Installation and Product Safety Manual

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Preliminary

M/A-COM

700 and 800 MHz M7200 Mobile Radio

Trunk-Mount Full-Duplex
Dual-Band Mobile Radio
with CH-721 Scan and System Control Heads

MANUAL REVISION HISTORY

REV.	DATE	REASON FOR CHANGE
–	Sep/06	Initial release.
A	Dec/06	Updated regulatory and safety information, specifications, wiring information for control head's white wire, and wiring diagram.
B	Aug/07	Added antenna AN-025167-015 and updated MPE information accordingly. Revised specifications, contents of radio's and control head's installation kits, and option cables' wiring tables.

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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, installation, 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. M/A-COM, Inc. assumes no liability for the customer's failure to comply with these standards.

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.

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.

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 and operational instructions to ensure compliance with RF exposure guidelines.

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.

Changes or modifications not expressly approved by M/A-COM, Inc. 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. 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 is marketed in the United States, the M7200 two-way mobile radio is 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 M7200 two-way mobile radio 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), and it 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 a standby mode.

The M7200 mobile two-way radio 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) C95.1-1992.
- Institute of Electrical and Electronic Engineers (IEEE) C95.1-1999.

Table 1-1 lists 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) at rated radio power for mobile radios installed in a vehicle. Transmit only when unaware bystanders are at least the uncontrolled recommended minimum safe lateral distance away from the transmitting antenna.

Table 1-1: Recommended Minimum Safe Lateral Distance from Transmitting Antenna

ANTENNA PART NUMBER (CATALOG NUMBER)	ANTENNA DESCRIPTION	RECOMMENDED MINIMUM LATERAL HUMAN BODY DISTANCE FROM TRANSMITTING ANTENNA	
		CONTROLLED ENVIRONMENT	UNCONTROLLED ENVIRONMENT
AN-025167-001 (MAMV-AN3J)	700/800 MHz Standard Rooftop-Mount; 3 dBd Gain	12.6 inches (32 centimeters)	27.6 inches (70 centimeters)
AN-025167-002 (MAMV-AN3K)	700/800 MHz Elevated-Feed Rooftop-Mount; 3 dBd Gain		
AN-025167-004 (MAMV-AN3V)	700/800 MHz GPS Combo Rooftop-Mount; 3 dBd Gain		
AN-025167-015 (MAMV-NAN5V)	700/800 MHz GPS Combo Rooftop-Mount; 5 dBd Gain	7.9 inches (20 centimeters)	26.4 inches (67 centimeters)

1.3.1 Mobile Antennas

The antenna(s) for the radio must be installed in accordance with Section 7 in this manual. Refer to Figure 7-1 on page 27 for applicable antenna part numbers. Installation guidelines presented in Section 7 are limited to metal-body motor vehicles or vehicles with appropriate ground planes.

Use only the M/A-COM 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 M/A-COM 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 17) and/or M/A-COM's Products and Services Catalog.

1.3.3 Contact Information

For additional information on RF exposure and other information, contact M/A-COM using one of the contact links listed in Section 3.3 on page 16.

1.4 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 M/A-COM 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.

1.5 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 while its motor running, be sure to turn the radio **OFF** while fueling 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. 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 **N**ational **F**ire **P**rotection **A**ssociation standard **NFPA 58**. This requires:

  - The space containing the radio equipment must be isolated by a seal 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.

1.6 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.

1.7 OPERATING RULES REGULATIONS

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

In the United States, the M7200 mobile radio 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 confine them to business. To save time, use coded messages whenever possible.
- 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.

1.8 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[1]

2.1 GENERAL

Dimensions, Mobile Radio: (Height x Width x Depth)	2.8 x 8.8 x 9.3 inches (7.1 x 22.4 x 23.6 centimeters) (Includes bracket but not space required for cables)
Dimensions, Control Head: (Height x Width x Depth)	2.4 x 6.9 x 3.9 inches (6 x 17.5 x 10 centimeters) (Does not include bracket and mounting screws)
Weight, Mobile Radio:	8.0 pounds (3.63 kilograms)
Weight, Control Head:	1.7 pounds (0.8 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:	50,000 feet (15,240 meters) maximum
DC Supply Voltage Operating Range:	+13.6 Vdc ±10% (Normal range per TIA-603)
DC Supply Current Requirements	
Receive:	1.5 amps maximum at 0.5-watt speaker audio output power (includes control head)
Transmit:	8 amps maximum, 6 amps typical at 15 watts transmit RF output power (includes control head)
Quiescent/Off Current	
Mobile Radio:	100 microamps maximum
Control Head:	100 microamps maximum

2.2 TRANSCEIVER

Frequency Ranges	
Receive	
700 MHz Narrow Bands:	764 to 767 MHz and 773 to 776 MHz
800 MHz Band:	851 to 869 MHz
Transmit	
700 MHz Narrow Bands:	794 to 797 MHz and 803 to 806 MHz
800 MHz Band:	806 to 824 MHz
Transmit Output Power	
700 MHz Channels in Half-Duplex Mode:	1.5 to 15 watts (excluding interoperability channels)
700 MHz Interoperability Channels:	300 milliwatts maximum
800 MHz Channels in Full-Duplex Mode:	1 to 10 watts (programmable range)
800 MHz Channels in Half-Duplex Mode:	1.5 to 15 watts (programmable range)
Channel Spacing:	12.5 kHz or 25 kHz (mode dependent)
Data Communications Mode:	Full-Duplex

[1] These specifications are primarily intended for the use of the installation technician. See the appropriate Specifications Sheet for the complete specifications.

Voice Communications Mode:	Half-Duplex
Oscillator Stability:	±1.5 ppm with AFC disabled; ±0.5 ppm with AFC
Receiver Sensitivity	
700 MHz OTP Mode:	-111 dBm minimum
800 MHz OTP Mode:	-111 dBm minimum
700 MHz P25 Mode (TIA-102 Method):	-116 dBm minimum, -121 dBm typical for 5% BER
800 MHz P25 Mode (TIA-102 Method):	-116 dBm minimum, -121 dBm typical for 5% BER
800 MHz OCF Mode (TIA-603 Method):	-118 dBm minimum for 12 dB SINAD
700 MHz EDACS Mode:	-118 dBm minimum, for 12 dB SINAD
800 MHz EDACS Mode:	-118 dBm minimum, for 12 dB SINAD
Receiver Intermodulation Rejection:	75 dB minimum for OCF, P25, and EDACS modes
ACPR Mask	
P25 Mode (TIA-102 Method):	67 dBc (minimum)
OCF, OTP and EDACS Modes:	FCC Mask G and H compliant for 800 MHz channels; per FCC Part 90.543 for 700 MHz channels
Audio Frequency Response:	300 to 3000 Hz (with <3% audio distortion)
Audio Output Power (Control Head):	15 watts RMS maximum into 4-ohm external speaker; 1 watt into 4-ohm headset
Voice-Coding Method:	
OTP Mode:	Advanced Multi-Band Excitation (AMBE™)
EDACS, ProVoice & P25 Phase 1 Modes:	Improved Multi-Band Excitation (IMBE™)
P25 Phase 1 Mode:	Advanced Multi-Band Excitation Plus (AMBE+™)
OpenSky Data Rate:	19.2 kbps
OpenSky Compressed Voice Relative Data Rate:	2400 bps

2.3 REGULATORY

FCC Type Acceptance:	BV8M7200
Applicable FCC Rules:	Part 15 and Part 90 (for 700 and 800 MHz)
Industry Canada Certification:	3670A-M7200
Applicable Industry Canada Rules:	RSS-119

3 INTRODUCTION

3.1 GENERAL DESCRIPTION

The M7200 mobile radio is a high-performance full-duplex dual-band digital mobile radio. It can operate on 700 MHz and 800 MHz OpenSky trunked radio networks using the OpenSky Trunking Protocol (OTP). In the future, the radio will also operate on 800 MHz Enhanced Digital Access Communications System (EDACS) trunked radio networks, and 800 MHz APCO Project 25 phase I compliant Common Air Interface (P25 CAI) trunked radio networks. Other future operating modes include talk-around communications in accordance with the APCO Project 25 phase I standard, and conventional FM repeater-based and FM talk-around voice communications in accordance with the TIA/EIA-603 conventional land-mobile radio standard. The radio is illustrated in Figure 5-2 on page 22.

The initial release of this radio only supports operations on 700 MHz and 800 MHz OpenSky trunked radio networks. Later releases of the radio will add other modes to support other trunked radio networks, and conventional FM repeater-based and FM talk-around voice communication modes.

The M7200 is designed to operate in a mobile environment, typically within a motor vehicle. It must be connected to an external transmit/receive antenna such as one mounted to the vehicle's rooftop or trunk lid. In high-power half-duplex mode, the radio's 800 MHz RF transmit output power is rated at 15 watts minimum. The power limit for 700 MHz interoperability channel operations is 300 milliwatts maximum. This power limit guarantees the 2-watt ERP (effective radiated power) limit of the 700 MHz interoperability narrowband channels is not exceeded when the radio is connected to a 6 dB gain antenna. Several different types of external-mount antennas are approved and available for use with the radio, as listed in Table 1-1 and Table 4-2.

The radio 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. It is remotely controlled by up to five (5) control heads connected to it via 3-wire Controller Area Network (CAN) cables. Between the radio and control head(s), the CAN link carries digitized microphone and speaker audio, controlling data such as button presses and radio messages, and user data such as that for a mobile data terminal connected to serial port of the radio or control head. For proper operation, the CAN link must be terminated appropriately on each end. In multiple control head installations, two or more control heads are interconnected to the mobile radio in a series (daisy-chain) fashion via CAN link cables. Up to five (5) control heads can be connected to an M7200 in a multiple control head installation.

Control heads used with the M7200 radio include the CH-721 Scan and the CH-721 System model control heads. See Figure 9-1 (page 37) through Figure 9-3. Both heads feature a large 3-line graphical vacuum-florescent 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. The CH-721 System control head also has a 12-button numeric keypad that provides Dual-Tone Multi-Frequency (DTMF) functionality and easier operator system/group selection control at the control head's front panel.

As shown in Figure 9-3 on page 38, the CH-721 Scan and System model control heads have several connectors located on the 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.

The radio 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 control head(s) connected to the radio is also powered by the same DC power source, but separately fused. When the control head is powered-up by the operator, it "wakes up" the radio by transmitting data to the radio via the CAN link.

The radio provides half-duplex voice communications, and both half- and full-duplex data communications. Voice communications are accomplished via a "push-to-talk" (PTT) type microphone and a speaker connected to the control head.

For data communications, the radio has an industry-standard 9-pin serial interface port for connecting optional data-type equipment, such as a Mobile Data Terminal (MDT), a laptop PC, a third-party display, or a key-entry device. This port works seamlessly with equipment from popular manufacturers and off-the-shelf applications. OpenSky employs User Datagram Protocol over Internet Protocol (UDP/IP) data packet transfers, providing "plug and play" connectivity for data-type devices.

700 MHz operating bands of the radio include the two 3 MHz wide repeater output bands from 764 to 767 MHz and 773 to 776 MHz, and the two 3 MHz wide repeater input bands from 794 to 797 MHz and 803 to 806 MHz. The mobile can operate only on the narrowband channels within these bands and, as previously stated, transmit output power is limited to 300 milliwatts on interoperability channels.

800 MHz operating bands of the radio include the Specialized Mobile Radio (SMR) and the National Public Safety Planning Advisory Committee (NPSPAC) radio frequency channels. This includes the 806 to 824 MHz repeater input band and the 851 to 869 MHz band used for repeater output and talk-around communications. These bands provide a total of over 830 possible channels spread over the 806 to 824 MHz mobile transmission and 851 to 869 MHz mobile reception bands.

The radio has a built-in Global Positioning System (GPS) tracking receiver. GPS provides quick and accurate unit location information to dispatchers via the radio network. The GPS receiver determines the unit's location and the radio transmits it to the radio network. The GPS antenna may be integrated into the mobile transmit/receive antenna (a "combination" antenna) or it may be separate from the mobile transmit/receive antenna.

The radio and control head exceed 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.

An M7200 radio operating on an OpenSky radio network uses Time-Division Multiple-Access (TDMA) digital modulation technology on the radio frequency link. TDMA allows multiple radio users to share a single RF channel. In addition, a single RF channel can support simultaneous digital voice and data communications.

OpenSky employs Advanced Multi-Band Excitation (AMBE™) speech/data compression technology developed by Digital Voice Systems, Inc. When operating on an OpenSky radio network, AMBE gives an M7200 the ability to provide exceptional voice quality via the limited bandwidth of the radio frequency path, even when the received radio frequency (RF) signal is weak (i.e., even in "fringe" areas). AMBE is performed by a Digital Signal Processor (DSP) integrated circuit within the radio programmed to perform an AMBE compression algorithm during mobile transmissions, and an AMBE expansion algorithm during mobile reception.

Speech compression electronic circuitry—be it AMBE or another type such as IMBE—is sometimes referred to as "vocoding" circuitry for voice coding, or simply a "vocoder" circuit.

As previously stated, future M7200 radio upgrades will also support radio operation on 800 MHz APCO Project 25 phase I compliant Common Air Interface (P25 CAI) trunked radio networks, and operation in a talk-around mode in accordance with the APCO Project 25 phase I standard. P25 radio systems utilize

Improved Multi-Band Excitation (IMBE™) speech/data compression technology, also developed by Digital Voice Systems, Inc.

This manual contains installation procedures for the M7200 mobile radio and the CH-721 control heads. The procedures cover the mounting and cabling of the equipment as well as the basic testing of the radio and control head. An interconnection wiring diagram is included at the rear of this manual.

M/A-COM recommends the buyer use only a M/A-COM 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 M/A-COM shall have no further obligation to the buyer for any damage caused to the product or to any person or personal property.

3.2 RELATED DOCUMENTS

The following documents contain additional information:

- OpenSky Quick Guide: MM-010790-001
- OpenSky Operator's Manual: MM23016 (available at *www.macom-wireless.com*)
- Maintenance Manual: MM20117

3.3 CONTACTING M/A-COM FOR 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 M/A-COM's Technical Assistance Center (TAC) using the following telephone numbers or email address:

- U.S. and Canada: 1-800-528-7711 (toll free)
- International: 1-434-385-2400
- Fax: 1-434-455-6712
- Email: tac@tycoelectronics.com

4 UNPACKING AND CHECKING THE EQUIPMENT

4.1 MATERIALS

A typical set of M7200 installation materials includes:

- **Trunk-Mount Full-Duplex 700/800 MHz Mobile Radio Unit (MRU), part number RU25011-0001** (Catalog numbers MAMV-FDLXX, MAMV-FDLXA and MAMV-FDLXE)
- **CH-721 Scan Control Head, part number CU23218-0002** (Catalog number MAMV-CP9E)
  or
  CH-721 System Control Head, part number CU23218-0004 (Catalog number MAMV-CP9F)
- **Standard Microphone, part number MC-101616-040** (Part of catalog number MAMV-MC7Z)
- **Mobile Radio Installation Kit MAMV-ZN6X**
- **Control Head Installation Kit MAMV-ZN7N** (includes external speaker)

Mobile Radio Installation Kit MAMV-ZN6X can be used to install the mobile radio, or individual components may be purchased separately as needed. Table 4-1 lists the parts included in the kit. Table 4-2 lists part numbers for radio options and accessories. Table 4-3 lists the parts included in Control Head Installation Kit MAMV-ZN7N. Table 4-4 includes optional parts available for the CH-721 Scan and System model control heads.

Table 4-1: Mobile Radio Installation Kit MAMV-ZN6X

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	1000003678	Bracket, Base
2	1	FS23057	Kit, Fuse Distribution Rail. Includes (1) Fuse Distribution Rail Assembly, (1) In-Line ATC Fuse Holder, (1) 30-Amp ATC Fuse, 20 Feet of 10-AWG Red Wire, 1 Foot of 10-AWG Black Wire, (1) Moisture-Resistant Butt Splice, and (2) 3/8-Inch Ring Terminals. (Kit contents shown in Figure 8-1 on page 32.)
3	1	MAMROS0075-N1210	Cable, DC Power: 12-AWG, 10-Foot, Straight Connector
4	1	MACDOS0010	Terminator, CAN; 3-pin
5	2	AD00006	Screws: #8-32 Pan-Head (Package of 4)
6	1	FS-011855-015	Fuse, 15-Amp ATC (Color = Blue)

Table 4-2: Additional Options and Accessories for M7200 Radios

PART/MODEL NUMBER	DESCRIPTION
MAMV-ZN7P	Kit, Accessory; Remote-Mount for Data-Only Radio. Includes (1) Base Bracket 1000003678, (1) 10-foot DC Power Cable, (2) CAN Terminators (1) Fuse Distribution Rail Kit FS23057, (1) 15-Amp ATC Fuse and (1) Vehicle Fuse Tap FS24473.
MAMROS0044	Kit, Trunk Mounting. Includes base bracket, screws.
MACDOS0010	Terminator, CAN; 3-pin
MAMROS0075-N1210	Cable, DC Power; 12-AWG, 10 Feet, Straight Connector
MAMROS0075-N1220	Cable, DC Power; 12-AWG, 20 Feet, Straight Connector
MAMROS0075-R1210	Cable, DC Power; 12-AWG, 10 Feet, Right-Angle Connector
MAMROS0075-R1220	Cable, DC Power; 12-AWG, 20 Feet, Right-Angle Connector
1000022242-0001	Cable, Full-Data I/O Option
1000022242-0002	Cable, Programming Option
AN-025167-001 (Catalog No. MAMV-AN3J)	Antenna, 700/800 MHz; 3 dBd Gain, Rooftop-Mount
AN-025167-002 (Catalog No. MAMV-AN3K)	Antenna, 700/800 MHz; 3 dBd Gain, Elevated-Feed, Rooftop-Mount
AN-025167-004 (Catalog No. MAMV-AN3V)	Antenna, Combo GPS/700/800 MHz; 3 dBd Gain, Rooftop-Mount
AN-025167-015 (Catalog No. MAMV-NAN5V)	Antenna, Combo GPS/700/800 MHz; 5 dBd Gain, Rooftop-Mount
AN-025187-001 (Catalog No. MAMV-NAN5F)	Antenna, GPS; Roof-Mount
MAMROS0055	TIA/EIA-232 Serial Computer Cable (6 feet)

Table 4-3: Control Head Installation Kit MAMV-ZN7N

ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	KT-008608	Kit, Mounting Bracket. Includes (1) U-Shaped Mounting Bracket, (2) ¼-Inch #8-32 stainless-steel screws, (2) stainless-steel flat washers and (2) stainless-steel lockwashers.
3	1	MACDOS0010	Terminator, CAN; 3-Pin
4	1	CA-009562-030	Cable, CAN; 30 feet, Right-Angle-to-Straight Connectors
5	1	MAMROS0075-N1210	Cable, DC Power; 12-AWG, 10 feet, Straight Connector
6	1	FS23058	Kit, Fuse Distribution Accessory. Includes (1) Fuse Block, (1) Protective Marker, (1) Fuse Block Jumper, (1) 5-Amp ATC Fuse. (Kit contents shown in Figure 8-2 on page 33)
7	1	FS24473	Kit, Vehicle Fuse and T-Tap. Includes (1) ATM Fuse Holder, (1) 2-Amp ATM Fuse, (2) T-Tap Disconnects and (1) ¼-Inch Crimp Tab.
8	1	LS102824V10	Speaker, External Mobile; 20-Watt (with 4.6-foot cable)
9	1	MAMROS0034-NN006	Cable, Speaker; 6-Inch, Straight Connector
10	1	FM-104859-001	Cap, Waterproof (For CH-721's DB-9 serial port connector)
11	1	FM-104859-002	Cap, Waterproof (For CH-721's DB-25 accessory connector)

Table 4-4: Additional Options and 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
MACDOS0010	Terminator, CAN; 3-Pin
MACDOS0012	Kit, Control Head Pedestal Mounting. Includes Pedestal Mount and Mounting Screws.
MACDOS0013-CN004	Kit, Speaker; 20-Watt, Straight Connector
MACDOS0013-CR004	Kit, Speaker; 20-Watt, Right-Angle Connector
MC-101616-040	Microphone, Standard with Conxall Flush-Mount Connector (Included with catalog number MAMV-MC7Z)
MC-103334-050	Microphone, Noise-Canceling with Conxall Flush-Mount Connector (Included with catalog numbers MAMV-NMC9D)
344A4678P1	Microphone Hanger. (Included with catalog numbers MAMV-MC7Z and MAMV-NMC9D)
MAMROS0075-N1210	Cable, DC Power; 12-AWG, 10-Foot, Straight Connector
MAMROS0075-N1220	Cable, DC Power; 12-AWG, 20-Foot, Straight Connector
MAMROS0075-R1210	Cable, DC Power; 12-AWG, 10-Foot, Right-Angle Connector
MAMROS0075-R1220	Cable, DC Power; 12-AWG, 20-Foot, Right-Angle Connector

4.2 MATERIAL INSPECTION

CAUTION

After removal from the carton, examine the radio, control head and other components for broken, damaged, loose or missing parts. If any are noted, contact M/A-COM's Technical Assistance Center (see page 16) immediately to discuss and arrange the return of the equipment to M/A-COM 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.

CAUTION

Mounting of the radio, 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.

5 PLANNING THE INSTALLATION

5.1 GENERAL INFORMATION

Figure 5-1 provides an example of a typical trunk-mounted M7200 mobile radio installation. Before starting, plan the installation 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 mobile radio is mounted in a location assuring the vehicle occupant's safety and out of the way of passengers and auto mechanics.

A professional radio installer should perform the installation!

5.2 TOOLS REQUIRED

The following tools are recommended to complete the installation. Where specific vendor names and model/part numbers are given, equivalent substitutes may be used:

- Non-Insulated Crimp Tool: Thomas & Betts WT-111-M
- Insulated Terminal Crimp Tool: Klein 1005
- Ratcheting Coaxial Crimp Tool: Cambridge 24-9960P
- Non-Metallic Fish Tape, 25-Foot: Klein-Lite 50156
- Two Pairs of Slip-Jaw Pliers
- Various Socket and Driver Sets
- Various Fasteners
- Phillips-Head Screwdrivers, #1 and #2
- Flat-Blade Screwdrivers, #1 and #2
- 1/8-Inch Hex Key Wrench (Allen Wrench)
- ¾-Inch Hole Saw with Depth Protection: Ripley HSK 19 or Antenex HS34
- Clutch-Type Screw Cordless Gun/Drill with Driver Bits: Makita #6096DWE
- Cordless Electric Drill with Bits
- Deburring Tool (for ¼-inch and smaller holes)
- Flush-Cut and Large Wire Cutters

A separate list of test equipment is included in Section 16.2 on page 56.

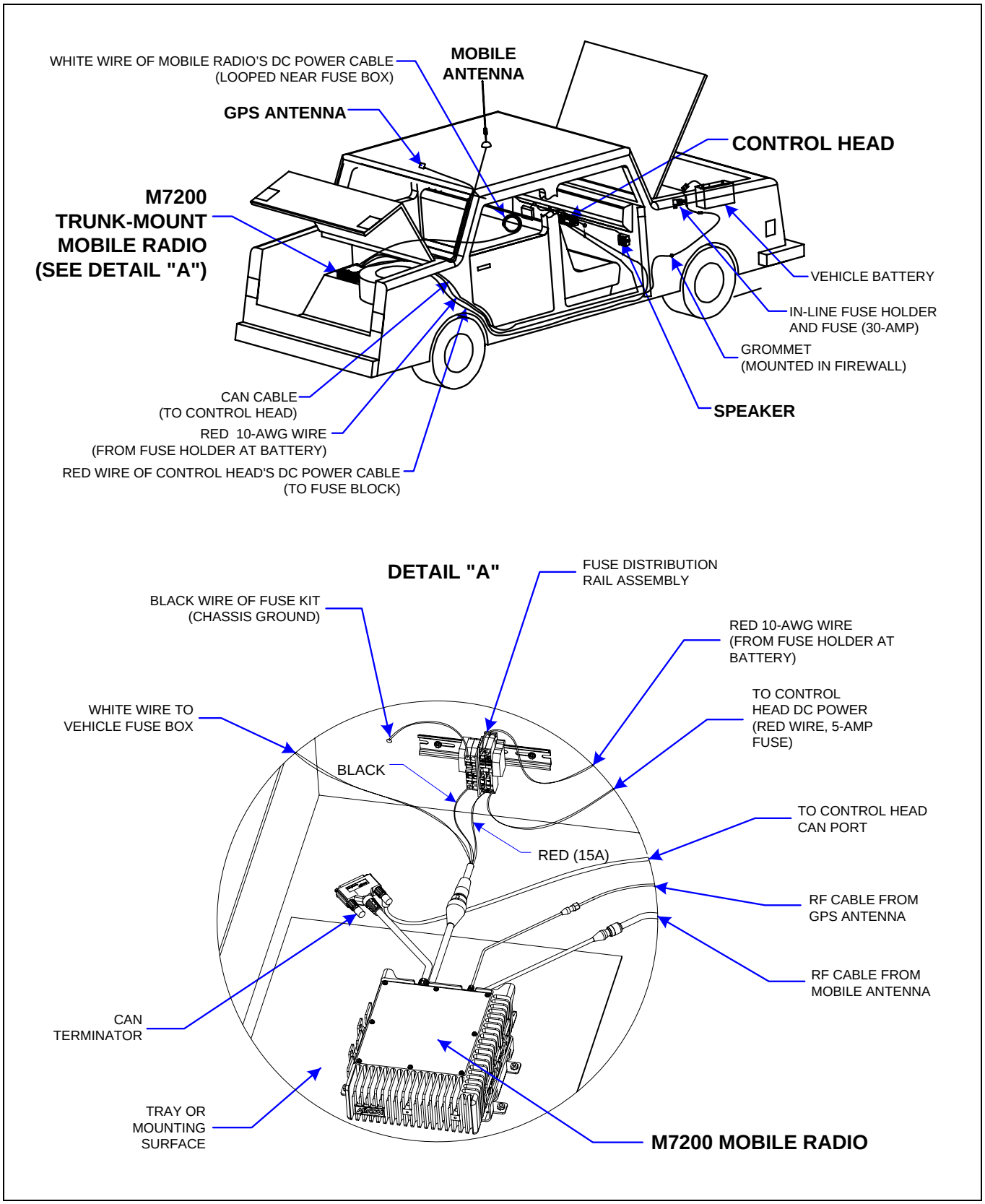


Figure 5-1: Typical Installation in a Standard Passenger Vehicle

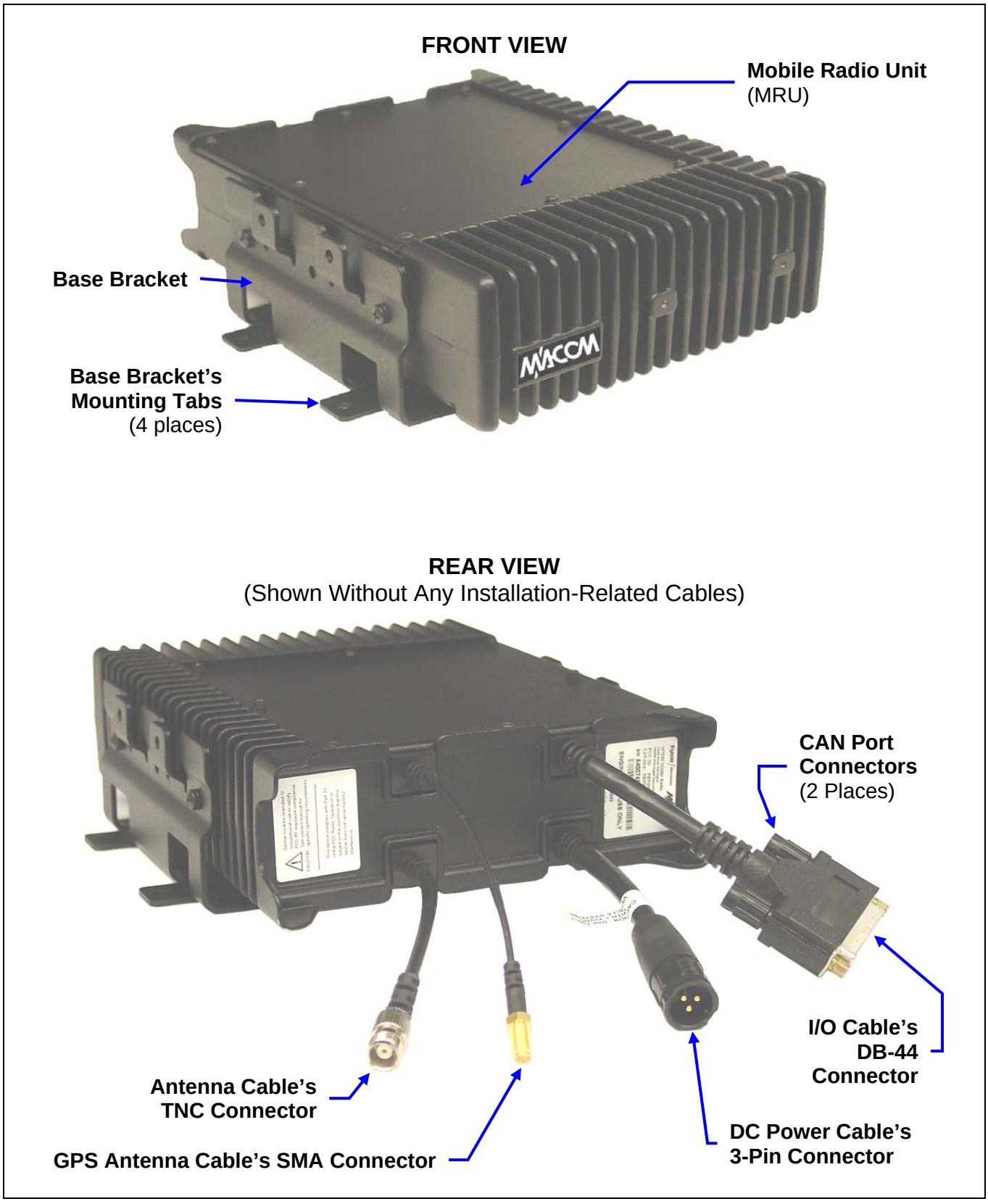


Figure 5-2: Mobile Radio Unit Front and Rear Views

5.3 LOCATING COMPONENTS

Plan the mounting locations of all components (radio, control head, antenna, 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 radio are 2.8 x 8.8 x 9.3 inches (7.1 x 22.4 x 23.6 centimeters; height x width x depth). This includes the base bracket and its mounting tabs, but it does not include any clearance space required for cabling, air circulation, access to mounting hardware, etc.
- Verify sufficient clearance behind the units 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 on the radio are made through "pigtail" type cables exiting the rear of the radio. 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 heads are made with connectors mounted on the rear panel of each head instead of "pigtail" type cables.

CAUTION

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 IN THE TRUNK

This section provides details on mounting the mobile radio in the trunk of the vehicle. See 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 9 (page 37).

As an assembled unit, the radio weighs approximately 8 pounds (3.63 kilograms). The preferred mounting of the radio is on top of a firm, flat surface.

NOTE

Mobile Radio Installation Kit MAMV-ZN6X (contents listed in Table 4-1 on page 17) contains the most complete 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.

NOTE

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

CAUTION

Though generally mounted in a trunk or remote location, the radio 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 ^{o} Fahrenheit (+60^{o} Celsius).

WARNING

At a minimum, the mounting surface should be 16-guage (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 radio 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-guage 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.

CAUTION

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 BRACKET INSTALLATION

Typically, the radio's Base Bracket (Item 1 in Table 4-1) is mounted in the vehicle's trunk, on the top surface of the trunk tray or the trunk floor. However, it 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-guage minimum).

Since the radio protrudes several inches from the bracket's front and back edges, maintain 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 the bracket. The bracket is front/back symmetrical, and left/right symmetrical.

As all installations differ, bracket-to-vehicle mounting screws are not included. Steel #10 self-threading screws are recommended. Sheet metal screws should not be used. The bracket has ten (10) available mounting holes; six (6) are underneath the radio when it is attached to the bracket. The following mounting procedure is recommended:

1. Using the Base Bracket (Item 1) as a template and/or the dimensional information shown in Figure 6-1, mark and drill mounting holes into the mounting surface as required. At least six (6) screws are recommended for proper installation: Four (4) in the screw holes of the 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.

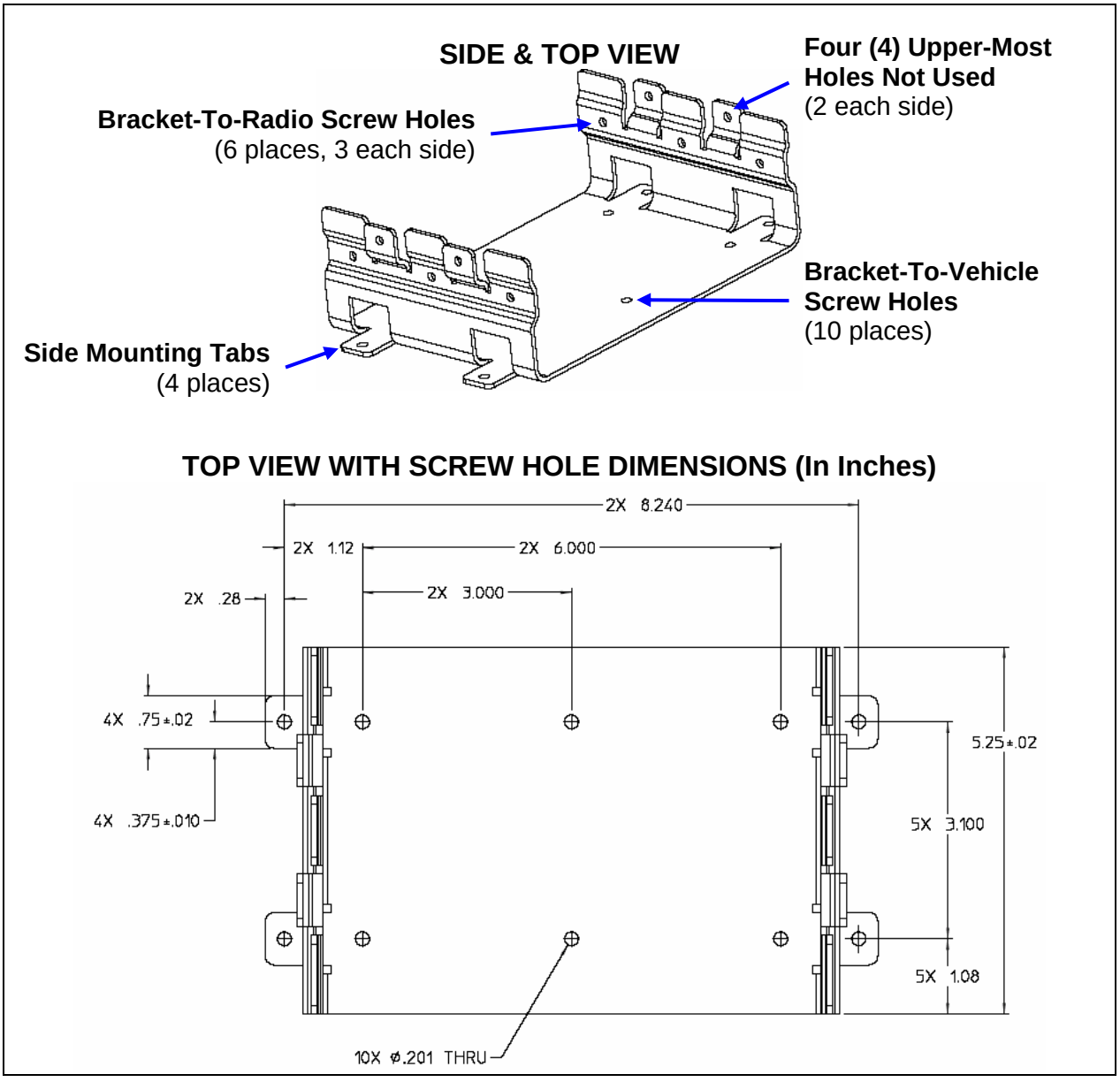


Figure 6-1: Base Bracket (Radio Not Shown)

2. Deburr all newly drilled mounting holes.
3. Set the bracket in place, and install and tighten the mounting screws.
4. Verify the bracket is 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.

6.2 MOUNT THE RADIO INTO THE BRACKET

The radio should now be mounted into the bracket according to this procedure:

1. Attach the radio into the Base Bracket using three #8-32 pan-head screws (Item 5 in Table 4-1) per side. Tighten all six screws with a screwdriver until the lock washer on the screws are fully compressed and the radio is firm and flush in between the brackets.
2. Check the mounting area for proper clearance for cable service looping and for air circulation, plus an area to secure and rest 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.

7 ANTENNA INSTALLATION

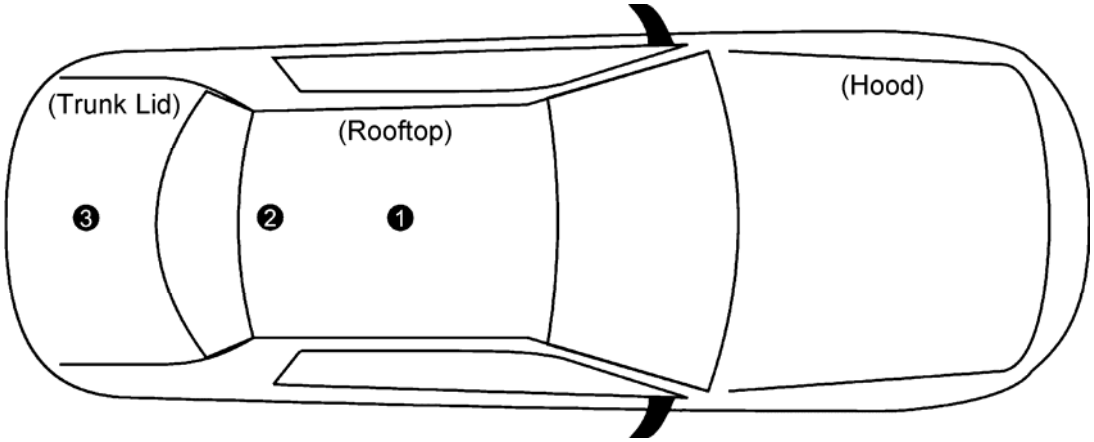
7.1 ANTENNA MOUNTING LOCATIONS

WARNING

At this time, review all information presented in the REGULATORY AND SAFETY INFORMATION section of this manual (begins on page 6). A transmitting antenna must be installed in accordance with the guidelines presented in the REGULATORY AND SAFETY INFORMATION section. Use Table 1-1 on page 8 and Figure 7-1 below as a guide for determining the best possible mounting configuration/location in order to reduce human exposure to radio frequency (RF) electromagnetic energy during transmit mode.

Antennas can be mounted in one of three (3) possible locations on the vehicle as described in the following subsections. Figure 7-1 shows the recommended locations and antenna part numbers for each location. Also, see Table 4-2 for additional information. Always follow manufacturer's instructions when mounting an antenna.

TYPICAL VEHICLE TOP VIEW



❶ Vehicle Rooftop, Direct Center
- AN-025167-001 = 700/800 MHz, 3 dBd
- AN-025167-002 = 700/800 MHz Elev. Feed
- AN-025167-004 = Combo GPS/700/800 MHz, 3 dBd
- AN-025167-015 = Combo GPS/700/800 MHz, 5 dBd
- AN-025187-001 = GPS Rx Only, Roof-Mount

❷ Vechicle Rooftop, Center-Rear
- AN-025167-001= 700/800 MHz, 3 dBd
- AN-025167-004 = Combo GPS/700/800 MHz, 3 dBd
- AN-025167-015 = Combo GPS/700/800 MHz, 5 dBd
- AN-025187-001 = GPS Rx Only, Roof-Mount

❸ Trunk Lid, Direct Center
- AN-025167-002 = 700/800 MHz Elev. Feed
- AN-025167-015 = Combo GPS/700/800 MHz, 5 dBd
- AN-025187-001 = GPS Rx Only, Roof-Mount

NOTE: See Table 4-2 for antenna catalog numbers.

Figure 7-1: Recommended Antenna Mounting Locations With Antenna Part Numbers

7.1.1 Direct Center or Center-Rear of Rooftop

The center of the vehicle's roof is the best location for the rooftop antenna (❶ in Figure 7-1). For optimal performance, the mounting area under the antenna must be a flat with a minimum radius of six (6) inches of metal ground plane. It must be located directly in the center of the roof to minimize human exposure to RF electromagnetic energy. Other obstructions such as a light bar or another antenna may prevent the antenna from being mounted in the direct center of the roof. In this case, 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 (❷ in Figure 7-1).

7.1.2 Center of Trunk Lid

Certain vehicles do not allow for the antenna to be placed in the center or center-rear of the roof. In this case, the next best location for the antenna is in the direct center of the trunk lid (❸ in Figure 7-1). In this case, an elevated-feed-point antenna is recommended. Although this type of antenna does not require a metal ground plane, it must be located directly in the center of the trunk lid to minimize human exposure to RF electromagnetic energy.

WARNING

The antenna cable of M/A-COM 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 (see Table 1-1 on page 8), 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.

7.2 ANTENNA INSTALLATION PROCEDURE

NOTE

An antenna **must** be installed before completing the radio installation.

7.2.1 Install and Connect Mobile Antenna

Table 4-2 lists several types of mobile radio antennas available for use with the radio. As presented in the previous section, various mounting locations exist. Optimal performance is achieved via a rooftop antenna mounted in the direct center of the motor vehicle's roof:

1. Once the mounting location is selected, refer to the antenna manufacturer's mounting and testing instructions included with the antenna kit for installation guidance. If necessary, contact M/A-COM's Technical Assistance Center (see page 16 for contact information).
2. Route the cable from the antenna to the rear of the radio. The cable should be kept out of casual contact from persons within the vehicle. Tie and stow as necessary.
3. Connect the antenna cable's TNC plug-type (male) connector to the radio's TNC receptacle-type (female) RF connector. Mate the two connectors until finger-tight.

This will be a temporary connection until the radio and antenna can be tested after the installation is complete. The antenna needs to be connected in case of accidental RF transmission.

7.2.2 Install and Connect GPS Antenna

The radio is equipped with a GPS receiver which 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.

The SMR/GPS combo antenna kit includes a GPS antenna built into the base of the mobile 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.

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 M/A-COM's Technical Assistance Center (see page 16 for contact information).
2. Route the cable from the GPS antenna to the rear of the radio. The cable should 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 RF connector. Mate the two connectors and turn the plug clockwise. Tighten using two 5/16-inch wrenches. Do not overtighten.

Do not attempt to alter the length of cable from the GPS antenna. Tie and stow excess cable as necessary.

8 RADIO DC POWER INSTALLATION

Refer to the wiring diagram at the end of this manual as necessary when performing wiring procedures presented in this section. With regards to control head installation, power connections for the CH-721 Scan and CH-721 System control heads are exactly the same.

8.1 ON/OFF POWER WIRING CONFIGURATIONS

The mobile radio can be wired in a motor vehicle in various ways to accommodate the user's preferences. In all cases, its red power wire must be connected through an in-line fuse to raw battery power (positive battery terminal). The white ignition wire of the radio's DC Power Cable is only used for the data-only radio (i.e., no control head), and it is the only means for turning its power on. An in-line switch for switched battery power to the radio must not be considered unless the user has the discipline to turn off the radio through the control head's on/off/volume control or through a separate switch wired to the ignition sense wire. Failure to wait for the radio to completely power down before disconnecting battery power will not damage the radio; however, it may result in the loss of settings that have changed (e.g., volume setting, etc.) during the operating session.

On/Off power functions for the radio are controlled by the control head or, in the case of a Data-Only radio, within the radio itself. The following power wiring configurations are supported:

- **Radio turns on/off automatically with vehicle's ignition switch/key** — The white sense wire of the control head's (or data-only radio's) DC Power Cable is connected to a fused switched power source, typically identified as "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 2 amperes. An ATM fuse holder and fuse are included with the applicable fuse kit. 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 a manual switch** — The white sense wire of the control head's (or data-only radio's) DC Power Cable is connected to one side of a manual toggle switch and the other side of this switch is connected to a fused vehicle power source. 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 required fuse rating is 2 amperes if no other devices share the switch. If other devices share the switch, the 2-ampere ATM fuse must be spliced in the white wire on the load/switched power side of the switch. 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 power on/off 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. In this case, the white sense wire of the control head's DC Power Cable must be connected to unswitched and fused vehicle power. The required fuse rating is 2 amperes.

8.2 POWER INSTALLATION PROCEDURE

8.2.1 Install Main Fuse Holder and 10-AWG Red Wire

The main power fuse, its holder, and related items are included in Fuse Distribution Rail Kit FS23057 illustrated in Figure 8-1 on page 32. Follow the procedure in this section to wire fused main power from

the vehicle's battery to the location of the radio and the Fuse Distribution Rail Assembly in the vehicle's trunk. The Fuse Distribution Rail Assembly is installed during the subsequent procedure (Section 8.2.2). Also refer to the respective wiring diagram at the end of this manual as necessary.

Do **not** install the fuse holder and the red wire over or in the near vicinity of the engine. Excessive engine heat can cause permanent damage to these components and can lead to intermittent electrical connection to the battery.

Before making connections to the battery's positive post, carefully disconnect the battery's negative (ground) cable. This will prevent tools or other metallic objects which come in contact with the battery's positive terminal from shorting to vehicle chassis ground, causing sparks or even a fire or an explosion! When disconnecting the negative cable, cover/insulate the positive post if it is not already so a tool cannot short between the posts.

A fuse must not be installed in the main fuse holder until all wiring is complete. This will prevent the unit from powering up prematurely and/or causing an in-rush of current that could lead to shorting of the battery, sparks, or even fire.

1. Strip one of the ATC Fuse Holder's wires and crimp a 3/8-inch ring terminal to it. Both items are included in the Fuse Distribution Rail Kit.
2. **Verify the fuse is NOT in the Fuse Holder.**
3. Connect the ring terminal directly to the battery's positive post (or if present, to a stud on the battery's main/non-switched power distribution terminal block).
4. Strip the Fuse Holder's other wire, strip one end of the 20-foot long 10-AWG red wire, and then connect these two wires together using a 10-AWG moisture-resistant butt splice. The red wire and the butt splice for this connection is included in the Fuse Distribution Rail Kit.

Plan the routing of the 10-AWG red wire 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 wire 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.**

5. Route the other (load) end of the 20-foot long red wire through a wire-loom then through the grommet in the firewall. This load end of the red wire will later be connected to a Fuse Block clipped on the Fuse Distribution Rail Assembly (both parts of the Fuse Distribution Rail Kit). The Fuse Distribution Rail Assembly will be located near the radio in the trunk.
6. Continue routing the 20-foot red wire through channels in the vehicle to the location of the radio. Remove interior panels, door kick panels, etc. Protect the wire from possible chafing where necessary.

8.2.2 Assemble and Install Fuse Distribution Rail Assembly

The Fuse Distribution Rail Assembly must be completely assembled and installed in the vicinity near the mobile radio. This rail assembly, included in Fuse Distribution Rail Kit FS23057, comes preassembled with only one (1) Fuse Block on the rail. However, the installation requires two blocks—one to fuse the

radio and one to fuse the control head. Therefore, the assembly must be partially disassembled so the Fuse Block and the Fuse Block Jumper from kit FS23058 can be added to the rail assembly. As shown in Figure 8-1 and Figure 8-2, one Fuse Block is included in kit FS23057 (preassembled to the rail) and one is included in kit FS23058. The completed assembly is shown in the photo on page 36.

Note: This kit is a part of Mobile Radio Installation Kit MAMV-ZN6X.
See Table 4-1 on page 17 for descriptions of the kit's contents (item 2 in the table).

Figure 8-1: Contents of Fuse Distribution Rail Kit FS23057

Note: This kit is a part of Control Head Installation Kit MAMV-ZN7N.
See Table 4-3 on page 18 for descriptions of the kit's contents (item 6 in the table).

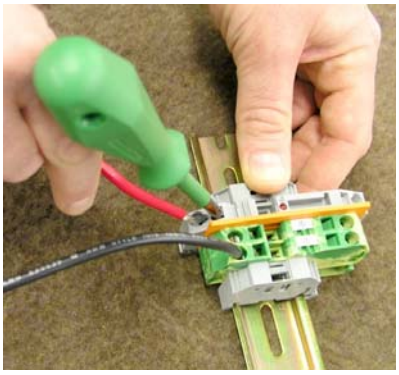
Figure 8-2: Contents of Fuse Distribution Accessory Kit FS23058

The Fuse Distribution Rail Assembly has a DIN-type rail allowing additional Fuse Blocks to be added to it if fuse expansion is necessary in the future, such as for multiple control head installations. The rail may be cut to decrease its length if necessary, but enough room for at least one control head and any additional future expansion should be considered first. Install the rail in accordance with the following procedure:

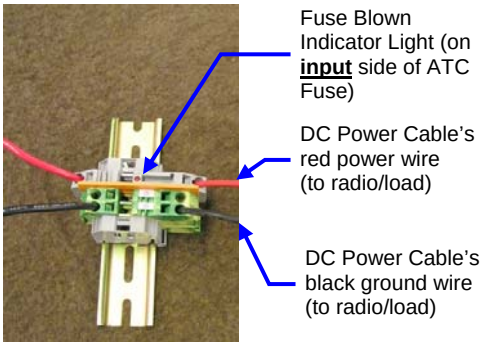
1. Mount the Fuse Distribution Rail Assembly in the vicinity of the radio's mounting location, but where casual contact is not likely. Use self-threading screws (not supplied) and any available mounting slots in the DIN rail to mount the block.
2. Strip one end of the 10-AWG black wire (included with the Fuse Distribution Rail Kit) and crimp a 3/8-inch ring terminal to it.
3. Near the Fuse Distribution Rail Assembly, locate an area of vehicle chassis ground within approximately six (6) inches of the assembly and strip the area of any paint or dirt to expose a bare metal surface.
4. Drill a hole as necessary and connect the ring terminal to chassis ground. Use a self-threading screw or other appropriate hardware to ensure a reliable metal-to-metal contact. Tighten securely.
5. Cut the black wire to a length long enough to reach a green-yellow Grounding Block on the Fuse Distribution Rail Assembly, plus length for a service loop. Strip the end to prepare it to connect to a Grounding Block.
6. The Fuse Distribution Rail Assembly has two green-yellow Grounding Blocks. Each Grounding Block has two wire-clamps with associated wire-clamp release slots. As shown in the photo at the right, insert a #1 or #2 flat-blade screwdriver completely into one of the wire-clamp release slots. Insert the screwdriver until it is captured in a vertical position as shown in the photo in the next step.

7. Insert the stripped end of the black wire fully into the wire-clamp beside the screwdriver, and then remove the screwdriver to lock the wire in the clamp. The adjacent Grounding Block is electrically connected together, so this black wire grounds both blocks.

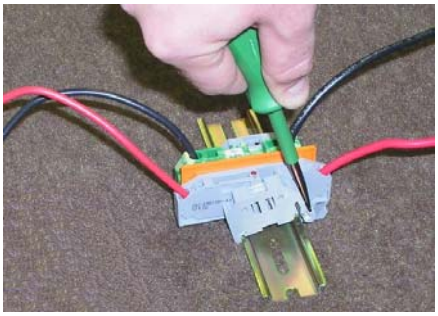
8. Prepare to connect the 10-AWG red wire from the Fuse Holder at the vehicle battery to the Fuse Block of the DIN rail assembly by cutting excess length and stripping the end. Leave enough wire length for a service loop.
9. As shown in the photo at the right, connect the 10-AWG red wire to the **Fuse Block's <u>supply-side</u> wire-clamp**.
10. Obtain the radio's DC Power Cable (Item 3 in Table 4-1).
11. Mate the cable's connector to the radio's 3-pin power connector as follows: 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.



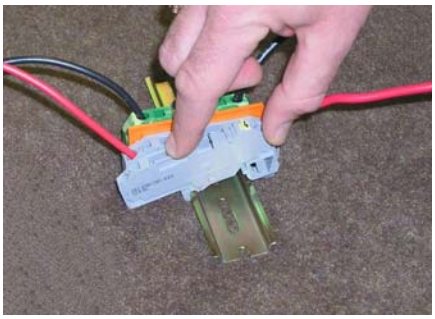
12. Prepare to connect the cable's black (negative) and red (positive) wires to a Grounding Block and to the Fuse Block by cutting excess length from both wires and stripping the ends. Leave enough wire length for service loops.
13. Connect the cable's red wire to the wire-clamp on the **Fuse Block's <u>load-side</u> wire-clamp** and connect the cable's black wire to any one of the wire-clamps on a Grounding Block.



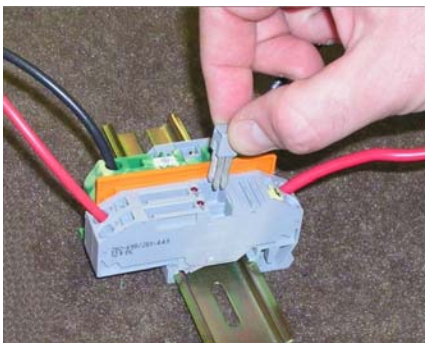
14. A second Fuse Block must be installed onto the Fuse Distribution Rail Assembly to supply power to the control head. Therefore, obtain the second Fuse Block from Fuse Distribution Accessory Kit FS23058.
15. As shown in the photo at the right, remove the End Stop next to the original Fuse Block on the DIN rail by prying at its side release with the screwdriver.



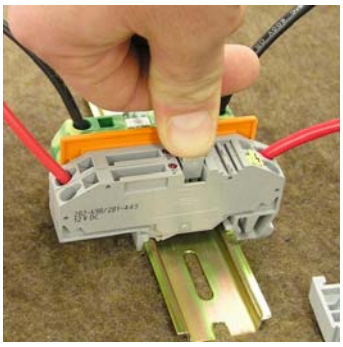
16. Hook the second Fuse Block's rail clip onto the DIN rail next to the original Fuse Block and snap it in place. When installed correctly, adjacent sides of the Fuse Blocks will snap together as well.



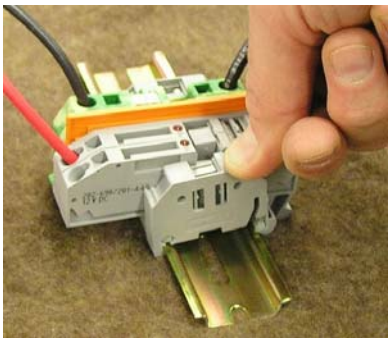
17. As shown in the photo at the right, install the Fuse Block Jumper into adjacent slots of the two Fuse Blocks. DC power distribution occurs through the jumper; therefore, daisy-chaining of the supply-side wire-clamps is not required. The Fuse Block from the Fuse Distribution Accessory Kit has a protection marker installed on the supply-side of the block to warn of inappropriate wire installation in its supply-side wire-clamp.



18. Press the Fuse Block Jumper firmly in place as shown in the photo at the right.

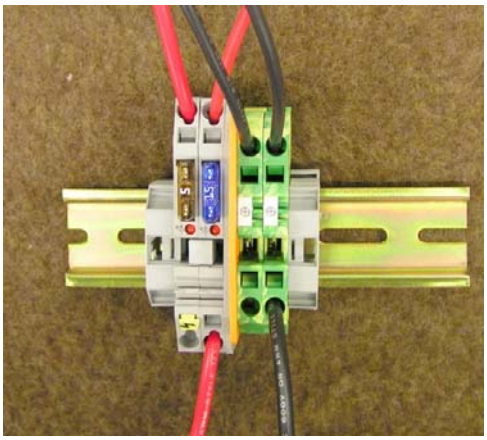


19. Reinstall the End Stop by hooking its rail clip onto the DIN rail and snapping in the other side. Make sure it is firmly against the second Fuse Block.



20. Install two ATC-type fuses into the Fuse Blocks. **The mobile radio requires a 15-amp fuse (blue) and the control head requires a 5-amp fuse (tan). Install the correct fuse into the correct Fuse Block!**
21. Tie and stow all cables and wires as necessary so they remain out of the way of casual contact, and so wire chafe is avoided.

The photo at the right also includes red and black wires for control head power. These wires are connected during a later procedure in this manual.



22. Apply the sticker included in the Fuse Distribution Rail Kit in the vicinity of the Fuse Block as future reference for service personnel.
23. Route the DC Power Cable's white wire to the vehicle's fuse box and label it accordingly. Tie and stow the wire as necessary so it remains out of the way of casual contact and wire chafe is avoided.

NOTE

The control head wakes up the radio via the CAN port when power is applied. However, connection of the white sense wire may be needed in future configurations that do not use the control head (e.g., Data-Only applications). Therefore, it is recommended that the white wire be labeled, routed up to the vehicle's fuse box, coiled, and stowed for possible future use rather than be cut from the DC Power Cable.

CAUTION

Installing a fuse with the wrong amperage rating could cause an unsafe condition and/or a prematurely blown fuse. Verify the correct fuse value for the radio is installed. The color of the 15-amp fuse is blue.

CAUTION

The fuse for the control head is rated at 5 amperes. Installing the wrong fuse value could lead to damage. Verify the control head is wired to the 5-amp (tan color) ATC fuse! The 15-amp (blue color) ATC fuse must **not** be used for control head power; it can be returned to stock or stored as a spare for the radio.

CAUTION

When servicing the radio and/or control head, always manually turn all units off and then pull the main power fuse in the engine compartment.

9 CONTROL HEAD INSTALLATION

9.1 GENERAL INFORMATION

Since the M7200 is a remote-mount mobile radio, each radio must be connected to a control head to provide the operator-to-radio interface. Two different control heads are available—the CH-721 Scan model and the CH-721 System model. See Figure 9-1 and Figure 9-2 respectively. The CH-721 Scan model control head features three (3) large menu selection buttons. The System model control head has a 12-button keypad to allow advanced operations without the need of a DTMF-capable microphone.

Figure 9-3 on page 38 illustrates the rear panel of the two control head models. Both models have identical rear panels and rear panel connectors.

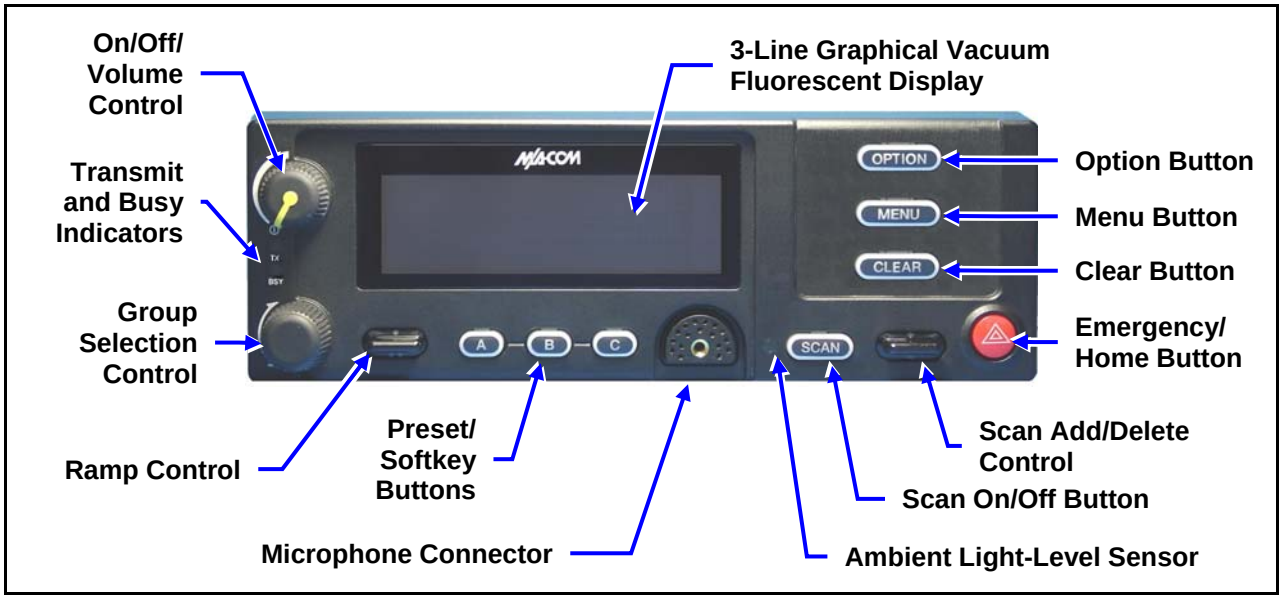


Figure 9-1: CH-721 Scan Model Control Head Front Panel

Figure 9-2: CH-721 System Model Control Head Front Panel

The CH-721 control heads feature a large easy-to-read 3-line graphical vacuum fluorescent display, an on/off/volume control knob, menu controls and buttons, trunking mode buttons, an emergency/home button, a scan on/off/volume control, and three (3) preset buttons. Other front panel components include a microphone connector and LED-type indictors. 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.

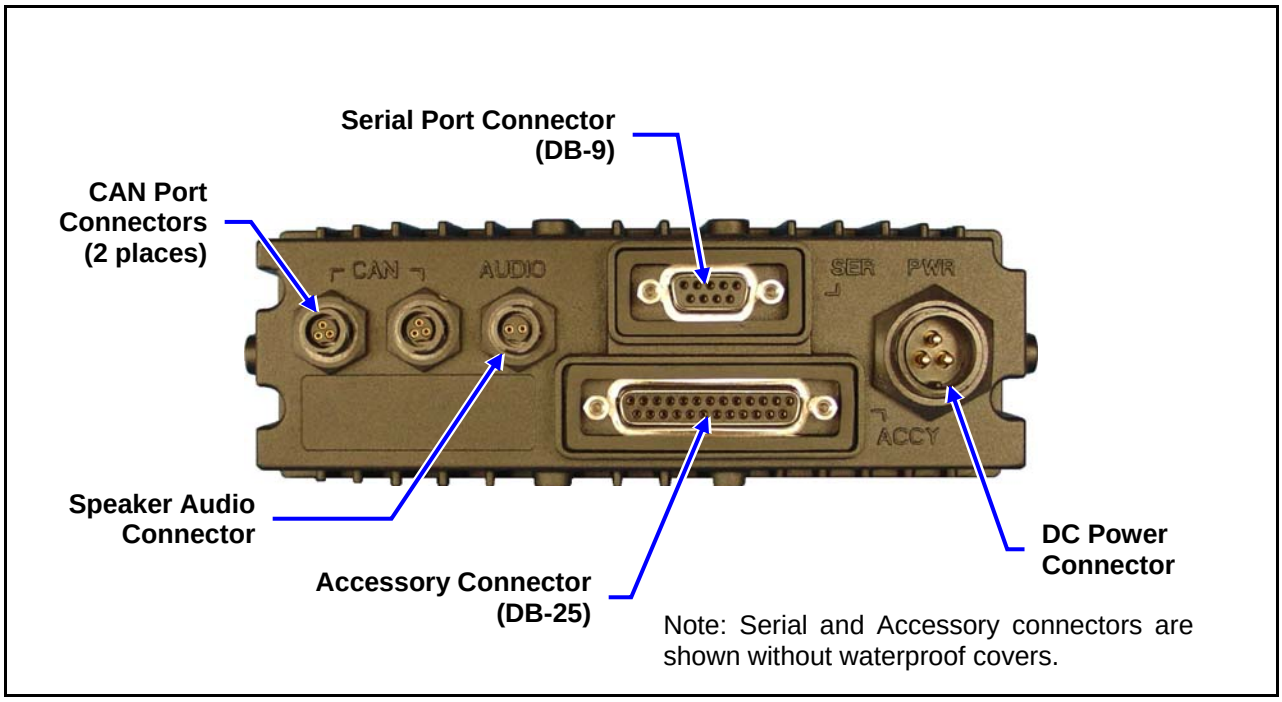


Figure 9-3: CH-721 Rear Panel (both control head models)

NOTE

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

NOTE

Because the Control Head Installation Kit MAMV-ZN7N contains the most complete set of materials for installing the control head, the following instructions make repeated reference to this kit. Item numbers given in parenthesis below refer to items in the kit. See Table 4-3 on page 18 for a complete listing of kit contents.

In a mobile installation, more than one control head can be connected to one mobile radio for multi-head installations. A multi-head installation may be required in a vehicle such as a fire truck or any large vehicle where more than one operator may require use of the radio. Multi-head installations also provide other benefits such as intercom functionality.

9.2 CONTROL HEAD MECHANICAL INSTALLATION

9.2.1 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 20. 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.

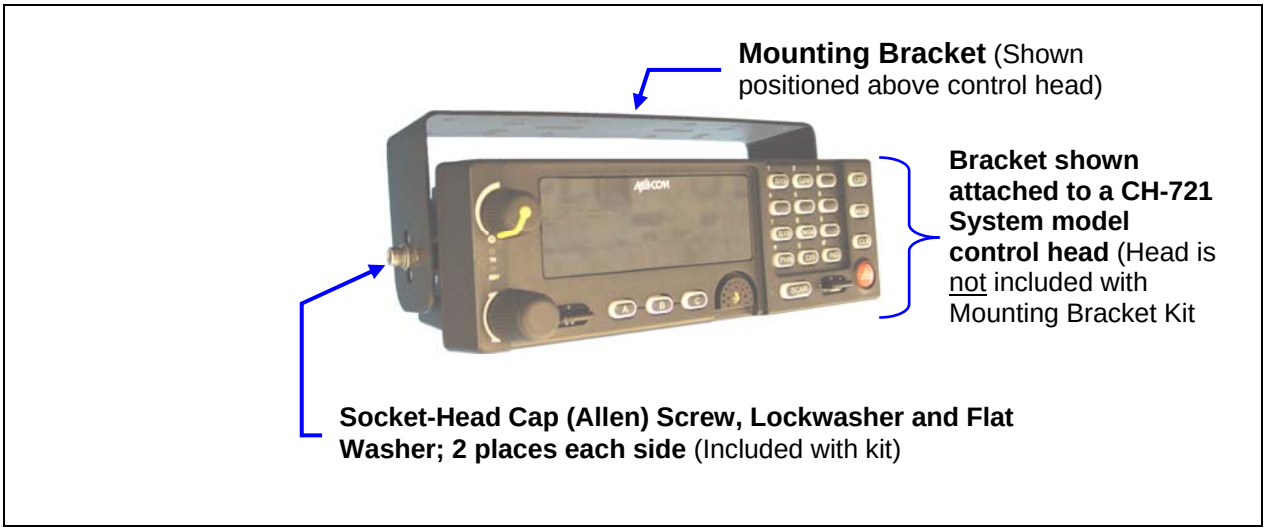


Figure 9-4: Standard U-Shaped Control Head Mounting Bracket (Kit Part Number KT-008608)

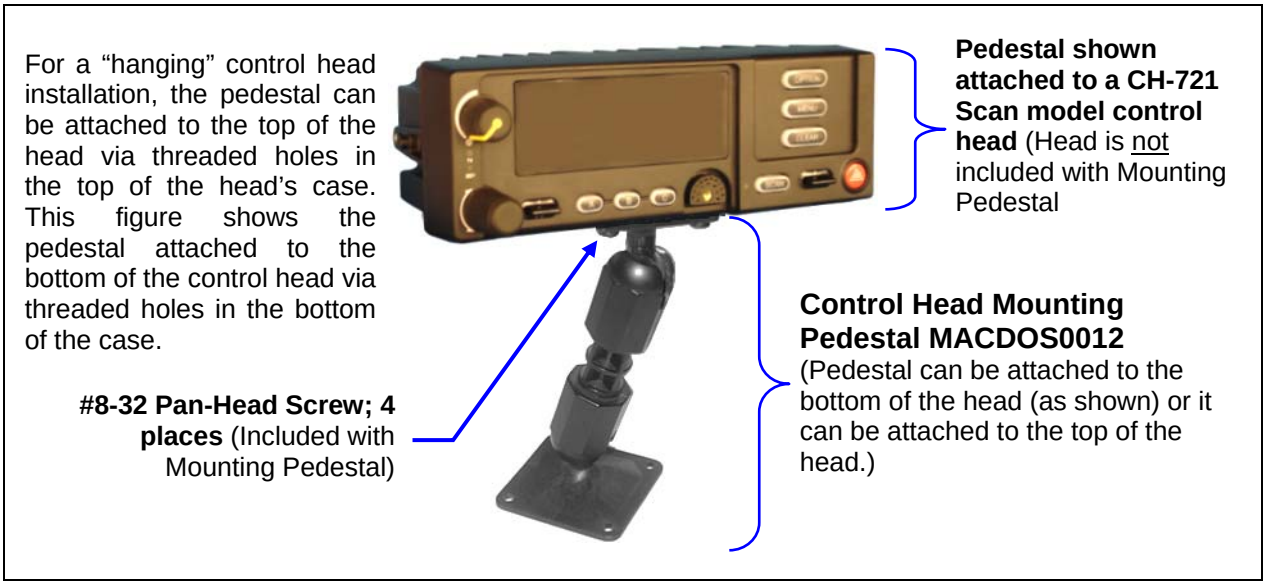


Figure 9-5: Optional Control Head Mounting Pedestal (Part Number MACDOS0012)

9.2.2 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 4-3 (page 18).

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-threading screws are recommended. Sheet metal screws should not be used.
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.

9.2.3 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 9-5 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.

9.3 CAN CONNECTIONS

9.3.1 General Information

The installation requires a CAN cable between every two "CAN devices" and CAN terminators on each end of the CAN link. The M7200 mobile radio is considered a CAN device, and each CH-721 control head in the installation is also considered a CAN device. Figure 9-6 illustrates CAN cable and CAN terminator connections for a single control head installation. Figure 9-7 illustrates this for a multi-head control head installation where, for example, one control head is located at the main operator location and another is located near the rear of the vehicle. Because CAN devices do not have internal terminators, the CAN link must be terminated at both ends via a CAN terminator.

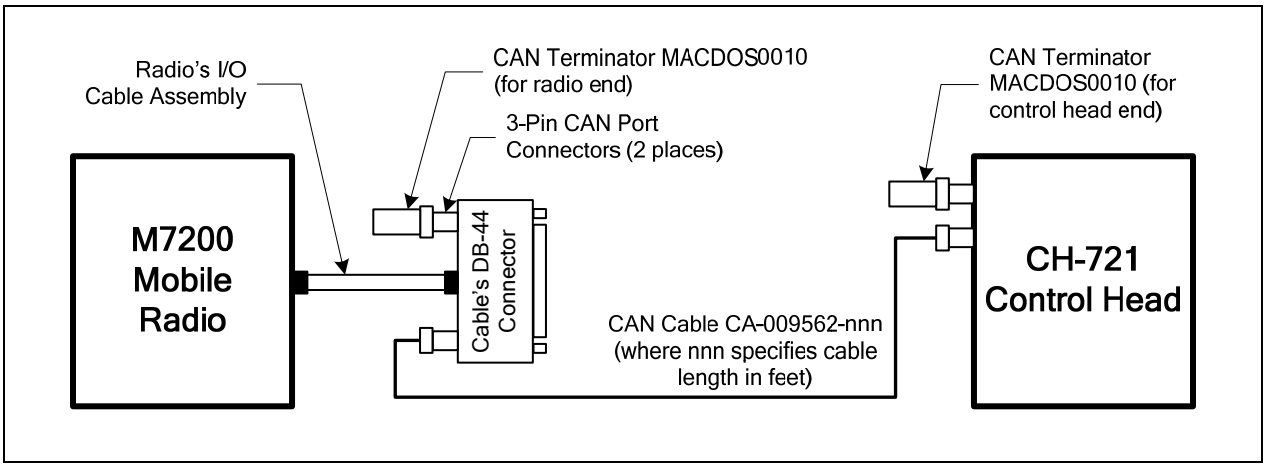


Figure 9-6: CAN Link Connections for a Single Control Head Installation

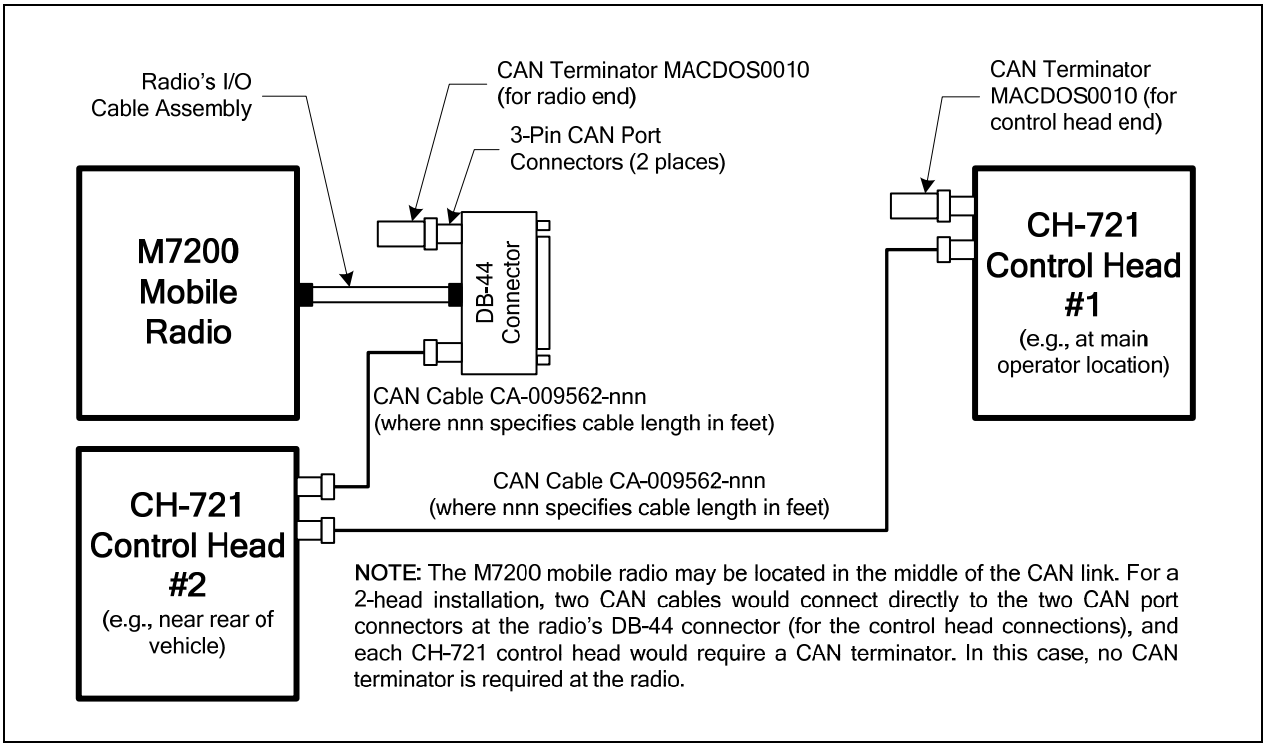


Figure 9-7: Typical CAN Link Connections for a Multi-Control Head Installation

Both the radio and the control head have two CAN ports to support "daisy-chaining" of multiple control heads or other CAN devices. Figure 5-2 on page 22 shows the radio's two CAN port connectors, which are located on cable side of the I/O cable's DB-44 connector. Figure 9-3 on page 38 shows the two ports on the control head's rear panel.

9.3.2 Make CAN Link Terminations and Cable Connection

Follow this procedure for an installation which has only one control head. For a multi-control head installation, refer to Figure 9-7 presented in the previous section as necessary.

1. Connect the CAN Terminator (Item 3 in Table 4-3) 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.

NOTE

When mating any CAN connection (terminators and cables), visually align the ¾-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 4 in Table 4-3) through the vehicle's interior wire/cable channeling to the radio. 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 radio'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 4 in Table 4-1) onto either one of the two smaller 3-pin connectors on the radio'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.

9.4 CONTROL HEAD POWER CABLE INSTALLATION

Plan the cable's route carefully. For the red wire, ensure a route that will not crush or damage the wire in any way.

9.4.1 Install DC Power Cable and Make Power and Ground Connections

1. Connect the control head's DC Power Cable (Item 5 in Table 4-3) to the large 3-pin connector at the rear of the control 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, form a cable service loop of at least six (6) inches, and tie and stow the cable as necessary.
3. Route the cable's red (positive power) wire through channels in the vehicle to the location of the Fuse Distribution Rail Assembly near the mobile radio. Remove interior panels, door kick panels, etc. Protect the wire from possible chafing as necessary.

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.

4. At the Fuse Distribution Rail Assembly near the radio, cut the red wire to the required length, strip it, and connect it to the load-side of the Fuse Block that has the 5-amp ATC fuse. (This fuse was installed during the rail assembly installation procedure presented in Section 8.2.2.) See the illustration on page 36 and the following CAUTION.

CAUTION

The fuse for the control head is rated at 5 amperes. Installing the wrong fuse value could lead to damage. Verify the control head is wired to the 5-amp (tan color) ATC fuse! The 15-amp (blue color) ATC fuse must **not** be used for control head power; it can be returned to stock or stored as a spare for the radio.

5. 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.
6. Cut the black wire of the control head's DC Power Cable as short as possible, but long enough for a service loop, then strip it and crimp a 3/8-inch ring terminal to it.
7. Drill a hole as necessary and screw this ring terminal to chassis ground. Use a self-threading screw or other appropriate hardware to ensure a reliable metal-to-metal contact.

9.4.2 Connect DC Power Cable's White Wire

A review of the information presented in Section 8.1 (page 30) 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. The control head's DC Power Cable and associated fuse and wire terminal devices are shown in Figure 9-8.

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 radio via the CAN connection.

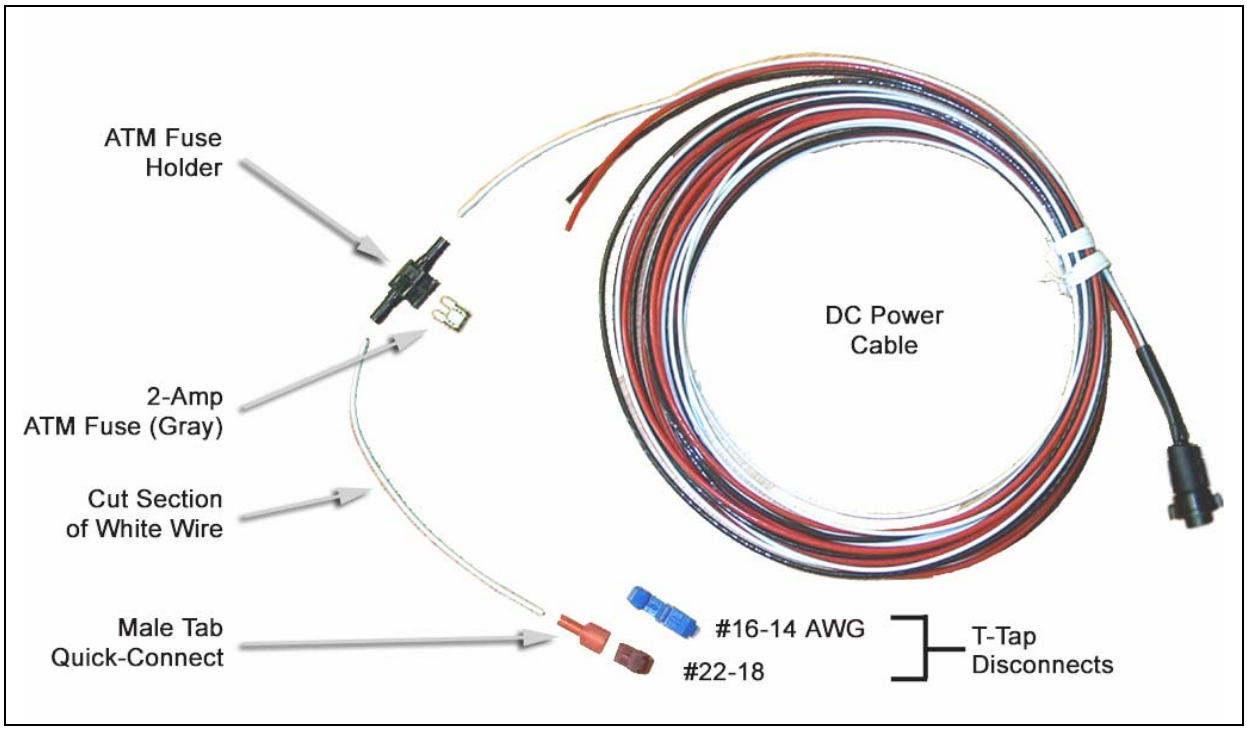


Figure 9-8: Connection of White Ignition Sense Wire Using Vehicle Fuse and T-Tap Kit

9.4.2.1 Control Head and Radio Turn on with Vehicle's Ignition Switch/Key

With this wiring configuration, the control head and radio automatically turn on and off with the vehicle's ignition switch/key. The white wire of the control head's DC Power Cable is typically identified as the "white ignition switch wire" or the "ignition sense 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 fused 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 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 loop of at least six (6) inches.
3. Cut a short section (6 to 8 inches) off the end of the white wire and strip each end of this short wire.

4. From the Vehicle Fuse and T-Tap Kit (Item 7 in Table 4-3), locate the male-tab quick-connect terminal and crimp it to one end the short wire. Refer to the respective wiring diagram at the end of this manual.
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 quick-disconnect terminals may be attached to it.
8. Two T-tap quick-disconnect terminals are included in the kit. Based on the gauge of wire, select the proper terminal size: Red is for 22 to 18-AWG wire and blue is for 18 to 14-AWG wire.
9. Attach the selected T-tap quick-disconnect terminal by fitting the wire into its wire groove and snapping the two halves together with a pair of pliers as shown in Figure 9-9.

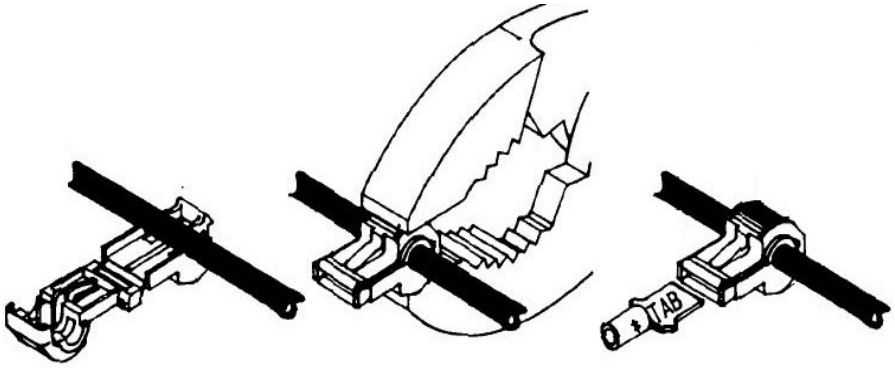


Diagram Courtesy of 3M Corp.

Figure 9-9: Attaching T-Tap Quick-Disconnect Terminals

10. Push the male-tab quick-disconnect terminal into the T-tap quick-disconnect 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.

9.4.2.2 Control Head and Radio Turn On with a Manual Switch

With this wiring configuration, the control head and radio are manually turned on and off via an on/off switch mounted separately from the control head and radio, 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. In this configuration, the white wire connects to a switched power source such as a toggle switch mounted on the vehicle's dash. 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 unit to an area near the on/off switch's location. At the back of the control head, be sure to maintain a cable service loop of at least six (6) inches.
2. Cut a short section (6 to 8 inches) off the end of the white wire and strip the ends.
3. For a new on/off switch (not supplied):

   (a) Tap a wire off non-switched battery power from the vehicle's fuse box with an 18-AWG wire. (Use wire remaining from the power cable, if available.) Keep wiring as short as possible and use approved wiring methods. Use techniques presented in Section 9.4.2.1 as a reference.

   (b) Strip and crimp this wire tap to one side of the ATM fuse holder. This holder is included with Vehicle Fuse and T-Tap Kit, item 7 in Table 4-3. It has built-in crimpable joints.

   (c) Crimp the short wire to the other side of the ATM fuse holder and connect the other end of this wire to the common terminal of the manual switch.

   (d) Connect the white wire of the power cable to the load (switched) side of the manual switch.

   For an existing switch:

   (a) Crimp the short wire to one side of the ATM fuse holder and connect the other end to the load (switched) side of the manual switch.

   (b) Crimp the white wire of the power cable to the other side of the ATM fuse holder.
4. 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.
5. Tie and stow these wires as necessary so they remain out of the way of casual contact and wire chafe is avoided.
6. Label this power switch accordingly. For example: "**RADIO ON/OFF**."

9.4.2.3 Control Head and Radio Are "Hot Wired"

In the "hot-wired" configuration, the control head and radio 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 9.4.2.1, except connect the white wire to **unswitched** battery power instead of switched ("Accessory") power.

10 DATA-ONLY RADIO CONNECTIONS

The Data-Only configuration of the radio has no control head. The only difference in connections from an installation with a control head is with respect to ignition sense wiring. For a Data-Only radio, follow the procedure described in Section 8.2, except make the connection of the white wire of the ***radio's*** DC Power Cable as detailed in the control head Section 9.4.2.1 (page 44) or Section 9.4.2.2 (page 46).

The ignition sense is the only means for turning the Data-Only radio on and off. The "hot wired" configuration cannot be utilized for the Data-Only radio, since this configuration does not employ the DC Power Cable's white wire.

11 MICROPHONE ATTACHMENT

There are several versions of microphones available for use with the radio. Each has a 17-pin flush-mount type connector that mates with the 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. As illustrated in Figure 11-1, grasp the mic's connector with a thumb and index finger on the sides of the connector just adjacent to the thumbscrew.
2. Position the connector in front of the control head's mic connector so the mic cable's stain relief is hanging down and out at an approximate 45 degree angle.
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. Attach the microphone clip to the mounting surface using self-threading screws. Select a location that has clearance for the mic when it is clipped to the clip.
7. The microphone clip must be grounded to the vehicle's chassis. If not mounted to a grounded metal surface, complete this requirement by adding a jumper wire attached from chassis ground to the clip.
8. Clip the microphone to the clip.

Figure 11-1: Attaching the Microphone to the CH-721Control Head

12 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 8 in Table 4-3) 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 9 in Table 4-3) to the 2-pin connector at the rear of the control head by visually aligning the ¾-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.

13 OPTIONAL CABLES

13.1 FULL-DATA I/O OPTION CABLE

The Full-Data I/O Option Cable 1000022242-0001 connects to the radio's 44-pin I/O cable connector. It breaks out into three (3) separate D-subminiature 9-pin (DB-9) type connectors. It also has blunt-end wires (i.e., not stripped or terminated with a connector) for optional/miscellaneous connections. This combination allows straightforward access to all external I/O connections provided by the radio. It also helps speed radio removal and re-installation time when required. This cable is shown in Figure 13-1.

When connected, each DB-9 connector of the Full-Data I/O Option Cable is a TIA/EIA-232 data interface port for the radio. The connector labeled "SERIAL" is the radio's serial programming port. The connector labeled "MODEM" supports the RF modem function that the radio can provide. The connector labeled "GPS" provides NMEA-formatted GPS serial data connections for the external computer processing the NMEA-formatted GPS data received by the radio's internal GPS receiver. The intent is for this option cable to adapt to standard 9-pin serial computer cables, or alternatively plug directly into the computer's or mobile data terminal's serial port connector.

The blunt-end wires of the Full-Data I/O Option Cable provide connections for the following: (2) vehicle signal inputs, (2) TTL logic level inputs, (2) open-collector logic outputs, and a baseband audio in/out with PTT input and activate output. Table 13-1 shows the wiring of the Full-Data I/O Option Cable.

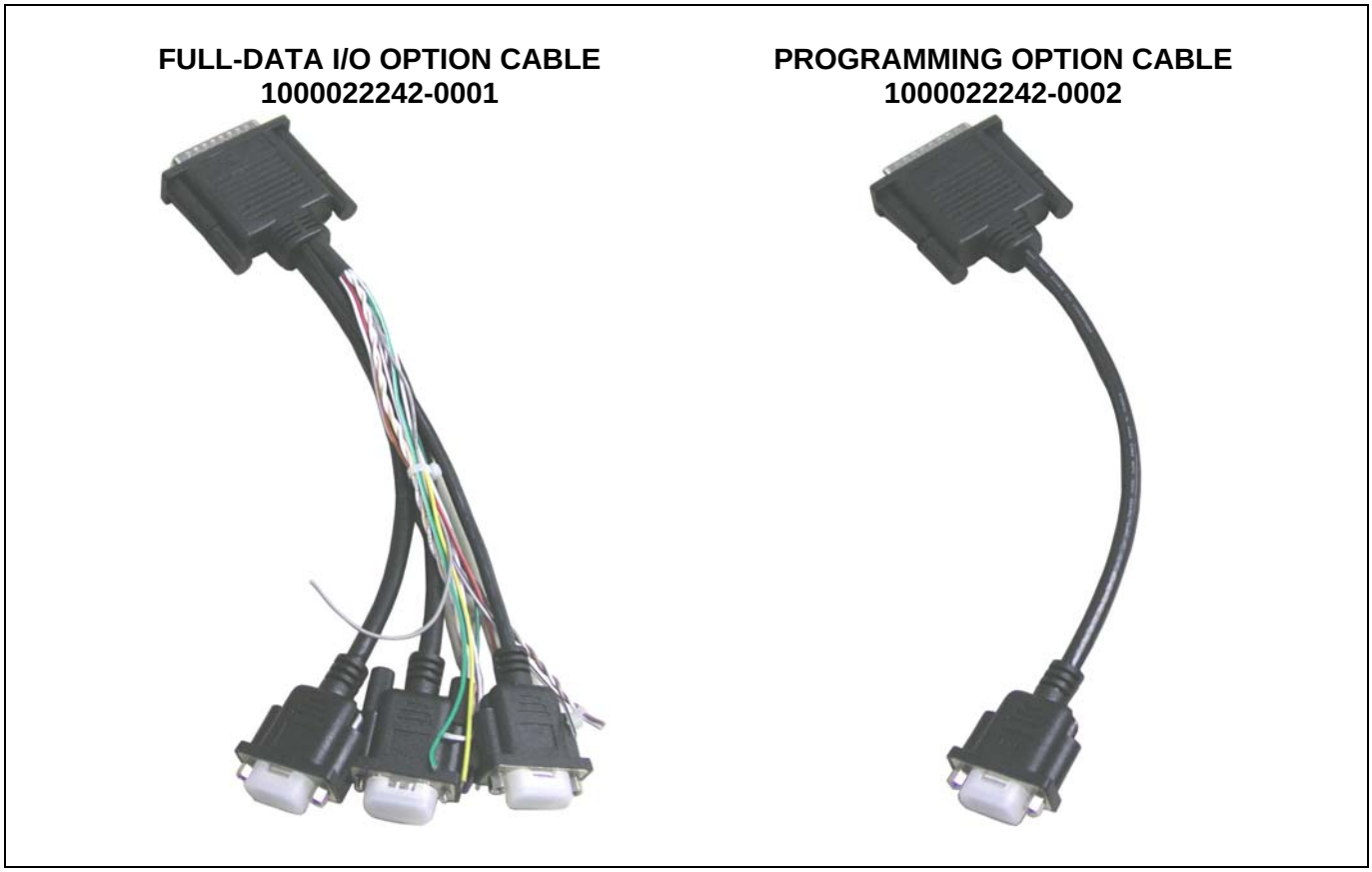


Figure 13-1: Full-Data I/O Option Cable 1000022242-0001 and Programming Option Cable 1000022242-0002

Table 13-1: Full-Data I/O Option Cable 1000022242-0001 Wire Interconnections

44-PIN I/O CABLE CONNECTOR PIN	DB-9 CONNECTOR NAME & PIN[2]	SIGNAL NAME	DESCRIPTION
1	SERIAL pin 7	CTS_A	TIA/EIA-232 Signal, Radio Serial Port
2	SERIAL pin 8	RTS_A	TIA/EIA-232 Signal, Radio Serial Port
3	SERIAL pin 1	DCD_A	TIA/EIA-232 Signal, Radio Serial Port
4	GPS pin 3	GPS_NMEA_RD	TIA/EIA-232 Signal, GPS Output Data
5	(N/C)	USB_D+	USB Port Data+ Line
6	MODEM pin 6	DSR_B	TIA/EIA-232 Signal, Modem Input
7	MODEM pin 4	DTR_B	TIA/EIA-232 Signal, Modem Input
8	MODEM pin 2	RD_B	TIA/EIA-232 Signal, Modem Input
9	MODEM pin 9	RI_B	TIA/EIA-232 Signal, Modem Input
10	(White/Black)	AUD_IN_PTT*	Push-to-Talk for Audio Input (active low)
11	(Orange)	TTL_IN1	TTL Digital Input #1
12	(Blue)	TTL_IN2	TTL Digital Input #2
13	(Gray)	OC_OUT2	Open-Collector Digital Output #2
14	(White/Blue)	IN_SHLD	Baseband Audio Input Shield
15	(Tan)	AUD_IN_L	Differential Audio Input Low (1/2 of twisted pair)
16	SERIAL pin 2	TD_A	TIA/EIA-232 Signal, Radio Serial Port
17	SERIAL pin 5, shell	GND_A	TIA/EIA-232 Ground, Radio Serial Port
18	SERIAL pin 4	DSR_A	TIA/EIA-232 Signal, Radio Serial Port
19	(N/C)	USB_VBUS	USB Port Voltage Bias Line
20	GPS pin 5, shell	GPS_GND	TIA/EIA-232 Ground, GPS Output Data
21	(N/C)	USB_D-	USB Port Data- Line
22	MODEM pin 5, shell	GND_B	TIA/EIA-232 Ground, Modem Input
23	MODEM pin 3	TD_B	TIA/EIA-232 Signal, Modem Input
24	(N/C)		(Pin 24 of 44-pin connector not used.)
25	I/O-shell	GND_SHLD	Overall Cable Shield/Radio Ground
26	(N/C)		(Pin 26 of 44-pin connector not used.)
27	(N/C)		(Pin 27 of 44-pin connector not used.)
28	(Red)	OC_OUT1	Open-Collector Digital Output #1
29	(White/Green)	AUD_OUT_ACT	Audio Output Activate
30	(White/Gray)	AUD_IN_H	Differential Audio Input High (½ of twisted pair)
31	SERIAL pin 3	RD_A	TIA/EIA-232 Signal, Radio Serial Port
32	SERIAL pin 6	DTR_A	TIA/EIA-232 Signal, Radio Serial Port
33	SERIAL pin 9	RI_A	TIA/EIA-232 Signal, Radio Serial Port

[2] No connection (n/c) terminations and blunt-wire colors are shown in parentheses.

Table 13-1: Full-Data I/O Option Cable 1000022242-0001 Wire Interconnections

44-PIN I/O CABLE CONNECTOR PIN	DB-9 CONNECTOR NAME & PIN[2]	SIGNAL NAME	DESCRIPTION
34	GPS pin 2	GPS_NMEA_TD	TIA/EIA-232 Signal, GPS Output Data
35	(White/Violet)	SGND1	Signal Ground Reference
36	MODEM pin 7	RTS_B	TIA/EIA-232 Signal, Modem Input
37	MODEM pin 8	CTS_B	TIA/EIA-232 Signal, Modem Input
38	MODEM pin 1	DCD_B	TIA/EIA-232 Signal, Modem Input
39	(N/C)		(Pin 39 of 44-pin connector not used.)
40	(Yellow)	VEHICLE_IN2	+12V Control Input #2 from Vehicle (Used in V-TAC installations only.)
41	(Green)	VEHICLE_IN1	+12V Control Input #1 from Vehicle
42	(N/C)		(Pin 42 of 44-pin connector not used.)
43	(White/Orange)	AUD_OUT_H	Differential Audio Output High (½ of twisted pair)
44	(White/Brown)	AUD_OUT_L	Differential Audio Output Low (½ of twisted pair)

13.2 PROGRAMMING OPTION CABLE

Related to the Full-Data I/O Option Cable is the Programming Option Cable 1000022242-0002, also shown in Figure 13-1. This option cable presents only the DB-9 serial interface necessary to program, control, or establish a data connection with the radio. It adapts to a standard 9-pin serial computer cable, or alternatively it plugs directly into the computer's or mobile data terminal's serial connector. Table 13-2 shows the wiring of the Programming Option Cable.

Table 13-2: Programming Option Cable 1000022242-0002 Wire Interconnections

44-PIN I/O CABLE CONNECTOR PIN	DB-9 "SERIAL" CONNECTOR PIN	SIGNAL NAME	DESCRIPTION
1	7	CTS_A	TIA/EIA-232 Signal, Radio Serial Port
2	8	RTS_A	TIA/EIA-232 Signal, Radio Serial Port
3	1	DCD_A	TIA/EIA-232 Signal, Radio Serial Port
16	2	TD_A	TIA/EIA-232 Signal, Radio Serial Port
17	5, shell	GND_A	TIA/EIA-232 Ground, Radio Serial Port
18	4	DSR_A	TIA/EIA-232 Signal, Radio Serial Port
31	3	RD_A	TIA/EIA-232 Signal, Radio Serial Port
32	6	DTR_A	TIA/EIA-232 Signal, Radio Serial Port
33	9	RI_A	TIA/EIA-232 Signal, Radio Serial Port

14 GPS NMEA-FORMATTED SERIAL DATA CONNECTION

To obtain GPS NMEA-formatted serial data from the radio, use of the Full-Data I/O Option Cable 1000022242-0001 is recommended. Follow this procedure to complete the GPS NMEA-formatted serial data connections if using the Full-Data I/O Option Cable:

1. Connect the Full-Data I/O Option Cable's 44-pin male connector to the radio's 44-pin female connector. Tighten the two jackscrews with a small flathead screwdriver. Do not over-tighten.
2. Connect the cable's DB-9 female connector labeled "GPS" to the computer's serial port DB-9 male connector — either directly or with an optional MAMROS0055 serial cable — and tighten the screws until firm. Route the cabling as required.
3. Follow the manufacturer's instructions on processing the NMEA-formatted GPS data from the radio.

If the Full-Data I/O Option Cable is not available, a 3-wire serial cable can be field-fabricated. On the radio end, this cable must interface to the three GPS-related signals of the radio's 44-pin I/O Cable connector (pins 4, 20 and 34). See Table 13-1 for additional information.

Industry software to process GPS information through this interface is not supported by M/A-COM.

15 INITIAL POWER-UP TEST

1. At the installation's main ATC fuse holder located near the vehicle battery, open the fuse holder's cap and install the 30-amp ATC fuse. This fuse is a part of the Fuse Distribution Rail Kit (a part of Item 2 in Table 4-1). Push the cap back onto the holder until the plastic tab snaps into place.

2. Optionally, fasten the cap to the wheel well or other vehicle surface via the hole in the cap's mounting tab and a self-threading screw (not supplied).

The installation's main fuse is a 30-ampere ATC fuse. Installing the wrong fuse value could lead to improper operation and/or damage. Verify the ATC fuse supplying power to the Fuse Distribution Rail Assembly has the correct rating! The color of a 30-amp ATC fuse is green.

3. Carefully reconnect the vehicle's battery ground cable.

4. If the control head is not already powered up, do so by rotating its on/off/volume control clockwise out of the detent position.

5. Verify the control head has powered-up by observing its display. If the display is not lit, refer to Section 8.1 as necessary.

Unlike many mobile radio products, the radio powers-up to the **state of last control**.

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 two Fuse Blocks. If problems persist, contact M/A-COM's Technical Assistance Center (see page 16).
- Consult the Operator's Manual for operational information.

Refer to the following section for performance test information.

16 PERFORMANCE TESTS

This section includes procedures to verify the performance of the radio installation's mobile antenna system. The tests require a peak-power reading wattmeter to measure RF power. There are three procedures in this section:

- Changing Operating Mode for Tests
- Testing by Transmitting into a Dummy Load (a 50-Ohm RF Terminator)
- Testing by Transmitting into the Mobile Antenna

The accuracy of test results depends upon a DC power source in the range of 13.8 to 16 volts dc, with a current capacity of greater than 8 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!** Alternatively, instead of running the vehicle's engine for an extended period of time, a 12-volt vehicle battery charger with a current capacity of at least 15 amps can be connected to the vehicle's battery. If using a battery charger, **observe polarity** when making the connections to the battery.

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 this radio requires jump-starting, the radio installation's main ATC fuse should be removed from the holder prior to jump-starting. Doing so will prevent damage to the radio system.

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

16.1 CHANGING OPERATING MODE FOR TESTS

The radio must be operating in the OpenSky Trunking Protocol (OTP) mode during the performance test procedures presented in this section:

16.1.1 Switching to OTP Mode

1. If necessary, apply power to the radio and turn it on.
2. Rotate the **Group Selection Control** until **Mode Menu** appears in the middle line of the display. Refer to Figure 9-1 and/or Figure 9-2 on page 37 as necessary.

3. Toggle the **Ramp Control** until **OTP** (or **M: NM** for mode = normal) appears in the top line of the display.
4. Confirm the OTP selection by pressing the **MENU** button, then toggling the **Ramp Control** once (to select **Y** for Yes), followed by pressing the **MENU** button again. The radio will reboot and enter OTP mode as indicated by the display.

16.2 REQUIRED TEST EQUIPMENT

Table 16-1: Required Test Equipment

TEST EQUIPMENT	MODEL / PART NUMBER & DESCRIPTION
Peak Power Wattmeter	• Bird Electronic Corp. Model 4314B (or equivalent) with N-type female connectors at input and output ports.
Wattmeter Slug	• Bird Electronic Corp. Element 25E, 25 watts, 400 - 1000 MHz (or equivalent).
RF Coaxial Jumper Cable	• Pasternack Enterprises PE3661-36 (or equivalent) 50-Ohm Coaxial Cable with TNC-type male connector and N-type male connector, approximately three (3) feet in length. The utilized cable **must** have VSWR below 1.5:1 within the RF passband.
N-Type to TNC RF Adapter	• Pasternack Enterprises PE9090 (or equivalent) N-type male to TNC-type female adapter. Required to connect the cable of the vehicle-mounted 700/800 MHz antenna to the wattmeter.
50-Ohm RF Terminator ("Dummy Load")	• Pasternack Enterprises PE6106 (or equivalent) 50-ohm RF terminator rated at greater than 50 watts power, with N-type male connector.
Vehicle-Mounted Antenna	Tests are performed with the vehicle-mounted 700/800 MHz antenna per the installation described in Section 7 of this manual.

16.3 TRANSMITTING INTO A DUMMY LOAD

1. Using the N-type male to TNC-type male RF coaxial jumper cable, connect the radio's antenna connector to the wattmeter's input connector. Refer to Figure 16-1 as necessary.
2. Connect the 50-ohm dummy load to the wattmeter's output connector, in place of the antenna cable from the vehicle-mounted 700/800 MHz antenna.

A peak-power reading RF wattmeter equivalent to the wattmeter specified in Table 16-1 must be used. Do **not** use an average or RMS-responding wattmeter.

3. If not already, turn the radio on and set it to the OTP mode. Refer to Section 16.1 as necessary.
4. Set the radio to a test talk group, if available.

NOTE

It is recommended that a test talk group be allocated for this testing. This same group should be used during the antenna test procedure which is presented in the subsequent section.

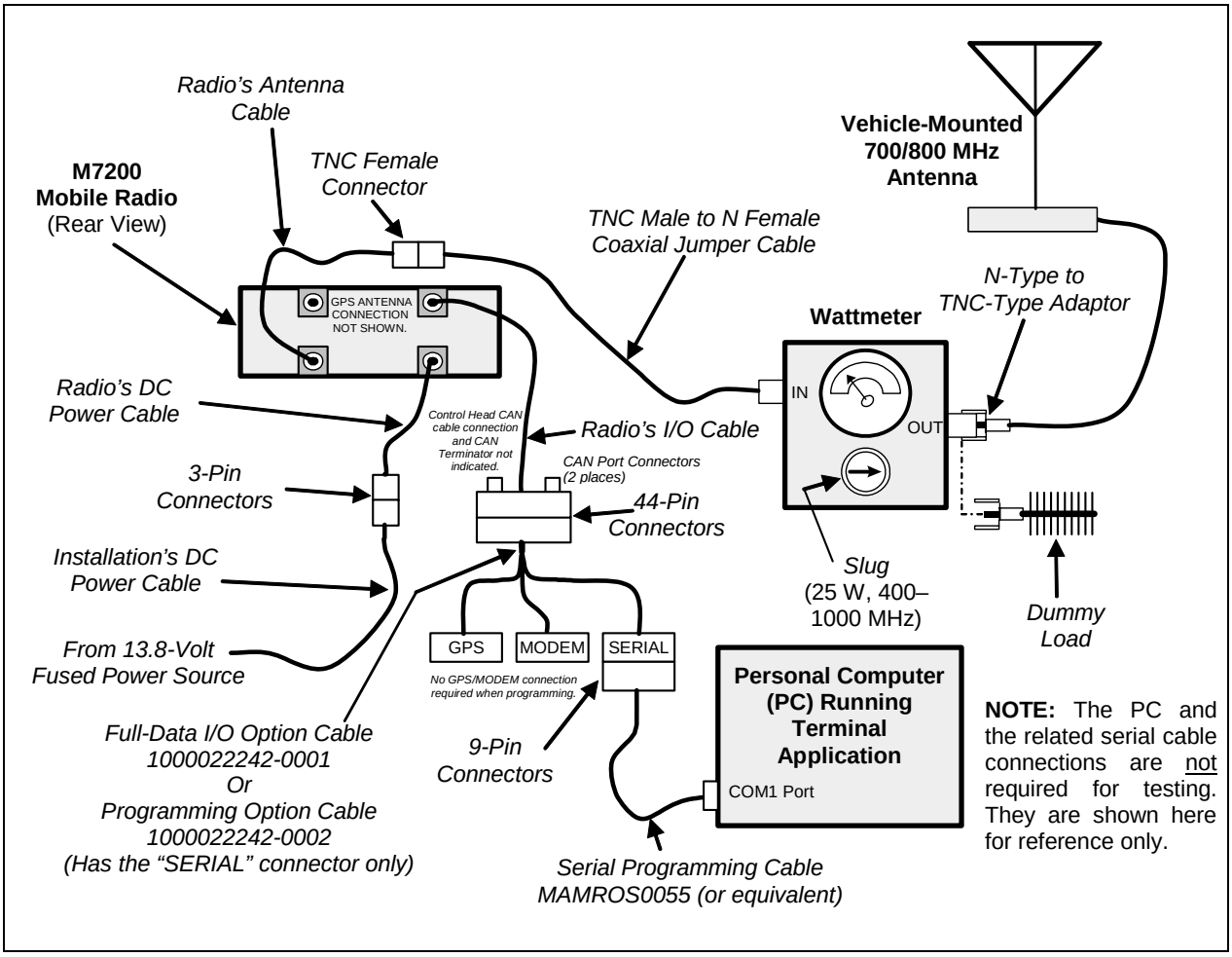


Figure 16-1: **Wattmeter Connections for Antenna System Tests**

5. Position the wattmeter's slug to measure forward RF output power. Rotate it if necessary. The arrow on the face of the slug must point away from the radio and towards the dummy load for forward power measurements.
6. Set the wattmeter to measure peak RF power.
7. Key the radio's transmitter via the microphone's PTT button.
8. Compare the wattmeter's reading with the target RF output power range of **11.8 – 20.0 watts.**

NOTE

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

9. **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.

   If the wattmeter reading is outside the range, verify the radio'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 M/A-COM's Technical Assistance Center (see page 16).

16.4 TRANSMITTING INTO THE MOBILE ANTENNA

1. Connect the antenna cable from the vehicle-mounted 700/800 MHz antenna to the wattmeter as shown in Figure 16-1.
2. If not already, turn the radio on and set it to OTP mode. Refer to Section 16.1 as necessary.
3. Set the radio to a test talk group, if available.

NOTE

It is recommended that a test talk group 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 on (begins on page 6).**

NOTE

A peak-power reading RF wattmeter equivalent to the wattmeter specified in Table 16-1 must be used. Do **not** use an average or RMS-responding wattmeter.

4. Position the wattmeter's slug to measure forward RF output power. Rotate it if necessary. The arrow on the face of the slug must point away from the radio and towards the antenna for forward power measurements.
5. Set the wattmeter to measure peak RF power.
6. Key the radio's transmitter via the microphone's PTT button.
7. Compare the wattmeter reading with the target RF output power range of **11.8 – 20.0 watts.**

NOTE

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

8. **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.

   If the wattmeter reading is outside the range, verify the radio's 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 M/A-COM's Technical Assistance Center (see page 16).
9. Position the wattmeter's 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 to the radio to measure reverse power.
10. Verify the wattmeter is still set to measure peak RF power.
11. Key the radio's transmitter via the microphone's PTT button.

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

NOTE

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

13. **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.

    If the wattmeter reading is outside the range, make sure the antenna is consistent with the specified frequency range of the radio. 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 M/A-COM's Technical Assistance Center (see page 16).

14. Disconnect the coaxial cable jumper and wattmeter.

15. Permanently connect the cable from the vehicle-mounted 700/800 MHz antenna to the radio's antenna cable by mating the two TNC connectors together. Use two pairs of slip-jaw pliers to gently tighten this connection. Do not over tighten and do not twist either cable.

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.

Testing is complete. The radio is now ready for normal communications.

16.5 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 M7200 mobile radio installation.

Mobile Radio Serial Number	*Antenna Make and Model Numbers*

/ /		
Date of Test (mm/dd/yyyy)	*Company Performing Installation*	*Technician Performing Test*

tyco / Electronics

M/A-COM

Watts	Watts	Watts
Power Into a Dummy Load	*Forward Power With Antenna*	*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 and properly rated.
- 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 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.

18 WARRANTY

A. M/A-COM, Inc. (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-M/A-COM 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) sold by Seller's Service Parts Operation, ninety (90) days.
3. for PANTHER™ Series hand-portable and mobile radios, two (2) years.
4. 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 a M/A-COM 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.

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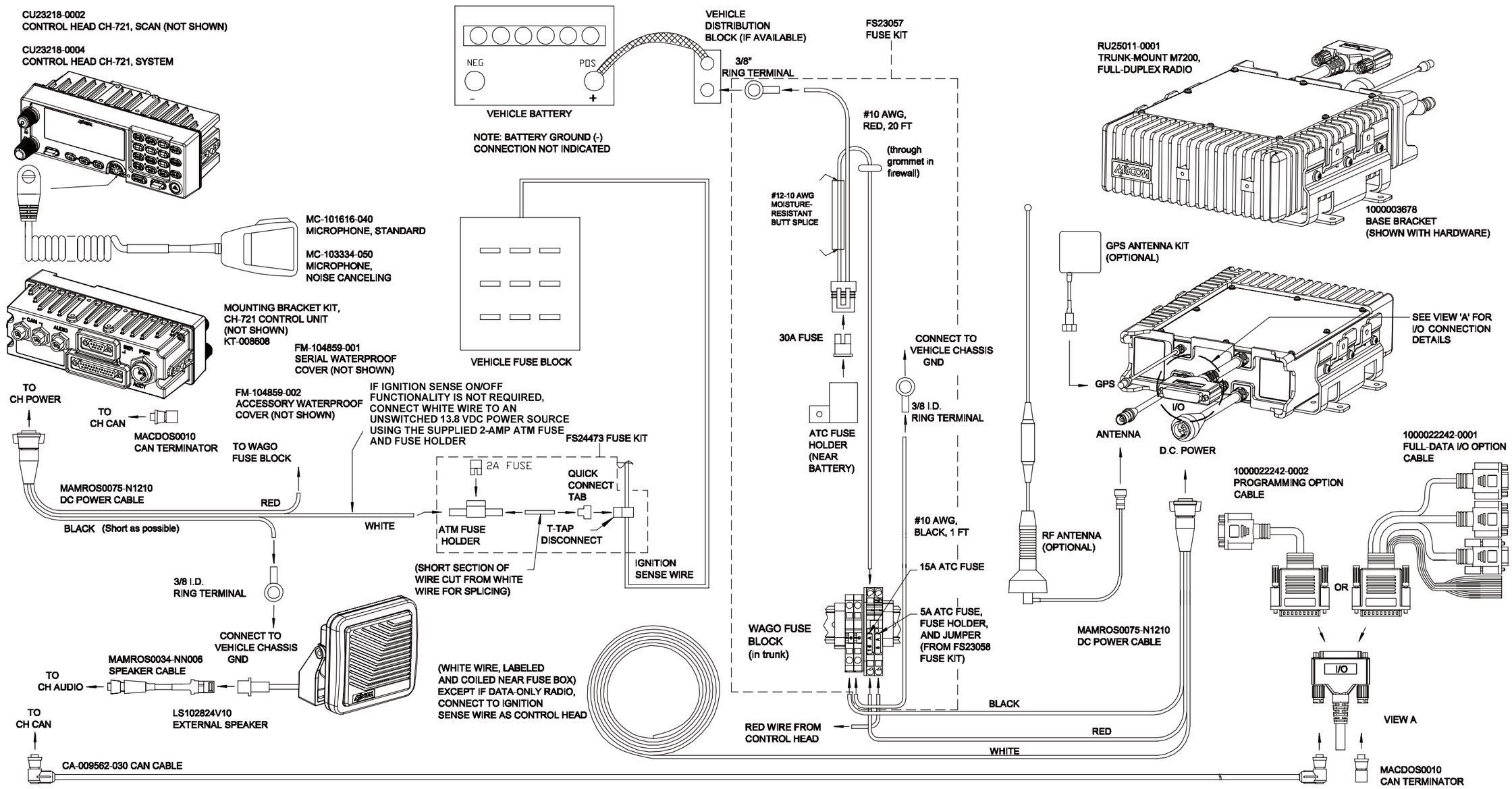
ECR-7047C

19 WIRING DIAGRAM: M7200 MOBILE RADIO WITH CH-721 CONTROL HEAD



WIRING DIAGRAM
M7200 Mobile Radio with
CH-721 Control Head

(AA-010461 Rev. A)

Wiring Diagram Inside

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