more than 100 Kbps data in a 25 kHz band. The high speed mobile radio 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 high speed 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) antennas 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 Figure 2 below, the *IP*Series High Speed 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 void if an uncertified or unauthorized individual removes the mobile radio cover.
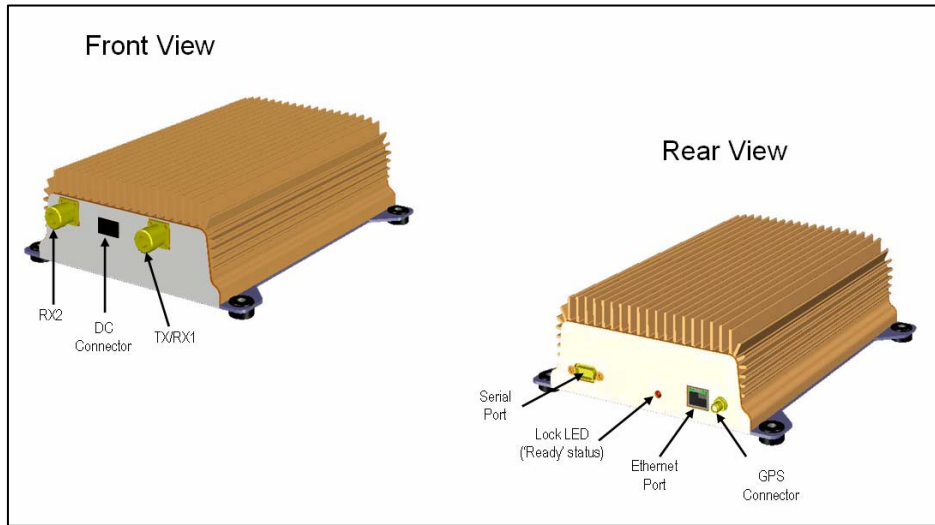
Figure 2: *IP*Series High Speed Mobile Radio (External Features)

The high speed 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 high speed 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

High Speed Mobile Radio Setup Scenarios

The following section describes the setup methods for high speed mobile radio in a vehicle. The two (2) possible configurations consist of the following:

1. Mobile Radio-to-Mobile Computer
2. Mobile Radio-to-VIU-to-Mobile Computer

Mobile Radio-to-Mobile Computer Setup

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

Additional components are required to setup a high speed mobile radio-to-mobile computer configuration, and are listed below in Table 2:

TABLE 2: HIGH SPEED MOBILE RADIO-TO-MOBLE COMPUTER COMPONENTS REQUIRED FOR INSTALLATION	
QTY	**DESCRIPTION**
1	*IP*Series High Speed Mobile Radio
1	Mobile Computer
1	20-foot serial cable (DB9F – DB9M)
1	*IP*MobileNet SLIP Port Driver Installation Diskette (SLIP2IPMN.exe)

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

To configure the high speed 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.

Mobile Radio-to-VIU-to-Mobile Computer Setup
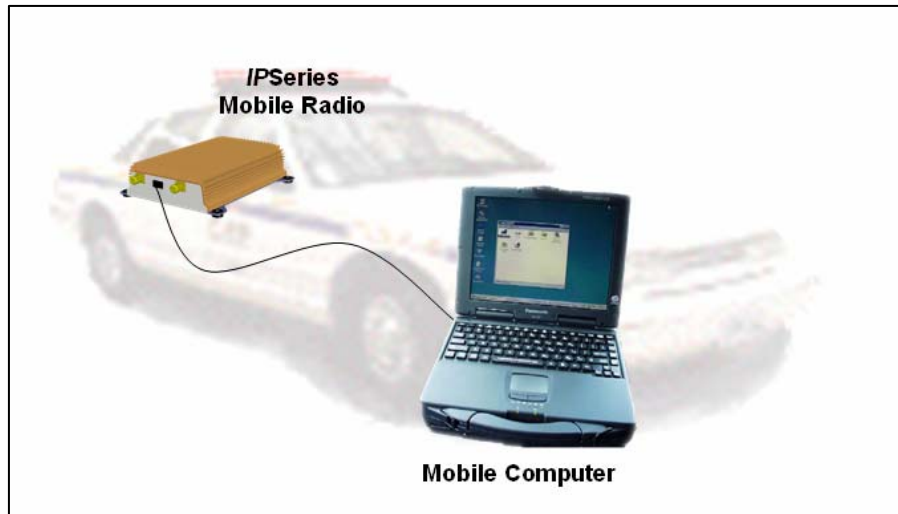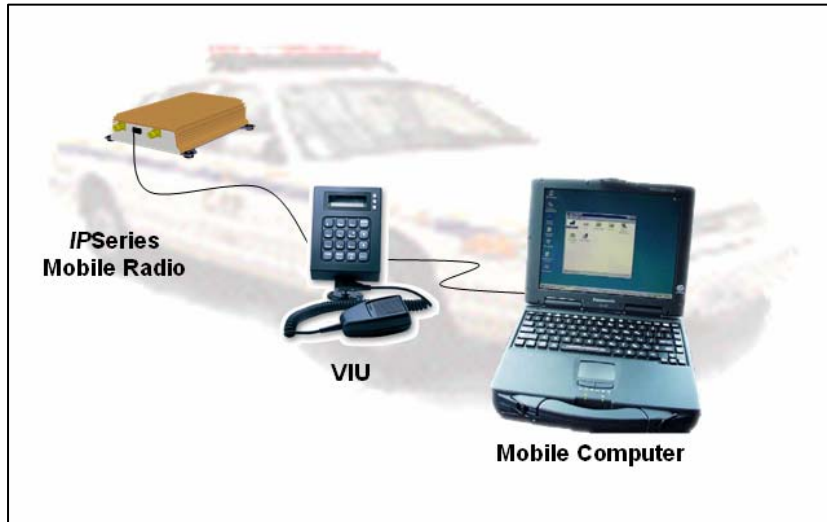

Figure 4: High Speed Mobile Radio-to-VIU-to-Mobile Computer Setup

Additional components are required to setup a high speed mobile radio-to-VIU-to-mobile computer configuration and they are listed below in Table 3:

TABLE 3: HIGH SPEED MOBILE RADIO-TO-VIU-TO-MOBLE COMPUTER COMPONENTS REQUIRED FOR INSTALLATION	
QTY	DESCRIPTION
1	*IP*Series High Speed Mobile Radio
1	Mobile Computer
1	Voice Interface Unit (VIU)
1	20-foot serial cable (DB9F – DB9M)
1	10-foot serial cable (DB9F – DB9M)
1	*IP*MobileNet SLIP Port Driver Installation Diskette (SLIP2IPMN.exe)

✎ To configure the high speed mobile radio, the voice interface unit, and the mobile computer for this type of setup, follow the instructions on pages 18 and 19 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.

Within this configuration, the high speed mobile radio is unable to fully list its parameters due to the limited buffers in the VIU. The high speed mobile radio will not be able to receive DHCP offers within this configuration.

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 high speed 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 chapter.

- Once the antennas are installed, as directed within this user manual, all persons must maintain a distance of no less than 39 inches from the antennas while the high speed mobile radio is in the transmit mode.

Installation Requirements
Table 4 lists the documents required to successfully install the high speed mobile radio and connect to the various components within the vehicle:

TABLE 4: DOCUMENTS REQUIRED FOR HIGH SPEED MOBILE RADIO INSTALLATION	
DESCRIPTION	**PART NUMBER**
The following documents are available on the Product Documentation CD enclosed in the shipment with the high speed mobile radio:	480.0001.001
▪ M64800D25 High Speed Mobile Radio Product Owner's Manual	516.80528.POM
▪ Installation Guide for Mobile Computer Setup for Communication with the Mobile Radio	516.80310.IG

Table 5 lists the components required to perform a successful high speed mobile radio installation and are available for purchase through *IP*MobileNet, Inc.

QTY	DESCRIPTION	IPMN PART NUMBER
	TABLE 5: MOBILE INSTALLATION ACCESSORIES KIT	
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 without VIU (included in this manual)	502.80259.52
1	Diagram, Mobile Installation with VIU (included in this manual)	502.80260
1	Diagram, Diversity Antenna Mobile Installation Detail (Typical Install)	DT450-10-0201

Table 6 lists the auxiliary equipment required to complete the installation process.

QTY	DESCRIPTION	IPMN PART NUMBER
	TABLE 6: AUXILIARY EQUIPMENT	
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	RG8X Cable and Mount, 800 MHz, 17 ft. (incl ¾" Brass Mount & N Male Crimp)	102.0200.002
2	Antenna, Radome type, 806-866 MHz, 3dB Gain (requires 1 MB8XN for ea antenna)	102.0207.001
2	Antenna, Radome Type 821-896 MHz, 3dB Gain (requires 1 MB8XN for ea antenna)	102.0207.002
2	Antenna, 5/8 Wave, 806-866 MHz, 3dB Gain (requires 1 MB8XN for ea antenna)	102.0199.001
2	Antenna, ¼ Wave, 806-896 MHz, Unity Gain (requires 1 MB8XN for ea antenna)	102.0204.010

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 high speed 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.
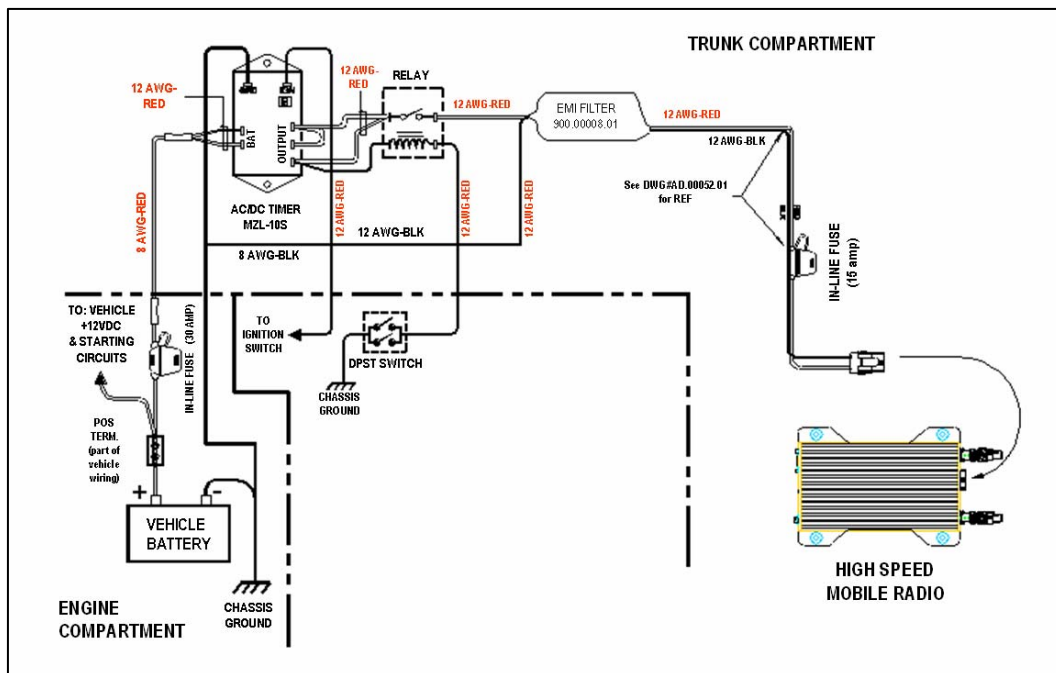

Figure 5: Trunk Compartment Installation

✎   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 high speed mobile radio, perform the following steps:

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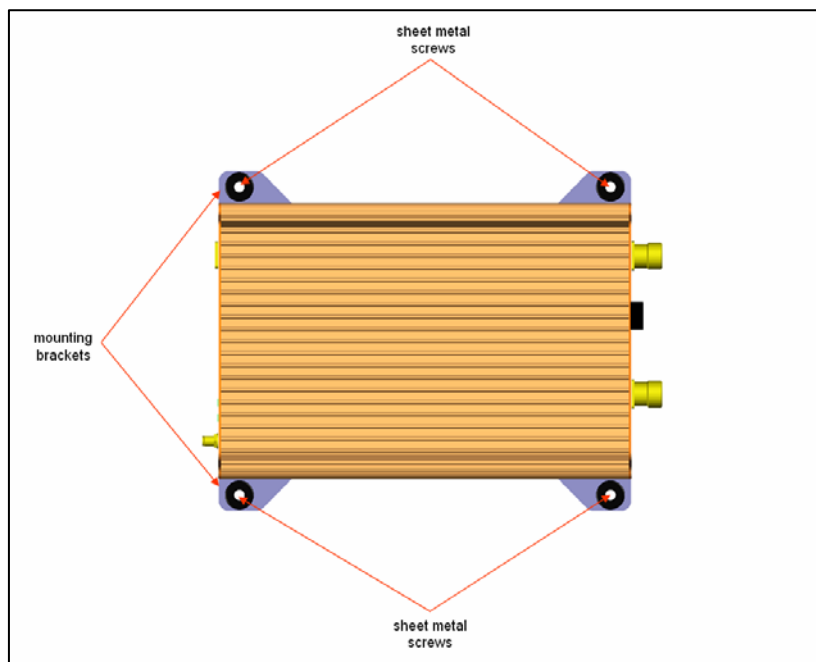

Figure 6: High Speed Mobile Radio Mounting

✍   If less than four (4) screws are used, the high speed mobile radio can become loose in the trunk compartment. This may cause the high speed mobile radio not to function properly.
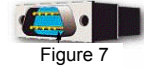
When inserting screws, be careful not to disturb the vehicle's gas tank.
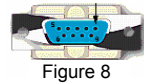
Serial Cable Connection and Routing

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 – see Figure 7) to the mobile radio.

Figure 7

Step 2 Route the female connector (DB9F – see Figure 8) to the driver compartment and connect to the serial port located on the rear of the mobile computer.

Figure 8

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

If connecting a Voice Interface Unit, see the Voice Interface Unit Connections section within this chapter.

Ethernet Setup

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

To connect the Ethernet crossover cable, perform the following steps:

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

Step 2 Route the other end of the Ethernet crossover 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.

Note that if installing a Voice Interface Unit (VIU), the Ethernet setup cannot be used, as the VIU is a serial-only device.

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 9).

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.
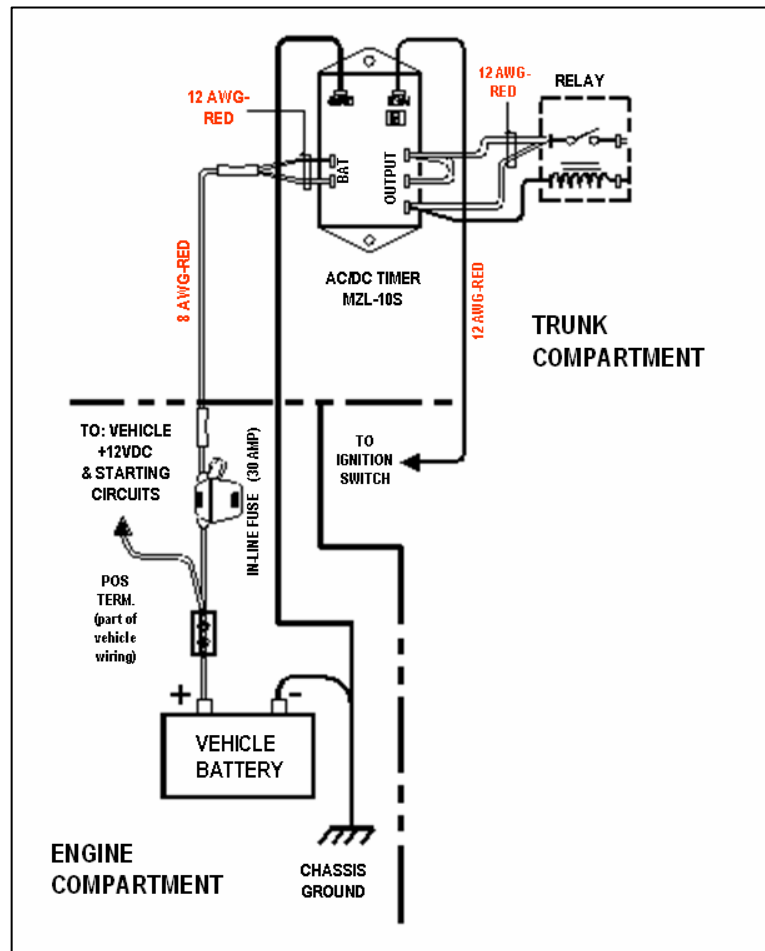
Figure 9: Delay Timer Installation

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).

Carling 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.
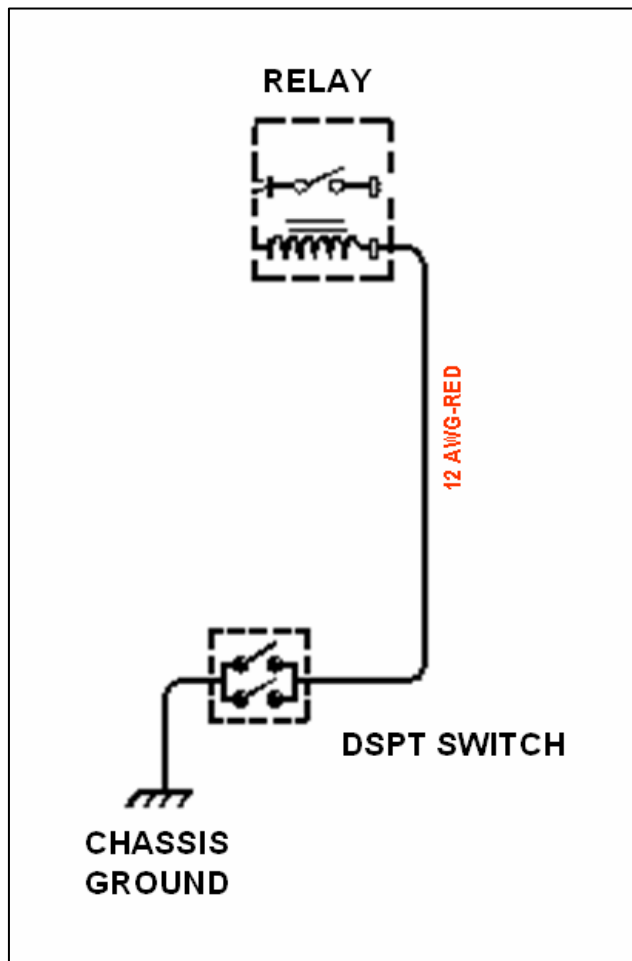

Figure 10: Carling Switch Installation

<u>Mobile Radio Power Supply Installation</u>

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.
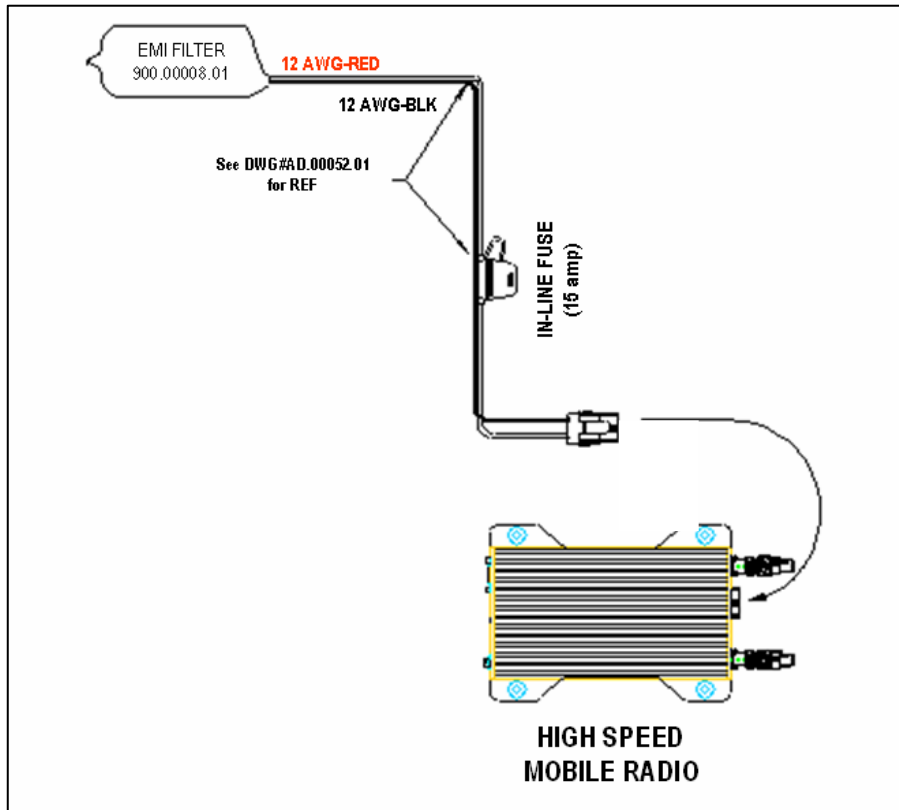

Figure 11: Power Supply Installation

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) antennas are mounted and installed on the roof of the vehicle using specific measurements for distance.

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

Step 1   Install antennas (see the figure below).

△1   △2

✎   *Observe correct separation between antennas (refer to Table 8: 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 antennas 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.
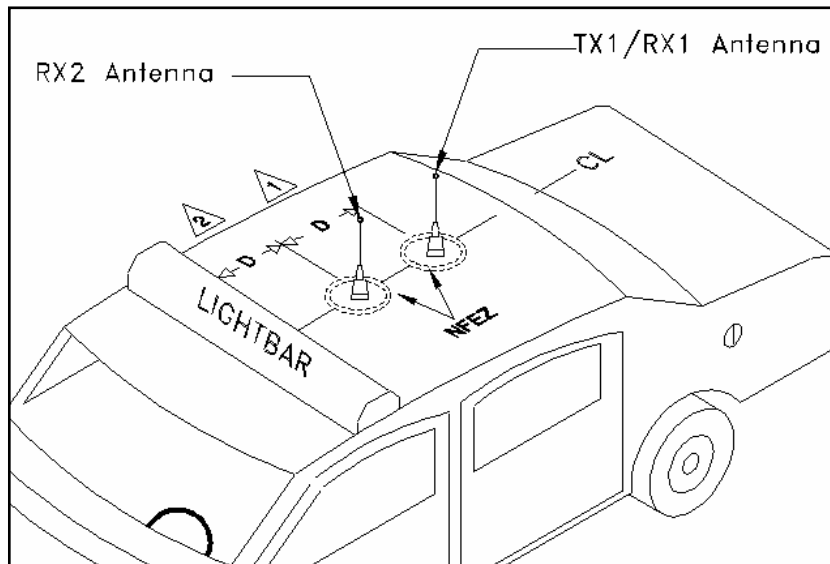
Figure 12: Antenna Distance Configuration

✎   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 high speed mobile radio is mounted.

✎   Both antennas 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 <u>no less than 39 inches from the antennas</u> 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 antennas the typical range will be between –14 and –28).

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).

Voice Interface Unit Connections

If connecting a VIU, an additional 10-ft serial cable is required (IPMN p/n: 156.0245.010 included with VIU).

> To connect the serial cables, perform the following steps:
>
> **Step 1**   Attach 20-ft serial cable male connector (DB9M) to the high speed mobile radio.
>
> **Step 2**   Route the female connector (DB9F) to the driver compartment and connect to the serial port located on the rear of the VIU near the microphone hang up clip.
>
> **Step 3**   Attach the 10-foot serial cable male connector (DB9M) to the other serial port located on the rear of the VIU.
>
> **Step 4**   Route the female connector (DB9F) serial cable to the serial port located on the rear of the mobile computer.
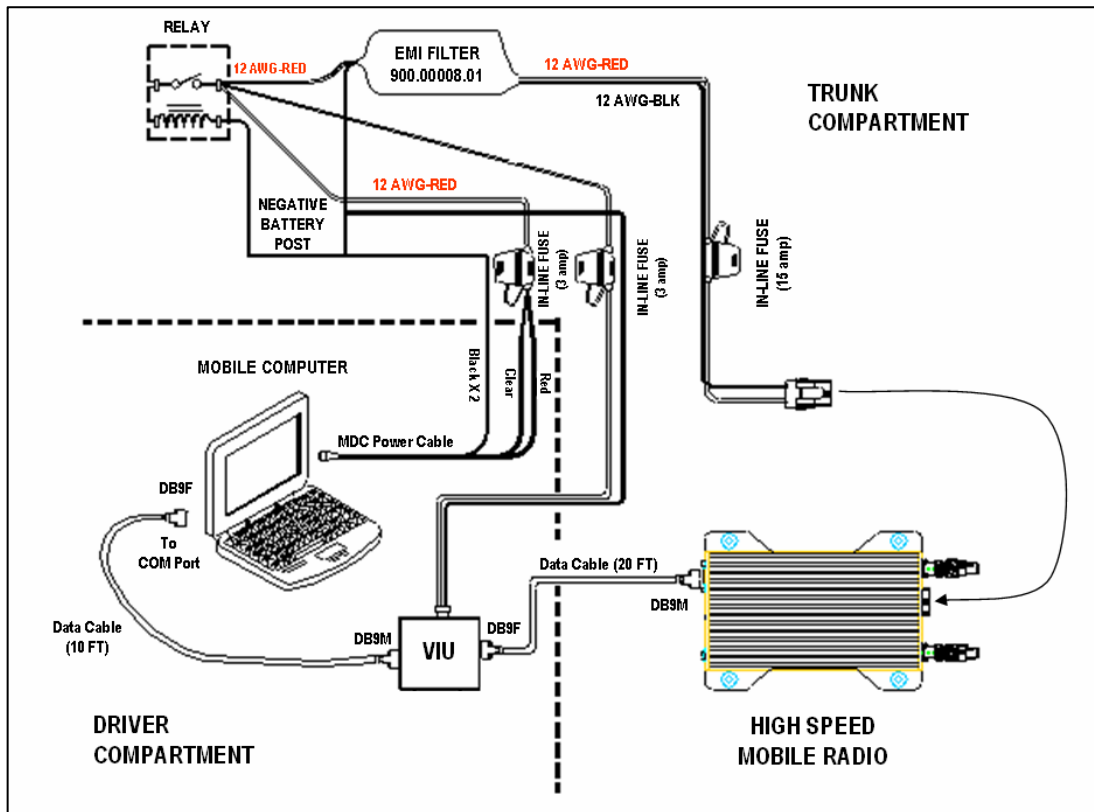
Figure 13: VIU Connections

To connect the VIU power supply, perform the following steps:

Step 1   Route the VIU's power supply cable from the driver compartment to the trunk compartment.

Step 2   Connect the red (#12 AWG) wire via an in-line fuse from the VIU power cable to the relay as shown in the figure above.

Step 3   Attach the black (#12 AWG) wire of the VIU power cable to the ground connection on the vehicle chassis.

Post Installation Checklist

Table 7 lists the tasks that should be performed upon completing installation.

TABLE 7: 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.
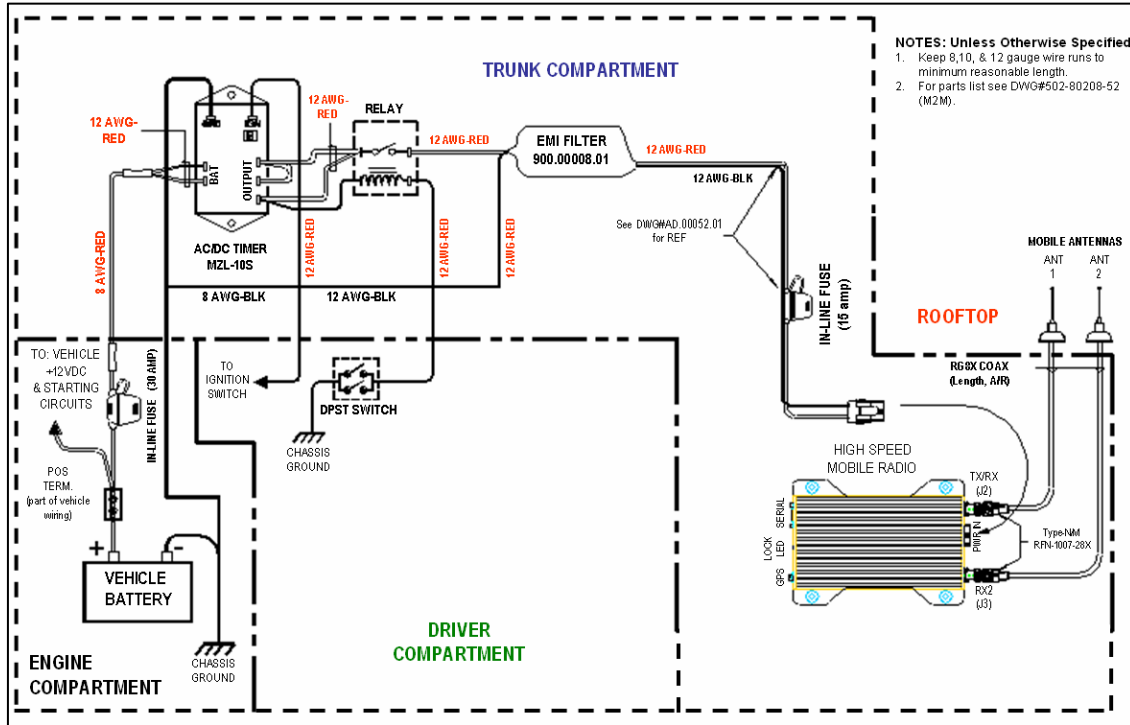
Mobile Installation Layout Diagrams

Figure 14: Vehicle Unit Wiring Interconnection Layout

Table 8 lists the high speed mobile radio antenna distances by frequency band.

TABLE 8: 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
806-824	814	10.8	14.5	1.8	3.6

*NFEZ = Minimum Near-Field Exclusion Zone   **Round antenna spacing to the nearest ⅛"
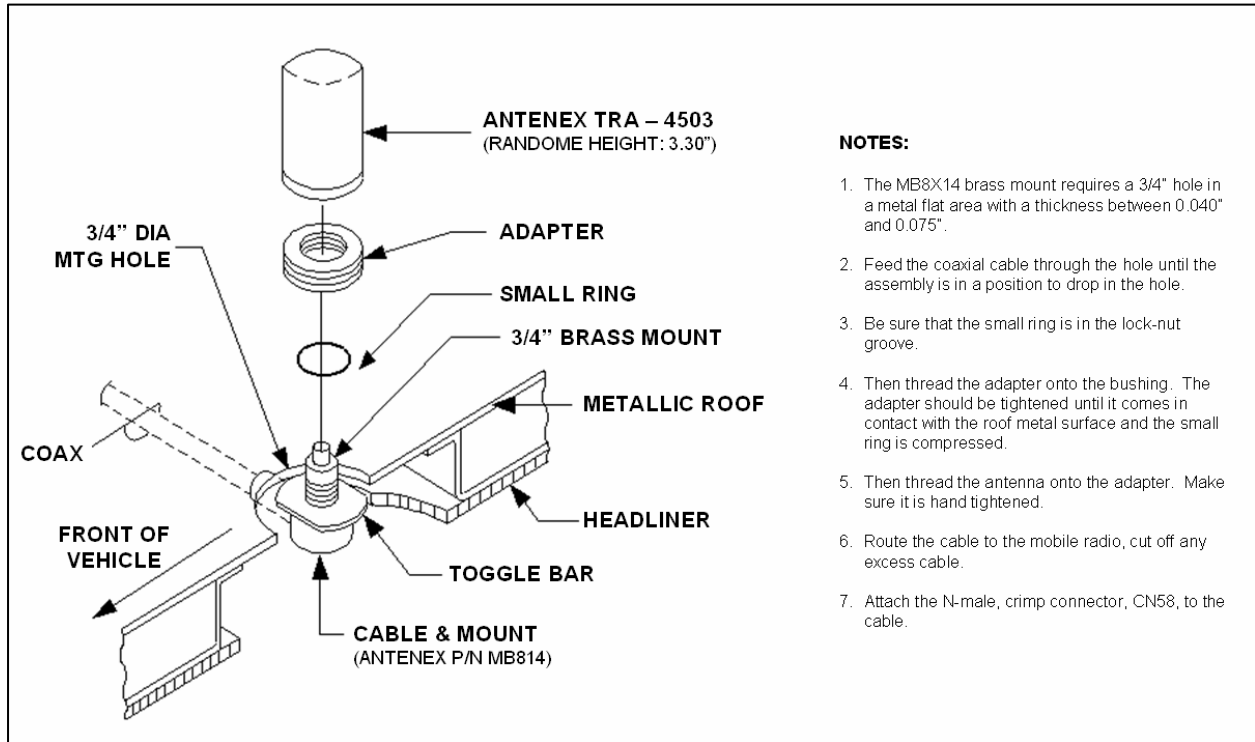
Figure 15: Diversity Antenna Mobile Installation Detail (Typical Installation)

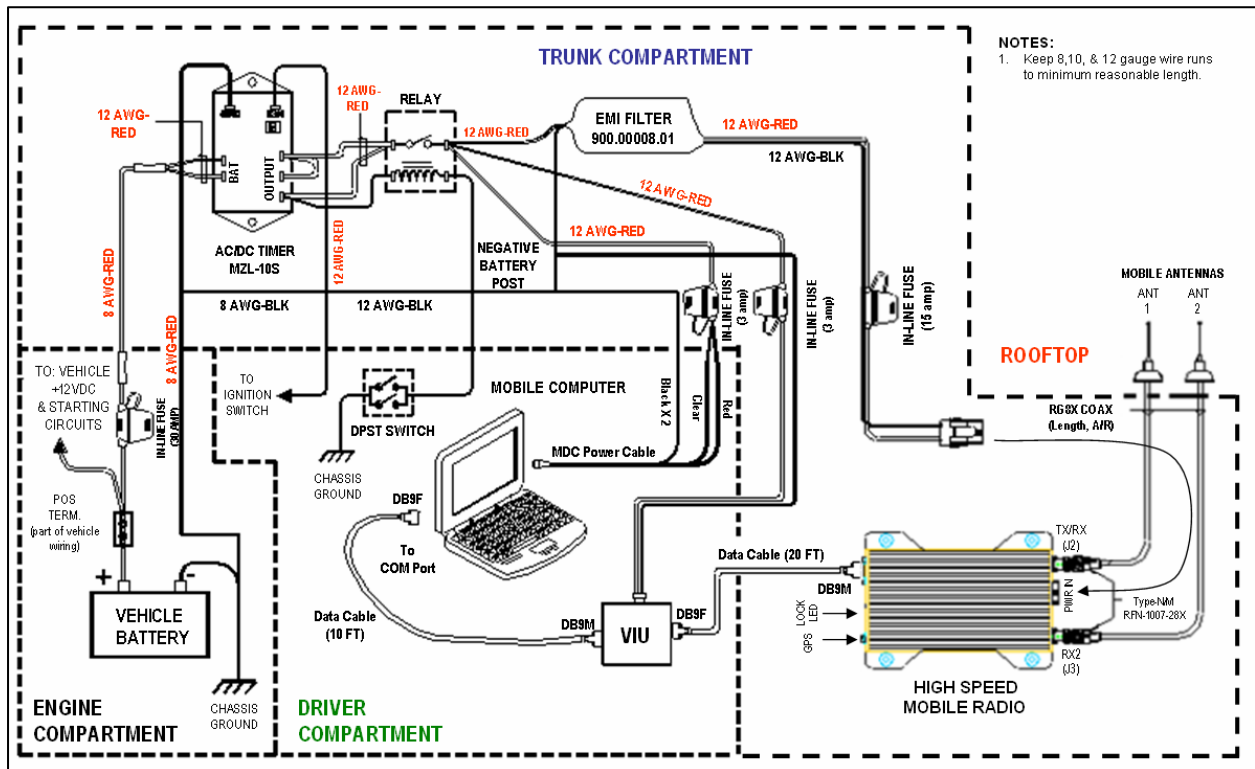
Figure 16: Vehicle Unit Wiring Interconnection Layout (with Voice Interface Unit)

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

Table 9 provides a checklist of the tools and equipment required to perform the preliminary test procedure.

NO.	REQUIRED TOOLS/EQUIPMENT	☑
TABLE 9: CHECKLIST OF REQUIRED MATERIAL TO PERFORM PRELIMINARY TESTING		
1	*IP*Series High Speed Mobile Radio installed in the vehicle as previously described in this chapter	☐
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 antennas (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 high speed mobile radio antennas are separated by at least 10 feet. If the antennas are too close, the high speed mobile radio receivers may overload 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.
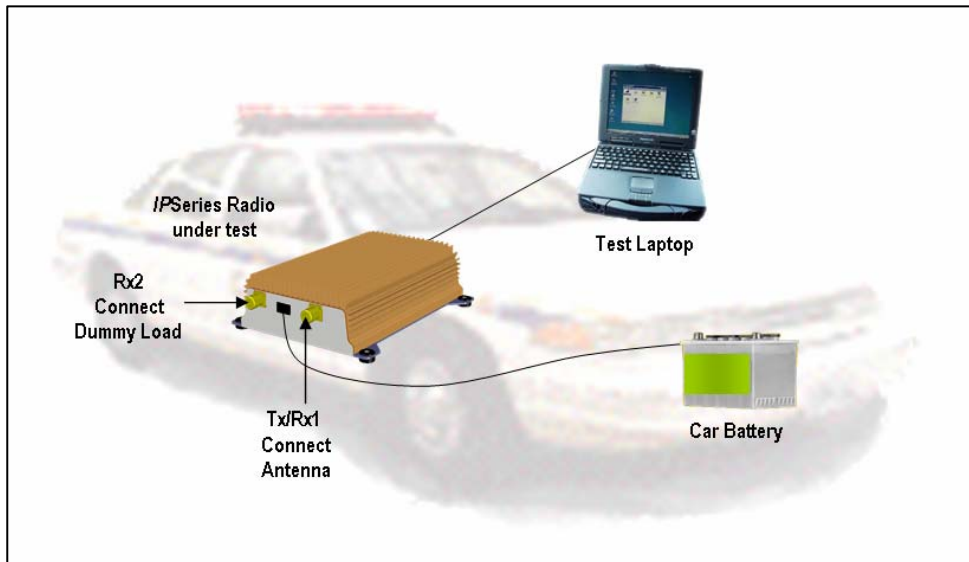

Figure 17: High Speed Mobile Radio Connection for Testing

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 **IPMsg** 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.*
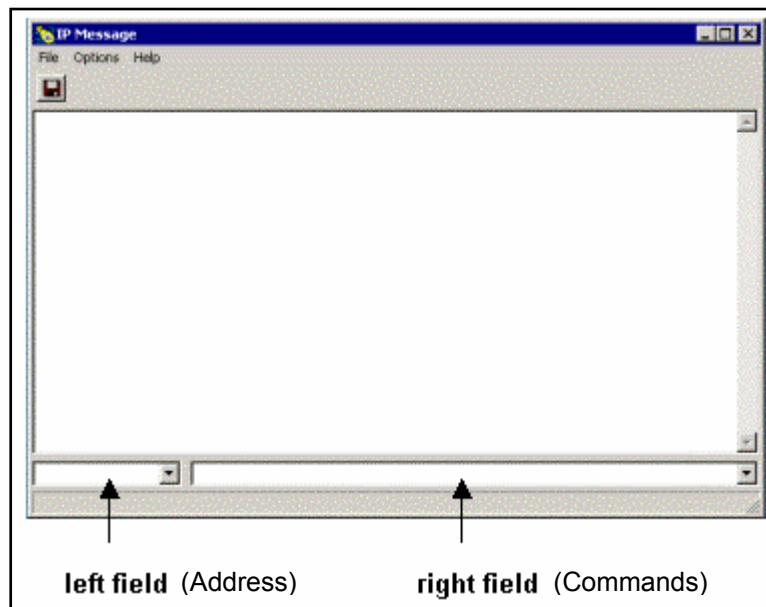

Figure 18: *IP*Message Window

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 high speed 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 antennas are separated by at least 10 feet. If the antennas are too close, the mobile radio receivers overload 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 transmitter/receiver 1, 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 M64800D25 Mobile Radio Factory Test Procedure:

TABLE 10: 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 multi-meter	Tektronix Fluke	77 or equivalent
1	DC power supply w/ ammeter, 13.8V, 23 Amps or more	Astron	RM35A
1	4-Channel Scope	Tektronix	TDS 460A
1	M64800D25 Mobile Radio		
1	B32800N25 Calibrated Base Station		
1	Internet Protocol Network Controller (IPNC)		
1	100 watt dummy load/attenuator	Pasternack	PE7021-40 or equivalent
2	UHF Antennas (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	Scope test probe (generic, X1 attenuation)		
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 M64800D25 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 an 806 to 824 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    ,  805.000000,  775.000000,  820.000000
[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
```

Adjustment / Alignment Procedures

Receiver Injection

Perform the following steps to adjust the receiver injection and injection frequency:

Step 1   While monitoring the receiver injection frequency at RXINJ1, input the value for the DAC frequency control for minimum frequency error (+/- 100Hz). Record this value on the **Test Data Sheet**.

Step 2   While monitoring the 44.545 MHz 2nd injection frequency at U6 pin 4, adjust trimmer capacitor CV22 for the maximum amplitude of this injection frequency. The maximum amplitude must be between -3 to -5 dBm. Record this value on the **Test Data Sheet**.

Step 3   Repeat Step 2 by monitoring U9 pin 4 and adjusting CV20 for Receiver2 IFLO. Record this value on the **Test Data Sheet**.

Receiver 1

Perform the following steps to adjust receiver 1:

Step1   Inject an on-frequency carrier signal with amplitude of -80 dBm, modulated with a 1 kHz test tone at +/- 5.0 kHz deviation into receiver 1's antenna port.

Step 2   While monitoring the voltage at RSSI1 Test Point with a DMM, adjust trimmer capacitor CV15 and C16 to midway between the points where the oscillation stops.

Step 3   While monitoring the DC level of the recovered modulation; adjust potentiometer RV6 for a reading of 2.500 VDC +/- 1 mV DC.

Step 4   While monitoring the amplitude of the recovered audio signal, adjust potentiometer RV5 and RV6 for a reading of 350 mV RMS and 2.500 VDC.

Step 5   Steps 3 and 4 are interactive adjustments, therefore repeat steps 3 and 4 until further adjustment is no longer required (i.e. when 350 mV RMS and 2.500 VDC are realized).

Step 6   While monitoring the recovered audio signal at TP1, verify the distortion is less than 3% adjust CV15 and CV16 if necessary to achieve less than 3% distortion. Record this value on the **Test Data Sheet**.

Step 7   While monitoring the recovered audio signal at TP1, verify the SINAD is -118 dBm or better. Record this value on the **Test Data Sheet**.

Receiver 2

Perform the following steps to adjust receiver 2:

Step 1   Inject an on-frequency carrier signal with amplitude of -80 dBm, modulated with a 1 kHz test tone at +/- 5.0 kHz deviation into Receiver 2's antenna port.

Step 2   While monitoring the voltage at RSSI2 Test Point with a DMM, adjust trimmer capacitor CV6 and CV7 to midway between the points where the oscillation stops.

Step 3   While monitoring the DC level of the recovered modulation, adjust potentiometer RV4 for a reading of 350 mV (+/-10 mV) RMS.

Step 4   While monitoring the amplitude of the recovered audio signal, adjust potentiometer RV3 for a reading of 2.500 (+/-10 mV) VDC.

Step 5   Steps 3 and 4 are interactive adjustments, therefore repeat steps 3 and 4 until further adjustment is no longer required (i.e. when 350 mV RMS and 2.500 VDC are realized).

Step 6   While monitoring the recovered audio signal at TP1, verify the distortion is less than 3%, adjust CV3 if necessary to achieve less than 3% distortion. Record this value on the ***Test Data Sheet***.

Step 7   While monitoring the recovered audio signal at TP1, verify the SINAD is -118 dBm or better. Record this value on the ***Test Data Sheet***.

Transcript Data
<u>Transmit Data</u>

Perform the following steps to adjust transmit data:

Step 1   Use *IP*Message to set the transmit power to 0.

Step 2   Using the **x=1400,n** command of *IP*Message to generate transmit data messages while observing the transmitted signal on the HP RF communications test set, adjust pot R33 for minimum frequency error while transmitting data messages.

Step 3   Turn potentiometer RV1 fully counterclockwise.

Step 4   Adjust RV2 for deviation of 4.9 kHz.

Step 5   Using calibrated base station, and monitoring the uplink received data quality on the base station's Hyperterminal screen, slowly turn RV1 clockwise until consistent data quality readings of 240 - 248 are achieved using 1400 character test messages. Data quality reading should not be less than 240 for 1400 character messages.

> ✏️   If unable to reach the data quality readings then ask for Technical Support. Poor data quality readings are indicative of poor group delay performance, or other defect.

Step 6   Verify transmit deviation, frequency error, and transmitting data messages quality and record this data on the ***Test Data Sheet***.

<u>Power Setting</u>

Perform the following steps to adjust the transmit power control:

Step 1   Attach a power attenuator to the transmit port of the radio.

Step 2   Using the **x=1400,n** command of *IP*Message, and while monitoring the transmit power level on the HP communications test set, check the level of the transmit power. Using *IP*Message set the power setting to **txpower=0**. The radio should have an output power level of approximately 1 mW. Record this value on the ***Test Data Sheet***.

Step 3   Using *IP*Message send the **txpower=** command to increase the power level settings until 30 Watts of output power is obtained. Record this value on the *Test Data Sheet*. Note that values on the table are to plot the codes vs. power output. The 30-Watt setting can be a code not on the table. Adjust **txpower** until the code is found that does not exceed 30.0 Watts. Record this value on the *Test Data Sheet*.

Do not to exceed 30 Watts of output power, as this may reduce the life of the amplifier.

Receive Data

Perform the following steps to verify the receive data performance:

Step 1   Using the DOS **ping** command on the PC connected to the radio, ping the network controller to generate uplink and downlink data messages. The following command will generate one Hundred 500 character messages:

```
>;Ping 192.168.3.3 –n 100 –l 500
```

Step 2   Observe the data quality readings on the *IP*Message window of the PC connected to the radio using the **V** (for Verbose) command in the *IP*Message program. With the mobile radio's antenna connected to receiver 1, verify the received data quality readings are consistently 248s. Data quality readings should also be verified at the base station using the **V** command on the Hyperterminal window.

Step 3   Verify receiver 2 data quality readings are also consistently 240 to 248s by changing the antenna from receiver 1 port to receiver 2 port. In this manner both uplink and downlink data quality can be verified. Record this data on the *Test Data Sheet*.

Final Test

A final test **must** be performed prior to shipping the M64800D25 mobile radio to the customer. This final test will verify that the timing characteristics are correct and that both transmit and receive data quality readings are consistently high.

Perform the following steps for the final test:

Step 1   Attach the 40dB 100-Watt power attenuator to the transmit port of the radio.

Step 2   Program the radio for full power operation. The **tx power** level setting can be found in the radio's *Test Data Sheet*.

The setting must not to exceed 40 Watts.

Step 3   Attach a digital scope to the base station as described in section the next section, *Uplink Hardware Timing Verification*. Using the **x=1400,19** command (which will cause the radio to transmit 19, 1400 character messages), verify the following:

Transmit frequency of radio is adjusted for minimum frequency error of +/- 100 Hz.

The **x=1400,19** command will generate different messages with differing DC components. Each message will slightly slew the frequency off from the center frequency). Be careful to closely monitor the variation in transmit frequency due to these different messages and ensure that on average the transit frequency error has been minimized to within +/-100 Hz. This indicates that some of these test messages will be slightly high in frequency, some messages will be slightly low in frequency, and some messages will be right on frequency.

Step 4   Verify the transmit deviation is 4.9 kHz

Step 5   Verify the timing characteristics are identical to the plots in the next section, *Uplink Hardware Timing Verification*.

Step 6   At the base station monitor PC, verify that all the data quality readings are 240 and higher.

Step 7   Move the scope probes to monitor the timing at the mobile radio as described in *Downlink Hardware Timing Verification*. Generate test messages by issuing a ping command to the IPNC from the PC attached to the radio. The following command will cause 100 pings, 500 bytes in length to be transmitted from the mobile radio and echoed by the IPNC through the base station:

```
.>;Ping 192.168.3.3 –n 100 –l 500 –w 2000
```

Step 8   Set **CRC =1 Enable** on the radio

Step 9   Verify the timing characteristics are identical to those in *Downlink Hardware Timing Verification*.

Step 10   Verify that both receivers on the mobile radio report data quality readings of 240 or higher (248 is typical). This can be accomplished by installing the antenna on the TX/RX1 port and verifying RX1 is selected by observing the RX1 LED on the mobile radio and installing the antenna on the RX2 port and verifying RX2 is selected by observing the RX2 LED on the mobile radio.

Step 11   Reset **CRC = 0 Disable** on the radio

Step 12   In *IP*Message, type the **?** command to radio. Copy the radio settings and paste them into the *Test Data File*.

Step 13   Perform a close visual inspection of the radio closely inspecting manufacturing related problems (loose screws, solder particles, etc.).

Uplink Hardware Timing Verification

The figure below displays an oscilloscope plot of an uplink data message from the mobile to the base station. Channel 1 is connected to the base station's RSSI (XXX-12), channel 2 is connected to the base station's recovered modulation, and channel 3 is connected to the base station's modem chip select line. The scopes acquisition mode is high-resolution.
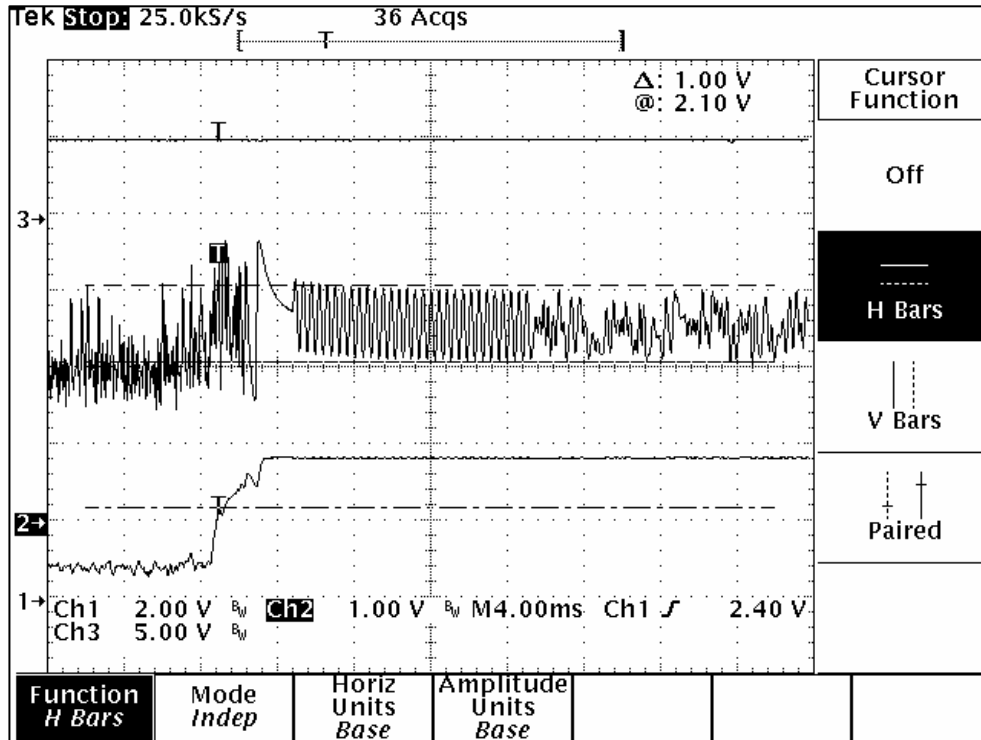
As seen in the above plot, the mobile radio's transmit carrier has ramped up to full power (channel 1) in just a few milliseconds. The recovered modulation (channel 2) is stable by this time. There follows a few milliseconds of quiet time followed by 12 milliseconds of symbol sync time.

The recovered modulation from a mobile radio should look identical 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.

The figure below displays another oscilloscope plot of an up-link data message from the mobile to the base station. As in the last plot, channel 1 is connected to the base station's RSSI (J5-12), channel 2 is connected to the base station's recovered modulation test point, and channel 3 is connected to the base station's modem chip select line (U16-13). The scope's acquisition mode is now in the peak detect mode. This enables the base station's modem CS (Chip Select) line to be viewed.
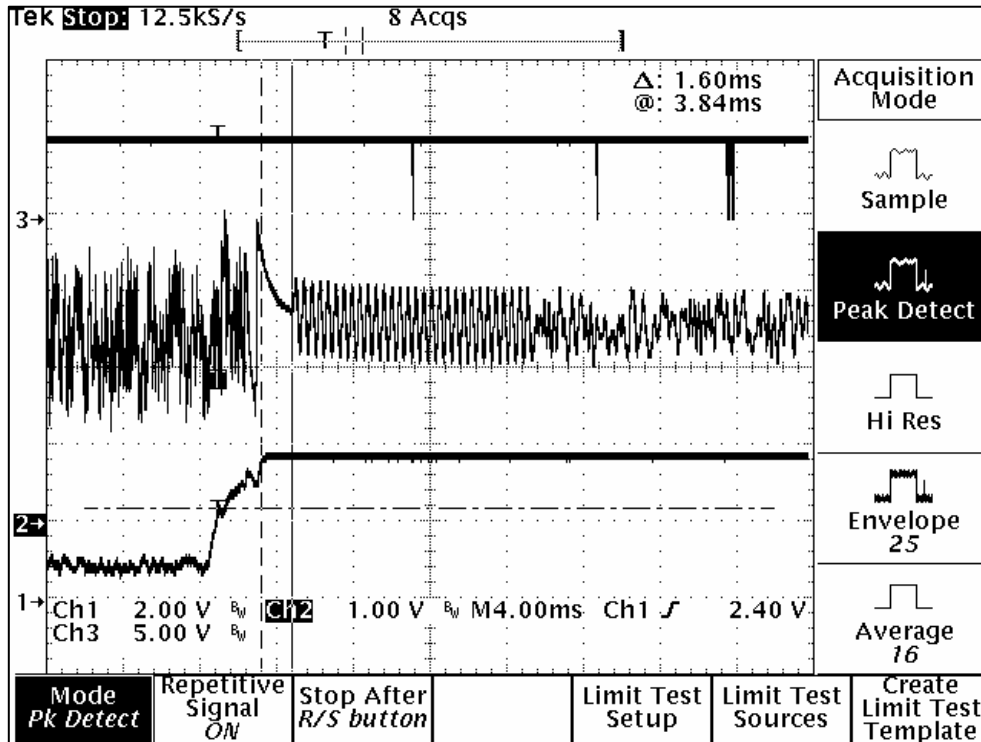
The base station's microcontroller, upon detecting a step response in the RSSI (caused by the mobile radio's transmitter coming up to power), waits a period of time equal to the programmed value of the base station's carrier detect delay time. The microcontroller then instructs the modem to search for 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 mobile radio's transmitter causes a step increase in the base station'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.

Downlink Hardware Timing Verification

The figure below displays a plot of the downlink 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.

> There is a very short period of quiet time (no modulation) followed by approximately 12 milliseconds of modem synchronization time (sync time).
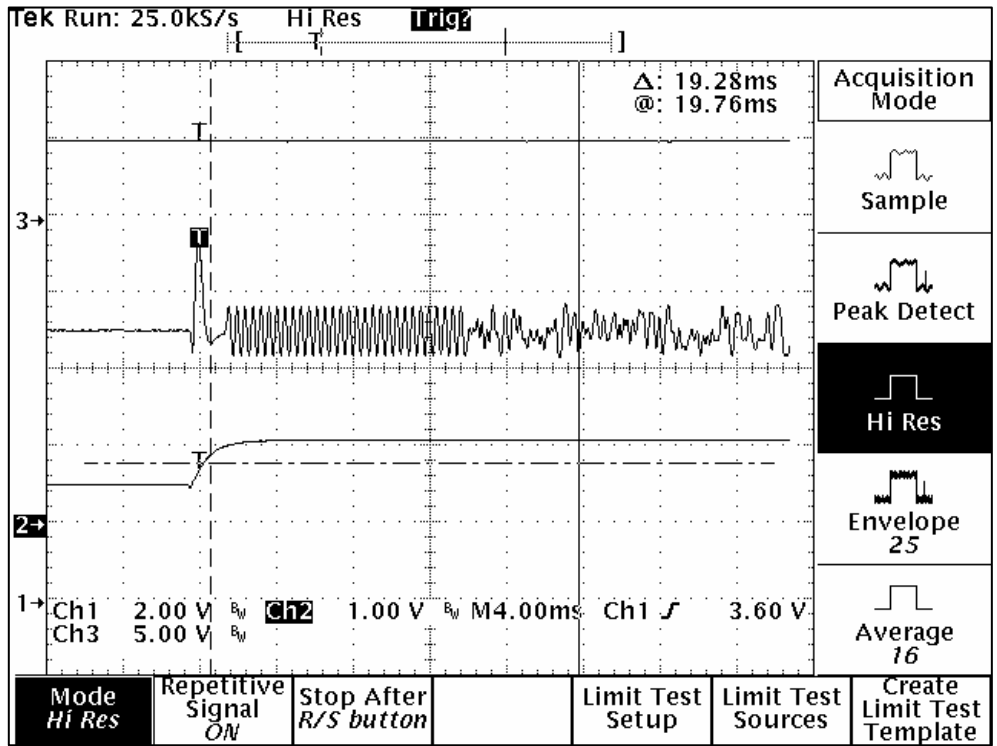
The plot shown in the figure below is the same as before but now the scope is in the peak detect acquisition mode. After the mobile radio detects a step response in the RSSI (caused by a down-link transmission), the radio's microcontroller waits an amount of time equal to the programmed value of the "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.
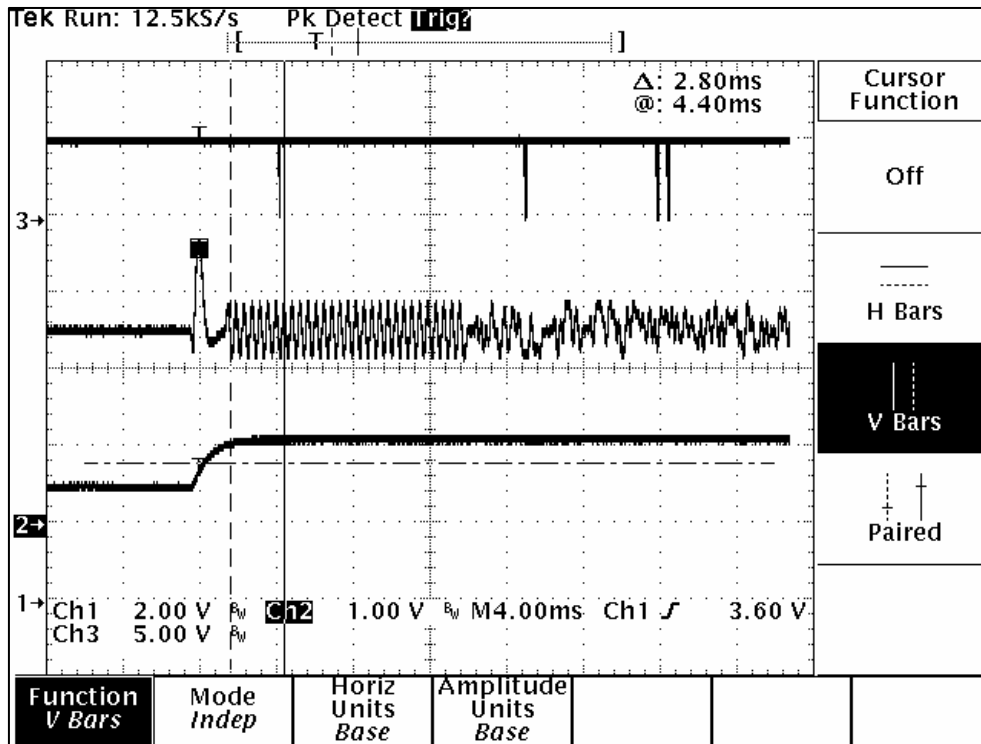
The recovered modulation should be centered at approximately 2.5 VDC and should have an amplitude of approximately 800 mV peal-to-peak as indicated in the plot above.

M64800D25 Data Transceiver FCC Label Placement
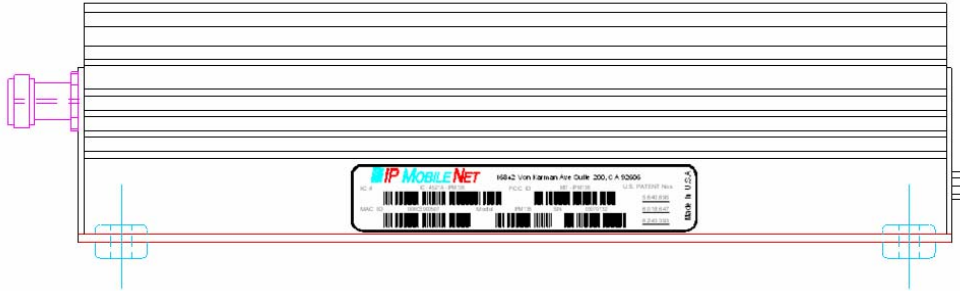
M64800D25 Data Transceiver FCC Label
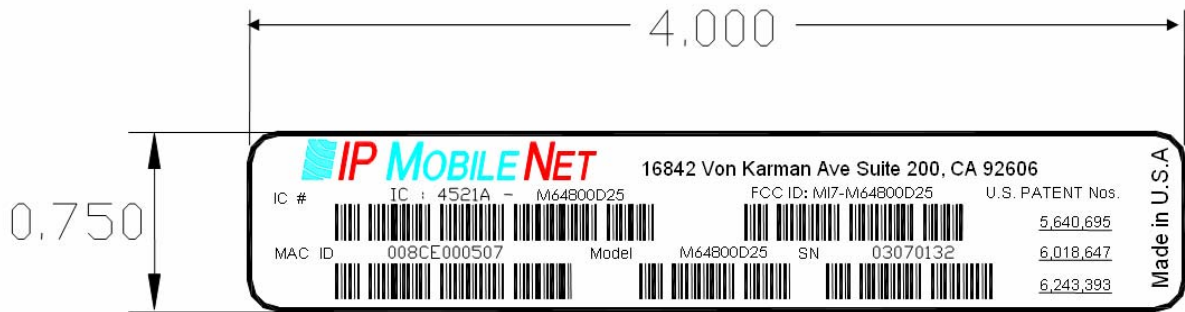
High Speed Mobile Radio OMAP 5910 Circuit Board
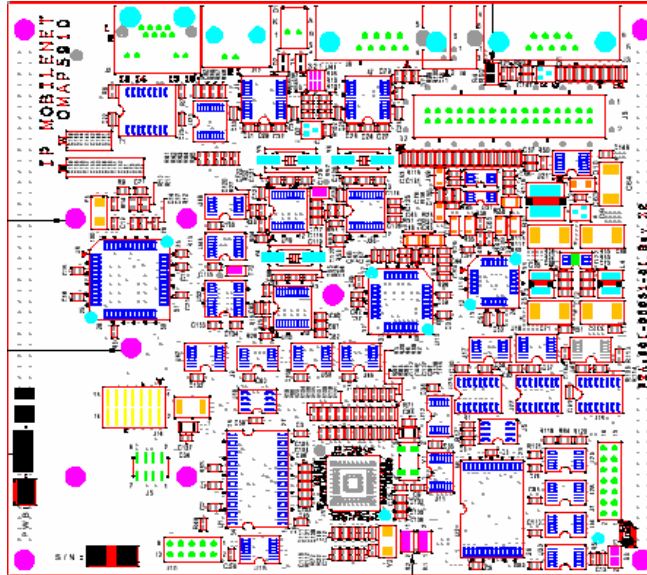
High Speed Mobile Radio RF Circuit Board

APPENDIX B: M64800D25 TEST DATA SHEET
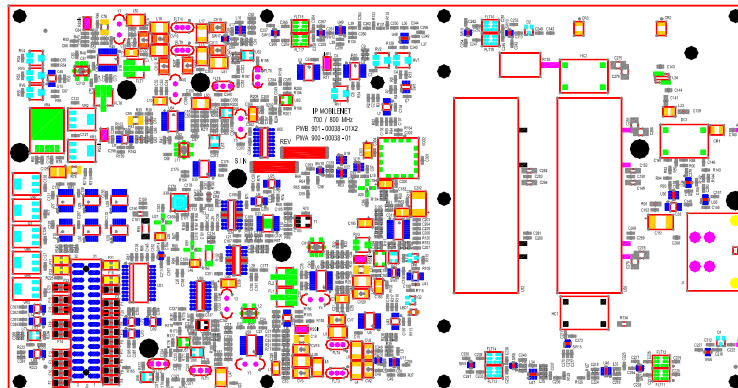
Program and Configure Mobile Radio

Date _____

Serial Number _____

Firmware Revision _____

Tester _____

Adjustment / Alignment Procedures

Receiver Injection

Parameter	**Spec**	**Measured**
Injection Frequency Error at RXINJ1(within +/- 100 Hz of exact injection frequency)	**+/- 100 Hz**	_____
U17 pin 4 power level	**-3 to -5 dBm**	_____

Receiver 1& 2

Parameter	**Spec**	**Receiver 1 Measured**	**Receiver 2 Measured**
Audio DC Amplitude (1 kHz Test tone @ 5.0 kHz Deviation)	**2.5 VDC +/- 1mV**	_____	_____
Audio AC Amplitude (1 kHz Test tone @ 5.0 kHz Deviation)	**350 mVRMS +/- 1mV**	_____	_____
Distortion (1 kHz Test tone @ 5.0 kHz Deviation)	**3%<**	_____	_____
SINAD 12 dB (1 kHz Test tone @ 5.0 kHz Deviation)	**-118dBm >**	_____	_____

Transmit Section

Parameter	Spec	Measured
Transmit Modulation Deviation (4.9 kHz while transmitting 1400 character test message)	4.9 kHz	
Transmit Data Quality (While transmitting 1400 character test messages to the base station)	240 >	
Transmit Frequency Error (Transmitting 1400 character test message)	+/- 100Hz	

Transmit Power Control
Caution: Do not to exceed 20-Watts RF output power during this test.

Transmit Power Setting	Expected RF Out	RF Out Watts
0	~ 1mW	
25		
50		
75		
100		
125		
150		
175		
200		
225		
250		

Parameter	Digital Code	Measure
Maximum power output setting without exceeding 20.0Watts		

APPENDIX B: M64800D25 TEST DATA SHEET

Data Quality

Parameter	Spec	Measured
Receiver 1 Data Quality (While receiving 500 character "pings" from base station, 100 pings min, no errors allowed, CRC errors enabled)	**240>**	
Receiver 2 Data Quality (While receiving 500 character "pings" from base station, 100 pings min, no errors allowed, CRC errors enabled)	**240>**	

Final Tests

Uplink Final

Parameter	Spec	Measured
Transmit Frequency Error	**+/- 100 Hz** (Transmitting 19, 2000 character test message)	
Transmit Modulation Deviation	**4.9 kHz** (while transmitting 19,2000 character test message)	
Uplink Hardware Timing Verified		
Transmit Carrier ramp up time	**2mS < X < 4mS**	
Symbol Sync time (Stable Amplitude to with in 100mV during the period)	**12ms +/- 1ms**	
Recovered modulation signal	**1 V PtoP ~**	
	2.5 VDC ~	
Verify Sync Start (RSSI to CS first going low)	**10mS +/- 0.5**	
Verify Fram Sync (From end of Sync to CS second time going low)	**4 +/- 0.1 mS**	
Transmit Data Quality (While transmitting 19, 1400 character test messages to the base station)	**240 >**	

Downlink Final

Parameter	Spec	Measured
Downlink Hardware Timing Verification		
Sync start (RSSI to CS first going low)	3.0 +/- 0.5ms	
Recovered Modulation Levels	800 mV~ 2.5VDC~	
Frame Sync (From end of Sync to CS second time going low)	3.2 +/- 0.5 mS	
Receiver 1 Data Quality (While receiving 500 character "pings" from base station, 100 pings min, no errors allowed, CRC errors enabled)	240>	
LED Receiver 1	Lit	
Receiver 2 Data Quality (While receiving 500 character "pings" from base station, 100 pings min, no errors allowed, CRC errors enabled)	240>	
LED Receiver 2	Lit	
Attach copy of all firmware settings	Completed	
Visual inspection	Completed	