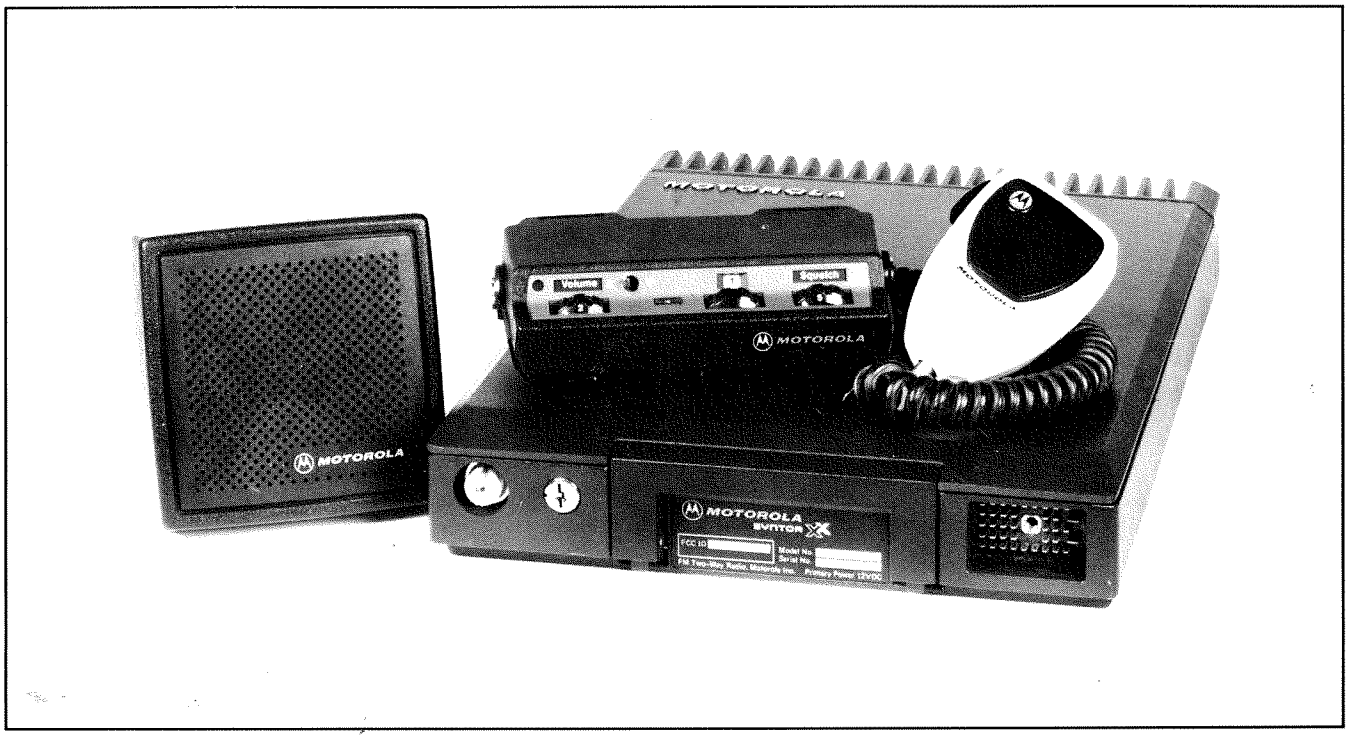
MOTOROLA

SYNTOR X™

Low Band

33–50 MHz

100 Watts



Instruction Manual

68P80100W51-O

MOTOROLA INC.
Communications Group

SYNTOR X Low-Band Radio

33–50 MHz
100 Watts

Contents

technical publication services
5555 North Beach Street, Fort Worth, Texas 76137
68P80100W51-O
8/27/85

Foreword

1. Scope of Manual

This manual is intended for the use of experienced technicians familiar with this general type of equipment. In it you should be able to find all the information you will need for installing and servicing the equipment it covers. It is current as of the publication date, and incorporates changes that have occurred since then in the form of instruction manual revisions (WMR's). (WMR's that cover production or engineering changes to the circuitry usually include corrected schematics and circuit board diagrams.)

2. Model and Kit Identification

Each Motorola product has an identifying model number stamped on its nameplate. In most cases, assemblies and kits that make up the product also have identifying kit numbers stamped on them. Schematics and circuit board diagrams for such kits show this same identifying number prominently in the lower lefthand or righthand corner.

3. Service

Motorola's national service organization maintains one of the finest nation-wide installation and maintenance programs available to users of communication equipment. The administrative staff of this organization consists of national, area, and district service managers, all of whom are Motorola employees dedicated to giving our customers the best possible service. The organization has about 900 authorized Motorola Service Stations (MSS's) throughout the United States, each manned by one or more trained, FCC-licensed technicians.

Motorola selected each one of these independently owned and operated MSS's to service its customers. They offer Motorola maintenance either by the job (priced by time and material), or on a service contract at a fixed periodic fee.

To buy a service contract for your Motorola equipment, contact your Motorola Service Representative or write to:

National Service Manager
Motorola Communications and Electronics, Inc.
1303 E. Algonquin Road
Schaumburg, Illinois 60196

4. Ordering Replacement Parts

Motorola maintains a number of area parts offices throughout the United States. These facilities have skilled staff to process orders for parts, identify part numbers, and otherwise assist in the maintenance and repair of Motorola Communications Sector products.

Order manuals and all parts except crystals, active filters, channel elements, and *Vibrasender* and *Vibrasponder* resonant reeds from the nearest area parts office.

When ordering replacement parts or requesting information about equipment, include the complete identification numbers. This applies to all components, kits, and chassis. If you do not know the part number for a component, include the part number of the chassis or kit of which it is a part, and identify the component with a full and accurate description.

Send orders for crystals, channel elements, active filters, and reeds to the Component Product Sales & Service Office (address on next page). When ordering crystals and channel elements, specify the type number, the crystal and carrier frequencies, and the model number of the chassis in which the part is used.

When ordering active filters and *Vibrasender* and *Vibrasponder* resonant reeds, specify the type by number and the frequency, identify the owner or operator of the system in which these items are to be used, and give any serial numbers stamped on the components to be replaced.

Component Product Sales & Service Office

All Mail Orders:
Motorola, Inc.
Component Product Sales & Service
P.O. Box 66191
O'Hare International Airport
Chicago, IL 60666

Correspondence:
Motorola, Inc.
Component Product Sales & Service
2553 N. Edgington Street, Franklin Park, IL 60131
Phone 312-451-1297, TWX 910-227-0799
Telex 433-0067

Area Parts Offices

Western Area Parts
1170 Chess Drive, Foster City, CA 94404
Phone 415-349-8621, TWX 910-375-3877

Rocky Mountain Area Parts
20 Inverness Place East, Englewood, CO 80112
Phone 303-790-2323, TWX 920-935-0785

Pacific-Southwestern Area Parts
P.O. Box 85036, San Diego, CA 92138
Street Address:
9980 Carroll Canyon Road, San Diego, CA 92131
Phone 619-578-8030, TWX 910-335-1516

Southwestern Area Parts
P.O. Box 34290
3320 Belt Line Road, Dallas, TX 75234
Phone 214-620-8511, TWX 910-860-5505

Midwest Area Parts
1313 E. Algonquin Road, Schaumburg, IL 60196
Phone 312-576-7430, TWX 910-693-0869

Southeastern Area Parts
P.O. Box 368, Decatur, GA 30031
Street Address:
5096 Panola Industrial Blvd., Decatur, GA 30032
Phone 404-987-2232, TWX 810-766-0876

Gulf States Area Parts
P.O. Box 73115
1140 Cypress Station, Houston, TX 77090
Phone 713-537-3636, TWX 910-881-6392

East Central Area Parts
12955 Snow Road, Parma, OH 44130
Phone 216-433-1560, TWX 810-427-9424

Eastern Area Parts
85 Harristown Road, Glen Rock, NJ 07452
Phone 201-447-4000, TWX 710-988-5614

Mid-Atlantic Area Parts
7230 Parkway Drive, Hanover, MD 21076
Phone 301-796-8763, TWX 710-862-1941

National Accounts
Railroads, Airlines, and Telephone Sales
1313 E. Algonquin Road, Schaumburg, IL 60196
Phone 312-576-6512, TWX 910-693-0869

All Canadian Orders
Motorola, Ltd., National Parts Department
3125 Steeles, Ave. E., Willowdale, Ontario M2H 2H6
Phone 416-499-1441, TWX 610-491-1032
Telex 06-526258

National Data Services

1711 West 17th Street, Tempe, AZ 85281
Phone 602-994-6472, TWX 910-951-1334

All Countries Except U.S. & Canada

Motorola, Inc., International Parts Department
1313 E. Algonquin Road
Schaumburg, IL 60196, U.S.A.
Phone 312-576-7241, TWX 910-693-0869
Telex 722443, Cable MOTOL PARTS

General Safety Information

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act of 1970 (OSHA), has established an electromagnetic energy safety standard that applies to the use of this equipment. Proper use of this radio will result in exposure below the OSHA limit. The following precautions are recommended:

DO NOT Operate the transmitter of a mobile radio when someone outside the vehicle is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of a fixed radio (base station, microwave, and rural telephone RF equipment) or marine radio when someone is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter of any radio unless all RF connectors are secure and any open connectors are properly terminated.

In addition,

DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere.

All equipment must be properly grounded according to Motorola installation instructions for safe operation.

All equipment should be serviced only by a qualified technician.

Refer to the appropriate section of the product service manual for additional pertinent safety information.

Installation Safety Warning

Consider the occupants' safety when you choose a location for the radio. Do not mount the radio overhead or on a sidewall unless you take special precautions.

If someone were to remove the radio and fail to latch it properly when replacing it, road shock could bump the radio loose, and the falling radio could in some circumstances cause serious injury to the driver or a passenger. In a crash, the radio, even when properly installed, could break loose and become a dangerous missile.

If you must mount the radio overhead or on a sidewall, give it the added protection of a retaining strap. Custom-made straps are available from Motorola National Parts. Order kit number HLN4698A (for *Mitrek*) or HLN4697A (for *SYNTOR* or *SYNTOR X*).

Warning

For vehicles equipped with electronic anti-skid braking systems, see "ANTI-SKID BRAKING PRECAUTIONS" Publication, Motorola Number 68P81109E34.

Warning

To gain full access to the Common Circuits Board for servicing, the regulator heat sink screw must be removed. When operating the radio with the regulator heat sink screw removed, care should be taken to avoid the exposed hot flange.

Note

See the next page for another important warning.

Warning

It is mandatory that radio installations in vehicles fueled by liquefied petroleum gas conform to the following standard.

National Fire Protection Association standard NFPA 58 applies to radio installations in vehicles fueled by liquefied petroleum (LP) gas with the LP-gas container in the trunk or other sealed-off space within the interior of the vehicles. This standard requires that:

1. Any space containing radio equipment shall be isolated by a seal from the space in which the LP-gas container and its fittings are located.

2. Remote (outside) filling connections shall be used.

3. The container space shall be vented to the outside.

MOTOROLA INC.
Communications Group

Safe Handling of CMOS Integrated-Circuit Devices

Many of the integrated-circuit devices used in communications equipment are of the CMOS (Complementary Metal Oxide Semiconductor) type. Because of their high open-circuit impedance, CMOS IC's are vulnerable to damage from static charges. Everyone involved in handling, shipping, and servicing them must be extremely careful not to expose them to such damage.

CMOS IC's do have internal protection, but it is effective only against overvoltages in the hundreds of volts, such as those that could occur during normal operations. Overvoltages from static discharge can be in the thousands of volts.

When a CMOS IC is installed in a system, the system's circuit elements distribute static charges and load the CMOS circuits. This decreases the vulnerability of the IC's to static discharge, but improper handling will probably cause static damage even when the IC's are so installed.

To avoid damaging CMOS IC's, take the following precautions when handling, shipping, and servicing them.

1. Before touching a circuit module, particularly after having moved around in the service area, touch *both* hands to a bare metal earth-grounded surface. This discharges any static charge you may have accumulated.

Note

Wear a conductive wrist strap (Motorola Part No. RSX-4015A) to minimize the buildup of static charges on your person while you are servicing CMOS equipment.

Warning

When wearing a conductive wrist strap, be careful near sources of high voltage. By grounding you thoroughly, the wrist strap also increases the danger of lethal shock from accidental contact with such a source.

2. Whenever possible, avoid touching any electrically conductive parts of the circuit module with your hands.

3. Check the INSTALLATION and MAINTENANCE sections of the service manual and the notes on the schematic to find out whether or not you can insert or remove circuit modules with power applied to the unit, and act accordingly.

4. When servicing a circuit module, avoid carpeted areas, dry environments, and the wearing of static-generating clothing.

5. Be sure that all electrically powered test equipment is grounded. *Attach* the ground lead from the test equipment to the circuit module *before* connecting the test probe. Similarly, *disconnect* the test probe *before* removing the ground lead.

6. When you remove a circuit module from the system, lay it on a sheet of aluminum foil or other conductive surface connected to ground through 100,000 ohms of resistance.

Warning

If the aluminum foil is connected directly to ground, you may get a shock if you touch it and another electrical circuit at the same time.

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7. When soldering, be sure the soldering iron is grounded.

8. Before connecting jumpers, replacing circuit components, or touching CMOS pins (if this becomes necessary during the replacement of an integrated-circuit device), be sure to discharge any static buildup on your person (see Procedure 1, above). Because you can have a voltage difference across your body, you should use only one hand if you must touch the board wiring or any of the pins on the CMOS device.

9. When replacing a CMOS integrated-circuit device, leave the device in its metal rail container or conductive foam until you are ready to insert it into the pronged circuit module.

10. Connect any low-impedance test equipment such as a pulse generator to CMOS device inputs after you have applied power the CMOS circuitry. Similarly, disconnect such low-impedance equipment before turning off the power.

11. Wrap CMOS modules in conductive material when transporting them from one area to another, even within the same room. Use wrapping material similar to that in which replacement modules are wrapped when they arrive from the factory. (You can also use aluminum foil.) *Never use nonconductive material for packaging these modules.*

Model Chart for Low-Band *SYNTOR X* Radio 33–50 MHz T71VBJ Models: 100 W

CODE:

- ● = ONE ITEM SUPPLIED
- ■ = INDICATES BREAKDOWN IN SEPARATE CHART

MODEL						DESCRIPTION
T71VBJ7204AK	T71VBJ7D04AK	T71VBJ7J04AK				8-MODE, 100-WATT
						16-MODE, 100-WATT
						32-MODE, 100-WATT

						ITEM	DESCRIPTION
●	●	●				■HUB1077A	UNIFIED CHASSIS
●						HCN1009A	CONTROL HEAD, 8-MODE
	●					HCN1019A	CONTROL HEAD, 16-MODE
		●				HCN1020A	CONTROL HEAD, 32-MODE
●	●	●				HKN4051A	POWER CABLE AND FUSE KIT
●	●					HLN1125A	MEMORY MODULE, 8, 16, AND 32-MODE
●	●	●				HLN4188A	MICROPHONE HANGUP BOX
●	●	●				HLN4028A	TRUNNION AND BREAKAWAY
●	●	●				HLN4111A	INSTALLATION KIT
●	●	●				HLN4243A	BOTTOM COVER
●	●	●				HLN4262A	TUNING TOOL
●	●	●				HLN4263A	TOP COVER
●	●	●				HLN4666A	MOUNTING TRAY
●	●	●				HMN4002A	MICROPHONE
●	●	●				HSN4005A	SPEAKER
●	●	●				TKN8087A	RADIO CABLE KIT
●	●	●				HLN4257A	NAMEPLATE
●	●	●				TAB1002C	ANTENNA WITH SPRING BASE
●	●	●				HKN4052A	CONTROL HEAD AND POWER CABLE

Model Chart for Low-Band *SYNTOR X* Radio Unified Chassis

CODE:

● = ONE ITEM SUPPLIED

MODEL							DESCRIPTION
						HUB1077A	UNIFIED CHASSIS, 33–50 MHz
						ITEM	DESCRIPTION
						HLB1016A	DIRECTIONAL COUPLER
						HLN4837A	DIRECTIONAL COUPLER HARDWARE
						HLE4092A	DIRECTIONAL COUPLER BOARD
						HLB1019A	INTERNAL CASTING
						HFB4001A	RECEIVE INJECTION FILTER
						HLB1021A	TRANSMIT MIXER
						HLN4909A	COAX CABLES
						HLB4084A	TRANSMIT MIXER
						HLB4085A	RECEIVE MIXER
						HLB4086A	VCO
						HLB4090A	EXTENDER FRONT END BOARD
						HLB4091A	EXTENDER BACK END BOARD
						HLN4813A	INTERNAL CASTING HARDWARE
						HLN4251A	VCO INTERCONNECT
						HLB4098A	HIGH IF
						HLB4087A	RF BOARD
						HLN4817A	COMMON CIRCUITS BOARD
						HLB4093A	PA TRANSISTORS
						HLN4814A	PA HARDWARE
						HLN4913A	FEEDTHRU BOARD, 7-PIN
						HLN4914A	FEEDTHRU BOARD, 2-PIN
						HKN4202A	INTERCONNECT CABLE
						HLN4461A	BUS WIRE, RED-BLACK
						HLN4915A	PERSONALITY BOARD
						HLN4815A	CHASSIS HARDWARE
						HLN4816A	FRONT HARDWARE
						TRN8876A	I/O BOARD
						HFB4000A	RECEIVE HIGH-PASS FILTER
						HLB4083A	TRANSMIT BUFFER BOARD
						HLB4094A	PA BOARD

Options Chart

OPTION	DESCRIPTION
W11	Time-out timer (60 seconds)
W54	Positive-ground cable
W71	Omit microphone
W87	Omit speaker
W90	Omit all accessories
W101	22-foot negative-ground cable
W109	Handset with hangup
W204	Double *Systems 90•S* housing with trunnion extenders
W239	Noise-cancelling microphone
W269	Siren, high-low tone
W271	Siren, steady tone
W415	Multi-coded squelch 4-code operator select
W416	Multi-coded squelch 8-code operator select
W417	8-frequency operator select scan
W420	*Channel Scan* with display, 8-mode rotary control
W421	Second priority for *Channel Scan*
W422	2-frequency sequential scan (internally programed by mode)
W425	Repeater/talkaround (selected by a switch)
W427	"AND" opening squelch
W428	Time-out timer (duration variable by mode)
W452	*MDC-600* unit ID
W470	*MDC-600* emergency footswitch
W478	Delete coded squelch
W492	Priority *Channel Scan,* 2-frequency (internally programed by mode)
W493	*Systems 90•S* single housing
W494	Mode-select, multi-coded squelch
W495	Scan display with pushbutton mode-select
W496	10-foot negative-ground cable
W543	Headset with lip microphone
W545	Digital dial encoder, 2805 Hz
W546	Digital dial decoder, 2805 Hz
W554	*Touch-Code* encoder
W562	*Quik-Call II* decoder, individual call
W563	*Quik-Call II* decoder, individual and group call
W564	One-tone, single-tone
W566	Five-tone, single-tone
W580	Voice privacy adapter
W582	Digital dial encoder, 1500 Hz
W583	Digital dial decoder, 1500 Hz
W585	*Touch-Code* decoder, individual call
W586	EMS accessory group with headset and footswitch
W587	EMS accessory group with handset
W589	Public address module
W591	Auxiliary switch panel
W599	Pushbutton control head, 8-mode
W614	Pushbutton control head, 16-mode
W615	Pushbutton control head, 32-mode
W652AA	Broadband antenna matching, 33–43 MHz
W681	*MDC-600* unit ID and Sel Call encode/decode
W682	*MDC-600* five status
W683	*MDC-600* five status, one message
W687	*MDC-600* unit ID and Sel Call encode/decode
W688	*MDC-600* emergency pushbutton
W703	Talkback scan
W711	*Mobile Voice Storage*
W921AA	Broadband Antenna Matching, 32–49 MHz
VB7607A	Spare accessory group, 8-mode
VB7608A	Spare accessory group, 16-mode
VB7609A	Spare accessory group, 32-mode

Performance Specifications

GENERAL

Number of Modes	Models available in 8, 16, and 32-mode configurations
Channel Resolution	Multiples of 5.0 kHz or 6.25 kHz
Squelch Options	*Private-Line* and *Digital Private-Line* coded squelch are standard and available within the same radio unit. Carrier squelch and multiple-coded squelch are optional.
Primary Power	±12 V dc with a dc-isolated floating ground system. Radio supplied for operation with negative-ground vehicles. Optional cable kit permits operation with positive-ground vehicles.
Radio Unit Dimensions	2.65″ H × 11.5″ W × 16.0″ L (67.5 mm × 292 mm × 406 mm)
Radio Unit Weight	Approximately 22 lb (10.2 kg). Shipping weight approximately 37 lb (17 kg).

			Maximum Battery Drain (inc. std. accessories)		
Model (Series)	**Frequency**	**Minimum RF Power Output**	**Standby @ 13.8 V**	**Receive at Rated Audio @ 13.8 V**	**Transmit @ Rated Power**
T71VBJ	33–50 MHz	100 W	.925 A	3.3 A	27 A

TRANSMITTER

Output Impedance	50 ohms
Spurious and Harmonic Emissions	More than 70 dB below carrier (for EIA spec. RS152B)
Frequency Stability	±.0005% of assigned center frequency from −30°C to +60°C ambient (+25°C reference)
Maximum Frequency Separation	17 MHz without degradation
Modulation	15F2 and 16F3, ±5 kHz for 100% @ 1000 Hz
Audio Sensitivity	0.080 V ±3 dB for 60% maximum deviation @ 1000 Hz
FM Hum and Noise EIA Method Companion Receiver Response RS152B Response	 −60 dB −50 dB
Audio Response	+1, −3 dB of 6 dB/octave pre-emphasis characteristic from 300 to 3000 Hz
Audio Distortion	Less than 2% @ 1000 Hz, 60% maximum deviation
FCC Designation	ABZ89FT1610—Licensable under FCC rules Parts 22, 74, and 90 for 15F2, 16F3, and 16F9 emission

CONTROL HEAD

Type	**Rotary (standard)**	**Pushbutton (optional)**
Dimensions: excluding mounting bracket	6⅞″ W × 2″ H × 3¾″ D (175 mm × 51 mm × 95 mm)	6⅞″ W × 2¼″ H × 5¾″ D (175 mm × 57 mm × 146 mm)
Weight	1 lb (453 g)	1.5 lb (680 g)
Current Drain	150 mA	500 mA

SPEAKER

Dimensions: excluding mounting bracket	5″ × 5″ × 2½″ (127 mm × 127 mm × 63 mm)
Weight	1.5 lb (680 g)

Performance Specifications (continued)

RECEIVER

Input Impedance	50 ohms			
EIA Modulation Acceptance	±6.5 kHz minimum			
Frequency Stability	±.0005% of assigned center frequency from −30°C to +60°C ambient (±25°C reference)			
Maximum Frequency Separation	17 MHz without degradation			
Sensitivity 20 dB quieting EIA SINAD	 0.35 μV 0.25 μV			
Intermodulation EIA SINAD	 75 dB			
Spurious & Image Rejection	90 dB except 80 dB @ 37.85 MHz			
Selectivity EIA SINAD	**Adjacent Channel**	**Alternate Channel**	**4th Channel**	**±400 kHz**
20 kHz Ch.	85 dB	90 dB	100 dB	100 dB
Squelch Sensitivity	Carrier squelch (at threshold setting), Tone-Coded Squelch (fixed), Digital-Coded Squelch (fixed), are all 8 dB SINAD (0.25 μV maximum without preamp; 0.13 μV with preamp)			
Audio Output	15 watts @ less than 3% distortion into an 8-ohm load			
FCC Designation	ABZ89FT1610			

SYSTEMS 90•S *OPTIONS*

- *Quik-Call II* Signaling
- *Touch-Code* Signaling
- Single-Tone Signaling
- EMS Accessory Group
- Digital Dial Signaling
- Electronic Siren and Public Address
- Mobile Public Address
- VPA (Speech Scrambler)
- Auxiliary Switch Panel
- *MDC-600*
- *MVS-20*

1. Introduction

The low-band *SYNTOR X* radio (Figures 1 and 2), a microcomputer-controlled transceiver with all-solid-state circuitry, uses a synthesizer to generate its frequencies.

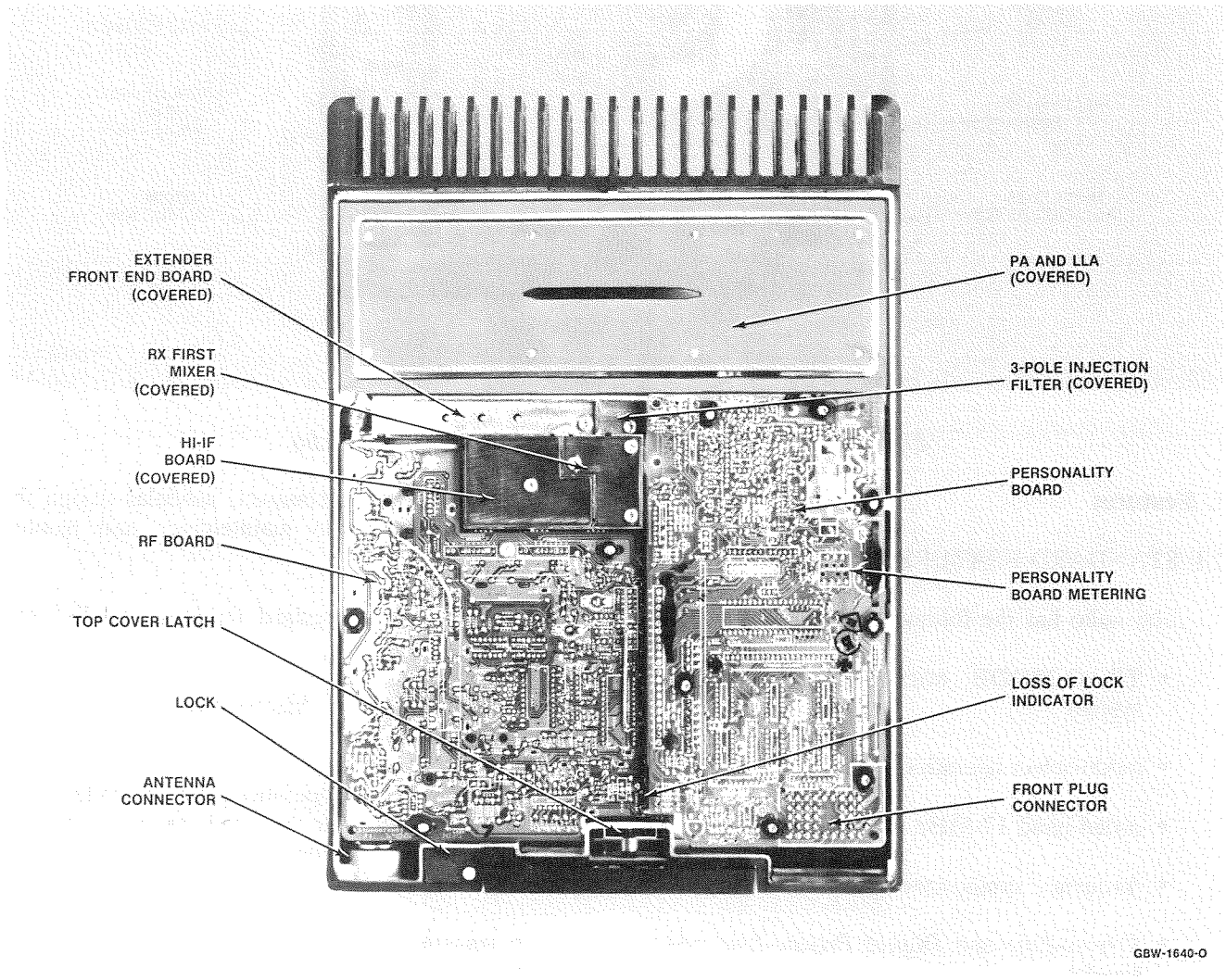


Figure 1. Top View of Low-Band SYNTOR X *Radio*

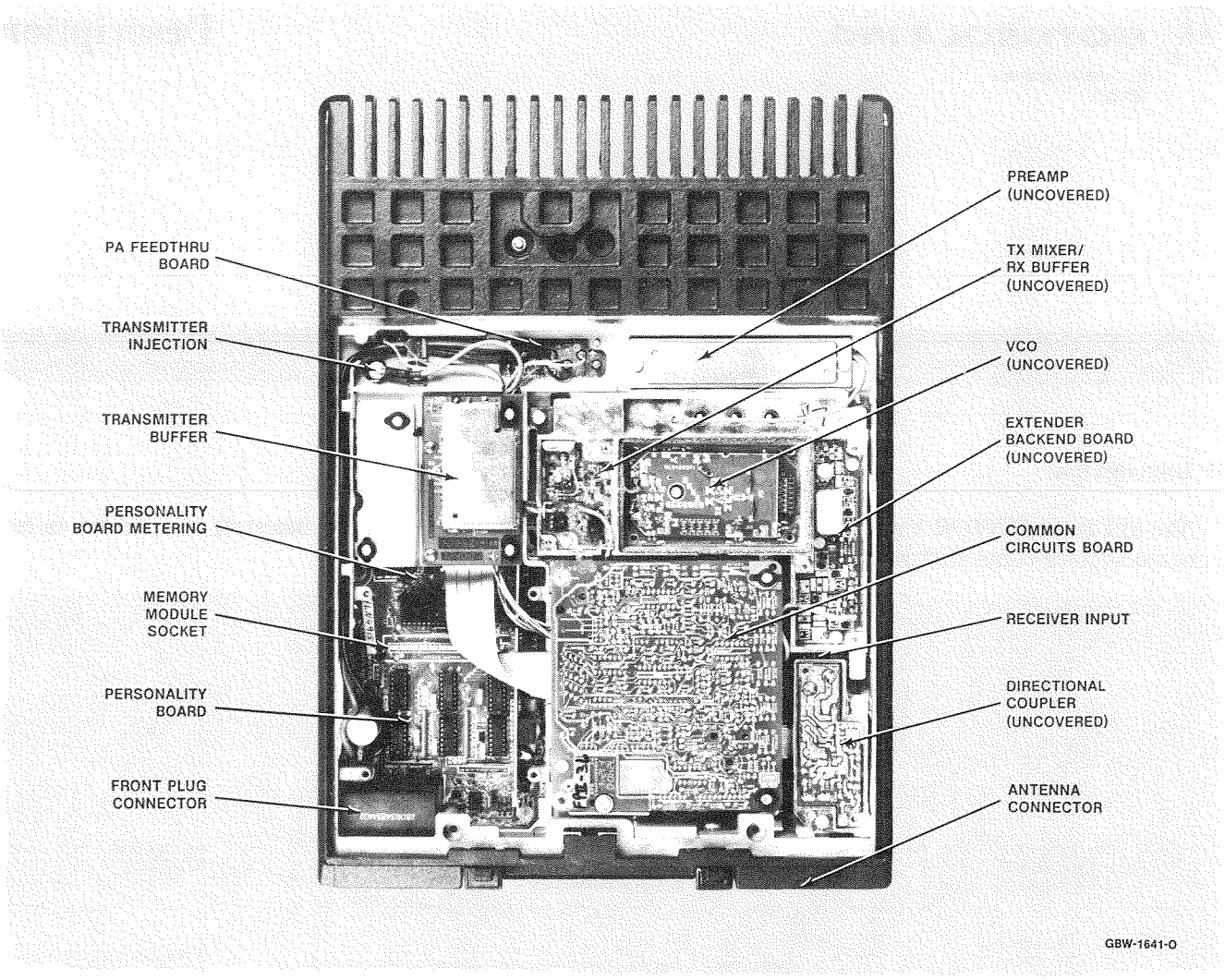


Figure 2. Bottom View of Low-Band SYNTOR X *Radio*

2. Features

2.1 STANDARD FEATURES

The radio has the following standard features:

- TRAC-MODE microcomputer-controlled system
- mode-select operation
- broad-band 17-MHz transmitter and receiver
- frequency synthesizer
- *Private-Line* and *Digital Private-Line* coded squelch
- rugged construction that meets MIL-STD-810C specifications with respect to rain, dust, salty atmosphere, shock, and vibration
- all-solid-state, compact, modular design that simplifies radio maintenance and trouble-shooting

Some of these standard features are discussed below.

2.1.1 TRAC-MODE Microcomputer-Controlled Operation

Major radio set operations are controlled by an eight-bit microcomputer that reads the user-specified operating parameters from a memory module. These parameters include:

- transmit and receive frequencies
- *Private-Line* or *Digital Private-Line* squelch codes
- *Channel Scan* operation
- time-out-timing
- ''AND'' or standard squelch

Customizing is simply a matter of replacing the memory module with one that has been programed according to the user's requirements. Consequently, a *SYNTOR X* radio can easily be moved between fleets with different operating parameters.

2.1.2 Mode-Select Operation

Mode-select operation is a major feature of the TRAC-MODE system. It gives the operator only one switch to control, thus simplifying the operation of the radio and reducing the chance of missing messages. A "mode" consists of a list of functions performed on a channel. The mode-select options put various auxiliary functions under control of the control head selector switch, thus eliminating the need for separate controls and control heads. The mode-select feature allows the operator to simultaneously select:

- the transmit and receive frequency or frequencies
- *Private-Line* operation on some channels, *Digital Private-Line* or carrier squelch (CSQ) on others; also "slaved" multiple *Private-Line* or *Digital Private-Line* squelch select (transmit or receive)
- *Channel Scan* monitoring, including the ability to specify the channels to be scanned as well as the priority level associated with each scanned channel
- duration for the time-out timer

2.1.3 Broad-Band 17-MHz Operation

The low-band *SYNTOR X* radio can transmit and receive on any combination of authorized frequencies, multiples of 5.0 kHz or 6.25 kHz, in the entire 33–50 MHz range without any degradation in performance. The radio has been designed not to need special "dual exciter" or "dual front end" circuits that operate on widely separated channels. Its radio frequencies can be changed or freqencies added without the set's being retuned or realigned.

2.1.4 Frequency Synthesis

The radio has a synthesizer that generates all required frequencies electronically without using individual channel elements. The synthesizer's "fast-locking" feature handles priority *Channel Scan* monitoring options as well as data applications that require fast frequency switching.

2.1.5 Improved Transmitter and Receiver Performance

The radio receives and transmits over 17-MHz bandwidths without degradation. Its frequency stability is rated at ±5 ppm, its transmit audio distortion less than 2%. Receiver sensitivity is rated at 0.35 microvolt (EIA SINAD) over the full 17-MHz bandwidth.

2.1.6 *Private-Line* and *Digital Private-Line* Coded Squelch

Private-Line or *Digital Private-Line* coded squelch is programed into the memory module as required. This feature allows the operator to hear only those messages that use his individual system code, thus reducing listening fatigue as well as the probability of missing or misunderstanding messages.

2.1.7 Positive and Negative-Ground Systems

The radio is designed to operate in vehicles with positive or negative-ground systems. The only requirement is that a cable kit with the correct polarity be used. Separate converter kits are not required.

2.2 OPTIONAL FEATURES

The radio has the following optional features:

- repeater talkaround
- mode-selectable *Channel Scan*
- operator-select *Channel Scan*
- programable time-out timer
- programable "AND" opening squelch
- multimode pushbutton control head
- *Systems 90•S* options

2.2.1 Repeater Talkaround

Repeater Talkaround permits direct communication between two mobile units or between a mobile and a portable unit. Talkaround operation is selected with the Mode-Select knob, a separate pushbutton, or a toggle switch.

2.2.2 Multiple *Private-Line* and *Digital Private-Line* Coded Squelch

Coded squelch for multiple *Private-Line* and *Digital Private-Line* is programed into the memory module and is activated by means of the Mode-Select knob. Coded squelch is used for repeater access, selective call, and other purposes. This feature allows a radio unit to operate into both *Private-Line* and *Digital Private-Line* systems. All *Private-Line* and *Digital*

Private-Line squelch codes are programed into the memory module, making both types of coded squelch as well as carrier squelch available in the same *SYNTOR X* radio to operate in systems having different squelch codes—single, multiple, or mixed. Codes can be changed with an appropriately programed memory module that plugs into the radio.

2.2.3 Mode-Select *Channel Scan*

The *Channel Scan* parameters are preprogramed into the memory module and are activated by means of the Mode-Select knob. *Channel Scan* operation is very simple, since this is the only switch or control that the operator has to use.

2.2.4 Operator-Select *Channel Scan*

Operator-Select *Channel Scan* allows the operator to select manually one to eight non-priority channels. This is suited to operators who prefer manual *Channel Scan* operation.

2.2.5 Time-Out Timer

When the time-out timer is preprogramed into the memory module, it makes the transmitter stop transmitting either after a fixed period of 60 seconds or after a duration ranging from a minimum of 15 seconds to a maximum of 7 minutes and 45 seconds, in 15-second increments, according to the information programed into the memory module. This timer option prevents repeaters and channels from being tied up by the prolonged keying of a transmitter.

2.2.6 "AND" Opening Squelch

When "AND" opening squelch is preprogramed into the memory module, it makes the audio unmute when both the proper signal strength (level set by the SQUELCH control) and the proper code (*Private-Line* or *Digital Private-Line*) are present. This squelch option has the advantages of *Private-Line* or *Digital Private-Line* for privacy and protection against fading signals, yet it allows the operator to select the signal quality required to unmute the receiver while "on hook." It can also be used to eliminate messages coming from distant users of the same frequency and *Private-Line* or *Digital Private-Line* code.

2.2.7 Pushbutton Control Head

The pushbutton control head is an optional substitute for the standard rotary control head. It is available in 8, 16, and 32-mode configurations. The optional *Channel Scan* monitoring display (W495) allows the radio to monitor frequencies up to the capacity of the pushbutton control head, in groups of eight.

3. Electrical Characteristics

The basic *SYNTOR X* radio consists of a single-frequency unit that operates from a negative-ground 12-volt dc source, a rotary-mode-select control head, a speaker, a microphone with a hangup box, a ¼-wave unity-gain antenna, and a 17-foot negative-ground cable kit. The basic radio also has coded squelch for both *Private-Line* and *Digital Private-Line* coding.

3.1 CIRCUIT BLOCKS

The low-band *SYNTOR X* radio can be grouped into physical blocks: personality board, input/output (I/O) board, memory module, common circuits board, 100-watt power amplifier, radio frequency (RF) board, directional coupler board, and internal casting. The internal casting includes a voltage-controlled oscillator (VCO), RX injection filter, TX mixer, RX mixer, extender front and back end, and high IF.

3.2 FUNCTIONAL DESCRIPTION

The radio has four functional parts: the microcomputer, the frequency synthesizer, the receiver/extender, and the transmitter. The microcomputer circuits are on the personality board; the frequency synthesizer circuits are on the common circuits board, RF board, and internal casting; the receiver/extender circuits are on the personality board, common circuits board, RF board, and internal casting; and the transmitter circuits are on the common circuits board, directional coupler board, and power amplifier. Each functional segment is discussed briefly below, and again in more detail in the section associated with the circuit in question.

3.2.1 Microcomputer

An eight-bit microcomputer controls the personality board. This board has a 3.6-MHz clock crystal with its own crystal oscillator circuitry. The microcomputer reads the user-specified operating parameters, such as the transmit/receive frequencies, *Private-Line* or *Digital Private-Line* codes, *Channel Scan,* time-out timing, and squelch codes, from a preprogramed memory. The operating mode of the radio is selected by means of the Mode-Select knob on the control head. This knob not only determines the transmit and receive frequencies, but also selects a specific set of operating parameters from those preprogramed into the memory module.

3.2.2 Frequency Synthesizer

The frequency synthesizer uses a phase-locked loop consisting of a reference oscillator, a voltage controlled oscillator (VCO), a multiplexed-input divider,

a sample-and-hold phase detector, a phase modulator, and an adaptive loop filter. In addition to the phase-locked loop, the frequency syntheiszer contains a receive injection doubler, transmit injection doubler, and a transmit injection mixer and buffer. For frequency generation control, the microcomputer reads the proper information from the memory module and then applies it to the multiplexed-input divider via four data lines. This information is contained in six four-bit words. A multiplexing sequence passes the six words to the divider. The divider divides the reference oscillator and VCO frequencies and generates four bits. Two of these bits (C0 and C1) turn the receiver's extender "on" or "off." The other two bits (S0 and S1) are used by the sample-and-hold phase detector to control the loop adaptive filter. Once the mode of operation and the channel are selected, the six four-bit words stay the same. However, any change in mode makes the microcomputer address different memory locations in the memory module. Consequently, the six four-bit words supply different information to the divider via the four data lines.

In the receive mode, high side injection is supplied to the receiver's second mixer by the receive injection doubler. This signal is generated by doubling the third harmonic of the reference oscillator. In the transmit mode, this signal is routed to the transmit injection doubler, which doubles and amplifies the signal to make it high-side injection for the transmit injection mixer. The transmit injection mixer then mixes this signal with that of the VCO to generate the transmit injection signal. The transmit injection signal is filtered and buffered before being applied to the transmitter's low level amplifier (LLA).

Microphone audio from the personality board is applied to the IDC circuitry along with the PL/DPL encode signals (if used). The IDC circuits process the audio to ensure that the proper level of audio drive is supplied to the frequency synthesizer. In *Private-Line/Digital Private-Line* radios, the low-frequency PL/DPL encode signals from the personality board are combined with the microphone audio signal and routed to the VCO and phase detector via the deviation and compensation circuits.

3.2.3 Receiver

Incoming RF signals go through the directional coupler, harmonic filter, antenna switch, high-pass filter, and preamp on their way to the first mixer stage. The combined selectivity of the harmonic filter and high-pass filter prevents high-level out-of-band signals from degrading receiver performance. The radio does not use receiver channel elements to generate the first mixer injection frequency. Rather, the frequency synthesizer supplies a high-side injection frequency that is applied to the first mixer via an injection filter. The resulting 75.7-MHz high IF signal is amplified, filtered by a SAW (Surface Acoustic Wave) filter, and applied to the second mixer. The second mixer converts the signal to the 10.7-MHz low IF via an 86.4-MHz high-side injection from the synthesizer. The 10.7-MHz signal passes through the extender's blanking switches (unless blanked) and several stages of amplification and crystal filtering before being applied to the limiter/detector.

The squelch circuit gives the microcomputer two signals (CHANNEL ACTIVITY and SQUELCH TAIL). In the absence of an RF carrier, both signals are low. When an RF carrier appears, both signals switch to high, and this tells the microcomputer to enable the audio stages. The faster CHANNEL ACTIVITY line is used as a preliminary indicator during *Channel Scan* operation, while the SQUELCH TAIL line protects the audio signals against fading.

3.2.4 Extender

The extender is a noise-pulse blanking circuit, so named because it extends the operating range of the radio in high-noise environments (ignition noise, dc motor noise). It consists of three basic elements: a tuned-RF AM receiver with post-detection pulse shaping, a delay element in the high IF, and a low-IF blanking switch. The latter two elements are part of the main radio receiver. The extender receiver's input is tapped off the main radio receiver's preamp output. The extender receiver is field-tuned to a clear frequency about three MHz from the user's channel, where it listens for noise pulses. When it detects one, it generates an output and routes it to the blanker switch. This switch shuts off the main receiver's low IF for the duration of the noise pulse, but since the blanking interval is short (6 μs), the operator does not hear an interruption in the audio. In order to allow time for the detection of the noise pulse and the generation of the blanking waveform, a SAW filter in the high IF ahead of the second mixer and blanking switches delays all signals (desired and undesired) in the main receiver signal path by 2.5 μs.

3.2.5 Transmitter

The RF output generated by the frequency synthesizer at the required transmit frequency goes to the low-level amplifier (LLA). A controlled stage on the PA circuit board, the LLA consists of Q801 and associated matching circuitry. It amplifies the synthesizer power from 75 milliwatts (typical) to 2.5 watts (typical).

The LLA drives the power amplifier, supplying it directly with A+ through the red lead. The PA

Table 1. Data Contained in Mode Label A (for illustration only)

Mode	Control Head Mode	RX Freq. (kHz)	TX Freq. (kHz)	RX Code	TX Code	Dir. req.	TOT (Min.)	Sql.
1	1	33000	33000	1A	1A	—	1	AND
2	2	34000	34000	CSQ	1A	—	0.25	Std
3	3	35000	35000	7A	036	—	7.75	AND
4	4	36000	36000	134.8	134.8	—	Off	AND
5	5	37000	37000	174	CSQ	—	1	Std
6	6	38000	38000	CSQ	CSSQ	—	Off	Std
7	7	39000	39000	CSQ	CSQ	—	Off	Std
8	8	43000	43000	CSQ	CSQ	—	Off	Std

Note: Label A is supplied with each radio.

circuitry consists of Q802, 3, 4, and associated matching circuits. Driver Q802 amplifies the drive from the LLA to approximately 20 watts, and Q803 and Q804, the final stage, amplify it further to approximately 140 watts. Losses in later passive circuits reduce this power to 110 watts (set level). The final stage also has current-sensing and temperature-sensing circuitry (R814, RT801, and R815) for power control functions.

The PIN diode antenna switch is a solid-state circuit that uses the dc-excitable, variable-resistance properties of PIN diodes to make either low or high-impedance paths for RF signal flow. In the receive mode, receiver PIN diodes CR971 and CR972 are forward-biased, and PIN diode CR970 is reverse-biased by saturated transistor Q980. This allows the incoming signal to pass from the low-pass filter to the high-pass filter and preamplifier.

During transmit, keyed 9.4V turns transistor Q980 off and concurrently forward-biases transmit PIN diode CR970, presenting a low-loss path from the PA to the low-pass filter. As the transmitter power increases, a peak detector consisting of C970, CR973, CR974, CR975, and R972 detects the negative portion of the RF signal, converting it to a negative dc potential, which reverse-biases the receiver PINs and keeps the receiver isolated from the high-power transmitter signal.

The harmonic filter is an 11-pole, five-zero elliptic filter. It has the steep roll-off it needs to accommodate the large bandwidth of the transmitter. This circuit is in the receive path, as is the directional coupler.

The directional coupler senses forward and reflected transmit power separately, and generates a detected dc voltage proportional to each. The forward detected voltage goes to the power-set circuitry on the common circuits board. The reflected detected voltage warns of a high (3½:1) VSWR and triggers the shutback circuitry, which is also on the common circuits board, along with temperature and over-current sense shutback circuits.

3.3 MODES OF OPERATION

3.3.1 The mode of a *SYNTOR X* radio is preprogramed with the following data:

- receive frequency
- receive coded squelch

} receive channel

- transmit frequency
- transmit coded squelch

} transmit channel

- time-out-timer duration
- squelch operation
- channel scan operation
- channel scan frequency list

} radio control data

Each mode position on the control head has its own receive channel, transmit channel, and radio control data information, some of which may be the same on different modes.

3.3.2 Every low-band *SYNTOR X* radio has a mode label (Table 1) that gives the data for the modes that have been preprogramed into the radio for the user. This label (Label A) is on the inside of the top cover of the radio. If the radio has all the options, it has two more labels: Label B (Table 2) for *Channel Scan*, and Label C (Table 3) for any of the operator-selectable coded squelch options (W415 or W416). The labels shown in Tables 1, 2, and 3 are illustrative examples of these.

Table 2. Date Contained in Mode Label B (for illustration only)

Control Head Mode	*Channel Scan*	Internal List	P1	P2
1	On	7, 8	1	4
2	Off	—	—	—
3	Off	—	—	—
4	On	4, 5, 7, 8	1	5
5	On	4, 5	None	None
6	On	1, 4, 5	6	None
7	Off	—	—	—
8	Off	—	—	—

Note: Label B is supplied for radios equipped with one of the *Channel Scan* options.

Table 3. Data Contained in Label C (for illustration only)

Code	TX	RX
1	1A	1A
2	7A	CSQ
3	CSQ	7A
4	036	036
5	214.0	214.0
6	306	M1
7	M6	M6
8	142.4	142.4

Note: Label C is supplied for radios equipped with the operator-selectable coded squelch option.

3.3.3 The sample Label A in Table 1 shows that the radio has eight modes and that each mode contains different data. For example, Mode 1 specifies the following:

- Receive frequency: 33000 kHz
- Transmit frequency: 33000 kHz
- Receive code: PL code 1A
- Transmit code: PL code 1A
- Direct frequency: none (this is specified only if the repeater/talkaround option is used)
- Time-out timer: one minute
- Opening squelch: AND

3.3.4 The one-minute timer-out timer duration specified for Mode 1 is standard. However, a radio can be preprogramed with shorter or longer time-outs—from 15 seconds to 7 minutes and 45 seconds in 15-second increments.

3.3.5 Squelch is specified as standard or "AND." When it is standard, the radio unmutes upon detecting the proper coded squelch and mutes upon losing it. Consequently, for standard squelch operation, the operator need not set the SQUELCH control. When "AND" squelch is used, the radio unmutes upon detecting both the proper coded squelch and channel activity, and mutes upon losing the proper coded squelch. With "AND" squelch, the operator can use the SQUELCH control on the control head to adjust the squelch. The difference between the two types of squelch is summarized in Table 4. With either type, the receiver reverts to the carrier squelch mode when the the operator removes the microphone from the hangup box, so that he can verify that the channel is clear before transmitting. With the microphone out of the hangup box, the SQUELCH control adjusts the squelch level even if the squelch is standard.

Table 4. Standard and "AND" Squelch Operation

Squelch Type	Radio Unmutes	Radio Mutes
STANDARD	Detection of proper coded squelch	Loss of detection of proper coded squelch
"AND"	Detection of proper coded squelch *and* channel activity	Loss of detection of proper coded squelch

3.3.6 Mode 1 of Label B (Table 2) specifies the following additional data for radios equipped with a *Channel Scan* option:

- *Channel Scan:* ON
- Internal list: Modes 7 and 8
- Highest priority mode (P1): Mode 1
- Second highest priority mode (P2): Mode 4

3.3.7 Where Table 2 shows *Channel Scan* off, it has no further data. Where it shows *Channel Scan* on, a list of non-priority channels follows. This can be followed by a priority-one (highest priority) channel and, possibly, by a priority-two (second-highest priority) channel. For example, Mode 1 of Table 2 has *Channel Scan*, with a non-priority internal list containing Modes 7 and 8. The highest-priority (P1) mode is Mode 1 (the selected mode) and the second-highest-priority mode is Mode 4. If the highest-priority and the second-highest-priority modes are not specified, P1 and P2 are labeled "NONE," as shown in Mode 5. If only the highest-priority mode is specified (as shown for Mode 6), the second-highest-priority mode (P2) is labeled "NONE."

3.3.8 With Mode 1 selected, and in the absence of channel activity, the radio receiver scans all the modes designated in the internal list, P1, and P2 (Modes 7, 8, 1, and 4). When it detects activity on a non-priority mode (Modes 7 and 8), the radio stops scanning all the channels and unmutes the audio on the mode with the activity, but persists in looking for activity on the highest-priority mode (Mode 1) and the second-highest-priority mode (Mode 4). This search is analogous to "cutting small holes" in the audio while the receiver is sampling the priority modes. If the radio detects activity on the second-highest-priority mode (Mode 4), that activity takes precedence over the non-priority modes, and the receiver reverts to it. Once locked on the second priority channel, the receiver keeps looking for activity on the highest-priority channel (Mode 1); again, the search "cuts small holes" in the audio while the receiver is looking for activity on the highest-priority channel. When it detects activity on the highest-priority channel, the receiver locks on this channel and no further scanning occurs until after activity has ceased on the highest-priority channel.

3.3.9 Code 1 of Label C (Table 3) specifies the following additional data for radios equipped with an operator-selectable coded squelch option:

- Transmit code: PL code 1A
- Receive code: PL code 1A

3.4 OPERATOR-SELECTABLE MULTIPLE CODED SQUELCH

With the *Systems 90•S* operator-selectable multiple coded squelch option, the transmit (TX) and receive (RX) codes are the ones specified in Table 3. For Mode 1, for example, the TX and RX codes are 1A, as shown in Table 3. If this option is turned off, the TX and RX codes are specified on Label A (Table 1).

4. Primary Power Source

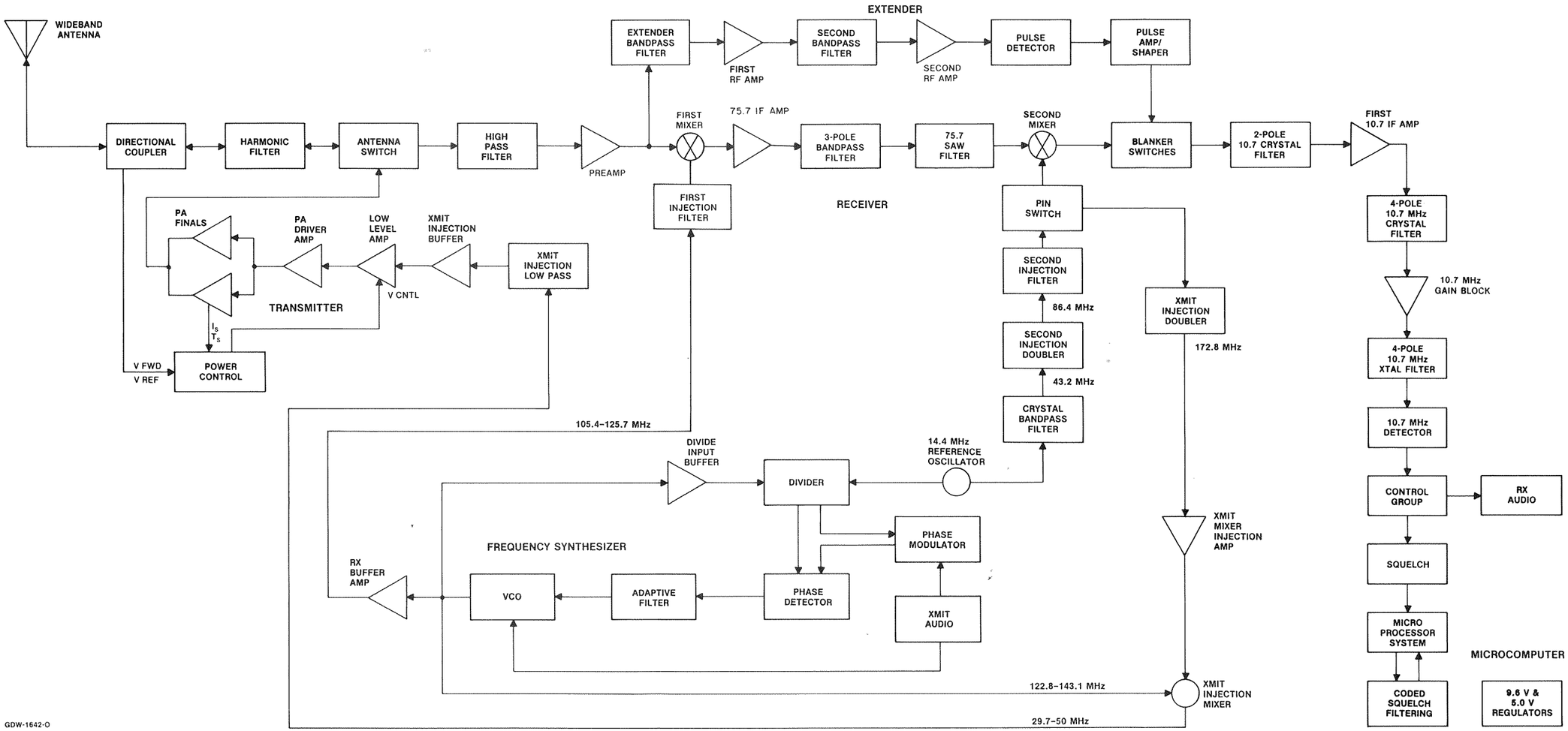
The *SYNTOR X* radio is designed to operate from a negative-ground, 12-volt dc source, but an optional cable kit allows it to operate from positive-ground sources. The radio has a built-in floating ground.

5. Physical Characteristics

5.1 The *SYNTOR X* electronic circuits are enclosed in a rugged low-profile housing. One end of the housing contains the antenna connector, lockswitch, main cable connector, and handle. The other end contains the heatsink fins, which cool the power amplifier circuits. Partitions and shielding covers isolate the various radio circuits. The radio has an easy-to-snap-on top cover and a bottom cover that is fastened to the radio by four screws. It also has a mounting tray.

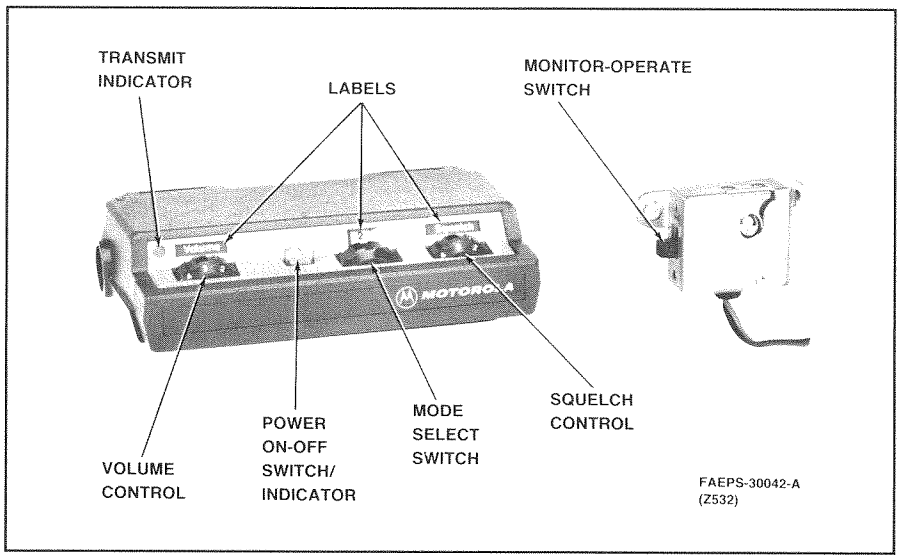
5.2 The radio uses printed circuit boards that are plugged together and can be unplugged. Its electronic circuits are in five major subassemblies that are easy to remove and replace. A simple procedure isolates the TRAC-MODE microprocessor. With Motorola's standard centralized metering arrangement, the radio requires only three field adjustments, and this simplifies servicing and the replacement of parts.

5.3 The *SYNTOR X* radio occupies 487 cubic inches (8002 cubic centimeters) of space and weighs approximately 22 lb (10 kg).



GDW-1642-O

Block Diagram for
Low-Band *SYNTOR X* Radio
PBW-2189-O
8/28/85



1. Introduction

1.1 The *SYNTOR X* control head has the following controls and indicators:

- rotary volume control
- two-way (up or down) power on-off switch and indicator
- rotary mode-select switch (not on single-mode control heads)
- rotary squelch control
- transmit indicator light
- labels associated with the volume, power on-off, mode-select, and squelch controls

1.2 The microphone hangup box has a single two-way (up or down) monitor-operate switch.

2. To Receive

(1) Put your finger under the control head and push the power on-off switch up until it locks in position. The indicator light will be visible only in low ambient light.

(2) On multiple-mode models, select a mode.

Note

The Description Section of the service manual contains a full description of the *SYNTOR X* mode operation.

(3) (PL/DPL models) With the microphone in its hang-up box, push the monitor-operate switch down. You can hear only the PL/DPL-encoded signals with the switch in this position. Push the monitor-operate switch up; now you can hear all signals on this frequency.

(4) Remove the microphone from its hangup box. Now you can hear all the on-frequency signals regardless of the position of the monitor-operate switch.

(5) Turn the squelch control counterclockwise to the stop.

(6) Turn the volume control clockwise.

(7) Slowly turn the squelch control clockwise until the noise is just squelched (cannot be heard).

(8) Set the volume control for a comfortable level with an incoming signal.

(9) To transmit, follow the steps in the next section. (To turn off the power, push the power on-off switch down until it locks.)

3. To Transmit

(1) If the equipment power has been turned off, turn it on by repeating Step 1 of the "To Receive" procedure.

(2) Turn on the vehicle ignition switch, if necessary. Keep the engine running while transmitting to avoid draining the battery.

(3) Perform Steps 2 through 8 of the "To Receive" procedure, if you have not already done so.

(4) Remove the microphone from its hangup box; now you hear all the on-frequency signals. After verifying that the channel is clear, push the microphone PTT switch. The transmit indicator lights up.

(5) Start transmitting by first identifying yourself and the mobile unit or station being called. (For best results, keep the microphone at least one inch from your lips.)

(6) At the end of the transmission, release the PTT switch and listen for a reply.

(7) When you are through transmitting and receiving, turn the power off by pushing down the power on-off switch. All indicators go out.

4. *SYNTOR X* Modes

4.1 The *SYNTOR X* modes are preprogramed into the radio's memory at the factory in accordance with the user's requirements. A *SYNTOR X* radio can be programed with four, eight, sixteen, or thirty-two modes (1, 2, 5, or 8 modes for 800 MHz). For example, a mode (depending on the options used) may be programed as follows:

- Mode: 1
- Receive frequency: XXXXXX
- Transmit frequency: XXXXXX
- Receive code: PL code 1A
- Transmit code: PL code 1A
- Time-out timer: one minute
- Opening squelch: AND
- *Channel Scan:* ON
- Internal list: Modes 7 and 8
- Highest-priority mode: Mode 1
- Second-highest-priority mode: Mode 4

4.2 For further information on the *SYNTOR X* modes, refer to the Description Section in this manual.

1. Service

To buy a service contract for your Motorola equipment, contact your Motorola Service Representative, or write to:

National Service Manager
Motorola Communications Group
1301 E. Algonquin Road
Schaumburg, Illinois 60196

2. FCC Requirements

2.1 The FCC requires that you obtain a station license for your radio equipment before transmitting. No operating license or permit is required. The station licensee is responsible for ensuring that the transmitter power, frequency, and deviation are within the limits defined by the station license.

2.2 The licensee of the station is at all times responsible for the proper operation and maintenance of the equipment. No FCC License is required for personally maintaining the equipment

2.3 The power input to the final radio frequency stage cannot exceed the maximum power specified on the current station authorization. You must measure this power input and record the results:

- when the transmitter is first installed
- when the transmitter is changed in any way that may increase the power input
- at least once a year

2.4 You must check the frequency and deviation of the transmitter:

- when it is first installed
- when the transmitter is changed in any way that may affect the carrier frequency or modulation characteristics
- at least once a year

3. Pre-Installation Tests

Although the equipment is aligned accurately at the factory, mishandling in transit may disturb some of the adjustments. In any case, FCC regulations require the checking of transmitter frequency and deviation at the time of installation. Therefore a pre-operational check is mandatory. To make a complete check, follow the sequence of tests presented below. (The tests are described in more detail in the Maintenance and Troubleshooting Section of this manual.)

(1) Check the highest transmit frequency (highest repeater frequency) and adjust as required. This adjustment also corrects any receive frequency errors caused by the reference oscillator.

(2) Measure the transmitter power output at the highest transmit frequency on modes programed for both high-power and low-power operation (only one power level for 800 MHz), and make adjustments as required.

(3) Measure the transmitter deviation at the highest transmit frequency (highest repeater frequency) and make the necessary adjustments.

(4) Measure the transmit frequencies.

(5) Measure the receive frequencies.

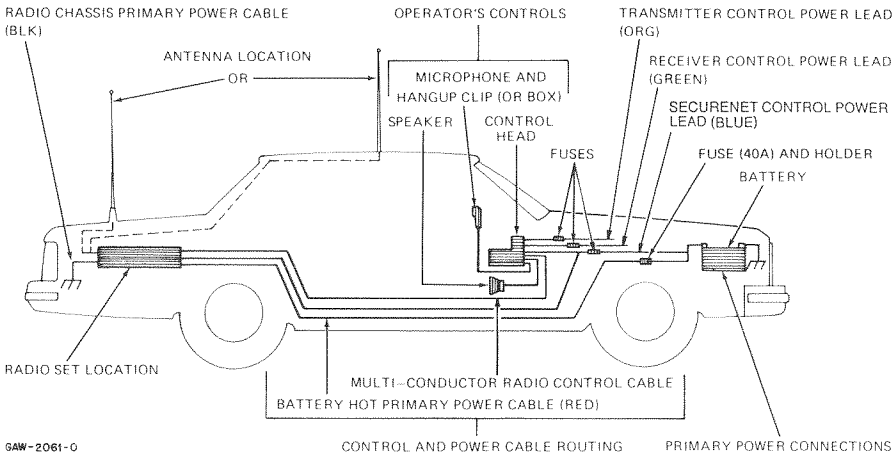


Figure 1. Installation Planning

(6) Measure the 20dB-quieting signal levels.

(7) Measure the PL or DPL sensitivity in PL/DPL modes.

Note

Repeat Steps 4 through 7 for each mode.

(8) Check the VSWR of the antenna after installing it in the vehicle.

4. Installation Planning

See the installation planning diagram (Figure 1) for information on antenna placement, operator's controls, radio set location, control and power cable routing, transmitter control power lead, receiver control power lead, and primary power connections.

WARNING

For vehicles equipped with electronic anti-skid braking systems, refer to "Anti-Skid Braking Precautions," Motorola publication 68P81109E34. This document is available free of charge.

4.1 ANTENNA LOCATION

The best location for the antenna is at the center of a large ground plane such as the vehicle's roof. This, however, is not ordinarily a practical location for a quarter-wave whip antenna. If you are using such an antenna, see the antenna manual for other suggestions.

Note

Do not alter the whip length of the antenna or the length of the coaxial cable when installing UHF and high-band radios, because these changes can affect the antenna's broadband performance.

The best location for the base-loaded antenna is at the center of the vehicle's roof. A good alternate location is at the center of the trunk lid. See the antenna manual for details.

Before mounting the antenna, be sure that the antenna cable can be routed to the radio set.

CAUTION

The antenna must be installed at least two feet (0.6 meter) from people in the vehicle unless they are shielded by a metallic surface.

4.2 RADIO LOCATION

In most vehicles, the best location for the radio unit is on the floor of the trunk compartment. Make certain that the location does not expose the radio set to dirt and moisture. Leave enough space around the radio for adequate cooling and for inserting the radio into and removing it from the mounting tray.

4.3 OPERATOR'S CONTROLS

The control head and the microphone hangup box must be within convenient reach of the vehicle's operator, and yet must not interfere with the operation of the vehicle or its accessories, or interfere with passenger seating or deprive the passenger of leg space. Adjustable trunnions allow the control head and speaker to be mounted on most surfaces, even those that are neither horizontal nor vertical. Good mounting surfaces for the control head, microphone hangup box, and speaker are the underside of the dashboard, the transmission hump, and the center console. The speaker can also be mounted on the firewall. The hangup box or clip can be mounted on the underside of the control head.

4.4 CONTROL AND POWER CABLE ROUTING

Many vehicles have wire troughs in the door sills. If the vehicle has this feature, use it to protect the cable and simplify cable installation. In vehicles without wire troughs, route the control and power cables where they are protected from sharp edges and from being pinched

or crushed. One suggested route is along one side of the driveshaft hump under the carpet. Be sure to insert a grommet wherever the cable passes through a hole in a metal panel.

Note

The alternator whine suppression may be degraded if the unused portion of the control cable is coiled and placed directly on top of the radio.

4.5 PRIMARY POWER CONNECTIONS (Red)

The best connection point for the hot primary power lead is the hot battery terminal, but you may also use any other point with adequate current capacity that is connected directly to the battery terminal. Be sure that the point you choose stays close to 13.6 volts; some systems switch to a higher-than-normal voltage during starting.

4.6 TRANSMITTER CONTROL POWER LEAD (Orange)

You can connect this lead to the ignition switch (recommended) or directly to a battery hot supply. See the cable connections diagram.

4.7 RECEIVER CONTROL POWER LEAD (Green)

You can connect this lead to a battery hot supply (recommended) or to the ignition switch. See the cable connections diagram.

Note

Securenet radios must have continuous power to the control head to retain the *Securenet* electronic code key. If the green power lead in the cable is not connected to the hot side of the battery, install Option W268. It adds the HLN4320 code storage battery to the control head.

4.8 RADIO CHASSIS PRIMARY POWER CABLE (Black)

Connect the primary power cable for the radio chassis to a good ground point on the vehicle chassis.

4.9 *SECURENET* CONTROL UNIT POWER LEAD (BLUE)

This lead connects the Securenet control unit to the hot battery terminal. Routing of the cable depends on where the unit is located and, like the primary power connections, it may be connected to another point carrying adequate current.

5. Cable Routing

(See Figures 1 and 2. Figure 2 is on the foldout page following Page 9.)

CAUTION

In positive-ground vehicles, use a positive-ground cable kit. A negative-ground cable kit can be converted for positive-ground operation if necessary.

CAUTION

Before routing the cable (after unpacking), remove the green fused power lead, the orange fused power lead, and the two PL/DPL leads from the control head.

(1) Choose a spot for the radio in the trunk compartment, and start the cable routing from that spot, leaving enough extra cable there to allow play for plugging it into and unplugging it from the radio set.

(2) Work from the trunk space forward. In some cars there is enough room below the trunk partition to run the cables. If not, make an opening through the partition. Remove the back seat.

(3) The control-head end of the multi-conductor cable kit ends in a black, a blue, a red, and a light green connector block. If you must run the cable through areas too small for these connector blocks, remove them. Use the contact removal tool (Motorola Part No. 66C8499B01) taped to the cable kit. Slide the small end of the tool into the front of the individual contact position and push up the tab of the female contact. Now pull carefully on the wire to remove the contact from the housing. When you have done this for each wire in each connector housing, tape all the female contacts into a small bundle.

(4) Pull the cables into the back seat area, through the wire troughs, and under the dashboard. If the vehicle does not have wire troughs, route the cables under the floor mat along the side of the driveshaft tunnel. Pull the control-head end of the multi-conductor cable to the point at which you intend to mount the control head. Now reinsert the female contacts into the proper positions in the connector housings.

(5) Run the red power cable and the blue fused *Securenet* cable, if applicable, into the engine compartment through any convenient hole already in the firewall. (If necessary, make a ½-inch hole, install the supplied grommet, and run the cable through the grommet.) Trim away the excess red cable. Do not coil any excess red or black power cable near the radio. A small section of heat-shrinkable tubing comes with each cable. Slide the heat-shrinkable tubing over the red power lead from the radio. A cable fuse kit also comes with the cable.

It has a ring-tongue lug on one end and an inline fuseholder on the other. Slide the strapped portion of the red cable into the end of the inline fuseholder and crimp the joint with a Burndy Model Y10B (indent "U") crimp. If this tool is not available, solder the joint.

(6) Slide the heat-shrinkable tubing over the connection and shrink the tubing with a Motorola Model ST697 heat gun or equivalent source of heated air. Remove the fuse from the fuseholder and reconnect the holder. Fasten the ring-tongue lug on the end of the cable to the battery's ungrounded terminal or to some point connected directly to the ungrounded terminal of the battery (such as the starter solenoid). Connect the blue fused lead in a similar way, if used. Move the inline fuseholder to a convenient location on one of the sheet metal parts of the engine compartment. Center punch and drill a $\frac{9}{64}$-inch (.140") hole through the mounting surface. Then use the supplied number 10-16-¾-inch self-tapping sheet metal screw to mount the bracket. Do not replace the fuse until the entire installation of the radio set is complete.

(7) The control head power cable kit contains two separate wires, each equipped with an inline fuse. The orange wire is 69 inches long and the green wire is 100 inches long. Taped to the lugless end of each cable are a crimp-on type ring-tongue lug and a crimp-on type spade lug. The spade lug connects to hot leads at the fuse block of the vehicle and the ring-tongue lug attaches to screws of terminals. Determine from Table 1 which radio functions are to be switched through the vehicle ignition switch. A typical hookup provides for ignition switch control of the transmitter function only, thus permitting the receiver to operate whenever the radio set is turned on. In this case, the orange wire is connected to the accessory terminal of the ignition switch and the green wire is connected directly to the ungrounded terminal of the battery or starter solenoid.

CAUTION

Do NOT connect either lead to the ungrounded terminal of the battery at this time.

(8) If either wire is to be connected in the engine compartment, pass the lugless end of the wire through the same firewall hole that the red power cable uses, trim to length, and crimp on the ring lug. If the wires are to go to a point in the passenger compartment, route the cable to that point, leaving some extra length, and trim. Strip the wires and crimp on either the spade or the ring-tongue lug, whichever is required. As an extra precaution, solder the wire and lug after crimping.

(9) If the *Securenet* control unit is located at the control head, route the blue lead to the battery the same as the orange or blue wires were routed in Step 8, above.

(10) Do not dress the wires at this time, but go to the next procedure.

6. Radio

(See Figures 3 and 4 on the foldout following Page 9.)

WARNING

For vehicles equipped with electronic anti-skid braking systems, see "Anti-Skid Braking Precautions," Motorola publication number 68P81109E34. This document is available free of charge.

(1) Choose a location where the mounting screws are not directly above the gas tank, fuel line, or other vital parts. The mounting tray of the radio set must be mounted permanently on a flat surface (four mounting holes) or on an uneven surface (alternate three-point mounting). The four-point mounting is strongly recommended for vehicles subject to extreme vibrations. The raised shelf in some car trunks makes a good mounting place. Mount the radio to one side to allow space for luggage. Leave at least three inches in front of the radio set, so that the handle can be opened and the radio assembly can be removed from the mounting tray. The radio must be located so that the black ground lead can reach a good chassis ground point in the trunk. When the final position is determined, unlock the radio, open the handle, and lift the radio assembly away from the mounting tray. (Pull forward and upward to release the radio assembly.) The mounting tray can be used as a template to mark the location for drilling the four mounting holes in the trunk floor. Use a number 11 drill (.191"). Mount the mounting tray as illustrated in Figures 3 and 4.

Table 1. Connection Arrangements

Conductor	Green	Orange	Green	Orange	Green	Orange
Connected to battery	●	●	●			
Connected to ignition switch				●	See Note	●
Ignition switch controls	No radio switches		Xmtr switch		Both radio switches	
In any application, trim and strip wires. Crimp on ring lug for battery connections. For ignition switch connections, crimp on ring or spade lug (whichever is required).						

Note

In cases where alternator whine or other interference is a problem, the green lead can be isolated with a relay (Motorola part number 59-813674).

(2) In some vehicles, the front panel of the radio presses against the floor or floor cushioning when the radio is mounted securely on the trunk floor. In some vehicles, it is necessary to mount the radio directly over the gas tank, and the mounting screws may penetrate the tank. (Always make a preliminary check to see how far the screws will extend below the trunk floor.) In either case, insert one of the thick spacer washers between the bottom of the mounting tray and the thin spacer washer at each of the four mounting holes. The washers help to keep the radio level, especially when the floor is covered with a mat of a spongy material such as soft rubber. When you have installed the mounting tray, replace the radio assembly by sliding the radio onto the tray at about the halfway point. Push it straight back until the tray tabs enter the two window areas on the radio front and engage the handle tabs, and then push the handle down until it locks. The handle locks the radio to the mounting tray and conceals the top cover release button. Push the multi-conductor plug onto the male connector and rotate the thumbscrew clockwise to seat the connector. Reverse the procedure to remove the radio.

(3) Connect the black ground cable lug to a convenient location on the trunk floor. Clean the trunk floor surface thoroughly before proceeding. Center punch and drill a 3/16-inch (.187″) hole through the mounting surface. Use the supplied number 14 x ¾-inch self-tapping screw and ¼-inch lockwasher to mount the cable lug.

CAUTION

Do not puncture the gas tank.

CAUTION

The black cable must have a good ground connection if the radio is to operate properly, and to prevent damage to the radio and cable kit. It should be grounded to the vehicle frame. On some late-model automobiles, the ground connection between the vehicle chassis and engine block is inadequate for good mobile radio operation. *Do not* remedy this by connecting the radio set ground directly to the battery. Connect a flexible metal ground strap between the engine block and a vehicle chassis point common to the radio set ground. Be sure the strap is heavy enough to carry maximum transmitter supply current.

(4) All cables (including the antenna lead-in) should be dressed out of the way as much as possible to prevent damage, and the radio heatsink should go where it will have the largest possible supply of air for cooling.

7. Control Head

7.1 GENERAL

Install the control head within the reach of the operator. Pull more control cable into the area, if necessary. At this time, insert the female contacts from the blue, green, and orange fused wires into the proper positions. Be sure that all wires are clear of the points on the instrument panel where holes are to be drilled.

7.2 INSTALLATION PROCEDURE

(See Figure 5 on the foldout following Page 9.)

(1) Choose a place to mount the control head.

(2) Remove the trunnion bracket and retainer assembly from the control head by removing the two trunnion side screws.

CAUTION

Carefully remove the trunnion bracket from the control head. After removing the side screws from the trunnion bracket, spread the bracket slightly to prevent damage to the circular friction face in the cup on the control head or the clutch facing on the bracket.

(3) Remove the retainer and breakaway disk assembly from the trunnion bracket by removing the number 10-32 x ½-inch lockscrew with a 5/16-inch nut driver.

(4) Remove the tapping screws and lockwashers from the control head retainer. Discard the paper retainers.

(5) Remove the backing from the self-adhesive mounting template and fasten the template at the point where the control head is to be mounted.

Note

This template shows where the mounting holes are to be drilled, but should be left in place to show how the trunnion bracket is reassembled if the installation is changed at a later date.

(6) Center-punch and drill two 0.157-inch (number 22 drill) holes at the positions on the template.

(7) Use a 5/16-inch nut driver to mount the control head retainer and breakaway disk assembly with the supplied hardware (two number 10 x ⅝-inch tapping screws and number 10 lockwashers).

(8) Mount the trunnion bracket on the control head retainer assembly with the number 10-32 x ½-inch lockscrew removed in Step 3.

Note

Before tightening the lockscrew, rotate the trunnion bracket to the best horizontal position; then tighten the lockscrew.

(9) Insert the connector housings into the proper locations on the back of the control head. Now connect the control-cable S hook to the proper hole in the strain-relief bracket on the rear of the control head.

(10) Reinstall the control head in the trunnion bracket, observing the caution given in Step 2.

Note

Before tightening the two trunnion side screws, rotate the control head to the best vertical position.

7.3 BULB REPLACEMENT

Replace pilot bulbs from the rear of the control head. Merely rotate the socket counterclockwise 45° and withdraw it from the circuit board. Remove the wedge-type bulb by pulling it straight out of the socket with your fingers.

8. Microphone

8.1 GENERAL

The microphone bracket must be within a comfortable arm's reach of the operator. Measure this distance before actually mounting the microphone bracket or the PL/DPL hangup switchbox. Since both the bracket and hangup switchbox have positive detent action, the microphone can be mounted in almost any attitude. Mounting the bracket or hangup box on the bottom of the control head gives the microphone a breakaway feature. After installing the bracket or hangup box, connect the microphone plug to the receptacle on the control head. Make sure that the clip on the control head engages the plug firmly. Connect the microphone-cable S hook to the proper hole in the strain-relief clip on the rear of the control head.

8.2 INSTALLATION PROCEDURE
(See Figure 6.)

(1) Remove the hangup clip from its taped position on the microphone.

(2) Remove the two paper retainers and screws from the clip.

(3) Choose a location.

(4) Using the clip as a template, mark the location of the two mounting holes.

(5) Center-punch and drill a 0.144-inch hole at each location.

(6) Mount the clip securely with the supplied screws.

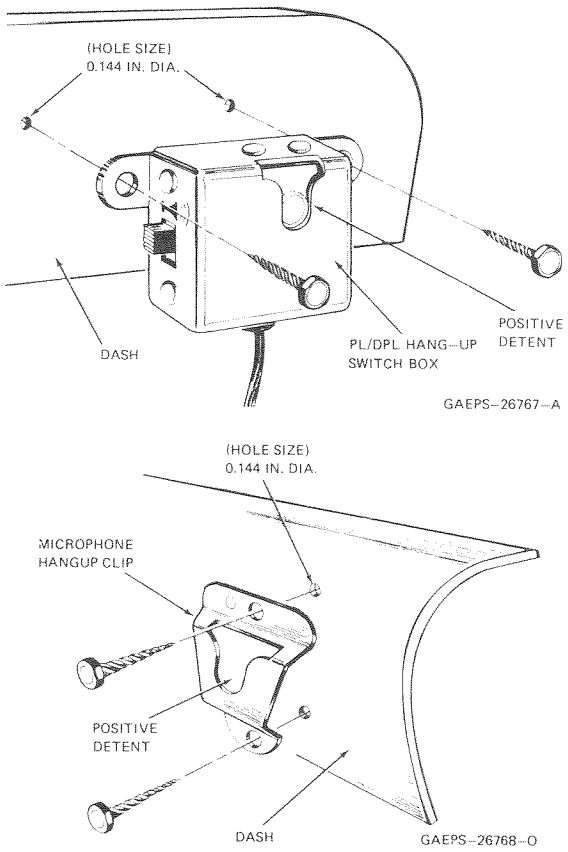


Figure 6. Microphone Accessory Installation

9. Microphone Hangup Switchbox

9.1 GENERAL (TONE *PRIVATE-LINE* AND *DIGITAL PRIVATE-LINE* MODELS ONLY)

The hangup box has a PL/DPL disable switch as well as an automatic disable that functions when the microphone is removed. It also has a positive detent. Because of the positive detent, and because the hangup box requires no external grounding of the housing, the hangup box can be mounted anywhere, in any attitude, as long as the two-circuit connector cable can reach the control head.

9.2 INSTALLATION PROCEDURE
(See Figure 6.)

(1) Remove the paper retainers and screws from the mounting flanges on the hangup box.

(2) Select a location and, using the hangup box as a template, mark the location of both screw holes.

(3) Center-punch and drill a 0.144-inch hole at each location.

(4) Fasten the hangup box securely to the mounting surface with the supplied screws.

(5) Connect the hangup box to the control head. Tape or tie up the extra cable.

10. Handset Hangup Switchbox (Optional)

The optional handset hangup switchbox can be mounted either with a trunnion bracket or flush against a flat surface.

10.1 TRUNNION MOUNT

(1) Remove the three protective caps and screws from the trunnion bracket.

(2) Place a handset in the hangup unit.

(3) Choose a location that is convenient for the operator and allows the handset to clear the floor or transmission tunnel.

(4) Mark this location lightly.

(5) Remove the handset from the hangup unit.

(6) Loosen the two screws securing the hangup unit to the trunnion bracket, and remove the trunnion bracket.

(7) Using the trunnion bracket as a template, mark the location of the three mounting holes.

(8) Center-punch and drill a 0.175-inch hole at each location.

(9) Mount the trunnion bracket with the screws supplied.

(10) Reinstall the hangup unit in the trunnion bracket and tighten the two screws.

(11) Remove the escutcheon backing and press the escutcheon firmly into place.

(12) Connect the hangup box wires to the black connector (P1101) and the blue connector (P1102).

10.2 FLUSH MOUNTING

(1) Remove the trunnion bracket, two screws, and two flat washers. Keep this hardware for future use.

(2) Put a handset in the hangup unit.

(3) Select a location that is convenient for the operator and allows the handset to clear the floor or transmission tunnel.

(4) Use the hangup unit as a template and mark the location of the two holes to be drilled.

(5) Remove the handset from the hangup unit.

(6) Lay the unit aside. Center-punch and drill a 0.128-inch hole at each location.

(7) Secure the hangup unit to the surface with the two 1¾-inch sheet metal screws provided.

Note

Dress the cable through the elongated hole before tightening the sheet metal screws.

(8) Remove the escutcheon backing and press the escutcheon firmly into place.

(9) Connect the hangup box wires to the black connector and blue connector.

11. Speaker

11.1 GENERAL

The speaker kit includes a trunnion bracket, hanger bracket, and wall-mount bracket, and these allow the speaker to be mounted in a variety of ways. With the trunnion bracket, the speaker can be mounted permanently on the dashboard or in accessible firewall areas, and can be tilted or angled for best results. There is a bracket already attached to the speaker. This by itself allows the speaker to be mounted temporarily on projections such as automobile windows. For such mountings, the trunnion bracket must be removed. The wall-mount bracket can be used for permanent mounting if the trunnion bracket is too large to fit in some inaccessible area. In this case, the trunnion bracket is removed and the speaker is attached to the wall-mount bracket by the hanger bracket.

11.2 INSTALLATION WITH TRUNNION BRACKET

(See Figure 7.)

(1) Remove the trunnion bracket by loosening the two wing screws.

(2) Remove the three paper retainers and screws from the trunnion bracket.

(3) Remove the wall-mount bracket from its taped position on the hanger bracket. (Retain for future use.)

(4) Choose a place. If space limitations require the removal of the hanger bracket, remove the Phillips screw and slide the bracket out of the speaker housing. (You need not disassemble the speaker housing to remove the hanger bracket.)

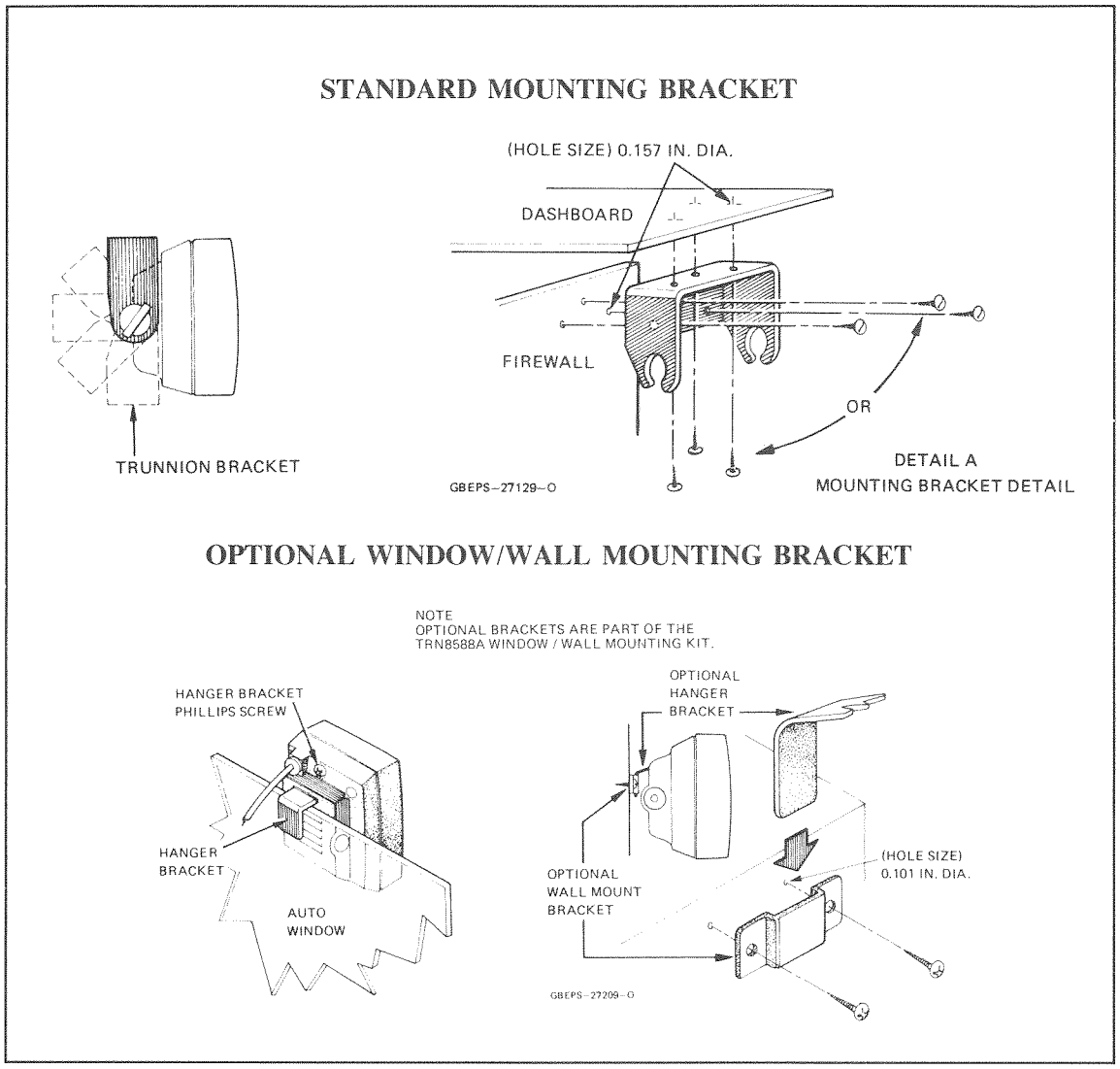


Figure 7. Speaker Installation Detail

(5) Using the trunnion bracket as a template, mark the location of the three mounting holes.

(6) Center-punch and drill a 0.101-inch (number 38 drill) hole at each location.

(7) Mount the trunnion bracket with the supplied screws.

(8) Remount the speaker in the trunnion bracket and tighten the two wing screws.

(9) Plug the speaker lead into the control head, making sure that the plug is solidly seated.

(10) Tie up surplus lead cable.

11.3 INSTALLATION WITH WALL-MOUNT BRACKET
(See Figure 7.)

(1) Remove the wall-mount bracket from its taped position on the hanger bracket.

(2) Remove the trunnion bracket and trunnion wing screws. (Retain for future use.)

(3) Remove the two paper retainers and screws from the wall-mount bracket.

(4) Choose a place.

(5) Using the bracket as a template, mark the locations for the screws.

(6) Center-punch and drill a 0.101-inch (number 38 drill) hole at each location.

(7) Mount the wall-mount bracket on the surface with the supplied screws.

(8) Seat the hanger bracket (attached to the speaker) firmly in the wall-mount bracket.

(9) Plug the speaker lead into the control head, making sure that the plug is seated solidly.

12. Power Connections
(See Figures 1 and 2.)

12.1 Replace the fuse in the inline fuseholder of the red power cable coming from the radio in the trunk. Also connect the green (or orange) fused wires coming from the control head to the ungrounded terminal (or source) of the battery.

12.2 Pull all excess cabling into the trunk. Clamp the cables to the vehicle body or chassis with the cable clamps supplied. Secure the clamps with the four tapping screws (number 8 × ⅜-inch) and four lockwashers (.25-inch) supplied. A ⅛-inch hole is needed for the tapping screws. Make certain that all inline fuses are installed.

13. Antenna
(See Figure 1.)

A diagram and complete installation instructions are supplied with each antenna ordered. Refer to these installation instructions for all information pertaining to the antenna.

14. Conclusion of Installation

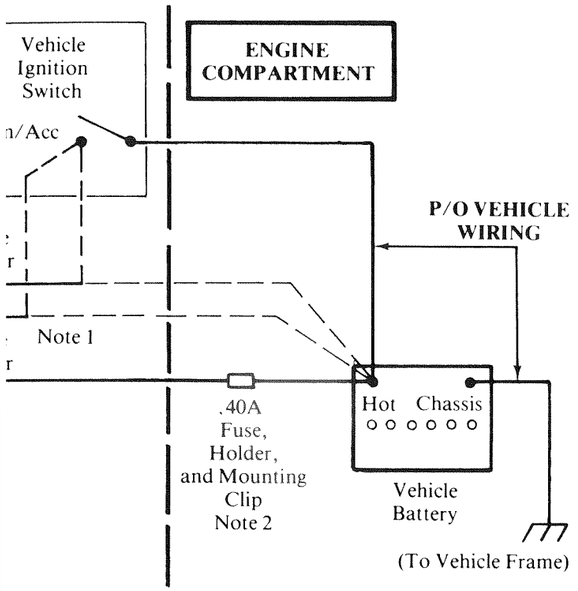
14.1 Make certain that the control head and microphone PTT switches are off. Replace the 40A fuse in the inline holder of the red primary power cable. Replace the 1.5A fuse in the inline holder of the orange cable. Replace the 7.5A fuse in the inline holder of the green cable.

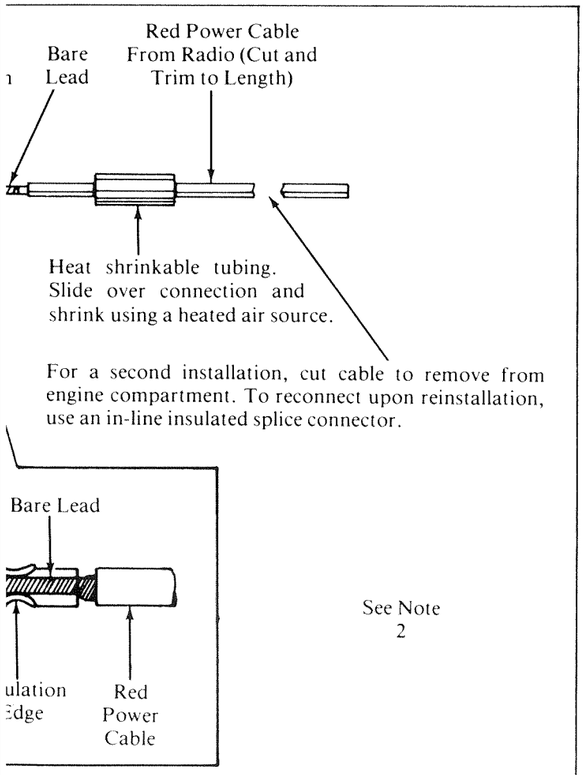
14.2 Turn the radio on at the control head and verify proper operation of all controls and indicators. (Radio operation in some installations requires that the vehicle ignition be turned on. See Table 1.) Perform a complete operational check of the radio.

Note

To avoid alternator or other noise, make sure that any excess black or red power cable is not coiled near the radio. If the received signal or transmission still carries such noise, refer to "Reducing Noise Interference in Mobile Two-Way Radio Installations," which is Motorola publication number 68P81109E33. This document is available free of charge.

14.3 Dress the control and power cables out of the way to prevent damage (pull any excess cable into the trunk area) and secure them with the supplied clamps and screws where necessary. Replace the rear seat if you removed it to route the cable.





B
USE INSTALLATION

NOTES:

1. The transmitter power control cable (ORG) and the receiver power control cable (GRN) may be connected to the vehicle battery or to the ignition switch. The recommended configuration of these cables connects the receiver control cable (GRN) directly to the battery and the transmitter control cable to the ignition switch (at the ON/ACC terminal). In this configuration, the receiver is operable whenever the control head is turned on but the transmitter is operable only when the ignition switch is turned on (as well as the control head). If both cables are connected directly to the battery, the entire radio is operable (under control of the control head). If both cables are connected to the ignition switch, the radio is operable only when the ignition switch is turned on. In this configuration, alternator whine and other noise problems may occur in the receiver section. If this is the case, the receiver control cable may be isolated with a relay (Motorola number 59-813674 or equivalent) as shown in Detail C.

2. Radios with *DVP* must have continuous power to the control head to retain the electronic *DVP* encryption key. The green lead must be connected to the battery hot supply or the code storage battery W268 option.

3. The radio battery hot primary power cable is supplied as two pieces, a red cable that is part of the radio control cable kit and another red cable with an in-line fuse on one end and a ring-tongue lug on the other. After routing the radio power cable from the radio connector to the engine compartment, splice these cables as shown in Detail B. Refer to the cable routing procedure for further details.

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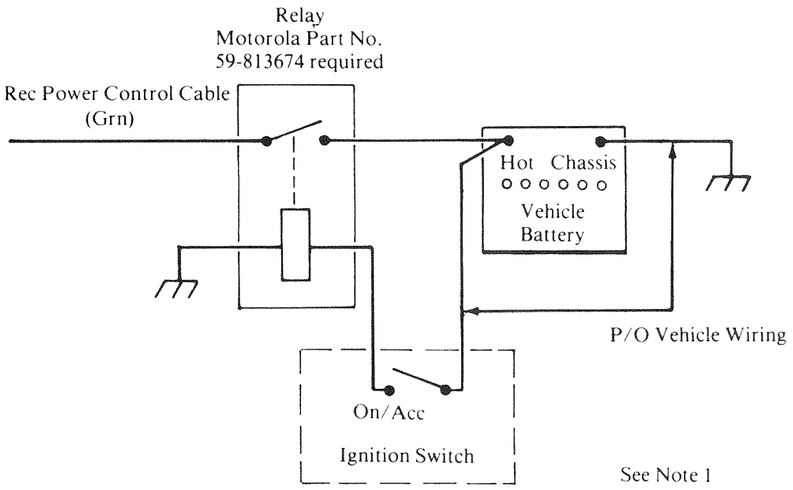
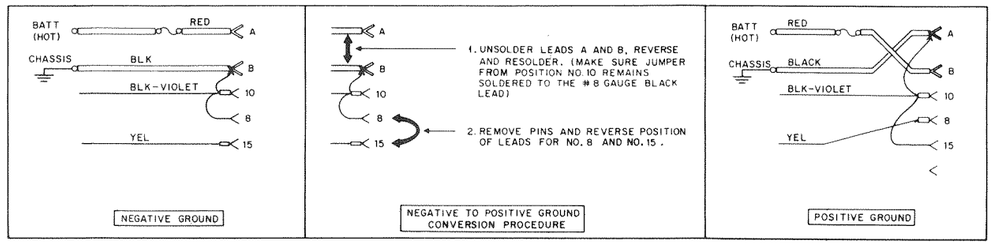


DETAIL C
RECEIVER POWER CONTROL ISOLATION

CAUTION

IN POSITIVE GROUND VEHICLES, A POSITIVE GROUND CABLE KIT MUST BE USED. A NEGATIVE GROUND CABLE KIT CAN BE CONVERTED FOR POSITIVE GROUND OPERATION AS FOLLOWS.



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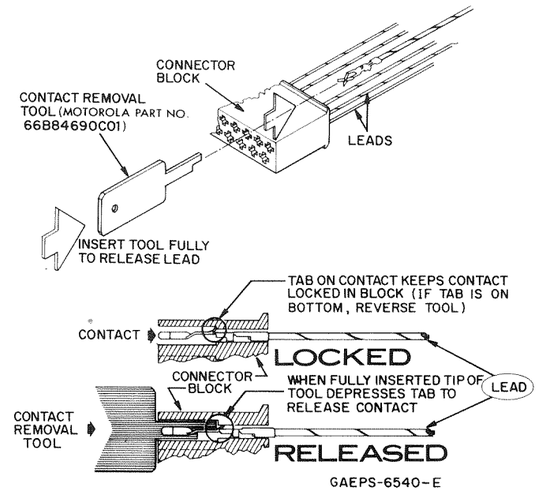

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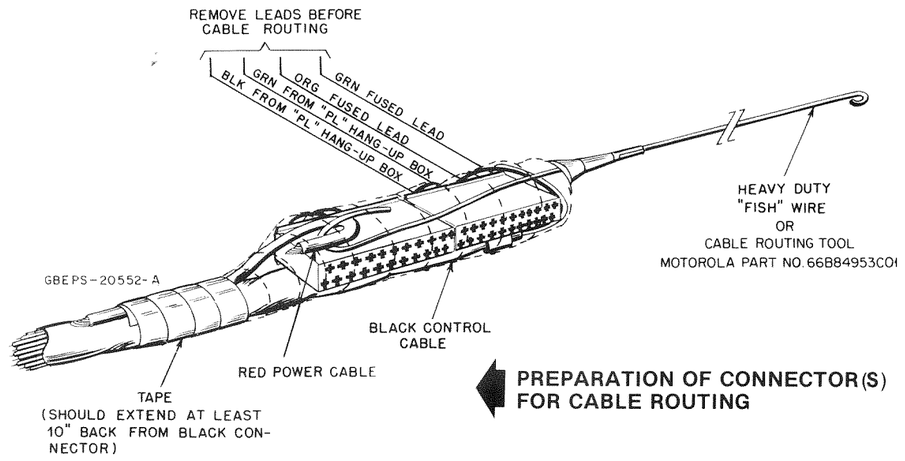
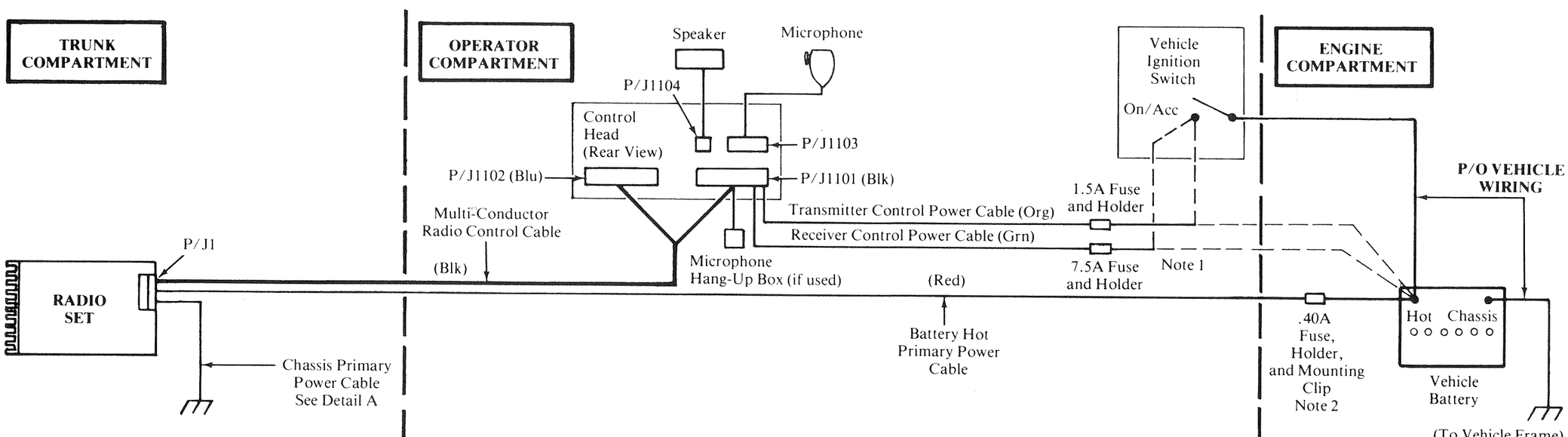


PREPARATION OF CONNECTOR(S) FOR CABLE ROUTING

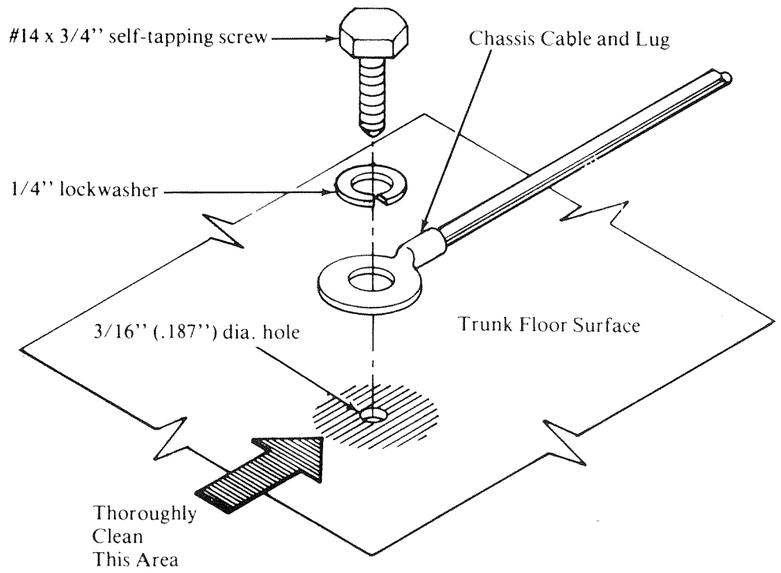
Figure 2. Cable Routing Details

INSTALLATION

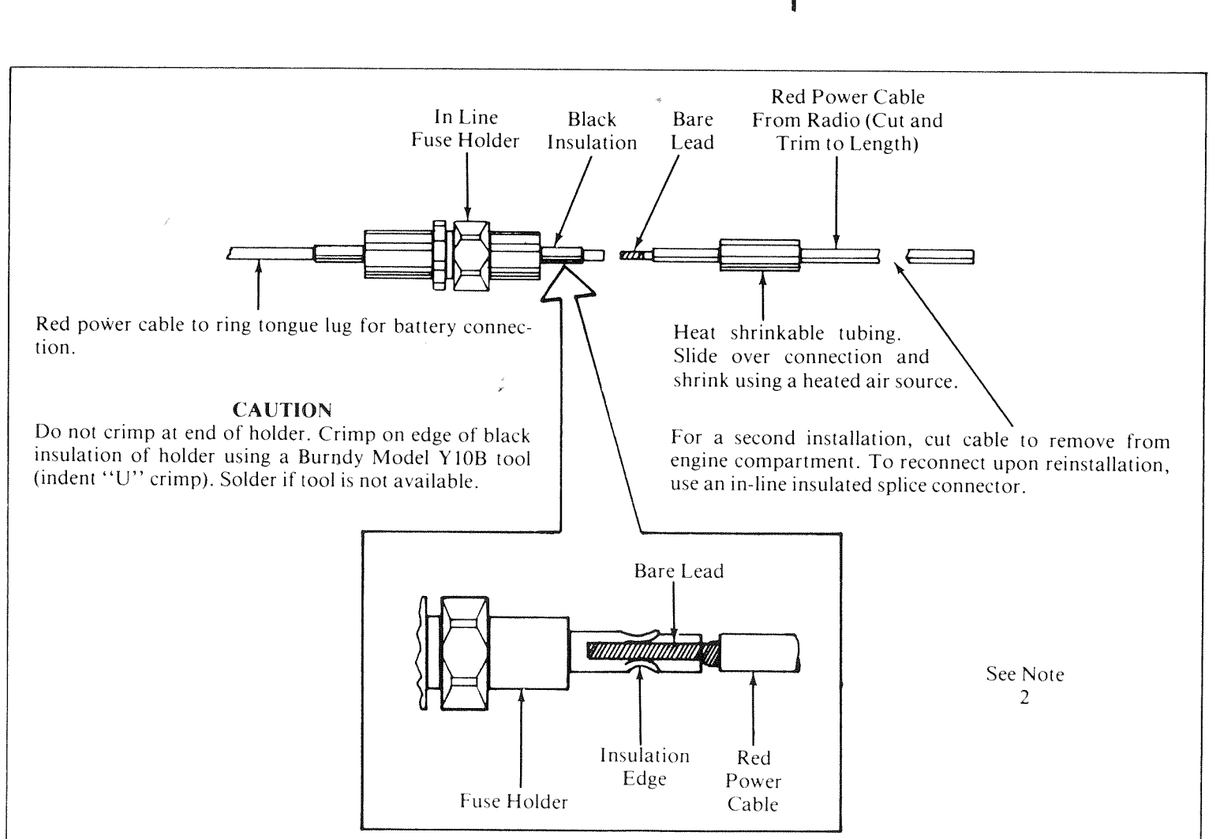


CAUTION

A good chassis connection via the black primary power cable is essential for radio operation and to prevent damage to the radio and cable kit. Connection to the vehicle frame is desirable.



DETAIL A
RADIO SET CHASSIS CONNECTION



CAUTION

Do not crimp at end of holder. Crimp on edge of black insulation of holder using a Burndy Model Y10B tool (indent "U" crimp). Solder if tool is not available.

DETAIL B
BATTERY HOT IN-LINE FUSE INSTALLATION

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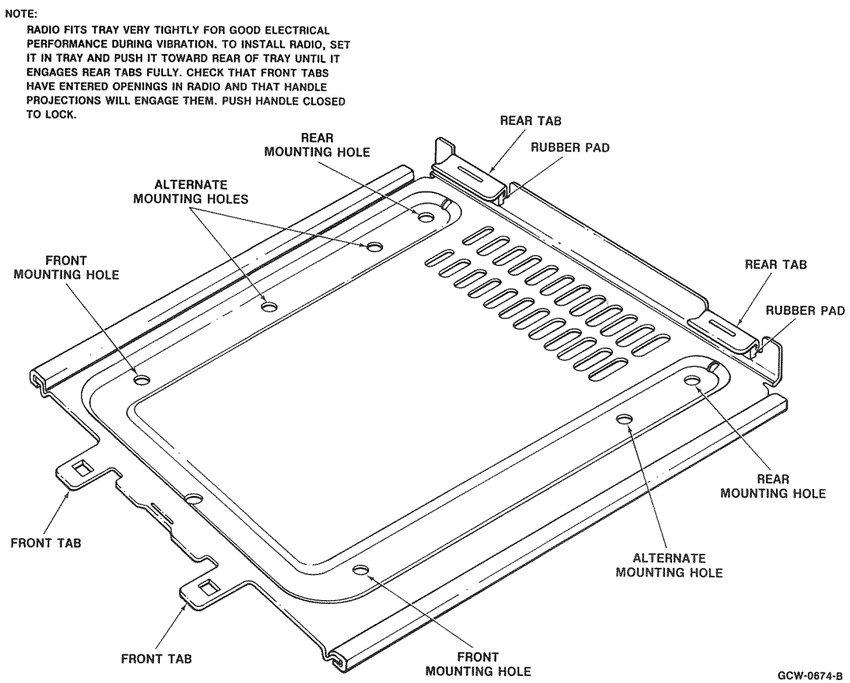


Figure 3. Mounting Tray

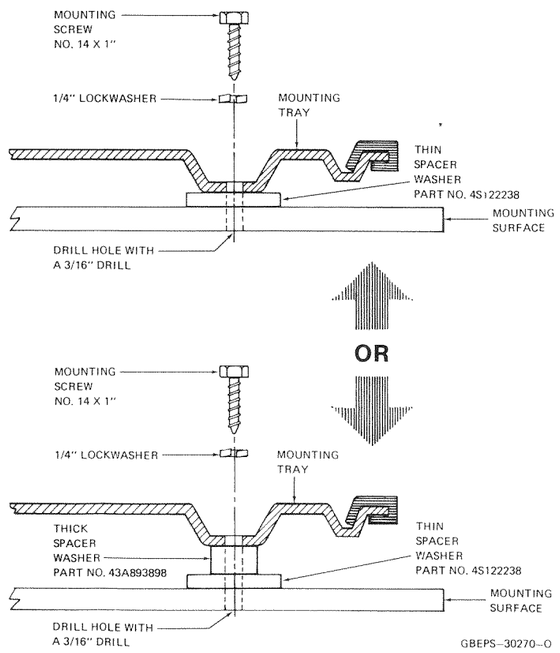
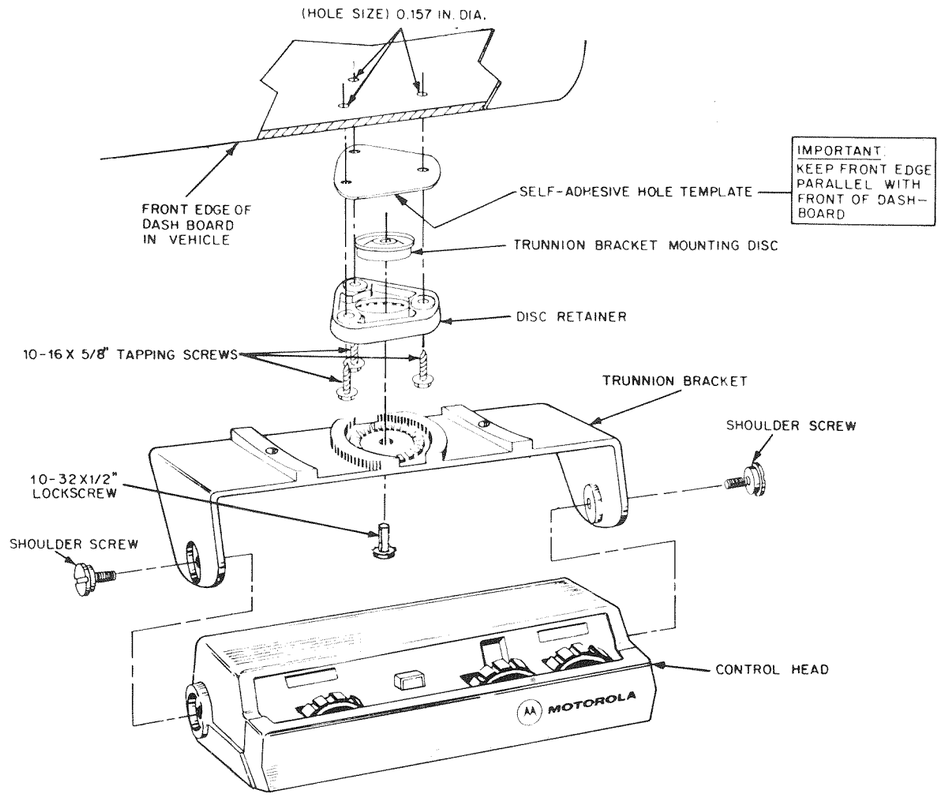


Figure 4. Mounting Tray Installation Detail



OR

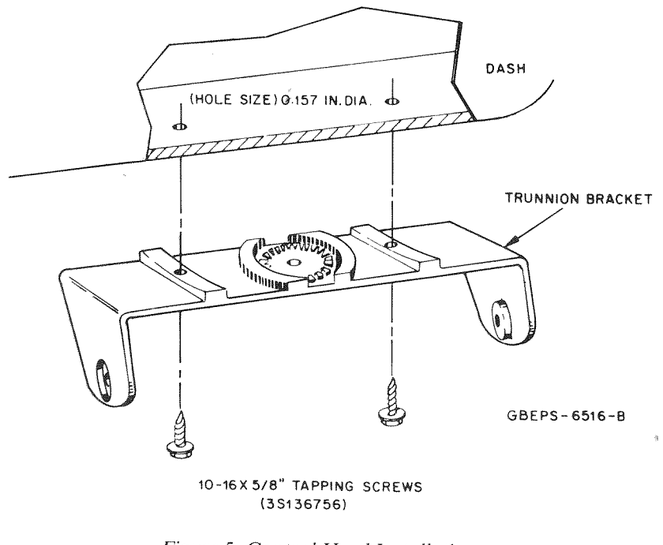


Figure 5. Control Head Installation

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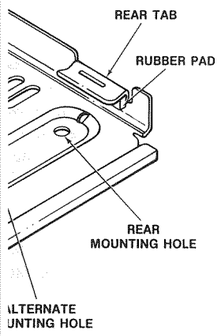

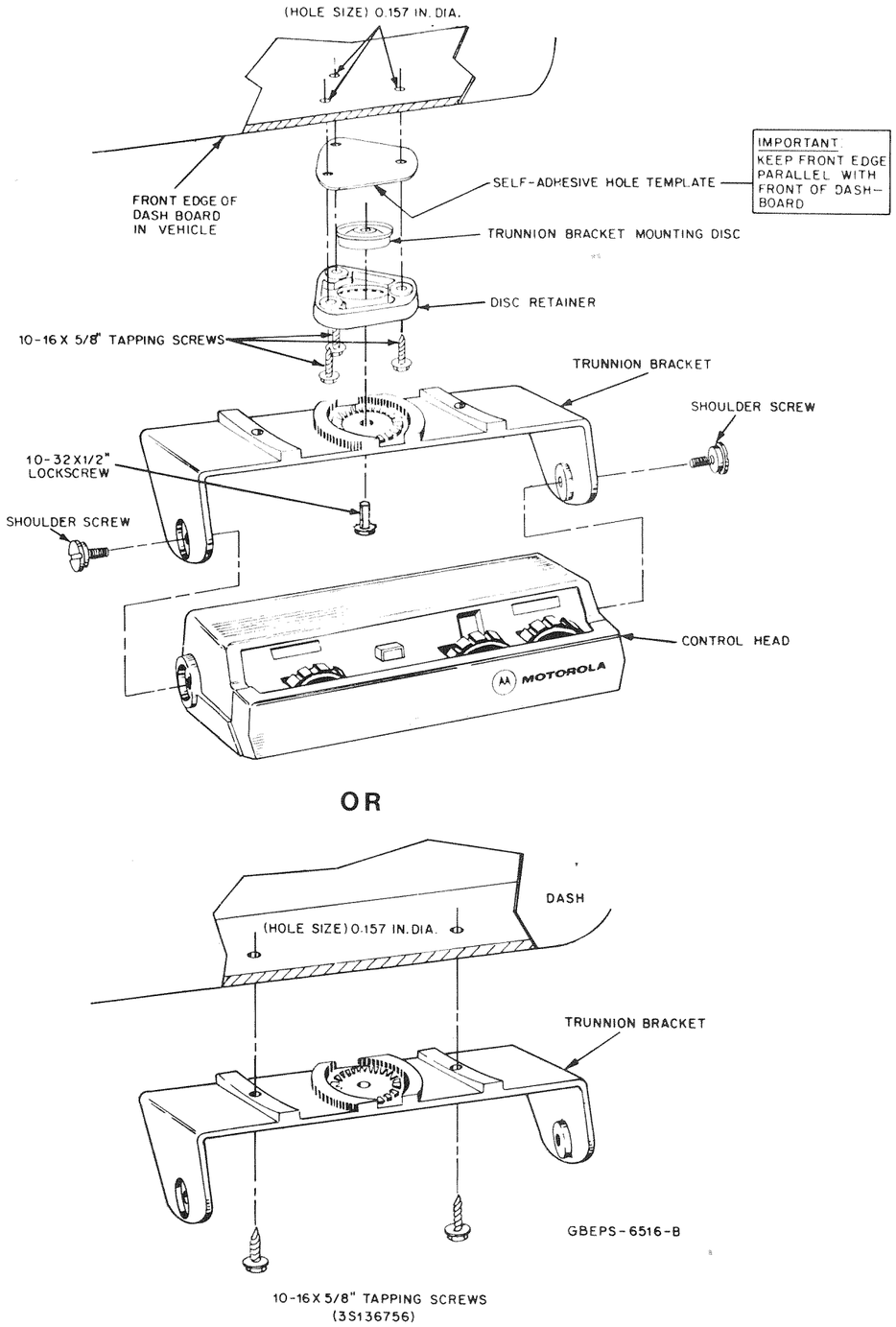

Figure 5. Control Head Installation

NOTICE: THIS RADIO IS *WEATHERPROOF*, NOT *WATERPROOF*

This radio meets the standards of MIL810C. This means the radio must remain functional after undergoing a number of tests, including a rain test (exposure for two hours to water *sprayed* at various flow rates in an air stream moving over the radio at 40 mph), a dust test (exposure for 28 hours to air-blown sand at higher-than-normal ambient temperatures), and a salt fog test (exposure for 48 hours to a mist of a 5% solution of salt in water).

These tests do **not** immerse or submerge the radio in water or chemicals. They prove the radio to be **weatherproof**, not **waterproof**. For installations that subject the radio to more stringent conditions, the radio must have extra protection. Unless you add this extra protection:

1. **Never** leave the radio in a vehicle such as a truck or bus that is washed out periodically with a high-pressure water hose, if the stream can hit the radio directly or form a puddle that immerses all or part of the radio.
2. **Never** leave the radio in a vehicle (most likely a bus) that has a dust-blowing system or vacuuming system that can coat the radio with layers of grit or dirt.
3. **Never** leave the radio in a place in a car, truck, or snow plow where snow or water accumulates and stands (as in a tool box).
4. **Never** install the radio in such a way as to alllow standing water to accumulate in recesses in its housing—such as in the areas of the cable connectors.
5. **Never** install the radio in a boat or other waterborne vehicle in such a position that salt water can drench it.
6. **Never** install the radio on a tractor or other agricultural vehicle in such a way as to allow the radio to be coated with highly corrosive fertilizers.

The protection the radio requires varies with the circumstances, of course. It may be as simple as drain holes drilled in the bottom of a tool box, or the reorientation of the radio so that its cable connector area points down instead of up. A low platform of wood or sheet metal may raise the radio above the level of water that normally accumulates during cleaning operations in a vehicle. Some circumstances, however, demand that the radio be protected with a waterproof enclosure or shroud—or be installed in an altogether different location.

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