MOTOROLA
Mobile Products Division

SYNTOR X 9000

High Band Radio System
Range 1: 136-154.4 MHz
Range 2: 150-174 MHz

THIS MANUAL HAS BEEN
DISCONTINUED

Instruction Manual

68P80102W05-O

MOTOROLA
Mobile Products Division

SYNTOR X 9000
High Band Radio System

Contents

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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.

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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 to 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 *SYNTOR X 9000* High Band Radios
Range 1: 136–154.4 MHz
Range 2: 150–174 MHz

CODE:

● = ONE ITEM SUPPLIED
■ = BREAKDOWN IN SEPARATE CHART
1 = ONE ITEM, DEPENDS ON RANGE

MODEL	T73KEJ7J04AK	T73KXJ7J04BK	T43KEJ7J04AK	T43KXJ7J04BK	ITEM	DESCRIPTION
DESCRIPTION	32 MODE, HIGH BAND, 100–50W	32 MODE, HIGH BAND, 100–50W, *SECURENET*– CAPABLE	32 MODE, HIGH BAND, 100–50W	32 MODE, HIGH BAND, 100–50W, *SECURENET*– CAPABLE		
	●	●			■ HUD1675B	UNIFIED CHASSIS, NON–PREAMP, 150–174 MHZ
			1	1	■ HUD1690A/B	UNIFIED CHASSIS, NON–PREAMP, 136–154.4 MHZ, RANGE 1
			1	1	■ HUD1694A/B	UNIFIED CHASSIS, NON–PREAMP, 136–154.4 MHZ, RANGE 2
	●	●	●	●	HCN1033D	CONTROL UNIT
	●	●	●	●	HLN4907D	CIRCUIT BOARD PANEL
	●	●	●	●	HLN4924B	CONTROL UNIT HARDWARE
	●	●	●	●	HLN5210A	CONTROL UNIT SOFTWARE & EEPROM
	●	●	●	●	HBN4036A	PACKING KIT
	●		●		HKN4241A	17' POWER CABLE, NEGATIVE GROUND
		●		●	HKN4256A	17' POWER CABLE, NEGATIVE GROUND, W/KEYLOAD
	●	●	●	●	HKN4051A	POWER CABLE AND FUSE
	●	●	●	●	HLN4111A	INSTALLATION KIT (EARLY VERSION)
	●	●	●	●	HLN4022C	INSTALLATION KIT (LATER VERSION)
	●	●	●	●	HLN4262A	TUNING TOOL
	●	●	●	●	HLN4666A	MOUNTING TRAY
	●	●	●	●	HLN4243A	BOTTOM COVER
	●	●	●	●	HLN4263A	TOP COVER
	●	●	●	●	HLN4921A	TRUNNION
	●	●	●	●	HLN4952A	FUSE KIT FOR GREEN AND ORANGE LEADS
	●	●	●	●	HLN4978A	NAMEPLATE
		●		●	HLN4980A	NAMEPLATE
			●		HLN4979A	NAMEPLATE
	●	●	●	●	HLN5095A	BLANK BUTTONS
	●	●	●	●	HLN5096A	BLANK PLUG
	●	●	●	●	HLN5105A	HANDLE AND SHIELD
	●	●	●	●	HLN4983A	*SYSTEMS 9000* BUTTONS
	●	●	●	●	HLN5027A	*SYSTEMS 9000* SOFTWARE
	●	●	●	●	HLN5028A	*SYSTEMS 9000* EEPROM
	●	●	●	●	HLN5064A	CONTACT REMOVAL TOOL
		●		●	HLN5092A	*SECURENET* BUTTON
	●	●	●	●	HLN5066A	*CHANNEL SCAN* BUTTON
	●	●	●	●	HMN1061A	*SYSTEMS 9000* MICROPHONE
	●	●	●	●	HLN4384B	CIRCUIT BOARD (EARLY VERSION)
	●	●	●	●	HLN5459A	CIRCUIT BOARD (LATER VERSION)
	●	●	●	●	HLN5389A	HARDWARE
	●	●	●	●	HLN5391A	HANG–UP CLIP
	●	●	●	●	HSN4018A	*SYSTEMS 9000* SPEAKER
			1	1	HAD4003A	BROADBAND ANTENNA, RANGE 1
	●	●	1	1	HAD4002A	BROADBAND ANTENNA, RANGE 2

Model Chart for *SYNTOR X 9000* High Band Radios Unified Chassis for Range 1

CODE:

● = ONE ITEM SUPPLIED

MODEL								DESCRIPTION
HUD1690A	HUD1690B	HUD1700A*	HUD1700B*					UNIFIED CHASSIS, NON–PREAMP
								UNIFIED CHASSIS, NON–PREAMP
								UNIFIED CHASSIS, WITH PREAMP
								UNIFIED CHASSIS, WITH PREAMP
ITEM								DESCRIPTION
●							HLD1071A	INTERNAL CASTING ASSEMBLY, NON–PREAMP
		●					HLD1614A	INTERNAL CASTING ASSEMBLY, WITH PREAMP
	●						HLD1620A	INTERNAL CASTING ASSEMBLY, NON–PREAMP
			●				HLD1621A	INTERNAL CASTING ASSEMBLY, WITH PREAMP
●	●						HLN4490A	INTERNAL CASTING
●	●						HLN4260A	INTERNAL CASTING HARDWARE
●	●	●	●				HLD4108A	FIRST MIXER
		●	●				HKN4066A	CASTING INTERCONNECT CABLE
●	●	●	●				HLN4251A	VCO INTERCONNECT
●		●					HLD4133A	VCO, RANGE 1 (EARLIER VERSION)
	●		●				HLD4336A	VCO, RANGE 1 (LATER VERSION)
●	●	●	●				HLN1116A	VCO BUFFER
●	●	●	●				HLN4521A	VCO BUFFER, RANGE 1
●	●	●	●				HKN4067A	VCO BUFFER CABLE KIT
●	●						HLN4491A	LOW PASS FILTER
		●	●				HLD4334A	RANGE 1 PREAMP CIRCUIT BOARD
		●	●				HLN5328A	RANGE 1 PREAMP HARDWARE
●	●						HLD4063A	PA POWER TRANSISTORS, 60–40W
●	●	●	●				HLN4134A	PA CIRCUIT BOARD
●	●						HLN4167A	PA HARDWARE, 60–40W
●	●	●	●				HLN4529A	CHASSIS HARDWARE
●		●					HLN4492A	RF BOARD
	●		●				HLN5377A	RF BOARD
●	●	●	●				HLN5299B	PERSONALITY BOARD
●	●	●	●				HLN4906B/C	COMMON CIRCUITS BOARD
●	●	●	●				HLN4242A	DIRECTIONAL COUPLER
●	●	●	●				HLN4247A	IPA BOARD
●	●	●	●				HLN4244A	IPA FEEDTHRU PLATE
●	●	●	●				HLN4046A	PA FEEDTHRU PLATE
●	●	●	●				HKN4225A	INTERCONNECT CABLE
●	●	●	●				HLN4241A	ANTENNA SWITCH
●	●	●	●				HLN4259A	FRONT HARDWARE
●	●	●	●				HLN4248B	BUS WIRES
●	●	●	●				HLN4994A	TRANSFORMER BRACKET

* USED WITH W12 OPTION

Model Chart for *SYNTOR X 9000* High Band Radios Unified Chassis for Range 2

CODE:

● = ONE ITEM SUPPLIED

ITEM	DESCRIPTION	HUD1675B	HUD1694B	HUD1677B*	HUD1692B*		
		UNIFIED CHASSIS, NON–PREAMP, 100–50W	UNIFIED CHASSIS, WITH PREAMP, 100–50W	UNIFIED CHASSIS, NON–PREAMP, 40–20W	UNIFIED CHASSIS, WITH PREAMP, 40–20W		
HLD1218A	INTERNAL CASTING ASSEMBLY, NON–PREAMP	●	●				
HLD1219A	INTERNAL CASTING ASSEMBLY, WITH PREAMP			●	●		
HLN4260A	INTERNAL CASTING HARDWARE	●	●				
HLN4261A	INTERNAL CASTING			●	●		
HLN4912A	INTERNAL CASTING HARDWARE	●	●				
HLD4123A	PREAMP			●	●		
HKN4066A	CASTING INTERCONNECT CABLE			●	●		
HLD4108A	FIRST MIXER	●	●	●	●		
HLN4251A	VCO INTERCONNECT	●	●	●	●		
HLN4318A	VCO, RANGE 2	●	●	●	●		
HLN1053A	VCO BUFFER	●	●	●	●		
HLN4249A	VCO BUFFER	●	●	●	●		
HKN4067A	VCO BUFFER CABLE KIT	●	●	●	●		
HLN4250A	LOW PASS FITLER	●	●	●	●		
HKN4225A	INTERCONNECT CABLE		●		●		
HLD4067A	PA POWER TRANSISTORS, 100–50W	●		●			
HLD4125A	PA POWER TRANSISTORS, 60–40W		●		●		
HLD4076B	PA CIRCUIT BOARD	●		●			
HLD4314A	PA CIRCUIT BOARD		●		●		
HLN4245A	PA HARDWARE, 100–50W	●		●			
HLN5109A	PA HARDWARE,40W		●		●		
HLN4246A	CHASSIS HARDWARE	●	●	●	●		
HLN5169A	RF BOARD	●	●	●	●		
HLN5299B	PERSONALITY BOARD	●	●	●	●		
HLN4906B/C	COMMON CIRCUITS BOARD	●	●	●	●		
HLN4242A	DIRECTIONAL COUPLER	●	●	●	●		
HLN4247A	IPA BOARD	●	●	●	●		
HLN4244A	IPA FEEDTHRU PLATE	●	●	●	●		
HLN4046A	PA FEEDTHRU PLATE	●	●	●	●		
HLN4241A	ANTENNA SWITCH	●	●	●	●		
HLN4259A	FRONT HARDWARE	●	●	●	●		
HLN4248B	BUS WIRES	●	●	●	●		
HLN4994A	TRANSFORMER BRACKET	●	●	●	●		

* USED WITH W12 OPTION

SYNTOR X 9000 VHF Radio Option Chart

W12	VHF Pre–amp
W20	Telephone Interconnect
W70	Omit Antenna, UHF
W71	Omit Microphone
W87	Omit Speaker
W90	Omit Accessories
W101	22' Negative Ground Cable
W109	Handset with hang–up
W116	External Alarms
W123	Antenna, 3.5 dB gain
W124	Antenna, 5 dB gain
W125	External option housing
W239	Noise cancelling microphone
W268	*SECURENET* code storage battery (secure–capable only)
W269	Siren/Public Address
W304	*SECURENET* proper code detect
W305	16 system/8 subfleet/64 modes
W306	15 system/16 subfleet/8 modes
W354	Trunked DEK (8)
W355	Trunked and *MDC–1200* DEK (8)
W370	*MDC–1200* DEK (8)
W373	Trunked DEK (16)
W374	Trunked and *MDC–1200* DEK (16)
W391	*SECURENET* with Physical Security (secure–capable only)
W412	*MDC–1200* Selective Call
W470	Emergency footswitch
W496	10' Negative ground
W496	10' Negative Ground, *SECURENET*
W589	Public Address
W591	Auxiliary Switch Panel
W674	Security Housing Cable
W688	Emergency pushbutton, hidden
W709	25 system/8 subfleet/ 32 modes
W793	*SECURENET*, DVI–XL encryption
W795	*SECURENET*, DES–XL encryption
W797	*SECURENET*, *DVP*–XL encryption
W814	*MDC–1200* PTT ID/Emergency
W820	Unlimited Private Call/*Call Alert*
W821	Wide area coverage, AMSS
W822	Dynamic regrouping
W826	Omit Emergency Alarm/Call
W829	8 systems/16 subfleets/64 modes
W838	Spare *DVP*–XL encryption
W839	Spare DES–XL encryption
W840	Spare DVI–XL encryption
W941	*MDC–1200* DEK (16)
W946	Conventional phone/DTMF
W995	Zone/Mode control unit
W996	System/Subfleet control unit

SYNTOR X 9000 VHF Performance Specifications

General

Number of Modes	Models available in 32 mode configuration. 64 modes optional.
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 in the same radio unit. Carrier Squelch and multiple coded squelch are optional.
Primary Power	±12 VDC 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 x 11.5" W x 16.0" L (63.5mm x 292mm x 406mm)
Radio Unit Weight	Approximately 22.5 lb (10.2 kg). Shipping weight approximately 37.5 lb (17 kg).
Metering	A single scale 0–50 microampere meter or Motorola portable test set can be used to measure all circuits essential to checking and adjustments.

		Maximum Battery Drain (inc. std. accessories)			
Model (series)	**Frequency (MHz)**	**Minimum RF Power Output**	**Standby @ 13.8V**	**Receive at Rated Audio @ 13.8V**	**Transmit @ Rated Power**
T73KEJ	150–174	100W Variable to 55W	1.2A	3.5A	27A
T43KEJ	150–174	40W Variable to 20W	1.2A	3.5A	14A

Transmitter

Output Impedance	50 ohms.
Spuious and Harmonic Emissions	More than 70 dB below carrier (for EIA spec. RS152B).
Frequency Stablility	±.0002% of reference frequency from –30°C to +60°C ambient (+30°C reference).
Maximum Frequency Separation	24 MHz without degradation
Modulation	15F2 and 16F3, ±5 kHz for 100% @ 1000 Hz.
Audio Sensitivity	0.080V ±3 dB of 60% maximum deviation @ 1000 Hz.
FM Hum and Noise EIA Method	
Companion Receiver Response	–60 dB.
RS152B Response	–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	T73KEJ: CC3372–Licensable under FCC rules Parts 22, 74, and 90 for 15F2, 16F3, and 16F9 emission. T43KEJ: ABZ89FT3688

Control Unit

Dimensions (excluding mounting bracket)	6.5" W x 3.375" H x 1.687" D (166mmm x 87mm x 43mm)
Weight	1 lb (456 g)
Current Drain	300 mA

Speaker

Dimensions (excluding mounting bracket)	5" x 5" x 2.5" (127mm x 127mm x 63mm)
Weight	1.5 lb (680 g)

Receiver

Input Impedence	50 ohms.			
EIA Modulation Acceptance	±6.5 kHz minimum.			
Frequency Stability	±.0002% of reference frequency from –30°C to +60°C ambient (±30°C reference).			
Maximum Frequency Separation	24 MHz without degradation			
Sensitivity		With Pre–Amp		Without Pre–Amp
20 dB quieting		0.25 uV		0.50 uV
EIA SINAD		0.175 uV		0.35 uV
Intermodulation EIA SINAD		80 dB		85 dB
Spurious and Image Rejection		85 dB		90 dB
Selectivity EIA SINAD	**Adjacent Channel**	**Alternate Channel**	**4th Channel**	**±400 kHz**
30 kHz Ch.	90 dB	95 dB	100 dB	110 dB
25 kHz Ch.	85 dB	90 dB	95 dB	110 dB
Squelch Sensitivity	Carrier squelch (at threshold setting), tone–coded squelch (fixed), digital–coded (fixed), are all 8 dB SINAD 0.25 uV maximum without preamp; 0.13 uV with preamp).			
Audio Output	15 watts @ less than 3% distortion into an 8 ohm load.			
FCC Designation	T73KEJ—RC0291 T43KEJ—ABZ89FT3688			

1. Radio Features

1.1 GENERAL

The *SYNTOR X 9000* VHF radio including *Systems 9000* options, provide the following features:

- Microcomputer control.
- Broad–band operation.
- Frequency synthesis.
- Programmable time–out timer.
- *Private–Line* and *Digital Private–Line* coded squelch.
- Talkaround.
- Operator select *Channel Scan* operation.
- Mode select *Channel Scan* operation.
- Wide operating temperature range (from –30°C to +60°C).
- Rugged construction that meets MIL–810D environmental specification related to rain, dust, salty atmosphere, shock, and vibration.
- All solid–state, compact, modular design that simplifies radio maintenance and troubleshooting.

Some of these features are discussed in the following paragraphs. More detailed information about the features and options are included in the appropriate *SYNTOR X 9000* Two–Way Radio Operator's Manual.

1.2 CONVENTIONAL FEATURES

SYNTOR X 9000 Radio Systems operate in the conventional mode for compatibility with conventional repeater systems. *Digital Private–Line* (DPL) or carrier squelch (CSQ) signalling is available. DPL coding is automatically selected (when available) by the Mode selector.

Talkaround is available in the conventional (non–trunked) mode for mobile–to–mobile communications. In conventional repeater systems, the transmit and receive frequencies are different. When Talkaround is selected, the transmitter frequency changes to the receiver frequency. All mobiles that need to communicate directly must select talkaround.

1.3 MICROCOMPUTER CONTROLLED SYSTEM

Most major radio operations are controlled by an 8–bit microprocessor, a Read Only Memory (ROM) that contains the operating program, and associated support and control circuitry. This sophisticated microcomputer system is designed to simplify mobile operation.

1.4 BROAD BAND OPERATION

The *SYNTOR X 9000* VHF radio operates over a broad band of frequencies. This band of authorized frequencies is in multiples of 5 kHz or 6.25 kHz in the following ranges.

- 136–154.4 MHz (Range 1)
- 150–174 MHz (Range 2)

The radio operates in these ranges without degradation in performance and without special "dual exciter" or "dual front end" circuits that operate on widely separated frequencies. Frequencies can be changed or added without retuning or realigning the radio.

1.5 FREQUENCY SYNTHESIS

Specific radio frequencies are generated electronically by using a frequency synthesizer rather than individual crystals or channel elements. This simplifies multiple–frequency operation since frequencies can be changed or added by reprogramming the radio. The frequency synthesizer reacts in milliseconds in priority mode scanning.

1.6 IMPROVED TRANSMITTER AND RECEIVER PERFORMANCE

The *SYNTOR X 9000* VHF radio receives and transmits over 14 MHz (Range 1) or 20 MHz (Range 2) bandwidths without degradation. Its frequency stability is rated at +2 ppm, its transmit audio distortion less than 2%. Receiver sensitivity (without a pre–amplifier) is rated at 0.35 microvolt (EIA SINAD) over the full 14 MHz (Range 1) or 20 MHz (Range 2) bandwidths.

1.7 PROGRAMMABLE TIME–OUT TIMER

The time–out timer causes the transmitter to stop transmission after the pre–programmed time interval. This prevents repeater or channel tie–up because of prolonged keying of the transmitter.

1.8 *PRIVATE–LINE* OR *DIGITAL PRIVATE–LINE* CODED SQUELCH

The *Private–Line* or *Digital Private–Line* coded squelch is programmed as required. This feature allows mobile units to receive only the messages that use their individual system code. This reduces an operator's listening fatigue as well as the probability of missed or misunderstood messages.

1.9 REPEATER TALKAROUND CAPABILITY

Repeater talkaround allows direct communication between two mobile units or between a mobile radio and a portable unit. Use the Mode select rocker or a separate pushbutton [**Dir**] to select talkaround operation.

1.10 *CHANNEL SCAN* OPERATION

The [**Scan**] button activates a pre–programmed set of *Channel Scan* parameters. This simplifies *Channel Scan* operation since it requires only one button to be used by an operator.

1.11 OPERATOR–SELECT *CHANNEL SCAN*

Operator–select *Channel Scan* allows you to manually select channels for scanning. This suits operators who prefer manual *Channel Scan* operation to a pre–programmed scan list.

1.12 PRE–AMPLIFIER

The optional pre–amplifier improves the 12 dB SINAD receiver sensitivity from 0.35 microvolt to 0.2 microvolt, with a 5 dB decrease in intermodulation protection.

2. Electrical Characteristics

The basic *SYNTOR X 9000* radios come fully equipped for operation. The units operate from a negative–ground, 12–volt DC source. A standard control unit, speaker, microphone with a hang–up bracket, antenna with a 14–foot cable, and a 17–foot negative–ground cable kit are included.

2.1 CIRCUIT BLOCKS

The *SYNTOR X 9000* radio can be grouped into physical blocks: personality board, memory module, common circuits board, transmitter power amplifier, radio frequency (RF) board, directional coupler board, and internal casting. The internal casting includes a voltage–controlled oscillator (VCO), mixer, filter board (or optional pre–amplifier).

2.2 FUNCTIONAL DESCRIPTION

The radio can be functionally divided into five parts: (a) microcomputer, (b) control unit, (c) frequency synthesizer, (d) receiver, and (e) transmitter. The microcomputer circuits are contained on the personality board. The frequency synthesizer circuits are contained on the personality board, RF board, and internal casting. The receiver circuits are contained on the personality board, RF board, and internal casting. The transmitter circuits are contained on the common circuits board and power amplifier. A brief description of each functional segment is provided below; further description is provided in the section associated with the circuit in question.

2.2.1 Microcomputer

The personality board contains the microcomputer system and code plug. The microcomputer consists of an eight–bit microprocessor, a read only memory that contains the operating program, and associated supporting and control circuitry. The microcomputer controls all operations of the radio from lighting the control panel indicators to frequency selection.

2.2.2 Control Unit

The control unit has two circuit boards. One is the controller board and the other is the display board. The display board contains switch contacts and an 11 character, 14 segment display. The display is driven by a driver that receives serial data from the microprocessor on the control board.

The microprocessor contains the operating software. The EEPROM contains re–programmable customer information.

The display board contains the following:

- Vacuum fluorescent (VF) display.
- VF display driver.
- Backlight and indicator LEDs.
- Switch contacts.

The controller board contains the following:

- Microprocessor and EEPROM.
- Serial data link receiver and transmitter.
- +5 volt regulator.
- Watchdog timer.
- Vehicle interface ports (VIPs).

2.2.3 Frequency Synthesizer

The frequency synthesizer uses a phase–locked loop (PLL) consisting of a reference oscillator, a voltage controlled oscillator (VCO), a programmable divide by 3–or–4 pre–scaler, a multiplex divider, a sample–and–hold phase detector, a VCO buffer, and a loop adaptive filter.

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) control a "C" counter inside the 3–or–4 pre–scaler. 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 mode change 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.

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 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 the synthesizer reference oscillator via the deviation and compensation circuits.

2.2.4 Receiver

Incoming RF signals go through the filter board (or optional pre–amplifier), via the antenna relay. The filter output passes through a six–pole preselector filter then goes to the first mixer stage. The selectivity of the two filters 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 (Range 1) or low–side (Range 2) injection frequency that is applied to the first mixer via a three–pole injection filter.

The second mixer uses the 53.9 MHz signal and a 43.2 MHz signal from an injection tripler to generate a 10.7 MHz IF. The receiver uses two four–pole 10.7 MHz crystal filters to attenuate signals outside the predetermined receiver bandpass range. After filtering and amplification, the 10.7 MHz signal passes to the limiter/detector stage.

The squelch circuit gives the microcomputer two signals (CHANNEL ACTIVITY and SQUELCH TAIL). In the absence of an RF carrier, SQL TAIL is low and CHAN ACT is high. When an RF carrier appears, these signals switch to SQL TAIL high and CHAN ACT low. 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.

2.2.5 Transmitter

The RF output generated by the frequency synthesizer at the required transmit frequency is applied to the controlled stage of the transmitter.

3. Radio Identification Label

The radio identification label identifies information needed for servicing the radio. Each field of information is explained by the following. The numbered items refer to Figure 1.

(1) DATE: this field identifies the date the trunking information was printed.

(2) SERIAL NUMBER (SN): this field identifies the radio's serial number.

(3) MODEL: this field identifies the radio's model number.

(4) FACTORY ORDER NUMBER (FO): this field identifies the factory sales order number.

(5) CONV: this area indicates the conventional mode information.

(6) MODE: this field identifies the specific conventional user mode number.

(7) RX: this field identifies the receive channel frequency in MHz.

(8) TX: this field identifies the transmit channel frequency in MHz.

(9) RX CODE: this field identifies the receiver PL, DPL or CSQ tone assignment.

(10) TX CODE: this field identifies the transmitter PL, DPL or CSQ tone assignment.

(11) T/A: this field identifies the transmit talk around frequency in MHz.

(12) TOT: this field identifies the time–out timer value.

(13) PR1: this field identifies the first priority scan selection.

(14) PR2: this field identifies the second priority scan selection.

(15) SQL DATA: This field identifies the squelch data selection.

(16) SCAN: this field identifies the modes scan list.

(17) RADIO NAME: this field identifies the radio name assigned at time of order processing.

(18) RADIO SERIAL NUMBER (RSN): this field identifies the original radio serial number when replacement codeplugs have been ordered.

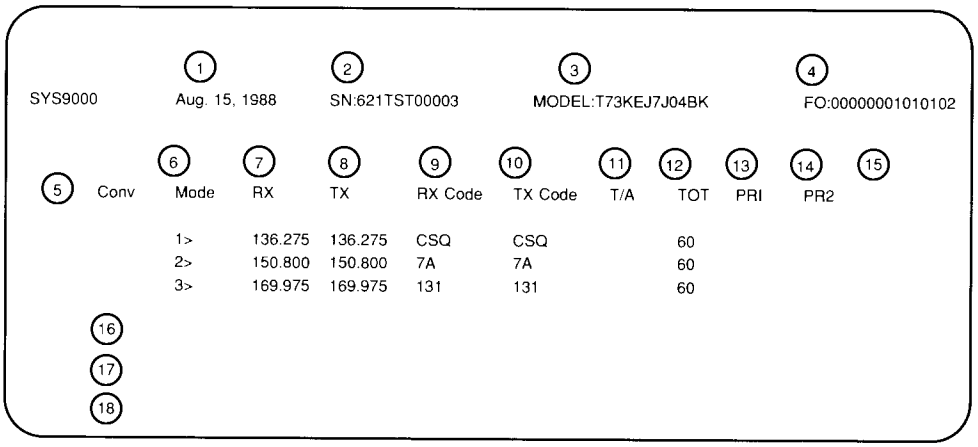
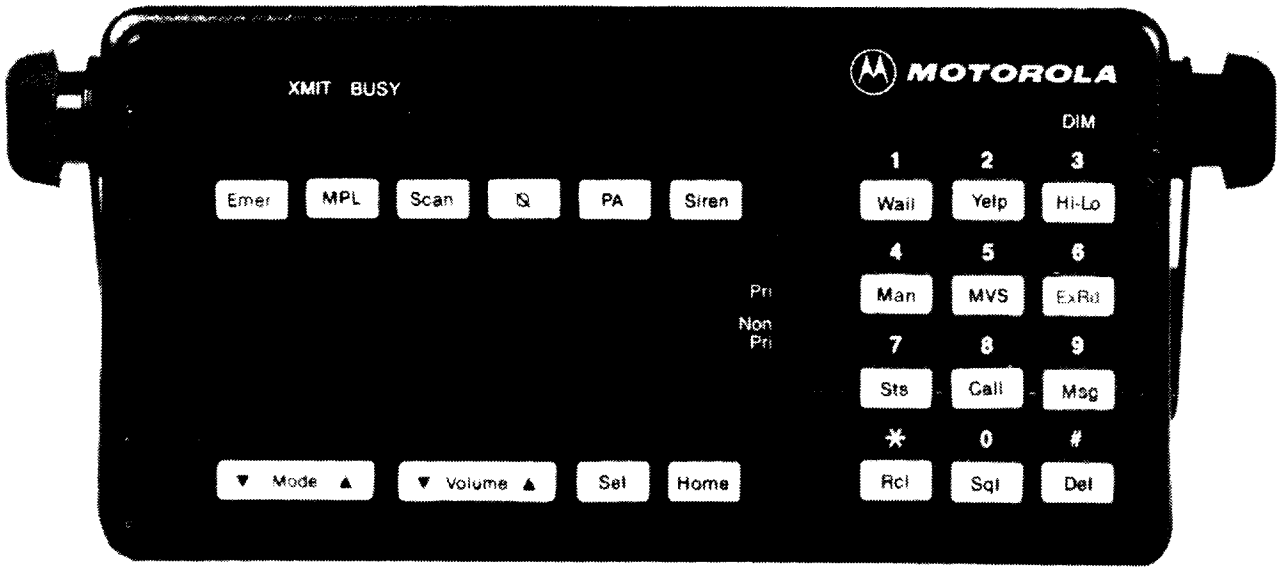


Figure 1. SYNTOR X 9000 *VHF Radio Identification Label*



GPW–2538–A

Figure 1. Systems 9000 *Control Unit*

1. General

The *SYNTOR X 9000* mobile units consist of:

- Remote mountable radio.
- Dual operation control unit.
- Microphone.
- Speaker.
- Antenna.
- Interconnecting cable.

The mobile units are supplied with *Systems 9000* control units that meet the basic requirements for conventional operation.

The *Systems 9000* Control Unit has the following controls and indicators:

- Power on/off slide switch.
- DIM button for display brightness.
- Rocker switch volume control.
- Rocker and keypad mode–select control.
- Channel BUSY indicator light.
- Transmit indicator light.
- Priority channel indicator light.
- Non–priority channel indicator light.
- Squelch button to set volume and monitor channel activity.
- Option control buttons and indicators.

2. Radio Operation

2.1 ALERT TONES

The following alert tones aid the operator by indicating unique system conditions:

Illegal Mode—A low pitched tone that indicates an invalid button position has been selected.

Time–Out Timer alert (optional)—A low pitched continuous tone that indicates your present transmission will soon be disabled.

2.2 TO RECEIVE

Perform the following steps to adjust your radio for operation.

(1) Slide the power ON/OFF switch to the left until it locks in position. The Control Unit display comes on showing "SELF CHECK" for two to three seconds, then displays the current selected mode. If the radio system fails its diagnostics on power up, an error code displays. See the Maintenance and Troubleshooting section of this manual. If the failure is critical, the radio ceases operation.

(2) Select a mode on which to operate.

(3) For modes with PL/DPL, turn squelch on.

(4) Adjust the volume level to a comfortable listening level during an incoming signal.

2.3 TO TRANSMIT

With the radio switched on, perform the following steps to transmit on your radio system.

(1) Select the desired channel with the **[Mode]** rocker.

(2) Lift microphone off–hook. Press and hold the microphone PTT button.

(3) When the red transmit indicator lights, hold the microphone about two inches from your lips, speak slowly into the microphone in a normal voice, state your FCC call sign, and proceed with your message. Release the microphone PTT button to receive.

3. Mode Select

Use the **[Mode]** rocker switch to scroll forward and backward through the list of programmed modes. Modes can be field programmed with user defined names. Mode names are allowed 11 characters, it is suggested however, to allow three digits for a mode number and eight digits for the mode name to provide both name and numeric mode association.

4. *Channel Scan*

The *Channel Scan* feature allows you to scan a previously defined list of conventional modes for activity. If no activity exists, the display shows your selected mode. When a scanned mode becomes active, the display shows the active mode, the appropriate priority (PRI) or non–priority (NON–PRI) indicator lights, and *Channel Scan* unmutes the radio.

Press the **[Scan]** button to turn *Channel Scan* on or off. With scan on, the previously selected scan list enables, and the red indicator lights.

4.1 MODE SLAVED SCAN

On mode select scan radios, the scan list is pre–programmed and may not be modified. When scan activity occurs, the currently active mode number or name displays, the appropriate priority (PRI) or non–priority (NON–PRI) indicator lights and the radio unmutes.

Press the **[Scan]** button to turn *Channel Scan* on and off. The internal scan list is enabled for the selected mode when scan is on, and the *Channel Scan* indicator lights.

4.2 OPERATOR SELECTABLE SCAN

On models with Operator Selectable Scan, you may review the scan list and/or modify it by holding the **[Scan]** button until an alert tone (beep) sounds and the red indicator blinks. Enter your new scan list by using the **[Mode]** rocker to locate the mode name, or by selecting a mode number with the keypad. Once the desired mode displays, press the **[Sel]** button to add it to the list.

Press the **[Sel]** button once to add the new mode as a non–priority list member (NON–PRI lights), press **[Sel]** a second time to add the new mode as a second priority list member (PRI lights), or press **[Sel]** three times to add the new mode as a first priority list member (PRI blinks).

You may remove modes from your list or review your scan list. Press the **[Del]** button to remove modes from your scan list. Review the scan list by pressing the **[Rcl]** button.

Press the **[Home]** button to exit the Scan list entry mode and return to normal operation.

4.3 DYNAMIC PRIORITIES

The Dynamic Priority feature allows you to modify the priority of a scanned mode using the **[Sel]** button. Press **[Sel]** during mode activity to temporarily assign a NON–PRI mode to second (PRI lights) priority.

Restore the scan list to the normal priority assignments by turning Scan off and on, changing modes, pressing **[Rcl]**, or turning the radio off and on.

4.4 NUISANCE DELETE

A NON–PRI mode in the scan list that becomes too active or you no longer desire may be temporarily deleted by the **[Del]** button during mode activity.

Press the **[Rcl]** button, turn Scan off and on, change modes, or turn the radio off and on to restore a temporarily deleted mode to your scan list.

Priority modes may not be temporarily deleted.

4.5 TALK BACK SCAN

Talk Back Scan allows you to transmit on the last active received mode, regardless of the selected mode on the control unit.

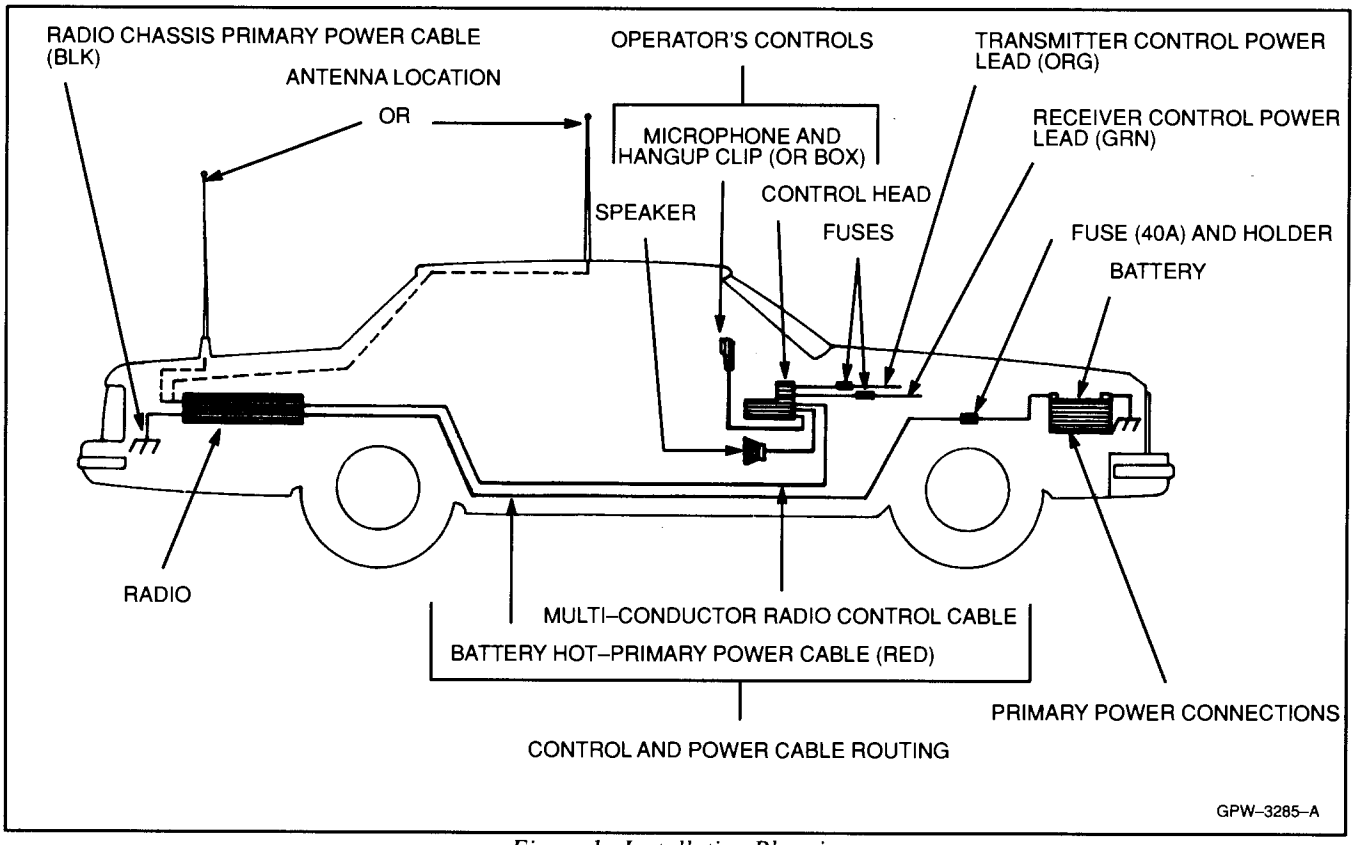


Figure 1. Installation Planning

1. Pre–Installation Tests

Although the factory aligns the equipment accurately, 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, 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.

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

(7) Measure the PL or DPL sensitivity in PL/DPL modes. Repeat Steps 4 through 7 for each mode.

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

2. Installation Planning

See Figure 1 for information on the antenna location, operator's controls, radio location, control and power cable routing, transmitter control power lead, receiver control power lead, primary power connections, and other accessories.

WARNING

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

2.1 ANTENNA LOCATION

The best location for the antenna is at the center of the vehicle roof. A good alternate location is at the center of the trunk lid. Be sure that the antenna cable can be acceptably routed to the radio before mounting the antenna. See the antenna instruction manual for details.

CAUTION

Antennas must be installed at least two feet (0.6 meter) from vehicle operators and passengers unless shielded by a metallic surface.

2.2 RADIO LOCATION

In most vehicles, the best location for the radio unit is the floor of the trunk compartment. When considering location, make sure to protect the radio from dirt and moisture. Make sure there is sufficient space around the radio to allow adequate cooling and permit removal of the unit.

2.3 OPERATOR'S CONTROLS

Recommended mounting surfaces for the control unit, microphone hang–up clip, and speaker are the following: under the dashboard, on the transmission hump, or on the center console. The speaker may be mounted on the firewall.

Adjustable trunnions are supplied for mounting the control unit and the speaker, allowing a number of mounting positions. The installation must not interfere with the operation of the vehicle or its accessories, nor disturb passenger seating or leg room. The control unit and the microphone hang–up clip must be within convenient reach of the user(s).

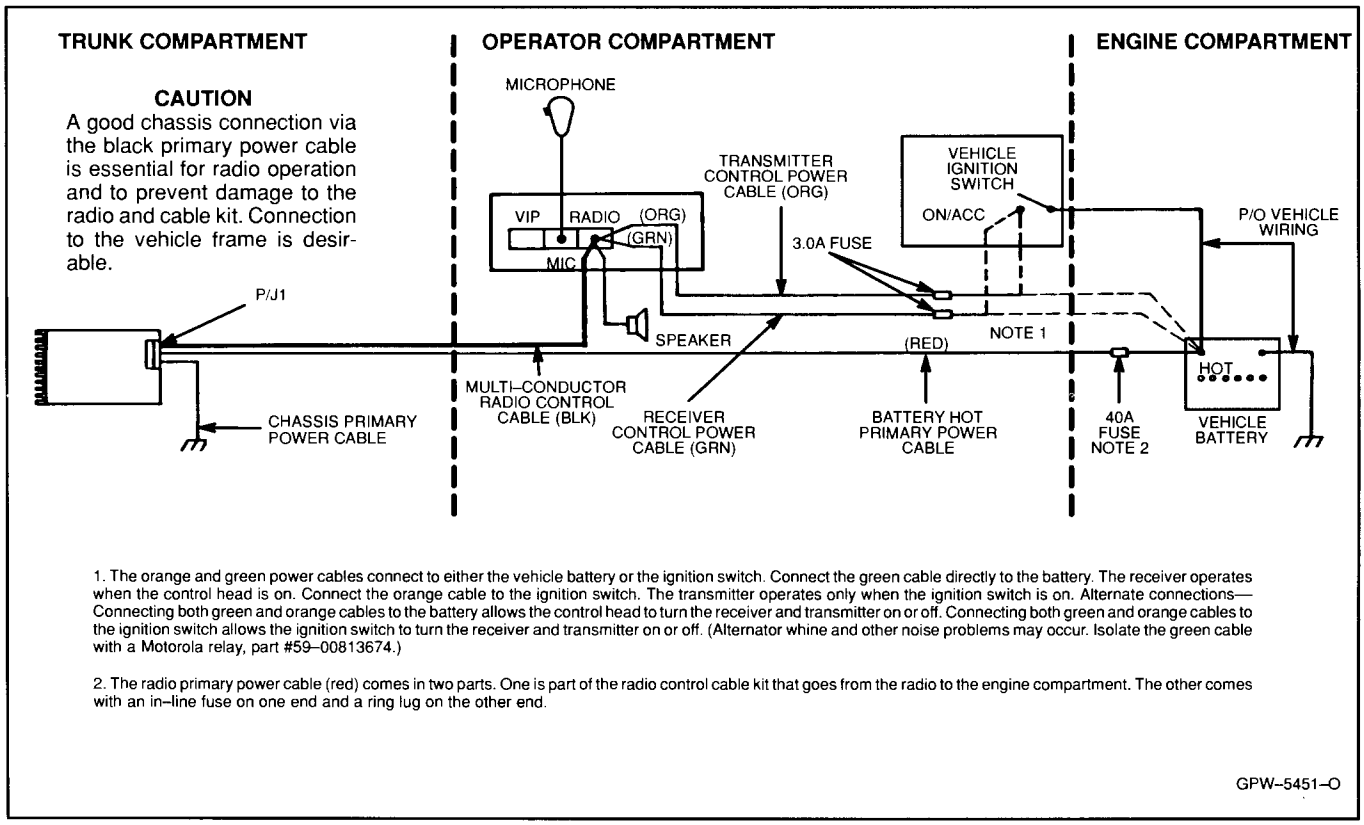


Figure 2. Cabling Interconnection Diagram

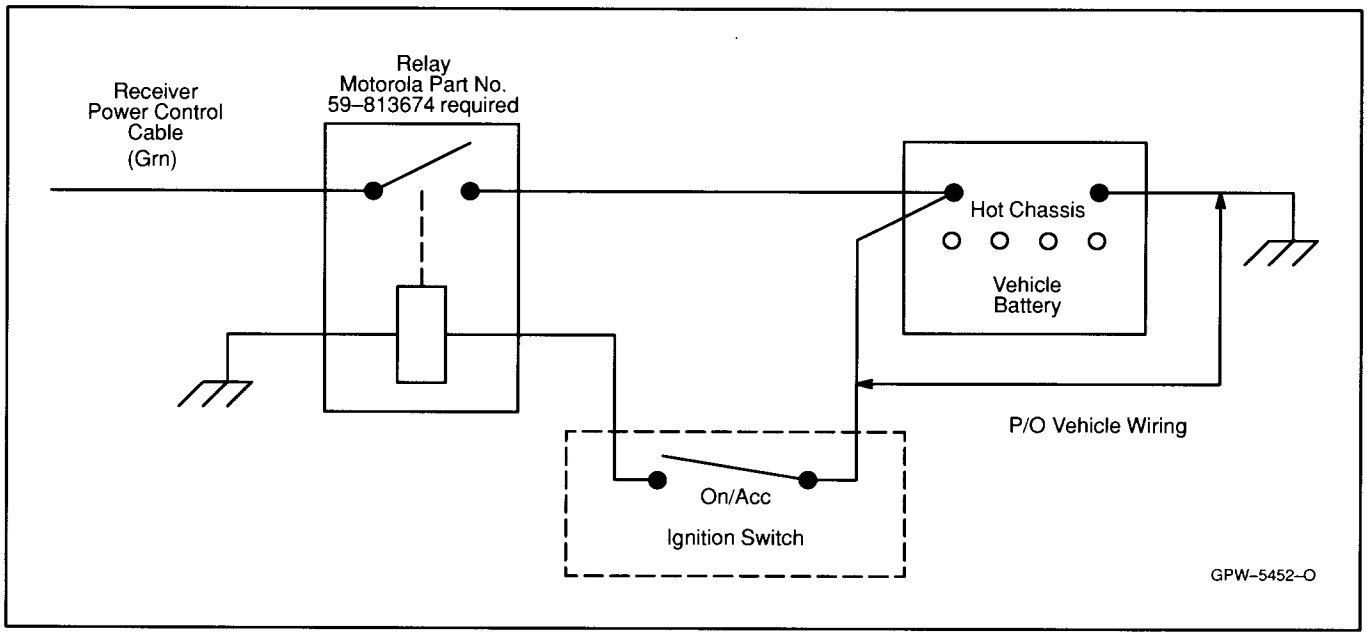


Figure 3. Power Control Isolation Detail

2.4 CONTROL AND POWER CABLE ROUTING

Many vehicles have wire troughs in the door sills. If the vehicle has this feature, use the troughs to provide maximum protection for the cable and to simplify the cable installation.

In vehicles without wiring troughs, route the control and power cables where they are protected from pinching, sharp edges, and crushing. One suggested route is along one side of the drive shaft hump under the carpet. Use grommets where the cable passes through holes in metal panels.

2.5 PRIMARY POWER CONNECTIONS (RED)

The best power connection point for the battery hot primary power lead is at the battery hot terminal. Points that connect directly to the battery terminal with sufficient current–handling capabilities may also be used. Make certain that the point chosen remains close to 13.6 volts; some systems switch to a higher–than–normal voltage during starting.

2.6 TRANSMITTER CONTROL POWER LEAD (ORANGE)

Connect this lead to the ignition switch (recommended) or directly to a battery hot supply. See Figure 2.

2.7 RECEIVER CONTROL POWER LEAD (GREEN)

Connect this lead to a battery hot supply (recommended) or to the ignition switch. See Figures 2 and 3.

2.8 RADIO CHASSIS PRIMARY POWER CABLE (BLACK)

The radio chassis primary power cable should connect to a good ground point on the vehicle chassis. See Figure 2.

3. Cable Routing

Note

Cables routed near metal edges or through holes may be damaged. Be sure to use rubber grommets, if necessary, to protect the cables.

(1) Determine the radio's location in the trunk compartment and leave enough slack cable to permit the plug to be easily connected or disconnected from the radio.

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

(3) If the vehicle has wire troughs, run the cables in the wire troughs. Otherwise, route the cables under the floor covering alongside the drive shaft hump. Pull the cables into the back seat area, under the floor mats, under the front seat, and under the front mats, exiting up under the dash at the firewall. Pull the control unit end of the multi–conductor cable to the approximate location of the control unit. Route the red power cable into the engine compartment through any convenient hole in the firewall.

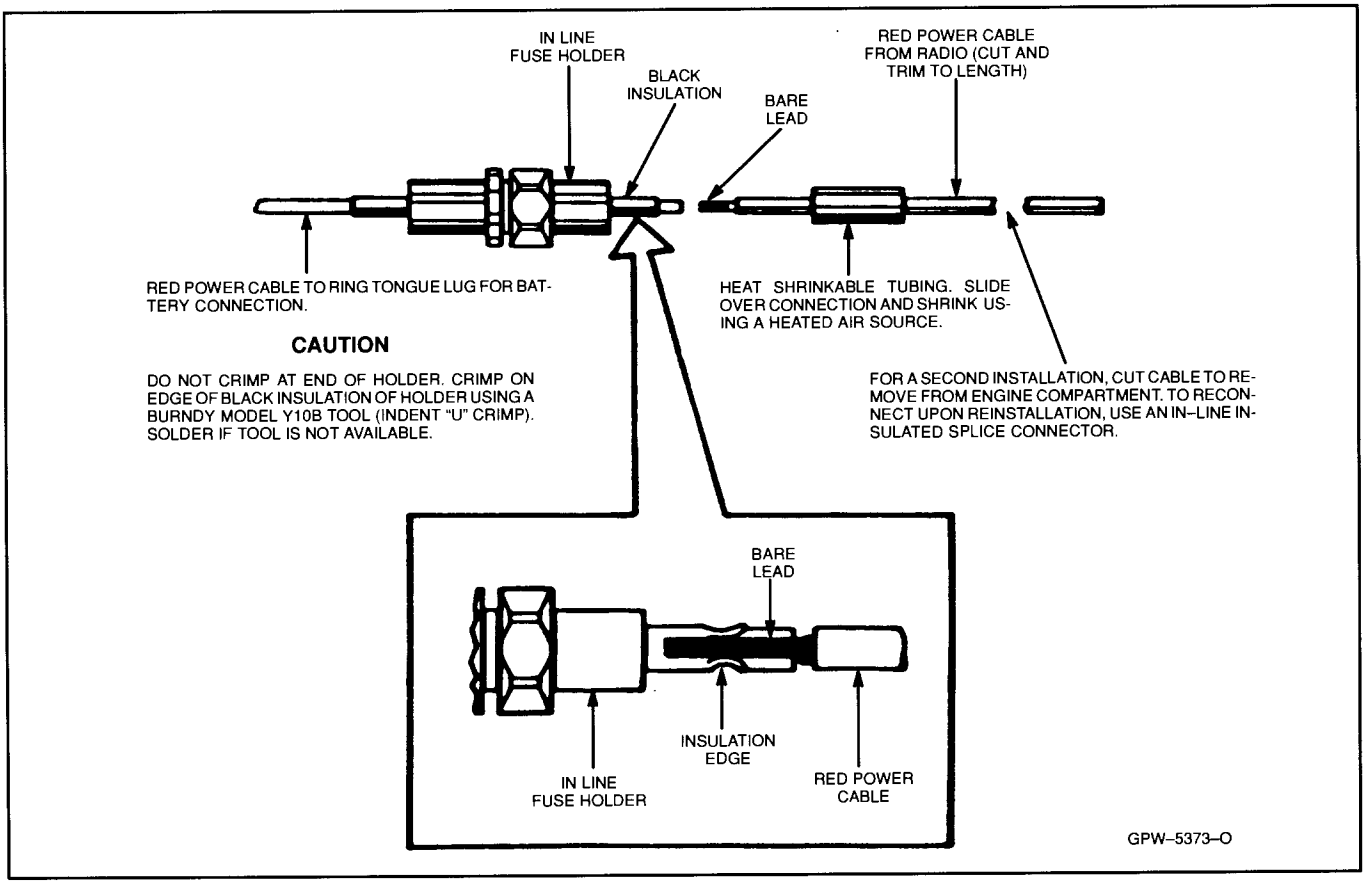
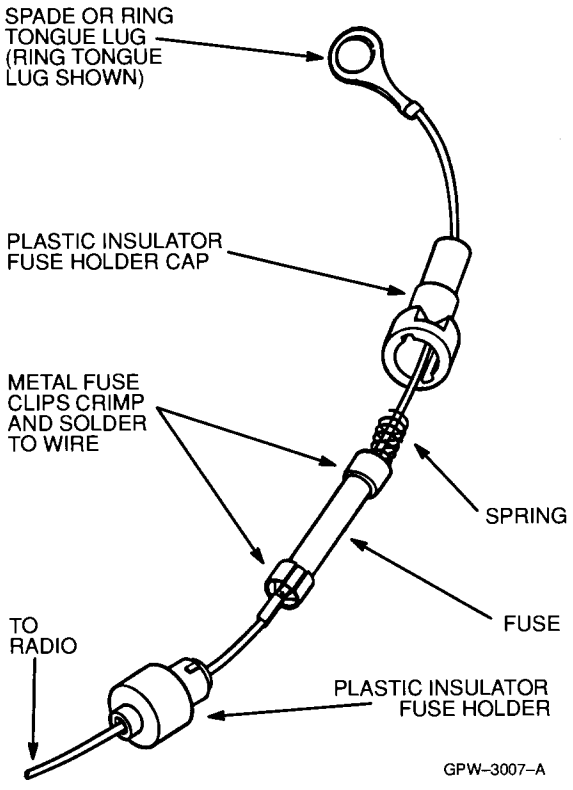


Figure 4. Fuse Installation



parts list

HLN4952A Fuse Kit for Green and Orange Leads — MXW-2273-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	14-82882A01	insulator, fuse hoder body
	14-82883A01	insulator, fuse holder cap
	29-00136968	lug
	29-00824456	ring tongue lug
	29-00865065	ring tongue lug
	41-82885A01	compression fuse spring
	42-82884A01	fuse clip
	65-00020404	3 amp fuse, 250V, (quantity 2)

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Figure 5. Fuseholder Assembly and Parts List

(4) Pull the red power cable into the engine compartment. A cable fuse kit comes with a ring tongue lug on one end and an in–line fuseholder on the other. Each cable includes a small section of heat–shrinkable tubing. Trim any excess length of red cable. Slide the heat–shrinkable tubing over the red power lead from the radio. Slide the strapped portion of the red cable into the end of the in–line fuseholder and crimp the joint using a Burndy Model Y10B (indent "U" crimp). If this tool is not available, solder the joint. See Figure 4.

(5) Slide the heat–shrinkable tubing over the connection and shrink the tubing with a Motorola Model ST697 Heat Gun or equivalent heated air source. 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 directly connected to the ungrounded terminal of the battery (such as the starter solenoid). Move the in–line fuseholder to a convenient location on one of the sheet metal parts of the engine compartment. Center punch and drill a 9/64" (.140") hole through the mounting surface. Then mount the bracket with the #10–16 x 1/4 self–tapping sheet metal screws. Do not install the fuse until the entire radio installation is complete.

(6) The control unit power cable kit contains two separate wires, one orange and the other green. The orange wire is 66 inches long and the green wire is 106 inches long. A fuse kit hardware bag comes with the radio. This bag contains crimp–on type ring tongue lugs and crimp–on type spade lugs. The spade lugs allow connection to hot leads at the fuse block of the vehicle and the ring tongue lugs permit attachment to screws of terminals. Determine from Table 1 which radio functions are to be switched through the vehicle ignition switch. A typical system allows the receiver to operate with the radio switched on while the ignition is off, but the transmitter does not operate unless the ignition is on. In this case, connect the orange wire to the accessory terminal of the ignition switch and the green wire to the ungrounded terminal of the battery or starter solenoid.

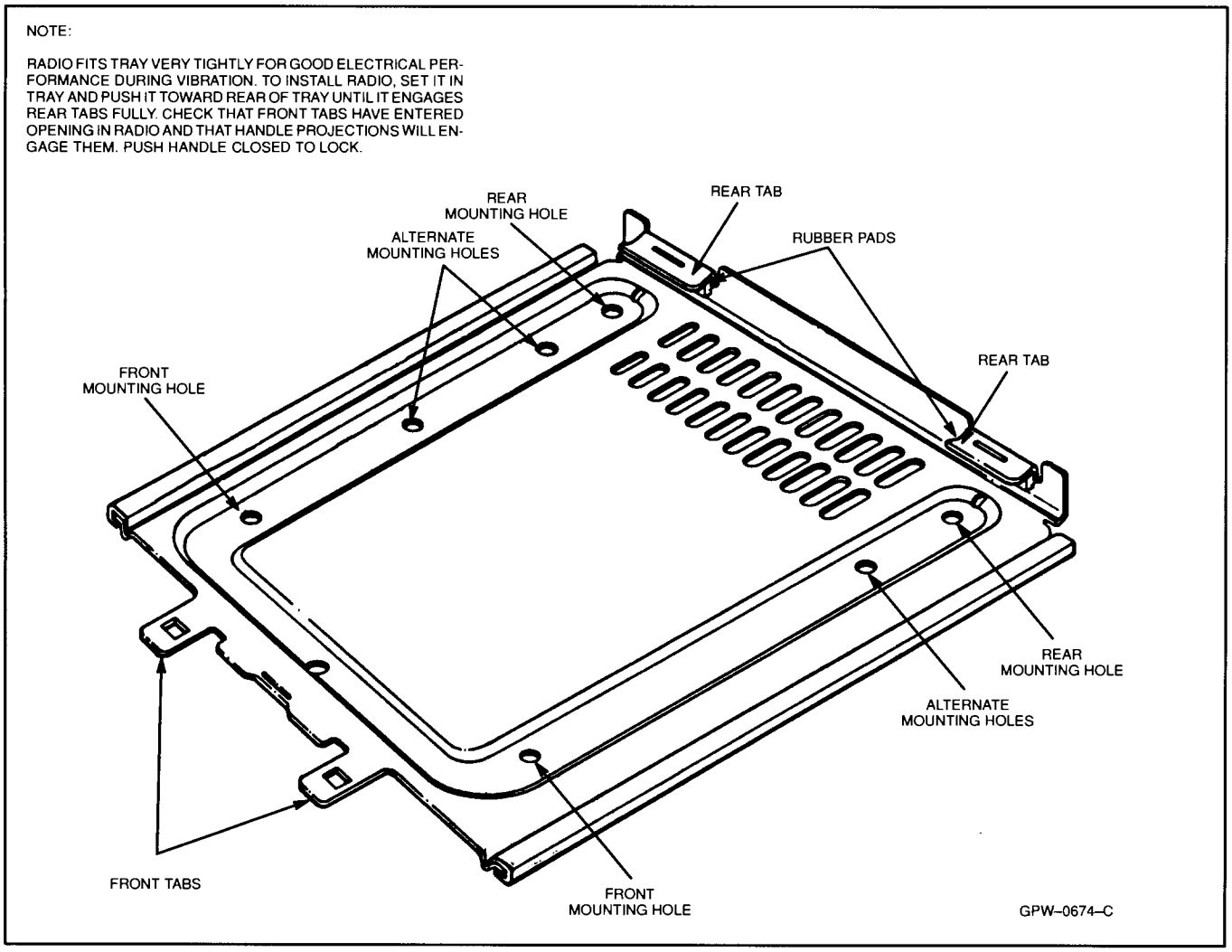


Figure 6. Radio Mounting Tray

CAUTION

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

(7) If either wire is to be connected in the engine compartment, pass the end of the wire through the same firewall hole that the red power cable uses. At this point, install a fuse in both wires.

(8) The following procedures apply to both the green and orange wires. See Figure 5 for more information. Cut the wires about 10 inches from the end. Strip the insulator from both sides so that about 1/8 inch of the wire is exposed. On the end still connected to the cable kit, install the plastic insulator fuse holder cap. On the same wire, crimp one of the metal fuse clips onto the exposed wire and apply solder for a good connection. On the 10–inch loose wire, crimp another metal fuse clip onto the exposed wire and apply solder. Install the fuse (both are three–amp) into the fuse clips on both sides. Slide the spring on the wire to the fuse. Then slide the plastic insulated fuse–holder over the loose end of the wire so that the spring is inside the fuseholder. Now, twist the fuseholders until they lock together.

(9) On the loose ends of the green and orange wires, strip the insulator and crimp either the spade or ring tongue lug on the wire. Solder the crimped connection.

(10) Do not dress the wires at this time. Go to the next procedure.

4. Radio Installation

(1) Choose a location where the mounting screws are not directly above the fuel tank, fuel line, or other vital parts. Permanently install the mounting tray of the radio to a flat surface with a four–point mounting scheme or, if on an uneven surface, with a three–point mounting scheme. (Four–point mounting is strongly recommended over three–point, especially in vehicles subject to extreme vibrations.) The raised shelf in some car trunk compartments makes a good mounting place. Place the radio at one side to allow space for luggage. Leave at least eight inches in front of the radio so that the handle can be opened and the programming cable can be plugged into the radio. Locate the radio so that the black ground lead in the trunk can reach a good chassis ground point in the trunk. Determine the radio's final position, 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). Mount the mounting tray as illustrated in Figures 6 and 7.

(2) When mounting the radio securely to the trunk floor in some vehicles, the front panel may press against the floor or floor cushioning. Also, some vehicles make it necessary to mount the radio directly over the fuel tank. Always make a preliminary check to see how far the screws will extend below the trunk floor. Do not puncture the fuel tank. If either condition exists, insert one of the thick spacer washers between the bottom of the mounting tray and the floor at each of the four mounting holes. The washers help to keep the radio level, especially when the floor is covered with a "spongy" mat such as soft rubber. Replace the radio assembly by sliding the radio onto the tray at about the halfway point. Push straight back until the tray tabs enter the two window areas on the radio front and engage the handle tabs. Close by pushing the handle 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 fully seat the connector. Reverse the procedure for removing the radio.

(3) Thoroughly clean the trunk floor surface before proceeding. Connect the black ground cable lug to a convenient location on the trunk floor. Center punch and drill a 3/16" (.187") hole through the mounting surface. Use a #14 x 3/4" self–tapping screw and the supplied 1/4" lockwasher to mount the cable lug. See Figure 8.

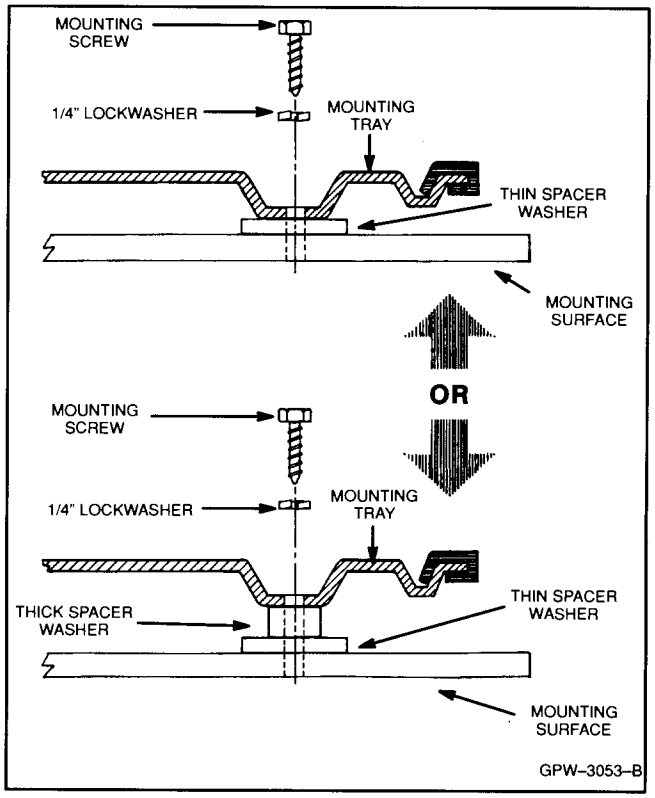


Figure 7. Radio Mounting Tray Installation Detail

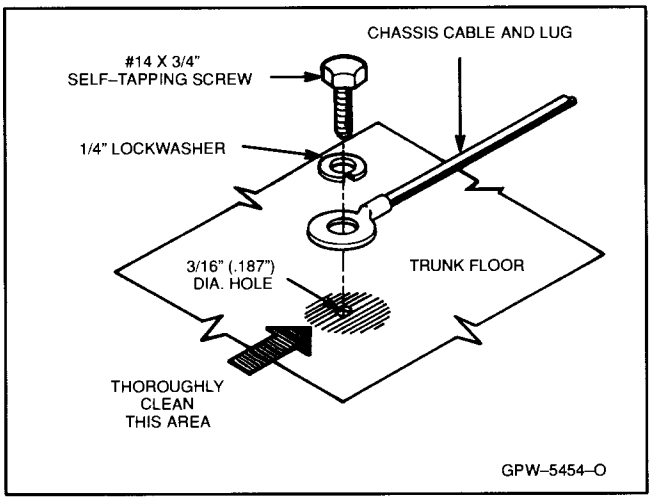


Figure 8. Radio Ground Connection

CAUTION

A good ground connection of the black cable is essential for radio operation and to prevent damage to the radio and cable kit. Grounding to the vehicle frame is desirable. On some late–model automobiles, the ground connection between the vehicle chassis and engine block is inadequate for good mobile radio operation. DO NOT compensate for this problem by connecting the radio ground directly to the battery. Connect a flexible metal ground strap between the engine block and a vehicle chassis point common to the radio 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. Mount the radio so the heatsink has the largest available air supply for cooling.

5. Microphone Installation

The microphone bracket must be within arm's reach of the operator. Measure this distance before actually mounting the microphone bracket. Since the bracket has a positive–detent action, the microphone can mount in almost any position. See the microphone instruction manual for more information.

After installation, connect the microphone plug to the receptacle on the control unit. Make sure that the clip on the control unit firmly engages the plug. Connect the microphone cable "S" hook to the proper hole in the strain relief clip on the rear of the control unit.

6. Speaker Installation

6.1 GENERAL

The speaker kit includes a trunnion bracket that allows the speaker to be mounted in a variety of ways. With the trunnion bracket, the speaker can mount permanently on the dashboard or in accessible firewall areas. The trunnion allows the speaker to tilt for best operation.

6.2 INSTALLATION WITH TRUNNION BRACKET

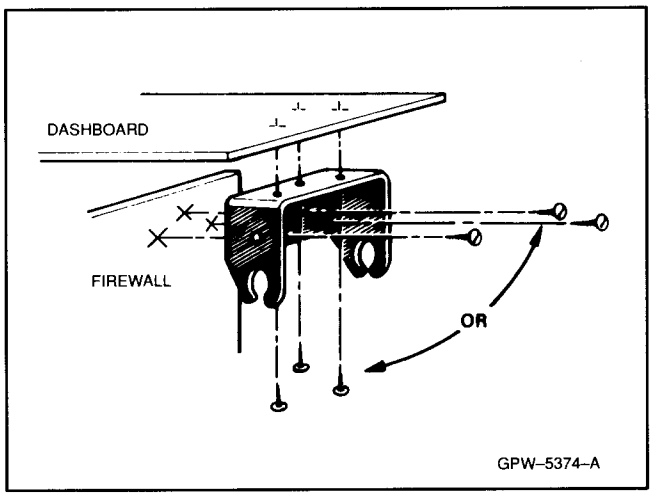


Figure 9. Standard Speaker Mounting

(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) Select a mounting position. 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.

(5) Mount the trunnion bracket with the supplied self drilling screws.

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

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

(8) Tie up surplus lead cable.

Note

Using the self drilling screws eliminates the need for predrilled holes.

7. Control Unit

7.1 MOUNTING CONSIDERATIONS

Examine the vehicle to find a suitable mounting location within the operator's reach. Although the trunnion mounting bracket can mount on a plastic dashboard, all four trunnion mounting screws should penetrate the dashboard's supporting

metal frame. If that is not possible, use a metal backing plate (not supplied) to strengthen the installation. The location should be convenient to the operator for viewing the display and operating the buttons and on–off switch, but vehicle operation should not be impaired and the driver's vision must not be obstructed.

If necessary, pull more cable into the dashboard area. Be sure all wires are clear of the instrument panel where holes are to be drilled.

7.2 INSTALLATION

(1) Mark the mounting location (see Figure 9) using the trunnion bracket as a template; drill four 5/32" holes. If mounting into a plastic surface, use a metal backing plate.

(2) Attach the trunnion bracket using all four #10–16 x 5/8" self–tapping screws supplied in the mounting kit.

Note

When the control unit is installed, it must not wobble or feel "spongy" when you press buttons. Use all four mounting screws and be sure they are tightly screwed into metal–either a dashboard support bracket or a backing plate.

(3) Plug in the radio cable connector and microphone cable connector in the proper location on the back of the control unit (see Figure 11). A "click" sounds when the connector snaps into place. Now connect the microphone cable "S" hook into the hole in the cable strain relief bracket on the back of the control unit.

(4) Plug in the Vehicle Interface Port (VIP) connector (see Figure 11) into the remaining location on the back of the control unit.

(5) Install the control unit to the trunnion bracket using the two wing screws. Rotate the control unit to the desired vertical position and tighten the wing screws.

8. Vehicle Interface Port (VIP)

8.1 GENERAL

The Vehicle Interface Port (VIP) allows the control unit to operate outside circuits and to receive inputs from outside the control unit. There are three VIP outputs which are used for relay control. There are also three VIP inputs which accept inputs from switches. See the cable kit section for typical connections of VIP input switches and VIP output relays.

8.2 OUTPUT CONNECTIONS

The VIP output pins are on the back of the control unit below the area labeled "VIP." Use these connections to wire control relays. One end of the relay should connect to switched B+, while the other side connects to a software controlled ON/OFF switch inside the control unit. The relay can be normally–on or normally–off depending on the VIP outputs' configuration. The control unit has 3 VIP output connections.

VIP OUTPUT NUMBER	SWITCHED B+ PIN NO.	ON/OFF SWITCHED PIN NO.
1	18	2
2	19	1
3	35	34

The function of these VIP outputs can be field programmed in the control unit. Typical applications for VIP outputs are external horn/lights alarm and horn ring transfer relay control. For further information on VIP outputs, see the control unit programming manual.

8.3 INPUT CONNECTIONS

The VIP input pins are on the back of the control unit below the area labeled "VIP." These connections control inputs from switches. One side of the switch connects to ground while the other side connects to a buffered input to the control unit. The switch can be normally–closed or normally–open depending on the VIP inputs' configuration. The control unit has 3 VIP input connections.

VIP OUTPUT NUMBER	GROUND PIN NO.	ON/OFF SWITCHED PIN NO.
1	20	4
2	21	3
3	36	37

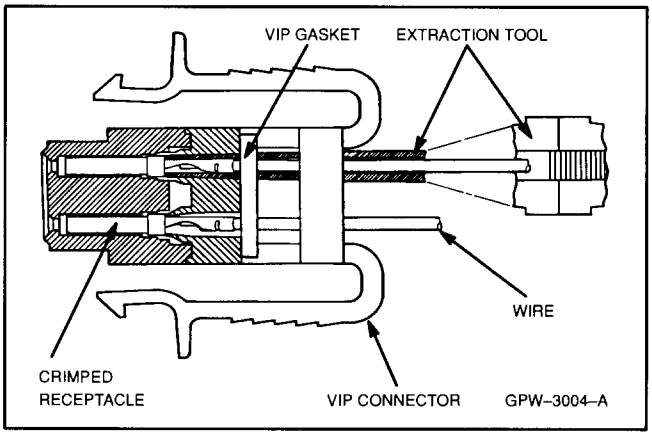


Figure 10. VIP Connector Detail

The function of the VIP inputs can be defined by field programming the control unit. Typical applications for the VIP inputs are for a foot switch or a horn ring switch. For further information on VIP inputs, see the control unit programming manual.

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

(1) Replace the fuse in the in–line fuseholder of the red power cable coming from the radio in the trunk. Connect the green (and/or orange) fused wire(s) coming from the control unit to the ungrounded terminal (or source) of the battery.

(2) Pull all excess cabling into the trunk. Clamp the cables to the vehicle body or chassis with the cable clamps supplied. Drill 1/8" mounting holes and then attach the clamps with four #8 x 3/8" tapping screws and four 1/4" lockwashers. Finally, be sure all in–line fuses are installed.

10. Antenna Installation

A diagram and complete installation instructions are supplied with each antenna ordered. See those installation instructions for pertinent information.

11. Conclusion of Installation

(1) Be sure the control unit and microphone PTT switches are off. Install the 40–amp fuse in the red primary power cable in–line holder. Install the 3–amp fuse in the orange cable in–line holder. Install the 3–amp fuse in the green cable in–line holder.

Note

If alternator or other noise is present in the received signal or in the transmission, see Motorola publications Number 68P81109E33 "Reducing Noise Interference" in Mobile Two–Way Radio Installations.

(2) Turn the radio on at the control unit and verify proper operation of all controls and indicators. Radio operation in some installations requires turning on the ignition. See Table 1. Perform a complete operational check of the radio.

(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 where necessary with the clamps and screws supplied. Replace the rear seat if it was removed for installing the cables.

Table 1. Radio Functions Connections

Conductor	Green	Orange	Green	Orange	Green	Orange
Connected to battery	•	•	•			
Connected to ignition switch				•	**See Note**	•
Ignition switch controls	No ignition switch control		Xmtr ignition switch controlled		Complete radio ignition switch controlled	
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 interference is a problem, isolate the green lead with a relay (Motorola Part No. 59–00813674).

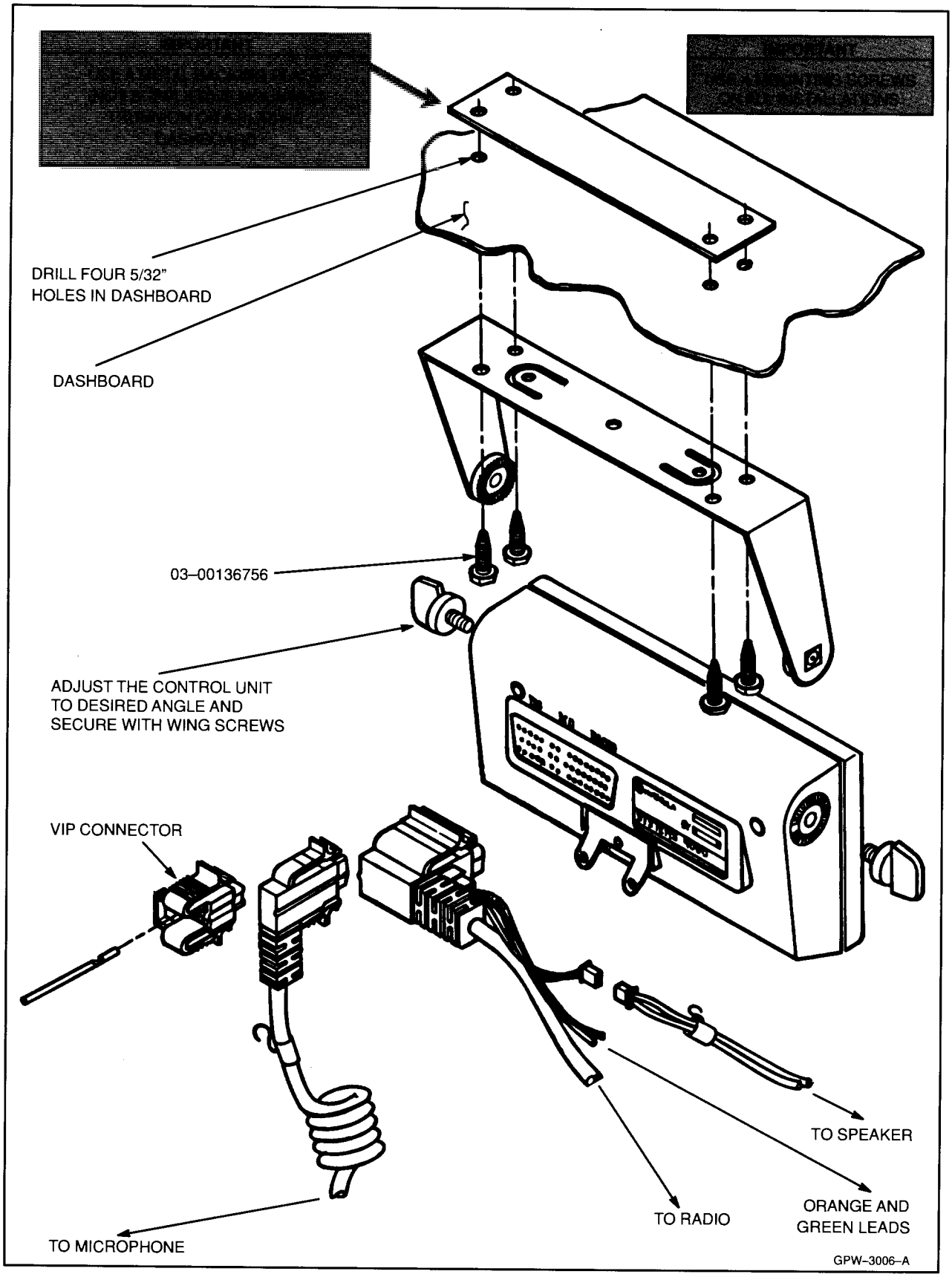


Figure 11. Control Unit Exploded View

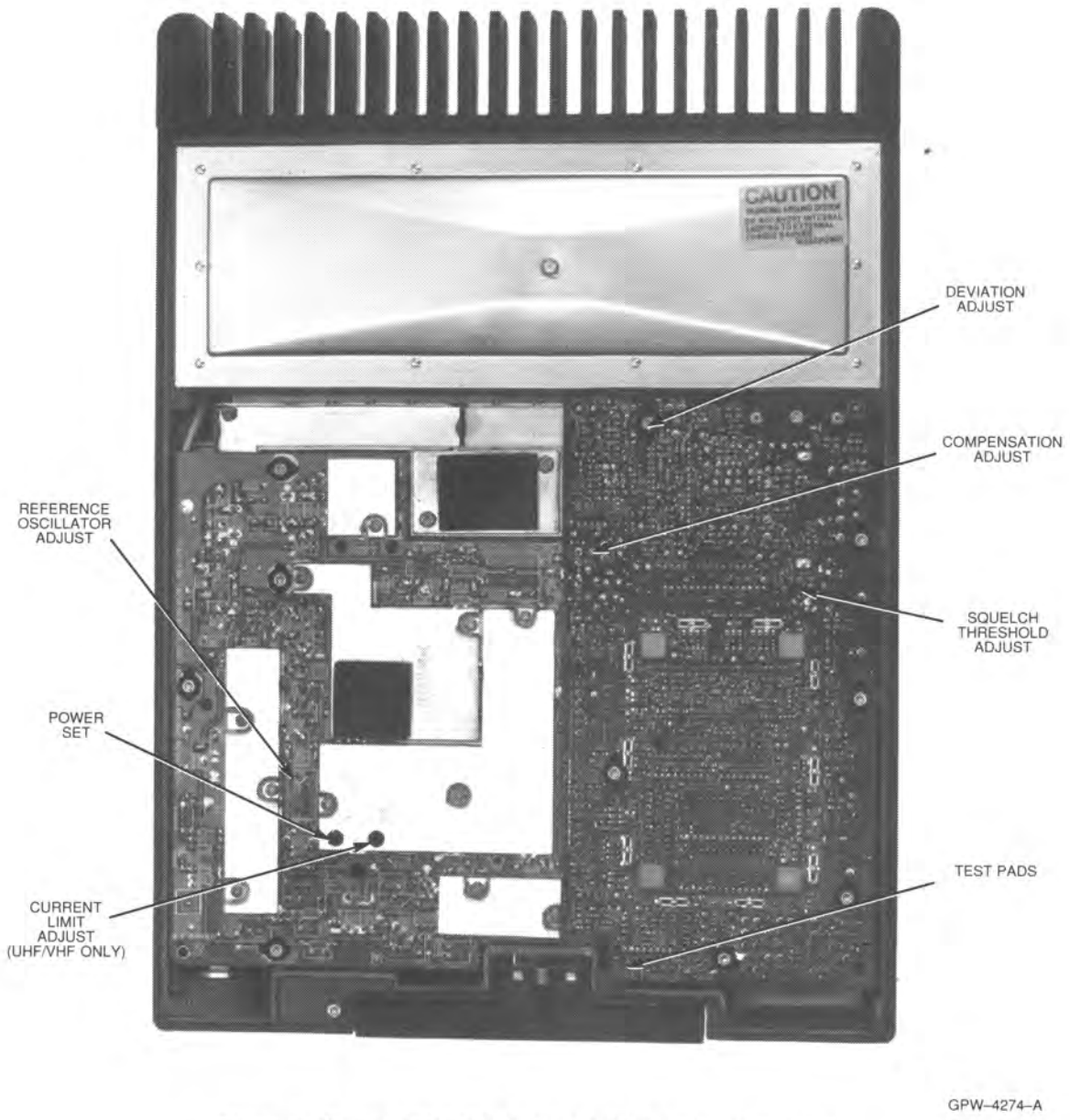


Figure 1. Typical SYNTOR X 9000/9000E *Radio (Top View)*

1. Recommended Test Equipment

Table 1. Test Equipment

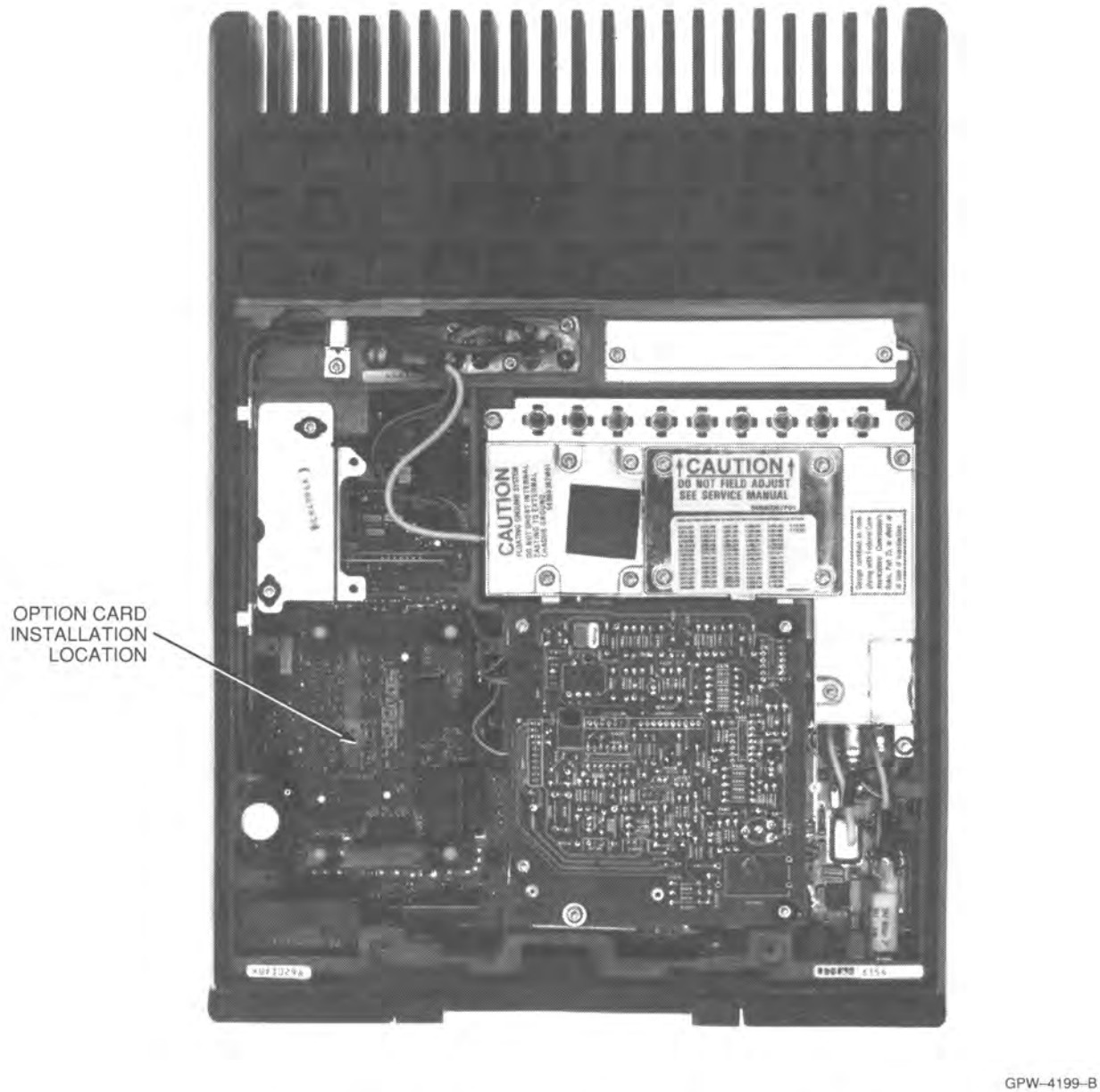
General type	Application	Recommended Model	Minimum Specification
AC–DC VOM	DC Voltage measurements, general	Motorola T1009A	Measurement range: 0–15V DC Sensitivity: 20,000 ohms/volt
DC Multimeter	DC voltage readings requiring an input resistance meter	Motorola S1063B	Measurement range: 0–15 V DC Input resistance: 11 megaohms
AC Voltmeter	Audio voltage measurements	Motorola S1053C	Measurement range: 100 mV AC Input resistance: 1 megaohm
RF Voltmeter	RF voltage measurements	Motorola S1339A	Measurement range:100 µV–3V from 1 MHz–900 MHz Inputs:50 ohm and high impedance
Oscilloscope, Dual–Trace	Waveform observation	Motorola R1004A	Vertical sensitivity: 5 mV–10 V/division Horizontal time base: 0.2 µsec–0.5 sec./division
RF Wattmeter	Transmitter output power measurement	Motorola T1039 with appropriate element and T1013 RF dummy load	Measurement range: 0–50 watts
Frequency Meter	Transmitter frequency measurement	Motorola R1200 Service Monitor with high stability oscillator (X suffix) option. Frequency calibration recommended every 6 months or less.	Measurement range: 806–870 MHz Frequency resolution: 10 Hz
Deviation meter	Transmitter modulation deviation measurement	Motorola R1200 Service Monitor with SLN6350 Deviation Meter.	Measurement range: 0–10 KHz deviation Frequency range: 806–870 MHz
RF Signal	Receiver alignment and troubleshooting	Motorola R1200 Service Monitor with attenuator.	Frequency range: 806–870 MHz Output level: 0.1 µV–100,000 µV Must be capable of at least ± 3 kHz deviation when modulated by a 1 kHz tone
Audio Signal Generator	Audio circuit troubleshooting	Motorola S1067B	Frequency range: 20 Hz–20 kHz Output level: 50 mV–1 V
•Double–Balance Mixer	Receiver front–end adjustment	Mini–Circuits Laboratory Model ZAD–4	—
•Logic Probe	Check various digital devices	Motorola RLT–4014	—
Radio Test set	Meter readings at circuit metering points for alignment and trouble–shooting	Motorola S1056 Portable Test Set with a TEK–37 or TEK–37A Test Set Adapter or a Motorola TEK–5 Meter Panel with a TEK–40 Cable.	—
•Tuning Tool Kit	Receiver and transmitter alignment	Motorola TRN4513A	—
•DC Power Supply	DC power for shop service	Motorola R1011AA	120 V DC 0–40 A
PL Tone Generator*	Tone coded "*Private–Line*" decoder troubleshooting	Motorola S133B	Frequency range: 10 Hz–9999 Hz Output level: 0–3 V rms
DPL Test Set**	"*Digital Private–Line*" encoder–decoder troubleshooting	Motorola SLN6413A	—

Note

All the test equipment listed above, with the exception of those marked with (•), can be replaced with the Motorola R2001 System Analyzer

CAUTION

In positive–ground systems, the case of the TEK–5 Meter Panel and portions of the S1056B Portable Test Set are hot with respect to the vehicle chassis due to the nature of the positive–ground installations. Take necessary precautions that the test equipment does not contact the vehicle chassis.



GPW–4199–B

Figure 2. Typical SYNTOR X 9000/9000E *Radio (bottom view)*

2. Radio Alignment and Adjustments

2.1 INTRODUCTION

The following four adjustments can be made to the *SYNTOR X 9000* radio:

- Oscillator frequency.
- Deviation.
- Compensation.
- Transmitter power.

Perform all adjustments through the holes that are directly accessible on the RF board. (See Figure 1). Readjustment of the receiver is not recommended since the factory adjusts the receiver to allow a wide passband for all frequencies within the radio model's range.

Note

See the list of recommended test equipment provided in this section of the manual.

2.2 OSCILLATOR FREQUENCY

Note

Perform the oscillator frequency adjustment before setting or checking the deviation adjustment.

(1) Use the mode rocker to set the radio on a carrier squelch transmit mode when adjusting the oscillator frequency.

(2) Use the portable test set to key the transmitter without modulation.

(3) Adjust the reference oscillator warp control (Figure 1) until the proper indication is obtained on the frequency meter.

(4) Use the mode rocker to scroll to all the remaining positions and check the proper transmitter frequencies. (No further oscillator frequency adjustments are required.)

2.3 DEVIATION

Note

Check deviation on all transmit channels when setting deviations; especially if wide transmit separations (more than 5 kHz) are required.

(1) Use the deviation adjust potentiometer, to set deviation on the selected transmit frequency to 4.7 KHz.

(2) Check the deviation on all transmit frequencies to ensure that it does not exceed 5 kHz on any of them.

2.4 COMPENSATION

Note

The compensation adjustment potentiometer is set at the factory and does not normally require readjustment.

Use this compensation adjustment procedure when any of the following conditions occur.

- If DPL transmit (encode) performance is poor
- If the VCO reference oscillator or common circuits board is replaced
- If the compensation potentiometer is replaced or inadvertently adjusted.

2.4.1 Radios with PL or DPL

This procedure balances the transmit audio signal fed to the VCO and reference oscillator. This insures good DPL waveform fidelity and flat modulation response.

(1) Turn the deviation potentiometer (Figure 1) one–half turn clockwise.

(2) Set the mode selector switch to the PL/DPL customer transmit frequency closest to the radio's first target frequency in Table 2.

(3) Connect the center lead of the shielded cable of an AC voltmeter to the modulation compensation test point and connect the shield to the radio ground(A–). Set the voltmeter to the 1 mV range.

(4) Modulate the PL or DPL and adjust the compensation potentiometer until a null indication is obtained on the voltmeter. Cover the hole with tape to prevent accidental adjustment of this control.

(5) Go to section 2.3, step 1.

2.4.2 Radios without PL or DPL

(1) Set the compensation potentiometer to its midpoint.

(2) Go to section 2.3, step 1.

2.5 POWER MEASUREMENT

Important

The following information is to insure accurate measurement of RF power. These instructions should be followed before performing any transmitter power tests. See the Transmitter section of this manual for information about the operation of the VSWR protection circuitry.

See the list of recommended test equipment in this section of the manual. Use only the recommended equipment for making these adjustments to avoid erroneous results. All transmitter adjustments can be performed from the top of the radio.

Connect the wattmeter to the radio antenna connector using a type N–to UHF coaxial adapter cable.

Note

This is the only place that a coaxial adapter cable is acceptable.

Use connectors with a plastic insulating dielectric for the coaxial adapter cable. Connectors using bakelite as the insulating dielectric, or low cost adapters intended for citizens band service, should NOT be used.

The coaxial cable to adapt the UHF antenna connector on the radio to the type N connector on the wattmeter should be of a high quality type. Cable types such as RG400/U (part #30–84173E01) or RG142 B/U (part #30–83278B01) are recommended.

Careful set–up of the measuring system is well worth the extra time and effort. These techniques are recommended for other Motorola radios.

2.5.1 Power Set Procedure

(1) Terminate the radio with a wattmeter and a 50 ohm load.

(2) Adjust the DC power supply voltage to 13.4 volts.

(3) Turn the power set potentiometer, R908, clockwise to the stop (minimum power position).

(4) Turn the current limit potentiometer R932 clockwise to the stop (fully open).

(5) For 100–watt radios, key the transmitter, and adjust R911 to get a nominal power output of 105 watts. For 40–watt radios, key the transmitter and adjust R908 to get a nominal output of 42 watts.

(6) Observe Meter 5 and determine the least efficient channel (highest Meter 5 indication). Note the Meter 5 indication and stay on this channel.

(7) On the least efficient channel (from step 6), turn R908 counterclockwise to the stop (maximum power position).

(8) Key the transmitter and compare the Meter 5 reading with the reading obtained in step 6. If the Meter 5 reading has increased by 3 uA or less, turn R932 until the output power decreases slightly. If the Meter 5 reading has increased by more than 3 uA, turn R932 until the reading is only 3 uA higher than the reading obtained in step 6.

(9) Key the transmitter and adjust R908 for an output power indication of 105 watts (100 watt radios), or 42 watts for 40–watt radios.

3. Radio Disassembly

3.1 GENERAL

Remove the top cover to access the solder side of the RF board, personality board, and the power amplifier deck. Remove the top cover by turning the key to release the front handle and then press the button under the handle. The top cover pops up and allows access to the boards. Remove the screw that holds the PA deck cover to access the PA deck. This procedure provides access to the metering sockets of the RF board (J2501) and the PA deck (J1101) without removing the radio from its mounting tray.

Remove the radio from the chassis by releasing the handle as described above. Slide the radio forward (about an inch) and lift it out. Disconnect the cables to remove the radio from the chassis.

Note

Mounting screws for the common circuits board, personality board, and RF board are those with the black plastic captivators holding them to the boards.

Access the rest of the radio by removing the four screws that secure the skid plate to the bottom of the radio. Remove the skid plate to access the metering socket of the common circuits board (J951). The common circuits board is hinged so when turned on its hinge, it provides access to its component side as well as to the component side of the RF board. Remove the screws on the board and on the regulator heat sink to turn the common circuits board over on its hinge.

CAUTION

When operating the radio with the regulator head sink screw removed, care should be taken to avoid the exposed hot flange. All serviceable mounting screws use either Posi–drive heads or TORX heads which can be damaged by using standard Phillips screwdrivers. Use the proper screwdriver.

3.2 COMMON CIRCUITS BOARD

To turn the common circuits board on its hinges requires the removal of three screws. However, to remove the board, you must remove the two hinge screws, unplug the cable between the common circuits board and the personality board, and unplug the wires between the common circuits board and the PA deck. When installing the board in the radio, take care to pass both the cable and the wires between the two board hinges.

3.3 PERSONALITY BOARD

Remove the personality board from the radio as follows:

(1) Remove the seven screws that secure the board to the radio.

(2) Disconnect the cable from the front plug.

(3) Disconnect the 10 conductor cable from the common circuits board.

(4) Pull the board away from the radio to disconnect the connectors from the RF board.

When installing the board in the radio, be sure that the front plug gasket is properly seated. (Silicone compound, Motorola Part #11–00834678, can be helpful in this process.)

3.4 RF BOARD

Remove the RF board as follows:

(1) Remove the personality board as explained in paragraph 3.3.

(2) Remove the six retention screws.

(3) Disconnect the coaxial cable between the RF board and the internal casting.

(4) Disconnect the wires located near the antenna switch.

Access to some segments of the solder side of the RF board requires the removal of shields attached to the board with screws. On the component side of the RF board, remove the two large cans by simply pulling them off the board. However, other cans on the board must be unsoldered to be removed.

Install the RF board back in the radio using care to align the board guide posts with the internal casting. Take care to

match the board spring connectors with those of the internal casting.

3.5 INTERNAL CASTING

3.5.1 General

Remove the internal casting from the radio as follows:

(1) Remove three screws to allow the common circuits board to hinge.

(2) Remove four cover mounting screws from the bottom of the radio.

(3) Remove two screws from the RF board (from the other side of the radio).

(4) Disconnect the cable between the internal casting and the RF board.

(5) Disconnect the cable between the internal casting and the PA deck.

(6) Disconnect the RF board wires located near the antenna switch.

Exercise care during the reassembly operation to make the proper connections between the various connectors and to replace all the screws without omission.

3.5.2 First Mixer

To remove the first mixer, remove the two screws that secure the first mixer cover and gasket to the internal casting.

CAUTION

Do not use excessive heat. Otherwise, the tap leads will come off the filter.

Carefully unsolder the two tap leads from the first mixer to the filter and remove solder between the feed through and the circuit board. Remove the two screws that hold the circuit board to the internal casting, then remove the first mixer board.

3.5.3 Low Pass Filter Board (or Optional Pre–amplifier)

With the cover off, remove the low pass filter board (or optional pre–amplifier) as follows: carefully unsolder and remove the wires from the phono connector, then unsolder and disconnect the coaxial cable from the six–pole filter. If an optional pre–amplifier is used, unsolder the feedthrough leads and remove the two retaining screws to remove the board.

CAUTION

See the Special Repair Procedures for soldering iron use on hybrid substrates. It is imperative that high silver content be used when removing the two insulated wires from the smaller pre–amplifier substrate. Since the smaller substrate is not copper clad, leaching of the pads can become a problem.

Remove the two screws that hold the carrier to the casting. Lift it out, using the handle that forms part of the carrier.

3.5.4 VCO Buffer/Doubler

Note

If the VCO assembly is replaced, it will be necessary to readjust the compensation level as explained in the Radio Adjustment Procedures in paragraph 2.

Remove the VCO buffer/doubler as follows: disconnect the coaxial cable to the VCO, disconnect the single wire to the feedthrough, disconnect the coaxial cable to the RF board, and disconnect the coaxial cable to the PA deck.

Remove the coaxial cables from the substrate, using the precautions explained in the Special Repair Procedures. Then, remove both cables from the internal casting. This may require the use of a larger soldering iron to heat the internal casting. However, never use the larger soldering iron on the substrate.

After removing the four mounting screws, the VCO buffer/doubler assembly can be removed by lifting the handle that forms part of the carrier. Lifting the carrier will simultaneously disengage the connector to the three–pole injection filter. This filter is located directly under the carrier.

3.6 TRANSISTOR MODULE REPLACEMENT

Note

Transistors are replaced as part of a module assembly. There are six module assemblies in each power amplifier: low–level amplifier (control stage), predriver, driver, and three finals.

To remove the low level amplifier (control stage), unsolder the input coax, output strap, and bias pin. Use C805 as a handle to carefully pull the module up until Q802 releases from its heatsink clip. Before installing a new module, apply a light coating of Wakefield compound to Q802. Be careful when installing the new module to avoid breaking the substrate. Align Q802 with the heatsink clip and apply pressure to Q802 until the module is firmly seated.

To remove any of the other modules, unsolder the tabs from the ceramic substrates (8 tabs on the predriver and driver modules; 6 on each of the final stage modules).

Remove transistor mounting screw and extract the module. Before installing the new module, apply a thin coating of Wakefield compound to the mounting surface. Be sure that the module output (indicated by the beveled corner) faces in the proper direction.

CAUTION

The transistor mounting screws must be tightened before the transistor tabs are soldered to the circuit board. Do not tighten to more than 6–7 inch pounds, or damage to the transistor may result.

Solder the module tabs to the substrate so that the connection covers the entire surface of the tab.

3.7 TRANSMITTER PA DECK

Perform the following steps to remove the power amplifier deck.

(1) Remove the transistor's mounting screws.

(2) Remove the stud nuts that are accessible from the bottom of the chassis.

(3) Remove the circuit board mounting screws and nuts.

(4) Unsolder and remove the input and output coaxial cables and all the power amplifier feedthrough capacitors from the board.

Perform the following steps to remove the intermediate power amplifier (IPA) board.

(1) Remove the 2 circuit board mounting screws.

(2) Remove the transistor heat sink mounting screw and shoulder washer.

(3) Unsolder the PA board output cable, then remove the IPA board.

CAUTION

Be sure that the insulator and shoulder washer insulate the transistor heat sink from the radio chassis properly when re–installing the circuit board.

3.8 FRONT LATCH

Remove the front latch key mechanism by inserting the key into the lock, turning the key about 45° in a clockwise direction, and inserting the special removal tool (Motorola Part #66–84909B01). Insert the tool with the point directed away from the lock while twisting it 180° in a clockwise direction. This releases the key mechanism for removal. Removal of the black plastic part requires the removal of a single screw.

3.9 DIRECTIONAL COUPLER

To remove the directional coupler, remove the top cover and unsolder the two coaxial cables. Remove the mounting screws. Swing the common circuits board up, unplug the connector, and lift the carrier from the radio.

3.10 ANTENNA RELAY

Disconnect the wires to the coil and the connector on the RF board to remove the antenna relay. The coaxial cable to the internal casting can be unplugged at the casting, but the cable to the transmitter PA deck must be unsoldered at the harmonic filter. The antenna relay is secured by means of a nut located outside the radio chassis. Remove the nut with a spanner nut removal tool (Motorola Part #RSX4028A).

4. General System Troubleshooting Guide

4.1 GENERAL

Tables 2 through 11, provide a general system troubleshooting guide. Table 2 is divided into three sections: symptoms of malfunction, possible cause of failure, and the procedure to be adopted to clear the fault.

The failure symptoms deal with the following conditions: absence of receive audio, distorted receive audio, low audio power, radio does not squelch, radio does not unsquelch, improper squelch sensitivity, no PL/DPL decode, no regulated 9.6 V or 5.0 V, no RF power output, low RF power output, no transmitter modulation, distorted transmitter modulation, improper microphone sensitivity, transmitter frequency shift with high–level modulation, synthesizer does not lock, reference frequency (6.25 kHz) heard in speaker or on transmitted audio, synthesizer locks on wrong frequency, slow synthesizer lock time, poor receive sensitivity, alternator whine.

4.2 REFERENCE

Depending on the cause of failure, the following troubleshooting charts and schematic diagrams are referred to for consultation:

- Schematic diagram of the audio section of the personality board; this diagram provides various voltage levels and waveforms and is located in the Microcomputer System section of this manual.
- Squelch troubleshooting chart; this is located in the Common Circuits Board section of this manual.
- Regulator troubleshooting guide; this is located in the Common Circuits Board section of this manual.
- Synthesizer troubleshooting chart; this is located in the Synthesizer section of this manual.

- Microcomputer troubleshooting chart; this is located in the Microcomputer System section of this manual.
- Power control troubleshooting chart; this is located in the Common Circuits Board section.
- Power amplifier troubleshooting chart; this is located in the Transmitter section.
- IDC troubleshooting chart; this is located in the Synthesizer section.
- Radio alignment and adjustment procedures; this is located in the General Maintenance section.
- Receiver troubleshooting chart; this is located in the Receiver section.

4.3 SYSTEM SELF CHECK

When the radio system is turned on it displays "SELF CHECK." During this time each processor does a diagnostic check. This includes checking ROM, RAM, EEPROMs, and serial bus circuitry. If no errors are detected, the display shows the selected mode. If there are any errors, they are displayed for two seconds each, after the self check display.

The error code is divided into two parts separated by a "/." The first part indicates the location of the error. The second part indicates the type of error. While the problem is not necessarily located on the board indicated by the location code, the troubleshooting guide for that board should be used to initially locate the problem. See Tables 3 through 11 for interpretation of these codes.

There are two types of errors. The first type does not stop the system from operating. This error occurs if an option board is not communicating on the serial bus. In this case the display indicates "ERROR __/__." This specifies the error. When this display appears, the operator is alerted by a beep. The system continues to operate without the option.

The second type of error inhibits the operation of the system. This occurs if the radio's EEPROM is corrupted. Since the data needed to operate the radio is stored in the EEPROM (frequencies and PL codes) the system cannot work if that data is invalid. This type of error is indicated by a display of "FAIL __/__." If there is a single error of this type, the display shows it indefinitely. If there are multiple errors, and at least one of them is of this type, each error display is shown for two seconds and the display cycles through them.

A special case exists for error "FAIL 01/90." This error indicates the control unit did not receive a message from the radio. If this error occurs, the control unit resets the system after all the error displays are shown in an effort to correct the failure.

Table 2. General System Troubleshooting Guide

SYMPTOMS	POSSIBLE CAUSE	PROCEDURES
No Receive Audio	Red or green lead fuse	Check the fuses.
	Audio PA malfunction	See audio section of personality board schematic diagram.
	Regulator malfunction	See regulator troubleshooting chart.
	Synthesizer not locking	See synthesizer troubleshooting chart.
	Quad detector malfunction	See receiver section schematic diagram.
Distorted Receive Audio	Audio PA malfunction	See audio section of personality board schematic diagram.
	Quad detector malfunction	See receiver schematic diagram.
	IF malfunction	See receiver schematic diagram.
Low Audio Power	Audio PA malfunction	See audio section of personality board schematic diagram.
	Red lead fuse	Check fuse.
	Quad detector malfunction	See receiver schematic diagram.
	IF malfunction	See receiver schematic diagram.
No Regulated 9.6V or 5.0V	Short on circuit board	—
	Regulator malfunction	See regulator troubleshooting chart.
No RF Power Output	PA enable switch	See microcomputer schematic diagram.
	Keyed 9.4V switch	See microcomputer schematic diagram.
	Synthesizer out–of–lock	See synthesizer troubleshooting chart.
	Red or orange lead fuse	Check fuse.
	Power control malfunction	See power control troubleshooting chart.
	PTT circuit malfunction	See troubleshooting serial data link and control unit. See the control unit and personality board schematic diagram.
	PA malfunction	See PA troubleshooting chart.
No Power Control Low RF Power Output	Power control malfunction	See power control troubleshooting chart.
	Power control malfunction	See PA troubleshooting chart.
	Antenna relay malfunction	See antenna relay test procedure.
No Transmitter Modulation	IDC malfunction	See IDC portion of the personality board schematic diagram.
	Microcomputer malfunction	See microcomputer schematic.
Distorted Transmitter Modulation	IDC malfunction	See IDC portion of synthesizer board schematic diagram.
	Reference oscillator malfunction	See IDC portion of synthesizer board schematic diagram.
	VCO malfunction	See IDC portion of personality board schematic diagram.
Improper Microphone Sensitivity	IDC malfunction	See IDC portion of synthesizer board schematic diagram.
	VCO malfunction	See IDC portion of synthesizer board schematic diagram.
	Reference oscillator malfunction	See IDC portion of personality board schematic diagram.
Transmitter Frequency Shift with High–Level Modulation	IDC malfunction	See IDC portion of personality board schematic diagram.
Synthesizer does not Lock	Is radio scanning?	Out–of–lock LED lights if radio is scanning.
	Synthesizer malfunction	See synthesizer troubleshooting chart.
	Microcomputer malfunction	See microcomputer schematic.
Reference Frequency (6.25kHz) on transmitted audio or in speaker	Adaptive filter malfunction	See synthesizer troubleshooting procedure.
Synthesizer locks on wrong frequency	Synthesizer malfunction	See synthesizer troubleshooting chart.
	Microcomputer malfunction	See synthesizer troubleshooting chart.
	Reference oscillator Out–of–adjustment	See synthesizer troubleshooting chart.
Long Synthesizer lock time	Synthesizer malfunction	See synthesizer troubleshooting chart.
Poor receive Sensitivity	High IF malfunction	See receiver section schematic diagram.
	Low IF malfunction	See receiver section schematic diagram.
	Quad detector malfunction	See receiver section schematic diagram.
	Pre–amp malfunction	See receiver section schematic diagram.
	First mixer malfunction	See receiver section schematic diagram.
	Second mixer	See receiver section schematic diagram.
	Antenna relay malfunction	See antenna relay test procedure.
Alternator Whine	Chassis to A– short	Disconnect control cable and check for a short between chassis and A–.
	Excessive whine in vehicle	See manual number 68P81109E33.
No PL/DPL	Microcomputer malfunction	See microcomputer troubleshooting chart.
	IDC malfunction	See IDC portion of synthesizer troubleshooting chart.

Table 3. Radio Troubleshooting Display Codes

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
FAIL 01/81 FAIL 01/82 FAIL 01/84	Reprogram EEPROM or check J501/502. If "FAIL" shows after reprogram, replace U502.
FAIL 01/83	Replace U501. Reprogram EEPROM or check J501/502.
FAIL 01/85	If "FAIL" shows after reprogram, replace U502.
FAIL 01/88	Replace U500.
FAIL 01/89	Replace U500 and U501.
FAIL 01/8A	Replace U500. Reprogram EEPROM or check J501/502.
FAIL 01/8C	If "FAIL" shows after reprogram, replace U502.
FAIL 01/8B FAIL 01/8D	Replace U500 and U501. Reprogram EEPROM or check J501/502. If "FAIL" shows after reprogram, replace U502.
FAIL 01/90 (Bus Failure)	Check cable kits. See Personality and Control Unit troubleshooting charts.

Table 4. Control Unit Troubleshooting Display Codes

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
FAIL 05/82	Control Unit EEPROM corrupted. See Control Unit troubleshooting in this manual.
FAIL 05/84	Control Unit EEPROM blank. See Control Unit troubleshooting in this manual.
FAIL 05/90	Control Unit serial bus failure. See Control Unit troubleshooting in this manual.

Table 5. SECURENET*–Capable Radio Troubleshooting Display Codes*

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
FAIL 09/90 ERROR 09/10	Option serial bus failure. See the appropriate *SECURENET* instruction manual.

Table 6. Trunking System Troubleshooting Display Codes

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
FAIL 10/82 ERROR 10/02	Option EEPROM corrupted. See the Trunking troubleshooting chart in this manual.
FAIL 10/84	Option EEPROM blank. See the Trunking troubleshooting chart in this manual.
FAIL 10/10	Option serial bus failure. See the Trunking troubleshooting chart in this manual.

Table 7. Siren/PA Troubleshooting Display Codes

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
ERROR 08/10	Option serial bus failure. See the *Systems 9000* Siren/PA option instruction manual.

Table 8. MDC–600 *PTT ID or* MVS *Troubleshooting Display Codes*

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
ERROR 0D/10	Option serial bus failure. See the appropriate option instruction manual.

Table 9. MDC–600 *Full–Feature Troubleshooting Display Codes*

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
ERROR 0A/10 ERROR 0B/10	Option serial bus failure. See the *MDC–600* Full–Feature option instruction manual.

Table 10. MDC–1200 *Troubleshooting Display Codes*

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
FAIL 0A/82	Option EEPROM corrupted. See the *MDC–1200* Signaling option instruction manual.
FAIL 0A/84	Option EEPROM blank. See the *MDC–1200* Signaling option instruction manual.
ERROR 0A/10	Option serial bus failure. See the *MDC–1200* Signaling option instruction manual.

Table 11. DTMF Troubleshooting Display Codes

DISPLAY SHOWS	DESCRIPTION OF PROBLEM
ERROR 0E/10	Option serial bus failure. See the DTMF Option instruction manual.
ERROR 0E/02	Option EEPROM failure. See the DTMF Option manual.

5. Antenna Switch Test Procedure

The antenna switch connects the antenna to the receiver via the receive reed, coaxial cable, and phono plug when the radio is in the receive mode. The antenna switch connects the antenna to the transmitter via the transmitter reed, coaxial cable, harmonic filter, and directional coupler when in the transmit mode.

5.1 TEST EQUIPMENT

A regular analog VOM is required for checking continuity paths or short circuits. See the list of recommended test equipment provided in Table 1 located in this section.

5.2 PROCEDURE

This procedure consists of the following two tests:

- Receive signal path test.
- Transmit signal path test.

As an initial step, disconnect the coaxial cable from the PA deck input. This allows the antenna switch to change from one condition to the other (i.e., from receive to transmit or vice versa) without causing the generation of PA output power.

5.2.1 Receive Signal Path Test

(1) Disconnect the receive cable plug from the internal casting socket. Using an ohmmeter, verify that continuity exists between the plug center pin and the antenna connector center pin. Verify that no continuity exists between the plug center pin and the plug shield (and/or radio chassis).

(2) Place the radio on a conventional mode or into the trunking test mode and key the radio. Under this condition, the receive reed opens. Verify that no continuity exists between the antenna switch center pin and the receive cable plug center pin.

5.2.2 Transmit Signal Path Test

(1) Verify that the coaxial cable is still disconnected from the PA deck input.

(2) Remove the PA shield.

(3) Key the transmitter and verify that continuity exists between the directional coupler input and the antenna switch center pin. If no continuity exists, check other points along the transmit signal path to locate any possible open circuits (see Figure 3).

(4) Verify that the transmitter path to the radio chassis is not less than 100 K ohms.

Note

Field servicing of the antenna switch assembly or the microstrip harmonic filter is NOT recommended. A defective unit must be replaced.

(5) Key the transmitter and verify that continuity exists between the harmonic filter output and the antenna switch center pin. If continuity does not exist between these two points during transmitter keyed conditions, or if continuity exists during the receive mode, then the antenna switch assembly is defective and must be replaced.

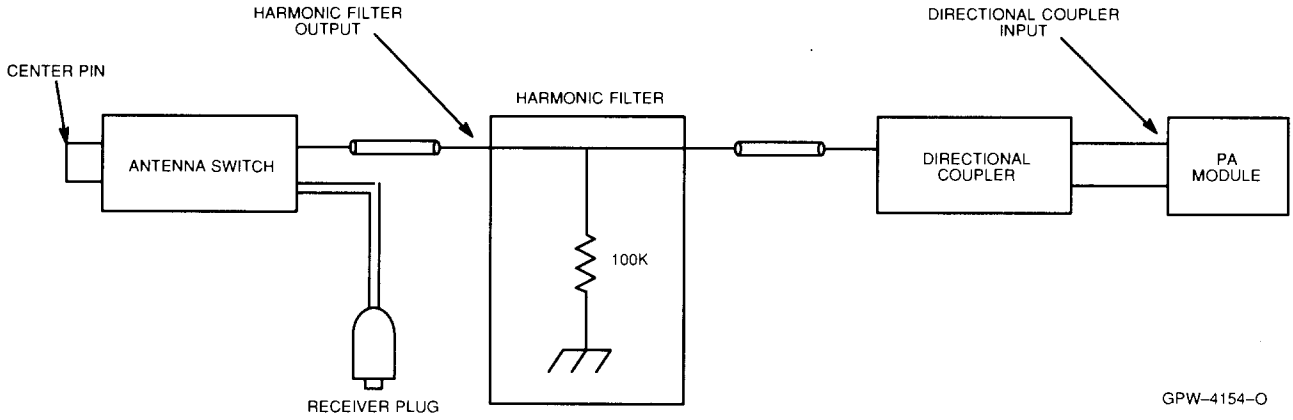
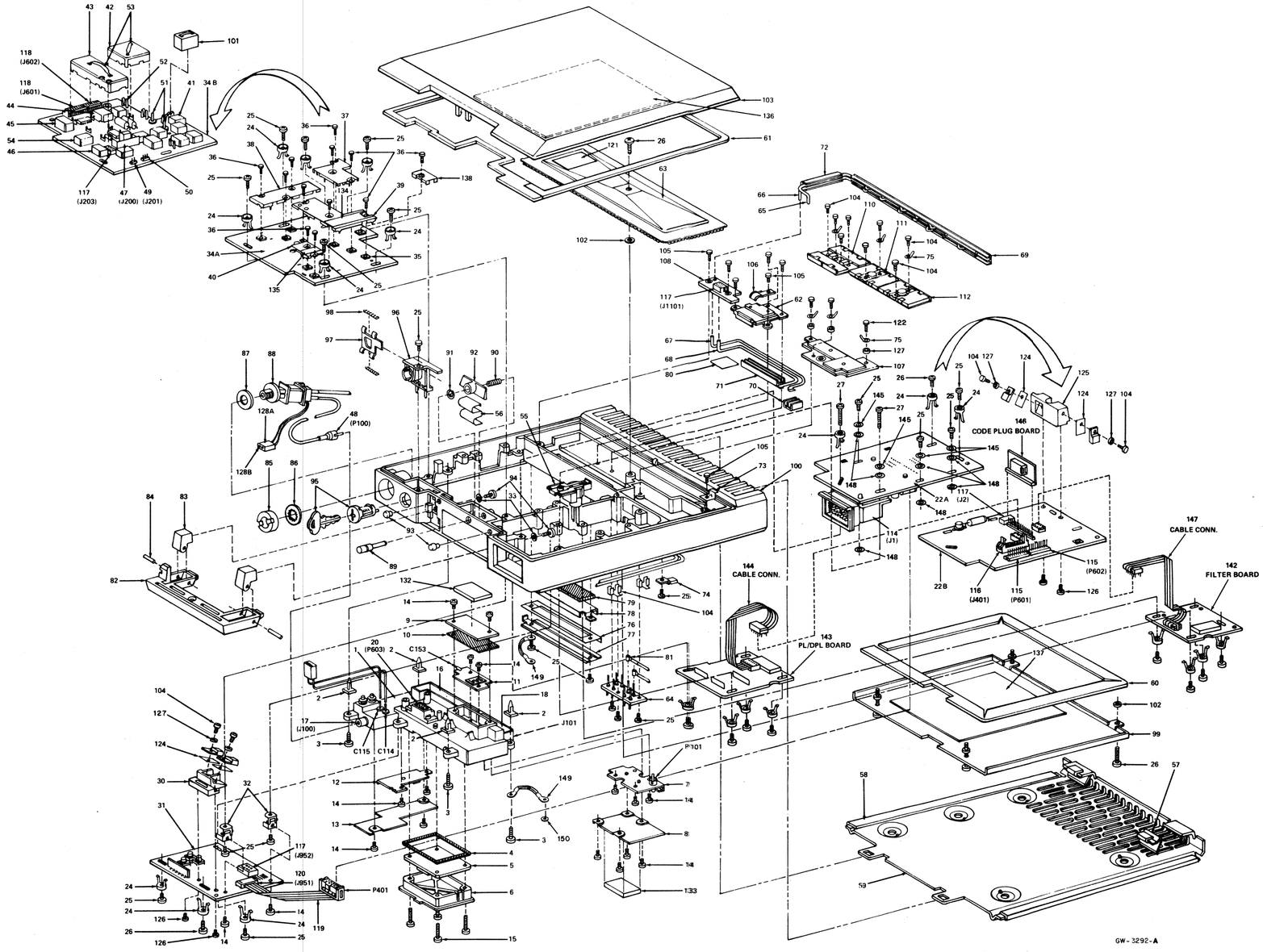


Figure 3. Transmit Signal Path



parts list

SYNTOR X 9000E Dual Operation Radio Mechanical Parts MXW–5563–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	15–80230B01	internal casting housing
2	14–80206B01	nylon grommet, 4 used
3	03–82002N01	tapping screw, 4.2 x 1.41 x 19mm; 4 used
4	32–82796H01	wire mesh gasket
5	—	VCO substrate
6	15–80206B01	VCO cover
7	—	VCO buffer substrate
8	15–83501M01	buffer cover
9	15–80208B01	mixer cover
10	32–84486M01	mixer gasket
11	—	mixer circuit board
12	—	preamplifier circuit board
13	15–80207B01	preamplifier cover
14	03–10943C28	tapping screw, 3.5 x 0.6 x 6 mm; 20 used
15	03–10943C34	tapping screw, 3.5 x 0.6 x 25 mm; 4 used
16	15–80209B01	preselector cover, (6 cell)
17	15–80210B01	preselector cover, (2 cell)
18	15–80210B02	preselector (3 cell)
19	15–83894M01	preselector tuning cover
20	—	VCO interconnect
22A	—	personality circuit board (solder side)
22B	—	personality circuit board (component side)
24	42–83503M01	retainer, 12 used
25	03–10943D29	tapping screw, 3.5 x 0.6 x 8 mm; 19 used
26	03–10943D32	tapping screw, 3.6 x 0.6 x 16 mm; 7 used
27	03–82001N02	tapping screw, 3.5 x 0.6 x 28 mm; 2 used
30	26–83398M01	regulator heat sink
31	—	common circuits board
32	55–83493M02	hinge, 2 used
33	04–00007652	external lockwasher (#10), 2 used
34A	—	RF circuit board (solder side)
34B	—	RF circuit board (component side)
35	05–84220B01	grommet, 12 used
36	03–84256M01	tapping screw, 12 used
37	26–83588M01	adaptive filter shield, (solder side)
38	26–83586M01	lower IF shield (solder side)
39	2683585M01	divider/phase detector shield (solder side)
40	2683587M01	quadrature detector shield (solder side)
41	26–83594M01	can shiled (component side), 7 used
42	2683592M01	adaptive filter shield (component side)
43	26–83593M01	divider/phase detector shield (component side)
44	26–83597M01	prescaler shield (component side)
45	26–83595M01	quadrature detector shield
46	26–83596M01	lower IF shield (component side), 4 used
47	26–83814M01	shield fence (component side)
48	28–84282D01	male phono connector
49	28–84324M01	male connector, 2 contact
50	28–84324M02	male connector, 3 contact
51	46–83948M01	guide post, 2 used
52	42–83891L01	mixer clip, 5 used
53	55–84300B02	handle, 2 used
54	42–80134B01	speed clip, 10 used
55	—	PA bus wiring
56	41–80158B01	cover lift spring
57	41–80172B01	spring clip, 2 used
58	07–80173b02	guide rail, 2 used
59	07–80208G03	mounting frame
60	32–80175B01	bottom cover gasket
61	32–80176B01	top cover gasket
62	—	directional coupler circuit board
63	26–80169B01	PA cover shield
64	01–80723D66	feedthru plate assembly (PA)
65	30–80136B01	bus wire (top positive)
66	30–81037b01	bus wire (top negative
67	30–80121b01	bus wire (bottom negative)
68	30–80120B01	bus wire (bottom positive)
69	52–83927M01	bus bar retainer
70	52–83927M02	bus bar retainer
71	52–83927M02	bus bar retainer
72	52–83927M04	bus bar retainer
73	42–80167B01	top bus clip
74	4208201B01	bus wire clip
76	29–84093M01	solder lug, 6 used
77	15–80124B01	harmonic filter cover
78	—	harmonic filter substrate
79	32–83926M01	mesh gasket
80	14–83901M01	lower bus insulator
81	29–83897M01	wire receptacle terminal, 2 used
82	55–80107B01	handle
83	07–80152B01	handle pivot bracket, 2 used
84	22–83491M01	spring pin
85	02–80006A01	spanner nut
86	04–00114522	lock washer
87	32–80080A01	ring gasket
88	—	antenna switch
89	38–80154B02	cover release button
90	41–80155B01	covert release spring
91	42–80156B01	retainer ring
92	55–80157B01	cover release catch
93	75–00838826	rubber bumper
94	03–10943D48	tapping screw, 5.0 x 0.8 x 16 mm, 2 used
95	55–84101B01	lock with key
96	15–80159B01	lock housing
97	55–80161B01	lock catch
98	41–80160B01	lock spring
99	15–80174B01	bottom cover
100	15–80105B01	radio housing
102	42–10128A18	O ring, 5 used

MXW–5563–O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
103	15–80106B01	top cover
104	03–10905A05	machine screw, 3.0 x 0.5 x 8 mm, 15 used
105	03–10943D20	tapping screw, 3.0 x 0.5 x 8 mm, 6 used
106	42–83982M01	cable clamp
107	—	power amplifier circuit board
108	—	metering circuit board
109	42–84367M01	wire hold–down clip, 2 used
110	—	final amplifier circuit board
111	—	driver circuit board
112	—	pre–driver circuit board
113	32–80219B01	front connector gasket
114	01–80726D99	front connector assembly, 37 contact male
115	28–82647K02	10 contact male connector, 2 used
118	09–83445L09	10 contact female connector
119	30–80263K01	20 conductor cable (includes P401)
120	28–84647L04	right–angle 6 contact connector
121	54–83895M01	radio label
123	04–84152B01	shoulder washer, 4 used
124	14–83820M02	transistor insulator (Q148, 149, 1001, 1002)
125	26–83498M01	audio PA heatsink
126	03=82741M01	tapping screw, 3.0 x 8 mm, 4 used
127	04–84180C01	shoulder washer
128A	15–84301K16	2 position connector housing
128B	39–82717M01	receptacle contact, 2 used
131	32–83997M01	feedthru gasket
132	75–82200H13	oscillator pad
133	75–82200H14	oscillator pad
134	14–84690M01	insulator
135	14–84690M02	insulator
136	14–84691M01	insulator
137	14–84691M02	insulator
144	30–83888P01	18 conductor flat cable (with DIP plugs)
145	04–00001719	flat metal washer
146	—	code plug with board
147	30–83776M01	14 conductor flat cable (with DIP plugs)
148	04–84345A12	flat plastic washer

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Exploded View, Mechanical Parts List and Functional Block Diagram for *SYNTOR X 9000* and *SYNTOR X 9000E* Radio

PW–4345–A

(Sheet 1 of 2)

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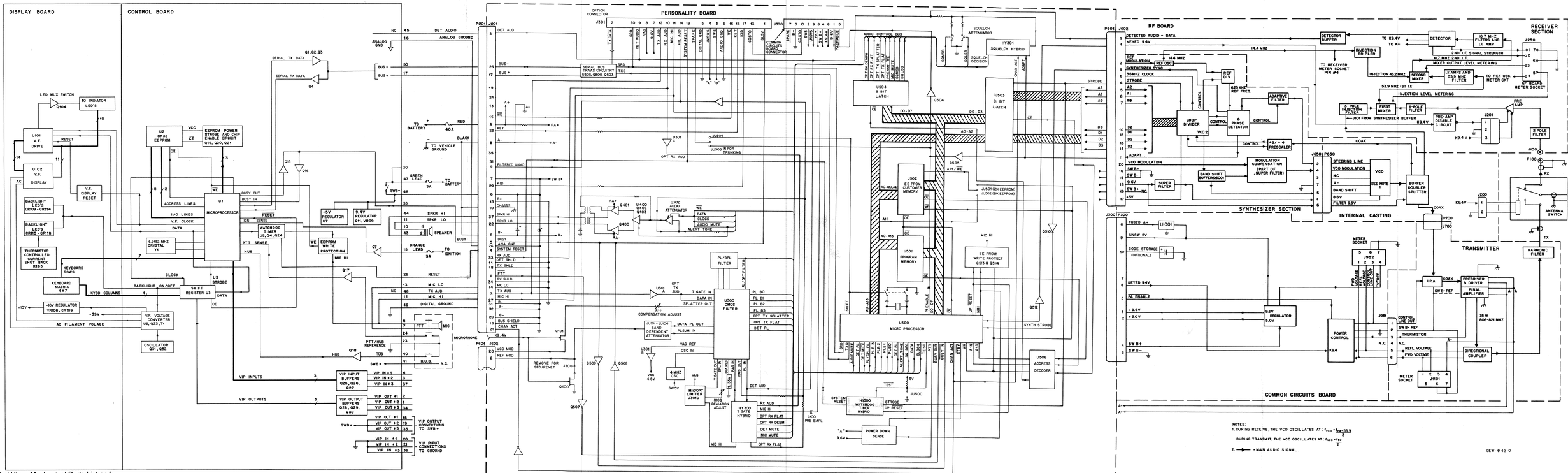


Exploded View, Mechanical Parts List and
Functional Block Diagram for *SYNTOR X 9000* and
SYNTOR X 9000E Radio
PW-4345-A
(Sheet 2 of 2)
5/20/88

1. Ceramic Microstrip Substrates

You should not attempt to repair the ceramic microstrip substrates of the radio. If a module has a faulty component, replace the whole module. Not only are repairs to the substrates and replacements of substrate components difficult to make without damaging the module, but also the factory uses special fixtures in building and testing the radio to make certain that each module operates properly. Field repairs to the microstrip substrates negate that initial factory adjustment.

The ceramic materials of the radio have properties similar to those of glass, and sharp blows and heat affect them the same way they affect glass. Therefore, if you must solder anything to ceramic microstrip modules, use as little heat and pressure as possible. You must also use solder with a high percentage of silver to avoid leaching the capacitors and non–copper runners.

2. Chip Capacitors

The radio uses many chips capacitors as circuit elements. They are extremely sensitive to heat and must not be re–used. Be very careful when making repairs to circuits near these components. Heat from a soldering iron being applied to a nearby component may "leach" the end metalization (terminals) of a chip capacitor. Figure 1 shows what a leached capacitor looks like.

To remove a chip capacitor, apply heat to both connecting terminals simultaneously, either with two soldering irons or a single iron with a special tip (Motorola #ST–1160). When the connecting solder melts, lift the chip. Figures 2 and 3 illustrate this removal technique.

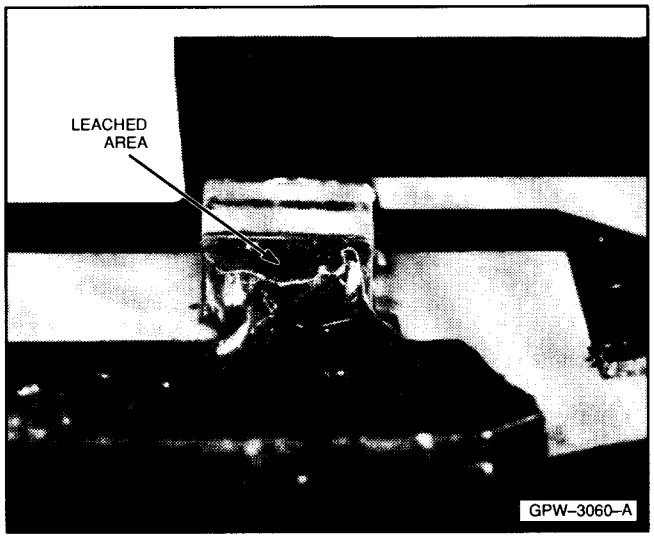


Figure 1. "Leached" Chip Capacitor

3. Replacing Transistors in the Power Amplifier

To remove the power transistors, remove two transistor mounting screws or one stud nut (accessible from the chassis bottom). Unsolder and remove the clamped mica capacitors, then unsolder an remove the transistors. Special soldering iron tips ST1160 and ST1161 (available form Motorola parts offices) make it easier to remove capacitors and transistors.

When replacing RF power transistors, you must take the following steps. First, use a soft cloth or paper towel to remove all thermal compound and residue from *both the chassis and the transistor*. Then apply a thin film of Wakefield thermal compound to the bottom of the transistor mounting flange. Replace the transistor in the center of the printed circuit board cutout, tightening the mounting hardware to a maximum of 7 inch–pounds. With a low power soldering iron (40–60W), solder the leads, using enough solder to completely cover the lead and solder pad. Make sure that the solder is flowing freely both *over* and *under* the lead before

removing the heat. If a lead tends to spring away from the circuit board, use the tips of a pair of pliers to hold the far end of the lead down against the board until the solder hardens. After replacing the transistors, replace the clamped mica capacitors, being sure to position them exactly as they were with respect to the transistor body.

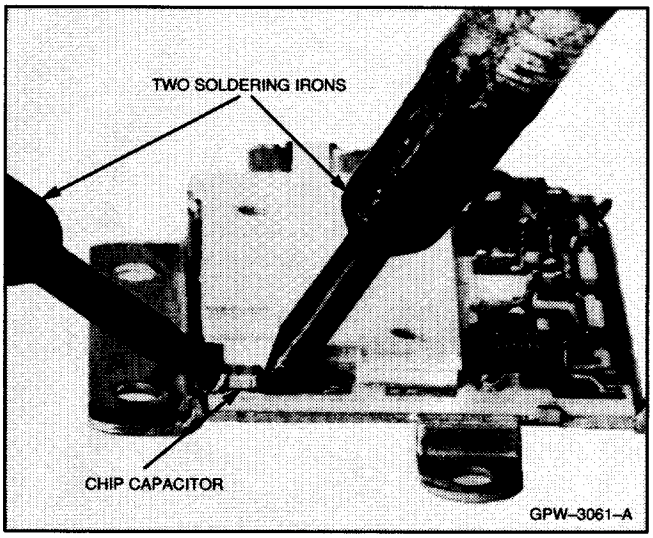


Figure 2. Capacitor Removal with Two Soldering Irons

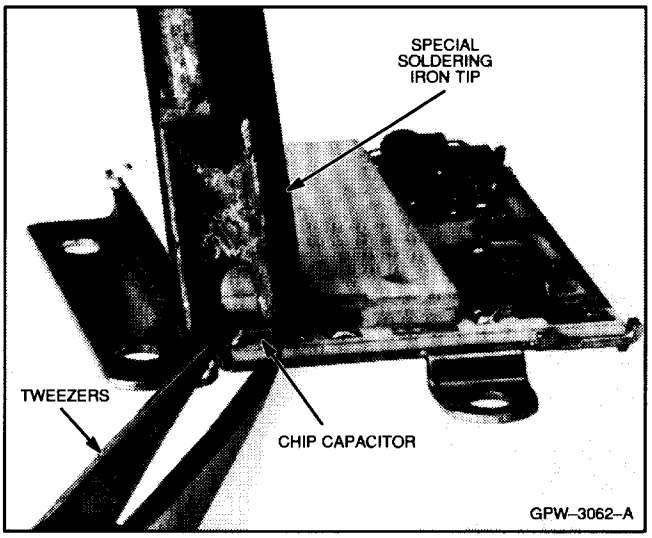


Figure 3. Capacitor Removal with Special Soldering Tip

Microcomputer System (Radio)

1. General

This section covers the Microcomputer System section of your radio.

2. Theory of Operation

2.1 INTRODUCTION

The *SYNTOR X 9000* personality board consists of two major sections; the digital section, and the analog section. The digital section is notated by the 500 series part designators. The analog section is notated by the 100, 200, 300, and 400 series part designators.

2.2 DIGITAL SECTION

The digital section communicates with the control head and the options over a serial bus link to receive and transmit information. This section also monitors parallel inputs from the radio. The digital section microprocessor uses both serial bus inputs and radio parallel inputs, to decide response to and control of the system. The digital section controls the radio since it controls the parallel outputs.

The outputs are controlled to perform various functions including:

- Audio routing.
- Synthesizer programming.
- Transmitter enables.
- Audio volume level control.
- PL and DPL detection.
- PL and DPL generation.
- Squelch level control.
- Alert tone generation.

The major blocks in the digital section are:

- U500—microprocessor.
- U501—program ROM.
- U502—customer system/mode EEPROM.
- U503—synthesizer programming latch.
- U504—audio control latch.
- U506—address decoder.
- HY500—watchdog timer hybrid.
- U505 and supporting circuitry–serial bus transceiver.

2.3 ANALOG SECTION

The personality board analog section contains all the non–RF analog circuitry in the radio, with the exception of the voltage regulators and the RF power control. The analog section circuitry is grouped by circuit designators as follows:

- 100 series transmit audio circuitry.
- 200 series receive audio circuitry.
- 300 series circuitry common to receive and transmit.
- 400 series audio power amplifier.

The analog section provides various audio and sub–audio filtering, summing, and amplifying functions that include:

- Receive audio switching.
- Transmit audio switching.
- Microphone pre–emphasis and deviation limiting.
- VCO compensation adjustment.
- Discriminator de–emphasis filtering.
- Received PL/DPL filtering and detection.
- PL/DPL D/A converter and filtering (PL/DPL generation).
- RF carrier detect/undetect (squelch).
- Digitally controlled audio attenuator.
- Audio power amplifier.
- Option receive and transmit summing/buffering.

The major blocks of the analog section are:

- U300—custom switched capacitor filter IC.

- 4 MHz crystal controlled oscillator (clocks U300).
- U301—quad opamp; microphone pre–emphasis/limiter; option RX and TX summer/buffer; biasvoltage buffer.
- HY300—audio switching hybrid.
- HY301—squelch hybrid.
- U302—pre–amplifier (digitally controlled attenuator).
- 400 series designator parts– audio power amplifier.
- Jumper selections.

3. Detailed Circuit Description

3.1 DIGITAL SECTION

3.1.1 Microprocessor System

The microprocessor (U500) with the program ROM (U501), the programmable EEPROM (U502), address decoder (U507), and output latches (U503 and U504) make up the microprocessor system.

The heart of the system is the high–speed CMOS microprocessor that runs at 1.2288 MHz. The processor uses Y500, a 4.9152 MHz crystal, for its time base. This oscillator is internally divided by four at the processor to obtain its operating frequency of 1.2288 MHz.

3.1.2 Address Decoding (U506)

The microprocessor controls the address lines, A14 and A15 output WR, to gain access to U501, U502, U503, and U504. The processor does this through the address decoder U506. The three inputs to U506 on Pins 2, 14, 3, 13, and 15 control U506 outputs to Pins 6, 7, 9, and 11. These signals, zero to five volt logic levels, are active low. When U506–6 is low, the processor is accessing U502 (EEPROM). When U506–7 is low, the processor is accessing U501 (program PROM). When U506–9 is low, U504 is accessed, and with U506–11 low, U503 is accessed.

3.1.3 Program Memory (U501)

The program that the processor executes is contained in the 16k by 8 UV–EEPROM. By manipulating the remaining 14 address lines (A13–A0), the processor can read the instructions stored permanently in the EEPROM. The address lines A14 and A15 are used for address decoding.

3.1.4 Customer Mode EEPROM (U502)

All radio mode information is stored in U502 (EEPROM). The standard EEPROM is 2k by 8 in a 24–pin package. This package is inserted in the rear 24 pins of the IC socket (Pins 1, 2, 27, and 28 are left open). The board design accepts an optional 8k by 8 EEPROM that is a 28–pin part. The EEPROM is reprogrammable, and is read from like the program memory IC (U501). It is also written to by the EEPROM programming mode, described later.

3.1.5 Synthesizer Programming Latch (U503)

The synthesizer programming latch is an eight–bit static latch whose outputs store the digital value (high or low) of its inputs when a low to high transition occurs on U503–11. To load data into the synthesizer, the latch stores correct data (D3–D0) from the customer mode EEPROM, and the corresponding address (A2–A0) with the strobe output high (U503–19). Then the latch stores the same address and data with the strobe output low. This clocks the four bits of data into the synthesizer. For valid programming to occur, this process is repeated for five sets of data with five different addresses. The synthesizer is continually updated to avoid corrupted data passing on a power supply transient condition. The update rate is approximately every 20 milliseconds.

3.1.6 Audio Control Latch (U504)

The audio control latch operates in the same manner as the synthesizer programming latch (U503). In addition, the audio control latch provides signals for five audio routing paths, both squelch level controls, and a control line for audio volume programming.

3.1.7 Watchdog Timer Hybrid (HY501)

The watchdog timer hybrid performs three functions. This hybrid circuit controls the system reset line, monitors the internal microprocessor reset line, and senses the system reset line.

The first function is performed on power–up of the radio system. The hybrid outputs a reset pulse approximately 30 milliseconds long to allow the crystal oscillators in the system to stabilize. The pulse is high on system reset (HY500–10).

Secondly, the watchdog timer monitors its input. The synthesizer strobe from U503–19 should toggle every 20 milliseconds. If the strobe pulse fails to toggle, the watchdog timer times out and initiates a 30–millisecond reset pulse. This is a failsafe in the event the radio's microprocessor gets lost due to a power supply transient.

The third function performed by the watchdog timer hybrid is its sensing of the system reset line. This line is bi–directional. If another processor in the system gets lost due to a transient, that processor initiates a reset pulse to recover. If the system reset line is pulsed, the watchdog timer stretches the pulse to a 30–millisecond reset pulse.

3.1.8 Serial Bus Transceiver (U505 and supporting circuitry)

Communication between processors in the system is handled by the serial bus at a data rate of 9600 bits per second. The signals generated are bus +, bus –, and busy. Bus + and bus – carry the same serial data. Bus – is bus + inverted (bus + high, bus – low). In using this pair of signals, the comparator U505 can differentiate between noise and valid data. In normal radio transmission, the radio microprocessor reads the line busy in (U500–9). If found to be HI, the processor pulls busy out high (busy in active LO, busy out active HI), and transmits as

message out of TX data (U500–13). To further avoid a collision on the serial bus, the radio processor reads serial RX data (U500–12) as it transmits. If the processor does not read back the same data that it sent out, some error occurred and the radio processor attempts to re–transmit the message. When receiving a transmission, (example: control head transmitting), the radio processor would sense busy in (U500–9) going LO and process the incoming message from serial RX data (U500–12).

3.1.9 EEPROM Programming

The EEPROM (radio mode information) is programmed by communication over the serial bus. Special commands are sent to and from the radio microprocessor from the IBM PC programmer interface.

Note

An IBM PC and Control Head/Radio Programming Software Version 3.0 (or later) are required to program this radio.

The EEPROM is equipped with an input called "write–enable" that is active LO (LO writes to the EEPROM). This input is at U502–23 for a 2k by 8 EEPROM or at U502–27 for an 8k by 8 EEPROM. To protect the contents of the EEPROM from being inadvertently written over, the write–enable line is held in active by the microphone HI audio input.

The line is protected to eliminate the possibility of corrupting the EEPROM data during power supply transients or other temporary battery supply conditions that could possibly alter the data. The microphone HI audio input is normally biased up to 9.6 volts while receiving, and pulled to approximately 4 volts when transmitting to power the active element microphone cartridge. When connected to either of the programmers, the microphone input is shorted to ground and allows access to the EEPROM write–enable line.

The microphone line is input to the digital section by R530 pulling the base of Q513 HI and forcing Q513 to pull the base of Q514 LO. With Q514 conducting, the input write–enable (U502–23 for 2k by 8 and U502–28 for 8k by 8) is held HI by Q514. Note that CR502 and CR503 protect the write–enable line in the same manner. The diode CR502 protects the EEPROM write line the instant the radio loses power (switched off) since this signal senses when the 9.6 volt supply falls off. The diode CR503 protects the EEPROM when the system is being reset due to power supply transients.

3.1.10 Power Down Sequence

With the power off, the radio microprocessor is put in its sleep mode. This mode requires to cut back the current drain on the unswitched five–volt regulator from 15 milliamps to a few micro–amps. The unswitched five–volt regulator remains powered up while the radio is off so that the radio microprocessor retains its memory and powers up in the last mode used. The radio processor retains the last mode, volume level, squelch level, and other operator–selected functions.

This eliminates the need for resetting all the controls every time the radio is turned on. For the radio processor to remember its last configuration, inputs are required that allow the processor to store this information be fore power is shut off to its memory and supporting circuitry (switched five volts turning off). The inputs NMI and STBY are generated to tell the processor that power is coming down.

The signals NMI and STBY are generated by the transistor circuits involving Q516 and Q517. Both signals are active LO, so when NMI is LO, the processor is put in the sleep mode (standby). The transistor Q516 remains off while the 9.6–volt supply is powered up. This is done through R542 that pulls the base of Q516 HI. When the 9.6 volt supply begins to fall off (radio is turned off), Q516 begins to conduct, since its emitter is connected to the unswitched five–volt supply (this supply remains powered). As Q516 begins to conduct, the base of Q517 is pulled HI, and the collector is pulled LO. The collector is connected to U500–8, the NMI input to the processor. The signal STBY is generated by the R–C circuit made by R547 and C521. This signal goes LO approximately 500 microseconds after the NMI signal goes LO. The STBY input is at U500–7.

3.1.11 Test Mode

The radio test mode allows finer audio volume steps to be input to the audio preamp. In standard operation, you can set volume in 30 discrete steps. These steps increment the audio level by approximately 3.2 dB. In the test mode, increments are approximately .4 dB. This allows setting the volume closer to rated audio, more accurately setting the audio volume level, and measuring receive parameters such as RX audio distortion, received FM hum and noise, squelch sensitivity, and other receive parameters.

Enter the test mode by shorting the two pins of jumper JU500, and turn the radio on. The radio processor reads this input (U500–21). By shorting this input, the processor reads this port LO, enters the test mode, and enables the finer volume increments. Jumper JU503 also disables the watchdog timer. This is useful for troubleshooting. If a malfunction causes the watchdog timer to time out, the timer sends out reset pulses until the system recovers. By shorting JU500, the reset pulses stop and the system resumes operation. This allows you to troubleshoot and find the source of a problem with out resetting the system.

3.2 ANALOG SECTION

The analog section of the personality board consists of four groups of circuitry. They are transmit audio, receive audio, common circuitry, and the audio power amplifier.

3.2.1 Transmit Audio Circuitry

To handle hardware options more efficiently, there are three possible paths for audio to pass through while transmitting. The first, the normal microphone path, follows the standard pre–emphasis curve of +20 dB per decade from 300 Hz to 3 kHz, and rolls off sharply at frequencies above 3 kHz.

The second two transmit–audio routing paths are available for hardware options. Both of these paths are accessed through the option TX buffer at J301–12 or J1–3. The input at J301–12 provides for options internal to the radio, and J1–3 provides for options in the external options box. This input is the null port of the opamp U301–1. The input allows summing of multiple option outputs without interference.

The first transmit audio route is TX splatter. This port, when enabled, displays a flat response from 300 Hz to 3 kHz, and rolls off sharply at frequencies above 3 kHz.

The other transmit route available to the options is TX flat. This port shows a flat response from approximately 2 Hz to above 6 kHz, and does not roll off sharply.

3.2.2 Microphone Transmit Audio

The microphone path enters the radio through J1–27. The resistors R101 and R102 with the capacitor C108 provide DC bias for the active microphone element. This signal is available as an input to the options at J301–11.

Microphone HI, after entering the radio, goes to C100. This capacitor blocks DC, and sets the pre–emphasis required to an 18–kHz high–pass corner. The high–pass filter provides the required +20 dB/decade pre–emphasis response. The microphone path is switched in or out by the transmission gate on HY300. The signal is input at HY300–6 and output at HY300–4. The control line to turn the microphone path on is at HY300–11, and microphone mute is active HI. HY300–6 and HY300–4 are the summing node of the opamp unless the path is open (HY300–11 HI).

The microphone signal is amplified by U301 by a factor of 24 (at 1 kHz), so the nominal 80 mV input from the microphone almost sends the opamp output into clip. A slightly stronger signal causes the output to clip. The signal can never be greater than the output swing of the opamp. The output of the opamp is attenuated by the deviation potentiometer R108. This adjustment is used to set deviation of the overall system to below 5 kHz.

After the microphone signal has been pre–emphasized, limited, and the level set through R108, the signal enters the splatter filter at U300–11. The splatter filter provides the sharp roll–off required to frequencies above 3 kHz. The output of the splatter filter (at U300–13) travels to the compensation potentiometer R111. The compensation potentiometer is used to adjust the sensitivity of the VCO modulation port to equal the reference modulation port.

The VCO modulation port response has a high–pass response, and the reference modulation port has a low–pass response. The compensation potentiometer sets the sensitivity of the VCO modulation port so that the overall response of the VCO is flat.

The correct tuneup procedure is to set the compensation potentiometer (R111) first, and then set the deviation potentiometer (R108).

Then the audio signal travels through the series FET (Q101) to the RF board where it is input to the VCO circuitry to modulate the RF carrier during transmit. The series FET (Q101) provides isolation to the VCO mode line during the VCO's receive mode of operation.

3.2.3 Option Transmit through Splatter

This option path is one of two paths that a hardware option is able to route audio to be transmitted. The path is enabled by the latch U504 from Pin 6. In normal operation, the port is enabled when the option sends a command over the serial bus. The radio processor then enables the port and keys the radio. The option (for example PTT–ID) enables its audio port to send an audio signal into TX audio. This audio signal is amplified by the opamp U301–A. The output of U301–A at U301–3 appears at the switch input on U300–9. The switch on U300 functions as an analog transmission gate.

The switch control is at U300–10, and closes the switch when this input is low. The output of this switch is at U300–14. Once routed through this switch, the signal is input to the same limiter opamp used by the microphone path (U301–D). The signal is amplified to almost clip the output at nominal levels (just as the microphone path), but it is not pre–emphasized. The output of the opamp follows the same path as the micro phone path: through the deviation limit potentiometer, through the splatter filter, and then to the VCO modulation port through the compensation potentiometer.

3.2.4 Option Transmit Flat

This is the second of the TX audio paths available to the hardware options. It is enabled by commands over the serial bus in the same manner as the option transmit through splatter path. This port is enabled by the output of the latch U504–5.

This audio port is named the flat TX port due to the extended response it provides. The flat TX port displays a flat frequency response from approximately 2 Hz to above 6 kHz. This response is required for digital signaling schemes such as the *SECURENET* option.

The audio for this path is input from the option the same as the TX splatter path (through U301–A). In this case, the splatter port is not enabled (the switch on U300–14 is open), and the flat port is enabled. The switch enables when the control at U300–22 is high. The audio input to the switch is at U300–21, and the output is at U300–15. The IC provides +7.5 dB of gain from input to output, and also sums with the IC's internal D/A converter.

The D/A converter is used to generate PL and DPL transmit signals with the data lines D3 through D0 at Pins 32, 31, 30 and 29 of U500. These outputs of the processor drive the inputs of the D/A on U300 at Pins 25, 26, 27, and 28. The D/A on U300 requires the reference voltage at U300–1 to function

properly. The reference voltage is a resistive divider, formed by R307 and R308, and provides the required 1.3 volts DC to this input. The output of the D/A is at U300–15. As discussed above, the D/A is summed with the TX flat path.

PL and DPL are used only when the microphone path or the option TX through the splatter path are enabled. The only signal present at U300–15 is a TX flat signal or a PL/DPL, but not both. The output of U300–16 is normally 500 mV above the analog ground voltage (Vag) at U300–7. The output, when generating PL or DPL, swings symmetrically about this normal voltage (Vag + 500 mV). The output at U300–15 follows the same paths as those described in the TX flat path section, and the signal is input to both the VCO modulation input and the reference modulation input to the RF board.

The output of the TX flat switch (U300–15) is routed to two different inputs to the VCO. The first is the VCO modulation port, and the second is the reference modulation port.

The TX flat signal routing to the VCO modulation port is from the output of the TX flat switch (U300–15). The signal is attenuated by R116 and R117. The attenuated signal is input to U300–8. The input is summed internally with the splatter filter input, and is output at U300–13. This summing node allows PL or DPL to be summed with normal audio from the micro phone path, and, in this case, allows the TX flat audio to reach the VCO modulation port. The output of U300–13 travels to the VCO modulation port via the compensation adjust potentiometer. The TX flat signal routing to the reference modulation port is through resistive attenuators. The jumpers JU101, JU102, JU103, and JU104 select the proper attenuation required for low–band, VHF, UHF, and 800–MHz bands respectively. The TX flat signal passes through the DC blocking capacitor C105, and then to the reference modulation port. The transistor Q100 shunts the reference modulation port to ground when the radio is powered up, and allows the VCO to lock more quickly when first powered up.

Due to the high deviation required by *SECURENET*, the transistor Q100 is removed from the circuit by removing JU100 on *SECURENET* model radios. If not removed from the circuit, the transistor Q100 begins to conduct, and distorts the signal.

3.2.5 Receive Audio Circuitry

There are four paths in the receive audio circuitry for audio output through the speaker. These paths are the discriminator path, the option through receive audio filter path, the option through flat response path, and the alert tone path.

The discriminator path is the recovered audio output from an RF signal at the antenna input. This path exhibits a –20 dB/decade response from 300 Hz to 3 kHz. The response falls off sharply with frequencies below 300 Hz and above 3 kHz.

The Personality Board provides two inputs in the receive audio path for hardware options for the receive audio string. First is RX through received audio shaping that follows the same response as the discriminator path, –20 dB/decade from 300 Hz to 3 kHz. Second is the RX flat that displays frequency response from 200 Hz to 10 kHz. The final path in the receive audio string is the alert tone path. This path allows the radio microprocessor to sound alert tones through the speaker.

3.2.6 Discriminator Audio

The discriminator audio path is input to the personality board from the RF board via P601–3. The discriminator path is then input to the transmission gate hybrid (HY300) through C201. C201 provides DC blocking. The input to HY300 is at HY300–7, and the output is at HY300–8. The control line for disc mute is controlled by the output of U500–26. The control line is input to HY300–11, and is active HI (HI mutes the audio). The output of HY300–8 inputs to the receive audio shaping filter on U300. The receive audio shaping filter input is at U300–20, and is not switched. An input between 300 and 3 kHz always causes an output at U300–17. The filter provides the standard de–emphasis response of –20 dB/decade from 300 to 3 kHz. The received audio shaping filter provides band–pass filtering. The pass band is approximately 270 Hz to 3.5 kHz. The filter exhibits a loss of –3 dB at 1 kHz.

The radio microprocessor decodes received PL or DPL, and determines if the proper code is present. The radio bases this decision on its input from the comparator on U300. The discriminator output from the RF board (P601–3) is input to the PL/DPL filter on U300 through C200. Input to the PL input filter is at U300–19. The PL filter has a low pass response, and changes its response when the selected mode is a PL mode or a DPL mode. The PL filter, when input PL/DPL is low (PL response), rolls off at approximately 250 Hz. When on a DPL mode (U300–23 is high), the PL filter rolls off at approximately 150 Hz. The output of the PL filter (U300–16) is averaged by R205 and C209 for PL, and R205 and C210 for DPL. The DC averaged signal is input to the negative input of the comparator on U300. The negative input is at U300–4 and the positive input is at U300–5. The PL filter output connects to the positive input of the comparator. This causes the output of the comparator (U300–3) to swing high when a positive going signal is output from the discriminator. The comparator output swings low when the discriminator output has a negative going signal. The output of the comparator attenuates by R208 and R209, and is read by the processor input at U500–24.

The output of the receive audio shaping filter inputs to the audio preamp (U302) through the audio summing node via R200. The audio summing node consists of R200, R201, R202, R203, and C202. The summing node provides attenuation for the receive audio shaping path, RX flat path, and the alert tone input. The summing node inputs to the audio pre–amplifier U302–15. The preamp is a digitally–controlled, variable gain buffer whose gain can vary from –70 to +18 dB. The gain is controlled by U500 and U503 through the control lines, UCS data, UCS write–enable, and UCS clock. The preamp gain is programmed with a serial data stream that controls the volume. The serial data appears on the UCS data line, and is clocked in bit by bit by the UCS clock when

write–enable is low. The preamp has another control to force its output to mute at U302–13. The mute line is an output of U500–25, and is active LO (LO mutes the preamp). The output of U302 next feeds into the audio power amplifier through C400 that blocks DC. The audio power amplifier is a class A/B amplifier stage, and runs approximately 200 milliamps of bias to the collectors of final output transistors (Q400 and Q401) while idling with no audio input. The audio power amplifier provides +34 dB of gain and presents an output impedance of 8 ohms to drive an 8–ohm speaker. At the nominal battery voltage of 13.8 volts, the power amp delivers over 15 watts of power with total harmonic distortion below 3%.

3.2.7 Option Play through Receive Audio Shaping

The first option path available to the hardware options is RX through receive audio shaping filter or RX–RAS. The internal options access the RX audio ports through J301–10, and the options residing in the external options box access the RX audio ports through J1–33. Both RX audio ports, RX–RAS and RX flat, are enabled in the same manner as TX audio ports, by commands over the serial bus.

The RX audio signals are input through J301–10 and/or J1–33, and are summed and buffered by the option RX buffer opamp U301–C. The input is the null port at U301–8, and allows options access without interference. The output of the option RX buffer is connected to two inputs to HY300.

The input at HY300–9 is the input for RX–RAS. The control input for RX–RAS is at HY300–2, and comes from the output of U504–2. The control is active low (HI when the switch is open). With the control low, the RX–RAS enables, and the signal output drives the input of the receive audio shaping filter. The signal path follows the same path as the discriminator audio path discussed earlier.

3.2.8 Option Play Flat Response

The option play flat response is input to the option RX buffer, the same as the option play through RAS. The option RX buffer output (U301–10) connects to the RX flat switch (HY300–9). This switch is controlled by U504–5, and is active low (HI when the switch is open). The control line input to the hybrid is at HY300–13. When enabled (closed), the RX option buffer connects directly to the audio summing node by R201. The summing node sets the correct attenuation for the input to the audio pre–amplifier. The remainder of the path is the same for the discriminator audio path.

3.2.9 Alert Tones

The alert tones are generated by the radio microprocessor by toggling its output at U500–15. This output is AC coupled by C208, and is summed directly into the audio summing node through R202.

3.2.10 Power Amplifier

The power amplifier is biased to 5.0 volts at its positive input by resistors R400 and R401. The dual output opamp U400 drives the pre–driver transistors (Q403 and Q402). The outputs of the opamp are approximately 2.1 volts apart, and U400–4 is higher than U400–1. The banded transistor pairs, Q403 and Q402, are graded NPN pairs and graded PNP pairs respectively. The pairs are graded to match base to emitter voltage drops. This transistors Q403–A and Q402– A form a current mirror into transistors Q403–B and Q402–B. The current is fixed through Q403–A and Q402–A by resistor R406.

When unmuted transistor Q404 is conducting, the bias current is higher than when muted. The mirrored current through Q403–B and Q402–B provides the base drive for the final output 6 transistors. The DC feedback for the opamp U400 comes from the tap between R407 and R408. The feedback DC biases the entire feedback winding of the transformer (Pins 7, 8 of T400). The transformer input windings (Pins 1, 6; Pins 2, 5) are driven by the final output transistors Q401 and Q400 respectively. The output winding of the transformer is routed from J1–37 and J1–22 in the radio, through the cable kit, into the control head, and finally to the speaker.

3.3 SUPPORT CIRCUITRY COMMON TO RECEIVE AND TRANSMIT

Supporting circuitry appears throughout the analog section of the personality board. All of the 300 series designators provide functions such as supply by–passing, etc. Two of the supporting sections are worthy of special note, the 4–MHz oscillator and the analog ground buffer opamp.

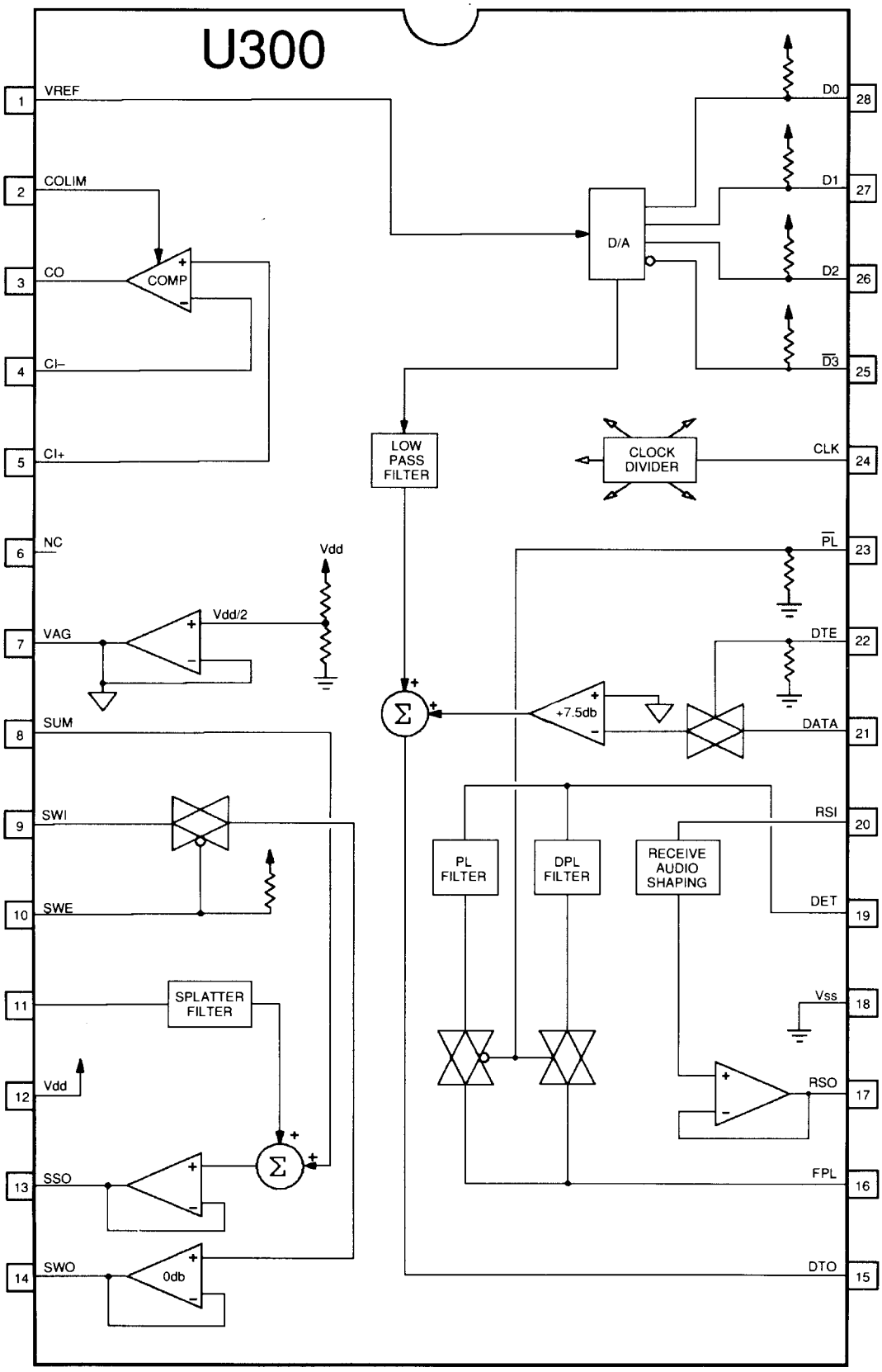
3.3.1 Oscillator (4–MHz)

The linear crystal oscillator provides the switched capacitor filter IC (U300) with its clocking rate. The oscillator provides a 4–MHz sine wave (distorted) at an amplitude of approximately 700 mV peak–to–peak to the clock input (U300–24). The oscillator uses Q300 and Y300 to produce the signal.

3.3.2 Analog Ground Voltage Buffer

The opamp U301–B is a unity gain voltage follower. The opamp output buffers the output of the Vag reference output (U300–7). IC U300 biases internally to approximately half of its 9.6–volt supply. To reduce audio transients when switching an audio path in or out, the buffered analog ground voltage biases all audio circuitry except the audio power amplifier. The analog ground voltage is presented to the internal hardware options via J301–8, so the options can use this DC potential to bias their analog circuitry.

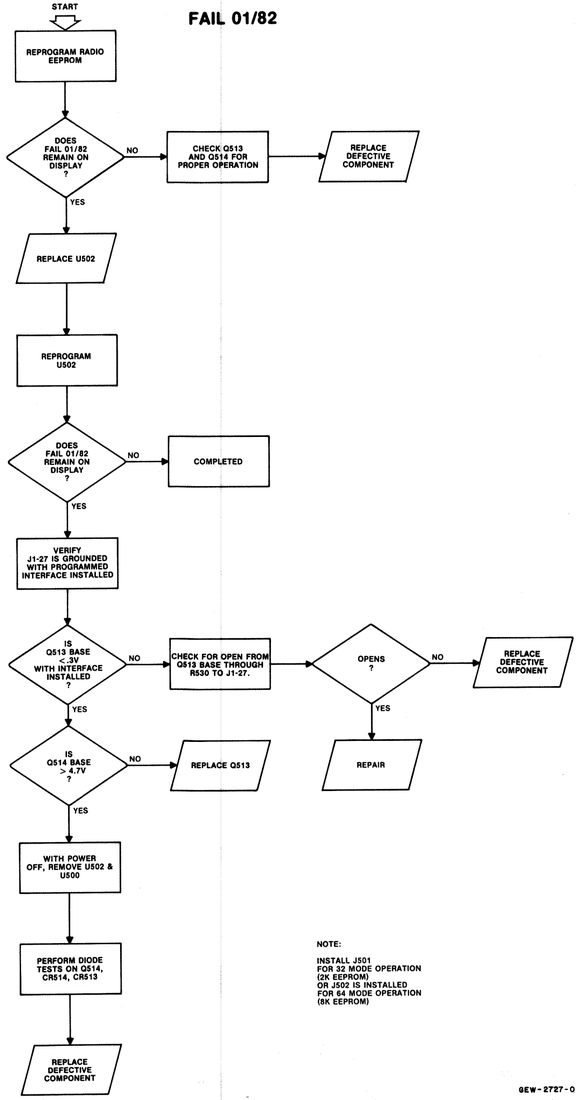
U300 BLOCK DIAGRAM



GPW–2585–A

U300 Functional
Block Diagram
PW–4552–A
8/30/88

FAIL 01/82

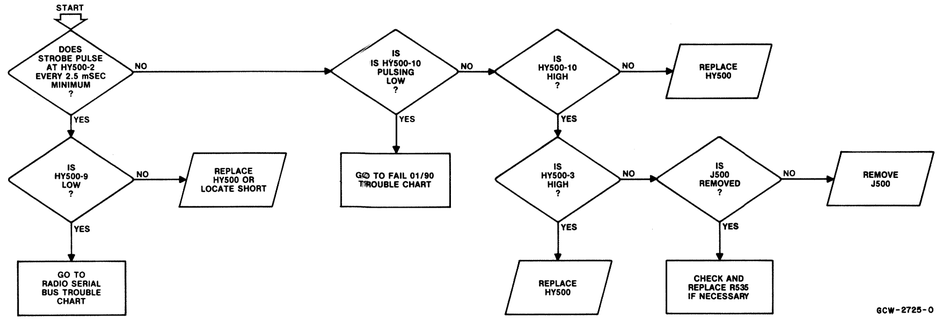


NOTE:

INSTALL J501
FOR 32 MODE OPERATION
(2K EEPROM)
OR J502 IS INSTALLED
FOR 64 MODE OPERATION
(8K EEPROM)

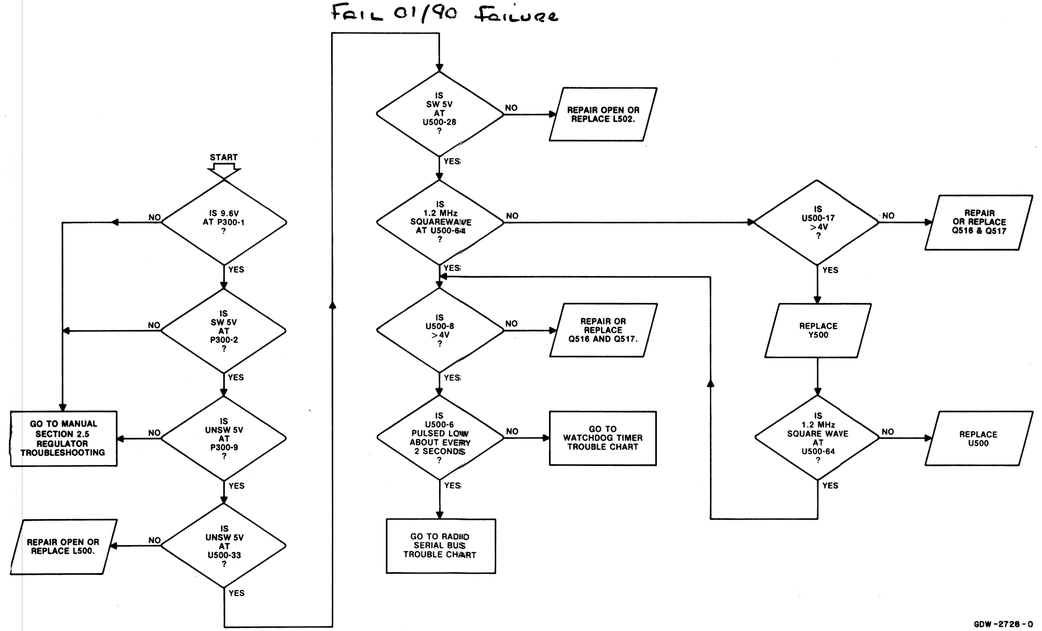
GEW-2727-0

WATCHDOG TIMER FAILURE



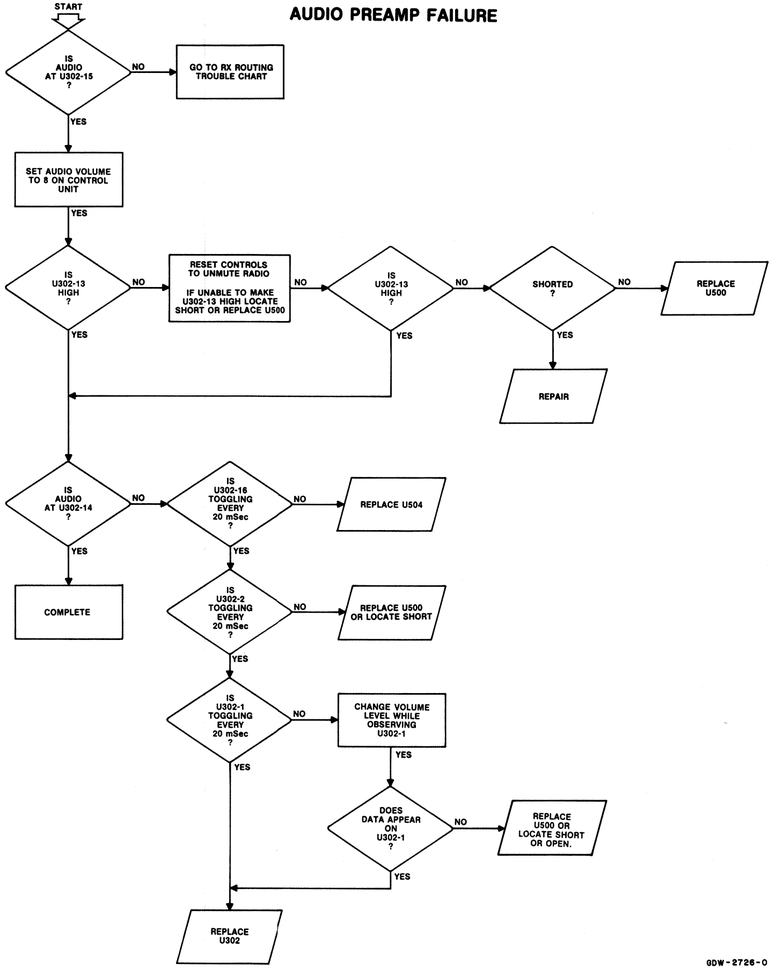
GCW-2725-0

Fail 01/90 Failure



GDW-2728-0

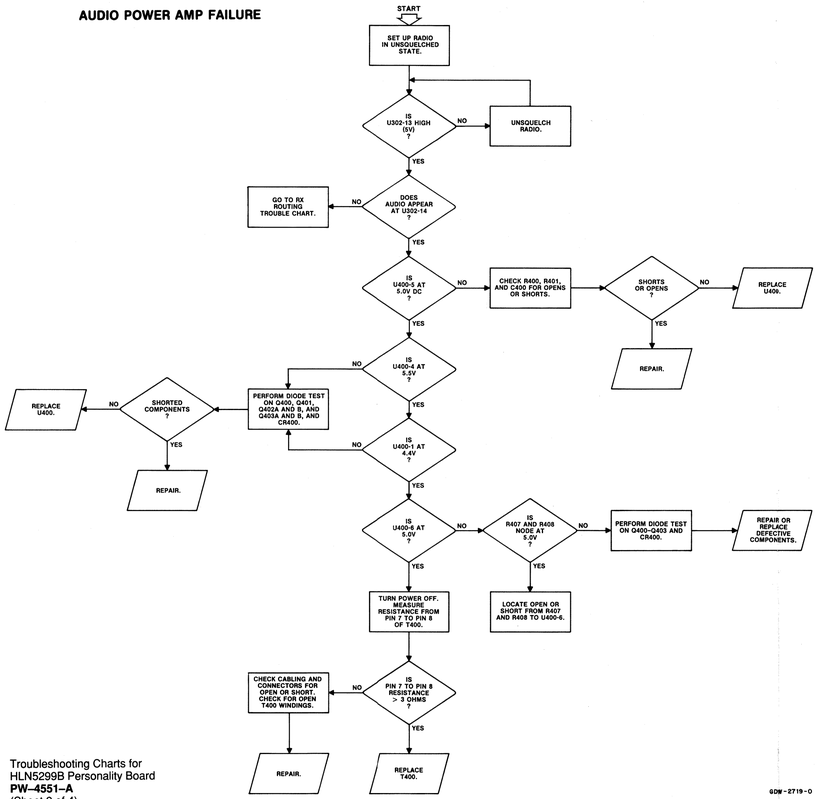
AUDIO PREAMP FAILURE



GDW-2726-0

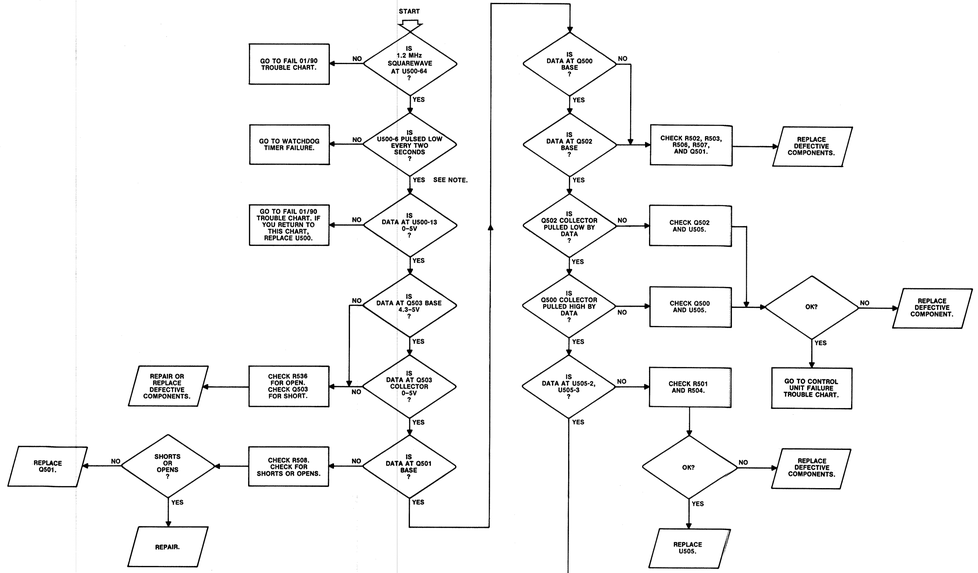
Troubleshooting Charts for
HLN5299B Personality Board
PW-4551-A
(Sheet 1 of 4)
5/10/88

AUDIO POWER AMP FAILURE

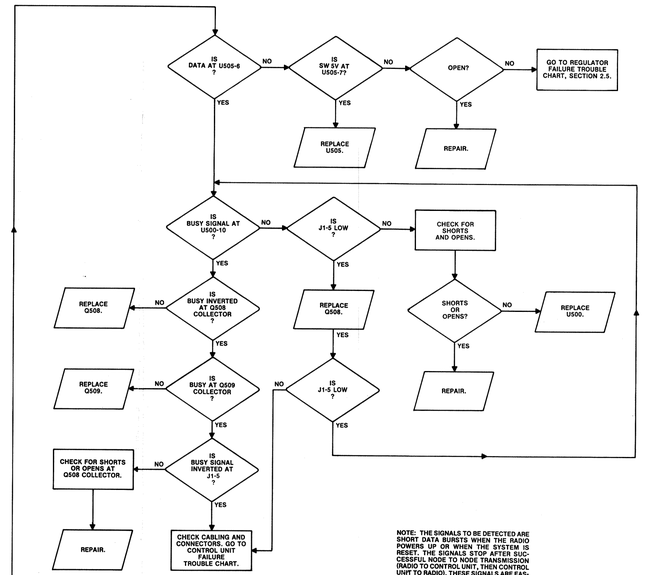


GDW-2719-O

Troubleshooting Charts for
HLN5299B Personality Board
PW–4551–A
(Sheet 2 of 4)
5/10/88



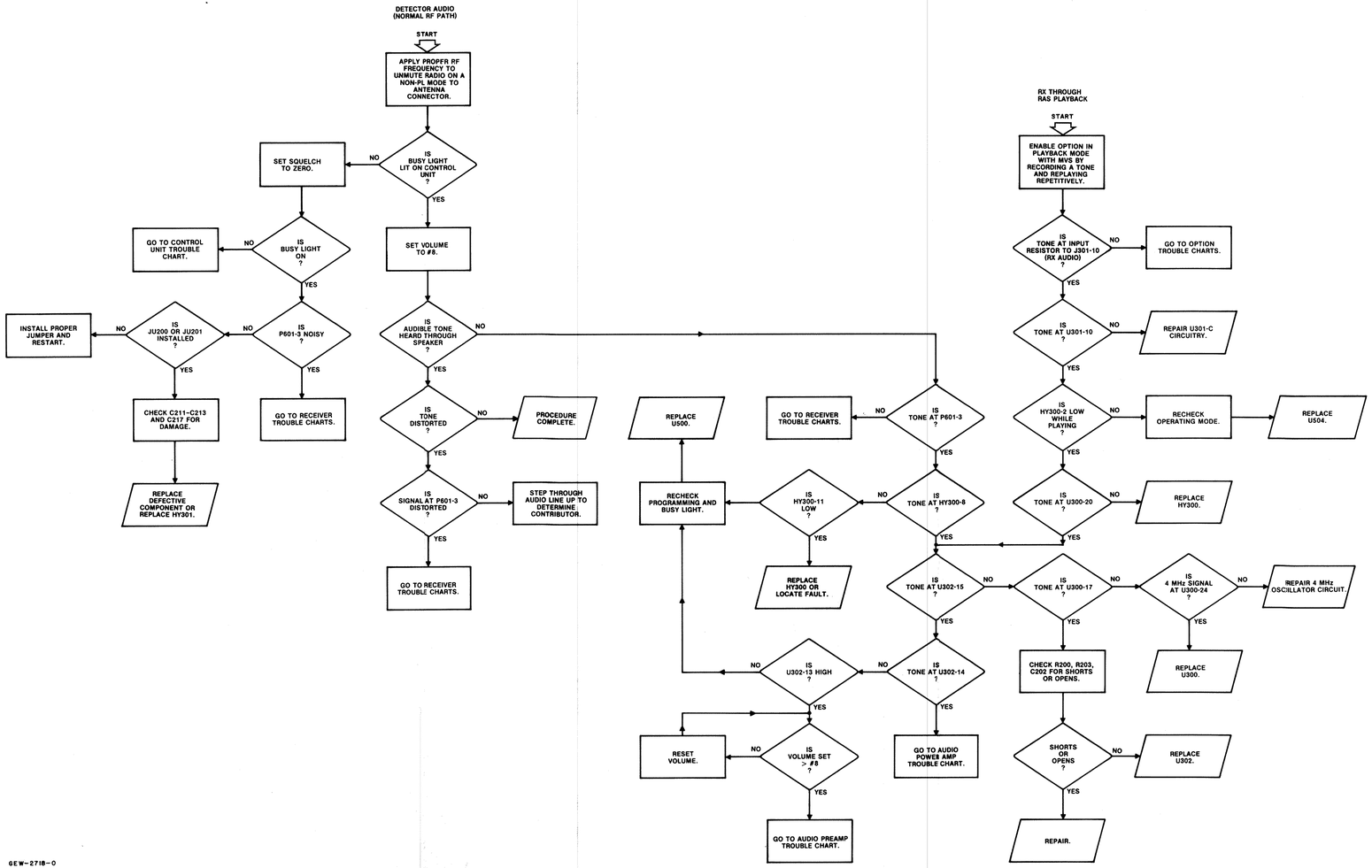
SERIAL BUS FAILURE



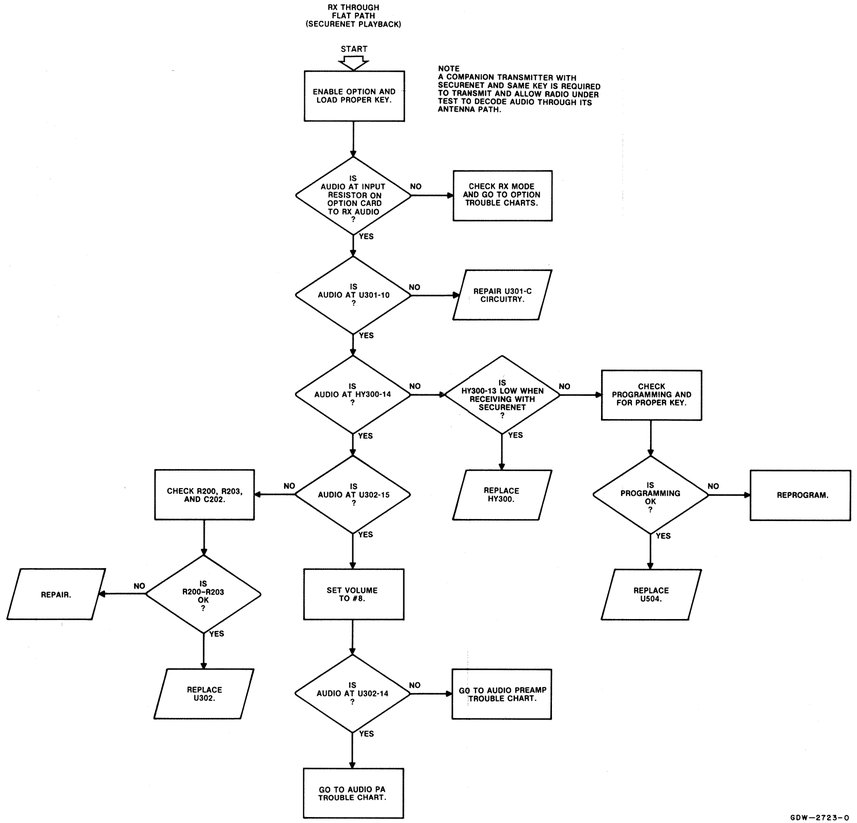
NOTE: THE SIGNALS TO BE DETECTED ARE SHORT DATA BURSTS WHEN THE RADIO POWERS UP OR WHEN THE SYSTEM IS RESET. THE SIGNALS STOP AFTER SUCCESSFUL NODE TO NODE TRANSMISSION (RADIO TO CONTROL UNIT, THEN CONTROL UNIT TO RADIO). THESE SIGNALS ARE EASIEST TO DETECT BY SWITCHING THE SYSTEM ON AND OFF AT THE CONTROL UNIT WHILE OBSERVING THE DATA AND BUSY SIGNALS.

GEW-2710-O

RX ROUTING



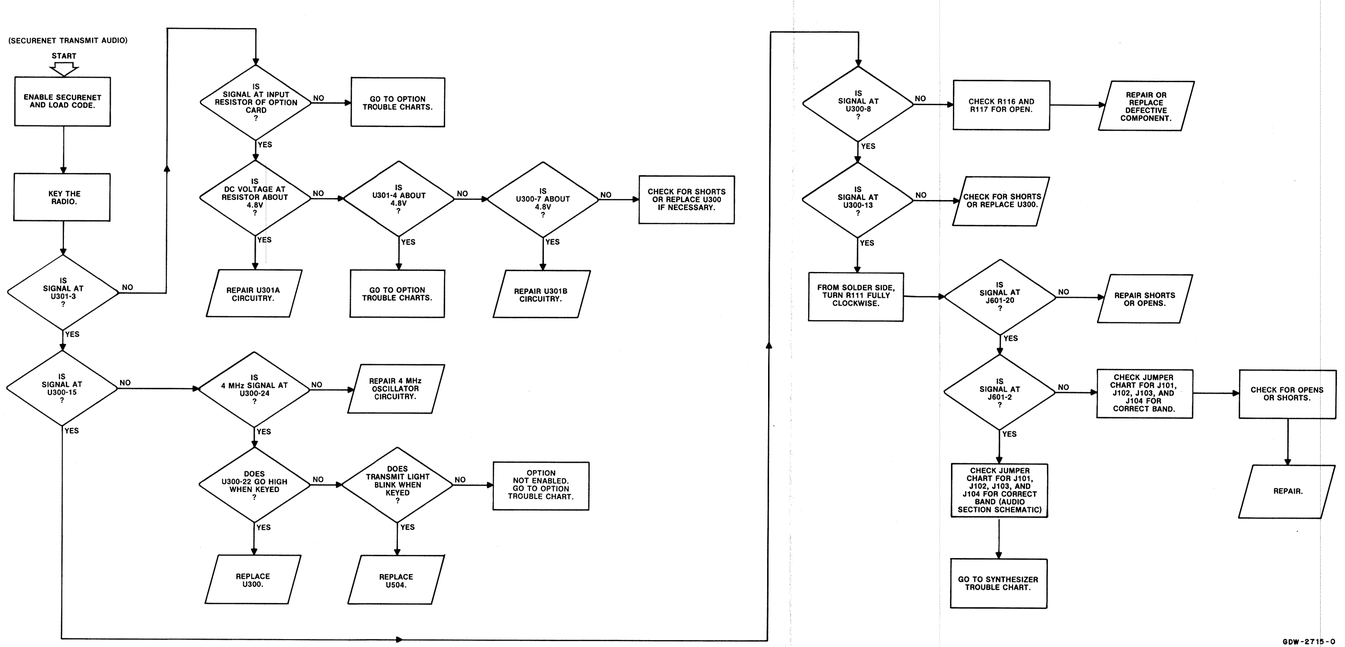
GEW-2718-0

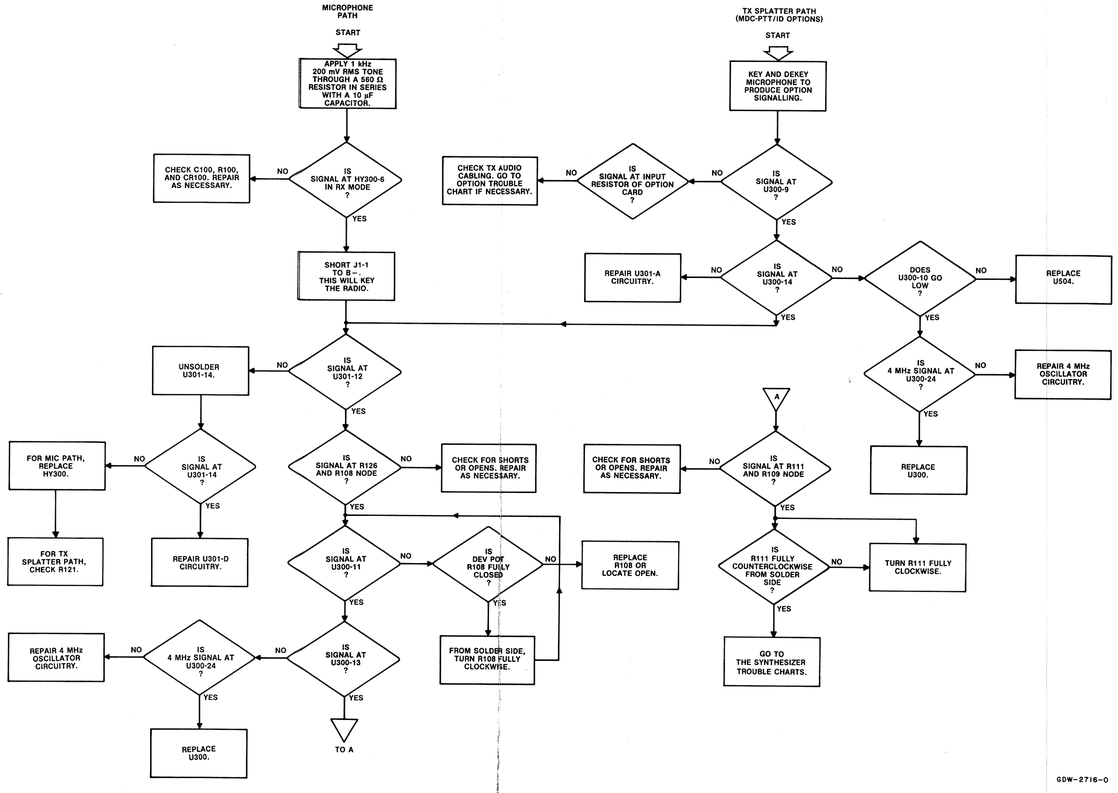


GDW-2723-0

Troubleshooting Charts for
HLN5299B Personality Board
PW-4551-A
(Sheet 3 of 4)
5/10/88

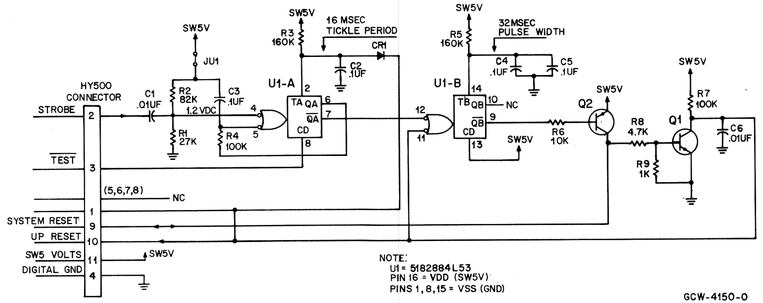
TX ROUTING





Troubleshooting Charts for
HLN5299B Personality Board
PW–4551–A
(Sheet 4 of 4)
5/10/88

WATCHDOG TIMER



NOTE:
U1 = 5182884L53
PIN 16 = VDD (SW5V)
PINS 1, 8, 15 = VSS (GND)

GCW-4150-O

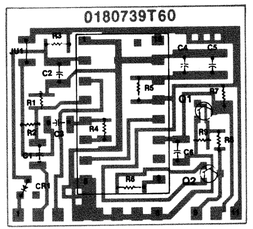
parts list

Watchdog Timer (p/o HLN5299B Personality Board) MXW-4564-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
HY500	01-80739T60	includes the following
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C1	21-13741B45	.01, ±10%
C2	21-13741C17	.1, ±20%, 25V
C3	21-11032B13	.1, +80, -20%, electrolytic
C4,5	21-13741C17	.1, ±20%, 25V
C6	21-13741B45	.01, ±10%
diode (see note)		
CR1	48-80236E08	silicon
jumper		
JU1	06-11024B23	0 ohm
transistor (see note)		
Q1	48-80141L04	NPN
Q2	48-80141L03	PNP
integrated circuit (see note)		
U1	51-82884L53	monostable multivibrator

1/03/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.



SUBSTRATE ● GAW-4358-O
OVERLAY — GAW-4359-O

SQUELCH HYBRID

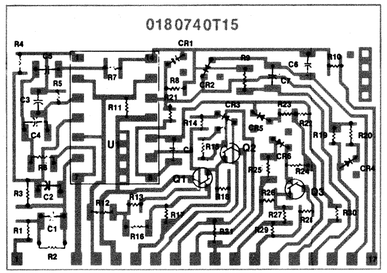
parts list

Squelch Hybrid (p/o HLN5299B Personality Board) MXW-4563-C

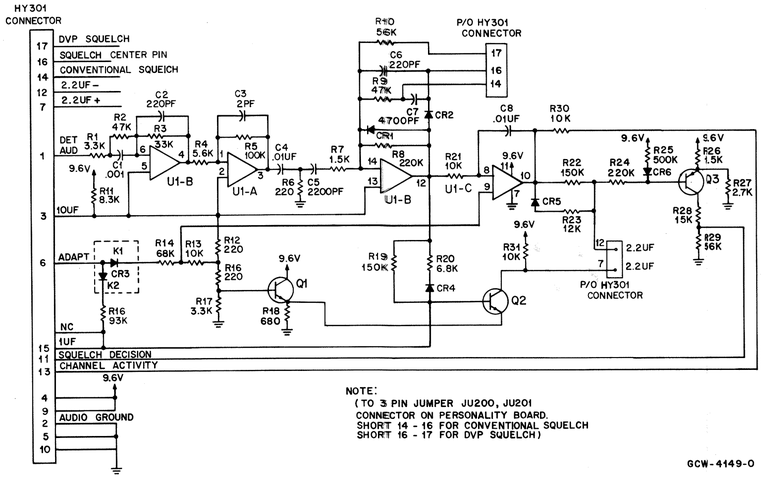
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
HY301	01-80740T15	includes the following
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C1	21-13740B73	.001
C2	21-13740B57	220 pF
C3	21-13740B47	82 pF
C4	21-13741N45	.01
C5	21-13741N29	.0022
C6	21-13740B57	220 pF
C7	21-13741N37	.0047, ±10%
C8	21-13741N45	.01
diode (see note)		
CR1-6	48-80236E08	silicon
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R6	06-11077A58	220
R9	06-11077B17	47k
R12	06-11077A58	220
R16	06-11077A58	220
R25	06-11077B45	820k
R31	06-11077A98	10k
transistor (see note)		
Q1,2	48-30141L04	NPN
Q3	48-80141L01	PNP
integrated circuit (see note)		
U1	51-80067C06	quad opamp

1/03/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.



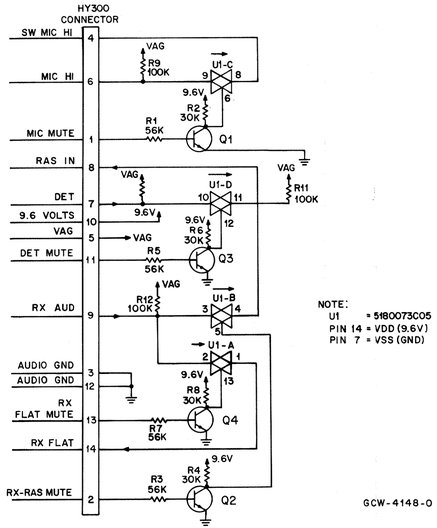
SUBSTRATE ● GAW-4356-O
OVERLAY — GAW-4357-O



NOTE:
(TO 3 PIN JUMPER JU200, JU201 CONNECTOR ON PERSONALITY BOARD.
SHORT 14 - 16 FOR CONVENTIONAL SQUELCH
SHORT 16 - 17 FOR DVP SQUELCH)

GCW-4149-O

TRANSMISSION GATE HYBRID



NOTE:
U1 = 5180073C05
PIN 14 = VDD (9.6V)
PIN 7 = VSS (GND)

GCW-4148-O

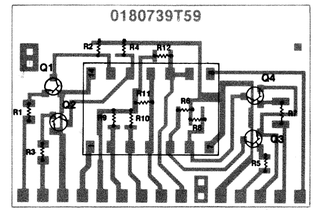
parts list

Transmission Gate (p/o HLN5299B Personality Board) MXW-4562-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
HY300	01-80739T59	includes the following
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R7	06-11077B17	56k
transistor (see note)		
Q1-4	48-80141L02	NPN
integrated circuit (see note)		
U1	51-80073C05	analog t-gate

5/4/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.



SUBSTRATE ● GAW-4354-O
OVERLAY — GAW-4355-O

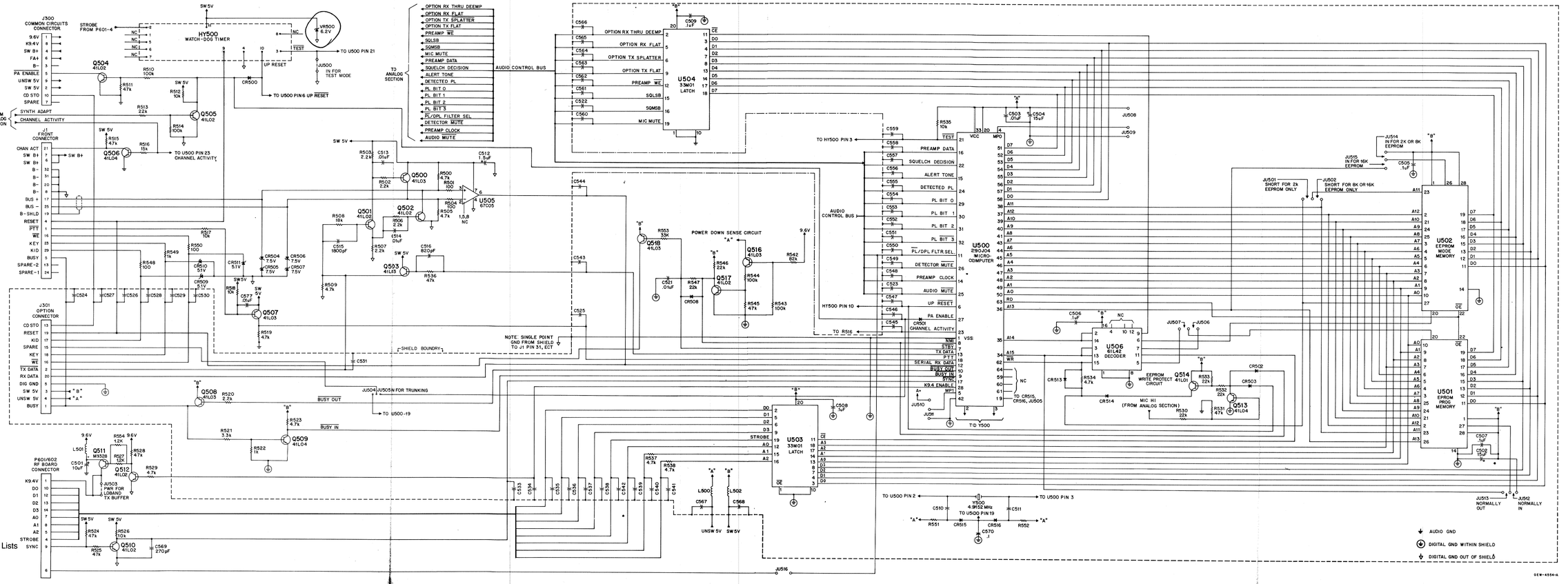
Schematics, Circuit Board Diagrams, and Parts Lists for the Transmission Gate, Squelch, and Watchdog Timer Hybrids
PW-4561-C
1/15/89

Cold Solder joint HY500 Board
Pin 1-2 of IC Flare
Intermittent - No display on
Control Head

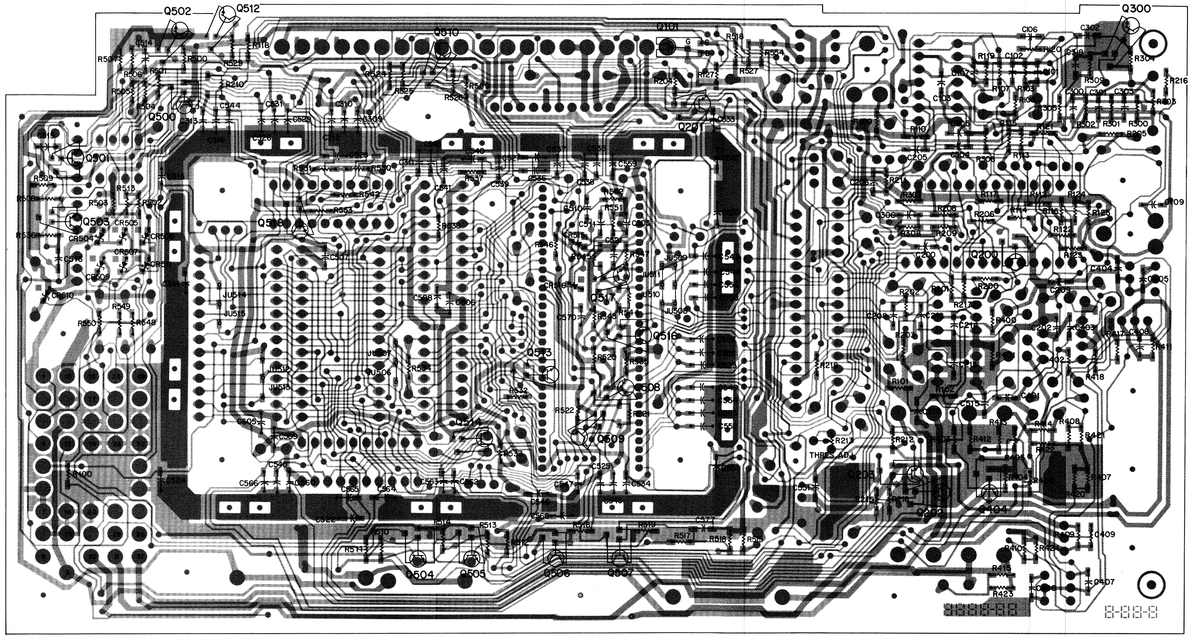
VR500 Short - Fail 01.90
No Switched 5v

JUMPER	NORMALLY	COMMENTS
JU500	OUT	IN FOR TEST MODE
JU501	——	IN FOR 2K EEPROM
JU502	——	IN FOR 8K OR 16K EEPROM
JU503	OUT	IN FOR LOWBAND TX BUFFER
JU504	IN	OUT FOR TRUNKING
JU505	OUT	IN FOR TRUNKING
JU506	IN	OUT FOR SP APPLICATIONS ONLY
JU507	OUT	IN FOR SP APPLICATIONS ONLY
JU508	IN	OUT FOR SP APPLICATIONS ONLY
JU509	OUT	IN FOR SP APPLICATIONS ONLY
JU510	OUT	IN FOR SP APPLICATIONS ONLY
JU511	IN	OUT FOR SP APPLICATIONS ONLY
JU512	IN	OUT FOR SP APPLICATIONS ONLY
JU513	OUT	IN FOR SP APPLICATIONS ONLY
JU514	IN	IN FOR 2K OR 8K EEPROM
JU515	OUT	IN FOR 16K EEPROM
JU516	OUT	IN FOR UHF TRUNKING

Schematics, Circuit Board Diagrams, and Parts Lists
for the HLN5299B Personality Board
PW-4553-C
(Sheet 1 of 3)
1/15/89

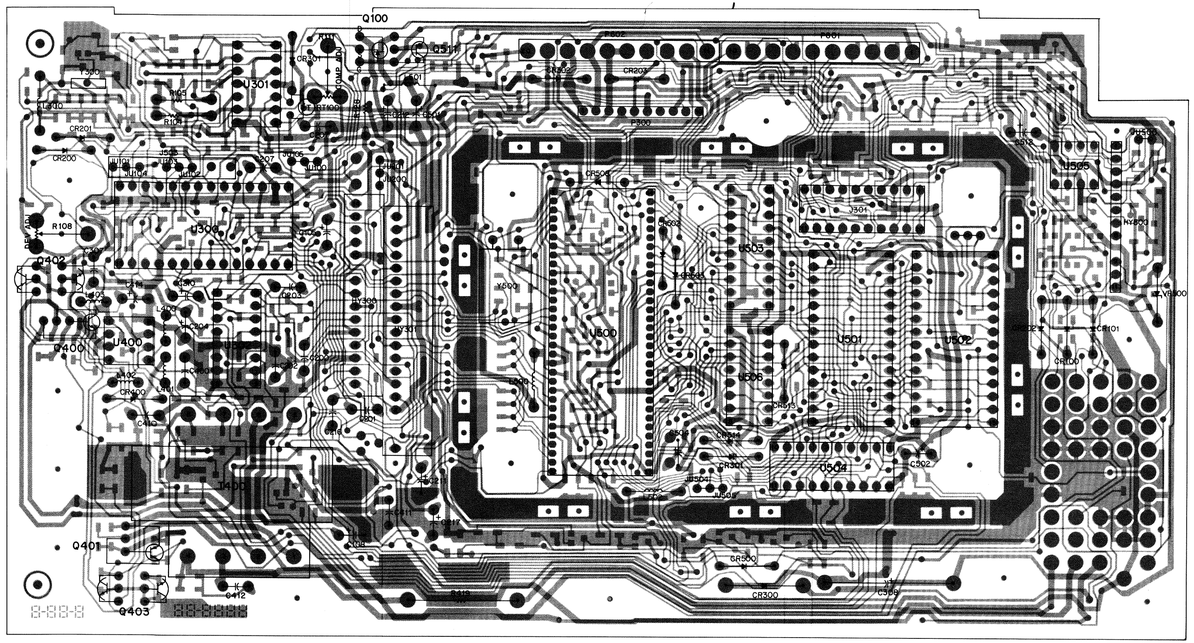


HLN5299B PERSONALITY BOARD



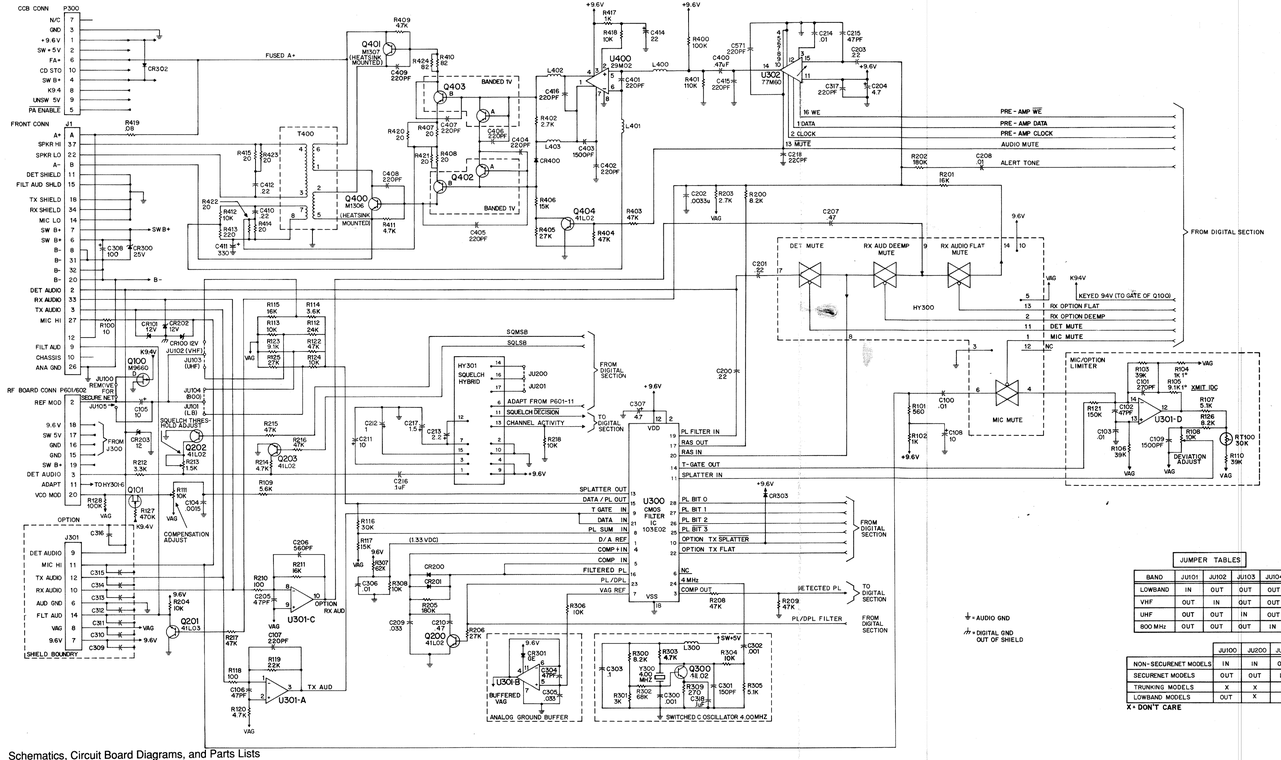
SHOWN FROM SOLDER SIDE

SOLDER SIDE ● GEW-4555-B
COMPONENT SIDE ● GEW-4556-B
OVERLAY — GEW-4557-A



SHOWN FROM COMPONENT SIDE

SOLDER SIDE ● GEW-4555-B
COMPONENT SIDE ● GEW-4556-B
OVERLAY — GEW-4558-0



Schematics, Circuit Board Diagrams, and Parts Lists
for the HLN5299B Personality Board
PW–4553–C
(Sheet 3 of 3)
1/15/89

JUMPER TABLES					
BAND	JU101	JU102	JU103	JU104	JU105
LOWBAND	IN	OUT	OUT	OUT	IN
VHF	OUT	IN	OUT	OUT	OUT
UHF	OUT	OUT	IN	OUT	OUT
800 MHz	OUT	OUT	OUT	IN	OUT

	JU100	JU200	JU201	JU505
NON–SECURENET MODELS	IN	IN	OUT	X
SECURENET MODELS	OUT	OUT	IN	X
TRUNKING MODELS	X	X	X	IN
LOWBAND MODELS	OUT	X	X	X

X = DON'T CARE

GEW-4560-B

parts list

HLN5299B Personality Board — MXW–4559–C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C100	08–11051A07	.01, 63V
C101	21–13740B59	270 pF
C102	21–13740B41	47 pF
C103	21–13741N45	.01, ±10%
C104	08–11051A02	.0015, 63V
C105	23–11048C11	10, ±20%, 35V, electrolytic
C106	21–13740B41	47 pF
C107	21–13740B57	220 pF
C108	23–11048C11	10, ±20%, 35V, electrolytic
C109	21–13740B19	1500 pF, ±5 pF
C200	21–11032B15	.22, +80, –20% 50V
C201	08–11051A15	.22, 63V
C202	08–11051A04	.0033, 63V
C203	08–11051A15	.22, 63V
C204	23–11013D55	4.7, ±20%, 20V, tantalum
C205	23–11054N28	4.7, ±10%, 35V, tantalum
C206	21–13740B41	47 pF
C207	21–13740B67	560 pF
C208	08–11051A17	.47, 63V
C209	21–13741N57	.033, ±10%
C210	08–11051A17	.47, 63V
C211	23–11048C11	10, ±20%, 35V, electrolytic
C212	23–11048C05	1, ±20%, electrolytic
C213	23–11048C06	2.2, ±20%, electrolytic
C214	21–13741N45	.01, ±10%
C215	21–13740B41	47 pF
C216	08–11051A13	.1, 63V
C217	23–11054N02	1.5, ±10%, 35V, tantalum
C218	21–13740B57	220 pF
C300	21–13741N21	.001, ±10%
C301	21–13740B53	150 pF
C302	21–13741N21	.001, ±10%
C303	21–11032B13	10, +80, –20% 50V
C304	21–13740B41	47 pF
C305	21–11032B15	.22, +80, –20% 50V
C306	21–13741N45	.01, ±10%
C307	23–84538G06	47, ±20%, 20V, tantalum
C308	23–84665A08	100, –10, +150%, 35V, electrolytic
C309–316	21–13740B49	12 pF
C317	21–13740B57	220 pF
C400	08–11051A17	.47, 63V
C401,402	21–13740B57	220 pF
C403	21–13740B76	.0015 pF, ±5 pF
C404,409	21–13740B57	220 pF
C410	08–11051A15	.22, 63V
C411	23–82747L01	330, –10, +100%, 20V, electrolytic
C412	08–11051A15	.22, 63V
C414	23–11054F10	2.2, ±10%, 15V, tantalum
C415,416	21–13740B57	220 pF
C501	21–11048C11	10, ±20%, 35V, electrolytic
C502	23–11054H10	15, ±10%, 25V, tantalum
C503	23–11741N45	.01, ±10%
C504	23–11054H10	15, ±10%, 25V, tantalum
C505–509	21–11032B13	1, +80, –20% 50V
C510,511	21–13740B25	12 pF
C512	23–11054N32	1.5, ±10%, 35V, tantalum
C513,514	21–13741N45	.01, ±10%
C515	21–13740B78	.0018 uF
C516	21–11031G61	820 pF
C517	21–11032B13	1, +80, –20% 50V
C562–569	21–13741N37	.270, ±10%
C570	21–13741N45	1, +80, –20%
C571–576	21–13740B51	220 pF
C577	21–13741N45	.01, ±10%
diode (see note)		
CR100,101	48–80007E02	12V zener
CR200,201	48–83654H01	silicon
CR202,203	48–80007E02	12V zener
CR300	48–80236E07	26V zener
CR301	48–8278A01	germanium
CR302	48–80038E03	rectifier silicon
CR303	48–8278A01	germanium
CR400	48–83654H01	silicon
CR500–503	48–83654H01	silicon
CR504–507	48–80140L11	5V zener
CR508	48–83654H01	silicon
CR509–511	48–80140L06	1V zener
CR513,514	48–83654H01	silicon
CR515,516	48–80013E02	silicon pin
hybrid (see note)		
HY300	01–80739T59	see parts list MXW–4562
HY301	01–80740T15	see parts list MXW–4563
HY500	01–80739T60	see parts list MXW–4564
connector receptacle		
J1	01–80746T79	front connector assembly
J100,101	28–84318M07	3 pin
J133	28–84318M07	3 pin
J220	28–84318M07	3 pin
J301	09–80269B05	dual socket
J500	28–84318M06	2 pin
J501	28–84318M07	3 pin
J504	28–84318M07	3 pin
J516	28–84318M06	2 pin
jumper		
JU100,101	09–80080L01	0 ohm
JU200	09–80080L01	0 ohm

MXW–4559–C (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
JU501	09–80080L01	0 ohm
JU504	09–80080L01	0 ohm
JU506	06–11077A01	0 ohm resistor
JU508	06–11077A01	0 ohm resistor
JU511,512	06–11077A01	0 ohm resistor
JU514	06–11077A01	0 ohm resistor
coil, RF		
L300	24–80293D02	ferrite
L400–403	24–80036A01	ferrite, 1/2 turn
L500	24–80036G04	ferrite, 1/2 turn
L501	24–80036A01	ferrite, 1/2 turn
L502	24–80138G04	5.6 uH, ±5%
connector plug		
P300	28–80264K01	htp entry
P601,602	28–82647K02	10 pin
transistor (see note)		
Q100	48–00869660	P–Channel, JFET
Q101	48–05128M66	N–Channel, JFET
Q200	48–80141L02	NPN
Q201	48–80141L03	PNP
Q202,203	48–80141L02	NPN
Q300	48–80141L02	NPN
Q402	01–80734T95	PNP transistor & clip assembly
Q403	01–80734T96	NPN transistor & clip assembly
Q404	48–80141L02	NPN
Q448	48–84413L07	PNP
Q449	48–84413L06	NPN
Q500	48–80141L03	PNP
Q501,502	48–80141L04	NPN
Q503	48–80141L03	PNP
Q504,505	48–80141L02	NPN
Q506	48–80141L04	NPN
Q507,508	48–80141L03	PNP
Q509	48–80141L04	NPN
Q510	48–80141L02	NPN
Q511	48–00869328	NPN
Q512,513	48–80141L04	NPN
Q514	48–80141L01	PNP
Q516	48–80141L03	PNP
Q517	48–80141L02	NPN
Q518	48–80141L03	PNP
thermistor		
RT100	06–80176D03	thermistor
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R100	06–11077A26	10
R101	06–11077A68	560
R102	06–11077A72	1k
R103	06–11077B13	39k
R104	06–11040B94	1k, ±1%, 1/4W
R105	06–11049C87	9090, ±1%, 1/4W
R106	06–11077B31	120k
R107	06–11077A92	5.6k
R108	18–80087E08	10k potentiometer
R109	06–11077A92	5.6k
R110	06–11077B13	39k
R111	18–80087E08	10k potentiometer
R112	06–11077B08	24k
R113	06–11077A98	10k
R114	06–11077A87	3.6k
R115	06–11077B04	16k
R116	06–11077B10	30k
R117	06–11077B03	15k
R118	06–11077A50	100
R119	06–11077B07	22k
R120	06–11077A90	4.7k
R121	06–11077B27	150k
R122	06–11077B15	47k
R123	06–11077A97	9.1k
R124	06–11077A98	10k
R125	06–11077B29	270k
R126	06–11077A96	8.2k
R127	06–11077B29	180k
R128	06–11099A97	100k
R200	06–11077A96	8.2k
R201	06–11077B04	16k
R202	06–11077B29	180k
R203	06–11077A84	2.7k
R204	06–11077A98	10k
R205	06–11077B29	180k
R206	06–11077B09	27k
R208,209	06–11077B15	47k
R210	06–11077A50	100
R211	06–11077B04	16k
R212	06–11077A86	3.3k
R213	18–05500L17	1.5k, ±20%, 100V, potentiometer
R214	06–11077A90	4.7k
R215–217	06–11077B15	47k
R218	06–11077A98	10k
R300	06–11077A96	8.2k
R301	06–11077A85	3k
R302	06–11077B19	68k
R303	06–11077A90	4.7k
R304	06–11077A98	10k
R305	06–11077A91	5.1k
R306	06–11077A98	10k
R307	06–11077B18	62k
R308	06–11077A98	10k

MXW–4559–C (3)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R309	06–11077A60	270
R400	06–11077B23	100k
R401	06–11077B24	110k
R402	06–11077A84	2.7k
R403,404	06–11077B15	47k
R405	06–11077B09	27k
R406	06–11077B03	15k
R407,408	06–11077A33	20
R409	06–11077A90	4.7k
R410	06–11077A48	82
R411	06–11077A33	20
R412	06–11077A98	10k
R413	06–11077A84	2.7k
R414,415	06–11077A33	20
R417	06–11077A74	1k
R418	06–11077A98	10k
R419	17–82350A14	.08, ±20%, 1W
R420,423	06–11077A33	20
R424	06–11077A48	82
R500	06–11077A90	4.7k
R501	06–11077A50	100
R502,503	06–11077A82	2.2k
R504	06–11077A52	150
R505	06–11077A90	4.7k
R506,507	06–11077A82	2.2k
R508	06–11077A86	3.3k
R509	06–11077A90	4.7k
R510	06–11077B23	100k
R511	06–11077B15	47k
R512	06–11077A98	10k
R513	06–11077B07	22k
R514	06–11077B23	100k
R515	06–11077A90	4.7k
R516	06–11077B03	15k
R517,518	06–11077A98	10k
R519	06–11077A90	4.7k
R520	06–11077A82	2.2k
R521	06–11077A86	3.3k
R522	06–11077A74	1k
R523	06–11077A90	4.7k
R524,525	06–11077B15	47k
R526	06–11077A98	10k
R527	06–11077A76	1.2k
R528	06–11077B15	47k
R529	06–11077A90	4.7k
R530	06–11077B07	22k
R531	06–11077B15	47k
R532,533	06–11077B07	22k
R534	06–11077A90	4.7k
R535	06–11077A98	10k
R536	06–11077B15	47k
R537,538	06–11077B07	22k
R542	06–11077B21	82k
R543,544	06–11077B23	100k
R545	06–11077B15	47k
R546	06–11077B07	22k
R547	06–11077A90	4.7k
R548	06–11077A50	100
R549	06–11077A74	1k
R550	06–11077A90	4.7k
R551,552	06–11077A98	10k
R553	06–11077B07	22k
R554	06–11077A76	1.2k
transformer		
T400	25–84083B03	audio
integrated circuit (see note)		
U300	51–80103E02	switch filter
U301	51–80067C04	opamp
U301	51–80067C06	opamp
U302	51–83977M50	digital volume control
U400	51–84621K14	driver
U500	51–80290J04	1.5 MHz microprocessor
U503	51–05133M01	octal latch
U504	51–05133M01	octal latch
U505	51–80067C05	opamp
U506	51–84561L42	bipolar
voltage regulator (see note)		
VR500	48–83696E07	6.2V zener
crystal (see note)		
Y360	48–80173D01	4 MHz
Y560	48–80173D12	4.9152 MHz

mechanical parts		
	03–10943M10	tapping screw (3 x 0.5 x 8)
	03–10911A11	machine screw (3 x 0.5 x 8)
	04–8418DC01	nylon shoulder washer
	07–05375P09	plated lead
	07–8004ZL01	hybrid support
	09–80269B03	dual socket
	09–82828R10	28 contact
	09–80269B01	dual socket
	09–82808R04	16 contact
	09–80052K01	socket
	14–80175M01	insulator shield
	14–80175M03	insulator shield
	14–80179N01	crystal pad
	14–80269M01	heat sink insulator

MXW–4559–C (4)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	14–8382DM02	heat conductive insulator
	26–80033M01	RFI shield
	26–80051K01	solder side option shield
	26–83498M01	heat sink
	26–80264A01	top entry
	28–82647K02	10 pin
	28–83485M05	male plug assembly
	29–10134A68	lug connector
	29–10134A70	lug connector
	32–80219B01	housing gasket
	37–00132026	tubing
	37–00132026	3/16 clear heatshrink tubing
	37–00132526	1/16 heatshrink tubing
	42–82891K01	transistor clip, 2 used
	43–80254K02	support spacer
	54–80072G01	circuit board label
	58–84303B04	handle
	75–80051P01	crystal pad
	75–80129K01	crystal mounting pad
	75–80144H01	vibration pads

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note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

Frequency Synthesizer

1. General

The *SYNTOR X* frequency synthesizer generates the first receive injection frequency and transmitter carrier. In the receive mode, the synthesizer locks on a frequency that is 53.9 MHz (first IF) higher than the desired receive frequency. In the transmit mode, it locks on the transmit output frequency. To do this it uses a phase–locked loop (PLL) consisting of a 14.4–MHz reference oscillator, separate transmit and receive low–noise voltage–controlled oscillators (VCO), a high–speed programmable divide–by–3–or–4 variable modulus prescaler, a low–speed programmable divider, a sample–and–hold phase detector, and an adaptive loop filter. The output of the 14.4–MHz reference oscillator goes via an injection tripler to the second mixer of the receiver, where it serves as the low–side second injection frequency. The synthesizer circuits are on the common circuits board and RF board, and in the RF internal casting.

2. Theory of Operation

2.1 INTRODUCTION

The PLL synthesizer is a single negative–feedback loop that uses the phase of the input signals to the phase detector as the controlling variable. The output frequency of a high–accuracy, temperature–compensated crystal reference oscillator (U608) is divided by the reference divider (part of U602). The reference divider puts out a high–stability 5.00–kHz (6.25–kHz for some radios) square–wave output that goes to the phase detector (U603–2) to serve as the reference frequency input.

The PLL negative feedback input, which originates at the VCO, is applied to the loop frequency input of the phase detector (U603–23). The VCO gives out a frequency proportional to the voltage on its steering line (P650–2). The VCO consists of a transmit FET RF oscillator (Q1403) that operates in a frequency range from 150 to 174 MHz, and a receive FET RF oscillator (Q1401) that operates in a frequency range from 203.9 to 227.9 MHz. The VCO output frequency is divided down by a programmable N divider that puts out a loop frequency equal to the VCO output frequency divided by N:

$$f_{(loop)} = f_{(vco)} / N$$

where: $f_{(loop)}$ = N divider loop frequency output
$f_{(vco)}$ = VCO output frequency
N = integer

The loop frequency and the reference frequency are applied to Pins U603–23 and U603–2, respectively, of the phase detector, and the phase detector then puts out a DC voltage proportional to the phase difference between the the loop and reference frequencies. Phase is the controlling variable, since there may be small phase errors in the locked loop but frequency errors cannot occur. The DC output voltage of the phase detector (PHASE DET OUT at U603–15) goes via the loop adaptive filter to the VCO steering line, thus completing the feedback loop. The loop filter controls the PLL closed–loop response and removes noise from the phase detector output. The loop negative feedback action is as follows. If the VCO output frequency goes high, the N divider loop frequency output also goes high, thus causing a leading phase displacement at the phase detector loop input. Since the reference signal phase does not change, the phase detector internal circuits detect this condition and cause the generation of a lower DC voltage at the output U603–15. This signal is applied to the VCO steering line, via the loop adaptive filter, causing a reduction in frequency, thus compensating for the original frequency difference.

2.2 LOOP PROGRAMMING AND CONTROL

For frequency generation and control, the microcomputer reads the programming information from the personality board memory module, combines it with the synthesizer control information, and multiplexes this information to the programmable divider (U602). The programming information, six four–bit words, goes to the multiplex programmed divider via four data lines (D0, D1, D2, D3) and via three data word address lines (A0, A1, A2). Address lines A0, A1, and A2 in the multiplexing sequence tell the divider which of the six four–bit words is being sent by the microcomputer on the data lines.

Of the bits sent to the divider, one selects between transmit or receive VCO operation. This bit is transferred from the divider (U602–19) to the transmit–receive VCO

switching network that sends regulated 8.4 V to the transmit VCO via P650–3 or receive VCO via P650–1. Another bit determines the frequency range of the VCO's. This bit is transferred via P650–5 and P650–6 from the divider (U602–20) to the bandshift network, which gives the VCO's the proper bandshift in formation. Sixteen bits program the "A" and "B" counters, inside the programmable divider. Two bits program a reference divider. Two latched bits ($\overline{C0}$ and $\overline{C1}$) go from the multiplex programmed divider (U602–15) to the programmable variable–modulus prescaler (U602–16) to control its operation during the divide cycle. Two other latched outputs from the divider, $\overline{S0}$ and $\overline{S1}$, go to the sample–and–hold phase detector to control the loop adaptive filter. When set high, $\overline{S1}$ indicates a change in frequency. In this case, a seventh word is generated to clear the frequency change indication by setting $\overline{S1}$ low, thus generating a control pulse. $\overline{S0}$ switches between the transmit and receive loop filters (high for transmit filter).

The six four–bit words on the data lines remain the same once the condition of synthesizer operation and the frequency have been selected. Any change in radio mode makes the microcomputer address different memory locations in the memory module. Consequently, the six four–bit words may send different information to the divider via the data lines. The microcomputer notifies the divider, via the STROBE line, when the binary information on the data and address lines can be read into the divider and latched in without any chance of error.

2.3 DIVIDER

The programmable N divider uses a method of frequency division known as "dual–modulus prescaling." It uses two dual–modulus prescalers: a divide–by–3–or–4 prescaler (with its own internal programmable "C" counter) and a divide–by–63–or–64 prescaler.

The divide–by–63–or–64 prescaler, with its two programmable counters, "A" and "B," is inside divider U602. The output frequency of each of the two prescalers is first divided by one divisor to yield a fixed number of counts, and then divided by a second divisor to yield a different number of counts. The programming of counters A, B, and C can set the total division performed by this system to an integral value, N. This system of division allows the basic division of programmable divider U602 to be expanded to a higher operating frequency without loss of resolution.

Each PLL output frequency requires that a different value of N be programmed into the programmable counters. On the positive–going loop pulse edge, the divide–by–3–or–4 prescaler starts dividing by four and continues to do so until the C counter reaches zero. At this time, the prescaler enters the divide–by–3 mode. Once the loop pulse goes low, the C counter is preset to the value determined by the $\overline{C0}$ and $\overline{C1}$ bits. This causes the of the next loop pulse.

The divide–by–63–or–64 variable–modulus prescaler works in a similar fashion. When a loop count begins, it first divides by 64 for the number of times programmed into the A counter. When the A counter counts to zero, the loop pulse goes low and the prescaler changes to the divide–by–63 mode. It stays in this mode until the B counter reaches zero. At this time the loop pulse goes high and the cycle repeats.

Another programmable divider acts on the 14.4–MHz reference oscillator input frequency at U602–2 to produce one of two reference frequencies: 5 kHz or 6.25 kHz. Two bits (D0 and D1) in one word of the frequency do the selecting, as shown in Table 1.

Table 1. Reference Frequency Selection

D0	D1	REFERENCE FREQUENCY
0	0	unused
1	0	6.25 kHz
1	1	5.00 kHz

The frequency select data also contains bits VCO1 and VCO2. VCO2 selects the VCO band shift window required by the selected operating frequency. (Refer to the VCO paragraph for details on the bandshift windows.) When the VCO bit is latched into the divider, VCO2 goes as a BANDSHIFT signal from U602–20 to the bandshift switching network. It then goes via the feedthrough plate to the VCO. An NPN transistor on U600 compensates for the differing modulation characteristics of the VCO windows. When the BANDSHIFT signal is high (at U602–20), the transistor turns on and sends a lower–amplitude audio signal to the VCO. (It takes less audio input to the VCO to modulate the RF signal fully when U602–20 is high than when it is low.)

2.4 PHASE DETECTOR

Phase detector U603 compares the reference and loop frequency outputs of the divider circuit and uses this information to generate a DC output signal that controls the VCO frequency. The phase detector also monitors the FREQUENCY CHANGE line ($\overline{S1}$) and the LOW BANDWIDTH SELECT line ($\overline{S0}$) and uses this information to generate control signals for the adaptive filter.

The phase detector output signal level is controlled by the length of time between the positive transition of the reference signal and the positive transition of the loop signal. When the

reference signal goes high (at U603–2), ramp generator Q603 turns on, maintaining a constant current through C630. This constant current generates a linear rise (ramp) in the voltage at U603–24. The rise of the ramp voltage halts when the LOOP signal (at U603–23) switches to a high level, causing Q603 to turn off.

The positive transition of the loop signal, in addition to halting the ramp generator, resets an internal sample timing circuit. The ramp voltage is held constant for a period of time determined by sample timing capacitor C631. During this time, the two hold capacitors (C632 and C633) are charged to a level determined by the ramp voltage. At the end of the sample time, the ramp capacitor is discharged in preparation for the next cycle.

The accumulated charge on the hold capacitors controls the conduction of a push–pull output driver. The output driver consists of an internal NPN transistor and an external PNP transistor controlled by the signal at U603–17. The PHASE DETECTOR OUTPUT signal at U603–15 is coupled, via the adaptive filter, to the VCO, where it controls the generation of injection frequencies.

The phase detector also generates control signals for the adaptive filter. It decodes the FREQUENCY CHANGE signal at U603–5 and the LOW BANDWIDTH SELECT signal at U603–3 to produce four control signals that are coupled to the adaptive filter: ADAPT, $\overline{\text{ADAPT}}$, RSW, and TSW (appearing at U603–10, –7, –9, and –8, respectively).

When the radio is changing operating channels while in the receive mode or changing from the transmit mode to the receive mode, the FREQUENCY CHANGE pulse at U603–5 causes the ADAPT line to go high and the $\overline{\text{ADAPT}}$ line to go low. Since the LOW BANDWIDTH SELECT line is low, the RSW line is driven high, the TSW is driven low, and the adaptive filter is forced into the receive–adapt mode. The $\overline{\text{ADAPT}}$ line returns to a high level and the ADAPT line returns to a low level after approximately 3.0 milliseconds, under the phase detector control, forcing the adaptive filter to enter into the normal receive mode.

When the PTT pushbutton is pressed, the FREQUENCY CHANGE pulse causes the ADAPT line to go high and the $\overline{\text{ADAPT}}$ line to go low.

Since the LOW BANDWIDTH SELECT line is high, the TSW line is driven high, the RSW is driven low, and the adaptive filter is forced into the transmit–adapt mode. The ADAPT and $\overline{\text{ADAPT}}$ lines switch states after approximately 15 milliseconds, under control of the phase detector, and the adaptive filter is forced to enter into the normal transmit mode.

While the ADAPT line is high during the transmit–adapt mode, the power amplifier is disabled. (This line is connected to the personality board via J602–11.) Moreover, the ADAPT line is forced to switch to a high state when the synthesizer cannot lock in, thus preventing the radio from transmitting unstable or off–frequency signals.

For maximum switching speed, the microcomputer gives the synthesizer new data at the appropriate time of the divide cycle. The phase detector forwards a SYNTHESIZER SYNC signal, from U603–4 via J602–9, telling the microcomputer when to send new frequency programming information.

2.5 ADAPTIVE FILTER

2.5.1 General

The adaptive filter is a low–pass filter in the steering line between the phase detector and the VCO. This filter removes noise and variations in the steering line level to prevent unwanted modulation of the VCO.

The adaptive filter, which is connected to PHASE DETECTOR OUTPUT line U603–15, is controlled by the phase detector to operate in one of four selectable modes, depending upon the state of the synthesizer at a given time. Transmit adapt mode and receive adapt mode differ only in the amount of time spent in adapt condition, while the transmit mode and receive mode each require different filter characteristics. These characteristics are selected by transmission gates that switch the filter components into and out of the steering line signal path as required.

2.5.2 Filter Mode Selection

The adaptive filter operates in one of four selectable modes: transmit, receive, transmit–adapt, and receive–adapt. Each mode is selected by a combination of states on two complementary pairs of lines: the TSW and RSW lines make up one such pair, and the ADAPT and $\overline{\text{ADAPT}}$ lines make up the other. These lines are coupled from the phase detector to the adaptive filter and are connected to the input pins of mode select gates U604A and U604B. The ADAPT line is also connected to transmission gates U605 and U606.

Low–input AND gate U604A has TRANSMIT MODE SELECT as an output line, and low input AND gate U604B has RECEIVE MODE SELECT as an output line. For each filter operation mode selected, one of these output lines is switched into a high state (between +8.6 and +9.6 V). Since these gates use low–level inputs, the output of a gate goes high whenever both of its inputs go low. Or, expressed as a Boolean expression, the input/output signals of U604A are:

$$\text{TRANSMIT MODE SELECT} = \overline{\text{ADAPT}} \bullet \overline{\text{RSW}}$$

In conjunction with the ADAPT line, the output lines of the mode select gates (U604A & B) control transmission gates U605 and U606. When a selector output is forced to a high level, the associated transmission gates turn on, passing the signals like a closed switch. (Transmission gates U605A–D have ON impedances of less than 200 ohms, and gates U606A–D have ON impedances of less than 500 ohms.)

2.5.3 Transmit Mode

When the synthesizer is in the normal transmit mode, the phase detector drives the TSW and $\overline{\text{ADAPT}}$ lines high and

their complements, RSW and ADAPT, low. The output of gate U604A goes high, causing transmission gates U605A, U606A, and U606D to turn on. The natural loop frequency of the synthesizer in this mode is approximately 15 Hz. The adaptive filter stays in this mode as long as the radio is transmitting.

In this mode, the steering line is filtered by R652 and a shunt path to ground consisting of C649, C641, C634, and R653. (The ON impedance of the transmission gates is neglected.) The signal now goes to the VCO via a test jumper (JU600) and J650–2.

2.5.4 Receive Mode

When the synthesizer is in the receive mode, the phase detector drives the RSW and $\overline{\text{ADAPT}}$ lines high and their complements, TSW and ADAPT, low. The output of gate U604B goes high, causing transmission gates U605C and U606C to turn on. The natural loop frequency of the synthesizer in this mode is approximately 75 Hz. The adaptive filter remains in this mode while the radio is in the receive mode.

In this mode, the steering line is filtered by R635, a shunt path consisting of R636, C640, and C641, and R637 and C654. (The ON impedance of the transmission gates is neglected.) The signal passes through the test jumper to the VCO via J650–2.

2.5.5 Transmit–Adapt Mode

When the synthesizer is in the transmit–adapt mode, the TSW and ADAPT lines are driven high by the phase detector, and their respective complements, RSW and $\overline{\text{ADAPT}}$, are driven low. Transmission gates U605B, U605D, U606D are turned on directly by the ADAPT line. The synthesizer has a high natural loop frequency in this mode, allowing it to change frequencies rapidly. The adaptive filter is switched into this mode for approximately 15 milliseconds while the radio changes from the receive mode to the transmit mode. The transmitter is inhibited in this mode by the SYNTHESIZER ADAPT line.

In this mode, transmission gate U606B by–passes the greater part of the adaptive filter. A grounded capacitor, C641, is connected to the steering line. (The ON impedance of the transmission gates is neglected.) While the filter is in this mode, C641 and C654 are being charged. The charge on C654 prevents the VCO from changing frequency during the transition from the transmit–adapt mode to the transmit mode. C654 always remains connected to the steering line. The steering line passes to the VCO through the test jumper via J650–2.

2.5.6 Receive–Adapt Mode

When the synthesizer is in the receive–adapt mode, the RSW and ADAPT lines are driven high by the phase detector, and their respective complements, TSW and $\overline{\text{ADAPT}}$, are driven low. Transmission gates U605B, U605D, and U606B are directly turned on by the ADAPT line. The synthesizer has a high natural loop frequency in this mode, allowing it to change injection frequencies rapidly. The adaptive filter switches into this mode for approximately 3.0 milliseconds while the radio changes from the transmit mode to the receive mode or from one receive frequency to another (as when the radio is changing from one operating channel to another.)

In this mode, the greater part of the adaptive filter is shorted by transmission gate U606B, and the steering line is connected to C641. (The ON impedance of the transmission gates is neglected.) When the filter is in the receive–adapt mode, C641 and C654 are being charged. The accumulated charge on C654 prevents the VCO from changing frequencies during the transition from the receive–adapt mode to the receive mode. C654 always remains connected to the steering line. The steering line passes to the VCO through the test jumper and J650–2.

When the frequency is changed (or if, for any reason, the loop falls out of lock), the phase detector causes the adaptive filter to switch to the ADAPT mode. Consequently, the $\overline{\text{ADAPT}}$ line switches to a low state, causing the out–of–lock LED to turn on. Therefore, in normal operation of the frequency synthesizer, the out–of–lock LED turns on briefly whenever the frequency is being changed. During *Channel Scan* operation, the radio may change frequencies rapidly for a long period, keeping the out–of–lock LED lighted dimly. However, a bright LED shows that there is an out–of–lock fault in the frequency synthesizer. Thus, this indicator LED is a troubleshooting aid.

Each time the synthesizer goes into the ADAPT mode, it deactivates various radio functions. First, the high ADAPT output disables the radio audio stages via the squelch circuits on the common circuits board. The transmitter and IDC circuits are also disabled via the personality board. This fail–safe feature prevents transmitter key–up if there is a loss of lock (unlikely, but not impossible), thus preventing the generation and transmission of uncontrolled RF signals.

2.5.7 Super Filter

Because the VCO requires a very pure DC supply voltage, an ultra–low–pass filter (U600) gives it a very–low–noise +8.6 output voltage. This filter removes all ripple and noise from the +9.6 V supply line, and thus prevents unwanted modulation of the VCO. A one–volt drop across the filter lowers the output voltage from +9.6 to +8.6 V.

The super filter consists of a low–pass filter, an error amplifier, and an external series–pass transistor (Q601). The +9.6 V supply is connected to U600–1 as well as to the emitter of Q601. Internally, the input from U600–1 passes through a low–pass filter to the non–inverting input of the error amplifier. C603, connected to U600–2, forms part of the low–pass filter. The output line (also connected to the collector of Q601) is fed back to the inverting input of the error amplifier through U600–4. The error amplifier output, connected to the base of Q601 via U600–3, controls the conduction of the transistor. These connections enable the super filter to compare the output line voltage with the filtered input line voltage and to increase or decrease the conduction of Q601 to remove ripple

and noise from the VCO supply line. The VCO supply is further filtered by C604, which is connected to ground. This filtered supply then goes to the transmit–receive VCO switching network. Depending on the state of U602–19, transmit 8.4 V or receive 8.4 V is sent to the appropriate VCO through the VCO interconnect plate, via J650–3 and J650–1. The filtered 8.6 V supply also goes to the bandshift switching network, which selects the proper state of the Bandshift 1 and Bandshift 2 lines, depending on the state of U602–20.

2.5.8 Feedback Buffer

A signal at the oscillator frequency goes back from the transmit and receive buffers to the main board. The divider/phase–detector circuits use this signal to monitor the oscillator frequency.

Two capacitors that form a capacitive tap network from the transmit buffer and receive buffer inputs send an input to feedback buffer Q602 via a coaxial cable and connector P/J600. The feedback amplifier output is coupled to divide–by–3–or–4 prescaler U601 via C607.

2.6 VOLTAGE–CONTROLLED OSCILLATOR (VCO)

2.6.1 General

The HLD4133A VCO has separate voltage–controlled circuits for transmitting and receiving. The output of each goes to a separate buffer amplifier on the HLN1053A buffer module. The VCO and the buffer amplifier, both of which are constructed on alumina thick–film substrates, produce frequency–modulated transmit injection frequencies and receive injection frequencies.

The operating frequency of the transmit VCO is from 150 MHz to 174 MHz and that of the receive VCO is from 203.9 MHz to 227.9 MHz. PIN diode switches allow the VCO to cover each 24–MHz bandwidth in two parts. The VCO and buffer also produce a feedback signal at the injection frequency for use by the phase–locked–loop synthesizer.

2.6.2 Receive Oscillator Circuit

The receive oscillator has a grounded–gate Colpitts oscillator that uses a FET (Q1401) as the amplifying element. This oscillator operates 53.9 MHz above the selected receive frequency. Its PIN–diode bandshift switch and varactor tuning diodes allow the single oscillator to tune the full 24–MHz band width in two parts. A transmission line section is PIN–switched in parallel with part of the main resonator transmission line to raise the bandshift resonant frequency. The drain of Q1401 is coupled to the main resonator transmission line through C1405.

The transmission line has microstrip capacitors that act as trimming capacitors for the oscillator tank circuit. These capacitors, which are adjusted at the factory, are not dependent on the customer's frequencies.

The oscillator produces an output signal that is coupled to amplifier Q1402 on the VCO substrate. Q1402, in turn, sends an output signal to the receive buffer amplifier (Q1460 and Q1461), on an alumina substrate in a compartment adjacent to the VCO. The receive buffer amplifier puts out two signals, one at the receive injection frequency that is coupled, via P600, to the RF board to drive the prescaler and send feedback to the PLL synthesizer, and one that goes to the receive injection filter.

The receive oscillator and buffer amplifier have supply voltage only in the receive condition, when REC 8.4 V goes to buffers Q1460 and Q1461 through the center conductor of the receive VCO output coaxial cable.

2.6.3 Transmit Oscillator Circuit

The transmit oscillator has a grounded–gate Colpitts oscillator that uses a FET (Q1403) as the amplifying element. This oscillator operates at the selected transmit frequency (150 to 174 MHz). A second PIN–diode Band shift switch and varactor tuning diodes give the oscillator its full 24–MHz transmit band width and allow it to shift between two frequency ranges. The transmission line, which shifts the frequency in the Band shift state, is shared by the transmit and receive oscillators. The polarity of the two PIN diodes is such that when the Band shift 1 line goes high (and Band shift 2 line goes low), CR1407 turns on, causing the Band shift transmission line to switch in parallel with part of the main resonator line. The effects of the receive main transmission line are negligible because of the high OFF impedance of CR1406. When the Band shift 1 line goes low (and Band shift 2 goes high), CR1407 turns off and CR1406 turns on, switching the transmit oscillator into the lower frequency range. This state of the Band shift 1 and Band shift 2 lines (for the transmit oscillator's lower frequency range) is also used for the receive oscillator Band shift range.

The main transmission line of the transmit oscillator has microstrip capacitors that act as trimming capacitors for the oscillator tank circuit. These capacitors, which are adjusted at the factory, do not depend on the customer's frequencies.

The output of the oscillator is coupled to amplifier Q1404, on the VCO substrate, and Q1404 in turn puts out a signal that is routed to the transmit buffer amplifier (Q1450 and Q1451), on an alumina substrate in a compartment adjacent to the VCO. The transmit buffer amplifier produces two output signals, one at the transmit frequency that is coupled, via P600, to the RF board. This signal drives the prescaler, which sends feedback to the PLL synthesizer. The other signal is coupled to the IPA (intermediate power amplifier) via P700.

The transmit oscillator and buffer amplifier stages have supply voltage only during the transmit state. TX +8.4 V is coupled to the buffers (Q1450 and Q1451) through the center conductor of the transmit VCO output coaxial cable.

2.6.4 Steering Line Circuit

The STEERING line, in conjunction with the Band shift lines, determines the operating frequency of the VCO. The STEERING line, driven by the phase detector (U603), is

coupled to the transmit and receive VCO's via the adaptive filter. The phase detector produces a DC output voltage to maintain the output of the transmit VCO at the desired frequency in the transmit condition. It also maintains the output of the receive VCO at the desired frequency in the receive condition. When the frequency is changed, the phase detector DC output voltage shifts to change the oscillator frequency and then maintain this new frequency. Figure 1 shows the transmit and receive oscillator frequencies as a function of the STEERING line DC voltage.

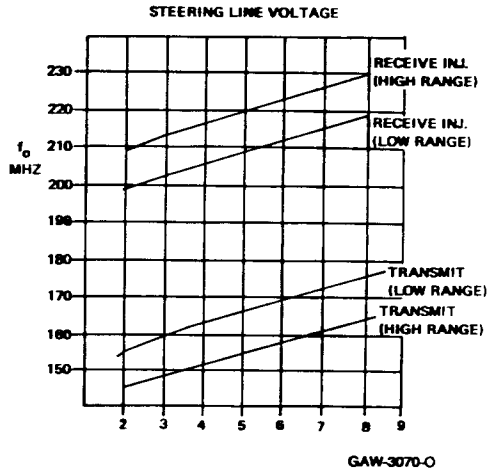


Figure 1. Injection Frequency vs. DC Voltage

The STEERING line is coupled from the RF board via J650–2 and the VCO interconnect plate. The plate contains the RF filters that shield the VCO. The DC voltage level of the STEERING line determines the capacitance of diodes CR1401, CR1402, CR1403, and CR1404 (which control the receive oscillator frequency) and CR1411, CR1412, CR1413, and CR1414 (which control the transmit oscillator frequency). An increase in the STEERING line voltage causes the capacitance of these diodes to decrease and the oscillator frequency to increase. On the other hand, a decrease in the STEERING line voltage causes an increase in the capacitance of the diodes and a reduction in the oscillator frequency.

2.6.5 Modulation Line

Transmit audio signals modulate the transmit VCO directly through a second varactor diode circuit that uses CR1409 and CR1410. Pin 4 of the VCO interconnect plate couples the transmit audio signal to CR1410, which modulates the oscillator frequency. CR1409 maintains the modulation level constant throughout the radio operating frequency range.

2.7 TRANSMIT AUDIO CIRCUITS

Note

While reading the following, refer to the IDC portion of the common circuits board schematic in the Common Circuits Board section of this manual.

The transmit audio circuits consist of four stages that condition the microphone audio signal for direct frequency modulation of the transmit injection signal. The greater part of the audio path is controlled by the IDC ENABLE signal that is coupled to the IDC (instantaneous deviation control) circuitry via J401–6. This signal controls transmission gate U501A, which enables the transmit audio circuits only when the radio is in the transmit mode (transmit +9.5 V is applied to the IDC ENABLE line).

The MIC HI signal is coupled into pre–emphasis amplifier U502D via J401–5. This amplifier has a frequency response that strengthens the audio frequencies toward the high end of the transmit audio frequency range (approximately 300–3000 Hz). The amplifier output (at U502–10) is coupled to U501–10. When PTT is activated, the transmission gate control line (at U501–5) switches to a high level and the signal passes through the gate to limiter/amplifier U502A.

The limiter/amplifier clips the audio signals at 7 volts peak–to–peak, thus preventing excessive audio modulation of the transmitted signal. (At lower audio input levels, this amplifier acts as a linear gain stage.) The limited transmit audio signal is coupled from U502–4 to splatter filter stage U502C.

The splatter filter, a 3 kHz low–pass filter, removes higher–order harmonics from the audio signal. With unity gain, this filter attenuates high frequency harmonics from the clipped audio signal from the limiter stage. Its output passes from U502–3 to the deviation adjust potentiometer (R517).

External modulation such as PL or DPL passes through gates U501B and U501C. These gates are connected in series with the external modulation inputs, and can therefore disable these modulation inputs to circuits where necessary. Normally, the HY501 resistors pull these enable lines high. The output of each gate passes to U502B via the resistors that form part of HY502.

The output of combiner U502B is coupled to compensation adjust potentiometer R543 and the reference oscillator. PL and DPL signals frequency–modulate the reference oscillator, thus preventing the phase detector output from defeating the direct low–frequency modulation of the VCO generated by the PL/DPL signal. (The synthesizer schematic includes the reference oscillator and phase detector.) The audio signal at the wiper of R517 joins the PL/DPL signals at the compensation adjust potentiometer (R453). This combined signal then passes to the transmit VCO. The compensation adjust potentiometer (R543) is adjusted at the factory and should be readjusted only if the common circuits board, reference oscillator, or VCO is changed. To readjust it, follow the procedure in the Radio Alignment and Adjustments part of the Maintenance and Troubleshooting Section of this manual.

Reference modulation inhibit switch Q502 conducts while the radio is in the receive mode, shorting the reference modulation signal line to ground. This prevents any noise induced on the line during the receive mode from affecting the reference oscillator and, consequently, the receive injection frequency. During initial turn–on, C508 is charged through

Q502. This allows a stable receive frequency to be attained almost immediately. Q502 is turned off by TX +9.5V during transmit, enabling the reference modulation signal line.

3. Synthesizer Troubleshooting Procedure

3.1 GENERAL

The Synthesizer Troubleshooting Chart in this section gives a comprehensive procedure for troubleshooting the frequency synthesizer.

Malfunctions that could occur in the frequency synthesizer are:

- Synthesizer does not lock.
- Synthesizer locks on wrong frequency.
- Excessive reference frequency feeds through (spurs).
- Frequency lock is noisy.
- Switching response is slow.

Table 2 lists the most likely causes of these malfunctions. To assist your troubleshooting, Tables 4 through 7 list pin connections and voltages for the phase detector, divider, prescaler, and super filter.

The troubleshooting chart for the frequency synthesizer mentions an open loop test and checking the divider programming, but does not give flow charts for these two procedures. The following paragraphs describe them.

Table 2. Synthesizer Malfunctions and Their Possible Causes

PROBLEMS	POSSIBLE SOURCE OF TROUBLE
Synthesizer does not lock.	(See synthesizer troubleshooting chart.)
Synthesizer locks on wrong frequency. (see note)	Reference oscillator (U608) frequency off (should be 14.4 MHz ± ppm.)
	Erroneous divider programming from microcomputer (possible defective memory module, or code plug, or microcomputer.)
	Defective divider U602.
	Defective prescaler U601.
Excessive reference frequency feeds through (spurs).	Defective hold capacitor C632 (open or leaky.)
	Defective ramp capacitor C630.
	Defective phase detector U603.
	Adaptive filter in ADAPTIVE mode or shorted input to output; guard band shorted to VCO steering line or other adaptive filter mode.
Frequency lock is noisy.	Marginal input level to loop divider (U602–25) or reference divider (U602–2.)
	Loose connection, cold solder joint, or faulty component.
	Noisy Q600.
	Defective phase detector U603.
	Defective divider U602 (jittery.)
	Noisy 5V or 9.6V supplies.
	Defective adaptive filter (open capacitors.)
Switching response is slow.	Improper synchronization from microcomputer (Check divider programming.)
	Malfunctioning adaptive filter (Check U604, U605, and U606.)
	Phase detector U603 gain too low (overdamped response) or too high (underdamped response) (Check R625, R626, RT600, C630, and Q600.)
	Leaky adaptive filter capacitors or transmission gates (U605, U606, and C641.)
	Leaky VCO varactor diodes.

NOTE: A frequency error of 5 kHz, 10 kHz, or 15 kHz OR 6.25 kHz, 12.5 kHz, or 18.75 kHz can be caused by a defective prescaler or by shorted or opened programming lines from the divider to the prescaler (U601–7, U601–6.)

3.2 OPEN LOOP TEST

3.2.1 Introduction

For this test you must have the following equipment: variable power supply, frequency counter, dual–trace oscilloscope, DC voltmeter, and RF voltmeter. The Maintenance and Troubleshooting Section of this manual has a list of recommended test equipment. The open loop test consists of four procedures:

- VCO frequency test.
- Loop and reference waveforms check.
- Phase detector check.
- Adaptive filter check.

3.2.2 VCO Frequency Test

(1) Remove jumper JU600 to open the STEERING LINE loop. Connect a one–kilohm resistor to the plus terminal of a 0–10 V adjustable power supply and connect the free end of the resistor to the VCO side (at the point from which JU600 was removed on the side that is not connected to C637). Connect the negative terminal to A–. This power supply serves as a steering line for this test.

(2) Connect a frequency counter to the divider port of the internal casting (P600). To check the transmit VCO, push the PTT switch and monitor the frequency while slowly changing the steering voltage from 2.5 V to 9.0 V. Verify that the VCO generates the right transmit or receive injection frequency (Table 3). Check the band shift line voltages if you cannot get the right frequency. If the Band shift lines are okay, the VCO is faulty and should be replaced. Also check the output of the VCO divider port (J600) and verify that it is greater than –15 dBm.

3.2.3 Loop and Reference Waveforms Check

(1) Connect one channel of a dual–trace oscilloscope to U602–5 (REF OUT) and the other to U602–9 (LOOP OUT). Adjust the oscilloscope so that it triggers on the REFERENCE waveform. The oscilloscope trace should be in the chopped mode.

(2) Observe the LOOP waveform and verify that it moves smoothly across the screen without any jitter when the steering line is varied from 1.0 V to 9.6 V.

(3) Observe the REFERENCE signal and verify that its period is correct without any jitter, and that one steering line voltage from 2.5 to 9.0 V does not exactly yield this period on the loop divider output. (The period depends on the customer's programming requirements. In most cases, it is 200 microseconds for 5 kHz reference).

(4) If the conditions specified in Steps 2 and 3 are met, then check the divider buffer (Q602 and associated components), the prescaler (U601), the divider (U602), the reference oscillator (U608), and the divider programming. To check the prescaler, capacitively couple a 200–MHz frequency counter to its output and verify that the output is approximately one–third of the input frequency (or one–sixth the desired loop output frequency). The frequency counter will not show exactly one–third of the input frequency, since the prescaler is dividing by four part of the time. The difference should not exceed 50 ppm.

3.2.4 Phase Detector Check

Check the phase detector (U603) by adjusting the steering line voltage for a loop period slightly longer than the reference period and then for a slightly shorter period. With a longer loop period, the phase detector output (U603–15) should switch to a high state (greater than 9 V); with a shorter loop period, the phase detector output should switch to a low state (1.2 V). If this fails to happen, then check the phase detector and associated circuitry.

3.2.5 Adaptive Filter Check

Check the adaptive filter for short or open circuits by removing jumper JU600 and then checking for a high voltage on the adaptive filter side when the base detector output is high. The absence of a high voltage is an indication of a faulty condition.

3.2.6 VCO Steering Line Leakage

Note

Be sure to use a shielded cable with the volt meter when making these measurements.

Check the VCO steering line leakage by removing jumper JU600 and connecting a one–megohm resistor to the VCO side. Connect the free end of the resistor to an adjustable power supply set to 9.5 V. Use a high–impedance voltmeter (impedance greater than 10 megohms) to verify that the voltage drop across the resistor is less than 18 mV. A higher voltage drop (greater than 18 mV) indicates either a leaky VCO interconnection plate or defective VCO steering line varactors (CR1401–1404, CR1409, and CR1411–1414). To find out which is defective, remove the VCO from the RF internal casting and perform the test again. If the voltage drop is greater than two millivolts, replace the interconnection plate.

Table 3. VCO Frequency Test Chart

BAND SHIFT 1	BAND SHIFT 2	RX/TX	VCO FREQUENCY RANGE
LOW	HIGH	TX	150–161.8 MHz
HIGH	LOW	TX	161.8–174 MHz
HIGH	LOW	RX	203.9–215.5 MHz
LOW	HIGH	RX	215.5–227.9 MHz

3.3 DIVIDER PROGRAMMING TEST

The synthesizer troubleshooting chart refers to the divider programming test. This test requires a dual–trace oscilloscope and a test memory module (Motorola No. HLN1074A). See the list of recommended test equipment in

the Maintenance and Troubleshooting Section of this manual. Table 4 lists the divider's pin numbers and their functions (U602). The timing diagram on the synthesizer troubleshooting chart shows the waveforms generated under Mode 4 of the test memory module.

(1) Connect Channel 1 of a dual–trace oscilloscope to the STROBE line (U602–27) of the divider. Trigger the oscilloscope on the rising edge of the strobe signal.

(2) Connect Channel 2 of the oscilloscope to the A0 line (U602–23) of the divider.

(3) Compare the waveforms observed on the oscilloscope with those shown in the timing diagram on the troubleshooting chart, and verify that the relationship between the STROBE and A0 signals is the same.

(4) Connect Channel 2 of the oscilloscope to the A1 line (U602–24) and compare the pattern observed on the oscilloscope with the one shown in the timing diagram.

(5) Repeat the procedure for A2 (U602–26), D0 (U602–11), D1 (U602–12), D2 (U602–13), and D3 (U602–14).

(6) Verify that the prescaler C inputs are as shown in Table 6, and that the frequency at the receive injection port changes by 100 kHz when the mode is changed from Mode 4 to Mode 5. If these indications are incorrect, look for a short circuit or repair the circuit board runner or replace the prescaler (U601).

Note

You can also check the programming with a single–trace oscilloscope with an external trigger input. Connect the external trigger to the strobe line, and display the strobe signal on the oscilloscope to verify proper triggering. (See the timing diagram on the troubleshooting chart.) Then check each of the address and data lines in Steps 1 through 5 above.

Table 4. Phase Detector (U603) Pin Connections and Voltages

PIN NO.	FUNCTION	TO/FROM	NOMINAL VOLTAGE
1	high current ground	—	0 VDC
2	REFERENCE IN	from HY601–8	0V to 4.3V square wave (200 ms period for 5 kHz reference frequency)
3	LOW BANDWIDTH	from U602–17	0 VDC receive; 5 VDC transmit
4	SYNTHESIZER SYNC	to microcomputer	60 ms positive pulse 0 5V at loop pulse rate; equal to Pin 2 if Pin 11 is low
5	FREQUENCY CHANGE	from U602–18	0.5V, 11.1 ms when frequency changes
6	TX	to adaptive filter	0 VDC receive, 9.6 VDC transmit
7	ADAPT	to adaptive filter	9.6 to 0.6V single pulse, 3.0 ms (RX) dekey; 15 ms (TX) key
8	no connection	—	—
9	no connection	—	—
10	ADAPT	to adaptive filter	0 9.0V single pulse, 3.0 ms (RX) dekey; 15 ms (TX) key
11	no connection	—	—
12	RX	to adaptive filter	9.6 VDC receive, 0 VDC transmit
13	HOLD 2	C632	1.4 to 8 VDC (use high–input–impedance voltmeter)
14	Guard Band	—	—
15	PHASE DET OUTPUT	to adaptive filter	1.2 to 9.5 VDC (depending on loop output frequency)
16	low current ground		0 VDC
17	EXT PNP BASE	to PNP Q604 base	8.9 VDC
18	VCC	from regulator	9.6 VDC
19	RAMP BASE	to PNP Q603 base (ramp generator)	9.1 VDC
20	FILTERED 9.1V	to R624, R625, RT600, C629	9.1 VDC
21	RAMP RES	to R626, PNP Q603 emitter	8.0 to 8.7 VDC rectangular wave @ reference rate
22	SAMPLE TIMING CAP	to C631	0 to 2V sawtooth wave at loop pulse rate
23	LOOP IN PULSE	from U602–9 via C628	1.4V pulse riding on 1.6 VDC (200 ms, typical period)
24	RAMP CAP	from C630 and ramp PNP Q603	collector flat–top ramp waveform at reference rate, top voltage 1.4 to 7V (depending on loop output frequency)

Table 5. Divider (U602) Pin Connections and Voltages

PIN NO.	FUNCTION	TO/FROM	NOMINAL VOLTAGES
1*	GND	—	0 VDC
2	REF IN	from U608 (reference oscillator)	1.5 VDC +0.6V pp AC (14.4 MHz)
3	3.6 MHz OUT	NC	—
4	GND	—	0 VDC
5*	REFERENCE OUT	to HY601 (phase modulator)	0 to 4.3V square wave (5.0 or 6.25 kHz)
6	NC	—	—
7	NC	—	—
8	NC	—	—
9*	LOOP OUT	to phase detector	2.9V to 4.3V narrow pulse (1.4V pp) (200 ms nominal period)
10*	VCC	from regulator	5 VDC
11	D0	from microcomputer	0 to 5V pulse train
12	D1	from microcomputer	0 to 5V pulse train
13	D2	from microcomputer	0 to 5V pulse train
14	D3	from microcomputer	0 to 5V pulse train
15	C0	to Q241 (extender)	0 to 5 VDC
16	NC	—	—
17	LOW BANDWIDTH	to phase detector	0 to 5 VDC
18	FREQ CHANGE	to phase detector	0 to 5 VDC
19	VCO1	to HY604–5	0 to 0.7 VDC
20	VCO2	to HY605–5	0 to 0.7 VDC
21	NC	—	—
22	VBB	to divider	1.5 VDC
23	A0	from microcomputer	0 to 5V pulse train
24	A1	from microcomputer	0 to 5V pulse train
25	PRESCALE IN	from HY601–8 via coaxial cable	1.5 VDC +0.7V pp AC (approx. 50–80 MHz)
26	A2	from microcomputer	0 to 5V pulse train
27*	STROBE	from microcomputer	0 to 5V pulse train (7 pulses/train)

*SHOULD BE CHECKED FIRST

Table 6. Prescaler (U601) Pin Connections and Voltages

PIN NO.	FUNCTION	TO/FROM	NOMINAL VOLTAGES
1	FIN	from VCO buffer	–12 to 0 dBm (at carrier or first injection freq.) riding on 3.8 VDC
2	VBB		3.8 VDC, bypassed for RF
3	PRESCALE OUT	to divider (U602)	0 dBm (0.6 V pp) riding on DC level of 3.6 VDC at approx. one–third VCO freq. (±50 ppm)
4	GND		0 VDC
5	FV	from divider (U602)	1.4 V p narrow pulse at reference frequency riding on 3.4 VDC
6	C1	from divider	DC level (programming bit) 0 or 5 VDC; test memory module Mode 4, 5 VDC; Mode 5, 0 VDC
7	C0	from divider	DC level (programming bit) 0 or 5 VDC; test memory module Mode 4, 0 VDC; Mode 5, 5 VDC
8	VCC	from regulator	+5.0 V ±0.1 V

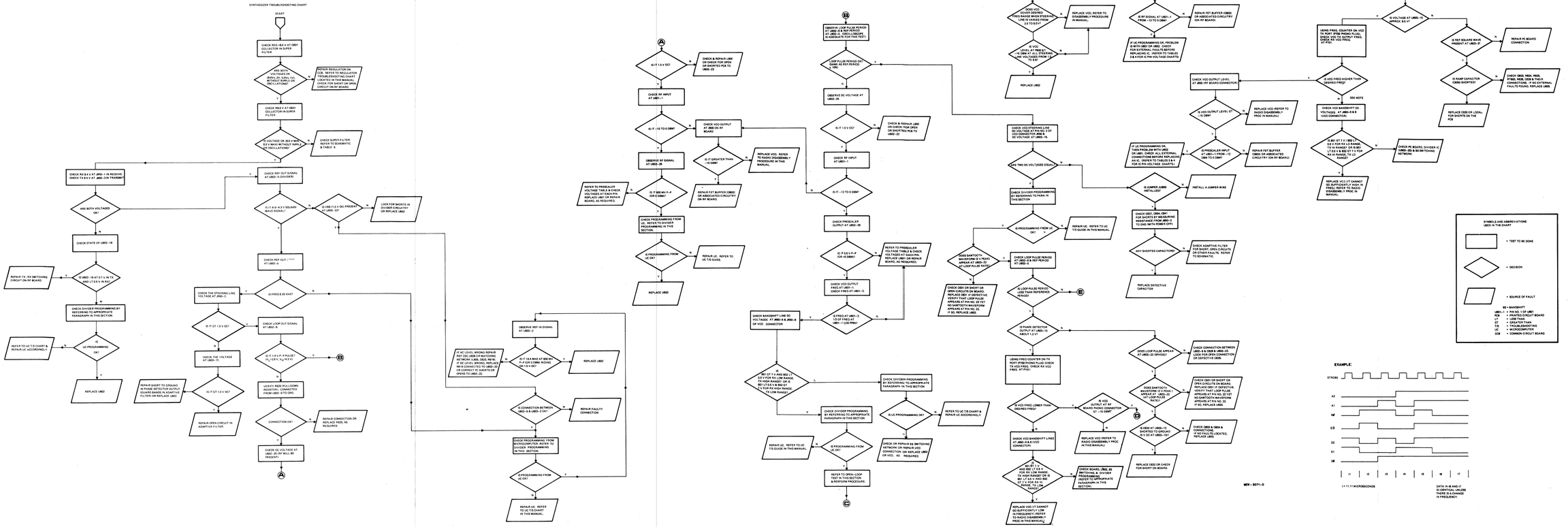
Table 7. Super Filter Pin Connections and Voltages

PIN NO.	FUNCTION	TO/FROM	NOMINAL VOLTAGE
1	VCC	from 9.6V regulator	9.6 VDC
2	FILTER CAP	C603	7.1 VDC
3	EXT DRIVER CONTROL	Q601 base	8.9 VDC
4	8.6V OUT	to VCO switching	8.6 VDC
5	Ground (internal NPN emitter)	from regulator	0 VDC
6	Internal NPN collector	to VCO modulation	—
7	Internal NPN base	from VCO Band shift; R605 and R606	0.2V, transmit high range 0.7V, transmit low range
8	no connection	—	—

9.66
7.39
8.35
8.64
0.0
0.0
0.7
0.0

9.67 E
8.33 B
8.82 C

TROUBLESHOOTING CHART FOR THE SYNTHESIZER



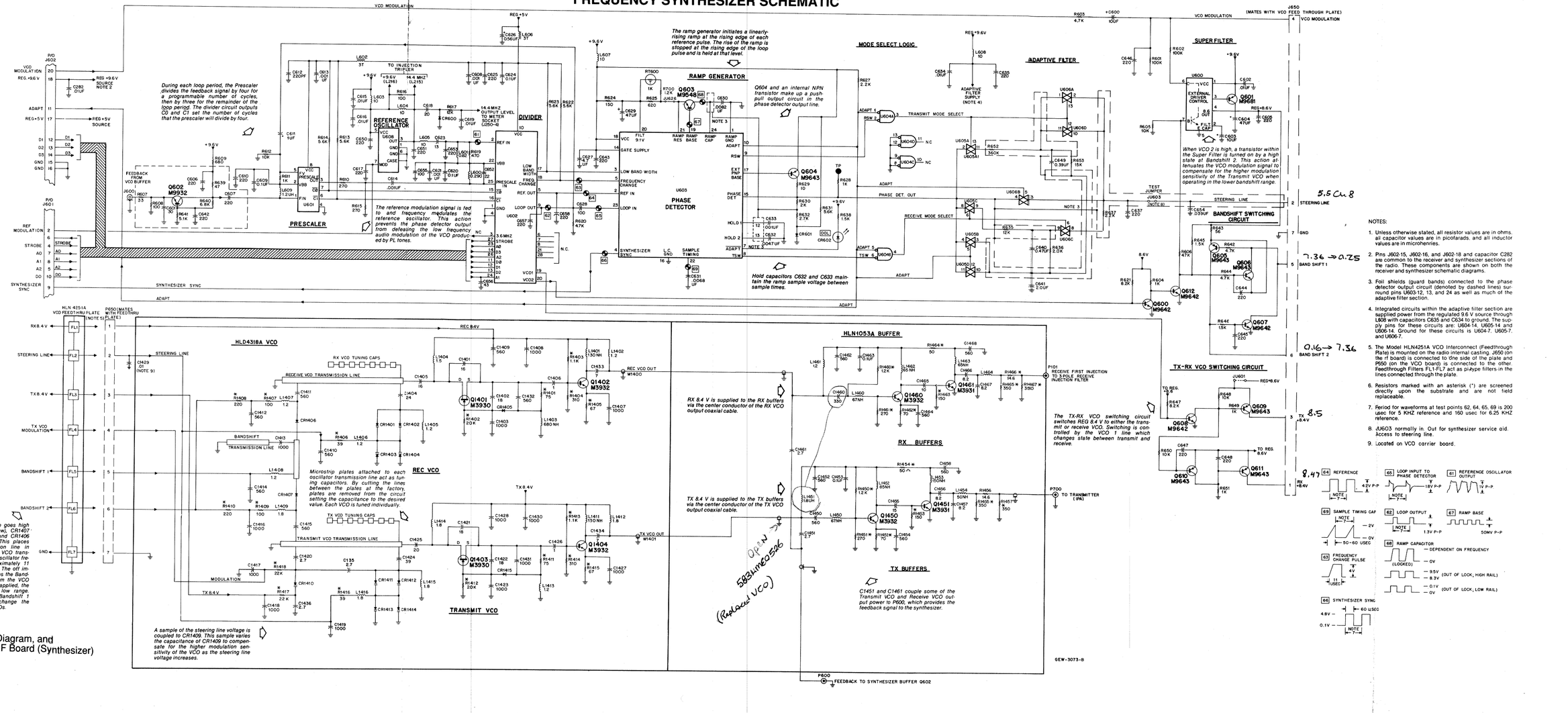
MEW - 9271-O

SYNTHESIZER

Synthesizer Troubleshooting Chart
PEW-0782-A
5/23/86

HLN5169A RF BOARD
RANGE 2

FREQUENCY SYNTHESIZER SCHEMATIC



NOTES:

1. Unless otherwise stated, all resistor values are in ohms, all capacitor values are in picofarads, and all inductor values are in microhenries.
2. Pins J602-15, J602-16, and J602-18 and capacitor C282 are common to the receiver and synthesizer sections of the radio. These components are shown on both the receiver and synthesizer schematic diagrams.
3. Foil shields (guard bands) connected to the phase detector output circuit (denoted by dashed lines) surround pins U603-12, 13, and 24 as well as much of the adaptive filter section.
4. Integrated circuits within the adaptive filter section are supplied power from the regulated 9.6 V source through L608 with capacitors C635 and C634 to ground. The supply pins for these circuits are: U604-14, U605-14 and U605-14. Ground for these circuits is U604-7, U605-7, and U606-7.
5. The Model HLN4251A VCO Interconnect (Feedthrough Plate) is mounted on the radio internal casting. J650 (on the rf board) is connected to one side of the plate and P650 (on the VCO board) is connected to the other. Feedthrough Filters FL1-FL7 act as pi-type filters in the lines connected through the plate.
6. Resistors marked with an asterisk (*) are screened directly upon the substrate and are not field replaceable.
7. Period for waveforms at test points 62, 64, 65, 69 is 200 usec for 5 KHZ reference and 160 usec for 6.25 KHZ reference.
8. JU603 normally in. Out for synthesizer service aid. Access to steering line.
9. Located on VCO carrier board.

Schematic, Circuit Board Diagram, and Parts List for HLN5169A RF Board (Synthesizer)
PW–3072–C
(Sheet 1 of 2)
11/10/88

parts list

HLN5169A RF Board (Synthesizer Section) MXW–5098–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C601	21–11014H36	30
C602	08–11051A07	.01 uF, 63V
C603	23–11013E57	10 uF, ±20%, 25V, tantalum
C604	23–82783B31	47 uF, ±20%, 20V, tantalum
C605–607	21–11015B05	220, ±10%
C608	08–11051A01	.001 uF, 63V
C609	08–11051A13	.1 uF, 63V
C610	21–11015B05	220, ±10%
C611	23–11054L06	1.0 uF, ±10%, 50V, tantalum
C612	21–11015B05	220, ±10%
C613–614	08–11051A01	.001 uF.001, 63V
C615–616	08–11051A07	.01 uF, 63V
C617	21–11015B05	220, ±10%
C618	21–11014H32	20
C619	08–11051A07	.01 uF, 63V
C620	08–11051A13	.1 uF, 63V
C621	08–11051A01	.001 uF, 63V
C623	21–11014H28	13
C624	08–11051A13	.1 uF, 63V
C625	21–11015B05	220, ±10%
C626	23–11013F10	.56 uF, ±10%, 35V, tantalum
C627	23–11013D55	4.7 uF, ±20%, 20V, tantalum
C628	21–11015B01	100, ±10%
C629	23–84538G06	47 uF, ±20%, 20V, tantalum
C630	08–80027B03	8200 uF
C631	08–11017B07	.0068 uF, ±10%, 50V
C632	08–11017B06	.0047 uF, ±10, 50V
C633	08–11017B01	.001 uF, ±10%, 50V
C633	21–11015B05	220, ±10%
C634	08–11051A07	.01 uF, 63V
C635	21–11015B05	220, ±10%
C637	21–11015B05	220, ±10%
C640	08–84637L42	.47, ±10%
C641	08–83862M02	.2 uF, ±10%
C642–648	21–11015B05	220, ±10%
C649	08–84637L39	.39, ±10%
C650	21–11015B05	220, ±10%
C652	21–11014H33	22
C654	08–80027B04	0.039 uF
C655	21–82204B06	100, ±10%, 500V
C656	21–83406D87	43, 500V
C658	21–82240K06	220, ±10%
diode (see note)		
CR600	48–82139G01	germanium
CR601	48–83329G02	silicon
CR602	48–84404E01	LED
connector receptacle		
J600	09–80001F01	phono jack
J601602	09–83445L09	10 contact
J650	09–83730M01	7 contact
jumper		
JU601	06–11009D23	0 ohm
JU603	06–11009D23	0 ohm
JU626	06–11009D23	0 ohm
coil, RF		
L600	24–82723H28	.29 uH yellow
L601	24–83397L13	.82 uH gray–red
L602	24–83961B01	choke, 3 turns silver–brown
L603–604	24–82723H45	10.0 uH blue–red
L605	24–83397L07	10 uH blue–blue
L606	24–83961B01	choke, 3 turns silver–brown
L607–608	24–82723H45	10.0 uH blue–red
L609	24–83397L12	1.2 uH white
transistor (see note)		
Q600	48–00869642	NPN, type M9642
Q601	48–00869681	PNP, type M9681
Q602	48–00869932	NPN, type M9932
Q603	48–00869548	PNP, type M9548
Q604–606	48–00869643	PNP, type M9643
Q607–608	48–00869642	NPN, type M9642
Q609–611	48–00869643	PNP, type M9643
Q612	48–00869642	NPN, type M9642
thermistor		
RT600	06–80275N01	thermistor
resistor, fixed ohm, ±5%, 1/4 watt (unless otherwise stated)		
R601–602	06–11009C97	100k
R603	06–11009C65	4.7k
R604	06–11009C49	1k
R605	06–11009C73	10k
R606	06–11009C89	47k
R607	06–11009C13	33
R608	06–11009C25	100
R609	06–11009C45	680
R610	06–11009C35	270
R611	06–11009C49	1k
R612	06–11009C73	10k
R613–614	06–11009C67	5.6k
R615	06–11009C35	270
R616	06–11009C25	100
R617	06–11009C75	12k
R619	06–11009C41	470

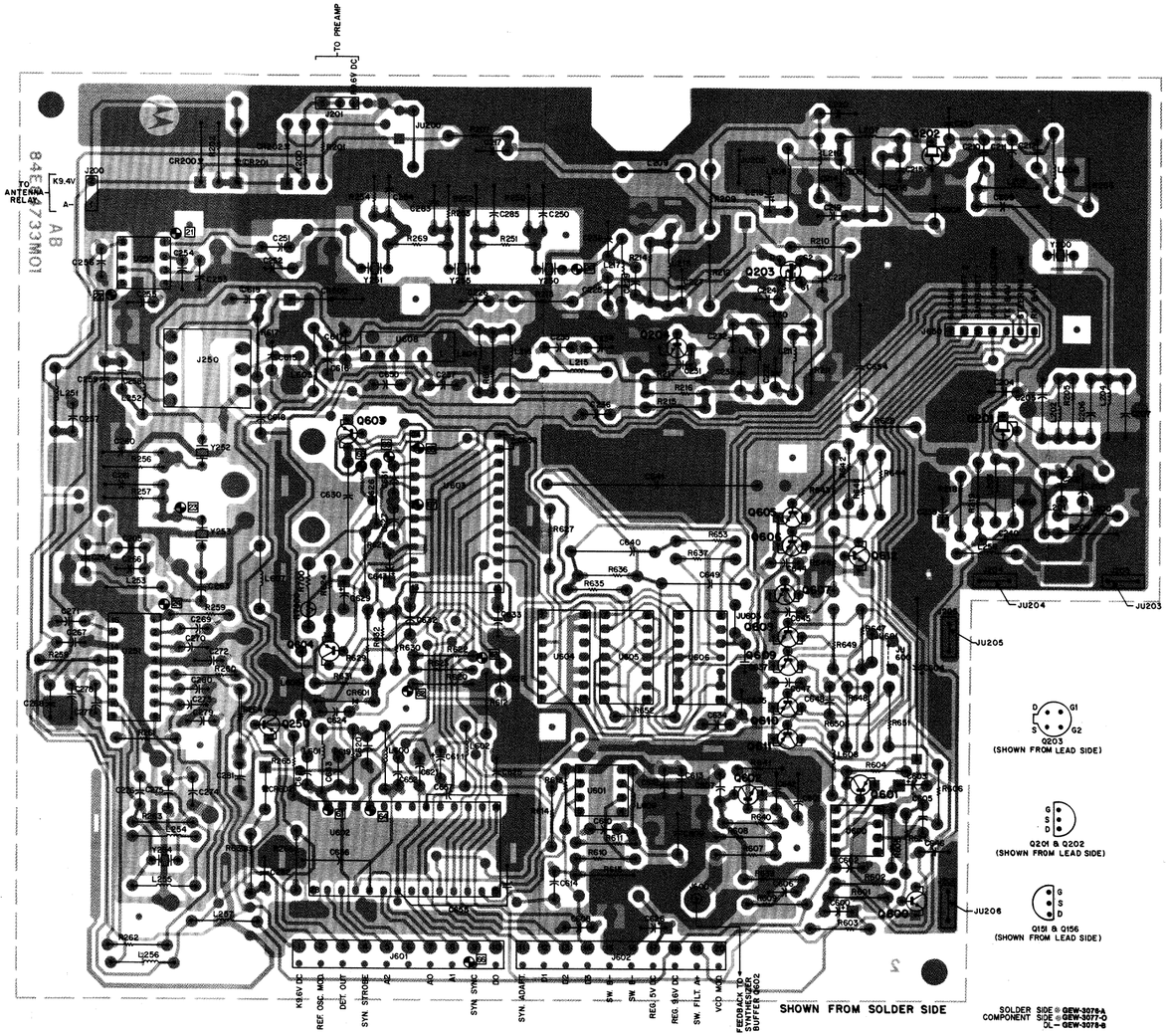
MXW–5098–A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R620	06–11009C65	4.7k
R621	06–11009C71	8.2k
R622–623	06–11009C67	5.6k
R624	06–11009C29	150
R625	06–11009C44	620
R627	06–11009C57	2.2k
R628	06–11009C49	1k
R629	06–11009C01	10
R630	06–11009C56	2k
R631	06–11009C67	5.6k
R632	06–11009C59	2.7k
R635	06–11009C75	12k
R636	06–11009C56	2k
R637	06–11009C57	2.2k
R638	06–11009C53	1.5k
R639	06–11009C17	47
R640	06–11009C69	6.8k
R641	06–11009C66	5.1k
R642	06–11009C65	4.7k
R643	06–11009C19	56
R644	06–11009C65	4.7k
R645–646	06–11009C53	1.5k
R647	06–11009C71	8.2k
R648	06–11009C73	10k
R649	06–11009C49	1k
R650	06–11009C73	10k
R651	06–11009C49	1k
R652	06–11009D11	360k
R653	06–11009C77	15k
R700	06–11009C51	1.2k
integrated circuit (see note)		
U600	51–84768F65	super–low–pass filter, type M6865
U601	51–84768F68	prescaler, type M6868
U602	51–82977M18	bialteral switch, type M7718
U603	51–83977M36	phase detector, type M7736
U604	51–80072C01	nor gate, quad 2–input, type M7201
U605	51–80073C02	bilateral switch, type M7302
U606	51–80073C03	bilateral switch, type M7303
U608	51–80291B02	reference oscillator, type M9102
	mechanical parts	
	26–83594M01	component side shield
	26–83597M01	prescaler component side shield
	26–83814M01	fence shield
	26–84978M01	shield
	55–84300B02	handle (2 used)
	26–83593M01	shield component side

6/20/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

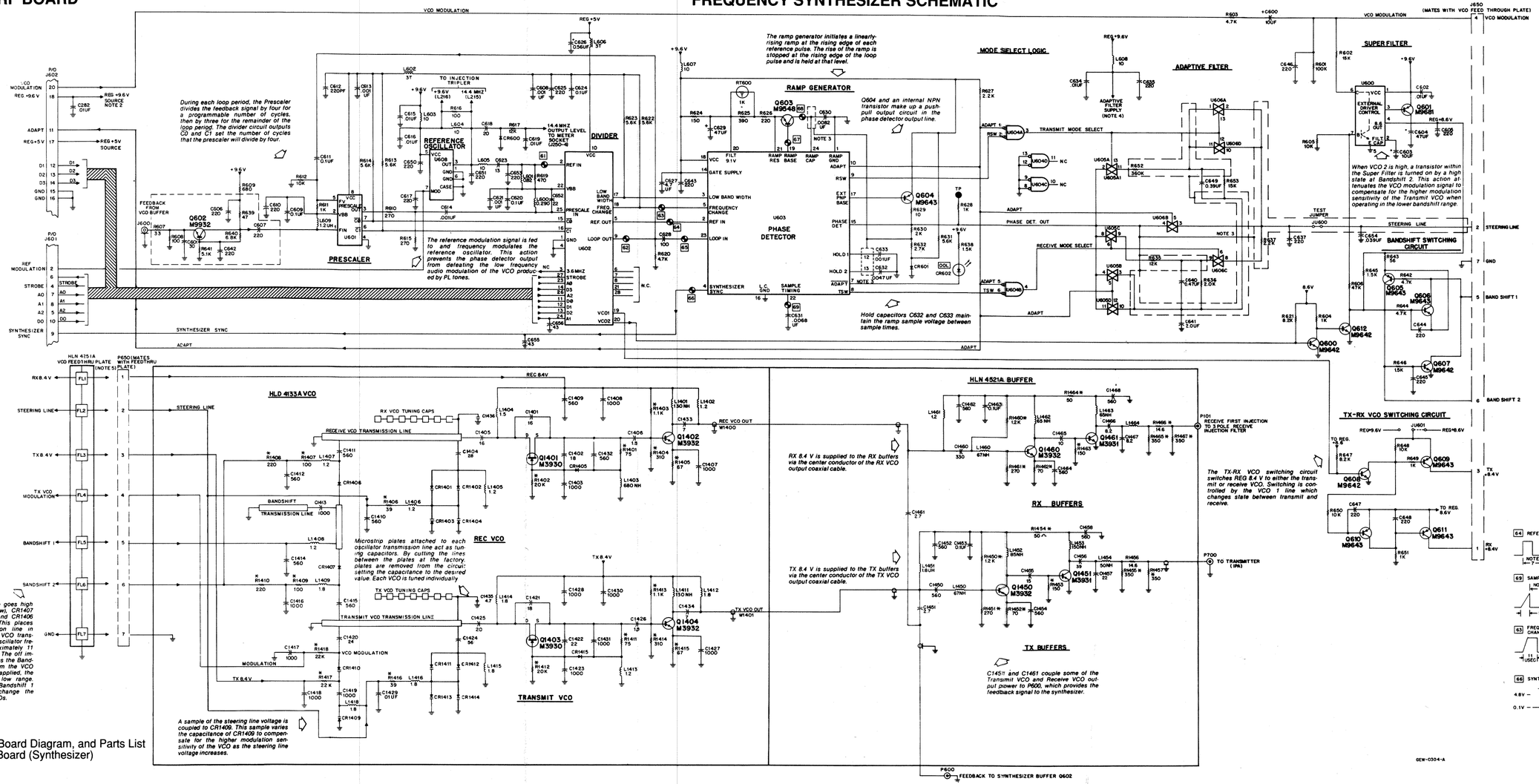
HLN5169A RF BOARD RANGE 2



Schematic, Circuit Board Diagram, and
Parts List for HLN5169A RF Board (Synthesizer)
PW–3072–C
(Sheet 2 of 2)
11/10/88

HLN4492A RF BOARD
RANGE 1

FREQUENCY SYNTHESIZER SCHEMATIC



NOTES:

1. Unless otherwise stated, all resistor values are in ohms, all capacitor values are in picofarads, and all inductor values are in microhenries.
2. Pins J602-15, J602-16, and J602-18 and capacitor C282 are common to the receiver and synthesizer sections of the radio. These components are shown on both the receiver and synthesizer schematic diagrams.
3. Foil shields (guard bands) connected to the phase detector output circuit (denoted by dashed lines) surround pins U603-12, 13, and 24 as well as much of the adaptive filter section.
4. Integrated circuits within the adaptive filter section are supplied power from the regulated 9.6 V source through L608 with capacitors C635 and C634 to ground. The supply pins for these circuits are: U604-14, U605-14 and U606-14. Ground for these circuits is U604-7, U605-7, and U606-7.
5. The Model HLN4251A VCO Interconnect (Feedthrough Plate) is mounted on the radio internal casting. J650 (on the rf board) is connected to one side of the plate and P650 (on the VCO board) is connected to the other. Feedthrough Filters FL1-FL7 act as pi-type filters in the lines connected through the plate.
6. Resistors marked with an asterisk (*) are screened directly upon the substrate and are not field replaceable.
7. Period for waveforms at test points 62, 64, 65, 69 is 200 usec for 5 KHZ reference and 160 usec for 6.25 KHZ reference.

64 REFERENCE — 4.2V P-P
65 LOOP INPUT TO PHASE DETECTOR — 18V P-P
61 REFERENCE OSCILLATOR OUTPUT — 1V P-P
69 SAMPLE TIMING CAP — 2V, 0V, 50-60 USEC
62 LOOP OUTPUT — 13V P-P
67 RAMP BASE — 50MV P-P
63 FREQUENCY CHANGE PULSE — 4V, 0V, 11 USEC
68 RAMP CAPACITOR — DEPENDENT ON FREQUENCY (LOCKED); -9.5V (OUT OF LOCK; HIGH RAIL); -8.3V; -0.1V (OUT OF LOCK; LOW RAIL); 0V
66 SYNTHESIZER SYNC — 4.8V, 0.1V, 60 USEC

GEW-0304-A

Schematic, Circuit Board Diagram, and Parts List for HLN4492A RF Board (Synthesizer)
PW–3542–B
(Sheet 1 of 2)
11/30/88

parts list

HLN4492A R1 RF Board (Synthesizer Section) MXW–3546–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C600	23–11013E57	10 uF ±20% 25V, tantalum
C601	21–11014H36	30
C602	08–11051A07	.01 uF, 63V
C603	23–11013E57	10 uF ±20% 25V, tantalum
C604	23–82783B31	47 uF, ±20%, 20V, tantalum
C605–607	21–11015B05	220, ±10%
C608	08–11051A01	.001 uF, 63V
C609	08–11051A13	.1 uF, 63V
C610	21–11015B05	220, ±10%
C611	23–11054L06	1 uF, ±10%, 50V
C612	21–11015B05	220, ±10%
C613,614	08–11051A01	.001 uF, 63V
C615,616	08–11051A07	.01 uF, 63V
C617	21–11015B05	220, ±10%
C618	21–11014H32	20
C619	08–11051A07	.01 uF, 63V
C620	08–11051A13	.1 uF, 63V
C621	08–11051A01	.001 uF, 63V
C623	21–11014H28	13
C624	08–11051A13	.1 uF, 63V
C625	21–11015B05	220, ±10%
C626	23–11013F10	.56 uF, ±10%, 35V, tantalum
C627	23–11013D55	4.7 uF, +20%, 20V, tantalum
C628	21–11015B01	100, ±10%
C629	23–84538G06	47 uF, ±20%, 20V, tantalum
C630	08–80027B03	8200 uF
C631	08–11017B07	.0068 uF ±10%, 50V
C632	08–11017B06	.0047 uF, ± 10%, 50V
C633	21–11015B05	220, ±10%
C634	08–11051A07	.01 uF, 63V
C635	21–11015B05	220, ±10%
C637	21–11015B05	220, ±10%
C640	08–84637L42	.47 uF, ± 10%
C641	08–83862M02	2 uF, ±10%
C642–648	21–11015B05	220, ±10%
C649	08–84637L39	.39 uF, ±10%
C650	21–11015B05	220, ±10%
C652	21–11014H33	22
C654	08–80027B04	.039 uF
C655	21–82204B06	100, ± 10%, 500V
C656	21–83406D87	43, 500V
C658	21–82240K06	220, ± 10%
diode (see note)		
CR600	48–82139G01	germanium
CR601	48–83329G02	silicon
CR602	48–84404E01	LED
connector receptacle		
J600	09–80001F01	phono jack
J601	09–83445L09	10 contact
J602	09–83445L09	10 contact, female
J650	09–83730M01	7 contact, female
jumper		
JU601	06–11009D23	resistor jumper
JU603	06–11009D23	resistor jumper
JU626	06–11009D23	resistor jumper
coil, rf		
L600	24–82723H28	.29 uH yellow
L601	24–83397L13	.82 uH gray red
L602	24–83961B01	3 turns, brown
L603,604	24–82723H45	10.0 uH blue red
L605	24–83397L07	10 uH blue blue
L606	24–83961B01	3 turns, brown
L607,608	24–82723H45	10.0 uH blue red
L609	24–83397L12	1.2 uH white
transistor (see note)		
Q600	48–00869642	NPN, type M9642
Q601	48–00869681	PNP, type M9681
Q602	48–00869932	NPN, type M9932
Q603	48–00869548	PNP, type M9548
Q604–606	48–00869643	PNP, type M9643
Q607,608	48–00869642	NPN, type M9642
Q609–611	48–00869643	PNP, type M9643
Q612	48–00869642	NPN, type M9642
thermistor		
RT600	06–80275N01	thermistor
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R601	06–11009C97	100k
R602	06–11009C77	15k
R603	06–11009C65	4.7k
R604	06–11009C49	1k
R605	06–11009C73	10k
R606	06–11009C89	47k
R607	06–11009C13	33
R608	06–11009C25	100
R609	06–11009C45	680
R610	06–11009C35	270
R611	06–11009C49	1k
R612	06–11009C73	10k
R613,614	06–11009C67	5.6k
R615	06–11009C35	270

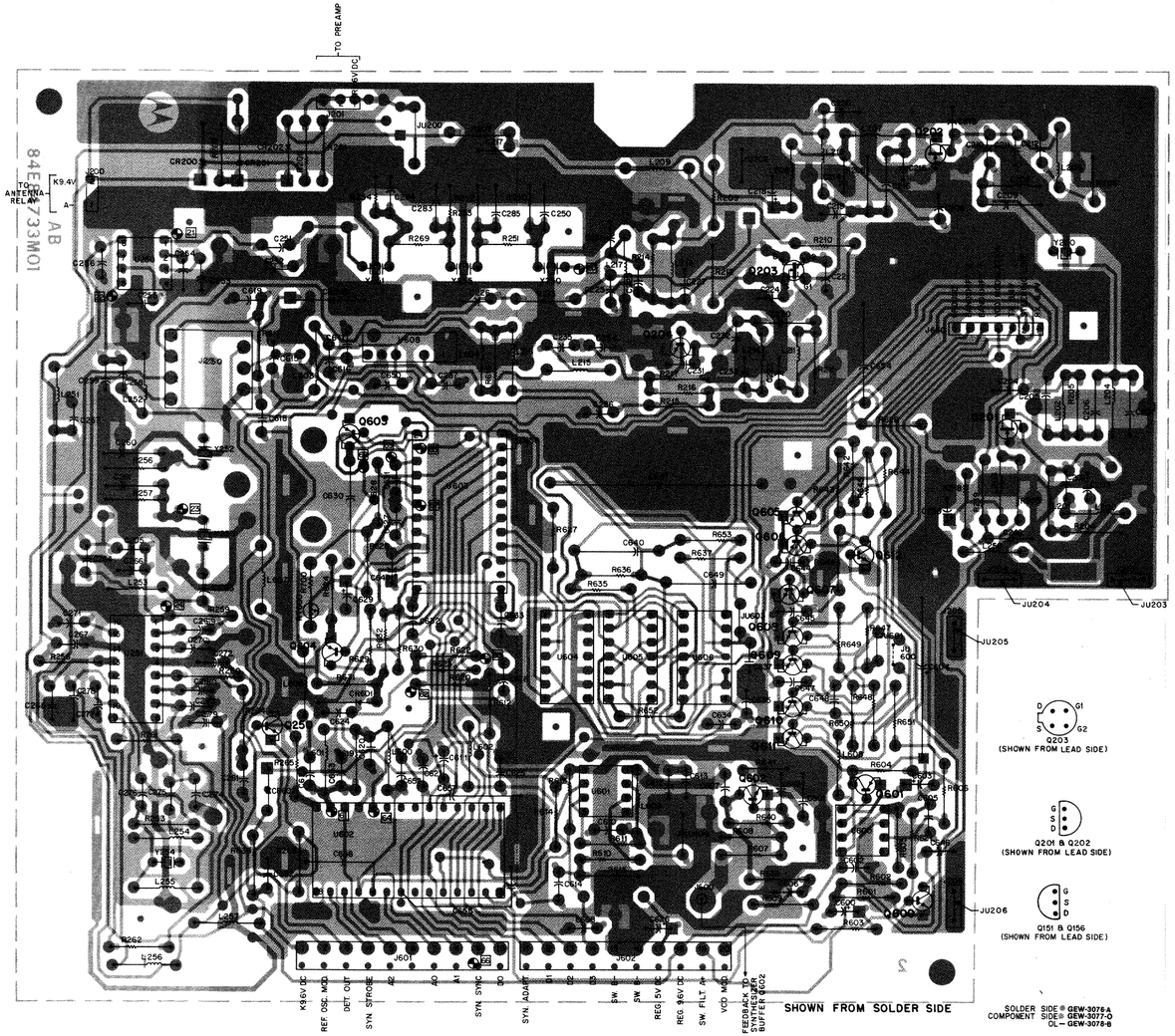
MXW–3546–A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R616	06–11009C25	100
R617	06–11009C75	12k
R619	06–11009C41	470
R620	06–11009C65	4.7k
R621	06–11009C71	8.2k
R622,623	06–11009C67	5.6k
R624	06–11009C29	150
R625	06–11009C44	620
R627	06–11009C57	2.2k
R628	06–11009C49	1k
R629	06–11009C01	10
R630	06–11009C56	2k
R631	06–11009C67	5.6k
R632	06–11009C59	2.7k
R635	06–11009C75	12k
R636	06–11009C56	2k
R637	06–11009C57	2.2k
R638	06–11009C53	1.5k
R639	06–11009C17	47
R640	06–11009C69	6.8k
R641	06–11009C66	5.1k
R642	06–11009C65	4.7k
R643	06–11009C19	56
R644	06–11009C65	4.7k
R645,646	06–11009C53	1.5k
R647	06–11009C71	8.2k
R648	06–11009C73	10k
R649	06–11009C49	1k
R650	06–11009C73	10k
R651	06–11009C49	1k
R652	06–11009D11	360k
R653	06–11009C77	15k
R700	06–11009C51	1.2k
integrated circuit (see note)		
U600	51–84768F65	super filter, type M6865
U601	51–84768F68	prescaler, type M6868
U602	51–84768F63	mono synthesizer
U602	51–83977M18	divider, type M7718
U603	51–83977M36	custom
U604	51–80072C01	quad 2 input, nor gate
U605	51–80073C02	quad analog switch, type M7302
U606	51–80073C03	quad analog switch, type M7303
U608	51–80291B02	reference oscillator
mechanical parts		
	26–83594M01	component side shield
	26–83597M01	component side prescaler shield
	26–83814M01	fence shield
	01–80707T22	strap and shield
	01–80707T23	strap and shield

4/30/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

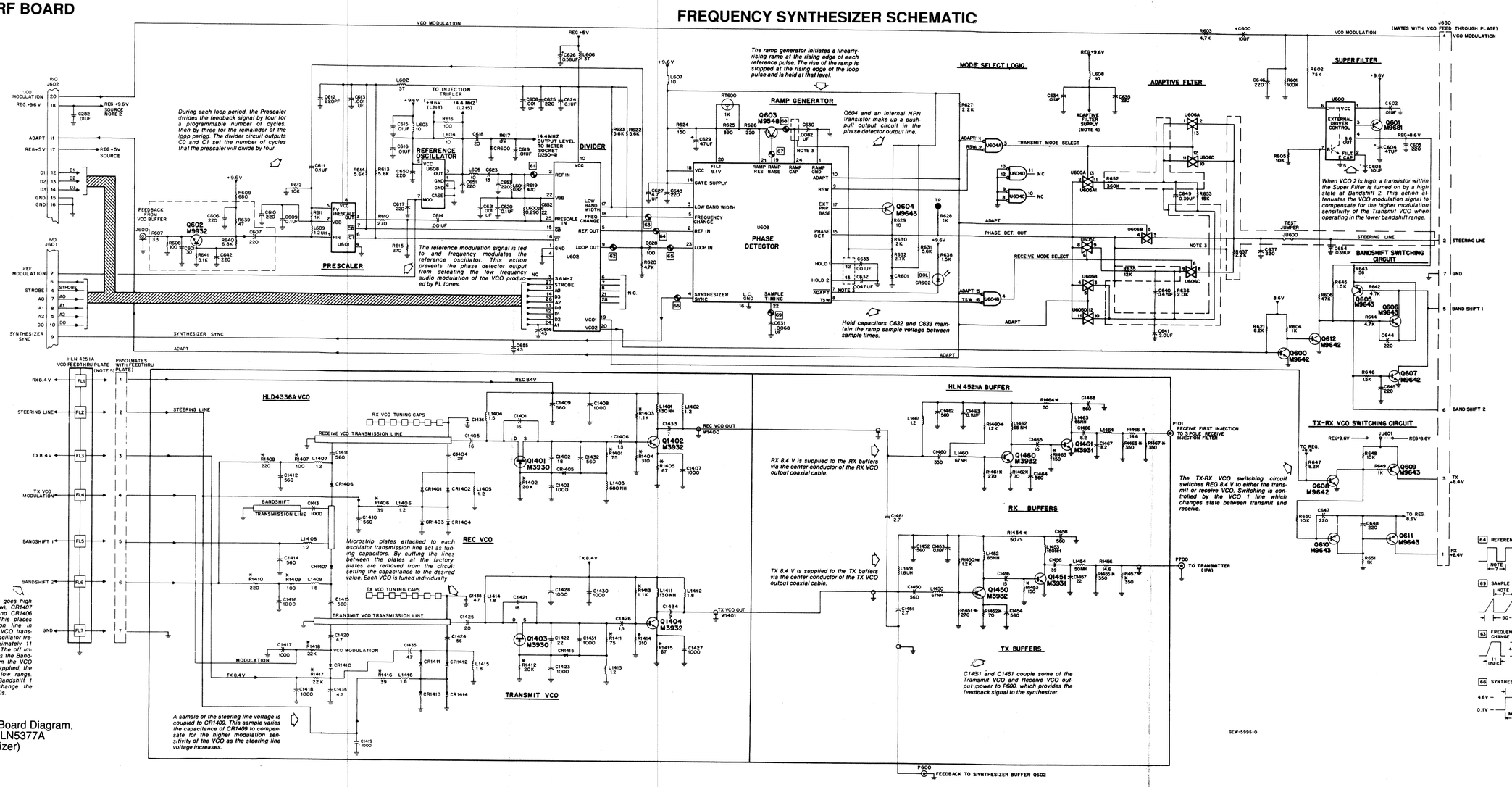
HLN4492A RF BOARD RANGE 1



Schematic, Circuit Board Diagram, and Parts List
for HLN4492A RF Board (Synthesizer)
PW–3542–B
(Sheet 2 of 2)
11/30/88

HLN5377A RF BOARD
RANGE 1

FREQUENCY SYNTHESIZER SCHEMATIC



NOTES:

1. Unless otherwise stated, all resistor values are in ohms, all capacitor values are in picofarads, and all inductor values are in microhenries.
2. Pins J602-15, J602-16, and J602-18 and capacitor C282 are common to the receiver and synthesizer sections of the radio. These components are shown on both the receiver and synthesizer schematic diagrams.
3. Foil shields (guard bands) connected to the phase detector output circuit (denoted by dashed lines) surround pins U603-12, 13, and 24 as well as much of the adaptive filter section.
4. Integrated circuits within the adaptive filter section are supplied power from the regulated 9.6 V source through L608 with capacitors C635 and C634 to ground. The supply pins for these circuits are: U604-14, U605-14 and U606-14. Ground for these circuits is U604-7, U605-7, and U606-7.
5. The Model HLN4251A VCO Interconnect (Feedthrough Plate) is mounted on the radio internal casting. J650 (on the rf board) is connected to one side of the plate and P650 (on the VCO board) is connected to the other. Feedthrough Filters FL1-FL7 act as pi-type filters in the lines connected through the plate.
6. Resistors marked with an asterisk (*) are screened directly upon the substrate and are not field replaceable.
7. Period for waveforms at test points 62, 64, 65, 69 is 200 usec for 5 KHZ reference and 160 usec for 6.25 KHZ reference.

64 REFERENCE — 4.2V P-P — NOTE 7
65 LOOP INPUT TO PHASE DETECTOR — 1.8V P-P — NOTE 7
61 REFERENCE OSCILLATOR OUTPUT — 1V P-P
69 SAMPLE TIMING CAP — NOTE 7 — 2V — 0V — 50-60 USEC
62 LOOP OUTPUT — NOTE 7 — 1.3V P-P
67 RAMP BASE — 50MV P-P
63 FREQUENCY CHANGE PULSE — 4V — 0V — 11 USEC
68 RAMP CAPACITOR — DEPENDENT ON FREQUENCY (LOCKED) — 9.5V — 8.3V (OUT OF LOCK, HIGH RAIL) — 0.1V — 0V (OUT OF LOCK, LOW RAIL)
66 SYNTHESIZER SYNC — 4.8V — 60 U SEC — 0.1V — NOTE 7

Schematic, Circuit Board Diagram, and Parts List for HLN5377A RF Board (Synthesizer)
PW-5994-O
(Sheet 1 of 2)
11/30/88

parts list

HLN5377A RF Board (Synthesizer Section) MXW–6005–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C600	23–11013E57	10, ±20%, 25V, tantalum
C601	21–11014H36	30
C602	08–11051A07	.01 uF, 63V
C603	23–11013E57	10, ±20%, 25V, tantalum
C604	23–82783B31	47, ±20%, 20V, tantalum
C605–607	21–11015B05	220, ±10%
C608	08–11051A01	.001 uF, 63V
C609	08–11051A13	.1 uF, 63V
C610	21–11015B05	220, ±10%
C611	23–11054L06	1, ±10%, 50V, tantalum
C612	21–11015B05	220, ±10%
C613,614	08–11051A01	.001 uF, 63V
C615,616	08–11051A07	.01 uF, 63V
C617	21–11015B05	220, ±10%
C618	21–11014H32	20
C619	08–11051A07	.01 uF, 63V
C620	08–11051A13	.1 uF, 63V
C621	08–11051A01	.001 uF, 63V
C623	21–11014H28	13
C624	08–11051A13	.1 uF, 63V
C625	21–11015B05	220, ±10%
C626	23–11013F10	.56 uF, ±10%, 35V, tantalum
C627	23–11013D55	4.7 uF, ±20%, 20V, tantalum
C628	21–11015B01	100, ±10%
C629	23–84538G06	47 uF, ±20%, 20V, tantalum
C630	08–80027B03	.0082 uF
C631	08–11017B07	.0068 uF, ±10%, 50V
C632	08–11017B06	.0047 uF, ±10%, 50V
C633	08–11017B01	.001 uF, ±10%, 50V
C633	21–11015B05	220, ±10%
C634	08–11051A07	.01 uF, 63V
C635	21–11015B05	220, ±10%
C637	21–11015B05	220, ±10%
C640	08–84637L42	.47 uF, ±10%
C641	08–83862M02	2 uF, ±10%
C642–648	21–11015B05	220, ±10%
C649	08–84637L39	.39 uF, ±10%
C650	21–11015B05	220, ±10%
C652	21–11014H33	22
C654	08–80027B04	.039 uF
C655	21–82204B06	100, ±10%, 500V
C656	21–83406D87	43, 500V
C658	21–82240K06	220, ±10%
diode (see note)		
CR600	48–82139G01	germanium
CR601	48–83329G02	silicon
CR602	48–84404E01	red LED
connector receptacle		
J600	09–80001F01	phono jack
J601,602	09–83445L09	10 contact
J650	09–83730M01	7 contact
jumper		
JU601	06–11009D23	0 ohm
JU603	06–11009D23	0 ohm
JU626	06–11009D23	0 ohm
coil, RF, uH		
L600	24–82723H28	.29, yellow
L601	24–83397L13	.82, gray red
L602	24–83961B01	silver brown
L603,604	24–82723H45	10, blue red
L605	24–83397L07	10, blue blue
L606	24–83961B01	silver brown
L607,608	24–82723H45	10, blue red
L609	24–83397L12	1.2, white
transistor (see note)		
Q600	48–00869642	NPN
Q601	48–00869681	PNP
Q602	48–00869932	NPN
Q603	48–00869548	PNP
Q604–611	48–00869643	PNP
Q612	48–00869642	NPN
thermistor		
RT600	06–80275N01	thermistor
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R601	06–11009C97	100k
R602	06–11009C94	75k
R603	06–11009C65	4.7k
R604	06–11009C49	1k
R605	06–11009C73	10k
R606	06–11009C89	47k
R607	06–11009C13	33
R608	06–11009C25	100
R609	06–11009C45	680
R610	06–11009C35	270
R611	06–11009C49	1k
R612	06–11009C73	10k
R613,614	06–11009C67	5.6k
R615	06–11009C35	270
R616	06–11009C25	100
R617	06–11009C75	12k
R619	06–11009C41	470
R620	06–11009C65	4.7k
R621	06–11009C71	8.2k
R622,623	06–11009C67	5.6k
R624	06–11009C29	150

MXW–6005–O (2)

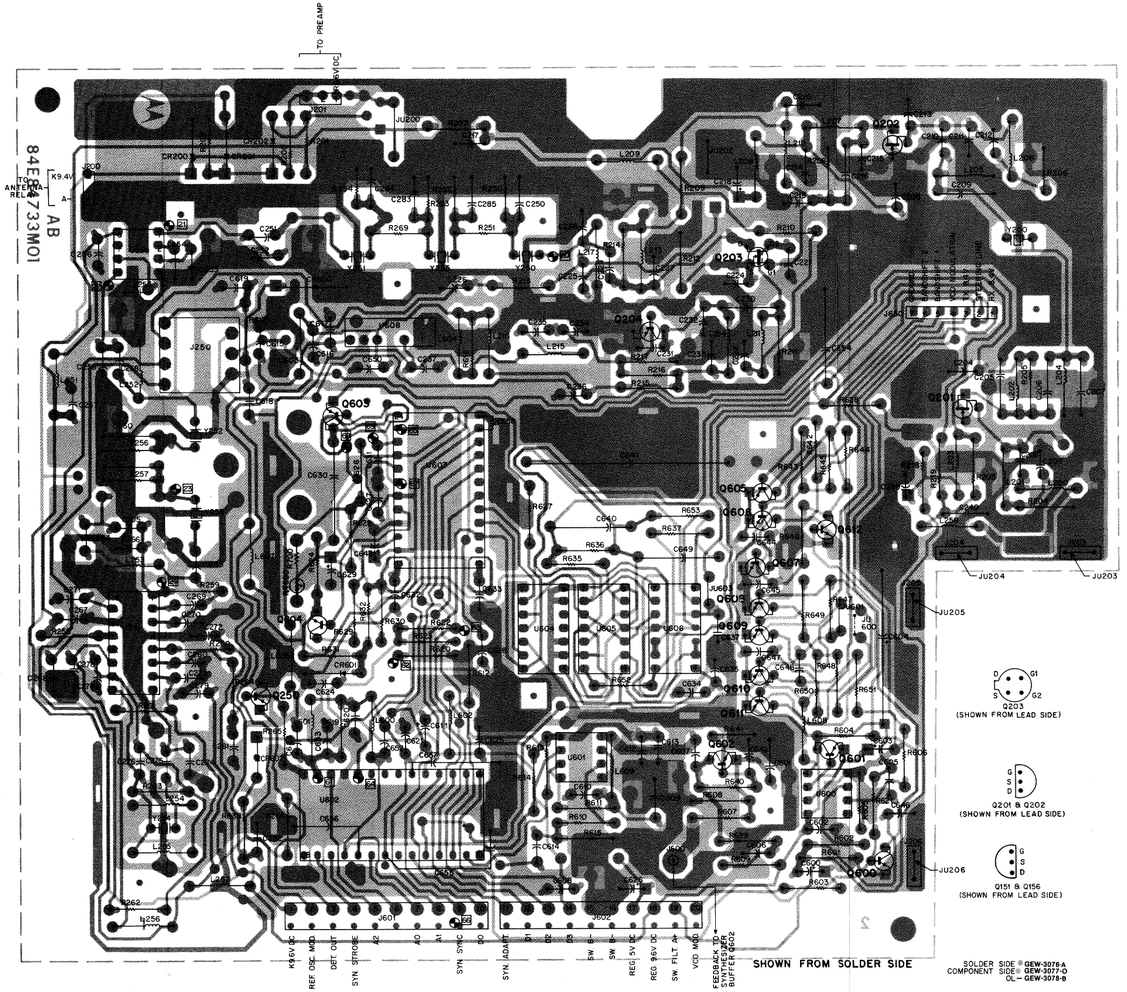
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R625	06–11009C44	620
R627	06–11009C57	2.2k
R628	06–11009C49	1k
R629	06–11009C01	10
R630	06–11009C56	2k
R631	06–11009C67	5.6k
R632	06–11009C59	2.7k
R635	06–11009C75	12k
R636	06–11009C56	2k
R637	06–11009C57	2.2k
R638	06–11009C53	1.5k
R639	06–11009C17	47
R640	06–11009C69	6.8k
R641	06–11009C66	5.1k
R642	06–11009C65	4.7k
R643	06–11009C19	56
R644	06–11009C65	4.7k
R645,646	06–11009C53	1.5k
R647	06–11009C71	8.2k
R648	06–11009C73	10k
R649	06–11009C49	1k
R650	06–11009C73	10k
R651	06–11009C49	1k
R652	06–11009D11	360k
R653	06–11009C77	15k
R700	06–11009C51	1.2k
integrated circuit (see note)		
U600	51–84768F65	noise filter
U601	51–84768F68	prescaler
U602	51–83977M18	phase detector
U602	51–84768F63	synthesizer
U603	51–83977M36	phase detector
U604	51–80072C01	2 input NAND gate
U605	51–80073C02	quad switch
U606	51–80073C03	quad switch
U608	51–80291B02	reference oscillator (KXN1096A)
mechanical parts		
	05–82050H12	eye lug
	26–84898M01	circuit board shield, 2 used
	26–83594M01	component side shield, 4 used
	26–83595M01	detector component side shield
	26–83597M01	prescaler component side shield
	26–83814M01	fence shield
	75–05295B01	crystal pad
	01–80707T22	shield & strap assembly
	01–80707T23	shield & strap assembly

11/1/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

- 7400 TTL

HLN5377A RF BOARD RANGE 1



Schematic, Circuit Board Diagram, and Parts List for HLN5377A RF Board (Synthesizer)
PW–5994–O
(Sheet 2 of 2)
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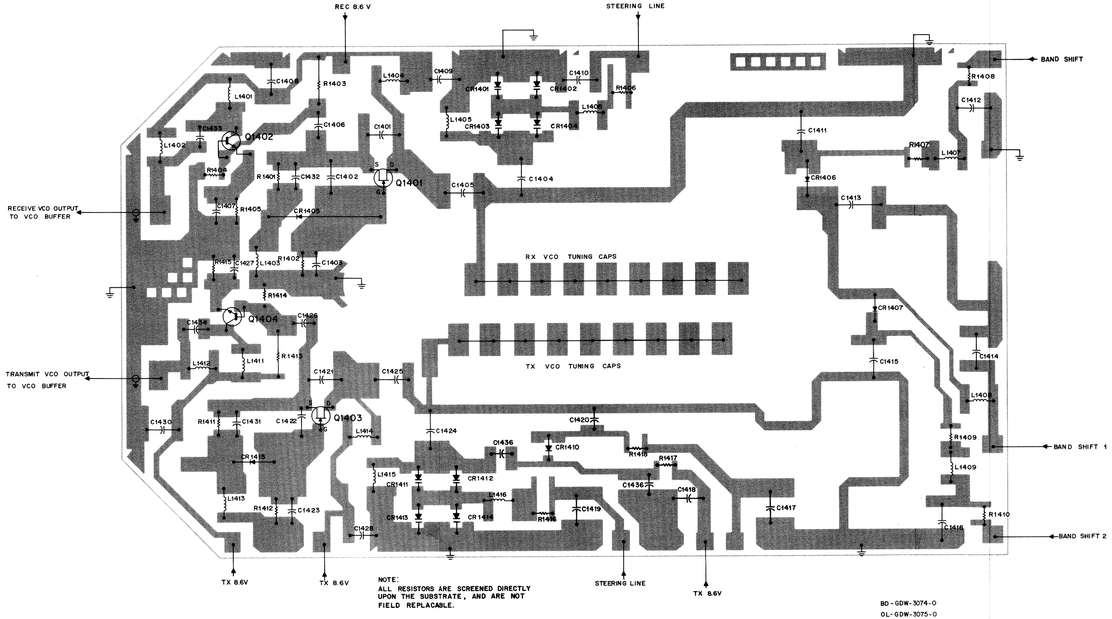
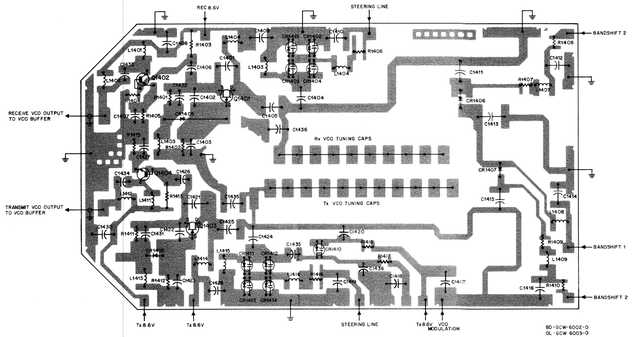
VCO AND VCO CARRIER RANGE 1 AND 2

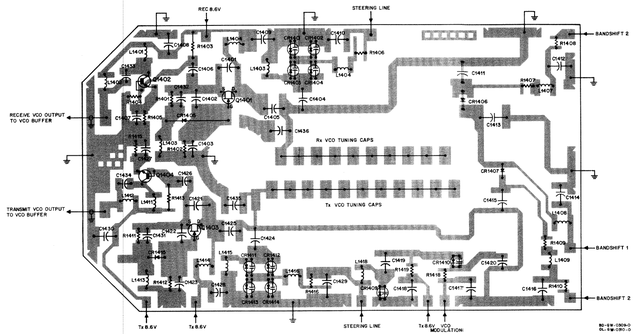
HLD4318A VCO RANGE 2



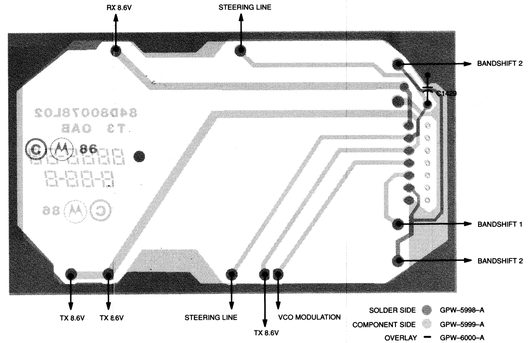
HLD4336A VCO RANGE 1



HLD4133A VCO RANGE 1



VCO CARRIER BOARD



Circuit Board Diagrams and
Parts Lists for VCO and VCO Carrier
PW–5997–O
(Sheet 1 of 2)
11/10/88

parts list

HLD4318A VCO R2 — MXW–5099–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C1401	21–11078B19	16
C1402	21–11078B20	18
C1403	21–84873H13	1000
C1404	21–11078B23	24
C1405	21–11078B19	16
C1406	21–11078A01	1, ±.25 pF
C1407–1408	21–84547A01	1000, ±20%, 50V
C1409–1412	21–84873H14	560
C1413	21–84873H13	1000
C1414–1415	21–84873H14	560
C1416–1419	21–84547A01	1000, ±20%, 50V
C1420	21–11078A15	2.7, ±.25 pF
C1421–1422	21–11078B20	18
C1423	21–84873H13	1000
C1424	21–11078B32	39
C1425	21–11078B21	20
C1426	21–11078A06	1.5, ±.25 pF
C1427–1428	21–84547A01	1000, ±20%, 50V
C1429	21–83162H36	.01, 50V
C1430–1431	21–84547A01	1000, ±20%, 50V
C1432	21–84873H14	560
C1433–1434	21–84873H75	7, ±.25 pF, 50V
C1435–1436	21–11078A15	2.7, ±.25 pF
diode (see note)		
CR1402–1404	48–80006E10	varactor
CR1406–1407	48–84622E02	silicon
CR1409–1414	48–80006E10	varactor
coil		
L1401	24–80140E06	130 nH
L1402	24–80140E01	1.2 uH
L1403	24–80140E07	680 nH
L1404	24–80140E08	1.5 uH
L1405–1408	24–80140E01	1.2 uH
L1409	24–80140E02	1.8 uH
L1411	24–80140E06	130 nH
L1412	24–80140E02	1.8 uH
L1413	24–80140E01	1.2 uH
L1414–1416	24–80140E02	1.8 uH
transistor (see note)		
Q1401	48–84939C30	FET, type M39C30
Q1402	48–84939C32	NPN, type 39C32
Q1403	48–84939C30	FET, type 39C30
Q1404	48–84939C32	NPN, type 39C32
	mechanical parts	
	07–80162D01	frame

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note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

parts list

HLD4336A *SYNTOR X* VHF VCO (Range 1) — MXW–6001–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C1401	21–11078B19	16
C1402	21–11078B20	18
C1403	21–84873H13	1000
C1404	21–11078B26	28
C1405	21–11078B19	16
C1406	21–11078A06	1.5, ±.25 pF
C1407,1408	21–13741N21	.001 uF, ±10%, 50V
C1409–1412	21–13740C11	560, 50V
C1413	21–84873H13	1000
C1414,1415	21–13740C11	560, 50V
C1416–1418	21–13741N21	.001 uF, ±10%, 50V
C1420	21–11078A21	4.7, ±.25 pF
C1421	21–11078B20	18
C1422	21–11078B22	22
C1423	21–84873H13	1000
C1424	21–11078B36	56
C1425	21–11078B21	20
C1426	21–11078A06	1.5, ±.25 pF
C1427–1431	21–13741N21	.001 uF, ±10%, 50V
C1432	21–13740C11	560, 50V
C1433,1434	21–84873H75	7, ±.25 pF, 50V
C1435,1436	21–11078A21	4.7, ±.25 pF
C1437	21–11078B01	3.3, ±.25 pF
C1438	21–11078B05	4.7, ±.25 pF
diode (see note)		
CR1401–1404	48–80006E10	varactor
CR1405	48–84616A11	hot carrier
CR1406	48–84622E02	silicon
CR1407	48–84622E02	silicon
CR1410–1414	48–80006E10	varactor
CR1415	48–84616A11	hot carrier
coil, RF, uH		
L1401	24–80140E06	.13
L1402	24–80140E01	1.2
L1403	24–80140E07	.68
L1404	24–80140E08	1.5
L1405–1408	24–80140E01	1.2
L1409	24–80140E02	1.8
L1411	24–80140E06	.13
L1412	24–80140E02	1.8
L1413	24–80140E01	1.2
L1414–1416	24–80140E02	1.8
transistor (see note)		
Q1401	48–84939C30	FET, N–channel
Q1402	48–84939C32	NPN
Q1403	48–84939C30	FET, N–channel
Q1404	48–84939C32	NPN

11/1/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

parts list

HLD4133A R1 VCO — MXW–3547–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C1401	21–11078B19	16
C1402	21–11078B20	18
C1403	21–84873H13	1k
C1404	21–11078B26	28
C1405	21–11078B19	16
C1406	21–11078A06	1.5, ±.25pF
C1407,1408	21–84547A01	1k, ± 20%, 50V
C1409–1412	21–84873H14	560
C1413	21–84873H13	1k
C1414,1415	21–84873H14	560
C1416–1419	21–84547A01	1k, ± 20% 50V
C1420	21–84873H94	24, 50V
C1421	21–11078B20	18
C1422	21–11078B22	22
C1423	21–84873H13	1k
C1424	21–11078B36	56
C1425	21–11078B21	20
C1426	21–11078A06	1.5, ±.25pF
C1427–1431	21–84547A01	1k, ± 20% 50V
C1432	21–84873H14	560
C1433,1434	21–84873H75	7, ±.25pF, 50V
C1435	21–11078B05	4.7, ±.25pF
C1436	21–11078B01	3.3, ±.25pF
diode (see note)		
CR1401–1404	48–80006E10	varacter
CR1405	48–84616A11	hot carrier
CR1406,1407	48–84622E02	silicon
CR1409–1414	48–80006E10	varacter
CR1415	48–84616A11	hot carrier
coil, rf		
L1401	24–80140E06	130 nH
L1402	24–80140E01	1.2 uH
L1403	24–80140E07	680 nH
L1404	24–80140E08	1.5 uH
L1405–1408	24–80140E01	1.2 uH
L1409	24–80140E02	1.8 uH
L1411	24–80140E06	130 nH
L1412	24–80140E02	1.8 uH
L1413	24–80140E01	1.2 uH
L1414–1416	24–80140E02	1.8 uH
L1418	24–80140E02	1.8 uH
transistor (see note)		
Q1401	48–84939C30	FET, type 39C30
Q1402	48–84939C32	NPN, type 39C32
Q1403	48–84939C30	FET, type 39C30
Q1404	48–84939C32	NPN, type 39C32

04/30/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

VCO AND VCO CARRIER RANGE 1 AND 2

Circuit Board Diagrams and
Parts Lists for VCO and VCO Carrier
PW–5997–O
(Sheet 2 of 2)
11/10/88

VCO BUFFER RANGE 1 AND 2

parts list

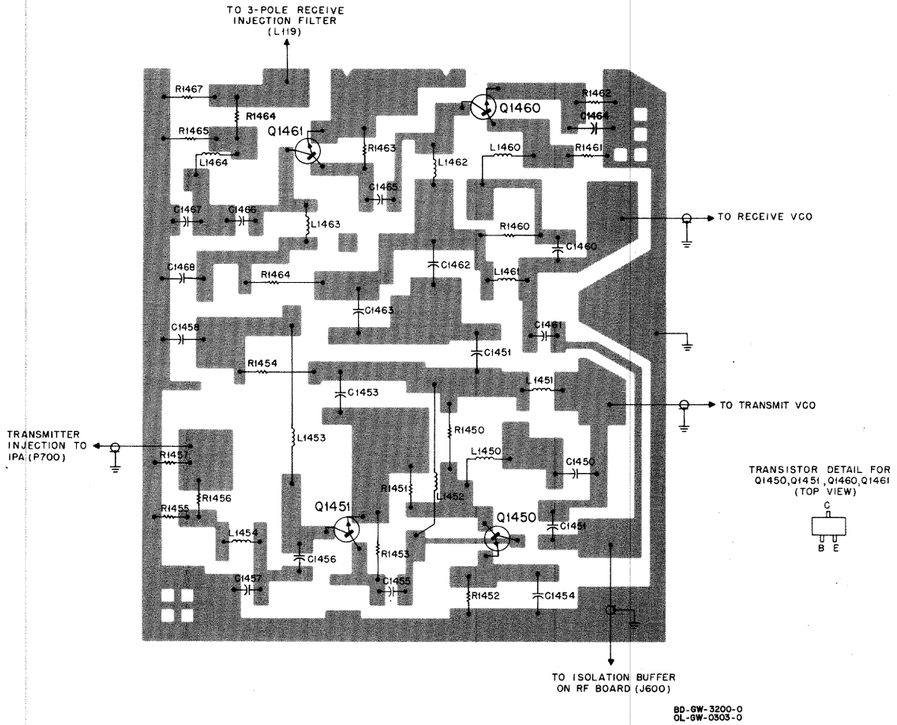
HKN4067A VCO Buffer Cable (Range 1 and 2) — MXW–3167–C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	37–00132251	heat sink tubing
	05–00136977	eyelet
	28–82365D02	coax
	37–00134165	heat sink tubing
	76–83466K01	ferrite core
	22–00400055	staple
	54–80072G01	circuit board label

11/10/88

Circuit Board Diagrams and Parts Lists for VCO Buffer
PW–6004–O
11/10/88

HLN4521A VCO BUFFER RANGE 1



parts list

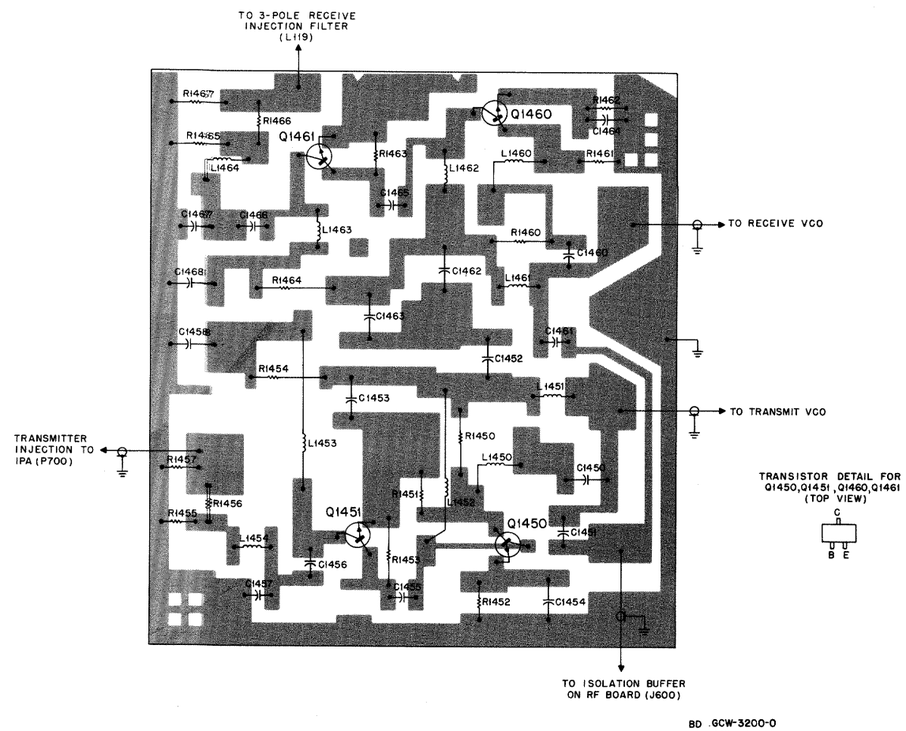
HLN4521A R1 VCO Buffer — MXW–3645–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C1450	21–84873H14	560
C1451	21–84873H60	2.7, ±.25pF
C1452	21–84873H14	560
C1453	21–84547A24	1k, +20%, 25V
C1454	21–84873H14	560
C1455	21–84873H97	15, 25V
C1456	21–84873H63	39
C1457	21–84873H90	22, ±2%
C1458	21–84873H14	560
C1460	21–84873H98	330, +10%
C1461	21–84873H60	2.7, ±.25pF
C1462	21–84873H14	560
C1463	21–84547A24	1k, +20%, 25V
C1464	21–84873H14	560
C1465	21–84873H76	10
C1466,1467	21–05157A23	8.2, ±.5 pF
C1468	21–84873H14	560
coil, rf		
L1450	24–80091G07	airwound
L1451	24–80140E02	1.8 uH
L1452	24–82723H48	.085 uH
L1453	24–82723H22	150 nH
L1454	24–80140E03	50 nH
L1460	24–80091G07	airwound
L1461	24–80140E01	1.2 uH
L1462,1463	24–80140E04	65 nH
L1464	24–80091G17	airwound
transistor (see note)		
Q1450	48–84939C32	NPN type 39C32
Q1451	48–84939C31	NPN type 39C31
Q1460	48–84939C32	NPN type 39C32
Q1461	48–84939C31	NPN type 39C31

04/30/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

HLN4249A VCO BUFFER RANGE 2



parts list

HLN4249A R2 VCO Buffer — MXW–3081–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C1450	21–84873H14	560
C1451	21–84873H60	2.7, ±.25 pF
C1452	21–84873H14	560
C1453	21–84547A24	.1, ±20%,25V
C1454	21–84873H14	560
C1455	21–84873H97	15, 25V
C1456–1457	21–05157A23	8.2, ±.5 pF
C1458	21–84873H14	560
C1460	21–84873H98	330, ±10%
C1461	21–84873H60	2.7, ±.25 pF
C1462	21–84873H14	560
C1463	21–84547A24	.1, ±20%, 25V
C1464	21–84873H14	560
C1465	21–84873H76	10, 50V
C1466–1467	21–05157A23	8.2, ±.5 pF
C1468	21–84873H14	560
coil		
L1450	24–80091G07	airwound
L1451	24–80140E02	1.8 uH
L1454	24–80140E03	50 nH
L1460	24–80091G07	airwound
L1461	24–80140E01	1.2 uH
L1462–1463	24–80140E04	65 nH
L1464	24–80091G17	airwound
transistor (see note)		
Q1450	48–84939C32	NPN, type 39C32
Q1451	48–84939C31	NPN, type 39C31
Q1460	48–84939C32	NPN, type 39C32
Q1461	48–84939C31	NPN, type 39C31
	mechanical parts	
	64–84854M03	buffer plate

11/10/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

1. Description

The *SYNTOR X* radio is a dual–conversion radio with intermediate frequencies of 53.9 MHz and 10.7 MHz. The factory–tuned preselector filter is wide enough to accommodate all frequencies in the receiver bandwidth without retuning.

The receiver circuits are in the RF internal casting, on the RF board, on the personality board, and on the common circuits board.

2. Theory of Operation

2.1 INTRODUCTION

The *SYNTOR X* radio does not use channel elements to generate the first mixer injection frequency. Instead, it applies the frequency synthesizer RF output to the first mixer via a three–pole injection filter. The first mixer, a balanced JFET (junction field–effect transistor) device, uses high–side injection for Range 1 and low–side injection for Range 2 to generate a first intermediate frequency (IF) of 53.9 MHz.

The 53.9–MHz IF signal is coupled from the first mixer to the RF board via P/J203, and is then applied to the first IF amplifier. This amplifier uses a JFET device in a common–gate configuration. The amplified output signal passes through a 53.9–MHz two–pole crystal filter and is then applied to a second IF amplifier so that it is strong enough to drive the second mixer.

The output of the frequency synthesizer's 14.4–MHz reference oscillator is split and part of the signal is applied to the injection tripler. The injection tripler uses a Class C bipolar transistor amplifier to generate the required harmonics. The injection tripler output is tuned at a fixed injection frequency of 43.2 MHz. The second mixer uses the two input signals to generate a second intermediate frequency of 10.7 MHz. Low–side injection is also used in the second mixer.

2.2 SECOND IF CIRCUITRY

The second IF circuitry uses several stages of filtering and amplification. Selective IF filtering is done with dual–resonator, mode–coupled monolithic crystals cut to a fundamental frequency of 10.7 MHz. No tuning is required in the second IF or detector circuitry.

The second mixer's output is applied to the four–pole filter (Y250 and Y251) via a matching network, and the output of the first six–pole filter is applied to a matching network and then to a high–gain (approximately 45 dB) second IF amplifier (U250). The output of the second IF amplifier is applied to a matching network, a four–pole filter (Y252 and Y253), a final matching circuit, and the limiter/detector (U251).

2.3 LIMITER/DETECTOR

The limiter/detector (U251) generates a limiting function and a means for recovering audio from the frequency–modulated carrier. Audio is recovered from the second IF signal by means of a quadrature detector in the limiter/detector

and an external two–pole dual–resonator crystal. The recovered audio from the limiter/detector output passes through an emitter–follower buffer (Q250) and then goes to the audio stages on the personality board (via the personality board and the control head). The detector buffer supplies approximately 650 millivolts rms to the control head.

2.4 AUDIO AND SQUELCH

Detected audio goes to the optional PL/DPL circuitry and then to the control head for application to the volume and squelch controls. The adjustable outputs of these voltage dividers are then routed to the radio for application to the respective audio and squelch circuits.

The incoming signals are buffered and filtered by the PL–filter/audio–shaping stages to remove any receive PL tones. These stages consist of quad operational amplifier U440 and associated circuitry up to the input of the audio driver (U441). The audio power amplifier consists of audio driver U441, the driver transistor pairs, and the Class B

complementary audio finals, Q448 and Q449. The audio power amplifier amplifies the filtered audio signals, and the amplified audio signal is then transformer–coupled to the external speaker. The transmit time–out–timer tone and any tones from the Systems 90 board are also injected at the input of the audio power amplifier stage.

Squelch muting is controlled at two points: at series–connected FET Q442 in the PL filter and shunt transistor Q441 on the volume wiper line. Q442 is used for squelch muting as well as for muting in the priority *Channel Scan* mode while the priority channel is being sampled. The MUTE line drives not only transistor Q441, but also the audio driver enable switch, Q447. When the audio driver is disabled, the bias cur rent to the audio finals is removed, thus reducing substantially the current drawn by the radio in the standby mode.

2.5 SQUELCH OPERATION

The squelch control on the control head varies the signal level of the buffered detector output. This signal, a combination of noise and recovered audio, is shaped by the squelch circuitry, which has good squelch characteristics because of:

- A high–pass filter ahead of the first amplifier to attenuate the audio frequencies to a specific level.
- Capacitors C403 and C404, which attenuate noise at frequencies above 22 kHz to leave a band of noise susceptible to detection.
- An input network to the detector that further attenuates audio and any harmonics generated by audio limiting at the output of the second amplifier/limiter.

The filtered noise is routed to a positive–peak detector, which adds negative–going spikes at its output. These spikes are forwarded to the integrator and the variable squelch–tail–control circuitry. The integrator compares the average DC level of the detector's output with a reference level and generates a fast–responding output signal, VO, as follows: VO is greater than 4.5 V for squelched, and less than 4.5 V for unsquelched.

The detector's output also goes to Q402 via a dual–time–constant network consisting of R416, CR403, and R417. If the signal is weak, or in the absence of a signal, the noise spike rate becomes high enough to keep C410 discharged below the turn–on volt age of Q402. The collector of Q402 therefore has a potential of +9.6 V. When the signal level increases, Q402 turns on and its collector voltage, VO, begins to decrease. With a strong signal, the collector voltage reaches a minimum level of approximately 4 V. For a given level at the integrator output, the voltage across C411 varies directly with VO of Q402.

Q403 generates an output signal (SQUELCH TAIL) that is a delayed and inverted version of the integrator output. The microcomputer mutes the audio when the SQUELCH TAIL signal goes low (0 V) and unmutes the audio when the signal goes high (4.8 V). The Q403 turn–on voltage at the node between R418 and R422 is approximately 4.5 V. This voltage is determined by the 9.6 V supply, R420, C411, and the dual–time–constant network comprised of R418, R419, and CR404.

With loss of signal, the greater the voltage across C411, the longer it takes the node voltage (R418 and R422) to increase above 4.5 V, and thus the longer the SQUELCH TAIL signal remains high after loss of signal. Since C411 charges through R419 and CR404, the SQUELCH TAIL detect time is very short. The integrator output is inverted by Q404 and supplied as a CHANNEL ACTIVITY signal. This is a fast–responding output signal that is used only in *Channel Scan* operation.

2.6 RECEIVER METERING SOCKET

Use the receiver metering socket (J250) to monitor the performance of the receiver as follows:

- MS1 (Pin 1 of the metering socket) shows the IF signal frequency relative to the center frequency of the quadrature detector.

Note

This should not be used for "warping" the radio onto frequency.

- MS2 shows the level of the IF signal at the in put of the limiter/detector.
- MS3 shows the second mixer bias current, the proper injection level, and the high–level RF signals at the second mixer output.
- MS4 shows the strength of the 14.4–MHz signal generated by the reference oscillator.
- MS5 shows the DC current to the first mixer.

When making 20 dB quieting measurements on a radio equipped with internal scan (W422 or W492), use the following procedure:

(1) Unsquelch the radio and set the volume control so that there is 5.5 volts RMS of noise at the speaker.

(2) Squelch the radio.

(3) Turn the generator on at one of the scan frequencies. The radio should stop scanning.

(4) Adjust the RF level until there is .55 volt RMS of noise at the speaker (20 dBq).

3. Receiver Troubleshooting Procedure

This procedure finds the cause of a loss of receiver sensitivity. Use equipment from the list of recommended test equipment in the Maintenance and Troubleshooting Section of this manual when performing it.

(1) Perform the preliminary checks of Table 1. If all the meter indications are correct, go to Step 2.

(2) Apply a 20–millivolt signal to the antenna connector. If the meter indication at J250–3 rises above 35 mA, check the low–IF amplifiers, filters, and quadrature detector.

Note

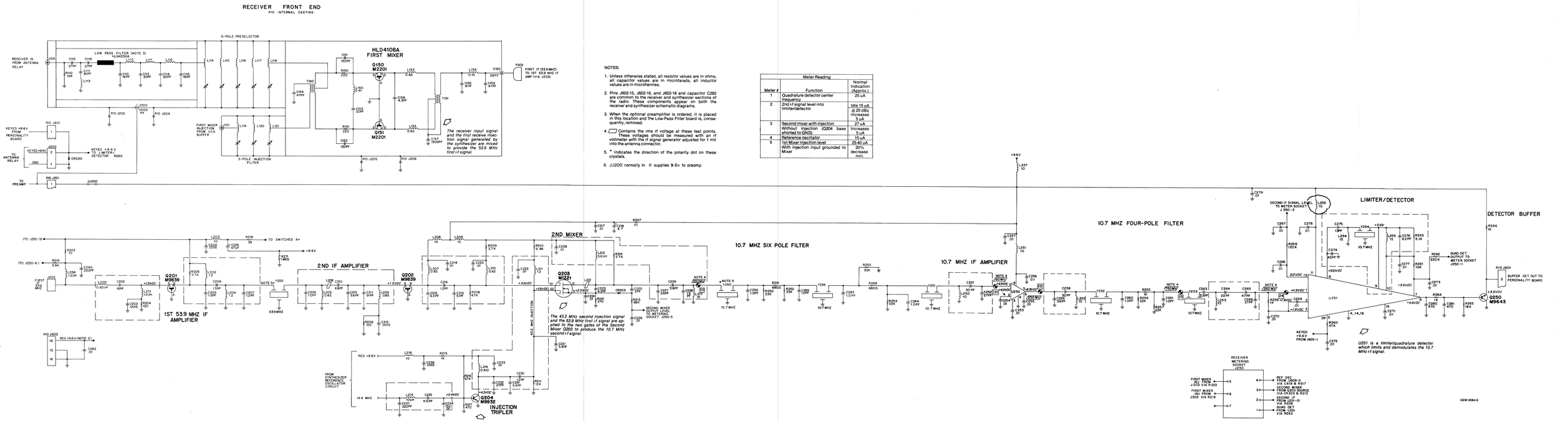
Use the meter voltages, RF voltages, and DC voltages shown on the receiver schematic diagram at the end of this section when troubleshooting the low–IF amplifiers and detector.

(3) If the meter indication at J250–3 is less than 35 mA, check the DC voltages of the high IF (Q201, Q202, Q203, and Q204).

Table 1. Receiver Preliminary Checks

METERING SOCKET PIN	NORMAL INDICATION	IF INDICATION IS INCORRECT
J250–1	25 ±5 uA.	Check the low IF and quad detector. See Note after step 2.
J250–2	a. (without signal): 20 ±5 uA. b. (with 20dB quieting signal): should be 2 to 5 uA above first signal.	Go to step 2 of section 3.
J250–3	a. 27 ±5 uA. b. (when Q204 base is shorted): should drop DC voltages 2–3uA.	a. Check Q203 DC voltages. b. Check Q203 and Q204
J250–4	Greater than 10 uA.	Check reference oscillator output level.
J250–5	a. 10–20 uA Range 1, Range 2. b. Shorted (injection filter output to ground): should drop at least 20%.	a. Check first mixer 25–40 uA for proper DC voltage. b. Insufficient low filter output drive; check VCO and buffer.

HLN5169A RF BOARD



Schematic, Circuit Board Diagram, and Parts List for Receiver Section
PW-3083-B
(Sheet 1 of 2)
11/11/88

parts list

HLN5169A RF Board (Receiver Section) — MXW–5491–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pf, ±5%, 100V (unless otherwise stated)*		
C202	21–11014H30	16
C203–204	08–11051A02	.0015 uF, 63V
C205–206	21–82450B13	1.5, 500V
C207	21–82450B08	1.2, 500V
C209	21–82450B47	1.0, 500V
C210	21–11014N14	6.8, ±.5 pF
C211	21–11014H48	91
C212	21–11015B15	1.5k, ±10%
C213	21–11014H19	5.6, ±.5 pF
C214	08–11051A07	.01 uF, 63V
C215	21–11014H20	6.2, ±.5 pF
C216	21–82450B08	1.2, 500V
C217	08–11051A07	.01 uF, 63V
C218	23–11013D55	4.7 uF, ±20%, 20V, tantalum
C219	21–11014H18	5.1, ±.5 pF
C220	08–11051A07	.01 uF, 63V
C221	21–11014H19	5.6, ±.5 pF
C222	08–11051A07	.01 uF, 63V
C223	21–11014H16	4.3, ±.25 pF
C224	08–11051A07	.01 uF, 63V
C225	21–11014H08	2, ±.25 pF
C226	08–11051A07	.01 uF, 63V
C227	21–11014H34	24
C228	08–11051A07	.01, 63V
C229	21–11014H19	5.6, ±.5 pF
C230	21–82450B08	1.2, 500V
C231	21–11014H19	5.6, ±.5 pF
C232	21–11014H36	30
C233	08–11051A07	.01 uF, 63V
C234	21–11015B03	150, ±10%
C235	21–80067A30	11.5, ±2.5%, 500V
C236	08–11051A02	.0015 uF, 63V
C237	21–11015B05	220, ±10%
C238	21–11014H22	7.5, ±.5 pF
C239	23–84538G06	47 uF, ±20%, 20V, tantalum
C240	21–11015B05	220, ±10%
C250	21–82450B47	1.0, 500V
C251	21–11014H36	30
C252	21–11014H35	27
C253–255	08–11051A07	.01 uF, 63V
C256	08–11051A13	.1 uF, 63V
C257	08–11051A07	.01 uF, 63V
C258	21–11014H36	30
C259	21–11014H39	39
C260–261	21–82450B47	1.0, 500V
C263	21–11014H13	3.3, ±.25 pF
C264	21–11014H33	22
C265	21–11014H41	47
C266	21–11014H35	27
C267–273	08–11051A07	.01 uF, 63V
C274	21–11014H40	43
C275	21–11014H28	13
C276	21–11014H20	6.2, ±.5 pF
C277	08–11051A07	.01 uF, 63V
C278	08–11051A13	.1 uF, 63V
C279	08–11051A07	.01 uF, 63V
C280–281	21–11015B09	470, ±10%
C282	08–11051A07	.01 uF, 63V
C283–285	21–82450B47	1.0, 500V
diode (see note)		
CR200	48–83654H01	silicon
CR203	48–83654H01	silicon
connector receptacle		
J200	28–84324M01	2 contact, polarized
J201	28–84324M02	3 contact, polarized
J202–206	42–83891L01	mixer clip
J250	09–84207B01	7 contact
jumper		
JU200	06–11009D23	0 ohm
coil, RF		
L200	24–83397L13	.82 uH gray–red
L201–202	24–83397L12	1.2 uH white
L203	24–82723H45	10.0 uH blue–red
L204	24–83397L12	1.2 uH white
L205	24–83397L13	.82 uH gray–red
L206	24–82723H48	.085 uH blue–orange
L207	24–83397L13	.82 uH gray–red
L208–209	24–82723H45	10.0 uH blue–red
L210	24–83397L13	.82 uH gray–red
L211	24–83397L12	1.2 uH white
L212	76–83960B01	ferrite bead
L213	24–82835G41	5.6 uH green–blue–gold
L214	24–82723H36	.41 uH yellow
L215	24–83397L07	10 uH blue–blue
L216	24–82723H45	10.0 uH blue–red
L217	24–83397L08	15 uH gray–gray
L218	76–83960B01	ferrite bead
L250	24–83397L07	10 uH blue–blue
L251	24–82723H45	10.0 uH blue–red
L252	24–83397L07	10 uH blue–blue
L253–255	24–82549D24	15 uH
L256–257	24–82723H45	10.0 uH blue–red
L258	24–83397L12	1.2 uH white

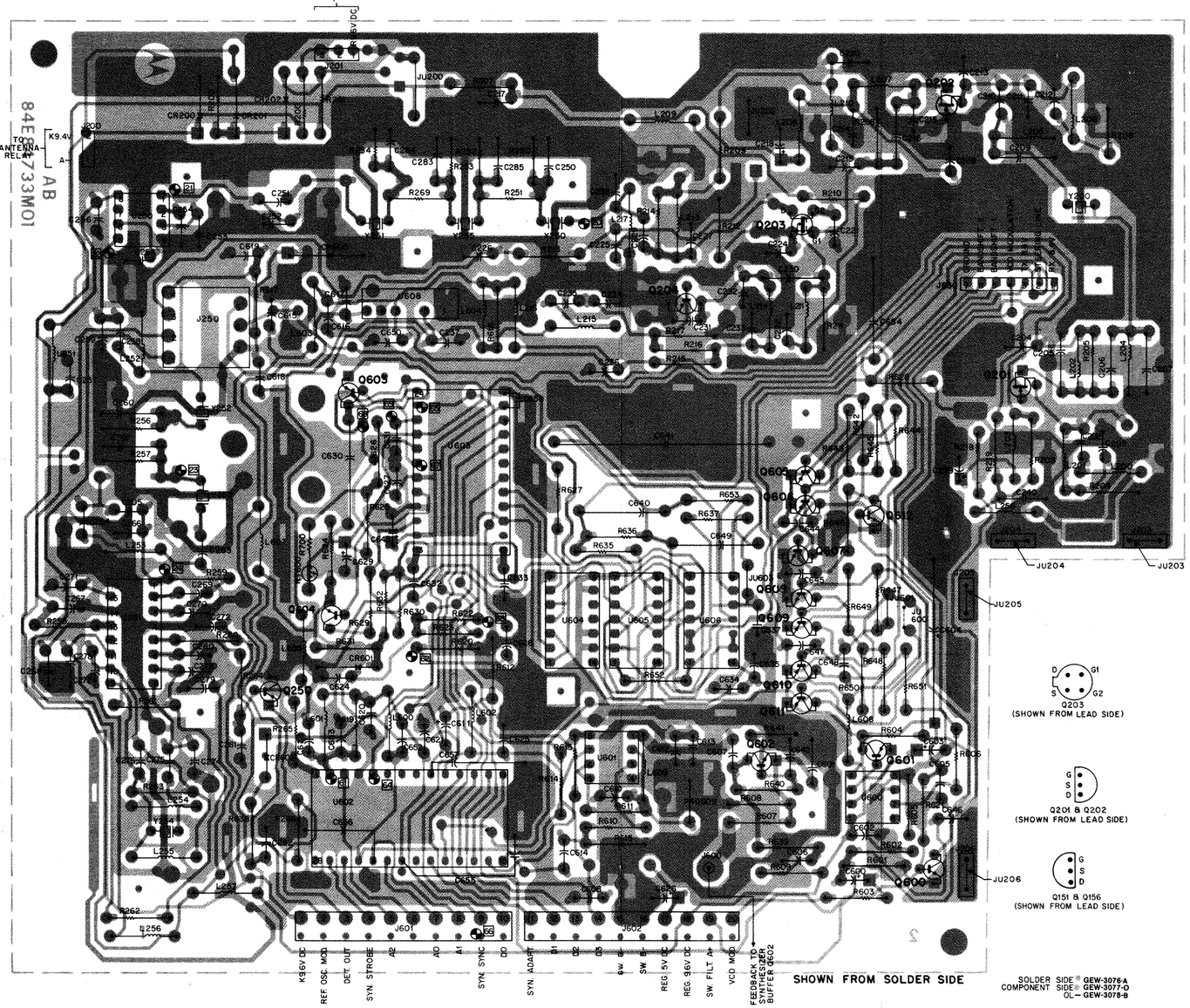
MXW–5491–O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
transistor (see note)		
Q201–202	48–00869839	FET, N–channel, type M9839
Q203	48–84412L21	FET, type 12L21
Q204	48–00869932	PNP, type M9932
Q250	48–00869643	PNP, type M9643
reistor, fixed ohm, ±5%, 1/4W (unless otherwise stated)		
R203	06–11009C01	10
R204	06–11009C27	120
R205	06–11009C59	2.7k
R206	06–11009C27	120
R207	06–11009C01	10
R208	06–11009C65	4.7k
R209	06–11009C59	2.7k
R210	06–11009C69	6.8k
R211	06–11009C75	12k
R212	06–11009C35	270
R213	06–11009C93	68k
R214	06–11009C59	2.7k
R215	06–11009C49	1k
R216	06–11009C65	4.7k
R217	06–11009C41	470
R218	06–11009C15	39
R219	06–11009C63	3.9k
R250	06–11009C85	33k
R251	06–11009C45	680
R252–254	06–11009C85	33k
R255	06–11009C49	1k
R256–257	06–11009C81	22k
R258	06–11009C99	120k
R259	06–11009C49	1k
R260	06–11009C89	47k
R261	06–11009C73	10k
R262	06–11009D06	220k
R263	06–11009C66	5.1k
R264	06–11009C49	1k
R265	06–11009C79	18k
R266	06–11009C49	1k
R269	06–11009C45	680
R271	06–11009D22	1 MEG
integrated circuit (see note)		
U250	51–83977M55	IF amplifier, type M7755
U251	51–80069C05	IF/audio, type M6905
crystal (see note)		
Y200	48–83742M02	crystal filter
Y250	91–80011E04	crystal filter
Y251–254	91–80011E05	crystal filter
Y255	48–84574K03	resonator, 10.7 MHz
	mechanical parts	
	26–84898M01	circuit board shield (2 used)
	26–83594M01	shield, component side (2 used)
	26–83594M01	shiedl, component side (2 used)
	26–83595M01	detector shield, component side
	05–82050H12	eyelet
	75–05295B01	crystal pase pad (2 used)

6/20/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

HLN5169A RF BOARD



Schematic, Circuit Board Diagram, and Parts List for Receiver Section
PW–3083–B
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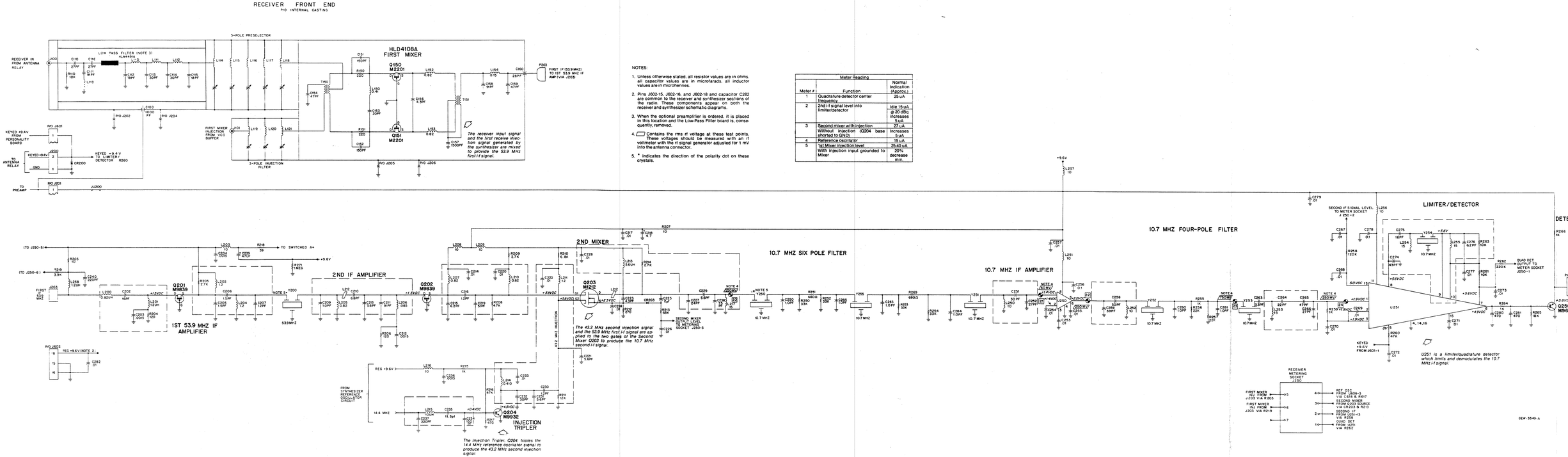
HLN4492A RF BOARD



Schematic, Circuit Board Diagram, and Parts List
for HLN4492A RF Board (Receiver)
PW–3548–O
(Sheet 1 of 2)
11/30/88

parts list

HLN4492A R1 RF Board (Receiver Section) — MXW–3550–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF ±5% 100V (unless otherwise stated)		
C202	21–11014H30	16
C203,204	08–11051A02	.0015 uF, 63V
C205,206	21–82450B13	1.5, 500V
C207	21–82450B08	1.2, 500V
C209	21–82450B47	1.0, 500V
C210	21–11014N14	6.8, ± .5pF, 100V
C211	21–11014H48	91
C212	21–11015B15	1.5k, ±10%
C213	21–11014H19	5.6
C214	08–11051A07	.01 uF, 63V
C215	21–11014H20	6.2
C216	21–82450B08	1.2, 500V
C217	08–11051A07	.01 uF, 63V
C218	23–11013D55	4.7 uF, ±20%, 20V, tantalum
C219	21–11014H18	5.1
C220	08–11051A07	.01 uF, 63V
C221	21–11014H19	5.6
C222	08–11051A07	.01 uF, 63V
C223	21–11014H16	4.3, ±.25pF
C224	08–11051A07	.01 uF, 63V
C225	21–11014H08	2, ±.25pF
C226	08–11051A07	.01 uF, 63V
C227	21–11014H34	24
C228	08–11051A07	.01 uF, 63V
C229	21–11014H19	5.6
C230	21–82450B08	1.2, 500V
C231	21–11014H19	5.6
C232	21–11014H36	30
C233	08–11051A07	.01 uF, 63V
C234	21–11015B03	150, ±10%
C235	21–80067A30	11.5, ±.25pF, 500V
C236	08–11051A02	.0015 uF, 63V
C237	21–11015B05	220, 10%
C238	21–11014H22	7.5
C239	23–84538G06	47 uF, +20%, 20V, tantalum
C240	21–11015B05	220, ±10%
C250	21–82450B47	1.0, 500V
C251	21–11014H36	30
C252	21–11014H35	27
C253–255	08–11051A07	.01 uF, 63V
C256	08–11051A13	.1 uF, 63V
C257	08–11051A07	.01 uF, 63V
C258	21–11014H36	30
C259	21–11014H39	39
C260,261	21–82450B47	1.0, 500V
C263	21–11014H13	3.3, ±.25pF
C264	21–11014H33	22
C265	21–11014H41	47
C266	21–11014H35	27
C267,273	08–11051A07	.01 uF, 63V
C274	21–11014H40	43
C275	21–11014H28	13
C276	21–11014H20	6.2
C277	08–11051A07	.01 uF, 63V
C278	08–11051A13	.1 uF, 63V
C279	08–11051A07	.01 uF, 63V
C280,281	21–11015B09	470, ±10%
C282	08–11051A07	.01 uF, 63V
C283–285	21–82450B47	1.0, 500V
diode (see note)		
CR200,203	48–83654H01	silicon
connector receptacle		
J200	28–84324M01	2–contact, male
J201	28–84324M02	3–contact, male
J202–206	42–83891L01	single contact, female
J250	09–84207B01	7–contact, female
jumper		
JU200	06–11009D23	jumper
coil, rf		
L200	24–83397L13	.82 uH gray/red
L201,202	24–83397L12	1.2 uH white
L203	24–82723H45	10 uH blue/red
L204	24–83397L12	1.2 uH white
L205	24–83397L13	.82 uH gray/red
L206	24–82723H48	.085 uH blue/orange
L207	24–83397L13	.82 uH gray/red
L208,209	24–82723H45	10 uH blue/red
L210	24–83397L13	.82 uH gray/red
L211	24–83397L12	1.2 uH white
L212	76–83960B01	ferrite bead
L213	24–82835G41	5.6 uH green/blue/gold
L214	24–82723H36	.41 uH yellow
L215	24–83397L07	10 uH blue/blue
L216	24–82723H45	10 uH blue/red
L217	24–83397L08	15 uH gray/gray
L218	76–83960B01	ferrite bead
L250	24–83397L07	10 uH blue/blue
L251	24–82723H45	10 uH blue/red
L252	24–83397L07	10 uH blue/blue
L253	24–83397L08	15 uH gray/gray
L254,255	24–82549D24	15 uH
L256,257	24–82723H45	10 uH blue/red
L258	24–83397L12	1.2 uH white

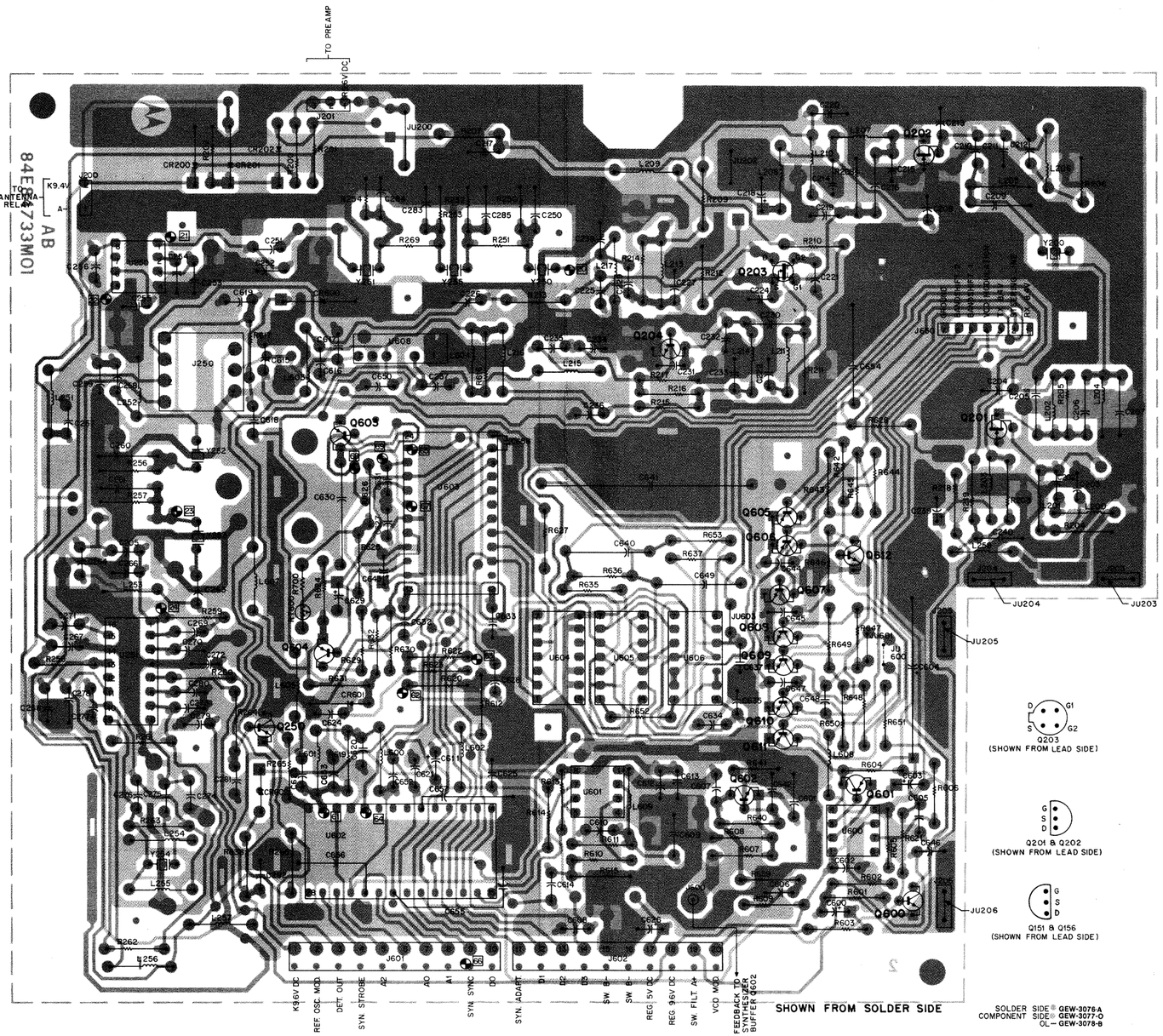
MXW–3550–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
transistor (see note)		
Q201–202	48–00869839	FET, N–channel, type M9839
Q203	48–84412L21	dual gate, type FE 12L21
Q204	48–00869932	NPN, type M9932
Q250	48–00869643	PNP, type M9643
resistor, fixed, ohm ±5%, 1/4 watt (unless otherwise stated)		
R203	06–11009C01	10
R204	06–11009C27	120
R205	06–11009C59	2.7k
R206	06–11009C27	120
R207	06–11009C01	10
R208	06–11009C65	4.7k
R209	06–11009C59	2.7k
R210	06–11009C69	6.8k
R211	06–11009C75	12k
R212	06–11009C35	270
R213	06–11009C93	68k
R214	06–11009C59	2.7k
R215	06–11009C49	1k
R216	06–11009C65	4.7k
R217	06–11009C41	470
R218	06–11009C15	39
R219	06–11009C63	3.9k
R250	06–11009C85	33k
R251	06–11009C45	680
R252–254	06–11009C85	33k
R255	06–11009C49	1k
R256,257	06–11009C81	22k
R258	06–11009C99	120k
R259	06–11009C49	1k
R260	06–11009C89	47k
R261	06–11009C73	10k
R262	06–11009D06	220k
R263	06–11009C66	5.1k
R264	06–11009C49	1k
R265	06–11009C79	18k
R266	06–11009C49	1k
R269	06–11009C45	680
R271	06–11009D22	1MEG
integrated circuit (see note)		
U250	51–83977M55	IF amplifier
U251	51–80069C05	IF/audio
crystal (see note)		
Y200	48–83742M02	crystal filter
Y250	91–80011E04	crystal filter
Y251–254	91–80011E05	crystal filter
Y255	48–84574K03	crystal coupled resonator
mechanical parts		
	26–84898M01	circuit board shield (2 used)
	26–83594M01	component side shield (4 used)
	26–83595M01	component side detector shield
	05–82050H12	eyelet .089X.093

04/30/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

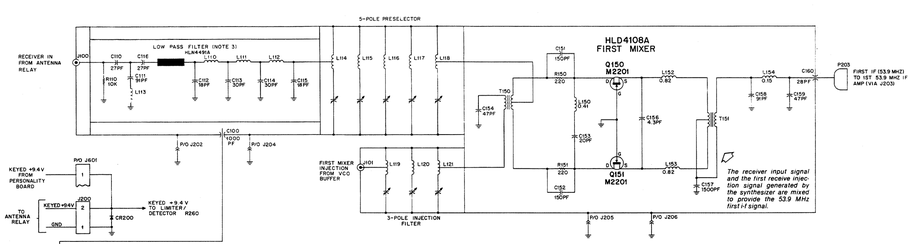
HLN4492A RF BOARD



Schematic, Circuit Board Diagram, and Parts List
for HLN4492A RF Board (Receiver)
PW–3548–O
(Sheet 2 of 2)
11/30/88

HLN5377A RF BOARD

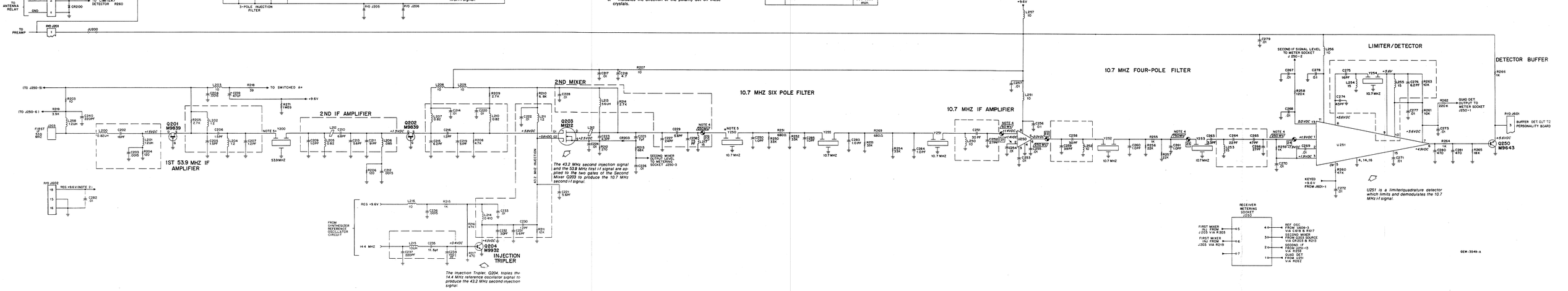
RECEIVER FRONT END
P/O INTERNAL CASTING



NOTES:

1. Unless otherwise stated, all resistor values are in ohms, all capacitor values are in microfarads, all inductor values are in microhenries.
2. Pins J602-15, J602-16, and J602-18 and capacitor C282 are common to the receiver and synthesizer sections of the radio. These components appear on both the receiver and synthesizer schematic diagrams.
3. When the optional preamplifier is ordered, it is placed in this location and the Low-Pass Filter board is, consequently, removed.
4. ▭ Contains the rms rf voltage at these test points. These voltages should be measured with an rf voltmeter with the rf signal generator adjusted for 1 mV into the antenna connector.
5. * indicates the direction of the polarity dot on these crystals.

Meter Reading		
Meter #	Function	Normal Indication (Approx.)
1	Quadrature detector center frequency	25 uA
2	2nd i-f signal level into limiter/detector	Idle 15 uA @ 20 dBq increases 5 uA
3	Second mixer with injection	27 uA
	Without injection (Q204 base shorted to GND)	Increases 5 uA
4	Reference oscillator	15 uA
5	1st Mixer injection level	25-40 uA
	With injection input grounded to Mixer	20% decrease min.



Schematic, Circuit Board Diagram, and Parts List for HLN5377A (Receiver)
PW-6006-O
(Sheet 1 of 2)
11/30/88

parts list

HLN5377A RF Board (Receiver Section) MXW–5996–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C202	21–11014H30	16
C203,204	08–11051A02	.0015 uF, 63V
C205,206	21–82450B13	1.5, 500V
C207	21–82450B08	1.2, 500V
C209	21–82450B47	1, 500V
C210	21–11014N14	6.8, ±.5 pF
C211	21–11014H48	91
C212	21–11015B15	.015 uF, ±10%
C213	21–11014H19	5.6, ±.5 pF
C214	08–11051A07	.01 uF, 63V
C215	21–11014H20	6.2, ±.5 pF
C216	21–82450B08	1.2, 500V
C217	08–11051A07	.01 uF, 63V
C218	23–11013D55	4.7, ±20%, 20V, tantalum
C219	21–11014H18	5.1, ±.5 pF
C220	08–11051A07	.01 uF, 63V
C221	21–11014H19	5.6, ±.5 pF
C222	08–11051A07	.01 uF, 63V
C223	21–11014H16	4.3, ±.25 pF
C224	08–11051A07	.01 uF, 63V
C225	21–11014H08	2, ±.25 pF
C226	08–11051A07	.01 uF, 63V
C227	21–11014H34	24
C228	08–11051A07	.01 uF, 63V
C229	21–11014H19	5.6, ±.5 pF
C230	21–82450B08	1.2, 500V
C231	21–11014H19	5.6, ±.5 pF
C232	21–11014H36	30
C233	08–11051A07	.01 uF, 63V
C234	21–11015B03	150 pF, ±10%
C235	21–80067A30	11.5, ±2.5 pF, 500V
C236	08–11051A02	.0015 uF, 63V
C237	21–11015B05	220, ±10%
C238	21–11014H22	7.5, ±.5 pF
C239	23–84538G06	47 uF, ±20%, 20V, tantalum
C240	21–11015B05	220, ±10%
C250	21–82450B47	1, 500V
C251	21–11014H36	30
C252	21–11014H35	27
C253–255	08–11051A07	.01 uF, 63V
C256	08–11051A13	.1 uF, 63V
C257	08–11051A07	.01 uF, 63V
C258	21–11014H36	30
C259	21–11014H39	39
C260,261	21–82450B47	1, 500V
C263	21–11014H13	3.3, ±.25 pF
C264	21–11014H33	22
C265	21–11014H41	47
C266	21–11014H35	27
C267–273	08–11051A07	.01 uF, 63V
C274	21–11014H40	43
C275	21–11014H28	13
C276	21–11014H20	6.2, ±.5 pF
C277	08–11051A07	.01 uF, 63V
C278	08–11051A13	.1 uF, 63V
C279	08–11051A07	.01 uF, 63V
C280,281	21–11015B09	470, ±10%
C282	08–11051A07	.01 uF, 63V
C283–285	21–82450B47	1, 500V
diode (see note)		
CR200	48–83654H01	silicon
CR203	48–83654H01	silicon
connector receptacle		
J200	28–84324M01	2 contact
J201	28–84324M02	3 contact
J202–206	42–83891L01	mixer clip
J250	09–84207B01	7 contact
jumper		
JU200	06–11009D23	0 ohm
coil, RF, uH		
L200	24–83397L13	.82, gray red
L201,202	24–83397L12	1.2, white
L203	24–82723H45	10, blue red
L204	24–83397L12	1.2, white
L205	24–83397L13	.82, gray red
L206	24–82723H48	.085, blue orange
L207	24–83397L13	.82, gray red
L208,209	24–82723H45	10, blue red
L210	24–83397L13	.82, gray red
L211	24–83397L12	1.2, white
L212	76–83960B01	ferrite
L213	24–82835G41	5.6, green blue gold
L214	24–82723H36	.41, yellow
L215	24–83397L07	10, blue blue
L216	24–82723H45	10, blue red
L217	24–83397L08	15, gray gray
L218	76–83960B01	ferrite
L250	24–83397L07	10, blue blue
L251	24–82723H45	10, blue red
L252	24–83397L07	10, blue blue
L253	24–83397L08	15, gray gray
L254,255	24–82549D24	15
L256,257	24–82723H45	10, blue red
L258	24–83397L12	1.2, white

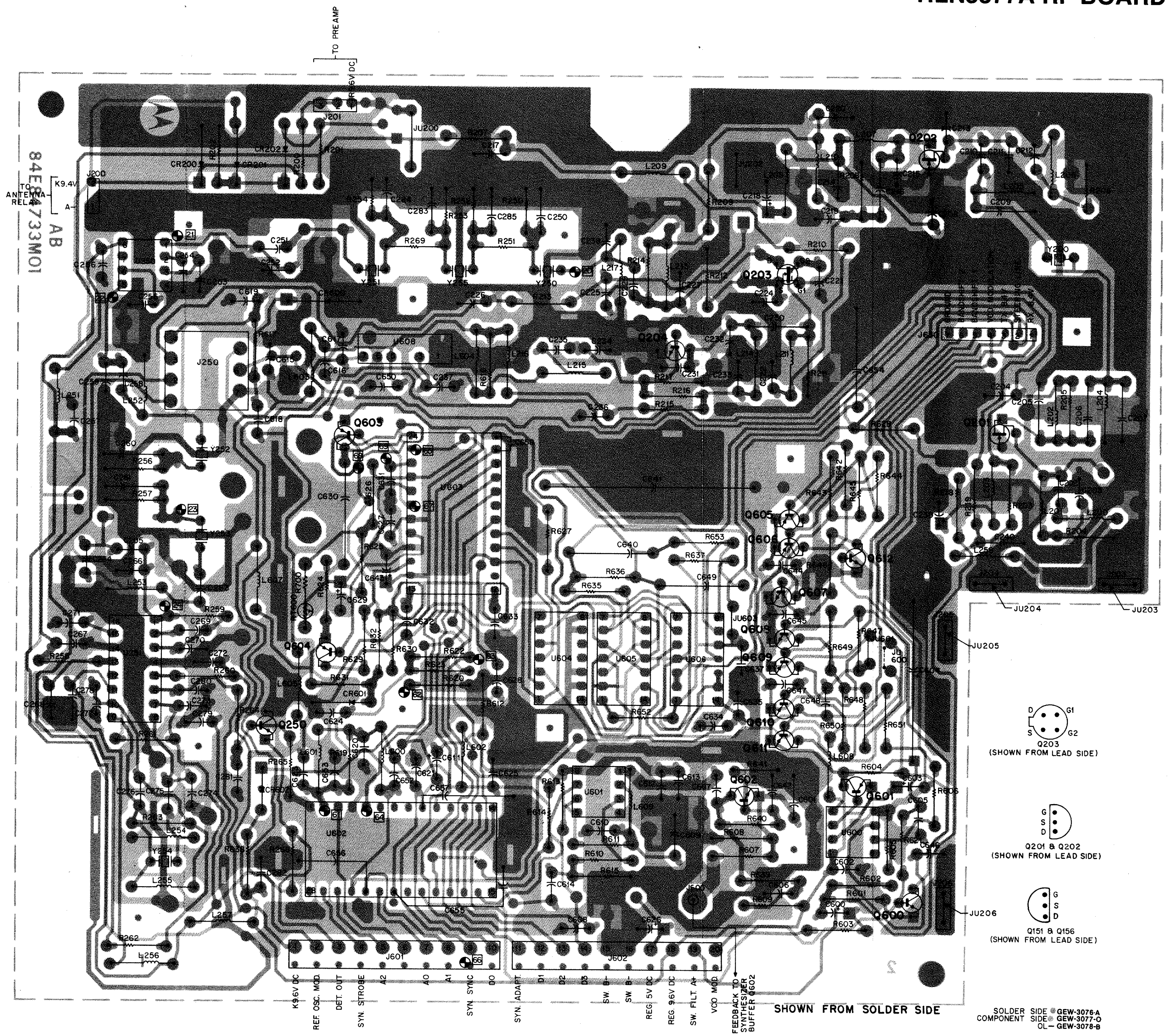
MXW–5996–O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
transistor (see note)		
Q201,202	48–00869839	JFET, N–channel
Q203	48–84412L21	FET, N–channel
Q204	48–00869932	NPN
Q250	48–00869643	PNP
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R203	06–11009C01	10
R204	06–11009C27	120
R205	06–11009C59	2.7k
R206	06–11009C27	120
R207	06–11009C01	10
R208	06–11009C65	4.7k
R209	06–11009C59	2.7k
R210	06–11009C69	6.8k
R211	06–11009C75	12k
R212	06–11009C35	270
R213	06–11009C93	68k
R214	06–11009C59	2.7k
R215	06–11009C49	1k
R216	06–11009C65	4.7k
R217	06–11009C41	470
R218	06–11009C15	39
R219	C6–11009C63	3.9k
R250	06–11009C85	33k
R251	06–11009C45	680
R252–254	06–11009C85	33k
R255	06–11009C49	1k
R256,257	06–11009C81	22k
R258	06–11009C99	120k
R259	06–11009C49	1k
R260	06–11009C89	47k
R261	06–11009C73	10k
R262	06–11009D06	220k
R263	06–11009C66	5.1k
R264	06–11009C49	1k
R265	06–11009C79	18k
R266	06–11009C49	1k
R269	06–11009C45	680
R271	06–11009D22	1 MEG
integrated circuit (see note)		
U250	51–83977M55	IF amp
U251	51–80069C05	quad detector
crystal (see note)		
Y200	48–83742M02	53.9 MHz filter
Y250	91–80011E04	10.7 MHz
Y251–254	91–80011E05	10.7 MHz
Y255	48–84574K03	10.7 MHz resonator
mechanical parts		
	05–82050H12	eye lug
	26–84898M01	circuit board shield, 2 used
	26–83594M01	component side shield, 4 used
	26–83595M01	detector component side shield
	26–83597M01	prescaler component side shield
	26–83814M01	fence shield
	75–05295B01	crystal pad
	01–80707T22	shield & strap assembly
	01–80707T23	shield & strap assembly

11/1/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

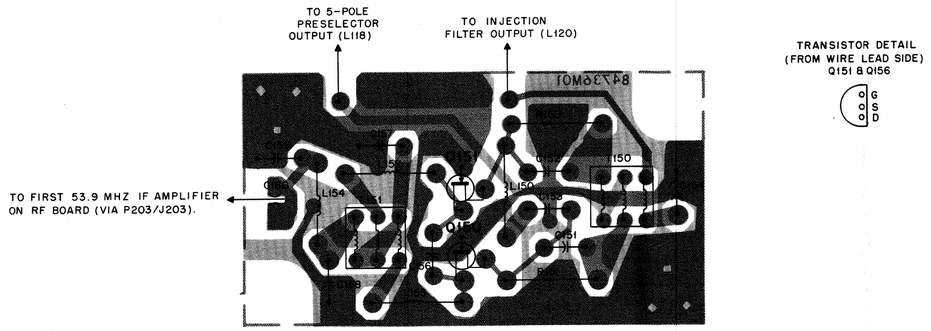
HLN5377A RF BOARD



SOLDER SIDE GEW-3076-A
COMPONENT SIDE GEW-3077-O
OL— GEW-3078-B

Schematic, Circuit Board Diagram, and Parts List for HLN5377A (Receiver)
PW–6006–O
(Sheet 2 of 2)
11/30/88

FIRST MIXER



SHOWN FROM COMPONENT SIDE

COMPONENT BD GCW-3085-O
SOLDER BD GCW-3086-A
OL GCW-3087-O

parts list

HLD4108A First Mixer Board — MXW-3094-B

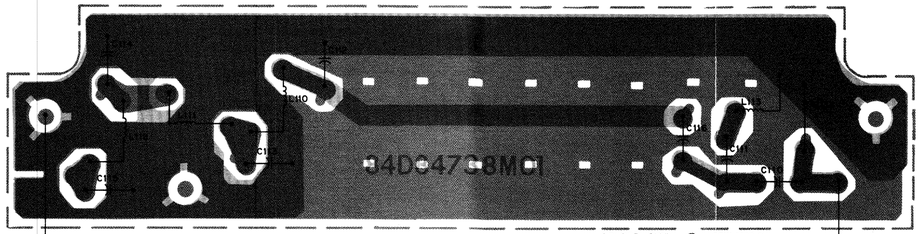
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C151,152	21-11015B03	150, ±10%
C153	21-11014H32	20
C154	21-11014H41	47
C156	21-11014H16	4.3, ±.25 pF
C157	21-11015B15	1500, ±10%
C158	21-11014H48	91
C159	21-11014H41	47
coil		
L150	24-82723H36	.41 uH, yellow
L152,153	24-83397L13	.82 uH, gray-red
L154	24-82723H22	.15 uH, brown-green
transistor (see note)		
Q150,151	48-82022N01	FET, type M2201
resistor, fixed, ohm, ±5%, 1/4 W (unless otherwise stated)		
R150,151	06-11009C33	220
transformer		
T150,151	24-80276D01	toroid

6/20/88

notes:
1. For best performance, order diodes, transistors, and integrated circuits by Motorola part number.
2. Transistors Q150 and Q151 must be replaced as a pair.

Circuit Board Diagrams and Parts Lists
for First Mixer and Low Pass Filter
PW-6008-O
11/11/88

LOW PASS FILTER



SHOWN FROM COMPONENT SIDE

SOLDER SIDE GCW-3088-O
COMPONENT SIDE GCW-3089-A
OL GCW-3090-O

parts list

HLN4491A Low-Pass Filter — MXW-3551-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed pF, ±5%, 100V (unless otherwise stated)		
C110	21-11014H35	27
C111	21-11014H48	91
C112	21-11014H31	18
C113,114	21-11014H36	30
C115	21-11014H31	18
C116	21-11014H35	27
coil, RF		
L110	24-83884G09	blue
L111	24-83884G04	yellow
L112,113	24-83884G09	blue
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R110	06-11009C73	10k
non-referenced parts		
	26-84918M01	filter shield

11/10/88

HLN4250A Low Pass Filter Board — MXW-3092-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C110	21-11014H35	27
C111	21-11014H48	91
C112	21-11014H30	16
C113-114	21-11014H36	30
C115	21-11014H30	16
C116	21-11014H35	27
coil		
L110-113	24-83884G09	blue, 6 1/2 turns
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R110	06-11009C73	10k
mechanical parts		
	26-84918M01	shield

6/20/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

parts list

HLN4912A Internal Casting Hardware — MXW-6009-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed pF, ±10%, 50V (unless otherwise stated)		
	21-82805H04	28, 200V
coil, RF		
L114	24-84832M01	HELICAL 16 1/2 turns
L115-117	24-84832M02	HELICAL 15 3/4 turns
L118	24-84832M06	HELICAL 17 1/4 turns
L119	24-84832M04	HELICAL 11 7/8 turns
L120	24-84832M05	HELICAL 11 1/4 turns
L121	24-84832M04	HELICAL 11 7/8 turns
non-referenced parts		
	04-83755H01	washer
	09-84135B02	connector (2 used)
	14-80175M02	insulator shield
	15-84776M01	casting

11/15/88

HLN4490A R1 Internal Casting Hardware Kit — MXW-3552-A

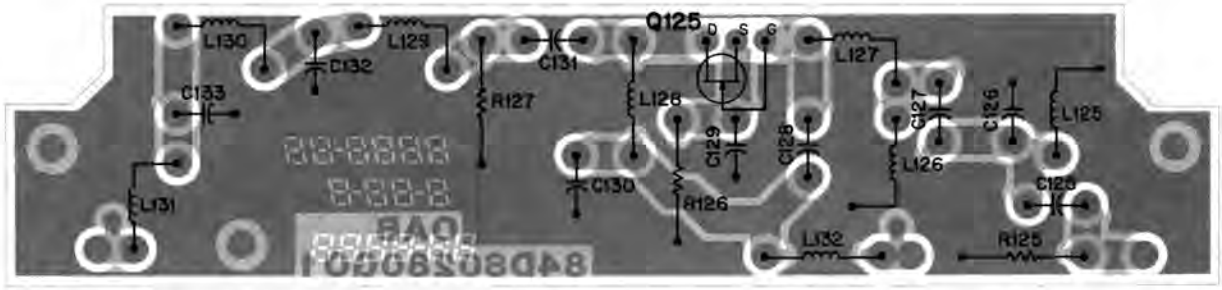
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C150	21-82805H04	28, ±10%, 200V
coil, rf		
L114	24-84832M07	green
L115-117	24-84832M08	yellow
L118	24-84832M09	orange
L119	24-84832M10	white
L120	24-84832M11	red
L121	24-84832M12	blue
mechanical parts		
	15-84776M01	cover

04/30/88

HLN4260A Internal Casting Hardware Kit — MXW-3093-A

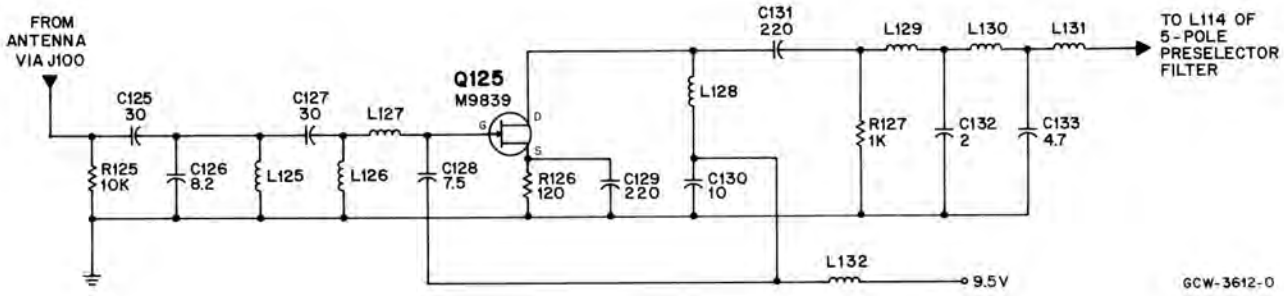
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	02-84773E02	tension nut
	03-00138841	set scres (8-32 X 5/8)
	03-10943M10	tapping screw (3 X 0.5 X 8)
	03-10943M14	tapping screw (3.5 X 0.6 X 6)
	03-10943M15	tapping screw (T3.5 X 0.6 X 8)
	03-80132J02	heavy duty pan screw
	15-80209B01	preselector cover
	15-80210B02	preselector cover
	15-83214M01	plug cover
	15-84817M01	VCO cover
	15-84851M01	buffer cover
	15-84852M01	mixer cover
	15-84853M01	preamp cover
	32-80042D01	mixer gasket
	32-80043D01	preamp gasket
	32-82796H01	gasket (2 used)
	37-00122063	teflon tubing (4 used)

6/20/88



SOLDER SIDE — GBW-3613-O
COMPONENT SIDE — GBW-3614-O
OVERLAY — GBW-3615-O

COMPONENT SIDE VIEW



parts list

HLD4123A Preamplifier — MXW-3104-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed, pF ±5%, 100V unless otherwise stated
C125	21-11014H36	30
C126	21-11038H23	8.2 ± .5
C127	21-11014H36	30
C128	21-11014H22	7.5 ± .5
C129	21-11015B05	220 ±10%
C130	21-11014H25	10 ± .5
C131	21-11015B05	220 ±10%
C132	21-11014H08	2 ± .25
C133	21-11014H17	4.7 ± .25
		coil
L125	24-83884G01	3½ turns, red
L126, 127	24-83884G08	5½ turns, orange
L128	24-82723H28	.29 µH
L129	24-84411B01	13½ turns, white
L130	24-83884G12	8½ turns,violet
L131	24-83884G04	7½ turns, yellow
L132	24-82549D48	2.2 µH
		transistor (see note)
Q125	48-00869839	field-effect, type M9839
		resistor, fixed, Ω ±5%, ¼ watt unless otherwise stated
R125	06-11009C73	10k
R126	06-11009C27	120
R127	06-11009C49	1000

8/10/86

note: For best performance, order diodes, transistors, and integrated circuits by Motorola part number.

FUNCTIONAL DESCRIPTION

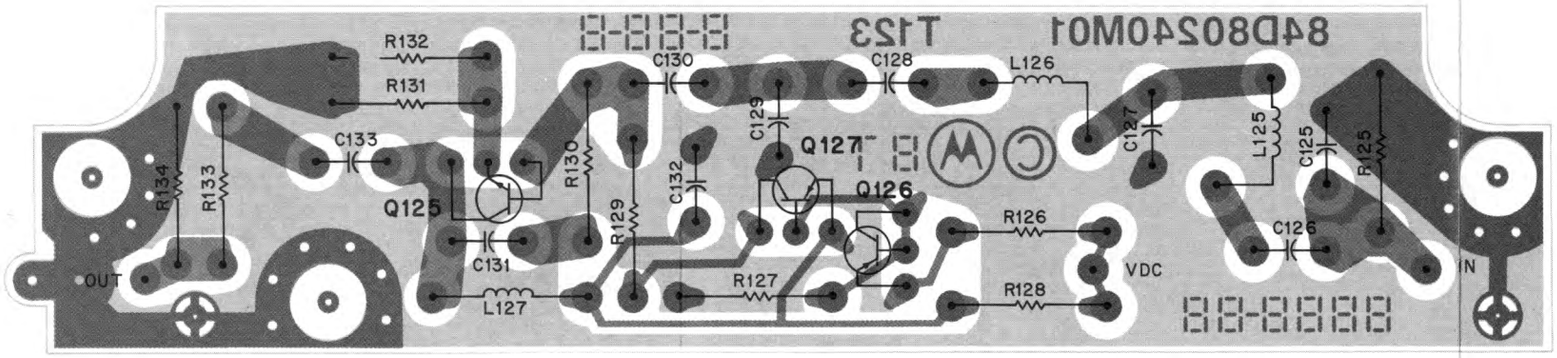
The HLD4123A Preamplifier consists of a band-pass/matching network, a neutralized FET rf amplifier, and a low pass filter.

The band-pass filter receives the input signal from the antenna relay through J100, and attenuates out-of-band interfering signals before they can reach the rf amplifier's input, and passes only the desired signal to the amplifier.

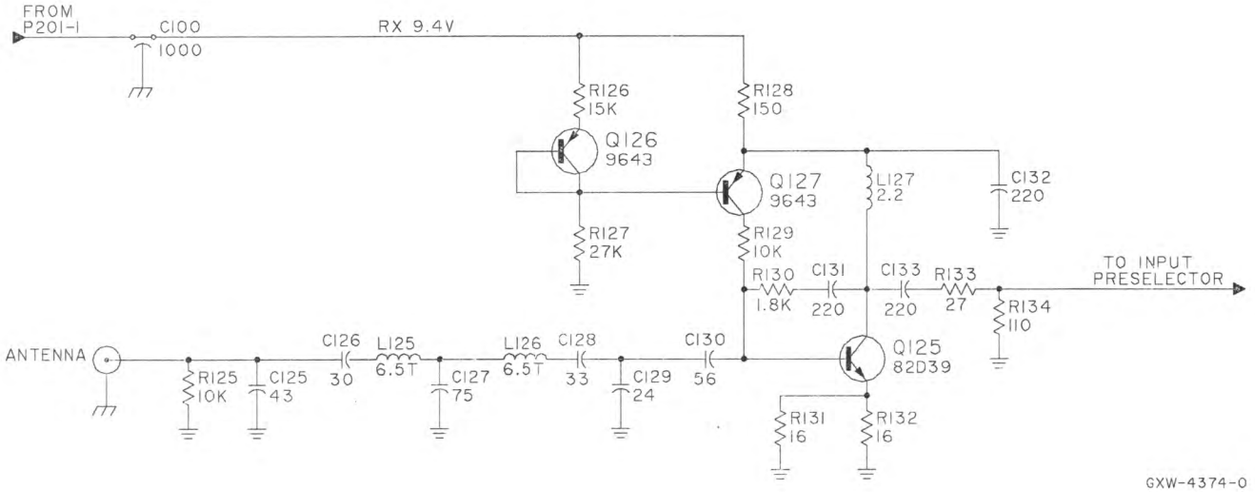
The rf amplifier includes an FET device, Q125, connected in a common-source configuration. C128 and L128 neutralize the gate-to-drain capacitance (C_{GD}) of Q125. This amplifier operates from a single 9.5 volt DC regulated power supply.

The low pass filter protects the rf amplifier from the harmonic response of the 5-pole preselector filter. A coaxial cable connects the low pass filter to the first pole of the preselector filter.

Schematic, Circuit Board Diagram, and Parts List for HLD4123A Preamplifier
PBW-3095-A
8/13/86



SOLDER SIDE — GCW-4375-O
COMPONENT SIDE — GCW-4376-O
OVERLAY — GCW-4377-O



GXW-4374-O

parts list

HLN5328A Preamp Hardware Range 1 — MXW–6010–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±10%, 100V (unless otherwise stated)		
	21–00861219	.001 uF, +100, –0%, 500V
	21–82805H04	28, 200V
coil, RF		
	24–84832M07	green
	24–84832M08	yellow (3 used)
	24–84832M09	orange
	24–84832M10	white
	24–84832M11	red
	24–84832M12	blue
mechanical parts		
	02–84773E02	tension nut
	09–84135B02	connector
	14–80175M02	insulator shield
	15–80209B01	preselector cover
	15–80210B02	preselector cover
	15–83214M01	cover plug
	15–84776M01	casting
	15–84817M01	VCO cover
	15–84851M01	buffer cover
	15–84852M01	mixer cover
	15–84853M01	preamp cover
	32–80042D01	mixer gasket
	32–80043D01	preamp gasket
	32–82796H01	gasket (2 used)

11/10/88

parts list

HLD4334A *SYNTOR X* RANGE 1 Preamp — MXW-4378-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed pF, ±5%, 100V unless otherwise stated
C125	21-11014H40	43
C126	21-11014H36	30
C127	21-11014H46	74
C128	21-11014H37	33
C129	21-11014H34	24
C130	21-11014H43	56
C131-133	21-11015B05	220 ±10%
		coil
L125, 126	24-83884G01	86.7 µH
L127	24-82549D48	2.2 µH
		transistor (see note)
Q125	48-80182D39	NPN
Q126, Q127	48-80182D09	PNP
		resistor, fixed ohm, ±5%, ¼ watt unless otherwise stated
R125	06-11009A73	10k
R126	06-11009A77	15k
R127	06-11009A83	27k
R128	06-11009A29	150
R129	06-11009A73	10k
R130	06-11009A55	1.8k
R131, 132	06-11009A06	16
R133	06-11009A11	27
R134	06-11009A26	110

4/28/87

note: For best performance, order diodes, transistors, and integrated-circuit devices by Motorola part number.

Schematic, Circuit Board Diagram, and Parts Lists for Range 1 Preamplifier
PW–4373–A
11/11/88

1. Theory of Operation

The *SYNTOR X* high–band transmitter has three major section: the intermediate power amplifiers (IPA), the power amplifier (PA), and the directional coupler board. All of them have 50–ohm interfaces that facilitate troubleshooting and repair.

1.1 IPA

The 40–mW transmit injection signal from the frequency synthesizer goes to the two–stage variable gain exciter. Collector current for these stages (Q701 and Q702) is proportional to the power control voltage developed by the regulating and protective feedback system. The output of the IPA (1.5 watts maximum) is coupled to the power amplifier.

1.2 POWER AMPLIFIERS

1.2.1 100–Watt Power Amplifier

The RF signal passes from the IPA to the final power amplifier via a coaxial cable. The signal then goes through the predriver stage Q801 and to the driver stage Q802. Two class C parallel transistor stages (Q803 and Q804) bring the output up to its final level.

The transmitter uses temperature–sensing circuitry to protect the final power amplifier against high temperatures. This circuitry works in conjunction with the power control circuits to reduce the radio output power whenever the transistor temperature exceeds 80°C. The power control circuitry measures the current in the final PA stage. The RF drive to the PA is reduced whenever it exceeds a safe level.

1.2.2 40–Watt Power Amplifier

The RF signal passes from the IPA to the final power amplifier via a coaxial cable. The signal then goes through the driver stage Q801. A class C transistor stage (Q802) brings the output up to its final level.

The transmitter uses temperature–sensing circuitry to protect the final power amplifier against high temperatures. This circuitry works in conjunction with the power control circuits to reduce the radio output power whenever the transistor temperature exceeds 80°C. The power control circuitry measures the current in the final PA stage. The RF drive to the PA is reduced whenever it exceeds a safe level.

1.3 DIRECTIONAL COUPLER BOARD

The RF power output from the final amplifier module goes to the directional coupler. The directional coupler measures both the forward and reflected power. Information relating to the forward and reflected power relays to the power control circuitry on the common circuits board. The power control circuits react to any change in power by changing the RF drive to restore the RF power output to its original level.

When the reflected power at the radio output connector reaches a level that can damage the final power transistors, the power control circuitry reacts by reducing the RF power output to a safe level. The reflected power should always be less than 40% of rated output power. The directional coupler RF output goes to the antenna via a harmonic filter and the antenna switch.

1.4 METERING

Through the transmitter metering socket (J952) on the common circuits board, transmitter parameters are monitored as follows:

- J952–3 checks the IPA control voltage.
- J952–4 produces a DC voltage proportional to the 9.6V regulated supply.
- J952–5 measures the current in the final stages of the transmitter.

1.5 POWER CONTROL AND PROTECTION CIRCUITRY

Sensing circuits monitor PA current, heatsink temperature, control voltage, forward power, and reflected power. The circuitry compares these parameters with acceptable references and combines them to produce the control voltage that regulates and protects the PA by controlling the variable gain exciter stages.

During normal operation, the regulation of transmitter output power is a function of the detected forward power level. The directional coupler board contains a pickup element and signal diodes that produce output voltage proportional to the forward and reflected power levels. The detected forward power voltage is applied to U901A. U901A compares its level with the adjustable reference established by POWER SET potentiometer R911. The output of the comparator is amplified by Q903 and Q904 to become the power control voltage to the exciter.

The circuits protect the transmitter by monitoring and limiting critical PA parameters. Current in the final PA stage passes through R801, causing a proportional current path form current limiter circuit Q905–Q908. If the current drawn overcomes an adjustable level established by CURRENT LIMIT potentiometer R939, then Q907 conducts harder, increasing the quiescent level applied to protection comparator U901B. Similarly, a voltage proportional to the VSWR at the directional coupler board is added to the steady–state level at the input of the protection comparator. Increasing the input level decreases the output of U901B. This increases the conduction of Q905, and the effect of this increase on the forward power level comparator circuitry decreases the control voltage, ultimately reducing the PA power level.

To monitor the control voltage, the circuitry applies a portion of the signal to the emitter of Q905 and compares it with the base, which is biased by the protection comparator output. An increase in the control voltage causes feedback to the comparators to lower the level of the control voltage.

2. Installation Power Set Procedure

See the Maintenance and Troubleshooting section of this manual for recommended equipment.

2.1 AUDIT POWER OUTPUT

After completion of the radio installation you must audit the power output of your radio. Each radio installation may affect the transmitter's power output due to variations in antenna loading. The factory sets each radio to its specific power output using a calibrated 50 ohm load. Your antenna might not present the same load impedance to the radio transmitter causing changes to system performance.

2.2 VERIFY POWER OUTPUT

Verify your system has the correct antenna for the frequency range of your radio.

Note

SYNTOR X radios operate over a greater portion of the spectrum than most antennas are resonant. Motorola offers a wideband antenna for each band of *SYNTOR X* model radios. Contact the nearest Motorola center for assistance.

Perform the following steps to verify the power output of your radio.

(1) Connect a 50 ohm power meter in series with the coax leading to the antenna.

(2) Measure the VSWR of the radio system for each channel.

(3) Verify power output on the transmit frequency with the lowest VSWR is at least the specified output in the instruction manual.

Note

Do not make adjustments to the power output if the measured VSWR is greater than 1.5:1 (2.0:1 for Low–band). Check your antenna for proper installation and ensure it is designed for your operating frequency.

(4) If measured power output using a 50 ohm load is within 5% of the recommended power, make NO adjustments to the radio.

(5) If measured power output using an antenna is within 10% of the recommended power, make NO adjustments to the radio.

Should the measured power output differ from expected levels outlined above, see the Power Set Procedure in this manual. Reset the power output to the specified level for your radio model.

3. Transmitter Tests

Note

See the Synthesizer section of the manual for information on transmit frequency, audio deviation, and modulation troubleshooting.

CAUTION

Key the transmitter only while making adjustments. Make adjustments from the bottom of the radio and through the common circuits board.

Table 1. Minimum Normal Current Indications for 100–watt Radios

TRANSISTOR	Collector Current	136–144 MHz	150–155 MHz	155–162 MHz	162–174 MHz
Q801	DIRECT	—	1.7A	1.2A	0.75A
Q802	DIRECT	—	2.4A	2.4A	2.5A
Q802	DROP ACROSS R822	—	240 mV	240 mV	250 mV
Q803,804	DROP ACROSS R801	—	160 mV	170 mV	160 mV
Q803,804	MTR 5	—	16 uA	17 uA	16 uA

3.1 PRELIMINARY TEST

Connect the radio to a proper wattmeter, dummy load, and 13.4V supply. Plug a TEK5–series meter panel set to position C or a portable test set into the alignment metering socket, J952. Use the neutral or receive position on the meter panel, or set the function switch on the portable test set to the receive position.

3.2 CONTROL AND PROTECTION TESTS

3.2.1 Current Limiting (R939)

(1) Set POWER SET (R911) fully clockwise.

(2) Set CURRENT LIMIT (R939) fully counterclockwise.

(3) Key the transmitter and observe the radio current drain. Drain should be less than 5 uA. Rotate CURRENT LIMIT clockwise. The current drain should increase to a maximum reading of less than 30 uA before you reach the maximum clockwise position.

3.2.2 Power Set (R911)

(1) Set CURRENT LIMIT (R939) fully clockwise.

(2) Set POWER SET (R911) fully counterclockwise.

(3) Key the transmitter and observe the wattmeter. Rotate POWER SET (R911) clockwise to set the maximum power output level.

3.2.3 Thermal Protection

(1) Set CURRENT LIMIT (R939) fully clockwise.

(2) Rotate POWER SET (R911) until the power reading is at the proper power set level for the radio under test.

(3) At the PA feedthrough plate, use an insulated jumper clip to short the TEMP SENSE lead (C883, connected to orange wire) to the B– lead (C882, connected to the black–white wire) of the 100–watt model or to the A– lead (C885, connected to heavy gauge black wire) of the 40–watt model.

(4) Key the transmitter and verify the power output indication is now less than 25% of set power.

3.2.4 Reflected Power (VSWR) Protection

(1) Set CURRENT LIMIT (R939) fully clockwise.

(2) Key the transmitter and adjust POWER SET (R911) for normal power.

CAUTION

Since the following test requires transmission without a dummy load, key the transmitter only long enough to allow verification of proper operation of the equipment.

(3) Remove the 50–ohm load from the radio. Briefly key the transmitter and verify the output power indicates less than 50%.

3.3 RF AMPLIFICATION TESTS

3.3.1 Injection

(1) Disconnect the RF drive signal to the exciter from the synthesizer (J700).

(2) Connect a 50–ohm terminated RF milli–voltmeter to the synthesizer's transmitter injection plug (P700). Residual RF drive to the exciter in the receive mode should be less than –15 dBm. Transmitter injection in the transmit mode should be greater than +16 dBm.

Table 2. Minimum Normal Current Indications for 40–Watt Radios

TRANSISTOR	Collector Current	150–174 MHz
Q801	DIRECT	1.5A–1.3A
Q802	DIRECT	7.2A–8.2A
	DROP ACROSS R801	215 mV–245 mV
	MTR 5	21–24 uA

3.3.2 Exciter

(1) Disconnect the exciter output cable from the PA and re–connect it to a wattmeter and dummy load.

(2) Set POWER SET (R911) and CURRENT LIMIT (R939) to mid–rotation.

(3) Key the transmitter. The minimum output power should be greater than 1.5 watts.

3.3.3 Power Amplifier

(1) Disconnect the PA from the antenna switch at J901 on the directional coupler board.

(2) Connect the PA to a wattmeter and dummy load via J901.

(3) Set POWER SET (R911) fully counterclockwise and CURRENT LIMIT (R939) fully clockwise. Key the transmitter. Output power should exceed rated radio power by at least 20%.

4. Power Amplifier Troubleshooting Guide

4.1 GENERAL

This guide is to help you locate faults once you have traced them to the power amplifier. To conduct the checks described here, connect 13.5 VDC to the radio through a standard cable kit. Start with POWER CONTROL (R911) set fully counterclockwise and CURRENT LIMIT (R939) set fully clockwise, and the radio keyed on a channel suspected to be defective.

4.2 NO POWER OUTPUT, OR OUTPUT LESS THAN 20% OF RATED POWER

4.2.1 Voltage Checks

With the radio unkeyed and the receiver audio at a minimum, check for +13.3V DC on the collectors. If one or more stages have zero voltage, check the associated DC feed circuits for an open circuit.

4.2.2 Individual Stage Current Checks

Check the collector currents drawn by all stages for the normal values shown in Table 1 or Table 2.

(1) If a stage is drawing less than the minimum collector current, check for shorts or defective components in that stage, then check both the preceding and following stages.

(2) If more than one stage indicates low current, check the earliest defective stage (toward the PA input) first.

(3) If all stages indicate low current, check the exciter output. The exciter is defective if the output is less than 1.5 watts.

4.3 POWER OUTPUT DOES NOT EXCEED THE RATED RADIO POWER BY 20% AT MAXIMUM POWER SETTINGS

Check the A+ and A– voltages at the collectors with the power amplifier operating. Use only a passive voltmeter or a VOM with 1.2 uH series chokes at the probe tips. With the power supply accurately set for 13.5V DC, voltages on the transistor collectors should exceed the Table 3 values (all voltages measured with respect to the A– plating on the power amplifier board).

(1) If all the voltages are low, recheck the power supply. If the power supply is satisfactory, check the feedthrough capacitors for poor solder connections and the front plug A+ and A– connections for good contact.

(2) If some, but not all, stages have low voltages, trace back through the DC feeds of the low voltage stages, checking for bad connections or defective components. The maximum normal voltage drops are 0.3V DC for R801, 0.5V DC for R822, and less than 0.1V DC for all other components in the DC feed circuits.

Table 3. PA Collector Voltages

TRANSISTOR	HLD4314A (40W)	HLD4076A (100W)
Q801	12.8V DC	12.0V DC
Q802	12.6V DC	11.8V DC
Q803,804	—	11.8V DC

Note

The following paragraphs apply only to the 100–watt model of the radio.

If there is trouble in the finals (Q803, Q804), or if other approaches have failed, check the balance in the final amplifier by soldering a 2.7V lamp (type 338, Motorola part #65–82671G01) across R819, using #14 wire or a 0.1 inch wide copper strap or braid. If the lamp lights to more than half its normal brilliance or flashes and burns out, on side of the parallel final amplifier circuitry is defective. If so, you should be able to isolate the defective section by shorting the base of one transistor to its emitter (at the transistor body, opposite C825 or C826) with a screwdriver blade. The section that shows the least drop in power output (when shorted) is the one to check for defective components, bad connections, or shorts. Make the following tests before considering the replacement of Q803 or Q804.

CAUTION

Remove all power from the radio for the following tests.

Note

Put the negative potential lead from the ohmmeter on the transistor base for this test.

(3) Check the in–circuit base–emitter resistance on any suspect transistor. If it is greater than one ohm, coil L809 or L810 is bad.

(4) If the resistance check shows that L809 and L810 are not defective, remove capacitor C825 or C826 and check it for shorts, both internal (with an ohmmeter), and external (visual check for solder shorts on the capacitor or printed circuit board). If the capacitor or its connection is suspect, replace it and recheck the power output and balance before you continue.

Note

When you find a gross imbalance and replace suspected faulty components, always recheck the balance with the new components.

Continue the investigation if this has not completely corrected the imbalance.

Note

Put the negative potential lead of the ohmmeter on the transistor base for the following test.

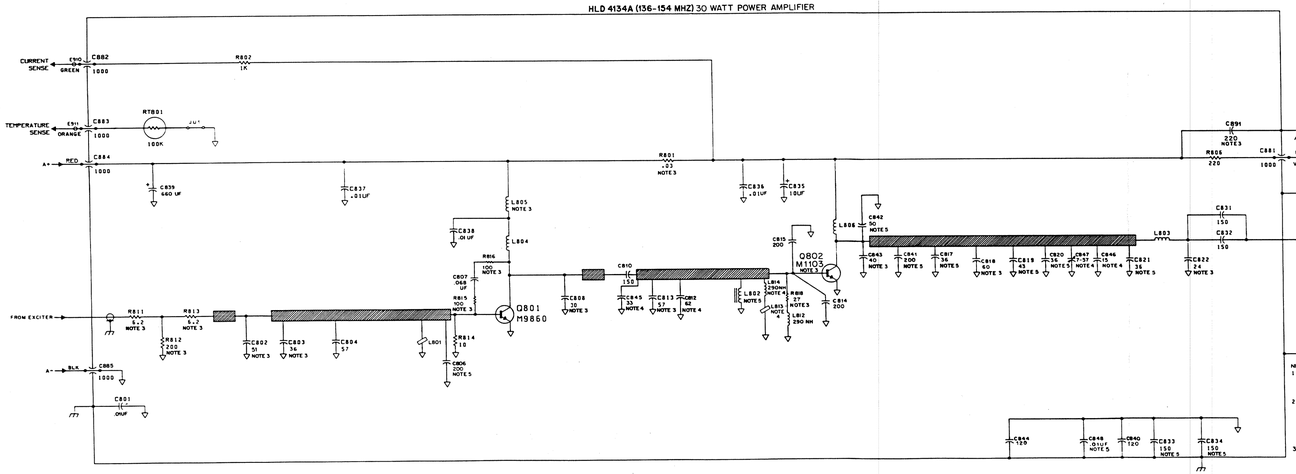
With all power removed from the radio, check for an open base return on Q801 and Q802 by measuring the in–circuit base–emitter resistance. The resistance should be less than one ohm on Q801 and less than 2.5 ohms on Q802.

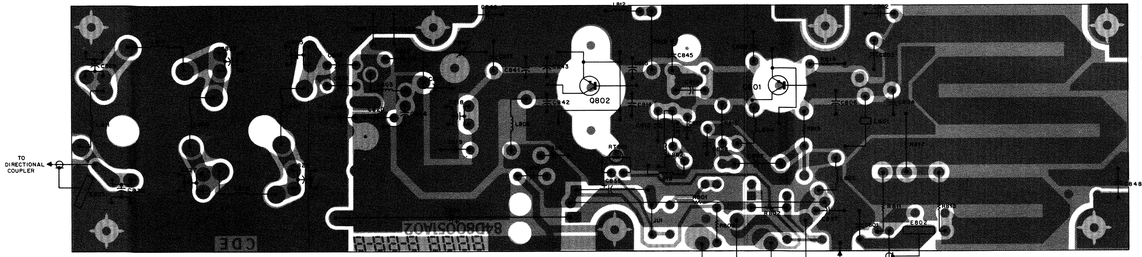
Table 4. Transmitter Troubleshooting Procedures

Step	Symptom	Procedure	Normal indication	If normal	If abnormal
1	Suspected Transmitter Failure	Measure RF output power at antenna connector.	Rated power	Transmitter OK	High Power–perform Transmitter Control and Protection Troubleshooting Procedure. Low Power–go to step 3. No power–go to step 2.
2	No Output Power	a. Set POWER SET control fully counterclockwise and CURRENT LIMIT fully clockwise and note if Meters 3 and 5 are greater than the values indicated.	Both greater than 10 uA	Go to 2b.	No indication–perform Transmitter Control and Protection Troubleshooting Procedure. Meter 3 indication, no Meter 5 indication–go to step 2e.
		b. Measure dc voltage across antenna relay coil during TX.	4.5 V dc	Go to step 2c.	Check coil continuity (dc resistance approx. 160 ohms).
		c. Check reed switch continuity.	Continuous during TX	Go to step 2d.	Replace switch.
		d. Check harmonic filter and output cable for shorts and discontinuities.	See schematic	Perform Power Amplifier Troubleshooting Procedure.	Repair defect.
		e. Measure RF signal level at synthesizer output J1151.	+16 dBm minimum	Go to step 2f.	Perform Synthesizer Troubleshooting Procedure.
		f. Measure RF power at exciter output.	1.5 W minimum	Perform Power Amplifier Troubleshooting Procedure.	Repair exciter.
3	Low Output Power	a. Set POWER SET control fully counterclockwise and CURRENT LIMIT fully clockwise and observe Meter 3.	Greater than 20 uA	Go to step 3b.	Perform Transmitter Control and Protection Troubleshooting Procedure.
		b. Measure RF signal level at synthesizer output J1151.	+ 16 dBm minimum	Go to step 3c.	Perform Synthesizer Troubleshooting Procedure.
		c. Measure RF power at exciter output.	1.5 W minimum	Perform Power Amplifier Troubleshooting Procedure.	Repair exciter.

Table 5. Troubleshooting Chart for Transmitter Control and Protection Circuitry

Step	Symptom	Procedure	Normal indication	If normal	If abnormal
1	No Meter 3 or 5 with all controls open (POWER SET counterclockwise and CURRENT LIMIT clockwise); adjusted from bottom of radio through holes in common circuits board	a. Disconnect exciter from synthesizer at J1151. Check for keyed 9.5 V dc at Pin 8, U901.	9.5 V dc	Go to step 1b.	a. check PA ENABLE at P401–10 b. Check for synthesizer lock. c. Check Q1007 (TX 9.5 V switch). d. Check PA ENABLE switch (Q5 and Q6).
		b. Measure output voltage of U901A, Pins 5 and 6.	> 3.3 V dc	Repair fault in control voltage amplifiers Q903 and Q904.	Go to step 1c.
		c. Measure voltage to input of U901A, Pins 5 and 6.	Pin 5 > Pin 6	U901 defective.	Check for shorts or opens in resistive feed circuits to Pins 5 and 6.
2	Meter 3 reads max of about 10 uA with all controls fully open. Little or no output power.	a. Disconnect exciter from synthesizer at J1151. Measure voltage of protection comparator output, Pin 1, U901B.	> 8 V dc	Troubleshoot Q905 circuit.	Go to step 2b.
		b. Measure voltage to input of U901B, Pins 2 and 3.	Pin 3 > Pin 2	U901 defective.	Analyze and repair current limiter and circuitry Q906, Q907, and Q908.
3	All controls inoperative and Meter 3 at 25 uA	a. Disconnect exciter from synthesizer at J1101. Observe Meter 3 in RX mode.	0 uA	Go to step 3b.	Repair fault in control voltage amplifiers Q903 and Q904.
		b. Set all controls counterclockwise. Measure Pins 5 and 6, U901A in TX mode.	Pin 6 > Pin 5.	U901 defective.	Look for defect in voltage reference network R926, R927, R928, R921, and R911.
4.	Current Limit (R939), and reflected power (VSWR) protection inoperative	Q905 and associated resistors probably open. Analyze and repair.			
5.	Current limit (R939) inoperative	Disconnect exciter from synthesizer at J700. Unsolder CURRENT SENSE line (GRN) from C887 (100–W model) or C882 (40–W model). Observe Meter 3.	15 uA	Check for short to A+ of current sense line.	Analyze fault in current limit circuit Q906, Q907, and Q908 and repair.
6.	Reflected power (VSWR) protection inoperative	Check and repair defect in reflected power detector components R901, CR901, etc.			
7.	Thermal Protection inoperative	Check and repair defect in thermal protection components R915, R930, and CR904.			
8.	Power set (R911) inoperative	Check and repair defect in forward power detector components R902, CR902, etc.			





parts list

HLD4134A Power Amplifier 30 Watt — MXW-3554-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 200V (unless otherwise stated)		
C801	21-8356E36	.01 uF, +60, -40%, 250V
C802	21-84493B27	51
C803,804	21-80169A55	57
C807	08-83813H23	.068 uF, 50V
C808	21-83406D56	24, 500V
C810	21-82204B54	150
C812,813	21-84493B30	62
C818	21-84395B26	160, ±2%, 250V
C822	21-83406D69	10, ±.5 pF, 500V
C825	21-84395B42	16.5, 250V
C826	21-84395B43	36, 250V
C827,828	21-84395B44	46, 250V
C829	21-84395B43	36, 250V
C830	21-84395B42	16.5, 250V
C831,832	21-82187B49	150, ±10%, 500V
C835	23-82783B27	10, ±10%, 25V
C836-838	21-8356E36	.01 uF, +60, -40%, 250V
C839	23-83210A22	660, -10, +150%, 25V
C840	21-84493B23	120
C844	21-84493B23	120
C845	21-83406D71	33, 500V
C846	21-83406D97	15, 500V
C847	20-84579B11	7 -5/+%, 175V, variable
C891	21-82187B49	150, ±10%, 500V
coil, RF		
L801	24-80036A02	ferrite bead, .5 turn
L803	24-84614A05	1.5 turns
L804	24-83894G06	4.5 turns, white
L805	24-83884G08	5.5 turns, orange
L806	24-84614A03	2.5 turns
L807,808	24-80066A03	harmonic filter
L809	24-80066A04	harmonic filter
L810,811	24-80066A03	harmonic filter
L812	24-82723H28	.29 uH, yellow
L813	24-80036A02	ferrite bead .5 turn
L814	24-82723H28	.29 uH, yellow
thermistor		
RT801	06-83600K09	100k, green
resistor, fixed, ohm, ±5%, 1/2 watt (unless otherwise stated)		
R801	17-80233B01	02
R802	06-11009C49	1k
R806	06-11009C33	220
R811	06-00125A01	10

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R812	06-00125A24	91
R813	06-00125A01	10
R814	06-11009C01	10
R815,816	06-00125A11	27
R818	06-00125C01	10, ±10%
mechanical parts		
	01-80705T56	40/60 Watt PA Board
	29-80014A01	terminal coax clip (2 used)
	42-10217A02	tie strap

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parts list

HLN4046A Feedthru Plate — MXW-4502-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, 500V (unless otherwise stated)		
C881-887	21-82812H03	100, +100, -0%
mechanical parts		
	64-80005A01	feedthru plate
	04-83755H01	solder washer, 7 used

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parts list

HLD4063A Power Amplifier Transistor — MXW-3557-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
transistor		
Q801	48-00869B60	NPN, type M9860
Q802	48-84411L04	NPN, type M1104

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note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

parts list

HLN4167A Power Amplifier Hardware — MXW-3555-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 250V (unless otherwise stated)		
C814,815	21-84366F12	200
C843	21-84366F22	50
mechanical parts		
	14-80077A01	PA insulator compartment
	14-80283B01	filter insulator
	32-80084A02	stud device gasket (2 used)
	43-80014B02	PCB standoff (5 used)
	02-00119913	nut (8-32X11/32X1/8)

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Schematic, Circuit Board Diagram, and Parts Lists for HLD4134A 30-Watt Power Amplifier

PW-3553-A

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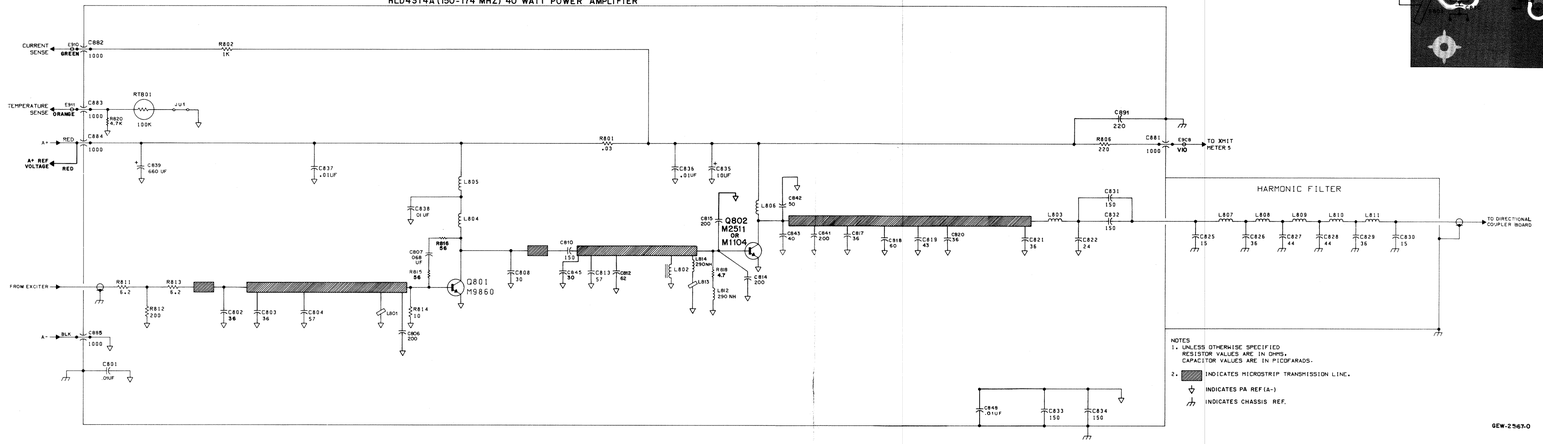

Schematic, Circuit Board Diagram, and Parts Lists for the HLD4314A 40–Watt Power Amplifier
PW–2564–A
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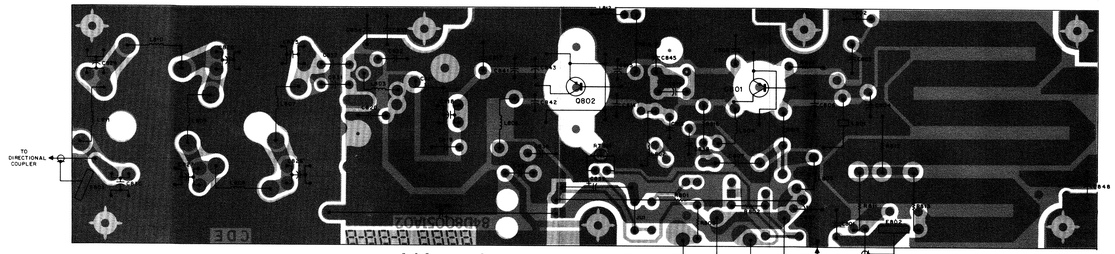

parts list

HLN5109A 40–Watt Power Amplifier Hardware — MXW–2589–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 250V (unless otherwise stated)		
C806	21-84366F12	200
C814	21-84366F12	200
C815	21-84366F12	200
C841	21-84366F12	200
C842	21-84366F20	50
C843	21-84366F08	40
coil, RF		
L850,851	76-80094B01	ferrite core
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R820	06-11009C65	4.7k
mechanical parts		
	14-80077A01	PA insulator compartment
	14-80283B01	insulator filter
	32-80084A02	stud gasket device (2 used)
	02-00119913	nut

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parts list

HLD4314A 40–Watt Power Amplifier Board — MXW–2565–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 500V (unless otherwise stated)		
C801	21-83596E36	.01 uF, +60, -40%, 250V
C802,803	21-83406D92	36
C804	21-80169A55	57, 200V
C807	08-83819H03	.068 uF, 50V
C808	21-80171A45	30
C810	21-83204B54	150, 200V
C813	21-80169A55	57, 200V
C817	21-83406D92	36
C818	21-84395B07	60, 250V
C819	21-83406D97	43
C820,821	21-83406D92	36
C822	21-83406D56	24
C825	21-84395B16	15, ±10%, 250V
C826	21-84395B17	36, 250V
C827,827	21-84395B18	44, 250V
C829	21-84395B17	36, 250V
C830	21-84395B16	15, ±10%, 250V
C831-834	21-82187B49	150, ±10%
C835	23-82783B27	10, ±10%, 25V
C836-838	21-83596E36	.01 uF, +60, -40%, 250
C839	23-83210A22	660, -10, +150%, 25V
C845	21-83406D69	30
C848	21-83596E36	.01 uF +60, -40%, 250
C851	21-83596E10	220, ±20%
coil, RF		
L801	24-80036A02	ferrite bead, 5 turn
L802	24-83977B02	ferrite choke, 2.5 turn
L803	24-84614A05	1.5 turns, airwound
L804	24-83884G06	white, 4.5 turns
L805	24-84411B02	yellow, 14.5 turns
L806	24-83547G10	2.5 turns, airwound
L807,808	24-80066A01	harmonic filter
L809	24-80066A02	harmonic filter
L810,811	24-80066A01	harmonic filter
L812	24-82723H43	.029 uH, yellow/orange
thermistor		
RT801	06-83609K09	100k, green
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R801	17-80233B02	shunt, .03, 5W
R802	06-11009C49	1k
R806	06-11009C33	220
R811	06-80125B64	6.2, 1/2W
R812	06-80125A32	200, 1/2W
R813	06-80125B64	6.2, 1/2W
R814	06-11009C01	10
R815	06-11009C19	56

parts list

HLN4046A Feedthru Plate — MXW–4502–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, 500V (unless otherwise stated)		
C881-887	21-82812H03	100, +100, -0%
mechanical parts		
	64-80005A01	feedthru plate
	04-83755H01	solder washer, 7 used

5/9/88

parts list

HLD4125A 40–Watt Power Amplifier Transistor — MXW–2591–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 25V (unless otherwise stated)		
C853	21-82372C07	.05 uF, +80, -20%
transistor (see note)		
Q801	48-80869B60	NPN, type M9860
Q802	48-80225C11	NPN, type M2511
Q802	48-84411L04	NPN, type M1104
resistor, fixed, ohm, ±5%, 1/2 watt (unless otherwise stated)		
R817	06-80125A09	22
R819	06-80125A09	22

11/15/88

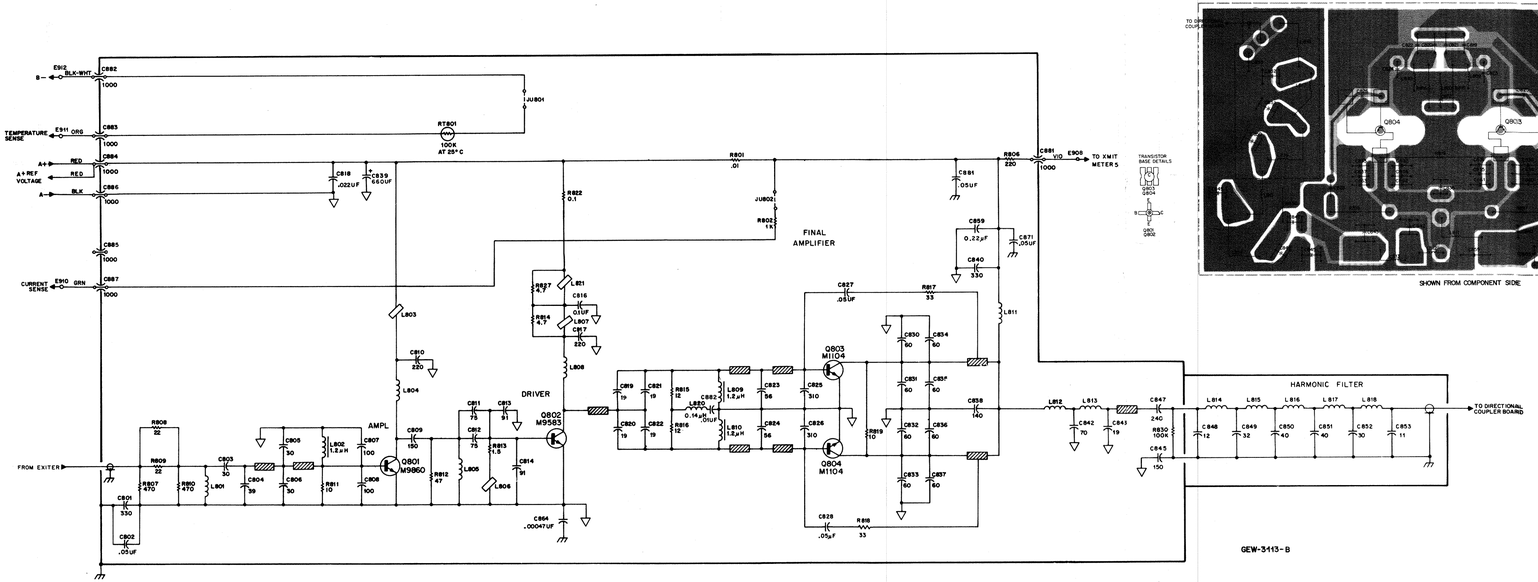
note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

parts list

MXW–2565–A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R816	06-11009C19	56
R818	06-80125B61	4.7, 1/2W
mechanical parts		
	01-80705T56	40/60 Watt PA solder resistor board
	29-80014A01	terminal coax clip (2 used)
	75-80054F01	compression pad
	42-10217A02	tie strap

11/15/88



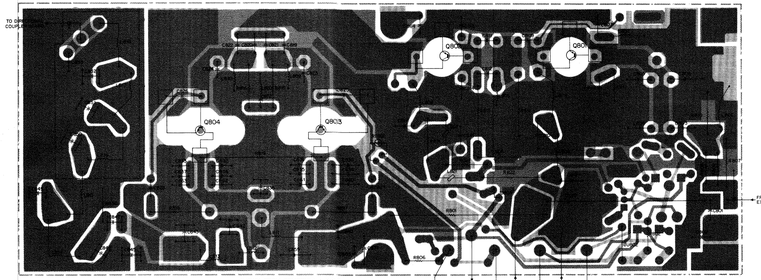
GEW-3113-B

NOTES:

1. UNLESS OTHERWISE SPECIFIED; CAPACITOR VALUES ARE IN PICOFARADS.
2. ▨ INDICATES MICROSTRIP TRANSMISSION LINE.
3. ▽ INDICATES PA REF (A–)
   ⫽ INDICATES CHASSIS REF
4. ALL PARTS MAY BE REMOVED FROM THE TOP OF THE BOARD.

CAUTION
WHEN MOUNTING TRANSISTORS DO NOT OVERTIGHTEN (BEYOND 5–7 INCH POINDS) OR DAMAGE TO TRANSISTORS MAY RESULT.

MODEL COMPLEMENT
HLN6094A HARDWARE KIT (RGII–RGIX)
HLO4076A PA BOARD (RE–RIX)
HLO4067A POWER TRANSISTOR (RGII–RGIX)
HLN4046A FEED THRU PLATE



SHOWN FROM COMPONENT SIDE

parts list

HLD4076A Power Amplifier Board — MXW-3121-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed, pF ±5% unless otherwise stated
C801	21-00863629	330 ±10%
C802	21-82372C10	.05 ±20%, 25V
C803	21-83406D77	30
C804	21-84493B59	39
C805, 806	21-83406D77	30
C807, 808	21-84493B65	100
C809	21-84493B66	150
C810	21-83396E10	220 pF ±20%
C811, 812	21-84493B63	75
C813, 814	21-84493B64	91
C816	08-82096J18	1 uF ±10%, 250V
C817	21-83396E10	220 pF ±20%
C818	08-82096J08	.022 uF ±10%, 250V
C819–822	21-84493B35	18
C823, 824	21-84715F26	56
C827, 828	21-82372C10	.05 uF ±20%, 25V
C830–837	21-80169A74	60
C838	21-84395B47	140, 350V
C839	23-83210A22	660 uF +150, −10%, 25V
C840	21-00863629	330 ±10%
C842	21-84395B40	70, 350V
C843	21-84395B41	19, 350V
C845	21-84395B46	150, 250V
C847	21-84395B35	240 ±10%, 350V
C848	21-84395B45	12, 350V
C849	21-84395B28	32, 350V
C850, 851	21-84395B38	40, 350V
C852	21-84395B39	30, 350V
C853	21-84395B38	11, 350V
C859	08-82096J20	.22 uF ±10%, 250V
C864	21-82187B07	470 ±10%
C865	21-82372C04	.05 uF +80, −10%
C882	21-83396E21	.01 uF +80, −20%, 200V
		coil
L801	24-83884G01	3½ turns
L802	24-82723H27	1.2 uH
L803	24-84036A02	ferrite bead, ½ turn
L804	24-80277A10	air wound
L805	07-80062B02	½ turn
L806, 807	24-84036A02	ferrite bead, ½ turn
L808	24-80277A14	1½ turns
L809, 810	24-82723H27	1.2 uH
L811	24-80277A13	7½ turns
L813	24-80277A17	1½ turns
L814	24-80277A18	6½ turns
L815–818	24-80277A11	6½ turns
L820	24-82723H41	.14 uH
L821	24-84036A02	ferrite bead, ½ turn
		thermistor
RT801	06-83600K09	100k @ 15°C
		resistor, fixed, Ω ±5%, ½ watt unless otherwise stated
R801	17-80165C01	.01 ±10%
R802	06-11009C49	1k, ¼ watt
R806	06-11009C33	220
R807	06-00125A41	470
R808, 809	06-11009C09	22, ¼ watt
R810	06-00125A41	470
R811	06-00125C01	10 ±10%
R812	06-00127C17	47 ±10%, 2 watt
R813	17-80336G07	1.5 ±10%, 2 watt
R814	06-00125B61	4.7
R815, 816	06-00125C03	12 ±10%
R817, 818	17-80336G11	33 ±10%, 2 watt
R822	17-82291B24	1, 3 watt
R827	06-00125B61	4.7
R830	06-11009C97	100k

5/23/86

note: For best performance, order diodes, transistors, and integrated circuits by Motorola part number.

parts list

HLN4245A Power Amplifier Hardware — MXW-3123–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C825,826	21–80069B01	310, 350V
mechanical parts		
	02–00119913	nut
	02–10971A63	machine nut
	02–80006A01	nut spanner
	03–10911A11	machine screw M3X0.5X8
	03–10943M15	tapping screw TT3.5X0.6X8
	03–10943M17	tapping screw TT3.5X0.6X13
	04–00114522	lock washer
	04–82345A01	shoulder washer
	14–80103B01	heat sink insulator
	14–80143A04	high band/low band insulator
	14–84985M01	insulator
	15–80053B01	shield cover
	15–84763M02	housing
26–80016B02		exciter board heat sink
26–84786M04		PA shield
26–84861M01		heat sink
	32–80080A01	antenna connector gasket
	32–80084A02	stud device gasket
	42–80013A01	coax clip
	43–80013B01	high power board stand off
	55–84300B04	handle

11/15/88

parts list

HLD4067A Power Amplifier Transistor — MXW–3124–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
transistor		
Q801	48–00869860	NPN, type M9860
Q802	48–00869583	NPN, type M9583
Q803,804	48–84411L04	NPN, type M1104
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R819	06–11086C11	10, 2W

11/15/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

parts list

HLN4046A Feedthru Plate — MXW–4502–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, 500V (unless otherwise stated)		
C881–887	21–82812H03	100, +100, –0%
mechanical parts		
	64–80005A01	feedthru plate
	04–83755H01	solder washer, 7 used

5/9/88

Schematic, Circuit Board Diagram, and Parts Lists for the HLD4076A 100–Watt Power Amplifier
PW–3109–A
11/20/88

parts list

HLD4076B VHF Power Amplifier Board 100 Watt — MXW–6015–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 500V (unless otherwise stated)		
C801	21–00863629	330, ±10%, 600V
C802	21–8237ZC10	.05 uF, ±20%, 25V
C803	21–8340ED77	30
C804	21–8449BB9	39
C805,806	21–8340ED77	30
C807,808	21–8449BB9	39
C809	21–8449BE10	150
C810	21–8239BB10	220, ±20%
C811,812	21–8449BB3	75
C813,814	21–8449BB4	91
C816	08–11051A13	1 uF, 63V
C817	21–8239BA10	220, ±20%
C818	08–11051A09	.022 uF, 63V
C819–822	21–8449BF36	68
C823,824	21–8237ZC10	.05 uF, ±20%, 25V
C827,828	21–8237ZC10	.05 uF, ±20%, 25V
C830–837	21–8340ED77	30
C838	21–8439SB47	140, 350V
C839	23–8321DA22	650 –10 +150, 25V
C840	21–0080B629	330, ±10, 600V
C842	21–8439SB41	70, 350V
C843	21–8439SB41	19, 350V
C847	21–8439SB46	150, 350V
C848	21–8439SB45	240, ±10%, 350V
C849	21–8439SB28	32, 350V
C850,851	21–8439SB36	40, 350V
C852	21–8439SB39	30, 350V
C853	21–8439SB38	11, 350V
C859	08–11051A15	.22 uF, 63V
C864	21–8215FB50	470, ±10%
C865	21–8396E10	220, ±20%
C871	21–8237ZC07	.05 uF +80, –20%, 25V
C872	21–8396E21	.01 uF +80, –20%, 200V
connector receptacle		
JU801,802	06–11009D23	0
coil, RF		
L801	24–8388AG01	red, 3 1/2 turns
L802	24–8272SH27	1.2 uH, green
L803	24–8003SA02	ferrite bead, 1/2 turn
L804	24–8027TA10	air wound
L806,807	24–8003SA02	ferrite bead, 1/2 turn
L808	24–8027TA14	1 1/2 turns, air wound
L809,810	24–8272SH27	1.2 uH, treen
L811	24–8027TA13	7 1/2 turns, airwound
L813	24–8027TA17	1 1/2 turns, airwound
L814	24–8027TA18	6 1/2 turns, airwound
L815–818	24–8027TA11	6 1/2 turns, airwound
L820	24–8272SH41	.14 uH, yellow/brown
L821	24–8003SA02	ferrite bead, 1/2 turn
thermistor		
RT801	06–83600K09	100k, green
resistor, fixed, ohm, ±5%, 1/2 watt (unless otherwise stated)		
R801	17–8016SC02	RES SHUNT
R802	06–11009C49	1k
R806	06–11009C33	220
R807	06–11045A41	470
R808,809	06–11009C09	22
R810	06–11045A41	470
R811	06–11045A01	10
R812	06–00127C17	47, ±10%, 2 watt
R813	17–8203SG07	1.5, ±10%, 2 watt
R814	06–00125B61	4.7
R815,816	06–11045A03	12
R817,818	17–8203SG11	33, ±10%, 2 watt
R822	17–8229YB24	1, 3 watt
R827	06–00125B61	4.7
R830	06–11009C97	100k
mechanical parts		
	29–8001AA01	terminal coax clip (2 used)
	26–8005ZB01	filter shield
	26–8001BC01	mounting cap heat sink
	07–8006ZB02	inductance bracket
	07–8006ZB04	inductance bracket

11/20/88

parts list

HLN4046A Feedthru Plate — MXW–4502–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, 500V (unless otherwise stated)		
C881–887	21–8281DH03	100, +100, –0%
mechanical parts		
	64–8000SA01	feedthru plate
	04–8375SH01	solder washer, 7 used

5/9/88

parts list

HLN4245A Power Amplifier Hardware — MXW–3123–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C825,826	21–8006B801	310, 350V
mechanical parts		
	02–0011I913	nut
	02–1097IA53	machine nut
	02–8000EA01	nut spanner
	03–1091IA11	machine screw M3X0.5X8
	03–1094JM15	tapping screw TT3.5X0.6X8
	03–1094JM17	tapping screw TT3.5X2.6X13
	04–0011I522	lock washer
	04–8234SA01	shoulder washer
	14–8010SB01	heat sink insulator
	14–8014SA04	high band/low band insulator
	14–8498SM01	insulator
	15–8005SB01	shield cover
	15–8476SM02	housing
	26–8001EB02	exciter board heat sink
	26–8478SM04	PA shield
	26–8486IM01	heat sink
	32–8008DA01	antenna connector gasket
	32–8008AA02	stud device gasket
	42–8001SA01	coax clip
	43–8001SB01	high power board stand off
	55–8430DB04	handle

11/15/88

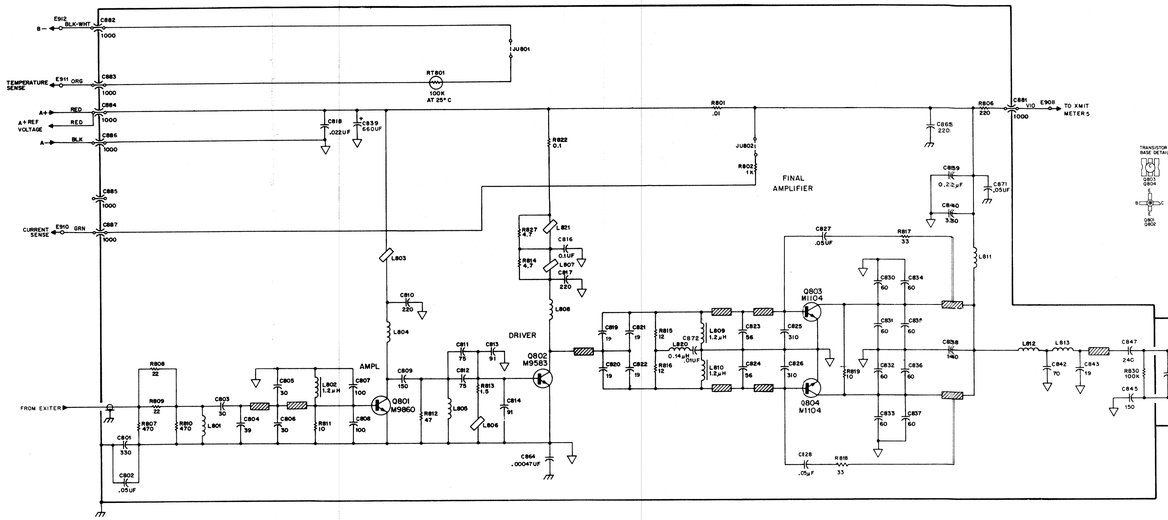
parts list

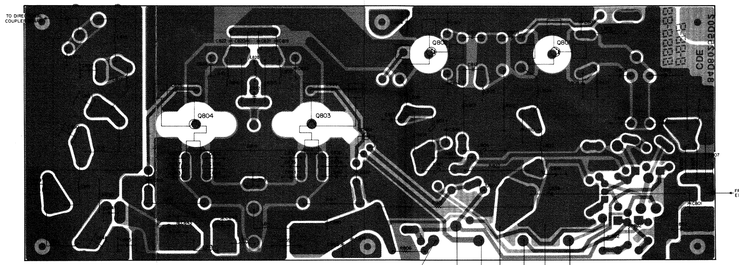
HLD4067A Power Amplifier Transistor — MXW–3124–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
transistor		
Q801	48–00869860	NPN, type M9860
Q802	48–00869583	NPN, type M9583
Q803,804	48–8441TL04	NPN, type M1104
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R819	06–11086C11	10, 2W

11/15/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.





MODEL COMPLEMENT
HLN4245A HARDWARE KIT (RGE–RGZE)
HLD4076A PA BOARD (RE–RZE)
HLD4067A POWER TRANSISTOR (RGE–RGZE)
HLN4046A FEED THRU PLATE

NOTES:
1. UNLESS OTHERWISE SPECIFIED; CAPACITOR VALUES ARE IN PICOFARADS.
2. INDICATES MICROSTRIP TRANSMISSION LINE.
3. INDICATES PA REF (A–)
   INDICATES CHASSIS REF
4. ALL PARTS MAY BE REMOVED FROM THE TOP OF THE BOARD.

CAUTION:
WHEN MOUNTING TRANSISTORS DO NOT OVERTIGHTEN (BEYOND 5–7 INCH POUNDS) OR DAMAGE TO TRANSISTORS MAY RESULT.

Schematic, Circuit Board Diagram, and Parts Lists for HLD4076B 100–Watt Power Amplifier
PW–6028–O
11/20/88

parts list

HLN4247A Intermediate Power Amplifier — MXW–3125–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±10%, 100V (unless otherwise stated)		
C700	21–11015B05	220
C701	08–11051A07	.01 uF, ±5%, 63V
C702	21–11014H40	43, ±5%
C703	21–11015B05	220
C704	23–11013D55	4.7, ±20%, 20V
C704	23–11054N08	4.7, 35V
C705	21–11014H22	7.5, ±.5 pF
C706	21–11015B05	220
C707	21–11014H38	36, ±5%
C708	21–11015B05	220
C710	21–11015B05	220
C711	21–11014H23	8.2, ±.5 pF
C712	21–11014H35	27
C713,714	21–11015B05	220
C715	08–11051A07	.01 uF, ±5%, 63V
connector receptacle		
J700	09–80001F01	phono jack
coil, RF		
L700	24–83884G01	3.5 turns, red
L701	24–83884G08	5.5 turns, orange
L702	24–80036A01	ferrite bead, .5 turn
L703	24–82723H27	1.2 uH
L704	24–83884G07	2.5 turns, green
L705	24–83961B02	5 turns, green
L706	24–83884G06	4.5 turns, white
L707	24–83884G07	2.5 turns, green
connector plug		
P700	09–83445L10	3–contact
transistor (see note)		
Q701	48–00869591	NPN
Q702	48–00869859	NPN
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R700	06–11009C25	100
R701	06–11009C49	1k
R702	06–11009C39	390
R703	06–11009C11	27
R704	06–11009C33	220
R705	06–00124B61	4.7
R706	06–11009C41	470
mechanical parts		
	29–80014A01	terminal coax clip

11/15/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

parts list

HLN4244A IPA Feedthru Plate — MXW–3126–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±20%, 500V (unless otherwise stated)		
C8,9	21–82812H07	470
mechanical parts		
	04–83755H01	solder washer
	64–80251A02	feedthru plate

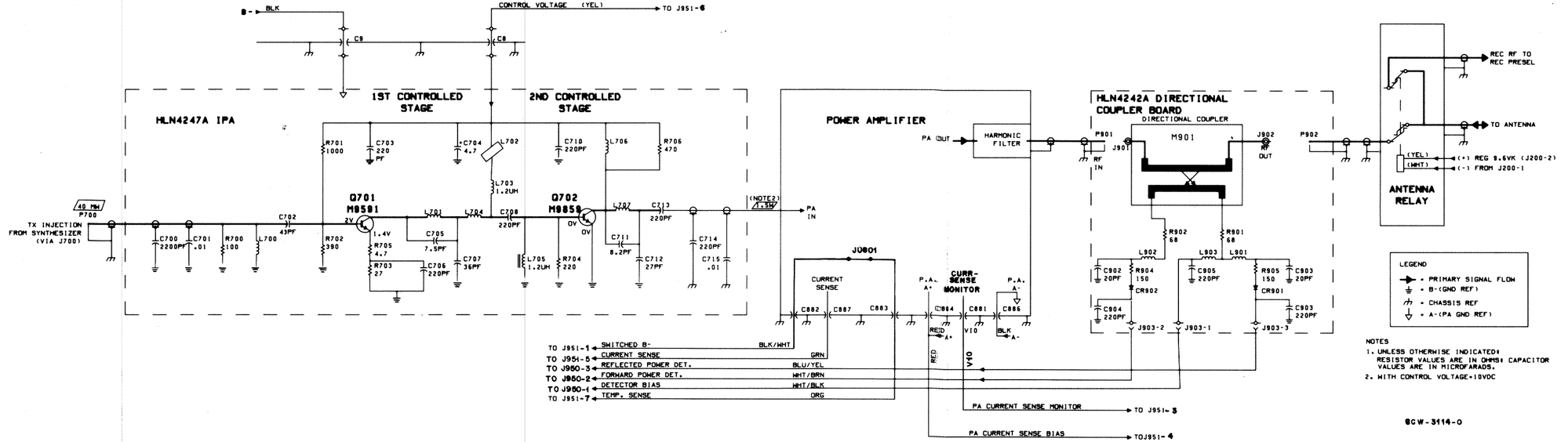
parts list

HLN4242A Directional Coupler — MXW–3127–A

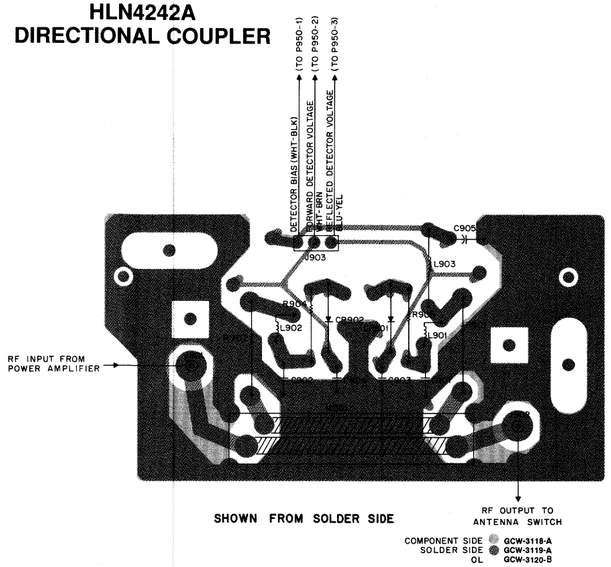
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±10%, 100V (unless otherwise stated)		
C901,902	21–11014H32	20, ±5%
C903–905	21–11015B05	220, ±10%
diode (see note)		
CR901,902	48–84616A11	hot carrier
connector receptacle		
J901,902	09–80001F01	jack phono
J903	28–84324M02	3–contact, male plug
coil, RF		
L901,902	24–84393B04	7 1/2 turns
L903	24–82723H27	1.2 uH, green
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R901,902	06–11045A21	68, 1/2 watt
R904,905	06–11009C29	150
mechanical parts		
	14–80278B01	coupler insulator (2 used)
	26–80279B01	coupler shield

11/15/88

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.



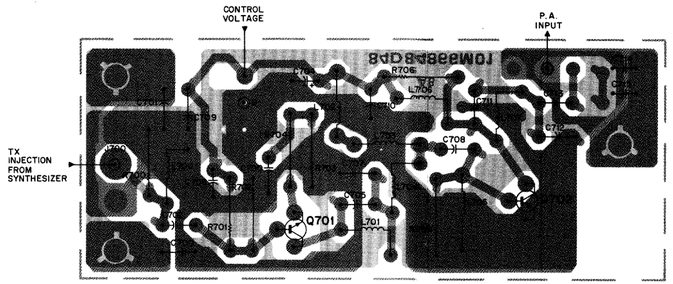
HLN4242A DIRECTIONAL COUPLER



SHOWN FROM SOLDER SIDE

COMPONENT SIDE GCW-3118-A
SOLDER SIDE GCW-3119-A
OL GCW-3120-B

HLN4247A IPA



SHOWN FROM COMPONENT SIDE

COMPONENT SIDE GBW-3115-O
SOLDER SIDE GBW-3116-A
OL GCW-3117-A

Schematic, Circuit Board Diagram, and Parts Lists for HLN4247A IPA and HLN4242A Directional Coupler

PW–6016–O

11/15/88

Section Contents

technical publication services
5555 North Beach Street, Fort Worth, Texas 76137

T10012–A
3/15/89

Common Circuits Board

1. Description

Common board circuitry performs two functions: voltage regulation and RF amplifier power control. The circuit description, theory of operation, and troubleshooting chart for the RF power control are in the transmitter section of your manual. This section covers the voltage regulators.

2. Regulator Theory of Operation

The voltage regulators consist of the 1000 series part designators. The regulator voltages are: switched 9.6 volts, switched 5 volts, and unswitched 5 volts. The power switch at the control unit controls the switched supplies (9.6 and 5 volts). The unswitched 5 volt supply remains powered up as long as the A+ lead to the radio is live, and the B– lead provides a ground return path.

2.1 9.6 VOLT REGULATOR

The 9.6 volt regulator obtains its reference from the zener diode on HY1000. The reference voltage input of U1000B at pin 5 is approximately 7.0 volts DC. The output of U1000B at pin 4 is the 9.6 volt reference. U1000C, Q1001, and the output transistor Q1000 amplifies this reference voltage. If a short circuit occurs on the 9.6 volt supply line, the diode CR1001 forward biases, removes base drive to Q1001, and shuts down the regulator to prevent further damage.

2.2 UNSWITCHED 5 VOLT REGULATOR

The TO220 packaged device U1001 contains the unswitched 5.0 volt regulator. The device generates its own reference, and is internally current limited and thermally protected. The switched 5 volt supply uses this unswitched voltage as reference, so the two regulated voltages closely track each other.

2.3 SWITCHED 5 VOLT SUPPLY

The switched 5 volt supply obtains its reference voltage from the unswitched 5 volt supply. The switched 5 volt supply is protected against excessive output current drain. Excessive current drain is sensed by the output resistors R1021 and R1022. If the drop across these resistors is .6 volts or more, the transistor Q1005 begins to conduct. This begins starving base drive to the output Darlington transistor Q1006.

2.4 SHUTBACK CIRCUIT

Both the switched supplies (5 and 9.6 volt) switch on and off by the shutback circuit. The shutback circuit senses the SW B+ line voltage, and turns the regulators off if line voltage is irregular. The shutback circuit senses over and under voltage conditions on the SW B+ line. The 9.6 volt regulator shuts back through Q1002. The base of Q1002 normally pulls low through R1006 and allows a path for Q1001 emitter current. When shut back, the base of Q1002 is pulled high by Q1004 and turns the 9.6 volt regulator off. The switched 5.0 volt regulator is shut back in a similar manner. The 5.0 volt supply is shut back through the diode CR1003. The diode is normally reverse biased and has no effect on the circuit. When shut back, the diode conducts and forces the op–amp output (U1000D) low. This causes the regulator to shut off completely. The shutback circuit senses the low–line shutback condition through the op–amp U1000A. The op–amp compares the unswitched 5.0 voltage on its positive input with the resistively divided SW B+ input on its negative input.

The circuit shuts back the regulators when SW B+ falls to approximately 8.5 volts, and turns on when SW B+ is over 9.4 volts. The high line shutback is sensed by 18–volt zener diode VR1000. This diode is presented with the SW B+ line voltage by Q1003. VR1000 has no effect to the circuit until SW B+ reaches about 20.5 volts. The 18–volt zener then conducts and clamps the base voltage of Q1004 to 19 volts. As SW B+ rises, the transistor Q1004 conducts and shuts back the switched regulators at high SW B+ voltages.

3. Regulator Troubleshooting

The following situations are explained to help troubleshoot the regulators in the *SYNTOR X 9000* radio.

- Failure of the switched 5.0 and 9.6 volt regulators
- Failure of the unswitched 5.0 volt regulator ONLY
- Failure of the 9.6 volt regulator ONLY
- Failure of the switched 5.0 volt regulator ONLY

3.1 BOTH 5 AND 9.6 VOLT REGULATOR FAILURE

(1) Inspect P300 and J1 and verify that they are properly installed.

(2) Measure SW B+ on the common circuits board. This voltage range is 10.7 to 16.2 volts. If SW B+ is outside of this range, the regulator shutback circuitry disables the regulators.

(3) Measure the voltage at the collector of Q1004. It should be .6 volts or less. If the collector is above .6 volts, repair the shutback circuit.

3.2 UNSWITCHED 5 VOLT REGULATOR FAILURE

(1) Measure the input to U1001 pin 1. This range is 10.7 to 16.2 volts. If not, repair the open path A+ or B– to the common circuits board.

(2) Measure the resistance from U1001 pin 2 to J1–B on the personality board. This should be below .1 ohms. If not, locate the resistive path or connector and repair.

(3) Measure the output of U1001 pin 3. If not between 4.75 to 5.25 volts, unsolder pin 3 to determine if the supply is shorted. If the unconnected output is not five volts, replace U1001.

3.3 9.6 VOLT REGULATOR FAILURE

(1) Measure the voltage at the emitter of Q1000. It should be between 10.7 to 16.2 volts. If not, find the open path supplying the collector.

(2) Check the op–amp output at U1000B pin 4. It should be 6.65 to 7.35 volts. Next, check U1000B pins 5 and 6. Reading should be 6.2 volts. If not, repair the reference circuit.

(3) Measure the base voltage on Q1001. This point is normally at 3.1 volts. If this point is below 2 volts or above 6 volts, repair the driving op–amp circuit involving U1000A.

(4) Measure the voltage on the base of Q1000 (output pass transistor). The base voltage should be .5 to .8 volts below the SW B+ voltage on the emitter of Q1000. If this voltage is out of range, repair the output driver involving Q1000 and Q1001.

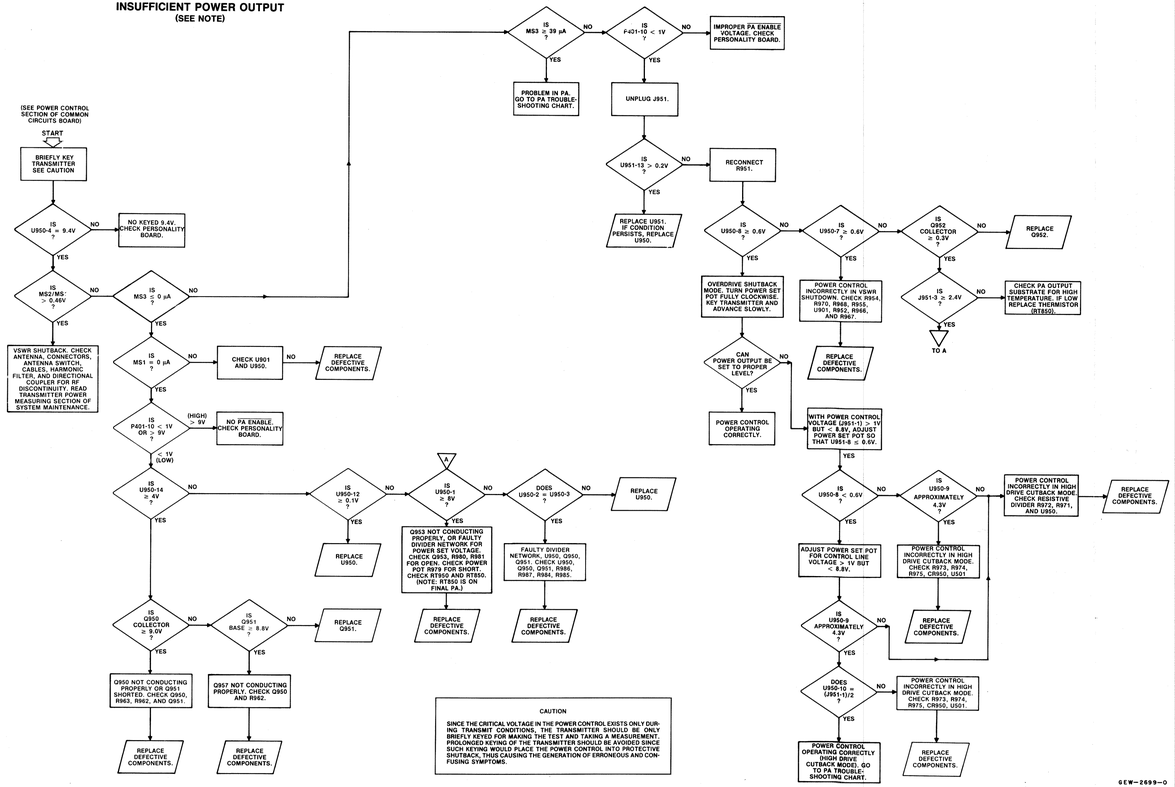
3.4 SWITCHED 5 VOLT REGULATOR FAILURE

(1) Measure the input reference voltage at U1000D pin 13, This should be 4.75 to 5.25 volts. If not, recheck the unswitched 5.0 volt regulator output. If the unswitched 5.0 supply is present, unsolder U1000 pin 13 to check if U1000 is faulty.

(2) Check the collector voltage of Q1005. Acceptable range is 10.7 to 16.2 volts. If not, find the open path to the common circuits board.

(3) Measure the driving op–amp U1000 pin 12 to determine if sufficient base drive is present for Q1006. U1000 pin 12 should be 6.4 to 7 volts. If this voltage is more than 7 volts, check the voltage drop across R1016. The drop is approximately .2 volts. If there is little or no drop across R1016, replace Q1006. If the voltage drop is excessive, remove Q1005 to disable the current shutback circuit, and recheck. Should the drop still be excessive, measure the drop across R1021. If R1021 drop is more than .7 volts, locate the fault on the switched 5.0–volt line. This fault is probably on another circuit board in the radio. If the R1021 voltage drop is less than .7 volts, replace Q1006. If the voltage on U1000 pin 12 is below 6.4 and pin 14 is less than pin 13 of U1000, replace U1000. If U1000 pin 14 is more than pin 13, check for an open R1017 or shorted CR1003.

INSUFFICIENT POWER OUTPUT
(SEE NOTE)

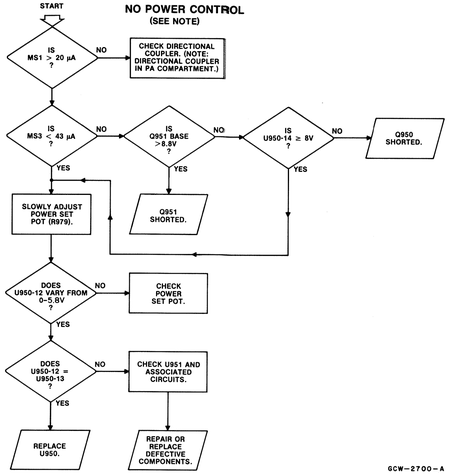


CAUTION

SINCE THE CRITICAL VOLTAGE IN THE POWER CONTROL EXISTS ONLY DURING TRANSMIT CONDITIONS, THE TRANSMITTER SHOULD BE ONLY BRIEFLY KEYED FOR MAKING THE TEST AND ADJUSTMENTS LISTED. IT IS ALSO RECOMMENDED THAT THE TRANSMITTER BE KEYED IN SUCH A MANNER AS TO AVOID ANY CONDITION WHICH WOULD PLACE THE POWER CONTROL INTO PROTECTIVE SHUTBACK, THUS CAUSING THE GENERATION OF ERRONEOUS AND CONFUSING SYMPTOMS.

GCW-2699-0

NO POWER CONTROL
(SEE NOTE)



GCW-2700-A

NOTE

WHEN THE POWER AMPLIFIER FAILS, IT IS VERY PROBABLE THAT THE POWER CONTROL PROTECTION FUNCTIONS ARE NOT OPERATING PROPERLY. CONSEQUENTLY, IT IS RECOMMENDED THAT THE FOLLOWING THREE CHECKS ILLUSTRATED ON THE FLOW CHART BE PERFORMED WHENEVER THE POWER AMPLIFIER FAILS.

(A) VSWR PROTECTION

(B) LOW-LINE CUTBACK

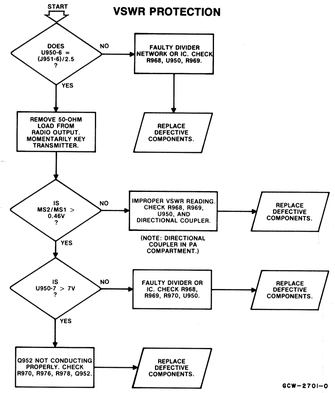
(C) HIGH-DRIVE PROTECTION

IT IS ALSO RECOMMENDED THAT THESE CHECKS BE PERFORMED AFTER COMPLETING EITHER OF THE TWO OTHER CHECKS, INSUFFICIENT POWER OUTPUT AND LACK OF POWER CONTROL.

NOTE

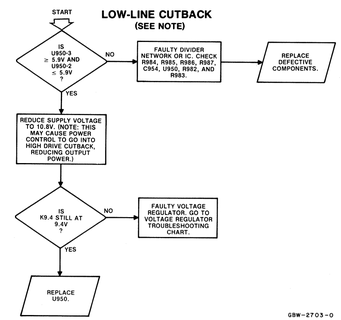
ALL VOLTAGE VALUES ARE REFERENCED TO A –.

VSWR PROTECTION



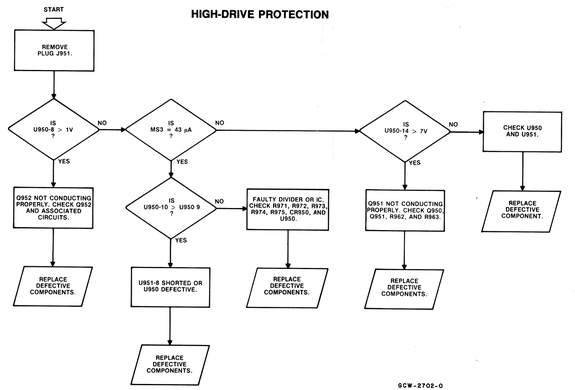
GCW-2701-0

LOW-LINE CUTBACK
(SEE NOTE)



GBW-2703-0

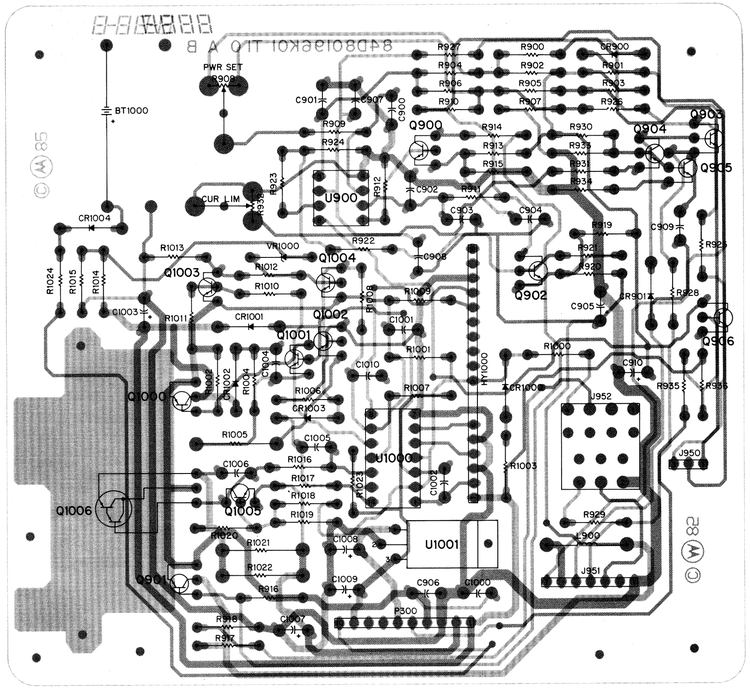
HIGH-DRIVE PROTECTION



GCW-2702-0

Troubleshooting Charts for Common Circuits Board
PW–2767–A
1/25/89

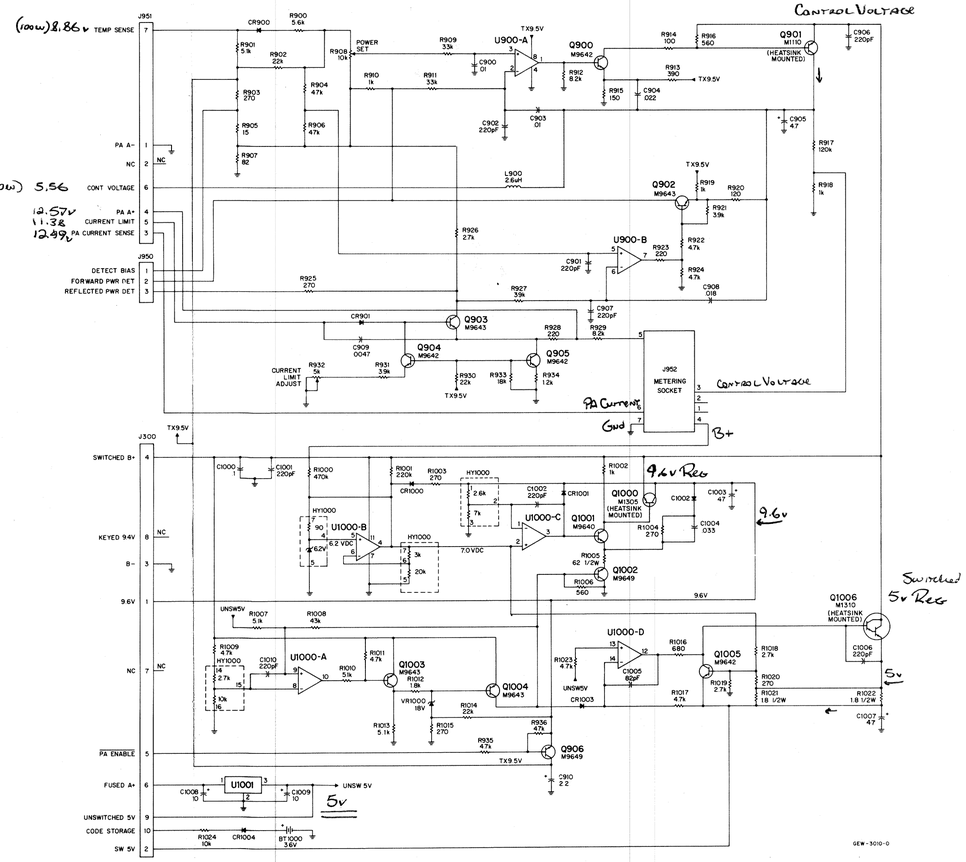
HLN4906A
VHF COMMON CIRCUITS BOARD



COMPONENT SIDE VIEW

SOLDER SIDE — GEW-2504-O
COMPONENT SIDE — GEW-2505-O
OVERLAY — GEW-2507-O

Schematics, Circuit Board Diagram, and
Parts List for HLN4906A VHF Common Circuits Board
PW-2587-C
3/15/89



parts list

HLN4906A VHF Common Circuit Board — MXW-2485-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed, pF ±10%, 100V unless otherwise stated
C900	08-11051A07	.01 ±5%, 63V
C901, 902	21-11015B05	220 pF
C903	08-11051A07	.01 ±5%, 63V
C904	08-11051A09	.022 ±5%, 63V
C905	23-11013D55	4.7 ±20%, 20V, tantalum
C906, 907	21-11015B05	220 pF
C908	08-11044A34	.018 ±5%, 63V
C909	08-11051A05	.0047 ±5%, 63V
C910	23-11013F59	2.2 ±20%, 35V, tantalum
C1000	08-11051A13	.1 ±5%, 63V
C1001, 1002	21-11015B05	220 pF
C1003	23-11019A39	47 ±20%, 16V, electrolytic
C1004	08-11051A10	.033 ±5%, 63V
C1005	21-11014B47	82 pF ±5%
C1006	21-11015B05	220 pF
C1007	23-84538G06	47 ±20%, 20V, tantalum
C1008	23-11048C11	10 ±20%, 35V, electrolytic
C1009	23-11013E57	10 ±20%, 25V, tantalum
C1010	21-11015B05	220 pF
		diode (see note)
CR900, 901	48-80005E01	silicon
CR1000-1004	48-80005E01	silicon
		hybrid (see note)
HY1000	01-80715D03	hybrid regulator
		connector receptacle
J300	30-80263K01	10-contact, cable assembly
J950	28-84324M02	polarized 3-contact
J951	28-84647L05	7-contact
J952	09-84207B01	7-contact
		coil
L900	24-82835G08	2.6 µH, red/blue/gold
		transistor (see note)
Q900	48-00869642	NPN
Q901	48-84411L10	PNP, heatsink mounted
Q902, 903	48-00869643	PNP
Q904, 905	48-00869642	NPN
Q906	48-00869649	PNP
Q1000	48-84413L05	PNP, type M1305 heatsink mounted
Q1001	48-00869640	NPN, type M9640
Q1002	48-00869649	PNP
Q1003, 1004	48-00869643	PNP
Q1005	48-00869642	NPN
Q1006	48-84413L10	NPN, type M1310 heatsink mounted, Darlington
		resistor, fixed, Ω ±5%, ¼ W unless otherwise stated
R900	06-11009A67	5.6k
R901	06-11009A56	5.1k
R902	06-11009A81	22k
R903	06-11009A35	270
R904	06-11009A89	47k
R905	06-11009A05	15
R906	06-11009A89	47k
R907	06-11009A23	82
R908	18-80087E08	10k, variable
R909	06-11009A85	33k
R910	06-11009A49	1k
R911	06-11009A85	33k
R912	06-11009A71	8.2k
R913	06-11009A39	390
R914	06-11009A25	100
R915	06-11009A29	150
R916	06-11009A43	560
R917	06-11009A99	120k
R918, 919	06-11009A49	1k
R920	06-11009A27	120
R921	06-11009A63	3.9k
R922	06-11009A65	4.7k
R923	06-11009A33	220
R924	06-11009A65	4.7k
R925	06-11009A35	270
R926	06-11009A59	2.7k
R927	06-11009A87	39k
R928	06-11009A33	220
R929	06-11009A71	8.2k
R930	06-11009A81	22k
R931	06-11009A63	3.9k
R932	18-80087E07	5k, variable
R933	06-11009A79	18k
R934	06-11009A51	1.2k
R935	06-11009A65	4.7k
R936	06-11009A89	47k
R1000	06-11009B14	470k
R1001	06-11009B06	220k
R1002	06-11009A49	1k
R1003	06-11009A35	270
R1004	06-11009A35	270
R1005	06-11045A20	62, ½ W

MXW-2485-O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R1006	06-11009A43	560
R1007	06-11009A56	5.1k
R1008	06-11009A88	43k
R1009	06-11009A65	4.7k
R1010	06-11009A66	5.1k
R1011	06-11009A65	4.7k
R1012	06-11009A55	1.8k
R1013	06-11009A66	5.1k
R1014	06-11009A81	22k
R1015	06-11009A35	270
R1016	06-11009A45	680
R1017	06-11009A65	4.7k
R1018, 1019	06-11009A59	2.7k
R1020	06-11009A35	270
R1021, 1022	06-80037G07	1.8, ½ W
R1023	06-11009A65	4.7k
R1024	06-11009A73	10k
		integrated circuit (see note)
U900	51-80067C03	dual op amp
U1000	51-80067C06	quad op amp
U1001	51-80068C02	voltage regulator, 5V
		voltage regulator (see note)
VR1000	48-82256C53	18V, zener
		mechanical parts
	14-83820M02	thermoconductor insulator
	04-84152B01	shoulder washer
	03-12065A05	machine screw (M3 × 0.5 × 8)
	05-80200K01	nylon rivet

note: For best performance, order diodes, transistors, and integrated circuits by Motorola part number.

parts list

HLN4906B VHF Common Circuits Board for *SYNTOR X 9000* MXW–2485–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C900	08–11051A07	.01 uF, ±5%, 63V
C901	21–11015B05	220 pF, ±10%, 100V
C902	21–11015B05	220 pF, ±10%, 100V
C903	08–11051A07	.01 uF, ±5%, 63V
C904	08–11051A09	.022 uF, ±5%, 63V
C905	23–11054M08	4.7 uF, ±10%, 35V, tantalum
C906,907	21–11015B05	220 pF, ±10%, 100V
C908	08–11051A20	.018 uF, ±5%, 63V
C909	08–11051A05	.0047 uF, ±5%, 63V
C910	23–11054M01	2.2 uF, ±10%, 35V, tantalum
C1000	08–11051A13	.1 uF, ±5%, 63V
C1001,1002	21–11015B05	220 pF, ±10%, 100V
C1003	23–11019A39	47 uF, ±20%, 16V, electrolytic
C1004	08–11051A10	.033 uF, ±5%, 63V
C1005	21–11014B47	82 pF, ±5%, 100V
C1006	21–11015B05	220 pF, ±10%, 100V
C1007	23–84538G06	47 uF, ±20%, 20V, tantalum
C1008	23–11048C11	10 uF, ±20% 35V, electrolytic
C1009	23–84538G29	47 uF, ±20% 10V, tantalum
C1010	21–11015B05	220 pF, ±10%, 100V
diode (see note)		
CR900,901	48–83654H01	silicon
CR1000–1007	48–83654H01	silicon
hybrid (see note)		
HY1000	01–80715D03	hybrid regulator assembly
connector receptacle		
J950	28–84324M02	3 contact
J951	28–84647L05	7 pin
J952	09–84207B01	7 contact
coil, RF		
L900	24–82835G08	2.6 uH. red blue gold
transistor (see note)		
Q900	48–00869642	NPN
Q902,903	48–00869643	PNP
Q904,905	48–00869642	NPN
Q906	48–00869649	PNP
Q1000	48–84413L05	PNP, with heatsink
Q1001	48–00869640	NPN, type M9640
Q1002	48–00869649	PNP
Q1003,1004	48–00869643	PNP
Q1005	48–00869642	NPN
Q1006	48–84413L10	NPN, Darlington
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R900	06–11009A67	5.6k
R901	06–11009A66	5.1k
R902	06–11009A81	22k
R903	06–11009A35	270
R904	06–11009A39	47k
R905	06–11009A05	15
R906	06–11009A89	47k
R907	06–11009A23	82
R908	18–80087E08	10k potentiometer
R909	06–11009A85	33k
R910	06–11009A49	1k
R911	06–11009A85	33k
R912	06–11009A71	8.2k
R913	06–11009A39	390
R914	06–11009A25	100
R915	06–11009A29	150
R916	06–11009A43	560
R917	06–11009A99	120k
R918,919	06–11009A49	1k
R920	06–11009A27	120
R921	06–11009A63	3.9k
R922	06–11009A65	4.7k
R923	06–11009A33	220
R924	06–11009A65	4.7k
R925	06–11009A35	270
R926	06–11009A59	2.7k
R927	06–11009A87	39k
R928	06–11009A33	220
R929	06–11009A71	8.2k
R930	06–11009A81	22k
R931	06–11009A63	3.9k
R932	18–80087E07	5k potentiometer
R933	06–11009A79	18k
R934	06–11009A51	1.2k
R935	06–11009A65	4.7k
R936	06–11009A89	47k
R1000	06–11009B14	470k
R1001	06–11009B06	220k
R1002	06–11009A49	1k
R1003,1004	06–11009A35	270
R1005	06–11045A20	62, 1/2W
R1006	06–11009A43	560
R1007	06–11009A66	5.1k
R1008	06–11009A88	43k
R1009	06–11009A65	4.7k
R1010	06–11009A66	5.1k
R1011	06–11009A65	4.7k
R1012	06–11009A55	1.8k
R1013	06–11009A66	5.1k
R1014	06–11009A65	4.7k
R1015	06–11009A35	270
R1016	06–11009A45	680
R1017	06–11009A65	4.7k
R1018,1019	06–11009A59	2.7k

MXW–2485–B (2)

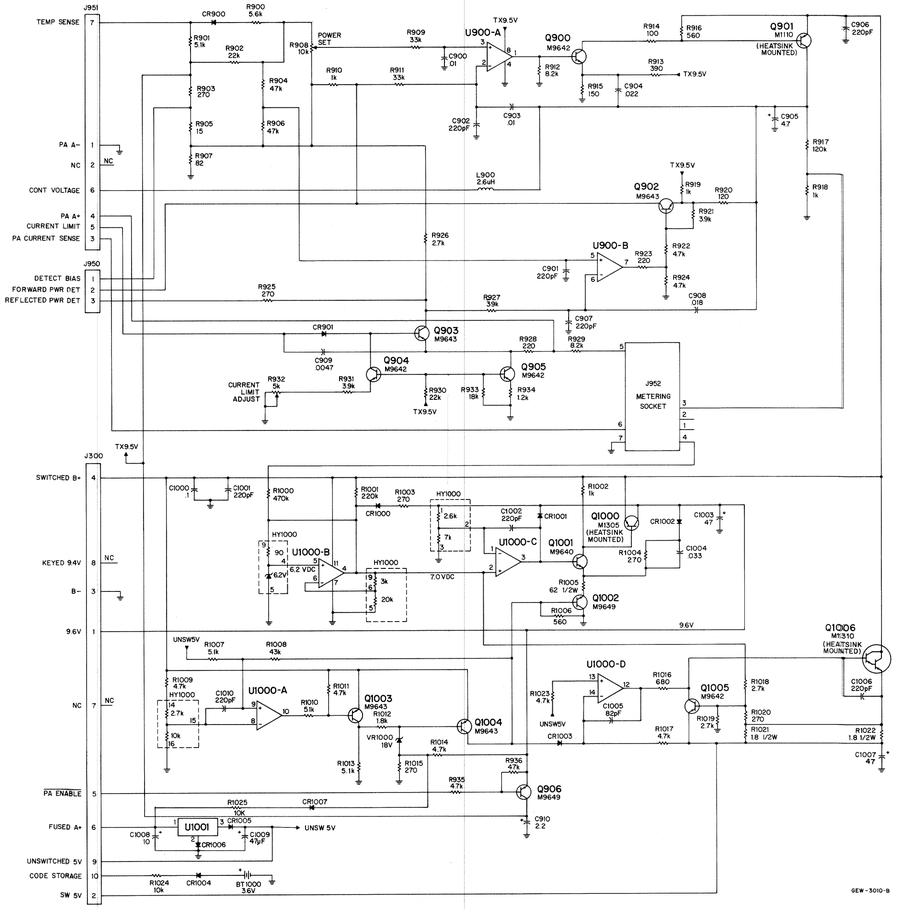
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R1020	06–11009A35	270
R1021,1022	06–80037G07	1.8, 1/2W
R1023	06–11009A65	4.7k
R1024	06–11009A49	1k
R1025	06–11009A73	10k
integrated circuit (see note)		
U900	51–80067C03	dual opamp
U1000	51–80067C06	quad opamp
U1001	51–80068C02	5V voltage regulator
voltage regulator (see note)		
VR1000	48–82256C53	18V

mechanical parts

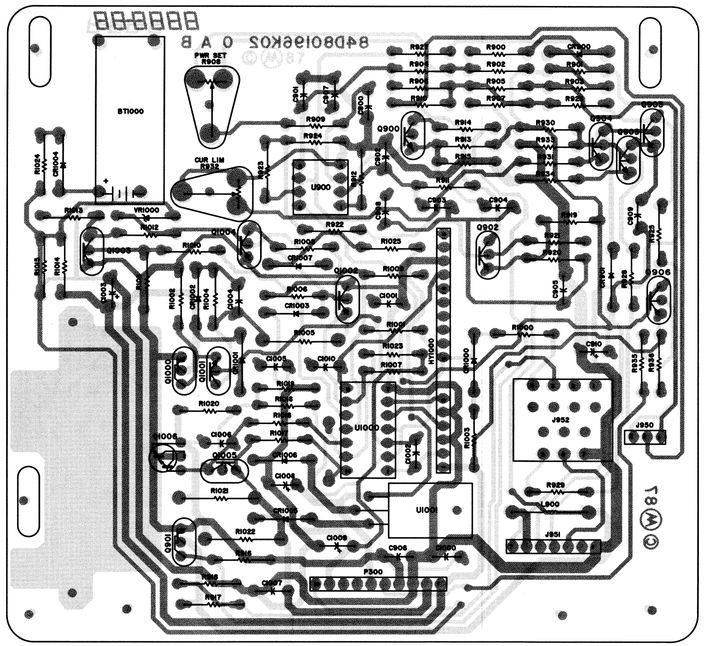
03–10911A11	machine screw (3 x 0.5 x 8)
26–84835M04	regulator heatsink
75–80171L01	hybrid pad
54–80072G01	label
03–10943M10	tapping screw (3 x 0.5 x 8)
05–80200K01	nylon rivet
14–83820M02	heat conductive insulator
04–84180C01	nylon shoulder washer

3/15/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.



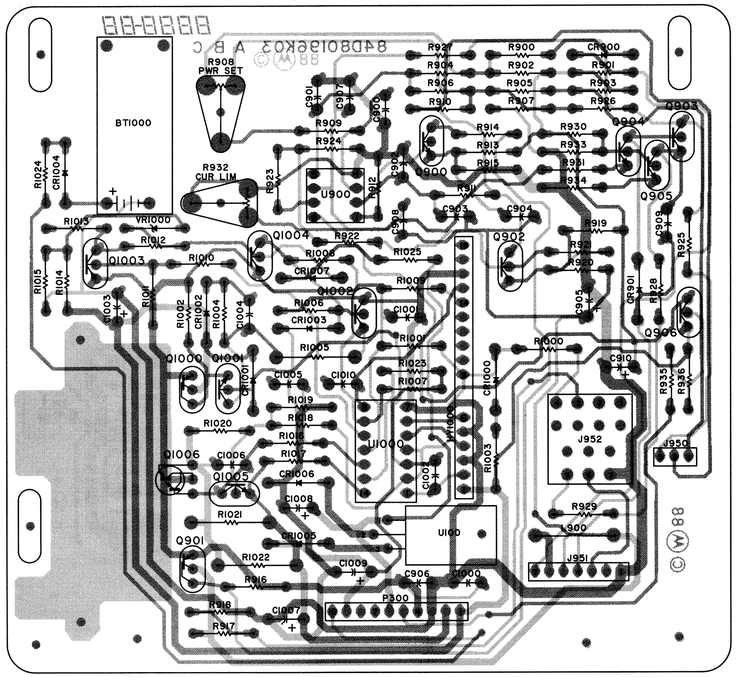
HLN4906B
VHF COMMON CIRCUITS BOARD



SOLDER SIDE GAW–2504–A
COMPONENT SIDE GW–2505–A
OVERLAY GXW–2507–A

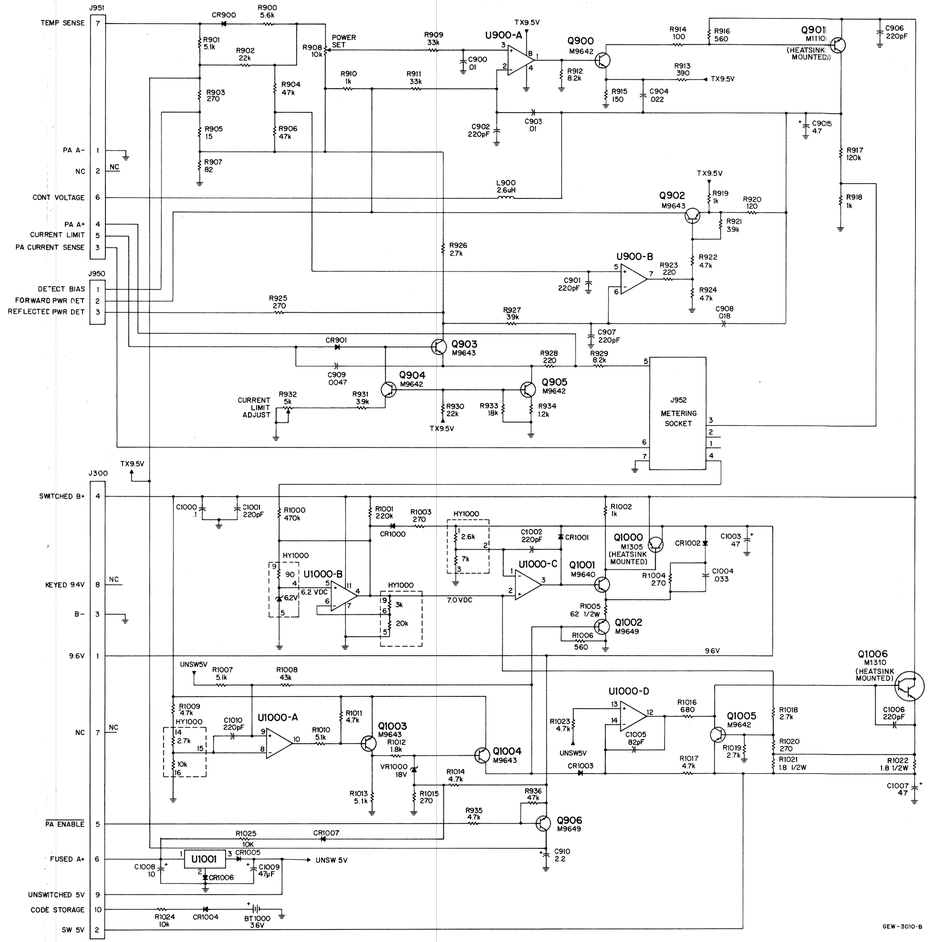
Schematics, Circuit Board Diagram, and
Parts List for HLN4906B VHF Common Circuits Board
PW–6468–O
3/15/89

HLN4906C
VHF COMMON CIRCUITS BOARD



COMPONENT SIDE VIEW

Schematic, Circuit Board Diagram and Parts List
for HLN4906C VHF Common Circuits Board
PW–6469–O
3/15/89



parts list

HLN4906C VHF Common Circuits Board for *SYNTOR X 9000* MXW–6474–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed (unless otherwise stated)		
C900	08–11051A07	.01 uF, ±5%, 63V
C901,902	21–11015B05	220 pF, ±10%, 100V
C903	08–11051A07	.01 uF, ±5%, 63V
C904	08–11051A09	.022 uF, ±5%, 63V
C905	23–11054N08	4.7 uF, ±10%, 35V, tantalum
C906,907	21–11015B05	220 pF, ±10%, 100V
C908	08–11051A20	.018 uF, ±5%, 63V
C909	08–11051A05	.0047 uF, ±5%, 63V
C910	23–11054M01	2.2 uF, ±10%, 35V, tantalum
C1000	08–11051A13	.1 uF, ±5%, 63V
C1001,1002	21–11015B05	220 pF, ±10%, 100V
C1003	23–11019A39	47 uF, ±20%, 16V, electrolytic
C1004	08–11051A10	.033 uF, ±5%, 63V
C1005	21–11014B47	82 pF, ±5%, 100V
C1006	21–11015B05	220 pF, ±10%, 100V
C1007	23–84538G29	47 uF, ±20%, 10V, tantalum
C1008	23–11048C11	10 uF, ±20%, 35V, electrolytic
C1009	23–84538G29	47 uF, ±20%, 10V, tantalum
C1010	21–11015B05	220 pF, ±10%, 100V
diode (see note)		
CR900,901	48–83654H01	silicon
CR1000–1007	48–83654H01	silicon
hybrid (see note)		
HY1000	01–80715D03	hybrid regulator assembly
connector receptacle		
J300	30–80263K01	10 contact cable assembly
J950	28–84324M02	3 contact
J951	28–84647L05	7 pin
J952	09–84207B01	7 contact
coil, RF		
L900	24–82835G08	2.6 uH, red blue gold
transistor (see note)		
Q900	48–00869642	NPN
Q901	48–84411L10	PNP, heatsink mounted
Q902,903	48–00869643	PNP
Q904,905	48–00869642	NPN
Q906	48–00869649	PNP
Q1000	48–84413L05	PNP, with heatsink
Q1001	48–00869640	NPN
Q1002	48–00869649	PNP
Q1003,1004	48–00869643	PNP
Q1005	48–00869642	NPN
Q1006	48–84413L10	NPN, Darlington, heatsink mounted
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R900	06–11009A67	5.6k
R901	06–11009A66	5.1k
R902	06–11009A81	22k
R903	06–11009A35	270
R904	06–11009A89	47k
R905	06–11009A05	15
R906	06–11009A89	47k
R907	06–11009A23	82
R908	18–80087E08	10k potentiometer
R909	06–11009A85	33k
R910	06–11009A49	1k
R911	06–11009A85	33k
R912	06–11009A71	8.2k
R913	06–11009A39	390
R914	06–11009A25	100
R915	06–11009A29	150
R916	06–11009A43	560
R917	06–11009A99	120k
R918,919	06–11009A49	1k
R920	06–11009A27	120
R921	06–11009A63	3.9k
R922	06–11009A65	4.7k
R923	06–11009A33	220
R924	06–11009A65	4.7k
R925	06–11009A35	270
R926	06–11009A59	2.7k
R927	06–11009A87	39k
R928	06–11009A33	220
R929	06–11009A71	8.2k
R930	06–11009A81	22k
R931	06–11009A63	3.9k
R932	18–80087E07	5k potentiometer
R933	06–11009A79	18k
R934	06–11009A51	1.2k
R935	06–11009A65	4.7k
R936	06–11009A89	47k
R1000	06–11009B14	470k
R1001	06–11009B06	220k
R1002	06–11009A49	1k
R1003,1004	06–11009A35	270
R1005	06–11045A20	62, 1/2W
R1006	06–11009A43	560
R1007	06–11009A66	5.1k
R1008	06–11009A88	43k
R1009	06–11009A65	4.7k
R1010	06–11009A66	5.1k
R1011	06–11009A65	4.7k
R1012	06–11009A55	1.8k
R1013	06–11009A66	5.1k
R1014	06–11009A65	4.7k
R1015	06–11009A35	270
R1016	06–11009A45	680
R1017	06–11009A65	4.7k

MXW–6474–O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R1018,1019	06–11009A59	2.7k
R1020	06–11009A35	270
R1021,1022	06–80037G07	1.8, 1/2W
R1023	06–11009A65	4.7k
R1024,1025	06–11009A73	10k
integrated circuit (see note)		
U900	51–80067C03	dual opamp
U1000	51–80067C06	quad opamp
U1001	51–80068C02	5V voltage regulator
voltage regulator (see note)		
VR1000	48–82256C53	18V
mechanical parts		
	26–84835M04	regulator heatsink
	14–83820M02	heat conductive insulator
	04–84180C01	nylon shoulder washer
	05–80200K01	nylon rivet

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note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

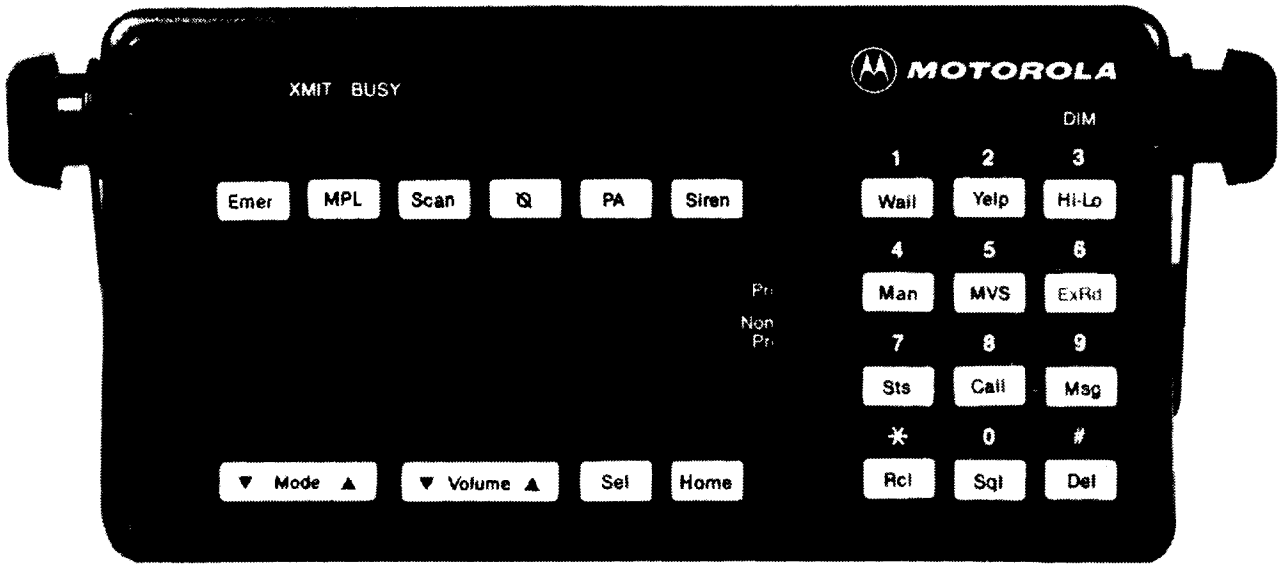
MOTOROLA
Mobile Products Division

Control Unit, Cable Kits, and Accessories

Section Contents

technical publication services
5555 North Beach Street, Fort Worth, Texas 76137
T10014–A
3/15/89

Control Unit, Cable Kits and Accessories



GPW–2538–A

Figure 1. Typical Systems 9000 *Control Unit*

1. Description

1.1 GENERAL

Note

A variety of Motorola's *SYNTOR X 9000* radio systems use the *Systems 9000* Control Unit. The differences between control units is in the programming software and button legends.

The *Systems 9000* control unit is a microcomputer based unit that processes all the button inputs and displays used by the radio and the options. It also interfaces with the vehicle via the vehicle interface ports (VIP).

1.2 CONTROLS AND INDICATORS

1.2.1 Power Switch

The power switch is a slide switch on the right–hand bottom surface of the control unit. It turns the radio and its accessories on and off.

1.2.2 Display

The eleven–character vacuum fluorescent display's primary function is to display mode numbers, mode names, volume level, and the status of options. It also functions as an on–off indicator for the entire system, and plays an integral role in the operator's reconfiguration of options.

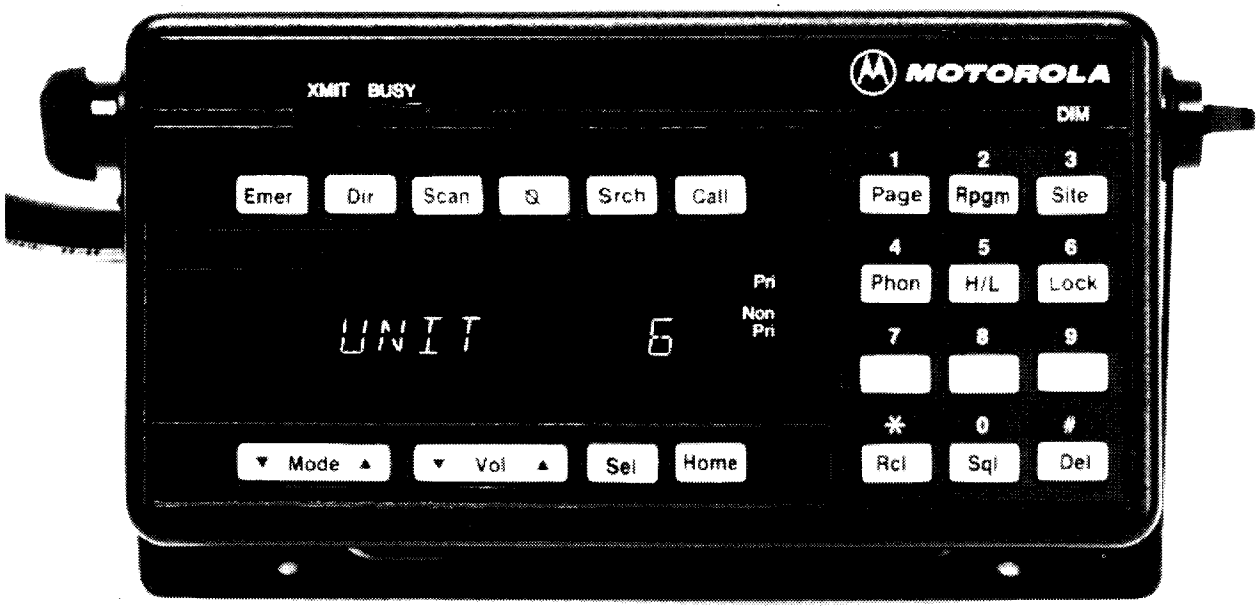


Figure 2. Systems 9000 *Control Unit for* SYNTOR X 9000E *Radios* GPW–4141–A

1.2.3 Option Buttons

Located above the display window is a row of six buttons for turning options on and off. Below each is a small indicator light to show the status of the option.

1.2.4 XMIT and BUSY Indicators

Above the six option buttons are XMIT and BUSY indicators. The XMIT indicator lights when the radio is transmitting. The BUSY indicator lights when the selected channel is busy.

1.2.5 Scan Indicators

In the right–hand side of the display window are the NON–PRI and PRI indicator lights. When scan operation detects activity on a non–priority (NON–PRI) channel, the NON–PRI light comes on. Activity on a second priority channel causes PRI to light. First priority channel activity causes PRI to flash.

1.2.6 Mode Rocker Switch

Below the display window is the Mode rocker. Pressing the right side of this rocker switch increases the mode number. Press the left side to decrease the mode number. If you press and hold the switch, it scrolls the mode numbers up or down. The mode names appear in the display window.

1.2.7 Volume Rocker Switch

Below the display window, beside the Mode switch is the Volume rocker. Press and release to check volume setting. Your display shows "VOLUME _ _" and a number value (0–15). Press and hold the right side of the rocker to increase the volume setting. Press and hold the left side to decrease volume. The number value scrolls up or down to your desired level.

The volume rocker also controls the volume level of the public address (PA) and external radio speaker (ExRd) options when they are enabled. The display window shows "PA VOL_ _" when public address is on and the volume rocker is pressed.

1.2.8 Home and Sel Buttons

Press the Home button to go to the radio's pre–programmed "Home" mode. You may use Home instead of Mode to change modes. Hold Home until a beep sounds to enter the configuration state. The display shows an entry prompt. Use the keypad to enter your new mode choice and press Home again. Your mode is now changed without scrolling.

Use the Sel button when configuring an option. See the descriptions of the options for more specific information.

1.2.9 DIM Button

Above the keypad, on the right side of the control unit, is the control for the brightness of the display and button backlighting. When you turn on the system, the display comes on at the highest level. Press DIM once to reduce the brightness of the display to medium level, and twice for low brightness level. Press DIM a third time to turn the display and button backlighting off. This is called the "surveillance" mode.

1.2.10 Keypad

The keypad is for changing the status of options and entering numbers to the display. See the Operator's Manual for a complete description of button operation.

2. Theory of Operation

2.1 GENERAL

The *Systems 9000* control unit has solid state microprocessor circuitry that operates the standard and optional features built into the system. The control unit design allows installation in even the smallest of down–sized vehicles. Systems that have many options simply require more control unit buttons, not larger control units.

The control unit may be field programmed to alter the information stored in certain areas of its electronic memory. Some options are also added by field programming.

2.1.1 Display

The control unit has an eleven–character alphanumeric vacuum fluorescent display for indicating the following:

- Mode Names
- Squelch Level
- Volume Level
- Status Codes
- Message Codes
- Telephone Numbers
- Identification Numbers
- Alarm Displays
- Option Status

2.1.2 Controls and Indicators

A twelve button keypad contains traditional alphanumeric keys. These keys double as function keys for *SYNTOR X 9000* options. All buttons are backlit to allow operation in low–light. Six ON/OFF option buttons and indicator lights above the display window tell whether these options are on or off.

Other indicators include BUSY, TRANSMIT, PRIORITY, and NON–PRIORITY. BUSY lights when activity is detected on the channel. The XMIT (transmit) indicator lights when you are transmitting.

When activity occurs during a Scan sequence, the NON–PRI (non–priority) or PRI (priority) light is on. If the detected activity be on a NON–PRI mode, the NON–PRI light is on. If the activity is on PRI mode the PRI indicator lights for second priority modes, and flashes for first priority modes.

2.2 CONTROL BOARD

The control board's microprocessor (MPU) communicates on the serial bus, receives and interprets keypad data, and controls the volume. The MPU sends ASCII data to a decoder to control the display, and sends data to turn the LEDs on or off. The control board has a watchdog timer that senses the need for a system reset. The vehicle interface ports are also controlled on this board.

2.2.1 Microprocessor (MPU)

The MPU operates in mode 2 (expanded bus with internal ROM active). Table 1 gives jumper placements for different modes. The clock frequency is 4.9152 MHz that results in an internal operating frequency of 1288 kHz. The limited number of I/O ports is augmented by using a serial–to–parallel shift register (U3) to scan the keyboard, and to switch the VIP drivers (Q28, Q29, Q30, and Q33).

Table 1. Mode Jumper Placement

Microprocessor Mode	JU3	JU6
No. 1–Expanded mode with external ROM only.	IN	OUT
No. 2–Expanded mode with internal ROM active.	OUT	IN
No. 3–Single Chip.	OUT	OUT

2.2.2 Watchdog Timer

The watchdog timer consists of U5 (comparator) and Q4 (SCR). On system power–up, C06 pulls the inverting input of U5 high while R10 and R11 hold the non–inverting input at VCC/2. The output goes low and the microprocessor resets.

As C06 charges through R14, the voltage on the inverting input drops below that of the non–inverting input, the output goes high, and the microprocessor can start operating. R14 is now pulling up on C06, and the inverting–input voltage begins to rise.

During this interval, the processor generates tickle pulses to periodically fire Q4, preventing the inverting–input voltage from rising above the non–inverting input voltage and repeating the reset cycle. If the tickle pulses stop for more than 150 mSec, the reset cycle is repeated.

2.2.3 EEPROM

The EEPROM stores customer data including mode names, button functions, and VIP settings. The customer data can be altered only by enabling the "STORE" function (grounding the MIC HI line); an automatic function of the control unit programmer. Power strobing minimizes EEPROM power consumptions. Jumpers configure the EEPROM for the uses shown in Table 2.

Table 2. EEPROM Jumper Table

JUMPER	USE/PLACEMENT
JU1	Used for future options
JU2	IN for 6301X Microprocessor
JU4	IN for 2K EEPROM; OUT for 8K EEPROM (option W930)
JU5	IN for 8K EEPROM (option W930) OUT for 2K EEPROM

2.2.4 Bus Transceiver

The serial bus transceiver consists of Q1, Q2, Q3, and U4 (CA3140). Q1, Q2, and Q3 transmit data on the bus while U4 acts as a comparator to receive data from the bus.

2.2.5 Vacuum Fluorescent Voltage Converter

Voltage for the vacuum fluorescent display is generated by a fixed frequency, variable–duty cycle driven, flyback voltage converter. Q31 and Q32 form an emitter–coupled astable multivibrator that runs at about 150 kHz. The square wave output from this circuit is integrated by R71 and C39 to form a triangle that is applied to the non–inverting input of half of U5.

During start up, the inverting input is biased at 3.7 volts by R66 and R67. Q23 is on while the non–inverting input voltage is below 3.7 volts. This allows current to flow the T1, building a magnetic field. When the triangle wave exceeds 3.7 volts, Q23 turns off and the magnetic field collapses, inducing negative current in T1.

This current flows through either CR13 or CR14, charging C27 and C28. As the voltage on C28 increases beyond –35 volts, CR13 begins to conduct, pulling U5's inverting input below 3.7 volts. This decreases the cycle time that Q23 is on to the time needed to produce –35 volts on C28. The –41 volt sup ply is not regulated, but it tracks the –35 volt supply.

Similarly, the AC supply for the vacuum fluorescent filament is not regulated, but is controlled to within one volt by and inductor on the display board.

2.2.6 Vehicle Interface Ports (VIP)

The VIP outputs are driven by a serial–to–parallel shift register. Output transistors (Q28, Q29, Q30) can sink 300 mA current. Primarily, these transistors control external relays. The relay is connected between the collector and switched B+.

Each VIP input transistor (Q25, Q26, Q27) is connected to a dedicated input port through transistors used for input protection. These VIP inputs are connected to ground with either normally–open or normally–closed switches.

2.2.7 Power Supplies

Both the +5 and the +9.4 volt supplies are linear regulators. The +9.4 supply is built with a discrete transistor (Q11). The regulation is provided by VR09. The +5 volt supply is a 7805, three–terminal regulator IC.

2.2.8 Ignition Sense Circuits

Q7 senses the vehicle ignition's state, disabling transmit when the ignition is off. For negative–ground systems, the orange lead is typically connected to the fuse box (+12V). For more information, see the cable kit section.

2.2.9 EEPROM Write–Protect Circuit

Q12, Q13, and associated circuitry guard against inadvertently writing into the EEPROM. When MIC HI is grounded, Q21 (normally on) is turned off. A hot–carrier diode (CR24) ensures that Q21 turns off. CR24 is normally off so it does not interfere with the MIC HI line.

CR19 forces the system to be write–protected during reset; this is especially crucial during system power–up.

2.3 DISPLAY BOARD

This board contains the main operator interface points of the system, including the vacuum fluorescent display, the status indicator LEDs, and the user keypad.

2.3.1 Vacuum Fluorescent Display

The vacuum fluorescent (VF) display is an eleven digit, 14–segment display that needs three separate voltages to operate: the cathode needs –35 volts to accelerate electrons to the anode; the grid needs –40 volts to totally shut off current flow; the filament needs 3.8 volts AC at 80 mA. These voltages are obtained from the VF up–converter on the controller board.

2.3.2 Vacuum Fluorescent Display Driver

This IC (U101) receives ASCII data from the controller board, decodes it into 14–segment display data, and then scans the display with the data. Once properly loaded into the driver, the displayed data is refreshed without any further processor action. The display driver is periodically reset by the actions of transistors Q118, Q119, and Q110 that watch the clock line from the processor to the display driver. When the clock line is held low for more than 600 mSec, the display driver resets and new display data follows.

2.3.3 Voltage Supply

The AC voltage present on Q23 of the controller board is used to obtain the –10 volts needed to run the display driver IC. This voltage is fed through L101 to limit the current and then rectified by CR107 and shunt regulated by CR108.

2.3.4 Status LEDs

These LEDs are driven by the display driver as though they were decimal points on the VF display. Level shifting transistors are required for this since the display driver uses 39 volts for control signals.

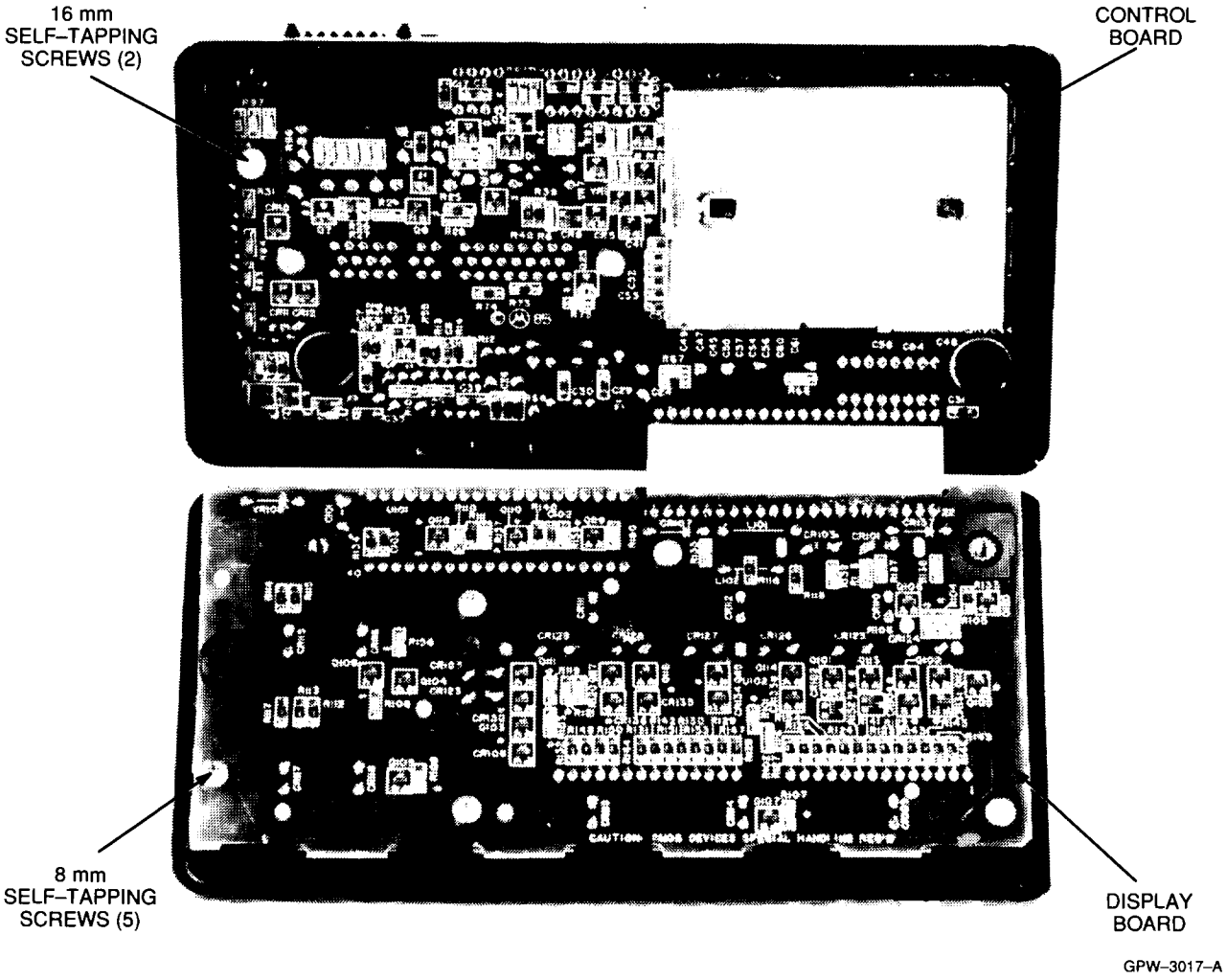


Figure 3. Disassembly of the Control Unit

2.3.5 Backlight LEDs

The same microprocessor signal that turns the VF power supply on and off also operates the backlight LEDs. Q120 supplies base current to the individual LED driver transistors. The driver transistors act as constant current sources to the LEDs. Backlight LEDs CR115, CR116, CR117, and CR118 are connected to thermistor R163 by way of Q108. This circuit allows more current to flow through these LEDs at room temperature and reduces current as the temperature rises.

3. Control Unit Maintenance

3.1 DISASSEMBLY OF CONTROL UNIT
(See Figure 3)

Note

Before disassembling the control unit, note the location of the labeled buttons.

Remove the two 30mm slotted screws that hold the front and back of the control unit together. The two halves separate at the top; at the bottom, they are held together by the flex cable that interconnects the circuit boards. Place the unit so the PC boards are facing up.

Remove the five 8mm screws in the display board and carefully remove the front of the control unit housing. Keep the front housing parts as a complete unit (including the front housing, buttons, and display board light pipe). Always keep the front of the display housing face down when handling.

Remove the two 16mm self–tapping screws on the control board. Remove the back of the control unit housing. Remove the black gasket around the switch and set it aside. Remove the shields from the top and bottom of the control board. All components should be easily accessible.

Note

When working with chips and SOT parts, use extreme caution when heating. Never reuse a chip or SOT part; always replace with correct Motorola parts.

3.2 RE–ASSEMBLY OF THE CONTROL UNIT

Be sure the orange gasket is still around the outside of the control cable "mini D" connector. If it was removed, replace it, ensuring a snug fit to the PC board. Replace the gasket around the power switch. Replace the shields on the top and bottom of the control board. Place the control board in the back housing, being careful to put the toggle switch arm in the proper position in the ON/OFF button actuator.

Screw in the two 16mm self–tapping screws to 6–8 inch lbs. Also, be sure the ON/OFF actuator still slides back and forth easily. Carefully check to see that all buttons are still in place, then place the display board in the front housing. Screw in the five 8mm self–tapping screws to 6–8 inch lbs. Be sure the black gasket is around the outside groove of the front housing. When mating the front and back housings, make sure the flex cable slides behind the control board and is not pinched. Screw in the two 30mm slotted screw to 9–10" lbs.

4. Vehicle Interface Ports

The Vehicle Interface Ports (VIP) allow the control unit to operate outside circuits and to receive inputs from outside the control unit. There are three VIP outputs that are used for relay control. There are also three VIP inputs that accept inputs from switches. See the cable kit section for typical connections of VIP input switches and VIP out put relays.

4.1 VIP OUTPUT CONNECTIONS

The VIP output pins are located on the back of the control unit below the area labeled "VIP." These connections are used to control relays. One end of the relay should be connected to switched B+, while the other side is connected to a software controlled ON/OFF switch inside the control unit.

The relay can be normally–on or normally–off depending on how the VIP outputs are configured. The control unit provides for three of these VIP output connections. See Table 3.

The function of these VIP outputs can be defined by field programming the control unit. Typical applications for VIP outputs are external horn/lights alarm and horn ring transfer relay control. For further information on VIP outputs, see the control unit programming manual.

4.2 VIP INPUT CONNECTIONS

The VIP input pins are located on the back of the control unit below the area labeled "VIP." These connections are used to accept inputs from switches. One side of the switch is connected to ground while the other side is connected to a buffered input to the control unit. The switch can be normally–closed or normally–open depending on how the VIP inputs are configured. The control unit permits three of these VIP input connections. See Table 4.

The function of these VIP inputs is defined by field programming the control unit. Typical applications for the VIP inputs are for a foot switch or a horn ring switch. For further information on VIP inputs, see the control unit programming manual.

5. Power Connections

CAUTION
Use only *SYNTOR X 9000* cable kits. Connection to other cable kits or control panels may cause electrical damage.

Replace the fuse in the in–line fuseholder of the red power cable coming from the radio in the trunk. Also connect the green (and/or orange) fused wire(s) coming from the control unit to the ungrounded terminal (or source) of the battery.

Pull all excess cabling into the trunk. Clamp the cables to the vehicle body or chassis with the cable clamps supplied. Drill 1/8" mounting holes, then attach the clamps with four #8 by 3/8" tapping screws and four 1/4" lockwashers. Finally, be sure all in–line fuses are installed.

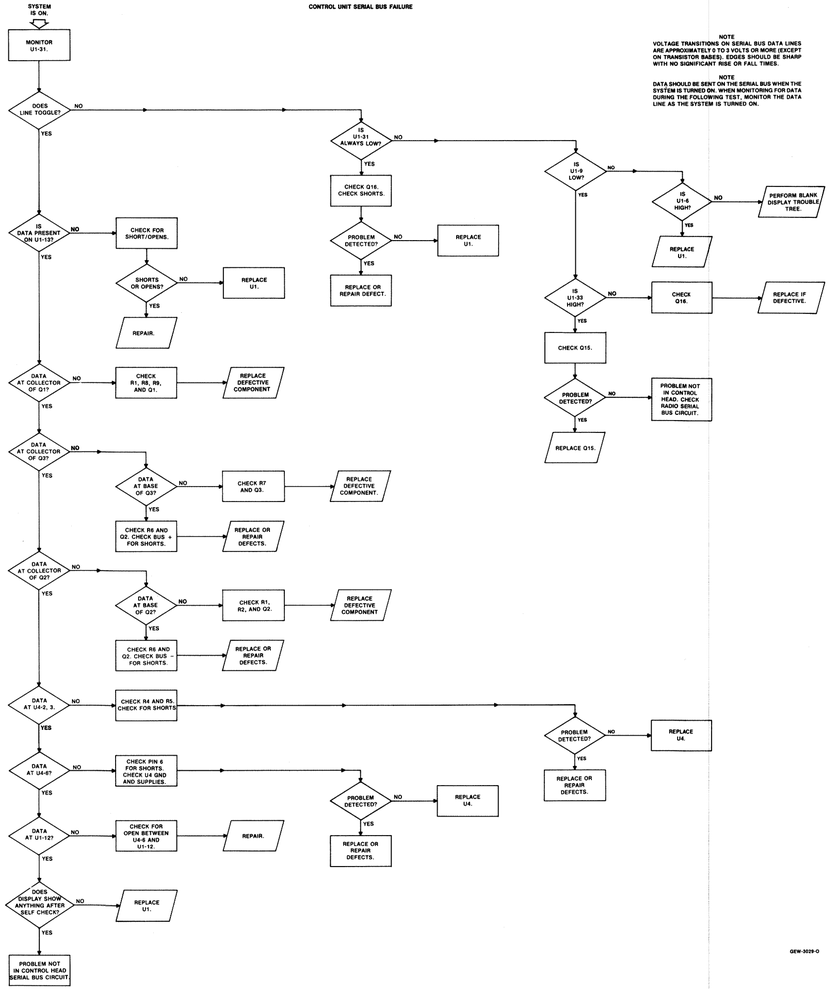
Table 3 . VIP Output Connections

VIP OUTPUT NO.	SWITCHED B+ PIN NO.	ON/OFF SWITCH PIN NO.	DEFAULT FUNCTION IS CHANGED WITH FIELD PROGRAMMER
1	18	2	HORN RELAY (ALARM)
2	19	1	LIGHT RELAY (ALARM)
3	35	34	SIREN–HORN TRANSFER

Table 4. VIP Input Connections

VIP INPUT NO.	GROUND PIN NO.	ON/OFF SWITCH PIN NO.	DEFAULT FUNCTION IS CHANGED WITH FIELD PROGRAMMER
1	20	4	SIREN; HORN RING
2	21	3	EMERGENCY (IF OPTION PRESENT)
3	36	37	NONE

CONTROL UNIT SERIAL BUS FAILURE

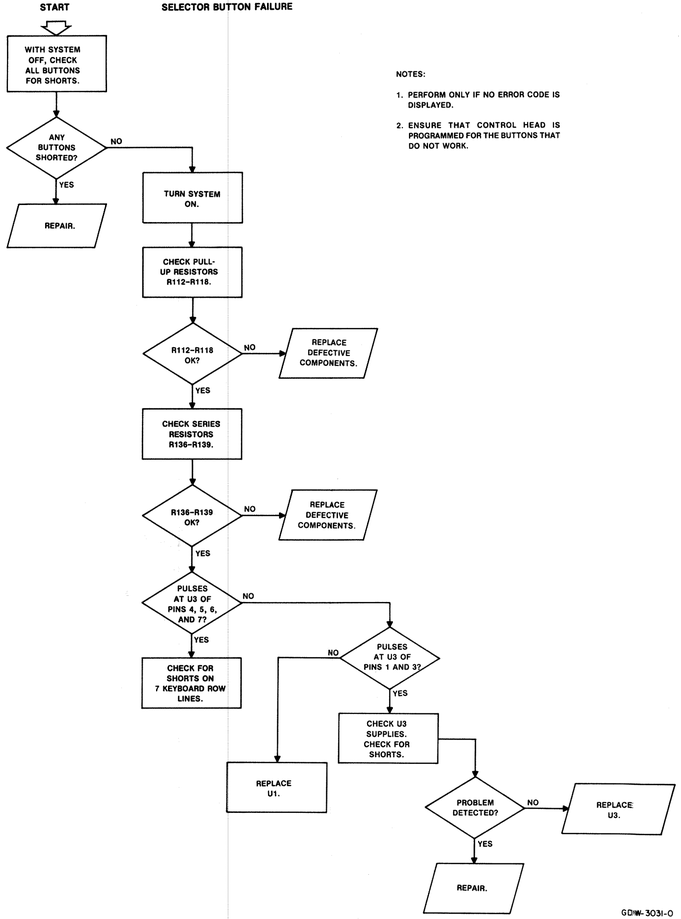


NOTE
VOLTAGE TRANSITIONS ON SERIAL BUS DATA LINES ARE APPROXIMATELY 0 TO 3 VOLTS OR MORE (EXCEPT ON TRANSISTOR BASES). EDGES SHOULD BE SHARP WITH NO SIGNIFICANT RISE OR FALL TIMES.

NOTE
DATA SHOULD BE SENT ON THE SERIAL BUS WHEN THE SYSTEM IS TURNED ON. WHEN MONITORING FOR DATA DURING THE FOLLOWING TEST, MONITOR THE DATA LINE AS THE SYSTEM IS TURNED ON.

GEW-3029-O

SELECTOR BUTTON FAILURE

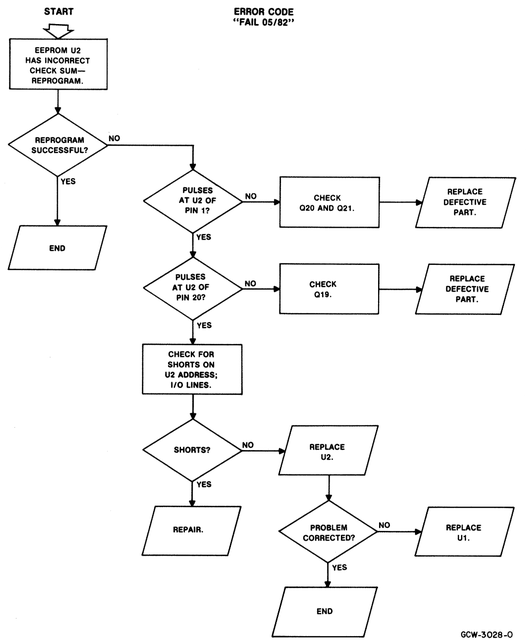


NOTES:

1. PERFORM ONLY IF NO ERROR CODE IS DISPLAYED.
2. ENSURE THAT CONTROL HEAD IS PROGRAMMED FOR THE BUTTONS THAT DO NOT WORK.

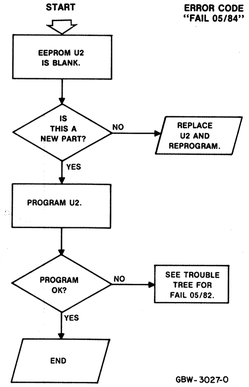
GDW-3031-O

ERROR CODE "FAIL 05/82"



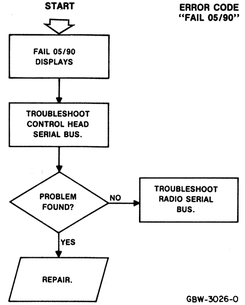
GCW-3028-O

ERROR CODE "FAIL 05/84"



GBW-3027-O

ERROR CODE "FAIL 05/90"



GBW-3026-O

Troubleshooting Charts for
Systems 9000 Control Unit
PW–6220–O
(Sheet 1 of 2)
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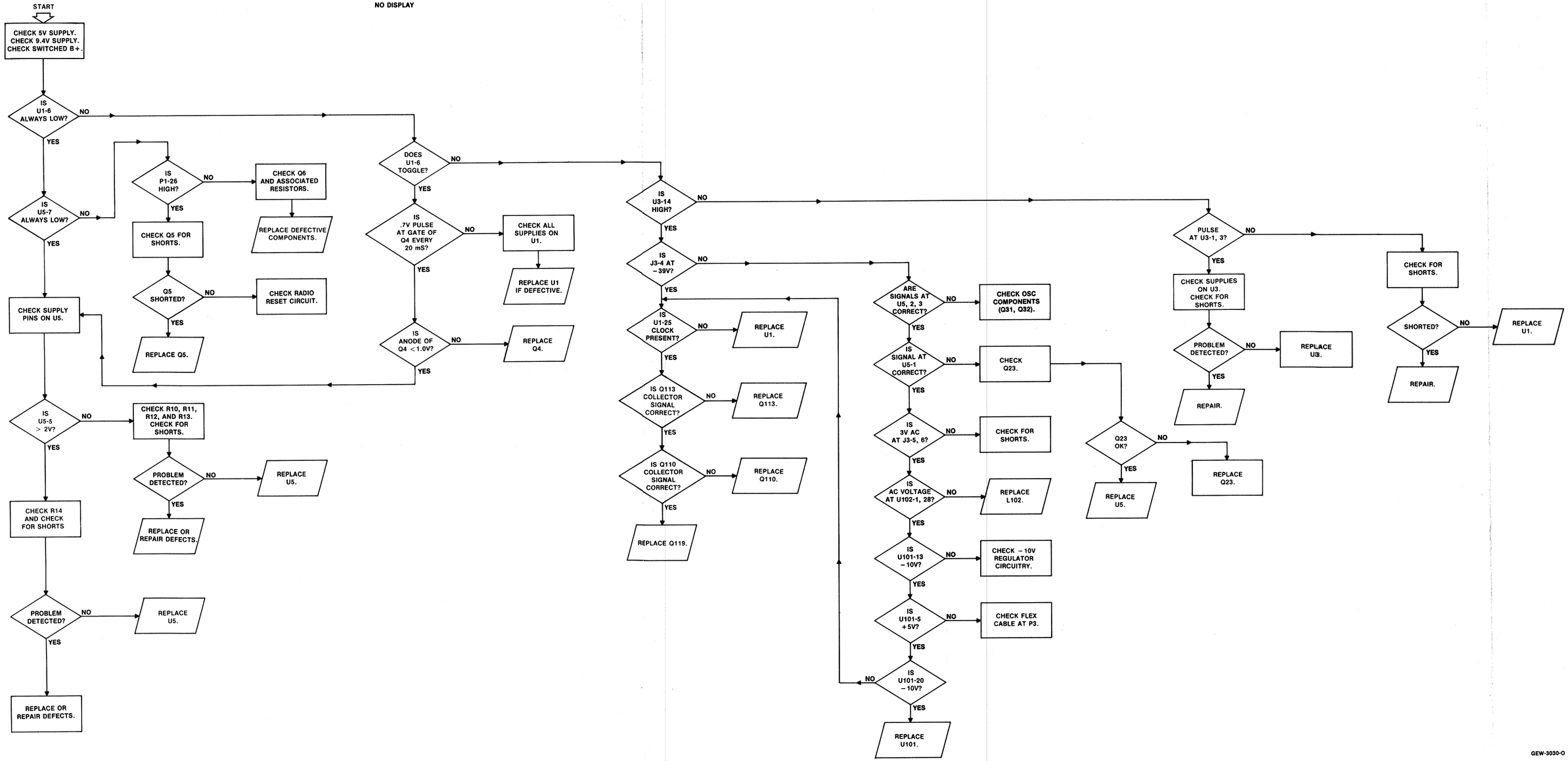

Troubleshooting Charts for
Systems 9000 Control Unit
PW–6220–O
(Sheet 2 of 2)
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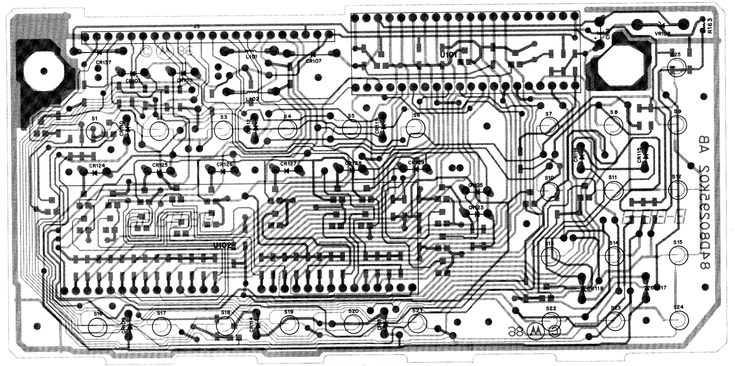
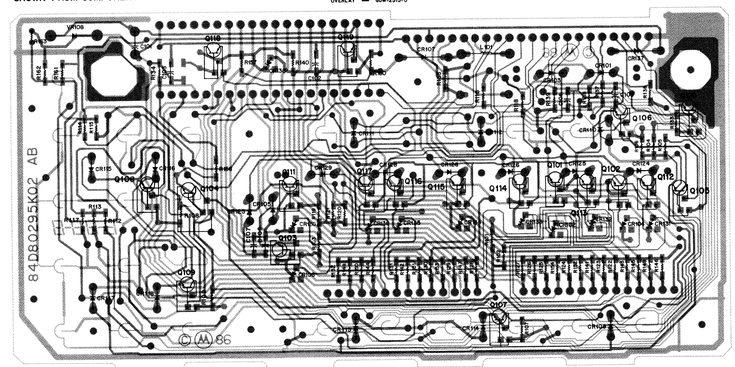
DISPLAY BOARD



SHOWN FROM COMPONENT SIDE



SHOWN FROM SOLDER SIDE

parts list

p/o HLN4907D Control Unit (Display Board)
p/o HLN4896C Control Unit (Display Board) — MXW–2568–C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C101	23–11048C11	10, ±20%, 44V, electrolytic
C102	21–13741B21	.001
C103–108	21–13741B29	.1, +80, –20%
diode (see note)		
CR101	48–80026P03	red LED
CR102	48–80236E08	silicon
CR103	48–80026P04	yellow LED
CR104	48–80236E08	silicon
CR105	48–80026P03	red LED
CR106	48–80236E08	silicon
CR107	48–83654H01	silicon
CR109–118	48–80246K04	green LED
CR123	48–80026P04	yellow LED
CR124–129	48–80026P03	red LED
CR130–136	48–80236E08	silicon
CR137	48–84616A11	silicon
CR137	48–80012E01	hot carrier
CR138	48–80236E08	silicon
coil, RF		
L101	24–11047A44	390 uH
L102	24–80138G07	15.0 uH, ±5%
transistor (see note)		
Q101–103	48–80141L02	NPN
Q104	48–80141L04	NPN
Q105–120	48–80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R101–103	06–11077A50	100
R104	06–11077A74	4.7k
R105–107	06–11077A64	390
R108	06–11077A82	2.7k
R109	06–11077A36	27
R112–118	06–11077B23	100k
R119	06–11077A50	100
R120,121	06–11077A70	680
R122–132	06–11077B23	100k
R133,134	06–11077A98	10k
R135	06–11077A50	100
R136–139	06–11077A90	4.7k
R140–154	06–11077B23	100k
R157	06–11077B11	33k
R158	06–11077A70	680
R160	06–11077B11	33K
R161	06–11077A94	6.8k
R162	06–11077A92	5.6k
R163	06–83609K09	100k green thermistor
R164	06–11077A98	10k
R200	06–11077A74	1k
integrated circuit (see note)		
U101	51–80236C04	display driver
U102	72–80242J01	vacuum–florescent display
varactor		
VR108	48–82256C67	10V zener, 1W

1/20/89

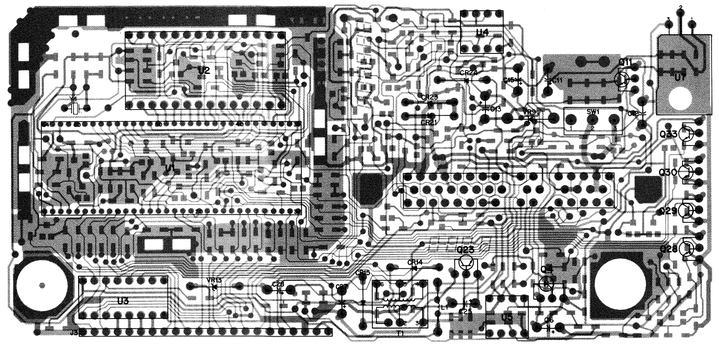
note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

HKN4241A and HKN4242A Cable Kits for *SYNTOR X 9000* — MXW–2529–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
non–referenced items		
	01–80739T53	22 foot cable assembly (HKN4241A only)
	01–80739T55	10 foot cable assembly (HKN4242A only)
	01–80701T89	66" lead and lug assembly
	09–84151B03	contact receptacle
	09–84151B05	plated contact recepta
	39–10184A44	contact receptacle
	15–10183A17	2 contact housing
	36–80220S06	connector knob
	03–00140079	tapping screw, 6–19 x 1/2
	42–80156B01	retainer ring
	09–80227B01	female contact
	15–80217K01	front cable housing
	15–80218B01	back housing connector
	32–83859M01	connector gasket

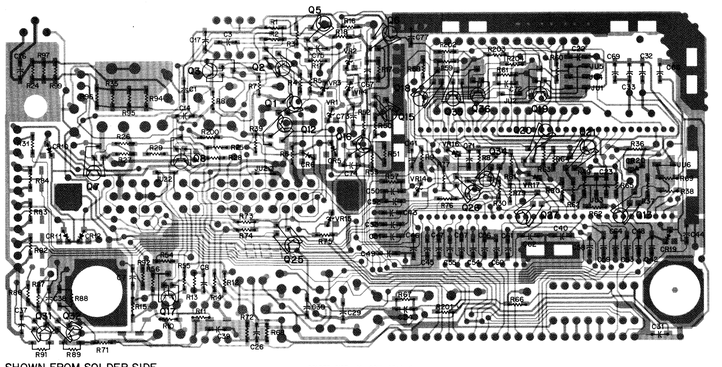
1/20/89

CONTROLLER BOARD



COMPONENT SIDE VIEW

SOLDER SIDE — GDW–2516– C
COMPONENT SIDE — GDW–2517– C
OVERLAY — GDW–2519– C



SHOWN FROM SOLDER SIDE

parts list

HLN4907D Control Unit (Controller Board) — MXW–2528–C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C1	21–11032B13	.1, +80, –20%
C3	21–13740B60	300 pF
C5	23–11048C05	1.0, ±20%, 63V, electrolytic
C7	21–11032B01	.001, +80, –20%
C8	21–13740B57	220 pF
C11	23–11048C10	10, ±20%, 63V, electrolytic
C12,13	23–11048C05	1, ±20%, 63V, electrolytic
C14	21–13740B39	39 pF
C15	23–11048C06	2.2, ±20%, electrolytic
C17	21–11032B13	.1, +80, –20%
C22,23	21–11032B13	.1, +80, –20%
C24	21–11032B15	.22, +80, –20%
C25	23–11013E57	10, ±20%, 25V, tantalum
C26	21–11032B13	.1, +80, –20%
C27,28	23–11048C10	10, ±20%, 63V, electrolytic
C29,30	21–11032B01	.001, +80, –20%
C31	21–11032B13	.1, +80, –20%
C32	21–13740B34	24 pF
C33	21–13740B31	18 pF
C37,38	21–11031A80	820 pF
C39–64	21–13740B60	300 pF
C66	21–13740B60	300 pF
C67	21–13741B45	.01, ±10%
C69	21–13740B19	5.6 pF, ±.5 pF, 50V
C71	21–13741B45	.01, ±10%
C72	21–13740B39	39 pF
C73–76	21–13740B57	220 pF
C77	21–13740B60	300 pF
C78–80	21–13741B45	.01, ±10%
C81	21–13740B60	300 pF
diode (see note)		
CR5,6	48–80236E08	silicon
CR10–12	48–80236E08	silicon
CR14,15	48–83654H01	silicon
CR19,20	48–80236E08	silicon
CR21	48–82466H18	rectifier
CR23	48–84616A11	silicon
CR24	48–84616A11	silicon
jumper		
JU2	06–11077A01	0 ohm
JU5–7	06–11077A01	0 ohm
JU20	06–11077A01	0 ohm
JU22	06–11077A01	0 ohm
connector receptacle		
J1	28–80228J01	50 contact mini D connector
coil, RF		
L1	24–80138G04	5.6 uH, ±5%
transistor (see note)		
Q1	48–80141L01	PNP
Q2	48–80141L03	PNP
Q3	48–80141L04	NPN
Q4	48–80182D22	SCR
Q5	48–80141L03	PNP
Q6	48–80141L04	NPN
Q7	48–80141L03	PNP
Q8	48–80141L04	NPN
Q11	48–80182D11	NPN
Q12	48–80141L04	NPN
Q13	48–80141L01	PNP
Q15	48–80141L03	PNP
Q16	48–80141L04	NPN
Q17,18	48–80141L03	PNP
Q19	48–80141L02	NPN
Q20	48–80141L03	PNP
Q21	48–80141L02	NPN
Q23	48–80869T32	NPN
Q25–27	48–80141L03	PNP
Q28–30	48–80182D08	NPN
Q31	48–80141L02	NPN
Q32	48–80141L02	NPN
Q33	48–80182D08	NPN
Q34	48–80141L04	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R1	06–11077A82	2.2k
R2	06–11077A98	10k
R3	06–11077A90	4.7k
R4	06–11077A50	100
R5	06–11077A50	100
R6	06–11077A90	4.7k
R7	06–11077A98	10k
R8	06–11077A82	2.2k
R9	06–11077B42	1Bk
R10,11	06–11077B31	220k
R12	06–11077A90	4.7k
R13	06–11077B23	100k
R14	06–11077B11	33k
R15	06–11077A98	10k
R16	06–11077A90	4.7k
R17	06–11077B15	47k
R18	06–11077B11	33k
R19	06–11077A98	10k
R24	06–11077A36	27
R25	06–11077A74	1k
R26	06–11077B07	22k
R27	06–11077A98	10k

MXW–2528–C (2)

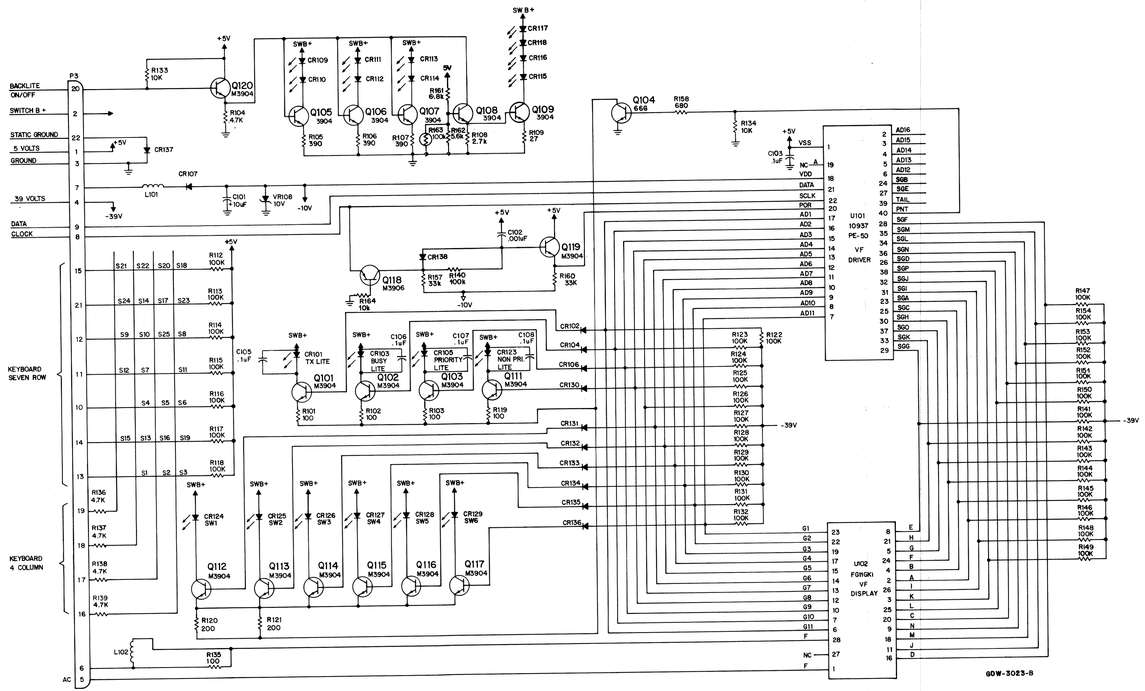
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R28	06–11077B15	47k
R29	06–11077A90	4.7k
R30,31	06–11077B11	33k
R35	06–11077A70	680
R36–38	06–11077A82	2.2k
R39	06–11077A98	10k
R49	06–11077B15	47k
R50	06–11077A90	4.7k
R51	06–11077A86	3.3k
R52	06–11077A90	4.7k
R53	06–11077A74	1k
R54	06–11077B07	22k
R55	06–11077A98	10k
R56	06–11077A90	4.7k
R57,58	06–11077A98	10k
R59	06–11077B15	47k
R60	06–11077A90	4.7k
R61–63	06–11077B15	47k
R63	06–11077A98	10k
R64	06–11077A66	470
R65	06–11077B15	47k
R66	06–11077A94	6.8k
R67	06–11077B09	20k
R68	06–11077A74	1k
R69,70	06–11077B15	47k
R71	06–11077A82	2.2k
R72	06–11077A74	1k
R73	06–11077B07	22k
R74	06–11077A98	10k
R75	06–11077B15	47k
R76	06–11077B07	22k
R77	06–11077A98	10k
R78	06–11077B15	47k
R79	06–11077B07	22k
R80	06–11077A98	10k
R81	06–11077B15	47k
R82–84	06–11077B11	33k
R86	06–11077A98	10k
R87	06–11077A84	2.7k
R88	06–11077A98	10k
R89	06–11077A84	2.7k
R91,92	06–11077A74	1k
R94–96	06–11077A70	680
R97	06–11077A36	27
R99	06–11077A36	27
switch		
S1	40–80033K01	toggle
transformer		
T1	25–80277J02	voltage conversion
integrated circuit (see note)		
U1	51–83627M42	bipolar
U4	51–80067C05	opamp
U5	51–80046K01	compartor
U7	51–80068C02	voltage regulator
varactor (see note)		
VR1–4	48–80140L11	7.5V zener
VR9	48–80256C67	10V zener, 1W
VR13	48–80236E14	43V zener
VR15–17	48–80140L11	7.5V zener
crystal (see note)		
Y1	48–80113K03	4.9152 MHz
non–referenced items		
	01–80740T41	component side shield assembly
	26–80003K01	component side shield
	55–84300B02	handle
	09–80200K01	mtg–nut
	09–80002K01	IC socket
	09–80369B02	dual IC socket
	14–80076L01	insulator shield
	14–80069K01	insulator
	26–80220K01	solder side shield
	29–10134A68	connector lug, 12 used
	32–80179J01	D connector gasket
	32–80181J01	face connector gasket
	43–80011L01	8 position LED spacer
	43–80012L01	2 position LED spacer
	54–80111F01	PROM label
	75–05259B01	crystal base pad
	75–80098J01	keypad
	75–80184J01	VF shock pad
	75–80268K01	IC shock pad

1/20/89

note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

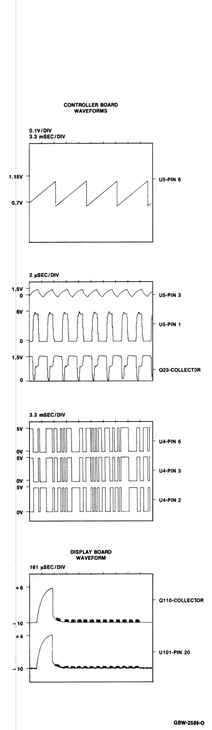
Schematics, Circuit Board Diagrams, and Parts Lists for the Control Unit
PW–6186–O
(Sheets 1 of 2)
1/18/89

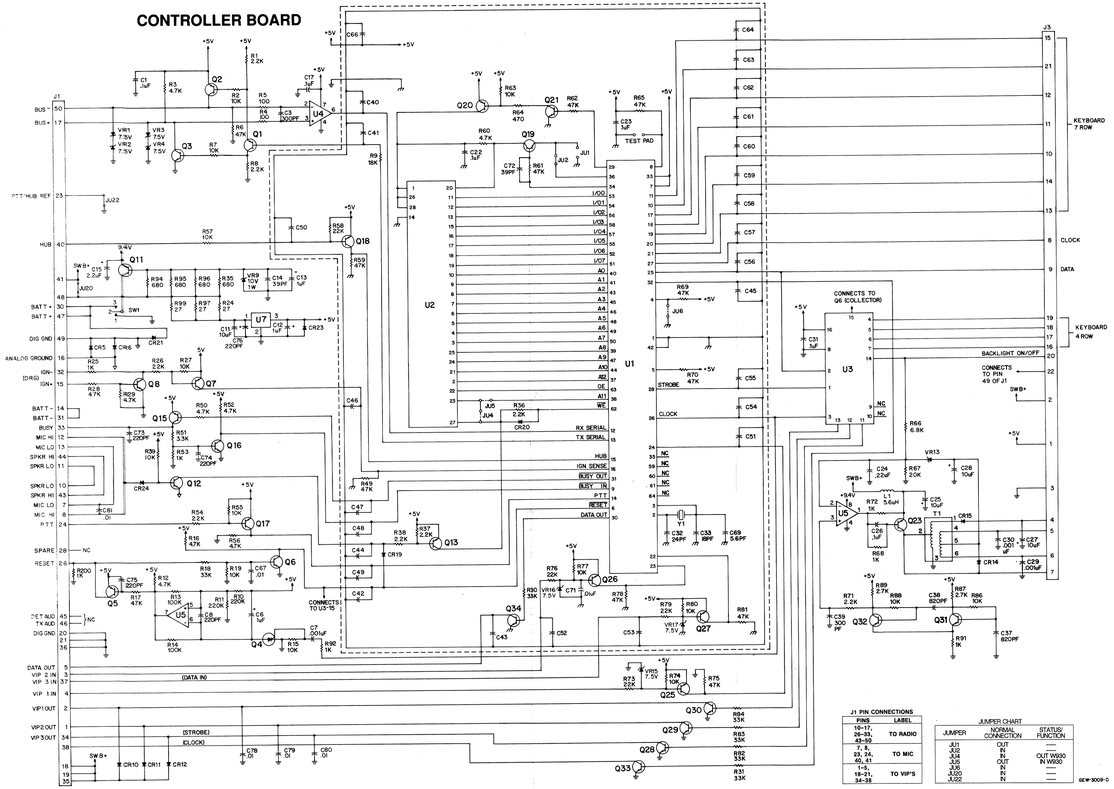
DISPLAY BOARD

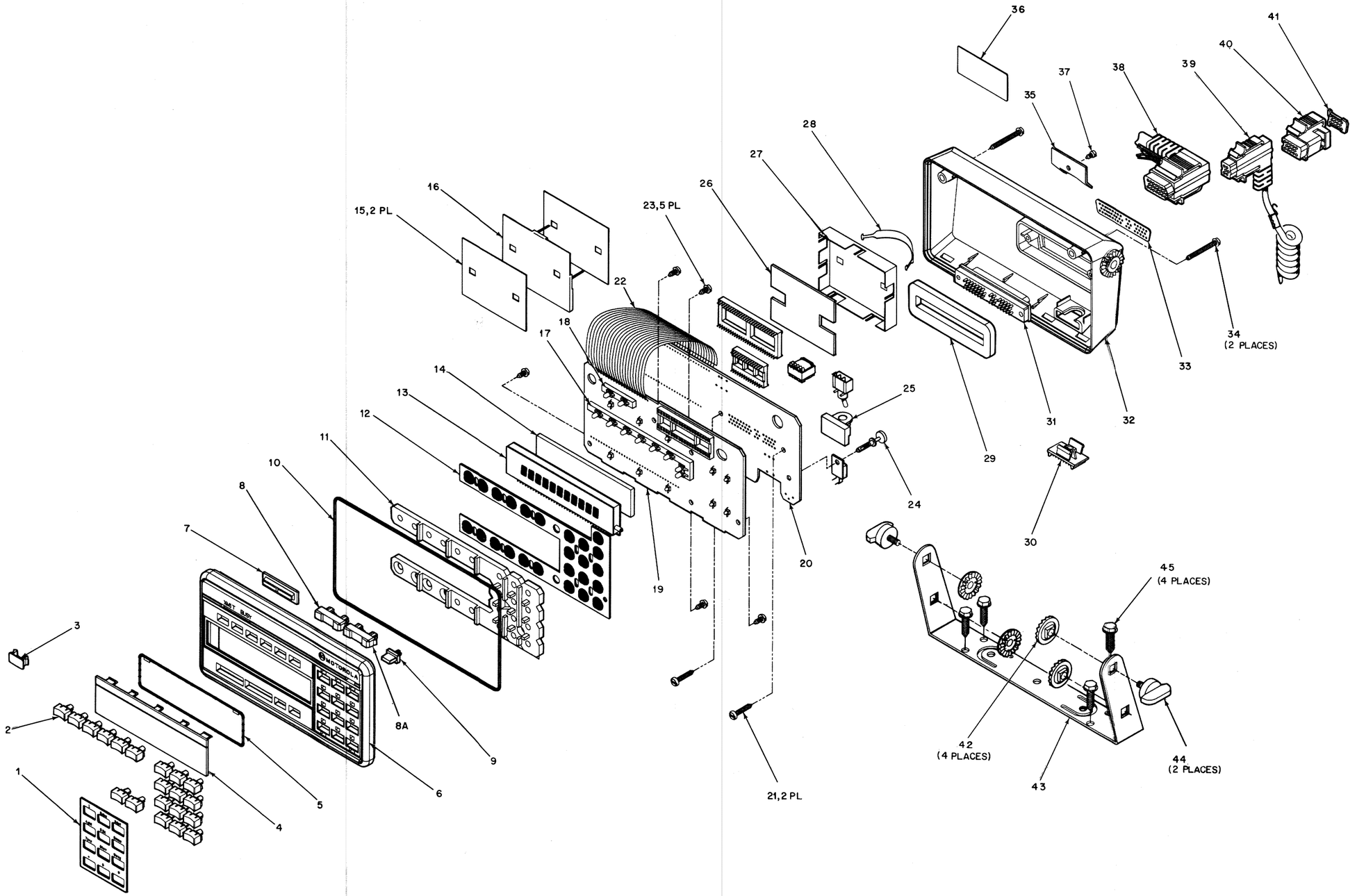


Schematics, Circuit Board Diagrams, and Parts Lists for the Control Unit
PW-6186-O
(Sheets 2 of 2)
1/18/89

CONTROLLER BOARD







GDW-2365-B

parts list

Mechanical Parts List for *Systems 9000* Control Unit — MXW–2293–F

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	13–80087J01	escutcheon
2	38–80090J01	push–in key top (specify legend required)
3	38–80253K01	plug key
4	61–80095J01	VF lens
5	32–80057K01	lens gasket
6	15–08088J01	front housing
7	61–80097J01	LED lens
8	38–80091J02	mode rocker top
8A	38–80091J02	volume rocker top
9	38–80092J01	dimmer key top
10	32–80180J01	housing gasket
11	61–80185J01	keyboard lightpipe
12	75–80098J01	elastomeric keypad
13	72–80242J01	VF display
14	75–80184J01	VF shock pad
15	14–80269K01	insulator
16	26–80220K01	solder side shield
17	73–80011L01	LED 8 position spacer
18	43–80012L01	LED 2 position spacer
19	84–80117J01	display PCB
20	84–80104J01	controller PCB
21	03–10945A14	TORX plastite screw, 3.12 x 1.27 x 16
22	30–80034K01	22 position flex cable
23	03–10945A11	TORX plastite screw, 2.12 x 1.27 x 8
24	05–80200K01	nylon rivet
25	32–80178J01	on/off gasket
26	75–80268K01	IC shock pad
27	26–80003K01	component side shield
28	55–84300B02	shield handle
29	32–80179J01	D connector gasket
30	38–80128J01	on/off key top
31	28–80228J01	50 position D connector
32	15–80089J01	back housing
33	32–80181J01	connector face gasket
34	03–10908A33	TORX machine screw, 3.0 x .6 x 30, 2 used
35	07–84323C01	strain relief bracket
36	33–80178M01	nameplate
37	03–10908A18	TORX machine screw, 3.0 x .5 x 6
38	30–80229N01	radio cable
39	30–80223J01	microphone cable
40	15–80221J01	vehicle interface port connector
41	32–80275K01	VIP gasket
42	43–80127J01	trunnion spacer
43	07–80263L01	trunnion bracket
44	03–80160E01	wing screw, 2 used
45	03–00136756	mounting screw, 4 used

3/30/89

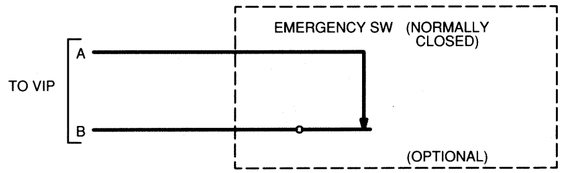
Exploded View and Parts List
for Control Unit
PW–2425–E
3/30/89

parts list

HKN4241A 17' Negative Ground Cable Kit — MXW–2046–A

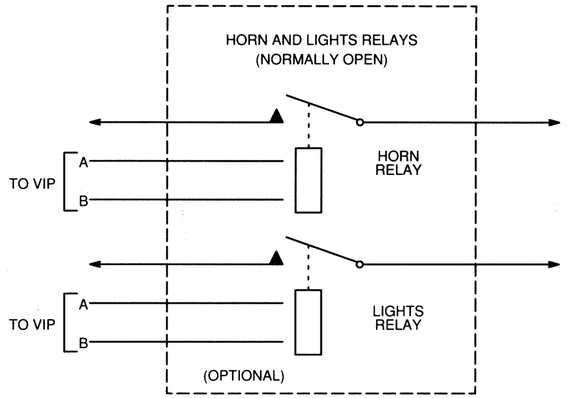
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	01–80739T54	17' cable assembly
	29–84528B05	lug
	30–00851875	battery cable, black
	01–80701T89	66" black lead and lug assembly
	09–84151B03	contact receptacle
	09–84151B05	contact receptacle
	30–80229N01	radio cable
	39–10184A44	contact receptacle, 2 used
	15–10183A17	2 contact receptacle housing
	36–80220B06	connector knob
	03–00140079	tapping screw, 6 x 19 x 1/2, 4 used
	42–10217A02	tie strap, 2 used
	42–80156B01	retainer ring
	09–80227B01	power contact, female, 2 used
	15–80217K01	front cable housing
	15–80216B01	back cable housing
	32–80004L01	cable connector gasket
	30–00812505	8 gage cable, red
	30–10286C79	20 strand wire, white/blue
	30–10286F21	20 strand wire, black/violet
	54–80072G01	circuit board label
	54–84032M02	label

5/10/88



NOTE:
VIP INPUTS ARE PROGRAMMABLE.THIS MEANS VIP IN #1, VIP IN #2, OR VIP IN #3 COULD BE MADE AN EMERGENCY SWITCH DEPENDING ON HOW THE CONTROL HEAD IS PROGRAMMED.
THE OTHER SWITCH CONTACT SHOULD BE CONNECTED TO DIG GND PINS 20, 21, OR 26.

GPW–3002–B

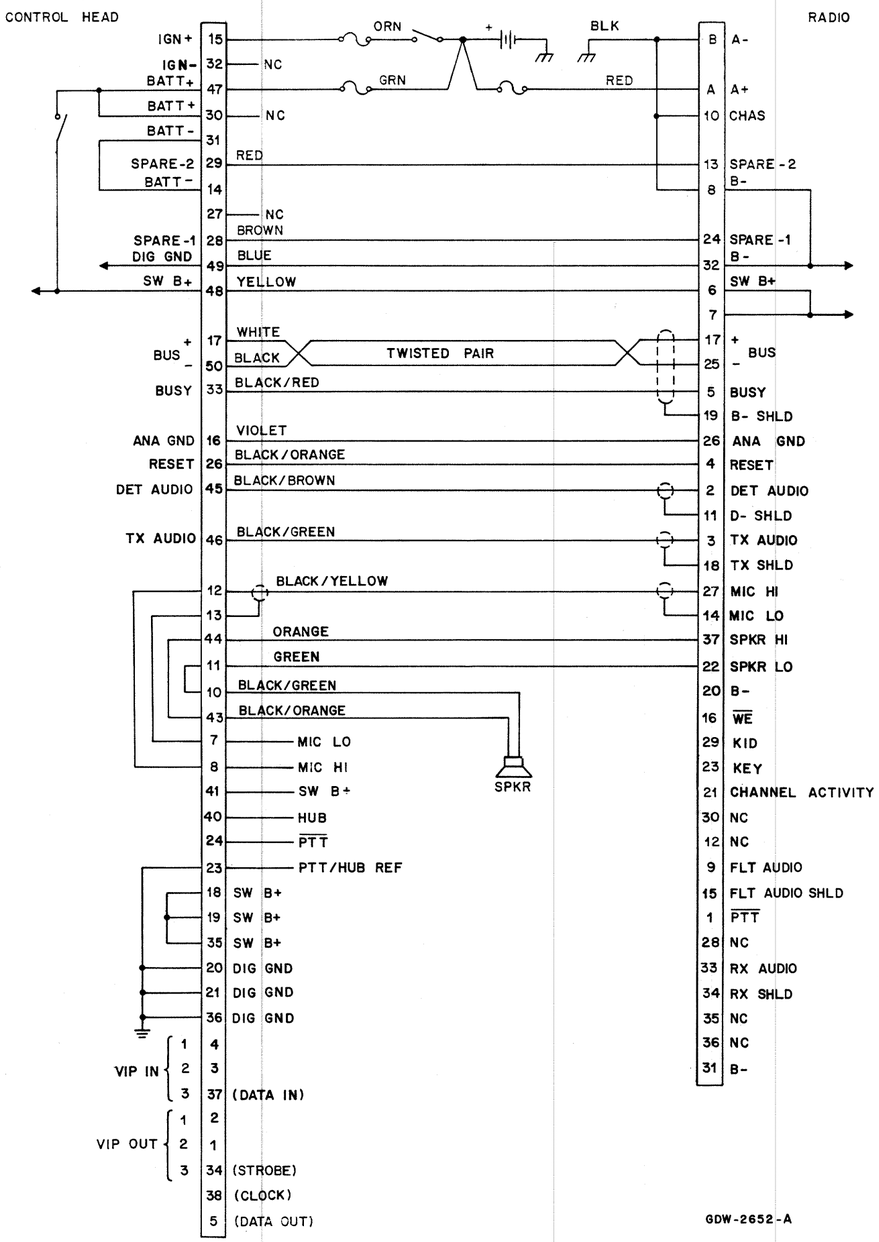


NOTE:
VIP OUTPUTS ARE PROGRAMMABLE. ONE CONTACT OF THE RELAY SHOULD BE CONNECTED TO THE VIP OUTPUT PROGRAMMED FOR THE RELAY AND THE OTHER CONTACT TO SW B+ PINS 18, 19, OR 35.

GPW–3003–A

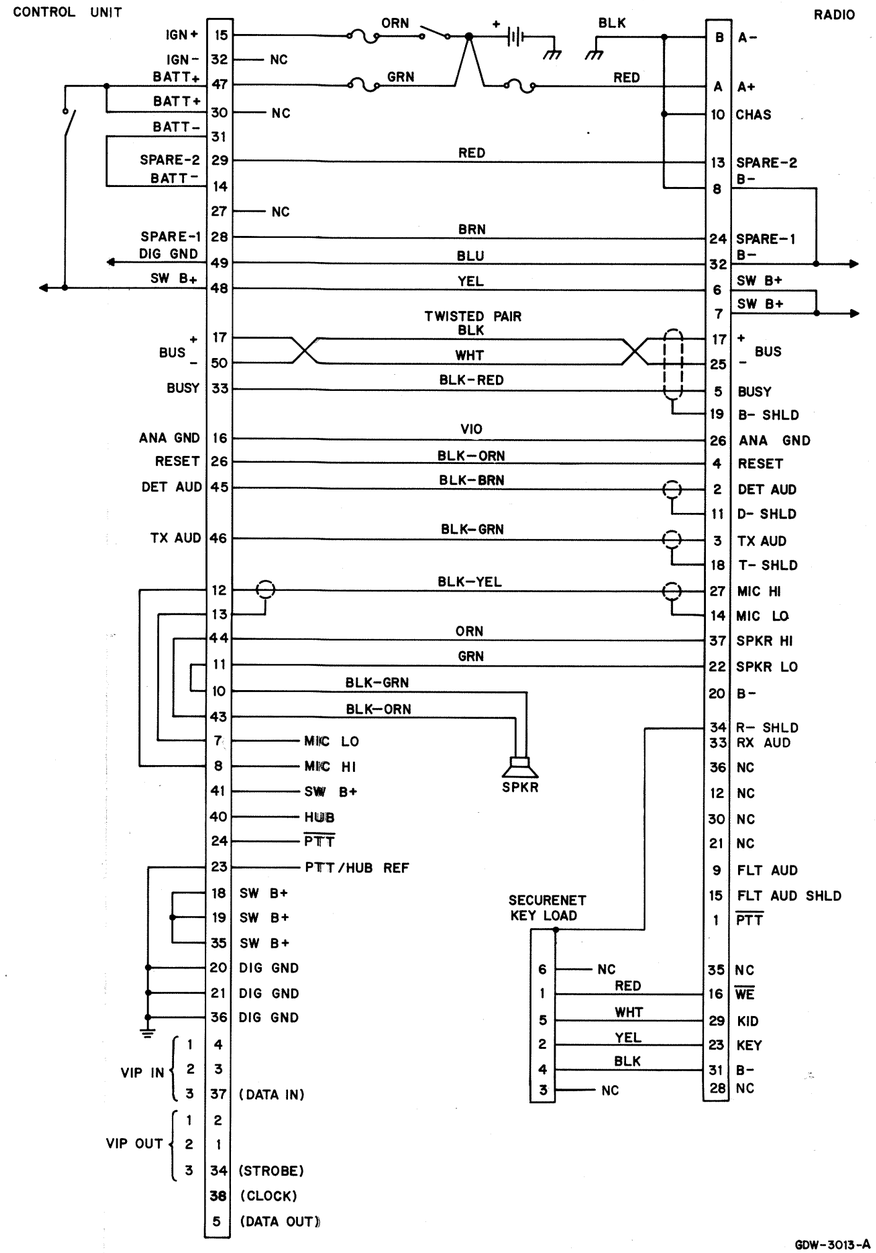
Negative Ground Cable
Wiring Diagrams
PW–2779–C
5/10/88

STANDARD CABLING

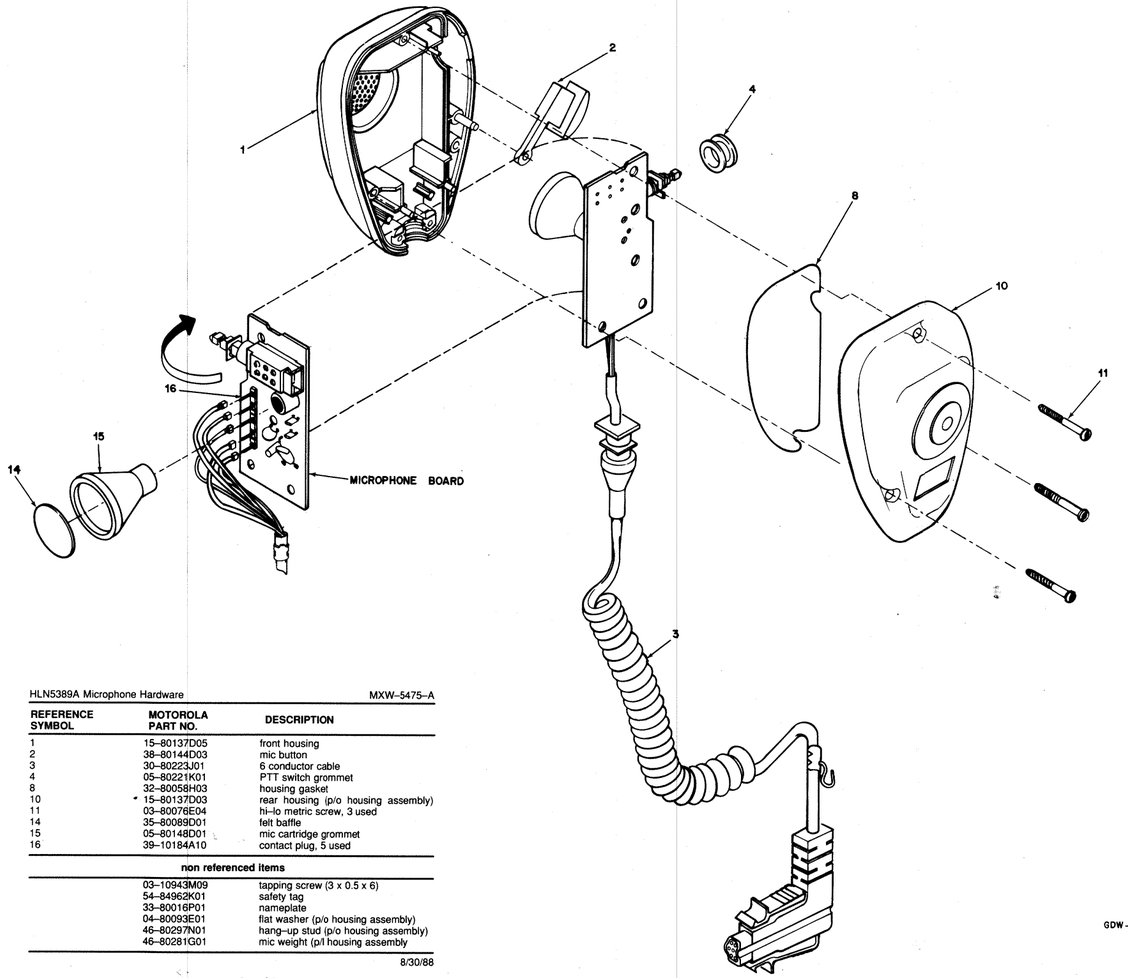


GDW–2652–A

SECURENET CABLING



GDW–3013–A



GDW-2049-A

HLN5389A Microphone Hardware MXW-5475-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	15-80137D05	front housing
2	38-80144D03	mic button
3	30-80223J01	6 conductor cable
4	05-80221K01	PTT switch grommet
8	32-80058H03	housing gasket
10	15-80137D03	rear housing (p/o housing assembly)
11	03-80076E04	hi-lo metric screw, 3 used
14	35-80089D01	felt baffle
15	05-80148D01	mic cartridge grommet
16	39-10184A10	contact plug, 5 used
	non referenced items	
	03-10943M09	tapping screw (3 x 0.5 x 6)
	54-84962K01	safety tag
	33-80016P01	nameplate
	04-80093E01	flat washer (p/o housing assembly)
	46-80297N01	hang-up stud (p/o housing assembly)
	46-80281G01	mic weight (p/l housing assembly

8/30/88

parts list

HLN4384B Microphone Circuit Board MXW-2051-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed uF, ±5%, 50V (unless otherwise stated)		
C1301	21-11038H35	24 pF
C1302	21-11039B13	.001 ±10%
C1304	23-11019A20	10 ±20% 25V, electrolytic
C1305	08-11017A14	.047
C1306	21-11038P50	220 pF
C1307	21-11039B13	.001 ±10%
C1308	08-11051A14	.15 63V
diode (see note)		
CR1301	48082256C25	12V zener ±5% 400mW
connector receptacle		
JU1301,1302	06-11009B23	0 ohm jumper
microphone		
MK1301	50-80258E04	electret cartridge
transistor (see note)		
Q1302	48-80182D08	NPN
resistor, fixed ohm, ±5%, 1/4 watt (unless otherwise stated)		
R1302	06-11009C57	2.2k
R1303	06-11009C49	1k
R1305	06-11009C97	100k
R1306	06-11009C19	56
switch		
S1301	40-80652E02	momentary switch
	mechanical part	
	14-80652E01	switch insulator

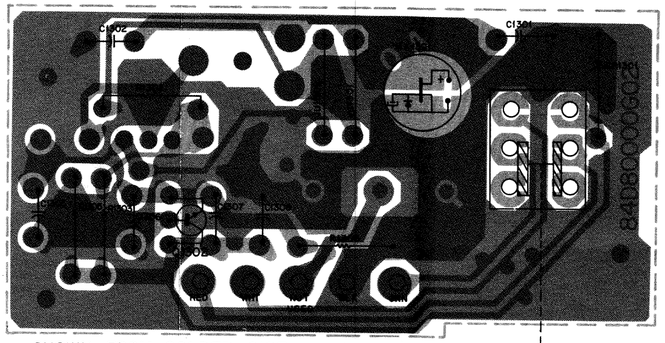
4/19/88

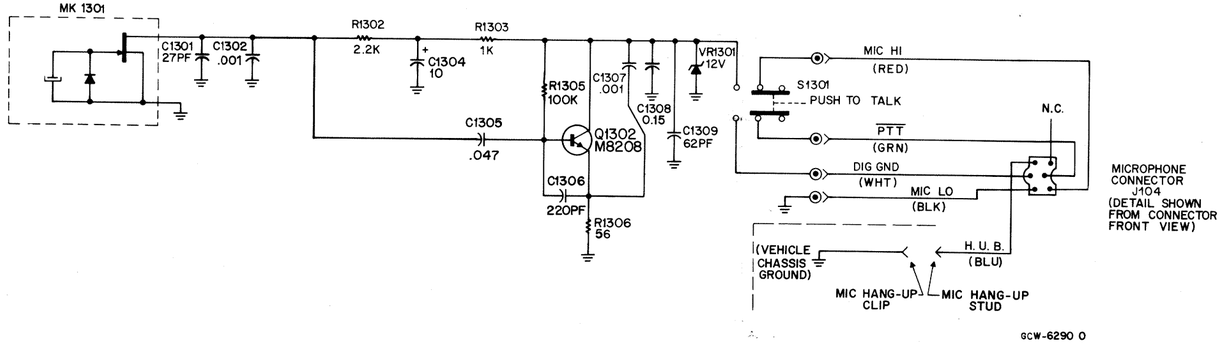
note: For best performance, order diodes, transistors, and integrated circuits by Motorola part number.

HLN4384B MICROPHONE BOARD (EARLY VERSION)

FUNCTION

The palm microphone contains an amplifier to provide the radio with a high-level, noise-free audio input. The microphone also provides push-to-talk transmit control for the radio as well as off-hook channel monitoring (PL/DPL squelch disable) capability.

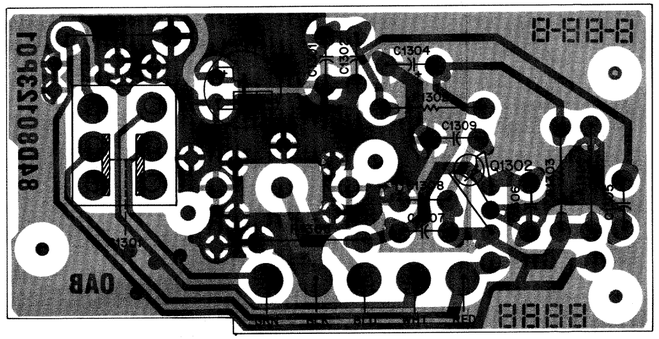




GCW-6290 O

HLN5459A MICROPHONE BOARD (LATER VERSION)

Yes



SOLDER SIDE ● GBW-6287-O
COMPONENT SIDE ● GBW-6288-O
OVERLAY — GBW-6289-O

parts list

HLN5459A Microphone Circuit Board — MXW-6286-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed uF, ±5%, 50V (unless otherwise stated)		
C1301	21-11038H35	24 pF
C1302	21-11039B13	.001 ±10%
C1304	23-11019A20	10 ±20% 25V, electrolytic
C1305	08-11051A11	.047
C1306	21-11038P50	220 pF
C1307	21-11039B13	.001 ±10%
C1308	08-11051A14	.15 63V
C1309	21-11014H44	62pF, 100V
diode (see note)		
CR1301	48-11034A36	12V zener ±5% 400mW
microphone		
MK1301	50-80258E04	electret cartridge
transistor (see note)		
Q1302	48-11043C05	NPN
resistor, fixed ohm, ±5%, 1/4 watt (unless otherwise stated)		
R1302	06-11009A57	2.2k
R1303	06-11009A49	1k
R1305	06-11009A97	100k
R1306	06-11009A19	56
switch		
S1301	40-80065E02	momentary switch
	mechanical part	
	14-80652E01	switch insulator

2/15/89

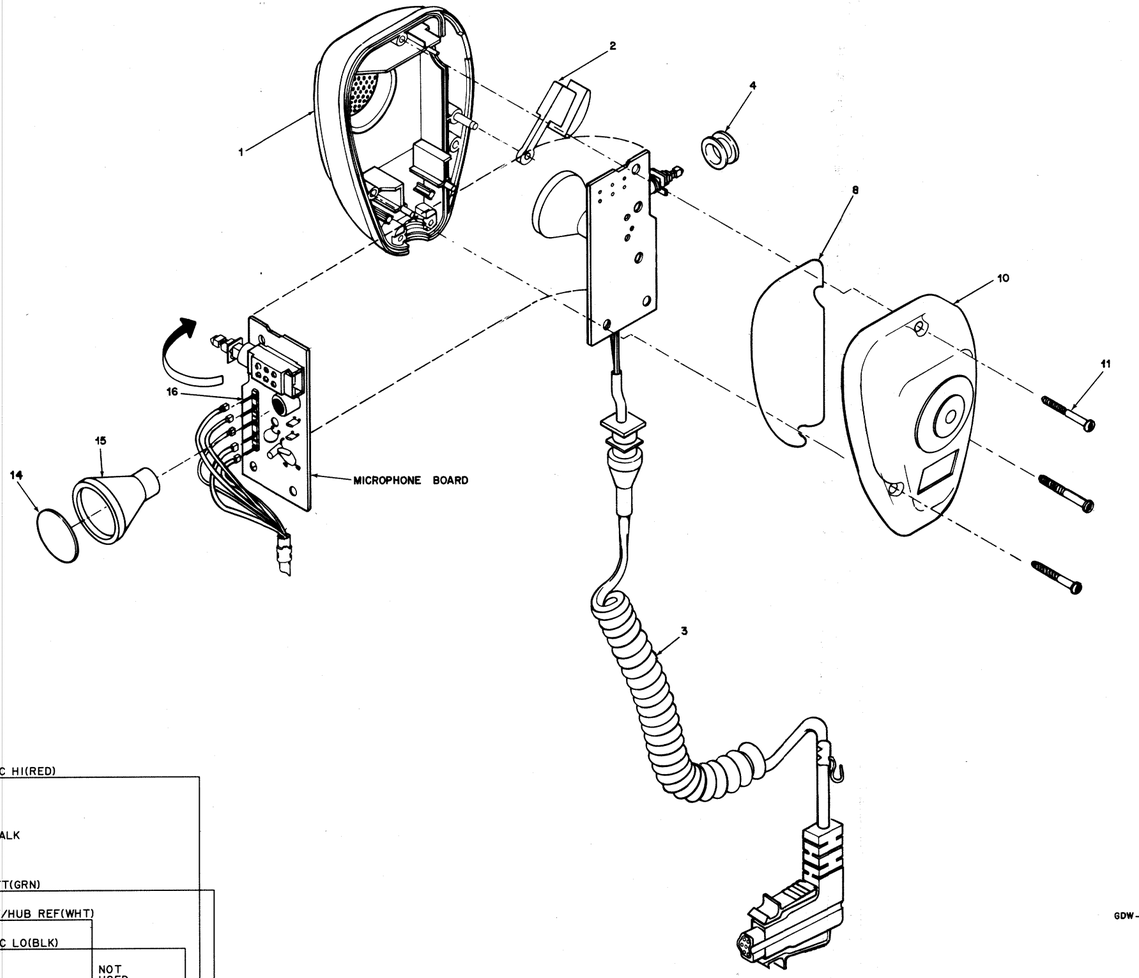
note: For best performance, order diodes, transistors, and integrated circuits by Motorola part number.

parts list

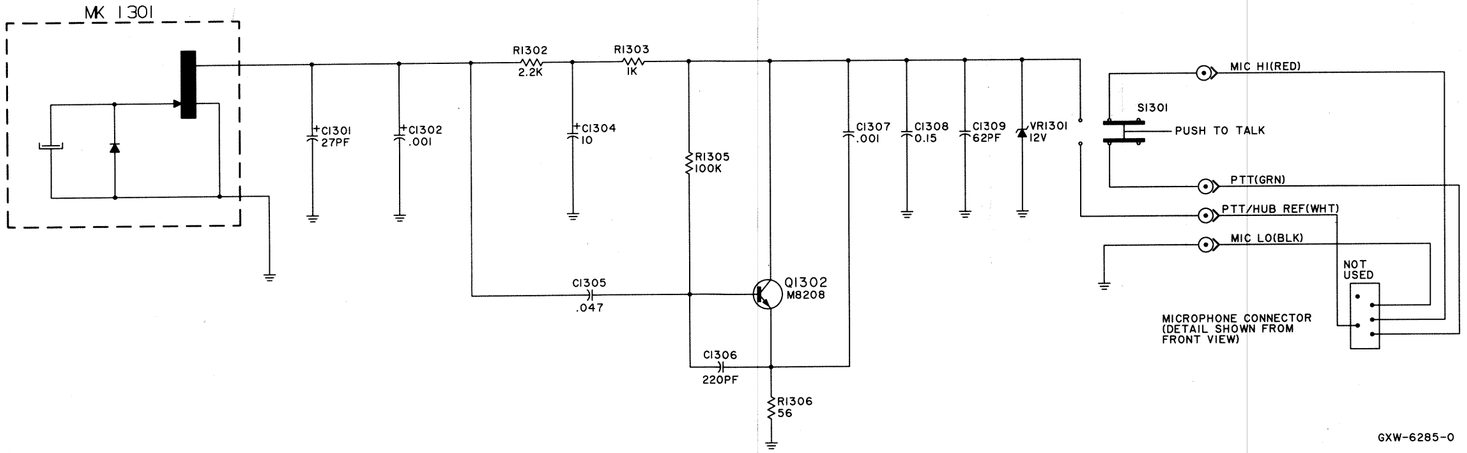
HLN5336A Microphone Hardware — MXW-5096-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	15-80137D05	microphone front housing
2	38-80144D03	microphone button
3	30-80147H04	microphone cable
4	05-80221K01	PTT switch grommett
8	32-80058H03	housing gasket
10	01-80710T70	rear housing
11	03-80076E04	hi-lo screw
14	35-80089D01	felt baffle
15	05-80148D01	microphone grommet

3/30/89



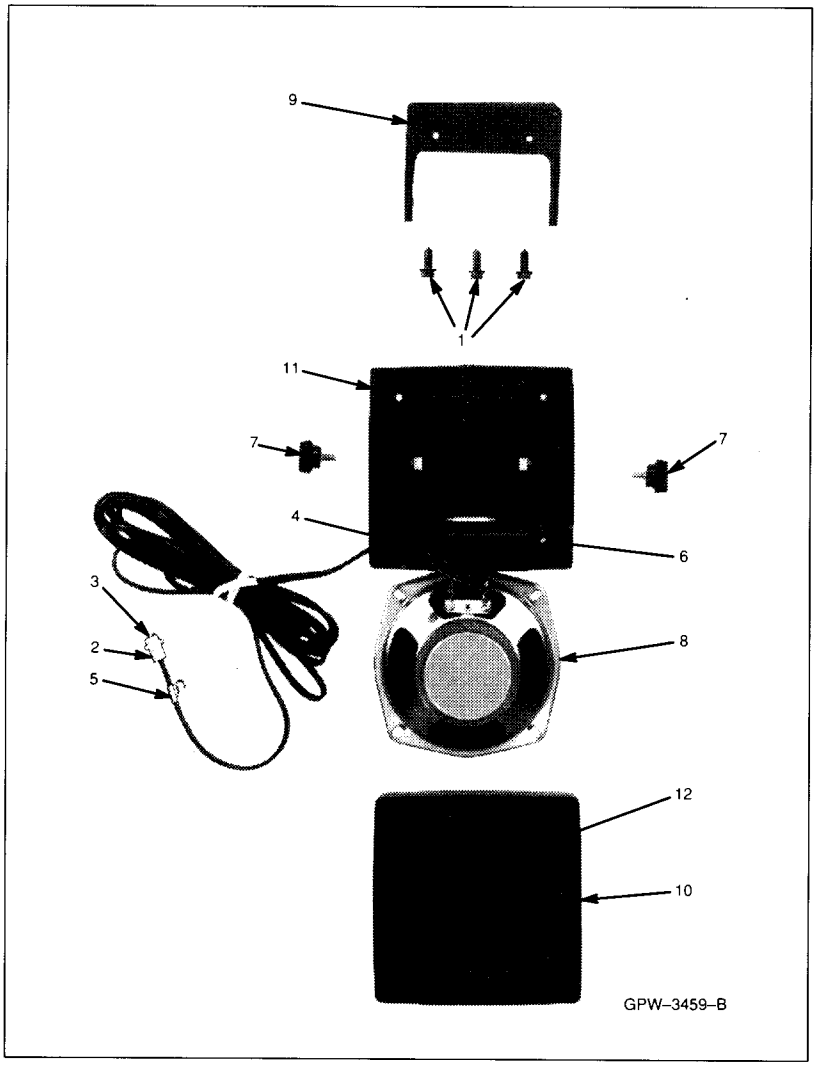
GDW-2049-A



GXW-6285-O

Microphone and Hardware
PW-2048-E
(Sheet 2 of 2)
4/15/89

HSN4018A SPEAKER AND ACCESSORIES



parts list

HLN4022C Installation Kit — MXW–6475–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	03–12002A28	screw, self–drilling, 1/4–14 x 1–1/2" (4 used)
	04–00007688	lockwasher, 1/4
	29–00812980	terminal, closed–end
	37–00081057	grommet, rubber, 1/2"
	42–80366B66	cable tie (10 used)
	43–82292M01	bushing, spacer (4 used)

4/11/89

HSN4018A Speaker — MXW–2053–C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	03–00136756	tapping screw (10–16x 5/8)
2	15–10183A18	connector housing plug, 2–contact
3	39–10184A45	contact plug, 2 used
4	42–82018H05	cable retainer
5	42–84081A03	wire clamp with S–hook
6	03–00140001	tapping screw (6–19 x 7/8), 4 used
7	03–84244C03	black shadow wing screw, 2 used
8	50–80135E01	speaker
9	07–80200E01	black speaker trunnion bracket
10	13–82671M04	bezel
11	15–84981B07	speaker base cover
12	32–84564B01	speaker gasket

4/19/88

END OF DOCUMENT