



**VRS7000 Series  
P25 Trunked Cross-Band  
Vehicular Repeater Systems  
VRS7010, VRS7020, and VRS7030**

Includes

VRBS7010, VRBS7020, VRBS7030,  
VRMS7010, VRMS7020, VRMS7030  
and CH-721 Control Head



**MANUAL REVISION HISTORY**

REV.	DATE	REASON FOR CHANGE
—	Feb/10	Original release.
A	Jul/10	Revised antenna part numbers, introduction, option and accessories tables, mounting procedures, antenna installation procedures, Interface Cable installation procedure, and performance test procedures.
B	Sep/11	Added VRBS7020, VRBS7030, VRMS7020, and VRMS7030. Revised optional cables section.

Harris Corporation, Public Safety and Professional Communications (PSPC) Business, continually evaluates its technical publications for completeness, technical accuracy, and organization. You can assist in this process by submitting your comments and suggestions to the following:

**Harris Corporation**  
 PSPC Business  
 Technical Publications  
 221 Jefferson Ridge Parkway  
 Lynchburg, VA 24501

fax your comments to: 1-434-455-6851  
 or  
 e-mail us at: [PSPC\\_TechPubs@harris.com](mailto:PSPC_TechPubs@harris.com)

**ACKNOWLEDGEMENT**

This device is made under license under one or more of the following US patents: 4,590,473; 4,636,791; 5,148,482; 5,185,796; 5,271,017; 5,377,229; 4,716,407; 4,972,460; 5,502,767; 5,146,497; 5,164,986; 5,185,795; 5,226,084; 5,247,579; 5,491,772; 5,517,511; 5,630,011; 5,649,050; 5,701,390; 5,715,365; 5,754,974; 5,826,222; 5,870,405; 6,161,089; and 6,199,037 B1. DVSI claims certain rights, including patent rights under aforementioned U.S. patents, and under other U.S. and foreign patents and patents pending. Any use of this software or technology requires a separate written license from DVSI.

**CREDITS**

Harris and assuredcommunications are registered trademarks of Harris Corporation.

All other brand and product names are trademarks, registered trademarks, or service marks of their respective holders.

**NOTICE!**

The material contained herein is subject to U.S. export approval. No export or re-export is permitted without written approval from the U.S. Government. Rated: EAR99 in accordance with U.S. Dept. of Commerce regulations 15CFR774, Export Administration Regulations.

Information and descriptions contained herein are the property of Harris Corporation. Such information and descriptions may not be copied or reproduced by any means, or disseminated or distributed without the express prior written permission of Harris Corporation, PSPC Business, 221 Jefferson Ridge Parkway, Lynchburg, VA 24501.

Repairs to this equipment should be made only by an authorized service technician or facility designated by the supplier. Any repairs, alterations or substitutions of recommended parts made by the user to this equipment not approved by the manufacturer could void the user's authority to operate the equipment in addition to the manufacturer's warranty.



This product conforms to the European Union WEEE Directive 2002/96/EC. Do not dispose of this product in a public landfill. Take it to a recycling center at the end of its life.

This manual is published by **Harris Corporation** without any warranty. Improvements and changes to this manual necessitated by typographical errors, inaccuracies of current information, or improvements to programs and/or equipment, may be made by **Harris Corporation** at any time and without notice. Such changes will be incorporated into new editions of this manual. No part of this manual may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, for any purpose, without the express written permission of **Harris Corporation**.

**TABLE OF CONTENTS**

<u>Section</u>		<u>Page</u>
<b>1 REGULATORY AND SAFETY INFORMATION .....</b>		<b>6</b>
1.1 SAFETY SYMBOL CONVENTIONS .....		6
1.2 RF ENERGY EXPOSURE AWARENESS AND CONTROL INFORMATION FOR FCC OCCUPATIONAL USE REQUIREMENTS .....		6
1.2.1 Federal Communications Commission Regulations .....		7
1.3 COMPLIANCE WITH RF EXPOSURE STANDARDS .....		7
1.3.1 Mobile Antennas .....		11
1.3.2 Approved Accessories .....		11
1.3.3 Contact Information .....		11
1.4 RADIO FREQUENCY INTERFERENCE .....		11
1.4.1 FCC Part 15 .....		11
1.4.2 Industry Canada .....		11
1.5 OCCUPATIONAL SAFETY GUIDELINES AND SAFETY TRAINING INFORMATION .....		11
1.6 COMMON HAZARDS .....		12
1.7 SAFE DRIVING RECOMMENDATIONS .....		13
1.8 OPERATING RULES REGULATIONS .....		13
1.9 OPERATING TIPS .....		14
<b>2 SPECIFICATIONS .....</b>		<b>15</b>
2.1 GENERAL .....		15
2.2 REGULATORY .....		16
<b>3 INTRODUCTION .....</b>		<b>17</b>
3.1 GENERAL INFORMATION .....		17
3.1.1 Vehicular Repeater Base System (VRBS) .....		17
3.1.2 Vehicular Repeater Mobile System (VRMS) .....		18
3.2 OPERATING MODES .....		19
3.2.1 Standard Mobile Radio Mode .....		19
3.2.2 Extended Coverage (XCOV) Vehicular Repeater Mode .....		19
3.3 EQUIPMENT MOUNTING AND CONTROL HEAD .....		20
3.4 OPERATING POWER .....		20
3.5 RELATED PUBLICATIONS .....		21
3.6 REPLACEMENT PARTS .....		21
3.7 TECHNICAL ASSISTANCE .....		21
<b>4 UNPACKING AND CHECKING THE EQUIPMENT .....</b>		<b>22</b>
4.1 MATERIALS .....		22
4.2 MATERIAL INSPECTION .....		23
<b>5 PLANNING THE INSTALLATION .....</b>		<b>28</b>
5.1 GENERAL INFORMATION .....		28
5.2 TOOLS REQUIRED .....		28
5.3 LOCATING COMPONENTS .....		31
<b>6 MOUNTING THE RADIO EQUIPMENT .....</b>		<b>32</b>
6.1 INSTALL THE MOUNTING BRACKETS .....		32
6.2 MOUNT THE RADIOS AND FILTER INTO THE BRACKETS .....		34
<b>7 ANTENNA INSTALLATION .....</b>		<b>36</b>
7.1 ANTENNA MOUNTING LOCATIONS .....		36
7.1.1 Direct Center or Center-Rear of Rooftop for VRMS Antenna .....		36
7.1.2 Center of Trunk Lid for VRBS Antenna .....		36
7.1.3 Rear Deck Lid for GPS Stand-Alone GPS Receive Antenna .....		38
7.2 ANTENNA INSTALLATION PROCEDURES .....		39
7.2.1 Installing NMO Antenna Mounts AN-125001-001, -002, -003 and -004 .....		39
7.2.2 Installing NMO Magnetic Antenna Mounts AN-125001-007 and AN-125001-008 .....		42

**TABLE OF CONTENTS (Continued)**

<u>Section</u>		<u>Page</u>
7.2.3	Installing all Other Antenna Mounts.....	42
7.2.4	Attaching NMO Antenna Elements .....	42
7.2.5	Connecting the Mobile Antennas.....	43
7.2.6	Connect RF Cable Between VRM Radio and 800 MHz Bandpass Filter.....	44
7.2.7	Install and Connect GPS Antenna (if Required) .....	44
<b>8</b>	<b>INTERFACE CABLE INSTALLATION .....</b>	<b>46</b>
8.1	INTERFACE CABLE CA-012349-003 OVERVIEW .....	46
8.2	INTERFACE CABLE CA-012349-003 INSTALLATION PROCEDURE .....	49
<b>9</b>	<b>DC POWER INSTALLATION.....</b>	<b>52</b>
9.1	OVERVIEW OF ON/OFF POWER WIRING CONFIGURATIONS.....	52
9.2	POWER INSTALLATION PROCEDURE.....	53
9.2.1	Radio DC Power Cables and Main Fuse Holders Installation .....	53
<b>10</b>	<b>CONTROL HEAD INSTALLATION.....</b>	<b>56</b>
10.1	GENERAL INFORMATION .....	56
10.2	CONTROL HEAD MECHANICAL INSTALLATION .....	58
10.2.1	Selecting the Mounting Location.....	58
10.2.2	Using the Standard U-Shaped Mounting Bracket .....	59
10.2.3	Using the Mounting Pedestal (Optional) .....	59
10.3	CAN CONNECTIONS .....	60
10.3.1	General Information.....	60
10.3.2	Make CAN Link Terminations and Cable Connection.....	60
10.4	CONTROL HEAD POWER CABLE INSTALLATION.....	61
10.4.1	Install DC Power Cable and Make Power and Ground Connections.....	61
10.4.2	Connect DC Power Cable's White Wire.....	62
10.4.3	Using Vehicle Fuse and T-Tap Kit (Optional) Instead of Waterproof Inline Fuse Holder (Standard) .....	64
<b>11</b>	<b>SPEAKER INSTALLATION.....</b>	<b>66</b>
<b>12</b>	<b>MICROPHONE ATTACHMENT.....</b>	<b>66</b>
<b>13</b>	<b>OPTIONAL CABLES.....</b>	<b>67</b>
13.1	SERIAL PROGRAMMING CABLE CA-013671-020 .....	67
13.2	CH-721 OPTION CABLE CA-011854-001.....	68
13.3	CH-721 SERIAL PROGRAMMING CABLE CA-104861.....	69
<b>14</b>	<b>GPS NMEA-FORMATTED SERIAL DATA CONNECTION.....</b>	<b>70</b>
<b>15</b>	<b>INITIAL POWER-UP TEST .....</b>	<b>71</b>
<b>16</b>	<b>PERFORMANCE TESTS .....</b>	<b>72</b>
16.1	REQUIRED TEST EQUIPMENT .....	73
16.2	VRMS TRANSMITTING INTO A 50-OHM LOAD/TERMINATOR.....	73
16.3	VRMS TRANSMITTING INTO ITS ANTENNA.....	75
16.4	VRBS TRANSMITTING INTO A 50-OHM LOAD/TERMINATOR .....	77
16.5	VRBS TRANSMITTING INTO ITS ANTENNA .....	78
16.6	TEST PERFORMANCE DATA FORM .....	81
<b>17</b>	<b>COMPLETE THE INSTALLATION .....</b>	<b>82</b>
<b>18</b>	<b>WARRANTY REGISTRATION .....</b>	<b>82</b>
<b>19</b>	<b>WARRANTY .....</b>	<b>83</b>
<b>20</b>	<b>WIRING DIAGRAM FOR VRS7000 AND CH-721 .....</b>	<b>85</b>

**LIST OF FIGURES**

<u>Figure</u>	<u>Page</u>
Figure 3-1: Simplified Block Diagram of Extended Network Coverage Mode .....	17
Figure 5-1: Vehicular Repeater Mobile System (VRMS) .....	29
Figure 5-2: Vehicular Repeater Base System (VRBS).....	30
Figure 6-1: Base Bracket (Two Required Per VRS7000 Installation).....	33
Figure 6-2: VRMS and VRBS Assembly into Brackets (Exploded Views).....	35
Figure 7-1: Required VRMS7010/VRMS7020 Antenna Mounting Locations with Antenna Part Numbers.....	37
Figure 7-2: Required VRMS7030 Antenna Mounting Locations with Antenna Part Numbers .....	38
Figure 7-3: Required VRBS7010/VRBS7020/VRBS7030 Antenna Mounting Locations with Antenna Part Numbers .....	39
Figure 7-4: Installing a Standard 3/4-Inch NMO Antenna Mount (e.g., AN-125001-001 or AN-125001-002) ...	41
Figure 7-5: Installing a Thick-Roof NMO Antenna Mount (e.g., AN-125001-003 or AN-125001-004) .....	42
Figure 7-6: Crimping Instructions for TNC RF Connector (Actual Size; Dimensions in Inches).....	44
Figure 8-1: Interface Cable CA-012349-003.....	46
Figure 10-1: CH-721 System Model Control Head Front Panel .....	56
Figure 10-2: CH-721 Rear Panel.....	57
Figure 10-3: Standard U-Shaped Control Head Mounting Bracket (Kit Part Number KT-008608).....	58
Figure 10-4: Optional Control Head Mounting Pedestal (Part Number MACDOS0012).....	58
Figure 10-5: CAN Cable and Terminator Connections .....	60
Figure 10-6: Contents of Vehicle Fuse and T-Tap Kit FS24473.....	64
Figure 10-7: Attaching T-Tap Terminals to a Switched Power Wire.....	65
Figure 13-1: Serial Data Cable CA-013671-020 .....	67
Figure 13-2: CH-721 Option Cable CA-011854-001 .....	68
Figure 13-3: Programming Cable CA-104861 .....	69
Figure 16-1: Wattmeter Connections for VRMS7010/VRMS7020/VRMS7030 Antenna Tests .....	74
Figure 16-2: Wattmeter Connections for VRBS7010/VRBS7020/VRBS7030 Antenna Tests.....	77

**LIST OF TABLES**

<u>Table</u>	<u>Page</u>
Table 1-1: Recommended Minimum Safe Lateral Distance from Transmitting Antenna for Mobile Radio-to-Network Radio Link (VRMS7010/VRMS7020 Transmit/Receive Antenna) .....	8
Table 1-2: Recommended Minimum Safe Lateral Distance from Transmitting Antenna for Mobile Radio-to-Network Radio Link (VRMS7030 Transmit/Receive Antenna).....	10
Table 1-3: Recommended Minimum Safe Lateral Distance from Transmitting Antenna for Vehicular Repeater-to-P25 Radio Link (VRBS7010/VRBS7020/VRBS7030 Transmit/Receive Antenna) .....	10
Table 4-1: VRS7010 Catalog and Part Numbers.....	22
Table 4-2: VRS7020 Catalog and Part Numbers.....	22
Table 4-3: VRS7030 Catalog and Part Numbers.....	23
Table 4-4: Installation Kit MAMW-NZN8X for VRS7000 and CH-721.....	24
Table 4-5: Options and Accessories for VRS7010/VRS7020/VRS7030 .....	26
Table 4-6: Accessories for CH-721 Control Heads .....	27
Table 8-1: Interface Cable CA-012349-003 Pin-Out/Interconnections.....	47
Table 8-2: VRS7000-to-VC3000/VC4000 Vehicular Charger Interconnections for Vehicular Repeater Enable/Disable if using VRMS's Aux I/O 1 = INP1 (Optional) .....	50
Table 8-3: VRS7000-to-VC3000/VC4000 Vehicular Charger Interconnections for Vehicular Repeater Enable/Disable if using VRMS's Aux I/O 2 = INP2 (Optional) .....	51
Table 16-1: Test Equipment Required for Performance Tests .....	73

# 1 REGULATORY AND SAFETY INFORMATION

## 1.1 SAFETY SYMBOL CONVENTIONS

The following conventions are used in this manual to alert the user to general safety precautions that must be observed during all phases of operation, service, and repair of this product. Failure to comply with these precautions or with specific warnings elsewhere violates safety standards of design, manufacture, and intended use of the product. Harris assumes no liability for the customer's failure to comply with these standards.



WARNING

The **WARNING** symbol calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** symbol until the conditions identified are fully understood or met.



CAUTION

The **CAUTION** symbol calls attention to an operating procedure, practice, or the like, which, if not performed correctly or adhered to, could result in damage to the equipment or severely degrade equipment performance.



NOTE

The **NOTE** symbol calls attention to supplemental information, which may improve system performance or clarify a process or procedure.

## 1.2 RF ENERGY EXPOSURE AWARENESS AND CONTROL INFORMATION FOR FCC OCCUPATIONAL USE REQUIREMENTS

Before using the mobile two-way radio, read this important RF energy awareness and control information to ensure compliance with RF exposure guidelines.



WARNING

This radio is intended for use in occupational/controlled conditions, where users have full knowledge of their exposure and can exercise control over their exposure to remain below RF exposure limits. This radio is NOT authorized for general population, consumer, or any other use.



CAUTION

Changes or modifications not expressly approved by Harris could void the user's authority to operate the equipment.

This two-way radio uses electromagnetic energy in the radio frequency (RF) spectrum to provide communications between two or more users over a distance. It uses RF energy or radio waves to send and receive calls. RF energy is one form of electromagnetic energy. Other forms include, but are not limited to, electric power, sunlight, and x-rays. RF energy, however, should not be confused with these other forms of electromagnetic energy, which, when used improperly, can cause biological damage. Very high levels of x-rays, for example, can damage tissues and genetic material.

Experts in science, engineering, medicine, health, and industry work with organizations to develop standards for exposure to RF energy. These standards provide recommended levels of RF exposure for both workers and the general public. These recommended RF exposure levels include substantial margins of protection. All two-way radios marketed in North America are designed, manufactured, and tested to

ensure they meet government-established RF exposure levels. In addition, manufacturers also recommend specific operating instructions to users of two-way radios. These instructions are important because they inform users about RF energy exposure and provide simple procedures on how to control it. Please refer to the following websites for more information on what RF energy exposure is and how to control exposure to assure compliance with established RF exposure limits:

<http://www.fcc.gov/oet/rfsafety/rf-faqs.html>

<http://www.osha.gov/SLTC/radiofrequencyradiation/index.html>

### **1.2.1     Federal Communications Commission Regulations**

Before it was marketed in the United States, the P25 Vehicular Repeater System was tested to ensure compliance with FCC RF energy exposure limits for mobile two-way radios. When two-way radios are used as a consequence of employment, the FCC requires users to be fully aware of and able to control their exposure to meet occupational requirements. Exposure awareness can be facilitated by the use of a label directing users to specific user awareness information. The radio has an RF exposure product label. Also, this Installation and Product Safety Manual and the applicable Operator's Manual include information and operating instructions required to control RF exposure and to satisfy compliance requirements.

## **1.3    COMPLIANCE WITH RF EXPOSURE STANDARDS**

The P25 Vehicular Repeater System is designed and tested to comply with a number of national and international standards and guidelines regarding human exposure to RF electromagnetic energy. This radio complies with the IEEE and ICNIRP exposure limits for occupational/controlled RF exposure environment at duty-cycle times of up to 50% (50% transmit, 50% receive) for the VRMS radio equipment, and up to 100% for the VRBS radio equipment. The radio equipment is authorized by the FCC for occupational use. In terms of measuring RF energy for compliance with the FCC exposure guidelines, the radio's antenna radiates measurable RF energy only while it is transmitting (talking), not when it is receiving (listening), or in standby mode.

The Vehicular Repeater System complies with the following RF energy exposure standards and guidelines:

- United States Federal Communications Commission (FCC), Code of Federal Regulations; 47 CFR § 2 sub-part J.
- American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE) C95.1-2005.
- Institute of Electrical and Electronic Engineers (IEEE) C95.1-2005.
- IC Standard RSS-102, Issue 2, 2005: Spectrum Management and Telecommunications Radio Standards Specification. Radiofrequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands).



**CAUTION**

Table 1-1 through Table 1-3 list the recommended minimum safe lateral distances for a controlled environment and for unaware bystanders in an uncontrolled environment, from transmitting antennas (i.e., monopoles over a ground plane, or dipoles). Table 1-1 and Table 1-2 have the distances for the respective VRMS section of the vehicular repeater on a per antenna basis. Table 1-3 has the distances for the VRBS section of the vehicular repeater on a per antenna basis. This data is based upon the mobile radio installed in a motor vehicle with the radio transmitting at its rated RF power level. Transmit only when unaware bystanders are at least the uncontrolled recommended minimum safe lateral distance away from the mobile radio's transmitting antenna.

**Table 1-1: Recommended Minimum Safe Lateral Distance  
from Transmitting Antenna for Mobile Radio-to-Network Radio Link  
(VRMS7010/VRMS7020 Transmit/Receive Antenna)**

ANTENNA PART NUMBER	ANTENNA DESCRIPTION	RECOMMENDED MINIMUM LATERAL HUMAN BODY DISTANCE FROM TRANSMITTING ANTENNA	
		CONTROLLED ENVIRONMENT	UNCONTROLLED ENVIRONMENT
AN-125001-002 (mount) with AN-225001-001 (element)	700/800 MHz Standard Rooftop-Mount; 3 dBd Gain		
AN-125001-002 (mount) with AN-225001-002 (element)	700/800 MHz Standard Rooftop-Mount; Elevated-Feed 3 dBd Gain	9.8 Inches (25 Centimeters)	21.7 Inches (55 Centimeters)
AN-125001-002 (mount) with AN-225001-003 (element)	700/800 MHz Standard Rooftop-Mount; Elevated-Feed, No Ground Plane 3 dBd Gain		
AN-125001-002 (mount) with AN-225001-004 (element)	700/800 MHz Standard Rooftop-Mount; Low-Profile 2 dBd Gain		
AN-125001-002 (mount) with AN-225001-005 (element)	700/800 MHz Standard Rooftop-Mount; 5 dBd Gain	11.8 Inches (30 Centimeters)	23.6 Inches (60 Centimeters)
AN-125001-004 (mount) with AN-225001-001 (element)	700/800 MHz Thick Rooftop-Mount; 3 dBd Gain		
AN-125001-004 (mount) with AN-225001-002 (element)	700/800 MHz Thick Rooftop-Mount; Elevated-Feed 3 dBd Gain	9.8 Inches (25 Centimeters)	21.7 Inches (55 Centimeters)
AN-125001-004 (mount) with AN-225001-003 (element)	700/800 MHz Thick Rooftop-Mount; Elevated-Feed, No Ground Plane 3 dBd Gain		
AN-125001-004 (mount) with AN-225001-004 (element)	700/800 MHz Thick Rooftop-Mount; Low-Profile 2 dBd Gain		
AN-125001-004 (mount) with AN-225001-005 (element)	700/800 MHz Thick Rooftop-Mount; 5 dBd Gain	11.8 Inches (30 Centimeters)	23.6 Inches (60 Centimeters)

(Table Continued on Next Page)

**Table 1-1: Recommended Minimum Safe Lateral Distance  
from Transmitting Antenna for Mobile Radio-to-Network Radio Link  
(VRMS7010/VRMS7020 Transmit/Receive Antenna)**

ANTENNA PART NUMBER	ANTENNA DESCRIPTION	RECOMMENDED MINIMUM LATERAL HUMAN BODY DISTANCE FROM TRANSMITTING ANTENNA	
		CONTROLLED ENVIRONMENT	UNCONTROLLED ENVIRONMENT
AN-125001-006 (mount) with AN-225001-001 (element)	700/800 MHz GPS Combo Rooftop-Mount; 3 dBd / 5.15 dBi Gain	9.8 Inches (25 Centimeters)	21.7 Inches (55 Centimeters)
AN-125001-006 (mount) with AN-225001-002 (element)	700/800 MHz GPS Combo Rooftop-Mount; Elevated-Feed 3 dBd Gain		
AN-125001-006 (mount) with AN-225001-003 (element)	700/800 MHz GPS Combo Rooftop-Mount; Elevated-Feed, No Ground Plane 3 dBd Gain		
AN-125001-006 (mount) with AN-225001-004 (element)	700/800 MHz GPS Combo Rooftop-Mount; Low-Profile 2 dBd Gain		
AN-125001-006 (mount) with AN-225001-005 (element)	700/800 MHz GPS Combo Rooftop-Mount; 5 dBd / 7.15 dBi Gain	11.8 Inches (30 Centimeters)	23.6 Inches (60 Centimeters)
AN-125001-008 (mount) with AN-225001-001 (element)	700/800 MHz Magnetic-Mount; 3 dBd Gain	9.8 Inches (25 Centimeters)	21.7 Inches (55 Centimeters)
AN-125001-008 (mount) with AN-225001-002 (element)	700/800 MHz Magnetic-Mount; Elevated-Feed 3 dBd Gain		
AN-125001-008 (mount) with AN-225001-003 (element)	700/800 MHz Magnetic-Mount; Elevated-Feed, No Ground Plane 3 dBd Gain		
AN-125001-008 (mount) with AN-225001-004 (element)	700/800 MHz Magnetic-Mount; Low-Profile 2 dBd Gain		
AN-125001-008 (mount) with AN-225001-005 (element)	700/800 MHz Magnetic-Mount; 5 dBd Gain	11.8 Inches (30 Centimeters)	23.6 Inches (60 Centimeters)

**Table 1-2: Recommended Minimum Safe Lateral Distance from Transmitting Antenna for Mobile Radio-to-Network Radio Link (VRMS7030 Transmit/Receive Antenna)**

ANTENNA PART NUMBER	ANTENNA DESCRIPTION	RECOMMENDED MINIMUM LATERAL HUMAN BODY DISTANCE FROM TRANSMITTING ANTENNA	
		CONTROLLED ENVIRONMENT	UNCONTROLLED ENVIRONMENT
AN102800V1	136 to 941 MHz, 1/4-Wavelength*, Standard Rooftop-Mount; 0 dBd Gain		
AN-125001-001 (mount) with AN-225002-001 (element)	136 to 174 MHz, Standard Rooftop-Mount; 0 dBd Gain		
AN-125001-003 (mount) with AN-225002-001 (element)	136 to 174 MHz, Thick Rooftop-Mount; 0 dBd Gain	24.8 Inches (63 Centimeters)	55.1 Inches (140 Centimeters)
AN-125001-003 (mount) with AN-225006-001 (element)	132 to 960 MHz,* Thick Rooftop-Mount; 0 dBd Gain		
AN-125001-007 (mount) with AN-225002-001 (element)	136 to 174 MHz, Magnetic-Mount; 0 dBd Gain		

\* Driven elements of AN102800V1 and AN-225006-001 must be trimmed to proper lengths in order to minimize antenna system VSWR.

**Table 1-3: Recommended Minimum Safe Lateral Distance from Transmitting Antenna for Vehicular Repeater-to-P25 Radio Link (VRBS7010/VRBS7020/VRBS7030 Transmit/Receive Antenna)**

ANTENNA PART NUMBER	ANTENNA DESCRIPTION	RECOMMENDED MINIMUM LATERAL HUMAN BODY DISTANCE FROM TRANSMITTING ANTENNA	
		CONTROLLED ENVIRONMENT	UNCONTROLLED ENVIRONMENT
AN-125001-002 (mount) with AN-225001-004 (element)	Standard Rooftop-Mount with Low-Loss Cable and 700/800 MHz Low-Profile 2 dBd Gain Element		
AN-125001-004 (mount) with AN-225001-004 (element)	Thick Rooftop-Mount with Low-Loss Cable and 700/800 MHz Low-Profile 2 dBd Gain Element	7.9 Inches (20 Centimeters)	7.9 Inches (20 Centimeters)
AN-125001-008 (mount) with AN-225001-004 (element)	Magnetic-Mount with Low-Loss Cable and 700/800 MHz Low-Profile 2 dBd Gain Element		

### **1.3.1 Mobile Antennas**

The antenna(s) for the radios must be installed in accordance with Section 7 in this manual. Installation guidelines presented in Section 7 are limited to metal-body motor vehicles or vehicles with appropriate ground planes.

Use only the Harris-approved/supplied antenna(s) or an approved replacement antenna. Unauthorized antennas, modifications, or attachments can cause the FCC RF exposure limits to be exceeded.

### **1.3.2 Approved Accessories**

The radio has been tested and meets FCC RF guidelines when used with accessories supplied or designated for use with it. Use of other accessories may not ensure compliance with the FCC's RF exposure guidelines, and may violate FCC regulations. For a list of approved accessories refer to Section 4 in this manual (begins on page 22) and/or the Products and Services Catalog.

### **1.3.3 Contact Information**

For additional information on RF exposure and other information, contact Harris using one of the contact links listed in Section 3.7 on page 21.

## **1.4 RADIO FREQUENCY INTERFERENCE**

### **1.4.1 FCC Part 15**

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

### **1.4.2 Industry Canada**

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

## **1.5 OCCUPATIONAL SAFETY GUIDELINES AND SAFETY TRAINING INFORMATION**

To ensure bodily exposure to RF electromagnetic energy is within the FCC allowable limits for occupational use. Always adhere to the following basic guidelines:

- The push-to-talk button should only be depressed when intending to send a voice message.
- The radio should only be used for necessary work-related communications.
- The radio should only be used by authorized and trained personnel. It should never be operated by children.

- Do not attempt any unauthorized modification to the radio. Changes or modifications to the radio may cause harmful interference and/or cause it to exceed FCC RF exposure limits. Only qualified personnel should service the radio.
- Always use only Harris-authorized accessories (antennas, control heads, speakers/mics, etc.). Use of unauthorized accessories can cause the FCC RF exposure compliance requirements to be exceeded.

The information listed above provides the user with information needed to make him or her aware of a RF exposure, and what to do to assure that this radio operates within the FCC exposure limits of this radio.

## 1.6 COMMON HAZARDS



**The operator of any mobile radio should be aware of certain hazards common to the operation of vehicular radio transmissions. Possible hazards include but are not limited to:**

- **Explosive Atmospheres** — Just as it is dangerous to fuel a vehicle with its engine running, be sure to turn the radio **OFF** while fuelling the vehicle. If the radio is mounted in the trunk of the vehicle, **DO NOT** carry containers of fuel in the trunk.  
Areas with potentially explosive atmosphere are often, but not always, clearly marked. Turn the radio **OFF** when in any area with a potentially explosive atmosphere. It is rare, but not impossible that the radio or its accessories could generate sparks.
- **Interference To Vehicular Electronic Systems** — Electronic fuel injection systems, electronic anti-skid braking systems, electronic cruise control systems, etc., are typical of the types of electronic devices that can malfunction due to the lack of protection from radio frequency (RF) energy present when transmitting. If the vehicle contains such equipment, consult the dealer for the make of vehicle and enlist his aid in determining if such electronic circuits perform normally when the radio is transmitting.
- **Electric Blasting Caps** — To prevent accidental detonation of electric blasting caps, **DO NOT** use two-way radios within 1000 feet (305 meters) of blasting operations. Always obey the “**Turn Off Two-Way Radios**” (or equivalent) signs posted where electric blasting caps are being used. (OSHA Standard: 1926.900).
- **Radio Frequency Energy** — To prevent burns or related physical injury from radio frequency energy, do not operate the transmitter when anyone outside of the vehicle is within the minimum safe distance from the antenna as specified in Table 1-1/Table 1-2 and Table 1-3. Refer to Section 1.2 for additional information.
- **Vehicles Powered By Liquefied Petroleum (LP) Gas** — Radio installation in vehicles powered by liquefied petroleum gas, where the LP gas container is located in the trunk or other sealed-off space within the interior of the vehicle, must conform to the **National Fire Protection Association** standard **NFPA 58**. This requires:
  - The space containing the radio equipment must be isolated and sealed from the space containing the LP gas container and its fittings.
  - Outside filling connections must be used for the LP gas container.
  - The LP gas container space shall be vented to the outside of the vehicle.
- **Vehicles Equipped with Airbags** — For driver and passenger safety, avoid mounting the radio's control head (or any other component) above or near airbag deployment areas. In addition to driver-side and passenger-side front-impact airbags, some vehicles may also be equipped with side-impact

airbags. For occupant safety, verify the location of all airbags within the vehicle before installing the radio equipment.

## **1.7 SAFE DRIVING RECOMMENDATIONS**

The American Automobile Association (AAA) advocates the following key safe driving recommendations:

- Read the literature on the safe operation of the radio.
- Keep both hands on the steering wheel and the microphone in its hanger whenever the vehicle is in motion.
- Place calls only when the vehicle is stopped.
- When talking from a moving vehicle is unavoidable, drive in the slower lane. Keep conversations brief.
- If a conversation requires taking notes or complex thought, stop the vehicle in a safe place and continue the call.
- Whenever using a mobile radio, exercise caution.

## **1.8 OPERATING RULES REGULATIONS**

Two-way radio systems must be operated in accordance with the rules and regulations of the local, regional, or national government.

In the United States, this vehicular repeater system must be operated in accordance with the rules and regulations of the Federal Communications Commission (FCC). Operators of two-way radio equipment, must be thoroughly familiar with the rules that apply to the particular type of radio operation. Following these rules helps eliminate confusion, assures the most efficient use of the existing radio channels, and results in a smoothly functioning radio network.

When using a two-way radio, remember these rules:

- It is a violation of FCC rules to interrupt any distress or emergency message. The radio operates in much the same way as a telephone “party line.” Therefore, always listen to make sure the channel is clear before transmitting. Emergency calls have priority over all other messages. If someone is sending an emergency message – such as reporting a fire or asking for help in an accident, do not transmit unless assistance can be offered.
- The use of profane or obscene language is prohibited by Federal law.
- It is against the law to send false call letters or false distress or emergency messages. The FCC requires keeping conversations brief and confined to business. Use coded messages whenever possible to save on-the-air time.
- Using the radio to send personal messages (except in an emergency) is a violation of FCC rules. Send only essential messages.
- It is against Federal law to repeat or otherwise make known anything overheard on the radio. Conversations between others sharing the channel must be regarded as confidential.
- The FCC requires self-identification at certain specific times by means of call letters. Refer to the rules that apply to the particular type of operation for the proper procedure.
- No changes or adjustments shall be made to the equipment except by an authorized or certified electronics technician.



Under U.S. law, operation of an unlicensed radio transmitter within the jurisdiction of the United States may be punishable by a fine of up to \$10,000, imprisonment for up to two (2) years, or both.

## 1.9 OPERATING TIPS

The following conditions tend to reduce the effective range of two-way radios and should be avoided whenever possible:

- Operating the radio in areas of low terrain, or while under power lines or bridges.
- Obstructions such as mountains and buildings.



In areas where transmission or reception is poor, communication improvement may sometimes be obtained by moving a few yards in another direction, or moving to a higher elevation.

## **2 SPECIFICATIONS<sup>1</sup>**

### **2.1 GENERAL**

**Dimensions (Height x Width x Depth):**

VRMS7010/VRMS7020/VRMS7030:

5.2 x 8.8 x 9.3 inches (13.2 x 22.4 x 23.6 centimeters)

(Includes bracket but not space required for cables)

VRBS7010/VRBS7020/VRBS7030:

7.3 x 8.8 x 9.3 inches (18.5 x 22.4 x 23.6 centimeters)

(Includes bracket but not space required for cables)

Control Head:

2.4 x 6.9 x 3.9 inches (6 x 17.5 x 10 centimeters)

(Does not include bracket and mounting screws)**Weights**

VRMS7010/VRMS7020/VRMS7030:

13.6 pounds (6.17 kilograms), less mounting bracket

VRBS7010/VRBS7020/VRBS7030:

13.6 pounds (6.17 kilograms), less mounting bracket

Control Head:

1.25 pounds (0.57 kilograms), less mounting bracket

Mounting Brackets:

1.25 pounds (0.57 kilograms) each

Cable, Interface:

1.25 pounds (0.57 kilograms)

**Operating Ambient Temperature Range:**

-22 to +140° Fahrenheit (-30 to +60° Celsius)

**Storage Temperature Range:**

-40 to +185° Fahrenheit (-40 to +85° Celsius)

**Altitude**

Operating:

15,000 feet (4572 meters) maximum

Storage/Shipment:

50,000 feet (15,240 meters) maximum

**DC Supply Voltage Operating Range**

For Full Performance:

+13.6 Vdc ±10% (Normal range per TIA-603)

Overall Operating Range:

+10.8 to +16.6 Vdc

Continuous without Damage:

0 to +17 Vdc

**DC Supply Current, VRS7010/VRS7020/VRS7030**

VRMS7010/VRMS7020/VRMS7030

Receive:

1.1 amps maximum

Transmit at 15 Watts Tx Power:

8 amps maximum, 6 amps typical

Transmit at 35 Watts Tx Power:

15 amps maximum, 12 amps typical

Quiescent/Off Current:

2 milliamps maximum

VRBS7010/VRBS7020/VRBS7030

P25 Vehicular Repeater Mode Disabled: 5 milliamps maximum, 2 milliamps typical

P25 Vehicular Repeater Mode Enabled: 6 amps maximum, 5 amps typical

Quiescent/Off Current: 5 milliamps maximum, 2 milliamps typical

**DC Supply Current, CH-721 Control Head**

With ½-Watt Speaker Output Power:

0.9 amps maximum

With 10-Watts Speaker Output Power:

2.0 amps maximum

With 15-Watts Speaker Output Power:

2.4 amps maximum

Standby Current (Muted):

0.6 amps maximum

Quiescent/Off Current:

100 microamps maximum

---

<sup>1</sup> These specifications are primarily intended for the use of the installation technician. See the appropriate Specifications Sheet for the complete specifications.

**NOTE**

For detailed transceiver-related specifications on the VRMS section of the vehicular repeater, refer to the M7300 mobile radio's installation or maintenance manuals, publications MM-014763-001 or MM-014718-001 respectively.

For detailed transceiver-related specifications on the VRBS section of the vehicular repeater, refer to the products maintenance manual, publication MM-018338-001.

## 2.2 REGULATORY

**FCC Identification Numbers:**

VRMS7010 and VRMS7020

(700/800 MHz M7300):

OWDTR-0051-E

VRMS7030 (VHF M7300):

OWDTR-0055-E

VRBS7010/VRBS7020/VRBS7030:

OWDTR-0058-E

**Applicable FCC Rules:**

Part 90 and Part 15

**Industry Canada Certifications:**

VRMS7010 and VRMS7020

(700/800 MHz M7300):

3636B-0051

VRMS7030 (VHF M7300):

3636B-0055

VRBS7010/VRBS7020/VRBS7030:

3636B-0058

**Applicable Industry Canada Rules:**

RSS-119

## 3 INTRODUCTION

This manual contains product safety and installation-related procedures for the VRS7000 series of Project 25 (P25) cross-band Vehicular Repeater Systems, together with the CH-721 control head. Installation procedures cover the mounting and cabling of the equipment, as well as the basic testing of the mobile radio and control head. An interconnection wiring diagram is included at the rear of this manual. Important product safety-related information is presented in Section 1.

### 3.1 GENERAL INFORMATION

The VRS7000 series of P25 cross-band vehicular repeaters includes the three (3) distinctly different P25 Vehicular Repeater Systems: the VRS7010, the VRS7020, and the VRS7030. Each repeater has different radio frequency bands upon which it operates on. The RF bands are included in Figure 3-1 below.



Henceforth, any reference of “VRS7000” or simply (“VRS”) in this manual applies to all three (3) P25 vehicular repeater systems, unless otherwise stated.

Each vehicular repeater is a P25 cross-band vehicular repeater for P25 trunked radio networks and a mobile radio for trunked and conventional radio networks. Each repeater consists of two (2) systems, as described in the following subsections.

#### 3.1.1 Vehicular Repeater Base System (VRBS)

The system that provides the RF link for nearby P25 radios when the VRS7000 is operating as a P25 vehicular repeater is called the Vehicular Repeater Base System (VRBS). As illustrated in Figure 5-2 on page 30, the VRBS is formed by a Vehicular Repeater Base (VRB) radio, a Traffic Controller module, and a duplexer. The VRB radio is the transceiver for the RF link to nearby P25 radios. See Figure 3-1 below. The Traffic Controller section interfaces the VRB radio to the VRM radio. The duplexer allows the VRB radio to transmit and receive via a single vehicle-mounted antenna.

Within the VRS7010 P25 vehicular repeater, the VRBS is called the VRBS7010. It consists of a dual-band 700/800 MHz VRB radio that operates in the 700 MHz band, a Traffic Controller, and a 700 MHz

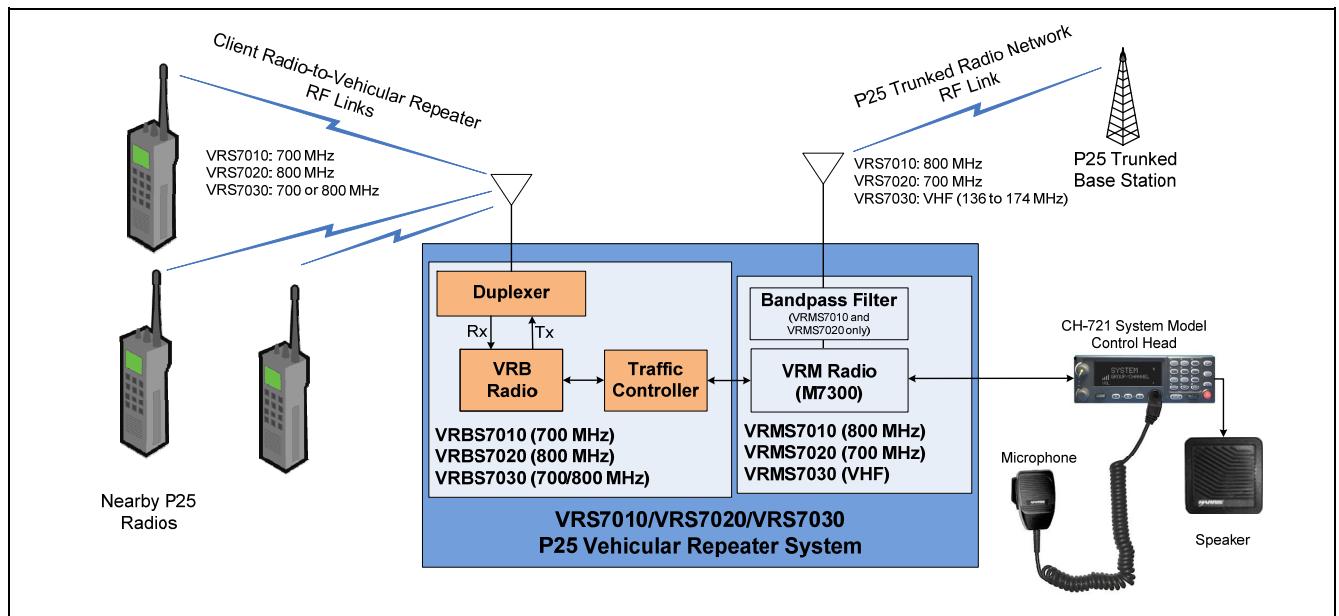


Figure 3-1: Simplified Block Diagram of Extended Network Coverage Mode

duplexer. This combination supports the 700 MHz link to portables radios connected to the VRS7010.

Within the VRS7020 P25 vehicular repeater, the VRBS is called the VRBS7020. It consists of a dual-band 700/800 MHz VRB radio that operates in the 800 MHz band, a Traffic Controller, and an 800 MHz duplexer. This combination supports the 800 MHz link to portables radios connected to the VRS7020.

Within the VRS7030 P25 vehicular repeater, the VRBS is called the VRBS7030. It consists of a dual-band 700/800 MHz VRB radio that can operate on either RF band, a Traffic Controller, and a wide-band 700/800 MHz duplexer. This combination supports a 700 MHz or an 800 MHz link to the portables radios connected to the VRS7030.

### **3.1.2 Vehicular Repeater Mobile System (VRMS)**

The system that provides access to a P25 network is called the Vehicular Repeater Mobile System (VRMS). The VRMS consists of a remote-mount M7300 mobile radio and a bandpass filter. The M7300 is the Vehicular Repeater Mobile (VRM) radio within the VRMS. The bandpass filter is in series with the M7300 radio's antenna port and the vehicle-mounted antenna. This combination provides connectivity to a trunked or conventional radio network. The M7300 mobile radio (VRM) is a dual-band 700 and 800 MHz mobile radio; however, in this application, only one of the two bands is utilized within a given VRMS. The VRMS7010/VRMS7020/VRMS7030 is shown in Figure 5-1 on page 29.

Within the VRS7010 vehicular repeater, the VRMS7010's bandpass filter is an 800 MHz bandpass filter. Together with the VRM radio, this filter supports the RF link to an 800 MHz P25 trunked radio network.

Within the VRS7020 vehicular repeater, the VRMS7020's bandpass filter is a 700 MHz bandpass filter. Together with the VRM radio, this filter supports the RF link to a 700 MHz P25 trunked radio network.

Within the VRS7030 vehicular repeater, the VRMS7030's bandpass filter is a dual-band 700/800 MHz bandpass filter. Together with the VRM radio, this filter supports the RF link to a 700 MHz or to an 800 MHz P25 trunked radio network.

When operating as a P25 vehicular repeater, the VRS7000 provides an end-to-end P25 communication link between nearby P25 trunked radios and a P25 trunked radio network. The VRS7000's network extension enables nearby P25 radios to maintain radio communications on a P25 radio network. In this mode, normal mobile radio communications cannot be accomplished from the radio's control head. The radio's microphone is disabled when it is operating in the P25 vehicular repeater mode.

When it is operating as a mobile radio (i.e., P25 vehicular repeater mode disabled), the VRS7000 supports communications on P25 trunked and P25 conventional radio systems. As such, the VRS7000's vehicular repeater functionality is not available. When the VRS is operating as a mobile radio, the VRBS is completely powered off and disabled and the VRMS provides half-duplex voice and data communications. Voice communications are accomplished via the "push-to-talk" (PTT) type microphone and the speaker connected to the control head.

Installation requires two (2) vehicle-mounted mobile antennas. One combination ("combo") type mobile antenna is typically used for the VRMS and its built-in GPS receiver, and another vehicle-mounted mobile antenna is required for the VRBS. If the VRMS is not connected to a combo-type antenna (i.e., if the GPS receiver antenna is not integrated into the VRMS transmit/receive antenna) and the VRMS is equipped with a GPS receiver option, a third vehicle-mounted antenna is required for the GPS receiver within the VRMS. Antenna installation procedures are included in Section 7 of this manual. A wiring diagram is shown at the end of this manual.

The radio installation also includes a CH-721 System model control head with a microphone and a speaker. This equipment provides the interface for the radio's operator/user. Mounting and installation accessories complete the mobile radio equipment package. Additional control head information is included in Section 3.3, and control head installation procedures are included in Section 10 of this manual.

This radio equipment exceeds many tough environmental specifications included within military standard MIL-STD-810F, automotive industry standard SAE-J1455, the radio industry standard TIA/EIA-603, and the radio standard established by the U.S. Forest Service.

## **3.2 OPERATING MODES**

The VRS7000 vehicular repeater with mobile radio has two (2) primary operating modes as described in the following subsections:

### **3.2.1 Standard Mobile Radio Mode**

When the VRS7000 is operating in the standard mobile radio mode, it functions like a normal mobile radio. The radio operator uses the interfaces of the connected CH-721 control head (i.e., display, control buttons/keys, mic and speaker) to control the radio and to communicate with other radio users and console dispatchers on a trunked or conventional radio network. Nearby P25 radios cannot be linked through the VRS7000 to the radio network when the VRS7000 is operating in this mode. The VRS7000's vehicular repeater functionality is disabled when it is in this operating mode. The VRBS is completely powered off and disabled.

### **3.2.2 Extended Coverage (XCOV) Vehicular Repeater Mode**

When the VRS7000 is operating in the extended coverage vehicular repeater mode, it provides the network extension interface that enables nearby P25 radios to access the P25 radio network through the VRS7000. This mode's name is typically abbreviated "XCOV vehicular repeater mode," "XCOV mode" or simply "VR mode." Radio coverage for nearby P25 radios is extended because VRS7000's high-performance mobile antenna system and higher transmitter output power used to access the P25 network. See Figure 3-1. When a nearby P25 radio is communicating through the VRS7000, it is considered "connected" to and a "client" on the VRS7000. The VRS7000 cannot function as a standard mobile radio when it is operating in this mode.



Detailed operating procedures are included in the VRS7000's Operator's Manual, publication MM-018336-001. See Section 3.5 for additional information.

Typically, the VRS7000 operator places the radio into this mode via a menu selection or preset button press at the installation's CH-721 control head. Likewise, the operator can disable this mode via a CH-721 control head menu selection or preset button press. Alternately, the radio installation may be wired so this mode can be enabled and disabled by an external switch.

When the VRS7000 is operating in this mode, its VRBS functions like a Voice and Data Over Control (VDOC) site for the nearby P25 radios. Essentially, the connected P25 radios and the VRBS are linked together via P25 VDOC protocols on the VRBS RF channel.

When using the XCOV vehicular repeater mode, P25 radios operating through the VRS7000 maintain the following P25 functions across the two RF links:

- **P25 Group Call** — Both digital clear voice and digital encrypted voice group calls are supported.
- **P25 Individual Call** — Unit-to-unit calls between two connected P25 radios, and between a nearby P25 radio and a radio/console on the P25 radio network are supported.
- **P25 User ID** — Caller identification information is sent between a connected P25 radio and the P25 radio network.

- **P25 Emergency** — The link through the VRS7000 provides P25 emergency communications between the P25 radios connected to the VRS7000 and the P25 radio network.
- **P25 System All Call (from Network Only)** — A system-wide all-call transmission from the P25 radio network is forwarded to P25 radios connected to the VRS7000.
- **Call Grant and Call Queued Tones** — A P25 client radio generates call grant and call queued tones in a similar manner as if it is operating directly on the P25 radio network.

A single VRS7000 allows attachment of up to sixty-four (64) nearby P25 radios. Each radio may communicate on the same talk group, or on multiple different talk groups (up to sixty-four maximum talk groups for one talk group per radio). Each connected P25 radio can communicate on the P25 network via the VRS7000.

When operating in the XCOV vehicular repeater mode, calls transmitted from connected P25 radios are not routed to the VRS7000's speaker.

The VRS7000 supports end-to-end Advanced Encryption Standard (AES) encrypted calls. In other words, if a P25 radio connected to the VRS7000 is transmitting an encrypted call, the VRS7000 simply repeats the call to the network base station; it does not un-encrypt and then re-encrypt the call.



Limitations of the VRS7000 are described in the product's operators manual, publication number MM-018336-001. See Section 3.5 on page 21 for additional information.

### 3.3 EQUIPMENT MOUNTING AND CONTROL HEAD

The VRS7000 is designed for remote mounting in a motor vehicle's trunk, or some other preferably unoccupied section in a vehicle, such as a fire truck's equipment shelf. A 3-wire Controller Area Network (CAN) cable provides radio-to-control head(s) interconnection. One end of the CAN cable connects to a CAN port on the rear of the VRS7000's VRMS mobile radio and the other end connects to a CAN port on the rear of the CH-721 control head. Between the radio and the control head, the CAN link carries digitized microphone and speaker audio, and controlling data such as button presses and radio messages. For proper operation, the CAN link must be terminated appropriately on each end.

The CH-721 System model control head provides the user/operator interface for the VRS7000. See Figure 10-2 on page 57. This control head has a large 3-line graphical vacuum-fluorescent display, front panel controls and buttons for user control of the mobile radio, an internal high-power audio amplifier to drive an externally-connected speaker, and a front panel microphone connector. It features a 12-key numeric keypad that provides Dual-Tone Multi-Frequency (DTMF) keypad functionality and easier operator system/group selection, three (3) preset buttons, and an emergency/home button.

As shown in Figure 10-2 on page 57, the CH-721 System model control head has several connectors located on its rear panel. These connectors include a DC power connector, two (2) CAN port connectors used for CAN link interconnections, an external speaker connector, a 9-pin serial port connector for connecting optional equipment such as a mobile data terminal, and a 25-pin multi-function connector.

### 3.4 OPERATING POWER

The VRS7000 must be powered by an external +13.6-volt (nominal) DC power source. In mobile applications, the motor vehicle's electrical system is utilized as the source of DC power. The VRS7000's VRMS and VRBS are separately fused. For detailed specifications, see Section 2 of this manual which begins on page 15.

The control head(s) connected to the radio is also powered by the same DC power source, but fused separately from the two (2) radios. When the control head is powered-up by the operator, it “wakes up” the VRM radio by transmitting data to the radio over the CAN link.



**Harris recommends the buyer use only a Harris-authorized representative to install and service this product.** The warranties provided to the buyer under the terms of sale shall be null and void if this product is installed or serviced improperly, and Harris shall have no further obligation to the buyer for any damage caused to the product or to any person or personal property.

### **3.5 RELATED PUBLICATIONS**

The following publications contain additional information about the VRS7000:

- Operator's Manual: MM-018336-001
- Maintenance Manual: MM-018338-001



Publications listed above are available at [www.pspc.harris.com](http://www.pspc.harris.com) via an Information Center login and Tech Link.

### **3.6 REPLACEMENT PARTS**

Replacement parts can be ordered through the Customer Resource Center. To order replacement parts through the Customer Resource Center, call, fax or e-mail our ordering system:

**United States and Canada:**

- Phone Number: 1-800-368-3277 (toll free)
- Fax Number: 1-800-833-7592 (toll free)
- E-mail: [PSPC\\_CustomerFocus@harris.com](mailto:PSPC_CustomerFocus@harris.com)

**International:**

- Phone Number: 1-434-455-6403
- Fax Number: 1-434-455-6676
- E-mail: [PSPC\\_InternationalCustomerFocus@harris.com](mailto:PSPC_InternationalCustomerFocus@harris.com)

### **3.7 TECHNICAL ASSISTANCE**

Should the mobile radio or control head require repair, or if there are questions or concerns about the installation of this equipment, contact the Technical Assistance Center (TAC) using the following telephone numbers or e-mail address:

- United States and Canada: 1-800-528-7711 (toll free)
- International: 1-434-385-2400
- Fax: 1-434-455-6712
- E-mail: [PSPC\\_tac@harris.com](mailto:PSPC_tac@harris.com)

## 4 UNPACKING AND CHECKING THE EQUIPMENT

### 4.1 MATERIALS

A typical set of VRS7010/VRS7020/VRS7030 installation materials includes:

- **Vehicular Repeater Mobile System (VRMS7010/VRMS7020/VRMS7030)**, consists of:
  - **M7300 Remote-Mount Mobile Radio**
  - **VRM Bandpass Filter (VRMS7010 and VRMS7020 only)**
- **Vehicular Repeater Base System (VRBS7010/VRBS7020/VRBS7030)**



NOTE

For catalog and part numbers, refer to the respective table that follows.

- **CH-721 System Control Head** [part number CU23218-0004; catalog number MAMW-CP9F]
- **Standard Microphone** [part number MC-101616-041; part of catalog number MAMW-MC7Z]
- **Installation Kit MAMW-NZN8X for VRS7010/VRS7020/VRS7030 and CH-721** as listed in Table 4-4
- **Two (2) or Three (3) Antennas** as listed in Table 4-5

The Installation Kit can be used to install the VRS7000, or individual components may be purchased separately as needed. Table 4-4 lists the parts included in the kit. Table 4-5 lists part numbers for radio options and accessories. Table 4-6 includes optional parts available for the CH-721 control head.

**Table 4-1: VRS7010 Catalog and Part Numbers**

CATALOG NUMBER	PART NUMBER	DESCRIPTION
MAMW-SDMXX	RU-144750-061	Remote-Mount Dual-Band 700/800 MHz M7300 Mobile Radio (VRM Radio of VRMS7010)
MAMW-NFL1A	FL-017938-010	800 MHz Bandpass Filter (Bandpass Filter of VRMS7010)
MAMW-VDLXX	RU-017933-010	VRBS7010

**Table 4-2: VRS7020 Catalog and Part Numbers**

CATALOG NUMBER	PART NUMBER	DESCRIPTION
MAMW-SDMXX	RU-144750-061	Remote-Mount Dual-Band 700/800 MHz M7300 Mobile Radio (VRM Radio of VRMS7020)
(TBD)	FL-017938-020	700 MHz Bandpass Filter (Bandpass Filter of VRMS7020)
(TBD)	RU-017933-020	VRBS7020

**Table 4-3: VRS7030 Catalog and Part Numbers**

CATALOG NUMBER	PART NUMBER	DESCRIPTION
MAMW-SHMXX	RU-144750-041	Remote-Mount 50-Watt VHF M7300 Mobile Radio (VRM Radio of VRMS7030)
(TBD)	RU-017933-030	VRBS7030

## 4.2 MATERIAL INSPECTION



After removal from the carton, examine the mobile radios, control head and other components for broken, damaged, loose or missing parts. If any are noted, contact the Customer Resource Center (see page 21) immediately to discuss and arrange the return of the equipment to Harris for replacement. Any unauthorized attempts to repair or modify this equipment will void the warranty and could create a safety hazard.

Upon removing items from the carton and verifying that all equipment is accounted for, proceed with the installation.



Mounting of the radios, control head, and/or antenna in ways other than those described in this manual may adversely affect performance, violate FCC rules on RF exposure, and even damage the unit, posing a potential safety hazard.

**Table 4-4: Installation Kit MAMW-NZN8X**

ITEM	QTY.	PART NUMBER	DESCRIPTION	ILLUSTRATION
1	2 <input type="checkbox"/>	1000003678	Bracket, Base.	
2	2 <input type="checkbox"/>	FM-018205	Extension Bracket.	
3	4 <input type="checkbox"/>	AD00006	Screws: #8-32 Pan-Head (Package of 4 screws).	
4	1 <input type="checkbox"/>	SC-018424	Screws: M5 x 10 mm Philips-Head SEMS Screws (Package of 6 screws).	
5	2 <input type="checkbox"/>	CA-012365-001	Cable, M7200/M7300/M5300 DC Power. Includes (1) 20-Foot DC Power Cable with straight connector, (2) waterproof inline HFB-type fuse holders, (1) 3-amp AGC fuse, (1) 15-amp AGC fuse, and (1) 20-amp AGC fuse.	
6	1 <input type="checkbox"/>	CA-012616-001	Cable, CH-721 DC Power. Includes (1) DC Power Cable with straight connector, (2) waterproof inline HFB-type fuse holders, (1) 3-amp AGC fuse, and (1) 5-amp AGC fuse. This DC Power Cable has a 10-foot 12-AWG red wire (main power input), a 20-foot white wire (switched power input), and a 5-foot black wire (ground).	
7	1 <input type="checkbox"/>	CA-012349-003	Cable, VRS7000 Interface.	

**Table 4-4: Installation Kit MAMW-NZN8X (Continued)**

ITEM	QTY.	PART NUMBER	DESCRIPTION	ILLUSTRATION
8	1 <input type="checkbox"/>	CA-018378	Cable, RF; TNC Female to TNC Male.	
9	1 <input type="checkbox"/>	CA-009562-030	Cable, CAN; 30 feet, Right-Angle-to-Straight Connectors.	
10	1 <input type="checkbox"/>	KT-008608	Kit, CH-721 Mounting Bracket. Includes (1) U-Shaped Mounting Bracket, (2) 1/4-Inch #8-32 stainless-steel screws, (2) stainless-steel flat washers and (2) stainless-steel lockwashers.	
11	2 <input type="checkbox"/>	CD-014027-001	Terminator, CAN; 3-Pin, Straight Body.	
12	1 <input type="checkbox"/>	LS102824V10	Speaker, External Mobile; 20-Watt (with 4.6-foot cable).	
13	1 <input type="checkbox"/>	MAMROS0034-NN006	Cable, Speaker; 6-Inch, Straight Connector.	
14	1 <input type="checkbox"/>	FM-104859-001	Cap, Waterproof (For CH-721's DB-9 serial port connector).	
15	1 <input type="checkbox"/>	FM-104859-002	Cap, Waterproof (For CH-721's DB-25 accessory connector).	

**Table 4-5: Options and Accessories for VRS7010/VRS7020/VRS7030**

PART NUMBER	DESCRIPTION
AN-125001-001	Antenna Mount: Standard Rooftop, NMO Mounting Base, 15-foot (4.6-meter) RG-58 A/U (or equivalent) Low-Loss RF Cable, Male TNC RF Connector
AN-125001-002	Antenna Mount: Standard Rooftop, NMO Mounting Base, 15-foot (4.6-meter) RF-195 (or equivalent) Low-Loss RF Cable, Male TNC RF Connector
AN-125001-003	Antenna Mount: Thick Rooftop, NMO Mounting Base, 15-foot (4.6-meter) RG-58 A/U (or equivalent) Low-Loss RF Cable, Male TNC RF Connector
AN-125001-004	Antenna Mount: Thick Rooftop, NMO Mounting Base, 15-foot (4.6-meter) RF-195 (or equivalent) Low-Loss RF Cable, Male TNC RF Connector
AN-125001-005	Antenna Mount: GPS Combo Rooftop, NMO Mounting Base, 17-foot (5.1-meter) RF-195 (or equivalent) Low-Loss RF Cable, Male TNC RF Connector; 17-foot (5.1-meter) RG174/U (or equivalent) GPS RF Cable with Male SMA RF Connector (attached); 2.7 to 3.3 Vdc or 4.8 to 5.2 Vdc Bias
AN-125001-006	Antenna Mount: GPS Combo Rooftop, NMO Mounting Base, 17-foot (5.1-meter) RF-195 (or equivalent) Low-Loss RF Cable, Male TNC RF Connector; 17-foot (5.1-meter) RG174/U (or equivalent) GPS RF Cable with Male SMA RF Connector (attached); 2.7 to 3.3 Vdc or 4.8 to 5.2 Vdc Bias
AN-125001-007	Antenna Mount: Magnetic, NMO Mounting Base, 15-foot (4.6-meter) RG-58 A/U (or equivalent) Low-Loss RF Cable, Male TNC RF Connector
AN-125001-008	Antenna Mount: Magnetic, NMO Mounting Base, 15-foot (4.6-meter) RF-195 (or equivalent) Low-Loss RF Cable, Male TNC RF Connector
AN-225002-001	Antenna Element: 136 to 174 MHz, 0 dBd Gain, NMO, Factory-Tuned
AN-225001-001	Antenna Element: 700/800 MHz, 3 dBd Gain, NMO, Factory-Tuned
AN-225001-002	Antenna Element: 700/800 MHz, 3 dBd Gain, Elevated-Feed, NMO, Factory-Tuned
AN-225001-003	Antenna Element: 700/800 MHz, 3 dBd Gain, Elevated-Feed No Ground Plane, NMO, Factory-Tuned
AN-225001-004	Antenna Element: 700/800 MHz, 2 dBd Gain, Low-Profile, NMO, Factory-Tuned
AN-225001-005	Antenna Element: 700/800 MHz, 5 dBd Gain, NMO, Factory-Tuned
AN-225006-001	Antenna Element: 132 to 960 MHz, 0 dBd Gain, NMO, Field-Tuned
AN102800V1	Antenna Kit: 136 to 941 MHz, 1/4-Wavelength, Standard Rooftop-Mount 0 dBd Gain, Field-Tuned
AN-025187-001 (Cat. No. MAMW-NAN5F)	Antenna: GPS Receive-Only, Roof-Mount, 17-foot (5.2-meter) RG174/U (or equivalent) RF Cable with Male SMA RF Connector (attached); 2.7 to 3.3 Vdc or 4.8 to 5.2 Vdc Bias
AN-025187-003 (Cat. No. MAMW-NAN3L)	Antenna: GPS Receive-Only, Magnetic-Mount, 17-foot (5.2-meter) RG174/U (or equivalent) RF Cable with Male SMA RF Connector (attached); 2.7 to 3.3 Vdc or 4.8 to 5.2 Vdc Bias
CA-012349-001 (Cat. No. MAMW-NCL8B)	Cable, M5300/M7300 Option. See page 46.
CA-013671-020	Cable, Serial Data (20 feet). See page 67.
CN-014756	Connector, RF; TNC Male Crimp-Type for RG58U, RG58A/U and RGU400 Coaxial Cable
KT-012350-001 (Cat. No. MAMW-NMK5F)	Kit, GPS Receiver for M5300/M7300

**Table 4-5: Options and Accessories for VRS7010/VRS7020/VRS7030**

PART NUMBER	DESCRIPTION
KT-015037	Kit, Front-Mount to Remote-Mount Conversion for M5300/M7300 Radio. Includes CH-721 Conversion Kit, CH-721 Mounting Bracket Kit, CH-721 DC Power Cable, CAN Cable, CAN Terminator, Speaker Cable, Etc.
CD-014027-001	Terminator, CAN; 3-Pin, Straight Body

**Table 4-6: Accessories for CH-721 Control Heads**

PART/MODEL NUMBER	DESCRIPTION
CA-009562-006	Cable, CAN; 6 feet, Right-Angle-to-Straight Connectors.
CA-009562-030	Cable, CAN; 30 feet, Right-Angle-to-Straight Connectors.
CA-009562-090	Cable, CAN; 90 feet, Right-Angle-to-Straight Connectors.
CA-009562-250	Cable, CAN; 250 feet, Right-Angle-to-Straight Connectors.
CA-011854-001	Cable, CH-721 Option. (Shown in Figure 13-2 on page 68.)
MACDOS0012	Kit, Control Head Pedestal Mounting. Includes Pedestal Mount and Mounting Screws.
MACDOS0013-CN004	Kit, Speaker; 20-Watt, Straight Connector. (Includes 4-Ohm 20-Watt Speaker LS102824V10 with 4.6-Foot Cable and 6-Inch Speaker Cable MAMROS0034-NN006.)
FS24473	Kit, Vehicle Fuse and T-Tap. Includes (1) ATM Fuse Holder, (1) 2-Amp ATM Fuse, (2) T-Tap Quick-Disconnect Terminals and (1) 1/4-Inch Crimp Tab Terminal. (Contents shown in Figure 10-6 on page 64.)
MC-101616-041	Microphone, Standard with Flush-Mount 90-Degree Connector (Included with catalog number MAMV-MC7Z)
MC-103334-050	Microphone, Noise-Canceling with Flush-Mount 45-Degree Connector (Included with catalog number MAMV-NMC9D)
MC-103334-051	Microphone, Noise-Canceling with Flush-Mount 90-Degree Connector
344A4678P1	Microphone Hanger. (Included with catalog numbers MAMV-MC7Z, MAMV-NMC9C and MAMV-NMC9D.)
MACDOS0010	Terminator, CAN; 3-Pin, Right-Angle Body.
CD-014027-001	Terminator, CAN; 3-Pin, Straight Body.

## 5 PLANNING THE INSTALLATION

### 5.1 GENERAL INFORMATION

Before beginning the radio installation, plan it carefully so it will meet the following requirements:

- The installation is safe for the operator and passengers within the vehicle.
- The equipment is installed away from the airbag deployment areas.
- The installation allows for convenient access by the operator, as applicable (i.e., the control head).
- The equipment is protected from water damage.
- The installation is neat and allows easy service access.
- The radio is mounted in a location assuring the vehicle occupant's safety and out of the way of passengers and auto mechanics.
- The two (2) transmit/receive antennas can be mounted at least three (3) feet (0.92 meters) apart.



A professional radio installer should perform the installation!

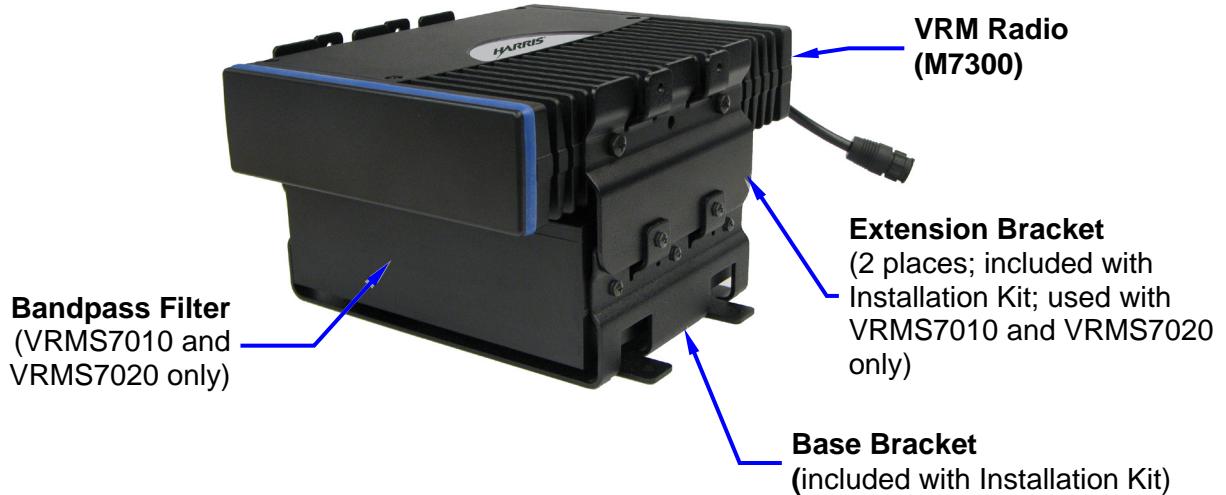
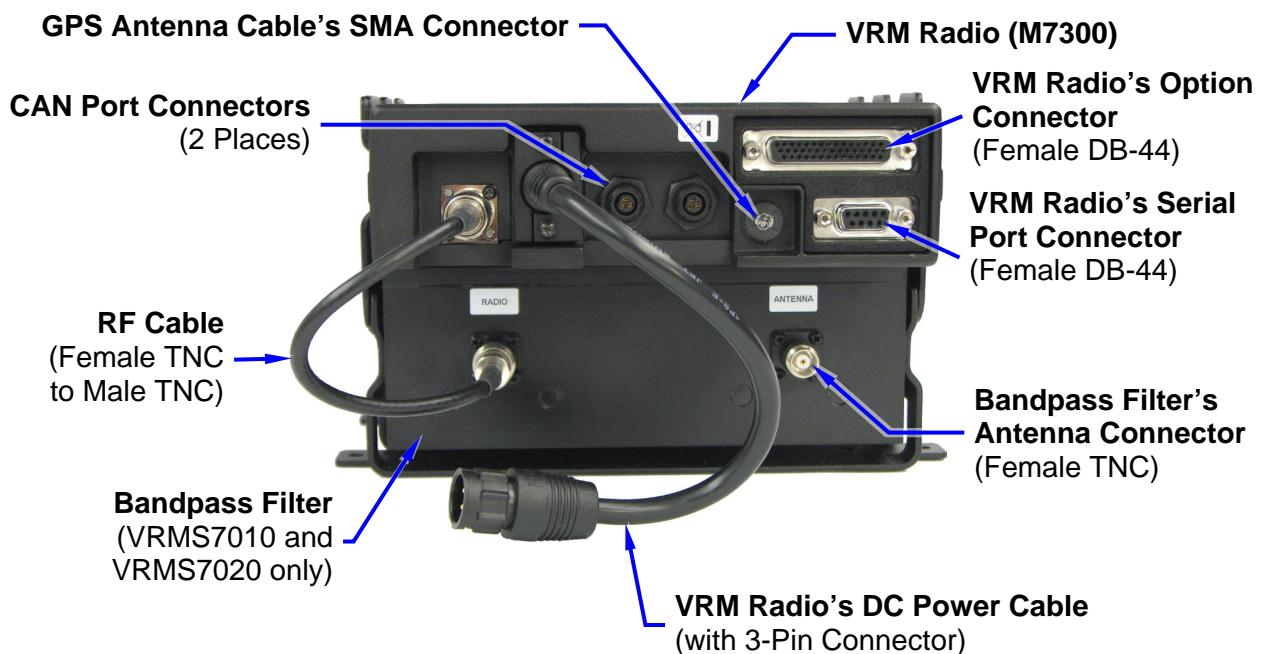
### 5.2 TOOLS REQUIRED

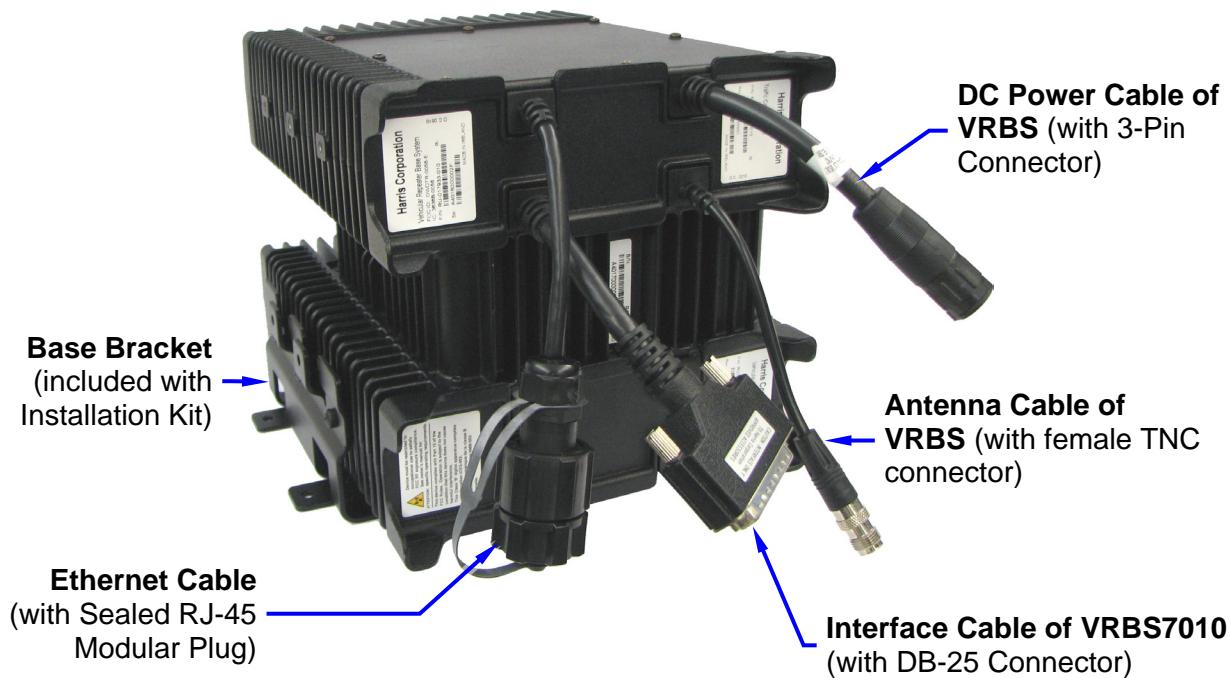
The following list of equipment is recommended for the installation. Equivalents may be used unless otherwise specified:

- Non-Insulated Crimp Tool: Thomas & Betts WT-111-M
- Insulated Terminal Crimp Tool: Klein 1005
- Fuse Holder Crimp Tool: Thomas & Betts – WT-112M or California Terminal Products No. 1250 or Channellock No. 909
- 3-Blade Coax Cable Stripper for RG-58 Cable similar to Tyco Electronics 1490490-1 (includes blades)
- Ratcheting Hex-Crimp Tool for 50-Ohm TNC and BNC RF Connectors and RG-58 Cable similar to Tyco Electronics 58433-2 (includes Crimper 354940-1 and Die Set 58436-1) or Emerson Network Power 24-9960P
- Non-Metallic Fish Tape, 25-Foot: Klein-Lite 50156
- Two Pairs of Soft-Jaw Pliers: Tessco 450520 or equivalent
- Flush-Cut and Large Wire Cutters
- Phillips-Head Screwdrivers, #1 and #2
- Flat-Blade Screwdrivers, #1 and #2
- $\frac{1}{8}$ -Inch Hex Key Wrench (Allen Wrench)
- $\frac{5}{16}$ -Inch Combination or Open-End Wrench
- Socket and/or Nut Driver Sets
- $\frac{3}{4}$ -Inch Hole Saw with Depth Protection: Ripley HSK 19 or Antenex HS34
- Clutch-Type (i.e., with torque limit) Cordless Drill with Drill Bits and Driver Bits
- Deburring Tool (for  $\frac{3}{8}$ -inch and smaller holes)
- Tie Wraps: 6-inches or larger
- Various Fasteners (e.g., machine screws and nuts, Tek screws, etc.)



A separate list of test equipment is included in Section 16.1 on page 73.

**VRMS7010/VRMS7020/VRMS7030 FRONT-SIDE VEW****VRMS7010/VRMS7020/VRMS7030 REAR VIEW**  
(Shown Without Any Installation-Related Cables Connected)**Figure 5-1: Vehicular Repeater Mobile System (VRMS)**

**VRBS7010/VRBS7020/VRBS7030 FRONT-SIDE VIEW****VRBS7010/VRBS7020/VRBS7030 REAR VIEW**  
(Shown Without Any Installation-Related Cables Connected)**Figure 5-2: Vehicular Repeater Base System (VRBS)**

## 5.3 LOCATING COMPONENTS

Plan the mounting locations of all components (VRS7000, CH-721, antennas, and cables) and determine the routes for all wiring and cables. Particularly consider the connection of the control head for planning purposes.

- Determine the customer's preferences, if any, for location of components. Comply with these preferences as long as they are consistent with safety recommendations and guidelines presented in this manual, and other generally accepted professional radio installation practices.
- Nominal dimensions for the VRS7000 and the CH-721 are listed in Section 2.1 of this manual (page 15). These dimensions do not include any clearance space required for cabling, air circulation, access to mounting hardware, etc. Always plan for and include adequate clearance around the radios.
- The VRMS and the VRBS must be located and mounted within approximately twelve (12) inches of each other.
- Verify sufficient clearance behind the radios is provided so cables will not be stressed, crushed, twisted, or bent at severe angles. Also, the front and sides must have clearance for air circulation, access to mounting hardware, etc.
- Connections at the VRS7000 are made through both "pigtail" type cables exiting the rear of its two radios, and panel-mount type connectors. This design minimizes the stresses associated with mating connections and it allows for easy connector mating. However, stresses can still be induced if adequate service looping is not employed. Connections to the control head is made with connectors mounted on the rear panel of each head, instead of "pigtail" type cables.
- The VRMS and the VRBS transmit-receive antennas must be located at least three (3) feet (0.92 meters) apart. Refer to Section 7 (page 36) for additional information.



All cables should have a service loop near each connector end. Do not bend the cables at severe angles near the connector end. Above all, after all components are installed, verify no cable is under any tension. Failure to do so may lead to damaged cables, causing intermittent radio operation or complete radio failure.

## 6 MOUNTING THE RADIO EQUIPMENT

This section provides details on mounting the VRS7000. The preferred mounting is on top of a firm, flat surface. See Figure 5-1, Figure 5-2, and refer to the respective wiring diagram at the end of this manual as necessary. Control head installation procedures are included in Section 10 (page 56) of this manual.

The VRS7000 is relatively heavy, at approximately thirty (30) pounds (13.6 kilograms). Consider this weight when selecting a mounting surface. Refer to the specifications listed in Section 2.1 (page 15) of this manual for radio and control head weight specifications.



Installation Kit MAMW-NZN8X (contents listed in Table 4-4 on page 24) contains the set of materials for installing the radio. Therefore, the following instructions make repeated reference to this kit. Item numbers given in parenthesis refer to items in the kit.



Prior to beginning the installation, verify the VRS7000 has the proper version of software installed and it has been configured for customer usage.



Though generally mounted in a trunk or remote location, the VRS7000 must be kept away from heat sources. Mounting it in a location which is out of direct sunlight is recommended but not required. Adequate ventilation space must be provided to the rear and side fins. The radio reduces its RF output power when its ambient temperature exceeds approximately +140° Fahrenheit (+60° Celsius).



**At a minimum, the mounting surface should be 16-gauge (approximately 1/16-inch thick) steel sheet metal. Mounting to plastic or other material with low tensile and shear strength could lead to an unsafe and/or failed mounting condition, turning the VRS7000 and its base bracket into a projectile during a high-shock incident such as a motor vehicle accident. If the selected mounting surface does not meet the minimum 16-gauge steel sheet metal requirement, the surface should be reinforced with a metal backing plate (not supplied) or it should be reinforced using some other approved mounting method.**



Before drilling holes and/or installing mounting screws, verify these operations will not damage or interfere with any existing vehicle component (fuel tank, fuel line, transmission housing, existing vehicle wiring, etc.). Always check to see how far the mounting screws will extend below the mounting surface prior to installation. Always deburr drilled holes before installing screws.

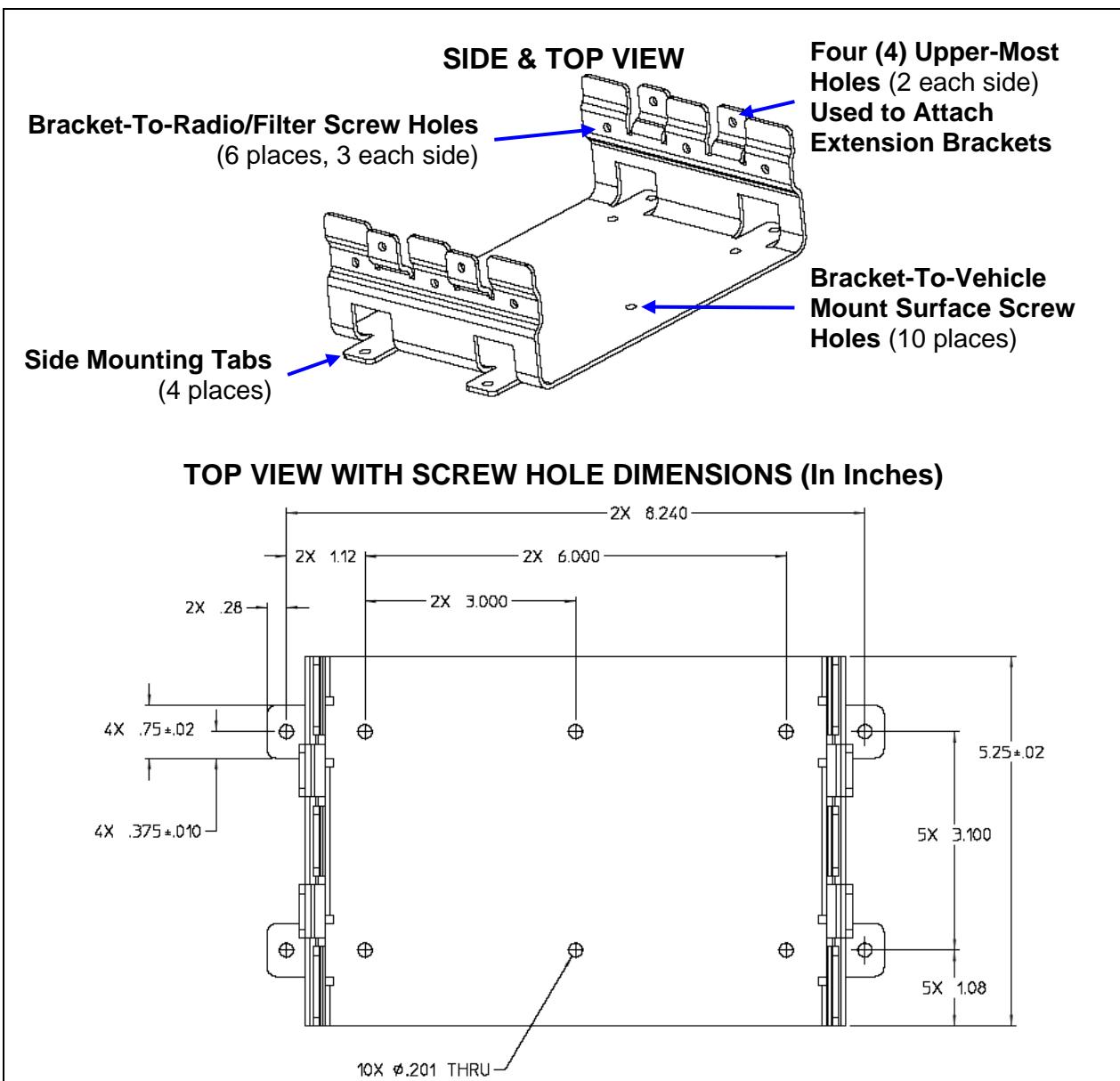
### 6.1 INSTALL THE MOUNTING BRACKETS

Two (2) identical Base Brackets (Item 1 in Table 4-4) are included with the installation kit. One bracket is used to mount the VRMS, and the other bracket is used to mount the VRBS. Two (2) Extension Brackets are also required to mount the VRM radio above its filter. The Extension Brackets basically extend the height of a Base Bracket to provide a mounting space above the 800 MHz bandpass filter for the VRM (M7300) mobile radio.

Typically, both Base Brackets are mounted in the vehicle's trunk, on the top surface of a trunk tray or the trunk floor. However, both can be suspended from the trunk's rear deck if the surface is completely flat, does not require any shimming and the gauge of deck's sheet metal is high (16-gauge minimum).



The section of the cable which interconnects the DB-44 connector on the rear of the VRMS to the DB-25 connector on the rear of the VRBS is approximately eighteen (18) inches long. After the radios are secured within mounted brackets, they must be located so the respective connectors of the cable can mate to the connectors on the rear of the radios. Typically, both brackets must be mounted within approximately twelve (12) inches of each. The brackets/radios may be oriented parallel or perpendicular to each other.



**Figure 6-1: Base Bracket (Two Required Per VRS7000 Installation)**

When installed in a bracket, each radio protrudes several inches from the bracket's front and back edges. Therefore, when selecting an exact mounting location, verify sufficient distance at the front and back for this and additional clearance. A minimum distance of three (3) inches is required from the rear edge of the bracket; however four (4) inches or more is recommended to improve radio installation and removal ease. A minimum distance of two (2) inches is recommended from the front edge of each bracket. The bracket is front/back symmetrical, and left/right symmetrical.

As all installations differ, bracket-to-vehicle mounting screws are not included. The use of #10 stainless-steel machine screws, stainless-steel flatwashers and stainless-steel self-locking nuts is recommended. Alternately, #10 stainless-steel self-drilling screws and stainless-steel flatwashers may be used to speed installation time and/or if the underside of the mounting surface is not easily accessible. Self-drilling screws such as "TEK" screws do not require drilling of a pilot hole prior to installation. Do **not** use common self-threading sheet metal screws because they will loosen over time with vehicle vibrations.

1. Select a location for each Base Bracket—one location for the VRMS's Base Bracket and one location for the VRBS's Base Bracket. As previously stated, both brackets must be mounted within approximately twelve (12) inches of each other so the section of the cable which interconnects the two radios will have sufficient length.
2. Using each Base Bracket (Item 1 in Table 4-4) as a template and/or the dimensional information shown in Figure 6-1, mark and drill mounting holes into the mounting surface for each bracket. At least six (6) screws per bracket are recommended for proper installation: Four (4) in the screw holes of a bracket's side tabs and two (2) in its center-most screw holes. If the installation prevents the installation of six screws, a minimum of four screws installed in the side tabs' holes is required, per bracket.
3. Deburr all newly drilled mounting holes.
4. Set each bracket in place, and install and tighten the mounting screws.
5. Verify both brackets are firmly secured to the mounting surface. A secure mount prevents unreasonable vibration, which could damage the radio and/or cause its cable connections to loosen.
6. Attach an Extension Bracket to each side of the VRMS's Base Bracket. Use two #8-32 pan-head screws per Extension Bracket. These screws are included in the installation kit (Item 3 in Table 4-4). When tightening the screws, push each Extension Bracket firmly down into the Base Bracket so each is firm and flush to the other when the screws are tight.

## 6.2 MOUNT THE RADIOS AND FILTER INTO THE BRACKETS

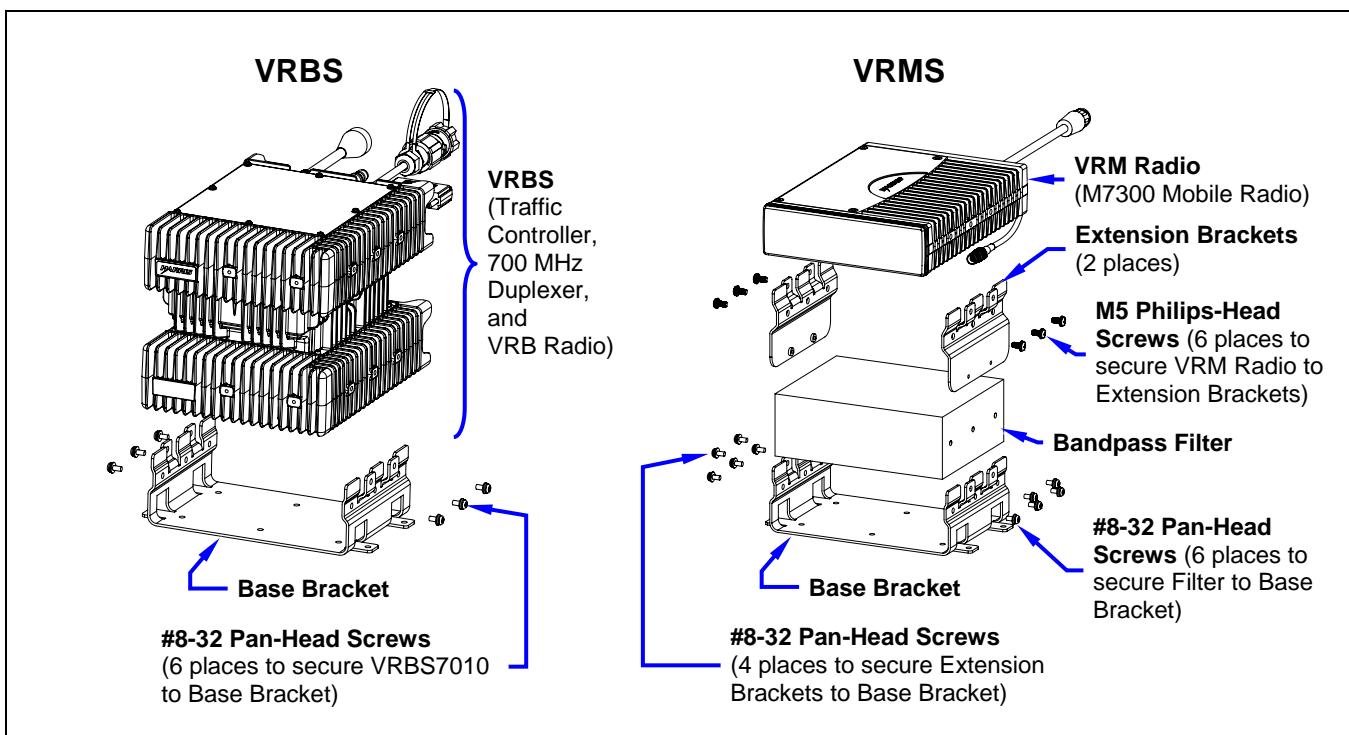
The radios and the 800 MHz bandpass filter must now be mounted into the brackets in accordance with this procedure. Exploded view diagrams of each radio stack are shown in Figure 6-2.

1. Slide the 800 MHz bandpass filter into the Base Bracket that has the two (2) attached Extension Brackets. The two (2) RF connectors must face towards the cabling area of the radio installation.
2. Secure the filter to the Base Bracket using three #8-32 pan-head screws (Item 3 in Table 4-4) per side. Tighten all six (6) screws with a screwdriver until the lock washers on the screws are fully compressed and the filter is firm and flush between the sides of the bracket.
3. Slide the M7300 mobile radio between the Extension Brackets, just above the 800 MHz bandpass filter. The rear of the radio must face towards the cabling area of the radio installation.
4. Secure the M7300 mobile radio to each Extension Bracket using six M5 Philips-head screws (Item 4 in Table 4-4), three (3) screws per radio side. These screws have a captive-type (SEMS) lockwasher. Tighten all six (6) screws with a screwdriver until the lock washer on each screw is fully compressed, and the filter is firm and flush between the brackets.

5. Slide the VRBS into the other Base Bracket. The rear of the radio must face towards the cabling area of the radio installation.
6. Secure the VRBS to this bracket using three #8-32 pan-head screws (Item 3 in Table 4-4) per side. Tighten all six (6) screws with a screwdriver until the lock washers on the screws are fully compressed and the radio is firm and flush between the sides of the brackets.
7. Check the mounting area for proper clearance for cable service looping and for air circulation, plus an area to secure and stow the excess cable lengths.



Proper mounting is one factor that ensures optimal radio performance. An improperly mounted radio may experience degradation in the quality of voice and data communications.



**Figure 6-2: VRMS and VRBS Assembly into Brackets (Exploded Views)**

## 7 ANTENNA INSTALLATION

### 7.1 ANTENNA MOUNTING LOCATIONS

The VRMS and the VRBS transmit-receive antennas must be located at least three (3) feet (0.92 meters) apart. For a standard motor vehicle, the VRMS antenna must be installed at or near the center of the vehicle's rooftop, and the VRBS antenna must be installed in the center of the vehicle's trunk lid.



WARNING

At this time, review all information presented in the REGULATORY AND SAFETY INFORMATION section of this manual (begins on page 6). Both transmit-receive antennas must be installed in accordance with the guidelines presented in the REGULATORY AND SAFETY INFORMATION section. In order to reduce human exposure to radio frequency (RF) electromagnetic energy during transmit mode, use Table 1-1/Table 1-2 and Table 1-3, and Figure 7-1/Figure 7-2 and Figure 7-3 to determine the best possible antenna mounting locations

Antennas must be mounted in locations on the vehicle as illustrated and described in this section. Also, see Table 4-5 for additional information. Always follow manufacturer's instructions when mounting an antenna. References to locations ① through ④ apply to the locations illustrated in Figure 7-1 through Figure 7-3.

#### 7.1.1 Direct Center or Center-Rear of Rooftop for VRMS Antenna

The center of the vehicle's roof is the best location for the VRMS antenna (location ①). For optimal performance, the mounting area under the antenna must be flat with a minimum radius of six (6) inches of metal ground plane. Locating the antenna directly in the center of the roof will minimize human exposure to RF electromagnetic energy.

If obstructions such as a light bar or another antenna prevent the VRMS antenna from being mounted in the direct center of the roof, the antenna should be mounted a minimum of one foot away from and behind the obstruction but in the middle of the roof with respect to the left and right sides of the vehicle (location ②).



NOTE

The VRMS and the VRBS transmit-receive antennas must be located at least three (3) feet (0.92 meters) apart. See Figure 7-1 through Figure 7-3. The radio-end of each antenna cable must be labeled so each cable is connected to the correct radio.

#### 7.1.2 Center of Trunk Lid for VRBS Antenna

For a standard motor vehicle, the VRBS antenna should be located in the center of the vehicle's trunk lid (location ④). Locating the antenna directly in the center of the lid will provide the best P25 vehicular repeater mode improve coverage, and minimize human exposure to RF electromagnetic energy.



WARNING

The antenna cable of Harris-approved antennas should never be cut to a shorter length. Instead, excess cable must be tied and stowed. This not only prevents the antenna from radiating above its intended or configured power, but it also allows for future installation considerations such as a relocation of the mobile radio within the vehicle. Installations requiring longer cables are to be treated as custom and separately specified.

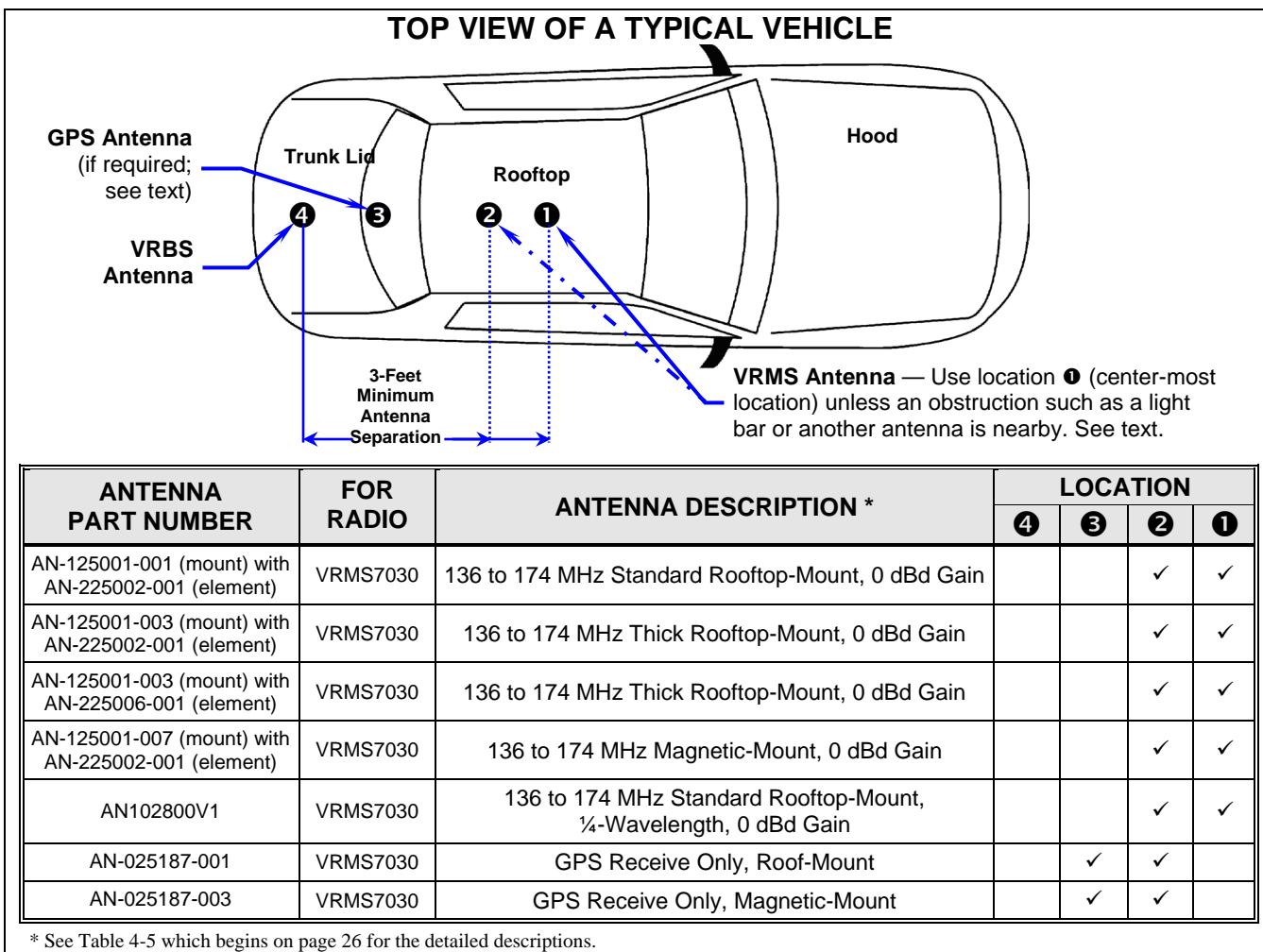
**TOP VIEW OF A TYPICAL VEHICLE**

**VRMS Antenna** — Use location 1 (center-most location) unless an obstruction such as a light bar or another antenna is nearby. See text.

ANTENNA PART NUMBER	FOR RADIOS	ANTENNA DESCRIPTION *	LOCATION			
			4	3	2	1
AN-125001-002 (mount) with AN-225001-001 (element)	VRMS7010 VRMS7020	700/800 MHz Standard Rooftop-Mount, 3 dBd Gain			✓	✓
AN-125001-002 (mount) with AN-225001-002 (element)	VRMS7010 VRMS7020	700/800 MHz Standard Rooftop-Mount, Elevated-Feed, 3 dBd Gain			✓	✓
AN-125001-002 (mount) with AN-225001-003 (element)	VRMS7010 VRMS7020	700/800 MHz Standard Rooftop-Mount, Elevated-Feed, No Ground Plane, 3 dBd Gain			✓	✓
AN-125001-002 (mount) with AN-225001-005 (element)	VRMS7010 VRMS7020	700/800 MHz Standard Rooftop-Mount, 5 dBd Gain			✓	✓
AN-125001-004 (mount) with AN-225001-001 (element)	VRMS7010 VRMS7020	700/800 MHz Thick Rooftop-Mount, 3 dBd Gain			✓	✓
AN-125001-004 (mount) with AN-225001-002 (element)	VRMS7010 VRMS7020	700/800 MHz Thick Rooftop-Mount, Elevated-Feed, 3 dBd Gain			✓	✓
AN-125001-004 (mount) with AN-225001-003 (element)	VRMS7010 VRMS7020	700/800 MHz Thick Rooftop-Mount, Elevated-Feed, No Ground Plane, 3 dBd Gain			✓	✓
AN-125001-004 (mount) with AN-225001-005 (element)	VRMS7010 VRMS7020	700/800 MHz Thick Rooftop-Mount, Elevated-Feed, 5 dBd Gain			✓	✓
AN-125001-006 (mount) with AN-225001-001 (element)	VRMS7010 VRMS7020	700/800 MHz GPS Combo Rooftop-Mount, 3 dBd Gain			✓	✓
AN-125001-006 (mount) with AN-225001-002 (element)	VRMS7010 VRMS7020	700/800 MHz GPS Combo Rooftop-Mount, Elevated-Feed, 3 dBd Gain			✓	✓
AN-125001-006 (mount) with AN-225001-003 (element)	VRMS7010 VRMS7020	700/800 MHz GPS Combo Rooftop-Mount, Elevated-Feed, No Ground Plane, 3 dBd Gain			✓	✓
AN-125001-006 (mount) with AN-225001-005 (element)	VRMS7010 VRMS7020	700/800 MHz GPS Combo Rooftop-Mount, 5 dBd Gain			✓	✓
AN-125001-008 (mount) with AN-225001-001 (element)	VRMS7010 VRMS7020	700/800 MHz Magnetic-Mount, 3 dBd Gain			✓	✓
AN-125001-008 (mount) with AN-225001-002 (element)	VRMS7010 VRMS7020	700/800 MHz Magnetic-Mount, Elevated-Feed 3 dBd Gain			✓	✓
AN-125001-008 (mount) with AN-225001-003 (element)	VRMS7010 VRMS7020	700/800 MHz Magnetic-Mount, Elevated-Feed, No Ground Plane, 3 dBd Gain			✓	✓
AN-125001-008 (mount) with AN-225001-005 (element)	VRMS7010 VRMS7020	700/800 MHz Magnetic-Mount, 5 dBd Gain			✓	✓
AN-025187-001	VRMS7010 VRMS7020	GPS Receive Only, Roof-Mount		✓	✓	
AN-025187-003	VRMS7010 VRMS7020	GPS Receive Only, Magnetic-Mount		✓	✓	

\* See Table 4-5 which begins on page 26 for the detailed descriptions.

**Figure 7-1: Required VRMS7010/VRMS7020 Antenna Mounting Locations with Antenna Part Numbers**



\* See Table 4-5 which begins on page 26 for the detailed descriptions.

**Figure 7-2: Required VRMS7030 Antenna Mounting Locations with Antenna Part Numbers**

### **7.1.3      Rear Deck Lid for GPS Stand-Alone GPS Receive Antenna**

If the VRMS7010 does not use a GPS combination-type antenna and it is equipped with a GPS receiver, a stand-alone GPS receive antenna must be separately located and mounted. The vehicle's rear deck lid (location ③) is the recommended mounting location for this case. This locates the GPS antenna inside the vehicle.

**TOP VIEW OF A TYPICAL VEHICLE**

ANTENNA PART NUMBER	FOR RADIOS	ANTENNA DESCRIPTION *	LOCATION			
			④	③	②	①
AN-125001-002 (mount) with AN-225001-004 (element)	VRBS7010 VRBS7020 VRBS7030	700/800 MHz Standard Rooftop-Mount, 2 dBd Gain	✓			
AN-125001-004 (mount) with AN-225001-004 (element)	VRBS7010 VRBS7020 VRBS7030	700/800 MHz Thick Rooftop-Mount, 2 dBd Gain	✓			
AN-125001-006 (mount) with AN-225001-004 (element)	VRBS7010 VRBS7020 VRBS7030	700/800 MHz GPS Combo Rooftop-Mount, 2 dBd Gain	✓			
AN-125001-008 (mount) with AN-225001-004 (element)	VRBS7010 VRBS7020 VRBS7030	700/800 MHz Magnetic-Mount, 2 dBd Gain	✓			

\* See Table 4-5 which begins on page 26 for the detailed descriptions.

**Figure 7-3: Required VRBS7010/VRBS7020/VRBS7030  
Antenna Mounting Locations with Antenna Part Numbers**

## 7.2 ANTENNA INSTALLATION PROCEDURES



Antennas **must** be installed before completing the radio installation.

### 7.2.1 Installing NMO Antenna Mounts AN-125001-001, -002, -003 and -004

These NMO style antenna mounts can each be used with several different antenna elements. Only limited access under the mounting location is typically required. The installation procedure is presented in Section 7.2.1.3.

#### 7.2.1.1 **Standard NMO Antenna Mounts AN-125001-001 and AN-125001-002**

These standard 3/4-inch NMO antenna mounts require a 3/4-inch hole in a relatively flat area of the vehicle body, with a vehicle metal thickness of between 0.020 and 0.040 inches. AN-125001-002 has a very-low-loss coax cable (LMR-195 or equivalent).

### 7.2.1.2 Thick-Roof NMO Antenna Mounts AN-125001-003 and AN-125001-004

Both of these thick-roof NMO antenna mounts use either  $\frac{3}{8}$ -inch or a  $\frac{3}{4}$ -inch mounting hole in a relatively flat area of the vehicle body, with a vehicle metal thickness of between 0.040 and 0.1875 inches ( $\frac{3}{16}$ -inch maximum thickness). AN-125001-004 has a very-low-loss coax cable (LMR-195 or equivalent).



NOTE

For thick-roof NMO antenna mounts AN-125001-003 or AN-125001-004, using a  $\frac{3}{8}$ -inch mounting hole will require better access to the underside of the mounting location than if a  $\frac{3}{4}$ -inch hole is used. This is because, in the case of a  $\frac{3}{8}$ -inch hole, the antenna mount's bushing assembly must be inserted from the underside of the mounting surface.

When using a  $\frac{3}{4}$ -inch mounting hole to mount thick-roof NMO antenna mounts AN-125001-003 or AN-125001-004, the thickness of the mounting surface must be at least  $\frac{1}{8}$ -inch (0.125-inch minimum thickness). This requirement is due to the thickness of the alignment ring used to center the bushing assembly within the  $\frac{3}{4}$ -inch mounting hole.

### 7.2.1.3 Installation Procedure for Mounts AN-125001-001 through -004

1. Select the antenna mounting location in accordance with the information presented in Sections 1 and 7.1 of this manual. If necessary, contact the Technical Assistance Center for assistance. See page 21 for TAC contact information.
2. Verify no obstructions exist immediately below the respective mounting location on the underside of the vehicle body, such as vehicle ribbing/body framing, a wiring harness, air bag equipment, etc. Also verify there is a sufficient access path and clearance for the mount's coax cable. If there is an obstruction or insufficient clearance, select another nearby mounting location.
3. Measure and mark the center point of the selected antenna mounting location. Be sure to center the mark from side-to-side of the vehicle.
4. Obtain a hole saw specifically designed for drilling NMO mounting holes of the required diameter. (e.g., Antenex/Laird Technologies model HS34 or equivalent for a  $\frac{3}{4}$ -inch hole; Antenex/Laird Technologies model HS38 or equivalent for a  $\frac{3}{8}$ -inch hole).
5. If the vehicle's headliner panel, carpet, seats, or otherwise, is below the mounting location, move or remove the headliner panel, etc. as necessary to protect it. Alternately, apply a heat-resistant mask material (such as a fiberglass mat or thin sheet metal with masked edges) as required to "catch" the metal shavings and the metal plug (if any) produced by the hole saw. The plug (if any) may be relatively hot if/when it drops out of the saw upon completion of the hole drilling process.  $\frac{3}{8}$ -inch diameter hole saws generally produce only shavings, not plugs.
6. With the hole saw and a drill, drill a hole at the marked hole center point. Position the drill square to (i.e., 90 degrees from) the vehicle mounting surface so paint immediately outside of the perimeter of the hole is evenly removed.

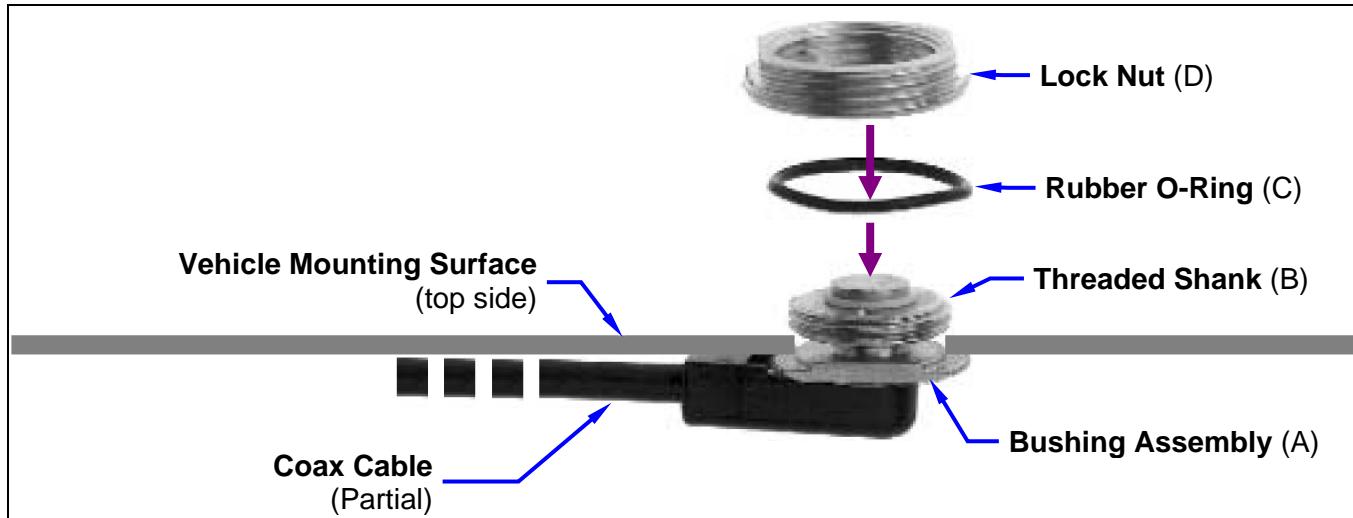


**Excessive use of the hole saw and/or failure to position the drill square with (i.e., at a 90-degree angle from) the vehicle mounting surface may result in damage to the metal mounting surface, in the area immediately outside of the perimeter of the hole.**

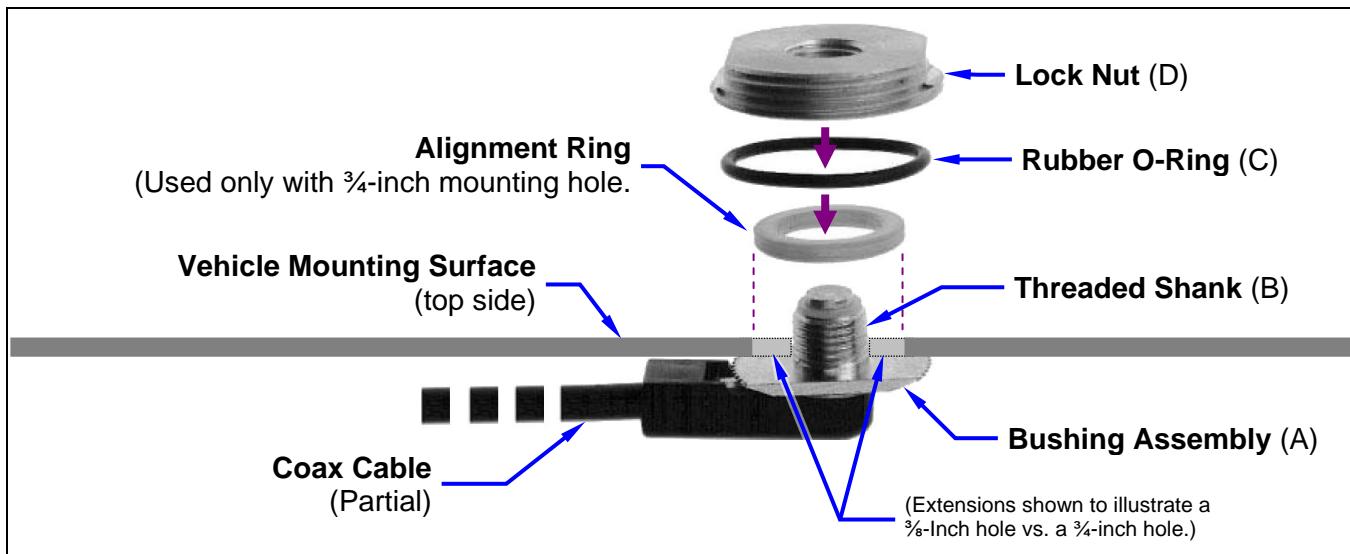
7. Ensure the saw removed the paint immediately around the hole as the drilling operation completes. If not, do so by reinserting the saw completely into the hole and spinning it as required. This allows proper grounding via the mount's lock nut on the top of the mounting surface. On the bottom of the

mounting surface, the “teeth” of the mount’s bushing assembly may not provide a good ground due to thick vehicle undercoating, thick primer, oxidation/rust, etc.

8. **For a  $\frac{3}{4}$ -inch hole**, feed the unterminated end of the mount’s coax cable into the hole from the top surface of the vehicle until the mount’s bushing assembly is in position to drop into the hole. The bushing should be tilted at a slight angle and fed into the hole. The threaded shank of the mount’s bushing assembly will not fall through a  $\frac{3}{4}$ -inch hole.  
**For a  $\frac{5}{8}$ -inch hole**, feed the threaded shank of the mount’s bushing assembly into the hole from the underside of the mounting surface. Hold it into position until the lock nut is installed.
9. If installing a thick-roof antenna mount  $\frac{7}{8}$ -inch shank) into a  $\frac{3}{4}$ -inch hole, place the alignment ring onto the threaded shank of the mount. This ring has an approximate  $\frac{3}{4}$ -inch outside diameter.
10. A tube of synthetic lubricant is included with the antenna mount. Apply this lubricant to the mount’s rubber O-ring. **Do not** get any lubricant on the center contact of the mount’s bushing assembly.
11. As illustrated in Figure 7-4 and Figure 7-5, add the O-ring (C) and lock nut (D) to the top of the mount’s bushing assembly (A). With the O-ring in the groove in the underside of the lock nut, thread the lock nut onto the bushing assembly. Be sure the O-ring remains in the groove before tightening the lock nut.



**Figure 7-4: Installing a Standard  $\frac{3}{4}$ -Inch NMO Antenna Mount  
(e.g., AN-125001-001 or AN-125001-002)**



**Figure 7-5: Installing a Thick-Roof NMO Antenna Mount  
(e.g., AN-125001-003 or AN-125001-004)**

12. Using a  $15/16$ -inch open-end wrench, tighten the lock nut until it fully compresses the O-ring and makes good contact with the vehicle mounting surface. The groove's ridges on the bottom of the lock nut must make full contact with the unpainted metal surface of the vehicle.
13. Install the antenna element per the procedure in Section 7.2.4.

### **7.2.2 Installing NMO Magnetic Antenna Mounts AN-125001-007 and AN-125001-008**

1. Thoroughly clean the bottom of the magnetic mount and the selected vehicle mounting surface by removing all dust, dirt, etc.
2. Carefully place the magnet mount onto the metal surface of the vehicle at the selected location. The coax cable exiting the mount's base should be orientated towards the point at which it will enter into the interior of the vehicle. Do not try to reposition it by sliding it on a painted metal surface.
3. Route the mount's coax cable to the radio location, passing it by the trunk lid's perimeter gasket, door perimeter gasket, etc., as necessary.
4. Install the antenna element per the procedure in Section 7.2.4.



To remove a magnetic antenna mount, hold it at the bottom of its base and tilt it at an angle to release the magnetic attraction force. **Do not pull on the mount's coax cable. Do not drag the mount across the mounting surface.**

### **7.2.3 Installing all Other Antenna Mounts**

For any other type of antenna mount not covered in the previous sections, such as GPS combination antennas, install the mount in accordance with the installation instructions included with the mount.

### **7.2.4 Attaching NMO Antenna Elements**

1. Clean the top surface of the NMO mount and the surface of the vehicle immediately around the mount.

2. Place the gasket included with the antenna element (not pictured in Figure 7-4 or Figure 7-5) around the mount and against the surface of the vehicle. If a lubricant or sealant was included with the gasket, apply it to the gasket before placing the gasket.
3. Apply the antenna element to the top of the mount and tighten it in a clock-wise direction (as viewing from the top). Use an appropriate wrench if required. Do **not** over-tighten.
4. Install a placard (not supplied) on the vehicle's dash panel, in accordance with the following **CAUTION**. Place the placard in plain view of the vehicle operator's position.
5. Continue with the connection procedure presented in the next section.



Before entering any automatic vehicle ("car") wash equipment, remove the antenna elements from the antenna mounts, and secure the elements in a safe location inside the vehicle. This will prevent the wash equipment from damaging the elements and/or mounts. After exiting the wash equipment, thoroughly dry the top of the mount before re-installing the elements.

### **7.2.5 Connecting the Mobile Antennas**

1. Label the radio-end of each antenna cable. The cable from the rooftop-mounted antenna (highest of the two) should be labeled "VRMS Antenna" and the cable from the trunk-mounted antenna (lowest of the two) should be labeled "VRBS Antenna"
2. Route each antenna cable from the antenna to the rear of the respective radio. Remove headliner panel, other interior panels, etc., as necessary. Keep each cable out of casual contact areas from persons within the vehicle. Tie and stow as necessary to protect the cables.



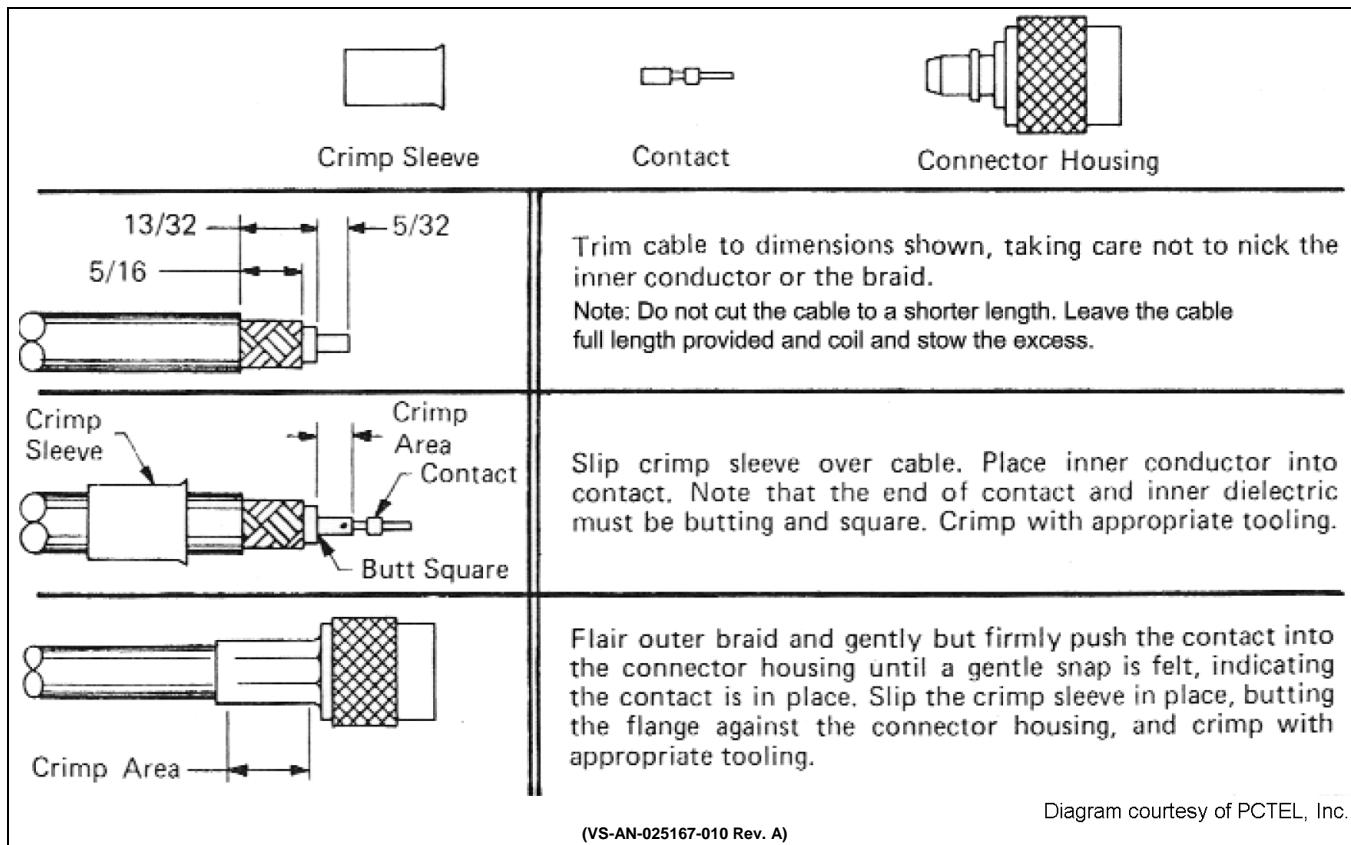
**Use the full length of coaxial cable included with each antenna. Never cut the cable to a shorter length, but rather coil any excess. Reducing the length of cable increases the output power radiated by the antenna, thereby exceeding the Maximum Permissible Exposure (MPE) allowance regulated by the FCC.**



**The VRMS and VRBS antennas are not interchangeable. Therefore, label the radio-end of each cable for future reference, as described in step 1.**

3. Using an appropriate crimp tool, crimp the supplied TNC RF connector to the end of each antenna cable. See Figure 7-6 for crimping instructions.
4. Connect each antenna cable's TNC plug-type (male) connector to the respective radio's TNC receptacle-type (female) RF connector at the rear of the radio. The VRMS antenna cable (labeled "VRMS Antenna") must be connected to the "ANTENNA" connector on the rear of the 800 MHz bandpass filter. The VRMS antenna cable (labeled "VRBS Antenna") must be connected to the "pigtail" type antenna cable of the VRBS. Mate the connectors and turn the plug clockwise until finger-tight.

This will be a temporary connection until the radios and antennas can be tested after the installation is complete (in accordance with test procedures presented in Section 16). The antennas should be connected now in case of accidental transmission.



**Figure 7-6: Crimping Instructions for TNC RF Connector (Actual Size; Dimensions in Inches)**

### **7.2.6 Connect RF Cable Between VRM Radio and 800 MHz Bandpass Filter**

An RF cable must be connected between the antenna connector of the M7300 and the 800 MHz bandpass filter as follows:

1. Obtain RF Cable CA-018378 from the installation kit (item 8 in Table 4-4).
2. Mate the cable's male TNC connector to the radio's female TNC connector. Do not fully tighten at this time.
3. Mate the cable's female TNC connector to the 800 MHz bandpass filter's male TNC connector.
4. Using a pair of soft-jaw pliers, firmly tighten both of the cable's TNC connectors. Do not over-tighten.

### **7.2.7 Install and Connect GPS Antenna (if Required)**

The VRMS's M7300 mobile radio may be equipped with an internal GPS receiver. If so, this receiver requires connection to an externally-mounted GPS antenna if the GPS functions will be utilized. Some installations may use a magnetic-mount stand-alone GPS antenna installed separately from the SMR mobile antenna.



Operation in either the standard mobile radio mode or in a vehicular repeater mode does not require GPS receiver operation. The radio's GPS receiver is typically used to support a computer running GPS software connected to the radio via NMEA-formatted serial data link. Refer to Section 14 for additional information.

The following antenna installation procedure is recommended:

1. Once the mounting location is selected, refer to the antenna manufacturer's mounting and testing instructions for installation guidance. If necessary, contact the Technical Assistance Center (see page 21 for contact information).
2. Route the cable from the GPS antenna to the rear of the radio. Remove headliner panel, other interior panels, etc., as necessary. The cable must be kept out of casual contact from persons within the vehicle.
3. Connect the GPS antenna cable's SMA plug-type (male) connector to the radio's SMA receptacle-type (female) "pigtail" type RF connector at the rear of the radio. Mate the two connectors and turn the plug clockwise. Tighten using a  $\frac{5}{16}$ -Inch combination or open-end wrenches. Do not over-tighten.



Do **not** alter the length of cable from the GPS antenna. The SMA connector on the end of the antenna cable is not field-replaceable. Tie and stow excess cable as necessary.

The GPS combo antenna kit includes a GPS antenna built into the base of the mobile antenna. No extra holes are required for the GPS cable when using this antenna. The antenna must be kept at least six (6) inches away from any other antenna mounted on the vehicle and have at least six inches of surface ground plane beneath it.

## 8 INTERFACE CABLE INSTALLATION

### 8.1 INTERFACE CABLE CA-012349-003 OVERVIEW

Interface Cable CA-012349-003 interconnects the VRMS to the VRBS. It also provides connections for optional equipment, if necessary. The cable interconnects the 44-pin I/O connector on the rear of the VRMS to the 25-pin connector at the rear of the VRBS. For connection of optional equipment, the cable breaks out into several smaller standardized connectors, allowing straightforward access to external I/O interfaces provided by the VRMS. The cable is shown in Figure 8-1 below. The cable's installation procedure begins on page 49.

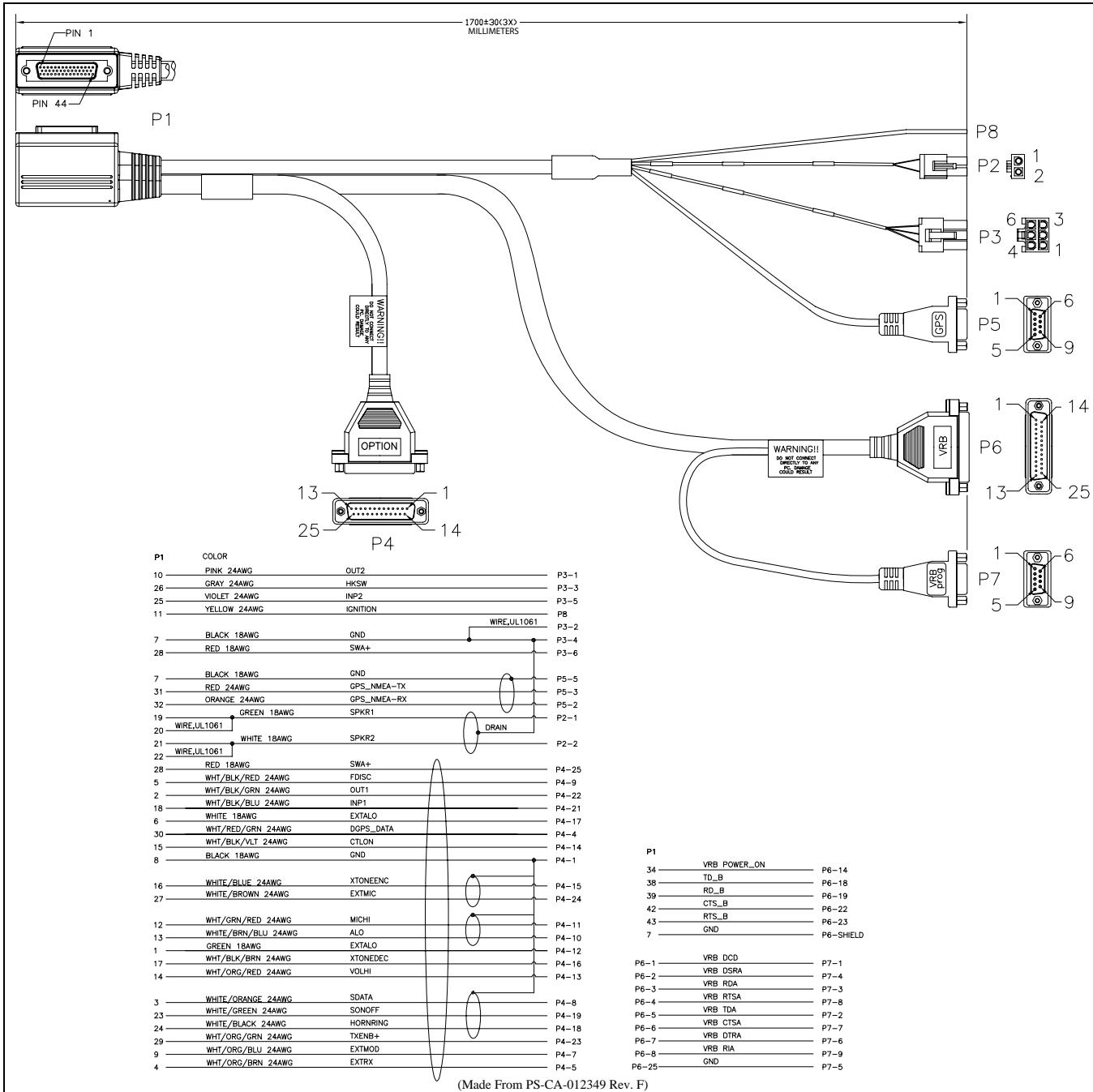


Figure 8-1: Interface Cable CA-012349-003



Observe caution before connecting any external device to the radio via its 44-pin I/O connector. If an external device has its own DC power source/cable (i.e., if it is powered separately from the radio), both the radio **and** the external device must be properly grounded **before** connecting the two units and before making a positive (+) power connection to either unit. Otherwise, fuse(s) inside the radio may fail (open) and/or other equipment damage could occur.

P1, the cable's 44-pin D-subminiature (DB-44) connector, mates with the connector on the rear of the VRMS.

P2, the cable's 2-pin connector, is not used in this application.

P3, the cable's 6-pin connector, can be used to connect an external switch used for enabling and disabling vehicular repeater mode via the radio's "auxiliary input 2" (i.e., the INP2 digital input). Refer to the installation procedure in Section 8.2 for the respective connection information. Refer to the maintenance manual for the respective configuration information. P3 can also be used for connecting optional equipment to the VRS7000.

P4, the cable's female D-subminiature 25-pin (DB-25) connector, can be used to connect an external switch used for enabling and disabling vehicular repeater mode via the radio's "auxiliary input 1" (i.e., the INP1 digital input). Refer to the installation procedure in Section 8.2 for the respective connection information. Refer to the maintenance manual for the respective configuration information. P4 also has audio and data connections for connecting optional equipment to the VRS7000.

P5, the cable's D-subminiature 9-pin (DB-9) connector, provides (optional) NMEA-formatted GPS serial data connections for the external computer processing the NMEA-formatted GPS data received by the GPS receiver within the VRMS (M7300 mobile radio). See Section 14 on page 70 for additional information.

P6, the cable's male D-subminiature 25-pin (DB-25) connector, mates to the female 25-pin D-subminiature connector of the VRBS. These interconnections provide the audio and digital control paths between the VRMS and the VRBS.

**Table 8-1: Interface Cable CA-012349-003 Pin-Out/Interconnections**

44-PIN I/O CABLE CONNECTOR P1 PIN	SIGNAL NAME	TO/FROM	DESCRIPTION	
19	SPKR1	P2 pin 1	Speaker Audio Outputs (not used in a VRS7000 installation).	
20	SPKR1			
21	SPKR2	P2 pin 2		
22	SPKR2			
10	OUT2	P3 pin 1	Digital Output 2 (open-collector, 500 mA / 30 V maximum). Use P3 pin 2 for ground. Configure via the "External Output Control Line 2" in RPM's External I/O dialog box.	
7	GND	P3 pins 2 & 4	Chassis Ground (fused on VRM radio's PK Board at 3.15 amps).	
26	HKSW	P3 pin 3	Digital Input for Hookswitch (default) or for radio PTT. Active = Grounded. Inactive = Open. Also see P4 pin 21.	

**Table 8-1: Interface Cable CA-012349-003 Pin-Out/Interconnections**

44-PIN I/O CABLE CONNECTOR P1 PIN	SIGNAL NAME	TO/FROM	DESCRIPTION
25	INP2	P3 pin 5	Digital Input 2. Active/Enable = Grounded. Inactive/Disable = Open. Use P3 pin 4 for ground. For use as a vehicular repeater enable/disable input controlled by an external switch, configure by using "Auxiliary Input 2" in RPM's P25 Vehicular Repeater Options dialog box. Refer to Section 8.2 in this manual, and the configuration information presented in the VRS7000 maintenance manual for additional information.
28	SWA+	P3 pin 6	Switched A+ DC Power Output (not normally used).
8	GND	P4 pin 1	Chassis ground (fused on VRM radio's PK Board at 3-amps).
30	DGPS_DATA	P4 pin 4	NMEA-Formatted GPS Receiver Module DGPS Correction Data Serial Data Input.
4	EXTRX	P4 pin 5	External Rx Audio Input (not normally used).
9	EXTMOD	P4 pin 7	External Tx Audio Input (not normally used).
3	SDATA	P4 pin 8	See footnote <sup>2</sup> .
5	FDISC	P4 pin 9	Buffered Discriminator Audio Output (not normally used).
13	ALO	P4 pin 10	Audio Ground/Reference (fused on VRM radio's PK Board at 3.15 amps).
12	MICHI	P4 pin 11	See footnote <sup>2</sup> .
1	EXTALO	P4 pin 12	
14	VOLHI	P4 pin 13	Volume High Audio Output (not muted; not normally used).
15	CTLON	P4 pin 14	Control-On Digital Input (not used).
16	XTONEENC	P4 pin 15	External Tone Encode Audio Input (default) or Auxiliary Mic Audio Input. Also see P4 pin 24.
17	XTONEDEC	P4 pin 16	External Tone Decode Audio Output.
6	EXTALO	P4 pin 17	Reference/Ground for external audio.
24	HORNRING	P4 pin 18	See footnote <sup>2</sup> .
23	SONOFF	P4 pin 19	See footnote <sup>2</sup> .
18	INP1	P4 pin 21	Digital Input 1. Active/Enable = Grounded. Inactive/Disable = Open. Use P4 pin 1 for ground. For use as a vehicular repeater enable/disable input controlled by an external switch, configure by using "Auxiliary Input 1" in RPM's P25 Vehicular Repeater Options dialog box. Refer to Section 8.2 in this manual, and the configuration information presented in the VRS7000 maintenance manual for additional information.

<sup>2</sup> This pin on the radio's DB-44 connector is typically not used. Use the respective pin on the CH-721 Option Cable's female DB-25 pin connector. Refer to the installation manual for additional information.

**Table 8-1: Interface Cable CA-012349-003 Pin-Out/Interconnections**

<b>44-PIN I/O CABLE CONNECTOR P1 PIN</b>	<b>SIGNAL NAME</b>	<b>TO/FROM</b>	<b>DESCRIPTION</b>
2	OUT1	P4 pin 22	Digital Output 1 (open-collector, 500 mA / 30 V maximum). Use P4 pin 1 for ground. Configure via the "External Output Control Line 1" in Radio Personality Manager's (RPM's) External I/O dialog Box.
29	TXENB+	P4 pin 23	Transmit Enable B+ Output (open-collector). Active/Radio Transmitting = Grounded. Inactive/Not Transmitting = Open. (not normally used).
27	EXTMIC	P4 pin 24	External/Auxiliary Mic Audio Input. Use P4 pin 17 for ground. Also see P4 pin 15.
28	SWA+	P4 pin 25	Switched A+ DC Power Output (not normally used).
32	GPS_NMEA_RX	P5 pin 2	NMEA-Formatted GPS Receiver Position Data Serial Data Output.
31	GPS_NMEA_TX	P5 pin 3	NMEA-Formatted GPS Receiver Module Initialization Data Serial Data Input.
7	GND	P5 pin 5	Ground for GPS Serial Data Signals (fused on VRM radio's PK Board at 3.15 amps).
11	IGNITION	(no connection)	Unused/Spare ignition sense input
34	VRB_POWER_ON	P6 pin 14	When a vehicular repeater mode is enabled, a logic output from the VRM (i.e., M7300 mobile radio) pulls this logic line high (greater than 2 volts). This turns on the VRBS via a high-current DC switch circuit located on the I/O Board within the VRBS. When a vehicular repeater mode is disabled, the logic output from the VRM remains in a low state, keeping the VRBS powered off.
38	TD_B	P6 pin 18	Asynchronous serial data interface between VRM (i.e., M7300 mobile radio) and Traffic Controller in VRBS. These interface lines transfer digitized audio and control data messages between the VRM and the Traffic Controller.
39	RD_B	P6 pin 19	
42	CTS_B	P6 pin 22	
43	RTS_B	P6 pin 23	
33, 35, 36, 37, 40, 41, 44	(no connection)	—	These connections of the VRM radio's DB-44 connector are not used in the VRS7000 application.

## 8.2 INTERFACE CABLE CA-012349-003 INSTALLATION PROCEDURE

Follow this procedure to install the Interface Cable:

1. Obtain Interface Cable CA-012349-003. It is included in the installation kit.
2. Mate the cable's male 44-pin D-subminiature (DB-44) connector to the female 44-pin D-subminiature connector on the rear of the VRMS. Using a screwdriver, tighten the two jackscrews securely.
3. Mate the cable's male D-subminiature 25-pin (DB-25) connector (labeled VRB) to the VRBS's female 25-pin D-subminiature connector. Using a screwdriver, tighten the two jackscrews securely.

4. The VRS7000's configuration may require connection to an external switch to enable and disable vehicular repeater mode (with or without a corresponding control head button press action). Consult with the radio system administration personnel as necessary, to determine the configuration of the "VR Enable Method." In this case, either digital input INP1 ("Aux I/O 1" in RPM) or digital input INP2 ("Aux I/O 2" in RPM) of the VRMS (i.e., M7300 mobile radio) must be wired to an external single-pole switch as follows:

- If the "VR Enable Method" is configured for "Keypad and Aux I/O 1" or just "Aux I/O 1," wire an appropriate switch between connector P4 pin 1 (ground) and pin 21 (digital input INP1). P4 is the cable's 25-pin option connector. The required connector to mate to P4, switch, and wire are not supplied. The use of 18-AWG wire is recommended.
- If the "VR Enable Method" is configured for "Keypad and Aux I/O 2" or just "Aux I/O 2," wire an appropriate switch between connector P3 pin 4 (ground) and pin 5 (digital input INP2). P3 is the cable's 6-pin connector. A connector to mate to P3 with six terminals (Molex part numbers 39-01-2066 and 39-01-0061) is supplied with the Interface Cable when it ships from the factory. The required switch and wire are not supplied. The use of 18-AWG wire is recommended.
- Mount the switch in an appropriate location and placard it appropriately (e.g., "Vehicular Repeater Enable/Disable."



NOTE

If the digital input providing the vehicular repeater enable/disable function must be controlled by an external device such as a portable radio's vehicular charger, substitute external switch connections for connections to the device's vehicular repeater switched output. In this case, be sure to connect the ground of the VRSM (P4 pin 1 if using INP1; P3 pin 4 if using INP2) to the ground of the external device, and connect the digital input of the VRMS (P4 pin 21 if using INP1; P3 pin 5 if using INP2) to the switched output of the external device. Interconnections for the VC3000 and VC4000 Vehicular Chargers are presented in Table 8-2 and Table 8-3.

5. Tie and stow the cable and all wiring.

Connection information for NMEA-formatted GPS serial data is included in Section 14 on page 70.

**Table 8-2: VRS7000-to-VC3000/VC4000 Vehicular Charger Interconnections for Vehicular Repeater Enable/Disable if using VRMS's Aux I/O 1 = INP1 (Optional)**

VRMS 44-PIN I/O CABLE CONNECTOR PIN	SIGNAL NAME	INTERFACE CABLE CA-012349-003's 25-PIN OPTION CONNECTOR	RECOMMENDED CONNECTOR AND TERMINALS FOR MATING TO P4	VC3000-/VC4000's 5-PIN CONNECTOR PIN	RECOMMENDED CONNECTOR AND TERMINALS FOR MATING TO VC3000/VC4000's 5-PIN CONNECTOR
18	INP1	P4 pin 21	Tyco Electronics 1658659-1 Connector (includes Shielded Enclosure and Jackscrews) and Tyco Electronics 1-745267-0 Contacts (Pins)	4 ("Repeater")	Molex 39-01-4051 Connector and Molex 39-00-0158 Contacts (Both are provided with the VC3000/VC4000's installation kit.)
8	GND	P4 pin 1		5 ("SW Gnd")	

**Table 8-3: VRS7000-to-VC3000/VC4000 Vehicular Charger Interconnections for Vehicular Repeater Enable/Disable if using VRMS's Aux I/O 2 = INP2 (Optional)**

VRMS 44-PIN I/O CABLE CONNECTOR PIN	SIGNAL NAME	INTERFACE CABLE CA-012349-003's 25-PIN OPTION CONNECTOR	RECOMMENDED CONNECTOR AND TERMINALS FOR MATING TO P3	VC3000-/VC4000's 5-PIN CONNECTOR PIN	RECOMMENDED CONNECTOR AND TERMINALS FOR MATING TO VC3000'S 5-PIN CONNECTOR
25	INP2	P3 pin 5	Molex 39-01-2066 Connector and Molex 39-01-0061 Contacts (Both are provided with Interface Cable CA-012349-003)	4 ("Repeater")	Molex 39-01-4051 Connector and Molex 39-00-0158 Contacts (Both are provided with the VC3000/VC4000's installation kit.)
7	GND	P3 pin 4		5 ("SW Gnd")	

## 9 DC POWER INSTALLATION

Refer to the wiring diagram at the end of this manual as necessary when performing wiring procedures presented in this section.

### 9.1 OVERVIEW OF ON/OFF POWER WIRING CONFIGURATIONS

Radio on/off power control is accomplished by the control head. When the control head is turned on, it “wakes-up” the VRMS via data activity on the CAN link. The VRMS automatically powers-up the VRBS when the P25 vehicular repeater mode is enabled. The following power wiring configurations are supported:

- **Radio turns on and off automatically with vehicle’s ignition switch/key** — This configuration allows the on/off state of the vehicle’s ignition switch/key to control the on/off power state of the radio. The white wire of the control head’s DC Power Cable is connected to a fused switched power source, typically identified as vehicle “Accessory” power. This source must switch on (up to positive (+) battery voltage potential) when the vehicle’s ignition switch/key turns on, and it must switch off (to near zero volts) when the ignition switch/key turns off. The required fuse rating is 3 amperes. When using this configuration, the CH-721 control head’s on/off/volume control must be left in the on position for automatic power-up/down to function properly.
- **Radio turns on and off with a manual switch** — This configuration is used when, for example, the radio must remain on even when the ignition key must be removed from the vehicle and a separate on/off switch is acceptable. The white wire of the control head’s DC Power Cable is connected to one side of a manually-controlled switch, and the other side of this switch is connected to unswitched and fused vehicle power. The required fuse rating is 3 amperes. When using this configuration, the CH-721 control head’s on/off/volume control must be left in the on position for automatic power-up/down to function properly.
- **Radio turns on with control head’s on/off/volume control (“hot wired”)** — This configuration allows radio on/off power control only via the control head’s on/off/volume control. It may be desired if, for example, the radio must remain on even when the ignition key must be removed from the vehicle and a separate on/off switch is not desired and/or not acceptable. The white wire of the control head’s DC Power Cable must be connected to unswitched and fused vehicle power. The required fuse rating is 3 amperes.

The VRMS, the VRBS, and the control head require separately-fused main DC power. This is the red wire of each DC power cable. The switch power source to the control head is also separately fused. This is the white wire of the control head’s DC power cable. In-line type fuses and fuse holders are utilized.



Any DC input power provided to the radio shall be no higher or lower than 13.6 volts DC  $\pm 10\%$ . The DC input power should be free and clear of any AC noise or DC spikes above 18 volts. If the vehicle cannot meet these requirements, then DC conditioning will be required before any DC power is connected to the radio. This includes conditioning for both the radio’s main DC power input lead and for its switched ignition sense power input. DC conditioning can be accomplished by a noise filter or DC isolation equipment such as Harris part number FL-018314-001 or FL-018314-002, or similar units with equal specifications. The fuse must be placed in-line before any noise filter. Contact TAC for additional information.

## 9.2 POWER INSTALLATION PROCEDURE

### 9.2.1 Radio DC Power Cables and Main Fuse Holders Installation

Each radio DC power cable has a 3-pin connector, a 20-foot red wire for the main power connection, a 20-foot white wire which is not used/not connected in this application, and a 4-foot black wire for the ground connection. Each cable is supplied with AGC-type waterproof fuse holders, AGC-type fuses, and non-insulated ring terminals. The following installation procedures are recommended:

#### 9.2.1.1 **Black Wire Connections (Ground Wires)**

1. Obtain two (2) DC Power Cables, part number CA-012365-001. These cables are included in the installation kit.



Do not confuse the radios' DC Power Cables which each has a 10-AWG red wire with the control head's DC Power Cable which has a 12-AWG red wire. The radios require much more DC operating current than the control head. Therefore, each radio requires the larger size (10-AWG) wire. Control head DC Power Cable installation procedures are included in Section 10 of this manual.

2. Connect one DC Power Cable to the VRMS by mating its 3-pin connector to the VRMS's 3-pin DC power cable connector. Visually align the key and firmly push and turn the outer locking ring clockwise until it stops. A click will be sensed to confirm proper mating.
3. Connect the other DC Power Cable to the VRBS using the same connection method.
4. **Prepare to connect both cables' black wires to vehicle ground by locating an area of vehicle metal within approximately three (3) feet of the two radios. This surface must have a solid and stable connection to vehicle ground (i.e., battery ground).**



The radios must have a solid and stable ground connection to vehicle ground. If there is no well-grounded metal surface within approximately three (3) feet of the radios, a metal grounding strap or a heavy-gauge wire (with proper wire terminals) must be added between the metal surface and a solid and stable vehicle grounding point, preferably near the battery. Some vehicles are equipped with a high-current DC power access point (a vehicle option) that provides high-current power and ground studs, typically in the vehicle's trunk area. In this case, the ground stud of the power access point can be considered a good vehicle ground, and used as such. Metal surfaces should be stripped of all paint and dirt to expose bare metal before attaching a grounding strap or wire terminal. To make all ground connections, the use of stainless-steel hardware with machine-screw threads, shelf-locking nuts and washers is recommended.

5. Strip the area of any paint or dirt to expose a bare metal surface, approximately  $\frac{3}{4}$ -inch square.
6. Drill a hole in the approximate center of the bare metal surface, and deburr it. A  $\frac{1}{8}$ -inch non-insulated ring terminal is supplied with each cable to make the ground connection. Therefore, hole diameter should be appropriate for the utilized grounding screw/bolt size and type used to connect the ring terminals to the bare metal surface. This hardware is not supplied.
7. Cut the two (2) black wires to the required length plus some additional length for service loops in each wire, then strip insulation back approximately  $\frac{1}{4}$ -inch.
8. Crimp a  $\frac{3}{8}$ -inch non-insulated ring terminal (supplied with the cable) to the end of each black wire.

9. Attach the two (2) ring terminals with black wires to the bare metal surface using stainless-steel self-locking hardware (i.e., machine screws with washers and locking nuts) or other appropriate hardware to ensure a reliable terminal-to-metal contact. Tighten securely.
10. Apply an approved paint or rust-inhibitor over the remaining exposed bare metal surface and around the ring terminal. Do not use an acid-based sealant.

#### 9.2.1.2 Red Wires and Main Fuse Holder Connections (Radios' Main Power Wires)

1. Continue installation of two (2) DC Power Cables by routing their 20-foot 10-AWG red wires to the location of the vehicle's battery (or its main DC bus bar or stud). Route the wires through channels in the vehicle to the location of the battery. Remove interior panels, door kick panels, etc., as necessary. Protect the wires from possible chafing where necessary. Tie and stow it as necessary.



NOTE

The white wire of both radios' DC Power Cables require no electrical connection. Rather than be cut from the two cables, it is recommended that these wires be routed up to the vehicle's fuse box, coiled, labeled, and stowed for possible future use. The white wire of the control head's DC Power Cable is the radio installation's ignition sense input for on/off power control of both the control head and radio. Radio on/off power control is accomplished by the control head. The control head "wakes-up" the VRMS via data activity on the CAN link.



CAUTION

Plan the routing of the two 10-AWG red wires carefully, using an existing access hole in the vehicle's firewall if possible. Alternately, drill a new hole approximately 3/8-inch in diameter and install a small rubber grommet to protect the wires from chafing on the hole's sharp metal edge. **To prevent fumes from entering the passenger compartment, this hole/grommet/wire combination must also be sealed with a silicon-based sealer before completing the installation.**



CAUTION

Do not install any wiring or fuse holder over or in the near vicinity of the vehicle's engine. Excessive engine heat can cause permanent damage to these components and can lead to intermittent electrical connection to the battery.

2. Obtain two (2) waterproof inline fuse holders (HFB type) included with the DC Power Cables.
3. **Observe and abide by the following WARNING!**
4. Cut the red wires to the required lengths for connection to the battery's positive (+) battery terminal (or the main DC bus bar or stud).
5. Prepare to splice the two (2) inline fuse holders into the red wires by cutting the red wires again, at approximately three (3) to six (6) inches from each end.
6. Strip all wire ends back approximately  $\frac{1}{8}$  -inch each, place a fuse holder shell on each wire, and securely crimp a fuse holder terminal to each wire end. Before crimping, verify fuse holder shells are oriented in the correct directions (i.e., with each large end towards the wire end).



Before making connections to the battery's positive post, carefully disconnect the battery's negative (ground) cable(s). This will prevent tools or other metallic objects which come in contact with the battery's positive terminal from shorting to vehicle ground, causing sparks or even a fire or an explosion! When disconnecting the negative cable(s), cover/insulate the positive post(s) if it is not already so a tool cannot short between the posts. Some vehicles, such as those with diesel engines have more than one battery; in this case, disconnect the negative cables at all batteries.

**Radio and control head fuses should not be installed until all wiring is complete. This will prevent the radio from powering up prematurely and/or causing an in-rush of current that could lead to shorting of the battery, sparks, or even fire.**

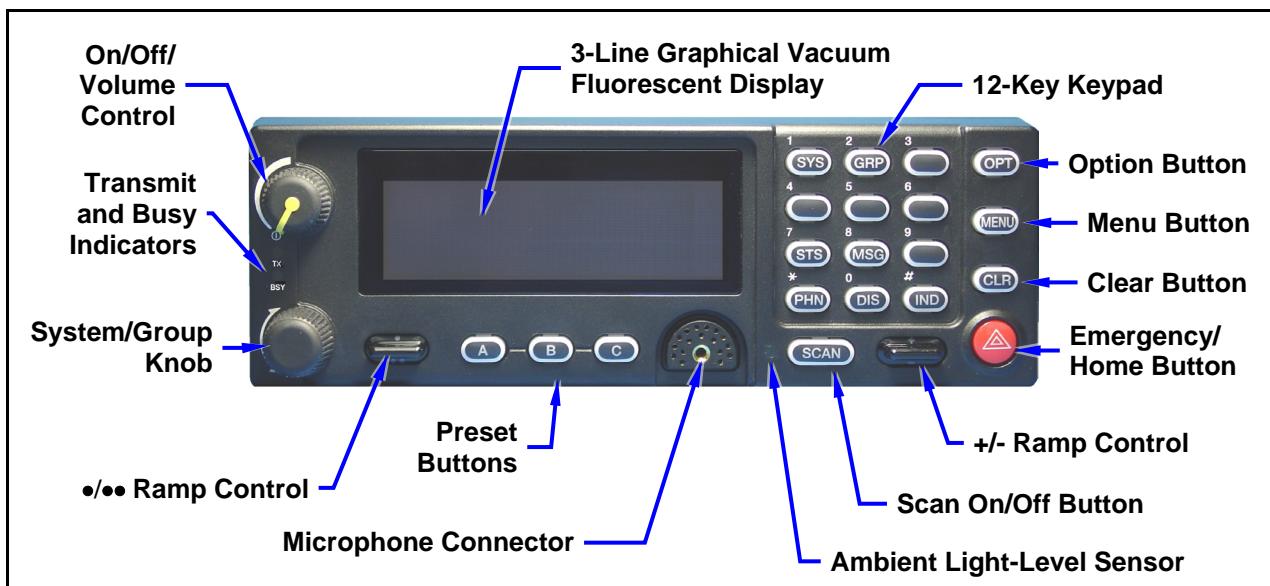
7. Label each fuse holder and red wire appropriately (e.g., "VRMS: 15-AMP FUSE" and "VRBS: 15-AMP FUSE").
8. **Do NOT install fuses into the fuse holders at this time.**
9. Crimp an appropriate electrical terminal to each short red wire. A  $\frac{3}{8}$ -inch ring terminal is included with each cable for this purpose, but another terminal type (not supplied) may be used if required.
10. Connect both ring terminals directly to the battery's positive post, or if present, to a stud on the battery's main/non-switched power distribution terminal block.

# 10 CONTROL HEAD INSTALLATION

## 10.1 GENERAL INFORMATION

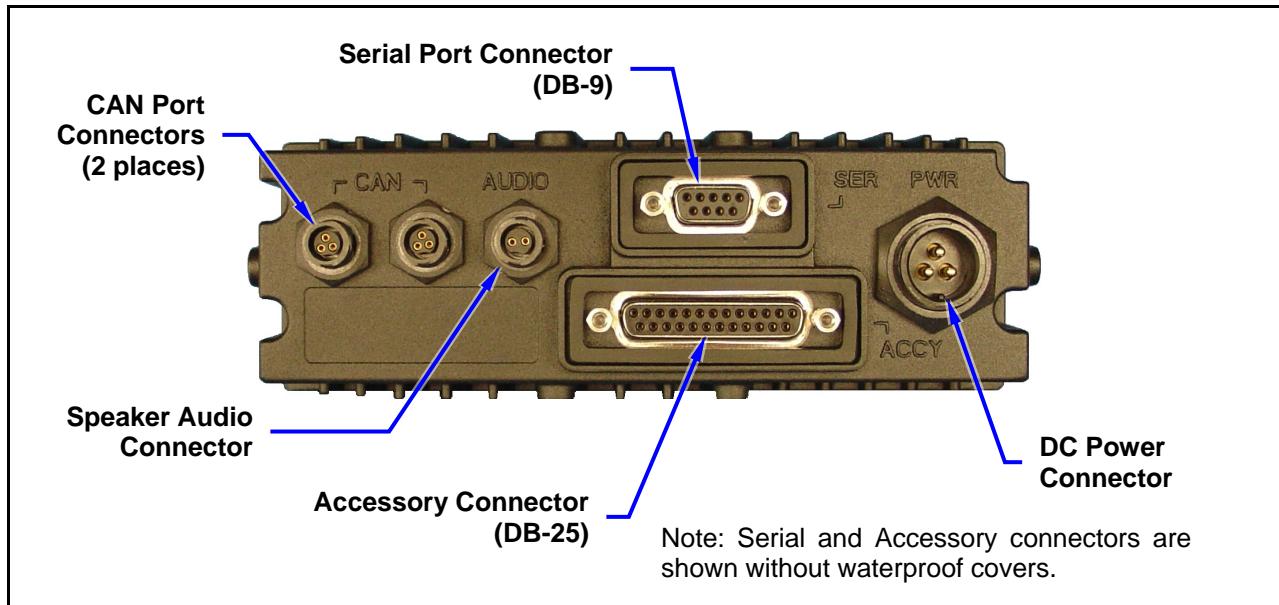
Since the VRS7000 is a remote-mount mobile radio, it must be connected to a control head to provide the operator-to-radio interface. The CH-721 System model control head is used with the VRS7000.

The front panel of the CH-721 System mode control head is shown in Figure 10-1. This control head has a large 3-line graphical vacuum-fluorescent display, front panel controls and buttons for user control of the mobile radio, an internal high-power audio amplifier to drive an externally-connected speaker, and a front panel microphone connector. It features a 12-key numeric keypad that provides Dual-Tone Multi-Frequency (DTMF) keypad functionality and easier operator system/group selection, three (3) preset buttons, and an emergency/home button. Other front panel components include a microphone connector and LED-type indicators. One LED indicator is the busy indicator that lights when the radio is receiving a call and one is the transmitter-enabled indicator that lights when the radio is transmitting. The front panel also has an ambient light sensor for automatic display dimming.



**Figure 10-1: CH-721 System Model Control Head Front Panel**

Figure 10-2 illustrates the control head's rear panel. Connectors on the rear panel include two (2) CAN port connectors, a speaker audio (output) connector and a 25-pin D-subminiature (DB-25) accessory connector, and a 9-pin D-subminiature (DB-9) serial port connector. The DB-25 accessory connector is used for connection of optional equipment to the control head, such as a siren/light control system. The DB-9 serial port connector is typically only used during programming performed at the factory.



**Figure 10-2: CH-721 Rear Panel**



Prior to installing the control head, verify it has the proper software version installed and verify it has been properly configured for customer use.

## 10.2 CONTROL HEAD MECHANICAL INSTALLATION

### 10.2.1 Selecting the Mounting Location

When selecting a location for the CH-721 control head, first observe the safety and operator-convenience related information presented in Section 5.1 on page 28. Also always consider and include clearance for the microphone's connector that must mate to the mic connector on the front panel of the head, and clearance for the connectors/cables that must mate to the connectors on the rear panel of the head. The CH-721 control head can be mounted under or on top of a mounting surface (typically the vehicle's dash) as space permits using either the standard U-shaped mounting bracket or the optional mounting pedestal.

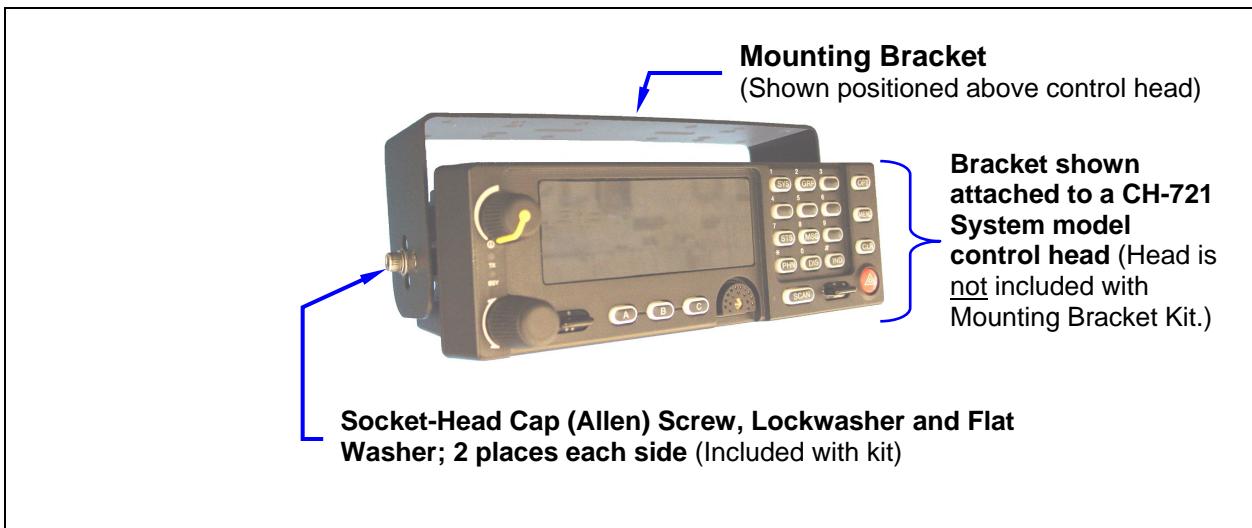


Figure 10-3: Standard U-Shaped Control Head Mounting Bracket (Kit Part Number KT-008608)

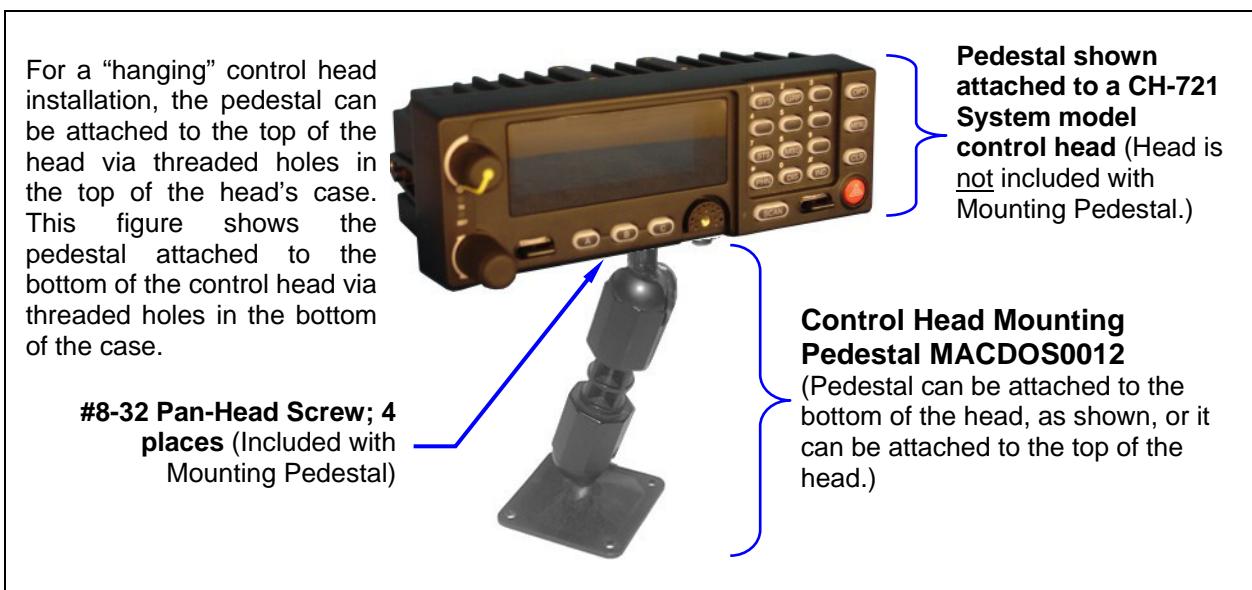


Figure 10-4: Optional Control Head Mounting Pedestal (Part Number MACDOS0012)

### **10.2.2 Using the Standard U-Shaped Mounting Bracket**

If the standard U-shaped Mounting Bracket will be used to mount the control head, the following mounting procedure is recommended. This bracket is included with the Mounting Bracket Kit listed in Table 4-4 (on page 24).

1. Using the Mounting Bracket as a template, mark and drill mounting holes into the mounting surface as required. The round and elliptical holes in the bracket's vehicle mounting surface are symmetrical so forward/backwards positioning is not important during this step. However, positioning is important in the next step.



When drilling holes, be careful to avoid damaging some vital part of the vehicle (fuel tank, transmission housing, etc.). Always check to see how far the mounting screws will extend below the mounting surface prior to installation. After drilling pilot holes, remove all metal shavings from them (i.e., deburr the holes) before placing the bracket and installing the mounting screws.

2. Postion the bracket at the mounting surface so the two round holes in its two side "ears" are nearest to the normal location of the operator (typically towards the rear of the vehicle) and the two slotted holes are farthest from the normal location of the operator (typically towards the front of the vehicle).
3. Install and tighten the mounting screws. Screws for mounting the bracket to the mounting vehicle's surface are not included, as all installations differ. Self-tapping screws are recommended. Do not use common self-threading sheet metal screws because they will loosen over time with vehicle vibrations.
4. Verify the bracket is held firmly to the mounting surface. Firm mounting prevents unreasonable vibration, which could damage the control head and/or cause its cable connections to loosen.
5. Slide the control head into the bracket, placing the two pegs protruding from its left and right sides into the respective round holes in the bracket's two side "ears."
6. In each side "ear" of the mounting bracket, start a #8-32 socket-head cap (Allen) head screw with a lockwasher and a flat washer by inserting the screw through the slotted hole in the bracket and then into the threaded hole in the side of the control head. This hardware is included with Mounting Bracket Kit. The lockwasher should be adjacent to the screw head and the flat washer should be adjacent to the bracket. Turn each screw clockwise as observed from the head of the screw.
7. The control head can be positioned at various angles for best display viewing at the normal position of the operator. As necessary, turn it on the pegs to a good position and tighten both screws using an 1/8-inch hex key (Allen) wrench until the control head is held firmly in place. Do not over-tighten.

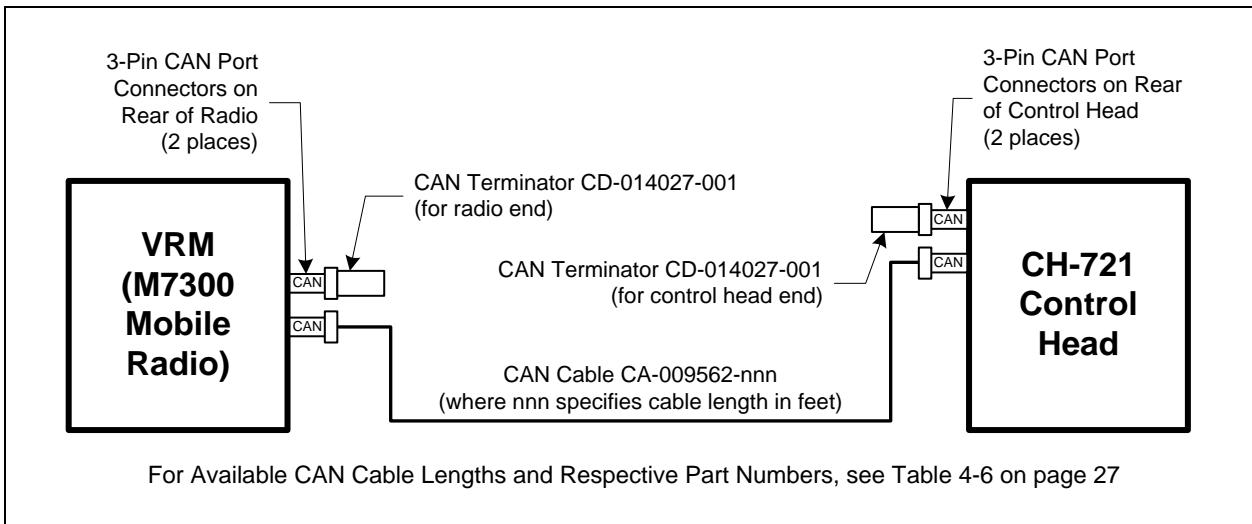
### **10.2.3 Using the Mounting Pedestal (Optional)**

An optional Mounting Pedestal, part number MACDOS0012, may be purchased separately to replace the standard U-shaped Mounting Bracket. This pedestal can be attached to the bottom of the control head as shown in Figure 10-4 and then mounted to a mounting surface below the two. It can also be attached to the top of the head and then mounted to a mounting surface above the two.

## 10.3 CAN CONNECTIONS

### 10.3.1 General Information

The installation requires a CAN cable between every two “CAN devices” and CAN terminators on each end of the CAN link. The VRMS7000’s VRMS is considered a CAN device, and each CH-721 control head in the installation is also considered a CAN device. Figure 10-5 illustrates CAN cable and CAN terminator connections. Because CAN devices do not have internal terminators, the CAN link must be terminated at both ends via a CAN terminator.



**Figure 10-5: CAN Cable and Terminator Connections**

Both the VRMS and the control head have two CAN ports. Figure 5-1 on page 29 shows the radio’s two CAN port connectors, which are located on cable side of the I/O cable’s DB-44 connector. Figure 10-2 on page 57 shows the two ports on the control head’s rear panel.

### 10.3.2 Make CAN Link Terminations and Cable Connection

Follow this procedure to complete CAN cable connections:

1. Connect the CAN Terminator (Item 11 listed in Table 4-4 on page 24) onto either one of the two smaller 3-pin connectors on the rear of the CH-721. This action makes the CAN termination at the control head end of the CAN link.



When mating any CAN connection (terminators and cables), visually align the  $\frac{3}{4}$ -moon-shaped keys of the connectors, and then gently push and turn the outer locking ring of the plug (male) connector clockwise until it stops. A mild click will be sensed to confirm proper mating. Without visual alignment as a guide, it is possible with excessive force to mate the CAN connectors improperly. Damage to the connector(s) may result. Therefore, visual alignment is recommended when mating CAN connectors.

2. Route the CAN Cable (Item 9 listed in Table 4-4) through the vehicle’s interior wire/cable channeling to the VRMS. Remove interior panels, door kick panels, etc., as necessary. Protect the cable from possible chafing as necessary.
3. Attach the CAN Cable’s connector to one of the two CAN port connectors on the VRMS’s I/O cable.

4. Connect the other end of the CAN Cable to the open CAN port connector at the rear of the control head.
5. Connect the CAN Terminator (Item 11 in Table 4-4) onto either one of the two smaller 3-pin connectors on the VRMS's I/O cable. This action makes the CAN termination at the radio end of the CAN link.
6. Loop, tie and stow the excess cable as necessary.

## **10.4 CONTROL HEAD POWER CABLE INSTALLATION**

Plan the route of the control head's DC Power Cable carefully. Do not route the cable where it will be damaged by heat sources or by casual contact, and protect it from wire chafe per standard installation methods. The following procedures are recommended:

### **10.4.1 Install DC Power Cable and Make Power and Ground Connections**

1. Connect the control head's DC Power Cable (Item 6 listed in Table 4-4 on page 24) to the large 3-pin connector at the rear of the head. Visually align the key and gently push and turn the outer locking ring clockwise until it stops. A click will be sensed to confirm proper mating.
2. At the back of the control head, locate a nearby section of vehicle chassis ground and strip this area of any paint or dirt to expose a bare metal surface.
3. Cut the black wire of the control head's DC Power Cable to the required length, plus a service loop of at least six (6) inches, then strip it and crimp a  $\frac{3}{8}$ -inch ring terminal to it. Two (2) ring terminals of this type are included with the cable.
4. Drill a hole as necessary and attach this ring terminal to chassis ground. Use stainless-steel self-locking hardware (i.e., machine screws with washers and locking nuts) or other appropriate hardware to ensure a reliable terminal-to-metal contact. Tighten securely.



**CAUTION**

The control head must have a solid and stable ground connection to vehicle ground. If there is no well-grounded metal surface within approximately four (4) feet of the control head, the DC Power Cable's black wire should be extended to a solid and stable vehicle grounding point, preferably near the battery. Some vehicles are equipped with a high-current DC power access point (option) that provides high-current power and ground studs, typically in the vehicle's trunk area. In this case, the ground stud of the power access point can be considered a good vehicle ground, and used as such. Metal surfaces should be stripped of all paint and dirt to expose bare metal before attaching a ground wire. To make all ground connections, the use of stainless-steel hardware with machine-screw threads, shelf-locking nuts and washers is recommended. To extend the length of the ground wire, use at least 12-AWG wire and approved wire splicing techniques.

5. At the back of the control head, tie and stow the cable as necessary.
6. For the positive 12-volt DC main power source connection, route the cable's red wire to the location of an unswitched 12-volt DC power source, typically near the vehicle's battery. Remove interior panels, door kick panels, etc. Protect the wire from possible chafing as necessary. This is the control head's main DC power source.
7. Obtain one of the waterproof inline fuse holders (HFB-type) included with the control head's DC Power Cable.

8. Cut excess length from the red wire and splice the fuse holder into it, near the location of the unswitched 12-volt DC power source connection point.
9. Label this fuse holder and red wire appropriately (e.g., “CH-721 Main Power: 5-AMP FUSE”).
10. Using an appropriate electrical terminal, connect the red wire to the unswitched DC power source. A  $\frac{3}{8}$ -inch ring terminal is included with the cable for this purpose, but another terminal type (not supplied) may be used if required.
11. Obtain the 5-amp AGC fuse included with the cable, and install it into the fuse holder.



NOTE

Do not share the control head’s fuse with any other device. Doing so can cause excess current to flow through the fuse, causing it to blow unnecessarily.



CAUTION

The fuse rating for the control head’s red wire is 5 amperes. The 3-amp fuse included with the cable must **not** be used for fusing the control head’s main DC power. It fuses the head’s white wire.

#### **10.4.2 Connect DC Power Cable’s White Wire**

A review of the information presented in Section 9.1 (page 52) may be beneficial at this time. As required per the chosen power-up configuration, connect the white wire by following one of the three procedures presented in the respective sub-section that follows.



NOTE

Only the control head’s white wire must be connected to the ignition or switched power sense. When this vehicle line is asserted (i.e., power switched on), the control head automatically powers-up the VRMS via the CAN connection.

##### **10.4.2.1 Control Head and Radio Turn on with Vehicle’s Ignition Switch/Key**

With this wiring configuration, the control head and the VRMS automatically turn on and off with the vehicle’s ignition switch/key. The white wire of the control head’s DC Power Cable is sometimes referred to as the “white ignition switch wire” or the “ignition sense input wire.” In this configuration, the white wire connects to a switched power source, typically identified as “Accessory” power, that switches on and off with the vehicle’s ignition switch/key. When using this configuration, the CH-721 control head’s on/off/volume control must be left in the on position for automatic power-up/down to function properly.



NOTE

The white ignition sense wire must be connected to a power source that switches from approximately zero volts to approximately +13.6 volts when the vehicle’s ignition switch/key is turned from the OFF position to the ACCESSORY and RUN positions. Use of a switched power source that is subject to voltage changes as a result of other actions, such as opening a vehicle door, may result in undesirable radio operation and/or a degradation of radio performance.

1. Locate the vehicle’s switched ignition or “Accessory” power connection point that will be used for the switched ignition 12-volt DC power source. This point is typically located at or near the vehicle’s fuse panel. It may be necessary to consult the vehicle manufacturer’s wiring diagram.
2. Route the white wire of the control head’s DC Power Cable from the back of the head to the area near this connection point. Protect the wire from possible chafing as necessary.

3. Obtain one of the waterproof inline fuse holders (HFB-type) included with the control head's DC Power Cable **or** see the following **NOTE**.
4. Cut excess length from the white wire and splice the fuse holder into it, near the location of the connection point.
5. Using an appropriate electrical terminal, connect the white wire to the switched power connection point. An open-barrel spade terminal is included with the cable for this purpose, but another type of terminal (not supplied) may be used as required.
6. Obtain the 3-amp AGC fuse included with the cable, and install it into the fuse holder.
7. Tie and stow all wiring as necessary so it remains out of the way of casual contact and wire chafe is avoided.

**NOTE**

The waterproof inline fuse holder and AGC fuse included with the DC Power Cable **must** be used if the white wire connection point is located in a harsh environment such as in the vehicle's engine compartment. However, if the connection point is **not** in a **harsh environment**, such as under the vehicle's dash panel, Vehicle Fuse and T-Tap Kit FS24473 may be ordered and used to make the white wire connection. As shown in Figure 10-6, this kit includes an ATM fuse holder and fuse, T-tap crimp terminals for tapping into an existing vehicle switched power wire, and a quick-disconnect terminal. See Section 10.4.3 on page 64 for additional information.

#### **10.4.2.2 Control Head and Radio Turn On with a Manual Switch**

With this wiring configuration, the control head and the VRMS are manually turned on and off via an on/off switch mounted separately from the control head and VRMS, not through the vehicle's ignition switch/key. This configuration is used when, for example, the radio must remain on even when the ignition key must be removed from the vehicle **and** a separate on/off switch is acceptable and/or required. In this configuration, the white wire connects to a fused switched power source such as that provided by a toggle switch mounted on the vehicle's dash panel. When using this configuration, the CH-721 control head's on/off/volume control **must be left in the on position** for automatic power-up/down to function properly.

1. Route the white wire of the control head's DC Power Cable from the back of the head to an area near the location of the panel-mounted on/off switch. Protect the wire from possible chafing as necessary.
2. Cut a short section (6 to 8 inches) off the end of the white wire and strip the ends.
3. Obtain one of the waterproof inline fuse holders (HFB-type) included with the control head's DC Power Cable, and crimp one half of it to one end of the short section of wire.
4. Using an appropriate electrical terminal, connect this short white wire to unswitched 12-volt DC power source at or near the vehicle's fuse box.
5. Cut another section of white wire from the cable. This wire must be long enough to reach from this fuse holder to the location of the panel-mounted on/off switch.
6. Strip one end of this wire and crimp the other half of the fuse holder to this wire end.
7. Strip the other end of this wire and, using an appropriate electrical terminal, connect it to the common terminal of the switch.
8. Connect the white wire of the power cable to the load (switched) side of the switch.
9. If not already, mount the switch to the vehicle's dash panel, or other customer-selected location.

10. Obtain the 3-amp AGC fuse included with the cable, and install it into the fuse holder.
11. Tie and stow these wires as necessary so they remain out of the way of casual contact and wire chafe is avoided.
12. Label this power switch accordingly. For example: “**VRSS7000 ON/OFF**.”

#### **10.4.2.3 Control Head and Radio Are “Hot Wired”**

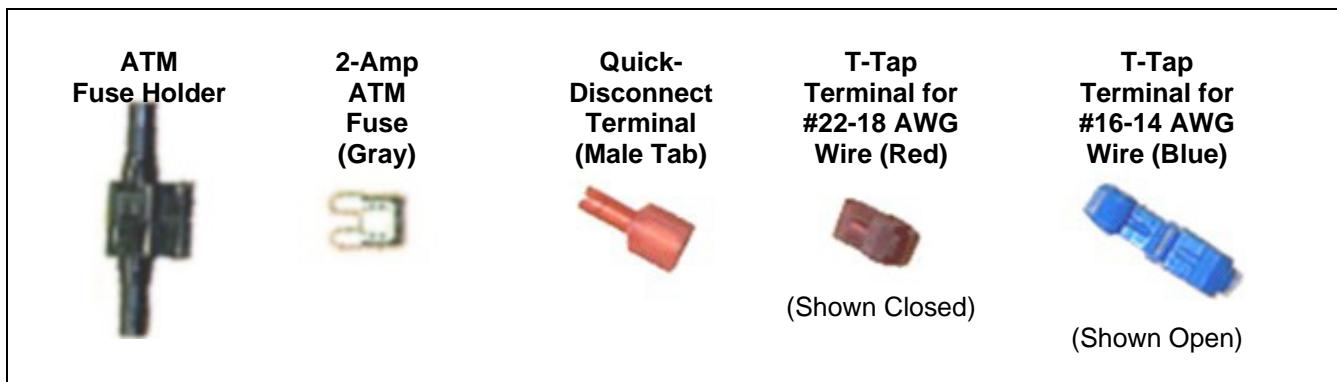
In the “hot-wired” configuration, the control head and VRMS are turned on and off only by the control head’s on/off/volume control located on the front panel of the control head. In this configuration, the control head’s white wire must be connected to **unswitched and fused 12-volt** vehicle power. Follow the procedure presented in Section 10.4.2.1, except connect the white wire to unswitched battery power instead of switched (“Accessory”) power.

#### **10.4.3 Using Vehicle Fuse and T-Tap Kit (Optional) Instead of Waterproof Inline Fuse Holder (Standard)**

The waterproof inline fuse holder and AGC fuse included with the DC Power Cable **must** be used if the white wire connection point is located in a harsh environment such as in the vehicle’s engine compartment. In this case, disregard all information presented in this section, and follow one of the three procedures presented in Section 10.4.2 to connect the white wire.

However, if the connection point is not in a harsh environment, such as under the vehicle’s dash panel, Vehicle Fuse and T-Tap Kit FS24473 may be ordered and used to make the white wire connection. As shown in Figure 10-6, this kit includes an ATM fuse holder and fuse, T-tap crimp terminals for tapping into an existing vehicle switched power wire, and a quick-disconnect terminal. The following installation procedure is recommended for this optional kit:

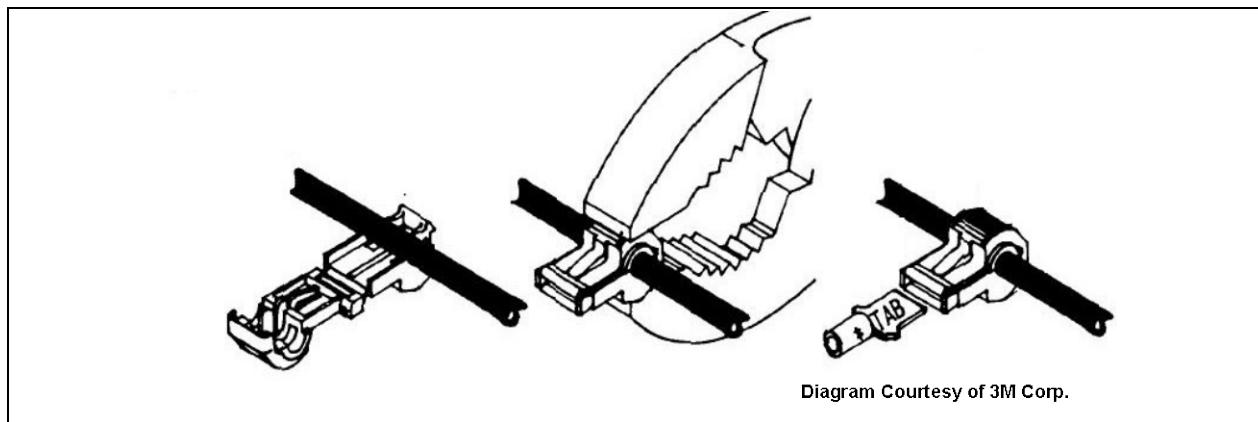
1. Locate the switched ignition or “Accessory” power wire (typically at or near the vehicle’s fuse block or in a vehicle wiring harness) that will be used for the switched ignition power source. It may be necessary to consult the vehicle manufacturer’s wiring diagram.
2. Route the white wire of the control head’s DC Power Cable from the back of the head to an area near the switched ignition power source. At the back of the head, be sure to maintain a cable service length of at least six (6) inches and do not loop the cable.
3. Cut a short section (6 to 8 inches) off the end of the white wire and strip each end of this short wire.



**Figure 10-6: Contents of Vehicle Fuse and T-Tap Kit FS24473**

4. From the Vehicle Fuse and T-Tap Kit, locate the male-tab quick-disconnect terminal and crimp it to one end of the short wire.

5. From the same kit, locate the ATM fuse holder and crimp it to the other end of the short wire. The holder has built-in crimpable joints.
6. Cut the excess length from the white wire of the control head's power cable, strip it, and crimp it to the other side of the ATM fuse holder.
7. Pull enough of the switched ignition source wire out of the vehicle's wiring harness so one of the T-tap terminals may be attached to it.
8. Two T-tap terminals are included in the kit. Based on the gauge of wire, select the proper terminal size: Red is for use with a 22 to 18-AWG wire, and blue is for use with an 18 to 14-AWG wire.
9. Attach the selected T-tap terminal by fitting the wire into its wire groove and snapping the two halves together with a pair of pliers as shown in Figure 10-7.
10. Push the male-tab quick-disconnect terminal into the T-tap terminal's inlet until it is fully engaged.
11. Install the 2-amp ATM fuse into the fuse holder. It is recommended that a piece of electrical tape be wrapped around the fuse connection to keep the fuse from being jostled out of the holder.
12. Tie and stow these wires as necessary so they remain out of the way of casual contact and wire chafe is avoided.



**Figure 10-7: Attaching T-Tap Terminals to a Switched Power Wire**

## 11 SPEAKER INSTALLATION

Select a location for the speaker that will allow for proper listening range with a moderate volume setting. Total speaker cable length (of both cables) is approximately five (5) feet. Therefore, to include service loops in the cables, the speaker must be mounted within approximately 4.5 feet of the control head.

1. Install the speaker (Item 12 in Table 4-4) using the hardware and mounting bracket supplied with it. Also refer to the instructions included in the speaker for additional mechanical installation information.
2. Route the speaker's cable to the rear of the control head.
3. Mate the Speaker Cable (Item 13 in Table 4-4) to the 2-pin connector at the rear of the control head by visually aligning the  $\frac{3}{4}$ -moon-shaped keys of the connectors, and then pushing and turning the outer locking ring of the cable connector clockwise until it stops. A mild click will be sensed to confirm proper mating.
4. Connect the speaker's 2-pin plastic connector to the respective mating connector on the Speaker Cable.
5. Route the cables out of the way of casual contact, and tie and stow as necessary.

## 12 MICROPHONE ATTACHMENT

There are several versions of microphones available for use with the CH-721 control head. Each has a 17-pin flush-mount type connector that mates with the microphone ("mic") connector on the front panel of the control head. The mic's connector includes a captive thumbscrew that secures it to the mic connector on the front panel of the control head. A microphone clip is included with each microphone. The radio can be configured to provide a monitor function when the microphone is cradled in the clip. Connect the mic to the control head and install the clip as follows:

1. Grasp the mic's connector with a thumb and index finger on the sides of the connector just adjacent to the thumbscrew.
2. Position connector just in front of the control head's mic connector so its male pins can engage straight into the female (socket) pins of the control head's mic connector. The thumbscrew must be oriented directly below the hanging mic cable.
3. Mate the two connectors by pressing them fully together. Do not apply any force to the thumbscrew when mating the connectors.
4. Tighten the thumbscrew finger-tight. Do not use a screwdriver to tighten it.
5. Using the microphone clip as a template, drill mounting holes in the surface of the selected location.
6. Select a mounting surface location that has clearance for the mic when it is clipped to the clip, and then attach the microphone clip to the surface. Use self-locking hardware (i.e., machine screws with washers and locking nuts), self-drilling screws, or other appropriate hardware as necessary. Tighten securely. Microphones used with the CH-721 control head have integrated hookswitches. Therefore, the microphone clip does not need to be grounded.
7. Clip the microphone to the clip.

## 13 OPTIONAL CABLES

### 13.1 SERIAL PROGRAMMING CABLE CA-013671-020

Serial Programming Cable CA-013671-020 (20 feet long) can be used to program and configure the VRMS and VRBS via a Personal Computer. This cable can also be used to extend the length of GPS NMEA-formatted serial data connections. The cable's assembly and wiring diagrams are shown in Figure 13-1 below.

To program and configure the VRMS, the cable's male DB-9 connector (J1) mates to the female DB-9 serial port connector on the rear of the VRMS. To program and configure the VRBS, the cable's male DB-9 connector (J1) mates to the female DB-9 serial port connector of Interface Cable CA-012349-003. Alternately, if the cable is being used to carry GPS NMEA-formatted serial data from the VRMS, its male DB-9 connector mates to connector P5 of Interface Cable CA-012349-003.

The cable's female DB-9 connector (J2) mates to a PC's male DB-9 serial port connector. If the utilized PC is not equipped with a DB-9 serial port connector, the use of a suitable adapter is required, such as USB-to-RS-232 Adapter Cable CN24741-0001. As of the publication of this manual, CN24741-0001 is available via the Customer Resource Center; refer to Section 3.6 on page 21 for contact information.

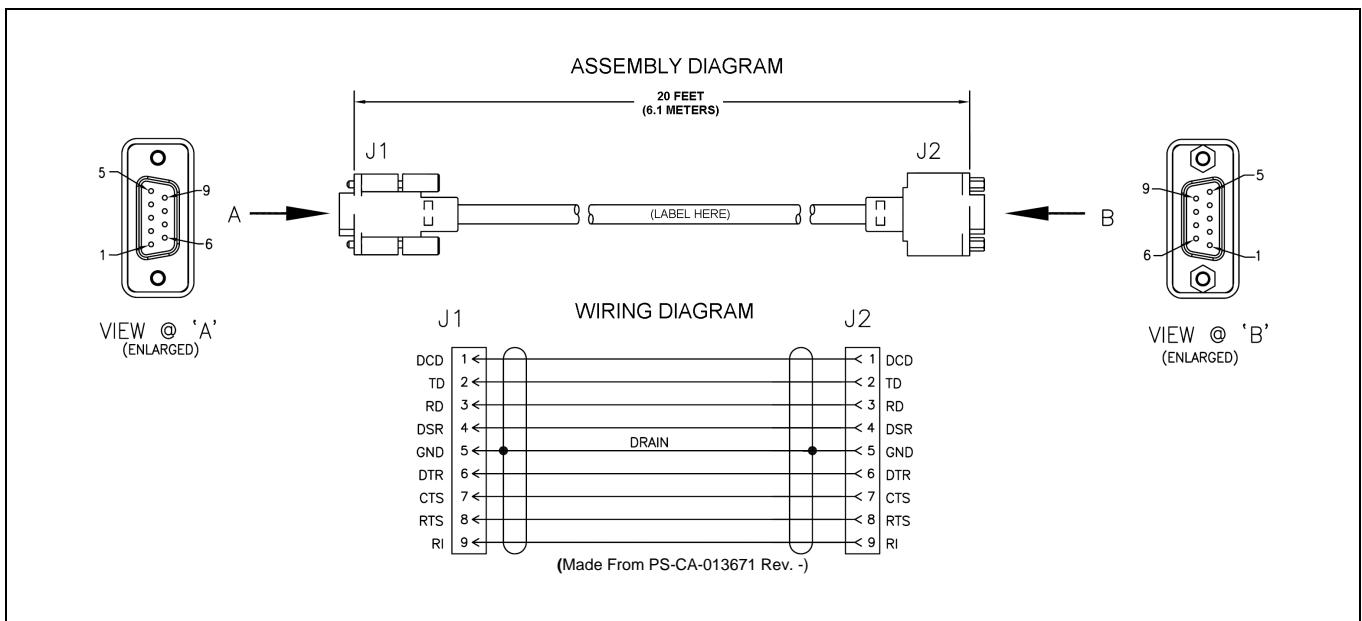


Figure 13-1: Serial Data Cable CA-013671-020

## 13.2 CH-721 OPTION CABLE CA-011854-001

CH-721 Option Cable CA-011854-001 can be used to connect optional equipment to the 25-pin D-subminiature (DB-25) connector on the rear of the CH-721. This cable expands the connections available at the 25-pin connector to three (3) separate connectors. The cable's assembly and wiring diagrams are shown in Figure 13-2 below.

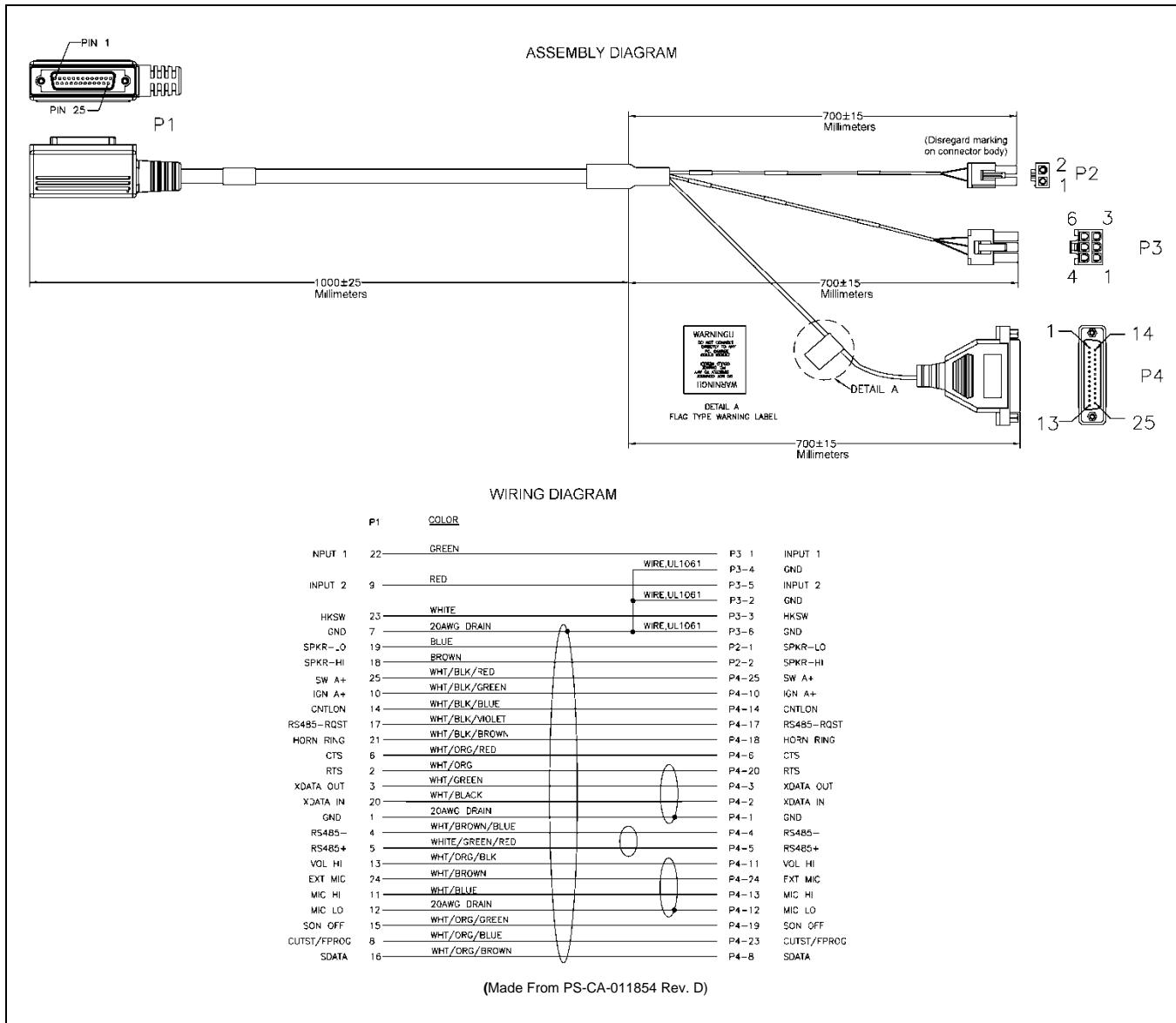
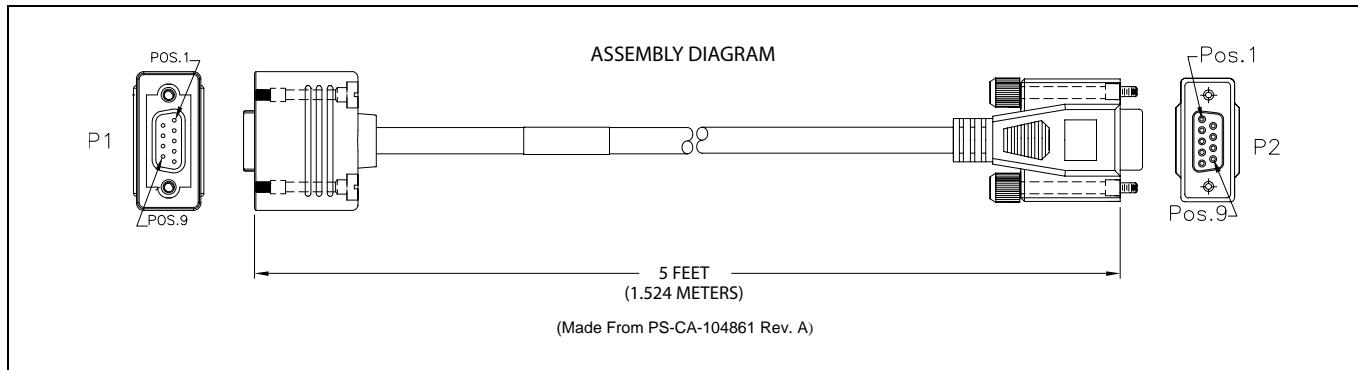


Figure 13-2: CH-721 Option Cable CA-011854-001

### 13.3 CH-721 SERIAL PROGRAMMING CABLE CA-104861

Serial Programming Cable CA-104861 (5 feet) can be used to program and configure the CH-721 control head via a Personal Computer. This cable has a female DB-9 connector on one end for connection to the PC's serial port connector and a male DB-9 connector on the other end for connection to the serial port connector on the rear of the head. The cable's assembly diagram and wiring list are shown in Figure 13-3 below.



**Figure 13-3: Programming Cable CA-104861**

## 14 GPS NMEA-FORMATTED SERIAL DATA CONNECTION

To obtain GPS NMEA-formatted serial data from the VRMS, follow this procedure to complete serial data connections:

1. Connect the DB-9 female connector labeled “GPS” of Interface Cable to the computer’s serial port DB-9 male connector—either directly or extended via a serial cable. Serial Programming Cable CA-013671-020 (20 feet) can be used to extend the length; see Section 13.1 for additional information. Tighten the screws firmly, and then route the cabling as required. If the computer is not equipped with a DB-9 serial port connector, the use of a suitable adapter is required, such as USB-to-RS-232 Adapter Cable CN24741-0001.
2. Follow the manufacturer’s instructions on processing the NMEA-formatted GPS data from the radio.



Industry software to process GPS information through this interface is not supported by Harris.

## 15 INITIAL POWER-UP TEST

1. At the main inline fuse holders located near the vehicle battery (or DC power access point), insert a **15-amp AGC fuse** into the fuse holder for VRMS main power. The fuse is included with the respective DC Power Cable (installed per Section 9.2.1.2).
2. Insert another **15-amp AGC fuse** into the fuse holder for VRBS main power. The fuse is included with the respective DC Power Cable (installed per Section 9.2.1.2).
3. If not already, insert a **5-amp AGC fuse** into the fuse holder for the CH-721 control head's main power fuse. The fuse is included with the respective DC Power Cable.
4. If not already, near the vehicle's fuse panel, install a **3-amp AGC fuse** in the respective inline fuse holder. The fuse is included with the respective DC Power Cable. However, if Vehicle Fuse and T-Tap Kit FS24473 was used to make the control head's ignition/switched power connection, install the **2-amp ATM fuse** included with the T-tap kit.
5. Tie and stow all fuse holders and wiring to prevent excess vibration/movement.
6. Carefully reconnect the vehicle's battery ground cable.
7. If not already, temporarily connect the two mobile antenna cables from the vehicle-mounted antennas to the female TNC RF connector at the rear of the two radios. These are temporary connections until test procedures in Section 16 are complete.
8. If the VRMS is equipped with the GPS receiver option, permanently connect the antenna cable from the GPS antenna (or mobile/GPS combo antenna) to the female SMA connector on the rear panel of the radio. The male SMA connector on most GPS antenna cables has a 5/16-inch hex collar, so the use of a wrench of this same size is normally required for tightening. However, some may have collars with only knurled surfaces, so a standard wrench or torque wrench cannot be used. In either case, do not over tighten the connector and do not twist the cable when tightening.
9. If the installation is wired so the vehicle's ignition key/switch turns the radio on and off, turn the switch to the Accessory or Run position.
10. If the control head is not already powered up, do so by rotating its on/off/volume control clockwise out of the detent position.
11. Verify the control head has powered-up by observing its display. If the display is not lit, refer to Section 9.1 as necessary.

As long as the software configuration parameters have been loaded, successful installation is almost immediately realized:

- After a short boot-up sequence, the control head displays login information and/or a talk group.
- If no errors are displayed, the installation is most-likely properly wired.
- If an error is displayed, recheck all cable connections, verify all fuses are properly installed, and verify battery power is getting to the radios' main power fuses. If problems persist, contact the Technical Assistance Center (see page 21).
- Consult the Operator's Manual for operational information. Refer to Section 3.5 on page 21 as necessary.

Refer to the following section for performance test information.

## 16 PERFORMANCE TESTS

This section includes procedures to verify the performance of the installation's antennas. Procedures include:

- VRMS and VRBS Testing by Transmitting into a 50-Ohm RF Load/Terminator ("Dummy Load")
- VRMS and VRBS Testing by Transmitting into the Respective Radio Antennas



The accuracy of test results depends upon a DC power source in the range of 13.6 volts DC  $\pm 10\%$ , with a current capacity of greater than 15 amps. Make sure the vehicle's battery is fully charged by running the engine for a few minutes before the test, and keep the engine running during the test procedures. **Abide by the following WARNING!**



**If the vehicle's engine must remain running, the vehicle location should be well ventilated so exhaust fumes from the engine do not cause harm!**



If a vehicle equipped with a VRS7000 requires jump-starting, the radio installation's four (4) fuses should be removed from the fuse holders prior to jump-starting. Doing so will prevent damage to the VRS7000 and CH-721.



NOTE

Prior to installation, VRMS and VRBS transmit RF output power levels should be configured appropriately. The wide range of power levels indicated in the following procedures take into account such things as: customer's requirements; measurement errors, especially to include uncalibrated equipment; cabling losses; and temperature variations. By no means should the result from Performance Testing in this section be construed as the exact value of power level outputs from the VRS7000 radio equipment, as values are set and more accurately measured in the factory. The values obtained in these test procedures determine a successful installation only.

## 16.1 REQUIRED TEST EQUIPMENT

Table 16-1: Test Equipment Required for Performance Tests

TEST EQUIPMENT	MODEL / PART NUMBER & DESCRIPTION
Peak-Reading Wattmeter	Bird Electronic Corp. Model 4314B (or equivalent) with Type N female connectors at input and output ports.
100-Watt RF Wattmeter Slug	Bird Electronic Corp. Element 100E, 100-watt, 400 - 1000 MHz (or equivalent).
5-Watt RF Wattmeter Slug	Bird Electronic Corp. Element 5E, 5-watt, 400 - 1000 MHz (or equivalent).
RF Coaxial Jumper Cable	Pasternack Enterprises PE3661-36 (or equivalent) 50-Ohm Coaxial Cable with TNC male connector and Type N male connector, approximately three (3) feet in length. The utilized cable <b>must</b> have VSWR below 1.5:1 within the RF passband.
Type N Male-to-TNC Female RF Adapter	Pasternack Enterprises PE9090 or Amphenol Connex 242130 (or equivalent) Type N male to TNC female adapter. Required to connect the cable of the vehicle-mounted antennas to the wattmeter.
Type N Female-to-TNC Male RF Adapter	Pasternack Enterprises PE9089 or Amphenol Connex 242131 (or equivalent) Type N female to TNC male adapter. Required to connect a female TNC connector to a 50-ohm RF load/terminator.
Two (2) 50-Ohm RF Loads/Terminators ("Dummy Loads")	Pasternack Enterprises PE6106 (or equivalent) 50-ohm RF terminator rated at greater than 50 watts power, with Type N male connector. Two 50-ohm RF terminators are required.
Vehicle-Mounted Antennas	Tests are performed with the vehicle-mounted antennas.

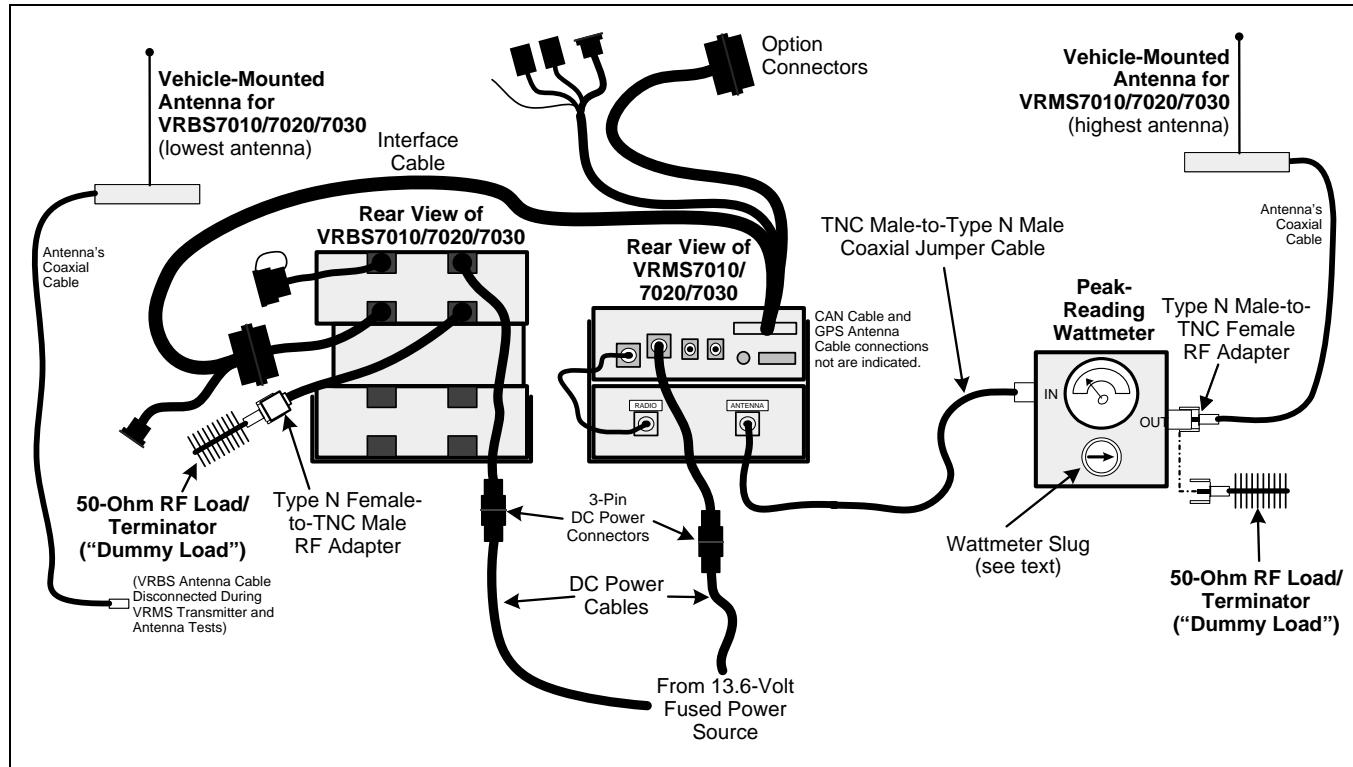
## 16.2 VRMS TRANSMITTING INTO A 50-OHM LOAD/TERMINATOR

1. At the rear of the VRMS, disconnect the antenna cable from the 800 MHz bandpass filter's antenna connector (TNC connector labeled "OUTPUT"). If it is not already, label this cable as the "VRMS Antenna" cable. This should be the cable from the highest (vehicle rooftop-mounted) antenna.
2. Using the Type N male to TNC male coaxial jumper cable, connect the antenna connector on the rear of the 800 MHz bandpass filter (connector labeled "ANTENNA") to the wattmeter's input connector. Refer to Figure 16-1 as necessary.
3. Connect a 50-ohm RF load/terminator to the wattmeter's output connector.
4. At the rear of the VRBS, disconnect the antenna cable from the VRBS. If it is not already, label this cable from the antenna as the "VRBS Antenna" cable. This should be the cable from the lowest (vehicle trunk lid-mounted) antenna.

5. Connect the other 50-ohm RF load/terminator to the VRBS. Use the Type N female to TNC male RF adapter. Refer to Figure 16-1 as necessary.
6. If not already, turn on the VRS via the CH-721's on/off volume control (or externally-mounted switch). The front panel of the CH-721 is shown in Figure 10-1 on page 56. The VRS powers-up in the mobile-only mode (vehicular repeater disabled).
7. For the VRS7010, set it to an 800 MHz test conventional channel.  
For the VRS7020, set it to a 700 MHz test conventional channel.  
For the VRS7030, set it to a VHF test conventional channel.
8. Insert the 100-watt slug into the wattmeter and position the slug to measure forward RF output power. Rotate it as necessary. The arrow on the face of the slug must point away from the VRMS antenna jack and towards the 50-ohm load/terminator for forward power measurements.



It is recommended that a test conventional RF channel be allocated for this testing. This same channel should be used during the antenna test procedure presented in the next section.



**Figure 16-1: Wattmeter Connections for VRMS7010/VRMS7020/VRMS7030 Antenna Tests**

9. Set the wattmeter to measure peak RF power.
10. Key the VRMS transmitter via the microphone's PTT button.
11. For an 800 MHz band transmission (VRMS7010), compare the wattmeter's reading with the target RF output power range of between **22.1 and 55.5 watts** (35 watts  $\pm 2$  dB). This transmit output power range assumes the VRMS7010 is currently configured for high-power transmit.

For a 700 MHz band transmission (VRMS7020), compare the wattmeter's reading with the target RF output power range of between **15.1 and 23.9 watts** (19 watts  $\pm 1$  dB). This transmit output power range assumes the VRMS7020 is currently configured for high-power transmit.

For a VHF band transmission (VRMS7030), compare the wattmeter's reading with the target RF output power range of between **39.8 and 63 watts** (50 watts  $\pm 1$  dB). This transmit output power range assumes the VRMS7030 is currently configured for high-power transmit.

**NOTE**

As stated in the **NOTE** on page 72, the wide power level range takes into account errors caused by test cable loss, etc.

**NOTE**

Transmit only for as long as needed to take the measurement, then immediately disable the transmission.

12. If the wattmeter reading is **within the range**, record the measured value in the appropriate space on the data collection form near the end of this manual (page 81).

If the wattmeter reading is **outside the range**, verify the VRS power supply voltage (i.e., battery voltage) is within the specified range, recheck all connections and measure the RF output power again. If this fails to produce a reading within the range, replace it and repeat this procedure. If problems persist, contact the Technical Assistance Center (see page 21).

13. Un-key the transmitter by releasing the microphone's PTT button.

### 16.3 VRMS TRANSMITTING INTO ITS ANTENNA

1. To verify transmit output power of the VRMS, perform the test procedure presented in the previous section (Section 16.2).
2. Disconnect the 50-ohm load/terminator from the wattmeter.
3. Connect the cable from the vehicle-mounted VRMS antenna (cable labeled "VRMS Antenna") to the wattmeter's output connector, as shown in Figure 16-1.
4. If not already, turn on the VRS via the CH-721's on/off volume control (or externally-mounted switch). The front panel of the CH-721 is shown in Figure 10-1 on page 56. The VRS powers-up in the mobile-only mode (vehicular repeater disabled).
5. Set the VRS (and thus its VRMS) to a test conventional channel. Use the same channel that was used when performing the previous procedure.

**NOTE**

It is recommended that a test conventional channel be allocated for this testing. Otherwise, interference with other radio users in the system may occur. **Also, during transmissions, always observe the RF exposure-related safety information presented in Section 1.2 of this manual (begins on page 6).**

6. Insert the 100-watt slug into the wattmeter and position the slug to measure forward RF output power. Rotate it as necessary. The arrow on the face of the slug must point away from the VRMS and towards the antenna for forward power measurements.
7. Set the wattmeter to measure peak RF power.
8. Key the transmitter via the microphone's PTT button.

9. For an 800 MHz band transmission (VRMS7010), compare the wattmeter's reading with the target RF output power range of between **22.1 and 55.5 watts** (35 watts  $\pm 2$  dB). This transmit output power range assumes the VRMS7010 is currently configured for high-power transmit.

For a 700 MHz band transmission (VRMS7020), compare the wattmeter's reading with the target RF output power range of between **15.1 and 23.9 watts** (19 watts  $\pm 1$  dB). This transmit output power range assumes the VRMS7020 is currently configured for high-power transmit.

For a VHF band transmission (VRMS7030), compare the wattmeter's reading with the target RF output power range of between **39.8 and 63 watts** (50 watts  $\pm 1$  dB). This transmit output power range assumes the VRMS7030 is currently configured for high-power transmit.



As stated in the **NOTE** on page 72, the wide power level range takes into account errors caused by test cable loss, etc.



Transmit only for as long as needed to take the measurement, then immediately disable the transmission.

10. **If the wattmeter reading is within the range**, record the value in the appropriate space on the data collection form near the end of this manual (page 81).

**If the wattmeter reading is outside the range**, verify the VRMS power supply voltage (i.e., battery voltage) is within the specified range, recheck all connections, and measure the forward power again. If this fails to produce a reading within the range, check all cabling and connections, and repeat the testing procedure to this point. In the event the wattmeter reading still falls outside the range, replace the antenna, make sure all connections are seated firmly, and repeat the testing procedure. If problems persist, contact the Technical Assistance Center (see page 21).

11. Position the wattmeter's 100-watt slug to measure reverse (reflected) RF power from the antenna. The arrow on the face of the slug must point away from the antenna and towards the VRMS to measure reverse power.

12. Key the transmitter via the microphone's PTT button.

13. Compare the wattmeter reading with the RF power output range of **2 watts or less**.



Transmit only for as long as needed to take the measurement, then immediately disable the transmission.

14. **If the wattmeter reading is within the range**, record the value in the appropriate space on the data collection form near the end of this manual (page 81).

**If the wattmeter reading is outside the range**, make sure the antenna is consistent with the specified frequency range of the VRMS. Recheck all antenna connections, and measure the reverse power again. If this fails to produce a reading within the range, replace the antenna and repeat the entire antenna test procedure. Any value exceeding the maximum allowable reflected power value will result in a diminished RF output signal. If problems persist, contact the Technical Assistance Center (see page 21).

15. Un-key the transmitter by releasing the microphone's PTT button.

16. Disconnect the coaxial cable jumper and wattmeter.

17. For the VRMS7010 and the VRMS7020, permanently connect the cable from the vehicle-mounted VRMS antenna to the bandpass filter's antenna connector (labeled "ANTENNA") by mating the two TNC connectors together. Use a pair of soft-jaw pliers to gently tighten this connection. Do not over tighten and do not twist the antenna cable.
18. Make several test calls on the radio system to verify VRMS operation. Before making the calls, select another conventional channel(s), as required to verify operation.

**NOTE**

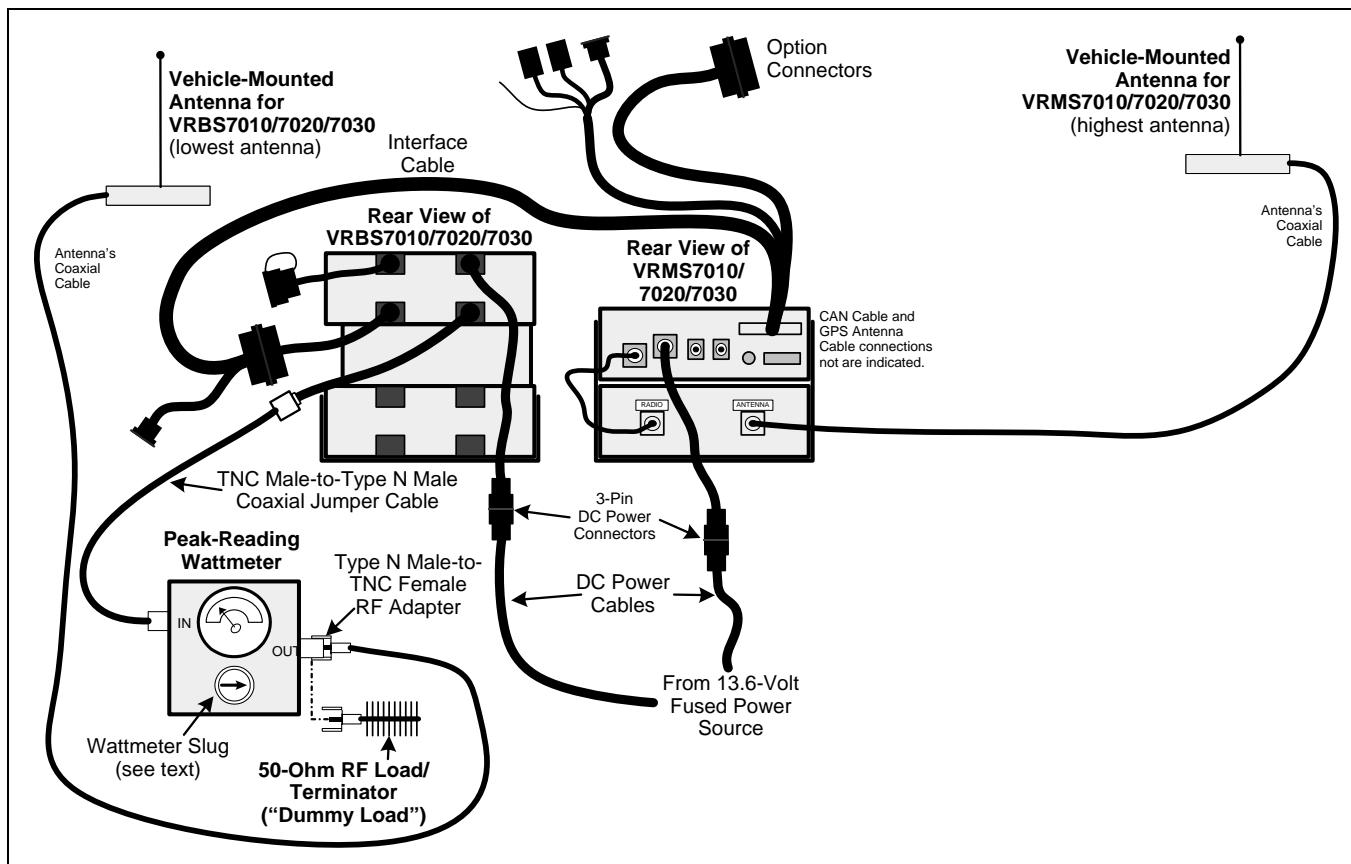
To prevent RF leakage and ensure peak performance, make sure the RF connectors are tight, but do not over-tighten so connector damage will not occur.



**Improper installation of the RF cables may lead not only to poor radio performance but also to harmful exposure to RF electromagnetic energy.**

## 16.4 VRBS TRANSMITTING INTO A 50-OHM LOAD/TERMINATOR

1. If it is not already, disconnect the VRBS antenna cable at the rear of the VRBS. Label this cable from the antenna as the "VRBS Antenna" cable. This should be the cable from the lowest (vehicle trunk lid mounted) antenna.
2. Using the Type N male to TNC male coaxial jumper cable, connect the antenna connector at the rear of the VRBS to the wattmeter's input connector. See Figure 16-2.



**Figure 16-2: Wattmeter Connections for VRBS7010/VRBS7020/VRBS7030 Antenna Tests**

3. Connect a 50-ohm RF load/terminator to the wattmeter's output connector.
4. Insert a 5-watt slug into the wattmeter and position the slug to measure forward RF output power. Rotate it as necessary. The arrow on the face of the slug must point away from the VRBS and towards the 50-ohm load/terminator for forward power measurements.
5. Set the wattmeter to measure peak RF power.
6. If not already, turn on the VRS7000 via the CH-721's on/off volume control (or externally-mounted switch). The front panel of the CH-721 is shown in Figure 10-1 on page 56. The VRS7000 powers-up in the mobile-only mode (vehicular repeater disabled). Refer to the operator's manual as necessary.
7. Switch the VRS to a P25 trunked radio network (i.e., make a "system" change if necessary) that it has access to and is within radio range. Use a test trunked system if available.
8. Enable/Activate the extended coverage (XCOV) vehicular repeater mode as follows:
  - a. Press the control head's **MENU** button.
  - b. Use the control head's **•/•• Ramp Control** to scroll through the menu until "P25 Menu" appears in the middle line of the display.
  - c. Press the **MENU** button again. After a short delay, "VR Standby" will appear in the display, indicating the VRS7000 is operating in XCOV vehicular repeater mode and waiting for (client) radios to connect to it. When one or more radios connect, the display changes to "VR Active."



NOTE

Within twelve (12) seconds of enabling the XCOV vehicular repeater mode, the VRBS should begin transmitting control channel information. For the VRBS7010, this occurs on a 700 MHz RF channel. For the VRMS7020, this occurs on an 800 MHz RF channel. For the VRMS7030, this can occur on either a 700 or an 800 MHz RF channel.

9. Compare the wattmeter's reading with the target RF output power range of between **2.4 and 3.8 watts** (3 watts  $\pm 1$  dB). This transmit output power range assumes the VRBS is currently configured for maximum transmit power. The VRBS may be configured with a lower RF output power (range =  $\frac{1}{4}$  to 3 watts) per its VRB radio configuration.
10. **If the wattmeter reading is within the range**, record the measured value in the appropriate space on the data collection form near the end of this manual (page 81).  
**If the wattmeter reading is outside the range**, verify the VRS's power supply voltage (i.e., battery voltage) is within the specified range, recheck all connections and measure the RF output power again. If this fails to produce a reading within the range, replace it and repeat this procedure. If problems persist, contact the Technical Assistance Center (see page 21).
11. At the control head, disable P25 vehicular repeater mode. The VRBS should immediately stop transmitting, as indicated by the wattmeter.

## 16.5 VRBS TRANSMITTING INTO ITS ANTENNA

1. To verify transmit output power of the VRBS, perform the test procedure presented in the previous section (Section 16.4).
2. Disconnect the 50-ohm load/terminator from the wattmeter.
3. Connect the cable from the vehicle-mounted VRBS antenna (cable labeled "VRBS Antenna") to the wattmeter's output connector. See Figure 16-2.

4. Insert a 5-watt slug into the wattmeter and position the slug to measure forward RF output power. Rotate it as necessary. The arrow on the face of the slug must point away from the VRBS and towards the 50-ohm load/terminator for forward power measurements.
5. Set the wattmeter to measure peak RF power.
6. If not already, turn on the VRS7000 via the CH-721's on/off volume control (or externally-mounted switch). The front panel of the CH-721 is shown in Figure 10-1 on page 56. The VRS7000 powers-up in the mobile-only mode (vehicular repeater disabled).
7. Enable the extended coverage (XCOV) P25 vehicular repeater mode. Refer to step 8 in the previous section (Section 16.4) as necessary. If no radios are connected to the VRS7000, "VR Standby" is indicated in the control head's display. When one or more radios connect, the display changes to "VR Active."

**NOTE**

Within twelve (12) seconds of enabling the XCOV vehicular repeater mode, the VRBS should begin transmitting control channel information. For the VRBS7010, this occurs on a 700 MHz RF channel. For the VRMS7020, this occurs on an 800 MHz RF channel. For the VRMS7030, this can occur on either a 700 or an 800 MHz RF channel.

**WARNING**

Since the VRBS automatically begins transmitting soon after enabling the vehicular repeater mode, before enabling this mode, an antenna must be connected to the VRBS and VRMS antennas and personnel should be at least the minimum safe distance from these two (2) antennas. Minimum safe distances from the VRMS antenna are listed in Table 1-1 on page 8 for the VRMS7010 and the VRMS7020. Minimum safe distances from the VRMS7030 antenna are listed in Table 1-2 (on page 10). Minimum safe distances from the VRBS7010-/VRBS7020/VRBS7030 antenna are listed in Table 1-3 (on page 10).

8. Compare the wattmeter's reading with the target RF output power range of between **2.4 and 3.8 watts** (3 watts  $\pm 1$  dB). This transmit output power range assumes the VRBS is currently configured for maximum transmit power. The VRBS may be configured with a lower RF output power (range =  $\frac{1}{4}$  to 3 watts) per its VRB radio configuration.
9. **If the wattmeter reading is within the range**, record the value in the appropriate space on the data collection form near the end of this manual (page 81).

**If the wattmeter reading is outside the range**, first verify the VRBS antenna's driven element is properly trimmed. **Before making any antenna adjustments, be sure to disable P25 vehicular repeater mode so the VRBS will stop transmitting.** Next, verify VRBS power supply voltage (i.e., battery voltage) is within the specified range, recheck all connections, and measure the forward power again. If this fails to produce a reading within the range, check all cabling and connections, and repeat the testing procedure to this point. In the event the wattmeter reading still falls outside the range, replace the antenna, make sure all connections are seated firmly, and repeat the testing procedure. If problems persist, contact the Technical Assistance Center (see page 21).

10. At the CH-721, disable the P25 vehicular repeater mode. The VRBS should immediately stop transmitting, as indicated by the wattmeter.
11. Position the wattmeter's 5-watt slug to measure reverse (reflected) RF power from the antenna. The arrow on the face of the slug must point away from the antenna and towards the VRBS to measure reverse power.

12. At the CH-721, enable P25 vehicular repeater mode. Within twelve (12) seconds, the VRBS should begin transmitting control channel information on a 700 MHz RF channel.
13. Compare the wattmeter reading with the RF power output range of **less than 1/2 watt**.
14. **If the wattmeter reading is within the range**, record the value in the appropriate space on the data collection form near the end of this manual (page 81).  
**If the wattmeter reading is outside the range**, first verify the VRBS antenna's driven element is properly trimmed. **Before making any antenna adjustments, be sure to disable P25 vehicular repeater mode so the VRBS will stop transmitting.** Verify VRBS power supply voltage (i.e., battery voltage) is within the specified range, recheck all connections, and measure the forward power again. If this fails to produce a reading within the range, check all cabling and connections, and repeat the testing procedure to this point. In the event the wattmeter reading still falls outside the range, replace the antenna, make sure all connections are seated firmly, and repeat the testing procedure. If problems persist, contact the Technical Assistance Center (see page 21).
15. At the CH-721, disable P25 vehicular repeater mode. The VRBS should immediately stop transmitting, as indicated by the wattmeter.
16. Disconnect the coaxial cable jumper and wattmeter.
17. Permanently connect the cable from the vehicle-mounted VRBS antenna to the VRBS antenna connector at the rear of the VRBS. Mate the two TNC connectors together. Use a pair of soft-jaw pliers to gently tighten this connection. Do not over tighten and do not twist the cable.
18. Re-enable extended coverage (XCOV) P25 vehicular repeater mode and make several test calls between P25 radios connected to the VRS7000.



NOTE

To prevent RF leakage and ensure peak performance, make sure the RF connectors are tight, but do not over-tighten so connector damage will not occur.



WARNING

**Improper installation of the RF cables may lead not only to poor radio performance but also to harmful exposure to RF electromagnetic energy.**

## 16.6 TEST PERFORMANCE DATA FORM

Clip  Here

Enter the information requested on this data collection form. Clip this form and file it as a permanent record of the tested performance of the installed VRS7010/VRS7020/VRS7030.

VRMS  
Serial Number

VRBS  
Serial Number

VRMS Antenna  
Make and Model Number

VRBS Antenna  
Make and Model Number

 / 

Date of Test  
(mm/dd/yyyy)

Company Performing Installation

Technician Performing Test

  
Watts  
VRMS Power Into  
50-Ohm Load  
Watts  
VRMS Forward Power  
with Antenna  
Watts  
VRMS Reflected Power  
with Antenna  
Watts  
VRBS Power Into  
50-Ohm Load  
Watts  
VRBS Forward Power  
with Antenna  
Watts  
VRBS Reflected Power  
with Antenna

## 17 COMPLETE THE INSTALLATION

Double-check the following items before considering the installation completed:

- Verify all newly installed mechanical hardware is mounted securely and all respective mounting hardware is tight.
- Verify all electrical interconnections are connected properly and the associated connector attachment hardware is tight. Pay special attention to all RF antenna cables!
- Verify all related fuses are correctly installed, properly rated, and correctly labeled.
- Verify all electrical cables and wiring are tied, stowed, and protected so they are out of the way of casual contact, away from sources of extreme heat, and wire chafing cannot occur. Pay special attention to all RF antenna cables!
- To prevent fumes from entering the vehicle's passenger compartment, seal the hole/grommet/wire combination at the firewall with a silicon-based sealer.
- Verify all vehicle components are properly reinstalled such as kick panels, headliners, and seats.
- If the installation includes a separately-mounted on/off power switch for manually turning the V-TAC mobile radio (and possibly others systems) on and off, verify it is labelled accordingly. For example: **“Radio ON/OFF.”**
- Remove all tools and unused hardware from the vehicle.
- Verify the test performance data has been recorded on the data collection form shown in this manual.
- Consult with the radio system administration personnel and placard/post required minimum antenna separation distances in plain view of all VRS7000 user/operator positions.

## 18 WARRANTY REGISTRATION

Please register this product within ten (10) days of purchase. Registration validates the warranty coverage, and enables Harris to contact you in case of any safety notifications issued for this product.

Registration can be made on-line at [www.pspc.harris.com/CustomerService](http://www.pspc.harris.com/CustomerService) or by contacting Harris Warranty Administration at the following:

### United States and Canada:

- Phone Number: 1-800-368-3277, Option 4 (toll free)
- Fax Number: 1-434-455-6821
- E-mail: [WarrantyClaims@Harris.com](mailto:WarrantyClaims@Harris.com)

### International:

- Phone Number: 1-434-455-6403
- Fax Number: 1-434-455-6676
- E-mail: [WarrantyClaims@Harris.com](mailto:WarrantyClaims@Harris.com)

## **19 WARRANTY**

- A. Harris Corporation, a Delaware Corporation, through its RF Communications Division (hereinafter "Seller") warrants to the original purchaser for use (hereinafter "Buyer") that Equipment manufactured by or for the Seller shall be free from defects in material and workmanship, and shall conform to its published specifications. With respect to all non-Seller Equipment, Seller gives no warranty, and only the warranty, if any, given by the manufacturer shall apply. Rechargeable batteries are excluded from this warranty but are warranted under a separate Rechargeable Battery Warranty (ECR-7048).
- B. Seller's obligations set forth in Paragraph C below shall apply only to failures to meet the above warranties occurring within the following periods of time from date of sale to the Buyer and are conditioned on Buyer's giving written notice to Seller within thirty (30) days of such occurrence:
  1. for fuses and non-rechargeable batteries, operable on arrival only.
  2. for parts and accessories (except as noted in B.1), ninety (90) days.
  3. for P7300, P7200, P7100<sup>IP</sup>, P5400, P5300, P5200, P5100, P3300, M7300, M7200 (including V-TAC), M7100<sup>IP</sup>, M5300 and M3300 radios, two (2) years, effective 10/01/2007.
  4. for Unity<sup>®</sup> XG-100P, three (3) years.
  5. for all other equipment of Seller's manufacture, one (1) year.
- C. If any Equipment fails to meet the foregoing warranties, Seller shall correct the failure at its option (i) by repairing any defective or damaged part or parts thereof, (ii) by making available at Seller's factory any necessary repaired or replacement parts, or (iii) by replacing the failed Equipment with equivalent new or refurbished Equipment. Any repaired or replacement part furnished hereunder shall be warranted for the remainder of the warranty period of the Equipment in which it is installed. Where such failure cannot be corrected by Seller's reasonable efforts, the parties will negotiate an equitable adjustment in price. Labor to perform warranty service will be provided at no charge during the warranty period only for the Equipment covered under Paragraph B.3 and B.4. To be eligible for no-charge labor, service must be performed at Seller's factory, by an Authorized Service Center (ASC) or other Servicer approved for these purposes either at its place of business during normal business hours, for mobile or personal equipment, or at the Buyer's location, for fixed location equipment. Service on fixed location equipment more than thirty (30) miles from the Service Center or other approved Servicer's place of business will include a charge for transportation.
- D. Seller's obligations under Paragraph C shall not apply to any Equipment, or part thereof, which (i) has been modified or otherwise altered other than pursuant to Seller's written instructions or written approval or, (ii) is normally consumed in operation or, (iii) has a normal life inherently shorter than the warranty periods specified in Paragraph B, or (iv) is not properly stored, installed, used, maintained or repaired, or, (v) has been subjected to any other kind of misuse or detrimental exposure, or has been involved in an accident.
- E. The preceding paragraphs set forth the exclusive remedies for claims based upon defects in or nonconformity of the Equipment, whether the claim is in contract, warranty, tort (including negligence), strict liability or otherwise, and however instituted. Upon the expiration of the warranty period, all such liability shall terminate. The foregoing warranties are exclusive and in lieu of all other warranties, whether oral, written, expressed, implied or statutory. NO IMPLIED OR STATUTORY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE SHALL APPLY. IN NO EVENT SHALL THE SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL, INDIRECT OR EXEMPLARY DAMAGES.

This warranty applies only within the United States.

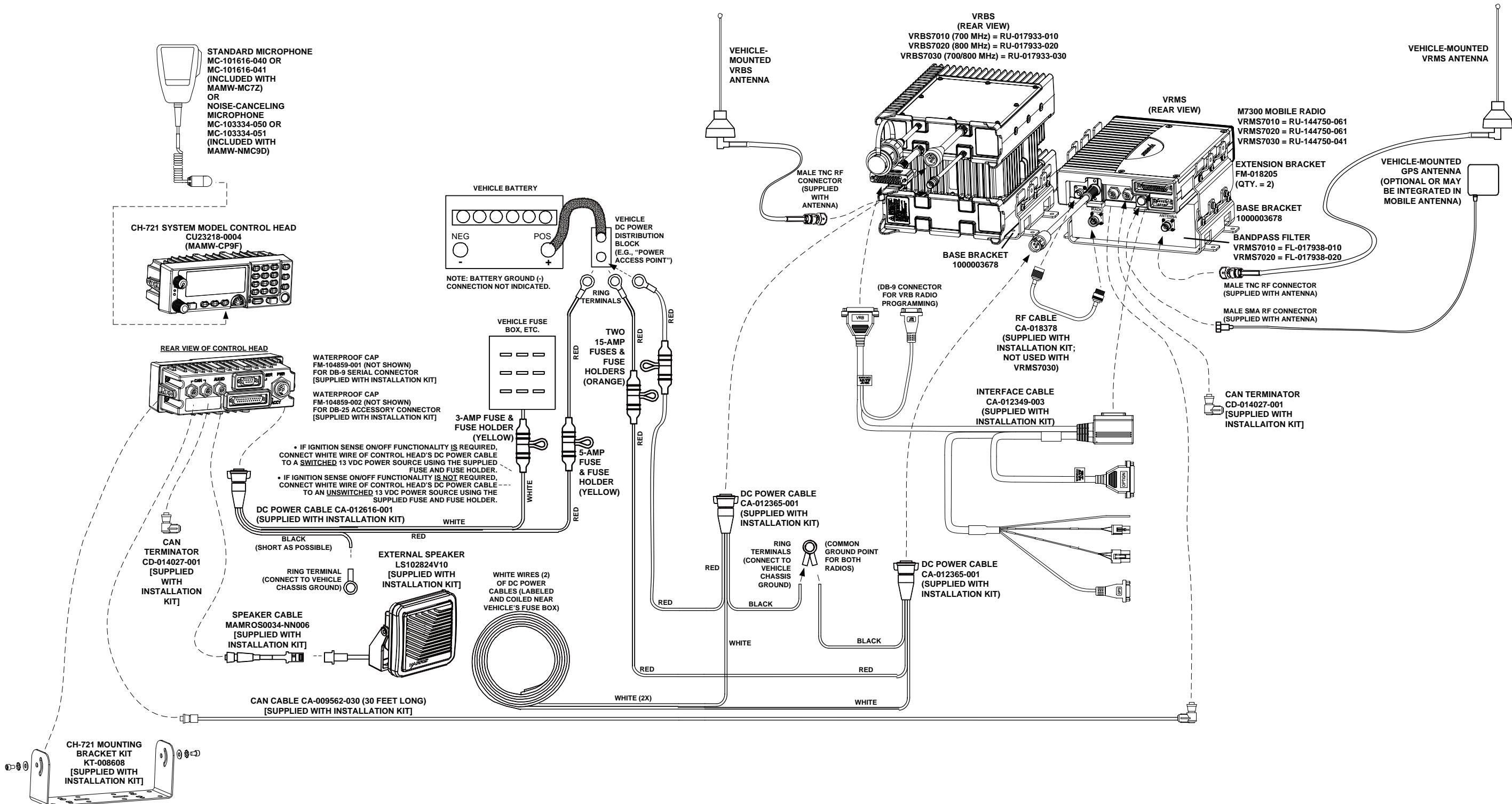
**Harris Corporation**  
RF Communications Division  
221 Jefferson Ridge Parkway  
Lynchburg, VA 24501  
1-800-528-7711

**Harris Corporation**  
RF Communications Division  
1680 University Avenue  
Rochester, NY 14610  
1-585-244-5830

ECR-7047L

*(This Page Intentionally Blank)*

## 20 WIRING DIAGRAM FOR VRS7000 AND CH-721



## **VRS7000 AND CH-721 WIRING DIAGRAM**

**Wiring Diagram Inside**



Public Safety and Professional Communications | [www.pspc.harris.com](http://www.pspc.harris.com)  
221 Jefferson Ridge Parkway | Lynchburg, VA USA 24501 | 1-800-528-7711