MOTOROLA
Mobile Products Division

instruction manual revision

GENERAL

This revision consists of changes that have occurred since your manual was printed. Please correct your manual accordingly.

INSTRUCTION MANUAL AFFECTED

68P80101W95–B	*SYNTOR X Systems 9000* VHF Low–Band
68P80102W05–O	*SYNTOR X Systems 9000* VHF High–Band
68P80102W04–A	*SYNTOR X Systems 9000* UHF
68P80102W32–A	*SYNTOR X Systems 9000E* UHF Trunking
68P80102W06–O	*SYNTOR X Systems 9000* 800 MHz
68P80101W62–B	*SYNTOR X Systems 9000E* 800 MHz Dual Operation
68P80102W61–O	*Spectra* Detailed Service Information

REVISIONS

A new *Systems 9000* Control Unit will begin shipping in late 1990. Attached, is Section W10003S48 which includes text, troubleshooting, exploded view, and detail pages of the new control unit. Please insert this information in the appropriate section of your manual.

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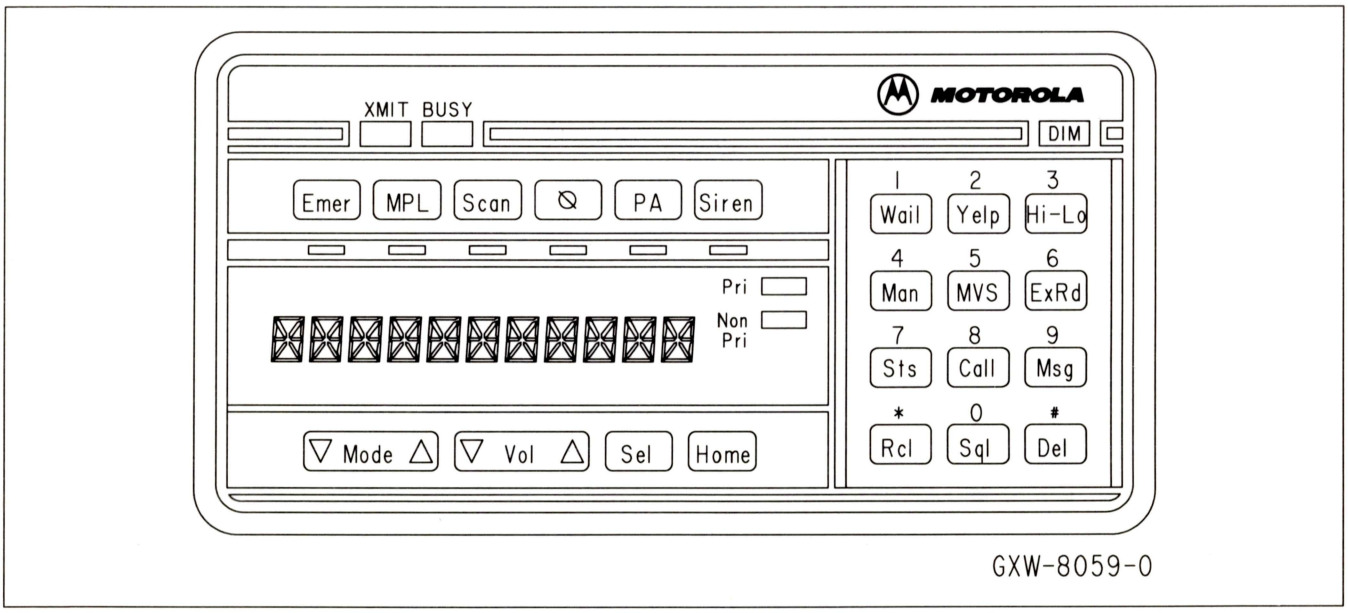


Figure 1. Typical Systems 9000 *Control Unit*

1. Description

1.1 GENERAL

Note

A variety of Motorola's 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.

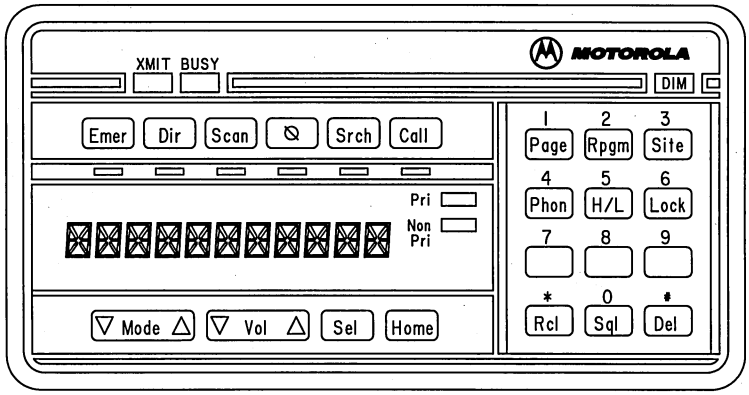
1.2.3 Option Buttons

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

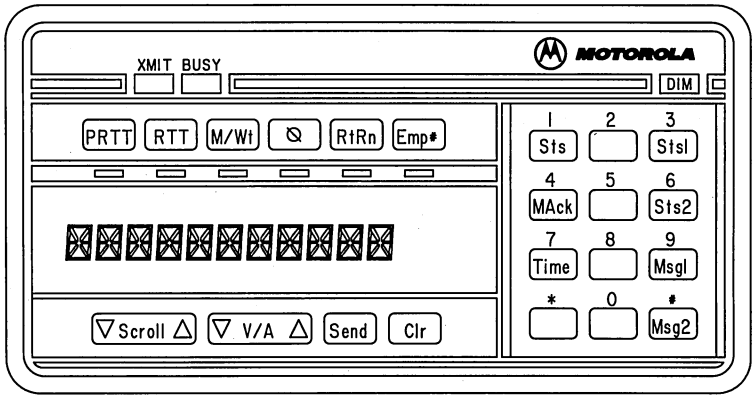
Above the six option buttons are XMIT and BUSY indicators. The XMIT indicator lights when the radio is transmitting. The BUSY indicator lights when the selected channel is busy.

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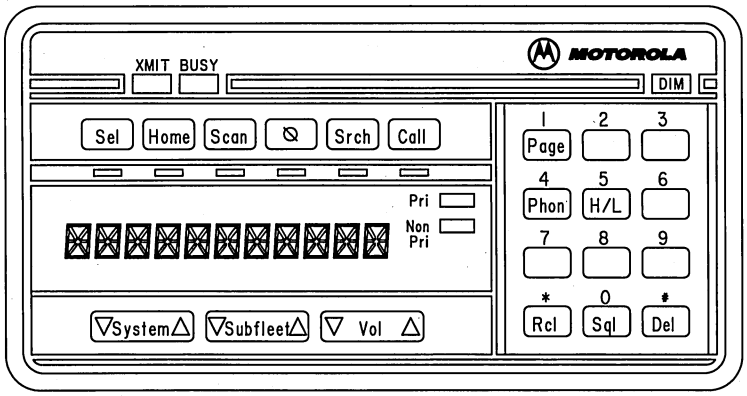
GXW-8055-0

Figure 2A. SYNTOR X 9000E *Control Unit*



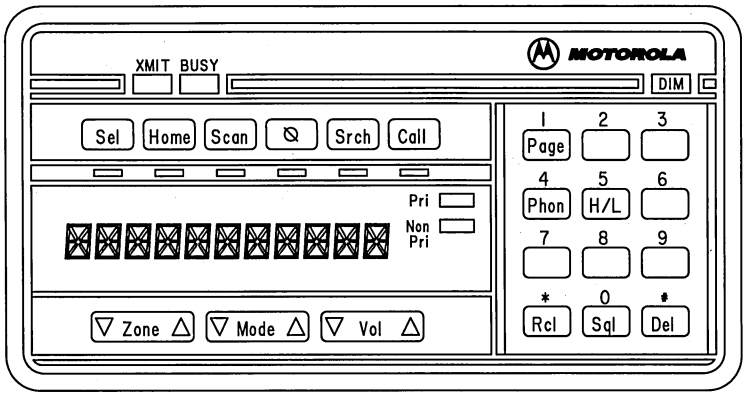
GXW-8056-0

Figure 2B. MCT–4800 *Control Unit*



GXW-8058-0

Figure 2C. System/Subfleet Control Unit



GXW-8057-0

Figure 2D. Group/Zone Control Unit

Figure 2. Alternate Control Units

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. Alternate Control Units

Alternate control units are available for different applications. Two of these applications include the Systems 9000E (extended) control unit for use in trunking radio systems and the MCT–3600 / MCT–4800 control unit. Figure 2 (A through D) shows a few of the configurations available.

2.1 CONTROL UNIT FOR *SYSTEMS 9000E*

Trunking radio systems may use this control unit. It allows you to field program your own names to represent talk groups. The larger display window allows you to see all the key operating information, including the talk group selected, the channel being scanned, and the on/off status of various options. This control unit can also show Channel Scan lists, Private Conversation lists, and frequenctly called telephone numbers.

2.2 DESCRIPTION OF SYSTEMS *9000E CONTROLS*

The following list describes the custom buttons used by the Systems 9000E system. See paragraph 1.2 for information covering the standard buttons and switches. See Figure 2A for button locations.

MICROPHONE—connector; accepts any *Systems 9000* microphone or handset.

[**Page**]—button to use the individual page encode/decode feature for selectively alerting specific usnits in a trunking system.

[**Rpgm**]—button used with Dynamic Re–grouping feature for some radio systems. It temporarily reassigns fleet/subfleet information.

[**Srch**]—button initiates the Automatic Multiple Site Switching (AMSS) option to search for a new repeater (site) when your radio signal to your home site becomes too weak.

[**Site**]—button works with the AMSS option to automatically switch sites when your radio signal becomes too weak.

[**Lock**]—button prevents AMSS automatic switching.

2.3 CONTROL UNIT FOR MCT–4800

The MCT control unit has solid state microprocessor circuitry that operates the standard and optional features built into the system.

2.4 DESCRIPTION OF *MCT–4800* CONTROLS

The following list describes the custom buttons used by the *MCT–4800* system. See paragraph 1.2 for information covering the standard buttons and switches. See Figure 2B for button locations.

MICROPHONE—connector; accepts any *Systems 9000* microphone or handset.

[**Scroll**]—rocker switch for cursor movement and message scrolling.

[**V/A**]—rocker switch for selecting volume level, editing names, and making certain radio adjustments.

[**Clr**]—button clears out entry field of the display.

[**Send**]—button sends entered information to base.

[**PRTT**]—button sends a Priority Request–To–Talk transmission to the controller.

[**RTT**]—button sends Request–To–Talk transmission to the controller.

[**PA**]—button turns on the Public Address system.

[**RtRn**]—button changes the display to show Route/Run identification.

[**Emp#**]—button displays the Employee number.

[**MAck**]—button for acknowledge reception of a text message.

[**M/Wt**]—button for viewing text messages.

2.5 OTHER CONTROL UNITS

Some control unit configurations may use a [**Zone**], [**Mode**], and [**Vol**] rocker switches or [**System**], [**Subfleet**], and [**Vol**] rocker switches in place of the conventional configurations. See Figure 2, C and D.

3. Theory of Operation

3.1 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.

3.1.1 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.

3.1.2 Controls and Indicators

A twelve button keypad contains traditional alphanumeric keys. These keys double as function keys for 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.

3.2 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 data to a driver 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.

3.2.1 Microprocessor (MPU)

The MPU operates in expanded bus mode with internal ROM active. The clock frequency is 7.9488 MHz that results in an internal operating frequency of 1987 kHz. The limited number of I/O ports is augmented by using a serial–to–parallel shift register (U6) to scan the keyboard, and to switch the VIP drivers (Q71, Q72, Q73, Q74, and Q75).

3.2.2 Watchdog Timer

The watchdog timer resides in U4. On system power–up, C06 pulls U4–43 high while the output (pin 4) goes low and the microprocessor resets.

As C6 charges, the voltage on U4–43 drops causing the output to go high and the microprocessor to start operating. At this point, positive bias shifts onto U4–43 causing the voltage to begin to rise, eventually causing another reset cycle. A high on U4–9 also initiates a reset to occur.

However, when the microprocessor operates correctly, the microprocessor sends pulses to U4–2. These pulses tickle the watchdog timer and keeps the voltage on U4–43 low enough to prevent reset. If the tickle pulses stop for more than 250 milliseconds, the reset cycle repeats.

3.2.3 EEPROM

The EEPROM stores customer data including mode names, button functions, and VIP settings. The customer data can be altered only by the control unit programmer.

3.2.4 Bus Transceiver

The serial bus transceiver resides within U4. U4 pins 10, 16, and 17 connect to the external bus. Pins 11, 13, 19, and 20

connect to microprocessor U2. These pins act as a serial communication buffer.

3.2.5 Vacuum Fluorescent Voltage Converter

Voltage for the vacuum fluorescent display is generated by a fixed frequency, variable–duty cycle driven, flyback voltage converter. Resistors R56 through R60 with C54 and U3B form a triangle wave generator that has an output swing between 1.5 and 3.2 volts. This triangle goes to U3A–3 and is compared to a feedback signal on U3A–2. The feedback signal comes from the power supply output and is regulated by VR50 to 43 volts. This voltage increases or decreases as the output voltage rises or falls. Consequently, the duty cycle seen at the gate of Q50 varies inversely with power supply output voltage and regulates it. The supply runs at 160 kHz while the secondary of T60 (pins 4 and 6) supplies 3.5 VAC for the VF display (U102) filaments.

3.2.6 Vehicle Interface Ports (VIP)

The VIP outputs are driven by a serial–to–parallel shift register. Output transistors (Q71, Q72, Q73) can sink 300 mA current. Primarily, these transistors control external relays. The relay is connected between the collector and switched B+.

Each VIP input connects to a dedicated input port through zener diodes (VR8, VR9, and VR10) for input protection while U4 buffers the inputs. These VIP inputs are connected to ground with either normally–open or normally–closed switches.

3.2.7 Power Supply

The +5 volt supply is a three–terminal regulator IC to regulate the 12V SWB+ down for the digital logic hardware.

3.2.8 Ignition Sense Circuits

U4 senses the vehicle ignition's state through pin 28, 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.

Note

Q40 supplies an inverting path for positive ground ignition sevice.

3.2.9 EEPROM Write–Protect Circuit

Q161, Q162, and associated circuitry guard against inadvertently writing into the EEPROM. The circuitry guarantees the EEPROM is protected during reset and when U6 is not in the proper programming state.

3.3 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.

3.3.1 Vacuum Fluorescent Display

The vacuum fluorescent (VF) display is an eleven digit, 14–segment display that needs two separate voltages to operate: the anode and grids need +43 volts to accelerate electrons from cathode and the filament needs 3.5 volts AC at 80 mA. These voltages are obtained from the VF up–converter on the controller board.

3.3.2 Vacuum Fluorescent Display Driver

This IC (U101) receives 14 segment display data, digit enable data, and indicator state data from the microprocessor on the controller circuit board. This data is clocked using CLOCK and DATA lines, then framed using LATCH and strobed on STB to control brightness. The 32 bit data frame is updated every millisecond in such a fashion that a coherent display is maintained and totally updated every 11 milliseconds.

3.3.3 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 43 volts for control signals.

3.3.4 Backlight LEDs

The same signal that turns the VF power supply on and off also operates the backlight LEDs. Q134 supplies base current to the individual LED driver transistors. The driver transistors act as constant current sources to the LEDs. Backlight LEDs CR131, CR132, CR133, and CR134 are connected to thermistor R133 by way of Q132. This circuit allows more current to flow through these LEDs at room temperature and reduces current as the temperature rises.

3.3.5 Default Jumper Settings

The factory installs jumpers in each control unit dependent on the customer–ordered options. See the following table for the standard jumper configuration. See the foldout page with the control unit artwork for other configurations.

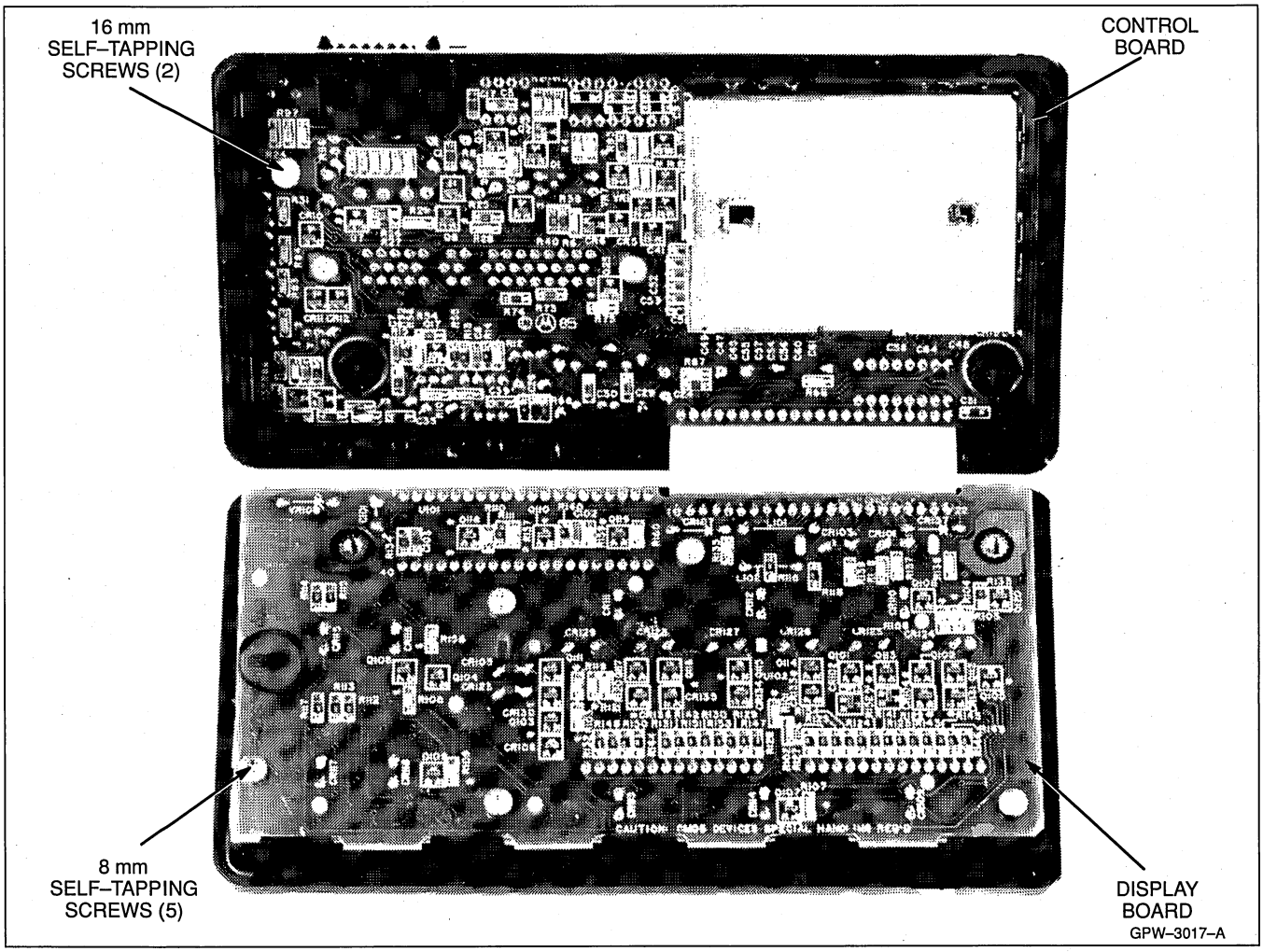


Figure 3. Disassembly of the Control Unit

Table 1. Standard Jumper Configuration

JUMPER NUMBER	NORMALLY
1	IN
2	OUT
3	IN
4	OUT
5	IN
7	IN
8	OUT
9	OUT
10	OUT
11	OUT
12	OUT
13	OUT
16	OUT
17	OUT
18	IN
19	IN
20	IN
21	OUT
22	OUT

4. Control Unit Maintenance

4.1 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.

4.2 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.

5. 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.

5.1 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 2.

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.

5.2 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 3.

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.

6. Power Connections

CAUTION

Use only *Systems 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.

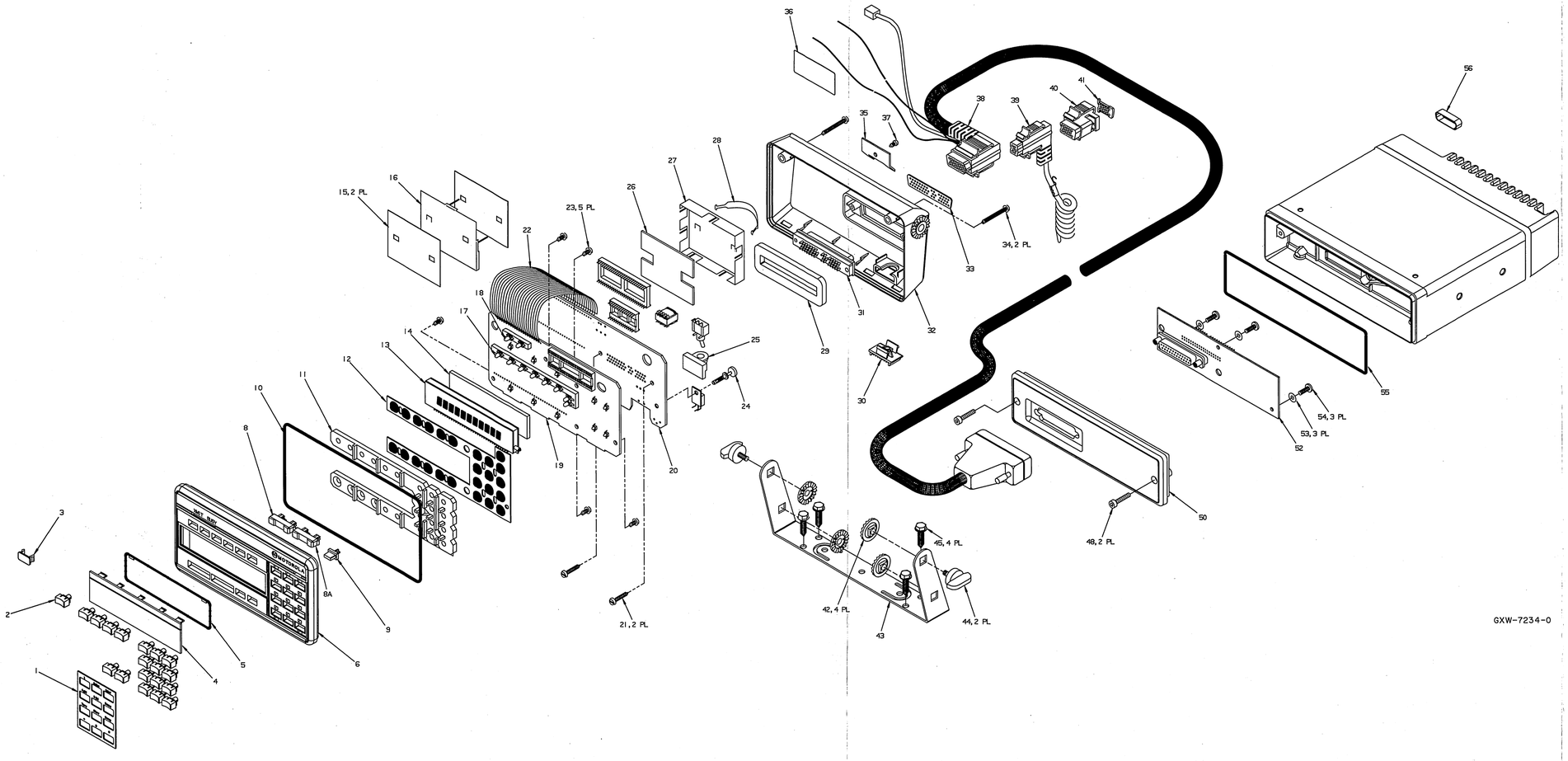
Pull all excess cabling into the trunk. Clamp the cables to the vehicle body or chassis with the cable clamps supplied. Drill 1/8" mounting holes, then attach the clamps with four #8 by 3/8" tapping screws and four 1/4" lockwashers. Finally, be sure all in–line fuses are installed.

Table 2. 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 3. 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



parts list

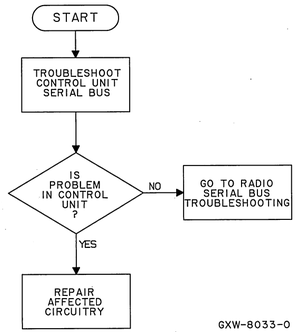
Control Head Exploded View MXW–7978–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	13–80087J03	escutcheon
2	HLN5499A	button, PRTT
2A	HLN5497A	button, RTT
2B	HLN5067A	button, PA
2C	HLN5500A	button, RTRN
2D	HLN5502A	button, Emgr
2E	HLN5503A	button, CLR
2F	HLN5498A	button, SEND
2G	HLN5095A	button, blank
2H	HLN5504A	button, M/Wt
2I	HLN5505A	button, M/Ack
2J	HLN6220A	button, TIME
3	HLN5096A	plug
4	61–80095J04	lens, VF display
5	32–80057K02	gasket, lens
6	15–80088J01	housing, front
8	38–80195P08	pushbutton rocker, SCROLL
8A	38–80195P10	pushbutton rocker, V/A
9	38–80092J01	key, DIM
10	32–80180J02	gasket, housing
11	61–80185J02	lightpipe, keypad
12	75–80098J01	keypad
13	(U102)	VF display (see electrical)
14	75–80184J01	shock pad
15	14–80269K01	insulator
16	26–80220K01	solder side shield
17	43–80011L01	spacer, LED, 8 position
18	43–80012L01	spacer, LED, 2 position
19	—	display board (see electrical)
20	—	command board (see electrical)
21	03–10945A14	screw, tapping, P3.12 x 1.27 x 8 (5 used)
22		flex cable
23	03–10945A11	screw, tapping, P3.12 x 1.27 x 16 (2 used)
24	05–80200K01	rivet, nylon
25	32–80178J01	gasket, ON/OFF switch
26	75–80268K01	shock pad, IC
27	26–80003K01	shield, component side
28	55–84300B02	handle
29	32–80179J01	gasket, D–connector
30	38–80128J01	key, ON/OFF
31	(J1)	connector, mini–D, 50 contact
32	15–80089J01	housing, back
33	32–80181J01	gasket, face connector
34	03–10908A33	screw, machine, M3.5 x 0.6 x 30 (2 used)
35	07–84323C01	bracket, strain relief
36	33–80178M01	nameplate
37	03–10908A18	screw, machine, M3 x 0.5 x 6
38	30–80183P01	radio cable
39	30–80265L02	handset cable
40	15–80221J01	housing, VIP connector
–	39–84257L01	contact, plug
41	32–80275K01	gasket, VIP connector
42	43–80127J01	spacer, trunnion (4 used)
43	07–80263L01	bracket, trunnion
44	03–80160E01	wing screw, M5 x 8 x 10 (2 used)
45	03–00136756	screw, tapping, 10–16 x 5/8 (4 used)
48	03–80077M01	screw, front mount (2 used)
50	15–80062P04	housing, remote front
52	—	interconnect board (see electrical)
53	04–83045H01	washer, thrust (3 used)
54	03–10945A11	screw, tapping, P3.12 X 1.27 X 8 (3 used)
55	32–80289L01	gasket, housing
56	15–80005G01	cover, dust

8/18/90

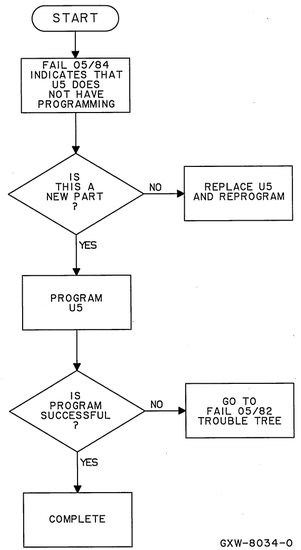
Exploded View and Parts List for
Systems 9000 Control Unit
PW–8017–O
8/18/90

FAIL 05/90



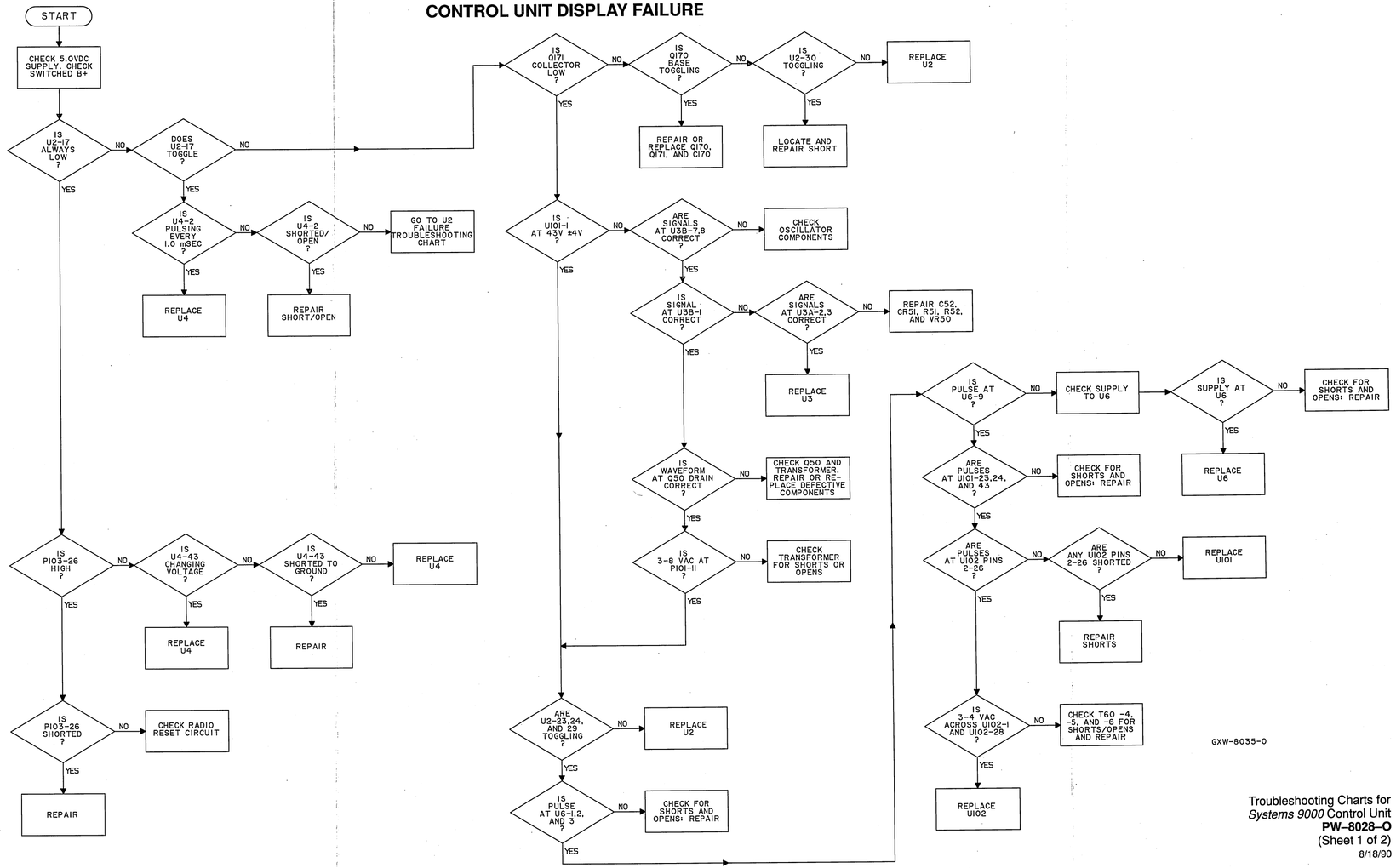
GXW-8033-O

FAIL 05/84



GXW-8034-O

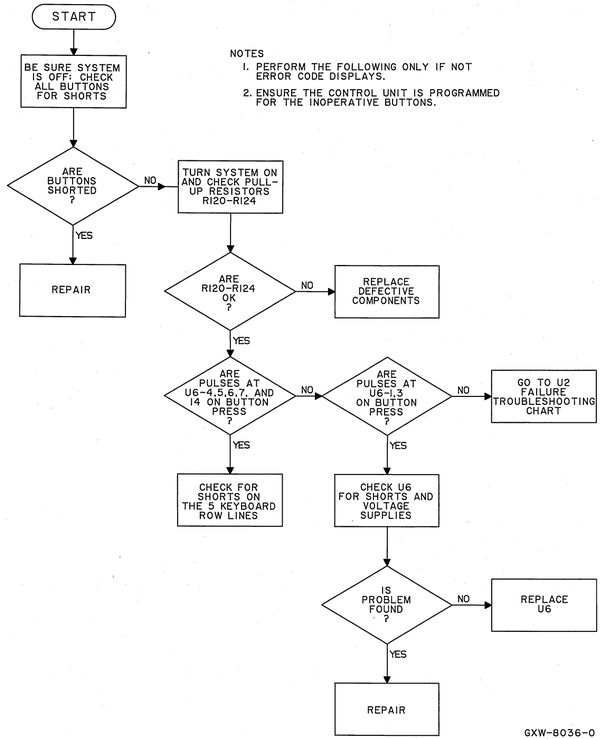
CONTROL UNIT DISPLAY FAILURE



GXW-8035-O

Troubleshooting Charts for
Systems 9000 Control Unit
PW-8028-O
(Sheet 1 of 2)
8/18/90

SELECTOR BUTTON FAILURE

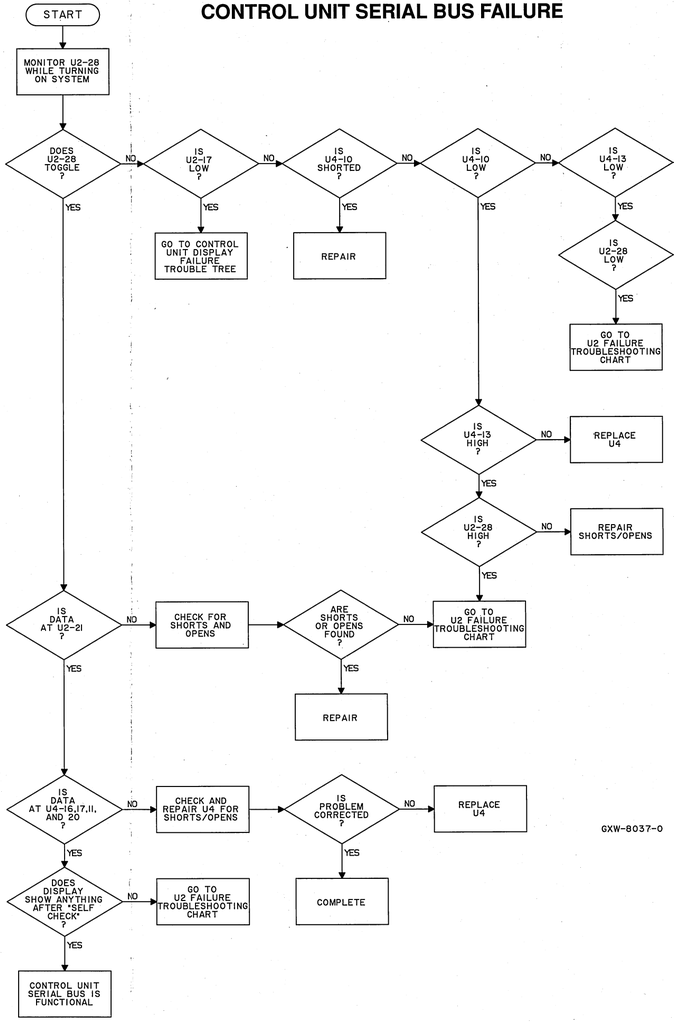


NOTES

1. PERFORM THE FOLLOWING ONLY IF NOT ERROR CODE DISPLAYS.
2. ENSURE THE CONTROL UNIT IS PROGRAMMED FOR THE INOPERATIVE BUTTONS.

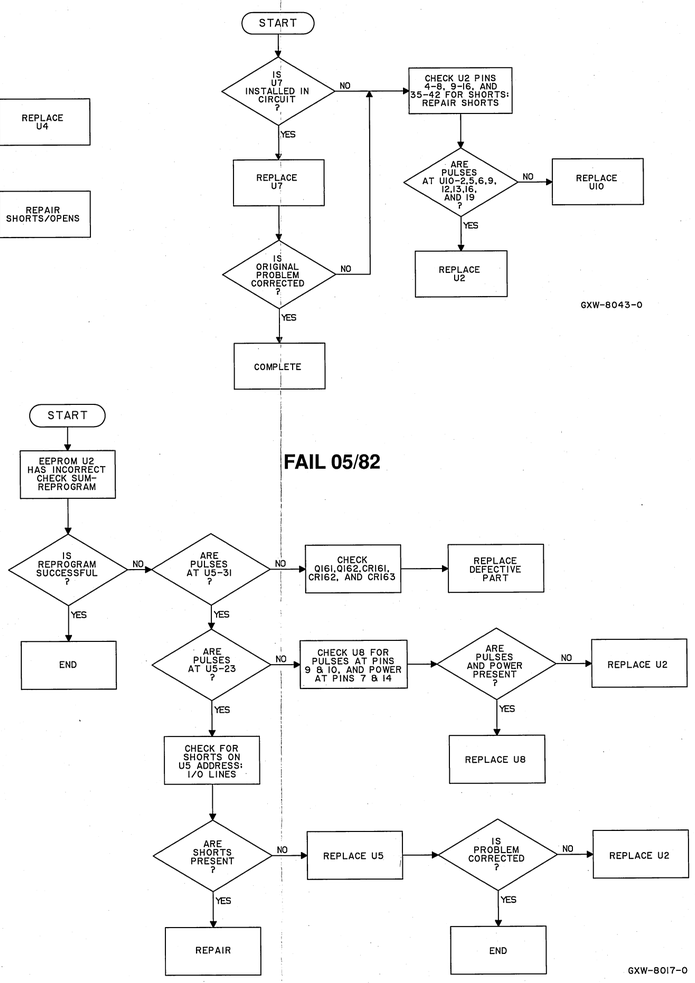
GXW-8036-0

CONTROL UNIT SERIAL BUS FAILURE



GXW-8037-0

U2 FAILURE



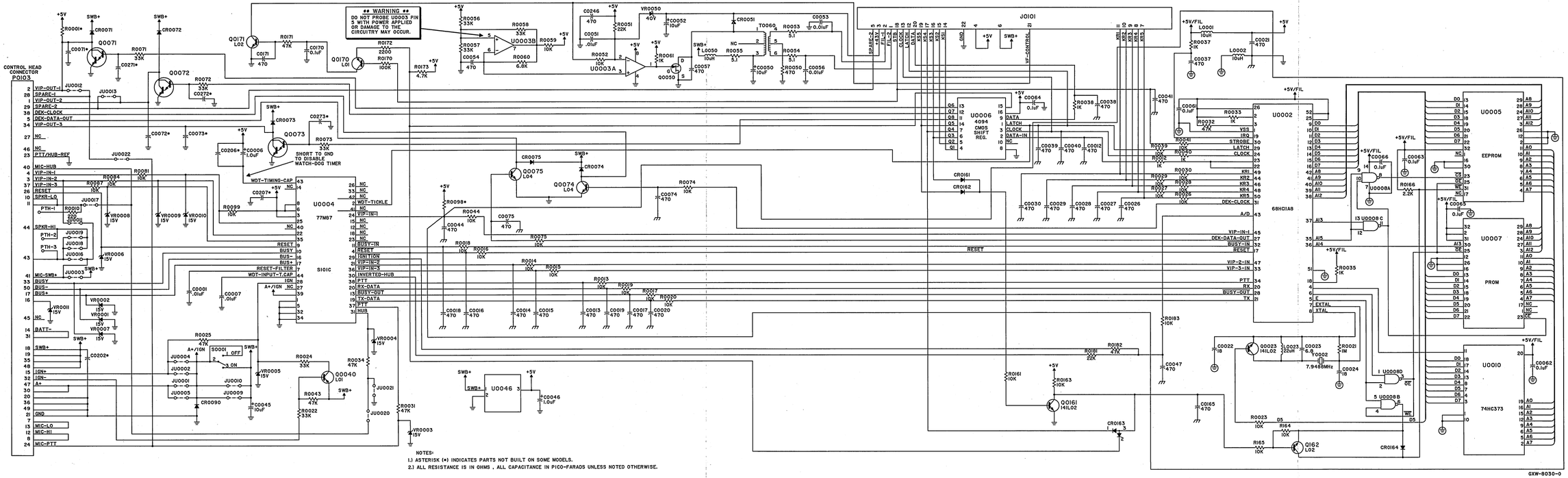
GXW-8017-0

FAIL 05/82

GXW-8043-0

Troubleshooting Charts for
Systems 9000 Control Unit
PW-8028-O
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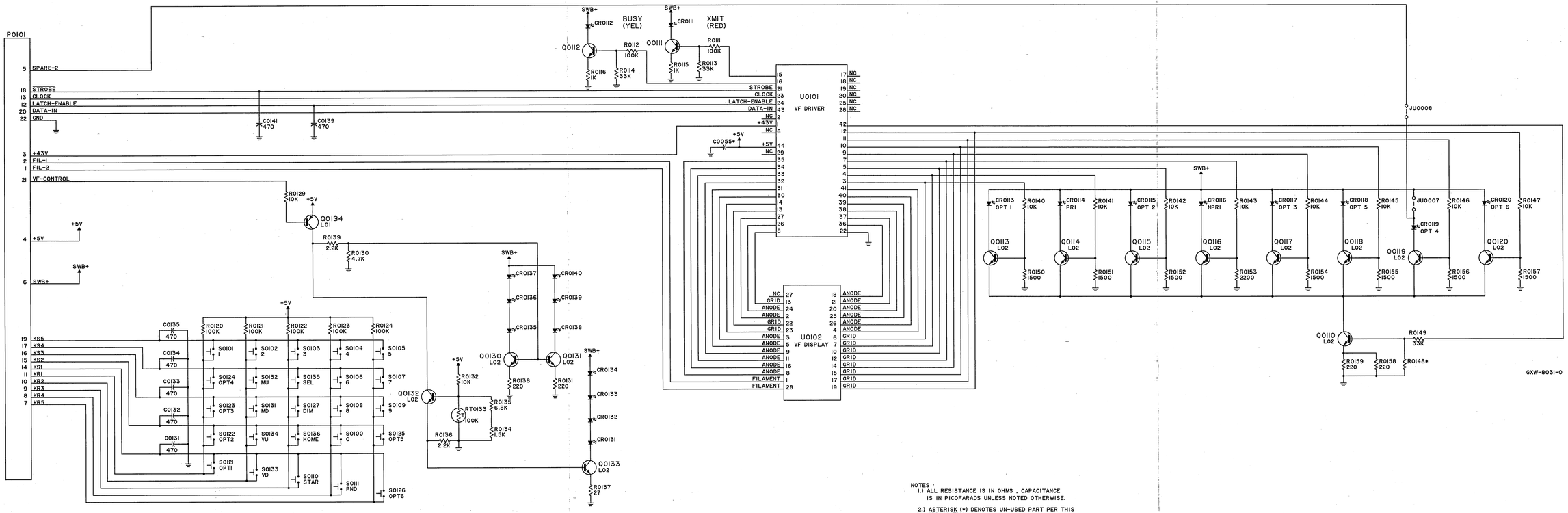
CONTROLLER BOARD SCHEMATIC



NOTES:
1.) ASTERISK (*) INDICATES PARTS NOT BUILT ON SOME MODELS.
2.) ALL RESISTANCE IS IN OHMS , ALL CAPACITANCE IN PICO-FARADS UNLESS NOTED OTHERWISE.

Schematics, Circuit Board Diagrams, Waveforms, and Parts Lists for *Systems 9000* Control Unit
PW–8032–O
(Sheet 1 of 4)
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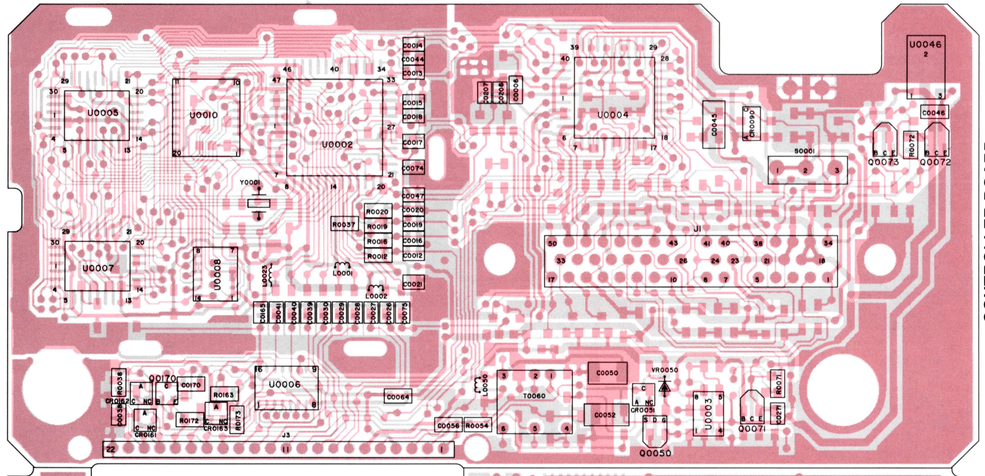
DISPLAY BOARD SCHEMATIC

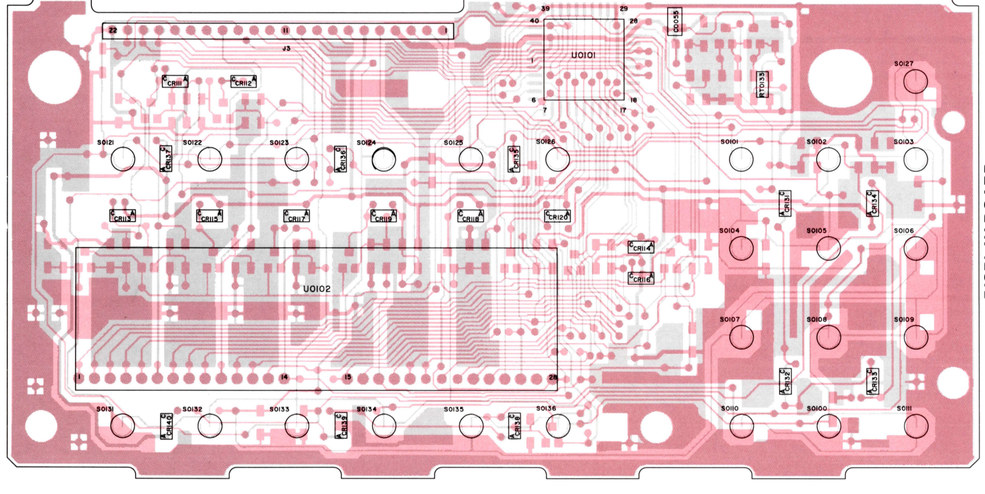


NOTES :
1.) ALL RESISTANCE IS IN OHMS , CAPACITANCE IS IN PICOFARADS UNLESS NOTED OTHERWISE.

2.) ASTERISK (*) DENOTES UN-USED PART PER THIS APPLICATION.

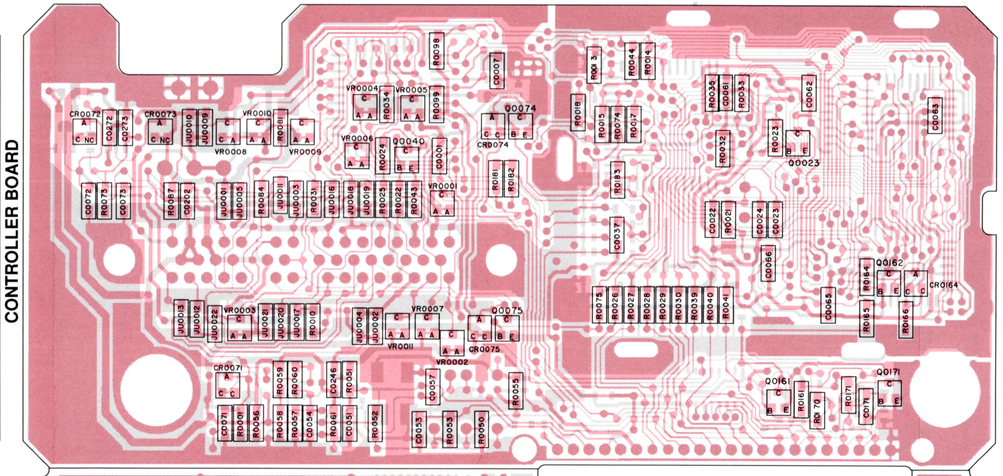
Schematics, Circuit Board Diagrams, Waveforms,
and Parts Lists for *Systems 9000* Control Unit
PW–8032–O
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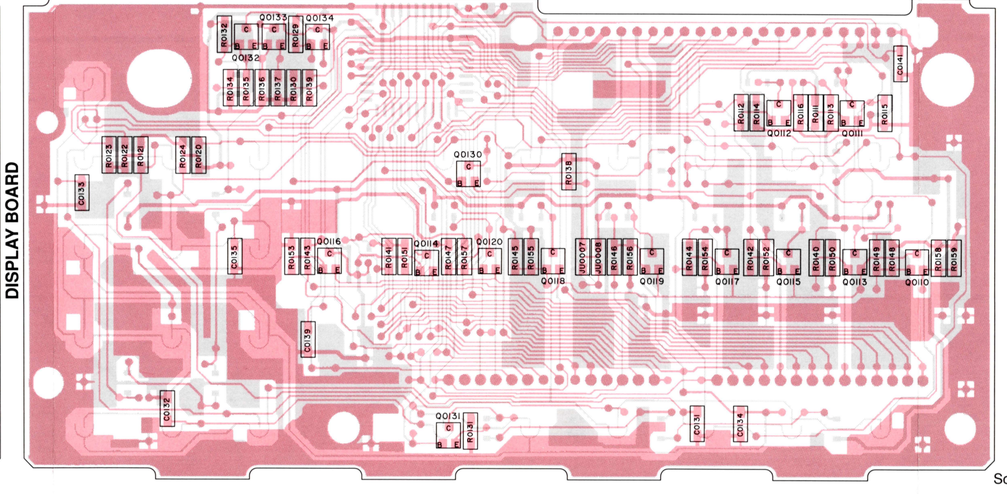




CONTROLLER BOARD

DISPLAY BOARD





SOLDER SIDE — GPW-8024-O
COMPONENT SIDE
OVERLAY — GXW-8025W01-O

COMPONENT SIDE VIEW

SOLDER SIDE — GPW-8024-O
COMPONENT SIDE
OVERLAY — GXW-8025W02-O

SOLDER SIDE VIEW

Schematics, Circuit Board Diagrams, Waveforms, and Parts Lists for *Systems 9000* Control Unit
PW–8032–O
(Sheet 3 of 4)
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parts list

HLN5464A *Systems 9000* Control Unit (Display Board) MXW–8023–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C55	21–13741N69	.1 uF, ±10%
C131–135	21–13740B65	470
C139	21–13740B65	470
C141	21–13740B65	470
diode (see note)		
CR111	48–80052R01	LED, red
CR112	48–80052R02	LED, yellow
CR113–115	48–80052R01	LED, red
CR116	48–80052R02	LED, yellow
CR117–120	48–80052R01	LED, red
CR131–140	48–80052R03	LED, green
transistor (see note)		
Q110–120	48–80141L02	NPN
Q130–133	48–80141L02	NPN
Q134	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R111,112	06–11077B23	100k
R113,114	06–11077B11	33k
R115,116	06–11077A74	1k
R120–124	06–11077B23	100k
R129	06–11077A98	10k
R130	06–11077A90	4.7k
R131	06–11077A58	220
R132	06–11077A98	10k
R133	06–80149M02	100k, ±10%, 240mW, thermistor
R134	06–11077A78	1.5k
R135	06–11077A94	6.8k
R136	06–11077A82	2.2k
R137	06–11077A36	27
R138	06–11077A58	220
R139	06–11077A82	2.2k
R140–147	06–11077A98	10k
R149	06–11077B11	33k
R150–152	06–11077A78	1.5k
R153	06–11077A82	2.2k
R154–157	06–11077A78	1.5k
R158,159	06–11077A58	220
integrated circuit (see note)		
U101	51–80236C05	VF driver
V102	72–80242J01	VF display
non–referenced parts		
	61–80027R01	8 indicator light pipe
	61–80026R01	2 indicator light guide
	01–80740T42	VF display & shock pad assembly
	75–80094M04	battery shock pad
	75–80094M05	VF shock pad
	84–80168P01	display circuit board

8/18/90

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

HLN5464A *Systems 9000* Control Unit (Controller Board) MXW–8022–O

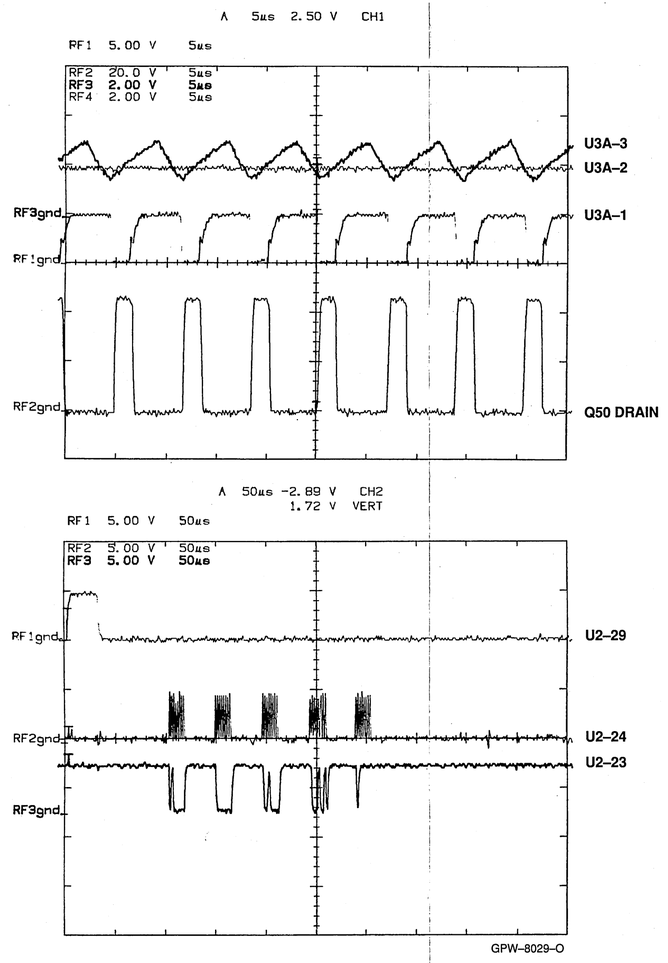
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C1	21–13741N45	.01 uF, ±10%
C6	23–11049A37	1 uF, ±20%, 25V, tantalum
C7	21–13741N45	.01 uF, ±10%
C12–21	21–13741M13	470, ±10%
C22	21–13740B31	18
C23	21–13740B21	6.8
C24	21–13740B31	18
C25–30	21–13741M13	470, ±10%
C36–42	21–13741M13	470, ±10%
C44	21–13741M13	470, ±10%
C45	23–80090M24	10 uF, ±20%, electrolytic
C46	23–11049A37	1 uF, ±20%, 25V, tantalum
C47	21–13741M13	470, ±10%
C50	23–11049J27	10 uF, ±10%, 25V, tantalum
C51	21–13741N45	.01 uF, ±10%
C52	23–80090M24	10 uF, ±20%, electrolytic
C53	21–13741N45	.01 uF, ±10%
C54	21–13740B65	470
C56	21–13741N45	.01 uF, ±10%
C57	21–13740B65	470
C61–66	21–13741N69	.1 uF, ±10%
C71–73	21–13740B65	470
C165	21–13741M13	470, ±10%
C170	21–13741N69	.1 uF, ±10%
C171	21–13740B65	470
C202	21–13740B65	470
C206,207	21–13741M13	470, ±10%
C246	21–13740B65	470
C271–273	21–13741M13	470, ±10%
diode (see note)		
CR51	48–11058B11	silicon
CR71–75	48–80236E08	rectifier
CR90	48–82660R02	rectifier
CR161–164	48–80236E08	rectifier
connector receptacle		
J1	28–80228J01	50 position mini–D connector
jumper		
JU1	06–11077A01	0 ohm resistor
JU3	06–11077A01	0 ohm resistor
JU5	06–11077A01	0 ohm resistor
JU7	06–11077A01	0 ohm resistor
JU16–20	06–11077A01	0 ohm resistor
relay		
KP1	75–80098J01	keypad
coil, RF		
L1,2	24–80140E16	10 uH, inductor
L23	24–80289M16	22 uH
L50	24–80140E16	10 uH, inductor
transistor (see note)		
Q23	48–80141L02	NPN
Q40	48–80141L01	PNP
Q50	48–80053M03	N–channel, MOSFET
Q71–73	48–80052M01	NPN, Darlington
Q74,75	48–80141L04	NPN
Q161,162	48–80141L02	NPN
Q170	48–80141L01	PNP
Q171	48–80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R1	06–11077A98	10k
R10	06–11077A58	220
R12	06–11077A74	1k
R13–20	06–11077A98	10k
R21	06–11077B47	1 MEG
R22	06–11077B11	33k
R23	06–11077A98	10k
R24	06–11077B11	33k
R25	06–11077B15	47k
R26–30	06–11077A98	10k
R31,32	06–11077B15	47k
R33	06–11077A74	1k
R34	06–11077B15	47k
R35	06–11077A74	1k
R37,38	06–11077A74	1k
R39	06–11077A98	10k
R40	06–11077A74	1k
R41	06–11077A98	10k
R43	06–11077B15	47k
R44	06–11077A98	10k
R50	06–11077A66	470
R51	06–11077B07	22k
R52	06–11077A98	10k
R53–55	06–11077A19	5.1
R56–58	06–11077B11	33k
R59	06–11077A98	10k
R60	06–11077A94	6.8k
R61	06–11077A74	1k
R71–73	06–11077B11	33k
R74,75	06–11077A98	10k
R81	06–11077A98	10k
R84	06–11077A98	10k
R87	06–11077A98	10k
R88,99	06–11077A98	10k
R161	06–11077A98	10k
R163–165	06–11077A98	10k
R166	06–11077A82	2.2k
R170	06–11077B23	100k

MXW–8022–O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R171	06–11077B15	47k
R172	06–11077A82	2.2k
R173	06–11077A90	4.7k
R181	06–11077B07	22k
R182	06–11077B15	47k
R183	06–11077A98	10k
switch		
S1	40–80033K01	toggle
transformer		
T60	25–80277J03	voltage conversion
integrated circuit (see note)		
U2	51–97024A01	microcomputer
U3	51–80056M01	dual comparator
U4	51–83977M87	serial input/output
U5	51–97014A10	EEPROM
U6	51–84704M54	register
U8	51–80177M03	quad NAND gate
U10	51–80177M02	octal latch
U46	51–80068C08	voltage regulator
voltage regulator (see note)		
VR1–11	48–80140L20	15V zener
VR50	48–80056K40	43V zener
crystal (see note)		
Y2	48–80173D10	7.9488 MHz
non–referenced parts		
	09–80049R01	32 pin socket
	32–80179J01	connector gasket
	01–80740T38	mini–D connector & gasket assembly
	32–80181J01	face connector gasket
	84–80167P01	controller circuit board

8/18/90

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



GPW–8029–O

Schematics, Circuit Board Diagrams, Waveforms, and Parts Lists for *Systems 9000* Control Unit
PW–8032–O
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MOTOROLA
Mobile Products Division

SPECTRA
Two–Way FM Radio

Detailed Service Information

68P80101W33–B

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Communications and Electronics Parts

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Control Head

Control Head **W10002S65**

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2. Theory of Operation 2
3. Vehicular Interface Ports 5
4. Special Repair and Troubleshooting 5

SPECTRA Control Head Block Diagram PW–4508
Schematic and Parts Lists for *SPECTRA*
Control Head Interconnect Board PW–6275
SPECTRA Button Kits and Control Head
Hardware Kits Parts Lists PW–6258
SPECTRA Control Head Waveforms PW–6274
Troubleshooting Charts for *SPECTRA* Control Head PW–4510
Schematics, Circuit Board Diagrams, and Parts Lists for:
HLN6020A, HLN6020B, and HLN6078A *SPECTRA* Control Head PW–4516
HLN6078B *SPECTRA* Control Head PW–6255
HLN6075A *SPECTRA* Control Head PW–6259

RF Board

RF Board **W10002S64**

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HRN6002A *SPECTRA* RF Board (900 MHz) PW–5665
HRN6005A *SPECTRA* RF Board (900 MHz) PW–5673
HRN6007A *SPECTRA* RF Board (900 MHz) PW–6352
HRN6001A and HRN6004A *SPECTRA* RF Board (VHF) PW–5680
HRN6003A and HRN6006A *SPECTRA* RF Board (UHF) PW–5827
HRN6009A and HRN6010A *SPECTRA* RF Board (800 MHz) PW–6359

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Command Board

Command Board **W10002S66**

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Troubleshooting Chart for *SPECTRA* Command Board Digital Circuitry PW–4744
Troubleshooting Chart for *SPECTRA* Command Board Signalling Circuitry PW–4761
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HLN6062A, HLN6062B, and HLN6064A *SPECTRA* Command Boards PW–5776
HLN6064B *SPECTRA* Command Board PW–5777
HLN6074A *SPECTRA* Command Board PW–6292
HLN6094A *SPECTRA* Command Board PW–6294

***HearClear* Board** **W10002S39**

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Schematic, Circuit Board Diagrams, and Parts Lists for:
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Memory Board **W10002S41**

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3. Reprogramming the Radio 1
4. Operation 1

VCO

Voltage Controlled Oscillator (VHF) **W10002S68**

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2. Theory of Operation 1
3. Troubleshooting 2

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HLD6000A and HLD6000B *SPECTRA* VHF VCO Carrier Board PW–6383

Voltage Controlled Oscillator (UHF) **W10002S73**

1. General 1
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Schematics, Circuit Board Diagrams, and Parts Lists for:
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Voltage Controlled Oscillator (800 MHz) **W10002S81**

1. General 1
2. Theory of Operation 1
3. Troubleshooting 2

Schematics, Circuit Board Diagrams, and Parts Lists for:
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HLF6080A *SPECTRA* 800 MHz VCO Carrier Board PW–6401

VCO (Continued)

Voltage Controlled Oscillator (900 MHz) **W10002S67**

1. General 1
2. Theory of Operation 1
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Schematics, Circuit Board Diagrams, and Parts Lists for:
HLF6072A *SPECTRA* 900 MHz VCO Hybrid PW–4762
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HLF6002A and HLF6073A *SPECTRA* 900 MHz VCO Carrier Board PW–4712
HLF6084A *SPECTRA* 900 MHz VCO Carrier Board PW–6413

Receiver Front End

Receiver Front End (VHF) **W10002S70**

1. General 1
2. Theory of Operation 1
3. Troubleshooting 1

Troubleshooting Chart for
SPECTRA VHF Receiver Front End PW–5875
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Receiver Front End (UHF) **W10002S74**

1. General 1
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Receiver Front End (800 MHz) **W10002S82**

1. General 1
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Receiver Front End (900 MHz) **W10002S69**

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Troubleshooting Chart for:
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HRF6003A *SPECTRA* Receiver Front End Hybrid PW–6440

Power Amplifier

Power Amplifier (VHF) **W10002S72**

1. Transmitter 1
2. Antenna Switch and Harmonic Filter 2
3. Power Control Circuitry 3
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Block Diagram for *SPECTRA* 50–Watt PA PW–5816
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HLD6022B SPECTRA VHF 50–Watt Power Amplifier PW–6505

Power Amplifier (UHF) **W10002S75**

1. Transmitter 1
2. Antenna Switch and Harmonic Filter 2
3. Power Control Circuitry 3
4. Transmitter Troubleshooting 4

Block Diagram for *SPECTRA* UHF 40–Watt PA PW–5942
Schematics, Circuit Board Diagrams, and Part Lists for:
HLE6043A and HLE6044A *SPECTRA* UHF 40–Watt Power Amplifier PW–5902
HLE6043B and HLE6044B *SPECTRA* UHF 40–Watt Power Amplifier PW–6533

Power Amplifier (800 MHz) **W10002S83**

1. Transmitter 1
2. Antenna Switch and Harmonic Filter 1
3. Power Control Circuitry 2
4. Transmitter Troubleshooting 4

SPECTRA 15 and 35 Watt Power Amplifier Block Diagrams PW–6628
Schematics, Circuit Board Diagrams, and Parts Lists for:
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HLF6077A *SPECTRA* 35 Watt Power Amplifier PW–6637

Power Amplifier (900 MHz) **W10002S71**

1. Transmitter 1
2. Antenna Switch and Harmonic Filter 2
3. Power Control Circuitry 2
4. Transmitter Troubleshooting 4

SPECTRA 12 and 30–Watt Power Amplifier Block Diagrams PW–4601
Schematics, Circuit Board Diagrams, and Part Lists for:
HLF6052A and HLF6074A *SPECTRA* 12–Watt Power Amplifier PW–4710
HLF6074B *SPECTRA* 12 Watt Power Amplifier PW–6614
HLF6062A *SPECTRA* 30–Watt Power Amplifier PW–4711
HLF6075A and HLF6082A *SPECTRA* 30 Watt Power Amplifier PW–6618

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Remote Mount Control Head for *SPECTRA* VHF and UHF Radio PW–5810
SPECTRA 800 MHz Radios PW–6323
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Remote Mount Control Head for *SPECTRA* Radio PW–6228
Schematic, Circuit Board Diagram, Exploded Views
and Parts Lists for Accessories 68P80102W17

1. Description

1.1 GENERAL

The solid–state microprocessor circuits in the *SPECTRA* Control Head operate the standard and optional features buit into the system. The compact control head was designed for installation in even the smallest of compact cars. Systems that have many options simply require more control buttons; not more space–consuming control units.

The microphone connects at the lower left corner of the front panel. The programming cable, for field programming, connects to the rear accessory connector.

1.2 CONTROLS AND INDICATORS (See Figure 1)

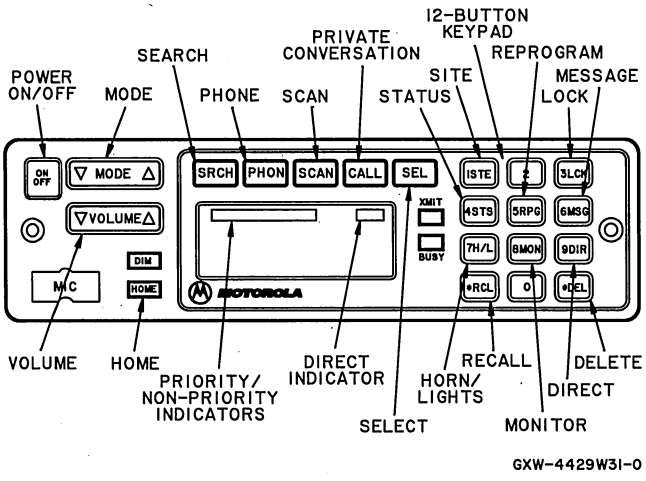


Figure 1. Typical SPECTRA *Radio Controls and Indicators*

1.2.1 Buttons

Most buttons are backlit to facilitate operation in low light. Four ON/OFF option buttons are arranged above the display with indicator symbols in the display to tell whether the options are on or off. A twelve–button keypad (on keypad models) contains the traditional alpha–numeric keys, some of which double as function keys for other *SPECTRA* options.

1.2.2 Power Switch

The push–on, push–off power switch, located at the upper left corner of the control head front panel, turns the radio and its accessories on and off.

1.2.3 Mode Rocker Switch

Located at the left of the display, the Mode rocker switch increases the mode number when you push on the right side, and decreases the mode number when you push on the left. If you push and hold the switch, it scrolls the mode numbers up or down. The mode names appear on the display.

1.2.4 Volume Rocker Switch

Located below the Mode rocker switch, the Volume rocker switch increases or decreases the volume setting. Push and release it to check the volume setting; the display shows, for example, "VOLUME 10." Push and hold the right side to increase volume; push and hold the left to decrease. The number value scrolls up or down to indicate your desired volume level.

1.2.5 Dim Button

Located below the Volume rocker switch, the Dim button controls the brightness of the display and button backlighting. When you turn the radio on, the display comes on at 'bright.' Press Dim once to add 'bright' button backlighting, twice for 'low', and three times for 'off.' Press a fourth time to return to the 'bright' display setting.

1.2.6 Home Button

Use the Home button (located below the Dim button) to go to the radio's pre–programmed "Home" mode. Also, on keypad–models, use it to change modes as follows: press and hold Home until a beep sounds, verifying entry into configuration state. The display shows an entry prompt. Enter the mode number with the keypad and press Home again. the mode changes to your selected mode.

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1.2.7 Options (Phon, Scan, Call) Buttons

Use these buttons, located above the display, to activate or deactivate the Phone, Channel/System Scan, and *Private Conversation/Call Alert* Options.

1.2.8 Sel (Select) Button

Use the Sel button, located to the right of the Options buttons, when configuring an option. see the Operator's Manual for specific information about how this button is used with the Options buttons.

1.2.9 Display

Eight 14–segment characters display the mode numbers, mode names, volume level, and a number of messages that tell you important facts about your radio, or the radio system. Also, build into the display are the following indicators:

(1) Options ON/OFF Indicators. Located near the top edge of the display, these "up–arrow" indicators are aligned beneath the option buttons. Each indicator arrow lights when an option is activated, and extinguishes when the option is deactivated.

(2) Scan Indicators. Located just beneath the "up–arrow" indicators are the priority indicators—PRI and NPRI. See Table 1 for meaning of display.

Table 1. Scan Indicator

DISPLAY	MEANING	
	Conventional Mode	Trunked Mode
PRI Flashes	Indicates displayed mode is in the *Channel Scan* list and has FIRST PRIORITY over all other modes in the list.	(Will not flash on a trunked mode.)
PRI Lights (Steady)	Indicates displayed mode is in the *Channel Scan* list and has PRIORITY over other modes except FIRST PRIORITY.	(Will not light on a trunked mode.)
NPRI Lights (Steady)	Indicates displayed mode is in the *Channel Scan* list but does not have priority over another mode.	Indicates dis–played mode is in the System Scan list.

(3) Dir (Direct) Indicator (Conventional modes only). Located to the right of the priority indicators, DIR lights to indicate a direct radio transmission to another unit without going through the conventional repeater system.

1.2.10 XMIT and BUSY Indicators

Located to the right of the display are two LED indicators. The XMIT LED lights when the radio is transmitting; the BUSY LED lights when the selected conventional mode has activity on it.

2. Theory of Operation

The following paragraphs describe the operational theory of the components of the control head. See the Control Head Block Diagram, PW–4508, for an illustration of these components and how the interrelate.

2.1 POWER SWITCH/IGNITION

A pushbutton ON/OFF switch (S1) on the front panel controls power to the radio and accessories. In addition to this switch, you can wire the vehicle's ignition and add or remove control head jumpers to further control radio operation. The three types of operation available to the customer are shown in Table 2.

The ignition cable is the fused red wire attached to the accessory connector. The control head is shipped with jumper JU1 out and jumper JU2 in. Configured this way, connect the ignition cable to:

"battery hot" on the fuse block to TRANSMIT and RECEIVE via the front panel pushbutton ON/OFF switch, regardless of the ignition switch setting;

or,

" ignition" at the fuse block to disable TRANSMIT and RECEIVE except when the ignition switch is ON. This method is more convenient because you need only to switch off your ignition . . . the radio will not drain your car's battery when you leave the radio switch "ON".

Table 2. Types of Operations

TYPE	HOW IT OPERATES	CONTROL HEAD JUMPER/STATUS	IGNITION WIRING
1	RECEIVE and TRANSMIT enabled via Control Head ON/OFF switch (Ignition has no effect).	JU1/OUT; JU2/IN	Connect Ignition cable to "Battery Hot" at Fuse Block.
2	RECEIVE and TRANSMIT enabled only when ignition switch is ON.	JU1/OUT; JU2/IN	Connect Ignition cable to "Ignition" at Fuse Block.
3	RECEIVE enabled by Control Head ON/OFF switch; TRANSMIT enabled only when Ignition switch is ON.	JU1/IN; JU2/OUT	Connect Ignition cable to "Ignition" at Fuse Block.

If the customer wants to inhibit TRANSMIT, but allow any RECEIVE, the two control head jumpers must be changed. Remove the two front panel screws, one from each end, and then pull straight out on the control head to detach it. The jumper locations on the PC board are shown in the foldout toward the end of this section. Locate jumper JU2, carefully un–solder it, and remove it from the board. Find the location for JU1 and solder a jumper in place. Install the control head. Connect the ignition cable to "Ignition" at the fuse block. (See paragragh 2.10 for Ignition Sense Circuitry.)

2.2 5–VOLT REGULATOR

Switched B+ is applied to U45, a 5–volt regulator. C45 and C46 filter SWB+ and the 5–volt line to ensure U45 operates properly. CR90 protects against accidental reverse polarity connections during installation. The 5–volt supply operates the microcomputercircuitry, interface circuitry, VF driver U101, and Comparator U3.

2.3 MICROCOMPUTER

The microcomputer, U1, operates on the 5–volt supply, and is filtered by L1. A resonator, Y1, oscillates at 4 MHz to provide a stable clock for microcomputer timing. U1 handles all communication with the radio command board over the serial bus, scans the keyboard for button presses, and generates the display information needed by the VF driver (U101) to driver the VF display (U102).

2.4 INTERFACE CIRCUITRY

The bulk of the interface circuitry is contained in bipolar custom IC, U4. This IC includes watchdog timer circuits, serial bus communication drive circuits, and input buffer circuits to protect microprocessor U1.

2.5 RESET

On initial power–up the $\overline{\text{RESET}}$ line to U1–1 is held low by U4 for approximately 120 milliseconds before going high. This resets U1 and starts it operating properly. Then, a pulse train generated at U1–38 sends tickle pulses to the watchdog timer circuitry in U4 and sends a STROBE signal to the VF display driver, U101. The tickle pulse train frequency is kHz. If the tickle pulse disappears for more than approximately 120 milliseconds, C6 charges to about 3.3 volts and triggers a reset as described above. Any time a reset occurs, U4–9 goes high, causing radio circuitry to also reset via the control cable. Should radio circuitry initiate the reset, pin 23 of the control unit PC board connector is forced high, triggering the same events described above. The control head can reset the radio command board and vice–versa via the reset line. (See Table 3.)

Table 3. Serial Data Bus Logic

DATA LINE	NO BUS ACTIVITY (Normal) Receiving Data)	BUS ACTIVITY (Sending or Receiving Data)	IN RESET*
Busy	Low	High	Low
$\overline{\text{BUSY IN}}$	High	Low	High
$\overline{\text{BUSY OUT}}$	High	Low**	High
BUS+	High	Low and High	High
BUS–	Low	High and Low	Low
TXDATA	High	Low and High**	High
RXDATA	High	Low and High	High
RESET	Low	Low	High
$\overline{\text{RESET}}$	High	High	Low

* Bus activity will occur immediately after a reset.
** Sending only.

2.6 BUS BUSY (See Table 3.)

The control head prepares to send data on the serial bus when U1–5 $\overline{\text{BUSY OUT}}$ goes low, causing U4–10 to go high. This signals the radio command board that the control head has data to send. U4–11 $\overline{\text{BUSY IN}}$ goes low whenever U4–10 goes high. This informs the control head microcomputer that the serial bus is in use.

2.7 SERIAL BUS DATA (See Table 3.)

Two lines, BUS+ and BUS–, send data between the control head and the radio command board. Under the normal conditionof inactivity, BUS+ is high and BUS– is low. This is the "inactive state" on the serial bus. When the two lines invert (BUS+ goes low, BUS– goes high), the serial bus is in the "active state."

The control head uses the TXDATA line (U1–33) to send data over the serial bus. When TXDATA goes low, the bus is placed in the active state by U4; when TXDATA goes high, the bus returns to the inactive state.

Data is sent to the microcomputer on the RXDATA line (U1–32). Whenever the serial bus is in the active state, RXDATA is low. An inactive state on the bus causes RXDATA to go high.

2.8 PUSH–TO–TALK $\overline{\text{PTT}}$

The $\overline{\text{PTT}}$ line from the microphone keys the transmitter. This line (U4–37) is normally biased at 5 volts but goes to DIG GND when the microphone PTT button is pressed. This causes the PTT line (U1–21) to go high. The transmit command is then sent over the serial bus to the radio command board. Releasing the PTT reverses this process. There is no PTT hardware connection from the control head to the radio command board. (See Table 4.)

Table 4. PTT Logic States

Microphone Push–to–talk	$\overline{PTT}$	PTT
PRESSED	Low	High
RELEASED	High	Low

2.9 HANG–UP BUTTON (HUB)

The control head senses when the microphone is off–hook by monitoring the HUB line from the microphone. When the microphone is on–hook, the HUB line (U4–31) is connected to ground, placing a high on the inverted HUB line (U1–20), and sending the "on–hook" command over the serial bus. When the microphone is off–hook, U4–31 biases to 5 volts, reversing the process, and sending the "off–hook" command over the serial bus. (See Table 5.)

Table 5. HUB Logic States

Microphone Hang–up–button	HUB Line	Inverted HUB
ON–HOOK	Low	High
OFF–HOOK	High	Low

2.10 IGNITION SENSE CIRCUITRY

Ignition sense voltage is sensed by U4–28. When this voltage is high, U4–29 goes low, resulting in U1–39 going low, and sending the "Ignition–on" command over the serial bus. When the ignition voltage drops off, the process is reversed.

2.11 KEYPAD SCAN

U1 scans the keypad switches for a button press by sending out periodic low–going pulses in sequence on pins 8 through 12. Keypad sense lines connect back to U1 on pins 13 through 17. Resistors R120 through R124 ensure that the sense lines are high until a key is pressed. When a button is pressed, keypad contacts close, allowing the low–going pulse to return to the microcomputer on the appropriate sense line. This informs U1 that a particular button was pressed.

2.12 VEHICLE INTERFACE PORTS (VIP)

The VIP outputs are controlled by microcomputer U1 pins 26, 27, and 28. A high level causes the associated transistor, Q71, Q72, and Q73 to conduct and sink up to 300 mA of current to ground. Primarily, these transistors control external relays. The relay coil is connected between the VIP output pin and SWB+. See to the Installation Manual for actual connection details.

VIP input lines connect to U4 pins 22, 25, and 35. U4 acts as an inverting stage, passing the VIP input signals to U1 pins 29, 30, and 31 to be read by the microcomputer. VIP inputs normally connect to ground via a normally open or normally closed switch.

2.13 VACUUM FLUORESCENT (VF) VOLTAGE CONVERTER CIRCUITRY

Voltage for the VF display is generated by a fixed frequency, variable duty–cycle controlled, flyback voltage converter. The switching frequency is about 210 kHz. One–half of U3 (pins 5, 6, and 7) from a 210 kMz sawtooth oscillator. The sawtooth waveform is produced at U3–6 and is applied to pin 3 of the other half of U3. This portion of U3 is a duty–cycle controlled comparator. Microcomputer U1–6 controls the entire voltage converter. During start up, U1–6 pulls to ground, biasing U3–2 to about 1.85 volts via R51 and R52. U3–1 and R61 then begin to switch Q50 on and off at a 210 kHz rate. This allows current to flow through T60, building a magnetic field, then collapsing it. When the field collapses, the back EMF (flyback) forward biases CR51 and charges C52 (after a few cycles) to about 37 volts, causing Zener diode CR50 to conduct. The high voltage is regulated by the effect that CR50 has on the bias voltage at U3–2. If the high voltage supply increases, CR50 pulls U3–2 higher in voltage, resulting in a decreased duty–cycle for Q50 (the switching frequency remains constant; only the duty–cycle of on–time versus off–time decreases). Less power is upconverted to C52 when the duty–cycle decreases, hence regulation is maintained.

The voltage converter also produces an AC filament voltage for the VF display across T60 pins 4 and 6. R101 drops this voltage to approximately 2.4 Vrms. This AC voltage rides on a positive DC offset due to R50, depending on brightness. The positive offset allows a VF display grid to be reverse biased with respect to the filament when that particular grid is supposed to be shut off. This prevents character "ghosting."

Display dimming is exclusively controlled by multiplexing information sent from U1 to the VF driver IC, U101. Display dimming has no effect on the voltage converter circuitry except in the OFF mode. In this mode, U1–6 goes high resulting in U3–2 going to +5 volts. This keeps U3–1 low and Q50 turned off. The high voltage supply drops to about 12 volts and the AC filament voltage drops to zero, shutting off the display.

2.14 VACUUM FLUORESCENT DISPLAY DRIVER IC

VF driver IC, U101, receives data directly from the microcomputer for multiplexing the VF display. All of the grid and anode driver lines from U101 are either at about 34 volts (ON) or ground (OFF).

2.15 VACUUM FLUORESCENT DISPLAY

The VF display is an 8–charcter, 14–segment device. Anodes are the actual phosphorescent segments and grids are the wire–mesh structures located over each character. Multiplexing allows character generation with a minimum of interconnecting lines between display and driver. Anodes and grids operate at about 34 volts when "on" and are at zero when "off." The filament operates on AC at about 2.4 Vrms, with current flow at 100 mA through the filament. DC current flowing from anodes and grids to the filament, and through R50 to ground, increases filament voltage by up to 5 VDC.

2.16 BACKLIGHT LEDS

Most buttons on the control head are backlit by ten LEDs for easy nighttime viewing. In medium and low brightness level settings, U1–19 goes high, turning on Q131 and causing a fixed current to flow through the LEDs.

In the OFF mode and the maximum brightness mode, U1–19 goes low, turning off Q131 and the LEDs. (Microprocessor U1 does not duty–cycle change the brightness level of the backlighting LEDs.)

2.17 TRANSMIT AND BUSY LEDS

Indicator LEDs for XMIT (red) and BUSY (yellow) function similarly in brightness level to the display. Multiplexing signals from U101 pins 15 and 16 control XMIT and BUSY brightness levels respectively. R111 and R113 drop the 34–volt control voltage from U101 down to approximately 8 volts at the base of Q111. This causes a fixed current to flow through CR111. CR112 operates similarly.

3. Vehicle Interface (VIP)

The VIP allows the control head to control outside circuits in the vehicle and to receive inputs from outside the control head. This results in greater flexibility and ease of installation when interfacing to other systems in the vehicle. There are up to three VIP outputs that can be used for relay control. There are also up to three VIP inputs that can accept input from switches, etc.

3.1 VIP OUTPUT CONNECTIONS

(1) *Dash Mount Installations.* Two VIP outputs are available in dash–mount installations. VIP OUT 1 is on Pin 12 of the rear accessory connector; VIP OUT 2 is on Pin 3. These connections are used to control relays. Connect one terminal of the relay coil to SWB+ (Rear Accessory Connector Pin 4); connect the other relay coil terminal to one of the VIP outputs. See the Installation Manual for the horn and lights connections.

(2) *Remote Mount Installations.* VIP outputs function exactly the same in remote–mount installations as the dash mount. However, three VIP outputs are available at the remote–mount accessory cable connector: VIP OUT 1 is on Pin 12; VIP OUT 2 is on Pin 3; and VIP OUT 3 is on pin 15.

3.2 VIP INPUT CONNECTIONS (REMOTE MOUNT ONLY)

Three VIP input lines are available in remote–mount installations. VIP IN 3 is on Pin 9. These connections are used to accept input from switches or other circuits in the vehicle. The VIP inputs are biased at about 5 volts, and to be "activated." the inputs are switched to ground. Normally, a switch is connected from a VIP in put line to ground. The switch can be normally–open or normally–closed depending on VIP programming and the particular function being performed.

4. Special Repair Instructions and Troubleshooting

4.1 REMOVING THE VACUUM FLUORESCENT DISPLAY

(1) Figure 2, Detail A illustrates the removal procedure. Cut through the shock pad located opposite the side of the display with the soldered leads.

(2) Wear finger protection to prevent cutting your fingers on the sharp edges of the glass. Pull up on the edge of the display (See Figure 2, Detail B), bending the solder leads. Then cut through the remaining shock pad.

(3) Unsolder the leads from the PC board to remove the display. Use toluene solvent to remove the remaining shock pad and adhesive residue from the board.

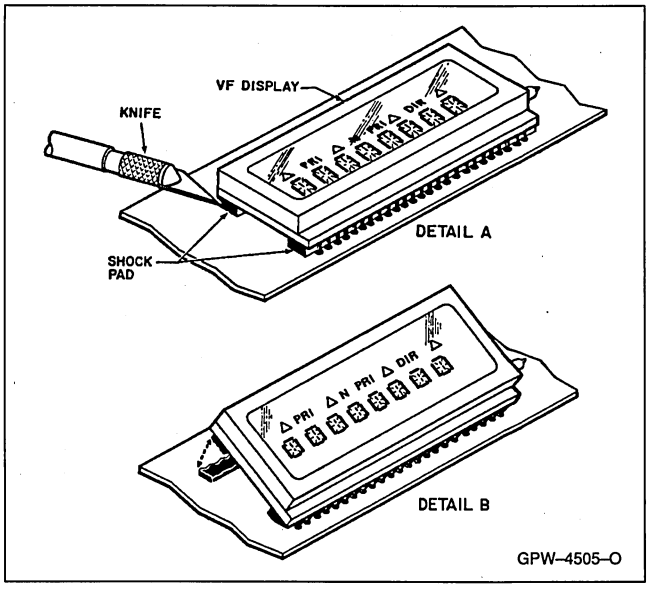


Figure 2. Replacing the Vacuum Fluorescent Display

4.2 INSTALLING THE VACUUM FLUORESCENT DISPLAY

(1) Apply the adhesive–backed shock pads to the new display. Carefully align the solder leads and insert the display into the PC board.

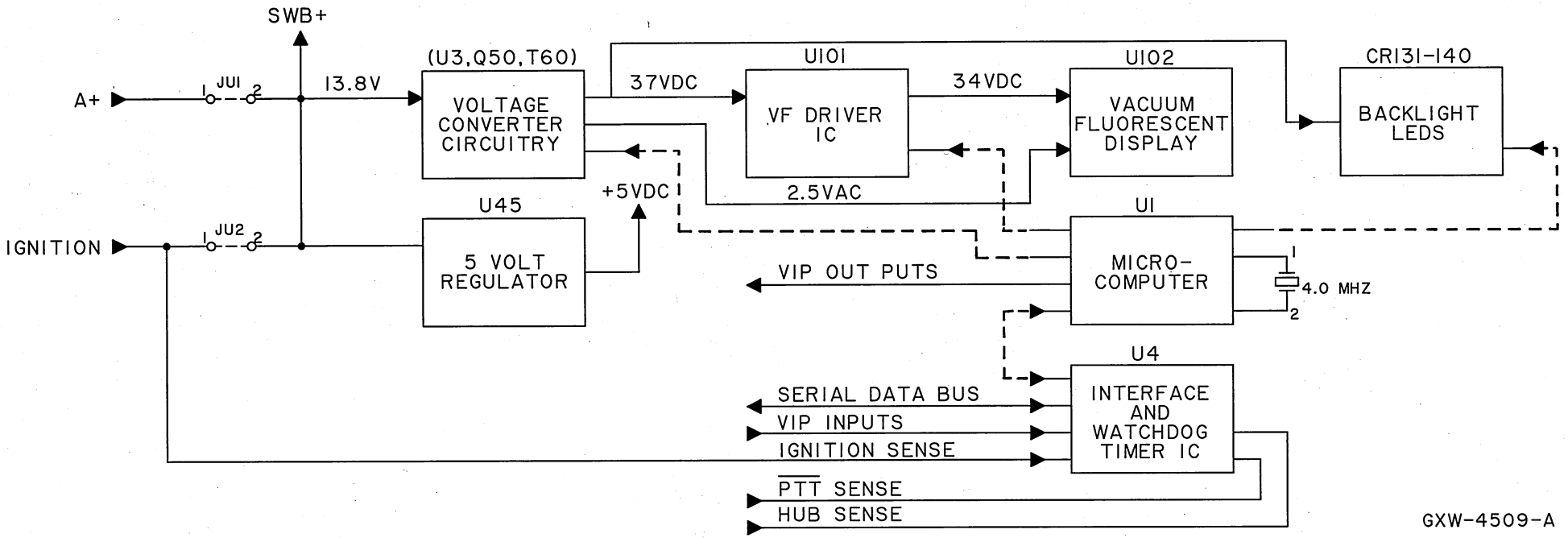
(2) Solder the leads of the new display to the PC board. Do not re–use the old display.

4.3 TROUBLESHOOTING

See the Troubleshooting Flow Chart, PW–4510, for trouble symptoms and the methods used to locate the causes of the problems.

Error and failure messages may appear on the VF display. These are identified in the service Manual.

SPECTRA Control Head Block Diagram
PW-4508-A
3/31/89



parts lists

HLN6058A Control Head Interconnect Board — MXW–5109–A

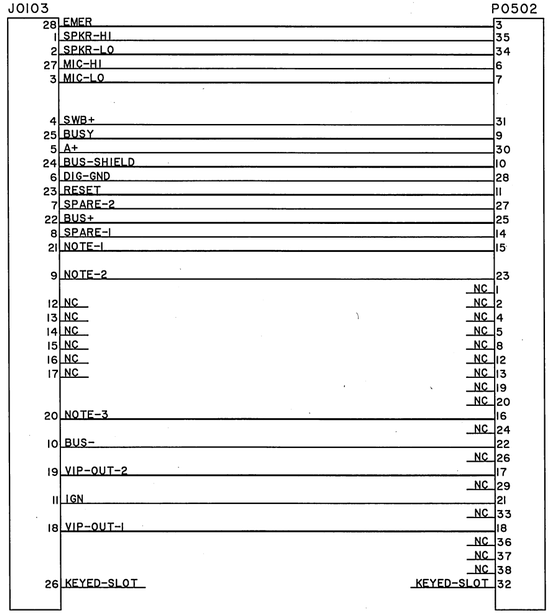
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
****THE FOLLOWING ARE USED ON 900 MHZ ONLY*****		
connector receptacle		
J103	09–80113M03	vertical, dual row, 28 position
connector plug		
P502	28–80102M05	vertical, 38 position

10/15/88

HLN6066A Control Head Interconnect Board — MXW–5959–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
connector receptacle		
J103	09–80113M03	vertical, dual row, 28 position
connector plug		
P502	28–80102M08	vertical, 38 position

10/15/88



NOTE 1 : CONTROL HEAD SWITCHED B+.
NOTE 2 : SERIAL BUS RESET.
NOTE 3 : DETECTED AUDIO.

GXW-6269-O

parts lists

HLN6026B Control Head Hardware (No Keypad) — MXW–6265–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
switch		
S1	40–80199N01	wiring assemblies
	mechanical parts	
	03–10945A14	tapping screw P3.12 X 1.27 X 16 (6 used)
	15–80010P02	front housing
	43–80208L02	internal frame spacer
	38–80009P01	pushbutton rocker, MODE
	38–80009P02	pushbutton rocker, VOLUME
	38–80092J01	key, DIM
	38–80092J02	key, HOME
	61–80186L01	lightpipe, 23–position
	75–80189L02	keypad, 21–position
	32–80289L01	housing gasket
	38–80227M01	on/off, BUTTON

3/31/89

HLN6101A Control Head Dash Hardware (No Keypad) — MXW–6266–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	03–10945A14	tapping screw P3.12 X 1.27 X 16 (6 used)
	15–80010P02	front housing
	43–80269N01	internal frame spacer
	38–80009P01	pushbutton rocker, MODE
	38–80009P02	pushbutton rocker, VOLUME
	38–80092J01	key, DIM
	38–80092J02	key, HOME
	61–80186L01	lightpipe, 23–position
	75–80189L03	keypad, 23–position
	32–80289L01	housing gasket
	38–80227M02	on/off button

3/31/89

HLN6001B Control Head Dash Hardware W/Keypad — MXW–6267–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
switch		
S1	40–80199N01	wiring assemblies
	mechanical parts	
	03–10945A14	tapping screw P3.12 X 1.27 X 16 (6 used)
	15–80010P01	front housing
	43–80208L02	internal frame spacer
	38–80009P01	pushbutton rocker, MODE
	38–80009P02	pushbutton rocker, VOLUME
	38–80092J01	key, DIM
	38–80092J02	key, HOME
	61–80186L01	lightpipe, 23–position
	75–80189L02	keypad, 21–position
	32–80289L01	housing gasket
	38–80227M01	on/off button

01/30/89

HLN6102A Control Head Hardware (With Keypad) — MXW–6268–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	mechanical parts	
	03–10945A14	tapping screw P3.12 X 1.27 X 16(6 used)
	15–80010P01	front housing
	43–80269N01	internal frame spacer
	38–80009P01	pushbutton rocker, MODE
	38–80009P02	pushbutton rocker, VOLUME
	38–80092J01	key, DIM
	38–80092J02	key, HOME
	61–80186L01	lightpipe, 23–position
	75–80189L03	keypad, 23–position
	32–80289L01	housing gasket
	38–80227M02	on/off button

3/31/89

HLN6026A Control Head Hardware (No Keypad) — MXW–6270–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
switch		
S1	40–80199N01	wiring assemblies
	mechanical parts	
	03–10945A14	tapping screw P3.12 X 1.27 X 16 (6 used)
	15–80112L02	front cover housing
	43–80208L01	internal frame spacer
	38–80091J03	pushbutton rocker, MODE
	38–80091J04	pushbutton rocker, VOLUME
	38–80092J01	key, DIM
	38–80092J02	key, HOME
	61–80186L01	lightpipe, 23–position
	75–80189L02	keypad, 21–position
	32–80289L01	housing gasket
	38–80227M01	on/off button

3/31/89

HLN6001A Control Head Hardware (With Keypad) — MXW–6291–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
switch		
S1	40–80199N01	wiring assemblies
	mechanical parts	
	03–10945A14	tapping screw P3.12 X 1.27 X 16(6 used)
	15–80112L02	front cover housing
	43–80208L01	internal frame spacer
	38–80091J03	pushbutton rocker, MODE
	38–80091J04	pushbutton rocker, VOLUME
	38–80092J01	key, DIM
	38–80092J02	key, HOME
	61–80186L01	lightpipe, 23–position
	75–80189L02	keypad, 21–position
	32–80289L01	housing gasket
	38–80227M01	on/off button

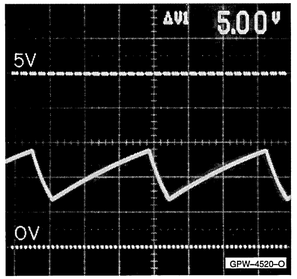
3/31/89

Button Kits parts list

HLN6105A	HLN6061A	HLN6061B	HLN6039A	HLN6038A	HLN6037A	HLN6031A	HLN6081A	HLN6083A	HLN6032A	HLN6082A	HLN6084A	HLN6034A	HLN6034B	HLN6035A	HLN6036A	HLN6040A	MOTOROLA PART NO.	DESCRIPTION
				1	2	2	2	2	1	2	2	2	2				38–80253K01	Option Button Plug
			1	1		1	1	1	1					1			38–80043M44	Option Button, PHON
			1	1		1	1	1	1	1	1	1	1				38–80043M03	Option Button, SCAN
			1	1	1	1	1	1	1	1	1	1	1				38–80043M18	Option Button, SEL
1			1	1	1		1		1	1	1	1	1				38–80043M12	Option Button, CALL
			1														38–80043M61	Option, Button, SRCH
1	1	1					1			1							38–80043M26	Option Button, EMER (White)
						1				2							38–80176M01	Keypad Button Plug
		1						1	1			1	1				38–80172L01	Keypad Button, 1
			1					1	1			1	1				38–80172L02	Keypad Button, 2
		1						1	1			1	1				38–80172L03	Keypad Button, 3
								1				1	1				38–80172L04	Keypad Button, 4
								1	1			1	1				38–80172L05	Keypad Button, 5
								1					1				38–80172L06	Keypad Button, 6
								1									38–80172L07	Keypad Button, 7
				1	1		1				1	1					38–80172L33	Keypad Button, H/L
			1						1				1	1			38–80172L29	Keypad Button, 7H/L
												1					38–80172L08	Keypad Button, 8
												1					38–80172L09	Keypad Button, 9
				1	1	1	1										38–80172L32	Keypad Button, MON
			1					1	1			1		1			38–80172L30	Keypad Button, 8MON
			1					1	1					1			38–80172L31	Keypad Button, 9DIR
			1					1	1			-	1	1			38–80172L21	Keypad Button, *RCL
								1	1				1	1			38–80172L10	Keypad Button, 0
			1					1	1				1	1			38–80172L22	Keypad Button, #DEL
				1	1	1	1					1					38–80172L34	Keypad Button, DIR
			1														38–80172L23	Keypad Button, 1STE
			1														38–80172L25	Keypad Button, 3LCK
			1					1									38–80172L26	Keypad Button, 4STS
			1														38–80172L27	Keypad Button, 5RPG
			1					1									38–80172L28	Keypad Button, 6MSG
		1															38–00028M01	Emergency Button
		1															38–00029M01	Insert Plunger
		1															38–80043M52	Option Button, Emergency
1																	38–80043M49	

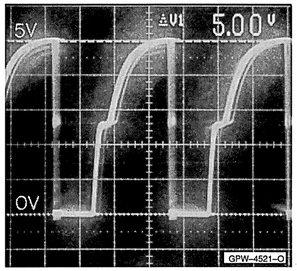
MXW–4485–B

SETTINGS:
1 Volt/Div.
1.5 uSec/Div.
DC Coupled



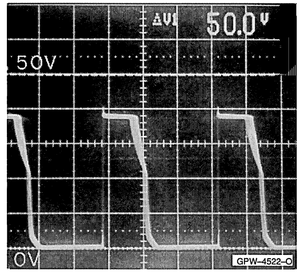
1. Sawtooth Oscillator Waveform

SETTINGS:
1 Volt/Div.
1.5 uSec/Dic.
DC Coupled



2. Q50 Gate Drive Voltage

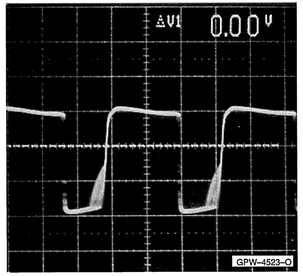
SETTINGS:
10 Volts/Div.
1.5 uSec/Dic.
DC Coupled



3. Transformer Flyback Voltage

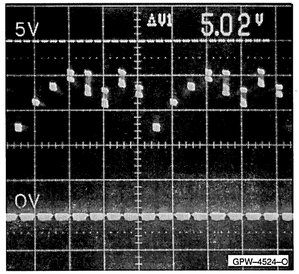
SETTINGS:
2 Volts/Div.
1.5 uSec/Div.
DC.Coupled

(Pin 1 to
Pin 25)



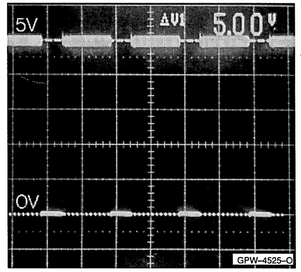
4. VF Display AC Filament Voltage

SETTINGS:
1 Volt/Div.
2 uSec/Div.
DC Coupled



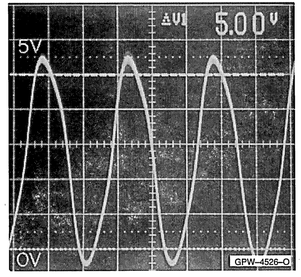
5. R50 Voltage Waveform

SETTINGS:
1 Volt/Div.
0.5 uSec/Div.
DC Coupled



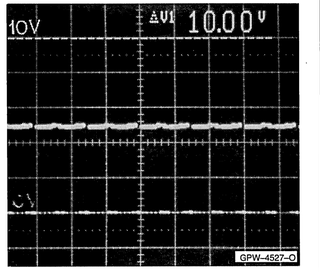
6. Watchdog Timer Tickle Pulse waveform

SETTINGS:
1 Volt/Div.
0.1 uSec/Div.
DC Coupled

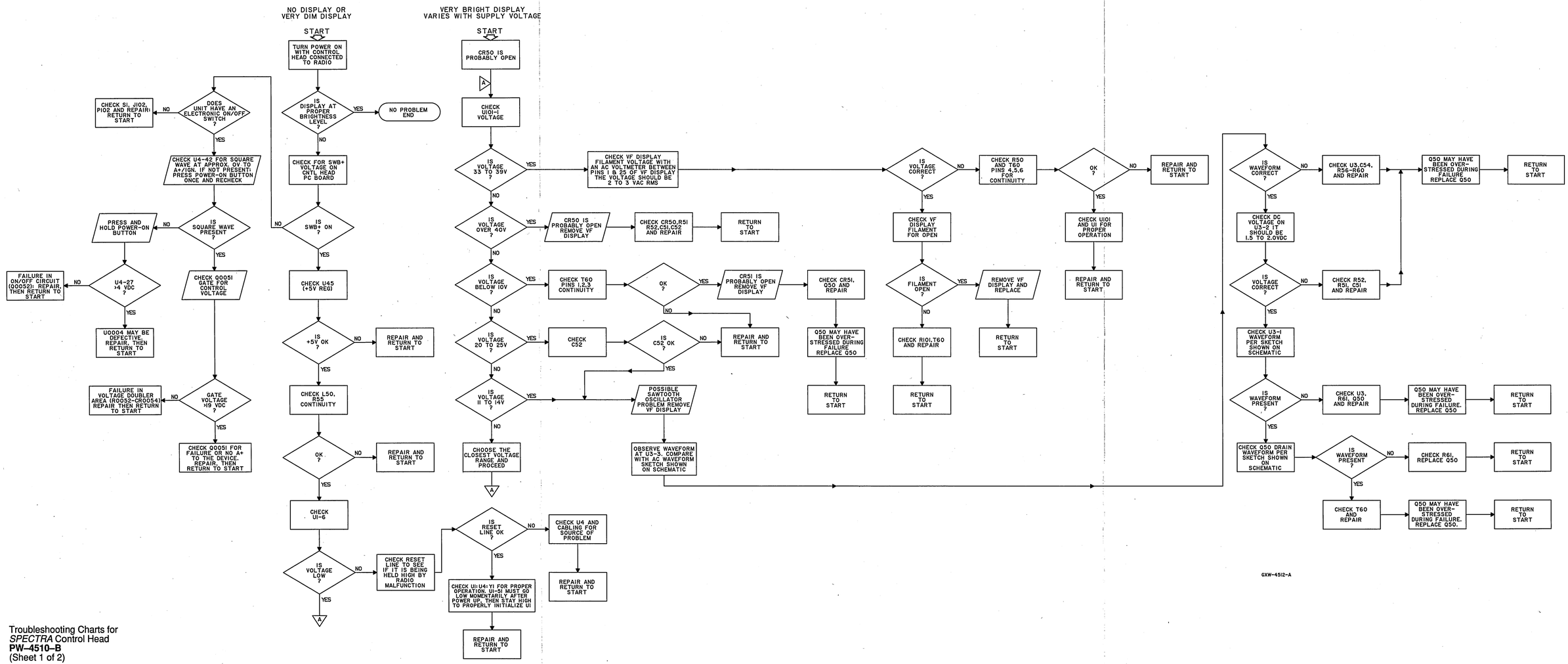


7. Microcomputer 4 MHz Resonator Waveform

SETTINGS:
2 Volts/Div.
2 uSec/Div.
DC Coupled

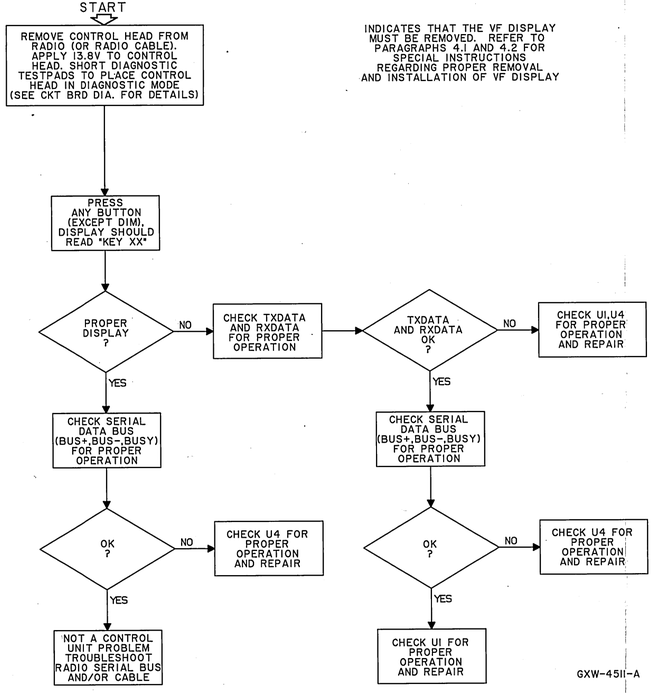


8. Keypad Scan Waveform



Troubleshooting Charts for
SPECTRA Control Head
PW–4510–B
(Sheet 1 of 2)
3/31/89

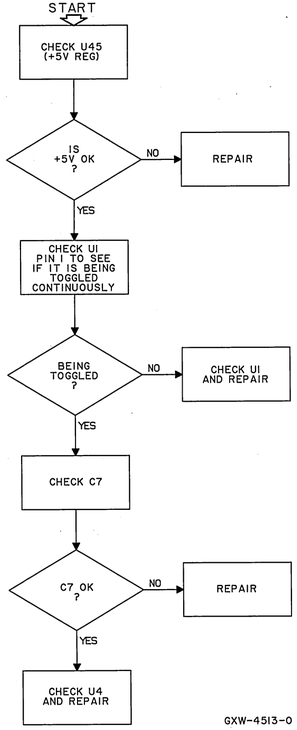
"SELF CHK, FLOI/90" ALTERNATES ON DISPLAY



INDICATES THAT THE VF DISPLAY MUST BE REMOVED. REFER TO PARAGRAPHS 4.1 AND 4.2 FOR SPECIAL INSTRUCTIONS REGARDING PROPER REMOVAL AND INSTALLATION OF VF DISPLAY

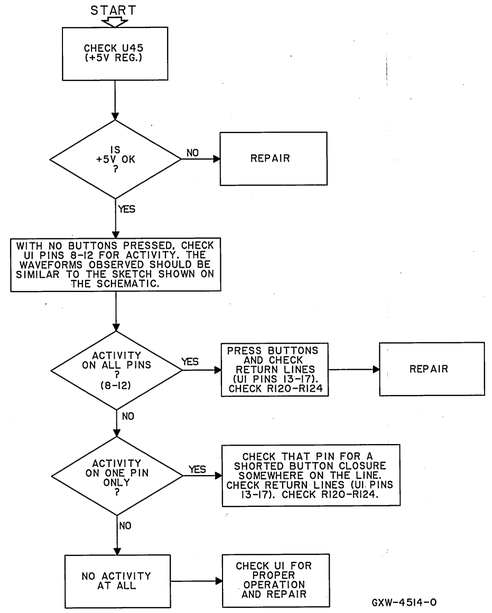
GXW-4511-A

FLICKERING "SELF-CHK" BUT NO FAILURE MESSAGE



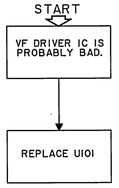
GXW-4513-0

CONTROL UNIT POWERS UP PROPERLY BUT BUTTON PRESSES DO NOT WORK



GXW-4514-0

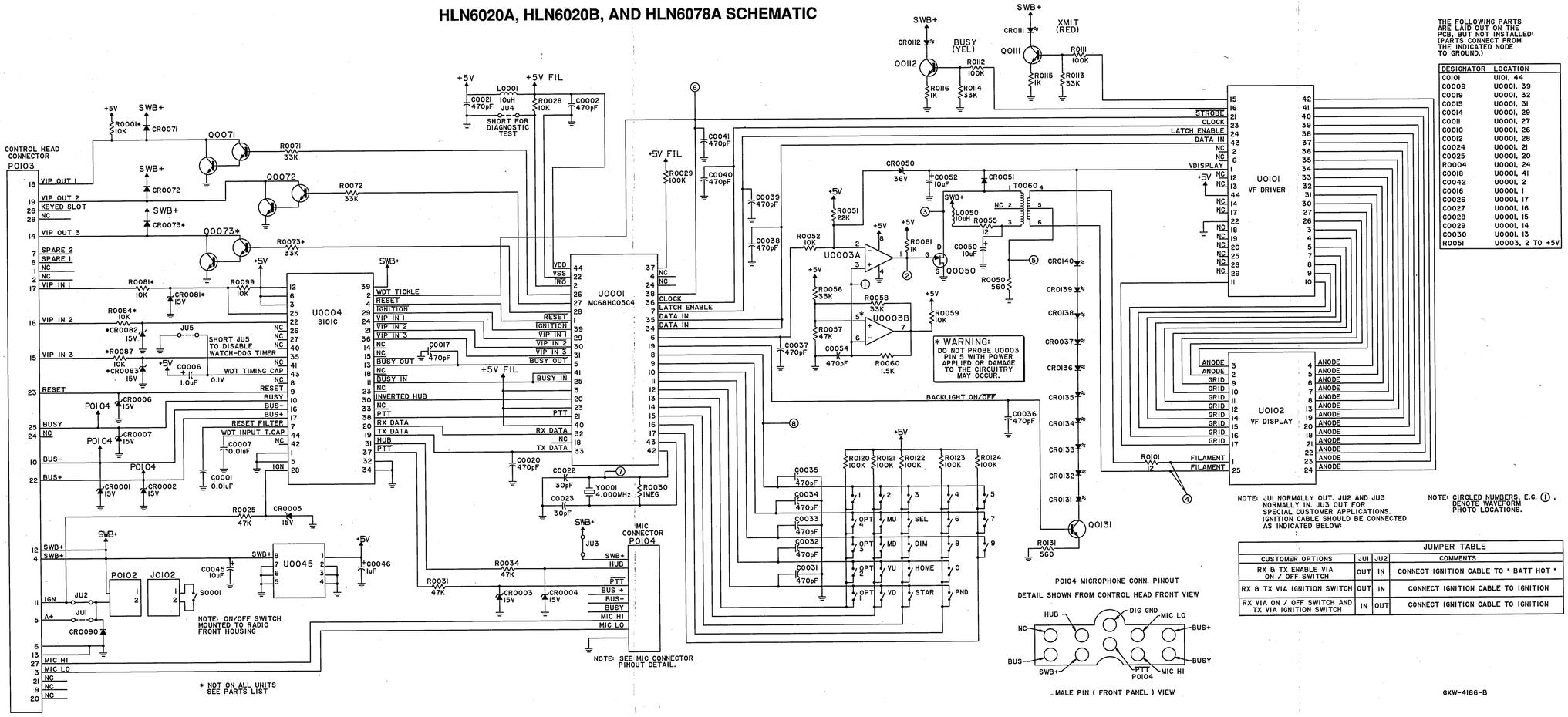
A FEW SEGMENTS OR CHARACTERS DO NOT LIGHT UP ON VF DISPLAY



GXW-4515-0

Troubleshooting Charts for
SPECTRA Control Head
PW–4510–B
(Sheet 2 of 2)
3/31/89

HLN6020A, HLN6020B, AND HLN6078A SCHEMATIC



THE FOLLOWING PARTS ARE LAID OUT ON THE PCB, BUT NOT INSTALLED: (PARTS CONNECT FROM THE INDICATED NODE TO GROUND.)

DESIGNATOR	LOCATION
C0101	U0101, 44
C0009	U0001, 39
C0019	U0001, 32
C0015	U0001, 31
C0014	U0001, 29
C0011	U0001, 27
C0010	U0001, 26
C0012	U0001, 28
C0024	U0001, 21
C0025	U0001, 20
R0004	U0001, 24
C0018	U0001, 41
C0042	U0001, 2
C0016	U0001, 1
C0026	U0001, 17
C0027	U0001, 16
C0028	U0001, 15
C0029	U0001, 14
C0030	U0001, 13
R0051	U0003, 2 TO +5V

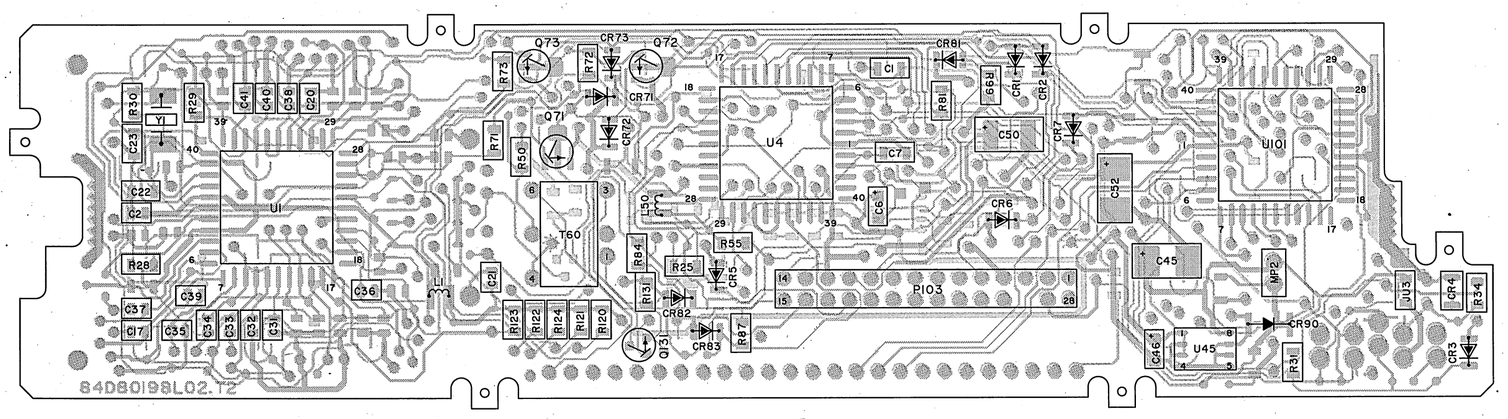
NOTE: JU1 NORMALLY OUT. JU2 AND JU3 NORMALLY IN. JU3 OUT FOR SPECIAL CUSTOMER APPLICATIONS. IGNITION CABLE SHOULD BE CONNECTED AS INDICATED BELOW:

NOTE: CIRCLED NUMBERS, E.G. (1), DENOTE WAVEFORM PHOTO LOCATIONS.

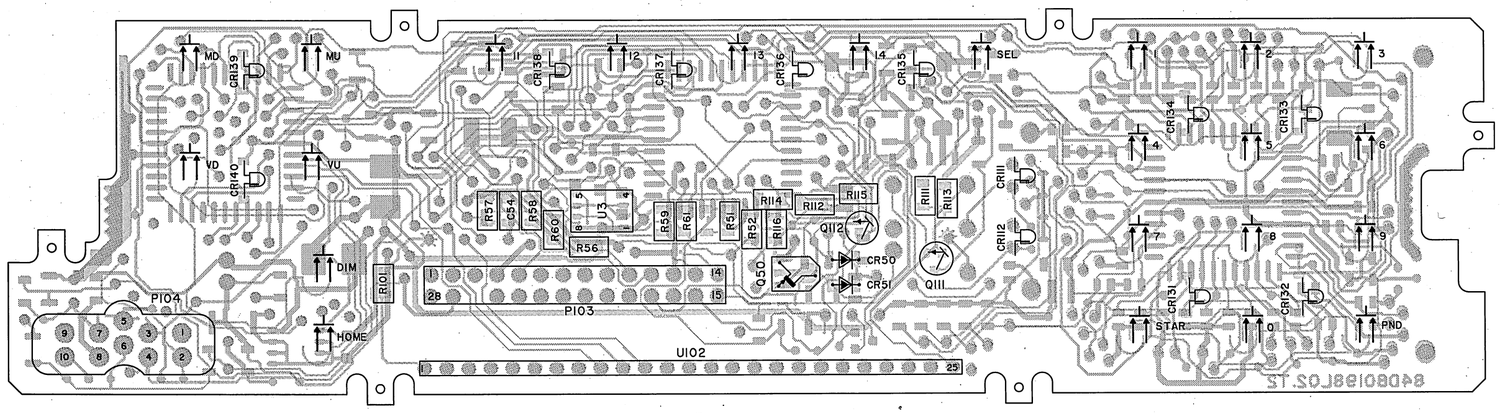
JUMPER TABLE			
CUSTOMER OPTIONS	JU1	JU2	COMMENTS
RX & TX ENABLE VIA ON / OFF SWITCH	OUT	IN	CONNECT IGNITION CABLE TO " BATT HOT "
RX & TX VIA IGNITION SWITCH	OUT	IN	CONNECT IGNITION CABLE TO IGNITION
RX VIA ON / OFF SWITCH AND TX VIA IGNITION SWITCH	IN	OUT	CONNECT IGNITION CABLE TO IGNITION

Schematic, Circuit Board Diagrams, and Parts Lists
for HLN6020A, HLN6020B, and HLN6078A
SPECTRA Control Head
PW–4516–C
(Sheet 1 of 2)
3/31/89

HLN6020A, HLN6020B, AND HLN6078A CIRCUIT BOARD



COMPONENT SIDE



SOLDER SIDE

parts lists

HLN6020A Control Head Board 900 MHz Early Version — MXW–4487–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C1	21–11032A21	0.01
C2	21–60521C09	470 pF, 25V
C6	23–62998B59	1, ±20%, 16V, tantalum
C7	21–11032A21	0.01
C17	21–60521C09	470 pF, 25V
C20,21	21–60521C09	470 pF, 25V
C22,23	21–11031A26	30 pF, ±5%
C31–41	21–60521C09	470 pF, 25V
C45	23–80090M24	10, ±20%, electrolytic
C46	23–62998B59	1, ±20%, 16V, tantalum
C50	23–62998D81	10, 25V, tantalum
C52	23–80090M24	10, ±20%, electrolytic
C54	21–11031A55	470 pF, ±5%, 25V
diode (see note)		
CR1–7	48–82958R91	zener, 15V
CR50	48–80049M38	zener, 36V
CR51	48–80066M01	signal
CR71–72	48–80066M01	signal
CR73	48–80066M01	signal
CR81–83	48–82958R91	zener, 15V
CR90	48–82960R02	rectifier
CR111	48–83636N06	LED, red, type 36N06
CR112	48–83636N02	LED, yellow , type 36N02
CR131–140	48–80050M01	LED, green
connector		
JU2–3	06–11077A01	jumper
coil, RF		
L1	24–80140E16	10 uH
L50	24–80140E16	10 uH
connector plug		
P102	28–80109N01	2–pin, male
P103	28–80102M07	28–pin, male
P104	28–80068M01	microphone header, 10–pin, male
transistor (see note)		
Q50	48–80053M01	n–channel type BSS–87
Q71–72	48–80052M01	NPN, Darlington MXTA27
Q73	48–80052M01	NPN, Darlington MXTA27
Q111–112	48–80141L02	NPN, type 41L02
Q131	48–80141L02	NPN, type 41L02
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R25	06–11077B15	47k
R28	06–11077A98	10k
R29	06–11077B23	100k
R30	06–11077B47	1 meg
R31	06–11077B15	47k
R34	06–11077B15	47k
R50	06–11077A68	560
R51	06–11077B07	22k
R52	06–11077A98	10k
R55	06–11077A28	12
R56	06–11077B11	33k
R57	06–11077B15	47k
R58	06–11077B11	33k
R59	06–11077A98	10k
R60	06–11077A78	1.5k
R61	06–11077A74	1k
R71–72	06–11077B11	33k
R73	06–11077B11	33k
R81	06–11077A98	10k
R84	06–11077A98	10k
R87	06–11077A98	10k
R99	06–11077A98	10k
R101	06–11077A28	12
R111–112	06–11077B23	100k
R113–114	06–11077B11	33k
R115–116	06–11077A74	1k
R120–124	06–11077B23	100k
R131	06–11077A68	560
transformer		
T60	25–80277J02	voltage conversion, shielded
T60	25–80277J01	voltage conversion (HLN6078A ONLY)
integrated circuit (see note)		
U1	51–97026D01	microprocessor
U3	51–80056M01	dual comparator, LM2903D
U4	51–83977M87	serial input/output device
U45	51–82276R13	voltage regulator, 5V
U101	51–80236C05	driver, vf display
U102	72–80032M01	display, vf, 14 segment, 8 character
crystal (see note)		
Y1	48–80065M01	resonator, ceramic 4.00 MHz
mechanical parts		
	75–80094M02	shock pad, VF display (2 used)
	43–80290L01	LED spacer
	54–80004N01	barcode label

9/12/88

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

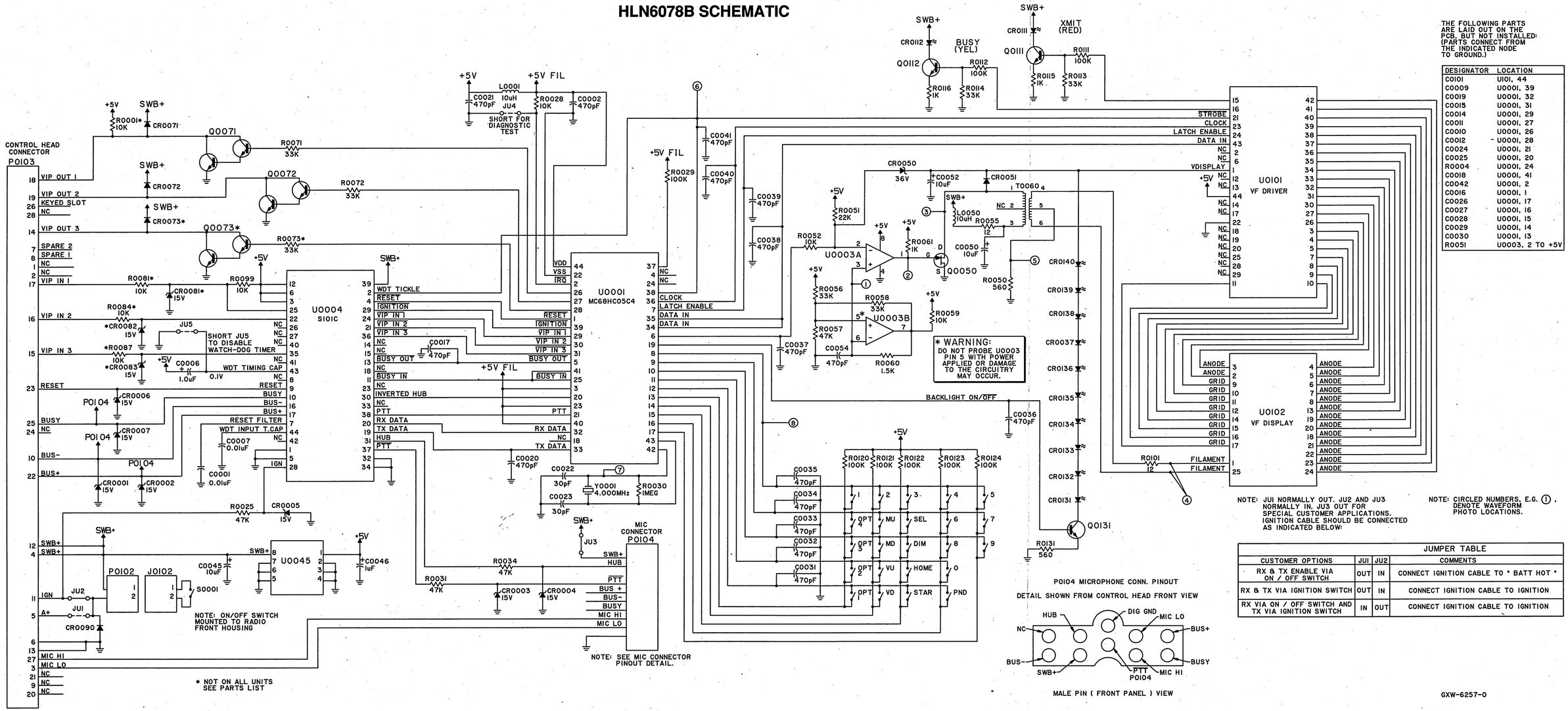
HLN6020B 900 MHz Control Head
HLN6078A 900 MHz, UHF/VHF Control Head — MXW–5819–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C1	21–13741B45	0.01 uF
C2	21–13741A13	470
C6	23–62998B59	1.0 uF, ±20%, 16V, tantalum
C7	21–13741B45	0.01 uF
C17	21–13741A13	470
C20,21	21–13741A13	470
C22,23	21–13740B36	30
C31–41	21–13741A13	470
C45	23–80090M24	10 uF, ±20%
C46	23–62998B59	1.0 uF, ±20%, 16V, tantalum
C50	23–62998D81	10 uF, ±10%, 25V, tantalum
C52	23–80090M24	10 uF, ±20%
C54	21–13740B65	470
diode (see note)		
CR1–7	48–82958R91	zener, 15V
CR50	48–80049M38	zener, 36V
CR51	48–80066M01	signal
CR71	48–80066M01	signal
CR72	48–80066M01	signal
CR90	48–82960R02	rectifier
CR111	48–83636N06	LED, red
CR112	48–83636N02	LED, yellow
CR131–140	48–80050M01	LED, green
connector receptacle		
JU2–3	06–11077A01	jumper
coil, RF		
L1	24–80140E16	10 uH
L50	24–80140E16	10 uH
connector plug		
P102	28–80109N01	2–pin, male
P103	28–80102M07	28–pin, male
P104	28–80068M01	microphone header, 10–pin, male
transistor (see note)		
Q50	48–80053M01	n–channel type BSS–87
Q71,72	48–80052M01	NPN
Q111,112	48–80141L02	NPN
Q131	48–80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R25	06–11077B15	47k
R28	06–11077A98	10k
R29	06–11077B23	100k
R30	06–11077B47	1 MEG
R31	06–11077B15	47k
R34	06–11077B15	47k
R50	06–11077A68	560
R51	06–11077B07	22k
R52	06–11077A98	10k
R55	06–11077A28	12
R56	06–11077B11	33k
R57	06–11077B15	47k
R58	06–11077B11	33k
R59	06–11077A98	10k
R60	06–11077A78	1.5k
R61	06–11077A74	1k
R71,72	06–11077B11	33k
R99	06–11077A98	10k
R101	06–11077A28	12
R111,112	06–11077B23	100k
R113,114	06–11077B11	33k
R115,116	06–11077A74	1k
R120–124	06–11077B23	100k
R131	06–11077A68	560
transformer		
T60	25–80277J01	voltage conversion
integrated circuit (see note)		
U1	51–97026D01	microprocessor
U3	51–80056M01	dual comparator, LM2903D
U4	51–83977M87	serial input/output device
U45	51–82276R13	voltage regulator, 5V
U101	51–80236C05	driver, vf display
U102	72–80032M01	display, vf, 14 segment, 8 character
crystal (see note)		
Y1	48–80065M01	resonator, ceramic 4.00 MHz
mechanical parts		
	75–80094M02	shock pad, VF dispaly (2 used)
	43–80290L01	LED spacer
	54–80004N01	barcode label

3/31/89

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

HLN6078B SCHEMATIC



THE FOLLOWING PARTS ARE LAID OUT ON THE PCB, BUT NOT INSTALLED: (PARTS CONNECT FROM THE INDICATED NODE TO GROUND.)

DESIGNATOR	LOCATION
C0101	U0101, 44
C0009	U0001, 39
C0019	U0001, 32
C0015	U0001, 31
C0014	U0001, 29
C0011	U0001, 27
C0010	U0001, 26
C0012	U0001, 28
C0024	U0001, 21
C0025	U0001, 20
R0004	U0001, 24
C0018	U0001, 41
C0042	U0001, 2
C0016	U0001, 1
C0026	U0001, 17
C0027	U0001, 16
C0028	U0001, 15
C0029	U0001, 14
C0030	U0001, 13
R0051	U0003, 2 TO +5V

NOTE: JU1 NORMALLY OUT. JU2 AND JU3 NORMALLY IN. JU3 OUT FOR SPECIAL CUSTOMER APPLICATIONS. IGNITION CABLE SHOULD BE CONNECTED AS INDICATED BELOW:

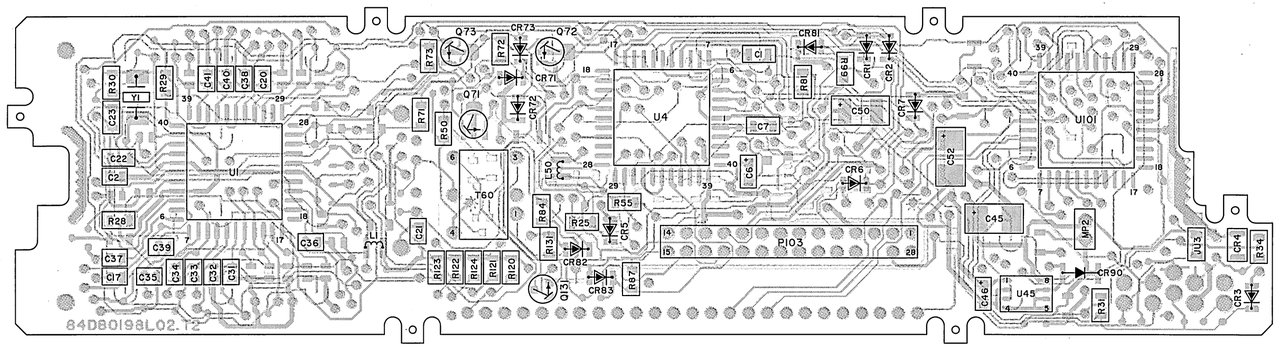
NOTE: CIRCLED NUMBERS, E.G. ①, DENOTE WAVEFORM PHOTO LOCATIONS.

JUMPER TABLE			
CUSTOMER OPTIONS	JU1	JU2	COMMENTS
RX & TX ENABLE VIA ON / OFF SWITCH	OUT	IN	CONNECT IGNITION CABLE TO * BATT HOT *
RX & TX VIA IGNITION SWITCH	OUT	IN	CONNECT IGNITION CABLE TO IGNITION
RX VIA ON / OFF SWITCH AND TX VIA IGNITION SWITCH	IN	OUT	CONNECT IGNITION CABLE TO IGNITION

GXW-6257-O

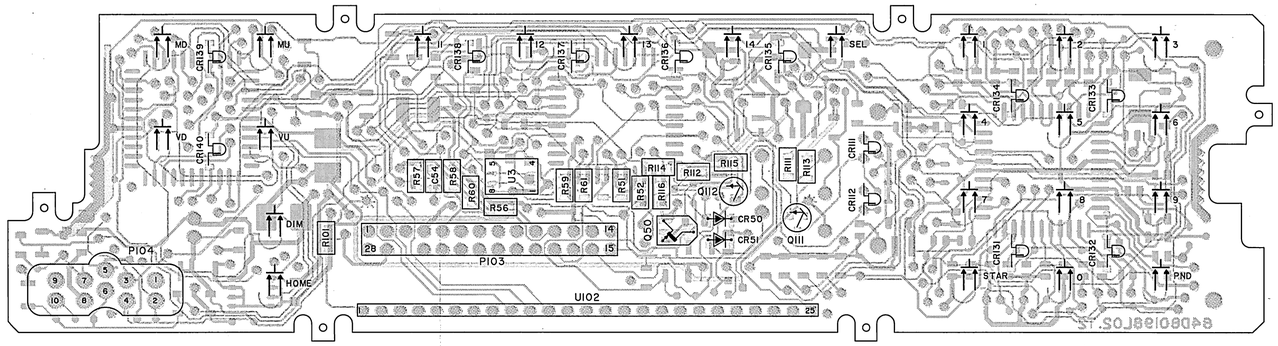
Schematic, Circuit Board Diagrams, and Parts List
for HLN6078B *SPECTRA* Control Head
PW–6255–O
(Sheet 1 of 2)
3/31/89

HLN6078B CIRCUIT BOARD



SOLDER SIDE ○ GPW-5051-O
COMPONENT SIDE ● GPW-5052-O
OVERLAY ▬ GXW-5006W03-A

COMPONENT SIDE



SOLDER SIDE ○ GPW-5051-O
COMPONENT SIDE ● GPW-5052-O
OVERLAY ▬ GXW-5006W04-A

SOLDER SIDE

parts list

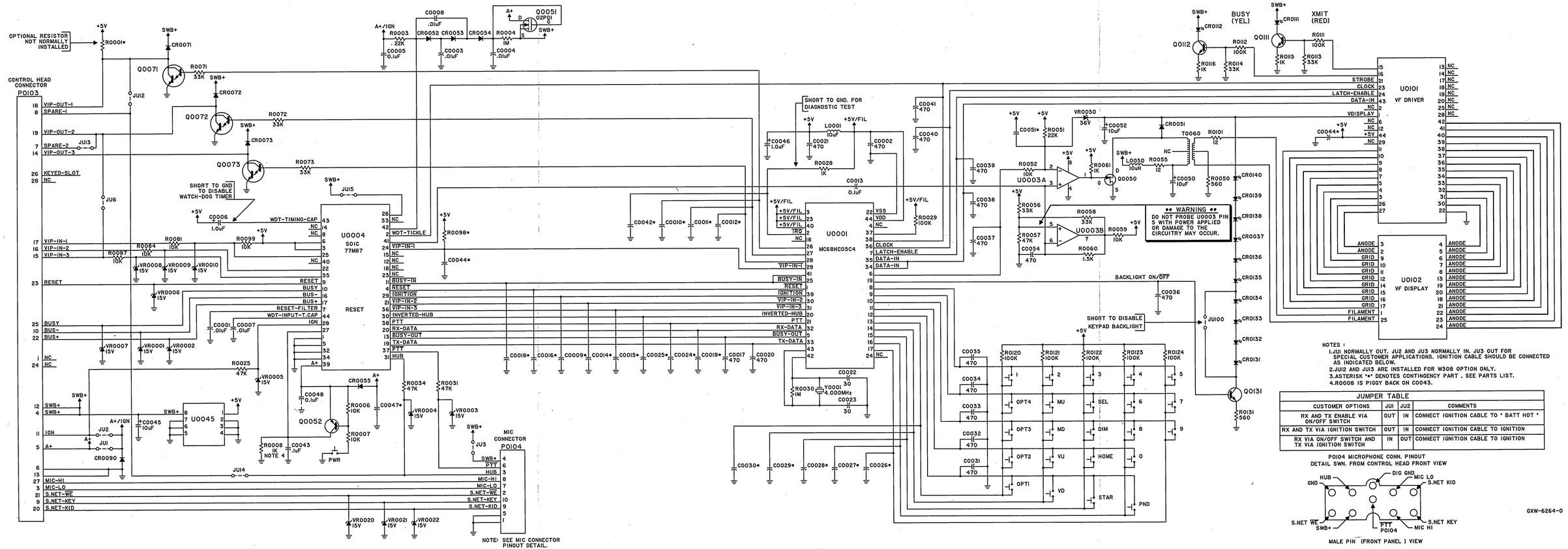
HLN6078B Control Head Board — MXW–6256–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C1	21–13741N45	0.01 uF, ±10%
C2	21–13741M13	470, ±10%
C6	23–11049A37	1.0 uF, ±20%, 25V
C7	21–13741N45	0.01 uF, ±10%
C17	21–13741M13	470, ±10%
C20,21	21–13741M13	470, ±10%
C22,23	21–13740B36	30
C31–41	21–13741M13	470, ±10%
C45	23–80090M24	10 uF,±20%
C46	23–11049A37	1.0 uF, ±20%, 25V
C50	23–11049J27	10 uF, ±10%, 25V
C52	23–80090M24	10 uF, ±20%
C54	21–13740B65	470
diode (see note)		
CR1–7	48–82958R91	zener, 15V
CR50	48–80056K38	zener, 36V
CR51	48–80066M01	signal
CR71,72	48–80066M01	signal
CR90	48–82960R02	rectifier
CR111	48–80026P01	LED, red
CR112	48–80026P02	LED, yellow
CR131–140	48–80050M01	LED, green
connector receptacle		
JU2,3	06–11077A01	jumper
coil, RF		
L1	24–80140E16	10 uH
L50	24–80140E16	10 uH
connector plug		
P102	28–80109N01	2–pin, male
P103	28–80102M07	28–pin, male
P104	28–80068M01	microphone header, 10–pin, male
translstor (see note)		
Q50	48–80053M01	n–channel MOSFET, type BSS–87
Q71,72	48–80052M01	NPN, Darlington
Q111,112	48–80141L02	NPN
Q131	48–80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R25	06–11077B15	47k
R28	06–11077A98	10k
R29	06–11077B23	100k
R30	06–11077B47	1 MEG
R31	06–11077B15	47k
R34	06–11077B15	47k
R50	06–11077A68	560
R51	06–11077B07	22k
R52	06–11077A98	10k
R55	06–11077A28	12
R56	06–11077B11	33k
R57	06–11077B15	47k
R58	06–11077B11	33k
R59	06–11077A98	10k
R60	06–11077A78	1.5k
R61	06–11077A74	1k
R71,72	06–11077B11	33k
R99	06–11077A98	10k
R101	06–11077A28	12
R111,112	06–11077B23	100k
R113,114	06–11077B11	33k
R115,116	06–11077A74	1k
R120–124	06–11077B23	100k
R131	06–11077A68	560
transformer		
T60	25–80277J02	voltage conversion
integrated circuit (see note)		
U1	51–97026D01	microprocessor
U3	51–80056M01	dual comparator, LM2903D
U4	51–83977M87	serial input/output device
U45	51–82276R13	voltage regulator, 5V
U101	51–80236C05	driver, vf display
U102	72–80032M01	display, vf, 14 segment, 8 character
crystal (see note)		
Y1	48–80065M01	resonator, ceramic 4.00 MHz
mechanical parts		
	75–80094M02	shock pad, VF Display (2 used)
	43–80260L01	LED spacer
	54–80004N01	barcode label

3/31/89

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

HLN6075A SCHEMATIC



NOTES :
1. JUI NORMALLY OUT. JU2 AND JU3 NORMALLY IN. JU3 OUT FOR SPECIAL CUSTOMER APPLICATIONS. IGNITION CABLE SHOULD BE CONNECTED AS INDICATED BELOW.
2. JUI2 AND JUI3 ARE INSTALLED FOR W308 OPTION ONLY.
3. ASTERISK '*' DENOTES CONTINGENCY PART . SEE PARTS LIST.
4. R0008 IS PIGGY BACK ON C0043.

JUMPER TABLE			
CUSTOMER OPTIONS	JUI	JU2	COMMENTS
RX AND TX ENABLE VIA ON/OFF SWITCH	OUT	IN	CONNECT IGNITION CABLE TO " BATT HOT "
RX AND TX VIA IGNITION SWITCH	OUT	IN	CONNECT IGNITION CABLE TO IGNITION
RX VIA ON/OFF SWITCH AND TX VIA IGNITION SWITCH	IN	OUT	CONNECT IGNITION CABLE TO IGNITION

P0104 MICROPHONE CONN. PINOUT
DETAIL SWN. FROM CONTROL HEAD FRONT VIEW

MALE PIN (FRONT PANEL) VIEW

GXW-6264-O

Schematic, Circuit Board Diagrams, and Parts List
for HLN6075A *SPECTRA* Control Head
PW–6259–O
(Sheet 1 of 2)
3/31/89

parts list

HLN6075A Control Head Board — MXW–6263–O

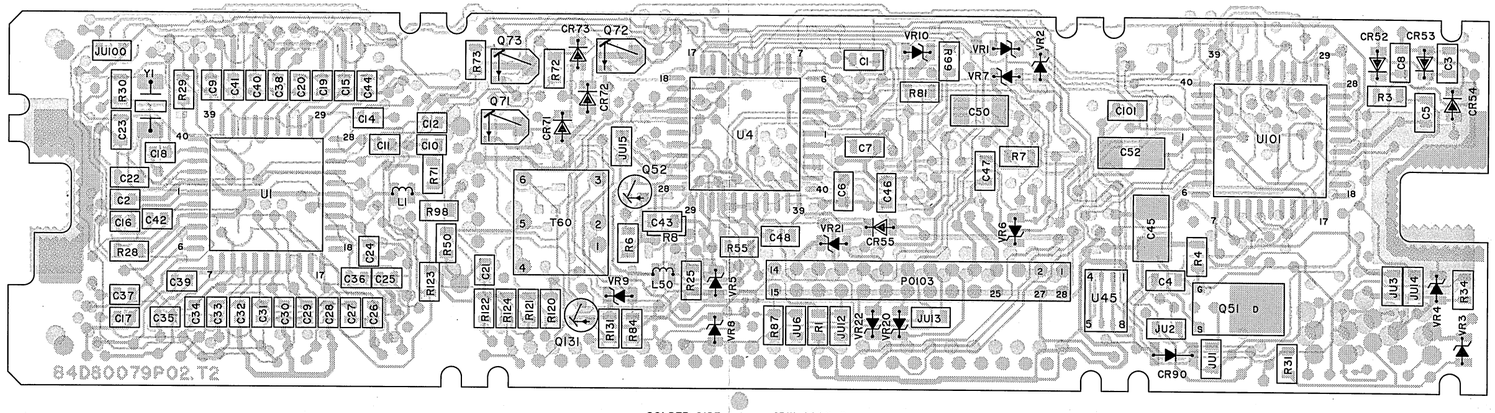
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C1	21–13741N45	0.01 uF, ±10%
C2	21–13741M13	470, ±10%
C3,4	21–13741N45	0.01 uF, ±10%
C5	21–13741N69	0.1 uF, ±10%
C6	23–11049A37	1.0 uF, ±20%
C7,8	21–13741N45	0.01 uF, ±10%
C13	21–13741N69	0.1 uF, ±10%
C17	21–13741M13	470, ±10%
C20,21	21–13741M13	470, ±10%
C22,23	21–13740B36	30
C31–41	21–13741M13	470, ±10%
*C43	21–13741N69	0.1 uF, ±10%
C45	23–80090M24	10 uF, ±20%
C46	23–11049A37	1.0 uF, ±20%, 25V
C48	21–13741N69	0.1 uF, ±10%
C50	23–11049J27	10.0 uF, ±10%, 25V
C52	23–80090M24	10 uF, ±20%
C54	21–13740B65	470
diode (see note)		
CR51–55	48–80066M01	signal
CR71,72	48–80066M01	signal
CR90	48–82960R02	rectifier
CR111	48–80026P01	LED, red
CR112	48–80026P02	LED, yellow
CR131–140	48–80050M01	LED, green
connector receptacle		
JU2,3	06–11077A01	jumper
coil, RF		
L1	24–80140E16	10 uH
L50	24–80140E16	10 uH
connector plug		
P103	28–80102M07	28–position
P104	28–80068M01	microphone header, 10–pin, male
transistor (see note)		
Q50	48–80053M01	n–channel MOSFET, type BSS–87
Q51	48–80002P01	MOSFET
Q52	48–80141L01	PNP
Q71,72	48–80052M01	NPN, Darlington
Q111,112	48–80141L02	NPN
Q131	48–80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R3	06–11077B07	22k
R4	06–11077B47	1 MEG
R6,7	06–11077A98	10k
*R8	06–11077A74	1k
R25	06–11077B15	47k
R28	06–11077A74	1k
R29	06–11077B23	100k
R30	06–11077B47	1 MEG
R31	06–11077B15	47k
R34	06–11077B15	47k
R50	06–11077A68	560
R51	06–11077B07	22k
R52	06–11077A98	10k
R55	06–11077A28	12
R56	06–11077B11	33k
R57	06–11077B15	47k
R58	06–11077B11	33k
R59	06–11077A98	10k
R60	06–11077A78	1.5k
R61	06–11077A74	1k
R71,72	06–11077B11	33k
R99	06–11077A98	10k
R101	06–11077A28	12
R111,112	06–11077B23	100k
R113,114	06–11077B11	33k
R115,116	06–11077A74	1k
R120–124	06–11077B23	100k
R131	06–11077A68	560
transformer		
T60	25–80277J02	voltage conversion
integrated circuit (see note)		
U1	51–97026D01	microprocessor
U3	51–80056M01	dual comparator, LM2903D
U4	51–83977M87	serial input/output device
U45	51–82276R13	voltage regulator, 5V
U101	51–80236C05	driver, vf display
U102	72–80032M01	display, vf, 14 segment, 8 character
voltage regulator (see note)		
VR1–7	48–82958R91	diode, 15V
VR20–22	48–82958R91	diode, 15V
VR50	48–80056K38	diode, 36V
crystal (see note)		
Y1	48–80065M01	resonator, ceramic 4.00 MHz
mechanical parts		
	75–80094M02	vf shock pad, 2 used
	43–80290L01	LED spacer
	54–80004N01	barcode label

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

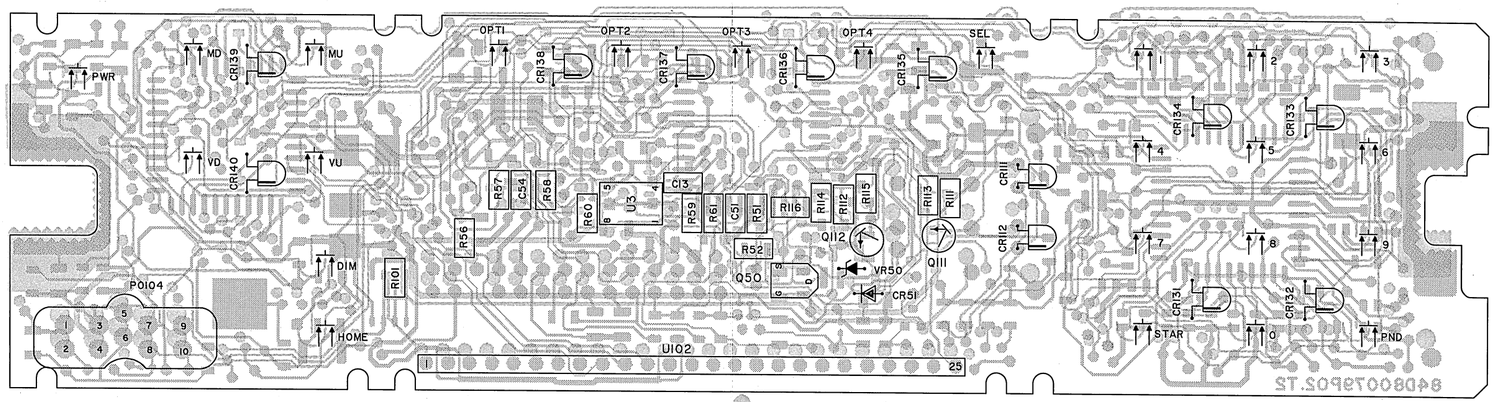
* R8 is piggy backed on C43.

HLN6075A CIRCUIT BOARD



SOLDER SIDE GPW–6260–O
COMPONENT SIDE GPW–6261–O
OVERLAY GXW–6262W01–O

COMPONENT SIDE



SOLDER SIDE GPW–6260–O
COMPONENT SIDE GPW–6261–O
OVERLAY GXW–6262W02–O

SOLDER SIDE

Schematic, Circuit Board Diagrams, and Parts List
for HLN6075A *SPECTRA* Control Head
PW–6259–O
(Sheet 2 of 2)
2/28/89

1. Description

The *SPECTRA* RF Board contains the common synthesizer circuits (synthesizer section) and dual IF receiver and demodulation circuits (receiver back–end).

The synthesizer section includes the Prescaler IC (U601), the Synthesizer IC (U602), and the Reference Oscillator (U600). the Prescaler and the Synthesizer chips are completely controlled by the serial data bus. The Prescaler IC (See Figure 1) provides the following:

- Multi–dual modulus prescaler
- 5–volt regulator
- Super filter 8.6–volt regulator
- Fixed divide–by–8 circuit for the Reference Oscillator
- Programmable divide–by–N and charge pump phase detector to support the second injection VCO.

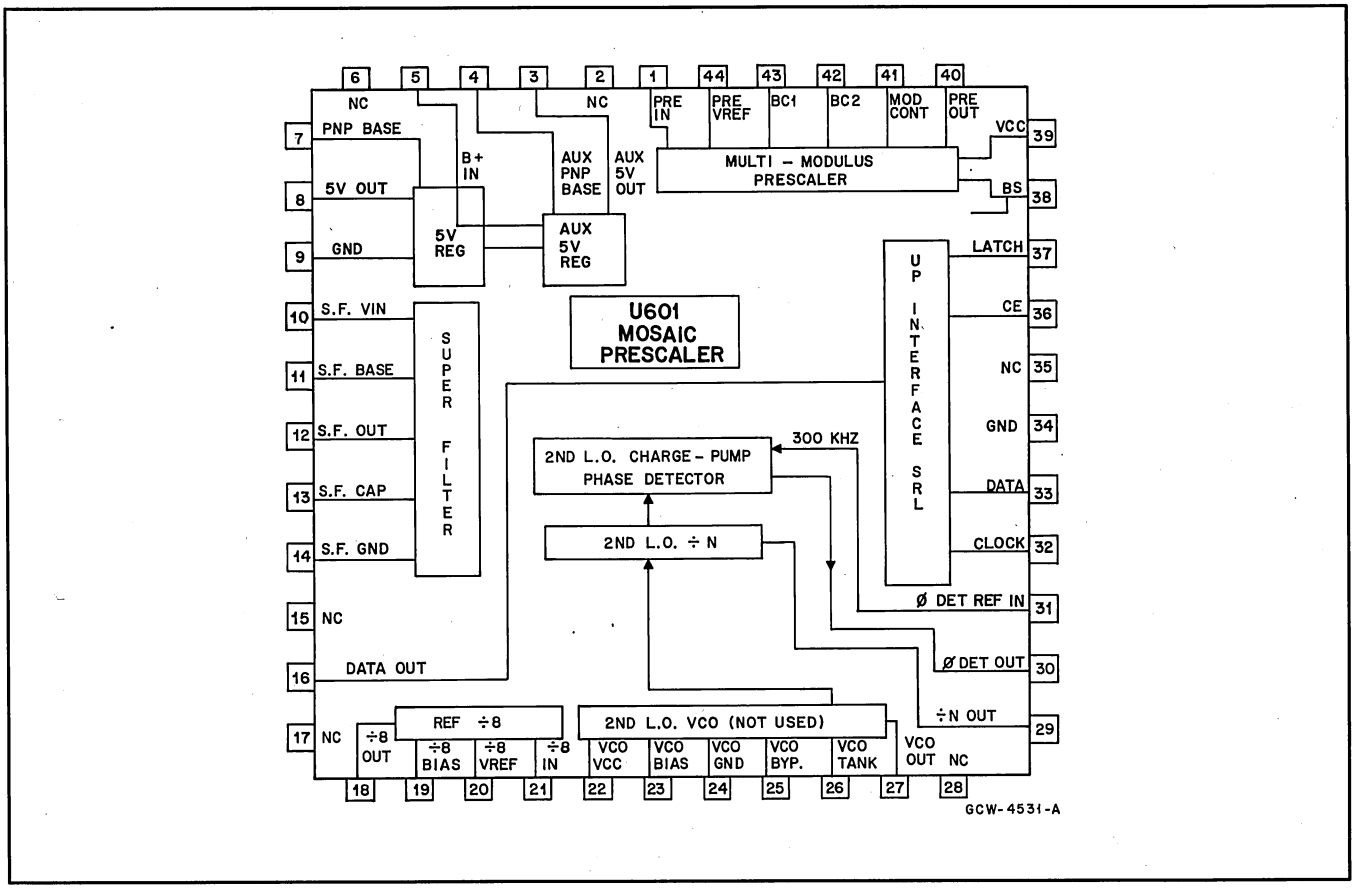


Figure 1. Prescaler IC Block Diagram

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The Synthesizer IC (See Figure 2) provides:

- Reference divider
- Phase modulator
- Dual bandwidth adaptive filter
- Ramp generator
- Sample–and–hold phase detector
- Programmable loop divider
- Auxiliary output bits for system control

The Reference Oscillator generates the 16.8 MHz signal that serves as the reference for all radio frequency accuracy. It uses a proprietary temperature compensation circuit to keep the radio within its specified frequency tolerance.

The receiver back–end includes the first and second IF stages, the second mixer, demodulation circuit, and squelch circuit.

2. Theory of Operation

2.1 SYNTHESIZER

2.1.1 Reference Frequency Generation

Reference Oscillator (U600) generates a 16.8 MHz reference signal that is tuned onto frequency via a DC–fed varactor input. The Digital/Analog IC (U502), which is on the command board and is under the control of the serial data bus, generates the DC voltage to the varactor. The reference signal from U600–3, is capacitively coupled into the Prescaler (U601–21), where it is divided by 8. The resulting 2.1 MHz signal is routed to the Synthesizer IC (U602). The 2.1 MHz signal is buffered and routed to the command board where it serves as a clock for the audio filter and signalling filter chips.

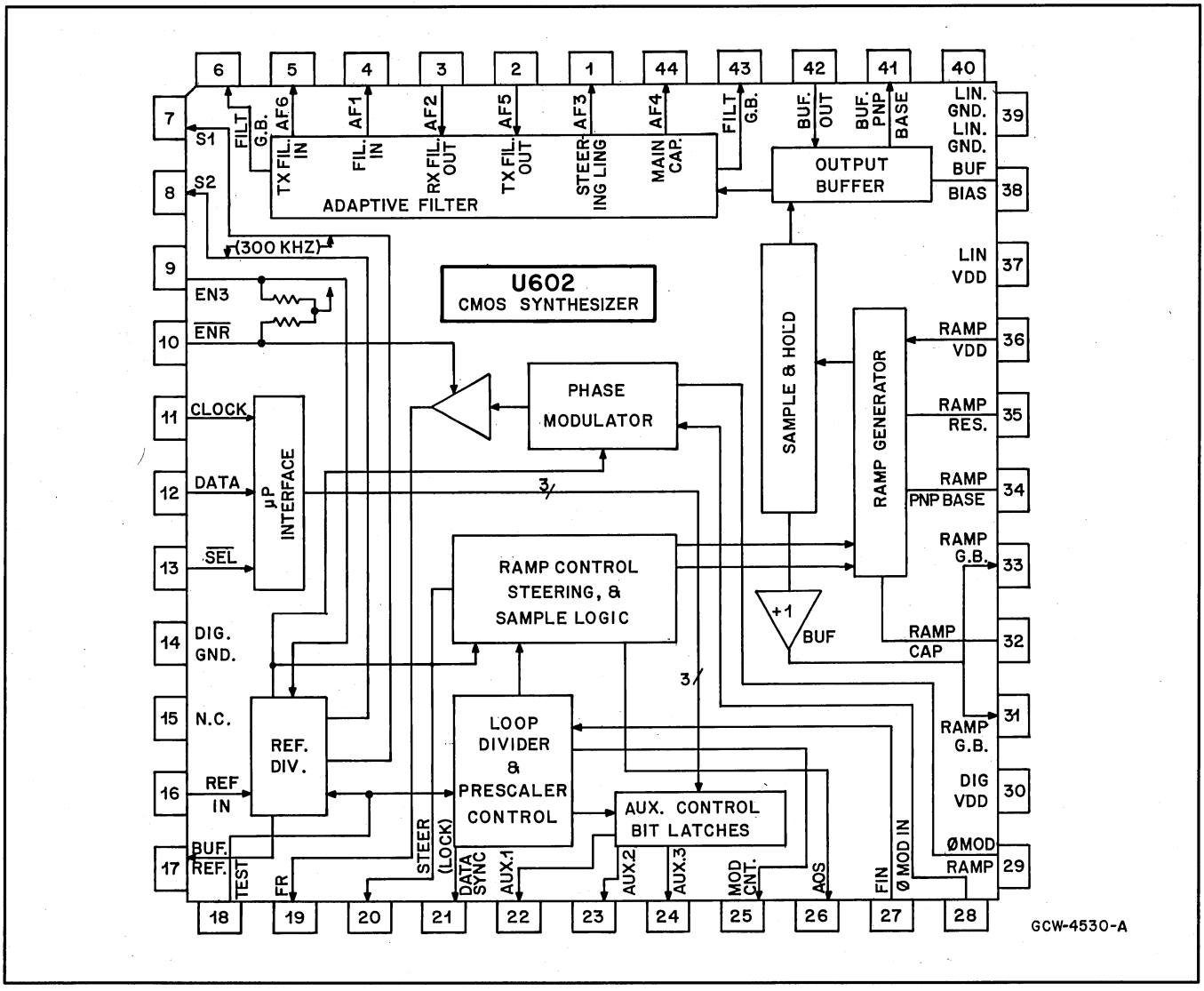


Figure 2. Synthesizer IC Block Diagram

The 2.1 MHz signal is divided by 7, with the result, a 300 kHz signal, serving the following purposes:

- Input to the Prescaler IC for second VCO reference
- A source for the negative voltage generator
- Input to the programmable reference divider.

2.1.2 First VCO Frequency Generation

Important

For reasons of clarity and simplicity, 900 MHz is used as the example product in all synthesizer text. Band–to–band and kit–to–kit variations are noted in the text as required.

The first VCO in *SPECTRA* radios is a thick–film hybrid transmission line resonator. Its frequency is controlled by a DC fed varactor bank.

On the HRN6000A and HRN6002A kits, the output frequency is coupled back to the Prescaler via J602 and through Q601, which serves as a unity–gain buffer. The HRN6005A kit still makes use of the feedback coax and its mating receptacle, J602, but does not require the buffer Q601. The HRN6001A, HRN6004A, HRN6003A, HRN6006A, HRN6007A, HRN6009A, and HRN6010A kits use neither J602 nor Q601. A transmission line feedback path from J601, Pin 1 to C604 eliminates the need for the jack and buffer. The signal from the Prescaler output (U601, Pin 40) is routed to the Synthesizer input (U602, Pin 27) where it is divided by the A&B counters of the loop divider. The loop equations required for calculating the counter values are as follows:

Note

These are examples—the prescaler modulus and the reference frequency are programmable and vary from band–to–band. The examples that follow are for 900 MHz and assume P/P+1 = 255/256 and Fr = 6.25 kHz. For UHF and VHF, P/P+1 = 127/128 and Fr = 5 kHz.

EQUATION: $N = \frac{Fvco}{FR}$

EXAMPLE: $N = \frac{Fvco}{FR} = \frac{450\ MHz}{6.25\ KHz}$ or N=72,000

EQUATION: A = (fractional remainder of $\frac{N}{P}$) (P)

EXAMPLE: $A = \frac{N}{P} = \frac{72,000}{255}$ = 282.3529; .3529 x 255 or A=90

EQUATION: $B = \frac{N - \{A \times (P + 1)\}}{P}$

EXAMPLE: $B = \frac{72,000 - \{90 \times (255 + 1)\}}{255}$ or B=192

Plug in the calculated numbers to test the value of N with the following equation:

EQUATION: N = B(P) + A(P + 1)

EXAMPLE: N = (192)(255) + (90)(256); or N = 72,000

The synthesizer generates a modulus control output which instructs the prescaler to divide by either P or P+1 (e.g. 255 or 256). When modulus control is low, the prescaler is dividing by P+1 (256) and the A counter is running; when modulus control is high, the prescaler is dividing by P (255) and the B counter is running. One complete cycle of loop division is repeated for each reference period.

Assume that the VCO is operating correctly at 450 MHz, and the reference frequency is 6.25 kHz. The prescaler and loop divider work in tandem to divide the VCO frequency down to the reference frequency. The waveforms in Figure 3 depict what happens in a locked system. Notice in the waveforms that the leading edge of Fr goes high to turn on the constant current source Q607. The ramp capacitor (C634) begins to charge through Q607 and R627, charging at a constant rate while the prescaler and loop divider are dividing the VCO frequency by N (72,000 in the example).

At this point, the loop divider generates a loop pulse (Fv) which turns off the current source. The voltage that was on C634 is sampled and held by the phase detector. This voltage is amplified approximately 1.8 times and applied to the VCO varactors via the adaptive loop filter and the steering line. This event is repeated at the reference rate so that frequency errors will always be corrected.

Assume that the VCO frequency tends to drift low. If this happens, the loop pulse will occur at some later time. The current source still begins at the rising edge of Fr, but it stays on longer because the leading edge of Fv has been time–delayed. Thus, C634 charges to a higher value and the steering line drives the VCO to a higher frequency. The opposite case also applies.

2.1.3 Programmable Reference Divider

The reference frequency for 900 MHz is 6.25 kHz; for VHF and UHF, the typical reference frequency is 5.0 kHz.

2.1.4 Phase Modulator

SPECTRA radios use a dual–port modulation scheme. The nature of the Synthesizer loop is to track out low–frequency errors. In order to enable low–frequency modulation, such as DPL, the reference signal is modulated with the same signal as the VCO. Effectively, this prevents the low–frequency error in the loop (DPL) from tracking out because the same error is on the reference signal. The net effect is that the leading edge of the reference pulse is time–varying at the same rate as the loop pulse, and therefore, there is no phase error between the two signals, and low–frequency modulation is allowed to pass.

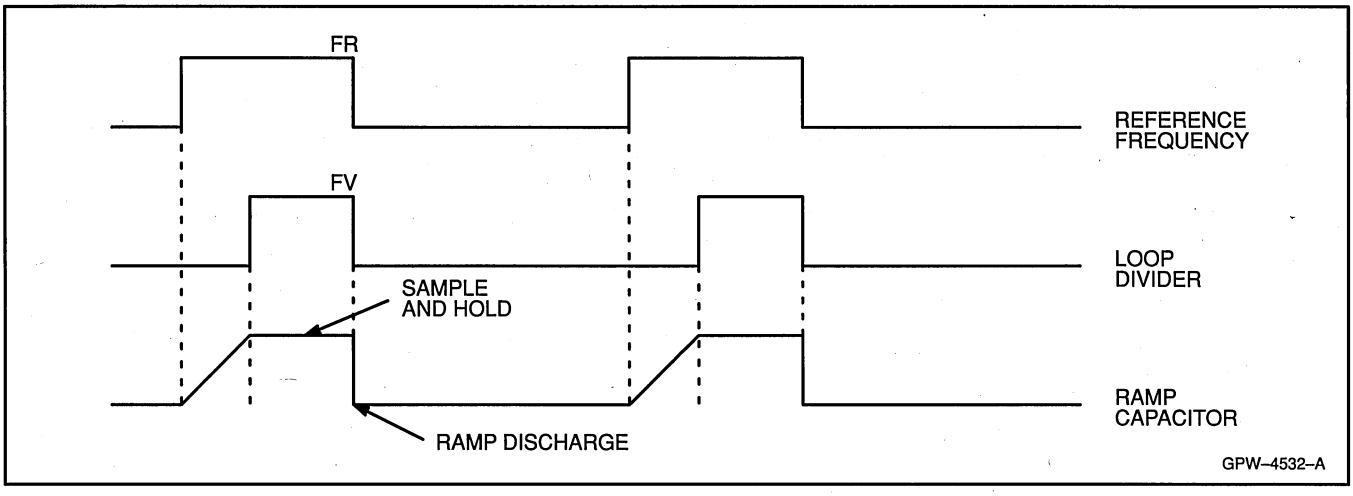


Figure 3. Loop Divider Waveforms

The phase modulation comparator has two inputs, U602, Pins 28 and 29. R625 and C630 form an exponential ramp into the plus side of the comparator on U602, Pin 29. This ramp is tickled at the reference rate. R626 and C631 form an integrator through which modulation is applied to the minus side of the comparator. The comparator trips when the ramp voltage reaches the voltage on U602, Pin 28. The output of the comparator is the time–shifted leading edge of Fr.

2.1.5 Loop Filter

SPECTRA radios use a switchable, dual bandwidth, loop filter. It also uses adaptive filter switching to achieve fast lock. The output of the phase detector is routed to an external device (Q608), the output of which is routed back into the IC for proper filter path selection.

In normal operation, the high drive buffer output is routed through the appropriate transmission gates into the selected filter. A simplified schematic is shown in Figure 4.

The loop filters greatly minimize voltage transients that contribute to system hum and noise, but due to their low–pass nature, it takes considerable time to change the average charge in the filters. Therefore, the adapt scheme was implemented. When the radio is changing frequency, the loop goes into the adapt mode. Selected transmission gates in the IC effectively place a short across the resistors in the filter (eliminating associated R–C time constants) and quickly charge the loop filter capacitors to the correct steering line voltage for the new frequency. At the end of the adapt sequence, the appropriate filter is reconnected via internal transmission gates.

2.1.6 Auxiliary Control Bits

The auxiliary control bits are system control outputs whose states are controlled by the microprocessor via the serial data bus. AUX 1 and AUX 2 are sent to the first VCO to control pin shift states. AUX 3 controls the state of the negative steering line.

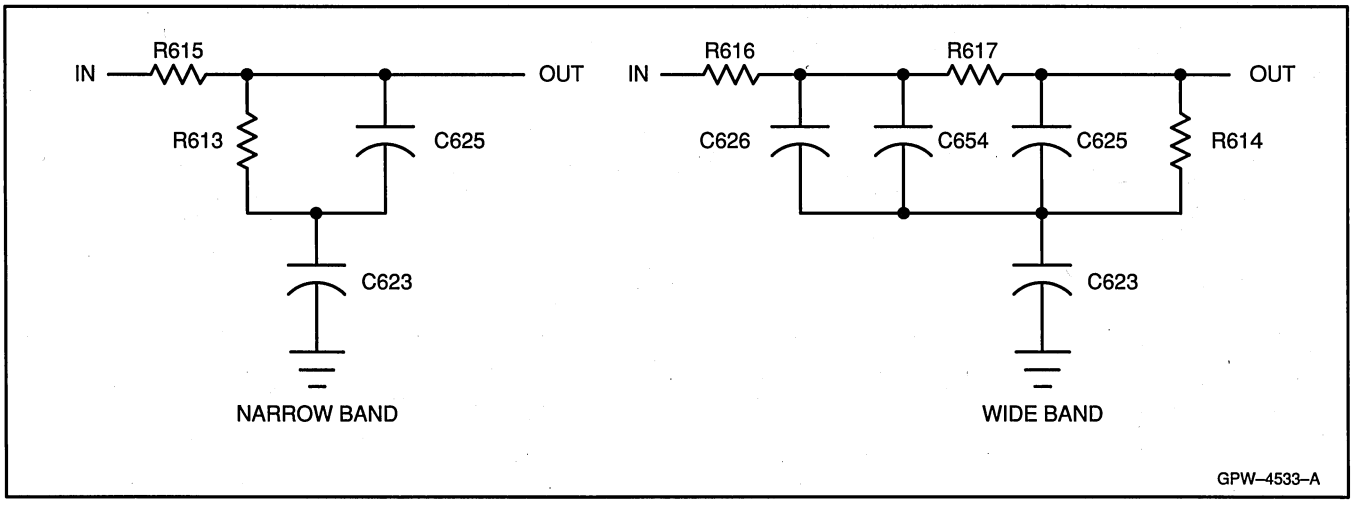


Figure 4. Loop Filter Schematic

2.1.7 Negative Voltage Generator and Switches

300 kHz from U602, Pin 7, is routed to C638 of the negative voltage generator. Once through C638, CR602 clamps the maximum positive voltage at 0.7 volts and CR603 peak rectifies the signal to –9 volts. R637 and R640 form a voltage divider to drop the voltage further to the desired voltage. R637 and C640 form a low–pass network which filters noise from the negative steering line.

Note

This section on negative voltage switching applies only to HRN6000A and older versions of the HRN6002A. On newer model kits, the switching circuitry is deleted and bypassed by JU602.

When selected, Q612 passes the negative voltage through to the negative steering line, and thus to the VCO varactor bank.

2.1.8 Second VCO

The second VCO is a grounded–gate FET Colpitts oscillator. The resonator consists of a fixed inductor and a varactor. The varactor is reverse–biased with a –9 volt potential on HRN6000A and HRN6002A. On the newer kits, a potentiometer has been added (R634) to adjust the negative voltage to the varactor. This adjustment is performed at board test to bring the phase detector output to the center of its linear region—i.e. approximately 2.25 volts. The negative voltage is filtered by R611 and C612. The oscillator output is coupled into the IF IC (U301) as a second injection source. It is also fed back to the prescaler (U601, Pin 26) for phase locking. The prescaler contains a programmable, single modulus, divide–by–N circuit, and a charge pump phase detector. The reference frequency (Fr) is 300 kHz and comes in on U601, Pin 31. The low–side injection oscillator runs at 109.2 MHz and is divided by 364 inside the IC. The phase detector in the chip compares the divided signal to Fr and either sources or sinks current as necessary in order to maintain frequency control.

The phase–detector output is routed to the varactor via decoupling choke L604. A divide–by–N test point is also provided from U601, Pin 29.

2.1.9 Power Distribution

The command board provides all power to the synthesizer in the form of 9.6 VDC. The prescaler has on–board voltage regulators for 5V and Super Filter 8.6V. The 5V regulator drives the external series pass device Q602; the super filter's pass device is Q603.

2.2 RECEIVER BACK END (See Figure 5)

2.2.1 First IF (See Figure 6)

Through J350, the 109.65 MHz IF signal reaches the RF board. Q350 amplifies the signal approximately 9 dB and supplies the proper impedance for crystal filter Y350. Q351 supplies filtered A+ for powering Q350 and the receiver front end. Q352 switches the filtered A+ supply by robbing base current from Q351.

Note

Since there is 12.5 VDC on J350, it is important to use a DC block when connecting J350 to an external source.

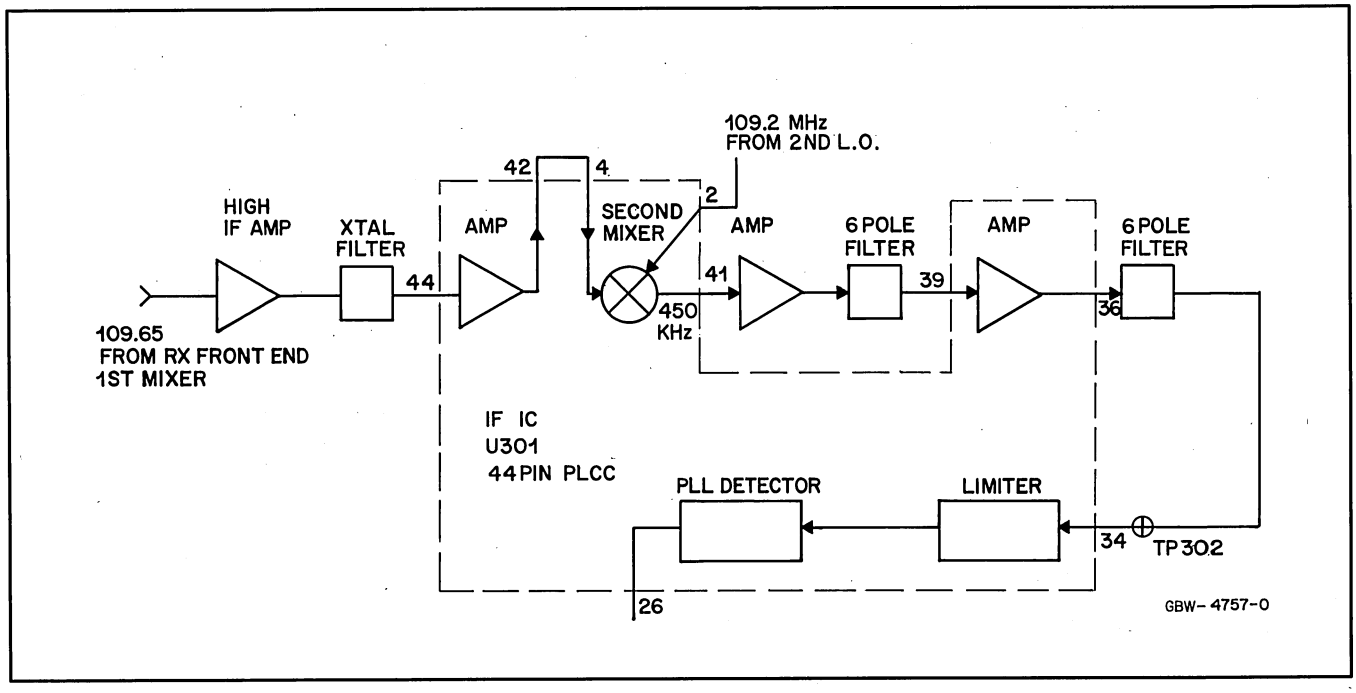


Figure 5. Back End Block Diagram

Y350, is a 4–pole crystal filter, comprised of two independent 2–pole crystal filters contained in a single package. The filter package has a polarization mark located on the top to ensure proper installation.

Y350 supplies the 109.65 MHz IF selectivity. L352 and R357 couple the two 2–pole filters. Y350's output passes through a matching network and then goes, via U301, Pin 44, to the input of a 109.65 MHz amplifier inside the IF IC. After it is amplified approximately 11 dB, the signal exits U301 at Pin 42 and returns at U301, Pin 4. Inside the IF IC, the second mixer takes the signal at Pin 4, mixes it with the second local oscillator signal that enters the IC at Pin 2, produces the second IF (450 kHz), and outputs that signal at U301, Pin 41.

2.2.2 Second IF

After leaving the second mixer, the second IF signal goes to Q301, which amplifies it approximately 20 dB. From there, the signal passes to a 6–pole ceramic filter FL301, and then returns to U301 at Pin 39. Inside U301, a 450 kHz amplifier boosts the signal another 35 dB, and outputs it, via U301, Pin 36, to FL302, a 6–pole ceramic filter. Together, these two filters provide the 450 kHz IF selectivity. FL302 outputs to the limiter/demodulator at U301, Pin 34. U301 outputs the demodulated signal at Pin 26 at a level approximately 100 mV peak for every 1 kHz of peak FM deviation. A receive–signal strength indicator (RSSI) is output on U301, Pin 5, in the form of DC voltage.

2.2.3 Squelch

Squelch noise exits U301, Pin 28, and is coupled by C315 to U301, Pin 20. The signal is limited by a squelch limiter inside U301 and then exits U301 at Pin 18 to be coupled to the command board.

3. Troubleshooting

This information will help field service technicians troubleshoot the *SPECTRA* radio. Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, the following troubleshooting information identifies tests and checks designed to help isolate problems.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at high frequencies, measurements must be taken very carefully. Notes and cautions are added to the text to alert the reader to this need in areas of greatest sensitivity. However, the need for extreme care does exist in all measurements and tests.

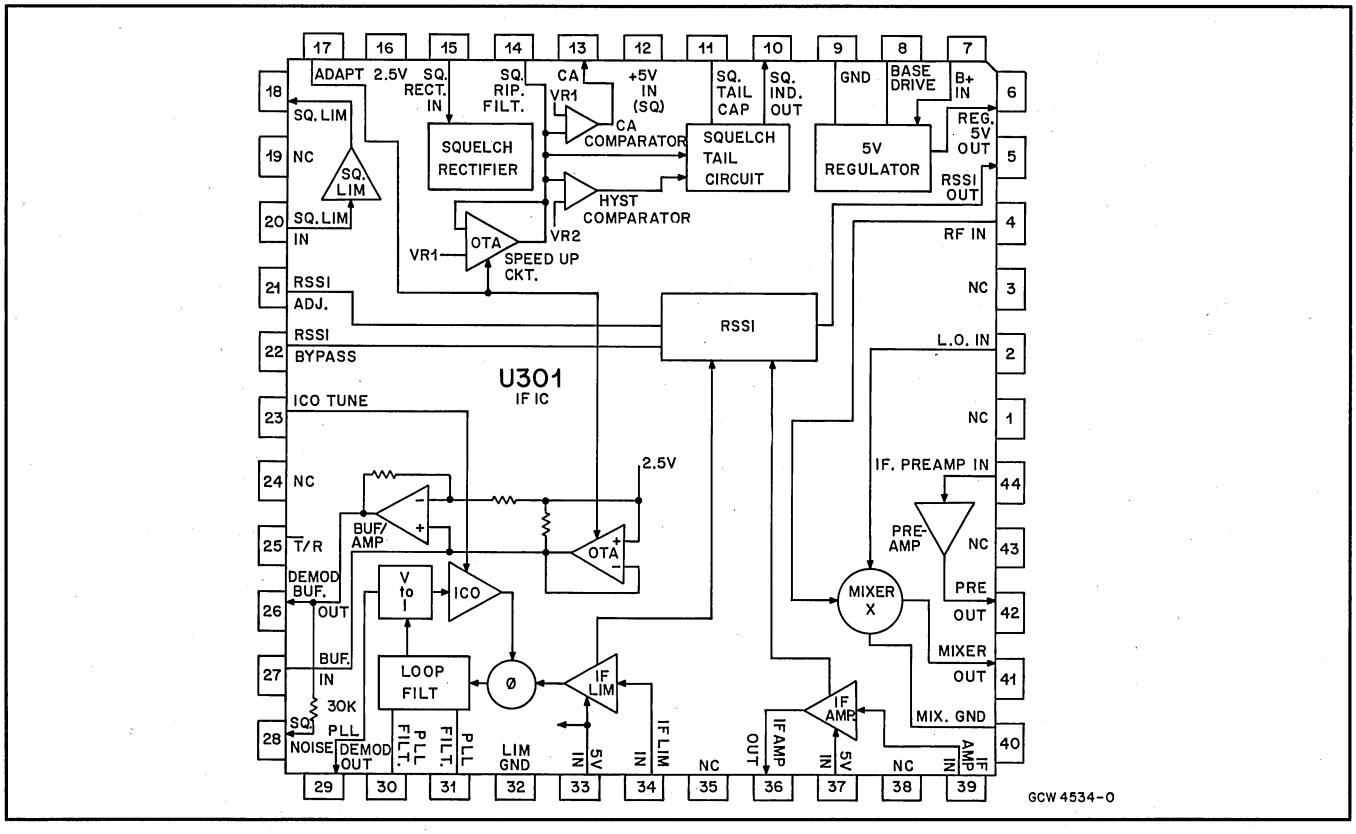


Figure 6. IF IC Block Diagram

3.1 DISPLAY FLASHES "FAIL 001"

This display indicates a synthesizer "out–of–lock" condition. Check the DC power supplies for the correct voltages at the following locations:

VOLTAGE	LOCATION	REMARKS
+5VDC	Q602 Collector	
+8.6VDC	Q603 Collector	
+5VDC +3.25VDC	J500 Pin 1 J500 Pin 2	Power from command board to reference oscillator.

(1) If any of the DC voltages are not correct, troubleshoot the source of the supplied power and correct the problem. If the voltages are correct, continue with the following checks.

(2) Check U602, Pin 19 for reference frequency, 0 to 9 volt, square wave. If not correct, go to paragraph 3.1.1; otherwise, continue with the following checks.

(3) Check U602, Pin 25 for reference frequency, 0 to 9 volt, square wave. If not correct, go to paragraph 3.1.2; otherwise, continue with the following checks.

(4) Check the negative steering line, J601, Pin 4. If not correct, go to paragraph 3.1.3; otherwise, continue with the following checks.

(5) Check the positive steering line, J601, Pin 1 or 2 for positive voltage between 1.0 and 8.0 volts. If not correct, go to paragraph 3.1.4; otherwise, continue with the following checks.

Note

It is common for both steps 3 and 5 to be incorrect in an "out–of–lock" condition.

(6) Check U602, Pin 27 for a 1.5V p–p square wave whose frequency is determined in the following equation. If the values are not correct, go to paragraph 3.1.5.

$$\frac{\text{Freq into U601–1}}{\text{Prescaler Modulus}} \text{ ,e.g. } \frac{Fin}{P} = \frac{455\text{ MHz}}{255} = 1.77\text{ MHz, or } \frac{Fin}{P+1} = \frac{455\text{ MHz}}{256} = 1.76\text{ MHz}$$

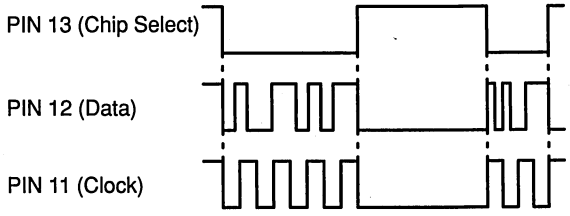
Note

The frequency at U601, Pin 40, is seldom exactly equal to "Fin" divided by "P" or "P+1" because the prescaler is continuously changing from one division to the other. In the above example, P is 255 and P+1 is 256.

3.1.1 Incorrect Values at U602 Pin 19

(1) If the reference frequency is not equal to 6.25 kHz (900 MHz) or 5.0 kHz (VHF/UHF), check U602–7 for 300 kHz, 0 to 9 volt square wave. Then:

- If 300 kHz is good, check the power to U602, Pins 30 and 37. Also, check the serial data programming by pressing and holding the mode select button and probing pins 11, 12, and 13. The 0 to 5V logic waveforms should appear similar to the following:



Note

The above waveforms are crude representations. See the microcomputer (Command Board) section for specific timing and programming information.

- If the programming appears normal and the power supplies have all checked out correctly, the out–of–lock condition is caused by a defective synthesizer IC (U602).

(2) If 300 kHz is not present, check U602, Pin 16, for 2.1 MHz, 1.5V p–p square wave.

- If the signal is present and the power to the chip is normal, the condition is caused by a defective synthesizer IC (U602).
- If the signal is not present, check for the same signal at U601, Pin 18. If not on Pin 18, check the reference oscillator output signal at U601, Pin 21; it should be 16.8 MHz, 300 millivolt p–p. If the reference oscillator signal is present and the prescaler power supply voltages are normal, the prescaler IC (U601) is defective.
- If the reference oscillator signal (16.8 MHz) is not present on U601, Pin 21, check U600, Pin 1 for 3.25 VDC, Pin 2 for ground, Pin 3 for 16.8 MHz at 300 millivolt p–p, and Pin 4 for 5 VDC.

Note

Before concluding that the reference oscillator is defective, remove it from its socket, power it up externally, and test it as an independent circuit.

3.1.2 Incorrect Values at U602 Pin 25 (MODULUS CONTROL)

If the frequency is not 6.25 kHz (or 5.0 kHz for VHF), verify the proper VCO pin–shift logic. See VCO block diagram for pin–shift logic. Also, check the VCO feedback for approximately –10 to 5 dBm at proper VCO frequency. Use the following table:

VCO Feedback Frequency	
900 MHz 800 MHz	VCO Feedback Freq. = $\frac{\text{TX Freq.}}{2}$ or $\frac{\text{RX Freq} - 109.65\ \text{MHz}}{2}$
UHF	VCO Feedback Freq = TX Freq or RX Freq + 109.65 MHz
VHF	VCO Feedback Freq = TX Freq x 2 or RX Freq + 109.65 MHz

If the VCO is running at approximately the correct level and frequency, proceed to step 3.1.5.

3.1.3 Incorrect Value at J601 Pin 4 (Negative Steering Line)

Check for the following (HRN6000A and HRN6002A only):

- –6.0 volts at drain of Q612
- –6.0 volts at source of Q612
- +5.0 volts at gate of Q612
- 0 volts at U602 Pin 24.

Also, check the following (all boards):

- –8.2 volts at anode of CR603
- +0.7 to –8.3 volts, 300 kHz square wave at cathode of CR603.

Troubleshoot missing 300 kHz signal. (Refer back to paragraph 3.1.1, Step 2.)

3.1.4 Incorrect Voltage at Positive Steering Line

Verify that the VCO is running—check VCO feedback for –10 to 0 dBm. Verify that the feedback buffer (if used) is working—check U601–1.

3.1.5 Incorrect Values at U602 Pin 27

Check prescaler (U601) operation; U601–40 should be:

EQUATION: $F = \frac{Fvco}{P \text{ or } P+1}$

3.2 REVIEW OF SYNTHESIZER FUNDAMENTALS

(1) The synthesizer is a phase–locked loop system with a sample–and–hold phase detector.

(2) In a locked system, the prescaler, in conjunction with the counters in the synthesizer chip, counts the VCO frequency down to the reference frequency. Think of this division process as a time domain function rather than frequency domain.

(3) For each reference period (if using 6.25 kHz reference), you have 160 microseconds in which the VCO frequency is divided by N. Recall the equations:

EQUATION: $N = \frac{Fvco}{FR}$

EXAMPLE: $N = \frac{Fvco}{FR} = \frac{450\ \text{MHz}}{6.25\ \text{KHz}}$ or 72,000

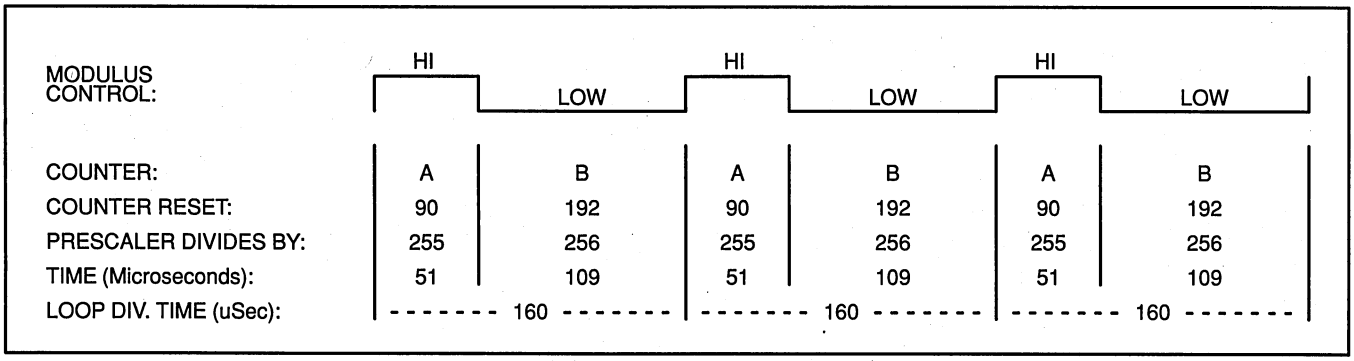
EQUATION: A = (fractional remainder of $\frac{N}{P}$) (P)

EXAMPLE: $A = \frac{N = 72{,}000}{P = 255}$ = 282.3529; .3529 x 255 0r A=90

EQUATION: $B = \frac{N - \{A \times (P + 1)\}}{P}$

EXAMPLE: $B = \frac{72{,}000 - \{90 \times (255 + 1)\}}{255}$ or 192

At 450 MHz, there are 72,000 counts of 2.22 nanoseconds each per reference period. When modulus control (MCT) is high, the VCO output is prescaled by 255 (see the diagram below). The output frequency of the prescaler is 1.765 MHz which corresponds to a period–per–cycle of 567 nanoseconds.



The "A" counter runs long enough to count down 90 cycles which equals 51 microseconds. When MCT is low, the prescaled output equals 1.758 MHz which corresponds to a period of 569 nanoseconds. The "B" counter counts 192 cycles which takes 109 microseconds. The total time required for proper loop division is thus 160 microseconds (the reciprocal of 6.25 kHz).

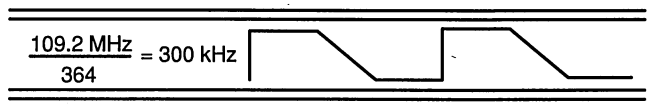
3.3 SECOND VCO CHECKS

(1) Check for 300 kHz reference frequency at U601, Pin 31.

(2) Check for 0.5 to 4.0V phase detector output at U601, Pin 30.

(3) Check for –12 to –16 dBm at 109.2 MHz feedback (U601, Pin 26).

(4) Check the divide–by–N test point for a 700 millivolt p–p waveform at 300 kHz (the second VCO frequency divided by 364). See example.

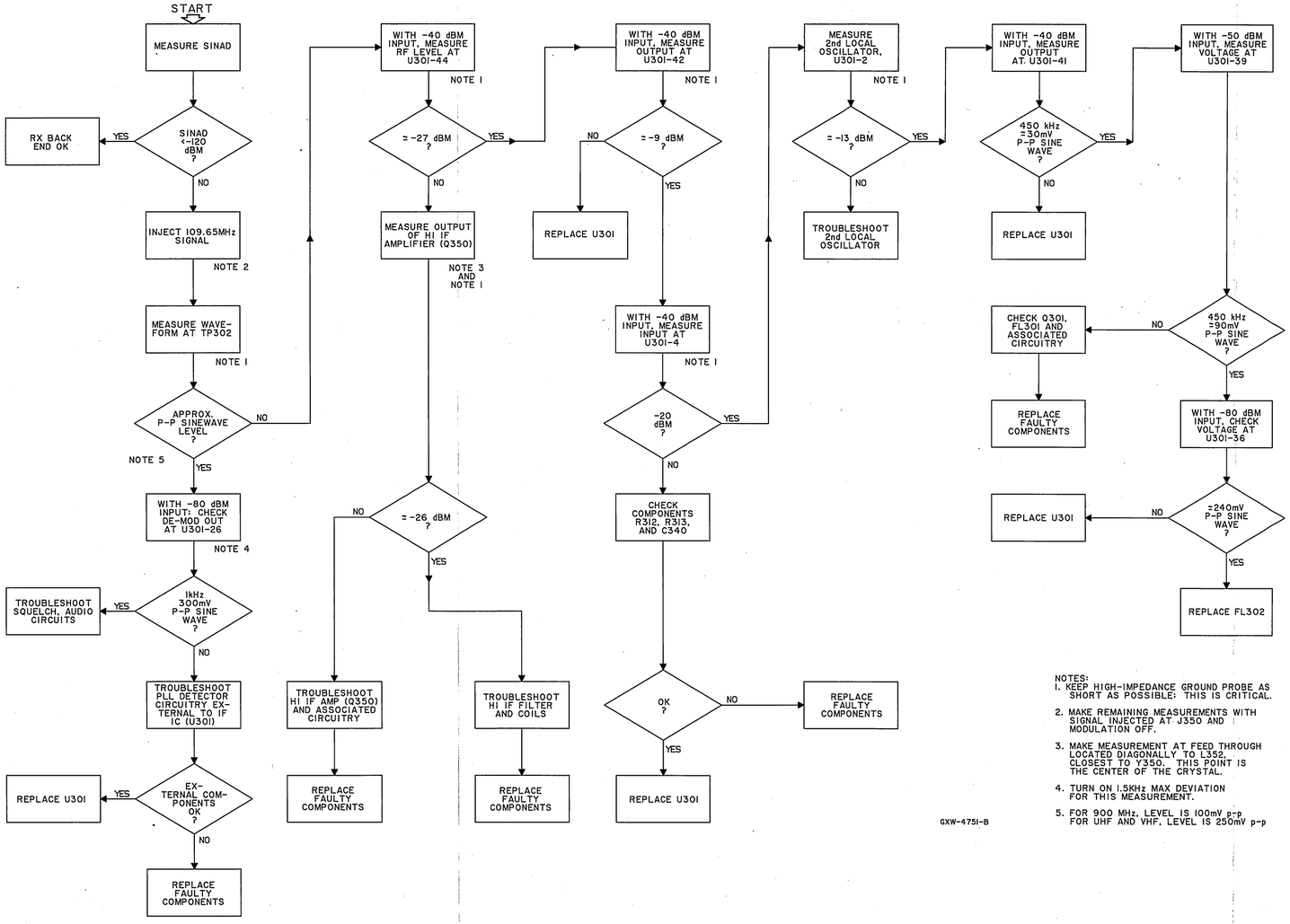


Note

The second VCO circuit is external to U601, and while it does depend on U601 for proper phase–locking, it should free–run, open loop, at some frequency if U601 fails. If the 8.8V super filter and the oscillator are "dead," U601 is defective.

3.4 TROUBLESHOOTING THE BACK END

See the Back End Troubleshooting Chart PW–4750. The chart details sequential testing and checking designed to isolate the probable failure areas of the RF board back end.

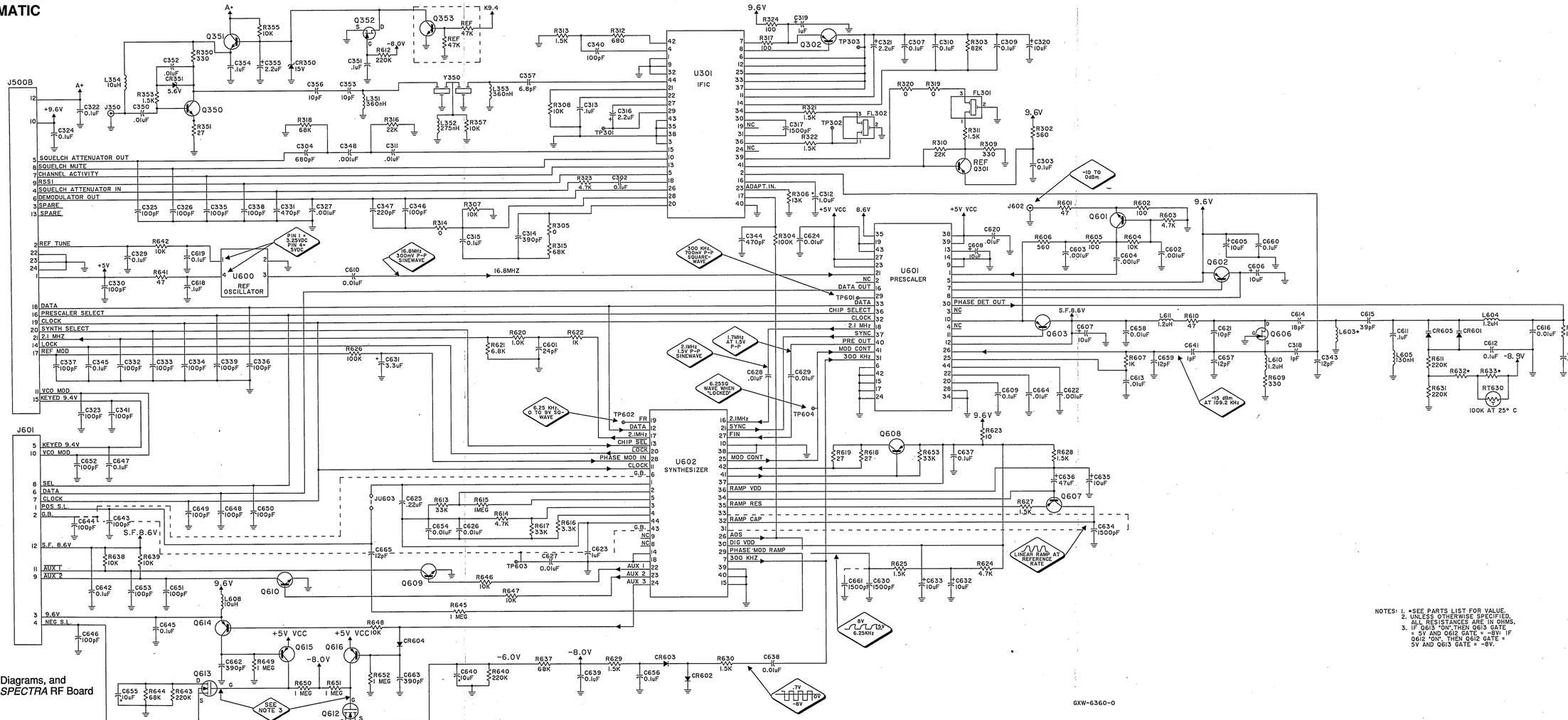


NOTES:

1. KEEP HIGH-IMPEDANCE GROUND PROBE AS SHORT AS POSSIBLE: THIS IS CRITICAL.
2. MAKE REMAINING MEASUREMENTS WITH SIGNAL INJECTED AT J350 AND MODULATION OFF.
3. MAKE MEASUREMENT AT FEED THROUGH LOCATED DIAGONALLY TO L352, CLOSEST TO Y350. THIS POINT IS THE CENTER OF THE CRYSTAL.
4. TURN ON 1.5KHz MAX DEVIATION FOR THIS MEASUREMENT.
5. FOR 900 MHz, LEVEL IS 100mV p-p FOR UHF AND VHF, LEVEL IS 250mV p-p

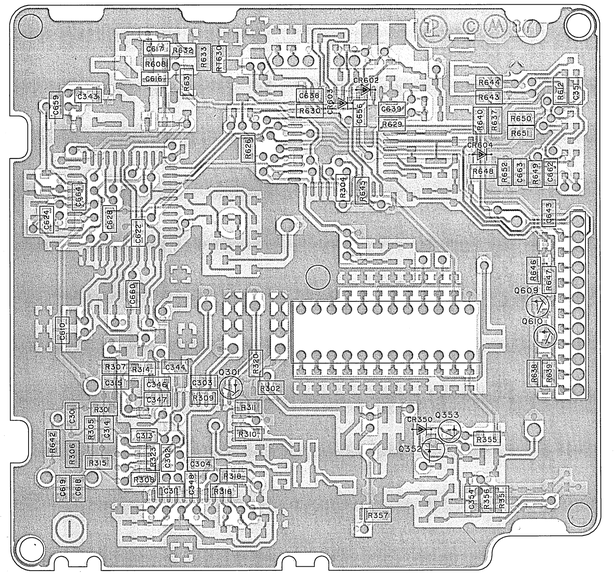
Troubleshooting Chart for
SPECTRA RF Board Back End
PW–4750–B
2/25/89

HRN6000A SCHEMATIC
900 MHz



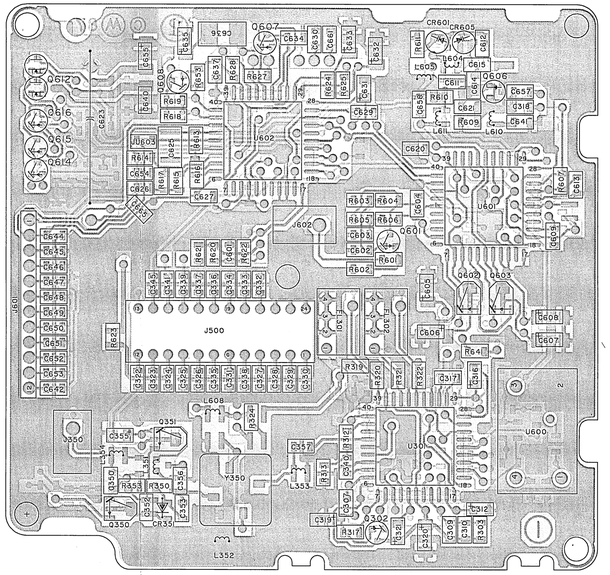
Schematic, Circuit Board Diagrams, and Parts List for HRN6000A *SPECTRA* RF Board
PW–4707–C
(Sheet 1 of 2)
2/25/89

SOLDER SIDE VIEW



SOLDER SIDE GAW-4695-0
COMPONENT SIDE GAW-4694-0
OVERLAY GXW-4696W02-0

COMPONENT SIDE VIEW



SOLDER SIDE GAW-4695-0
COMPONENT SIDE GAW-4694-0
OVERLAY GXW-4696W01-0

parts list

HRN6000A RF Board (12.5 kHz Channel Spacing) MXW-4708-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed, µF, ±10%, 50V unless otherwise stated
C302,303	21-11032A33	0.1
C304	21-11031A59	680 pF, ±5%
C307	21-11032A33	0.1
C309,310	21-60521B37	0.1, ±5%, 25V
C311	21-11032A21	0.01
C312	23-62998B59	1, ±20%, 16V, tantalum
C313	21-11032A33	0.1
C314	21-11031A53	390 pF, ±5%
C315	21-11032A33	0.1
C316	23-62998B64	2.2, ±20%, 20V, tantalum
C317	21-11031A64	1500 pF, ±5%
C318	21-11031A01	1 pF, ±.25 pF
C319	23-62998B59	1, ±20%, 16V, tantalum
C320	23-62998B73	10, ±20%, 16V, tantalum
C321	23-62998B64	2.2, ±20%, 20V, tantalum
C322	21-11032A33	0.1
C323	21-11031A39	100 pF, ±5%
C324	21-11032A33	0.1
C325,326	21-11031A39	100 pF, ±5%
C327	21-11032A09	0.001
C328	21-11031A39	100 pF, ±5%
C329	21-11032A33	0.1
C330	21-11031A39	100 pF, ±5%
C331	21-11031A55	470 pF, ±5%
C332-341	21-11031A39	100 pF, ±5%
C343	21-11031A17	12 pF, ±5%
C344	21-11031A55	470 pF, ±5%
C345	21-11032A33	0.1
C346	21-11031A39	100 pF, ±5%
C347	21-11031A47	220 pF, ±5%
C348	21-11031A61	1000 pF, ±5%
C350	21-11032A21	0.01
C351	21-11032A33	0.1
C352	21-11032A21	0.01
C353	21-11031A15	10 pF, ±.5 pF
C354	21-11032A33	0.1
C355	23-62998B64	2.2, ±20%, 20V, tantalum
C356	21-11031A15	10 pF, ±.5 pF
C357	21-11031A11	6.8 pF, ±.5 pF
C601	21-11031A24	24 pF, ±5%
C602-604	21-11032A09	0.001
C605-608	23-62998B73	10, ±20%, 16V, tantalum
C609	21-11032A33	0.1
C610	21-11032A21	0.01
C611	21-11032A33	0.1
C612	21-11032A33	0.1
C613	21-11032A21	0.01
C614	21-11031A21	18 pF, ±5%
C615	21-11031A29	39 pF, ±5%
C616	21-11032A21	0.01
C617	21-60521B37	0.1, ±5%, 25V
C618,619	21-11032A33	0.1
C620	21-11032A21	0.01
C621	21-11031A15	10 pF, ±.5 pF
C622	21-11032A09	0.001
C623	08-60027B09	1.0, 100V
C624	21-11032A21	0.01
C625	21-60521K43	22, 25V
C626-629	21-11032A21	0.01
C630	21-11031A64	1500 pF, ±5%
C631	23-62998B16	3.3, 16V, tantalum
C632,633	23-62998B73	10, ±20%, 16V, tantalum
C634	21-11031A64	1500 pF, ±5%
C635	23-62998B73	10, ±20%, 16V, tantalum
C636	23-80009M07	47, ±20%, 16V, electrolytic
C637	21-11032A33	0.1
C638	21-11032A21	0.01
C639	21-11032A33	0.1
C640	23-62998B73	10, ±20%, 16V, tantalum
C641	21-11031A01	1 pF, ±.25 pF
C642	21-11032A33	0.1
C643,644	21-11031A39	100 pF, ±5%
C645	21-11032A33	0.1
C646	21-11031A39	100 pF, ±5%
C647	21-11032A33	0.1
C648-653	21-11031A39	100 pF, ±5%
C654	21-11032A21	0.01
C655	23-62998B73	10, ±20%, 16V, tantalum
C656	21-11032A33	0.1
C657	21-11031A17	12 pF, ±5%
C658	21-11032A21	0.01
C659	21-11031A17	12 pF, ±5%
C660	21-11032A33	0.1
C661	21-11031A64	1500 pF, ±5%
C662,663	21-11031A53	390 pF, ±5%
C664	21-11032A21	0.01
C665	21-11031A17	12 pF, ±5%
		diode (see note)
CR350	48-82956R91	zener, 15V
CR351	48-82956R78	zener, 5.6V
CR601	48-80006E09	varactor
CR602-604	48-80066M01	rectifier
CR605	48-80006E09	varactor

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		filter
FL301	91-80297K03	ceramic, 450 kHz, 7.5 HKZ bandwidth
FL302	91-80297K02	ceramic, 450 kHz, 7.5 HKZ bandwidth
		connector receptacle
J500	09-80104M01	receptacle, bottom entry
J302-313	09-80103N01	socket circuit board
J350	09-80110M01	coax, PC board mount
J601	09-05287C07	socket circuit board
J602	09-80110M01	coax, PC board mount
J603-605	09-05287C07	socket circuit board
		jumper, resistor
JU603	06-11077A01	0 ohm
		coil, rf
L351	24-80140E11	360 nH
L352	24-80140E15	270 nH
L353	24-80140E11	360 nH
L354	24-80140E19	10 µH
L603	24-80260N01	9 turns, toroid (See R632, R633)
L604	24-80140E01	1.2 µH
L605	24-80140E06	130 nH
L606	24-80140E19	10 µH
L610,611	24-80140E01	1.2 µH
		transistor (see note)
Q301	48-80182D48	PNP, type BD48, SOT-23
Q302	48-80141L01	PNP, type 41L01
Q350	48-80182D49	NPN, type BD49, SOT89
Q351	48-80052M01	NPN, Darlington, type MXTA27
Q352	48-05128M66	JFET, type 2SM66
Q353	48-80048M01	NPN, digital 47k/47k
Q601	48-82940R01	NPN, type 40R01
Q602,603	48-05128M27	PNP, type 2SM27, SOT89
Q606	48-05128M66	JFET, type 2SM66
Q607	48-80182D48	PNP, type BD48, SOT-23
Q608	48-80141L01	PNP, type 41L01
Q609,610	48-80141L02	NPN, type 41L02
Q612,613	48-80182D47	n-channel MOSFET, 2N7002
Q614-618	48-80141L01	PNP, type 41L01
		thermistor
RT630	06-80149M02	100k ohm
		resistor, fixed, ω, ±5%, 1/8 watt unless otherwise stated
R302	06-11077A68	560
R303	06-11077B21	82k
R304	06-11077B23	100k
R305	06-11077A01	0
R306	06-11024H03	10k, ±1%
R307,308	06-11077A98	10k
R309	06-11077A42	330
R310	06-11077B07	22k
R311	06-11077A78	1.5k
R312	06-11077A70	680
R313	06-11077A78	1.5k
R314	06-11077A01	0
R315	06-11077B19	68k
R316	06-11077B07	22k
R317	06-11077A50	100
R318	06-11077B19	68k
R319	06-11077A01	0
R320	06-11077A01	0
R321,322	06-11077A78	1.5k
R323	06-11077A60	4.7k
R324	06-11077A50	100
R350	06-11077A42	330
R351	06-11077A36	27
R353	06-11077A78	1.5k
R355	06-11077A98	10k
R357	06-11077A98	10k
R601	06-11077A42	47
R602	06-11077A50	100
R603	06-11077A90	4.7k
R604	06-11077A98	10k
R605	06-11077A50	100
R606	06-11077A68	560
R607	06-11077A74	1k
R608	06-11077A98	10k
R609	06-11077A62	330
R610	06-11077A42	47
R611,612	06-11077B31	220k
R613	06-11077B11	33k
R614	06-11077A90	4.7k
R615	06-11077B47	1 meg
R616	06-11077A66	3.3k
R617	06-11077B11	33k
R618,619	06-11077A36	27
R620	06-11077A74	1k
R621	06-11077A94	6.8k
R622	06-11077A74	1k
R623	06-11077A26	10
R624	06-11077A90	4.7k
R625	06-11077A78	1.5k

900 MHz

MXW-4708-C (3)

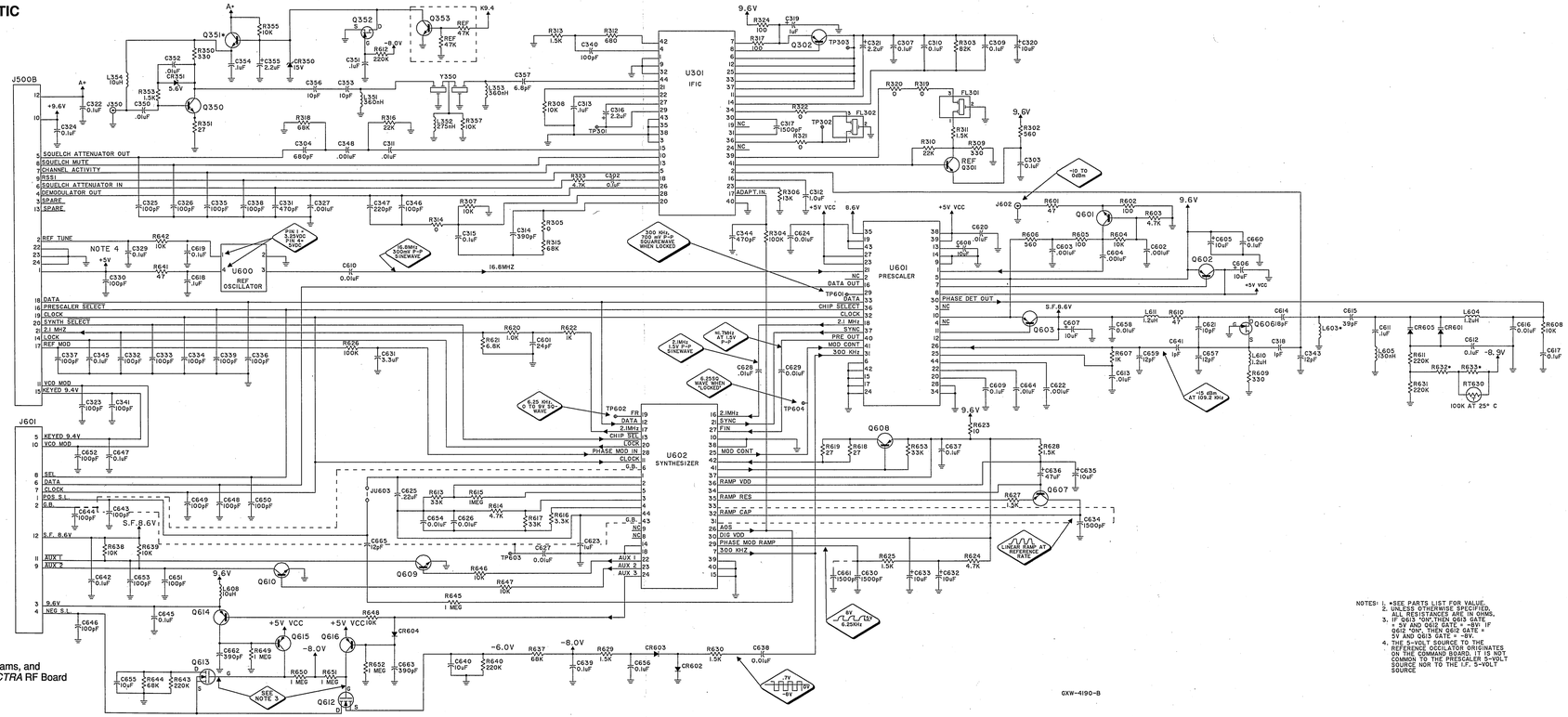
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R626	06-11077B23	100k
R627-630	06-11077A78	1.5k
R631	06-11077B31	220k
R632	06-11077B31	220k (if L603 has YELLOW or NO DOT)
R632	06-11077B25	330k (if L603 has BLUE or ORANGE DOT)
R633	06-11077B19	68k (if L603 has YELLOW or NO DOT)
R633	06-11077B31	220k (if L603 has BLUE DOT)
R633	06-11077B15	47k (if L603 has ORANGE DOT)
R637	06-11077B19	68k
R638,639	06-11077A98	10k
R640	06-11077B31	220k
R641	06-11077A42	47
R642	06-11077A98	10k
R643	06-11077B31	220k
R644	06-11077B19	68k
R645	06-11077B47	1 meg
R646-648	06-11077A98	10k
R649-652	06-11077B47	1 meg
R653	06-11077B11	33k
		integrated circuit (see note)
U301	51-83977M76	IF IC
U601	51-83977M77	prescaler IC
U602	51-83977M78	synthesizer IC
		crystal (see note)
Y350	91-80084M01	4-pole 109.65 MHz
		non-referenced parts
	26-80003M01	shield, high IF
	26-80004M01	shield, output match
	26-80005M01	shield, doubler feedback
	26-80006M01	shield, second VCO

7/19/88

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

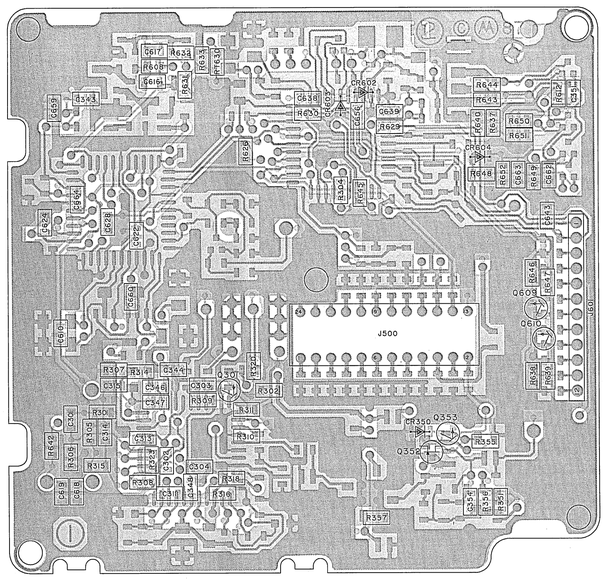
Schematic, Circuit Board Diagrams, and Parts List for HRN6000A *SPECTRA* RF Board
PW–4707–C
(Sheet 2 of 2)
2/25/89

HRN6002A SCHEMATIC
900 MHz



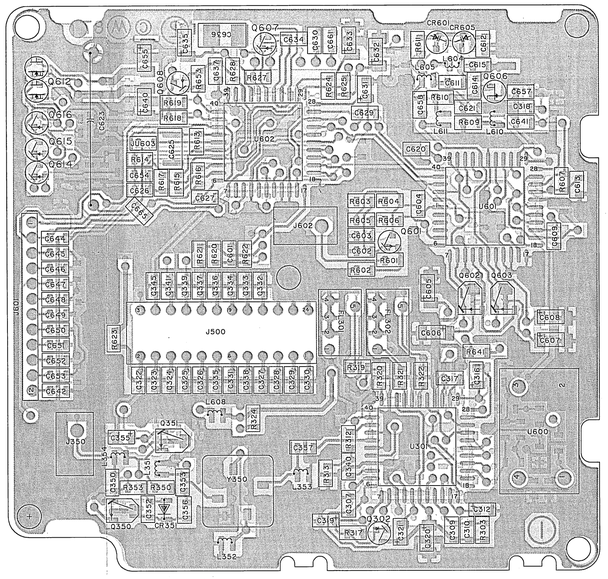
Schematic, Circuit Board Diagrams, and Parts List for HRN6002A *SPECTRA* RF Board
PW–5665–O
(Sheet 1 of 2)
7/25/88

SOLDER SIDE VIEW



SOLDER SIDE GAW-4695-A
COMPONENT SIDE GAW-4694-A
OVERLAY GXW-4696W02-A

COMPONENT SIDE VIEW



SOLDER SIDE GAW-4695-A
COMPONENT SIDE GAW-4694-A
OVERLAY GXW-4696W01-A

parts list

HRN6002A RF Board (12.5 kHz Channel Spacing) MXW-5768-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C6302,6303	21–11032A33	0.1
C6304	21–11031A59	680 pF, ±5%
C6307	21–11032A33	0.1
C6309,6310	21–11032A33	0.1
C6311	21–11032A21	0.01
C6312	23–62998B59	1.5, ±20%, 16V, tantalum
C6313	21–11032A33	0.01
C6314	21–11031A33	390 pF, ±5%
C6315	21–11032A33	0.1
C6316	23–62998B64	2.2, ±20%, 20V
C6317	21–11031A64	1500 pF, ±5%
C6318	21–11031A01	1.0 pF, ±.25% pF
C6319	23–62998B59	1., ±20%, 16V, tantalum
C6320	23–62998B73	10, ±20%, 16V, tantalum
C6321	23–62998B64	2.2, ±20%, 20V, tantalum
C6322	21–11032A33	0.1
C6323	21–11031A39	100 pF, ±5%
C6324	21–11032A33	0.1
C6325,6326	21–11031A39	100 pF, ±5%
C6327	21–11032A09	0.001
C6328	21–11031A39	100 pF, ±5%
C6329	21–11032A33	0.1
C6330	21–11031A39	100 pF, ±5%
C6331	21–11031A55	470, ±5%
C6332–6341	21–11031A39	100 pF, ±5%
C6343	21–11031A17	12 pF, ±5%
C6344	21–11031A55	470 pF, ±5%
C6345	21–11032A33	0.1
C6346	21–11031A39	100 pF, ±5%
C6348	21–11031A61	1000 pF, ±5%
C6350	21–11032A21	0.01
C6351	21–11032A33	0.1
C6352	21–11032A21	0.01
C6353	21–11031A15	10 pF, ±5%
C6354	21–11032A33	0.1
C6355	23–62998B64	2.2, ±20%, 20V tantalum
C6356	21–11031A15	10 pF, ±.5 pF
C6357	21–11031A11	6.8 pF, ±.5 pF
C6601	21–13740B34	24 pF, ±5%
C6602–6604	21–11032A09	0.001
C6605–6608	23–62998B73	10, ±20%, 16V
C6609	21–11032A33	0.1
C6610	21–11032A21	0.01
C6611,6612	21–11032A33	0.1
C6613,6614	21–11032A21	0.01
C6615	21–11031A59	39 pF, ±5%
C6616	21–11032A21	0.01
C6617–6619	21–11032A33	0.1
C6620	21–11032A21	0.01
C6621	21–11031A15	10 pF, ±.5% pF
C6622	21–11032A09	0.001
C6623	08–80027D09	1.0, 100V
C6624	21–11032A21	0.01
C6625	21–48261A41	0.22, 25V
C6626–6629	21–11032A21	0.01
C6630	21–11031A64	1500 pF, ±5%
C6631	23–62998B16	1.3, 16V, tantalum
C6632,6633	23–62998B73	10, ±20%, 16V tantalum
C6634	21–11031A64	1500 pF, ±5%
C6635	23–62998B73	10, ±20%, 16V, tantalum
C6637	21–11032A33	0.1
C6638	21–11032A21	0.01
C6639	21–11032A33	0.1
C6640	23–62998B73	10, ±20%, 16V, tantalum
C6641	21–11031A01	1. pF, ±.25% pF
C6642	21–11032A33	0.1
C6643,6644	21–11031A39	100 pF, ±5%
C6645	21–11032A33	0.1
C6646	21–11031A39	100 pF, ±5%
C6647	21–11032A33	0.1
C6651–6653	21–11031A39	100 pF, ±5%
C6654	21–11032A21	0.01
C6656	21–11032A33	0.1
C6657	21–11031A17	12 pF, ±5%
C6658	21–11032A21	0.01
C6659	21–11031A17	12 pF, ±5%
C6660	21–11032A33	0.1
C6664	21–11032A21	0.01
C6665	21–11031A17	12 pF, ±5%
diode (see note)		
CR6350	48–82958R91	zener, 15V
CR6351	48–82958R78	zener, 5.6V
CR6601	48–80006E09	varactor
CR6602,6603	48–80066M01	rectifier
CR6605	48–80006E09	varactor

HRN6002A RF Board (12.5 kHz Channel Spacing) MXW-5768-O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
fuse		
FL6301,6302	91–80297K03	ceramic, 450 kHz, 7.5 kHZ bandwidth
connector receptacle		
J6500	09–89104M01	receptacle, bottom entry
J6301	09–80103N01	socket circuit board
J6350	09–80010M01	coax, PC board mount
J6501	09–05287C07	socket circuit board
J6502	09–80010M01	coax, PC board mount
J6603–6605	09–05287C07	socket circuit board
jumper, resistor		
J6603	06–11077A01	0 ohm
coil, RF		
L6351	24–80140E11	360 nH
L6352	24–80140E15	270 nH
L6353	24–80140E11	360 nH
L6354	24–80140E16	10 uH
L6603	24–80260N01	90 nH, 9 turns toroid (See R632,R633)
L6604	24–80140E01	1.2 uH
L6605	24–80140E06	130 nH
L6606	24–80140E16	10 uH
L6610,6611	24–80140E01	1.2 uH
transistor (see note)		
Q6301	48–80182D48	PNP, type 82D48, SOT–23
Q6302	48–80141L01	PNP, type 41L01
Q6350	48–80182D49	NPN
Q6351	48–80052M01	NPN, Darlington, type MXTA27
Q6352	48–05128M66	JFET, type 28M66
Q6353	48–80048M01	NPN, digital 47k/47k
Q6601	48–8294OR01	NPN, type 40R01
Q6602,6603	48–05128M27	PNP, type 28M27, SOT89
Q6606	48–05128M66	JFET, type 28M66
Q6607	48–80182D48	PNP, type 82D48, SOT–23
Q6608	48–80141L01	PNP, type 41L01
Q6609,6610	48–80141L02	NPN, type 41L02
Q6612	48–80182D47	n-channel MOSFET, 2N7002
Q6616	48–80141L01	PNP, type 41L01
thermistor		
RT6630	06–80149M02	100k ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R6302	06–11077A68	560
R6303	06–11077B21	82k
R6304	06–11077B23	100k
R6305	06–11077A01	0
R6306	06–11024H03	13k, ±1%
R6307,6308	06–11077A58	10k
R6309	06–11077A62	330
R6310	06–11077A97	22k
R6311	06–11077A78	1.5k
R6312	06–11077A70	680
R6313	06–11077A78	1.5k
R6314	06–11077A01	0
R6315	06–11077B19	68k
R6316	06–11077B07	22k
R6317	06–11077A50	100
R6318	06–11077B19	68k
R6319–6322	06–11077A01	0
R6323	06–11077A90	47k
R6324	06–11077A50	100
R6325	06–11077B41	560k
R6350	06–11077A62	330
R6351	06–11077A36	27
R6353	06–11077A78	1.5k
R6355	06–11077A98	10k
R6357	06–11077A58	10k
R6601	06–11077A42	47
R6602	06–11077A50	100
R6603	06–11077A90	4.7k
R6604	06–11077A58	10k
R6605	06–11077A50	100
R6606	06–11077A68	560
R6607	06–11077A74	1k
R6608	06–11077A98	10k
R6609	06–11077A62	330
R6610	06–11077A42	47
R6611,6612	06–11077B31	220k
R6613	06–11077B11	33k
R6614	06–11077A90	4.7k
R6615	06–11077B47	1 meg
R6616	06–11077A86	3.3k
R6617	06–11077B11	33k
R6618,6619	06–11077A36	27

HRN6002A RF Board (12.5 kHz Channel Spacing) MXW-5768-O (3)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R6620	06–11077A74	1k
R6621	06–11077A84	6.8k
R6622	06–11077A74	1k
R6623	06–11077A26	10
R6624	06–11077A90	4.7k
R6625	06–11077A78	1.5k
R6626	06–11077B23	100k
R6627–6630	06–11077A78	1.5k
R6631,	06–11077B31	220k
R6632	06–11077B31	220k (if L603 has YELLOW or NO DOT)
R6633	06–11077B35	330k (if L603 has BLUE or ORANGE DOT)
R6634	06–11077B19	68k (if L603 has YELLOW or NO DOT)
R6633	06–11077B31	220k (if L603 has BLUE DOT)
R6633	06–11077B15	47k (if L603 has ORANGE DOT)
R6637	06–11077B19	68k
R6638,6639	06–11077A98	10k
R6640	06–11077B31	220k
R6641	06–11077A42	47
R6642	06–11077A68	10k
R6645	06–11077B47	1 meg
R6646,6647	06–11077A68	10k
R6651,6652	06–11077B47	1 meg
R6653	06–11077B11	33k
integrated circuit (see note)		
U6301	51–83977M76	IF IC
U6601	51–83977M77	prescaler IC
U6602	51–83977M78	synthesizer IC
crystal (see note)		
Y6350	91–80084M01	4–pole 109.65 MHz
mechanical parts		
	26–80003M02	shield, high IF
	26–80004M02	shield, output match
	26–80005M01	shield, doubler feedback
	26–80006M01	shield, second VCO
	54–80004N01	label barcode

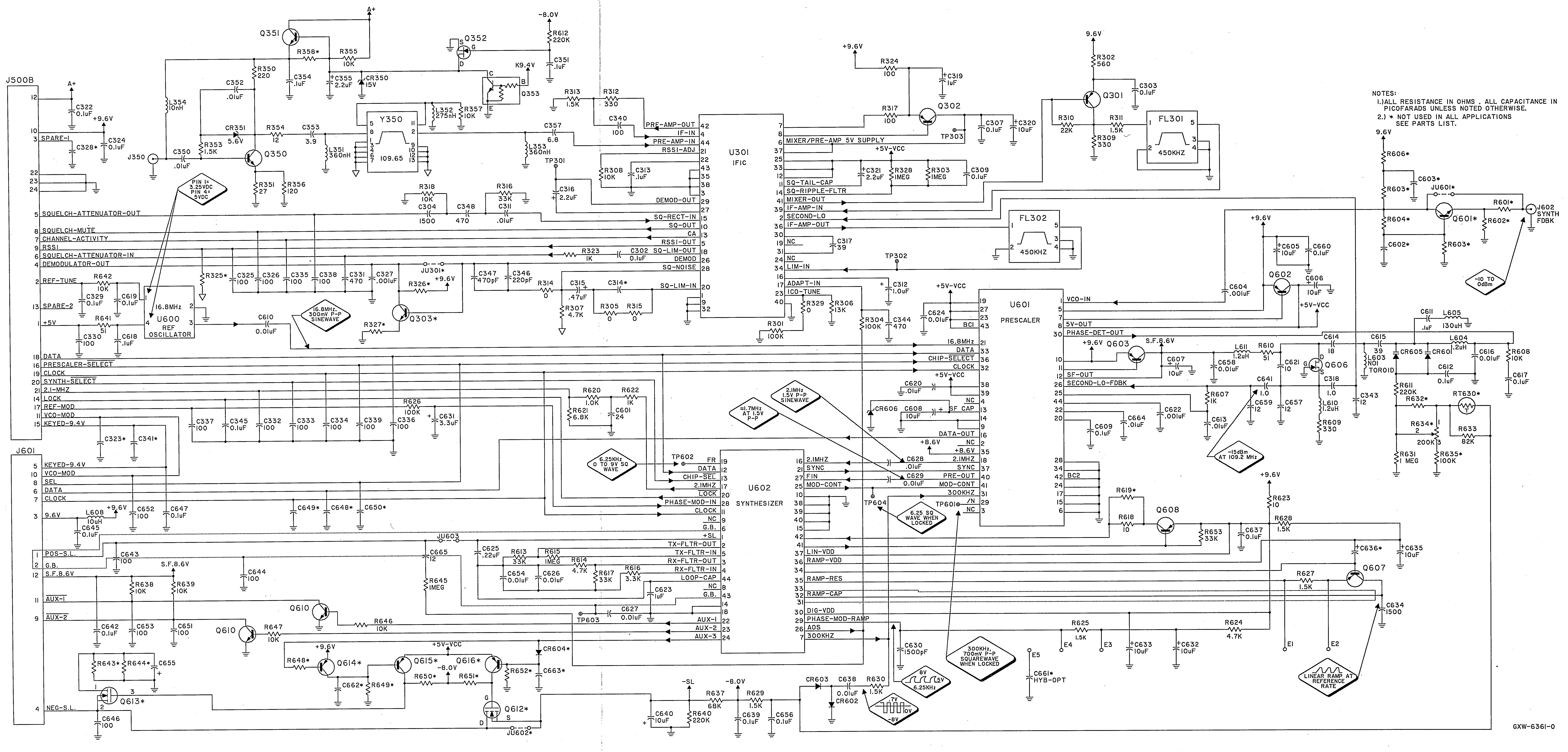
7/15/88

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

900 MHz

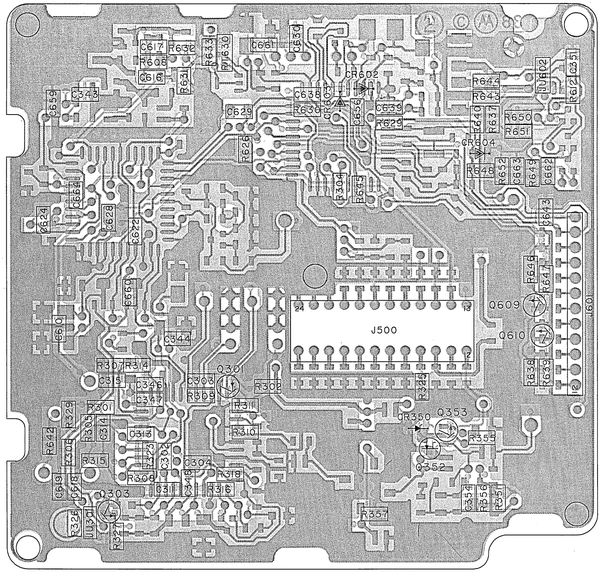
Schematic, Circuit Board Diagrams, and Parts List for HRN6002A *SPECTRA* RF Board
PW–5665–O
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HRN6005A SCHEMATIC
900 MHz



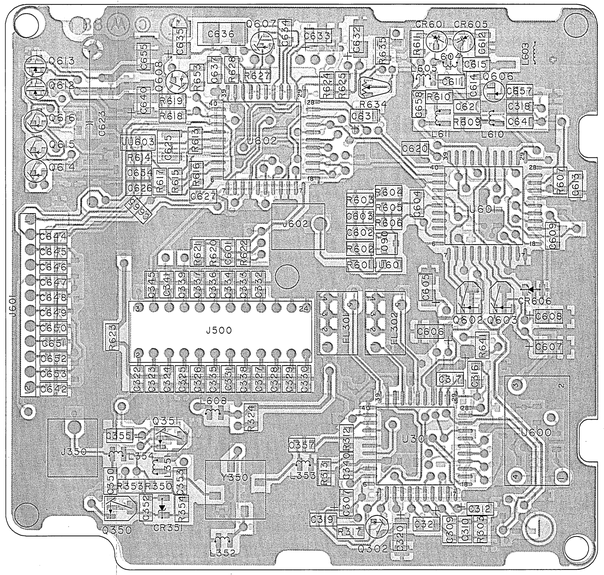
Schematic, Circuit Board Diagrams, and Parts List for HRN6005A *SPECTRA* RF Board
PW–5673–A
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HRN6005A RF CIRCUIT BOARD



SOLDER SIDE VIEW

SOLDER SIDE — GAW-4695-B
COMPONENT SIDE — GAW-4694-B
OVERLAY — GXW-4696W02-B



SOLDER SIDE — GAW-4695-B
COMPONENT SIDE — GAW-4694-B
OVERLAY — GXW-4696W01-B

COMPONENT SIDE VIEW

parts list

HRN6005A 900 MHz RF Board (12. 5 kHz Channel Spacing) MXW–5769–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C6302,6303	21–13741N69	0.1
C6304	21–13740B76	1500 pF, ±5%
C6307	21–13741N69	0.1
C6309	21–13741N69	0.1
C6311	21–13741N45	0.01
C6312	23–11049A37	1, ±20%, 25V, tantalum
C6313	21–13741N69	0.1
C6314	00–00000000	NOT USED
C6315	23–11049A35	0.47, ±20%, 25V
C6316	23–11049J04	2.2, ±20%, 20V
C6317	21–13740B39	39 pF
C6318	21–13740B01	1.0 pF, ±.25 pF
C6319	23–11049A37	1, ±20%, 25V, tantalum
C6320	23–11049J05	10, ±20%, 16V, tantalum
C6321	23–11049J04	2.2, ±20%, 20V, tantalum
C6322	21–13741N69	0.1
C6323	00–00000000	NOT USED
C6324	21–13741N69	0.1
C6325,6326	21–13740B49	100 pF, ±5%
C6327	21–13741N21	1000 pF
C6328	00–00000000	NOT USED
C6329	21–13741N69	0.1
C6330	21–13740B49	100 pF, ±5%
C6331	21–13740B65	470 pF, ±5%
C6332–6340	21–13740B49	100 pF, ±5%
C6341	00–00000000	NOT USED
C6343	21–13740B27	12 pF, ±5%
C6344	21–13740B65	470 pF, ±5%
C6345	21–13740B57	220 pF
C6346	21–13740B57	220 pF
C6347,6348	21–13740B65	470 pF, ±5%
C6350	21–13741N45	0.01
C6351	21–13741N69	0.1
C6352	21–13741N45	0.01
C6353	21–13740B15	3.9 pF, ±.25 pF
C6354	21–13741N69	0.1
C6355	23–11049J04	2.2, ±20%, 20V, tantalum
C6357	21–13740B21	6.8 pF, ±.5 pF
C6601	21–13740B34	24 pF, ±5%
C6602	00–00000000	NOT USED
C6603	00–00000000	NOT USED
C6604	21–13741N21	1000 pF
C6605	23–80090M06	10, ±20%, 16V
C6606,6607	23–11049J26	10, ±20%, 16V
C6608	23–80090M06	10, ±20%, 16V
C6609	21–13741N69	0.1
C6610	21–13741N45	0.01
C6611,6612	21–13741N69	0.1
C6613	21–13741N45	0.01
C6614	21–13740B31	18, ±5%
C6615	21–13740B39	39, ±5%
C6616	21–13741N45	0.01
C6617–4619	21–13741N69	0.1
C6620	21–13741N45	0.01
C6621	21–13740B25	10 pF, ±.5 pF
C6622	21–13741N21	1000 pF
C6623	08–80027B09	1.0, 100V
C6624	21–13741N45	0.01
C6625	21–13741D28	0.22
C6626–6629	21–13741N45	0.01
C6630	21–13740B76	1500 pF, ±5%
C6631	23–11049J07	3.3, 20V
C6632	23–80090M06	10, ±20%, 16V
C6633	23–11049J26	10, ±20%, 16V
C6634	21–13740B76	1500 pF, ±5%
C6635	23–80090M06	10, ±20%, 16V
C6636	00–00000000	NOT USED
C6637	21–13741N69	0.1
C6638	21–13741N45	0.01
C6639	21–13741N69	0.1
C6640	23–11049J26	10, ±20%, 16V
C6641	21–13740B01	1 pF, ±.25 pF
C6642	21–13741N69	0.1
C6643,6644	21–13740B49	100, ±5%
C6645	21–13741N69	0.1
C6646	21–13740B49	100, ±5%
C6647	21–13741N69	0.1
C6648	00–00000000	NOT USED
C6649	00–00000000	NOT USED
C6650	00–00000000	NOT USED
C6651–6653	21–13740B49	100, ±5%
C6654	21–13741N45	0.01
C6655	00–00000000	NOT USED
C6656	21–13741N69	0.1
C6657	21–13740B27	12 pF, ±5%
C6658	21–13741N45	0.01
C6659	21–13740B27	12 pF, ±5%
C6660	21–13741N69	0.1
C6661	00–00000000	NOT USED
C6662	00–00000000	NOT USED
C6663	00–00000000	NOT USED
C6664	21–13741N45	0.01
C6665	21–13740B27	12 pF, ±5%
diode (see note)		
CR6350	48–82958R91	zener, 15V
CR6351	48–82958R78	zener, 5.6V
CR6601	48–80066E09	varactor
CR6602,6603	48–82068M01	rectifier

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
CR6604	00–00000000	NOT USED
CR6605	48–80066E09	varactor
CR6606	48–82958R91	zener, 15V
fuse		
FL6301,6302	91–80297K03	ceramic, 450 kHz, 7.5 kHz bandwidth
connector receptacle		
J500	09–80104M01	receptacle bottom entry
J601	09–80103N02	sockets 12-position
J6350	09–80110M01	coax, PC board mount
J6602	09–80110M01	coax, PC board mount
jumper		
JU6301	00–00000000	NOT USED
JU6601–6603	06–11077A01	0
coil, RF		
L6351	24–80140E11	360 nH
L6352	24–80140E15	275 nH
L6353	24–80140E11	360 nH
L6354	24–80140E16	10 uH
L6603	24–80260N01	90 nH, 9 turns
L6604	24–80140E01	1.2 uH
L6605	24–80140E06	130 nH
L6606	24–80140E16	10 uH
L6610,6611	24–80140E01	1.2 uH
transistor (see note)		
Q6301	48–80182D48	PNP
Q6302	48–80141L01	PNP
Q6303	48–80141L02	NPN
Q6350	48–82971R01	NPN
Q6351	48–80052M01	NPN
Q6352	48–05128M66	JFET
Q6353	48–80048M01	NPN
Q6601	00–00000000	NOT USED
Q6602,6603	48–05128M27	PNP
Q6606	48–05128M66	JFET
Q6607	48–80182D48	PNP
Q6608	48–80141L01	PNP
Q6609,6610	48–80141L02	NPN
Q6612	00–00000000	NOT USED
Q6613	00–00000000	NOT USED
Q6614	00–00000000	NOT USED
Q6615	00–00000000	NOT USED
Q6616	00–00000000	NOT USED
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R6301	06–11077B23	100k
R6302	06–11077A68	560
R6303	06–11077B47	1 MEG
R6304	06–11077B23	100k
R6305	06–11077A01	0
R6306	06–11024H03	13k, ±1%
R6307	06–11077A09	4.7k
R6308	06–11077A98	10k
R6309	06–11077A62	330
R6310	06–11077B27	22k
R6311	06–11077A78	1.5k
R6312	06–11077A62	330
R6313	06–11077A78	1.5k
R6314,6315	06–11077A01	0
R6316	06–11077B11	33k
R6317	06–11077A50	100
R6318	06–11077A98	10k
R6323	06–11077A74	1k
R6324	06–11077A50	100
R6325	00–00000000	NOT USED
R6326,6327	06–11077A74	1k
R6328	06–11077B47	1 MEG
R6329	06–11077A01	0
R6350	06–11077A58	220
R6351	06–11077A36	27
R6353	06–11077A78	1.5k
R6354	06–11077A12	12
R6355	06–11077A98	10k
R6356	06–11077A52	120
R6357	06–11077A98	10k
R6601	00–00000000	NOT USED
R6602	00–00000000	NOT USED
R6603	00–00000000	NOT USED
R6604	00–00000000	NOT USED
R6605	00–00000000	NOT USED
R6606	00–00000000	NOT USED
R6607	06–11077A74	1k
R6608	06–11077A98	10k
R6609	06–11077A62	330
R6610	06–11077A43	51
R6611,6612	06–11077B31	220k
R6613	06–11077B11	33k
R6614	06–11077A09	4.7k
R6615	06–11077B47	1 MEG
R6616	06–11077A86	3.3k
R6617	06–11077B11	33k
R6618	06–11077A26	10
R6619	00–00000000	NOT USED
R6620	06–11077A74	1k
R6621	06–11077A94	6.8k
R6622	06–11077A74	1k
R6623	06–11077A26	10

900 MHz

MXW–5769–A (3)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R6624	06–11077A50	4.7k
R6625	06–11077A78	1.5k
R6626	06–11077B23	100k
R6627–6630	06–11077A78	1.5k
R6631	06–11077B47	1 MEG
R6632	00–00000000	NOT USED
R6633	06–11077B21	82k
R6634	18–80273N01	200k, potentiometer
R6635	06–11077B31	220k
R6637	06–11077B19	68k
R6638,6639	06–11077B31	220k
R6640	06–11077A98	10k
R6641	06–11077A43	51
R6642	06–11077A98	10k
R6643	00–00000000	NOT USED
JU6601–6603	06–11077A01	0
R6645	06–11077B47	1 MEG
R6646,6647	06–11077A98	10k
R6648	00–00000000	NOT USED
R6649	00–00000000	NOT USED
R6650	00–00000000	NOT USED
R6651	00–00000000	NOT USED
R6652	00–00000000	NOT USED
R6653	06–11077B11	33k
R6655	00–00000000	NOT USED
thermistor		
RT6630	00–00000000	NOT USED
integrated circuit (see note)		
U6301	51–83977M86	IF
U6500	51–80291B10	reference oscillator, 16.8 MHz 1PPM
U6600	51–80291B11	REF OSC X0N114AA 16.8MHZ 1PPM (after 12–31–89)
U6601	51–83977M77	prescaler
U6602	51–83977M79	synthesizer
crystal (see note)		
Y6350	91–80084M01	4 pole, 109.65 MHz

mechanical parts

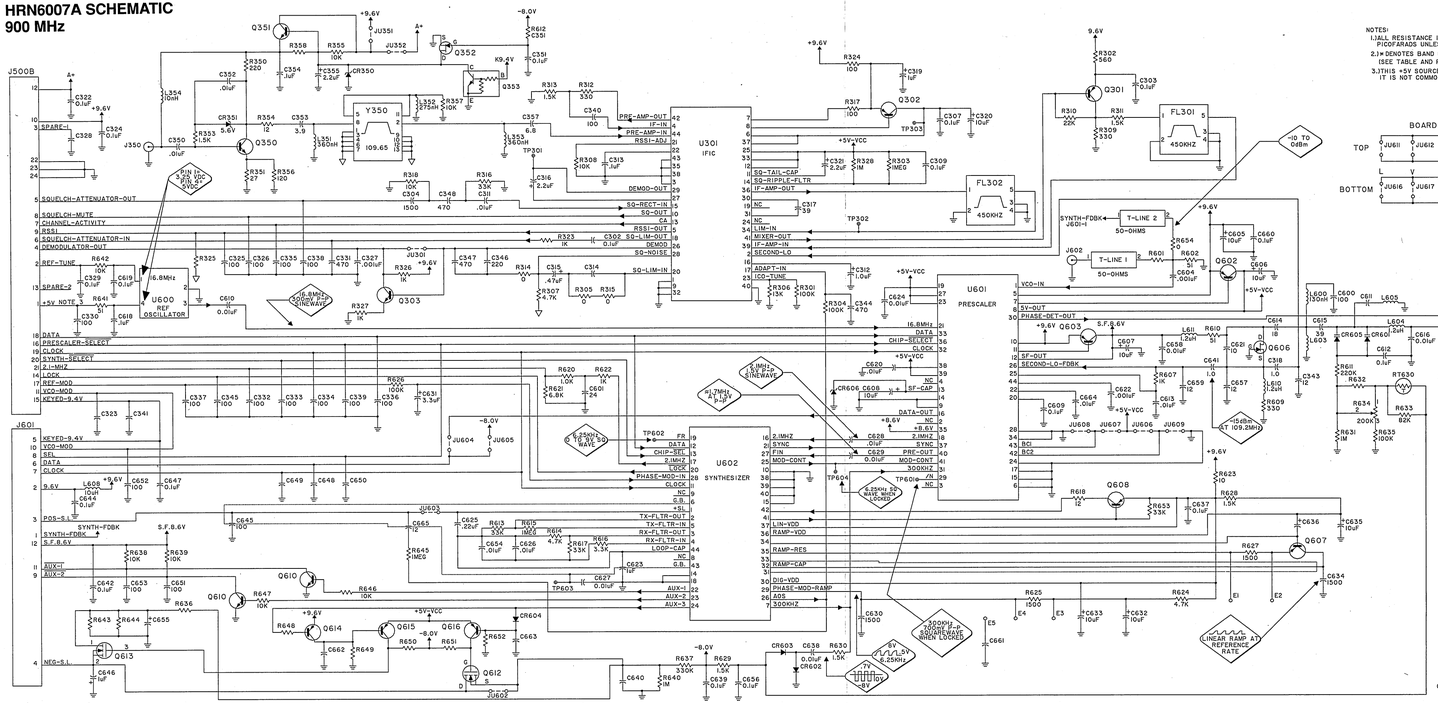
E6301	26–80003M02	shield, hight IF
E6302	26–80004M02	shield, output match
E6602	26–80006M01	shield, second VCO
MP6301	54–80004N01	barcode label
MP6601	75–80154M01	pad, reference oscillator

4/15/89

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

Schematic, Circuit Board Diagrams, and Parts List for HRN6005A *SPECTRA* RF Board
PW–5673–A
(Sheet 2 of 2)
4/25/89

HRN6007A SCHEMATIC
900 MHz



NOTES:
1. ALL RESISTANCE IN OHMS , ALL CAPACITANCE IN PICOFARADS UNLESS NOTED OTHERWISE.
2. /# DENOTES BAND DEPENDENT PART. (SEE TABLE AND PARTS LIST)
3. THIS +5V SOURCE ORIGINATES ON THE COMMAND BD. IT IS NOT COMMON TO ANY OTHER +5V SOURCE ON THIS BOARD.

Schematic, Circuit Board Diagrams, and
Parts List for HRN6007A *SPECTRA* RF Board
PW–6352–O
(Sheet 1 of 2)
4/25/89

parts list

HRN6007A 900 MHz RF Board (12.5kHz Channel Spacing) MXW–6357–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uf, ±10%, 50V (unless otherwise stated)		
C6302,6303	21–13741N69	0.1
C6304	21–13740B76	1500 pF, ±5%
C6307	21–13741N69	0.1
C6309	21–13741N69	0.1
C6311	21–13741N45	0.01
C6312	21–13741N69	0.1
C6314	00–00000000	NOT USED
C6315	23–11049A35	0.47, ±20%, 25V
C6316	23–11049J04	2.2, ±20%, 20V
C6317	21–13740B39	39 pF, ±5%
C6318	21–13740B01	1.0 pF, ±.25 pF
C6319	23–11049A37	1., ±20%, 16V
C6320	23–11049J26	10, ±20%, 16V
C6321	23–11049A38	2.2, ±20%, 20V
C6322	21–13741N69	0.1
C6323	00–00000000	NOT USED
C6324	21–13741N69	0.1
C6325&6326	21–13740B49	100 pF, ±5%
C6327	21–13741N21	1000 pF
C6328	00–00000000	NOT USED
C6329	21–13741N69	0.1
C6330	21–13740B49	100 pF, ±5%
C6331	21–13740B65	470 pF, ±5%
C6332&6340	21–13740B49	100 pF, ±5%
C6341	00–00000000	NOT USED
C6343	21–13740B27	12 pF, ±5%
C6344	21–13740B65	470 pF, ±5%
C6345	21–13740B49	100 pF, ±5%
C6346	21–13740B57	220 pF, ±5%
C6347&6348	21–13740B65	470 pF, ±5%
C6350	21–13741N45	0.01
C6351	21–13741N69	0.1
C6352	21–13741N45	0.01
C6353	21–13740B15	3.9 pF, ±.25 pF
C6354	21–13741N69	0.1
C6355	23–11049J04	2.2, ±20%, 20V
C6357	21–13740B21	6.8 pF, ±.25 pF
C6358	21–13740B49	100 pF, ±5%
C6601	21–13740B34	24 pF, ±5%
C6604	21–13741N21	1000 pF
C6605	23–80090M05	10, ±20%, 16V
C6606,6607	23–11049J26	10, ±20%, 16V
C6608	23–80090M06	10, ±20%, 16V
C6609	21–13741N69	0.1
C6610	21–13741N45	0.01
C6611	00–00000000	NOT USED
C6612	21–13741N69	0.1
C6613	21–13741N45	0.01
C6614	21–13740B31	18 pF, ±5%
C6615	21–13740B39	39 pF, ±5%
C6616	21–13741N45	0.01
C6617	21–13741N69	0.1
C6618,6619	21–13741N45	0.01
C6620	21–13741N45	0.01
C6621	21–13740B25	10 pF, ±5%
C6622	21–13741N21	1000 pF
C6623	08–80027B03	1.0, 100V
C6624	21–13741N45	0.01
C6625	21–13741D28	0.22
C6626–6629	21–13741N45	0.01
C6630	21–13740B76	1500 pF, ±5%
C6631	23–11049J07	3.3, 35V
C6632	23–80090M06	10, ±20%, 16V
C6633	23–11049J26	10, ±20%, 16V
C6634	21–13740B76	1500 pF, ±5%
C6635	23–80090M06	10, ±20%, 16
C6636	00–00000000	NOT USED
C6637	21–13741N69	0.1
C6638	21–13741N45	0.01
C6639	21–13741N69	0.1
C6640	00–00000000	NOT USED
C6641	21–13740B01	1.0, ±.25 pF
C6642	21–13741N69	0.1
C6644	21–13741N69	0.1
C6645	21–13740B49	100 pF, ±5%
C6646	23–11049A17	1., ±20%, 25V
C6647	21–13741N69	0.1
C6649–6650	00–00000000	NOT USED
C6651–6653	21–13740B49	100 pF, ±5%
C6654	21–13741N45	0.01
C6655	00–00000000	NOT USED
C6656	21–13741N69	0.1
C6657	21–13740B27	12 pF, ±5%
C6658	21–13741N45	0.01
C6659	21–13740B27	12 pF, ±5%
C6660	21–13741N69	0.1
C6662,6663	00–00000000	NOT USED
C6664	21–13741N45	0.01
C6665	21–13740B27	12 pF, ±5%
diode (see note)		
CR6350	48–82958R91	zener, 15V
CR6351	48–82958R78	zener, 5.6V
CR6601	48–80006E09	varactor
CR6602,6603	48–80066M01	rectifier
CR6604,6605	00–00000000	NOT USED
CR6606	48–82958R91	zener, 15V
fuse		
FL6301,6302	91–80297K03	ceramic 450 kHZ, 7.5 kHZ bandwidth

MXW–6357–A (2)

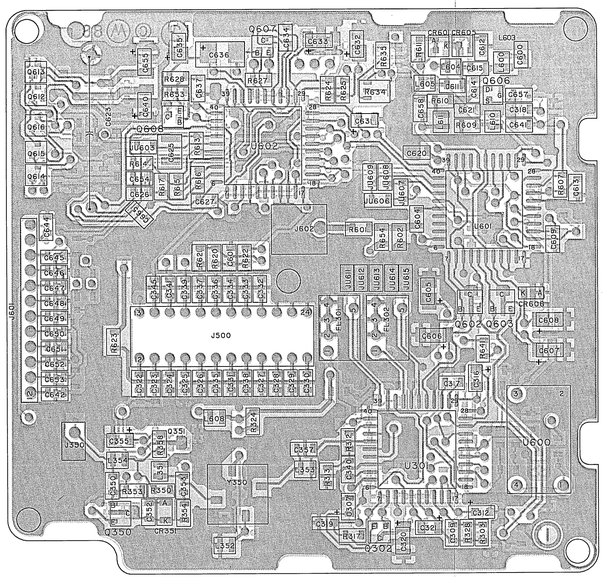
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
connector receptacle		
J500	09–80104M01	receptacle, bottom entry
J601	09–80103N02	socket, circuit board
J6350	09–80110M01	coax, PC board mount
J6602	00–00000000	NOT USED
connector receptacle		
J6301	00–00000000	NOT USED
J6351	00–00000000	NOT USED
J6352	09–11049A35	0.47, ±20%, 25V
J6602,6603	09–11077A01	2.2, ±20%, 20V
J6604,6605	00–00000000	NOT USED
J6606	00–00000000	NOT USED
J6607	09–11077A01	1., ±20%, 16V
J6608	09–11077A01	10, ±20%, 16V
J6609	09–11077A88	2.2, ±20%, 20V
J6610	09–11077A01	0 ohm
J6611–6614	00–00000000	NOT USED
J6615	09–11077A01	0 ohm
J6616–6619	00–00000000	NOT USED
J6620	09–11077A01	0 ohm
coil, RF		
L6351	24–80140E11	360 nH
L6352	24–80140E15	275 nH
L6353	24–80140E11	360 nH
L6354	24–80140E16	10 uH
L6600	24–80140E06	130 nH
L6603	00–00000000	NOT USED
L6604	24–80140E01	1.2 uH
L6605	00–00000000	NOT USED
L6608	24–80140E16	10 uH
L6610,6611	24–80140E01	1.2 UH
translator (see note)		
Q6301	48–80182D48	PNP
Q6302	48–80141L01	PNP
Q6303	48–80141L02	NPN
Q6304	48–80071R01	NPN
Q6305	48–80052M01	NPN
Q6351	48–05128M06	JFET
Q6352	48–80048M01	NPN
Q6602,6603	48–05128M27	PNP
Q6606	48–05128M06	JFET
Q6607	48–80182D48	PNP
Q6608	48–80141L01	PNP
Q6609,6610	48–80141L02	NPN
Q6612,6616	00–00000000	NOT USED
thermistor		
RT6630	00–00000000	NOT USED
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R6301	06–11077B23	100K
R6302	06–11077A49	560
R6303	06–11077B47	1 MEG
R6304	06–11077B23	100K
R6305	06–11077A01	0
R6306	06–11024H03	13K, ±1%
R6307	06–11077A90	4.7k
R6308	06–11077A98	10k
R6309	06–11077A65	330
R6310	06–11077B07	22k
R6311	06–11077A78	1.5k
R6312	06–11077A62	330
R6313	06–11077A78	1.5k
R6314,6315	06–11077A01	0
R6316	06–11077B31	33k
R6317	06–11077A50	100
R6318	06–11077A06	10k
R6323	06–11077A74	1k
R6324	06–11077A50	100
R6325	00–00000000	NOT USED
R6326,6327	06–11077A74	1k
R6328	06–11077B47	1 MEG
R6350	06–11077A06	220
R6351	06–11077A36	27
R6353	06–11077A78	1.5k
R6354	06–11077A28	12
R6355	06–11077A06	10k
R6356	06–11077A52	120
R6357	06–11077A98	10k
R6358	00–00000000	NOT USED
R6601	00–00000000	NOT USED
R6602	06–11077A43	51
R6607	06–11077A74	1k
R6608	06–11077A98	10k
R6609	06–11077A62	330
R6610	06–11077A43	51
R6611,6612	06–11077B31	220k
R6613	06–11077B11	33k
R6614	06–11077A90	4.7k
R6615	06–11077B47	1 MEG
R6616	06–11077A86	3.3k
R6617	06–11077B11	33k
R6618	06–11077A28	12
R6620	06–11077A74	1k
R6621	06–11077A94	6.8k
R6622	06–11077A74	1k
R6623	06–11077A26	10
R6624	06–11077A90	4.7k
R6625	06–11077A78	1.5k
R6626	06–11077B23	100k

MXW–6357–A (3)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R6627–6630	06–11077A78	1.5k
R6631	06–11077B47	1 MEG
R6632	00–00000000	NOT USED
R6633	06–11077B21	82k
R6634	18–80273N01	200k, potentiometer
R6635	06–11077B23	100k
R6636	00–00000000	NOT USED
R6637	06–11077B35	330k
R6638,6639	06–11077A98	10k
R6640	06–11077B47	1 MEG
R6641	06–11077A43	51
R6642	06–11077A98	10k
R6643,6644	00–00000000	NOT USED
R6645	06–11077B47	1 MEG
R6646,6647	06–11077A98	10k
R6648–6652	00–00000000	NOT USED
R6653	06–11077B31	33k
R6654	06–11077A01	0
R6661	00–00000000	NOT USED
thermistor		
RT6630	00–00000000	NOT USED
integrated circuit (see note)		
U6301	51–83977M86	IF
U6501	51–80291B11	ref oscillator, 16.8MHz 1PPM
U6601	51–83977M77	prescaler
U6602	51–83977M78	synthesizer
crystal (see note)		
Y6350	91–80084M01	4 pole, 109.65 MHz
mechanical parts		
E6301	26–80003M02	shield, high IF
E6302	26–80004M02	shield, output match
E6602	26–80008M01	shield, second VCO
MP6301	54–80004N01	barcode label
MP6601	75–80154M01	reference oscillator pad

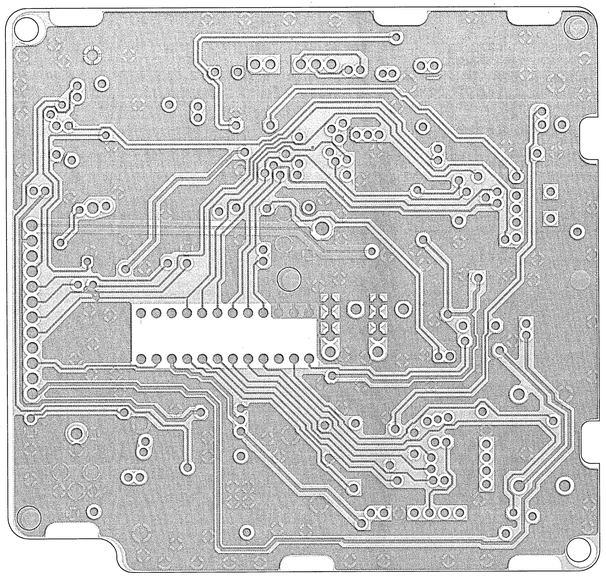
2/25/89

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



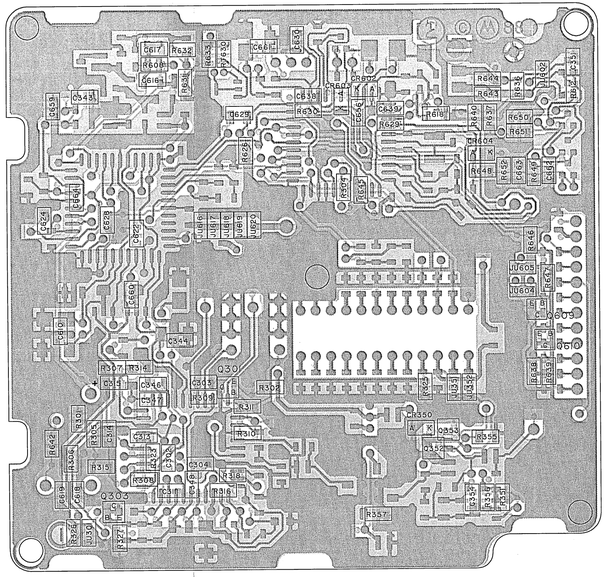
SOLDER SIDE GAW-6355-O
COMPONENT SIDE GAW-6354-O
OVERLAY GXW-6356W01-O

COMPONENT SIDE VIEW



LAYER 2 GAW-6432-O
LAYER 3 GAW-6433-O
OVERLAY GXW-6356W03-O

INNER LAYERS
(COMPONENT SIDE VIEW)

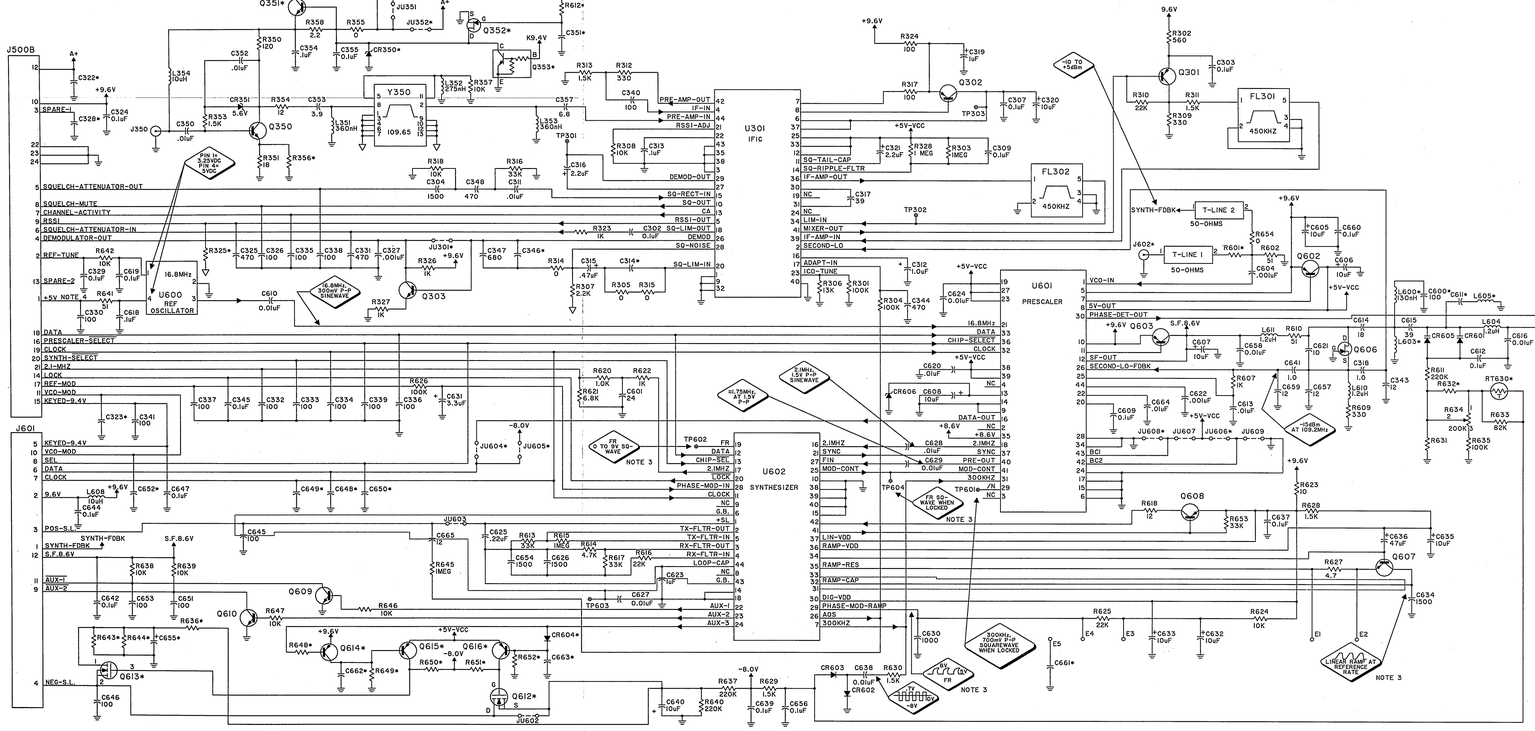


SOLDER SIDE GAW-6355-O
COMPONENT SIDE GAW-6354-O
OVERLAY GXW-6356W02-O

SOLDER SIDE VIEW

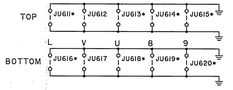
Schematic, Circuit Board Diagrams, and
Parts List for HRN6007A *SPECTRA* RF Board
PW–6352–O
(Sheet 2 of 2)
4/25/89

HRN6001A AND HRN6004A SCHEMATIC
VHF



NOTES:
1. ALL RESISTANCE IN OHMS , ALL CAPACITANCE IN PICOFARADS UNLESS NOTED OTHERWISE.
2. * NOT USED IN ALL APPLICATIONS. SEE TABLE AND PARTS LIST
3. REFERENCE FREQUENCY (FR) IS TYPICALLY 5.0KHz OR 6.25KHz.
4. THIS 5V SOURCE ORIGINATES ON THE COMMAND BOARD. IT IS NOT COMMON TO ANY OTHER 5V SOURCE ON THIS BOARD.

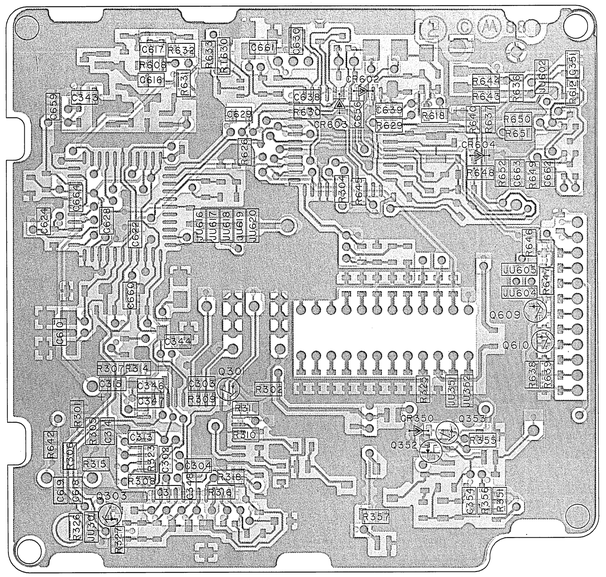
BOARD INDICATORS



GXW-5765-A

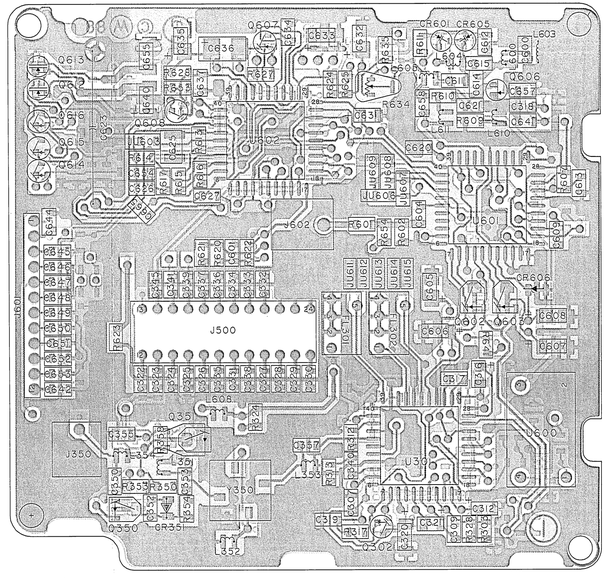
Schematic, Circuit Board Diagrams, and Parts List for HRN6001A and HRN6004A
SPECTRA RF Board
PW-5680-A
(Sheet 1 of 2)
4/25/89

HRN6001A AND HRN6004A RF CIRCUIT BOARD



SOLDER SIDE VIEW

SOLDER SIDE — GAW-5763-O
COMPONENT SIDE — GAW-5762-O
OVERLAY — GXW-5764W02-O



SOLDER SIDE — GAW-5763-O
COMPONENT SIDE — GAW-5762-O
OVERLAY — GXW-5764W01-O

COMPONENT SIDE VIEW

parts list

HRN6001A VHF RF Board 25 kHz Channel 5PPM
HRN6004A VHF RF Board 25 kHz Channel 2.5PPM

MXW-5766-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C6302,6303	21–13741N69	0.1
C6304	21–13740B76	1500 pF, ±5%
C6307	21–13741N69	0.1
C6309	21–13741N69	0.1
C6311	21–13741N45	0.01
C6312	23–11049A37	1., ±20%, 25V, tantalum
C6313	21–13741N69	0.1
C6314	00–00000000	NOT USED
C6315	23–11049A35	0.47, ±20%, 25V, tantalum
C6316	23–11049J04	2.2, ±20%, 20V, tantalum
C6317	21–13740B39	39 pF
C6318	21–13740B53	1.0 pF, ±.25 pF
C6319	23–11049A37	1., ±20%, 25V, tantalum
C6320	23–11049J26	10., ±20%, 16V, tantalum
C6321	23–11049J04	2.2, ±20%, 20V, tantalum
C6322,6623	00–00000000	NOT USED
C6324	21–13741N69	0.1
C6325	21–13741N55	470 pF, ±5%
C6326	21–13740B49	100 pF, ±5%
C6327	21–13741N21	1000 pF
C6328	00–00000000	NOT USED
C6329	21–13741N69	0.1
C6330	21–13740B49	100 pF, ±5%
C6331	21–13740B55	470 pF, ±5%
C6332–6341	21–13740B49	100 pF, ±5%
C6343	21–13740B27	12 pF, ±5%
C6344	21–13740B55	470 pF, ±5%
C6345	21–13741N69	0.1
C6346	00–00000000	NOT USED
C6347	21–13740B59	680 pF, ±5%
C6348	21–13740B65	470 pF, ±5%
C6350	21–13741N45	0.01
C6351	00–00000000	NOT USED
C6352	21–13741N45	0.01
C6353	21–13740B15	3.9 pF, ±.25 pF
C6354,6355	21–13741N69	0.1
C6357	21–13740B21	6.8 pF, ±.5 pF
C6360	21–13740B49	100 pF, ±5%
C6601	21–13740B34	24 pF, ±5%
C6604	21–13741N21	1000 pF
C6605	23–80090M06	10, ±20%, 16V
C6606,6607	23–11049J26	10., ±20%, 16V, tantalum
C6608	23–80090M06	10, ±20%, 16V
C6609	21–13741N69	0.1
C6610	21–13741N45	0.01
C6611	00–00000000	NOT USED
C6612	21–13741N69	0.1
C6613	21–13741N45	0.01
C6614	21–13740B31	18 pF
C6615	21–13740B39	39 pF, ±5%
C6616	21–13741N45	0.01
C6617–4619	21–13741N69	0.1
C6620	21–13741N45	0.01
C6621	21–13740B25	10 pF, ±.5 pF
C6622	21–13741N21	1000 pF
C6623	08–80027B09	1.0, 100V
C6624	21–13741N45	0.01
C6625	21–13741D28	0.22, 25V
C6626	21–13740B76	1500 pF, ±5%
C6627–6629	21–13741N45	0.01
C6630	21–13740B73	1000 pF, ±5%
C6631	23–11049J07	3.3, ±10%, 20V, tantalum
C6632	23–80090M06	10, ±20%, 16V
C6633	23–11049J26	10., ±20%, 16V
C6634	21–13740B76	1500 pF, ±5%
C6635	23–80090M06	10, ±20%, 16V
C6636	23–80090M07	47, ±20%, 16V
C6637	21–13741N69	0.1
C6638	21–13741N45	0.01
C6639	21–13741N69	0.1
C6640	23–11049J26	10., ±20%, 16V, tantalum
C6641	21–13740B01	1 pF, ±.25 pF
C6642	21–13741N69	0.1
C6644	21–13741N69	0.1
C6645,6646	21–13740B49	100 pF, ±5%
C6647	21–13741N69	0.1
C6648–6650	00–00000000	NOT USED
C6651	21–13740B49	100 pF, ±5%
C6652	00–00000000	NOT USED
C6653	21–13740B49	100 pF, ±5%
C6654	21–13740B76	1500 pF, ±5%
C6655	00–00000000	NOT USED
C6656	21–13741N69	0.1
C6657	21–13740B27	12 pF, ±5%
C6658	21–13741N45	0.01
C6659	21–13740B27	12 pF, ±5%
C6660	21–13741N69	0.1
C6661–6663	00–00000000	NOT USED
C6664	21–13741N45	0.01
C6665	21–13740B27	12 pF, ±5%
diode (see note)		
CR6350	00–00000000	NOT USED
CR6351	48–82958T78	zener, 5.6V
CR6601	48–80006E09	varactor
CR6602,6603	48–80066M01	rectifier
CR6604,6605	00–00000000	NOT USED
CR6606	48–82958T91	zener, 15V

MXW-5766-A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
fuse		
FL6301,6302	91–80297K05	ceramic, 450 kHz, 12 kHz bandwidth
connector receptacle		
J500	09–80104M01	receptacle bottom entry
J501	09–80102H02	sockets, 15–position
J6350	09–80110M01	coax, PC board mount receptacle
jumper		
J,6301	00–00000000	NOT USED
J,6351	08–11077A01	0
J,6352	00–00000000	NOT USED
J,6602,6603	08–11077A01	0
J,6603–6605	00–00000000	NOT USED
J,6607	08–11077A01	0
J,6608	00–00000000	NOT USED
J,6609	08–11077A01	0
J,6611	00–00000000	NOT USED
J,6612	08–11077A01	0
J,6613–6616	00–00000000	NOT USED
J,6617	08–11077A01	0
J,6618–6620	00–00000000	NOT USED
coil, RF		
L6351	24–80140E11	360 nH
L6352	24–80140E15	275 nH
L6353	24–80140E11	360 nH
L6354	24–80140E16	10 uH
L6355	24–80140E06	130 nH
L6603	00–00000000	NOT USED
L6604	24–80140E03	1.2 uH
L6605	00–00000000	NOT USED
L6609	24–80140E16	10 uH
L6610,6611	24–80140E01	1.2 uH
transistor (see note)		
Q6301	48–80182D48	PNP
Q6302	48–80141L01	PNP
Q6303	48–80141L02	NPN
Q6350	48–82971R01	NPN
Q6351–6353	00–00000000	NOT USED
Q6602,6603	48–05128M27	PNP, type 28M27, SOT89
Q6606	48–05128M66	JFET, type 28M66
Q6607	48–80182D48	PNP
Q6608	48–80141L01	PNP
Q6609,6610	48–80141L02	NPN
Q6612–6616	00–00000000	NOT USED
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R6301	00–11077B23	100k
R6302	08–11077A68	560
R6303	08–11077B47	1 MEG
R6304	08–11077B23	100k
R6305	08–11077A01	0
R6306	08–11082H03	13k, 1%
R6307	08–11077A52	2.2k
R6308	08–11077A98	10k
R6309	08–11077A62	330
R6310	08–11077B07	22k
R6311	08–11077A78	1.5k
R6312	08–11077A62	330
R6313	08–11077A78	1.5
R6314,6315	08–11077A01	0
R6316	08–11077B11	33k
R6317	08–11077A55	100
R6318	08–11077A98	10k
R6323	08–11077A74	1k
R6324	08–11077A50	100
R6325	00–00000000	NOT USED
R6326,6327	08–11077A74	1k
R6328	08–11077B47	1 MEG
R6350	08–11077A52	120
R6351	08–11077A32	18
R6353	08–11077A78	1.5k
R6354	08–11077A28	12
R6355	08–11077A01	0
R6356	00–00000000	NOT USED
R6357	08–11077A98	10k
R6358	08–11077A10	2.2
R6601	00–00000000	NOT USED
R6602	08–11077A43	51
R6607	08–11077A74	1k
R6608	08–11077A98	10k
R6609	08–11077A62	330
R6610	08–11077A43	51
R6611	08–11077B01	220k
R6612	00–00000000	NOT USED
R6613	08–11077B11	33k
R6614	08–11077A50	4.7k
R6615	08–11077B47	1 MEG
R6616	08–11077B07	22k
R6617	08–11077B11	33k
R6618	08–11077A28	12
R6620	08–11077A74	1k
R6621	08–11077A94	6.8k
R6622	08–11077A74	1k
R6623	08–11077A25	10
R6624	08–11077A98	10k
R6625	08–11077B07	22k
R6626	08–11077B23	100k
R6627	08–11077A90	4.7

MXW-5766-A (3)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R6628–6630	08–11077A78	1.5k
R6631	08–11077B47	1 MEG
R6632	00–00000000	NOT USED
R6633	08–11077B21	82k
R6634	18–80273N01	200k, potentiometer
R6635	08–11077B23	100k
R6636	00–00000000	NOT USED
R6637	08–11077B31	220k
R6638,6639	08–11077A98	10k
R6640	08–11077B31	220k
R6641	08–11077A43	51
R6642	08–11077A98	10k
R6643,6644	00–00000000	NOT USED
R6645	08–11077B47	1 MEG
R6646,6647	08–11077A98	10k
R6648–6652	00–00000000	NOT USED
R6653	08–11077B11	33k
R6654	08–11077A01	0
thermistor		
RT6630	00–00000000	NOT USED
integrated circuit (see note)		
U6500	51–80291B08	reference oscillator, 16.8 MHz, 5PPM (HRN6001A only)
U6600	51–80291B09	reference oscillator, 16.8 MHz, 2PPM (HRN6004A only)
U6301	51–83977M86	IF
U6601	51–83977M77	prescaler
U6602	51–83977M78	synthesizer
crystal (see note)		
Y6350	91–80084M01	4-pole, 109.65 MHz
mechanical parts		
E6301	26–80003M02	shield, high IF
E6302	26–80004M02	shield, output match
E6602	26–80006M01	shield, second VCO
MP6801	54–80004N01	barcode label
MP6001	75–80154M01	reference oscillator pad

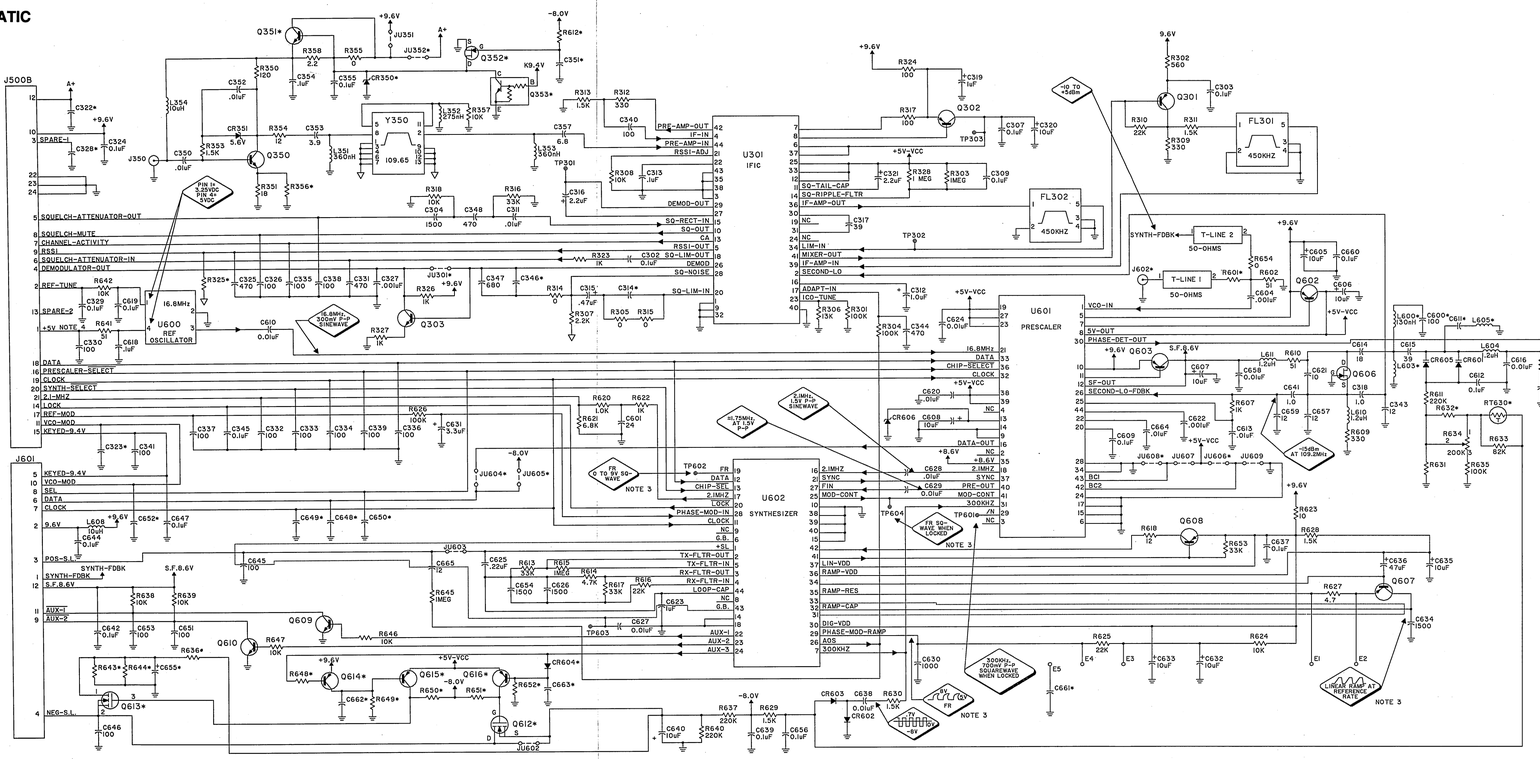
2/25/89

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

VHF

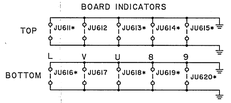
Schematic, Circuit Board Diagrams, and Parts List for HRN6001A and HRN6004A
SPECTRA Radio Board
PW–5680–A
(Sheet 2 of 2)
4/25/89

HRN6003A AND HRN6006A SCHEMATIC
UHF



NOTES:
1.) ALL RESISTANCE IN OHMS , ALL CAPACITANCE IN PICOFARADS UNLESS NOTED OTHERWISE.
2.) * NOT USED IN ALL APPLICATIONS. SEE TABLE AND PARTS LIST
3.) REFERENCE FREQUENCY (FR) IS TYPICALLY 5.0KHz OR 6.25KHz.
4.) THIS 5V SOURCE ORIGINATES ON THE COMMAND BOARD. IT IS NOT COMMON TO ANY OTHER 5V SOURCE ON THIS BOARD.

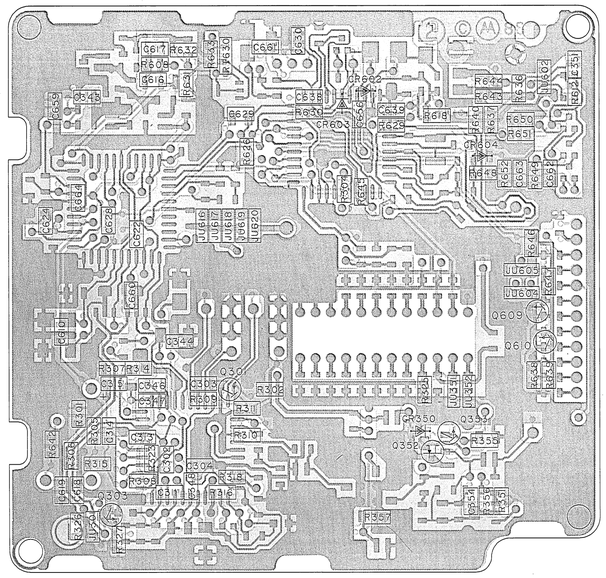
BOARD INDICATORS



GXW-5765-A

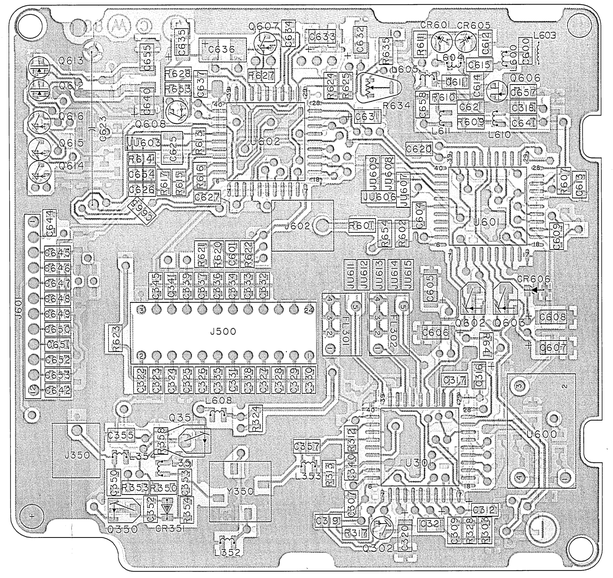
Schematic, Circuit Board Diagrams, and Parts List for HRN6003A and HRN6006A
SPECTRA RF Board
PW-5827-A
(Sheet 1 of 2)
4/25/89

HRN6003A AND HRN6006A RF CIRCUIT BOARD



SOLDER SIDE GAW-5763-O
COMPONENT SIDE GAW-5762-O
OVERLAY GXW-5764W02-O

SOLDER SIDE VIEW



SOLDER SIDE GAW-5763-O
COMPONENT SIDE GAW-5762-O
OVERLAY GXW-5764W01-O

COMPONENT SIDE VIEW

parts list

HRN6003A UHF RF Board 25kHz 5PPM
HRN6006A UHF RF Board 25kHz 2PPM MXW–5828–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C6302,6303	21–13741N69	0.1
C6304	21–13740B76	1500 pF, ±5%
C6307,6309	21–13741N69	0.1
C6311	21–13741N45	0.01
C6312	23–11040A47	1., ±20%, 25V, tantalum
C6313	21–13741N69	0.1
C6314	00–00000000	NOT USED
C6315	23–11040A35	0.47, ±20%, 25V, tantalum
C6316	23–11040L24	2.2, ±20%, 20V, tantalum
C6317	21–13740B39	39 pF, ±5%
C6318	21–13740B01	1.0 pF, ±.25 pF
C6319	23–11040A37	1., ±20%, 25V, tantalum
C6320	23–11040L24	10., ±20%, 16V, tantalum
C6321	23–11040J04	2.2, ±20%, 20V, tantalum
C6322	21–13741N69	0.1
C6323	00–00000000	NOT USED
C6324	21–13741N69	0.1
C6325,6326	21–13740B49	100 pF, ±5%
C6327	21–13741N21	1000 pF, ±5%
C6328	00–00000000	NOT USED
C6329	21–13741N69	0.1
C6330	21–13740B49	100 pF, ±5%
C6331	21–13740B65	470 pF, ±5%
C6332–6340	21–13740B49	100 pF, ±5%
C6341	00–00000000	NOT USED
C6343	21–13740B27	12 pF, ±5%
C6344	21–13740B65	470 pF, ±5%
C6345	21–13740B49	100 pF, ±5%
C6347	21–13740B69	680 pF, ±5%
C6348	21–13740B65	470 pF, ±5%
C6350	21–13741N45	0.01
C6351	21–13741N69	0.1
C6352	21–13741N45	0.01
C6353	21–13740B15	3.9, ±.25 pF
C6354	21–13741N69	0.1
C6355	23–11040J04	2.2, ±20%, 20V, tantalum
C6357	21–13740B51	6.8, ±.5 pF
C6600	21–13740B49	100 pF, ±5%
C6601	21–13740B34	24 pF, ±5%
C6604	21–13741N21	1000 pF, ±5%
C6605	23–80060M06	10uF, electrolytic
C6606,6607	23–11040J26	10uF, ±20%, 16V, tantalum
C6608	23–80060M06	10uF, electrolytic
C6609	21–13741N69	0.1
C6610	21–13741N45	0.01
C6611	00–00000000	NOT USED
C6612	21–13741N69	0.1
C6613	21–13741N45	0.01
C6614	21–13740B31	18 pF
C6615	21–13740B39	39 pF, ±5%
C6616	21–13741N45	0.01
C6617–6619	21–13741N69	0.1
C6620	21–13741N45	0.01
C6621	21–13740B25	10 pF, ±.5 pF
C6622	21–13741N21	1000 pF, ±5%
C6623	08–80027B09	1.0, 100V
C6624	21–13741N45	0.01
C6625	21–13741D39	0.22, 25V
C6626	21–13741K07	4700 pF
C6627–6629	21–13741N45	0.01
C6630	21–13740B73	1000 pF, ±5%
C6631	23–11040J07	3.3, ±10%, 20V, tantalum
C6632	23–80060M06	10uF, electrolytic
C6633	23–11040J26	10., ±20%, 16V, tantalum
C6634	21–13740B76	1500 pF, ±5%
C6635	23–80060M05	10uF, electrolytic
C6636	23–80060M07	47., ±20%, 16V
C6637	21–13741N69	0.1
C6638	21–13741N45	0.01
C6639	21–13741N69	0.1
C6640	23–11040L26	10., ±20%, 16V, tantalum
C6641	21–13740B01	1 pF, ±.25 pF
C6642	21–13741N69	0.1
C6644	21–13741N69	0.1
C6645	21–13740B49	100 pF, ±5%
C6646	21–13740B49	100 pF, ±5%
C6647	21–13741N69	0.1
C6648–6650	00–00000000	NOT USED
C6651–6653	21–13740B49	100 pF, ±5%
C6654,6655	00–00000000	NOT USED
C6656	21–13741N69	0.1
C6657	21–13740B27	12 pF, ±5%
C6658	21–13741N45	0.01
C6659	21–13740B27	12 pF, ±5%
C6660	21–13741N69	0.1
C6661–6663	00–00000000	NOT USED
C6664	21–13741N45	0.01
C6665	21–13740B27	12 pF, ±5%
diode (see note)		
CR6350	48–82958R91	zener, 15V
CR6351	48–82958R78	zener, 5.6V
CR6501	48–80058E09	varactor
CR6502,6603	48–80066M01	rectifier
CR6604,6605	00–00000000	NOT USED
CR6606	48–82958R91	zener, 15V
fuse		
FL6301,6302	91–80297K05	ceramic, 450 kHz, 12 kHz bandwidth

MXW–5828–A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
connector receptacle		
J500	09–80104M01	receptacle, bottom entry
J6302		
J6350	09–80212N01	receptacle, coax, PC board mount
J6501	09–80103N02	sockets, 12 position
jumper		
JU6301	00–00000000	NOT USED
JU6351	00–00000000	NOT USED
JU6352	08–11077A01	0
JU6602	08–11077A01	0
JU6603	08–11077A01	0
JU6604	00–00000000	NOT USED
JU6605,6606	08–11077A01	0
JU6607	00–00000000	NOT USED
JU6608	08–11077A01	0
JU6609	00–00000000	NOT USED
JU6611,6612	00–00000000	NOT USED
JU6613	08–11077A01	0
JU6614–6617	00–00000000	NOT USED
JU6618	08–11077A01	0
JU6619,6620	00–00000000	NOT USED
coil, RF		
L6351	24–80140E11	360 nH
L6352	24–80140E15	275 nH
L6353	24–80140E11	360 nH
L6354	24–80140E16	10 uH
L6600	24–80140D56	130 nH
L6603	00–00000000	NOT USED
L6604	24–80140E01	1.2 uH
L6605	00–00000000	NOT USED
L6608	24–80140E15	10 uH
L6610,6611	24–80140E01	1.2 uH
transistor (see note)		
Q6301	48–80182D48	PNP
Q6302	48–80141L01	PNP
Q6303	48–80141L02	NPN
Q6350	48–82971R01	NPN
Q6351	48–80052M01	NPN
Q6352	48–05128M66	JFET
Q6353	48–80048M01	NPN
Q6502,6603	48–05128M27	PNP
Q6606	48–05128M66	JFET
Q6607	48–80214D48	PNP
Q6608	48–80141L01	PNP
Q6609,6610	48–80141L02	NPN
Q6612–6616	00–00000000	NOT USED
thermistor		
RT6630	00–00000000	NOT USED
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R6301	08–11077B23	100k
R6302	08–11077A68	560
R6303	08–11077B47	1 MEG
R6304	08–11077B23	100k
R6305	08–11077A01	0
R6306	08–11024H03	13k
R6307	08–11077A82	2.2k
R6308	08–11077A58	10k
R6309	08–11077A62	330
R6310	08–11077B07	22k
R6311	08–11077A78	1.5k
R6312	08–11077A62	330
R6313	08–11077A78	1.5k
R6314,6315	08–11077A01	0
R6316	08–11077B11	33k
R6317	08–11077A50	100
R6318	08–11077A58	10k
R6323	08–11077A74	1k
R6324	08–11077A50	100
R6325	00–00000000	NOT USED
R6326,6327	08–11077A74	1k
R6328	08–11077B47	1 MEG
R6350	08–11077A56	220
R6351	08–11077A36	27
R6353	08–11077A78	1.5k
R6354	08–11077A28	12
R6355	08–11077A58	10k
R6356	08–11077A52	120
R6357	08–11077A58	10k
R6358	00–00000000	NOT USED
R6501	00–00000000	NOT USED
R6601	08–11077A43	51
R6607	08–11077A74	1k
R6608	08–11077A58	10k
R6609	08–11077A62	330
R6610	08–11077A43	51
R6611,6612	08–11077B31	220k
R6613	08–11077B11	33k
R6614	08–11077A70	4.7k
R6615	08–11077B47	1 MEG
R6616	08–11077B01	12k
R6617	08–11077B11	33k
R6618	08–11077A28	12
R6620	08–11077A74	1k
R6621	08–11077A84	6.8k
R6622	08–11077A74	1k
R6623	08–11077A26	10

UHF

MXW–5828–A (3)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R6624	08–11077A90	4.7k
R6625	08–11077A94	6.8k
R6626	08–11077B23	100k
R6627	08–11077A82	2.2k
R6628–6630	08–11077A78	1.5k
R6631	08–11077B47	1 MEG
R6632	00–00000000	NOT USED
R6633	08–11077B31	220k
R6634	18–80273N01	200k potentiometer
R6635	08–11077B23	100k
R6636	00–00000000	NOT USED
R6637	08–11077B31	220k
R6638,6639	08–11077A98	10k
R6640	08–11077B31	220k
R6641	08–11077A43	51
R6642	08–11077A98	10k
R6643,6644	00–00000000	NOT USED
R6645	08–11077B47	1 MEG
R6646	08–11077A98	10k
R6647	08–11077A98	10k
R664–6652	00–00000000	NOT USED
R6653	08–11077B11	33k
R6654	08–11077A01	0
thermistor		
RT6630	00–00000000	NOT USED
integrated circuit (see note)		
U6301	51–83977M86	IF
U6600	51–80291B08	reference oscillator 5PPM (HRN6003A)
U6600	51–80291B09	reference oscillator 2PPM (HRN6006A)
U6601	51–83977M77	prescaler
U6602	51–83977M78	synthesizer
crystal (see note)		
Y6350	91–80084M01	4–pole, 109.65 Mhz

mechanical parts

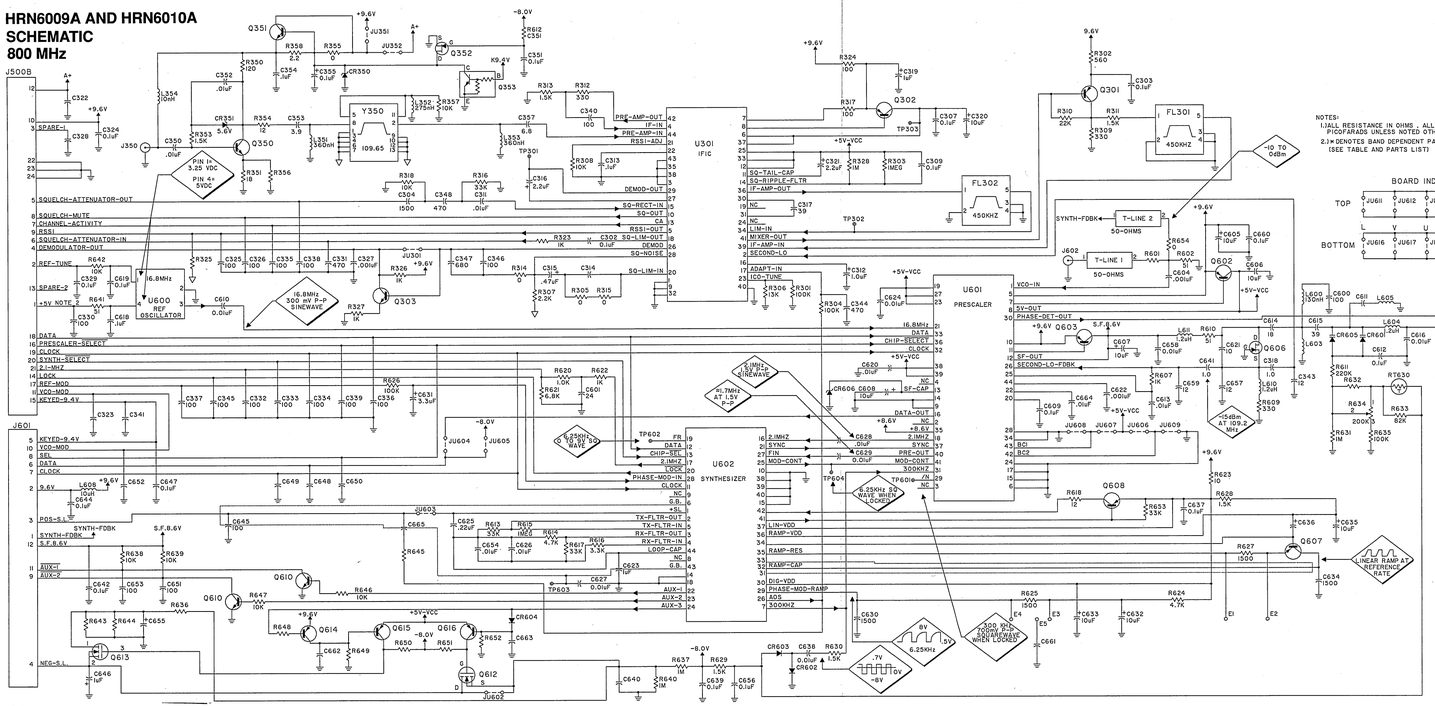
E6301	26–80003M02	shield, high IF
E6302	26–80004M02	shield, output match
E6603	26–80006M01	shield, second VCO
MP6301	54–80004N01	barcode label
MP6501	75–80154N01	pad, reference oscillator

2/25/89

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

Schematic, Circuit Board Diagrams, and Parts List for HRN6003A and HRN6006A *SPECTRA* RF Board
PW–5827–A
(Sheet 2 of 2)
4/25/89

HRN6009A AND HRN6010A SCHEMATIC 800 MHz



Schematic, Circuit Board Diagrams, and Parts List for HRN6009A and HRN6010A *SPECTRA* RF Board
PW-6359-O
(Sheet 1 of 2)
4/25/89

parts list

HRN6009A 800 MHz RF Board
HRN6010A 800 MHz RF Board

MXW-6358-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C6302,6303	21-13741N69	0.1
C6304	21-13740D76	1500 pF, ±5%
C6307	21-13741N69	0.1
C6309	21-13741N69	0.1
C6311	21-13741N45	0.01
C6312	23-11049J37	1, ±20%, 25V
C6313	21-13741N69	0.1
C6314	21-00000000	NOT USED
C6315	23-11049A35	0.47, ±20%, 25V
C6316	23-11049J04	2.2, ±20%, 20V
C6317	21-13740B39	39 pF, ±5%
C6318	21-13740B01	1.0 pF, ±.25 pF
C6319	23-11049A37	1, ±20%, 25V
C6320	23-11049J29	10, ±20%, 16V
C6321	23-11049J04	2.2, ±20%, 20V
C6322,6323	00-00000000	NOT USED
C6324	21-13741N69	0.1
C6325	21-13740B49	100 pF, ±5%
C6326	21-13740B49	100 pF, ±5%
C6327	21-13741N21	1000 pF
C6328	00-00000000	NOT USED
C6329	21-13741N69	0.1
C6330	21-13740B49	100 pF, ±5%
C6331	21-13740B55	470 pF, ±5%
C6332-6340	21-13740B49	100 pF, ±5%
C6343	21-13740B27	12 pF, ±5%
C6344	21-13740B55	470 pF, ±5%
C6345	21-13740B49	100 pF, ±5%
C6346	21-13740B49	100 pF, ±5%
C6347	21-13740B69	680 pF, ±5%
C6348	21-13740B65	470 pF, ±5%
C6350	21-13741N45	0.01
C6351	00-00000000	NOT USED
C6352	21-13741N45	0.01
C6353	21-13740B15	3.9 pF, ±.25 pF
C6354	21-13741N69	0.1
C6357	21-13740B21	6.8 pF, ±.25 pF
C6500	21-13740B49	100 pF, ±5%
C6601	21-13740B34	24 pF, ±5%
C6604	21-13741N21	1000 pF
C6605	23-80090M06	10, ±20%, 16V
C6606,6607	23-11049J29	10, ±20%, 16V
C6608	23-80090M06	10, ±20%, 16V
C6609	21-13741N69	0.1
C6610	21-13741N45	0.01
C6611	00-00000000	NOT USED
C6612	21-13741N69	0.1
C6613	21-13741N45	0.01
C6614	21-13740B31	18 pF, ±5%
C6615	21-13740B39	39 pF, ±5%
C6616	21-13741N45	0.01
C6617-6619	21-13741N69	0.1
C6620	21-13741N45	0.01
C6621	21-13740B25	10 pF, ±5%
C6622	21-13741N21	1000 pF
C6623	08-80027B10	4.7, 10V
C6624	21-13741N45	0.01
C6625	21-13741D28	0.22
C6626	21-13741N45	.01
C6627-6629	21-13741N45	0.01
C6630	21-13740D76	1500 pF, ±5%
C6631	23-11049J07	3.3, 50V
C6632	23-80090M06	10, ±20%, 16V
C6633	23-11049J26	10, ±20%, 16V
C6634	21-13740D76	1000 pF, ±5%
C6635	23-80090M06	10, ±20%, 16V
C6636	23-80090M07	47, ±20%, 16V
C6637	21-13741N69	0.1
C6638	21-13741N45	0.01
C6639	21-13741N69	0.1
C6640	00-00000000	NOT USED
C6641	21-13740B01	1.0 pF, ±.25 pF
C6642	21-13741N69	0.1
C6644	21-13741N69	0.1
C6645	21-13740B49	100 pF, ±5%
C6646	23-11049A37	1, ±20%, 25V
C6647	21-13741N69	0.1
C6648-6650	00-00000000	NOT USED
C6651	21-13740B49	100 pF, ±5%
C6652	00-00000000	NOT USED
C6653	21-13740B49	100 pF, ±5%
C6654	21-13741N45	.01
C6655	00-00000000	NOT USED
C6656	21-13741N69	0.1
C6657	21-13740B27	12 pF, ±5%
C6658	21-13741N45	0.01
C6659	21-13740B27	12 pF, ±5%
C6660	21-13741N69	0.1
C6661-6663	00-00000000	NOT USED

MXW-6358-A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C6664	21-13741N45	0.01
C6665	00-00000000	NOT USED
diode (see note)		
CR6350	00-00000000	NOT USED
CR6351	48-82858R78	zener, 5.6V
CR6601	48-00000A01	varactor
CR6602,6603	48-80668M01	rectifier
CR6604,6605	00-00000000	NOT USED
CR6606	48-82858R92	zener, 15V
fuse		
FL6201	91-80297K03	ceramic, 450 kHz 7.5 kHz
FL6302	91-80297K05	ceramic, 450 kHz 12 kHz
connector receptacle		
J500	09-80104M01	receptacle, bottom entry
J601	09-80103N02	sockets, 12 position
J6350	09-80312N01	coax, PC board mount
J6602	00-00000000	NOT USED
jumper		
JU6301	00-00000000	NOT USED
JU6302	06-11077A01	0 ohm
JU6351	06-11077B47	1 MEG
JU6352,6603	06-11077A01	0 ohm
JU6604	00-00000000	NOT USED
JU6605	06-11077A01	0 ohm
JU6606	00-00000000	NOT USED
JU6607	06-11077A01	0 ohm
JU6608	00-00000000	NOT USED
JU6609	06-11077A01	0 ohm
JU6611-6613	00-00000000	NOT USED
JU6614	06-11077A43	51
JU6615-6618	00-00000000	NOT USED
JU6619	06-11077A01	0 ohm
JU6620	00-00000000	NOT USED
coil, RF		
L6351	24-80140E11	360 nH
L6352	24-80140E15	375 nH
L6353	24-80140E11	360 nH
L6354	24-80140E16	10 uH
L6600	24-80140E06	130 nH
L6603	00-00000000	NOT USED
L6604	24-80140E01	1.2 uH
L6605	00-00000000	NOT USED
L6608	24-80140E11	360 nH
L6610,6611	24-80140E01	1.2 uH
transistor (see note)		
Q6301	48-80182D48	PNP
Q6302	48-80141L01	PNP
Q6303	48-80141L02	NPN
Q6304	48-82071R01	PNP
Q6351-6353	00-00000000	NOT USED
Q6600,6603	48-85128M07	FET
Q6606	48-85128M66	JFET
Q6607	48-80182D48	PNP
Q6608	48-80141L01	PNP
Q6609,6610	48-80141L02	NPN
Q6612-6616	00-00000000	NOT USED
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R6301	06-11077B23	100k
R6302	06-11077A68	560
R6303	06-11077B47	1 MEG
R6304	06-11077B23	100k
R6305	06-11077A01	0
R6306	06-11024H03	13k, ±1%
R6307	06-11077A62	2.2k
R6308	06-11077A98	10k
R6309	06-11077A62	330
R6310	06-11077B07	22k
R6311	06-11077A78	1.5k
R6312	06-11077A62	330
R6313	06-11077A78	1.5k
R6314,6315	06-11077A01	0
R6316	06-11077B11	33k
R6317	06-11077A50	100
R6318	06-11077A98	10k
R6323	06-11077A74	1k
R6324	06-11077A50	100
R6325	00-00000000	NOT USED
R6326,6327	06-11077A74	1k
R6328	06-11077B47	1 MEG
R6350	06-11077A52	120
R6351	06-11077A32	18
R6353	06-11077A78	1.5k
R6354	06-11077A28	12
R6355	06-11077A01	0
R6356	00-00000000	NOT USED
R6357	06-11077A98	10k
R6358	06-11077A10	2.2

MXW-6358-A (3)

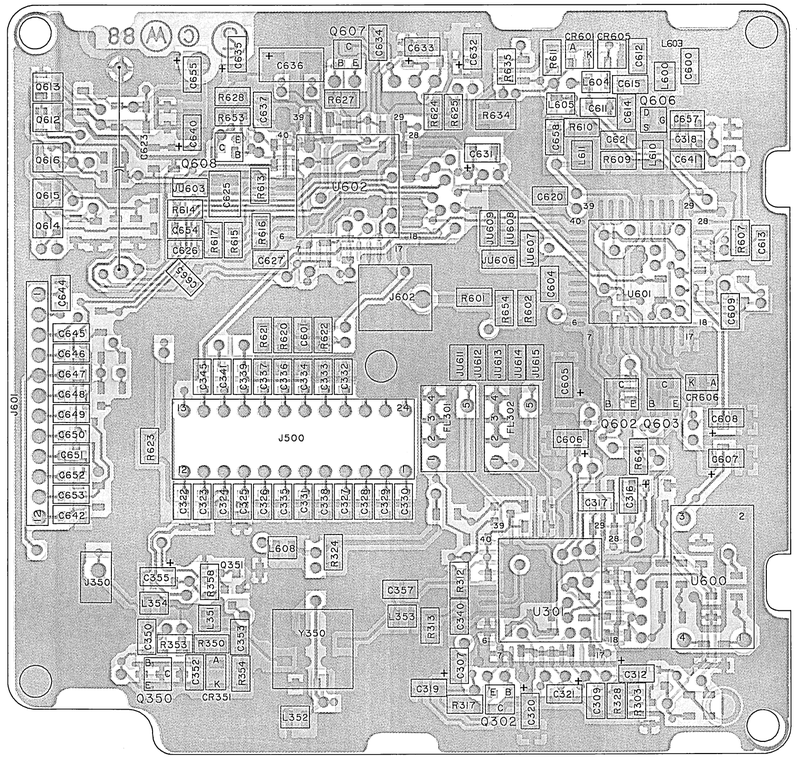
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R6601	00-00000000	NOT USED
R6602	06-11077A43	51
R6607	06-11077A74	1k
R6608	06-11077A98	10k
R6609	06-11077A62	330
R6610	06-11077A43	51
R6611	06-11077B31	220K
R6612	00-00000000	NOT USED
R6613	06-11077B11	33k
R6614	06-11077B49	4.7k
R6615	06-11077B47	1 MEG
R6616	06-11077A86	3.3k
R6617	06-11077B11	33k
R6618	06-11077A98	10k
R6620	06-11077A74	1k
R6621	06-11077A86	3.3k
R6622	06-11077A74	1k
R6623	06-11077A98	10
R6624	06-11077A90	4.7k
R6625	06-11077A78	1.5k
R6626	06-11077B23	100k
R6627-6630	06-11077A78	1.5k
R6631	06-11077B47	1 MEG
R6632	06-11077A01	0 ohm
R6633	06-11077B21	82k
R6634	18-80027A03	200k, potentiometer
R6635	06-11077B23	100k
R6636	06-11077A01	0 ohm
R6637	06-11077B47	1 MEG
R6638,6639	06-11077A98	10K
R6640	06-11077B47	1 MEG
R6641	06-11077A43	51
R6642	06-11077A98	10k
R6643,6644	06-20000000	NOT USED
R6646,6647	06-11077A98	10k
R6648-6652	06-20000000	NOT USED
R6653	06-11077B11	33k
R6654	06-11077A01	0
thermistor		
RT6630	00-00000000	NOT USED
integrated circuit (see note)		
U600	51-80291B10	reference oscillator 16.8 MHz, 1PPM (HRN6009A only)
U600	51-80291B09	reference oscillator 16.8 MHz, 2PPM (HRN6010A only)
U6301	51-83977M85	if
U6601	51-83977M77	prescaler
U6602	51-83977M78	synthesizer
crystal (see note)		
Y6350	91-80084M01	4-pole, 109.65 MHz

mechanical parts

E6301	26-80003M02	shield, high IF
E6302	26-80004M02	shield, output match
E6602	26-80006M01	shield, second VCO
MP6301	54-80004N01	barcode label
MP6601	75-80154M01	reference oscillator pad

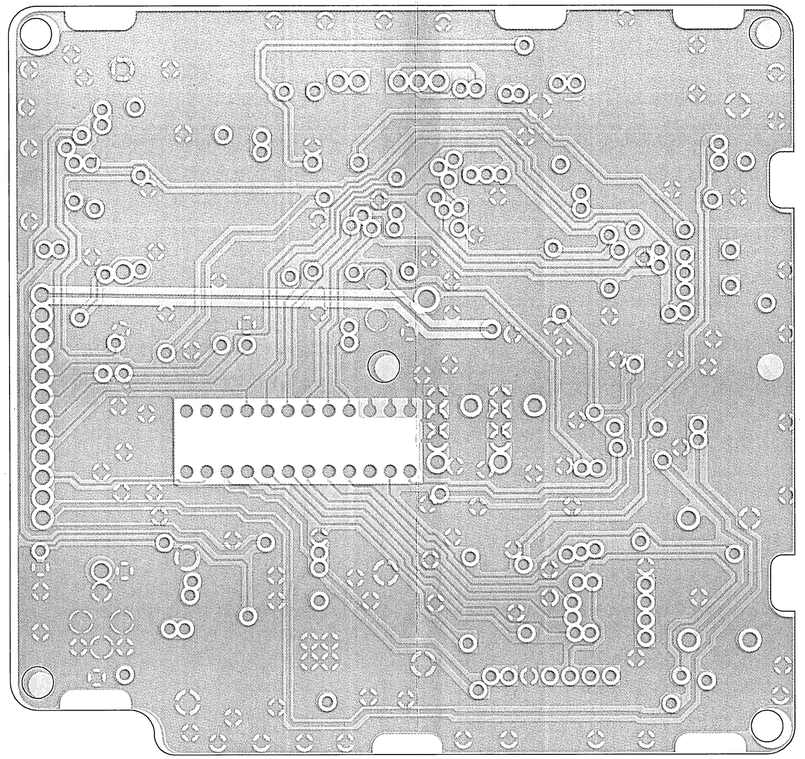
2/25/89

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



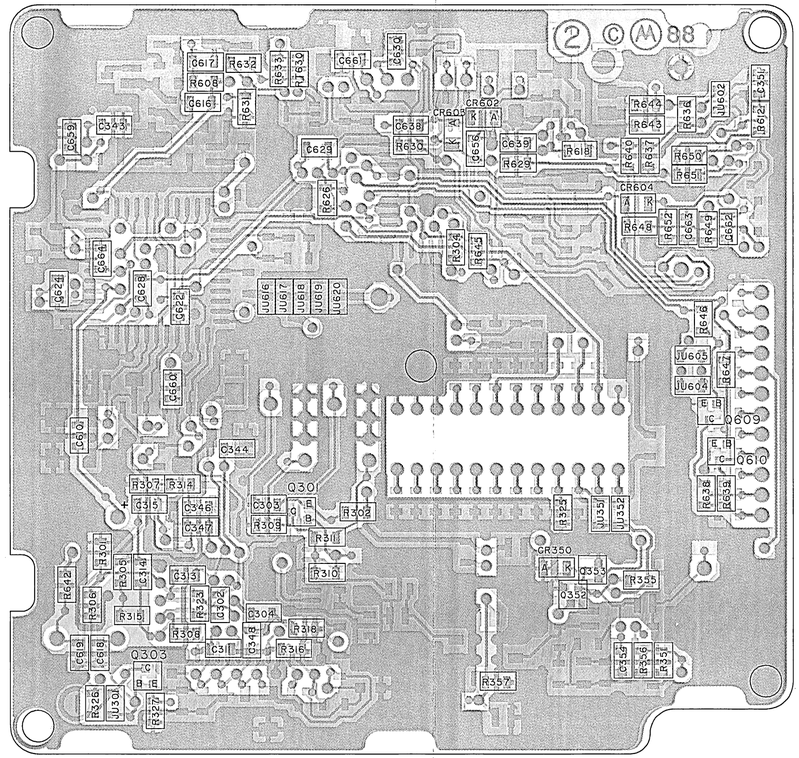
SOLDER SIDE — GAW-6355-O
COMPONENT SIDE — GAW-6354-O
OVERLAY — GXW-6356W01-O

COMPONENT SIDE VIEW



LAYER 2 — GAW-6432-O
LAYER 3 — GAW-6433-O
OVERLAY — GXW-6356W03-O

INNER LAYERS
(COMPONENT SIDE VIEW)



SOLDER SIDE — GAW-6355-O
COMPONENT SIDE — GAW-6354-O
OVERLAY — GXW-6356W02-O

SOLDER SIDE VIEW

Schematic, Circuit Board Diagrams, and Parts List for HRN6009A and HRN6010A *SPECTRA* RF Board
PW-6359-O
(Sheet 2 of 2)
4/25/89

1. Description

The control section of the command board consists of the following integrated circuits and attached kits:

- U520 Microcomputer IC (MC68HC11A1)
- U521 Support Log IC (SLIC)
- U522 Serial Input/Output IC (SIOIC)
- U500 Regulator/Power Control IC (RPCIC)
- Memory Board
- *HearClear* Board (900 MHz only)
- Control Head

The microcomputer controls all functions of the radio with either direct logic control or a serial communications path to the device. Functions controlled include audio levels, signalling, receive/transmit frequencies, power levels, etc.

2. Theory of Operation

2.1 MICROCOMPUTER IC, SUPPORT LOGIC IC, AND MEMORY BOARD

The microcomputer executes a program stored in PROM on the memory board, which also contains an EEPROM for long term variable parameters and an SRAM for system–stack and scratch–pad operations. Data is transferred to and from the memory board via the microcomputer data bus (U520, Pins 9 through 16). The memory location from which data is read, or to which data is written, is selected via the address lines. The upper eight address lines (U520, Pins 35 through 42) are applied directly from the microcomputer to the memory board while the lower address lines are latched by the Support Logic IC (U521) and then applied via U521 (Pins 4, 5, 51, 53, 55, 63, 65, and 66) to the memory board.

The lower address is multiplexed onto the data bus and latched into the SLIC (U521, Pins 17, 19, 21, 23, 28, 30, 31, and 32) via the address strobe (AS) line from the microcomputer (U520), Pin 4). The upper address lines are also applied to the SLIC (U521, Pins 3, 36, 37, 45, 46, 58, 59, and 68) for device decoding. The SLIC determines which device is requested and applies a logic low to the memory board on Pin 13, 14, or 15 to select a device – Pin 13 for PROM, Pin 14 for EEPROM, and Pin 15 for SRAM. The direction of data to or from the memory board device is determined by the read/write and output enable lines as follows:

DATA DIRECTION	R/$\overline{W}$ (U521–16)	$\overline{OE}$ (U521–57)
Write to Memory	LOW	HIGH
Read from Memory	HIGH	LOW

The microcomputer and SLIC also have lines that control radio operation. These control lines are either drivers or receivers, depending on their application. Each line will be described in the subject area where it is used.

2.2 SERIAL INPUT/OUTPUT IC

The Serial Input/Output IC (SIOIC) enables the functions described in the following:

(1) Buffer for PTT to SLIC (U522, Pins 37 and 38). Normally a contact closure for PTT is detected by the control head, which sends a command to the microcomputer via the external serial bus. However some applications require direct PTT control. To generate PTT via the buffer, a contact closure to ground at J502, Pin 24, will generate a logic high to the SLIC (U521, Pin 22).

(2) Buffer for Channel Active from the RF Board to SLIC and External Bus (U522, Pins 21, 22, and 23). A logic low from the RF board (J500, Pin 7) generates a logic high at the SLIC (U522, Pin 29) and a logic low at the External Bus (J502, Pin 4). This indicates that the selected radio channel is not active.

(3) Buffer for Squelch Mute from the RF Board to the SLIC (U522, Pins 35 and 36). A logic low from the RF board (J500, Pin 8) generates a logic high at the SLIC (U522, Pin 54). This indicates the radio is squelched.

(4) Buffer for Busy from the Microcomputer to the External Bus and back to the Microcomputer. This function is described in the SERIAL COMMUNICATIONS ON THE EXTERNAL BUS description.

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(5) Buffer for Data Transmission from the Microcomputer to the External Bus and back to the Microcomputer. This function is described in the SERIAL COMMUNICATIONS ON THE EXTERNAL BUS description.

(6) Inputs to accept Switched B+ or Emergency that enable the Power Regulators and make up the Microcomputer. This function is described in the POWER UP/DOWN SEQUENCE description.

(7) Reset Circuits for the Command Board and External Bus. This function is described in the RESET CIRCUITS description.

2.3 POWER UP/DOWN SEQUENCE

Note

This paragraph discusses the power up/down sequence. Initial application of A+ to the radio is discussed in the RESET CIRCUITS paragraph.

Normally, Switched B+ (SWB+) is switch–connected to a battery voltage. When the radio is in the OFF mode, placing SWB+ (J502, Pin 31) to the active state (switch closed) puts the radio in the ON mode.

The EMERG (Emergency) input (J502, Pin 3) also is switched, but in this case, either battery or ground may be connected to the switch. EMERG's active state depends on the Emergency Polarity (EMERG POL) input to the SIOIC (U522, Pin 32). When jumper JU502 is installed, EMERG is in the active state when the switch is open; when JU502 is not installed, EMERG is active when the switch is closed. Either way, activating the switch turns the radio on, enabling it to transmit and receive, although there is no power to the control head.

When SWB+ or EMERG become active, the RPCIC $\overline{EN}$ line (U522, Pin 15) goes to a logic low, enabling Switched +5V and +9.6V regulators. Approximately ten milliseconds later, the $\overline{IRQ}$ line (U522, Pin 24) goes to a logic low, awakening the microcomputer, which then applies a logic low to 9.6 and 5V $\overline{EN}$ (U521, Pin 40). Therefore, if SWB+ or EMERG go inactive, the regulator will remain enabled until the microcomputer turns them off as a result of taking 9.6/5V $\overline{EN}$ to logic high. (This is especially true since the Emergency Switch is usually momentary.) The microcomputer now examines EMERG (U522, Pin 30) and $\overline{SWB+}$ (U522, Pin 29) to determine which switch turned on the radio.

To turn off the radio, SWB+ is taken inactive. The microcomputer periodically examines $\overline{SWB+}$ at U521, Pin 20, to see if it has returned to a logic high. When it sees the high (caused by an inactive switch), the microcomputer initiates the power sequence. In the latter part of that sequence, when 9.6/5V $\overline{EN}$ goes to a logic high, the regulators are turned off and the microprocessor enters the "sleep" mode.

2.4 REGULATORS

The regulator circuits include an Unswitched +5V (UNSW5V) discrete circuit and the Regulator/Power Control IC (RPCIC) that produces Switched +5V (U500, Pin 14) and 9.6V (U500, Pin 17). The UNSW5V source is used by the RPCIC as a reference (U500, Pin 20) for its switched +5V source. It is also filtered to produce UNSW5VFILA/B/C. The RPCIC is controlled at Pin 24 via a digital transistor Q538 from 9.6/5V $\overline{EN}$.

The various voltages used by the IC's on the command board are shown in Table 1.

2.5 RESET CIRCUITS

The reset circuits consist of the power–on–reset (POR), high/low battery voltage reset, and the external bus system reset. The reset circuits allow the microcomputer to recover from an unstable condition, such as no battery on the radio, battery voltage to high or too low, and remote devices on the external bus not communicating.

When the battery (A+) is first applied to the radio, the voltage at the junction of R538 and C532 rises until the SLIC RESET (U521, Pin 1) detects a logic high. This time duration is approximately 200 milliseconds. The logic level passes through the SLIC and on to the microcomputer (U520) at Pin 17. When Pin 17 goes high, the microcomputer can execute code.

Table 1. Integrated Circuits Voltage Chart

Integrated Circuit	UNSW5V	UNSW5VFIL (A/B/C)	SW +5V	9.6V
Serial Input/Output (SIOIC)	U522–6, –24		U522–3, –12	U522–14
Regulator/Power Control (RPCIC)	U500–20		U500–14	U500–17
MicroComputer		(A) U520–26		
Support Logic (SLIC)		(B) U521–9, –27, –43, & –61		
Memory Board		(C) J505–13–29		
Audio Filter IC (AFIC)			U400–5, –41	U400–1, –20
Digital/Analog IC (DAIC)			U502–1, –28	
Signalling Filter IC (SFIC)			U700–27	

Another reset circuit monitors 9.6V from the RPCIC (U500). When 9.6V is enabled, yet not present because of too high or too low battery voltage, a reset will be generated at SLIC RESET (U521, Pin 1). The radio remains in reset until A+ returns to a voltage defined by the RPCIC to allow 9.6V to recover. This A+ voltage ranges from 8.6V to 18.0V. There are two possible locations for the circuit: on the *HearClear* board or in the SIOIC.

The microcomputer resets external (control head) devices on the external bus, usually when communication is not established on the bus. Likewise, if an external device cannot communicate with the microcomputer, the microcomputer can be reset by the external device. The microcomputer can generate a system reset by setting pin 49 on the SLIC (U521). This sets the SIOIC SYSTEM RESET line (U522, Pin 9), which resets the external bus (J502, Pin 11). If an external device needs to reset the microcomputer, then it would generate a logic high on the external bus system reset. Pin 4 of the SIOIC would produce a logic high at Pin 2 of the SLIC. The SLIC would then reset the microcomputer via Pin 47.

2.6 SERIAL COMMUNICATIONS ON THE EXTERNAL BUS

Serial communications on the external bus use BUS+ (J502, Pin 25), BUS– (J502, Pin 22), and BUSY (J502, Pin 9). These three lines are bidirectional; therefore numerous devices can be in parallel on the bus. All devices monitor the bus while data is being transmitted (at 9600 baud rate). The transmitted data includes the address of the device for which the data is intended. Examples of the different types of data are control head display data and button closure data.

Data bus drivers for BUS+ and BUS– are differentially driven (BUS+ and BUS– should always have different logic states). Their idle states are: BUS+ = logic high; BUS– = logic low; and BUSY = logic low. The drivers are so designed that any of the devices on the bus can drive these lines to their non–idle state without loading problems.

In a typical transmission, the microcomputer examines the BUSY line. If the BUSY line is in the idle state, the microcomputer sets the BUSY line and then transmits. At the end of transmission, the microcomputer returns the BUSY line to idle. The microcomputer monitors the BUSY line via J502–9, U522 (SIOIC) Pins 10 and 11, and U520 (microcomputer) Pin 33. The microcomputer sets the BUSY line via microcomputer Pin 30, SIOIC Pins 10 and 13, and J502–9.

Data transmission is sent onto the bus asynchronously. When the microcomputer sends data onto the bus, the microcomputer also monitors the transmitted data as a collision detection measure. If a collision is detected as a result of receiving a different data pattern, the microcomputer will stop transmission and try again. The microcomputer monitors and receives data via BUS+ (J502–25) to SIOIC (U522, Pin 17), and BUS– (J502–22) to SIOIC (U522, Pins 18 and 20), and microcomputer Pin 20. Data is transmitted via microcomputer Pin 21 to SIOIC Pin 19, SIOIC to BUS+, and SIOIC to BUS–.

In the remote version of the radio, option cards can be installed. If data transmission is required, it is transmitted via J502–20 to SIOIC Pin 19, SIOIC to BUS+, and SIOIC to BUS–.

2.7 SYNCHRONOUS SERIAL BUS

The synchronous serial bus is an internal bus used by the microcomputer for communicating with various ICs. The following are on the bus:

Audio Filter IC	U400	Command Board
Signalling Filter IC	U700	Command Board
D/A Converter IC	U502	Command Board
Prescaler IC	U601	RF Board
Synthesizer IC	U602	RF Board

The ICs require different length data strings for programming. For example, U400 is programmed with up to 48 bits of data, while U700 requires only 16 bits. Clock (U520, Pin 24) and Data (U520, Pin 23) lines are routed in parallel to all serially programmed ICs from the microcomputer. Also, separate Chip Select lines (U521, Pins 41,42,48,62, and 64) are routed to each IC. The ICs are programmed one at a time by the microcomputer, with each IC ignoring activity on its clock and data lines unless it has been selected. The SLIC applies an active low on the IC's Chip Select line to select the IC before data is transmitted.

2.8 CRYSTAL PULL

The purpose of the crystal–pull circuit is to adjust the crystal oscillator's frequency on the microcomputer so that the E–Clock (U520, Pin 5) frequency harmonics do not cause interference with the radio's receive channel. For each channel frequency stored in the code plug, a corresponding bit has been assigned to determine if it is necessary to pull the oscillator's frequency. The pulling circuit is inactive if SLIC Pin 38 is a logic high. A logic low inserts L521 and C522 into the oscillator, changing its loading characteristics and, effectively, adjusting the oscillator's frequency.

2.9 2.1 MHz CLOCK

The Audio Filter IC (U400) and Signalling Filter IC (U700) contain switched–capacitor filters that require an external 2.1 MHz clock signal to function. The 16.8 MHz reference oscillator (U600) is divided by 8 on the RF board and routed to the command board via J500–21. This signal is then capacitively coupled to the 2.1 MHz inputs of the audio and signalling ICs. The command board audio is NOT functional with the RF board removed, unless an external 2.1 MHz source is applied to J500–21 on the command board.

2.10 U400 CONTROL LINES

The Audio Filter IC (U400) has six output control bits that are controlled by serial programming of U400. These outputs are 0 to 9.6 volts logic, and are assigned as follows:

U400 Pin	FUNCTION
2	Keyed 9.4V Enable
42	IF Bandwidth Select
43	Audio PA Enable
44	Flutter Fighter Enable
3	Blanker Enable
4	Compandor Enable

2.11 VAG CIRCUIT

VAG, the "AC Ground" for audio circuits, has bias voltage one–half of 9.6V through the divider circuit of R417 and R418. VAG is used by quad op–amp (U401), transmission gate U523, *HearClear* op–amps, and options op–amps (if any). The audio filter IC (U400) and signalling filter IC (U700) internally generate DC biases for audio circuits that may be different from the 4.8V VAG. Therefore, all audio inputs and outputs for U400 and U700 are capacitively coupled.

2.12 RECEIVE AUDIO/DATA (See Figure 1)

2.12.1 Receive Audio

Receive audio from the detector enters the command board on J500–4. The signal is routed through C408 to U401D, Pin 13. The output of U401D is sent to J502–13 for options, and to P501–11, which is the *HearClear* flutter fighter (900 MHz only) input. The flutter fighter output signal returns to the command board on P501–18 and is sent to U523B, Pin 3. Transmission gate U523B switches between flutter fighter audio on Pin 3, and direct detected audio on Pin 5. The output of U523B, Pin 4, is AC–coupled through C409 to the RX input of audio filter IC, U400, Pin 9. U523B, Pin 9, controls the switch with a signal from U400, Pin 44.

Inside U400, receive audio passes through the priority sample mute gate, PL/DPL rejection filters, de–emphasis, and the 8–bit volume control. The volume control is adjusted by serial programming of U400. Receive audio exits U400 on Pin 26 and is routed to the *HearClear* expandor input (P501–2) and to transmission gate U523A, Pin 2. U523A switches either direct receive audio or expanded receive audio to the audio PA. Expanded receive audio comes from P501–7 to U523A, Pin 1. The output of U523A, Pin 15 goes to divider/lowpass filter components (R455, R456, and C455), and then is AC–coupled through C454 to the Audio PA (U450, Pin 2). U523A, Pin 10, controls the switch with a signal from U400, Pin 4.

The audio PA, U450, is a DC–coupled output, bridge–type amplifier. The gain is internally fixed at 36dB. Speaker audio leaves U450 on Pins 11 and 13, and, in dash–type radios, is routed to the speaker via P503–14 and 16. The amplifier outputs are at one–half of 13.8V and are directly connected to the speaker. *The speaker outputs must NOT be grounded in any way.* An audio isolation transformer must be used if grounded test equipment (such as a service monitor) is to be connected to the speaker outputs.

When the radio is squelched, the audio PA is disabled. U400, Pin 43 is programmed low by the microcomputer, and inverted twice through Q401 and Q400 to remove SWB+ from U450, Pin 10, the audio PA. When U450, Pin 10 does not have SWB+, the speaker is totally muted and audio PA current drain is greatly reduced. However, the audio PA remains on during priority sample muting.

2.12.2 Alert Tones

Whenever alert tones are required (out–of–range, busy, private call alert, telephone ring, mode change, etc.), the microcomputer produces a clock signal on U520, Pin 29. This clock signal is at the desired tone frequency, and is routed to U400, Pin 14. Internally, U400 routes the tone through the volume control to transmission gate U523A. The alert tones are not expanded, so U400, Pin 4 will switch U523A so that the tones go directly to the audio amplifier and speaker. The alert "tone" waveform is actually a slightly filtered square wave.

2.12.3 Receive Signalling Data

The *SPECTRA* radio is capable of operating in either a Trunking or a Conventional Mode. In Trunking modes, receive signalling is either High Speed (HS), used for control channel access, or Low Speed (LS), used to maintain a voice channel. On Conventional modes, receive signalling is either *MDC–1200* data or PL/DPL (described later). High Speed, Low Speed and *MDC–1200* signals are processed by the Signalling IC (U701) before being sent to the microprocessor (U520) for decoding.

DETECTED AUDIO (J500–4) is routed from the demodulator on the RF board to the Signalling IC via coupling capacitor C701. A Guard Ring (U700, Pins 37 and 41) is provided on the RX IN (U700, Pin 39) line to minimize leakage on this high input impedance point. The guard ring should be at the same DC voltage as the TX IN line. The input signal is filtered in the Signalling IC with a filter determined by its serial programming. The filtered signal is then applied to an internal limiter to provide a 0 to 5 volts signal that is usable by the microprocessor and output on RX DATA (U700, Pin 30). The limiter uses capacitor C707 for HS and *MDC–1200* signals and C706 for LS signals to determine its low frequency response. In order for the limiter output to be valid, the DATA STROBE (U700, Pin 11) line must be low. The state of this line is determined by the microprocessor and switches between Transmit and Receive modes of operation. The limited signal is then filtered by C555/R543 and applied to the microprocessor (U520, Pin 34).

The limiter in the Signalling IC has a programmable minimum deviation level. If the input deviation is less than this minimum level, there will not be an output, and if it exceeds this minimum level, the output will be a 0 to 5 volt waveform that resembles the input waveform. The minimum deviation level is programmed by the microprocessor, depending on the signalling type.

When the radio is on a Conventional mode with *MDC–1200* enabled, the 1200 Hz output (U700, Pin 5) will be a 1200 Hz square wave which is routed to the microprocessor

(U520, Pin 32) via C567/R522 to assist in demodulation of *MDC–1200* data.

2.12.4 Received PL/DPL

DETECTED AUDIO (J500–4) is routed from the demodulator on the RF board to the Audio Filter IC via coupling capacitor C407. The input signal, PL/DPL IN (U400, Pin 10), is filtered to eliminate the effects of voice/signalling modulation and then applied to its internal limiter to provide a 0 to 5 volt signal that is usable by the microprocessor. It is output on PL/DPL RX DATA (U400, Pin 30) and is routed to the microprocessor (U520, Pin 43) via R548/C558. The limiter uses capacitor C403 for DPL signals and C402 for PL signals to determine its low frequency response. When the microprocessor samples the limited PL/DPL signal, it places a pulse on PL/DPL STROBE (U520, Pin 31). This is routed to the Audio Filter IC (U400–35) via a filter composed of L530/C557. The falling edge of this signal latches the current state of the limited signal in the Audio Filter IC for decoding by the microprocessor. On PL modes, this pulse will occur every 933 microseconds on DPL modes, every 1.86 milliseconds.

The radio Test Mode provides a rapid method to troubleshoot the Receive Signalling paths. See that section for additional details.

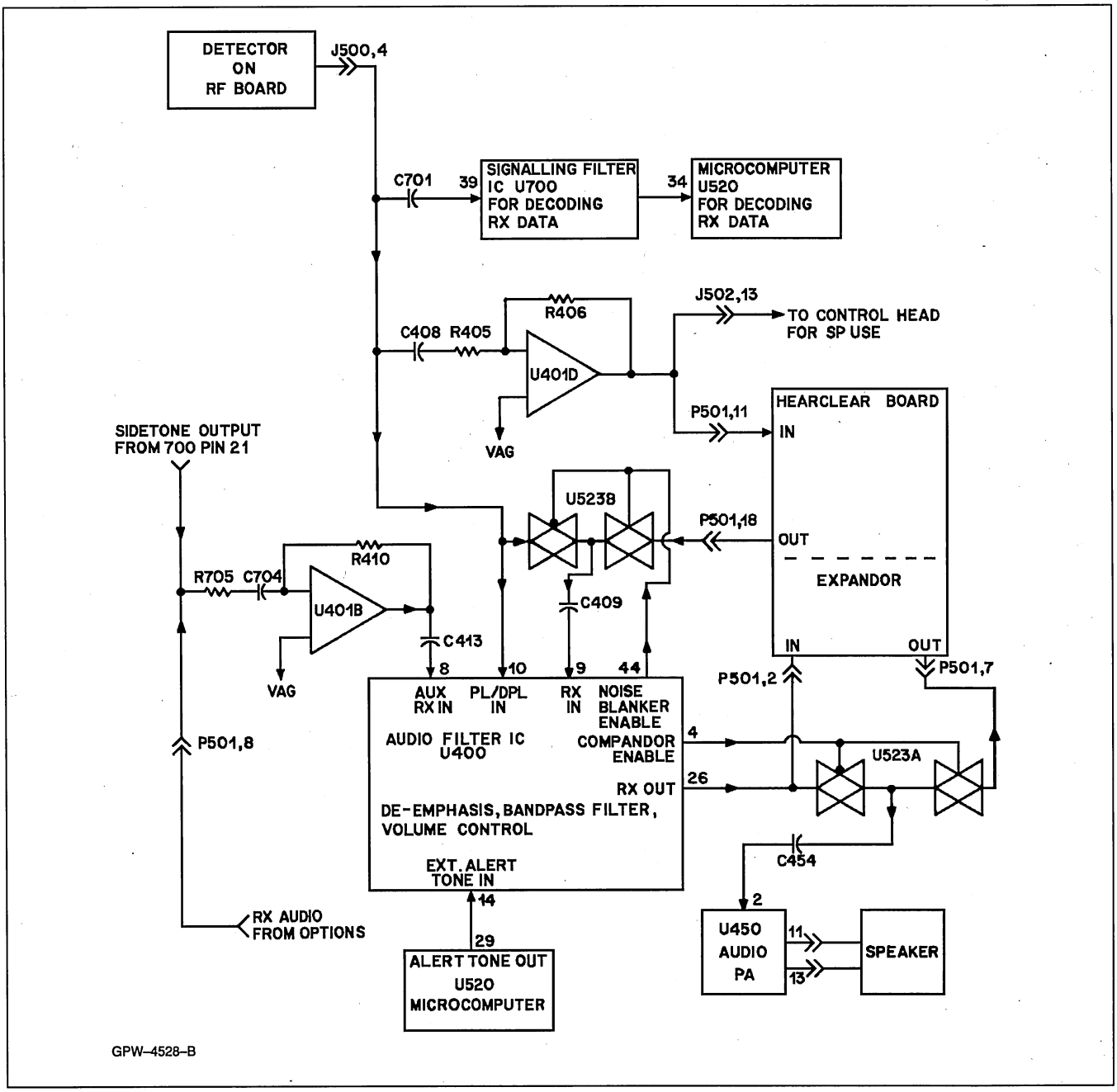


Figure 1. Receive Audio/Data Signal Flow

2.13 TRANSMIT AUDIO/DATA (See Figure 2)

2.13.1 Microphone Audio

The microphone connects to the front of the control head. Mic HI enters the command board via P502–6. Components R414,R415, and C416 provide DC to the condenser microphone element and convert the microphone output current into an audio voltage. Microphone audio always connects to the *HearClear* board compressor input at P501–6. The *HearClear* board returns compressed audio through P501–19 to U523C, Pin 13. In addition, Mic audio goes directly to U523, Pin 12.

U523C switches between microphone audio and compressed microphone audio. A 0 to 9.6V logic signal from U400, Pin 4 (Controlled by software) connects to U523C, Pin 11 to control U523C switching. The output of switch U523C, Pin 14 connects to pre–emphasis components R420, C419, and R419. R419 is the feedback resistor of an op–amp in U400. R419 and C419 set the pre–emphasis corner frequency. The pre–emphasized Mic audio on U400, Pin 11 goes through the limiter, splatter filter, modulation summer, and exits on U400, Pin 24. The signal then goes to the 4–bit (deviation) attenuator input, U400, Pin 16.

The 4–bit attenuator output, U400, Pin 22, has a 4.1V bias, and is routed two places. First, it goes to the RF board via J500–17 to the CMOS Synthesizer IC, U602, Pin 28. This signal is applied to the phase modulator input via a lowpass filter formed by R626 and C631. Second, the signal goes to the 5–bit (compensation) attenuator input, U400, Pin 17.

The 5–bit attenuator output, U400, Pin 23, also with a 4.1V bias, goes through the RF board via J500–11 to the VCO connector J601–10. This modulating signal is capacitively coupled to the negative steering line of the VCO. The 4–bit and 5–bit attenuators are adjusted during radio alignment with an IBM PC.

2.13.2 Transmit Signalling Data

The *SPECTRA* radio is capable of operating in either a Trunking or a Conventional mode. In Trunking modes, transmit signalling is either High Speed (HS), used for control channel access, or Connect Tone, used to maintain a voice channel (described later). On Conventional modes, transmit signalling is either *MDC–1200* data or PL/DPL (described later). In addition, DTMF tones can be sent in either Trunking or Conventional modes.

MDC–1200 or High Speed data originates from the microprocessor (U520, Pin 28) and is routed to the Signalling IC (U700, Pin 11) via R544/C556. The microprocessor generates a rising edge at its output for each required transition in the data waveform. Therefore, to generate a 1500 Hz tone, the microprocessor generates a 3000 Hz waveform at its output. The data waveform is then filtered and its level is controlled by an attenuator in U700. The selection of filter and level is determined by serial programming. The modulation output (U700–19) is summed with other modulation in U401C and routed to Audio Filter IC (U400, Pin 15) via C411. R700 determines the gain applied to the signalling data as it goes through the summing amp (U401C) and C700 determines the low frequency responses of this path. In the Audio Filter IC, the transmit signal is routed through the same attenuators used for voice. Serial programming determines any filtering used in the Audio Filter IC.

DTMF tones are generated using two lines from the microprocessor. The low frequency tone is generated at U520, Pin 29 (the same pin that is used to generate alert tones) and routed to U700, Pin 8. The high frequency tone is generated at U520, Pin 28 (the same pin that is used to generate Trunking/*MDC–1200* data) and routed to U700, Pin 11. The waveform used to generate the low frequency tone will be six (6) times the frequency of the desired tones due to internal dividers in U700. The waveform used to generate the high frequency tone will be either 10 or 6 times the frequency of the desired tone, depending on the tone frequency. The Signalling IC sums the two tones with the proper gain between the two tones (the level of the high frequency tone is 2 dB greater than the low frequency tone), and applies this signal to an internal attenuator. The attenuator level and selection of tone frequency multiplier is determined by serial programming. The modulation output (U700, Pin 19) follows the same path as for Trunking or *MDC–1200* data. To enable the operator to hear the DTMF tones as they are generated, the same signal that is sent on U700, Pin 19 is also sent on U700, Pin 21. This is routed to gain–determining resistor R705 and coupling capacitor C704 to summing amplifier U401B. The output of the amplifier is coupled to the Audio Filter IC (U400, Pin 8) via C413 where it is routed to the volume attenuator, Audio PA, and the speaker.

2.13.3 TRANSMIT PL/DPL AND CONNECT TONE

The PL/DPL and Connect tones are produced by the microprocessor generating a clock signal to the Audio Filter IC (U400, Pin 35). This signal is generated at U520, Pin 31 and filtered by L530/C557. For PL and Connect tones, the microprocessor generates a clock signal 12 times the desired tone frequency, and for DPL, the microprocessor generates six clock pulses for each transition in the DPL waveform (e.g., from a 1 to a 0). The Audio Filter IC converts the clock pulses to the proper waveform and applies it to the proper internal filter. It then adjusts the level to obtain the proper deviation as determined by serial programming. Different deviation levels are used for PL/DPL and Connect tone. This waveform exits U400, Pin 24 and is then routed through the same attenuators as are used for voice.

On Conventional modes without PL/DPL, no signal will be generated at the microprocessor output. The PL/DPL signal is combined in U400 with either voice, *MDC–1200*, or DTMF data as specified on that channel.

On Trunking modes, the connect tone is combined in U400 with either voice or DTMF.

The radio Test Mode provides a rapid method to troubleshoot the transmit signalling paths. See that section for additional details.

3. Troubleshooting

This information will help field service technicians troubleshoot the *SPECTRA* radio. Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, this section includes Troubleshooting Charts that will guide you through a sequence of tests and checks designed to isolate problems. For the purpose of troubleshooting it, the command board is divided into three parts – one for audio circuitry, one for digital circuitry, and one for signalling circuitry. (See Foldout Pages PW–4752, PW–4744, and PW–4761)

Prior to troubleshooting, review the theory of operation, including specific precautions and troubleshooting methods. Take measurements very carefully on all band radios, but take special care on the higher–frequency radios. Notes and cautions are added to the text to alert you to this need in areas of greatest sensitivity. However the need for extreme care does exist in *all* measurements and tests at high frequencies.

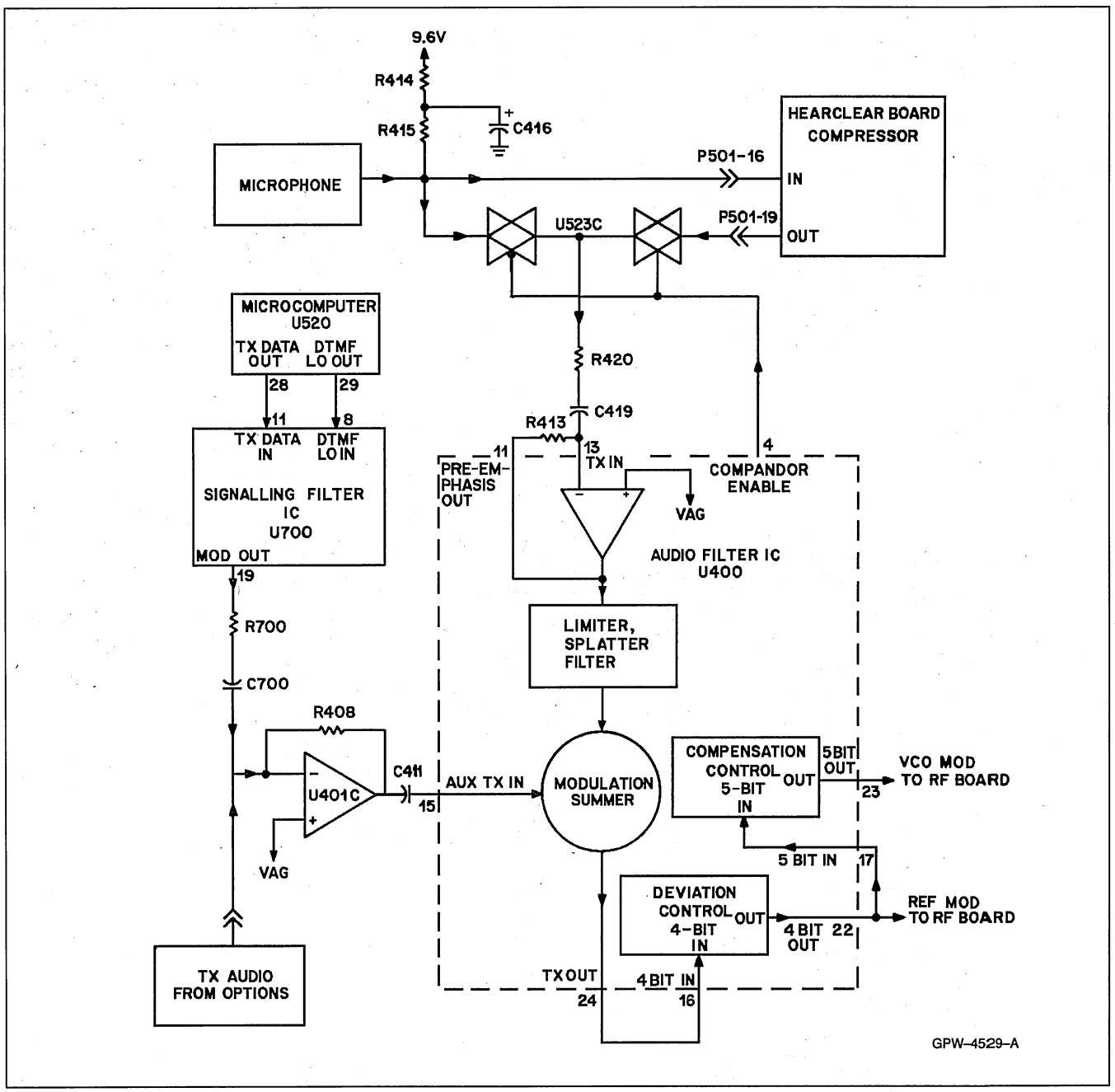
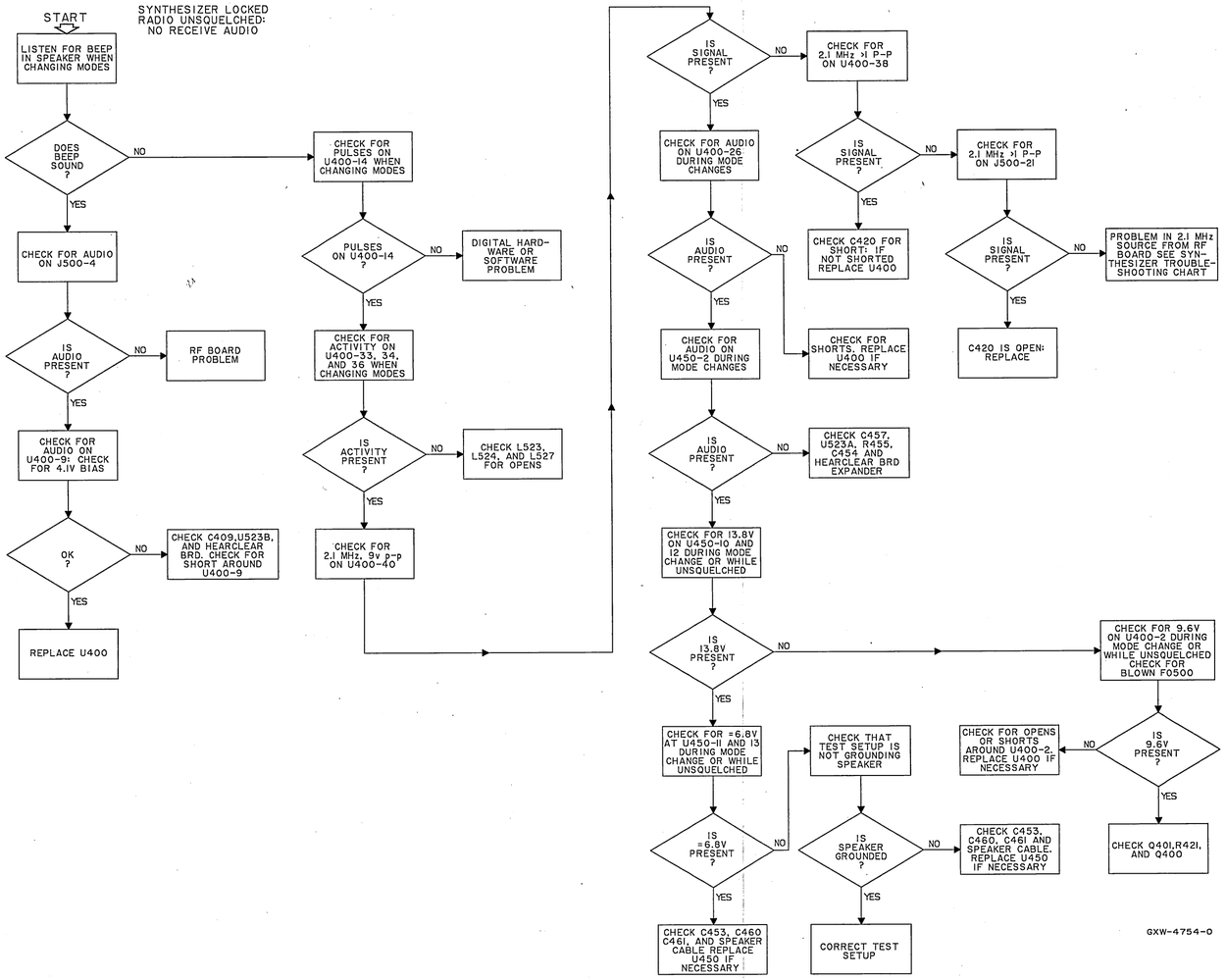
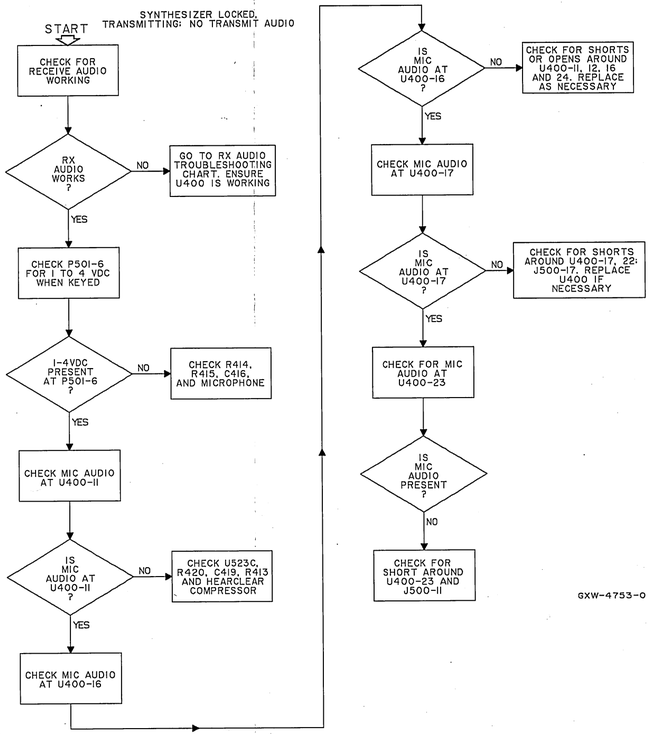


Figure 2. Transmit Audio/Data Signal Flow

SYNTHESIZER LOCKED RADIO UNSQUELCHED: NO RECEIVE AUDIO

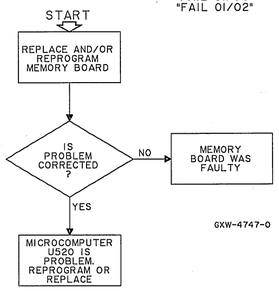


SYNTHESIZER LOCKED. TRANSMITTING: NO TRANSMIT AUDIO



Troubleshooting Chart for *SPECTRA*
Command Board Audio Circuitry
PW-4752-O
9/18/87

CONTROL HEAD DISPLAY: "FAIL 01/82"
"FAIL 01/84"
"FAIL 01/88"
"FAIL 01/02"



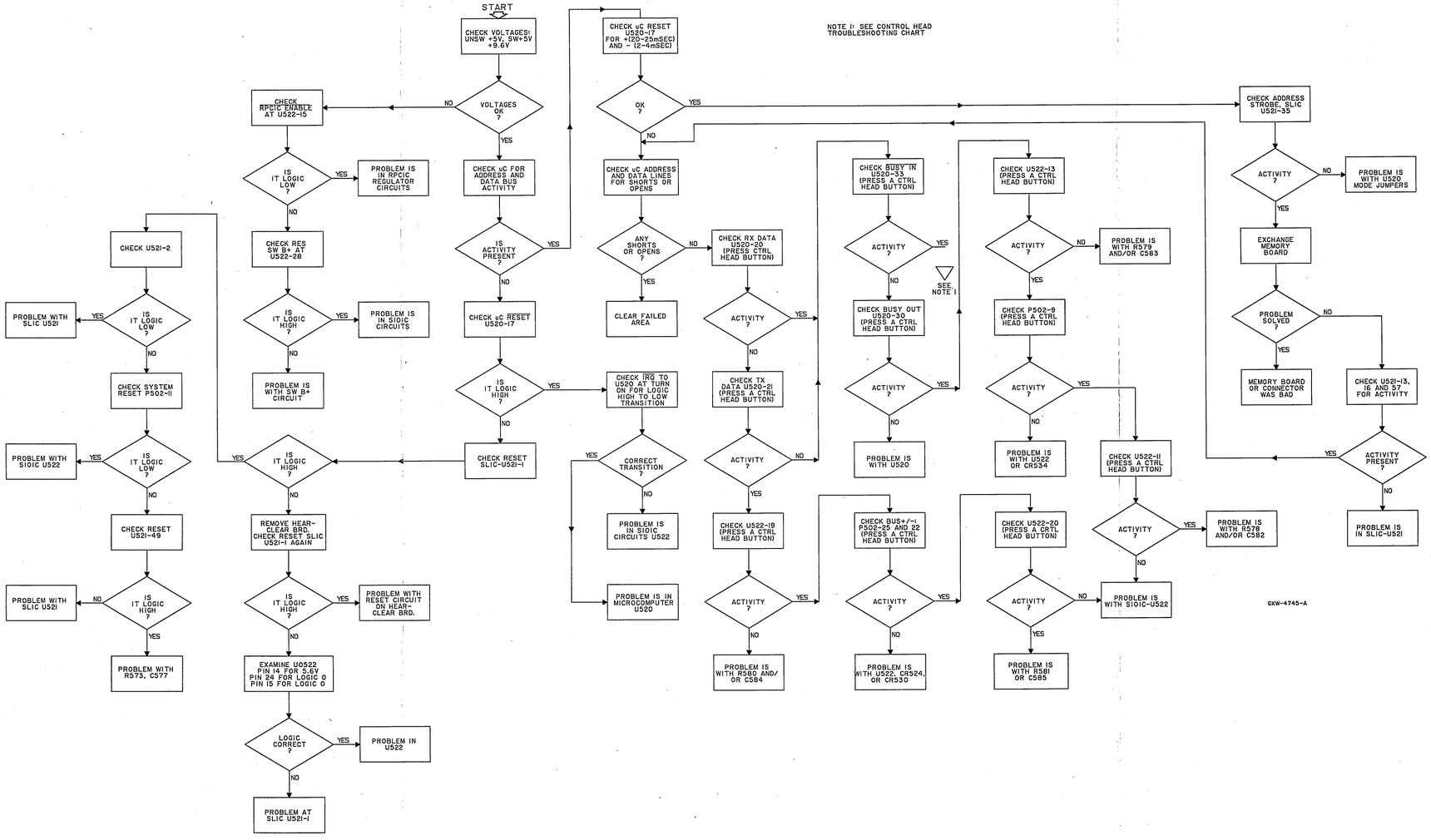
GXW-4747-0

CONTROL HEAD DISPLAY: "FAIL 01/81"



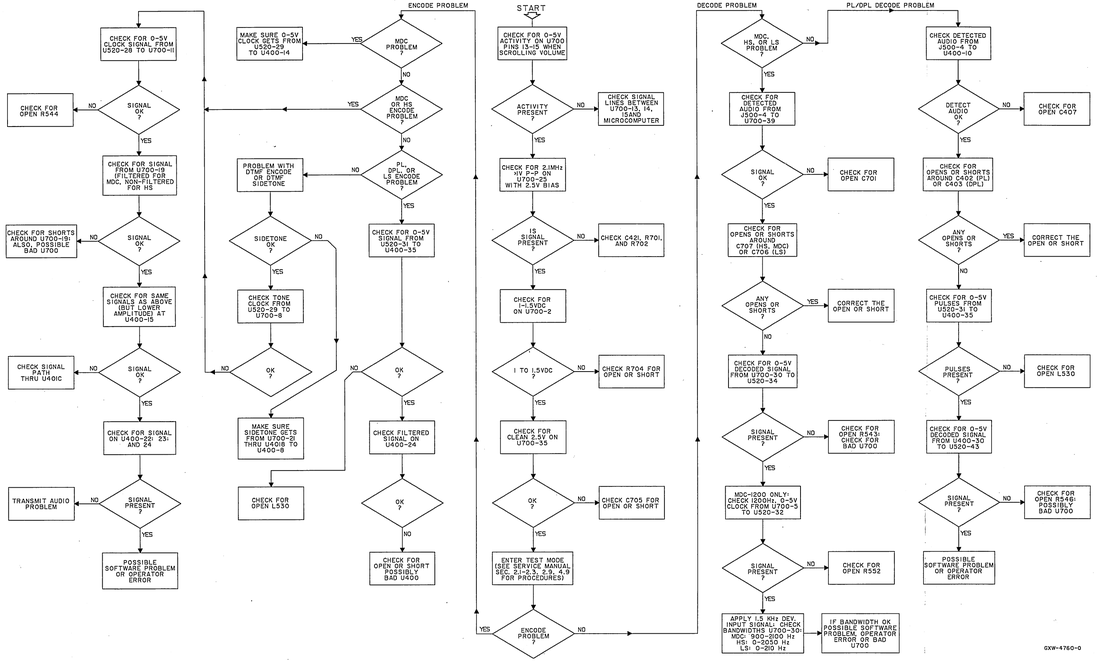
GXW-4746-0

CONTROL HEAD DISPLAY: "FAIL 01/90" OR BLANK

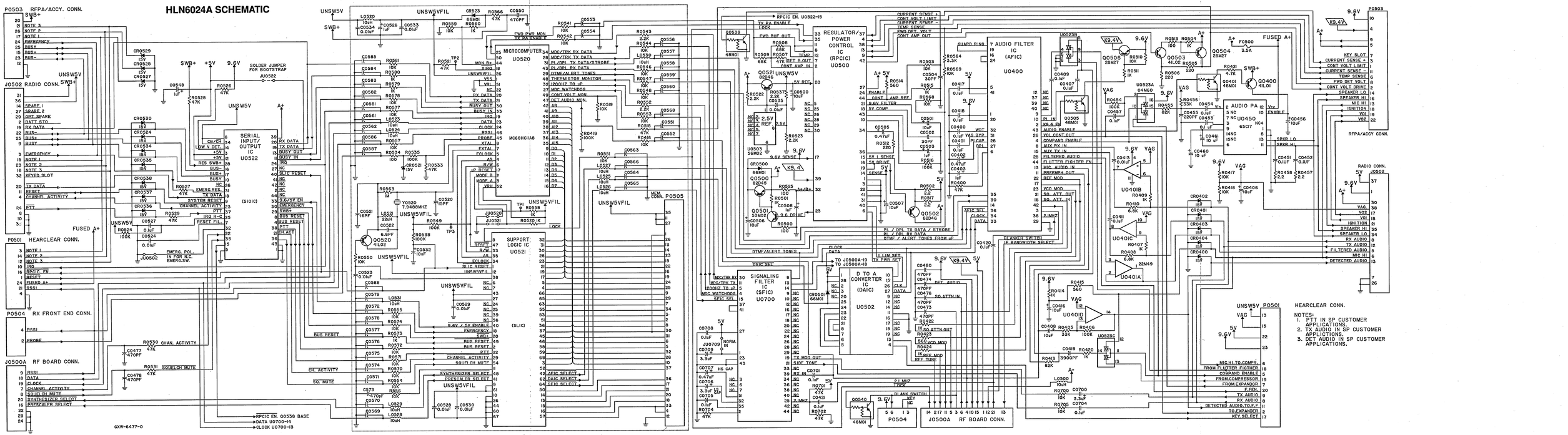


GXW-4745-A

Troubleshooting Chart for *SPECTRA*
Command Board Digital Circuitry
PW-4744-A
3/31/89



Troubleshooting Chart for *SPECTRA*
Command Board Signalling Circuitry
PW-4761-O
9/18/87



Schematic, Circuit Board Diagrams, and Parts List
for HLN6024A *SPECTRA* Command Board
PW-4709-A
(Sheet 1 of 2)
3/31/89

parts list

HLN6024A Command Board — MXW–4662–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C400	21–60521B37	0.1, ±5%, 25V
C401	21–11032A33	0.1
C402	23–62998B55	0.47, ±20%, 25V, tantalum
C403	23–62998B59	1, ±20%, 16V, tantalum
C406	23–62998B73	10, ±20%, 16V, tantalum
C407	21–11032A33	0.1
C408	23–62998B73	10, ±20%, 16V, tantalum
C409	21–11032A33	0.1
C411	21–11032A33	0.1
C413	21–11032A21	0.01
C416	23–62998B73	10, ±20%, 16V, tantalum
C417,418	21–11032A33	0.1
C419	21–11032A16	.0039
C420,421	21–11032A33	0.1
C451–454	21–60521B37	0.1, ±5%, 25V
C455	21–11031A47	220 pF, ±5%
C456	23–80090M24	10, ±20%, electrolytic
C457	21–11032A33	0.1
C460,461	23–80090M06	10, ±20%, 16V, electrolytic
C473,474	21–60521C09	470, 25V
C476–478	21–60521C09	470, 25V
C480	21–60521C09	470, 25V
C500,501	23–62998B73	10, ±20%, 16V, tantalum
C502	21–11031A26	30 pF, ±5%
C503	23–62998B59	1, ±20%, 16V, tantalum
C504	21–11031A26	30 pF, ±5%
C505	23–62998B55	0.47, ±20%, 25V
C506,507	23–62998B73	10, ±20%, 16V tantalum
C508	23–62998B59	1, ±20%, 16V, tantalum
C520	21–11031A19	15 pF, ±5%
C521	21–11031A20	16 pF, ±5%
C522	21–11031A11	6.8, ±.5pF
C523,524	21–11032A21	.01
C525	23–62998B59	1, ±20%, 16V, tantalum
C527	21–60521B37	0.1, ±5%, 25V
C528–530	21–11032A21	.01
C532	23–62998B73	10, ±20%, 16V, tantalum
C533–535	21–11032A21	.01
C548	23–62998B59	1, ±20%, 16V, tantalum
C550–554	21–60521C09	470, 25V
C556–566	21–60521C09	470, 25V
C568–579	21–60521C09	470, 25V
C581–588	21–60521C09	470, 25V
C700	23–62998B66	3.3, ±20%, 16V, tantalum
C701	21–11032A33	0.1
C704,705	21–11032A33	0.1
C706	23–62998B16	3.3, 16V, tantalum
C707	23–62998B55	0.47, ±20%, 25V, tantalum
C708	21–11032A33	0.1
C709	23–62998B16	3.3, 16V, tantalum
diode (see note)		
CR400–404	48–82958R91	zener, 15V
CR500,501	48–80066A01	signal, type RSL4148
CR521	48–82958R91	zener, 15V
CR523	48–80066A01	signal, type RLS4148
CR524	48–82958R91	zener, 15V
CR527–530	48–82958R91	zener, 15V
CR534–538	48–82958R91	zener, 15V
fuse		
F500	65–80011N01	3.5 amp fast blow
connector receptacle		
J500A	09–80104M01	bottom entry, 24 contact
J502	09–80103M02	right angle, 38 contact
jumper		
JU502	06–11077A01	0 ohm
JU709	06–11077A01	0 ohm
coil, RF		
L500	24–80140E16	inductor, 10 uH
L520	24–80140E16	inductor, 10 uH
L521	24–80289M16	inductor, 22 uH, ±3%
L523–531	24–80140E16	inductor, 10 uH
connector plug		
P501	28–80102M01	vertical, 24 contacts
P503	28–80057M01	right angle, 26 contacts
P504	28–80102M04	vertical, 6 contacts
P505	09–80168M01	37 contacts
transistor (see note)		
Q400	48–80141L01	PNP
Q401	48–80048M01	NPN
Q500	48–80182D45	PNP
Q501	48–80053M02	NPN
Q502	48–80182D46	NPN
Q503	48–80141L02	NPN
Q504	48–05128M27	PNP
Q505	48–80048M01	NPN
Q506	48–05128M27	PNP
Q520	48–80141L02	NPN
Q521	48–80182D46	NPN
Q538	48–80048M01	NPN
Q540	48–80048M01	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R400	06–11077B15	47k
R405	06–11077B11	33k
R406	06–11077B23	100k
R407	06–11077A74	1k

MXW–4662–A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R408	06–11077A94	6.8k
R409	06–11077A74	1k
R410	06–11077A94	6.8k
R413	06–11077B21	82k
R414	06–11077A74	1k
R415	06–11077A68	560
R416–418	06–11077A98	10k
R419	06–11077B23	100k
R420	06–11077A74	1k
R421	06–11077A90	4.7k
R422	06–11077A74	1k
R423	06–11077A68	560
R424	06–11077A74	1k
R454	06–11077B03	100k
R455	06–11077B21	82k
R456	06–11077B11	33k
R457,458	06–11077A10	2.2
R500	06–11077A50	100
R501	06–11077A74	1k
R502	06–11077A10	2.2
R503	06–11077A98	10k
R504	06–11077B15	47k
R505,506	06–11077A58	220
R507	06–11077B15	47k
R508,509	06–11077B19	68k
R510	06–11077A98	10k
R511	06–11077A74	1k
R512	06–11077A58	220
R513	06–11077A50	100
R514	06–11077A68	560
R515	06–11077A74	1k
R516	06–11077B23	100k
R517	06–11077A10	2.2
R518	06–11077B15	47k
R519	06–11077A98	10k
R520	06–11077A74	1k
R521	06–11077B15	47k
R522,523	06–11077A82	2.2k
R524	06–11077B23	100k
R525	06–11077A50	100
R526–531	06–11077B15	47k
R533	06–11077B15	47k
R534	06–11077A50	100
R535	06–11077B23	100k
R537	06–11077A82	2.2k
R538	06–11077B23	100k
R541,542	06–11077A98	10k
R543	06–11077A82	2.2k
R544	06–11077A98	10k
R546–548	06–11077A98	10k
R549	06–11077B23	100k
R550,551	06–11077A98	10k
R552	06–11077A82	2.2k
R553–557	06–11077A98	10k
R558	06–11077A74	1k
R559	06–11077A98	10k
R560	06–11077A74	1k
R563	06–11077B47	1 MEG
R564	06–11077A86	3.3k
R566	06–11077B15	47k
R568–572	06–11077A98	10k
R573	06–11077A74	1k
R574	06–11077A98	10k
R577,578	06–11077A98	10k
R579,580	06–11077A74	1k
R581	06–11077A98	10k
R700	06–11077A98	10k
R701,702	06–11077B15	47k
R704	06–11077B15	47k
R705	06–11077A98	10k
integrated circuit (see note)		
U400	51–83977M74	audio filter
U401	51–83222M49	quad op–amp, 22M49
U450	51–80065C17	bridge, audio amplifier 4.5 amp 20 watt
U500	51–83977M70	regulator, power control bipolar
U502	51–83977M73	digital–analog converter CMOS
U503	51–80056M02	precision voltage reference, 2.5V
U520	51–87024A01	microprocessor, MC68HC11A1CFN
U521	51–82862N09	gate array, HCA5312
U522	51–83977M72	serial input/output device
U523	51–84704M60	analog multiplexer, CMOS 04M60
U700	51–83977M75	signalling filter, CMOS
crystal (see note)		
Y520	48–80173D10	crystal 7.9488 MHz
	mechanical parts	
	26–80119M01	shield, command fence
	75–05295R01	pad, crystal
	54–80004N01	barcode label

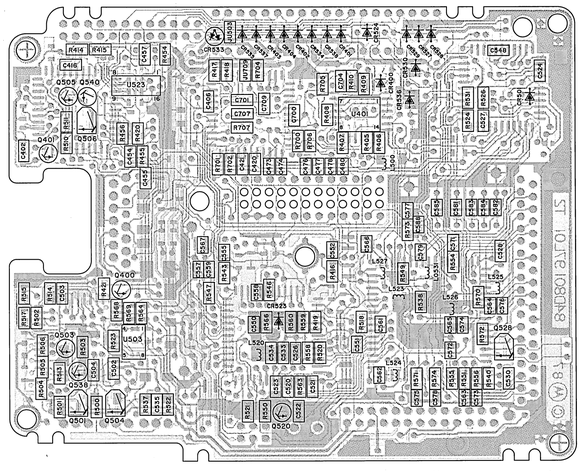
03/31/89

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

HLN6024A CIRCUIT BOARD

SOLDER SIDE — GPW–4692–O
COMPONENT SIDE — GPW–4691–O
OVERLAY — GXW–4693W01–A

COMPONENT SIDE VIEW

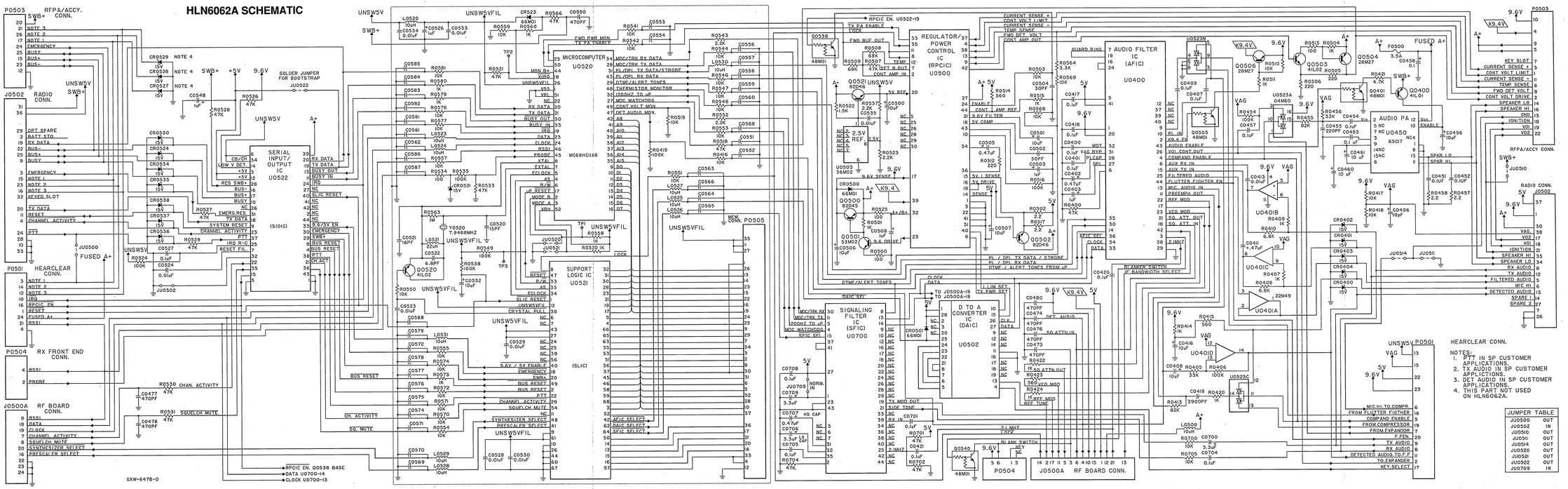


SOLDER SIDE — GPW–4692–O
COMPONENT SIDE — GPW–4691–O
OVERLAY — GXW–4693W02–A

SOLDER SIDE VIEW

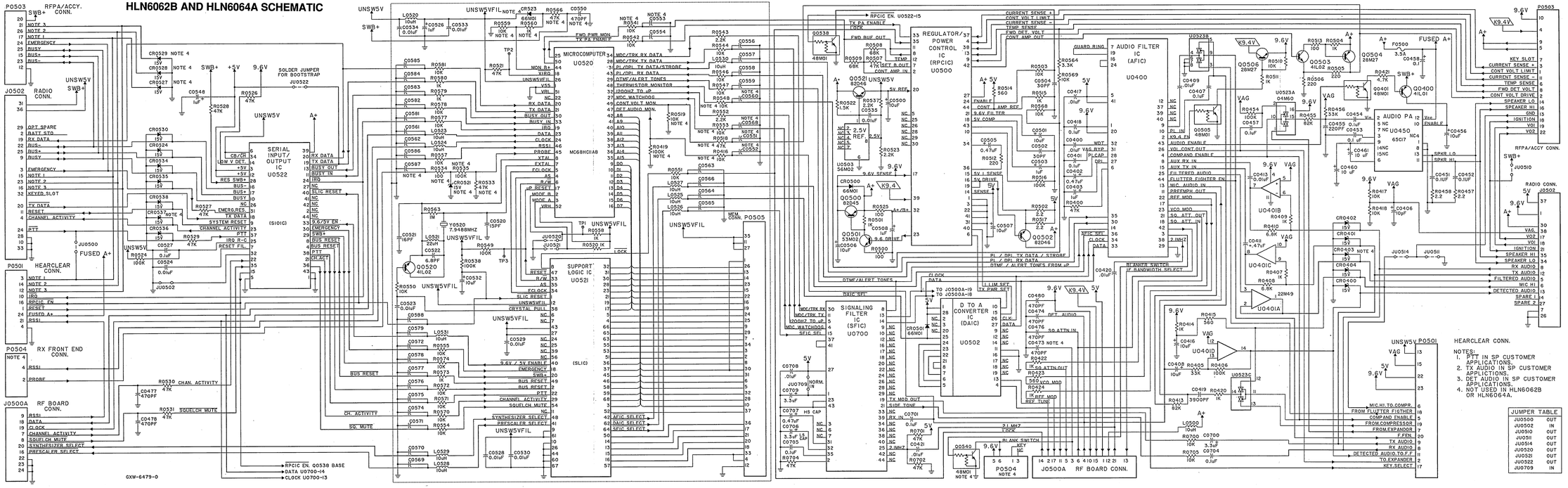
Schematic, Circuit Board Diagrams, and Parts List
for HLN6024A *SPECTRA* Command Board
PW–4709–A
(Sheet 2 of 2)
3/31/89

HLN6062A SCHEMATIC



Schematics, Circuit Board Diagrams, and Parts Lists
for HLN6062A, HLN6062B, and HLN6064A
SPECTRA Command Boards
PW-5776-A
(Sheet 1 of 4)
3/31/89

HLN6062B AND HLN6064A SCHEMATIC



Schematics, Circuit Board Diagrams, and Parts Lists
for HLN6062A, HLN6062B, and HLN6064A
SPECTRA Command Boards
PW–5776–A
(Sheet 2 of 4)
3/31/89

parts list

HLN6062B/HLN6064A Command Board — MXW–5773–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C400	21–13741B45	0.01
C401	21–13741B69	0.1
C402	23–62998B55	0.47, ±20%, 25V, tantalum
C403	23–62998B59	1, ±20%, 16V, tantalum
C406	23–62998B73	10, ±20%, 16V, tantalum
C407	21–13741B69	0.1
C408	23–62998B73	10, ±20%, 16V, tantalum
C409	21–13741B45	0.01
C411	23–62998B55	0.47, ±20%, 25V, tantalum
C413	21–13741B45	0.01
C416	23–62998B73	10, ±20%, 16V, tantalum
C417	21–13741B45	0.01
C418	21–13741B69	0.1
C419	21–13741B35	0.0039
C420,421	21–13741B45	0.01
C431–454	21–13741B69	0.1
C455	21–13740B57	220 pF
C456	23–80293M24	10, ±20%, electrolytic
C457,458	21–13741B69	0.1
C460,461	23–80293M06	10, ±20%, 16V, electrolytic
C474	21–13741A13	470 pF
C476–478	21–13741A13	470 pF
C480	21–13741A13	470 pF
C500,501	23–62998B73	10, ±20%, 16V, tantalum
C502	21–13740B36	30 pF
C503	23–62998B59	1, ±20%, 16V, tantalum
C504	21–13740B36	30 pF
C505	23–62998B55	0.47, ±20%, 25V, tantalum
C506,507	23–62998B73	10, ±20%, 16V, tantalum
C508	23–62998B59	1, ±20%, 16V, tantalum
C520	21–13740B29	15 pF
C521	21–13740B30	16 pF
C522	21–13740B21	6.8 pF ± 0.25 pF
C523,524	21–13741B45	0.01
C526	23–62998B59	1, ±20%, 16V, tantalum
C527	21–13741B69	0.1
C528–530	21–13741B45	0.01
C532	23–62998B73	10, ±20%, 16V, tantalum
C533–535	21–13741B45	0.01
C548	23–62998B59	1, ±20%, 16V, tantalum
C554	21–13741A13	470 pF
C556–559	21–13741A13	470 pF
C561–566	21–13741A13	470 pF
C569–572	21–13741A13	470 pF
C574–579	21–13741A13	470 pF
C581–586	21–13741A13	470 pF
C588	21–13741A13	470 pF
C700	23–62998B16	3.3, ±10%, 16V
C701	21–13741B69	0.1
C704,705	21–13741B69	0.1
C706	23–62998B16	3.3, ±10%, 16V, tantalum
C707	23–62998B55	0.47, ±20%, 25V, tantalum
C708	21–13741B45	0.01
C709	23–62998B16	3.3, ±10%, 16V, tantalum
diode (see note)		
CR400–402	48–82958R01	zener, 15V (HLN6062B ONLY)
CR404	48–82958R01	zener, 15V (HLN6062B ONLY)
CR500,501	48–80066M01	signal, type RSL4148
CR534	48–82958R01	zener, 15V (HLN6062B ONLY)
CR530	48–82958R01	zener, 15V (HLN6062B ONLY)
CR534–536	48–82958R01	zener, 15V (HLN6062B ONLY)
CR538	48–82958R01	zener, 15V (HLN6062B ONLY)
fuse		
F500	65–80011N01	3.5 amp fast blow
connector receptacle		
J500A	09–80104M01	bottom entry, 24 contact
J502	09–80103M02	right angle, 38 contact
jumper		
JU502	06–11077A01	0
JU709	06–11077A01	0
coil, RF		
L500	24–80140E16	inductor, 10uH
L520	24–80140E16	inductor, 10uH
L521	24–82939M16	inductor, 22uH, ±3%
L523–531	24–80140E16	inductor, 10uH
connector plug		
P501	28–80102M01	vertical, 24 contacts
P503	28–80267M01	right angle, 26 contacts
P505	09–80168M01	37 contacts
transistor (see note)		
Q400	48–80141L01	PNP
Q401	48–80048M01	NPN
Q500	48–80182D45	PNP
Q501	48–80053M02	NPN
Q502	48–80182D46	NPN
Q503	48–80141L02	NPN
Q504	48–05128M27	PNP
Q505	48–80048M01	NPN
Q506	48–05128M27	PNP
Q520	48–80141L02	NPN
Q521	48–80182D46	NPN
Q538	48–80048M01	NPN

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R400	06–11077B15	47k
R405	06–11077B11	33k
R406	06–11077B23	100k
R407	06–11077A74	1k
R408	06–11077A94	6.8k
R409	06–11077A74	1k
R410	06–11077A94	6.8k
R413	06–11077B21	82k
R414	06–11077A74	1k
R415	06–11077A68	560
R416,418	06–11077A68	10k
R419	06–11077B23	100k
R420	06–11077A74	1k
R421	06–11077A90	4.7k
R422	06–11077A74	1k
R423	06–11077A68	560
R424	06–11077A74	1k
R454	06–11077B23	100k
R455	06–11077B21	82k
R456	06–11077B11	33k
R457,458	06–11077A10	2.2
R500	06–11077A50	100
R501	06–11077A74	1k
R502	06–11077A10	2.2
R503	06–11077A68	10k
R504	06–11077A74	1k
R505,506	06–11077A58	220
R507	06–11077B15	47k
R508,509	06–11077B19	68k
R510	06–11077A98	10k
R511	06–11077A74	1k
R512	06–11077A58	220
R513	06–11077A50	100
R514	06–11077A68	560
R515	06–11077A74	1k
R516	06–11077B23	100k
R517	06–11077A10	2.2
R520	06–11077A74	1k
R521	06–11077B15	47k
R522	06–11077A78	1.5k
R523	06–11077A82	2.2k
R524	06–11077B23	100k
R525	06–11077A50	100
R526–531	06–11077B15	47k
R533	06–11077A74	1k
R538	06–11077B23	100k
R539	06–11077A98	10k
R543	06–11077A82	2.2k
R544	06–11077A98	10k
R546,547	06–11077A98	10k
R549	06–11077B23	100k
R550,551	06–11077A98	10k
R552	06–11077A82	2.2k
R554,555	06–11077A98	10k
R557	06–11077A98	10k
R558	06–11077A74	1k
R563	06–11077B47	1 MEG
R564	06–11077A86	3.3k
R568–572	06–11077A98	10k
R573	06–11077A74	1k
R574	06–11077A98	10k
R577,578	06–11077A68	10k
R579,580	06–11077A74	1k
R581	06–11077A98	10k
R701,702	06–11077B15	47k
R704	06–11077B15	47k
R705	06–11077A98	10k
integrated circuit (see note)		
U400	51–83977M74	audio filter
U401	51–83222M49	quad op–amp, 22M49
U450	51–80365C17	bridge, audio amplifier 4.5 amp 20 watt
U500	51–83977M70	regulator, power control bipolar
U502	51–83977M73	digital–analog converter CMOS
U503	51–80056M02	precision voltage reference, 2.5V
U520	51–97024A01	microprocessor, MC68HC11A1CFN
U521	51–82862N09	gate array, HCA6312
U522	51–83977M72	serial input/output device
U523	51–84704M60	analog multiplexer, CMOS 04M60
U700	51–83977M75	signalling filter, CMOS
crystal (see note)		
Y520	48–80173D10	crystal 7.9488 MHz
mechanical parts		
	26–80119M01	shield, command fence
	75–05295B01	pad, crystal
	54–80004N01	barcode label

3/31/89

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

Schematics, Circuit Board Diagrams, and Parts Lists for HLN6062A, HLN6062B, and HLN6064A *SPECTRA* Command Board
PW–5776–A
(Sheet 3 of 4)
3/31/89

parts list

HLN6062A Command Board — MXW–5775–A

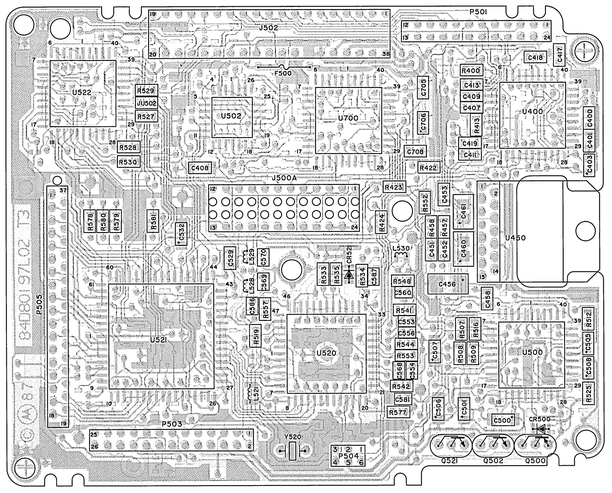
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C400	21–60521B37	0.1, ±5%, 25V
C401	21–11032A53	0.1
C402	23–62998B55	0.47, ±20%, 25V, tantalum
C403	23–62998B59	1, ±20%, 16V, tantalum
C406	23–62998B73	10, ±20%, 16V, tantalum
C407	21–11032A53	0.1
C408	23–62998B73	10, ±20%, 16V, tantalum
C409	21–11032A53	0.1
C411	23–62998B55	0.47, ±20%, 25V, tantalum
C413	21–11032A21	0.01
C416	23–62998B73	10, ±20%, 16V, tantalum
C417,416	21–11032A33	0.1
C419	21–11032A16	0.0039
C420	21–11032A53	0.1
C431–454	21–60521B37	0.1, ±5%, 25V
C455	21–11031A47	220 pF, ±5%
C456	23–80293M24	10, ±20%, electrolytic
C457,458	21–11032A53	0.1
C460,461	23–80293M06	10, ±20%, 16V, electrolytic
C473,474	21–60521C09	470, 25V
C476–478	21–60521C09	470, 25V
C480	21–60521C09	470, 25V
C500,501	23–62998B73	10, ±20%, 16V, tantalum
C502	21–11031A26	30 pF, ±5%
C503	23–62998B59	1, ±20%, 16V, tantalum
C504	21–11031A26	30 pF, ±5%
C505	23–62998B55	0.47, ±20%, 25V, tantalum
C506,507	23–62998B73	10, ±20%, 16V, tantalum
C508	23–62998B59	1, ±20%, 16V, tantalum
C520	21–11031A18	15 pF, ±5%
C521	21–11031A30	16 pF, ±5%
C522	21–11031A11	6.8 pF, ±5%
C523,524	21–11032A21	0.01
C526	23–62998B59	1, ±20%, 16V, tantalum
C527	21–60521B37	0.1, ±5%, 25V
C528–530	21–11032A21	0.01
C532	23–62998B73	10, ±20%, 16V, tantalum
C533–535	21–11032A21	0.01
C548	23–62998B59	1, ±20%, 16V, tantalum
C550–553	21–60521C09	470, 25V
C554	21–60521C09	470, 25V
C556–566	21–60521C09	470, 25V
C569–572	21–60521C09	470, 25V
C574–579	21–60521C09	470, 25V
C581–588	21–60521C09	470, 25V
C700	23–62998B16	3.3, +80–20%
C701	21–11032A53	0.1
C704,705	21–11032A33	0.1
C706	23–62998B16	3.3, +80–20%
C707	23–62998B55	0.47, ±20%, 25V, tantalum
C708	21–11032A33	0.1
C709	23–62998B16	3.3, +80–20%
diode (see note)		
CR400–404	48–82958R91	zener, 15V
CR500,501	48–80066M01	signal, type RSL4148
CR521	48–82958R91	zener, 15V
CR523	48–80066M01	signal, type RSL4148
CR524	48–82958R91	zener, 15V
CR530	48–82958R91	zener, 15V
CR534–538	48–82958R91	zener, 15V
fuse		
F500	65–80011N01	3.5 amp fast blow
connector receptacle		
J500A	09–80104M01	bottom entry, 24 contact
J502	09–80103M02	right angle, 38 contact
jumper		
JU502	06–11077A01	0 ohm
JU709	06–11077A01	0 ohm
coil, RF		
L500	24–80140E16	inductor, 10 uH
L520	24–80140E16	inductor, 10 uH
L521	24–82939M16	inductor, 22 uH, ±3%
L523–531	24–80140E16	inductor, 10 uH
connector plug		
P501	28–80102M01	vertical, 24 contacts
P503	28–80267M01	right angle, 26 contacts
P504	28–80102M04	amp, 5 contacts
P505	09–80168M01	37 contacts
transistor (see note)		
Q400	48–80141L01	PNP
Q401	48–80048M01	NPN
Q500	48–80182D45	PNP
Q501	48–80053M02	NPN
Q502	48–80182D46	NPN
Q503	48–80141L02	NPN
Q504	48–05128M27	PNP
Q505	48–80048M01	NPN
Q506	48–05128M27	PNP
Q520	48–80141L02	NPN
Q521	48–80182D46	NPN
Q538	48–80048M01	NPN
Q540	48–80048M01	NPN

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R400	06–11077B15	47k
R405	06–11077B11	33k
R406	06–11077B23	100k
R407	06–11077A74	1k
R408	06–11077A94	6.8k
R409	06–11077A74	1k
R410	06–11077A94	6.8k
R413	06–11077B21	82k
R414	06–11077A74	1k
R415	06–11077A68	560
R416–418	06–11077A68	10k
R419	06–11077B23	100k
R420	06–11077A74	1k
R421	06–11077A90	4.7k
R422	06–11077A74	1k
R423	06–11077A68	560
R424	06–11077A74	1k
R454	06–11077B23	100k
R455	06–11077B21	82k
R456	06–11077B11	33k
R457,458	06–11077A10	2.2
R500	06–11077A50	100
R501	06–11077A74	1k
R502	06–11077A10	2.2
R503	06–11077A68	10k
R504	06–11077A74	1k
R505,506	06–11077A58	220
R507	06–11077B15	47k
R508,509	06–11077B19	68k
R510	06–11077A98	10k
R511	06–11077A74	1k
R512	06–11077A58	220
R513	06–11077A50	100
R514	06–11077A68	560
R515	06–11077A74	1k
R516	06–11077B23	100k
R517	06–11077A10	2.2
R518	06–11077B15	47k
R519	06–11077A68	10k
R520	06–11077A74	1k
R521	06–11077B15	47k
R522	06–11077A78	1.5k
R523	06–11077A82	2.2k
R524	06–11077B23	100k
R525	06–11077A50	100
R526–531	06–11077B15	47k
R533	06–11077A74	1k
R534	06–11077A50	100
R535	06–11077B23	100k
R537	06–11077A82	2.2k
R538	06–11077B23	100k
R541,542	06–11077A68	10k
R543	06–11077A82	2.2k
R544	06–11077A68	10k
R546–548	06–11077A98	10k
R549	06–11077B23	100k
R550,551	06–11077A98	10k
R552	06–11077A82	2.2k
R553–555	06–11077A98	10k
R557	06–11077A98	10k
R558	06–11077A74	1k
R559	06–11077A98	10k
R560	06–11077A74	1k
R563	06–11077B47	1 MEG
R564	06–11077A86	3.3k
R566	06–11077B15	47k
R568–572	06–11077A98	10k
R573	06–11077A74	1k
R574	06–11077A98	10k
R577,578	06–11077A98	10k
R579,580	06–11077A74	1k
R581	06–11077A98	10k
R700	06–11077A98	10k
R701,702	06–11077B15	47k
R704	06–11077B15	47k
R705	06–11077A98	10k
integrated circuit (see note)		
U400	51–83977M74	audio filter
U401	51–83222M49	quad op–amp, 22M49
U450	51–80365C17	bridge, audio amplifier 4.5 amp 20 watt
U500	51–83977M70	regulator, power control bipolar
U502	51–83977M73	digital–analog converter CMOS
U503	51–80056M02	precision voltage reference, 2.5V
U520	51–97024A01	microprocessor, MC68HC11A1CFN
U521	51–82862N09	gate array, HCA6312
U522	51–83977M72	serial input/output device
U523	51–84704M60	analog multiplexer, CMOS 04M60
U700	51–83977M75	signalling filter, CMOS
crystal (see note)		
Y520	48–80173D10	quartz, 7.9488MHZ
mechanical parts		
	26–80108M01	shield, command fence
	75–05295B01	crystal pad
	54–80004N01	label barcode

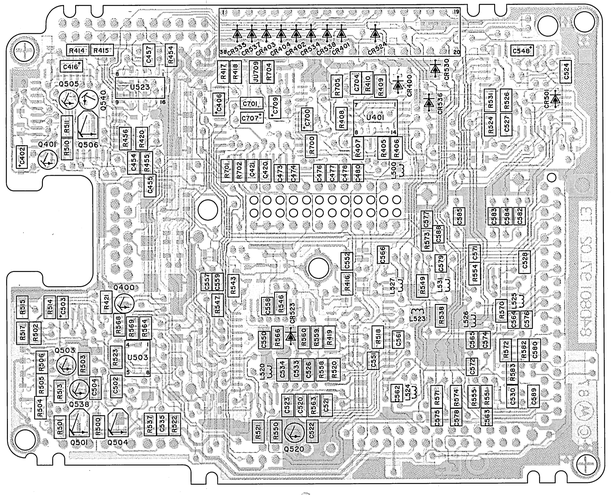
3/31/89

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

HLN6062A, HLN6062B, AND HLN6064A CIRCUIT BOARD




COMPONENT SIDE VIEW



SOLDER SIDE VIEW

Schematics, Circuit Board Diagrams, and Parts Lists
for HLN6062A, HLN6062B, and HLN6064A
SPECTRA Command Board
PW–5776–A
(Sheet 4 of 4)
3/31/89

HLN6064B SCHEMATIC



NOTE :

1. NOT INSTALLED.
2. CAPACITORS WITH NO VALUES ARE 470pF.
3. ALL RESISTANCES ARE IN OHMS, AND ALL CAPACITANCES ARE IN PICOFARADS UNLESS OTHERWISE INDICATED.
4. HLN6074A USES 39C27. HLN6064B USES 41L01. RECOMMENDED REPLACEMENT PART 39C27.

JUMPER	STANDARD
JU0500	OUT
JU0502	IN
JU0510	OUT
JU0511	OUT
JU0512	OUT
JU0513	OUT
JU0514	IN
JU0520	OUT
JU0521	OUT
JU0522	OUT
JU9730	OUT
R9745	OUT
R0001	OUT
JU0709	IN

GXW-4187-D

Schematic, Circuit Board Diagrams, and Parts List
for HLN6064B *SPECTRA* Command Board
PW-5777-A
(Sheet 1 of 2)
3/31/89

parts list

HLN6064B Command Board — MXW–5774–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C400	21–13741N45	0.01, ±10%
C401	21–13741N69	0.1, ±10%
C402	23–11049A35	0.47, ±20%, 25V, tantalum
C403	23–11049A37	1, ±20%, 25V, tantalum
C406	23–11049J26	10, ±20%, 16V, tantalum
C407	21–13741N69	0.1, ±10%
C408	23–11049J26	10, ±20%, 16V, tantalum
C409	21–13741N45	0.01, ±10%
C411	23–11049A35	0.47, ±20%, 25V, tantalum
C413	21–13741N45	0.01, ±10%
C416	23–11049J26	10, ±20%, 16V, tantalum
C417	21–13741N45	0.01, ±10%
C418	21–13741N69	0.1, ±10%
C419	21–13741N35	0.0039, ±10%
C420,421	21–13741N45	0.01, ±10%
C451–454	21–13741N69	0.1, ±10%
C455	21–13740B57	220 pF
C456	23–80090M24	10, ±20%, 50V, electrolytic
C457,458	21–13741N69	0.1, ±10%
C460,461	23–80090M06	10, ±20%, 16V, electrolytic
C474	21–13741M13	470 pF
C476–478	21–13741M13	470 pF
C480	21–13741M13	470 pF
C481	21–13741N21	.001, ±10%
C500,501	23–11049J26	10, ±20%, 16V, tantalum
C502	21–13740B36	30 pF
C503	23–11049A37	1, ±20%, 25V, tantalum
C504	21–13740B36	30pF
C505	21–11049A35	0.47, ±20%, 25V, tantalum
C506,507	23–11049J26	10, ±20%, 16V, tantalum
C508	23–11049A37	1, ±20%, 25V, tantalum
C510	21–13741N69	0.1, ±10%
C520	21–13740B29	15 pF
C521	21–13740B30	16 pF
C522	21–13740B17	4.7 pF, ±.25 pF
C523,524	21–13741N45	0.01, ±10%
C526	23–11049A37	1, ±20%, 25V, tantalum
C527	21–13741N69	0.1, ±10%
C528–530	21–13741N45	0.01, ±10%
C532	23–11049J26	10, ±20%, 16V, tantalum
C533	23–11049A37	1, ±20%, 25V, tantalum
C534,535	21–13741N45	0.01, ±10%
C548	23–11049A37	1, ±20%, 25V, tantalum
C549	21–13741M13	470 pF
C554	21–13741M13	470 pF
C556–559	21–13741M13	470 pF
C561–566	21–13741M13	470 pF
C569–572	21–13741M13	470 pF
C574–579	21–13741M13	470 pF
C580	21–13740B65	470 pF
C581–586	21–13741M13	470 pF
C588	21–13741M13	470 pF
C589	21–13740B65	470 pF
C700	23–11049J07	3.3, ±10%, 20V, tantalum
C701	21–13741N69	0.1, ±10%
C704,705	21–13741N69	0.1, ±10%
C706	23–11049J07	3.3, ±10%, 20V ,tantalum
C707	23–11049A35	0.47, ±20%, 25V, tantalum
C708	21–13741N45	0.01, ±10%
C709	23–11049J07	3.3, ±10%, 20V, tantalum
C800	21–13740B65	470 pF
C802–815	21–13741M13	470 pF
C816	21–13740B65	470 pF
C817–823	21–13741M13	470 pF
C860–864	21–13741M13	470 pF
C865–868	21–13740B65	470 pF
C869–872	21–13741M13	470 pF
C873,874	21–13740B65	470 pF
C875,876	21–13741M13	470 pF
C877	21–13740B65	470 pF
diode (see note)		
CR500,501	48–80066M01	signal, type RSL4148
fuse		
F500	65–80011N01	3.5 amp fast blow
connector receptacle		
J500A	09–80104M01	bottom entry, 24 contact
J502	09–80103M02	right angle, 38 contact
jumper		
JU502	06–11077A01	0 ohm
JU514	06–11077A01	0 ohm
JU709	06–11077A01	0 ohm
coil, RF		
L500	24–80067M01	inductor, 28Mz
L506	24–80067M01	inductor, 28Mz
L521	24–80289M16	inductor, 22uH, ±3%
L528	24–80067M01	inductor, 28Mz
connector plug		
P501	28–80102M01	vertical, 24 contacts
P503	28–80267M01	right angle, 26 contacts
P505	09–80168M01	37 contacts
transistor (see note)		
Q400	48–80141L01	PNP
Q401	48–80048M01	NPN
Q500	48–80182D45	PNP
Q501	48–80053M02	NPN

MXW–5774–A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
Q502	48–80182D46	NPN
Q503	48–80141L02	NPN
Q504	48–05128M27	PNP
Q505	48–80048M01	NPN
Q506	48–05128M27	PNP
Q520	48–80141L02	NPN
Q521	48–80182D46	NPN
Q538	48–80048M01	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R400	06–11077B15	47k
R405	06–11077B11	33k
R406	06–11077B23	100k
R407	06–11077A74	1k
R408	06–11077A94	6.8k
R409	06–11077A74	1k
R410	06–11077A94	6.8k
R413	06–11077B21	82k
R414	06–11077A74	1k
R415	06–11077A68	560
R417,418	06–11077A98	10k
R420	06–11077A74	1k
R421	06–11077B07	22k
R422	06–11077A74	1k
R423	06–11077A68	560
R424	06–11077A74	1k
R454	06–11077B23	100k
R455	06–11077B21	82k
R456	06–11077B11	33k
R457,458	06–11077A10	2.2
R500	06–11077A50	100
R501	06–11077A58	220
R502	06–11077A10	2.2
R503	06–11077A98	10k
R504	06–11077A74	1k
R505,506	06–11077A58	220
R507	06–11077B15	47k
R508,509	06–11077B19	68k
R510	06–11077A98	10k
R511	06–11077A74	1k
R512	06–11077A58	220
R513	06–11077A50	100
R514	06–11077A68	560
R515	06–11077A74	1k
R516	06–11077B23	100k
R517	06–11077A10	2.2
R518	06–11077A19	5.1
R520	06–11077A74	1k
R521	06–11077B15	47k
R522	06–11077A78	1.5k
R523	06–11077A82	2.2k
R524	06–11077B23	100k
R525	06–11077A50	100
R526–531	06–11077B15	47k
R537	06–11077A82	2.2k
R538	06–11077B23	100k
R542	06–11077A98	10k
R543	06–11077A82	2.2k
R544	06–11077A98	10k
R545	06–11077A50	100
R546,547	06–11077A98	10k
R549	06–11077B23	100k
R550,551	06–11077A98	10k
R552	06–11077A82	2.2k
R554,555	06–11077A98	10k
R557	06–11077A98	10k
R558	06–11077A74	1k
R561,562	06–11077A50	100
R563	06–11077B47	1 MEG
R564	06–11077B07	22k
R565	06–11077A50	100
R567	06–11077A50	100
R570–572	06–11077A98	10k
R573	06–11077A74	1k
R574	06–11077A98	10k
R575,576	06–11077A50	100
R577,578	06–11077A98	10k
R579,580	06–11077A74	1k
R581–583	06–11077A98	10k
R584,585	06–11077A50	100
R586	06–11077A98	10k
R700	06–11077A98	10k
R701,702	06–11077B15	47k
R704	06–11077B15	47k
R705	06–11077A98	10k
integrated circuit (see note)		
U400	51–83977M90	audio filter
U401	51–83222M49	quad op–amp, 22M49
U450	51–80065C17	bridge, audio amplifier 4.5 amp 20W
U500	51–83977M70	regulator, power control bipolar
U502	51–83977M73	digital–analog converter CMOS
U503	51–80056M02	precision voltage reference, 2.5V
U520	51–97024A01	microprocessor, MC68HC11A1CFN
U521	51–82862N09	gate array, HCA6312
U522	51–83977M87	serial input/output device
U523	51–84704M60	analog multiplexer, CMOS 04M60
U700	51–83977M75	signalling filter, CMOS
crystal (see note)		
Y520	48–80173D10	crystal 7.9488 MHz 4.00 MHz

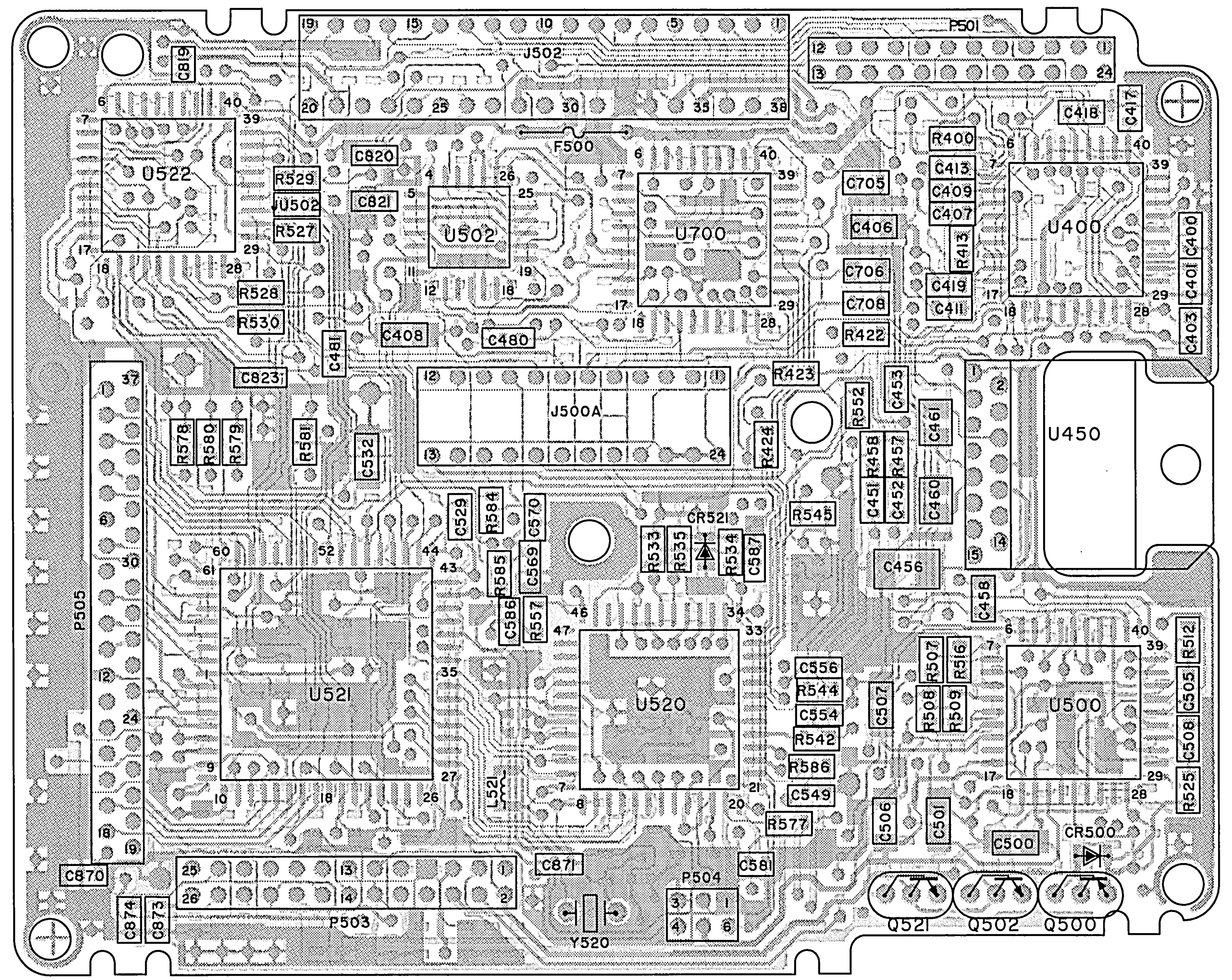
MXW–5774–A (3)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
mechanical parts		
	26–80119M01	shield, command fence
	75–05295B01	pad, crystal
	54–80004N01	barcode label

3/31/89

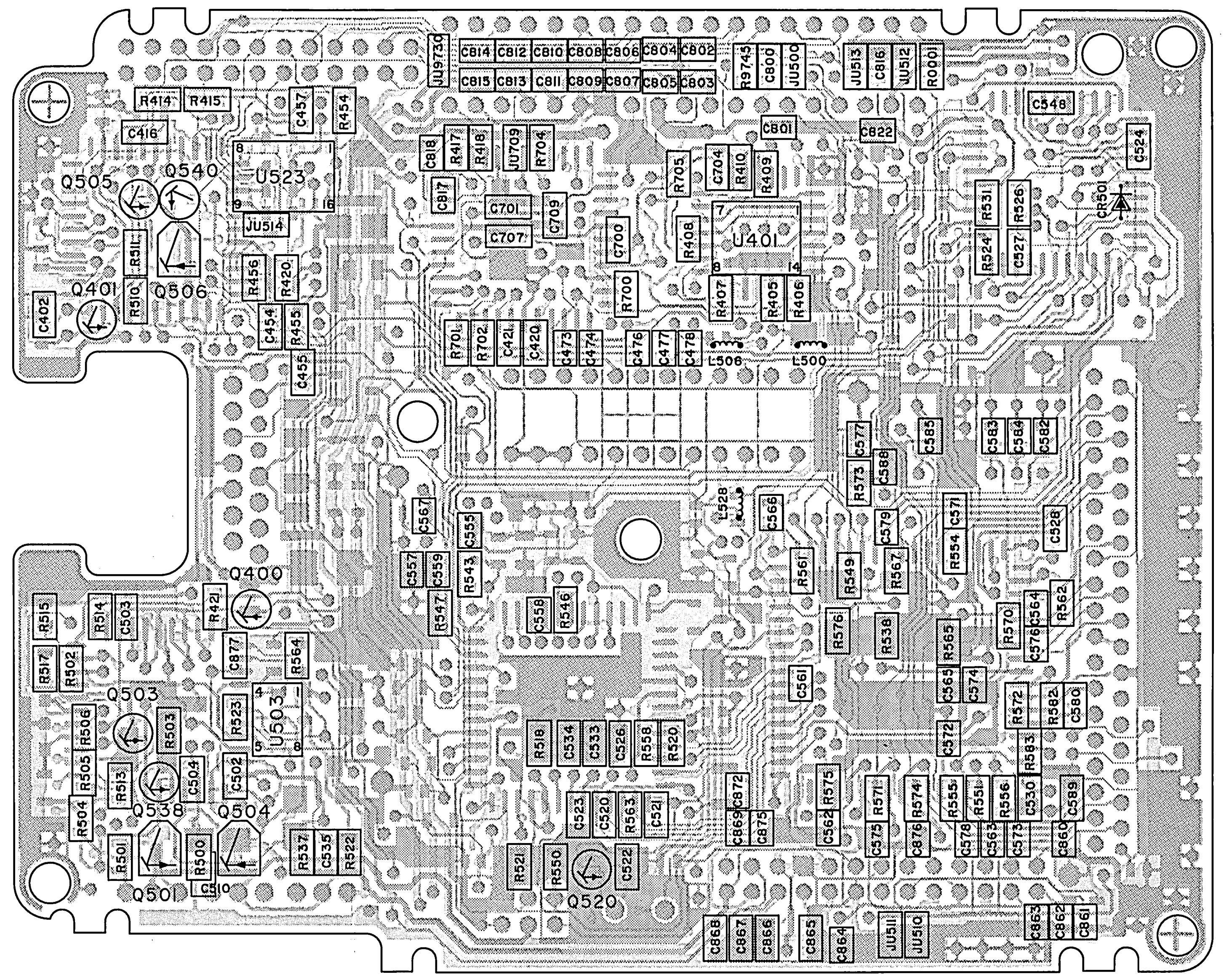
note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

HLN6064B CIRCUIT BOARD



SOLDER SIDE ○ GPW–5778–O
COMPONENT SIDE ● GPW–5779–O
OVERLAY ▬ GXW–5780W01–A

COMPONENT SIDE VIEW

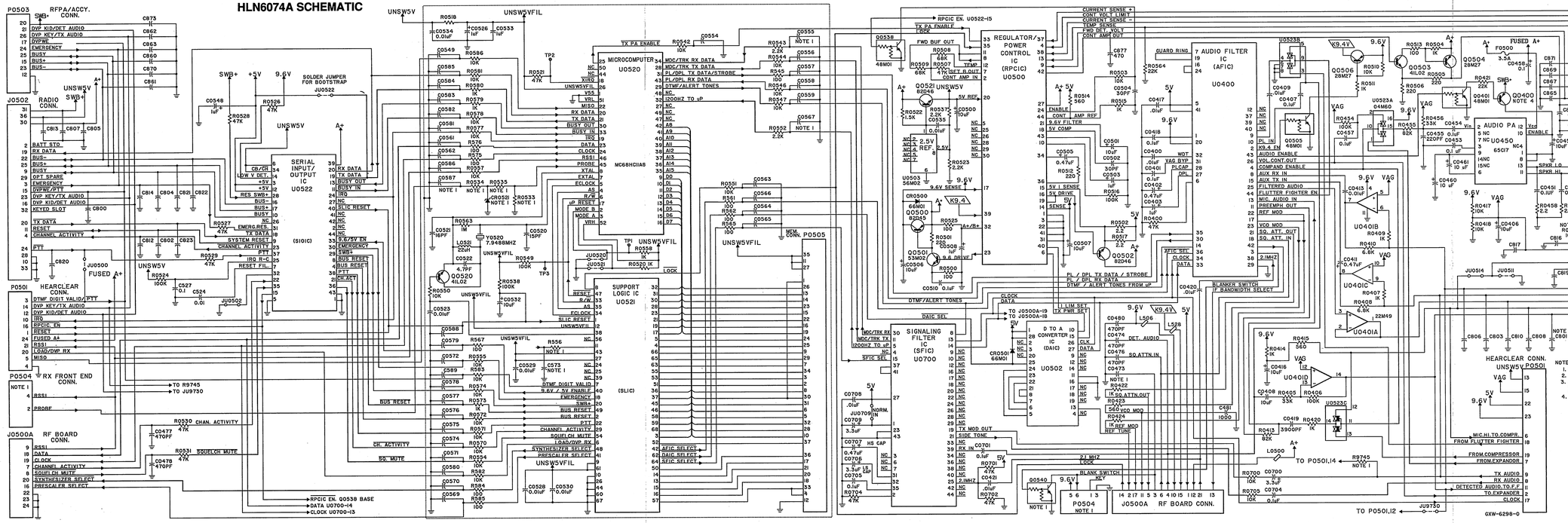


SOLDER SIDE ○ GPW–5778–O
COMPONENT SIDE ● GPW–5779–O
OVERLAY ▬ GXW–5780W02–A

SOLDER SIDE VIEW

Schematic, Circuit Board Diagrams, and Parts List
for HLN6064B *SPECTRA* Command Board
PW–5777–A
(Sheet 2 of 2)
3/31/89

HLN6074A SCHEMATIC



NOTE 1
1. NOT INSTALLED.
2. CAPACITORS WITH NO VALUES ARE 470pF.
3. ALL RESISTANCES ARE IN OHMS, AND ALL CAPACITANCES ARE IN PICOFARADS UNLESS OTHERWISE INDICATED.
4. HLN6074A USES 39C27, HLN6064B USES 41L01. RECOMMENDED REPLACEMENT PART 39C27.

JUMPER	STANDARD
JU0500	OUT
JU0501	OUT
JU0510	OUT
JU0511	OUT
JU0512	OUT
JU0513	OUT
JU0514	IN
JU0520	OUT
JU0521	OUT
JU0522	OUT
JU9730	OUT
R9745	OUT
R0001	OUT
JU0709	IN

Schematic, Circuit Board Diagrams, and Parts List
for HLN6074A *SPECTRA* Command Board
PW-6292-O
(Sheet 1 of 2)
3/31/89

parts list

HLN6074A Command Board — MXW–6293–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C400	21–137411N45	0.01, ±10%
C401	21–137411N69	0.1, ±10%
C402	23–11049A35	0.47, ±20%, 25V, tantalum
C403	23–11049A37	1, ±20%, 25V, tantalum
C406	23–11049J26	10, ±20%, 16V, tantalum
C407	21–137411N69	0.1, ±10%
C408	23–11049J26	10, ±20%, 16V, tantalum
C409	21–137411N45	0.01, ±10%
C411	23–11049A35	0.47, ±20%, 25V, tantalum
C413	21–137411N45	0.01, ±10%
C416	23–11049J26	10, ±20%, 16V, tantalum
C417	21–137411N45	0.01, ±10%
C418	21–137411N69	0.1, ±10%
C419	21–137411N35	0.0039, ±10%
C420,421	21–137411N45	0.01, ±10%
C451–454	21–137411N69	0.1, ±10%
C455	21–137408D37	220 pF
C456	23–80009M24	10, ±20%, 50V, electrolytic
C457,458	23–137411N69	0.1, ±10%
C460,461	23–80009M06	10, ±20%, 16V, electrolytic
C474	21–137411M13	470 pF
C476–478	21–137411M13	470 pF
C480	21–137411M13	470 pF
C481	21–137411N21	.001, ±10%
C500,501	23–11049J26	10, ±20%, 16V, tantalum
C502	21–137408J39	30 pF
C503	23–11049A37	1, ±20%, 25V, tantalum
C504	21–137408J36	30pF
C505	23–11049A35	0.47, ±20%, 25V, tantalum
C506,507	23–11049J26	10, ±20%, 16V, tantalum
C508	23–11049A37	1, ±20%, 25V, tantalum
C510	21–137411N69	0.1, ±10%
C520	21–137408J29	15 pF
C521	21–137408J30	16 pF
C522	21–137408J17	4.7 pF, ±.25 pF
C523,524	21–137411N45	0.01, ±10%
C526	23–11049A37	1, ±20%, 25V, tantalum
C527	21–137411N69	0.1, ±10%
C528–530	21–137411N45	0.01, ±10%
C532	23–11049J26	10, ±20%, 16V, tantalum
C533	23–11049A37	1, ±20%, 25V, tantalum
C534,535	21–137411N45	0.01, ±10%
C548	23–11049A37	1, ±20%, 25V, tantalum
C549	21–137411M13	470 pF
C554	21–137411M13	470 pF
C556–559	21–137411M13	470 pF
C561–566	21–137411M13	470 pF
C569–572	21–137411M13	470 pF
C574–579	21–137411M13	470 pF
C580	21–137408E65	470 pF
C581–586	21–137411M13	470 pF
C588	21–137411M13	470 pF
C589	21–137408E65	470 pF
C700	23–11049J07	3.3, ±10%, 20V, tantalum
C701	21–137411N69	0.1, ±10%
C704,705	21–137411N69	0.1, ±10%
C706	23–11049J07	3.3, ±10%, 20V ,tantalum
C707	23–11049A35	0.47, ±20%, 25V, tantalum
C708	21–137411N45	0.01, ±10%
C709	23–11049J07	3.3, ±10%, 20V, tantalum
C800	21–137408E65	470 pF
C802–815	21–137411M13	470 pF
C816	21–137408E65	470 pF
C817–823	21–137411M13	470 pF
C860–864	21–137411M13	470 pF
C865–868	21–137408E65	470 pF
C869–872	21–137411M13	470 pF
C873,874	21–137408E65	470 pF
C875,876	21–137411M13	470 pF
C877	21–137408E65	470 pF
diode (see note)		
CR500,501	48–80066M01	signal, type RSL4148
fuse		
F500	65–800111N01	3.5 amp fast blow
connector receptacle		
J500A	09–80104M01	bottom entry, 24 contact
J502	09–80103M02	right angle, 38 contact
jumper		
JU502	06–11077A01	0 ohm
JU514	06–11077A01	0 ohm
JU709	06–11077A01	0 ohm
coil, RF		
L500	24–80087M01	Inductor, 28Hz
L506	24–80087M01	Inductor, 28Hz
L521	24–80289M16	Inductor, 22uH, ±3%
L528	24–80087M01	Inductor, 28Hz
connector plug		
P501	28–80102M01	vertical, 24 contacts
P503	28–80267M01	right angle, 26 contacts
P505	09–80168M01	37 contacts
transistor (see note)		
Q400	48–84939C27	PNP
Q401	48–80048M01	NPN
Q500	48–80182D45	PNP
Q501	48–80053M02	NPN

MXW–6293–O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
Q502	48–80182D46	NPN
Q503	48–80141L02	NPN
Q504	48–85128M27	PNP
Q505	48–80048M01	NPN
Q506	48–85128M27	PNP
Q520	48–80141L02	NPN
Q521	48–80182D46	NPN
Q538	48–80048M01	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R400	06–11077B15	47k
R405	06–11077B11	33k
R406	06–11077B23	100k
R407	06–11077A74	1k
R408	06–11077B04	6.8k
R409	06–11077A74	1k
R410	06–11077A94	6.8k
R413	06–11077B21	82k
R414	06–11077A74	1k
R415	06–11077A68	560
R417,418	06–11077A98	10k
R420	06–11077A74	1k
R421	06–11077B07	22k
R422	06–11077A74	1k
R423	06–11077A68	560
R424	06–11077A74	1k
R454	06–11077B23	100k
R455	06–11077B21	82k
R456	06–11077B11	33k
R457,458	06–11077A10	2.2
R500	06–11077A50	100
R501	06–11077A58	220
R502	06–11077A10	2.2
R503	06–11077A98	10k
R504	06–11077A74	1k
R505,506	06–11077A58	220
R507	06–11077B15	47k
R508,509	06–11077B19	68k
R510	06–11077A98	10k
R511	06–11077A74	1k
R512	06–11077A58	220
R513	06–11077A50	100
R514	06–11077A68	560
R515	06–11077A74	1k
R516	06–11077B23	100k
R517	06–11077A10	2.2
R518	06–11077A19	5.1
R520	06–11077A74	1k
R521	06–11077B15	47k
R522	06–11077A78	1.5k
R523	06–11077A82	2.2k
R524	06–11077B23	100k
R525	06–11077A50	100
R526–531	06–11077B15	47k
R537	06–11077A82	2.2k
R538	06–11077B23	100k
R542	06–11077A98	10k
R543	06–11077A82	2.2k
R544	06–11077A98	10k
R545	06–11077A50	100
R546,547	06–11077A98	10k
R549	06–11077B23	100k
R550,551	06–11077A98	10k
R552	06–11077A82	2.2k
R554,555	06–11077A98	10k
R557	06–11077A98	10k
R558	06–11077A74	1k
R561,562	06–11077A50	100
R563	06–11077B47	1 MEG
R564	06–11077B07	22k
R565	06–11077A50	100
R567	06–11077A50	100
R570–572	06–11077A98	10k
R573	06–11077A74	1k
R574	06–11077A98	10k
R575,576	06–11077A50	100
R577,578	06–11077A98	10k
R579,580	06–11077A74	1k
R581–583	06–11077A98	10k
R584,585	06–11077A50	100
R586	06–11077A98	10k
R700	06–11077A98	10k
R701,702	06–11077B15	47k
R704	06–11077B15	47k
R705	06–11077A98	10k
integrated circuit (see note)		
U400	51–83977M90	audio filter
U401	51–83222M49	quad op–amp, 22M49
U450	51–80065C17	bridge, audio amplifier 4.5 amp 20W
U500	51–83977M70	regulator, power control bipolar
U502	51–83977M73	digital–analog converter CMOS
U503	51–80056M02	precision voltage reference, 2.5V
U520	51–97024A01	microprocessor, MC68HC11A1CFN
U521	51–83982N09	gate array, HCA5312
U522	51–83977M87	serial input/output device
U523	51–84704M60	analog multiplexer, CMOS 04M60
U700	51–83977M75	signalling filter, CMOS
crystal (see note)		
Y520	48–80173D10	crystal 7.9488 MHz 4.00 MHz

MXW–6293–O (3)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		mechanical parts
	26–80119M01	shield, command fence
	75–05295B01	pad, crystal
	54–80004N01	barcode label

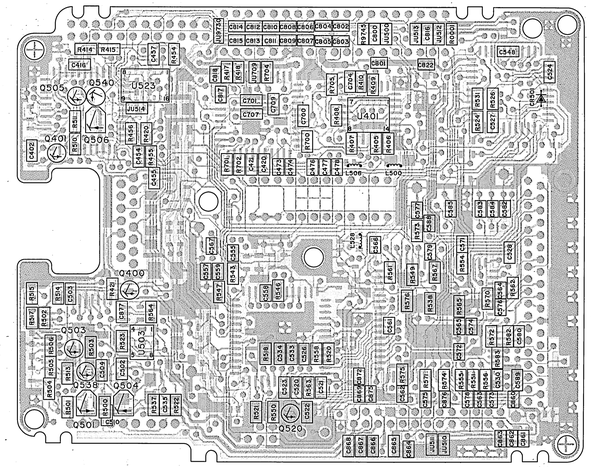
3/31/89

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

HLN6074A CIRCUIT BOARD

SOLDER SIDE — GPW–5778–O
COMPONENT SIDE — GPW–5779–O
OVERLAY — GXW–5780W01–A

COMPONENT SIDE VIEW

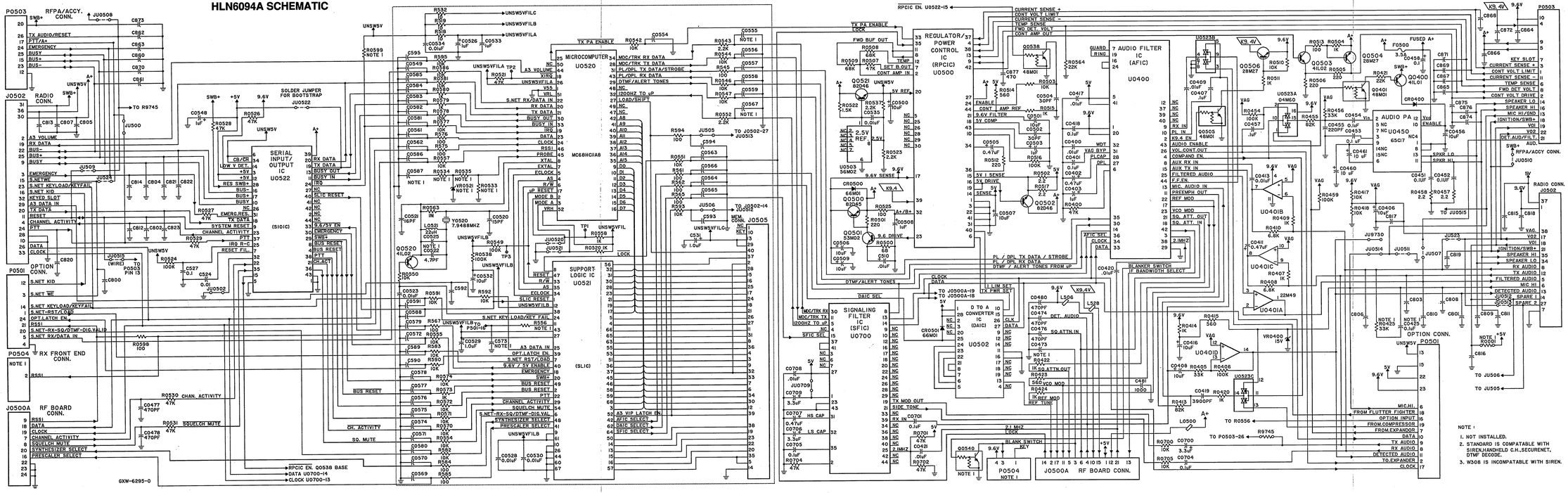


SOLDER SIDE — GPW–5778–O
COMPONENT SIDE — GPW–5779–O
OVERLAY — GXW–5780W02–A

SOLDER SIDE VIEW

Schematic, Circuit Board Diagrams, and Parts List
for HLN6074A *SPECTRA* Command Board
PW–5292–O
(Sheet 2 of 2)
3/31/89

HLN6094A SCHEMATIC

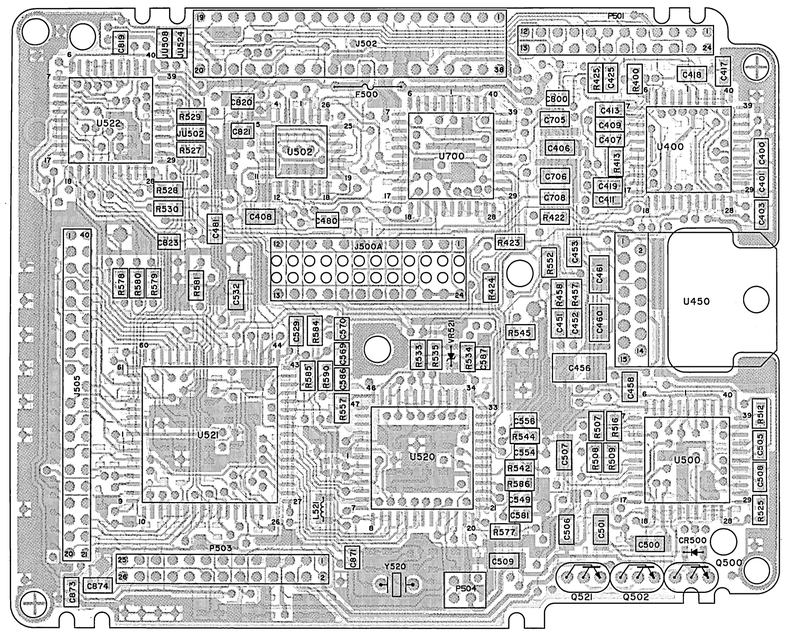


JUMPER	STANDARD
JU0500	IN
JU0502	IN
JU0506	OUT
JU0511	OUT
JU0512	OUT
JU0513	OUT
JU0514	IN
JU0520	OUT
JU0521	OUT
JU0522	OUT
JU9730	IN
R9745	10K
R0001	OUT
JU0709	IN
JU0508	OUT
JU0509	OUT
JU0507	OUT
JU0506	IN
JU0505	IN
JU0524	OUT
JU0523	OUT

NOTE :
1. NOT INSTALLED.
2. STANDARD IS COMPATABLE WITH SIREN,HANDHELD C.H.,SECURENET, DTMF DECODE.
3. W300 IS INCOMPATABLE WITH SIREN.

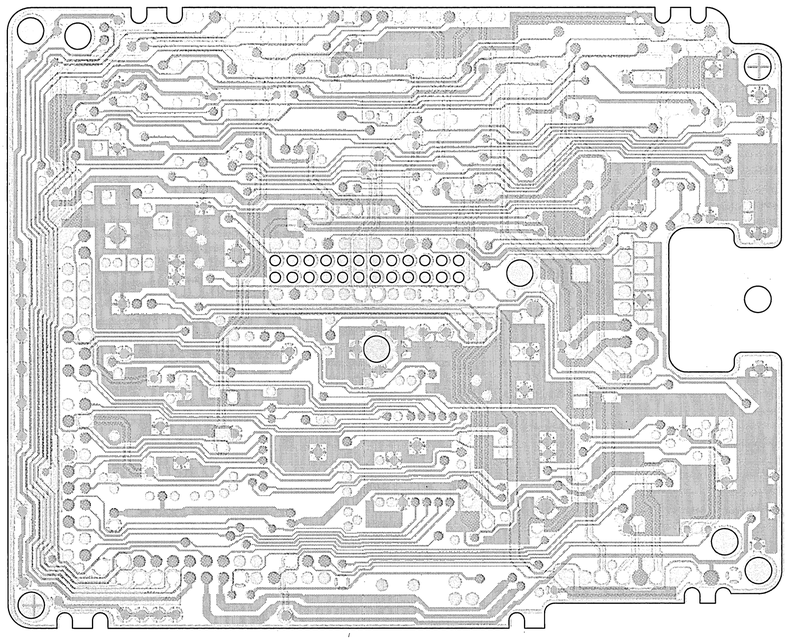
Schematic, Circuit Board Diagrams, and Parts List
for HLN6094A *SPECTRA* Command Board
PW-6294-O
(Sheet 1 of 3)
2/28/89

HLN6094A CIRCUIT BOARD



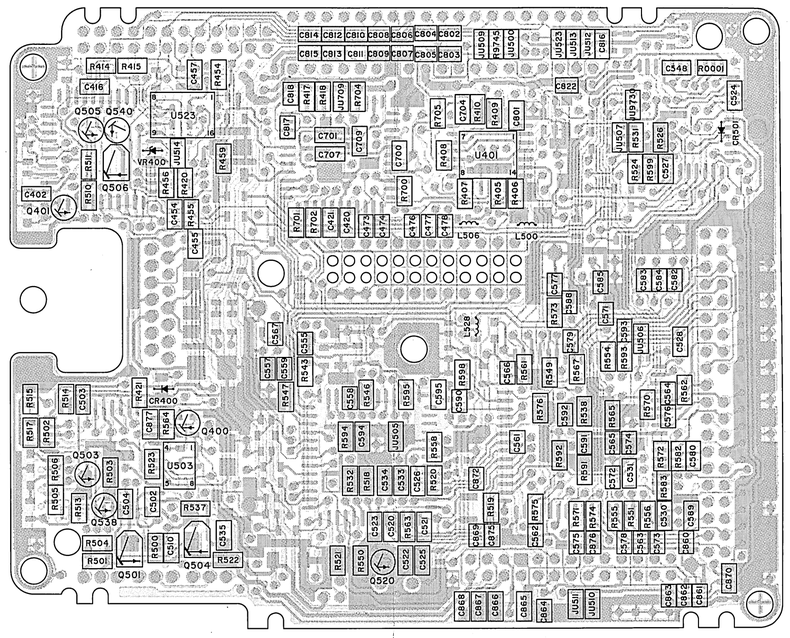
SOLDER SIDE GPW-6296-0
COMPONENT SIDE GPW-6297-0
OVERLAY GXW-6172W01-0

COMPONENT SIDE



LAYER 2 GPW-6368-0
LAYER 3 GPW-6369-0
INNER LAYERS GXW-6172W03-0

INNER LAYERS



SOLDER SIDE GPW-6296-0
COMPONENT SIDE GPW-6297-0
OVERLAY GXW-6172W02-0

SOLDER SIDE

Schematic, Circuit Board Diagrams, and Parts List
for HLN6094A *SPECTRA* Command Board
PW–6294–O
(Sheet 2 of 3)
2/28/89

parts list

HLN6094A Command Board — MXW–6299–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±5%, 50V (unless otherwise stated)		
C400	21–13741N45	0.01, ±10%
C401	21–13741N69	0.1, ±10%
C402	23–11049A35	0.47, ±20%, 25V, tantalum
C403	23–11049A37	1, ±20%, 25V, tantalum
C406	23–11049J26	10, ±20%, 16V, tantalum
C407	21–13741N69	0.1, ±10%
C408	23–11049J26	10, ±20%, 16V, tantalum
C409	21–13741N45	0.01, ±10%
C411	23–11049A35	0.47, ±20%, 25V, tantalum
C413	21–13741N45	0.01, ±10%
C416	23–11049J26	10, ±20%, 16V, tantalum
C417	21–13741N45	0.01, ±10%
C418	21–13741N69	0.1, ±10%
C419	21–13741N35	3900 pF
C420–421	21–13741N45	0.01, ±10%
C451–454	21–13741N69	0.1, ±10%
C455	21–13740B57	220 pF
C456	23–80090M24	10, ±20%, 50V, electrolytic
C457,458	21–13741N69	0.1, ±10%
C460,461	23–80090M06	10, ±20%, 16V, electrolytic
C474	21–13741M13	470 pF
C476–478	21–13741M13	470 pF
C480	21–13741M13	470 pF
C481	21–13741N21	.001, ±10%
C500,501	23–11049J26	10, ±20%, 16V, tantalum
C502	21–13740B36	30 pF
C503	23–11049A37	1, ±20%, 25V, tantalum
C504	21–13740B36	30pF
C505	21–11049A35	0.47, ±20%, 25V, tantalum
C506,507	23–11049J26	10, ±20%, 16V, tantalum
C508	23–11049A37	1, ±20%, 25V, tantalum
C509	23–11049J26	10, ±20%, 16V, tantalum
C510	21–13741N69	0.1, ±10%
C520	21–13740B29	15 pF
C521	21–13740B30	16 pF
C522	21–13740B17	4.7 pF, ±.25 pF
C523,524	21–13741N45	0.01, ±10%
C526	23–11049A37	1, ±20%, 25V, tantalum
C527	21–13741N69	0.1, ±10%
C528	21–13741N45	0.01, ±10%
C529	23–11049A37	1, ±20%, 25V, tantalum
C530	21–13741N45	0.01, ±10%
C531	23–11049A37	1, ±20%, 25V, tantalum
C532	23–11049J26	10, ±20%, 16V, tantalum
C533	23–11049A37	1, ±20%, 25V, tantalum
C534,535	21–13741N45	0.01, ±10%
C548	23–11049A37	1, ±20%, 25V, tantalum
C549	21–13741M13	470 pF
C554	21–13741M13	470 pF
C556–559	21–13741M13	470 pF
C561–566	21–13741M13	470 pF
C569–572	21–13741M13	470 pF
C574–579	21–13741M13	470 pF
C580	21–13740B65	470 pF
C581–586	21–13741M13	470 pF
C588	21–13741M13	470 pF
C589	21–13740B65	470 pF
C590–593	21–13741M13	470 pF
C594,595	21–13740B65	470 pF
C700	23–11045J07	3.3, ±10%, 20V
C701	21–13741N69	0.1, ±10%
C704,705	21–13741N69	0.1, ±10%
C706	23–11045J07	3.3, ±10%, 20V
C707	21–11049A35	0.47, ±20%, 25V, tantalum
C708	21–13741N45	0.01, ±10%
C709	23–11045J07	3.3, ±10%, 20V
C800	21–13741M13	470 pF
C801	21–13740B65	470 pF
C802–815	21–13741M13	470 pF
C816	21–13740B65	470 pF
C817–823	21–13741M13	470 pF
C860–864	21–13741M13	470 pF
C865–868	21–13740B65	470 pF
C869	21–13741M13	470 pF
C870	21–13740B65	470 pF
C871,872	21–13741M13	470 pF
C873,874	21–13740B65	470 pF
C875,876	21–13741A13	470 pF
C877	21–13740B65	470 pF
diode (see note)		
CR400	48–80066M01	signal, type RSL4148
CR500,501	48–80066M01	signal, type RSL4148
fuse		
F500	65–80011N01	3.5 amp fast blow
connector receptacle		
J500	09–80104M01	bottom entry, 24 contact
J502	09–80103M02	right angle, 38 contact
J505	09–80113M05	vertical, 40 contact
jumper		
JU500	06–11077A01	0 ohm
JU502	06–11077A01	0 ohm
JU505,506	06–11077A01	0 ohm
JU514	06–11077A01	0 ohm
JU709	06–11077A01	0 ohm
JU9730	06–11077A01	0 ohm

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
coil, RF		
L500	24–80067M01	inductor, 28Mz
L506	24–80067M01	inductor, 28Mz
L521	24–80289M16	inductor, 22uH, ±3%
L528	24–80067M01	inductor, 28Mz
connector plug		
P501	28–80102M01	vertical, 24 contacts
P503	28–80267M01	right angle, 26 contacts
P505	09–80168M01	37 contacts
transistor (see note)		
Q400	48–80141L01	PNP
Q401	48–80048M01	NPN
Q500	48–80182D45	NPN
Q501	48–80053M02	NPN
Q502	48–80182D46	NPN
Q503	48–80141L02	NPN
Q504	48–05128M27	PNP
Q505	48–80048M01	NPN
Q506	48–05128M27	PNP
Q520	48–80141L02	NPN
Q521	48–80182D46	NPN
Q538	48–80048M01	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R400	06–11077B15	47k
R405	06–11077B11	33k
R406	06–11077B23	100k
R407	06–11077A74	1k
R408	06–11077A94	6.8k
R409	06–11077A74	1k
R410	06–11077A94	6.8k
R413	06–11077B21	82k
R414	06–11077A74	1k
R415	06–11077A68	560
R417,418	06–11077A98	10k
R420	06–11077A74	1k
R421	06–11077B07	22k
R422	06–11077A74	1k
R423	06–11077A68	560
R424	06–11077A74	1k
R454	06–11077B23	100k
R455	06–11077B21	82k
R456	06–11077B11	33k
R457,458	06–11077A10	2.2
R459	06–11077B23	100k
R500	06–11077A46	68
R501	06–11077A58	220
R502	06–11077A10	2.2
R503	06–11077A98	10k
R504	06–11077A74	1k
R505,506	06–11077A58	220
R507	06–11077B15	47k
R508,509	06–11077B19	68k
R510	06–11077A98	10k
R511	06–11077A74	1k
R512	06–11077A58	220
R513	06–11077A50	100
R514	06–11077A68	560
R515	06–11077A74	1k
R516	06–11077B23	100k
R517	06–11077A10	2.2
R518	06–11077A26	10
R519	06–11077A26	10
R520	06–11077A74	1k
R521	06–11077B15	47k
R522	06–11077A78	1.5k
R523	06–11077A82	2.2k
R524	06–11077B23	100k
R525	06–11077A50	100
R526–531	06–11077B15	47k
R532	06–11077A26	10
R537	06–11077A82	2.2k
R538	06–11077B23	100k
R542	06–11077A98	10k
R543	06–11077A82	2.2k
R544	06–11077A98	10k
R545	06–11077A50	100
R546,547	06–11077A98	10k
R549	06–11077B23	100k
R550,551	06–11077A98	10k
R552	06–11077A82	2.2k
R554,555	06–11077A98	10k
R557	06–11077A98	10k
R558	06–11077A74	1k
R561,562	06–11077A50	100
R563	06–11077B47	1 MEG
R564	06–11077B07	22k
R565	06–11077A50	100
R567	06–11077A50	100
R570–572	06–11077A98	10k
R573	06–11077A74	1k
R574	06–11077A98	10k
R575,576	06–11077A50	100
R577,578	06–11077A98	10k
R579,580	06–11077A74	1k
R581,582	06–11077A98	10k
R583	06–11077A98	10k

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R584,585	06–11077A50	100
R586	06–11077A98	10k
R590–593	06–11077A98	10kR
594	06–11077A50	100
R595	06–11077A98	10k
R598	06–11077A50	100
R700	06–11077A98	10k
R701,702	06–11077B15	47k
R704	06–11077B15	47k
R705	06–11077A98	10k
R9745	06–11077A98	10k
integrated circuit (see note)		
U400	51–83977M90	audio filter
U401	51–83222M49	quad op–amp, 22M49
U450	51–80065C17	bridge, audio amplifier 4.5 amp 20W
U500	51–83977M70	regulator, power control bipolar
U502	51–83977M73	digital–analog converter CMOS
U503	51–80056M02	precision voltage reference, 2.5V
U520	51–97024A01	microprocessor, MC68HC11A1CFN
U521	51–82992N09	gate array, HCA6312
U522	51–83977M87	serial input/output device
U523	51–84704M60	analog multiplexer, CMOS 04M60
U700	51–83977M75	signalling filter, CMOS
varactor		
VR400	48–82958R91	15V
crystal (see note)		
Y520	48–80173D10	crystal 7.9488 MHz 4.00 MHz
	mechanical parts	
	26–80119M01	shield, command fence
	75–05295B01	pad, crystal
	54–80004N01	barcode label

2/28/89

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

Schematic, Circuit Board Diagrams, and Parts List
for HLN6094A *SPECTRA* Command Board
PW–6294–O
(Sheet 3 of 3)
2/28/89

HearClear Board

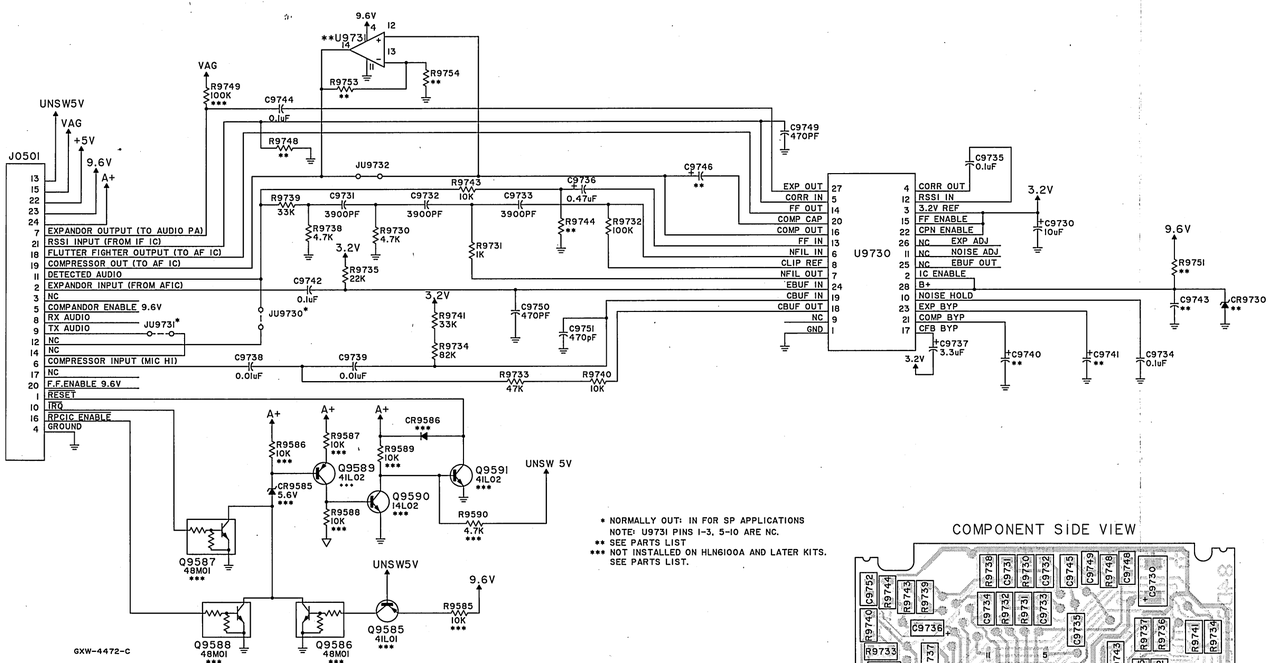
1. Introduction

The *HearClear* board's audio shaping circuitry decreases the effects of multipath (Rayleigh) fading in 900 MHz bands that have 12.5 kHz channel separation. Multipath fading is more pronounced at 900 MHz because of reduced system deviation. Primarily, through dynamic attenuation and companding, the *HearClear* IC reduces noise caused by fading.

When either a fade occurs or high frequency noise (greater than 3 kHz) is present, the *HearClear* IC circuitry dynamically attenuates the audio signal. Companding, similar to that used in cellular radios, further reduces the audible effects of fading by lowering the noise floor of the audio signal.

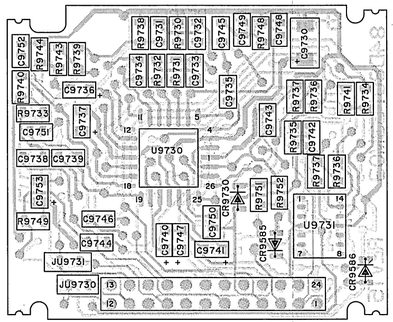
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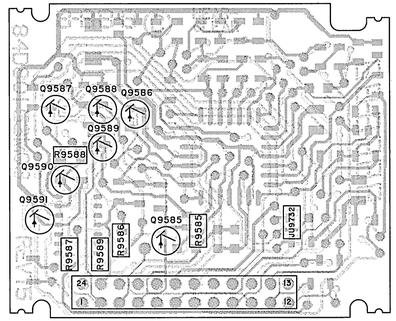


* NORMALLY OUT: IN FOR SP APPLICATIONS
NOTE: U9731 PINS 1-3, 5-10 ARE NC.
** SEE PARTS LIST
*** NOT INSTALLED ON HLN6100A AND LATER KITS. SEE PARTS LIST.

COMPONENT SIDE VIEW



SOLDER SIDE VIEW



SOLDER SIDE — GPW-4701-A
COMPONENT SIDE — GPW-4700-A
OVERLAY — GXW-4702W01-A

SOLDER SIDE — GPW-4701-A
COMPONENT SIDE — GPW-4700-A
OVERLAY — GXW-4702W02-A

parts lists

HLN6100A *HearClear* Board — MXW-6330-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 100V (unless otherwise stated)		
C9730	23-11049J26	10, ±20%, 16V
C9731-9733	21-13741N35	.0039, 50V
C9734	21-13741N69	0.1, 50V
C9736	23-11049A35	0.47, ±20%, 25V
C9737	23-11049J07	3.3, 20V
C9738,9739	21-13741N45	.01, 50V
C9740,9741	23-11049A34	0.33, ±20%, 35V
C9742-9745	21-13741N69	0.1, 50V
C9746	23-11049J07	3.3, 20V
C9749-9751	21-13741M13	470 pF, 50V
connector receptacle		
J501	09-80113M04	24 contacts, 2 rows
jumper		
JU9732	06-11077A01	0 ohm
JU9751	06-11077A01	0 ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9730	06-11077A90	4.7k
R9731	06-11077A74	1k
R9732	06-11077B23	100k
R9733	06-11077B15	47k
R9734	06-11077B21	82k
R9735	06-11077B07	22k
R9738	06-11077A90	4.7k
R9739	06-11077B11	33k
R9740	06-11077A98	10k
R9741	06-11077B11	33k
R9743	06-11077A98	10k
R9744	06-11077A94	6.8k
integrated circuit (see note)		
U9730	51-83977M89	custom CMOS
mechanical parts		
	43-80121M01	PCB spacer
	54-80004N01	barcode label

3/31/89

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

HLN6019A *HearClear* Board — MXW-4661-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V/t6/ (unless otherwise stated)		
C9730	23-62998B73	10, ±20%, 16V, tantalum
C9731-9733	21-11032A16	.0039
C9734,9735	21-60521B37	.1, ±5%, 25V
C9736	23-62998B55	.47, ±20%, 25V, tantalum
C9737	23-62998B66	3.3, ±20%, 16V, tantalum
C9738,9739	21-11032A21	.01
C9740,9741	23-62998B59	1, ±20%, 16V, tantalum
C9742	21-60521B37	.1, ±5%, 25V
C9743	21-11032A33	.1
C9744	21-60521B37	.1, ±5%, 25V
C9746	23-62998B55	.47, ±20%, 25V, tantalum
C9749-9751	21-60521C09	470, 25V
diode (see note)		
CR9585	48-82958R78	Zener, 5.6V
CR9586	48-80066M01	signal, type RLS4148
CR9730	48-82958R48	Zener, 6.8V
connector receptacle		
J501	09-80113M01	24 contacts, 2 rows
transistor (see note)		
Q9585	48-80141L01	PNP, type 41L01
Q9586-9588	48-80048M01	NPN, 47K/47K digital
Q9589	48-80141L01	PNP, type 41L01
Q9590,9591	48-80141L02	NPN, type 41L02
resistor, fixed, ohm,±5%, 1/8 watt (unless otherwise stated)		
R9585-9589	06-11077A98	10K
R9590	06-11077A90	4.7K
R9730	06-11077A90	4.7K
R9731	06-11077A74	1K
R9732	06-11077B23	100K
R9733	06-11077B15	47K
R9734	06-11077B21	82K
R9735	06-11077B07	22K
R9738	06-11077A90	4.7K
R9739	06-11077B11	33K
R9740	06-11077A98	10K
R9741	06-11077B11	33K
R9743,9744	06-11077A98	10K
R9748	06-11077B47	1 MEG
R9749	06-11077B23	100K
R9751	06-11077A58	220
R9753	06-11077A90	4.7K
R9754	06-11077A98	10K
integrated circuit (see note)		
U9730	51-83977M81	custom bipolar, HearClear
U9731	51-83222M49	quad op-amp

8/3/88

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

HLN6019B/HLN6063A *HearClear* Board — MXW-5781-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 50V (unless otherwise stated)		
C9730	23-62998B73	10, ±20%, 16V, tantalum
C9731-9733	21-13741B35	.0039
C9734	21-13741B69	0.1
C9735	21-13741B69	0.1 (HLN6019B ONLY)
C9736	23-62998B55	0.47, ±20%, 25V, tantalum
C9737	23-62998B66	3.3, ±20%, 16V, tantalum
C9738,9739	21-13741B45	0.01
C9740,9741	23-62998B54	0.33 ±20%, 35V, tantalum
C9742-9744	21-13741B69	0.1
C9745	21-13741B69	0.1 (HLN6063A ONLY)
C9746	23-62998B16	3.3, 16V, tantalum
C9749-9751	21-60521C09	470 pF, 25V
diode (see note)		
CR9585	48-82958R78	zener, 5.6V
CR9586	48-80066M01	signal, type RLS4148
connector receptacle		
J501	09-80113M04	24 contacts, 2 rows
jumper		
JU9732	06-11077A01	0 ohm
transistor (see note)		
Q9585	48-80141L01	PNP
Q9586-9588	48-80048M01	NPN
Q9589	48-80141L01	PNP
Q9590,9591	48-80141L02	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9585-9589	06-11077A98	10k
R9590	06-11077A90	4.7k
R9730	06-11077A90	4.7k
R9731	06-11077A74	1k
R9732	06-11077B23	100k
R9733	06-11077B15	47k
R9734	06-11077B21	82k
R9735	06-11077B07	22k
R9738	06-11077A90	4.7k
R9739	06-11077B11	33k
R9740	06-11077A98	10K
R9741	06-11077B11	33k
R9743	06-11077A98	10k
R9744	06-11077A90	4.7k (HLN6019B ONLY)
R9744	06-11077A94	6.8k (HLN6063A ONLY)
R9749	06-11077B23	100k
R9751	06-11077A01	0 ohm
integrated circuit (see note)		
U9730	51-83977M89	custom CMOS
mechanical parts		
	43-80121M01	spacer
	54-80004N01	barcode label

8/3/88

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

Schematic, Circuit Board Diagrams, and Parts Lists for *SPECTRA HearClear* Board
PW-4713-C
3/31/89

Memory Board

1. Description

Most of the data that the *SPECTRA* radio's command board requires is stored in memory devices on the memory board. The devices are: a static random access memory (SRAM) for stack and scratch pad operations, a programmable read–only memory (PROM) for program storage, and an electrically erasable programmable read–only memory (EEPROM) for variable system parameters. The memory board is initially programmed at the factory for specific customer data. Radio Service Software is available for field programming of all conventional features and limited programming of trunked features. All other trunking system parameters may be changed only through TCMS (Trunking Code Management System).

2. Board Replacement

Each memory board is configured to function with a specific radio and may not be interchanged with any other radio. If you attempt to interchange memory boards, the control head will display "FAIL 999" and the transceiver will be disabled. However, all radio test modes remain accessible for troubleshooting purposes.

The memory board is not field repairable; replacement memory boards are available on an exchange–only basis from Motorola National Parts Department. The Radio Service Software must be used to replace a memory board. Once initialized for a specific radio, a replacement memory board may not be initialized a second time. Before you initialize a replacement board, use the radio test modes to be sure that replacing the memory board will solve the problem.

3. Reprogramming the Radio

After the replacement board has been installed and initialized, restore the radio to service by reprogramming it from the codeplug archive file. If the radio codeplug was not archived, conventional radios may be reprogrammed with the Radio Service Software. Replacement codeplug data for trunked radios must be obtained from TCMS. Find additional information in the Radio Service Software User's Manual.

The radio requires no additional tuning or alignment after replacing only the memory board. All alignment parameters are stored in the command board microprocessor (U520) EEPROM.

4. Operation

Normal operation of the memory board is similar to that of any other random access memory device (see Figure 1). When a "read" operation is initiated by the microprocessor and support logic IC, the desired address is placed on the address BUS and carried to the memory board. The OE (Output Enable) line and the desired CS (Chip Select) line are taken to a logic low. Data from the selected memory device is placed on the data BUS and carried to the microprocessor. Similarly, in the "write" operation, the address is provided to the memory board, but in this case, the CS and R/W (Read/Write) lines are taken to a logic low. Data then passes from the microprocessor to the selected memory device via the data BUS.

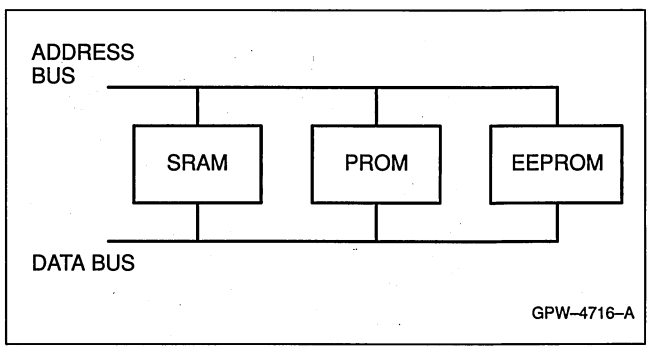


Figure 1. Memory Board Block Diagram

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Voltage Controlled Oscillator (VCO) (VHF)

1. General

The frequency injection string consists of a voltage controlled oscillator (VCO) constructed on a ceramic substrate, and amplifier and divider stages located on the PC board. The components associated with the PC board may be repaired by conventional methods while the VCO substrate should be replaced as a unit.

2. Theory of Operation

2.1 DC VOLTAGE SUPPLIES

The 9.6–volt supply enters the VCO carrier board at J601–2. It powers the receiver amplifier (Q3675) and its associated biasing components. The Keyed 9.4–volt supply enters the carrier board at J601–5, but only during the transmit mode. K9.4 powers U3675 (the 5–volt regulator for divider, U3676) and the transmit amplifier (Q3676) and its biasing components. The 8.6–volt supply enters through J601–12 and passes to MP3652, MP3653, and MP3654 on the VCO substrate. 8.6 supplies Q3640 and Q3641, which bias the output buffer on the VCO substrate, and supplies Q3642 and Q3643, the PIN diode drivers.

2.2 VCO

The VCO utilizes a common–gate FET in a Colpitts configuration as the gain device. The LC tank circuit's capacitive portion consists of a varactor bank and a laser–trimmed stub capacitor. The inductive portion consists of microstrip transmission line resonators. The stub capacitor serves to tune out build variations. Tuning is performed at the factory and is not field adjustable. The varactor network changes the oscillator frequency when the DC voltage of the steering line changes. The microstrip transmission lines are shifted in and out of the tank by PIN diodes for coarse frequency jumps. The varactor bank consists of CR3644, CR3645, and L3648. The positive steering line connects to the cathodes of both varactors through L3647, an RF choke. This line is normally between 0.5 and 8.5 volts DC, depending on the frequency programmed in the synthesizer. The negative steering line connects to the anodes of the varactors through L3646 and is normally –3.9 (±0.3) volts DC.

CR3643, a third varactor tapped into the main transmission line resonator, modulates the oscillator during transmit. 8.6 volts DC supplies bias to the cathode; the anode is referenced to DC ground through R3639. Modulation is coupled to the anode through C3639. R3636, C3636, and R3637 provide filtering and attenuation to the modulation path.

CR3650, C3668, and R3655 provide automatic gain control for the FET. CR3650, a hot carrier diode, detects the peak RF voltage swings on the source of the FET. A negative voltage, proportional to the magnitude of the RF voltage swing, is applied to the gate of the FET, thereby lowering its gain and accomplishing automatic gain control. Typical DC value of the gate bias is –0.8 to –1.7 volts, depending on the state of the oscillator.

PIN diodes, CR3640, CR3641, and CR3642, serve to couple secondary transmission lines into and out of the main oscillator tank, depending on which range the VCO is operating in. $\overline{\text{AUX 1}}$ controls CR3642 and CR3643; $\overline{\text{AUX 2}}$ controls CR3640. When $\overline{\text{AUX 1}}$ goes high, Q3643 turns off and a reverse bias voltage of about 8.6 volts DC is applied to the PIN diodes to turn them off. When $\overline{\text{AUX 1}}$ goes low, Q3643 turns on and a forward bias current of about 15 mA is supplied to the PIN diodes to turn them on. The other PIN diode driver network operates similarly.

The VCO output is coupled through C3672 to Q3675 to amplify the signal and provide load isolation for the VCO. Q3640 and Q3641 provide bias to the stage. Q3675 collector voltage is normally about 5 volts DC.

2.3 SYNTHESIZER FEEDBACK

The synthesizer locks the VCO on–frequency by the VCO feedback to the Prescaler IC on the RF board. The output of the VCO goes into a low–pass filter consisting of C3685, L3676, and C3687. After it is filtered, the signal splits into three directions—the majority of which passes to the RX buffer through a 2 dB attenuator. A smaller portion of the signal passes through C3679 and R3676 to the Divider IC. Finally, another small portion of the signal is fed back to the RF board through L3684 and C3676 to P601–1. Although on a DC connector, P601–1 is an RF–sensitive node. To measure

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the synthesizer feedback power, use a high–impedance probe, or operate the VCO in an external fixture.

2.4 RX BUFFER CIRCUITRY

After the low–pass filtering stage, VCO power is attenuated 2 dB by R3678, R3680, and R3676. The RX buffer is a 50–ohm in–and–out stage that uses L3681 and C3689 for the input match and C3691, L3678, C3692, and R3699 for the output match. 9.6–volts DC supplies the RX buffer for a gain of about 10 dB. R3677 and C3686 help to filter out some of the 9.6 volt supply's noise from the RX buffer. Q3677, Q3678, and associated resistors set the bias level of the RX buffer device, Q3675. The collector voltage and current should be near 6.6 V and 29 mA, respectively. R3682 feeds the base of Q3675 while L3677 is used as the collector choke; R3681, C3690, and C3688 are added to increase stability. Power is fed to the RX Front End through the stand–up connector, J3642.

2.5 DIVIDER IC

The VCO operates at twice the transmit frequency for ease of VCO design. To return the frequency into VHF range, U3676 divides the transmit frequency by two. U3676, an MC12090, high–speed, master flip–flop MECL device, is capable of toggle rates in excess of 700 MHz. A portion of the VCO power is fed to the first clock pin through R3676. R3695 and R3696 set a 3.9–volt bias on the input. The device requires a 5–volt source as its supply to Vcc1 and Vcc2. U3675 is the 5–volt regulator; C3694 and C3696 are added to decrease noise. Keyed 9.4 volts (off during receive mode) supplies U3675, and therefore, U3676. Turning these devices off during receive mode conserves radio current drain. Q and $\overline{Q}$ are at a DC offset and require biasing resistors (R3697 and R3686) to set the current drain (and therefore the power–out) of the device. C3681 and C3697 simply block DC. Both Q and $\overline{Q}$ should have the same impedance; therefore R3698 is added to $\overline{Q}$ to keep its load at 50 ohms. The output of Q is sent to the TX buffer.

2.6 TX BUFFER CIRCUITRY

The TX buffer is a simple amplifier with about 10 dB gain; it uses K9.4 volts for its DC supply. Q3676 is matched to 50 ohms using L3682, C3699, C3683, L3680, and C3698. Q3679, Q3680, and associated resistors set the bias level while R3688 and L3679 feed the bias to the device. The collector voltage and current of the TX buffer should be approximately 5 volts and 33 mA, respectively. The output of the TX buffer goes through a 2.9 dB attenuator (R3692, R3693, and R3694) to the TX–to–PA connector, J3641.

3. Troubleshooting

Use these instructions along with the theory of operation, the block diagram, and the schematic to help isolate failures, first, to the individual circuits, and finally to the failing piece part.

3.1 VCO HYBRID ASSEMBLY

The VCO hybrid substrate is glued to the carrier board. The hybrid is not a field–repairable assembly. If a failure is indicated in this assembly, replace the complete hybrid. You will need a hot air source to heat and soften the glue to separate the hybrid from the carrier board. If no hot air source is available, replace the entire carrier board.

3.2 OUT–OF–LOCK CONDITION

The probable cause of an out–of–lock condition is a failure in the synthesizer circuit. (See the synthesizer troubleshooting information in the RF Board Section.) If the voltages on the $\overline{AUX1}$ and $\overline{AUX2}$ lines do not conform to the table in Figure 1, troubleshoot the synthesizer.

If the $\overline{AUX1}$ and $\overline{AUX2}$ voltages are correct but the synthesizer feedback level is not within the range indicated, troubleshoot the first buffer on the VCO carrier board. If no problem is found with the first buffer and the level out of the VCO is below that indicated on the block diagram, then replace the VCO assembly.

If the $\overline{AUX1}$ and $\overline{AUX2}$ voltages are correct and the synthesizer feedback level is correct but an out–of–lock condition persists, troubleshoot the synthesizer.

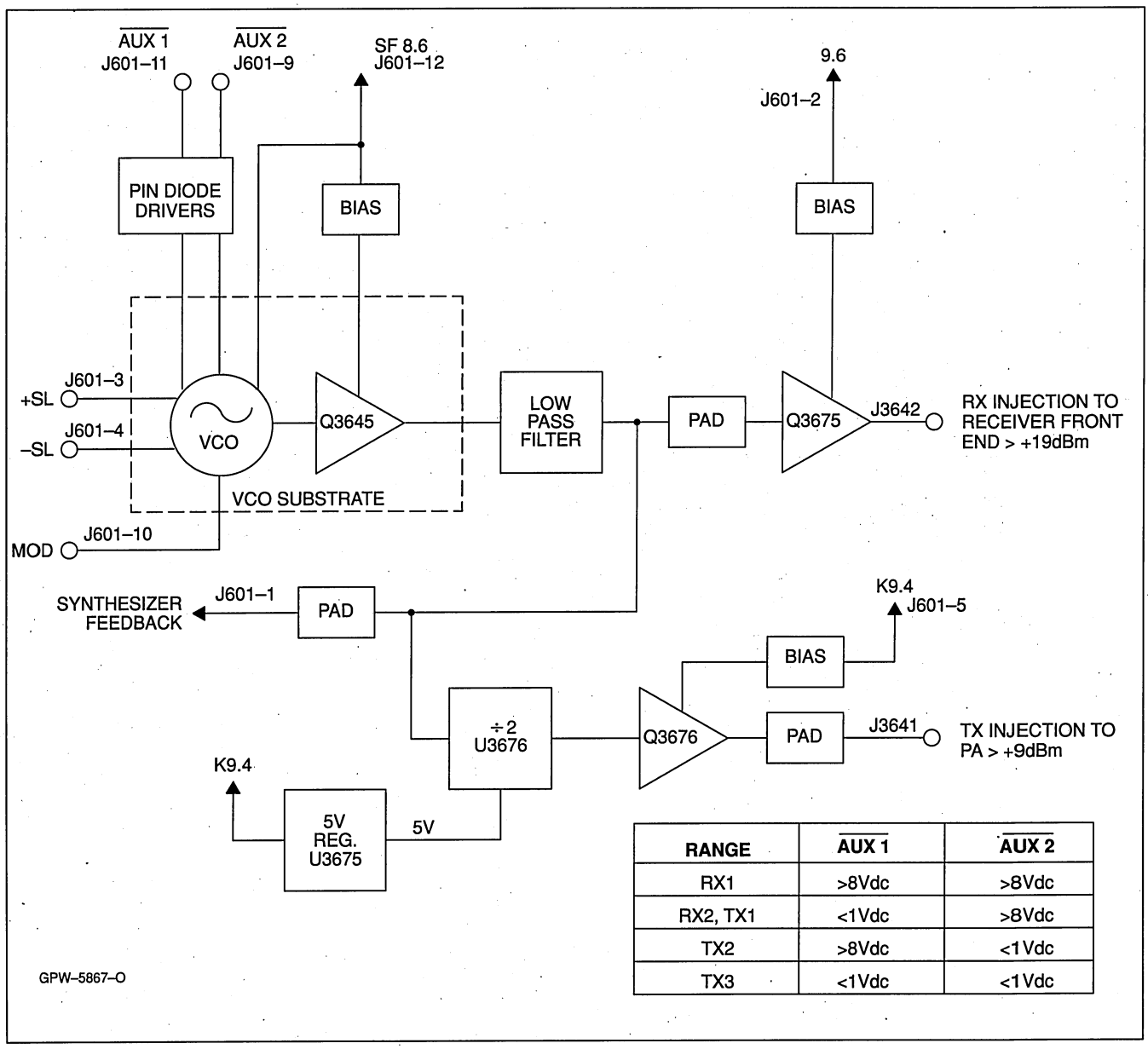
3.3 NO OR LOW OUTPUT POWER TX OR RX INJECTION

Use the test cables listed in the Service Aids in the Service Manual. Measure the power at the synthesizer feedback port—if it is not within the range specified in the block diagram, troubleshoot the first buffer. If failure is found in the first buffer, replace the defective component. If no failure is found in the first buffer and the level out of the VCO (measured with an RF millivolt meter) is below that indicated in the block diagram, then replace the VCO assembly.

If the level at the synthesizer feedback port is within the indicated range, then troubleshoot the divider, RX and TX buffer.

3.4 NO OR LOW MODULATION

Under standard test conditions with a 1 kHz tone injected and 4.5 kHz (±500 Hz) deviation, there should be at least 0.8 volts peak–to–peak present on J601, Pin 10 (modulation input). (See the circuit board overlay for location.) If this level is not present, troubleshoot the audio circuitry. If it is present, check the VCO modulation circuitry.



RANGE	AUX 1	AUX 2
RX1	>8Vdc	>8Vdc
RX2, TX1	<1Vdc	>8Vdc
TX2	>8Vdc	<1Vdc
TX3	<1Vdc	<1Vdc

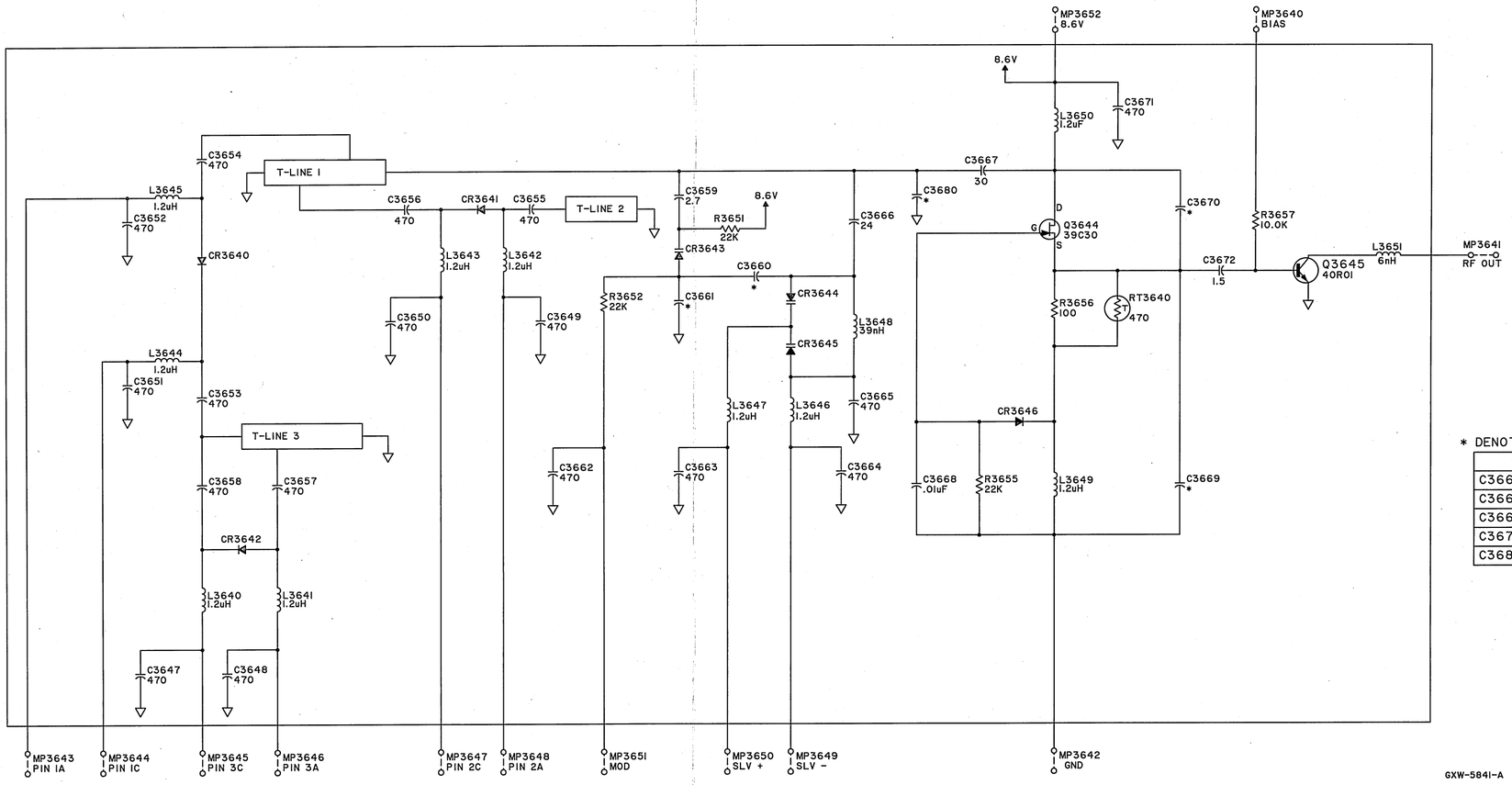
Figure 1. VCO Block Diagram

Table 1. VCO Frequency

Mode	AUX 1	AUX 2	Radio Freq (MHz)	VCO Freq (MHz)	Port Freq (MHz)	Port
VHF RANGE 1						
RX	HIGH	HIGH	136.00 – 158.35	245.65 – 268.00	245.65 – 268.00	(RX)
RX	LOW	HIGH	158.35 – 162.00	268.00 – 271.65	268.00 – 271.65	(RX)
TX	LOW	HIGH	136.00 – 145.20	272.00 – 290.40	136.00 – 145.20	(TX)
TX	HIGH	LOW	145.20 – 157.00	290.40 – 314.00	145.20 – 157.00	(TX)
TX	LOW	LOW	157.00 – 162.00	314.00 – 324.00	157.00 – 162.00	(TX)
VHF RANGE 2						
RX	HIGH	HIGH	146.00 – 166.15	255.65 – 275.80	255.65 – 275.80	(RX)
RX	LOW	HIGH	166.15 – 174.00	275.80 – 283.65	275.80 – 283.65	(RX)
TX	LOW	HIGH	146.00 – 150.00	292.00 – 300.00	146.00 – 150.00	(TX)
TX	HIGH	LOW	150.00 – 162.00	300.00 – 324.00	150.00 – 162.00	(TX)
TX	HIGH	HIGH	162.00 – 174.00	324.00 – 348.00	162.00 – 174.00	(TX)

Note: "HIGH" is >8V, "LOW" is <1V.

VHF VCO HYBRID SCHEMATIC

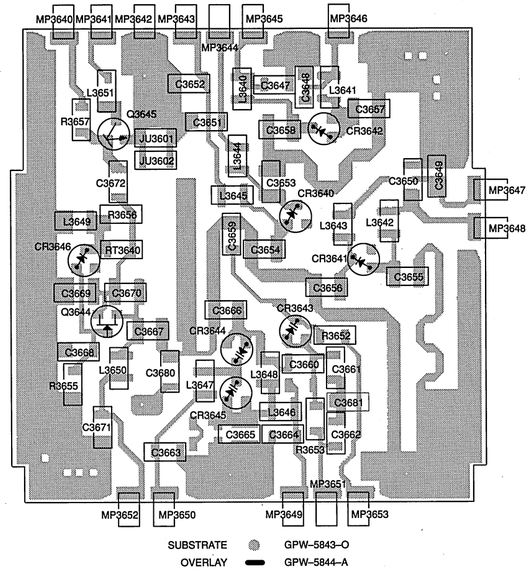


* DENOTES BAND DEPENDENT PARTS

	RANGE 1	RANGE 2
C3660	1.5pF	2.7pF
C3661	5.6pF	6.8pF
C3669	6.8pF	8.2pF
C3670	6.2pF	8.2pF
C3680	1.5pF	NOT USED

Schematic, Circuit Board Diagram, and
Parts Lists for HLD6062A and HLD6061A
SPECTRA VHF VCO Hybrid
PW–5840–A
(Sheet 1 of 2)
3/31/89

VHF VCO HYBRID BOARD



parts list

HLD6062A VHF VCO Hybrid, Range 2, 146/174 MHz — MXW–5860–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C3647–3652	21–13740B65	470
C3653–3558	21–11078B59	470, 100V
C3659,3660	21–13740B11	2.7, ±.25 pF
C3661	21–13740B21	6.8, ±.25 pF
C3662,3663	21–13740B65	470
C3664	21–13741N45	0.01 uF
C3665	21–11078B59	470, 100V
C3666	21–11078B23	24, 100V
C3667	21–11078B27	30, 100V
C3668	21–13741N45	0.01 uF
C3669	21–11078B11	8.2, ±.5 pF, 100V
C3670	21–11078B11	8.2, ±.5 pF, 100V
C3671	21–13740B65	470
C3672	21–13740B05	1.5, ±.25 pF
C3681	21–13740B65	470
diode (see note)		
CR3640–3642	48–80142L01	PIN
CR3643	48–80006E09	varactor
CR3644,3645	48–80006E10	varactor
CR3646	48–80236E05	hot carrier
connector receptacle		
JU3602	06–11077A01	0
coil, RF		
L3640–3647	24–80140E01	1.2 uH
L3648	24–05452C87	39 nH
L3649,3650	24–80140E01	1.2 uH
L3651	24–80091G06	airwound
transistor (see note)		
Q3644	48–80141L06	n–channel JFET
Q3645	48–82940R01	NPN
thermistor		
RT3640	06–80149M01	470 ohms
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R3652	06–11077B07	22k
R3655	06–11077B07	22k
R3656	06–11077A50	100
R3657	06–11077A98	10k
mechanical parts		
MP3640–3653	07–80299L01	frame, J–strap

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

parts list

HLD6061A VHF VCO Hybrid, Range 1, 136/162 MHz — MXW–5842–A

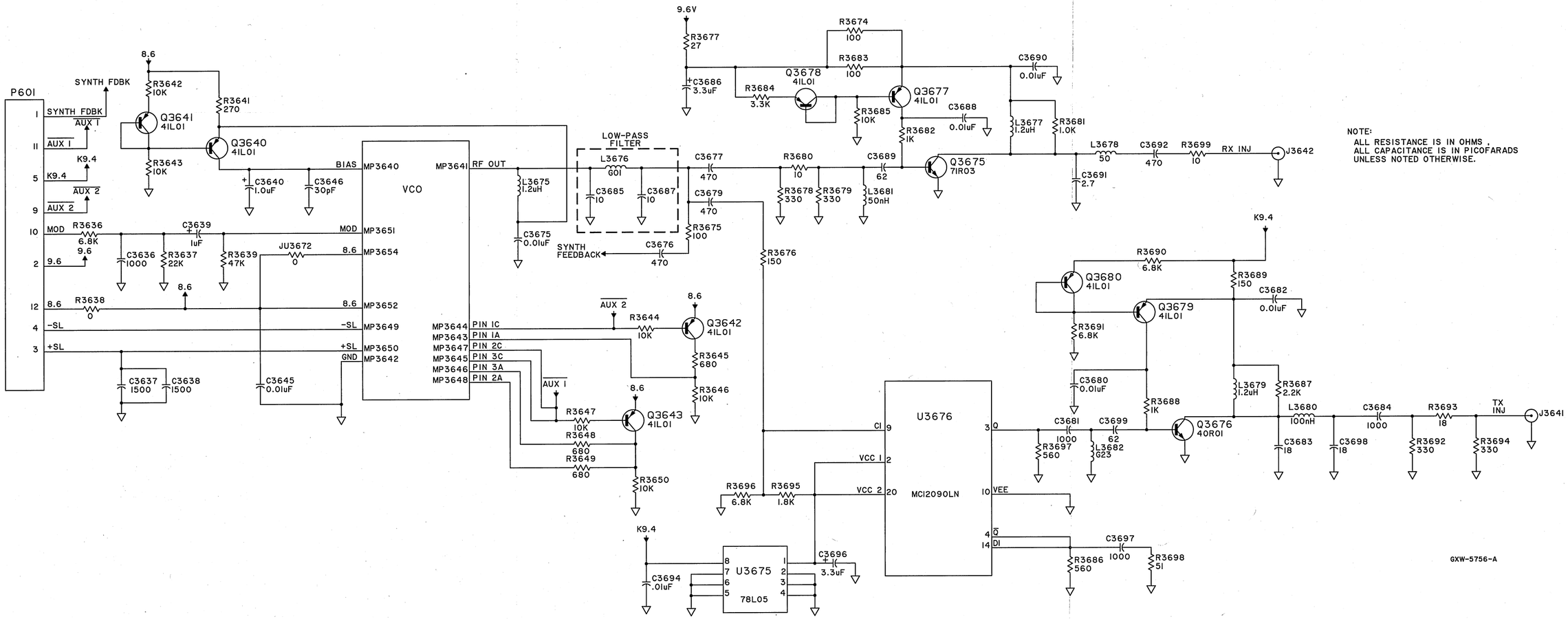
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C3647–3652	21–13740B65	470
C3653–3558	21–11078B59	470, 100V
C3659	21–13740B11	2.7, ±.25 pF
C3660	21–13740B05	1.5, ±.25 pF
C3661	21–13740B19	5.6, ±.25 pF
C3662,3663	21–13740B65	470
C3664	21–13741N45	0.01 uF
C3665	21–11078B59	470, 100V
C3666	21–11078B23	24, 100V
C3667	21–11078B27	30, 100V
C3668	21–13741N45	0.01 uF
C3669	21–13740B21	6.8, ±.25 pF
C3670	21–11078B08	6.2, ±.25 pF, 100V
C3671	21–13740B65	470
C3672	21–13740B05	1.5, ±.25 pF
C3680	21–13740B05	1.5, ±.25 pF
C3681	21–13740B65	470
diode (see note)		
CR3640–3642	48–80142L01	PIN
CR3643	48–80006E09	varactor
CR3644,3645	48–80006E10	varactor
CR3646	48–80236E05	hot carrier
connector receptacle		
JU3602	06–11077A01	0
coil, RF		
L3640–3647	24–80140E01	1.2 uH
L3648	24–05452C87	39 nH
L3649,3650	24–80140E01	1.2 uH
L3651	24–80091G06	airwound
transistor (see note)		
Q3644	48–80141L06	n–channel JFET
Q3645	48–82940R01	NPN
thermistor		
RT3640	06–80149M01	470 ohms
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R3652	06–11077B07	22k
R3655	06–11077B07	22k
R3656	06–11077A50	100
R3657	06–11077A98	10k
mechanical parts		
MP3640–3653	07–80299L01	frame, J–strap

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

Schematic, Circuit Board Diagram, and
Parts Lists for HLD6062A and HLD6061A
SPECTRA VHF VCO Hybrid
PW–5840–A
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HLD6000A SCHEMATIC



Schematics, Circuit Board Diagrams, and
Parts Lists for HLD6000A and HLD6000B
SPECTRA VHF VCO Carrier Board
PW–6383–O
(Sheet 1 of 4)
3/31/89

parts list

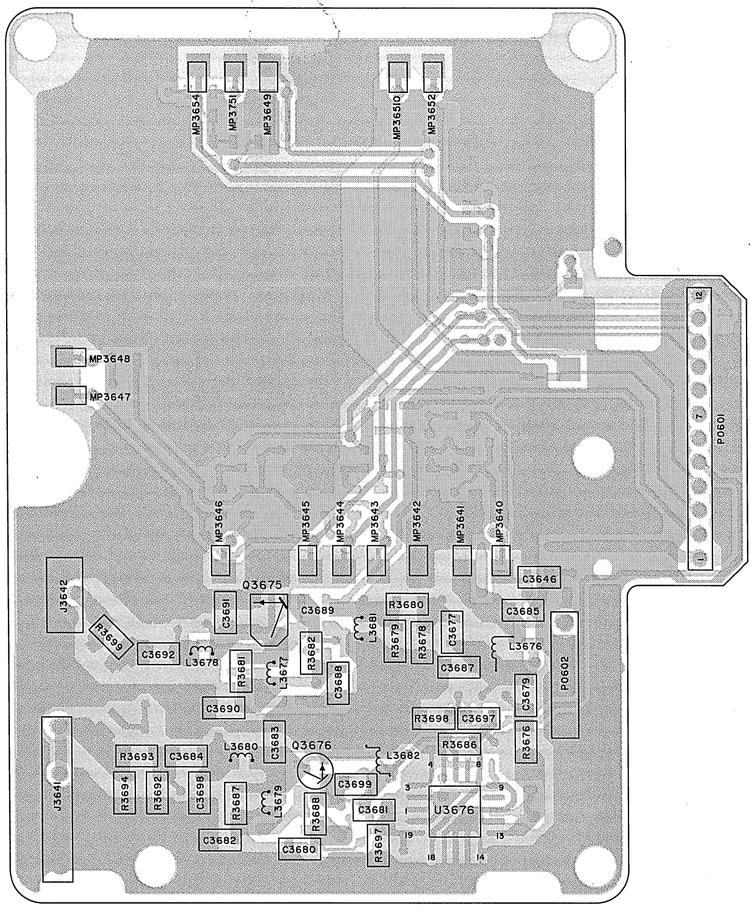
HLD6000A VHF VCO Carrier Board, Divider/Buffer — MXW–5845–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C3636	21–13741N21	1000, ±10%
C3637,3638	21–13740B76	1500
C3639,3640	23–11049A37	1 uF, ±20%, 25V tantalum
C3645	21–13741N45	0.01 uF
C3646	21–13740B36	30
C3675	21–13741N45	0.01 uF
C3676,3677	21–13740B65	470
C3679	21–13740B65	470
C3680	21–13741N45	0.01 uF
C3681	21–13741N21	1000, ±10%
C3682	21–13741N45	0.01 uF
C3683	21–13740B31	18
C3684	21–13741N21	1000, ±10%
C3685	21–13740B25	12
C3686	23–11049J07	3.3, ±10%, 20V
C3687	21–13740B25	10
C3688	21–13741N45	0.01 uF
C3689	21–13740B44	62
C3690	21–13741N45	0.01 uF
C3691	21–13740B11	2.7, ±.25 pF
C3692	21–13740B65	470
C3694	21–13741N45	0.01 uF
C3696	23–11049J07	3.3, ±10%, 20V
C3697	21–13741N21	1000, ±10%
C3698	21–13740B31	18
C3699	21–13740B44	62
connector receptacle		
J3641	09–80110M01	coax, PC board mount
J3642	09–80212N03	coax, PC board mount
jumper		
JU3672	06–11077A01	0
JU3675	06–11077A01	0
coil, RF		
L3675	24–80140E01	1.2 uH
L3676	24–80091G01	airwound
L3677	24–80140E01	1.2 uH
L3678	24–80140E03	50 nH
L3679	24–80140E01	1.2 uH
L3680	24–80140E10	100 nH
L3681	24–80140E03	50 nH
L3682	24–80091G23	airwound
connector plug		
P601	28–80099M03	vertical
transistor (see note)		
Q3640–3643	48–80141L01	PNP
Q3675	48–82971R01	NPN
Q3676	48–82940R01	NPN
Q3677–3680	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R3636	06–11077A94	6.8k
R3637	06–11077B07	22k
R3638	06–11077A01	0
R3639	06–11077B15	47k
R3641	06–11077A60	270
R3642–3644	06–11077A98	10k
R3645	06–11077A70	680
R3646,3647	06–11077A98	10k
R3648,3649	06–11077A70	680
R3650	06–11077A98	10k
R3674,3675	06–11077A50	100
R3676	06–11077A54	150
R3677	06–11077A36	27
R3678,3679	06–11077A62	330
R3680	06–11077A26	10
R3681,3682	06–11077A74	1k
R3683	06–11077A50	100
R3684	06–11077A86	3.3k
R3685	06–11077A98	10k
R3686	06–11077A68	560
R3687	06–11077A82	2.2k
R3688	06–11077A74	1k
R3689	06–11077A54	150
R3690,3691	06–11077A94	6.8k
R3692	06–11077A62	330
R3693	06–11077A32	18
R3694	06–11077A62	330
R3695	06–11077A80	1.8k
R3696	06–11077A94	6.8k
R3697	06–11077A68	560
R3698	06–11077A43	51
R3699	06–11077A26	10
integrated circuit (see note)		
U3675	51–82276R13	voltage regulator, 5V
U3676	51–80135C11	prescaler IC
mechanical parts		
MP3675	54–80004N01	barcode label

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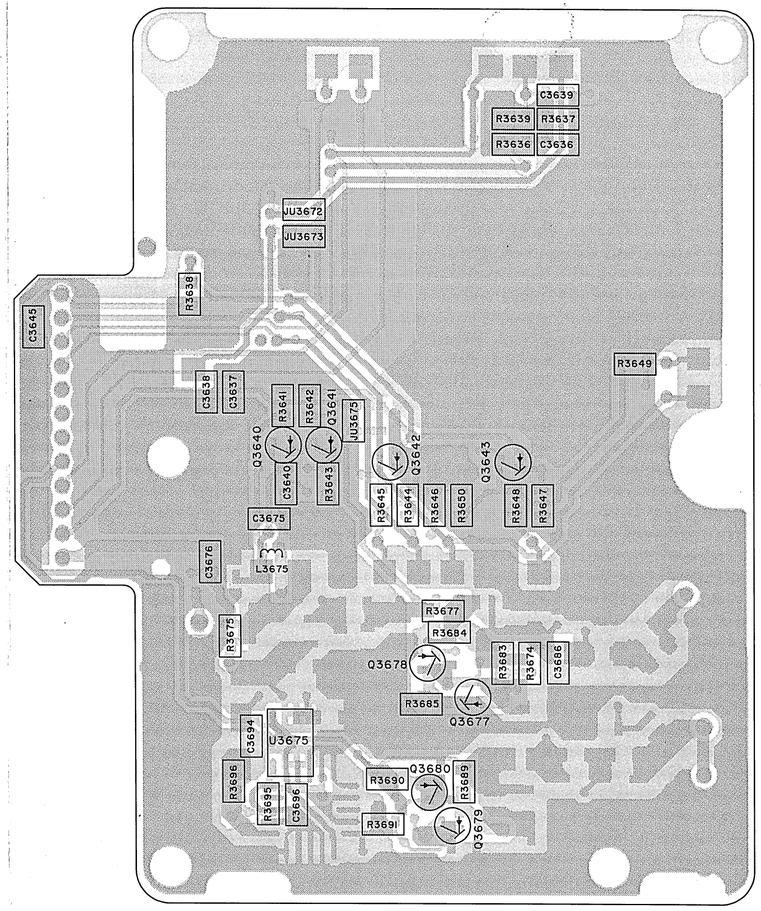
note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

HLD6000A CIRCUIT BOARD



SOLDER SIDE — GPW–5846–O
COMPONENT SIDE — GPW–5847–O
OVERLAY — GXW–5848W01–A

COMPONENT SIDE

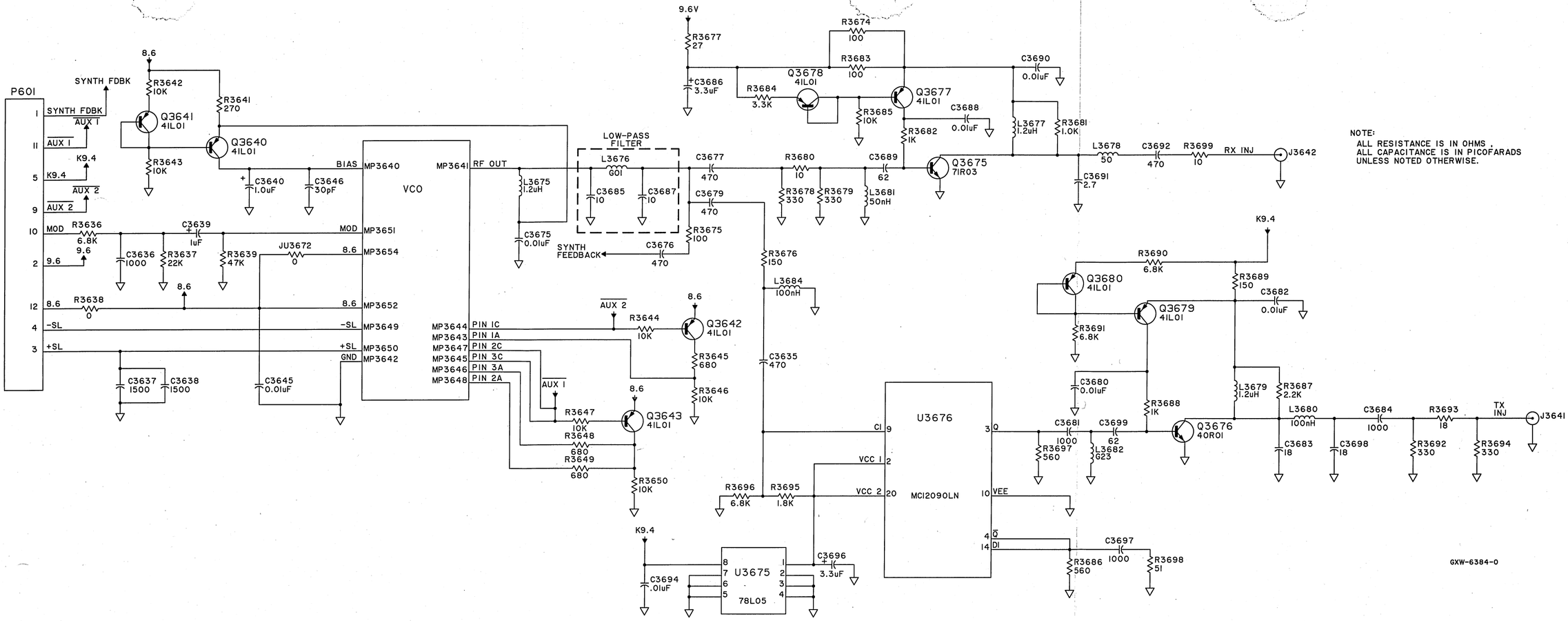


SOLDER SIDE — GPW–5846–O
COMPONENT SIDE — GPW–5847–O
OVERLAY — GXW–5848W02–A

SOLDER SIDE

Schematics, Circuit Board Diagrams, and Parts Lists for HLD6000A and HLD6000B
SPECTRA VHF VCO Carrier Board
PW–6383–O
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HLD6000B SCHEMATIC



Schematics, Circuit Board Diagrams, and
Parts Lists for HLD6000A and HLD6000B
SPECTRA VHF VCO Carrier Board
PW–6383–O
(Sheet 3 of 4)
3/31/89

parts list

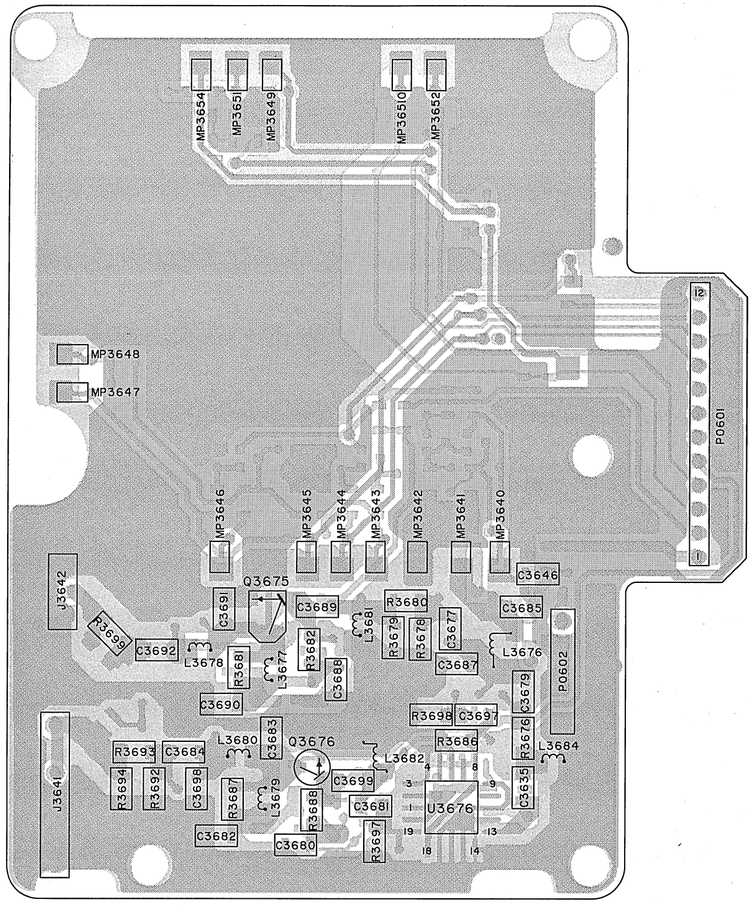
HLD6000B VHF VCO Carrier Board, Divider/Buffer — MXW–6385–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C3635	21–13740B65	470
C3636	21–13741N21	1000, ±10%
C3637,3638	21–13740B76	1500
C3639,3640	23–11049A37	1 uF, ±20%, 25V tantalum
C3645	21–13741N45	0.01 uF
C3646	21–13740B36	30
C3675	21–13741N45	0.01 uF
C3676,3677	21–13740B65	470
C3679	21–13740B65	470
C3680	21–13741N45	0.01 uF
C3681	21–13741N21	1000, ±10%
C3682	21–13741N45	0.01 uF
C3683	21–13740B31	18
C3684	21–13741N21	1000, ±10%
C3685	21–13740B25	10
C3686	23–11049J07	3.3, ±10%, 20V
C3687	21–13740B25	10
C3688	21–13741N45	0.01 uF
C3689	21–13740B44	62
C3690	21–13741N45	0.01 uF
C3691	21–13740B11	2.7, ±.25 pF
C3692	21–13740B65	470
C3694	21–13741N45	0.01 uF
C3696	23–11049J07	3.3, ±10%, 20V
C3697	21–13741N21	1000, ±10%
C3698	21–13740B31	18
C3699	21–13740B44	62
connector receptacle		
J3641	09–80110M01	coax, PC board mount
J3642	09–80212N03	coax, PC board mount
jumper		
JU3672	06–11077A01	0
JU3675	06–11077A01	0
coil, RF		
L3675	24–80140E01	1.2 uH
L3676	24–80091G01	airwound
L3677	24–80140E01	1.2 uH
L3678	24–80140E03	50 nH
L3679	24–80140E01	1.2 uH
L3680	24–80140E10	100 nH
L3681	24–80140E03	50 nH
L3682	24–80091G23	airwound
L3684	24–80140E10	100 nH
connector plug		
P601	28–80099M03	vertical
transistor (see note)		
Q3640–3643	48–80141L01	PNP
Q3675	48–82971R01	NPN
Q3676	48–82940R01	NPN
Q3677–3680	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R3636	06–11077A94	6.8k
R3637	06–11077B07	22k
R3638	06–11077A01	0
R3639	06–11077B15	47k
R3641	06–11077A60	270
R3642–3644	06–11077A98	10k
R3645	06–11077A70	680
R3646,3647	06–11077A98	10k
R3648,3649	06–11077A70	680
R3650	06–11077A98	10k
R3674,3675	06–11077A50	100
R3676	06–11077A54	150
R3677	06–11077A36	27
R3678,3679	06–11077A62	330
R3680	06–11077A26	10
R3681,3682	06–11077A74	1k
R3683	06–11077A50	100
R3684	06–11077A86	3.3k
R3685	06–11077A98	10k
R3686	06–11077A68	560
R3687	06–11077A82	2.2k
R3688	06–11077A74	1k
R3689	06–11077A54	150
R3690,3691	06–11077A94	6.8k
R3692	06–11077A62	330
R3693	06–11077A32	18
R3694	06–11077A62	330
R3695	06–11077A80	1.8k
R3696	06–11077A94	6.8k
R3697	06–11077A68	560
R3698	06–11077A43	51
R3699	06–11077A26	10
integrated circuit (see note)		
U3675	51–82276R13	voltage regulator, 5V
U3676	51–80135C11	prescaler IC
mechanical parts		
MP3675	54–80004N01	barcode label

3/31/89

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

HLD6000B CIRCUIT BOARD

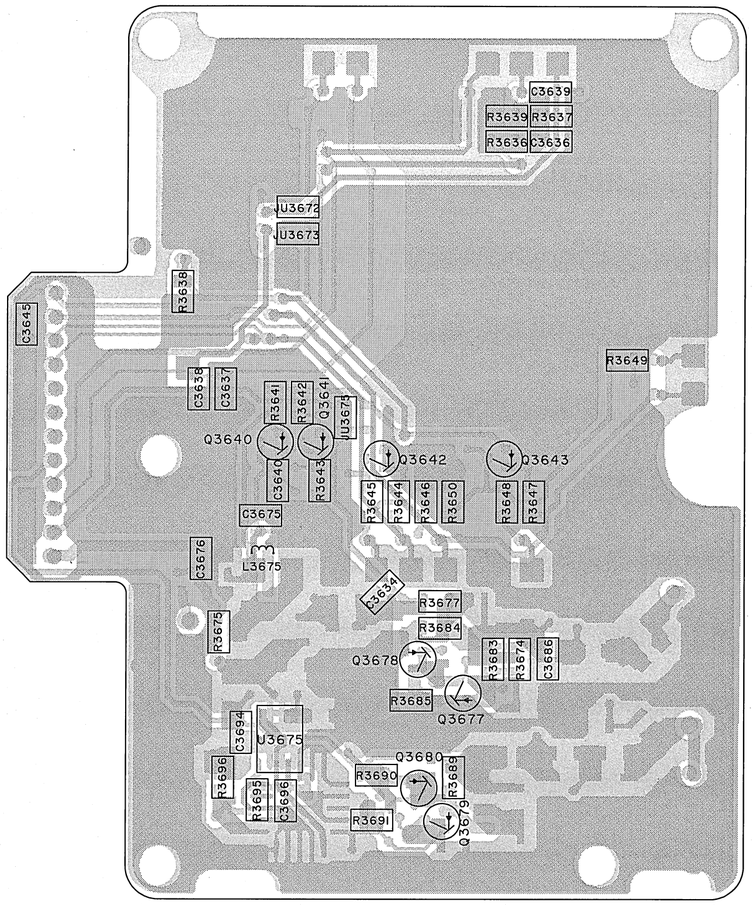


SOLDER SIDE — GPW–6386–O

COMPONENT SIDE — GPW–6387–O

OVERLAY — GXW–6388W01–O

COMPONENT SIDE



SOLDER SIDE — GPW–6386–O

COMPONENT SIDE — GPW–6387–O

OVERLAY — GXW–6388W02–O

SOLDER SIDE

Schematics, Circuit Board Diagrams, and Parts Lists for HLD6000A and HLD6000B
SPECTRA VHF VCO Carrier Board
PW–6383–O
(Sheet 4 of 4)
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MOTOROLA
Mobile Products Division

Voltage Controlled Oscillator (VCO) (UHF)

1. General

The VCO oscillator is located on an alumina substrate with a metallic cover. The buffer–doubler–buffer section is located on the PC board and may be repaired using normal repair methods.

2. Theory of Operation

2.1 SUPER FILTER 8.6V

Super–filtered 8.6 Volts enters the carrier board at J601–12, thru an R–C filter, then on to the drain of Q9610 and the collector of Q9635.

2.2 VCO

The oscillator consists of Q9610, the main transmission line (T–line), varactor bank (CR9616–9617, C9616–9617, L9616) and feedback capacitors (C9611–9613). Components CR9610, C9614, and R9613 form an AGC circuit to prevent breakdown of the FET. Components CR9626 and C9626 form a bandshift circuit to shift the oscillator frequency up 5–10 MHz; C9630–9631 and CR9630 form the Receive shift circuit which shifts the VCO up 50 MHz. The main modulation circuit consists of C9621 and CR9621 in conjunction with the deviation compensating capacitors (C9622 and C9623). Finally, transistor (Q9635), resistors (R9635–9639), and capacitors (C9635–9636, C9638) form the output buffer.

This VCO utilizes both a positive and negative steering line. The SL– should be –4.0V (±.3V) at all times. The SL+ will range from 1 to 8 volts, depending on frequency and AUX bits.

2.3 RECEIVE MODE ($\overline{\text{AUX2}}$ LOW)

When $\overline{\text{AUX2}}$ input is low, the receive pin diode, CR9630, is forward biased by 8.6V supply thru Q5650 and R5652. This current is then sunk into the RF board thru R5654. At this time the voltage divider output of R5649, R5651, and R5653 will keep Q5651 turned off.

2.4 TRANSMIT MODE ($\overline{\text{AUX2}}$ HIGH)

When $\overline{\text{AUX2}}$ is high (8.4V), Q5650 will be off and Q5651 will be on. This puts –8V on the anode of CR9630 and +8.4V on its cathode. With approximately 16V reverse bias on the diode, the receive bandshift T–line is removed from the circuit.

2.5 BANDSHIFT CIRCUIT

R9625, C9625, L9628, and C9628 form a bandshift circuit which shifts the frequency of the oscillator slightly. There is one bandshift in receive and one in transmit. The circuitry works similar to the receive pin circuitry but with the cathode of CR9626 returned to ground. This results in a maximum of 8V reverse bias on this diode.

2.6 OUTPUT BUFFER

Transistor (Q9635), resistors (R9635–9639), and capacitors (C9635–9636, C9638) form a simple common–emitter buffer to provide isolation to the VCO and an output power of +10 dBm.

2.7 FIRST BUFFER

The VCO output is coupled to the first buffer via blocking capacitor (C5661), resistive pads (R5661 and R5662), and a high–pass filter (L5660 and C5662). Q5660 is a self–biased, common–emitter amplifier which provides approximately +10 dBm drive to the doubler as well as reverse isolation to the VCO.

2.8 DOUBLER

The first buffer output is coupled to the input of the doubler by C5663. Q5660 doubles the drive frequency and increases power by approximately 3 dB as a result of the high and low impedances presented to its collector at the doubled frequency and drive frequency, respectively. The collector impedances are presented by an elliptical high–pass filter (C5670–C5674, L5670, and L5671). The filter is terminated in a resistive pad (R5676–R5678) which also serves to terminate one end of the elliptical low–pass filter (C5675, C5677, and L5672–L5674). In addition to filtering, the low–pass filter provides part of the impedance match required

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between the resistive pad and the second buffer. The remaining impedance match is accomplished with L5680 and C5680, configured to provide additional high–pass selectivity.

2.9 SYNTHESIZER FEEDBACK

The base of Q5680 provides the tap location for the synthesizer feedback circuit (C5685–C5688, L5681, L5683, R5674) and two microstrip T–lines. R5674 sets the tapped power level to approximately –5 dBm while C5685–C5686 and L5681 provide low–pass filtering and C5688 and L5683 provide high–pass filtering.

2.10 SECOND BUFFER

The second buffer, Q5680, is a common–emitter amplifier with approximately 12 dB gain. It is biased to 40 milliamps with an active current source, Q5681 and R5580–R5587, which ensures saturated operation.

2.11 RECEIVE/TRANSMIT SWITCH

In the receive mode where K9.4V is off, Q5640 conducts current to turn on the part of CR5690 (a dual–common cathode pin diode) that is in series with the receive path, and the part of CR5691 that is in shunt with the transmit path. The output of Q5680 is then coupled to a resistive pad R5697–R5699 which sets the power out of J5642 to approximately +12 dBm.

In the transmit mode, K9.4V applies 9.4 volts to the anode of CR5640, thus turning off Q5640. K9.4V is also applied to resistors R5688 and R5694 which turn on the parts of CR5690 and CR5691 that are in series with the transmit path. The output of Q5680 is then coupled to a resistive pad (R5689–R5691) which sets the power out of J5641 to approximately +16 dBm.

3. Troubleshooting

Use these instructions along with the theory of operation, the VCO block diagram, and the schematic to help isolate failures, first to the individual circuits, and finally to the failing piece part.

3.1 VCO HYBRID ASSEMBLY

The VCO hybrid substrate is glued to the carrier board. The hybrid is not a field–repairable assembly. If a failure is indicated in this assembly, replace the complete hybrid. You will need a hot air source for heating and softening the glue to separate the hybrid from the carrier board. If no hot air source is available, replace the entire carrier board.

3.2 OUT–OF–LOCK CONDITION

The probable cause of an out–of–lock condition is a failure in the synthesizer circuit. (See the synthesizer troubleshooting information in the RF board section.) If the voltages on the $\overline{\text{AUX1}}$, $\overline{\text{AUX2}}$, or –8V lines at P0601 do not conform to the values shown in figure 1, check the pin shift circuitry on the carrier board for proper operation. If no trouble is found, troubleshoot the synthesizer.

If the $\overline{\text{AUX1}}$, $\overline{\text{AUX2}}$, and –8V voltages are correct at P0601, check the pin shift circuitry on the carrier board for proper operation. If no problem is found, probe the level of the synthesizer feedback at P0601–1 using an RF milli–voltmeter. The meter should indicate greater than –15 dBm. If it does not, troubleshoot the synthesizer feedback circuitry; then troubleshoot the first buffer on the VCO carrier board. If no trouble is found and the level out of the VCO is below that indicated on the block diagram, then replace the VCO assembly.

If the $\overline{\text{AUX1}}$, $\overline{\text{AUX2}}$, and –8V voltages are correct and the synthesizer feedback level is correct but an out–of–lock condition persists, troubleshoot the synthesizer.

3.3 NO OR LOW OUTPUT POWER
(TX OR RX INJECTION)

Using an RF milli–voltmeter, probe the synthesizer feedback level at P0601–1. If the meter indication is not greater than –15 dBm, troubleshoot the first buffer. If no failure is found and the level out of the VCO (measured into 50 ohms at the RF output of the hybrid) is below that indicated in the block diagram, then replace the VCO assembly.

If the level of synthesizer feedback at P0601–1 is correct, troubleshoot the doubler, second buffer, and then the RX/TX pin diode switch.

3.4 NO OR LOW MODULATION

Under standard test conditions with a 1 kHz tone injected and 4.5 kHz deviation, there should be 700 millivolts (RMS) ±20% present on P0601–10. If this level is not present, troubleshoot the modulation circuit on the carrier board and then troubleshoot the audio circuitry. If the proper level is present, troubleshoot the modulation circuitry on the VCO kit. If no failure exists, replace the VCO.

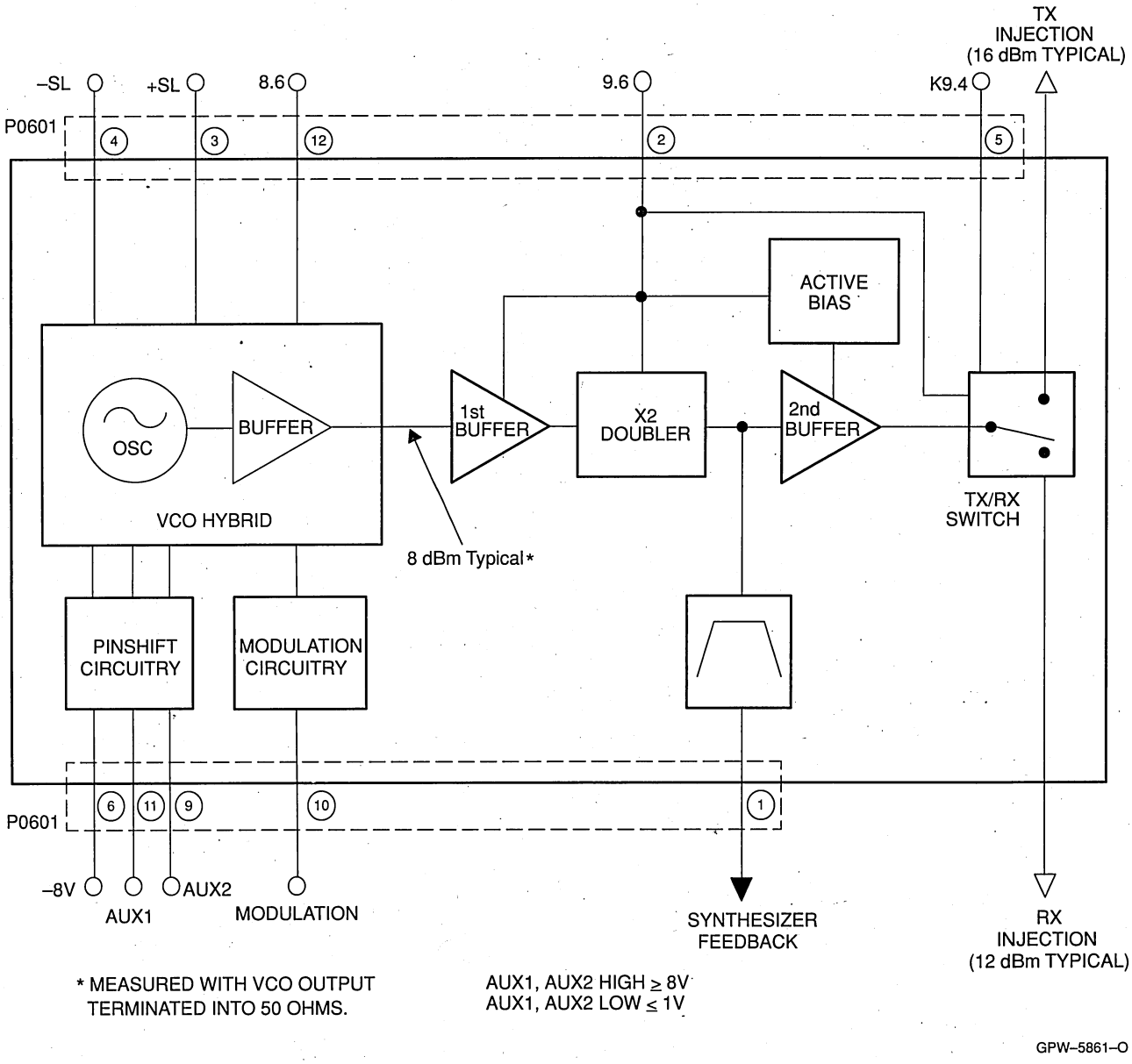
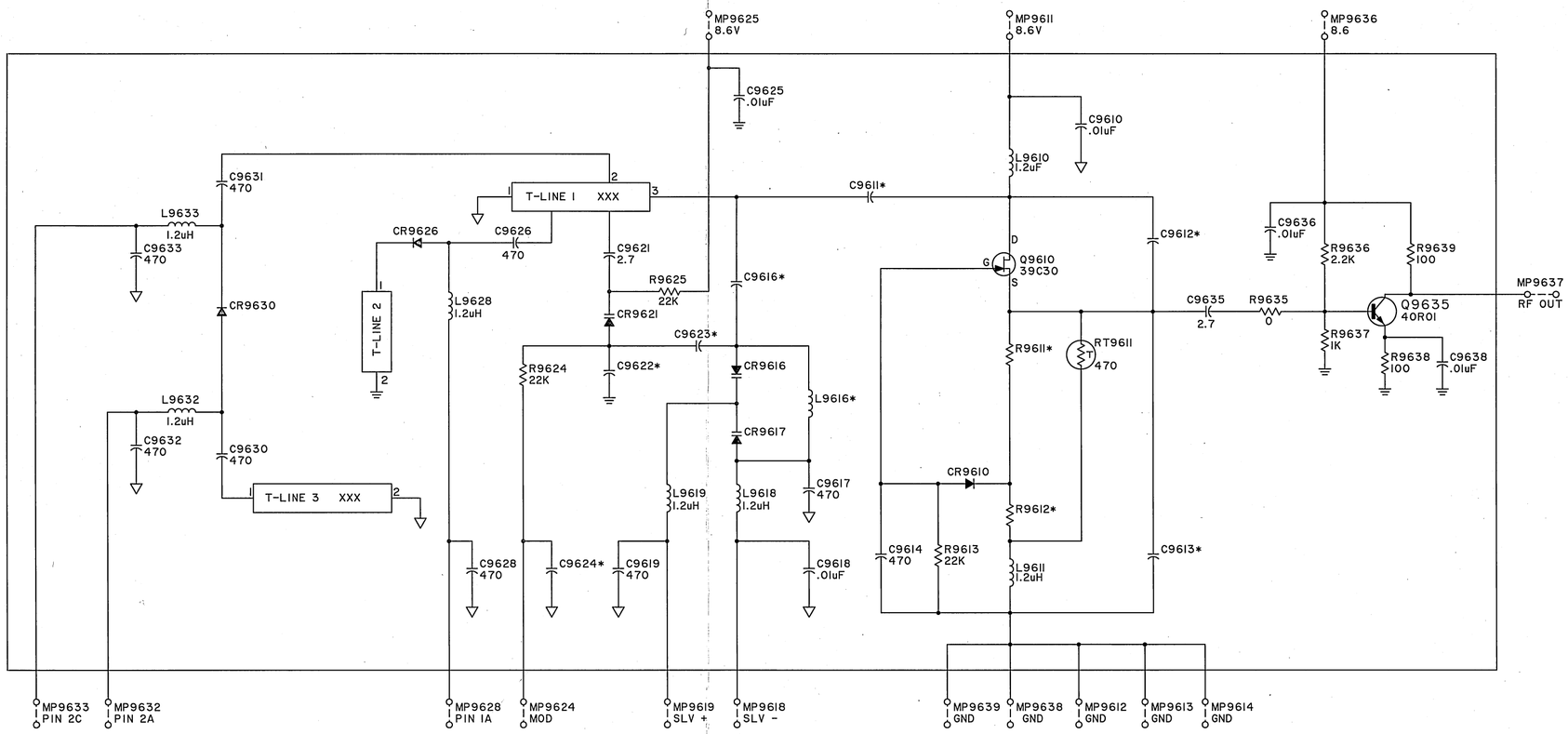


Figure 1. VCO Block Diagram

UHF VCO HYBRID SCHEMATIC



$\overline{AUX1}$ =1= LO BS=PIN 1 OFF
=0= HI BS=PIN 1 ON
$\overline{AUX2}$ =1= TX =PIN 2 OFF
=0= RX =PIN2 ON

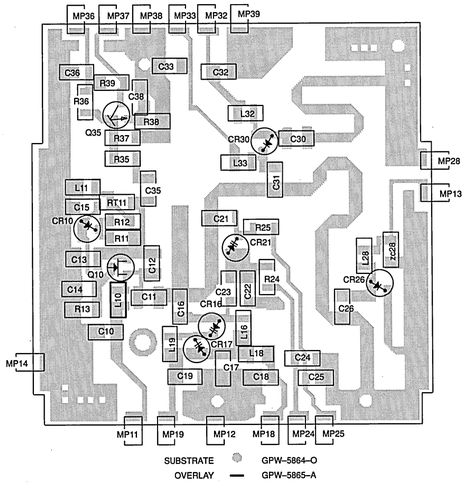
VCO VERSION	C11	C12	C13	C16	C22	C23	L16	R11	R12	C24
R3	22	12	12	13	3.9	1.5	120	18	68	1500PF
R4	22	12	12	8.2	15	1.5	65	51	51	1500PF

GXW-5851-A

* = SEE PARTS LISTS

Schematic, Circuit Board Diagrams, and Parts Lists for HLE6103B and HLE6104B
SPECTRA UHF VCO Hybrid
PW–5850–A
(Sheet 1 of 2)
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HYBRID RANGE 3



parts list

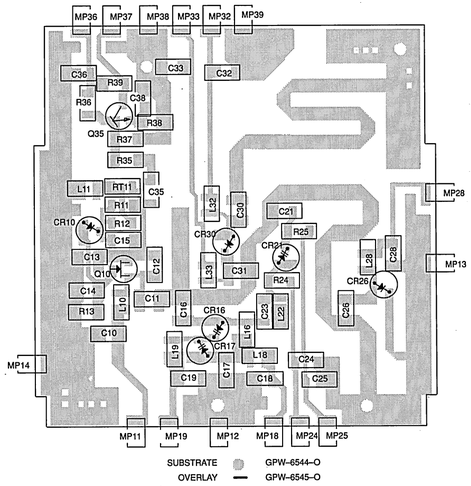
HLE6103B UHF VCO Hybrid Range 3 — MXW–5938–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C9610	21–11059B11	0.01 uF, ±10%
C9611	21–11078B22	22
C9612,9613	21–11078B15	12
C9614	21–11078B59	470
C9616	21–11078B16	13
C9617	21–11078B59	470
C9618	21–11059B11	0.01 uF, ±10%
C9619	21–13740B65	470, 50V
C9621	21–13740B11	2.7, ±.25 pF, 50V
C9622	21–13740B15	3.9, ±.25 pF, 50V
C9623	21–13740B05	1.5, ±.25 pF, 50V
C9624	21–13740B76	1500 pF, 50V
C9625	21–11059B11	C0.01 uF, ±10%
C9626	21–11078B59	470
C9628	21–13740B65	470, 50V
C9630,9631	21–11078B59	470
C9632,9633	21–13740B65	470, 50V
C9635	21–13740B11	2.7, ±.25 pF, 50V
C9636	21–11059B11	0.01 uF, ±10%
C9638	21–11059B11	0.01 uF, ±10%
diode (see note)		
CR9610	48–80236E05	hot carrier
CR9616,9617	48–80006E10	varactor
CR9621	48–80006E10	varactor
CR9626	48–80154K05	dual pin
CR9630	48–80154K05	dual pin
coil, RF		
L9610,9611	24–80140E01	1.2 uH
L9616	24–80140E06	130 nH
L9618,9619	24–80140E01	1.2 uH
L9628	24–80140E01	1.2 uH
L9632,9633	24–80140E01	1.2 uH
transistor (see note)		
Q9610	48–80141L06	n–channel JFET
Q9635	48–82940R01	NPN
thermistor		
RT9611	06–80149M01	470 ohms
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9611	06–11077A32	18
R9612	06–11077A46	68
R9613	06–11077B07	22k
R9624,9625	06–11077B07	22k
R9635	06–11077A01	0
R9636	06–11077A82	2.2k
R9637	06–11077A74	1k
R9638,9639	06–11077A50	100
mechanical parts		
	07–80299L01	frame lead, j–strap (15 used)

2/25/89

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

HYBRID RANGE 4



parts list

HLE6104B UHF VCO Hybrid Range 4 — MXW–5939–A

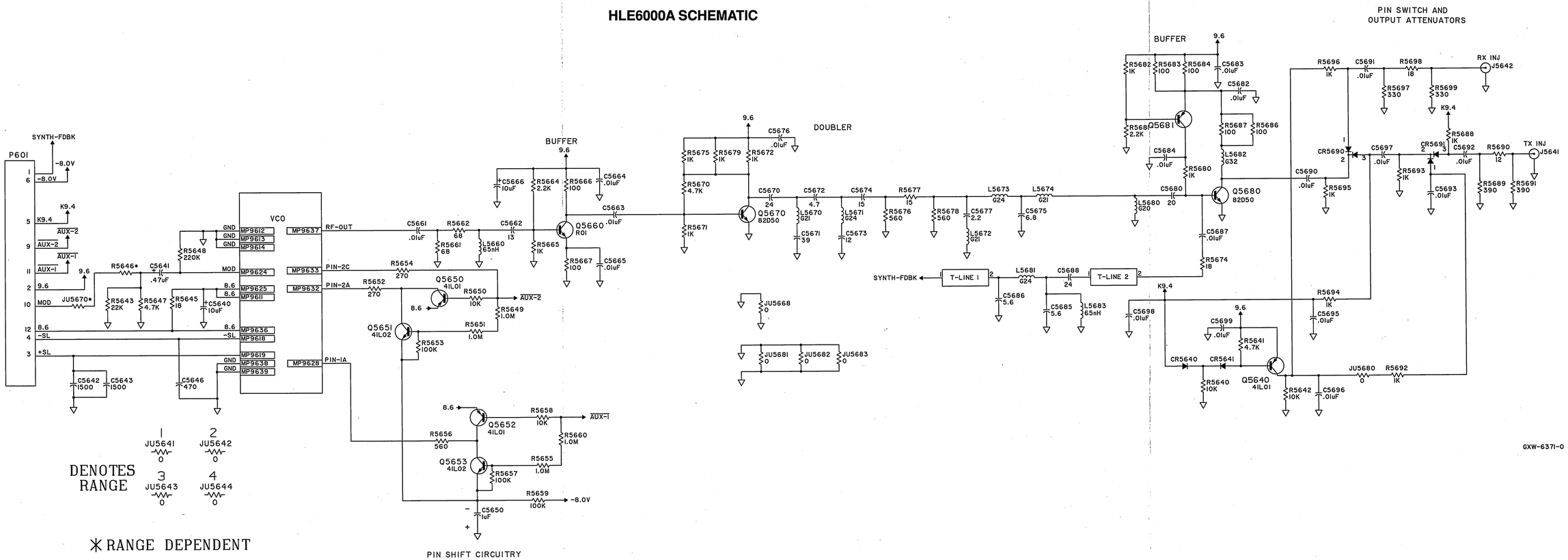
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C9610	21–11059B11	0.01 uF, ±10%
C9611	21–11078B22	22
C9612,9613	21–11078B15	12
C9614	21–11078B59	470
C9615	21–13740B65	470, 50V
C9616	21–11078B11	8.2, ±.5 pF
C9617	21–11078B59	470
C9618	21–11059B11	0.01 uF, ±10%
C9619	21–13740B65	470, 50V
C9621	21–13740B11	2.7, ±.25 pF, 50V
C9622	21–13740B29	15, 50V
C9623	21–13740B05	1.5, ±.25 pF, 50V
C9624	21–13740B76	1500 pF, 50V
C9625	21–11059B11	0.01 uF, ±10%
C9626	21–11078B59	470
C9628	21–13740B65	470, 50V
C9630,9631	21–11078B59	470
C9632,9633	21–13740B65	470, 50V
C9635	21–13740B11	2.7, ±.25 pF, 50V
C9636	21–11059B11	0.01 uF, ±10%
C9638	21–11059B11	0.01 uF, ±10%
diode (see note)		
CR9610	48–80236E05	hot carrier
CR9616,9617	48–80006E10	varactor
CR9621	48–80006E10	varactor
CR9626	48–80154K05	dual pin
CR9630	48–80154K05	dual pin
coil, RF		
L9610,9611	24–80140E01	1.2 uH
L9616	24–80140E04	65 nH
L9618,9619	24–80140E01	1.2 uH
L9628	24–80140E01	1.2 uH
L9632,9633	24–80140E01	1.2 uH
transistor (see note)		
Q9610	48–80141L06	n–channel JFET
Q9635	48–82940R01	NPN
thermistor		
RT9611	06–80149M01	470 ohms
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9611,9612	06–11077A43	51
R9613	06–11077B07	22k
R9624,9625	06–11077B07	22k
R9635	06–11077A01	0
R9636	06–11077A82	2.2k
R9637	06–11077A74	1k
R9638,9639	06–11077A50	100
mechanical parts		
	07–80299L01	frame lead, j–strap (15 used)

2/25/89

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

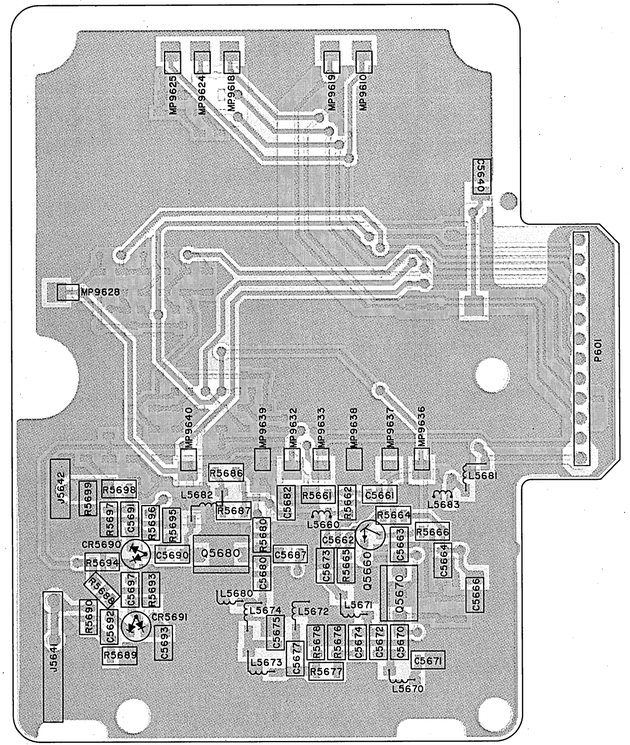
Schematic, Circuit Board Diagrams, and Parts Lists for HLE6103B and HLE6104B *SPECTRA* UHF VCO Hybrid
PW–5850–A
(Sheet 2 of 2)
3/31/89

HLE6000A SCHEMATIC

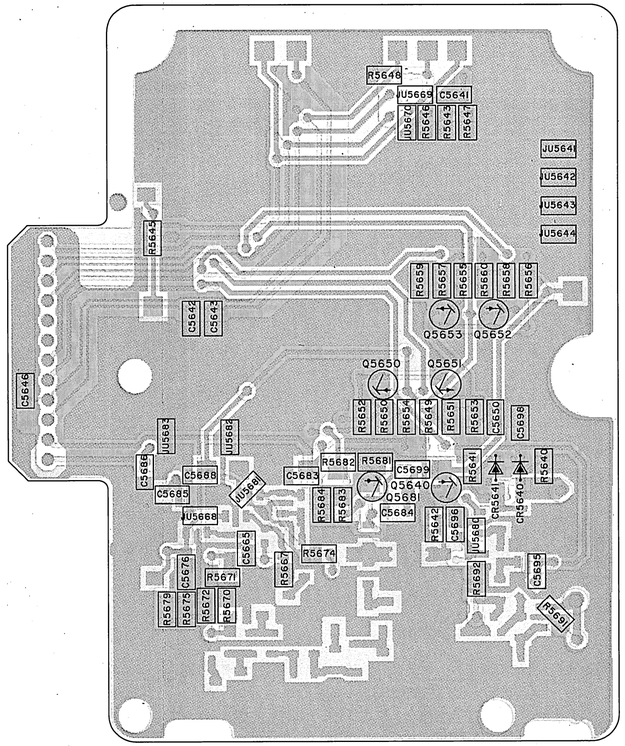


Schematics, Circuit Board Diagrams, and Parts
Lists for HLE6000A, HLE6000B, and HLE6041B
SPECTRA UHF VCO Carrier Board
PW-6370-O
(Sheet 1 of 4)
3/31/89

HLE6000A CIRCUIT BOARD



COMPONENT SIDE VIEW



SOLDER SIDE VIEW

parts list

HLE6000A UHF VCO Carrier Board — MXW-5937-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C5640	23–11049J28	10, ±20%, 16V
C5641	23–11049A35	0.47, ±20%, 25V
C5642,5643	21–13740B76	1500
C5646	21–13740B65	470
C5650	23–11049A37	1, ±20%, 25V
C5661	21–13741N45	0.01 uF, ±10%
C5662	21–13740B28	13
C5663–5665	21–13741N45	0.01 uF, ±10%
C5666	23–11049J26	10, ±20%, 16V
C5670	21–13740B34	24
C5671	21–13740B39	39
C5672	21–13740B17	4.7, ±.25 pF
C5673	21–13740B27	12
C5674	21–13740B29	15
C5675	21–13740B21	6.8, ±.25 pF
C5676	21–13741N45	0.01 uF, ±10%
C5677	21–13740B09	2.2, ±.25 pF
C5680	21–13740B32	20
C5682–5684	21–13741N45	0.01 uF, ±10%
C5685,5686	21–13740B19	5.6, ±.25 pF
C5687	21–13741N45	0.01 uF, ±10%
C5688	21–13740B34	24
C5690–5699	21–13741N45	0.01 uF, ±10%
diode (see note)		
CR5640,5641	48–80066M01	signal
CR5690,5691	48–80154K05	dual pin
connector receptacle		
J5641	09–80212N01	coax, PC board mount
J5642	09–80212N02	coax, PC board mount
jumper		
JU5643	06–11077A01	0
JU5668	06–11077A01	0
JU5670	06–11077A01	0
JU5680–5683	06–11077A01	0
coil, RF		
L5660	24–80140E04	65 nH
L5670	24–80091G21	4 turns, airwound
L5671	24–80091G24	5 turns, airwound
L5672	24–80091G21	4 turns, airwound
L5673	24–80091G24	5 turns, airwound
L5674	24–80091G21	4 turns, airwound
L5680	24–80091G20	3 turns, airwound
L5681	24–80091G24	5 turns, airwound
L5682	24–80091G32	6 turns, airwound
L5683	24–80140E04	65 nH
connector plug		
P601	28–80099M03	vertical, 12–contacts
transistor (see note)		
Q5640	48–80141L01	PNP
Q5650	48–80141L01	PNP
Q5651	48–80141L02	NPN
Q5652	48–80141L01	PNP
Q5653	48–80141L02	NPN
Q5660	48–82940R01	NPN
Q5670	48–80182D50	NPN
Q5680	48–80182D50	NPN
Q5681	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R5640	06–11077A98	10k
R5641	06–11077A90	4.7k
R5642	06–11077A98	10k
R5643	06–11077B07	22k
R5645	06–11077A32	18
R5646	06–11077B19	68k
R5647	06–11077A90	4.7k
R5648	06–11077B31	220k
R5649	06–11077B47	1 MEG
R5650	06–11077A98	10k
R5651	06–11077B47	1 MEG
R5652	06–11077A60	270
R5653	06–11077B23	100k
R5654	06–11077A60	270
R5655	06–11077B47	1 MEG
R5656	06–11077A68	560
R5657	06–11077B23	100k
R5658	06–11077A98	10k
R5659	06–11077B23	100k
R5660	06–11077B47	1 MEG
R5661,5662	06–11077A46	68
R5664	06–11077A82	2.2k
R5665	06–11077A74	1k
R5666,5667	06–11077A50	100
R5670	06–11077A90	4.7k
R5671,5672	06–11077A74	1k
R5674	06–11077A32	18
R5675	06–11077A74	1k
R5676	06–11077A68	560
R5677	06–11077A30	15
R5678	06–11077A68	560
R5679,5680	06–11077A74	1k
R5681	06–11077A82	2.2k
R5682	06–11077A74	1k
R5683,5684	06–11077A50	100
R5686,5687	06–11077A50	100
R5688	06–11077A74	1k
R5689	06–11077A64	390

MXW–5937–A (2)

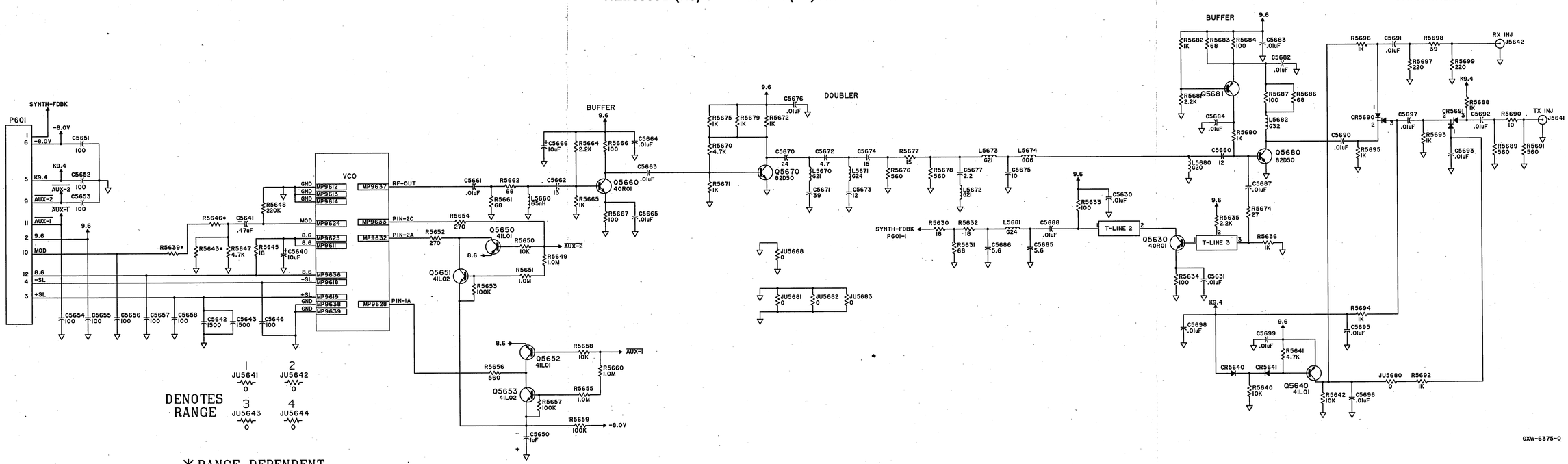
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R5690	06–11077A28	12
R5691	06–11077A64	390
R5692–5696	06–11077A74	1k
R5697	06–11077A62	330
R5698	06–11077A32	18
R5699	06–11077A62	330
mechanical parts		
MP5675	54–80004N01	barcode label
MP5676	15–80223N02	cover shield

2/25/89

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

Schematics, Circuit Board Diagrams, and Parts Lists for HLE6000A, HLE6000B, and HLE6041B
SPECTRA UHF VCO Carrier Board
PW–6370–O
(Sheet 2 of 4)
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HLE6000B (R3) & HLE6041B (R4) SCHEMATIC

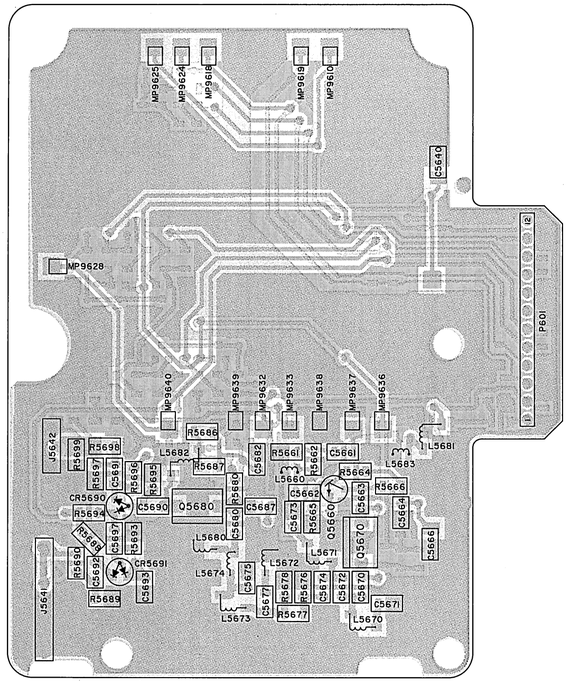


✳RANGE DEPENDENT

		R5639	R5646	R5643
HLE6000B	RNG 3	0 OHM	68K	22K
HLE6041B	RNG 4	6.8K	68K	4.7K

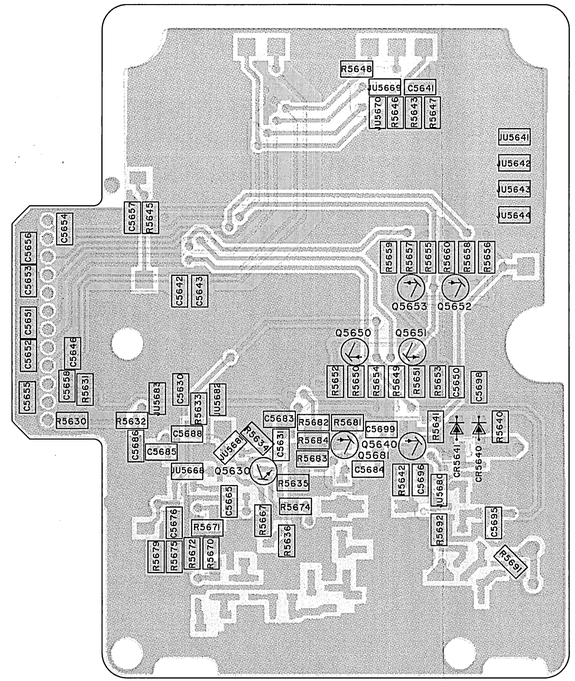
Schematics, Circuit Board Diagrams, and Parts
Lists for HLE6000A, HLE6000B, and HLE6041B
SPECTRA UHF VCO Carrier Board
PW–6370–O
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HLE6000B & HLE6041B CIRCUIT BOARD



SOLDER SIDE GPW-6376-O
COMPONENT SIDE GPW-6377-O
OVERLAY GXW-6378W01-O

COMPONENT SIDE VIEW



SOLDER SIDE GPW-6376-O
COMPONENT SIDE GPW-6377-O
OVERLAY GXW-6378W02-O

SOLDER SIDE VIEW

parts list

HLE6000B UHF Carrier Board (Range 3) MXW–6379–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C5630,5631	21–13741N45	0.01 uF, ±10%
C5640	23–11049J26	10, ±20%, 16V
C5641	23–11049A35	0.47, ±20%, 25V
C5642,5643	21–13740B76	1500
C5646	21–13740B49	100
C5650	23–11049A37	1, ±20%, 25V
C5651–5658	21–13740B49	100
C5661	21–13741N45	0.01 uF, ±10%
C5662	21–13740B28	13
C5663–5665	21–13741N45	0.01 uF, ±10%
C5666	23–11049J26	10, ±20%, 16V
C5670	21–13740B34	24
C5671	21–13740B39	39
C5672	21–13740B17	4.7, ±.25 pF
C5673	21–13740B27	12
C5674	21–13740B29	15
C5675	21–13740B25	10, 50V
C5676	21–13741N45	0.01 uF, ±10%
C5677	21–13740B09	2.2, ±.25 pF
C5680	21–13740B27	12
C5682–5684	21–13741N45	0.01 uF, ±10%
C5685,5686	21–13740B19	5.6, ±.25 pF
C5687–5688	21–13741N45	0.01 uF, ±10%
C5690–5693	21–13741N45	0.01 uF, ±10%
C5695–5699	21–13741N45	0.01 uF, ±10%
diode (see note)		
CR5640,5641	48–80066M01	signal
CR5690,5691	48–80154K05	dual pin
connector receptacle		
J5641	09–80212N01	coax, PC board mount
J5642	09–80212N03	coax, PC board mount
jumper		
JU5643	06–11077A01	0
JU5668	06–11077A01	0
JU5680–5683	06–11077A01	0
coil, RF		
L5660	24–80140E04	65 nH
L5670	24–80091G21	4 turns, airwound
L5671	24–80091G24	5 turns, airwound
L5672,5673	24–80091G21	4 turns, airwound
L5674	24–80091G06	2 turns, airwound
L5680	24–80091G20	3 turns, airwound
L5681	24–80091G24	5 turns, airwound
L5682	24–80091G32	6 turns, airwound
connector plug		
P601	28–80099M03	vertical, 12–contacts
transistor (see note)		
Q5630	48–82940R01	NPN
Q5640	48–80141L01	PNP
Q5650	48–80141L01	PNP
Q5651	48–80141L02	NPN
Q5652	48–80141L01	PNP
Q5653	48–80141L02	NPN
Q5660	48–82940R01	NPN
Q5670	48–80182D50	NPN
Q5680	48–80182D50	NPN
Q5681	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R5630	06–11077A32	18
R5631	06–11077A46	68
R5632	06–11077A32	18
R5633,5634	06–11077A50	100
R5635	06–11077A82	2.2k
R5636	06–11077A74	1k
R5639	06–11077A01	0
R5640	06–11077A98	10k
R5641	06–11077A90	4.7k
R5642	06–11077A98	10k
R5643	06–11077B07	22k
R5645	06–11077A32	18
R5646	06–11077B19	68k
R5647	06–11077A90	4.7k
R5648	06–11077B31	220k
R5649	06–11077B47	1 MEG
R5650	06–11077A98	10k
R5651	06–11077B47	1 MEG
R5652	06–11077A60	270
R5653	06–11077B23	100k
R5654	06–11077A60	270
R5655	06–11077B47	1 MEG
R5656	06–11077A68	560
R5657	06–11077B23	100k
R5658	06–11077A98	10k
R5659	06–11077B23	100k
R5660	06–11077B47	1 MEG
R5661,5662	06–11077A46	68
R5664	06–11077A82	22k
R5665	06–11077A74	1k
R5666,5667	06–11077A50	100
R5670	06–11077A90	4.7k
R5671,5672	06–11077A74	1k
R5674	06–11077A36	27
R5675	06–11077A74	1k
R5676	06–11077A68	560
R5677	06–11077A30	15
R5678	06–11077A68	560

MXW–6379–O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R5679,5680	06–11077A74	1k
R5681	06–11077A82	2.2k
R5682	06–11077A74	1k
R5683	06–11077A46	68
R5684	06–11077A50	100
R5686	06–11077A46	68
R5687	06–11077A50	100
R5688	06–11077A74	1k
R5689	06–11077A68	560
R5690	06–11077A26	10
R5691	06–11077A68	560
R5692–5696	06–11077A74	1k
R5697	06–11077A58	220
R5698	06–11077A40	39
R5699	06–11077A58	220
mechanical parts		
MP5675	54–80004N01	barcode label
MP5676	15–80223N02	cover shield

2/25/89

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

parts list

HLE6041B UHF VCO Carrier Board R4 MXW–6380–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C5630,5631	21–13741N45	0.01 uF, ±10%
C5640	23–11049J26	10, ±20%, 16V
C5641	23–11049A35	0.47, ±20%, 25V
C5642,5643	21–13740B76	1500
C5646	21–13740B49	100
C5650	23–11049A37	1, ±20%, 25V
C5651–5658	21–13740B49	100
C5661	21–13741N45	0.01 uF, ±10%
C5662	21–13740B28	13
C5663–5665	21–13741N45	0.01 uF, ±10%
C5666	23–11049J26	10, ±20%, 16V
C5670	21–13740B34	24
C5671	21–13740B39	39
C5672	21–13740B17	4.7, ±.25 pF
C5673	21–13740B27	12
C5674	21–13740B29	15
C5675	21–13740B25	10, 50V
C5676	21–13741N45	0.01 uF, ±10%
C5677	21–13740B09	2.2, ±.25 pF
C5680	21–13740B27	12
C5682–5684	21–13741N45	0.01 uF, ±10%
C5685,5686	21–13740B19	5.6, ±.25 pF
C5687–5688	21–13741N45	0.01 uF, ±10%
C5690–5693	21–13741N45	0.01 uF, ±10%
C5695–5699	21–13741N45	0.01 uF, ±10%
diode (see note)		
CR5640,5641	48–80066M01	signal
CR5690,5691	48–80154K05	dual pin
connector receptacle		
J5641	09–80212N01	coax, PC board mount
J5642	09–80212N03	coax, PC board mount
jumper		
JU5644	06–11077A01	0
JU5668	06–11077A01	0
JU5680–5683	06–11077A01	0
coil, RF		
L5660	24–80140E04	65 nH
L5670	24–80091G21	4 turns, airwound
L5671	24–80091G24	5 turns, airwound
L5672,5673	24–80091G21	4 turns, airwound
L5674	24–80091G06	2 turns, airwound
L5680	24–80091G20	3 turns, airwound
L5681	24–80091G24	5 turns, airwound
L5682	24–80091G32	6 turns, airwound
connector plug		
P601	28–80099M03	vertical, 12–contacts
transistor (see note)		
Q5630	48–82940R01	NPN
Q5640	48–80141L01	PNP
Q5650	48–80141L01	PNP
Q5651	48–80141L02	NPN
Q5652	48–80141L01	PNP
Q5653	48–80141L02	NPN
Q5660	48–82940R01	NPN
Q5670	48–80182D50	NPN
Q5680	48–80182D50	NPN
Q5681	48–80141L01	PNP

MXW–6380–O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R5630	06–11077A32	18
R5631	06–11077A46	68
R5632	06–11077A32	18
R5633,5634	06–11077A50	100
R5635	06–11077A82	2.2k
R5636	06–11077A74	1k
R5639	06–11077A01	0
R5640	06–11077A98	10k
R5641	06–11077A90	4.7k
R5642	06–11077A98	10k
R5643	06–11077B07	22k
R5645	06–11077A32	18
R5646	06–11077B19	68k
R5647	06–11077A90	4.7k
R5648	06–11077B31	220k
R5649	06–11077B47	1 MEG
R5650	06–11077A98	10k
R5651	06–11077B47	1 MEG
R5652	06–11077A60	270
R5653	06–11077B23	100k
R5654	06–11077A60	270
R5655	06–11077B47	1 MEG
R5656	06–11077A68	560
R5657	06–11077B23	100k
R5658	06–11077A98	10k
R5659	06–11077B23	100k
R5660	06–11077B47	1 MEG
R5661,5662	06–11077A46	68
R5664	06–11077A82	22k
R5665	06–11077A74	1k
R5666,5667	06–11077A50	100
R5670	06–11077A90	4.7k
R5671,5672	06–11077A74	1k
R5674	06–11077A36	27
R5675	06–11077A74	1k
R5676	06–11077A68	560
R5677	06–11077A30	15
R5678	06–11077A68	560
R5679,5680	06–11077A74	1k
R5681	06–11077A82	2.2k
R5682	06–11077A74	1k
R5683	06–11077A46	68
R5684	06–11077A50	100
R5686	06–11077A46	68
R5687	06–11077A50	100
R5688	06–11077A74	1k
R5689	06–11077A68	560
R5690	06–11077A26	10
R5691	06–11077A68	560
R5692–5696	06–11077A74	1k
R5697	06–11077A58	220
R5698	06–11077A40	39
R5699	06–11077A58	220
mechanical parts		
MP5675	54–80004N01	barcode label
MP5676	15–80223N01	cover shield
MP5676	15–80223N02	cover shield

2/25/89

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

Schematics, Circuit Board Diagrams, and Parts Lists for HLE6000A, HLE6000B, and HLE6041B *SPECTRA* UHF VCO Carrier Board
PW–6370–O
(Sheet 4 of 4)
3/31/89

Voltage Controlled Oscillator (VCO) (800 MHz)

1. General

The VCO oscillator is located on an alumina substrate with a metal cover. The buffer–doubler–buffer section is located on the PC board and may be repaired using normal repair methods.

2. Theory of Operation

2.1 SUPER FILTER 8.6 VOLTS

Super filter 8.6 volts is applied to the VCO carrier board at J601–12. From there, SF8.6 passes to the drain of Q9641, to the emitters of Q9643 and Q9644, and to the collector of Q9642.

2.2 VCO

Q9641, the main and transmit/talkaround transmission lines, and the varactors CR9641 through CR9644 form the major circuitry of the oscillator. CR9645, C9648, C9647, and R9641 make up an automatic gain control (AGC) circuit.

The positive steering line connects to the cathodes of the four varactors and the negative steering line connects to the anodes. The negative line should be –4.0 ±0.3 volts and the positive line can go as high as 9 volts, allowing a difference of 15 to 16 volts between the two. Normally, at room temperature, the positive steering line will be between 1.5 and 5.5 volts and will fluctuate with temperature change in the radio. Modulation is connected to the negative steering line via R9651 and C9651.

When the radio is transmitting, the oscillator's frequency will be in the 403 to 412 MHz range. When receiving, the frequency will be between 370.675 and 379.675 MHz. If the radio is in the talkaround mode, the frequency will be between 425.5 and 434.5 MHz. The transmit and talkaround ranges are produced by coupling an additional length of transmission line to the main transmission line and is done by a high or low on the $\overline{\text{AUX 1}}$ or $\overline{\text{AUX 2}}$ input lines.

2.3 RECEIVE MODE—$\overline{\text{AUX 1}}$ AND $\overline{\text{AUX 2}}$ HIGH

When $\overline{\text{AUX 1}}$ is HIGH, 8.6 volts is applied to the cathode of CR9646. Q9643 is turned off and Q9647 is turned on placing approximately –6.2 volts at the anode of CR9646 reverse biasing it. Likewise with $\overline{\text{AUX2}}$ high the same occurs except CR9647 is reversed biased with Q9644 off and Q9646 on. This isolates the TRANSMIT/TALKAROUND transmission line from the MAIN transmission line.

2.4 TRANSMIT MODE–$\overline{\text{AUX 1}}$ HIGH; $\overline{\text{AUX 2}}$ LOW

When $\overline{\text{AUX 1}}$ is high, the same occurs as mentioned above, however, with $\overline{\text{AUX 2}}$ low, CR9647 is forward–biased, connecting the TRANSMIT/TALKAROUND transmission line through C9658 and C9657 to the MAIN transmission line.

2.5 TALKAROUND MODE–$\overline{\text{AUX 1}}$ LOW; $\overline{\text{AUX 2}}$ LOW

With $\overline{\text{AUX 1}}$ and $\overline{\text{AUX 2}}$ low, CR9647 and CR9646 are forward–biased, connecting the TRANSMIT/TALKAROUND transmission line through C9656, C9655, C9657, and C9658 to the MAIN transmission line.

2.6 VCO BUFFER

Q9642 amplifies and provides reverse isolation to the oscillator. The frequency is then applied to the buffer–doubler–buffer section of the VCO carrier board.

2.7 FIRST BUFFER CIRCUIT

The VCO output is coupled to the first buffer section through C9677. Q9660 amplifies and provides additional isolation between the doubler and the VCO.

2.8 DOUBLER

The first buffer output is coupled to the doubler section through C9662 and a lowpass input match circuitry (C9675, L9675, C9676, and L9676), which serves two purposes—it matches the input of the doubler to 50 ohms, and improves isolation between the VCO and doubler. It also keeps the desired doubler output frequency from getting to the synthesizer. The synthesizer feedback frequency is via C9674 and R9669.

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Q9675 doubles the frequency applied to its base. The components on the collector are built so that a 400 MHz signal is effectively shorted to ground, while the 800 MHz signal sees high impedance to ground. The doubler is coupled to the buffer through C9681, and into a 50–ohm matching network made up of C9683 and L9680.

Doubler–biasing differs between receive mode and transmit mode. For receive, R9677, R9678, and R9676 (in parallel to dissipate power) plus R9679 and R9680 bias the base of Q9675 to 0.7 volt potential, if NO input RF power is applied to the base. For transmit mode, keyed 9.4 volts is fed through CR9694 and another parallel resistor network R9674 and R9675. This raises the current to the collector of Q9675 via L9678, producing more power out.

2.9 SECOND BUFFER

The second buffer circuit is Q9676 with a 460 MHz trap, made up of L9682 and C9686, on the collector. The signal is coupled by series LC network of L9683 and C9687. For the receive mode, Q9676's gain is approximately 1 to 4 dB; in transmit, its gain is approximately 7 dB.

In receive mode, K9.4 volts is off so that the base voltage of Q9692 is controlled by voltage divider, R9694 an R9695. With temperature changes, the emitter–base junction of Q9691 tracks that of Q9692's, stabilizing the collector current and collector voltage of Q9676. R9690, R9691, and R9692 set the current level to the collector of Q9676 in receive.

In transmit mode, K9.4 volts is applied to CR9693 and through R9697, R9699, and R9693, increasing the current flow to Q9676. K9.4 volts on the anode of CR9690 increases the voltage on the base of Q9692. This increases voltage at Q9692's emitter and Q9676's collector. In the transmit mode, the buffer draws approximately 60 milliamps.

2.10 $\overline{\text{K9.4 V}}$ SWITCH

In the receive mode, K9.4 volts is off. CR9691 is reverse–biased, CR9692 is forward–biased; therefore Q9693 conducts to produce 9.4 volts on the collector. This forward–biases CR9678 and CR9677, allowing RF to pass through C9688. R9687, R9688, and R9689 drop the 12 dBm signal on the anode of CR9678 down to 0 to 5 dBm. This is the receiver injection signal which is applied to the first mixer in the front end of the radio.

In the transmit mode, K9.4 volts is on. Q9693 turns off, reverse biasing CR9678 and CR9677. However, CR9675 and CR9676 are forward–biased, allowing the RF signal to pass through C9689. The signal (approximately 20 dBm) at the junction of CR9675 and CR9677, is attenuated about 1 dB across the diodes. The transmit signal, at approximately 18 to 23 dBm, is applied to the power amplifier via C9689.

3. Troubleshooting

Use these instructions along with the theory of operation, the block diagram, and the schematic to help isolate failures, first, to the individual circuits, and finally to the failing piece part.

3.1 VCO HYBRID ASSEMBLY

The VCO hybrid substrate is glued to the carrier board. The hybrid is not a field–repairable assembly. If a failure is indicated in this assembly, replace the entire carrier board.

3.2 OUT–OF–LOCK CONDITION

The probable cause of an out–of–lock condition is a failure in the synthesizer circuit. (See the synthesizer troubleshooting information in the RF Board Section.) If the voltages on the $\overline{\text{AUX 1}}$ and $\overline{\text{AUX 2}}$ lines do not conform to the table in Figure 1, troubleshoot the synthesizer.

If the $\overline{\text{AUX 1}}$ and $\overline{\text{AUX 2}}$ voltages are correct but the synthesizer feedback level is not within the range indicated, troubleshoot the first buffer on the VCO carrier board. If no problem is found with the first buffer and the level out of the VCO is below that indicated on the block diagram, check J straps MP9656–MP9668. If no problem is found with these, replace the entire carrier board.

If the $\overline{\text{AUX 1}}$ and $\overline{\text{AUX 2}}$ voltages are correct and the synthesizer feedback level is correct but an out–of–lock condition persists, troubleshoot the synthesizer.

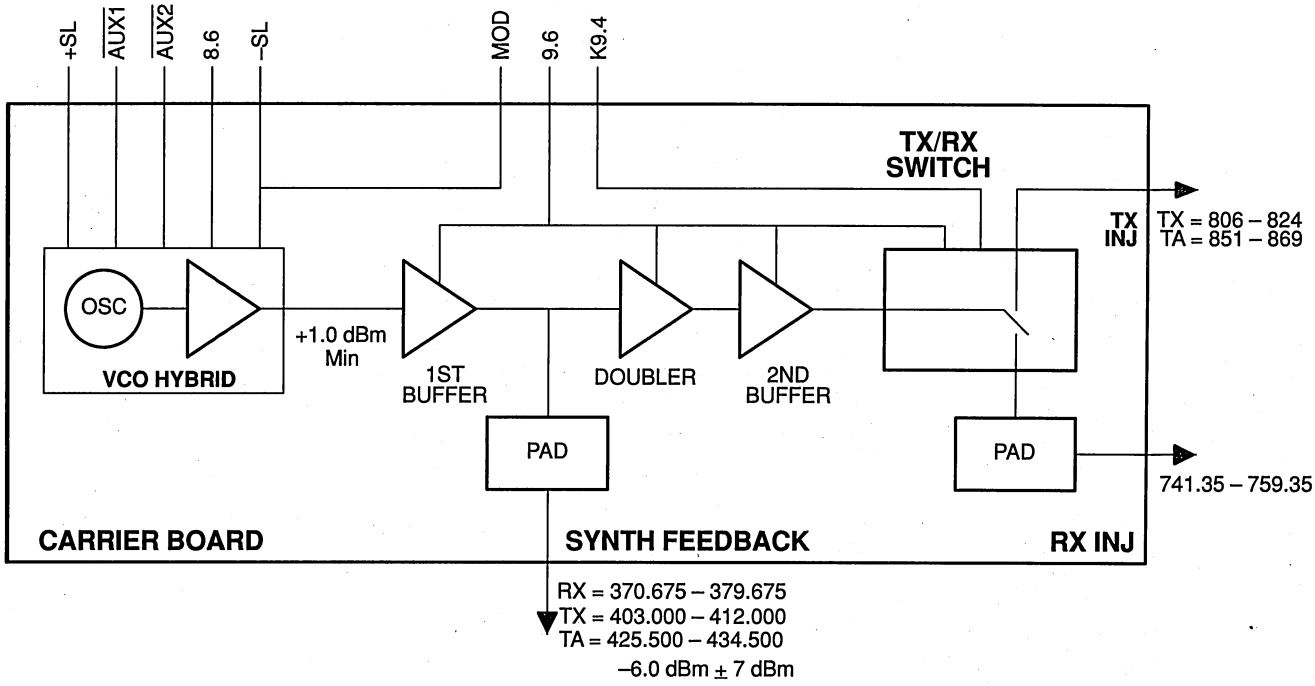
3.3 NO OR LOW OUTPUT POWER (TX OR RX INJECTION)

Use the test cables listed in the Service Aids in the Service Manual. Measure the power at the synthesizer feedback port–if it is not within the range specified in the block diagram, troubleshoot the first buffer. If failure is found in the first buffer, replace the defective component. If no failure is found in the first buffer and the level out of the VCO (measured with an RF millivolt meter) is below that indicated in the block diagram check J straps MP9656–MP9668. If no problem is found with these, replace the entire carrier board.

If the level at the synthesizer feedback port is within the indicated range, then troubleshoot the doubler, second buffer, and PIN diode switch.

3.4 NO OR LOW MODULATION

Under standard test conditions with a 1 kHz tone injected and 4.6 kHz (±250 Hz) deviation, there should be between 500 and 1000 millivolts present on J601, Pin 10 (modulation input). (See the circuit board overlay for location.) If this level is not present, troubleshoot the audio circuitry. If it is present, check J601, Pin 4 (NEG S.L.). The negative steering line should be –4.0 (±0.3) volts. If this is not correct, check the negative steering line circuitry on the RF board and/or check R9651 and C9651 on the carrier board. If no problem is found, check J straps MP9656–MP9668. If no problem is found with these, replace the entire carrier board.

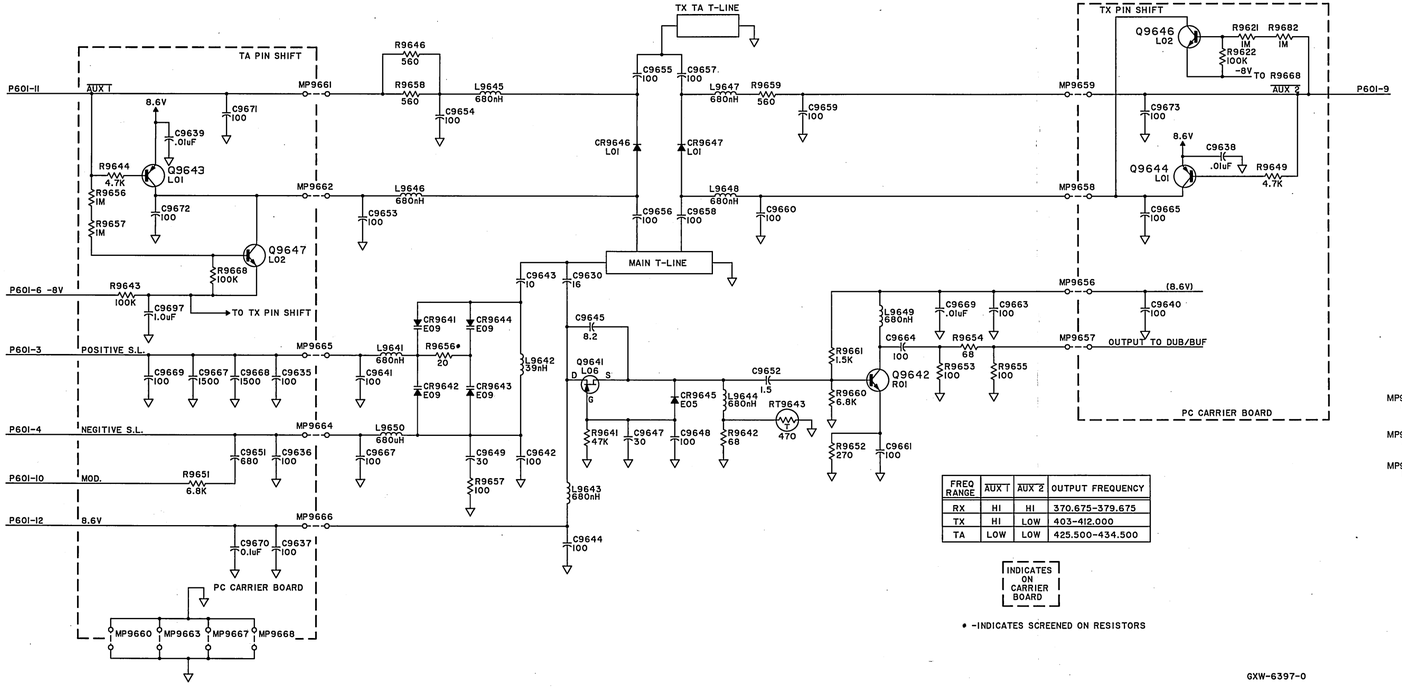


FREQUENCY RANGE	$\overline{\text{AUX1}}$	$\overline{\text{AUX2}}$	OUT PUT FREQUENCY
RX	HI	HI	741.35 – 759.35
TX	HI	LOW	806.00 – 824.00
TA	LOW	LOW	851.00 – 869.00

GPW–6395–O

Figure 1. VCO Block Diagram

HLF6079A HYBRID SCHEMATIC



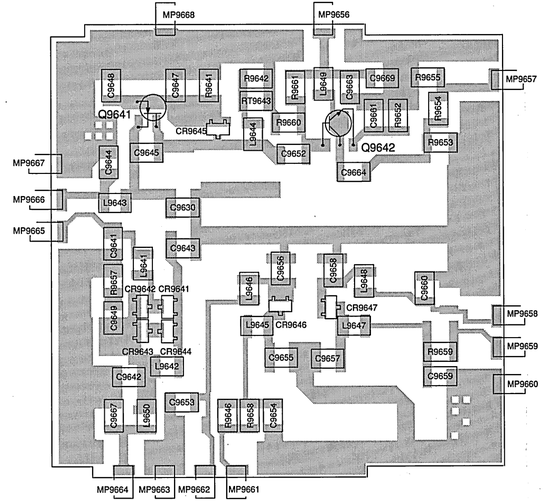
FREQ RANGE	AUX T	AUX 2	OUTPUT FREQUENCY
RX	HI	HI	370.675-379.675
TX	HI	LOW	403-412.000
TA	LOW	LOW	425.500-434.500

INDICATES ON CARRIER BOARD

* -INDICATES SCREENED ON RESISTORS

GXW-6397-O

HLF6079A HYBRID



SUBSTRATE GPW-6399-O
OVERLAY GPW-6400-O

parts list

HLF6079A 800 MHz VCO Hybrid — MXW-6398-O

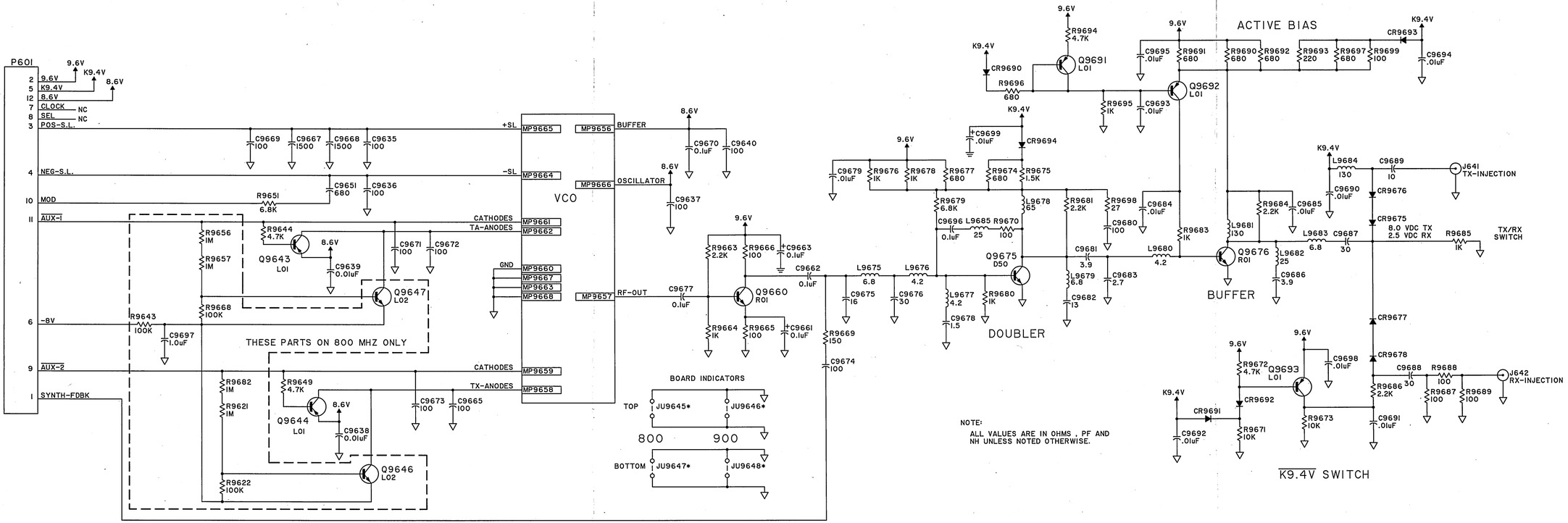
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C9630	21-11078B19	16
C9641	21-13740B49	100, 50V
C9642	21-11078B42	100
C9643	21-11078B13	10, ±.5 pF
C9644	21-13740B49	100, 50V
C9645	21-11078B11	8.2, ±.5 pF
C9647	21-11078B27	30
C9648	21-11078B42	100
C9649	21-13740B36	30, 50V
C9652	21-13740B05	1.5, ±.25 pF, 50V
C9653,9654	21-13740B49	100, 50V
C9655-9658	21-11078B42	100
C9659-9661	21-13740B49	100, 50V
C9663,9664	21-13740B49	100, 50V
C9667	21-13740B49	100, 50V
C9669	21-13741N45	0.01 uF, 50V
diode (see note)		
CR9641-9644	48-80006E09	varactor
CR9645	48-80236E05	hot carrier
CR9646,9647	48-80142L01	pin
coil, RF		
L9641	24-80140E07	680 nH
L9642	24-05452C87	39 nH
L9643-9650	24-80140E07	680 nH
transistor (see note)		
Q9641	48-80141L06	n-Channel, JFET
Q9642	48-82971R01	NPN
thermistor		
RT9643	06-80149M01	470 ohms
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R9641	06-11077B15	47k
R9642	06-11077A46	68
R9646	06-11077A68	560
R9652	06-11077A60	270
R9653	06-11077A50	100
R9654	06-11077A46	68
R9655	06-11077A50	100
R9657	06-11077A50	100
R9658,9659	06-11077A68	560
R9660	06-11077A04	6.8k
R9661	06-11077A78	1.5k
mechanical parts		
MP9656-9668	07-80299L01	frame, J-strap
E8641	84-80105P01	800 VCO substrate

02/27/89

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

Schematic,Circuit Board Diagram, and Parts List
for HLF6079A *SPECTRA* 800 MHz VCO Hybrid
PW-6396-O
3/31/89

HLF6080A SCHEMATIC



NOTE:
ALL VALUES ARE IN OHMS , PF AND NH UNLESS NOTED OTHERWISE.

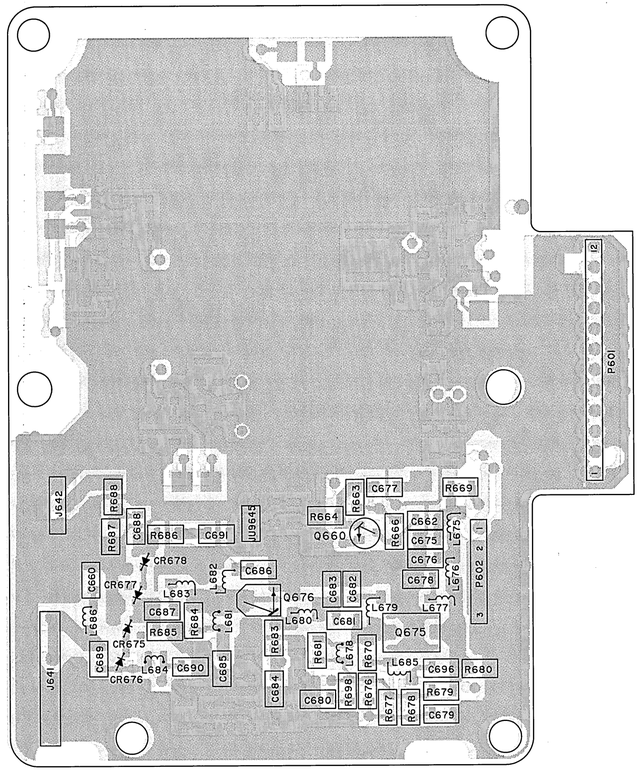
* = BAND DEPENDENT VALUES

JU9645	IN 0 OHM
JU9646	OUT
JU9647	IN 0 OHM
JU9648	OUT

GXW-6402-0

Schematic, Circuit Board Diagrams, and Parts List for
HLF6080A *SPECTRA* 800 MHz VCO Carrier Board
PW–6401–O
(Sheet 1 of 2)
3/31/89

HLF6080A CIRCUIT BOARD

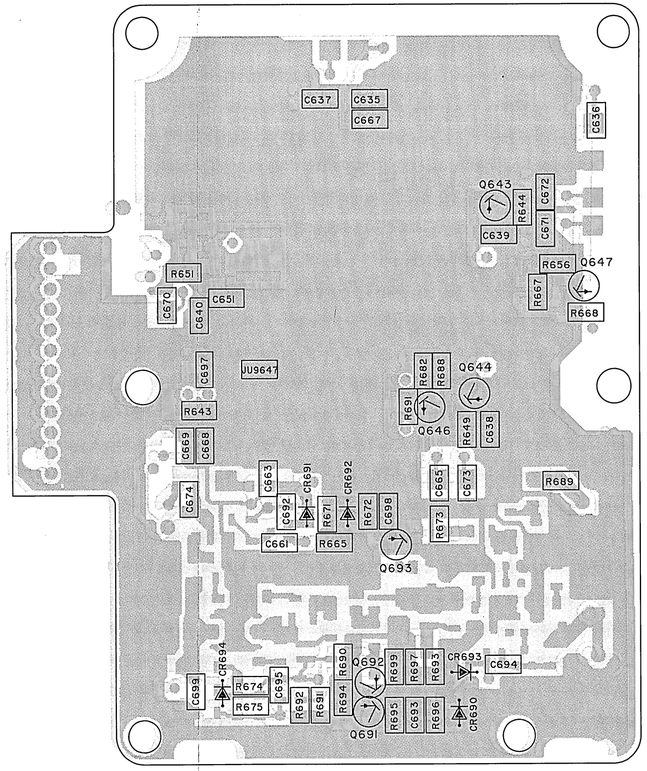


SOLDER SIDE GPW-6404-O

COMPONENT SIDE GPW-6405-O

OVERLAY GXW-6406W01-O

COMPONENT SIDE



SOLDER SIDE GPW-6404-O

COMPONENT SIDE GPW-6405-O

OVERLAY GXW-6406W02-O

SOLDER SIDE

parts list

HLF6080A 800 MHz VCO Carrier Board — MXW-6403-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C9635,9637	21–13740B49	100
C9638,9639	21–13741N45	0.01 uF, ±10%
C9640	21–13740B49	100
C9651	21–13740B69	680
C9661–9663	21–13741N69	.1 uF ±10%
C9665	21–13740B49	100
C9667,9668	21–13740B76	1500, ±5 pF
C9669	21–13740B49	100
C9670	21–13741N69	.1 uF, ±10%
C9671–9674	21–13740B49	100
C9675	21–13740B30	16
C9676	21–13740B36	30
C9677	21–13741N69	.1 uF, ±10%
C9678	21–13740B05	1.5, ±.25 pF
C9679	21–13741N45	0.01 uF, ±10%
C9680	21–13740B49	100
C9681	21–13740B15	3.9, ±.25 pF
C9682	21–13740B28	13
C9683	21–13740B11	2.7, ±.25 pF
C9684,9685	21–13741N45	0.01 uF, ±10%
C9686	21–13740B15	3.9, ±.25 pF
C9687,9688	21–13740B36	30
C9689	21–13740B25	10
C9690–9695	21–13741N45	0.01 uF, ±10%
C9696	21–13741N69	.1 uF, ±10%
C9697	23–11049A37	1, ±20%, 25V
C9698,9699	21–13741N45	0.01 uF, ±10%
diode (see note)		
CR9675–9678	48–80142L01	pin
CR9690–9694	48–80066M01	diode
connector receptacle		
J9641	09–80212N01	coax, PC board mount
J9642	09–80212N03	coax, PC board mount
jumper		
JU9645	06–11077A01	0 ohm
JU9647	06–11077A01	0 ohm
coil, RF		
L9675	24–80091G20	3 turns, airwound
L9676,9677	24–80091G06	2 turns, airwound
L9678	24–80140E04	65 nH
L9679	24–80091G20	3 turns, airwound
L9680	24–80091G06	2 turns, airwound
L9681	24–80140E06	130 nH
L9682	24–80091G01	7 turns, airwound
L9683	24–80091G20	3 turns, airwound
L9684	24–80140E06	130 nH
L9685	24–80091G01	7 turns, airwound
connector plug		
P9601	28–80099M03	vertical
transistor (see note)		
Q9643,9644	48–80141L01	PNP
Q9646,9647	48–80141L02	NPN
Q9660	48–82940R01	NPN
Q9675	48–80182D50	NPN
Q9676	48–82971R01	NPN
Q9691–9693	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9621	06–11077B47	1 MEG
R9622	06–11077B23	100k
R9643	06–11077B23	100k
R9644	06–11077A90	4.7k
R9649	06–11077A90	4.7k
R9651	06–11077A94	6.8k
R9656,9657	06–11077B47	1 MEG
R9663	06–11077A82	2.2k
R9664	06–11077A74	1k
R9665,9666	06–11077A50	100
R9668	06–11077B23	100k
R9669	06–11077A54	150
R9670	06–11077A50	100
R9671	06–11077A98	10k
R9672	06–11077A90	4.7k
R9673	06–11077A98	10k
R9674	06–11077A70	680
R9675	06–11077A78	1.5k
R9676	06–11077A74	1k
R9677	06–11077A70	680
R9678	06–11077A74	1k

MXW-6403-O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R9679	06–11077A94	6.8k
R9680	06–11077A74	1k
R9681	06–11077A82	2.2k
R9682	06–11077B47	1 MEG
R9683	06–11077A74	1k
R9684	06–11077A82	2.2k
R9685	06–11077A74	1k
R9686	06–11077A82	2.2k
R9687–9689	06–11077A50	100
R9690–9692	06–11077A70	680
R9693	06–11077A58	220
R9694	06–11077A90	4.7k
R9695	06–11077A74	1k
R9696,9697	06–11077A70	680
R9698	06–11077A36	27
R9699	06–11077A50	100
mechanical parts		
MP9676	15–80223N02	cover shield
MP9655	11–80117M01	adhesive Preform VCO

3/31/89

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

Voltage Controlled Oscillator (VCO) (900 MHz)

1. General

The VCO oscillator is located on an alumina substrate with a ceramic or metal cover. The buffer–doubler–buffer section is located on the PC board and may be repaired using normal repair methods.

2. Theory of Operation

2.1 SUPER FILTER 8.6 VOLTS

Super filter 8.6 volts is applied to the VCO carrier board at J601–12. From there, SF8.6 passes to the drain of Q9641, to the emitters of Q9643 and Q9644, and to the collector of Q9642.

2.2 VCO

Q9641, the main and transmit/talkaround transmission lines, and the varactors CR9641 through CR9644 form the major circuitry of the oscillator. CR9645, C9648, C9647, and R9641 make up an automatic gain control (AGC) circuit.

The positive steering line connects to the cathodes of the four varactors and the negative steering line connects to the anodes. The negative line should be –6.0 (+0.3) volts and the positive line can go as high as 9 volts, allowing a difference of 15 to 16 volts between the two. Normally, at room temperature, the positive steering line will be between 1.5 and 4.5 volts and will fluctuate with temperature change in the radio. Modulation is connected to the negative steering line via R9651, C9650, Q9645, R9650, and R9662.

When the radio is transmitting, the oscillator's frequency will be in the 448 to 451 MHz range. When receiving, the frequency will be between 412.675 and 415.675 MHz. If the radio is in the talkaround mode, the frequency will be between 467.5 and 471.5 MHz. The transmit and talkaround ranges are produced by coupling an additional length of transmission line to the main transmission line and is done by a high or low on the $\overline{\text{AUX 1}}$ or $\overline{\text{AUX 2}}$ input lines.

2.3 RECEIVE MODE—$\overline{\text{AUX 1}}$ AND $\overline{\text{AUX 2}}$ HIGH

When $\overline{\text{AUX 1}}$ is high, 8.6 volts is applied to the cathodes of CR9651 and CR9646. Q9643 turns off, placing a low potential on the anodes of the two diodes, reverse–biasing both. Likewise, with $\overline{\text{AUX 2}}$ high, the same occurs except CR9650 and CR9647 are reverse–biased and Q9644 turns off. This isolates the TRANSMIT/TALKAROUND transmission line from the MAIN transmission line.

2.4 TRANSMIT MODE—$\overline{\text{AUX 1}}$ HIGH; $\overline{\text{AUX 2}}$ LOW

When $\overline{\text{AUX 1}}$ is high, the same occurs as mentioned above, however, with $\overline{\text{AUX 2}}$ low, CR9650 and CR9647 are forward–biased, connecting the TRANSMIT/TALKAROUND transmission line through C9658 and C9657 to the MAIN transmission line.

2.5 TALKAROUND MODE—$\overline{\text{AUX 1}}$ LOW; $\overline{\text{AUX 2}}$ LOW

With $\overline{\text{AUX 1}}$ and $\overline{\text{AUX 2}}$ low, CR9650, CR9647, CR9651, and CR9646 are forward–biased, connecting the TRANSMIT/TALKAROUND transmission line through C9656, C9655, C9657, and C9658 to the MAIN transmission line.

2.6 VCO BUFFER

Q9642 amplifies and provides reverse isolation to the oscillator. The frequency is then applied to the buffer–doubler–buffer section of the VCO carrier board.

2.7 FIRST BUFFER CIRCUIT

The VCO output is coupled to the first buffer section through C9677. Q9660 amplifies and provides additional isolation between the doubler and the VCO.

2.8 DOUBLER

The first buffer output is coupled to the doubler section through C9662 and a lowpass input match circuitry (C9675, L9675, C9676, and L9676), which serves two purposes—it matches the input of the doubler to 50 ohms, and improves isolation between the VCO and doubler. It also keeps the desired doubler output frequency from getting to the synthesizer. The synthesizer feedback frequency is via C9674 and R9669.

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Q9675 doubles the frequency applied to its base. The components on the collector are built so that a 450 MHz signal is effectively shorted to ground, while the 900 MHz signal sees high impedance to ground. The doubler is coupled to the buffer through C9681, and into a 50–ohm matching network made up of C9683 and L9680.

Doubler–biasing differs between receive mode and transmit mode. For receive, R9677, R9678, and R9676 (in parallel to dissipate power) plus R9679 and R9680 bias the base of Q9675 to 0.7 volt potential, if NO input RF power is applied to the base. For transmit mode, keyed 9.4 volts is fed through CR9694 and another parallel resistor network R9674 and R9675. This raises the current to the collector of Q9675 via L9678, producing more power out.

2.9 SECOND BUFFER

The second buffer circuit is Q9676 with a 460 MHz trap, made up of L9682 and C9686, on the collector. The signal is coupled by series LC network of L9683 and C9687. For the receive mode, Q9676's gain is approximately 1 to 4 dB; in transmit, its gain is approximately 7 dB.

In receive mode, K9.4 volts is off so that the base voltage of Q9692 is controlled by voltage divider, R9694 an R9695. With temperature changes, the emitter–base junction of Q9691 tracks that of Q9692's, stabilizing the collector current and collector voltage of Q9676. R9690 and R9691 set the current level to the collector of Q9676 in receive.

In transmit mode, K9.4 volts is applied to CR9693 and through R9697 and R9693, increasing the current flow to Q9676. K9.4 volts on the anode of CR9690 increases the voltage on the base of Q9692. This increases voltage at Q9692's emitter and Q9676's collector. In the transmit mode, the buffer draws approximately 60 milliamps.

2.10 $\overline{\text{K9.4}}$ V SWITCH

In the receive mode, K9.4 volts is off. CR9691 is reverse–biased, CR9692 is forward–biased; therefore Q9693 conducts to produce 9.4 volts on the collector. This forward–biases CR9678 and CR9677, allowing RF to pass through C9688. R9687, R9688, and R9689 drop the 12 dBm signal on the anode of CR9678 down to 0 to 5 dBm. This is the receiver injection signal which is applied to the first mixer in the front end of the radio.

In the transmit mode, K9.4 volts is on. Q9693 turns off, reverse biasing CR9678 and CR9677. However, CR9675 and CR9676 are forward–biased, allowing the RF signal to pass through C9689. The signal (approximately 20 dBm) at the junction of CR9675 and CR9677, is attenuated about 1 dB across the diodes. The transmit signal, at approximately 18 to 23 dBm, is applied to the power amplifier via C9689.

3. Troubleshooting

Use these instructions along with the theory of operation, the block diagram, and the schematic to help isolate failures, first, to the individual circuits, and finally to the failing piece part.

3.1 VCO HYBRID ASSEMBLY

The VCO hybrid substrate is glued to the carrier board. The hybrid is not a field–repairable assembly. If a failure is indicated in this assembly, replace the entire carrier board.

3.2 OUT–OF–LOCK CONDITION

The probable cause of an out–of–lock condition is a failure in the synthesizer circuit. (See the synthesizer troubleshooting information in the RF Board Section.) If the voltages on the $\overline{\text{AUX 1}}$ and $\overline{\text{AUX 2}}$ lines do not conform to the table in Figure 1, troubleshoot the synthesizer.

If the $\overline{\text{AUX 1}}$ and $\overline{\text{AUX 2}}$ voltages are correct but the synthesizer feedback level is not within the range indicated, troubleshoot the first buffer on the VCO carrier board. If no problem is found with the first buffer and the level out of the VCO is below that indicated on the block diagram, check J straps MP9656–MP9668. If no problem is found with these, replace the entire carrier board.

If the $\overline{\text{AUX 1}}$ and $\overline{\text{AUX 2}}$ voltages are correct and the synthesizer feedback level is correct but an out–of–lock condition persists, troubleshoot the synthesizer.

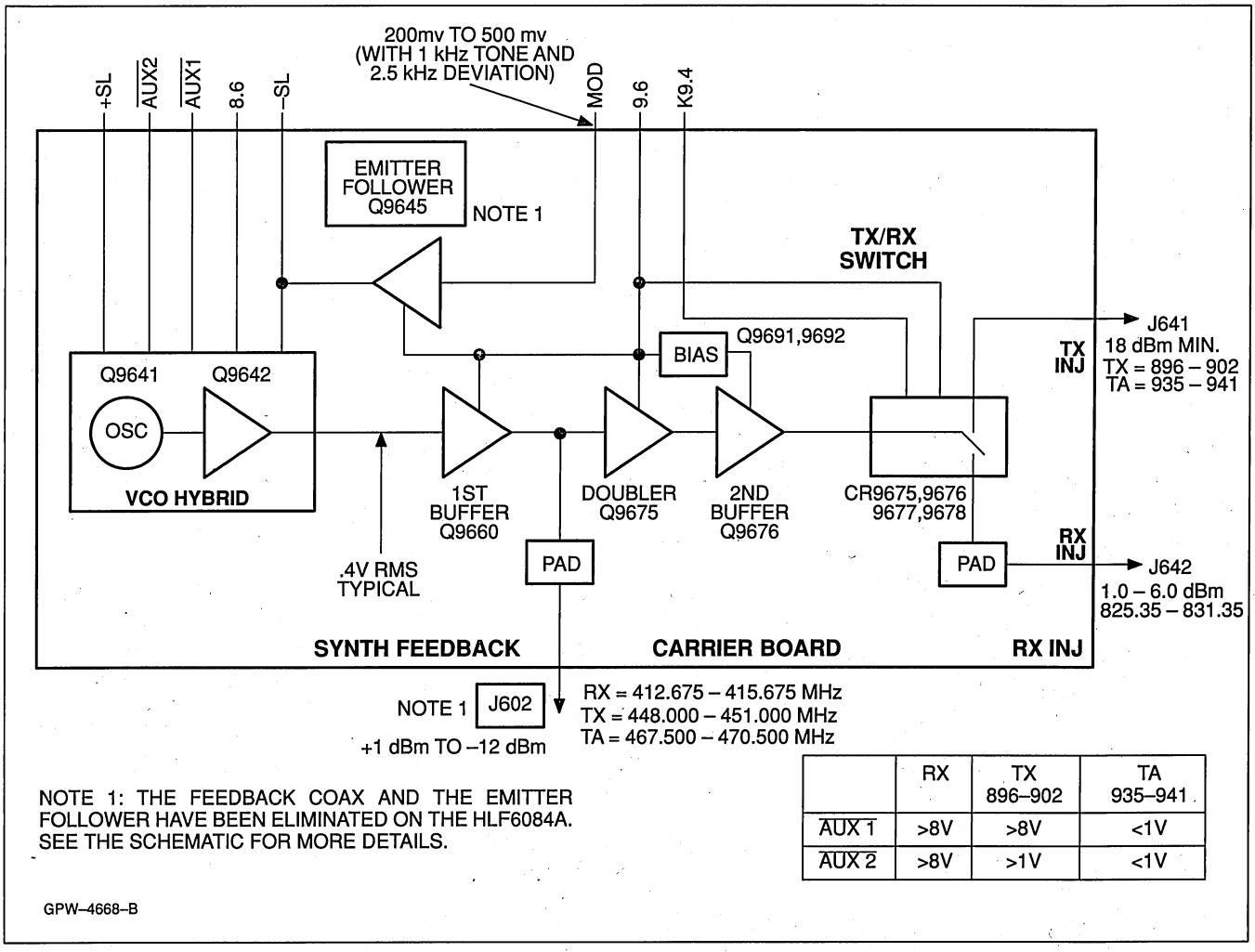
3.3 NO OR LOW OUTPUT POWER
(TX OR RX INJECTION)

Use the test cables listed in the Service Aids in the Service Manual. Measure the power at the synthesizer feedback port–if it is not within the range specified in the block diagram, troubleshoot the first buffer. If failure is found in the first buffer, replace the defective component. If no failure is found in the first buffer and the level out of the VCO (measured with an RF millivolt meter) is below that indicated in the block diagram check J straps MP9656–MP9668. If no problem is found with these, replace the entire carrier board.

If the level at the synthesizer feedback port is within the indicated range, then troubleshoot the doubler, second buffer, and PIN diode switch.

3.4 NO OR LOW MODULATION

Under standard test conditions with a 1 kHz tone injected and 2.25 kHz (+250 Hz) deviation, there should be between 200 and 500 millivolts present on J601, Pin 10 (modulation input). (See the circuit board overlay for location.) If this level is not present, troubleshoot the audio circuitry. If it is present, check J601, Pin 4 (NEG S.L.). The negative steering line should be –6.0 (+0.3) volts. If this is not correct, check the negative steering line circuitry on the RF board and/or check the emitter follower circuitry (Q9645 and associated parts) on the carrier board. If no problem is found, check J straps MP9656–MP9668. If no problem is found with these, replace the entire carrier board.



	RX	TX 896–902	TA 935–941
$\overline{\text{AUX 1}}$	>8V	>8V	<1V
$\overline{\text{AUX 2}}$	>8V	>1V	<1V

Figure 1. VCO Block Diagram

parts list

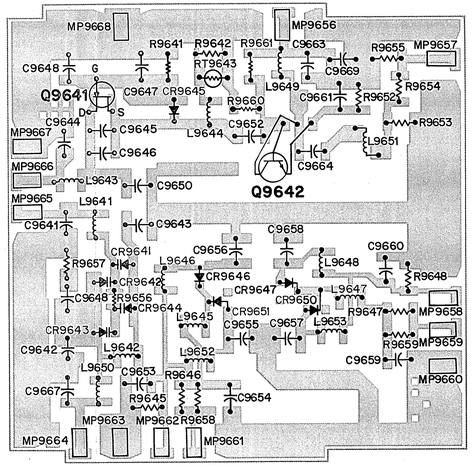
HLF6072A 900 MHz VCO Hybrid — MXW–4655–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C9641	21–13740B40	100, 50V
C9642	21–11078B42	10
C9643	21–11078B08	6.2, ±.25 pF
C9644	21–13740B49	100, 50V
C9645	21–80075N05	3.9, ±.25 pF, 63V
C9646	21–80075N06	4.7, ±.25 pF, 63V
C9647	21–11078B42	100
C9648	21–11078B27	30
C9649	21–13740B36	30, 50V
C9650	21–11078B15	12
C9651	21–13740B05	1.5, ±.25 pF, 50V
C9653,9654	21–13740B49	100, 50V
C9655–9658	21–11078B42	100
C9659–9661	21–13740B49	100, 50V
C9663,9664	21–13740B49	100, 50V
C9667	21–13740B49	100, 50V
C9669	21–13741N45	0.01 uF, 50V
diode (see note)		
CR9641–9644	48–80006E09	varactor, type MMBV109 350mW
CR9645	48–80236E05	hot carrier
CR9646,9647	48–80142L01	pin, type MMBV3401
CR9650,9651	48–80142L01	pin, type MMBV3401
coil, RF		
L9641	24–80140E07	680 nH
L9642	24–80140E06	130 nH
L9643–9650	24–80140E07	680 nH
L9651	24–80091G01	air wound
L9652–9653	24–80140E07	680 nH
transistor (see note)		
Q9641	48–80141L06	n-channel JFET
Q9642	48–82971R01	NPN
thermistor		
RT9643	06–80149M01	470 ohms
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9641	06–11077B15	47k
R9645	06–11077A94	6.8k
R9646,9647	06–11077A68	560
R9648	06–11077A94	6.8k
R9652	06–11077A60	270
R9653	06–11077A50	100
R9654	06–11077A46	68
R9655	06–11077A50	100
R9657	06–11077A50	100
R9658,9659	06–11077A68	560
R9660	06–11077A94	6.8k
R9661	06–11077A78	1.5k
mechanical parts		
MP9656–9668	07–80299L01	frame, j-strap
substrate		
E9641	84–83185R01	CKT, thick film, type E

02/21/89

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

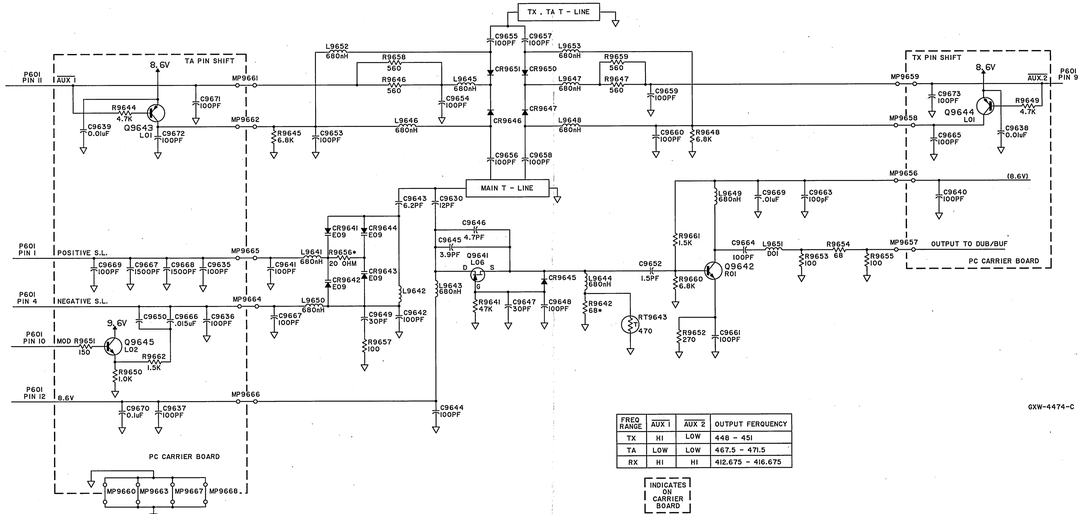
HLF6072A HYBRID



SUBSTRATE — GCW–4705–0

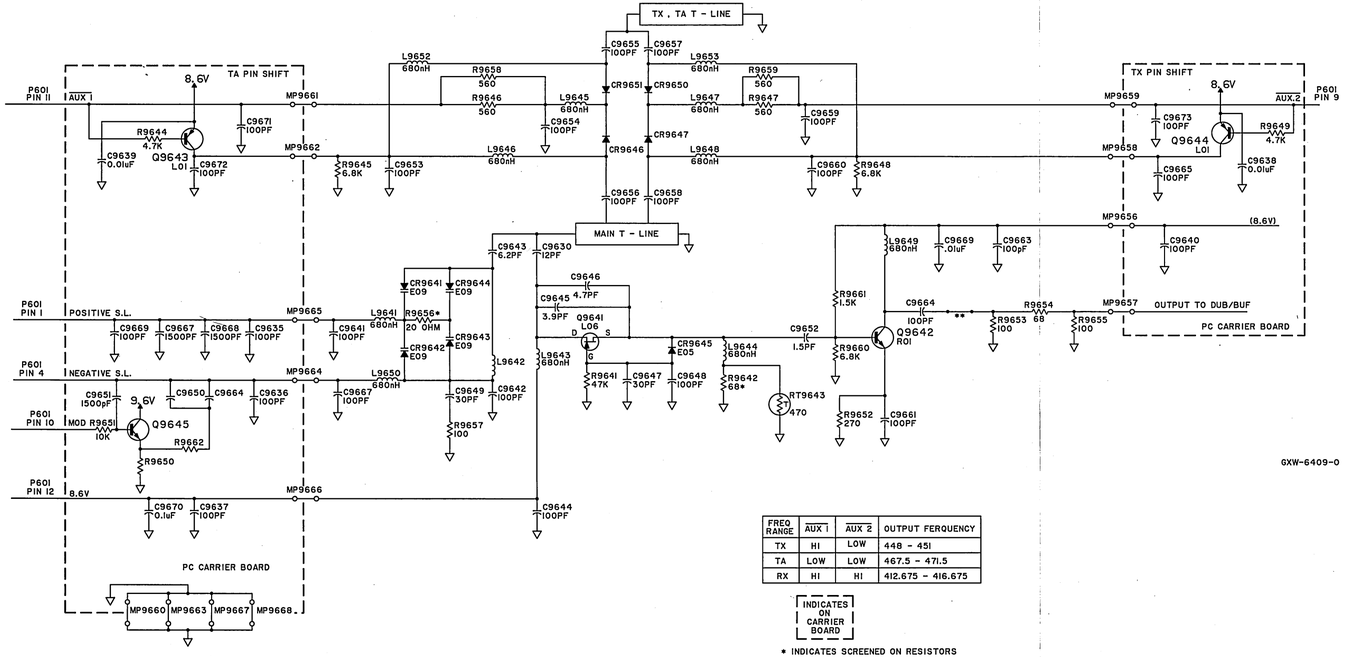
OVERLAY — GCW–4706–B

HLF6072A SCHEMATIC



Schematic, Circuit Board Diagram, and Parts List
for HLF6072A *SPECTRA* 900 MHz VCO Hybrid
PW–4762–C
3/31/89

HLF6072B SCHEMATIC



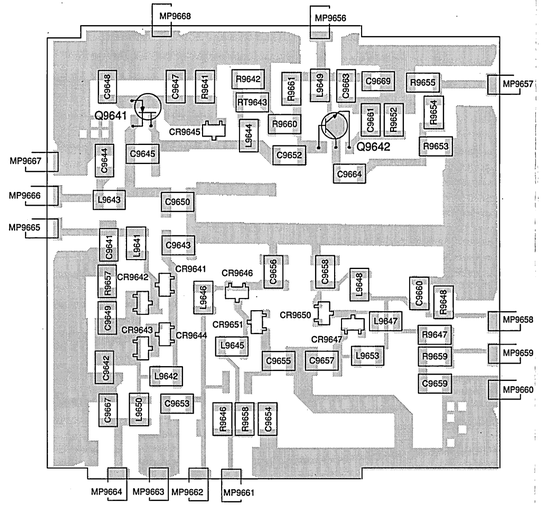
GXW-6409-O

FREQ RANGE	AUX 1	AUX 2	OUTPUT FERQUENCY
TX	HI	LOW	448 - 451
TA	LOW	LOW	467.5 - 471.5
RX	HI	HI	412.675 - 416.675

INDICATES ON CARRIER BOARD

* INDICATES SCREENED ON RESISTORS
** L9651 IS OMITTED ON HLF6072B

HLF6072B CIRCUIT BOARD



SUBSTRATE GPW-6411-O
OVERLAY GPW-6412-O

parts list

HLF6072B 900 MHz VCO Hybrid — MXW-6410-O

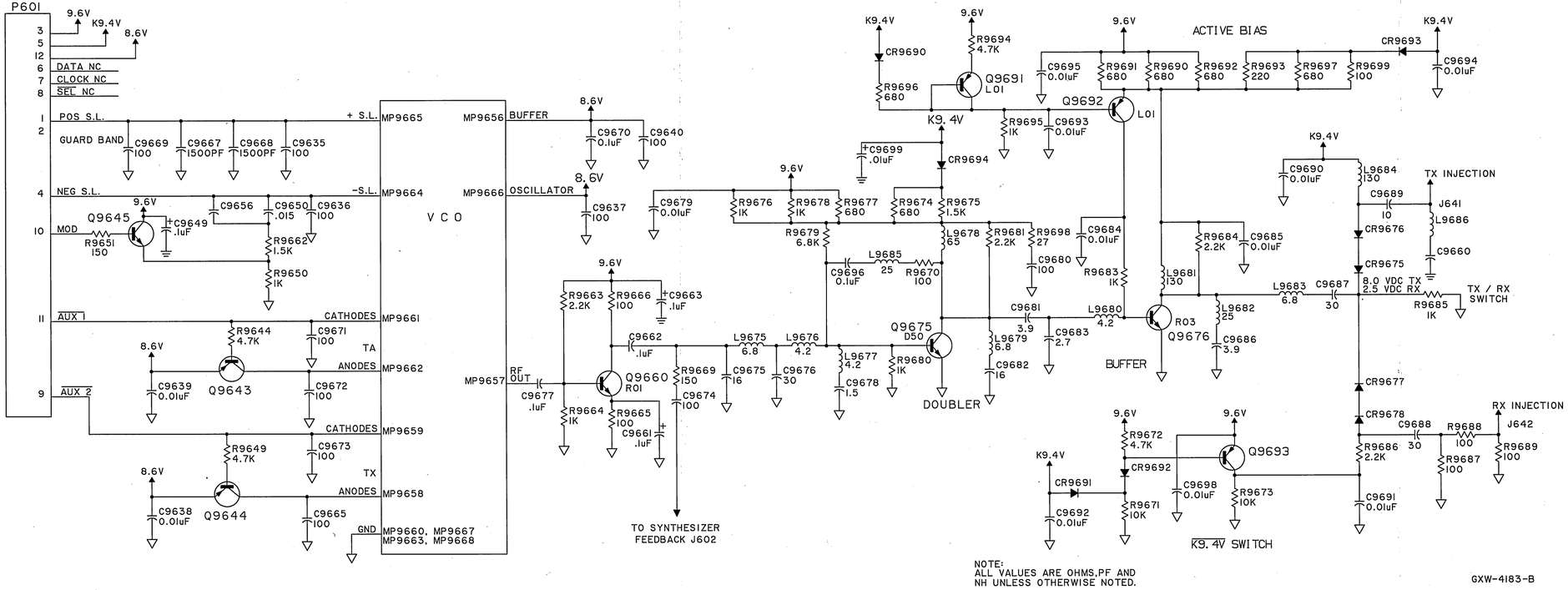
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C9641	21-13740B49	100, 50V
C9642	21-11078B42	100
C9643	21-11078B08	6.2, ±.25 pF
C9644	21-13740B49	100, 50V
C9645	21-80075N05	3.9, ±.25 pF, 63V
C9646	21-80075N06	4.7, ±.25 pF, 63V
C9647	21-11078B42	100
C9648	21-11078B27	30
C9649	21-13740B36	30, 50V
C9650	21-11078B15	12
C9652	21-13740B05	1.5, ±.25 pF, 50V
C9653,9654	21-13740B49	100, 50V
C9655-9658	21-11078B42	100
C9659-9661	21-13740B49	100, 50V
C9663,9664	21-13740B49	100, 50V
C9667	21-13740B49	100, 50V
C9669	21-13741N45	0.01 uF
diode (see note)		
CR9641-9644	48-80006E09	varactor, type MMBV109 350mW
CR9645	48-80236E05	hot carrier
CR9646,9647	48-80142L01	pin, type MMBV3401
CR9650,9651	48-80142L01	pin, type MMBV3401
coil, RF		
L9641	24-80140E07	680 nH
L9642	24-80140E04	65 nH
L9643-9653	24-80140E07	680 nH
transistor (see note)		
Q9641	48-80141L06	n-channel JFET
Q9642	48-82971R01	NPN
thermistor		
RT9643	06-80149M01	470 ohms
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9641	06-11077B15	47k
R9645	06-11077A94	6.8k
R9646,9647	06-11077A68	560
R9648	06-11077A94	6.8k
R9652	06-11077A60	270
R9653	06-11077A50	100
R9654	06-11077A46	68
R9655	06-11077A50	100
R9657	06-11077A50	100
R9658,9659	06-11077A68	560
R9660	06-11077A94	6.8k
R9661	06-11077A78	1.5k
mechanical parts		
MP9656-9668	07-80299L01	frame, j-strap
substrate		
E9641	84-83185R01	CRT, thick film, type F

02/21/89

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

Schematic, Circuit Board Diagram, and Parts List
for HLF6072B *SPECTRA* 900 MHz VCO Hybrid
PW-6408-O
3/31/89

HLF6002A AND HLF6073A SCHEMATIC



NOTE:
ALL VALUES ARE OHMS,PF AND NH UNLESS OTHERWISE NOTED.

GXW-4183-B

Schematic, Circuit Board Diagrams, and Parts List
for HLF6002A and HLF6073A *SPECTRA*
900 MHz VCO Carrier Board
PW-4712-C
(Sheet 1 of 2)
3/31/89

parts list

HLF6002A 900 MHz VCO Carrier Board
HLF6073A 900 MHz VCO Carrier Board — MXW–4651–D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C9635–9637	21–13740B49	100
C9638,9639	21–13741N45	0.01 uF
C9640	21–13740B49	100
C9649	21–13741N69	.1 uF
C9650	21–80027N01	.015 uF, ±10%
C9661–9663	21–13741N69	.1 uF
C9665	21–13740B49	100
C9667,9668	21–13740B76	1500
C9669	21–13740B49	100
C9670	21–13741N69	.1 uF
C9671–9674	21–13740B49	100
C9675	21–13740B30	16
C9676	21–13740B36	30
C9677	21–13741N69	.1 uF
C9678	21–13740B07	1.8 (HLF6002A only)
C9678	21–13740B05	1.5 (HLF6073A only)
C9679	21–13741N45	0.01 uF
C9680	21–13740B49	100
C9681	21–13740B15	3.9
C9682	21–13740B28	13
C9683	21–13740B11	2.7
C9684,9685	21–13741N45	0.01 uF
C9686	21–13740B15	3.9
C9687,9688	21–13740B36	30
C9689	21–13740B25	10
C9690–9695	21–13741N45	0.01 uF
C9696	21–13741N69	.1 uF
C9698,9699	21–13741N45	0.01 uF
diode (see note)		
CR9675–9678	48–80142L01	pin
CR9690–9694	48–80066M01	diode
connector receptacle		
J9602	30–80152M04	CBL: coax assembly
J9641	09–80110M01	coax, PC board mount
J9642	09–80111M01	coax, PC board mount
	09–80107M02	female
coil, RF		
L9675	24–80091G20	3 turns, airwound
L9676,9677	24–80091G06	2 turns, airwound
L9678	24–80140E04	65 nH
L9679	24–80091G20	3 turns, airwound
L9680	24–80091G06	2 turns, airwound
L9681	24–80140E06	130 nH
L9682	24–80091G01	7 turns, airwound
L9683	24–80091G20	3 turns, airwound
L9684	24–80140E06	130 nH
L9685	24–80091G01	7 turns, airwound
connector plug		
P9601	28–80099M01	vertical (HLF6002A only)
P9601	28–80099M03	vertical (HLF6073A only)
translistor (see note)		
Q9643,9644	48–80141L01	PNP
Q9645	48–80141L02	NPN
Q9660	48–82940R01	NPN
Q9675	48–80182D50	NPN
Q9676	48–82971R01	NPN
Q9691–9693	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9644	06–11077A90	4.7k
R9649	06–11077A90	4.7k
R9650	06–11077A74	1k
R9651	06–11077A54	150
R9662	06–11077A78	1.5k
R9663	06–11077A82	2.2k
R9664	06–11077A74	1k
R9665,9666	06–11077A50	100
R9669	06–11077A54	150
R9670	06–11077A50	100
R9671	06–11077A98	10k
R9672	06–11077A90	4.7k
R9673	06–11077A98	10k
R9674	06–11077A70	680
R9675	06–11077A78	1.5k
R9676	06–11077A74	1k
R9677	06–11077A70	680
R9678	06–11077A74	1k
R9679	06–11077A94	6.8k
R9680	06–11077A74	1k
R9681	06–11077A82	2.2k
R9683	06–11077A74	1k
R9684	06–11077A82	2.2k
R9685	06–11077A74	1k
R9686	06–11077A82	2.2k
R9687–9689	06–11077A50	100
R9690–9692	06–11077A70	680
R9693	06–11077A58	220
R9694	06–11077A90	4.7k
R9695	06–11077A74	1k
R9696,9697	06–11077A70	680
R9698	06–11077A36	27
R9699	06–11077A50	100

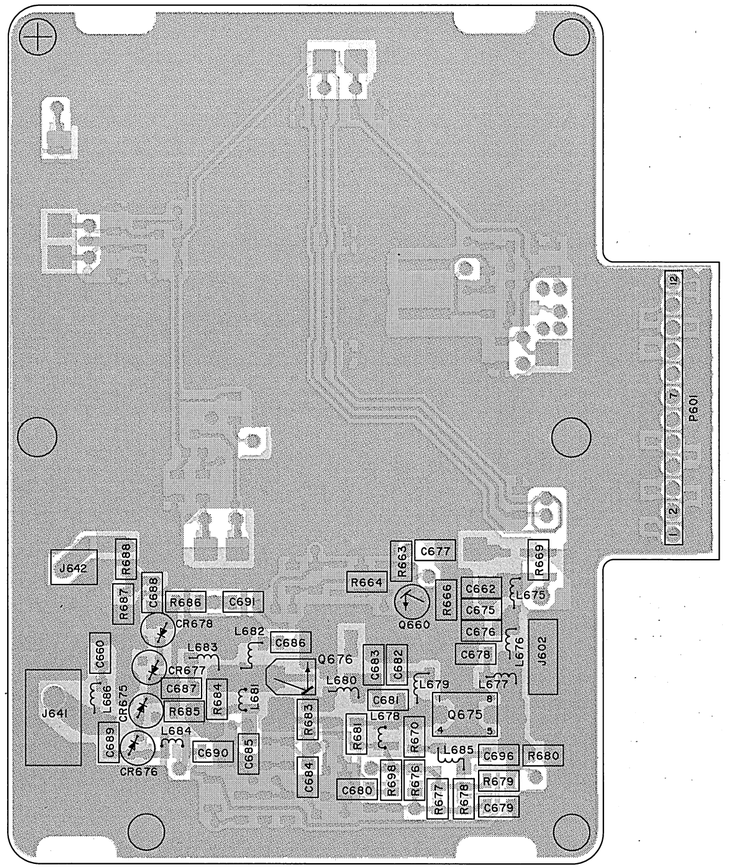
MXW–4651–D (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
mechanical parts		
MP9601,9602	75–05295B01	crystal base pad (HLF6002A only)
MP9655	11–80117M01	adhesive preform–VCO
MP9676	15–80223N01	shield cover (HLF6002A only)
MP9676	15–80223N02	shield cover (HLF6073A only)
PC board		
E9677	84–80191L01	BD CKT VCO carrier

02/21/89

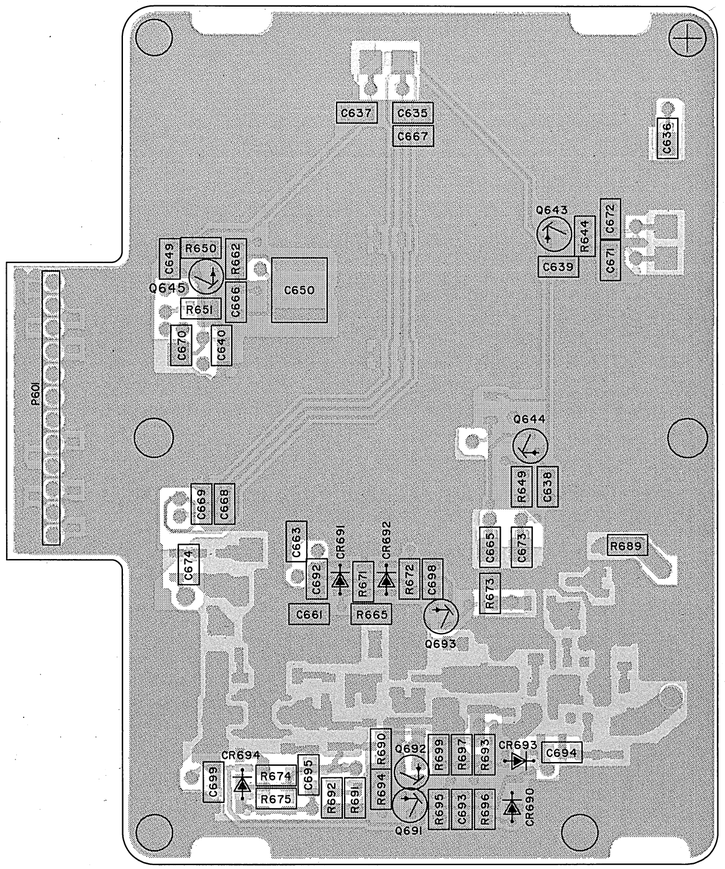
note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

HLF6002A AND HLF6073A CIRCUIT BOARD



SOLDER SIDE — GPW–4683–O
COMPONENT SIDE — GPW–4682–O
OVERLAY — GXW–4684WOI–B

COMPONENT SIDE

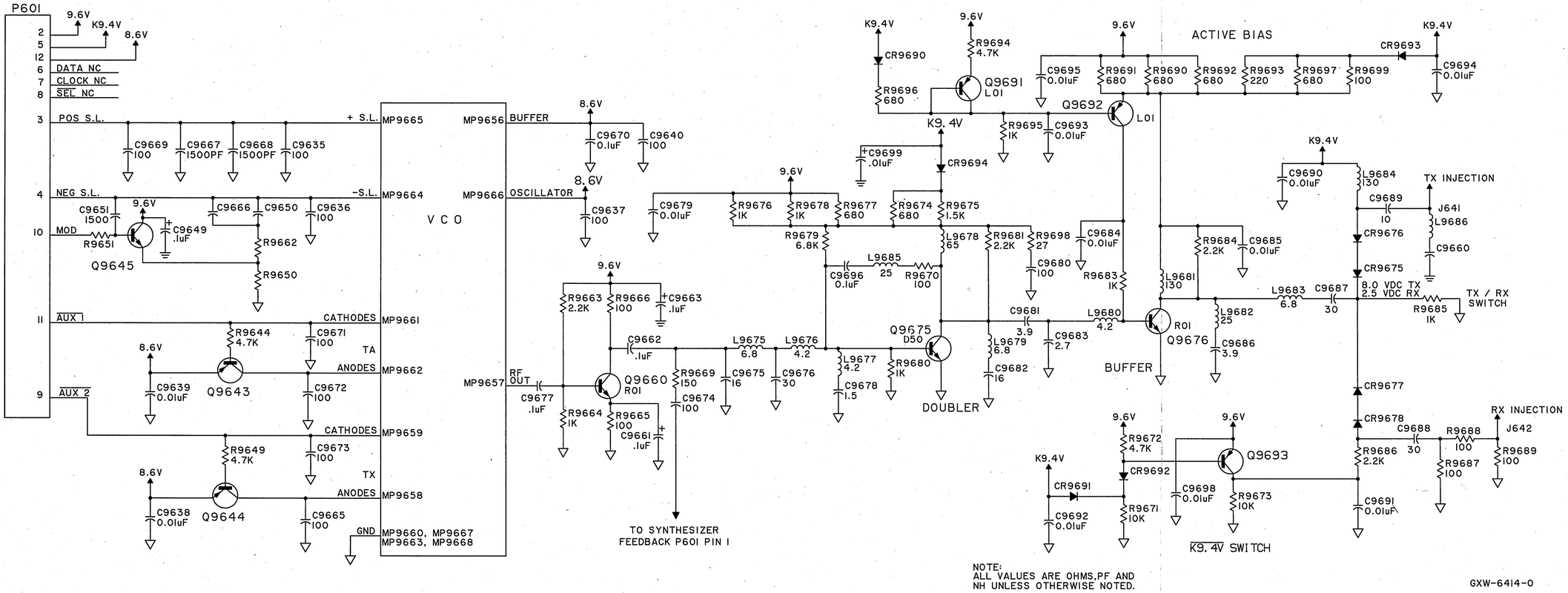


SOLDER SIDE — GPW–4683–O
COMPONENT SIDE — GPW–4682–O
OVERLAY — GXW–4684WO2–B

SOLDER SIDE

Schematic, Circuit Board Diagrams, and Parts List
for HLF6002A and HLF6073A *SPECTRA*
900 MHz VCO Carrier Board
PW–4712–C
(Sheet 2 of 2)
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HLF6084A SCHEMATIC



Schematic, Circuit Board Diagrams, and
Parts List for HLF6084A *SPECTRA*
900 MHz VCO Carrier Board
PW–6413–O
(Sheet 1 of 2)
3/31/89

parts list

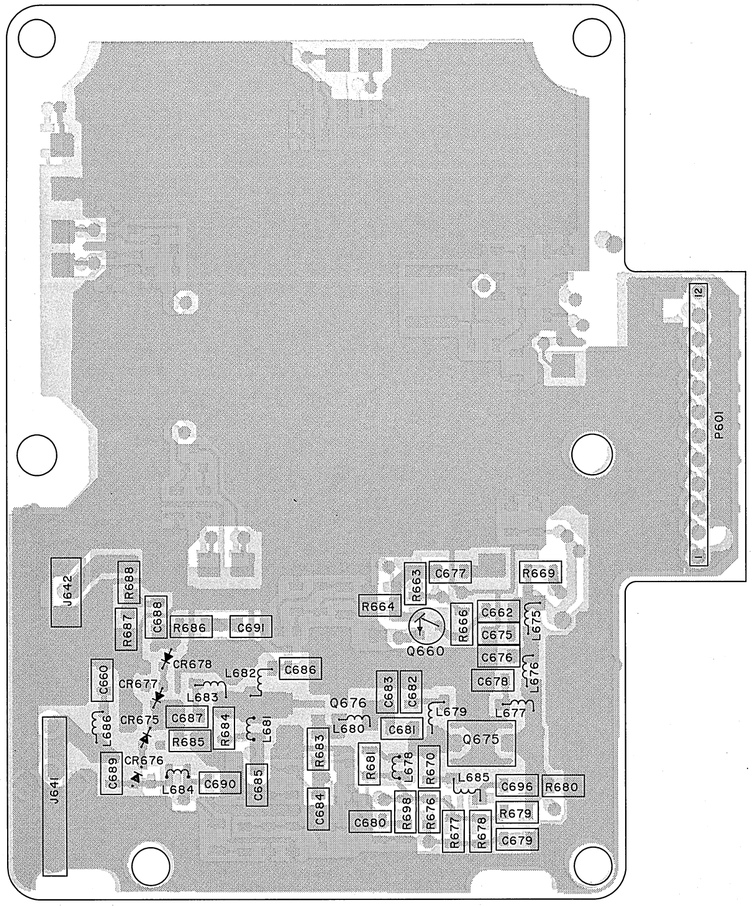
HLF6084A 900 MHz VCO Carrier Board — MXW–6415–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C9635,9637	21–13740B49	100
C9638,9639	21–13741N45	0.01 uF
C9640	21–13740B49	100
C9651	21–13740B76	1500
C9661–9663	21–13741N69	.1 uF
C9665	21–13740B49	100
C9667,9668	21–13740B76	1500
C9669	21–13740B49	100
C9670	21–13741N69	.1 uF
C9671–9674	21–13740B49	100
C9675	21–13740B30	16
C9676	21–13740B36	30
C9677	21–13741N69	.1 uF
C9678	21–13740B05	1.5, ±.25 pF
C9679	21–13741N45	0.01 uF
C9680	21–13740B49	100
C9681	21–13740B15	3.9, ±.25 pF
C9682	21–13740B28	13
C9683	21–13740B11	2.7, ±.25 pF
C9684,9685	21–13741N45	0.01 uF
C9686	21–13740B15	3.9, ±.25 pF
C9687,9688	21–13740B36	30
C9689	21–13740B25	10
C9690–9696	21–13741N45	0.01 uF
C9698,9699	21–13741N45	0.01 uF
connector receptacle		
J9641	09–80110M01	coax, PC board mount
J9642	09–80212N03	coax, PC board mount
coil, RF		
L9675	24–80091G20	3 turns, airwound
L9676,9677	24–80091G06	2 turns, airwound
L9678	24–80140E04	65 nH
L9679	24–80091G20	3 turns, airwound
L9680	24–80091G06	2 turns, airwound
L9681	24–80140E06	130 nH
L9682	24–80091G01	7 turns, airwound
L9683	24–80091G20	2 turns, airwound
L9684	24–80140E06	130 nH
L9685	24–80091G01	7 turns, airwound
diode (see note)		
CR9675–9678	48–80142L01	pin
CR9690–9694	48–80066M01	diode
connector plug		
P9601	28–80099M03	vertical
transistor (see note)		
Q9643,9644	48–80141L01	PNP
Q9660	48–82940R01	NPN
Q9675	48–80182D50	NPN
Q9676	48–82971R01	NPN
Q9691–9693	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9644	06–11077A90	4.7k
R9649	06–11077A90	4.7k
R9651	06–11077A98	10k
R9663	06–11077A82	2.2k
R9664	06–11077A74	1k
R9665–9666	06–11077A50	100
R9669	06–11077A54	150
R9670	06–11077A50	100
R9671	06–11077A98	10k
R9672	06–11077A90	4.7k
R9673	06–11077A98	10k
R9674	06–11077A70	680
R9675	06–11077A78	1.5k
R9676	06–11077A74	1k
R9677	06–11077A70	680
R9678	06–11077A74	1k
R9679	06–11077A94	6.8k
R9680	06–11077A74	1k
R9681	06–11077A82	2.2k
R9683	06–11077A74	1k
R9684	06–11077A82	2.2k
R9685	06–11077A74	1k
R9686	06–11077A82	2.2k
R9687–9689	06–11077A50	100
R9690–9692	06–11077A70	680
R9693	06–11077A58	220
R9694	06–11077A90	4.7k
R9695	06–11077A74	1k
R9696,9697	06–11077A70	680
R9698	06–11077A36	27
R9699	06–11077A50	100
mechanical parts		
MP9655	11–80117M01	adhesive preform–VCO
MP9676	15–80223N02	cover shield
PC board		
E9677	84–80103P01	BD CKT VCO carrier

02/21/89

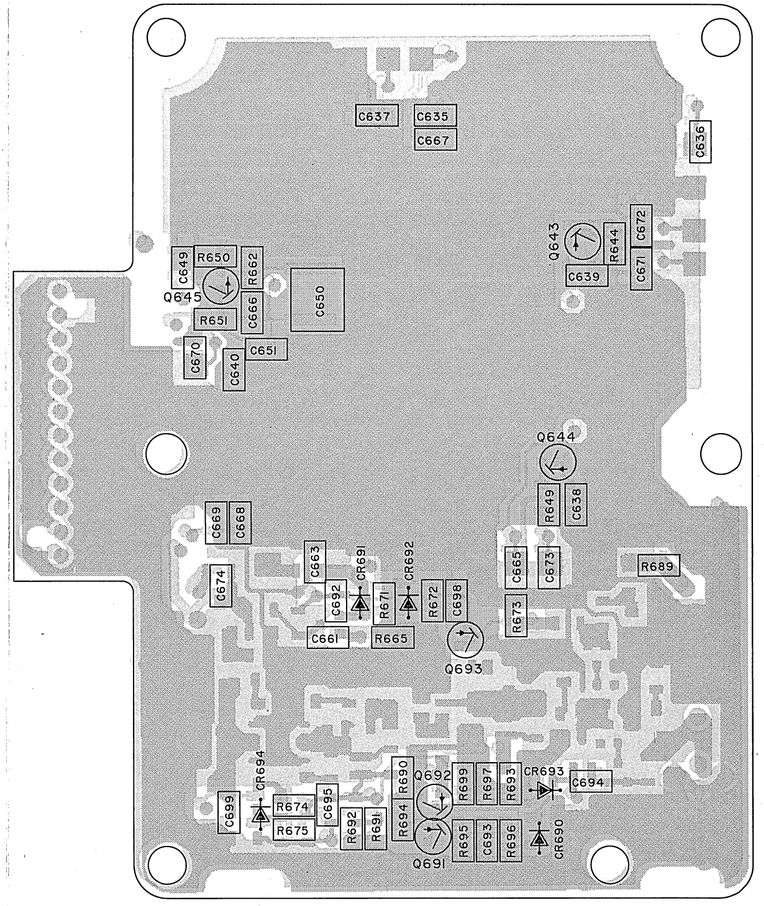
note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

HLF6084A CIRCUIT BOARD



SOLDER SIDE — GPW–6416–O
COMPONENT SIDE — GPW–6417–O
OVERLAY — GXW–6418W01–O

COMPONENT SIDE



SOLDER SIDE — GPW–6416–O
COMPONENT SIDE — GPW–6417–O
OVERLAY — GXW–6418W02–O

SOLDER SIDE

Schematic, Circuit Board Diagrams, and
Parts List for HLF6084A *SPECTRA*
900 MHz VCO Carrier Board
PW–6413–O
(Sheet 2 of 2)
3/31/89

Receiver Front–End (VHF)

1. General

The Receiver Front–End (RXFE) performs the first conversion of the received signal. The inbound signal is mixed with the high side injection signal, to produce the 109.65 MHz first IF. The pre–amp/mixer configuration of the RXFE includes a factory–tuned, 5–pole preselector, a fixed injection filter, and a double balanced mixer.

2. Theory of Operation

The factory–tuned preselector filter accepts RF input frequencies ranging from 136–162 MHz (Range 1) or 146–174 MHz (Range 2). The fixed 2–pole injection filter accepts frequencies of both ranges.

The RF board supplies DC voltage to the pre–amp. Transistors Q3200 and Q3201 stabilize the bias for pre–amp device Q3202 through temperature changes. L3200, L3201, L3203, C3200, and C3201 form the high pass filter; R3206, R3200, R3210, R3208, and R3209 are adjusted to meet radio performance specifications for High or Low sensitivity.

The double–balanced mixer has an injection level of +20 dBm, common for both ranges; at its output, a diplexer helps terminate the IF port at all frequencies of interest, and forms the bandpass filter.

From the pre–amp input to the IF output, there should be a conversion gain of –1.5 to +3.5 dB for high sensitivity, and +7.0 to +10 dB for low sensitivity specifications.

3. Troubleshooting

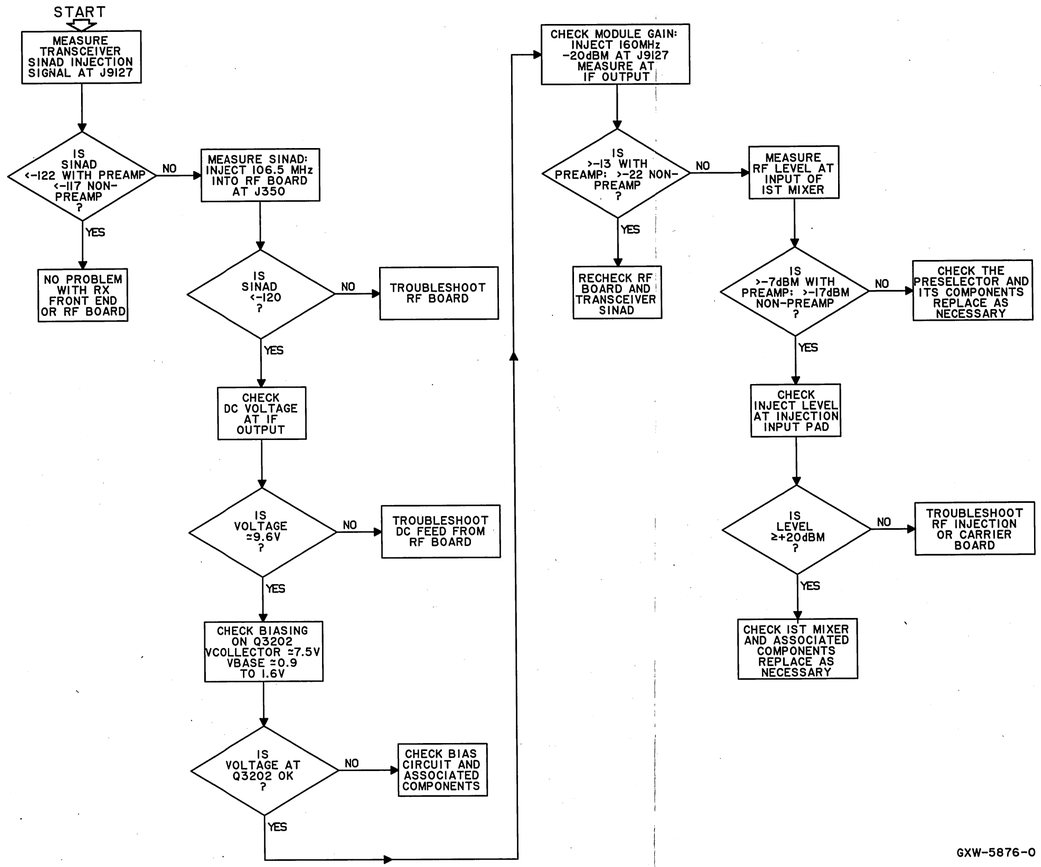
This information will help field service technicians troubleshoot the *SPECTRA* radio. Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, this section includes a Troubleshooting Chart that will guide you through a sequence of tests and checks designed to isolate problems.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods.

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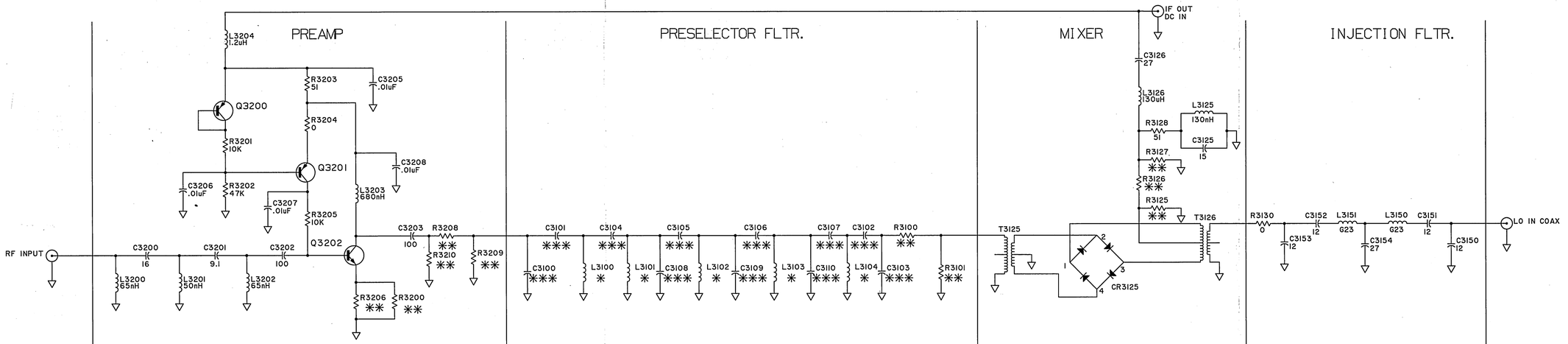
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W10002S70–A
3/31/89



GXW-5876-0

Troubleshooting Chart for
SPECTRA VHF Receiver Front–End
PW–5875–O
10/3/88

VHF RECEIVER FRONT–END SCHEMATIC



* NOT FIELD REPLACEABLE

*** SEE PARTS LIST

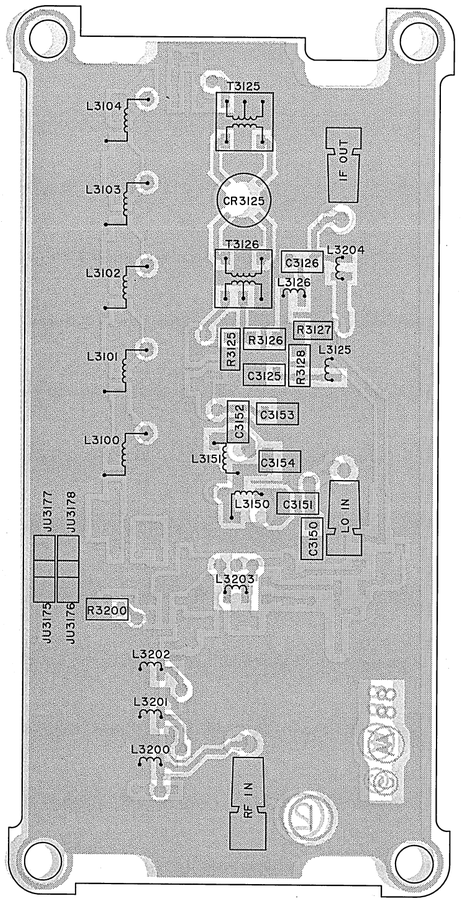
**		HRD6011A HRD6012A (PREAMP)	HRD6001A HRD6002A (NON-PREAMP)
	R3200	0	51
	R3206	10	68
	R3208	10	18
	R3209	680	560
	R3210	680	560
	R3101	NO RES	680
	R3127	NO RES	680
	R3125	NO RES	680
	R3100	JUMPER	10
	R3126	JUMPER	10

NOTE:
ALL RESISTANCE IN OHMS, ALL CAPACITANCE IN PICOFARADS UNLESS OTHERWISE NOTED.

GXW-5910-A

Schematic, Circuit Board Diagrams, and
Parts Lists for *SPECTRA* VHF Receiver Front–End
PW–5914–A
(Sheet 1 of 2)
3/31/89

VHF RECEIVER FRONT–END CIRCUIT BOARD DIAGRAMS

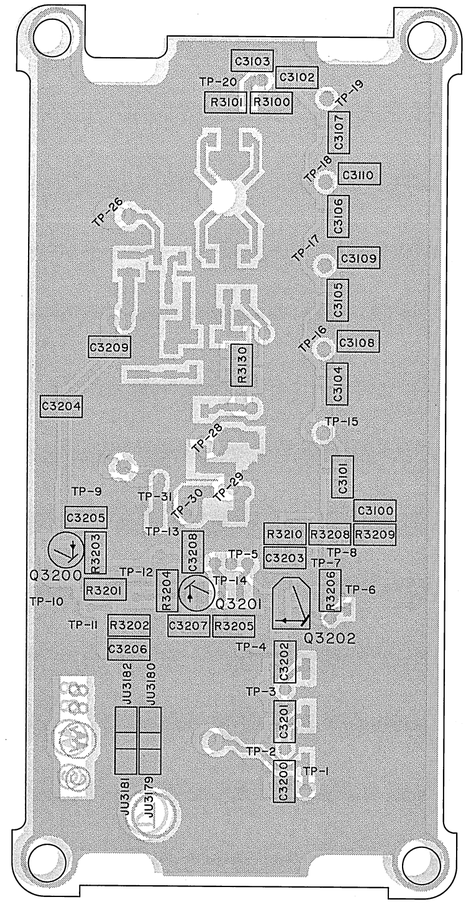


SOLDER SIDE GPW–6566–A

COMPONENT SIDE GPW–6567–A

OVERLAY GXW–6568W01–A

COMPONENT SIDE VIEW



SOLDER SIDE GPW–6566–A

COMPONENT SIDE GPW–6567–A

OVERLAY GXW–6568W02–A

SOLDER SIDE VIEW

parts list

HRD6001A Receiver Front End Board (R1) 136/162 MHz
HRD6011A Receiver Front End Board (R1 with pre–amp) 136/162 MHz MXW–5869–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C3100,3101	21–13740B34	24
C3102	21–13740B30	16
C3103	21–13740B34	24
C3104	21–13740B11	2.7, ±0.25 pF
C3105,3106	21–13740B09	2.2, ±0.25 pF
C3107	21–13740B11	2.7, ±0.25 pF
C3108	21–11078B16	13, 100V
C3109	21–11078B15	12, 100V
C3110	21–11078B16	13, 100V
C3125	21–13740B29	15
C3126	21–13740B35	27
C3150–3153	21–13740B27	12
C3154	21–11078B25	27, 100V
C3200	21–13740B30	16
C3201	21–13740B24	9.1
C3202,3203	21–13740B49	100
C3205–3208	21–13741N45	0.01 uF
diode (see note)		
CR3125	48–80236E17	Diode Quad Ring
connector receptacle		
J3102	09–80110M01	coax, PC board mounted
jumper		
JU3175	06–11077A01	0 ohm resistor (HRD6001A only)
JU3177	06–11077A01	0 ohm resistor (HRD6011A only)
JU3178	06–11077A01	0 ohm resistor
JU3180	06–11077A01	0 ohm resistor
JU3181	06–11077A01	0 ohm resistor (HRD6001A only)
JU3182	06–11077A01	0 ohm resistor (HRD6011A only)
coil, rf		
L3100–3104	24–80148M07	4–1/2 turns, 82 nh
L3125	24–80140E06	inductor, 130 nh (HRD6001A)
L3125	24–80140E04	65 nH (HRD6011A)
L3126	24–80140E06	inductor, 130 nh
L3150,3151	24–80091G23	airwound
L3200	24–80140E04	inductor, 65 nh
L3201	24–80140E03	inductor, 50 nh
L3202	24–80140E04	inductor, 65 nh
L3203	24–80140E07	inductor, 680 nh
L3204	24–80140E01	inductor, 1.2 uH
transistor (see note)		
Q3200,3201	48–80141L01	PNP
Q3202	48–82971R01	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R3100	06–11077A26	10 (HRD6001A)
R3101	06–11077A70	680 (HRD6001A)
R3125	06–11077A70	680 (HRD6001A)
R3126	06–11077A01	0 ohm jumper (HRD6011A)
R3126	06–11077A26	10 (HRD6001A)
R3127	06–11077A70	680 (HRD6001A)
R3128	06–11077A43	51
R3130	06–11077A01	0 ohm jumper
R3200	06–11077A43	51 (HRD6001A only)
R3201	06–11077A98	10k
R3202	06–11077B15	47k
R3203	06–11077A43	51
R3204	06–11077A01	0 ohm jumper
R3205	06–11077A98	10k
R3206	06–11077A46	68 (HRD6001A)
R3206	06–11077A26	10 (HRD6011A)
R3208	06–11077A32	18 (HRD6001A)
R3208	06–11077A26	10 (HRD6011A)
R3209,3210	06–11077A68	560 (HRD6001A)
R3209,3210	06–11077A70	680 (HRD6011A)
transformer		
T3125,3126	24–05548Q02	RF
mechanical parts		
	29–80014A01	clip coax terminal (2 used)
	26–80003M02	shield, high IF (2 used)
	26–80004M02	shield, output match

3/31/89

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

parts list

HRD6002A Receiver Front End (R2) 146/174 MHz
HRD6012A Receiver Front End (R2, with pre–amp) 146/174 MHz MXW–5870–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C3100,3102	21–13740B31	18
C3101	21–13740B35	27
C3103	21–13740B35	27
C3104	21–13740B13	3.3, ±0.25 pF
C3105,3106	21–13740B11	2.7, ±0.25 pF
C3107	21–13740B13	3.3, ±0.25 pF
C3108	21–11078B19	16, 100V
C3109	21–11078B16	13, 100V
C3110	21–11078B19	16, 100V
C3125	21–13740B29	15
C3126	21–13740B35	27
C3150–3153	21–13740B27	12
C3154	21–11078B25	27, 100V
C3200	21–13740B30	16
C3201	21–13740B24	9.1
C3202,3203	21–13740B49	100
C3205–3208	21–13741N45	0.01 uF
diode (see note)		
CR3125	48–80236E17	Diode Quad Ring
connector receptacle		
J3102	09–80110M01	coax, PC board mounted
jumper		
JU3175	06–11077A01	0 ohm resistor (HRD6002A only)
JU3176	06–11077A01	0 ohm resistor
JU3177	06–11077A01	0 ohm resistor (HRD6012A only)
JU3179	06–11077A01	0 ohm resistor
JU3181	06–11077A01	0 ohm resistor (HRD6002A only)
JU3182	06–11077A01	0 ohm resistor (HRD6012A only)
coil, rf		
L3100–3104	24–80148M04	3–1/2 turns, 62 nH
L3125	24–80140E06	inductor, 130 nH (HRD6002A)
L3125	24–80140E04	65nH (HRD6012A)
L3126	24–80140E06	inductor, 130 nH
L3150,3151	24–80091G23	airwound
L3200	24–80140E04	inductor, 65 nH
L3201	24–80140E03	inductor, 50 nH
L3202	24–80140E04	inductor, 65 nH
L3203	24–80140E07	inductor, 680 nH
L3204	24–80140E01	inductor, 1.2 uH
transistor (see note)		
Q3200,3201	48–80141L01	PNP
Q3202	48–82971R01	NPN
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R3100	06–11077A26	10 (HRD6002A)
R3101	06–11077A70	680 (HRD6002A)
R3125	06–11077A70	680 (HRD6002A)
R3126	06–11077A26	10 (HRD6002A)
R3126	06–11077A01	0 ohm jumper (HRD6012A)
R3127	06–11077A70	680 (HRD6002A)
R3128	06–11077A43	51
R3130	06–11077A01	0 ohm jumper
R3200	06–11077A43	51 (HRD6002A only)
R3201	06–11077A98	10k
R3202	06–11077B15	47k
R3203	06–11077A43	51
R3204	06–11077A01	0 ohm jumper
R3205	06–11077A98	10k
R3206	06–11077A46	68 (HRD6002A)
R3206	06–11077A26	10 (HRD6012A)
R3208	06–11077A32	18 (HRD6002A)
R3208	06–11077A26	10 (HRD6012A)
R3209,3210	06–11077A68	560 (HRD6002A)
R3209,3210	06–11077A70	680 (HRD6012A)
transformer		
T3125,3126	24–05548Q02	RF
mechanical parts		
	29–80014A01	clip, coax terminal (2 used)
	26–80003M02	shield, high IF (2 used)
	26–80004M02	shield, output match

3/31/89

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

Receiver Front–End (UHF)

1. General

The receiver ceramic filter has a typical insertion loss of about 0.5 to 1.5 dB; it should not have a loss greater than 2.0 dB. If any soldering must be done on the filter, be very careful not to get any solder on the filter tuning pads.

The injection filter is a printed pattern on the substrate which is laser–tuned at the factory. The insertion loss of this filter is about 3 dB.

2. Theory of Operation

The factory–tuned ceramic preselector filter accommodates RF input frequencies ranging from 450 to 482 MHz (Range 3) or 482 to 512 MHz (Range 4). The injection filter is tuned to pass frequencies from 559 to 592 MHz for Range 3 or 592 to 622 for Range 4. Each frequency is connected at a node just before C9138 via a transmission line which acts as a high impedance input to the other frequency.

The RF board supplies DC voltage to bias the mixer, Q9125. Transistor Q9126 controls the voltage to the base of Q9125. The voltage at the collector of Q9125 should be approximately 10 volts.

From the input of the ceramic filter to the IF output, there should be 2 dB power gain presented to the IF. If the beta of Q9125 falls below 60, the mixer (Q9125) is probably bad and must be replaced.

3. Troubleshooting

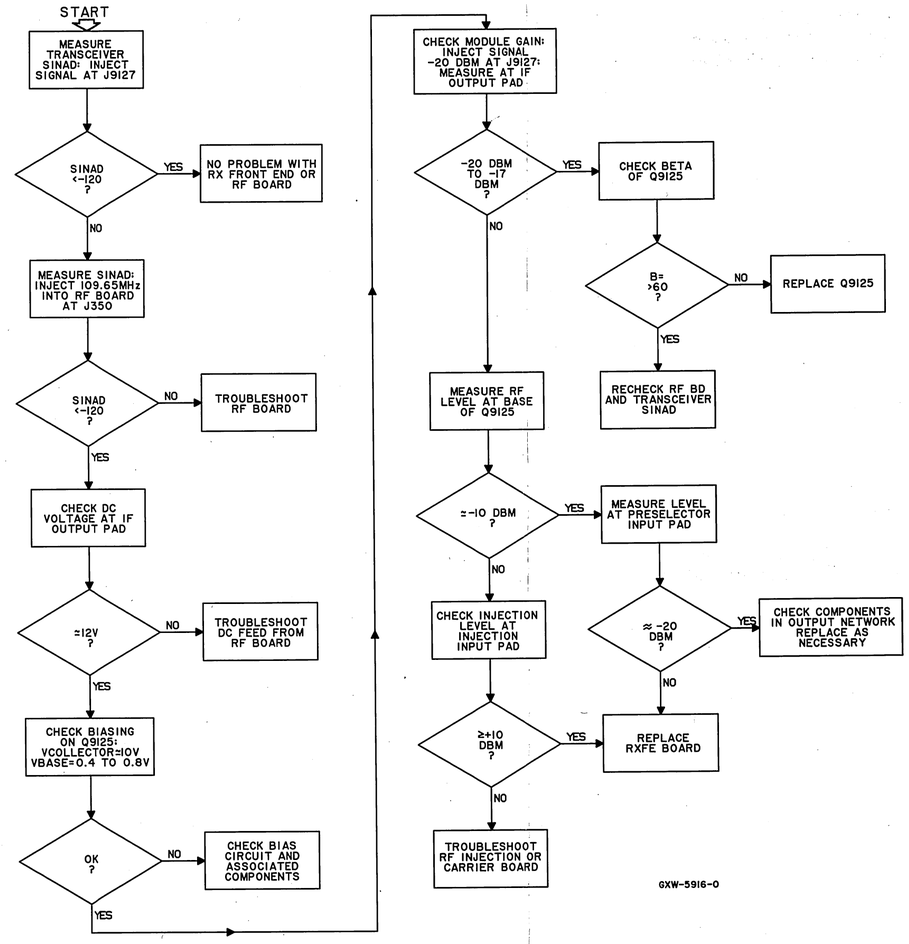
This information will help field service technicians troubleshoot the *SPECTRA* radio. Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, this section includes a Troubleshooting Chart that will guide you through a sequence of tests and checks designed to isolate problems.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at 500 MHz, measurements must be taken very carefully.

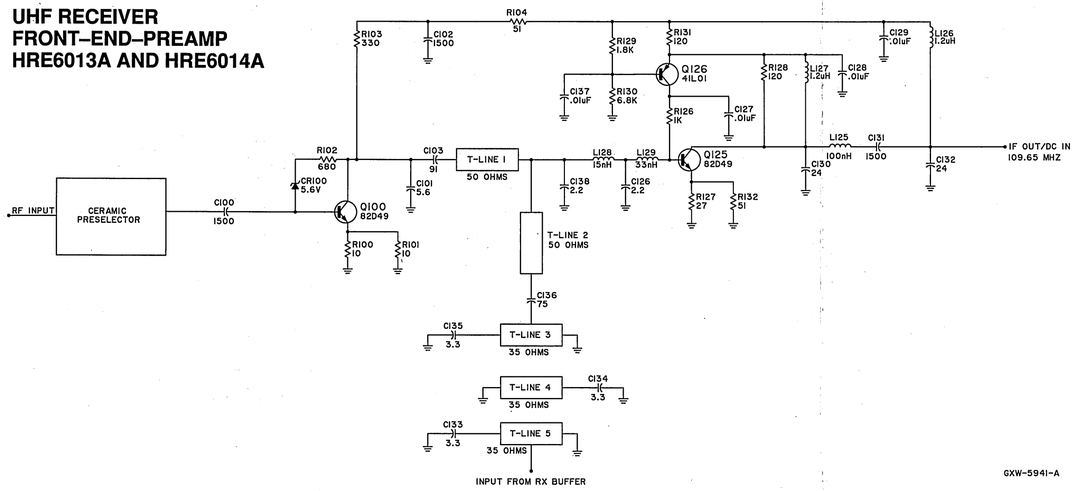
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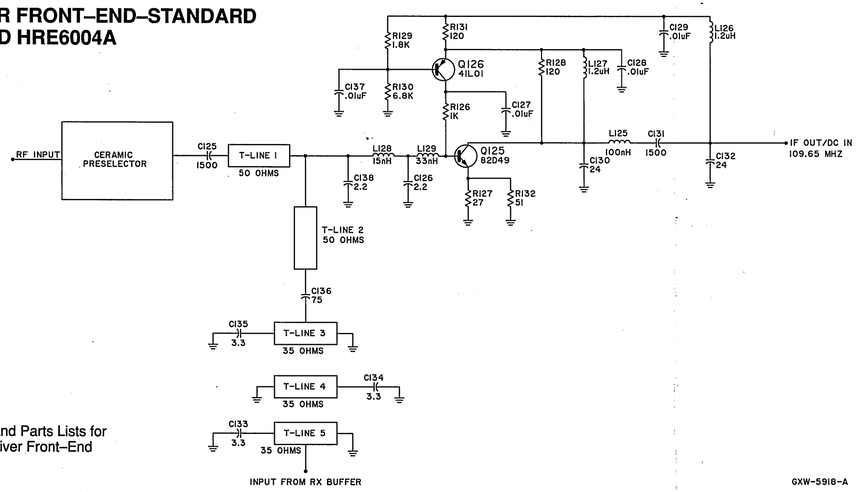


Troubleshooting Chart for
SPECTRA UHF Receiver Front–End Hybrid
PW–5915–O
10/3/88

UHF RECEIVER FRONT–END–PREAMP HRE6013A AND HRE6014A

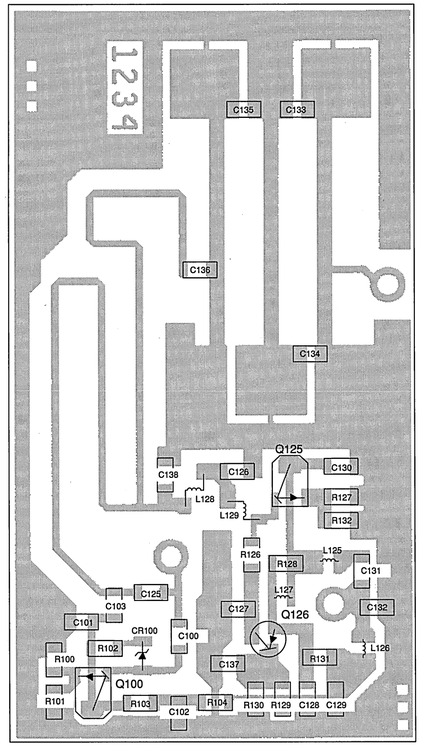


UHF RECEIVER FRONT–END–STANDARD HRE6003A AND HRE6004A



Schematics, Hybrid, and Parts Lists for *SPECTRA* UHF Receiver Front–End
PW–5917–A
3/31/89

UHF RECEIVER FRONT–END HYBRID



SUBSTRATE GPW–5919–O
OVERLAY GPW–5920–A

parts list

HRE6003A Receiver Front End, UHF Range 3
HRE6004A Receiver Front End, UHF Range 4 MXW–5935–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C5125	21–13740B76	1500
C5126	21–13740B09	2.2, ±.25 pF
C5127–5129	21–13741N45	0.01 uF, ±10%
C5130	21–13740B34	24
C5131	21–13740B76	1500
C5132	21–13740B34	24
C5133–5135	21–13740B13	3.3, ±.25 pF
C5136	21–13740B46	75
C5137	21–13741N45	0.01 uF, ±10%
C5138	21–13740B09	2.2, ±.25 pF
hybrid (see note)		
HY5126	91–80209N03	ceramic filter, bandpass, 465 MHz (Range 3)
HY5126	91–80209N04	ceramic filter, bandpass, 497 MHz (Range 4)
connector receptacle		
J5127	09–80212N01	coax, PC board mounted
coil, RF		
L5125	24–80140E10	100 nH
L5126,5127	24–80140E01	1.2 uH
L5128	24–80091G21	4 turns, airwound
L5129	24–80091G33	5 turns, airwound
transistor (see note)		
Q5125	48–82971R01	NPN
Q5126	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R5126	06–11077A74	1k
R5127	06–11077A36	27
R5128	06–11077A52	120
R5129	06–11077A80	1.8k
R5130	06–11077A94	6.8k
R5131	06–11077A52	120
R5132	06–11077A43	51
mechanical parts		
	26–80015P01	shield
	26–80002M01	shield, injection filter
	07–80091P01	bracket
	07–80214N01	frame, preselector lead
	42–80191N01	clip
	42–80013P01	retainer wire
	43–80025P01	spacer wire

3/31/89

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

parts list

HRE6013A Receiver Front End Range 3 UHF Pre–amp
HRE6014A Receiver Front End Range 4 UHF Pre–amp MXW–5940–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C5100	21–13740B76	1500
C5101	21–13740B19	5.6, ± .25 pF
C5102	21–13740B76	1500
C5103	21–13740B48	91
C5126	21–13740B09	2.2, ±.25 pF
C5127–5129	21–13741N45	0.01 uF, ±10%
C5130	21–13740B34	24
C5131	21–13740B76	1500
C5132	21–13740B34	24
C5133–5135	21–13740B13	3.3, ±.25 pF
C5136	21–13740B46	75
C5137	21–13741N45	0.01 uF, ±10%
C5138	21–13740B09	2.2, ±.25 pF
diode (see note)		
CR5100	48–82958R78	zener 5.6V
hybrid (see note)		
HY5126	91–80209N03	ceramic filter, bandpass 465 MHz (R3)
HY5126	91–80209N04	ceramic filter, bandpass 497 MHz (R4)
connector receptacle		
J5127	09–80212N01	coax, PC board mount
coil, RF		
L5125	24–80140E10	100 nH
L5126	24–80140E01	1.2 uH
L5127	24–80140E01	1.2 uH
L5128	24–80091G21	4 turns, airwound
L5129	24–80091G33	5 turns, airwound
transistor (see note)		
Q5100	48–82971R01	NPN
Q5125	48–82971R01	NPN
Q5126	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R5100	06–11077A26	10
R5101	06–11077A26	10
R5102	06–11077A70	680
R5103	06–11077A62	330
R5104	06–11077A43	51
R5126	06–11077A74	1k
R5127	06–11077A36	27
R5128	06–11077A52	120
R5129	06–11077A80	1.8k
R5130	06–11077A94	6.8k
R5131	06–11077A52	120
R5132	06–11077A43	51
mechanical parts		
E5125	26–80015P01	shield
E5126	26–80002M01	shield, injection fitler 900
MP5126	07–80091P01	bracket
MP5127	07–80214N01	frame, preselector lead
MP5128	42–80191N01	clip
MP5129	42–80013P01	retainer wire
MP5130	43–80025P01	spacer wire

3/31/89

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

Receiver Front End (800 MHz)

1. General

The receiver ceramic filter has a typical insertion loss of about 1.6 to 1.7 dB; it should not have a loss greater than 2.5 dB. If any soldering must be done on the filter, be very careful not to get any solder on the filter tuning pads.

The injection filter is a printed pattern on the substrate which is laser–tuned at the factory. The insertion loss of this filter is about 3dB.

2. Theory of Operation

The factory–tuned ceramic prescaler filter accommodates RF input frequencies ranging from 851 to 870 MHz. The injection filter is tuned to pass frequencies from 741 to 760 MHz. Each frequency is connected at a node just before C8126 via a transmission line which acts as a high impedance input to the other frequency.

DC voltage, supplied from the RF board, biases the mixer, Q8126. Transistors Q8127 and Q8128 control the voltage to tha base of Q8126. Q8128 acts as a diode to maintain a voltage on the base of Q8127, which keeps the bias of Q8126 stable through temperature changes. The voltage for the collector of Q8126, which passes through R8128, L8131, and L8130, should be approximately 8 volts.

C8129, L8129, C8131, and L8130 form the output network for the mixer. C8131 is a large capacitor that appears as a short to all frequencies of interest. the remaining components form a bandpass filter centered at the IF frequency.

R8130, R8129, and R8131 form an attenuator on the output path to stabilize both the mixer output impedance and the source impedance for the IF amplifier.

From the input to the ceramic filter to the IF output, there should be an 8 dB power gain presented to the IF. If the beta of Q8126 falls below 60, the mixer (Q8126) is probably bad and must be replaced.

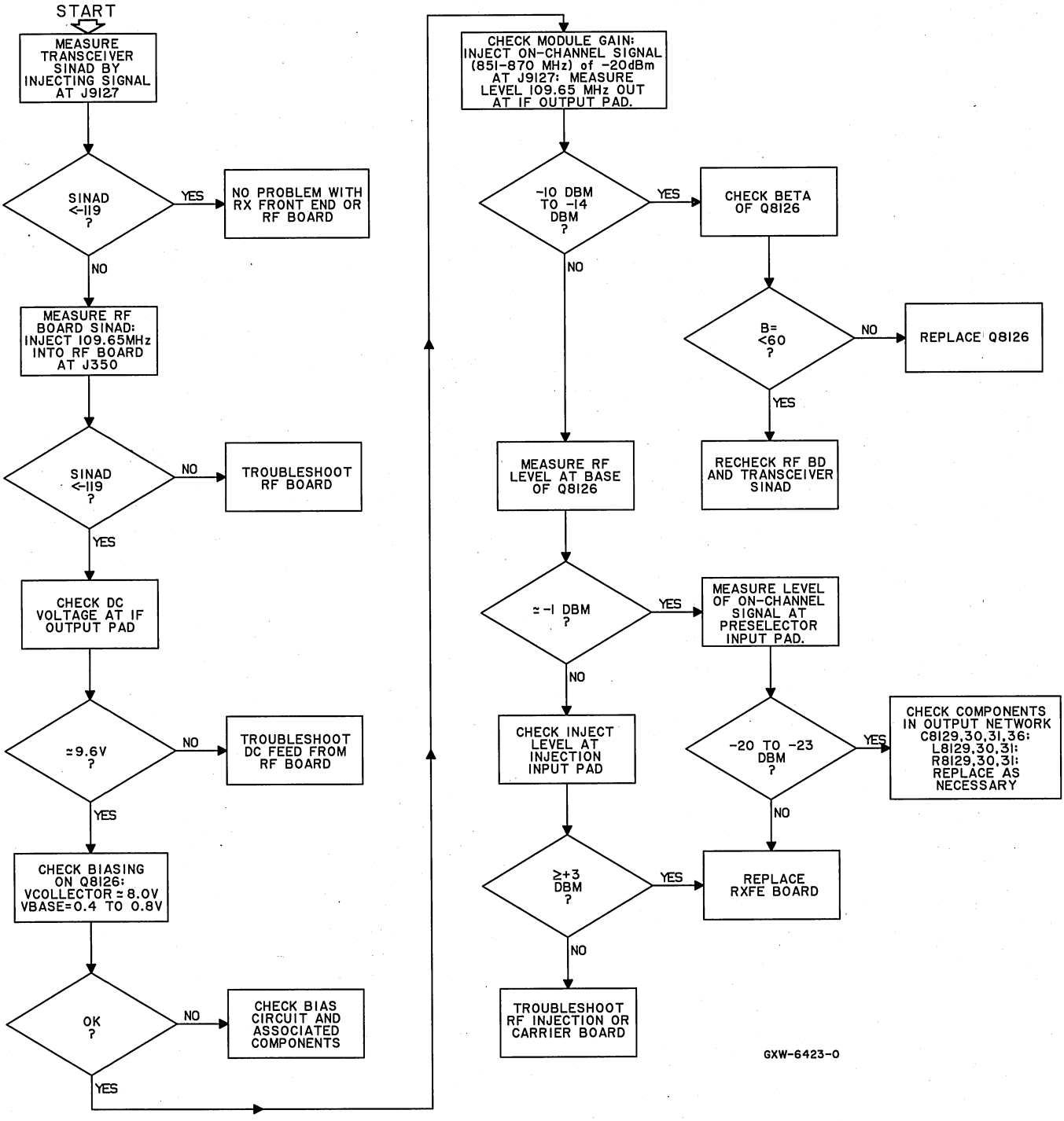
3. Troubleshooting

This information will help field service technicians troubleshoot the *SPECTRA* radio. Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, this section includes a Troubleshooting Chart that will guide you through a sequence of tests and checks designed to isolate problems.

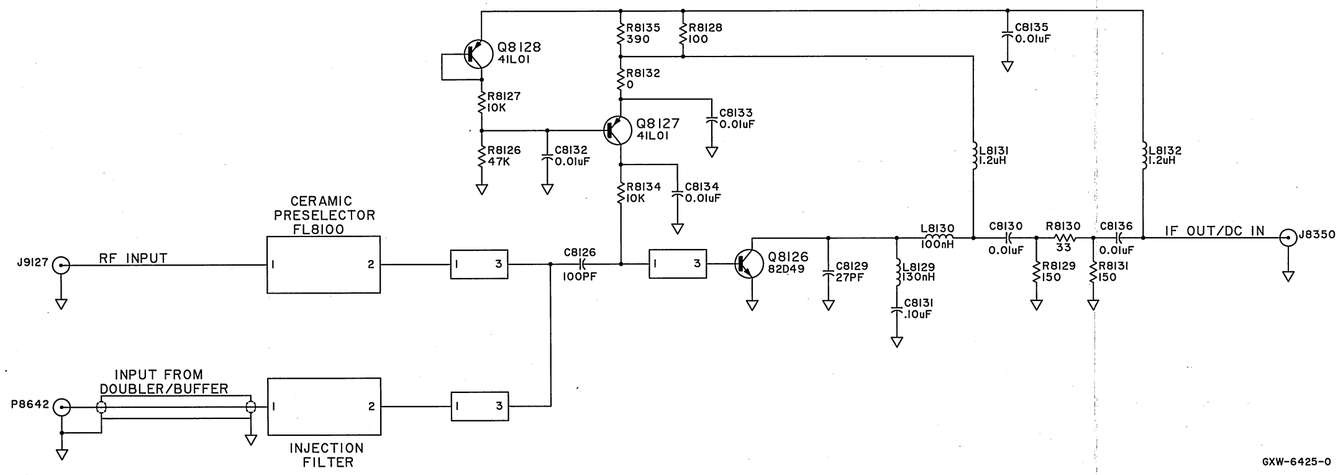
Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at 800 MHz, measurements must be taken very carefully.

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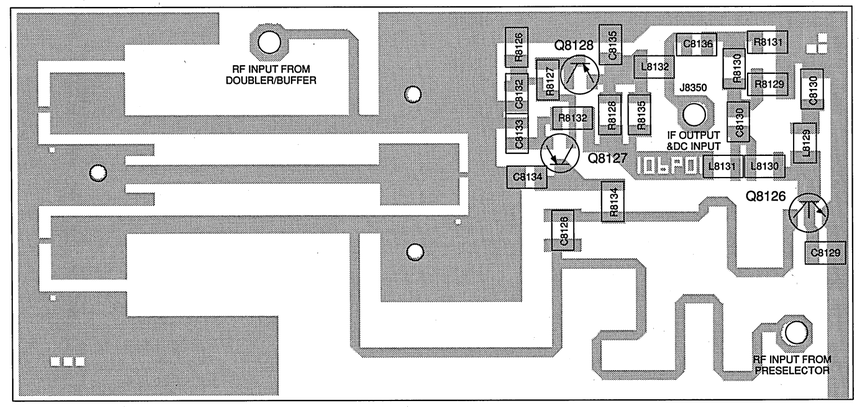
Troubleshooting Chart for *SPECTRA*
800 MHz Receiver Front End Hybrid
PW–6422–O
3/31/89

HRF60004A SCHEMATIC



GXW-6425-O

HRF60004A CIRCUIT BOARD



SUBSTRATE GPW-6426-O
OVERLAY GPW-6427-O

parts list

HRF6004A 800 MHz Receiver Front-End MXW-6428-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C8126	21-11078B42	100
C8129	21-11059D57	27, 50V
C8130	21-13741N45	0.01 uF, ±10%
C8131	21-13741N69	.1 uF, ±10%
C8132-8136	21-13741N45	0.01 uF, ±10%
ceramic filter		
FL8100	91-83722P01	filter RF
connector receptacle		
J8127	09-80110M01	coax, PC board mount
coil, RF		
L8129	24-80140E06	130 nH
L8130	24-80140E10	100 nH
L8131,8132	24-80140E01	1.2 uH
transistor (see note)		
Q8126	48-80182D49	NPN
Q8127,8128	48-80141L01	PNP
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R8126	06-11077B15	47k
R8127	06-11077A98	10k
R8128	06-11077A55	160
R8129	06-11077A54	150
R8130	06-11077A38	33
R8131	06-11077A54	150
R8132	06-11077A01	0
R8134	06-11077A98	10k
R8135	06-11077A66	470
mechanical parts		
E8127	26-80002M01	shield, injection filter 900
E8128	29-80258M01	solder lug
E8129	29-84985K01	terminal chain
E8130	26-80010N01	shield
MP8126	07-80259M01	preselector lead frame
MP8128	07-80031P01	bracket

02/27/89

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

Schematic, Circuit Board Diagram, and Parts List
for *SPECTRA* 800 MHz Receiver Front End
PW-6424-O
3/31/89

Receiver Front End (900 MHz)

1. General

The receiver ceramic filter has a typical insertion loss of about 1.6 to 1.7 dB; it should not have a loss greater than 2.5 dB. If any soldering must be done on the filter, be very careful not to get any solder on the filter tuning pads.

The injection filter is a printed pattern on the substrate which is laser–tuned at the factory. The insertion loss of this filter is about 3dB.

2. Theory of Operation

The factory–tuned ceramic preselector filter accommodates RF input frequencies ranging from 935 to 941 MHz. The injection filter is tuned to pass frequencies from 825 to 831 MHz. Each frequency is connected at a node just before C9126 via a transmission line which acts as a high impedance input to the other frequency.

DC voltage, supplied from the RF board, biases the mixer, Q9126. Transistors Q9127 and Q9128 control the voltage to the base of Q9126. Q9128 acts as a diode to maintain a voltage on the base of Q9127, which keeps the bias of Q9126 stable through temperature changes. The voltage for the collector of Q9126, which passes through R9128, L9131, and L9130, should be approximately 10 volts.

C9129, L9129, C9131, and L9130 form the output network for the mixer. C9131 is a large capacitor that appears as a short to all frequencies of interest. The remaining components form a bandpass filter centered at the IF frequency.

R9130, R9129, and R9131 form an attenuator on the output path to stabilize both the mixer output impedance and the source impedance for the IF amplifier.

From the input to the ceramic filter to the IF output, there should be an 8 dB power gain presented to the IF. If the beta of Q9126 falls below 60, the mixer (Q9126) is probably bad and must be replaced.

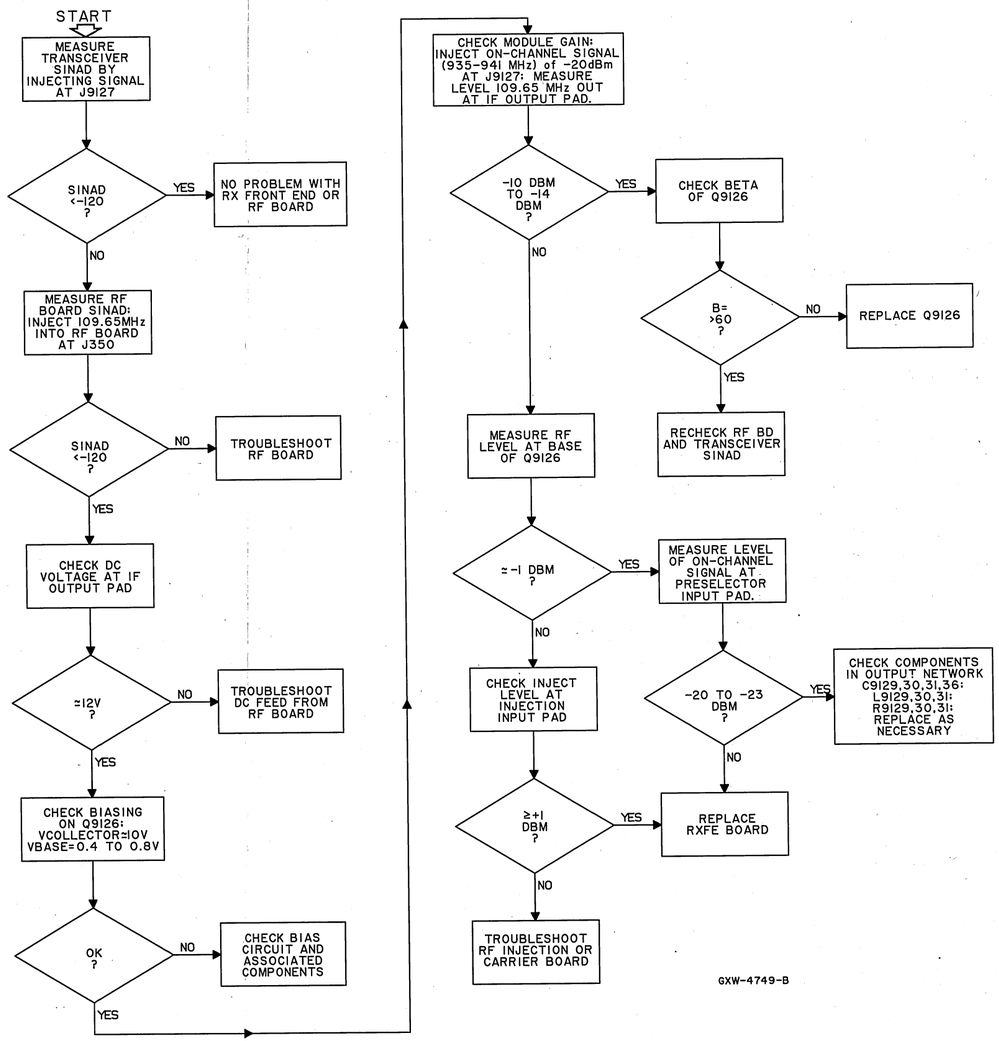
3. Troubleshooting

This information will help field service technicians troubleshoot the *SPECTRA* radio. Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, this section includes a Troubleshooting Chart that will guide you through a sequence of tests and checks designed to isolate problems.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at 900 MHz, measurements must be taken very carefully.

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Troubleshooting Chart for
SPECTRA 900MHz Receiver Front End Hybrid
PW–4748–B
8/30/88

parts list

HRF6002A Receiver Front-End Hybrid Board — MXW–4715–B

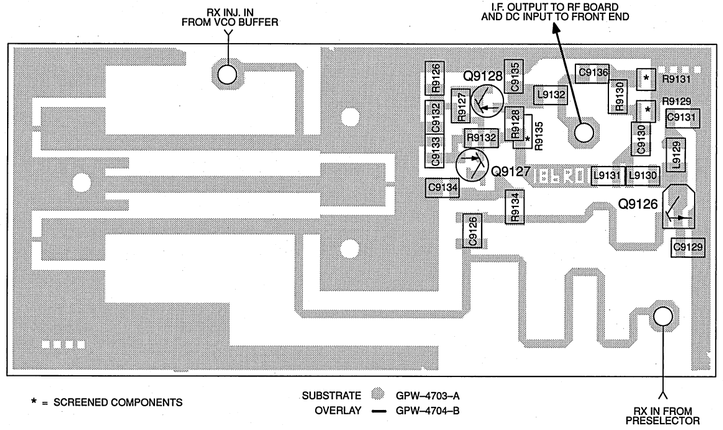
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, uF, ±10%, 100V (unless otherwise stated)		
C9126	21–11078B42	100 pF, ±5%
C9129	21–11059D57	27 pF, ±5%, 50V
C9130	21–11059B11	0.01
C9131	21–11032A33	0.1, 50V
C9132–9136	21–11059B11	0.01
filter		
FL9100	91–80087M01	ceramic
connector receptacle		
J9127	09–80110M01	coax
coil, RF		
L9129	24–80140E06	130 nH
L9130	24–80140E10	100 nH
L9131,9132	24–80140E01	1.2 uH
transistor (see note)		
Q9126	48–80182D49	NPN
Q9127,9128	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9126	06–11077B15	47k
R9127	06–11077A98	10k
R9128	06–11077A78	1.5k
R9130	06–11077A38	33
R9132	06–11077A01	0 ohm jumper
R9134	06–11077A98	10k

3/31/89

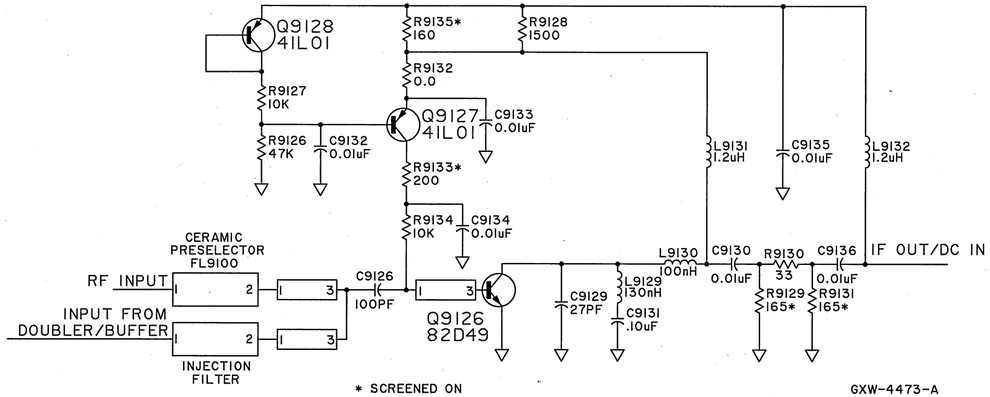
note: For best performance, order diodes, transistors, and integrated circuit devices by Motorola part number.

Schematic, Circuit Board Diagram, and Parts List
for HRF6002A *SPECTRA* 900 MHz
Receiver Front End Hybrid
PW–4714–B
3/31/89

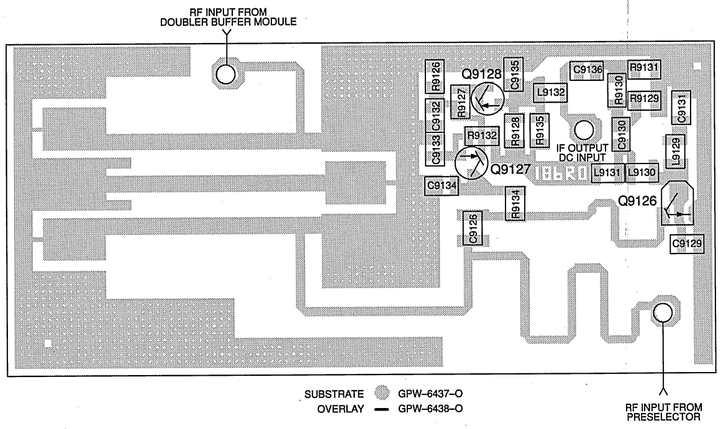
HRF6002A HYBRID



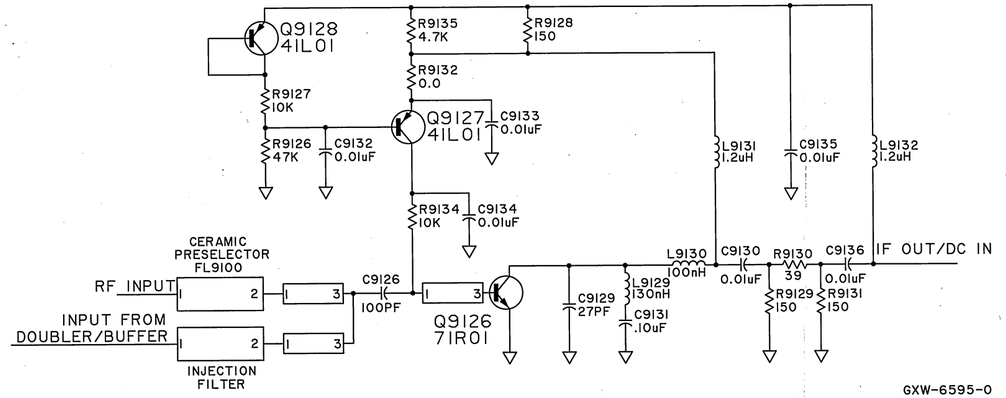
HRF6002A SCHEMATIC



HRF6002B HYBRID



HRF6002B SCHEMATIC



GXW-6595-O

parts list

HRF6002B 900 MHz Receiver Front-End Hybrid — MXW-6429-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C9126	21-11078B42	100
C9129	21-11059D57	27, 50V
C9130	21-11059B11	0.01 uF
C9131	21-13741N69	.1 uF, ±10%
C9132-9136	21-11059B11	0.01 uF
fuse		
FL9100	91-80087M01	ceramic 938 MHz
connector receptacle		
J9127	09-80110M01	coax, PC board mount
coil, RF		
L9129	24-80140E06	130 nH
L9130	24-80140E10	100 nH
L9131,9132	24-80140E01	1.2 uH
transistor (see note)		
Q9126	48-82971R01	NPN
Q9127,9128	48-80141L01	PNP
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R9126	06-11077B15	47k
R9127	06-11077A98	10k
R9128,9129	06-11077A54	150
R9130	06-11077A40	39
R9131	06-11077A54	150
R9132	06-11077A01	0
R9134	06-11077A98	10k
R9135	06-11077A90	4.7k
mechanical parts		
E9127	26-80002M01	900 injection filter shield
E9128	29-80258M01	solder lug
E9129	29-84985K01	terminal chain
E9130	26-80010N01	shield
MP9126	07-80259M01	preselector lead frame
MP9127	54-80004N01	barcode label
MP9128	07-80244M01	bracket

02/27/89

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

Schematic, Circuit Board Diagram, and
Parts List for HRF6002B *SPECTRA* 900 MHz
Receiver Front End Hybrid
PW-6436-O
3/31/89

parts list

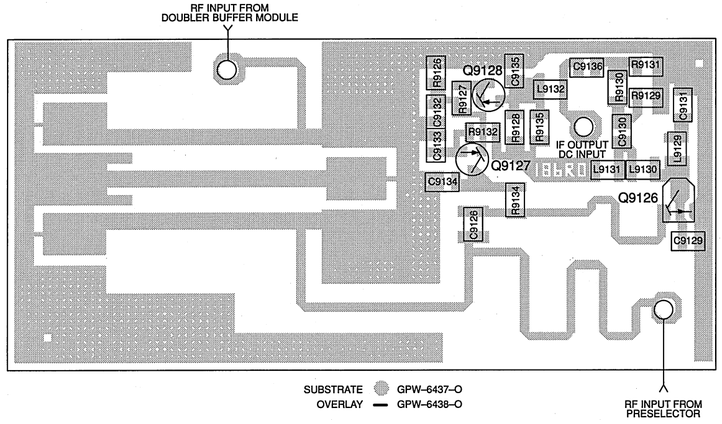
HRF6003A 900 MHz Receiver Front–End Hybrid — MXW–6430–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C9126	21–11078B42	100
C9129	21–11059D57	27, 50V
C9130	21–11059B11	0.01 uF
C9131	21–13741N69	.1 uF, ±10%
C9132–9136	21–11059B11	0.01 uF
fuse		
FL9100	91–80087M01	ceramic 938 MHz
connector receptacle		
J9127	09–80110M01	coax, PC board mount
coil, RF		
L9129	24–80140E06	130 nH
L9130	24–80140E10	100 nH
L9131,9132	24–80140E01	1.2 uH
L9133	76–83466K01	ferrite bead
transistor (see note)		
Q9126	48–82971R01	NPN
Q9127,9128	48–80141L01	PNP
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R9126	06–11077B15	47k
R9127	06–11077A98	10k
R9128,9129	06–11077A54	150
R9130	06–11077A40	39
R9131	06–11077A54	150
R9132	06–11077A01	0
R9134	06–11077A98	10k
R9135	06–11077A90	4.7k
mechanical parts		
E9127	26–80002M01	900 injection filter shield
E9128	29–80258M01	solder lug
E9130	26–80010N01	shield
MP9126	07–80259M01	preselector lead frame
MP9127	54–80004N01	barcode label
MP9128	07–80031P01	bracket

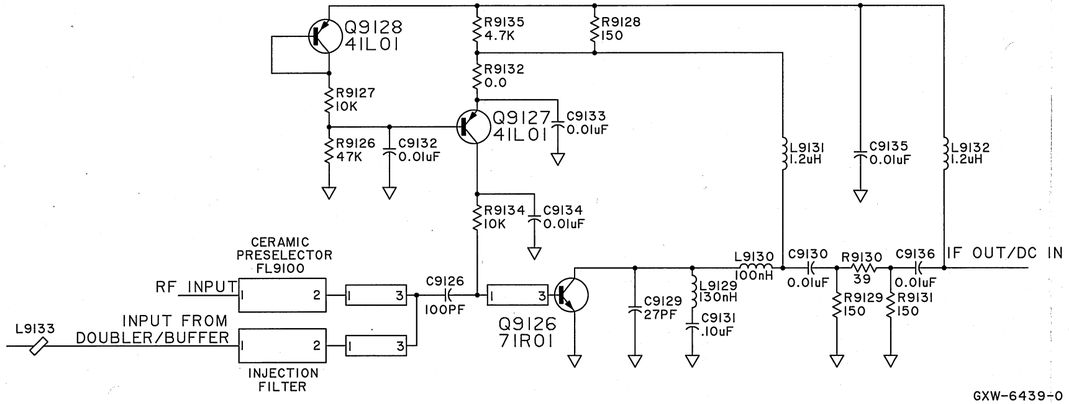
03/03/89

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

HRF6003A HYBRID



HRF6003A SCHEMATIC



GXW–6439–O

Schematic, Circuit Board Diagram, and Parts List for HRF6003A *SPECTRA* 900 MHz Receiver Front End Hybrid
PW–6440–O
3/31/89

50–Watt Power Amplifier (VHF)

1. Transmitter

The 50–watt *SPECTRA* power amplifier is discussed in the following text. A block diagram of the circuit is shown on the foldout drawing PW–5816.

1.1 TRANSMIT LOW LEVEL AMPLIFIER (LLA)

Note

The minimum input drive level to the PA into E3850 is 10 milliwatts. Refer to the synthesizer section if input drive is less than 10 milliwatts.

The Low Level Amplifier, the first stage of the PA, provides a gain that is a function of a control voltage. This control voltage comes from the Regulator Power Control IC (RPCIC) on the command board. The magnitude of the control voltage depends on PA output power, temperature, and final amplifier current drain. See Section 3 for a detailed explanation of the power control circuitry.

The LLA, Q3801, is unique in that its gain is controlled by varying the collector's current rather than its voltage. Q3801 and associated circuitry (Q3806, Q3802, R3804, and R3818) are best described as a voltage–controlled current source. This means that the collector current of Q3801 is controlled by the magnitude of the control voltage. Proper operation of the LLA can be checked by monitoring the voltage across the resistor R3804. The voltage should measure in the range of 0.1 volt to 1.0 volt, depending on the value of control voltage. A 0.1 volt reading corresponds to a low control voltage (1 to 5 volts) and a 1.0 volt reading corresponds to a high control voltage (up to control voltage limit).

1.2 PREDRIVER STAGE

The second stage of the PA, Q3804, is the predriver. The purpose of this stage is to amplify the output of the LLA to a level sufficient to drive the driver device, Q3850. Input power to this stage is approximately 100 milliwatts; output power from this stage is 1.0 watt.

1.3 DRIVER STAGE

The driver is a 1.2 to 15 watt device. It is driven by the predriver device through a matching circuit that consists of C3815, C3816, C3817, C3818, and L3811. A ferrite bead, L3810, and a parallel resistor, R3815, give the driver a zero–DC bias (required for the driver's class–C operation) and provides a low–Q network to prevent unwanted oscillations. The network of L3851, L3854, C3858, C3856, C3855, and R3850 provide A+ to the collector. L3851 and L3854 provide the DC path and block RF from coming up the DC line. R3850 resistively loads down the collector at low frequencies, preventing unwanted oscillations. C3856, C3855, C3858, and C5855 are bypass capacitors.

1.4 FINAL STAGE

The final device is a 12 to 75 watt device and is driven by the driver through a low–pass matching circuit that consists of C3850, C3851, C3852, C3853, C3854, and associated transmission lines. Base network, L3852, L3853, and R3851, provide the zero–DC bias required by the final device's class–C operation. L3852 and L3851 provide the DC path from base to ground. R3851 helps lower the network's Q at low frequencies. The collector DC network consists of L3875, L3876, R3876, C3880, C3885, C3881, C3882, and CR3875. This network provides the A+ voltage to the final while blocking RF from getting up the DC line. L3875 and L3876 provide the DC path and block RF. R3850 resistively loads down the final's collector at low frequencies and prevents unwanted oscillations. C3881, C3882, C3880, and C3885, are all bypass capacitors ranging from very low frequencies up to VHF frequencies. R3875 is the current–sense resistor. CR3875 protects against reverse polarity. Finally, the RF signal goes through a low–pass matching network (C3875, C3876, C3877, C3878, C3879, L3877, and associated transmission lines) to the rest of the output network (Directional Coupler, Antenna Switch, and Harmonic Filter).

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2. Antenna Switch and Harmonic Filter

2.1 ANTENNA SWITCH

The antenna switch's impedance inverter circuit, made up of C3920 and L3920, takes the place of a quarter–wave microstrip line. During transmission, Keyed 9.4 volts forward–biases CR3921, producing low impedance on CR3921's anode and high impedance on the C3920/L3920 node. Effectively, this isolates the transmitted power from the receiver. C3910 couples the power to the harmonic filter and on to the antenna.

Total TX to RX isolation exceeds 55 dB from 136–174 MHz. The impedance inverter contributes approximately 35 dB to transmit isolation. A second shunt switch, made up of CR3922, L3921, and C3921, provide additional isolation. C3922 and C3923 block DC.

During RX, CR3920 has an OFF capacitance of approximately 1 pF. CR3921 and CR3922, incorporated in the RX match, have similar OFF capacitance.

2.2 HARMONIC FILTER

The 50–watt harmonic filter is a 7–pole, low–pass filter, consisting of high Q chip capacitors (C3911, C3912, C3912, and C3914) and discrete inductors (L3911, L3912, and L3913). The filter's primary function is to attenuate harmonic spurs generated by the transmitter. It also adds low–pass selectivity for the receiver. L3914 protects the PA from static discharge.

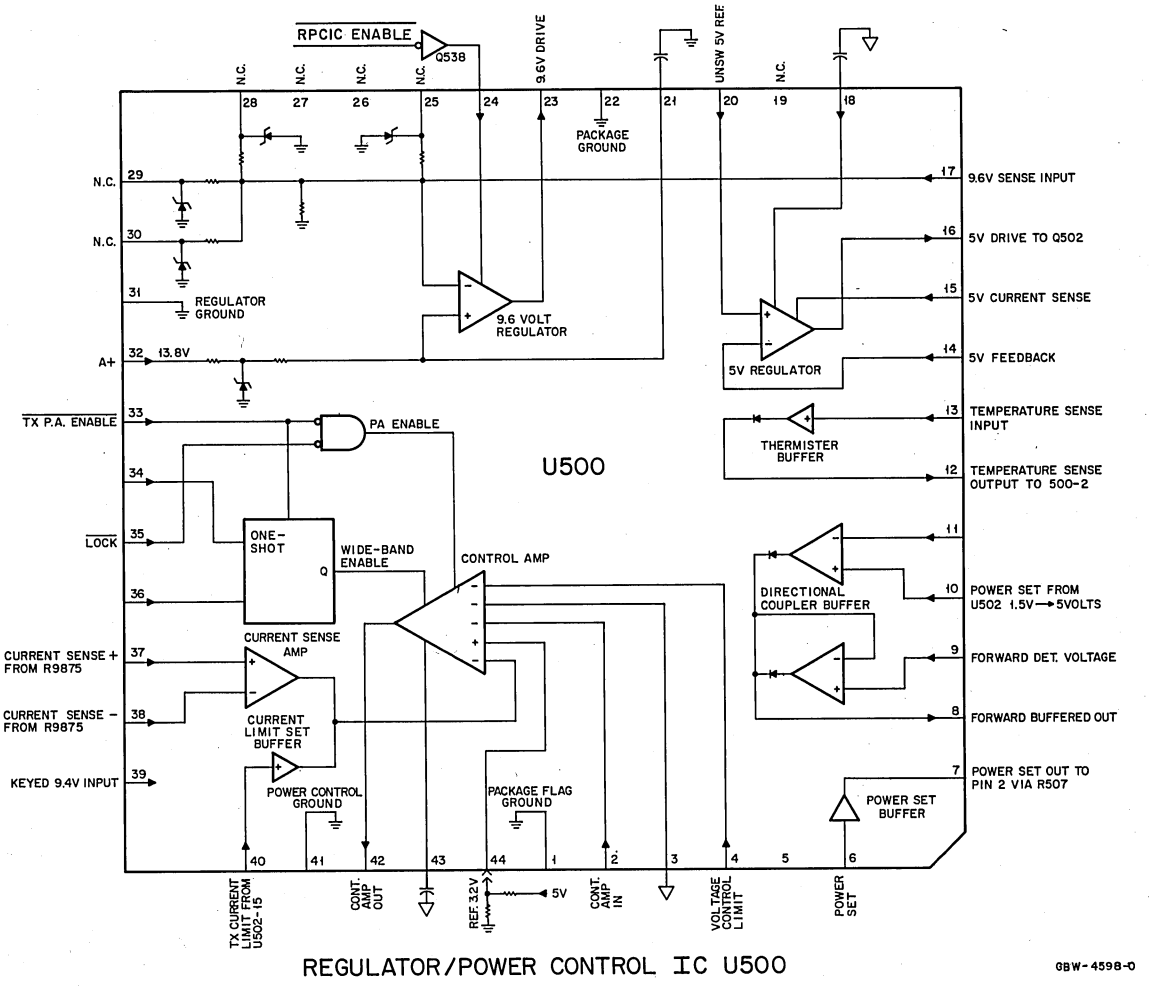


Figure 1. Regulator/Power Control IC Block Diagram

3. Power Control Circuitry

3.1 COMMAND BOARD CIRCUITRY

Inside U500, the Regulator Power Control IC (See Figure 1, RPCIC Block Diagram), is an operational amplifier that has four inverting inputs, and one non–inverting input (at Pin 44) which is the reference input for the entire power control loop of the power amplifier. The 3.2V reference voltage at U500–44 is produced by dividing SW +5V with the voltage divider circuit, R514 and R515.

The power control loop is controlled by the microprocessor, U520, on the command board. The microprocessor enables the RPCIC by pulling TX PA ENABLE low while the radio synthesizer is locked. Each is felt on Pins 33 and 35 respectively. U520 writes data to a digital–to–analog converter, U502, to change and control the power–set voltage from Pin 10 of U502 to Pin 6 of U500. The voltage on this line, 1.5 to 5 volts, will be inversely proportional to the power out of the PA, with 5 volts producing the lowest power output. This voltage may be set with an IBM PC or with a built–in program operated through the radio's control head. On U500, the voltage at Pin 6 is buffered internally and exits on Pin 7. Through R507, it is summed at the node connected to Pin 2, one of the inverting inputs.

3.2 CONTROL VOLTAGE LIMITER

R3807 and R3808 form a voltage divider that connects to control voltage drive. The output of this voltage divider is connected to the control–voltage–limit input (Pin 4) of the RPCIC. If the voltage at this input reaches 3.2 volts, then the control voltage will be clamped to a maximum value. For the 50–watt VHF PA, this maximum value is 8 volts. This voltage–control limit is set by the values of R3807 and R3808.

3.3 CURRENT LIMITER

U520, the processor on the command board, sends data to U502, the digital–to–analog converter, to properly set the voltage on U502, Pin 15, which is the TX CURRENT LIMIT control line to the RPCIC (U500, Pin 40). Sixteen different voltages, ranging from 1.5 to 4.5 volts, can be programmed from U502.

The collector current of the 50–watt amplifier is monitored by sensing the voltage across R3875. CURRENT SENSE + connects to one end of R3875; CURRENT SENSE – connects to the other end. These lines connect to the command board on U500, Pins 37 and 38, respectively. If the TX CURRENT LIMIT is set for 1.5 volts, then the voltage difference between U500, Pins 37 and 38 must be 0.1 volts before the current through R3875 is reduced. If U500, Pin 40 is programmed for 4.5 volts, then the difference of potential between Pins 37 and 38 must exceed 0.3 volts before current limiting begins. The voltage across R3875, where current sense occurs, can be determined by multiplying the voltage on U500, Pin 40, by 0.067. When current is being limited, the output of the op–amp (U500, Pin 42) begins shutting down the conduction of Q503 and Q504, reducing PA control voltage, and reducing drive to the final amplifier to, effectively, control the final amplifier's maximum current.

3.4 FORWARD POWER LIMITER

After the final amplifier, a parallel pair of non–symmetrical microstrip lines form a forward power–sensing directional coupler. Because of increased coupling with frequency, C3902 is used to compensate and filter out harmonics. R3905, R3906, C3902, and L3903 provide DC bias to CR3900, which rectifies the signal. During normal transmission, the DC voltage from the forward–detect line to the RPCIC ranges from 2 to 4.5 volts. This voltage connects to U500, Pin 9, the directional coupler buffer input.

The directional coupler's output, U500 Pin 8, is summed to Pin 2 with the digital/analog buffer's output through R509 and R507, respectively.

Closed loop operation reduces the control amp's output (Pin 42), reduces the power module's gain, and reduces power output to maintain the coupler buffer output (U500, Pin 2) at 3.2 volts regardless of the d/a voltage level. If the d/a voltage is high (4.5 volts), little detected voltage is needed to keep Pin 2 at 3.2 volts, and the power, consequently, is low. If the d/a voltage is low (1.5 volts), a large forward detected voltage is needed to keep Pin 2 at 3.2 volts and power, consequently, is at maximum value. The voltage at Pin 2 drops below 3.2 volts under proper operation during low line voltage conditions where the PA cannot produce rated power, or if, under any conditions, the control voltage, or the final device current exceeds safe levels.

3.5 TEMPERATURE SENSING

The temperature–sensing circuit of the PA works with the RPCIC to protect the PA devices from excessively high temperatures. On the PA board, this circuit, formed by resistors R3878, R3879, R3880, and thermistor RT3877, provides a temperature–dependent voltage to the RPCIC via P0853, Pin 7. As the PA temperature increases, the resistance of RT3875 decreases, causing the voltage at Pin 7 to increase. This voltage is routed to the RPCIC, U500, Pin 13, which is the input to the thermistor buffer. The buffer's output on Pin 12 is connected to Pin 2 via resistor R508. Note that Pin 2 is the control amp input and is a summing point for temperature, forward–power detect, and power set signals. If the PA temperature becomes high enough so that the voltage at Pin 7 exceeds 3.2 volts, the thermistor buffer starts supplying current to the node at Pin 2. Due to the fixed output current of the power–set buffer, the control loop can maintain 3.2 volts at Pin 2 only by reducing the forward–power detect voltage and, therefore, reducing the PA output power. Since power output is reduced, the generated heat is reduced to a safe level. If temperature decreases, the power output of the PA gradually increases to its nominal value. Temperature cutback should occur at about 140 degrees F (60 deg C).

The temperature sense circuitry can easily be tested by placing an ordinary leaded 4.7k ohm resistor across RT3875. PA output power should drop significantly if this circuit is working properly.

Note

Under severe environmental conditions, more than one circuit may be attempting to reduce power output at the same time (i.e., during high VSWR conditions, the current limiter may initially reduce power, but eventual heat build–up will cause further power reduction by the thermal cut–back circuit).

4. Transmitter Troubleshooting

This information will help field service technicians troubleshoot the *SPECTRA* radio. Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, this section includes troubleshooting information that will help you test and check the circuits to localize and isolate problems.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at high frequency, measurements must be taken very carefully. Notes and cautions are added to the text to alert the reader to this need in areas of greatest sensitivity. However, the need for extreme care does exist in all measurements and tests at high frequency.

4.1 GENERAL TROUBLESHOOTING AND REPAIR NOTES

Most of the common transmitter symptoms are caused by either failure of the power amplifier or a failure in the control circuitry. The initial troubleshooting effort should be toward isolating the problem to one of those two areas. If either the control voltage or keyed 9.4 volts are zero, then the problem is likely to be in the control circuit. If those voltages are present, then the problem is more likely in the power amplifier circuit.

If, for diagnostic reasons, a chip component needs to be removed to facilitate testing, such as a series capacitor removed to allow for signal insertion, then the component(s) returned to the circuit should be new parts. The application of a soldering iron to many chip components will tend to cause leaching which could lead to failure.

After a PA board is replaced, or if any power control circuitry components are replaced, readjust the power according to instructions in the Service Manual.

IMPORTANT

Due to high operating frequencies, you must use specified Motorola parts when component replacement is necessary. Substitute components may not work. It is also critical that you use great care when replacing parts. Excessive solder or flux, longer than original leads on coax connectors, mis–orientation of parts, and other commonly benign imperfections may cause the radio's performance to degrade.

4.2 PA FUNCTIONAL TESTING

To test the PA assembly for proper operation, perform the following steps:

(1) Disassemble the PA assembly from the radio, leaving the power cable connected to the rear connector. Replace the PA shield and cover. Disconnect the coax connectors and the ribbon cable. Connect a power meter to the antenna port using minimum cable length.

Notes

(a) When setting or measuring RF power, follow these guidelines to avoid measurement errors due to cable losses or non 50–ohm connector VSWR:

- All cables should be very short and have Teflon dielectric.
- Attenuators and 50–ohm loads should have at least 25 dB return loss.
- 'Mini UHF' to 'N' adapter, P/N 58–80367B21, should be used at the antenna connector. All other connectors should be 'N' type. No other adapters, barrel connectors, etc. should be used.

(b) Maximum input level to the PA is 20 milliwatts. Too much input power could result in damage to the LLA stage.

(2) Apply the input power and DC voltages indicated in Table 1 to the power amplifier assembly. To make the DC connections, use small spring–clips or make a test adapter similar to that shown in Figure 2.

Table 1. DC Voltages and Input Power Chart

TEST	KEYED 9.4 V	9.6 V	CONTROL VOLTAGE	POWER IN (mW)	A+ .V
Transmit	9.4	9.6	See note	10	13.6
Receive	0	9.6	0	0	13.6

Note: Set initially to zero. Increase value until power equals 55 watts or 8.0 volts maximum. Do NOT exceed 8.0 volts.

(3) Apply the required input power via an adapter cable. For this application, non 'N' type connectors are acceptable.

(4) With the applied control voltage initially at zero volts, slowly increase the voltage until power out equals 55 watts. Power should rise smoothly with control voltage once the turn–on threshold is reached. Control voltage should not exceed 8.0 volts.

(5) If 8.0 volts does not produce 55 watts, then a failure exists in the power amplifier circuit.

(6) Refer to the voltage chart (See Table 2). Measure the indicated voltages. If they are not within the limits shown in the chart, then a failure exists in the PA assembly.

(7) If the voltages in the chart are correct, verify that the injection is at least 10 milliwatts. (See the VCO troubleshooting section.)

(8) If no failure is located from the previous checks, troubleshoot the power control circuitry.

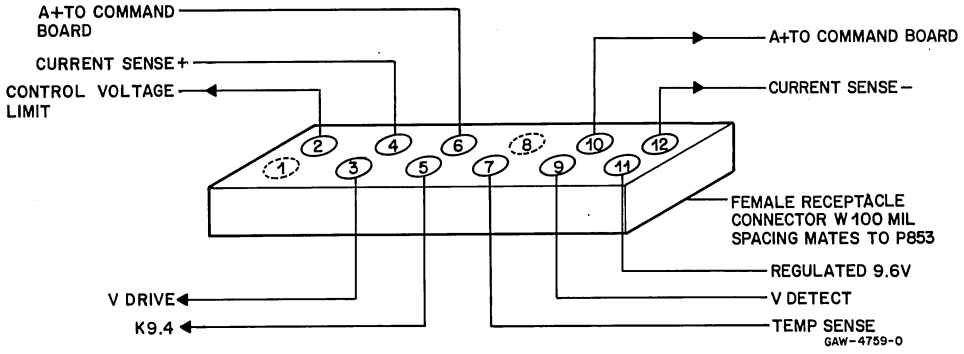


Figure 2. PA Test Adapter.

LOCATION	RX MODE			TX MODE			
LOCATION	LOW	TYP	HI	LOW	TYP	HI	COMMENTS
P0853							
1	——	——	——	——	——	——	KEY (NO PIN OR WIRE)
2		0		0	2.0	3.2	CONTROL VOLTAGE LIMIT
3		0		2.0	7.0	8.0	DRIVE VOLTAGE
4	10.8	13.6	16.5	10.0	13.0	16.0	CURRENT SENSE +
5	0	0	0	9.2	9.4	9.8	KEYED 9.4
6	10.8	13.6	16.5	10.0	13.0	16.0	A+ TO COMMAND BOARD
7		0			1.2		TEMP SENSE (CUTBACK BEGINS AT 3.3V)
8	——	——	——	——	——	——	KEY (NO PIN)
9		0		2.0	3.5	5.0	FORWARD DETECT VOLTAGE
10	10.8	13.6	16.5	10.0	13.0	16.0	A+ TO COMMAND BOARD
11	9.4	9.6	9.9	9.4	9.6	9.9	9.6V SUPPLY FROM COMMAND BOARD
12	10.8			9.8	12.8	15.8	CURRENT SENSE—(VOLTAGE DELTA 150mV)
U0500							
1	0	0	0	0	0	0	GROUND
2		0			3.2		CONTROL AMP INPUT
3	0	0	0	0	0	0	CONTROL AMP INPUT (NOT USED)
4		0		0	2	3.2	CONTROL VOLTAGE LIMIT (CUTBACK AT 3.3V)

Table 2. Power Control DC Voltage Chart

Table 2. Power Control DC Voltage Chart (Continued)

LOCATION	RX MODE			TX MODE			
LOCATION	LOW	TYP	HI	LOW	TYP	HI	COMMENTS
5		0			0	N.C.	
6	1.5	3.0	4.5	1.5	3.0	4.5	POWER SET FROM D–A (MAX POWER AT 1.5V)
7		0	0	1.5	3.0	4.5	POWER SET BUFFER OUT
8		0		1.3	3.5	6.0	COUPLER BUFFER OUT
9		0		1.3	3.5	6.0	FORWARD DETECT VOLTAGE
10		0			0		REFLECTED POWER DETECT (NOT USED)
11		0		1.3	3.5	6.0	SAME AS PIN 8 (NOT USED)
12		0		0	1.2	6.0	THERMISTER BUFFER OUT (INCREASES AS PA GETS HOT)
13		0		0	1.2	6.0	THERMISTER BUFFER IN
14		5.0			5.0		5V SENSE INPUT (FOLLOWS PIN 20 ±0.1V)
15	4.9	5.0	5.7	4.9	5.0	5.7	5V CURRENT LIMIT (LIMITS AT 5.7V)
16	5.0	5.7	6.4	5.0	5.7	6.4	5V SERIES PASS DRIVE (6.4V AT MAX CURRENT)
17	9.5	9.6	9.9	9.5	9.6	9.9	9.6 VOLT SENSE INPUT
18		7			7		5V REG. COMPENSATION CAPACITOR
19		5.7			5.7		N.C.
20	4.9	5.0	5.1	4.9	5.0	5.1	5V REFERENCE INPUT (UNSW5V)
21		1.2			1.2		9.6V REG. COMPENSATION CAPACITOR
22		0			0		N.C.
23		0.9	9.6		1.2	9.6	9.6V SERIES PASS DRIVE
24		2.9			3.3		REGULATOR ENABLE/COMPENSATION
25	—	—	—	—	—	—	9.6V PROGRAMMING (N.C.)
26		0			0		N.C.
27		13.6			13.6		N.C.
28	—	—	—	—	—	—	9.6V PROGRAMMING (N.C.)
29	—	—	—	—	—	—	9.6V PROGRAMMING (N.C.)
30	—	—	—	—	—	—	9.6V PROGRAMMING (N.C.)
31	0	0	0	0	0	0	GROUND
32	10.8	13.6	16.5	10.0	13.0	16.0	DECOUPLED A+
33	4.0	5.0			0	0.2	TX PA ENABLE (FROM U520–25)
34		0			1.3		CONTROL AMP ONE–SHOT
35		0			0		LOCK (5V OF SYNTH OUT OF LOCK)
36		0			0.8		CONTROL AMP ONE–SHOT
37	10.8	13.6	16.3	10.0	13.0	16.0	A+(CURRENT SENSE +)
38	10.8	13.6	16.3	10.0	13.0	16.0	CURRENT SENSE—VOLTAGE DELTA 150mV (30 WATT ONLY)
39		0		9.2	9.4	9.8	KEYED 9.4V IN
40	1.5	3.0	4.5	1.5	3.0	4.5	CURRENT LIMIT D–A (MAX CURRENT AT 4.5V)
41	0	0	0	0	0	0	GROUND
42		0			2.2	9.6	CONTROL AMP OUTPUT (APPX 1/2 V CONTROL)
43		1.3			7.0		LOOP INTEGRATOR CAPACITOR
44		2.1			3.2		CONTROL AMP REFERENCE
Q0500E		13.0			13.0		A+ —CR0500 DROP
Q0501C		12.3			12.3		VQ0500E—B/E DROP
Q0501E		0.2			0.2		V PIN 23—B/E DROP
Q0503E		0			1.5		V PIN 42—B/E DROP (TX)
Q0503C		13.6			9.0		
Q0504B		13.6			12.9		A+ —B/E DROP (TX)

Note: For antenna switch transmit bias conditions, RF drive must be removed from PA.

Table 2. Power Control DC Voltage Chart (Continued)

LOCATION		TYPICAL RX	TYPICAL TX NO PRE–DRIVE	COMMENTS
CR3920	ANODE	0	1.6	
	CATHODE	0	0.8	
CR3921	ANODE	0	0.8	
	CATHODE	——	——	
CR3922	ANODE	0	<0.8	
	CATHODE	——	——	

4.3 LOCALIZING PROBLEMS

Failure locations often can be determined by externally measured symptoms. Basic symptoms are noted below with probable failure locations.

(1) Low Power and High Current

- Check for improper load conditions caused by high VSWR external to the radio.
- Check output coax and mini–UHF connector.
- Check harmonic filter.
- Check output impedance–matching circuitry from the final device to the harmonic filter.

(2) Low Power and Low Current

- If control voltage is equal to 8.0 volts, then check per the above.
- If control voltage is less than 8.0 volts, then check the control circuitry.

(3) Power Intermittently Low (or Zero) and Current Less than 1–Amp When Power Drops

- Check LLA stage.

(4) Power Zero and Current Greater Than 5 amps

- Check harmonic filter, antenna switch, and matching circuits beyond final stage.

(5) Power Zero and Current Between 2 and 5 Amps

- Check driver and/or final stages.

(6) Power Zero and Current Less Than 1 Amp

- Check LLA/pre–driver circuitry.

4.4 ISOLATING FAILURES

Methods of analyzing individual stages of the Power Amplifiers are detailed below. Most of the stages are class C and must be analyzed under relatively high RF power levels. Generators capable of such levels may not be available in all service shops, therefore the tests below are arranged in order of ascending power. This tends to allow the preceding stage to be the source of RF power for testing the next stage.

(1) Testing Low–Level Amplifier (LLA) Circuitry

The required DC and RF conditions are defined in Table 1. Measure LLA voltages according to Table 3.

If the above DC bias conditions are correct, check to see if the LLA is providing drive power to the pre–driver, Q3804. Do so by checking Q3804's collector current under normal drive conditions, as follows:

- Remove R3810 and L3806 (Be sure to reinstall after testing.)
- Solder wires to the remaining pads.
- Place an ammeter in series with Q3804 collector.
- Check for 0.1 to 0.5 amps (depending on control voltage).

Note

With no RF drive to the input of the PA, Q3804's collector current should be zero.

Table 3. LLA and Pre–driver Typical Voltages

CONTROL VOLTAGE	RF DRIVE OFF 8.0 V	RF DRIVE OFF 6.0 V	RF DRIVE ON 8.0 V	RF DRIVE ON 6.0 V
Q3801	——	——	——	——
BASE	0.7	0.7	0.7	0.5
COLLECTOR	8.3	9.0	8.0	8.8
Q3802	——	——	——	——
BASE	7.7	8.4	7.5	8.2
COLLECTOR	2.0	1.4	2.3	1.2
EMITTER	8.3	9.0	8.0	8.8
Q3806	——	——	——	——
BASE	5.1	4.1	5.1	4.1
COLLECTOR	7.7	8.4	7.5	8.2
EMITTER	4.5	3.4	4.5	3.4
Q3804	——	——	——	——
BASE	0.5	0.5	0.0	0.2
COLLECTOR	9.6	9.6	9.5	9.5

Note: The LLA voltages change with different control voltages. An example of LLA voltages with control voltage equal to 8.0 volts and 6 volts is shown.

If the above DC bias conditions are correct, check to see if the LLA is providing drive power to the pre–driver, Q3804. Do so by checking Q3804's collector current under normal drive conditions, as follows:

- Remove R3810 and L3806 (Be sure to reinstall after testing.)
- Solder wires to the remaining pads.
- Place an ammeter in series with Q3804 collector.. Check for 0.1 to 0.5 amps (depending on control voltage).

Note

With no RF drive to the input of the PA, Q3804's collector current should be zero.

If Q3804 draws no current under normal conditions, then check for shorted or open input cable, or for defective parts in the input network or matching circuitry between Q3801 and Q3804. If all of the above check out OK, then replace Q3801.

(2) Testing Pre–Driver Circuitry.

The pre–driver is a typical class–C stage, except the base is biased with resistors R3809 and R3806. The necessary conditions for proper operation of this stage are input drive power, and bias conditions as shown in Table 3, above.

Note

If it is necessary to replace Q3804, use a hot–air blower to remove and replace the part. It is important that the replacement device's case be properly soldered to its heatsink. Do so by flowing a small bead of solder around the rim of the device while it is clamped in the hot–air soldering device. The base and collector leads must be hand–soldered on the bottom side of the board.

(3) Troubleshooting the Driver Stage

- Make sure A+ is at the collector.
- Check for shorts and/or opens in the matching circuitry. Also look for faulty components.
- Measure the DC resistance from Base to Emitter. It should be less than 1–ohm. If not, check L3810 for proper soldering, and replace if faulty.
- Check the current drain of the driver. It should be around 0.5 to 2.5 amps for 50 watt operation. If current drain is low, go to next step.
- Unsolder the base lead. Making sure the lead is not touching the PC board, check the Base–Emitter and Base–Collector junction diode drops. Normal voltage drop should be between 0.4 and 1.0 volts. If either junction reads outside this range, replace the driver device.
- Unsolder either L3854, R3875, or L3851 to isolate the driver and final stages. Measure the collector–emitter DC resistances. If the resistance is below 5 kilohms, then replace the driver device.

(4) Troubleshooting the Final Device

- Make sure A+ is at the final's collector; if not, check for shorts and/or opens.
- Check the matching circuitry for shorts and/or opens. Also, check for faulty components.
- Measure the resistance from base to emitter; it should be less than 1 ohm. If not, check for proper soldering on L3852 and L3853; replace faulty component(s).
- Current drain on the final device should be >6 amps for 50 watt operation. If low current, go on to the next step.
- Remove L3853 from the board and check the Base–Emitter and Base–Collector junction diode drops. Normal voltage drop should be between 0.4 and 1.0 volts. If either junction is outside this range, replace the final device.
- Unsolder either L3859, R3875, or L3851 to isolate the driver and final stages. Measure the collector–emitter DC resistances. If the resistance is below 5 kilohms, then replace the driver device.

Note

The position of capacitors C3853 and C3854 is critical to the performance of the circuit. If they are removed for any reason, they must be re–installed as close to the cap of the final device as possible.

When replacing either the driver or final device, apply thermal compound on the heatsink surface. Torque the screws to the correct value (See Service Manual).

(5) Testing the Antenna Switch and Harmonic Filter

Verify that most of this circuit is functioning properly by testing the receiver insertion loss as follows:

- Apply a low–level signal source at the antenna connector.
- Apply the conditions indicated in Table 1 for RX tests.
- Measure the power at the receive coax.
- If the difference between the input and output (insertion loss) is less than 1 dB, then the circuitry is functioning properly.

- Check CR9922 with an ohmmeter for forward and reverse continuity.
- In the transmit mode, adjust control voltage for 34 watts at the antenna connector. Check for less than 25 mW at the end of the receive input cable. If power exceeds 25 mW, then check CR9922 and associated circuitry. Receiver sensitivity can degrade if power at this port exceeds 25 mW.
- Check for proper DC current through the PIN diodes; correct current is indicated if approximately 1.5 volts is present at the junction of C9920 and L9920 during transmit mode.

WARNING

DO NOT measure bias directly at the pin diodes while in transmit mode unless TX Injection is removed.

4.5 POWER CONTROL AND PROTECTION CIRCUITRY

(1) Localizing Problems to a Circuit

Power leveling and current limiting (30–watt models only) are set to values detailed in the Service Manual. These values will vary from unit to unit, depending on the unique variations of each unit. If symptoms indicate that either of these circuits have failed, verify that the radio has been properly aligned before investigating the circuitry.

Temperature sense, voltage control limit, and interstage drive limit (on 30–watt only) are fixed by design and are not influenced by the alignment of the radio. If symptoms indicate that these circuits have failed, then troubleshoot the circuit.

The tests that follow are intended to provide a convenient means of verifying that a particular circuit is functioning properly. These tests will isolate the failure to a minimum number of components. Refer to the theory of operation and the schematic for information needed to identify the failed component(s).

(2) Temperature Sense Circuit Test

Temporarily install a 6.8k ohm resistor in parallel with R9650. Key the transmitter and monitor the output power. The power meter should read approximately 1/2 the rated power (6 watts or 15 watts).

(3) Control Voltage Limit Circuitry Test

Disconnect P9641 (Transmitter injection) from the internal transceiver chassis. This will require removal of the power amplifier assembly. With all other connections in normal condition, key the transmitter and monitor the control voltage on Pin 2 of the power module. If the voltage exceeds 12.5 volts, troubleshoot the control voltage limit circuitry.

(4) Interstage drive Limiter Circuitry Test (30–watt models)

Check this circuit only when the final device (Q9880) has failed. With the radio off, check CR9930 and associated components.

(5) Current Limiting Circuitry Test (30–watt models)

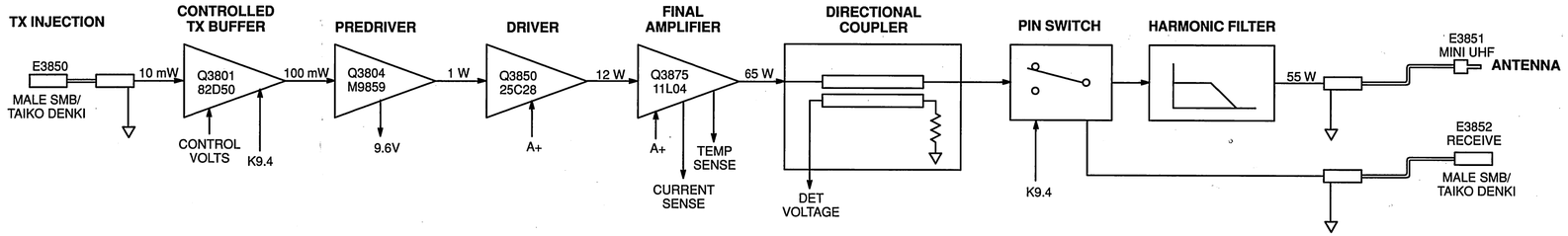
Refer to section 2 of the Service Manual for current limit setting instructions. When ready to adjust current limit, decrease the relative current limit value with the keyboard per instructions. After several decrements, the current limit should reduce power from 0.1 watt to 0.5 watt. After this test, reset the current limit. If the circuitry does not perform as indicated, troubleshoot the current limit circuitry.

(6) Power Leveling Circuitry Test

With the radio connected for power measurements, vary the line voltage from 12.5 to 16 volts. The power should not vary more than 3 watts. At a line voltage of 13.6 volts, vary the frequency using the three test modes. If power varies more than 3 watts, measure the detected voltage on P0853, Pin 9. If this voltage varies more than 0.2 volts over line and frequency variations, the power control circuitry (most of which is located on the command board) may be malfunctioning. If the detected voltage varies less than 0.2 volts, the problem is likely in CR9900, the harmonic filter, the antenna switch, or the output coax. Check continuity through 12 pin DC connector P0853 on the PA board; check digital/analog circuitry, and check 5V regulator operation. See the Table 2, DC Voltage Chart, for typical values.

Note

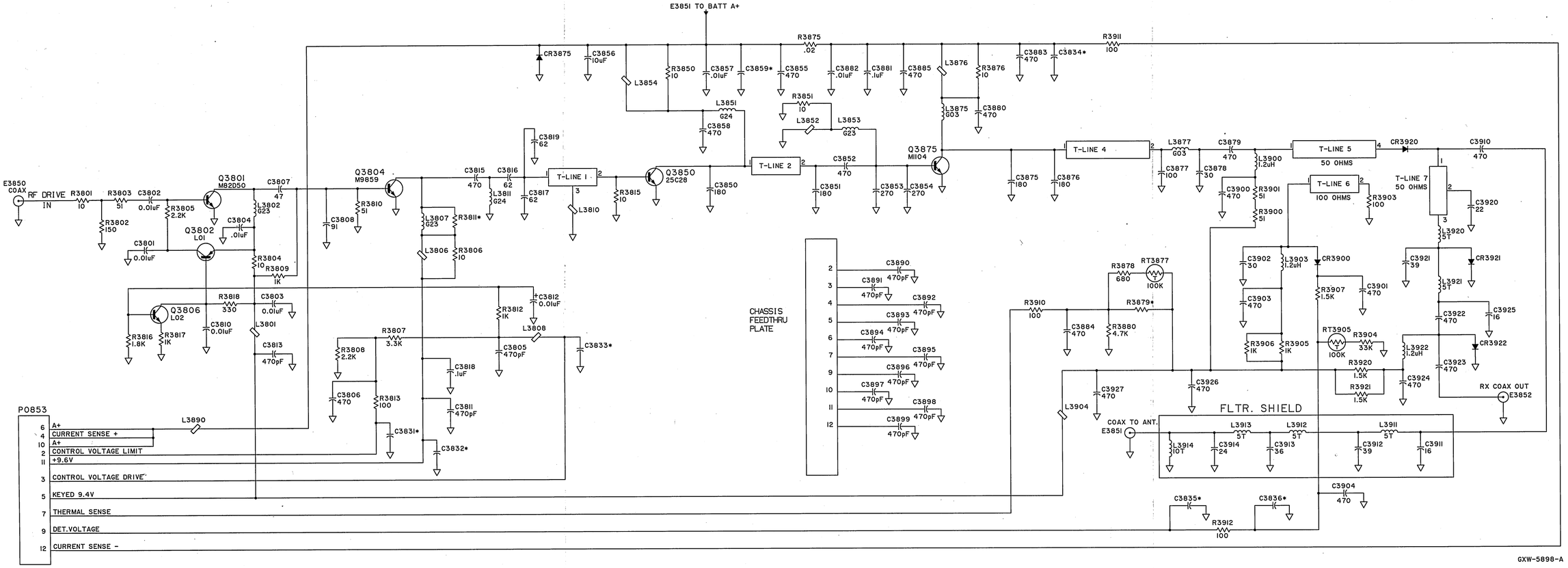
If any part of the power leveling circuitry is replaced, perform the power set procedure. See the Service Manual for details.



Block Diagram for
SPECTRA 50–Watt PA
PW–5816–A
3/31/89

HLD6022A VHF 50 WATT PA SCHEMATIC

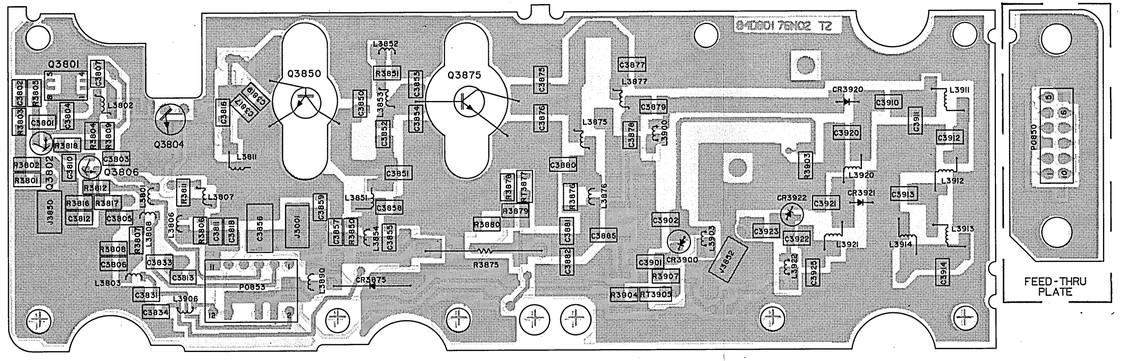
NOTES:
1.) ALL RESISTANCE IS IN OHMS , ALL CAPACITANCE IS IN PICOFARADS UNLESS NOTED OTHERWISE.
2.) ASTERISK * DENOTES CONTIGENCY PARTS.



GXW-5898-A

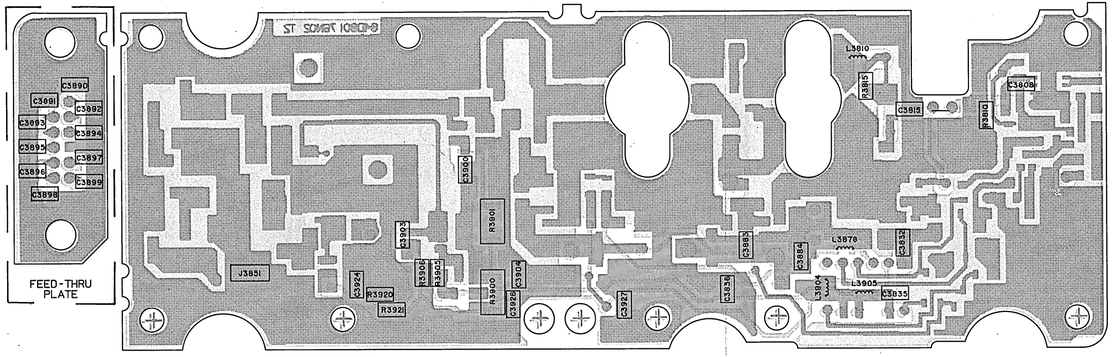
Schematic, Circuit Board Diagrams, and Parts List for
HLD6022A *SPECTRA* VHF 50 Watt PA
PW–5896–A
(Sheet 1 of 2)
3/31/89

HLD6022A 50–WATT PA CIRCUIT BOARD



SOLDER SIDE GPW-5900-O
COMPONENT SIDE GPW-5899-O
OVERLAY GXW-5901W01-O

COMPONENT SIDE



SOLDER SIDE GPW-5900-O
COMPONENT SIDE GPW-5899-O
OVERLAY GXW-5901W02-O

SOLDER SIDE

parts list

HLD6022A PA Board, 50W VHF 136/174 MHz MXW–5897–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C3801–3804	21–13741N45	0.01 uF, ±10%
C3805,3806	21–13740B65	470
C3807	21–13740B41	47
C3808	21–13740B48	91
C3810	21–13741N45	0.01 uF, ±10%
C3811	21–13740B65	470
C3812	21–13741N45	0.01 uF, ±10%
C3813	21–13740B65	470
C3815	21–13740B65	470
C3816,3817	21–13740B44	62
C3818	21–13741N69	0.1 uF, ±10%
C3819	21–13740B44	62
C3850,3851	21–11078B49	180, 100V
C3852	21–11078B59	470, 100V
C3853,3854	21–11078B53	270, 100V
C3855	21–13740B65	470
C3856	23–80090M24	10 uF, ±20%, electrolytic
C3857	21–13741N45	0.01 uF, ±10%
C3858	21–13740B65	470
C3859	21–13741N69	0.1 uF, ±10%
C3875,3876	21–11078B49	180, 100V
C3877	21–11078B42	100, 100V
C3878	21–11078B27	30, 100V
C3879	21–11078B59	470, 100V
C3880	21–13740B65	470
C3881	21–13741N69	0.1 uF, ±10%
C3882	21–13741N45	0.01 uF, ±10%
C3883–3885	21–13740B65	470
C3890–3901	21–13740B65	470
C3902	21–13740B36	30
C3903,3904	21–13740B65	470
C3910	21–11078B59	470, 100V
C3911	21–11078B19	16, 100V
C3912	21–11078B32	39, 100V
C3913	21–11078B31	36, 100V
C3914	21–11078B23	24, 100V
C3920	21–11078B22	22, 100V
C3921	21–11078B32	39, 100V
C3922–3924	21–13740B65	470
C3925	21–11078B19	16, 100V
C3926,3927	21–13740B65	470
diode (see note)		
CR3875	48–80236E07	zener, 28V
CR3900	48–80236E05	hot carrier
CR3920,3921	48–80236E20	pin
CR3922	48–80142L01	pin
coil, RF		
L3801	24–80067M01	chip bead
L3802	24–80091G23	7 turns, airwound
L3806	24–80132N01	ferrite bead
L3807	24–80091G23	7 turns, airwound
L3808	24–80067M01	chip bead
L3810	24–80067M01	chip bead
L3811	24–80091G24	5 turns, airwound
L3851	24–80091G24	5 turns, airwound
L3852	24–80132N01	ferrite bead
L3853	24–80091G23	7 turns, airwound
L3854	24–80132N01	ferrite bead
L3875	24–80090G03	3 turns, airwound
L3876	24–80132N01	ferrite bead
L3877	24–80090G03	3 turns, airwound
L3890	24–80132N01	ferrite bead
L3900	24–80140E01	1.2 uH
L3903	24–80140E01	1.2 uH
L3904	24–80067M01	chip bead
L3911	24–80090G15	5 turns, airwound
L3912	24–80090G10	5 turns, airwound
L3913	24–80090G15	5 turns, airwound
L3914	24–80090G13	10 turns, airwound
L3920,3921	24–80090G14	5 turns, airwound
L3922	24–80140E01	1.2 uH
connector plug		
P0850	28–80102M06	vertical, 12 position
P0853	09–80103M04	right angle, 12 position
transistor (see note)		
Q3801	48–80182D50	NPN
Q3802	48–80141L01	PNP
Q3804	48–00869859	NPN
Q3806	48–80141L02	NPN
Q3850	48–80225C28	NPN
Q3875	48–84411L04	NPN
thermistor		
RT3877	06–80149M02	100k ohm
RT3905	06–80149M02	100k ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R3801	06–11077A26	10
R3802	06–11077A54	150
R3803	06–11077A43	51
R3804	06–11077A26	10
R3805	06–11077A82	2.2k
R3806	06–11077A06	10
R3807	06–11077A86	3.3k
R3808	06–11077A82	2.2k
R3809	06–11077A74	1k
R3810	06–11077A43	51

HLD6022A PA Board, 50W VHF 136/174 MHz MXW–5897–A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R3812	06–11077A74	1k
R3813	06–11077A50	100
R3815	06–11077A26	10
R3816	06–11077A80	1.8k
R3817	06–11077A74	1k
R3818	06–11077A62	330
R3850,3851	06–11077A26	10
R3875	17–80328N02	shunt resistor, 0.020, ±10%, 2W
R3876	06–80195M01	10, 0.5W
R3878	06–11077A70	680
R3880	06–11077A90	4.7k
R3900,3901	06–80194M18	51, 1W
R3903	06–80195M25	100, 0.5W
R3904	06–11077B11	33k
R3905,3906	06–11077A74	1k
R3907	06–11077A78	1.5k
R3910	06–11077A50	100
R3911	06–11077A50	100
R3912	06–11077A50	100
R3920,3921	06–11077A78	1.5k
mechanical parts		
	26–80187N01	heatsink, transistor
	26–80188N01	shield, harmonic filter
	26–80286N01	shield, coax
	29–80014A01	clip coax (3 used)

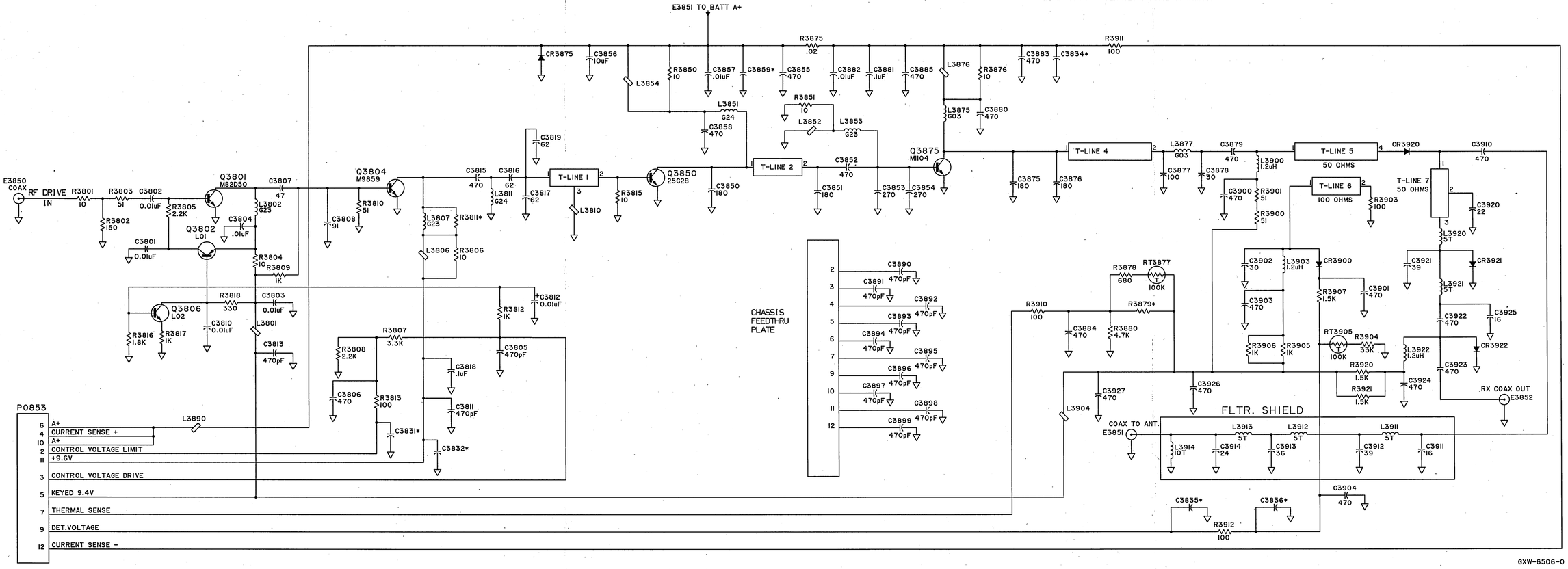
3/31/89

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

Schematic, Circuit Board Diagrams, and Parts List for
HLD6022A *SPECTRA* VHF 50 Watt PA
PW–5896–A
(Sheet 2 of 2)
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HLD6022B VHF 50–WATT PA SCHEMATIC

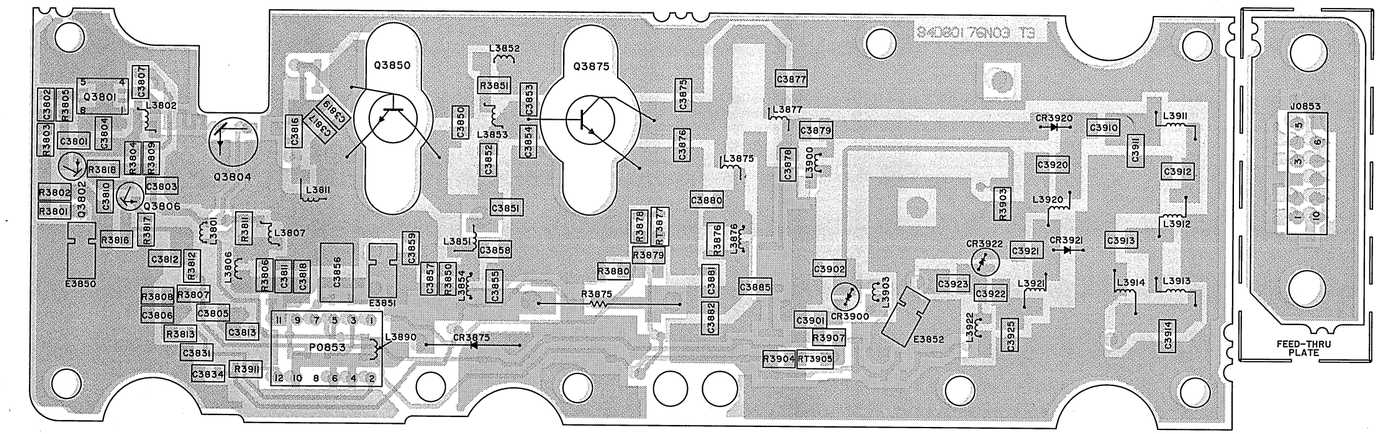
NOTES:
1.) ALL RESISTANCE IS IN OHMS . ALL CAPACITANCE IS IN PICOFARADS UNLESS NOTED OTHERWISE.
2.) ASTERISK * DENOTES CONTIGENCY PARTS.



GXW-6506-O

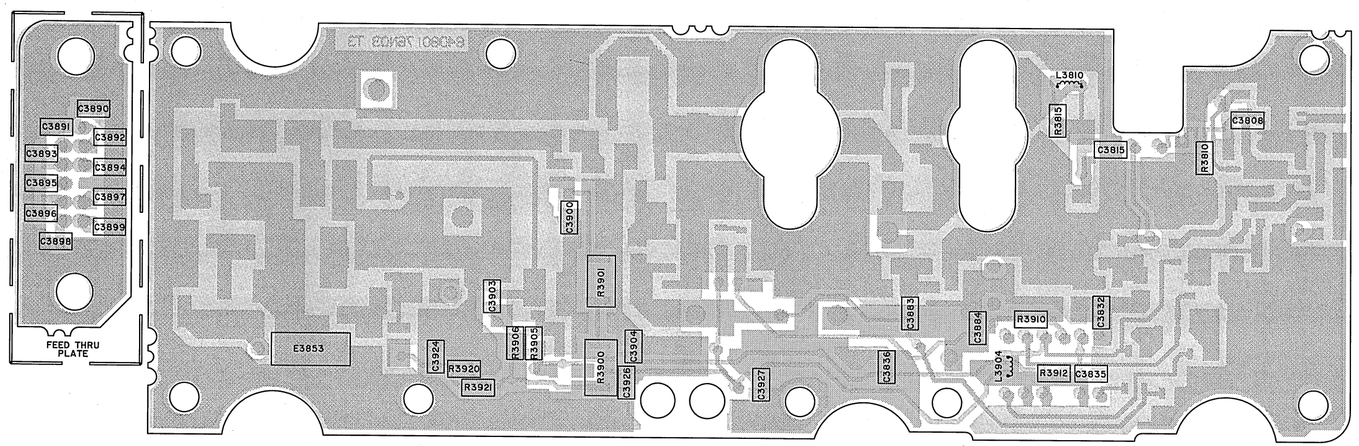
Schematic, Circuit Board Diagrams, and
Parts List for HLD6022B *SPECTRA* VHF 50–Watt PA
PW–6505–O
(Sheet 1 of 2)
3/31/89

HLD6022B 50–WATT PA CIRCUIT BOARDS



SOLDER SIDE GPW–6507–O
COMPONENT SIDE GPW–6530–O
OVERLAY GXW–6531W01–O

COMPONENT SIDE VIEW



SOLDER SIDE GPW–6507–O
COMPONENT SIDE GPW–6530–O
OVERLAY GXW–6531W02–O

SOLDER SIDE VIEW

parts list

HLD6022B PA Board, 50W VHF 136/174 MHz MXW–6532–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C3801–3804	21–13741N45	0.01 uF, ±10%
C3805,3806	21–13740B65	470
C3807	21–13740B41	47
C3808	21–13740B48	91
C3810	21–13741N45	0.01 uF, ±10%
C3811	21–13740B65	470
C3812	21–13741N45	0.01 uF, ±10%
C3813	21–13740B65	470
C3815	21–13740B65	470
C3816,3817	21–13740B44	62
C3818	21–13741N69	0.1 uF, ±10%
C3819	21–13740B44	62
C3850,3851	21–11078B49	180, 100V
C3852	21–11078B59	470, 100V
C3853,3854	21–11078B53	270, 100V
C3855	21–13740B65	470
C3856	23–80090M24	10 uF, ±20%, electrolytic
C3857	21–13741N45	0.01 uF, ±10%
C3858	21–13740B65	470
C3859	21–13741N69	0.1 uF, ±10%
C3875,3876	21–11078B49	180, 100V
C3877	21–11078B42	100, 100V
C3878	21–11078B27	30, 100V
C3879	21–11078B59	470, 100V
C3880	21–13740B65	470
C3881	21–13741N69	0.1 uF, ±10%
C3882	21–13741N45	0.01 uF, ±10%
C3883–3885	21–13740B65	470
C3890–3901	21–13740B65	470
C3902	21–13740B36	30
C3903,3904	21–13740B65	470
C3910	21–11078B59	470, 100V
C3911	21–11078B19	16, 100V
C3912	21–11078B32	39, 100V
C3913	21–11078B31	36, 100V
C3914	21–11078B23	24, 100V
C3920	21–11078B22	22, 100V
C3921	21–11078B32	39, 100V
C3922–3924	21–13740B65	470
C3925	21–11078B19	16, 100V
C3926,3927	21–13740B65	470
diode (see note)		
CR3875	48–80236E07	zener, 28V
CR3900	48–80236E05	hot carrier
CR3920,3921	48–80236E20	pin
CR3922	48–80142L01	pin
coil, RF		
L3801	24–80067M01	chip bead
L3802	24–80091G23	7 turns, airwound
L3806	24–80132N01	ferrite bead
L3807	24–80091G23	7 turns, airwound
L3810	24–80067M01	chip bead
L3811	24–80091G24	5 turns, airwound
L3851	24–80091G24	5 turns, airwound
L3852	24–80132N01	ferrite bead
L3853	24–80091G23	7 turns, airwound
L3854	24–80132N01	ferrite bead
L3875	24–80090G03	3 turns, airwound
L3876	24–80132N01	ferrite bead
L3877	24–80090G03	3 turns, airwound
L3890	24–80132N01	ferrite bead
L3900	24–80140E01	1.2 uH
L3903	24–80140E01	1.2 uH
L3904	24–80067M01	chip bead
L3911	24–80090G15	5 turns, airwound
L3912	24–80090G10	5 turns, airwound
L3913	24–80090G15	5 turns, airwound
L3914	24–80090G13	10 turns, airwound
L3920,3921	24–80090G14	5 turns, airwound
L3922	24–80140E01	1.2 uH
connector plug		
P0850	28–80102M06	vertical, 12 position
P0853	09–80103M04	right angle, 12 position
transistor (see note)		
Q3801	48–80182D50	NPN
Q3802	48–80141L01	PNP
Q3804	48–00869859	NPN
Q3806	48–80141L02	NPN
Q3850	48–80225C28	NPN
Q3875	48–84411L04	NPN
thermistor		
RT3877	06–80149M02	100k ohm
RT3905	06–80149M02	100k ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R3801	06–11077A26	10
R3802	06–11077A54	150
R3803	06–11077A43	51
R3804	06–11077A26	10
R3805	06–11077A82	2.2k
R3806	06–11077A26	10
R3807	06–11077A86	3.3k
R3808	06–11077A82	2.2k
R3809	06–11077A74	1k
R3810	06–11077A43	51
R3812	06–11077A74	1k
R3813	06–11077A50	100

HLD6022B PA Board, 50W VHF 136/174 MHz MXW–6532–O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R3815	06–11077A26	10
R3816	06–11077A80	1.8k
R3817	06–11077A74	1k
R3818	06–11077A62	330
R3850,3851	06–11077A26	10
R3875	17–80228N02	shunt resistor, 0.020, ±10%, 2W
R3876	06–80195M01	10, 0.5W
R3878	06–11077A70	680
R3880	06–11077A90	4.7k
R3900,3901	06–80194M18	51, 1W
R3903	06–80195M25	100, 0.5W
R3904	06–11077B11	33k
R3905,3906	06–11077A74	1k
R3907	06–11077A78	1.5k
R3910	06–11077A50	100
R3911	06–11077A50	100
R3912	06–11077A50	100
R3920,3921	06–11077A78	1.5k
mechanical parts		
	26–80187N01	heatsink, transistor
	26–80188N01	shield, harmonic filter
	26–80286N01	shield, coax
	29–80014A01	clip coax (3 used)

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

40–Watt Power Amplifier (UHF)

1. Transmitter

The 40–watt *SPECTRA* power amplifier is discussed in the following text. A block diagram of the circuit is shown on the foldout drawing PW–5942.

1.1 TRANSMIT LOW LEVEL AMPLIFIER (LLA)

Note

The minimum input drive level to the PA into P5850 is 30 milliwatts. Refer to the synthesizer section if input drive is less than 30 milliwatts.

The Low Level Amplifier, the first stage of the PA, provides a gain that is a function of a control voltage. This control voltage comes from the Regulator Power Control IC (RPCIC) on the command board. The magnitude of the control voltage depends on PA output power, temperature, and final amplifier current drain. See Section 3 for a detailed explanation of the power control circuitry.

The LLA, Q5801, is unique in that its gain is controlled by varying the collector's current rather than its voltage. Q5801 and associated circuitry (Q5806, Q5800, R5805, and R5818) are best described as a voltage–controlled current source. This means that the collector current of Q5801 is controlled by the magnitude of the control voltage. Proper operation of the LLA can be checked by monitoring the voltage across the resistor R5805 The voltage should measure in the range of 0.1 volt to 1.0 volt, depending on the value of control voltage. A 0.1 volt reading corresponds to a low control voltage (1 to 5 volts) and a 1.0 volt reading corresponds to a high control voltage (up to control voltage limit).

1.2 PREDRIVER STAGE

The second stage of the PA, Q5803, is the predriver which amplifies the output of the LLA to a level sufficient to operate the driver device, Q5850. This stage amplifies the LLA output from, approximately, 250 milliwatts in to 2.0 watts out.

1.3 DRIVER STAGE

The driver is a six–leaded 2.5 to 16 watt device. It is driven by the predriver device through a matching circuit that consists of C5851, C5852, C5850, C5858, and L5850. L5851 and L5852 give the driver a zero–DC bias (required for the driver's class–C operation). L5852, a ferrite bead, helps lower the driver base Q and prevent unwanted oscillations. The network of L5853, L5854, C5856, C5857, and R5850 provide A+ to the collector. L5853 and L5854 provide the DC path and block RF from coming up the DC line. R5850 resistively loads down the collector at low frequencies, preventing unwanted oscillations. C5856 and C5857 are bypass capacitors.

1.4 FINAL STAGE

The final device is a six–leaded 15 to 50 watt device and is driven by the driver through a quasi–low pass matching circuit that consists of C5853, C5854, C5855, C5875, C5876, and associated transmission lines. Base network, L5875, L5876, L5883, C5891, R5881, and R5882, provide the zero–DC bias required by the final device's class–C operation. L5875, L5876, and L5883 provide the DC path from base to ground. C5891, in parallel with L5875, presents a high impedance at UHF frequencies, thus minimizing RF losses in the base network. R5881, R5882, and L5883 resistively load down the base at low frequencies, thus preventing unwanted oscillations. The collector DC network consists of L5878, L5879, R5879, R5880, R5883, R5884, R5875, C5881, C5883, C5884, C5885, C5886, C5893, and CR5875. This network provides the A+ voltage to the final while blocking RF from getting up the DC line. L5878 and L5879 provide the DC path and block RF. R5879, R5880, R5883, and R5884 resistively load down the final's collector at low frequencies and prevents unwanted oscillations. C5881, C5883, C5884, C3885, C5886, and C5893 are all bypass capacitors ranging from very low frequencies up to UHF frequencies. R5875 is the current–sense resistor. CR5875 protects against reverse polarity. Finally, the power goes through a low–pass matching network (C5877, C5878, C5887, C5892, C5880, and associated transmission lines) to the rest of the output network (Directional Coupler, Antenna Switch, and Harmonic Filter).

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2. Antenna Switch and Harmonic Filter

2.1 ANTENNA SWITCH

The antenna switch's impedance inverter circuit, made up of C5923 and L5921, takes the place of a quarter–wave microstrip line. During transmission, Keyed 9.4 volts forward–biases CR5921, producing low impedance on CR5921's anode and high impedance on the C5923/L5921 node. Effectively, this isolates the transmitted power from the receiver. C5922 couples the power to the harmonic filter and on to the antenna.

Total TX to RX isolation exceeds 45 dB from 450–512 MHz. The impedance inverter contributes approximately 35 dB to transmit isolation. A second shunt switch, made up of CR5922, L5922, and C5924, provides additional isolation. C5926 and C5927 block DC.

During RX, CR5920 has an OFF capacitance of approximately 1 pF, which is tuned out by L5904. CR5921 and CR5922, incorporated in the RX match, have similar OFF capacitances.

2.2 HARMONIC FILTER

The 40–watt harmonic filter is a 7–pole, low–pass filter, consisting of screened plate capacitors and discrete inductors (L5924, L5925, and L5926) on a 35–mil alumina substrate. The filter's ground plane is attached to the PA printed circuit board with solder, while input and output connections are made via MP5901 and MP5902. The filter's primary function is to attenuate harmonic spurs generated by the transmitter. It also adds low–pass selectivity for the receiver. L5910, grounded through MP5903, protects the PA from static discharge.

Note

When removing any of the discrete coils, take care to avoid leaching the plate capacitor metalization. Removal of the entire hybrid is best accomplished by heating the hybrid/PC board assembly with a heat gun or heat blower until the solder joint reflows.

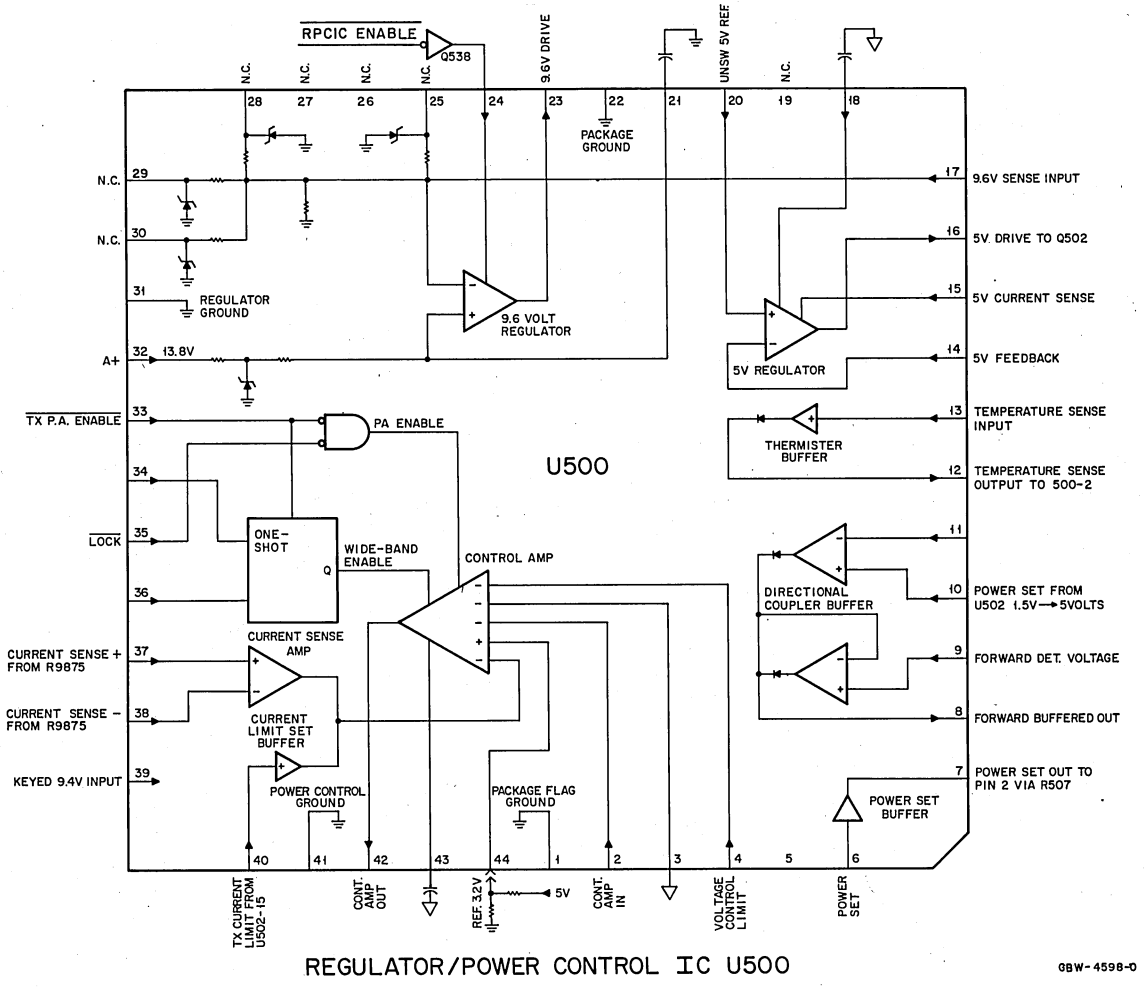


Figure 1. RPCIC Block Diagram

3. Power Control Circuitry

3.1 COMMAND BOARD CIRCUITRY

Inside U500, the Regulator Power Control IC (See Figure 1, RPCIC Block Diagram), is an operational amplifier that has four inverting inputs, and one non–inverting input (at Pin 44) which is the reference input for the entire power control loop of the power amplifier. The 3.2V reference voltage at U500–44 is produced by dividing SW +5V with the voltage divider circuit, R514 and R515.

The power control loop is controlled by the microprocessor, U520, on the command board. The microprocessor enables the RPCIC by pulling TX PA ENABLE low while the radio synthesizer is locked. Each is felt on Pins 33 and 35 respectively. U520 writes data to a digital–to–analog converter, U502, to change and control the power–set voltage from Pin 10 of U502 to Pin 6 of U500. The voltage on this line, 1.5 to 5 volts, will be inversely proportional to the power out of the PA, with 5 volts producing the lowest power output. This voltage may be set with an IBM PC or with a built–in program operated through the radio's control head. On U500, the voltage at Pin 6 is buffered internally and exits on Pin 7. Through R507, it is summed at the node connected to Pin 2, one of the inverting inputs.

3.2 CONTROL VOLTAGE LIMITER

R5807 and R5808 form a voltage divider that connects to control voltage drive. The output of this voltage divider is connected to the control–voltage–limit input (Pin 4) of the RPCIC. If the voltage at this input reaches 3.2 volts, then the control voltage will be clamped to a maximum value. For the 40–watt UHF PA, this maximum value is 10 volts. This voltage–control limit is set by the values of R5807 and R5808.

3.3 CURRENT LIMITER

U520, the processor on the command board, sends data to U502, the digital–to–analog converter, to properly set the voltage on U502, Pin 15, which is the TX CURRENT LIMIT control line to the RPCIC (U500, Pin 40). Sixteen different voltages, ranging from 1.5 to 4.5 volts, can be programmed from U502.

The collector current of the 40–watt amplifier is monitored by sensing the voltage across R5875. CURRENT SENSE + connects to one end of R5875; CURRENT SENSE – connects to the other end. These lines connect to the command board on U500, Pins 37 and 38, respectively. If the TX CURRENT LIMIT is set for 1.5 volts, then the voltage difference between U500, Pins 37 and 38 must be 0.1 volts before the current through R5875 is reduced. If U500, Pin 40 is programmed for 4.5 volts, then the difference of potential between Pins 37 and 38 must exceed 0.3 volts before current limiting begins. The voltage across R5875, where current sense occurs, can be determined by multiplying the voltage on U500, Pin 40, by 0.067. When current is being limited, the output of the op–amp (U500, Pin 42) begins shutting down the conduction of Q503 and Q504, reducing PA control voltage, and reducing drive to the final amplifier to, effectively, control the final amplifier's maximum current.

3.4 FORWARD POWER LIMITER

After the final amplifier, a parallel pair of microstrip lines form a forward power–sensing directional coupler. Because of increased coupling with frequency, C5903, L5902, C5904, L5903, and C5905 are used to compensate and filter out harmonics. CR5900 rectifies the signal. R5904, R5905, and RT5904 provide thermal compensation. During normal transmission, the DC voltage from the forward–detect line to the RPCIC ranges from 2 to 4.5 volts. This voltage connects to U500, Pin 9, the directional coupler buffer input.

The directional coupler's output, U500 Pin 8, is summed to Pin 2 with the digital/analog buffer's output through R509 and R507, respectively. Closed loop operation reduces the control amp's output (Pin 42), reduces the power module's gain, and reduces power output to maintain the coupler buffer output (U500, Pin 2) at 3.2 volts regardless of the d/a voltage level. If the d/a voltage is high (4.5 volts), little detected voltage is needed to keep Pin 2 at 3.2 volts, and the power, consequently, is low. If the d/a voltage is low (1.5 volts), a large forward detected voltage is needed to keep Pin 2 at 3.2 volts and power, consequently, is at maximum value. The voltage at Pin 2 drops below 3.2 volts under proper operation during low line voltage conditions where the PA cannot produce rated power, or if, under any conditions, the control voltage, or the final device current exceeds safe levels.

3.5 TEMPERATURE SENSING

The temperature–sensing circuit of the PA works with the RPCIC to protect the PA devices from excessively high temperatures. On the PA board, this circuit, formed by resistors R5878, R5876, R5877, and thermistor RT5875, provides a temperature–dependent voltage to the RPCIC via P0853, Pin 7. As the PA temperature increases, the resistance of RT5875 decreases, causing the voltage at Pin 7 to increase. This voltage is routed to the RPCIC, U500, Pin 13, which is the input to the thermistor buffer. The buffer's output on Pin 12 is connected to Pin 2 via resistor R508. Note that Pin 2 is the control amp input and is a summing point for temperature, forward–power detect, and power set signals. If the PA temperature becomes high enough so that the voltage at Pin 7 exceeds 3.2 volts, the thermistor buffer starts supplying current to the node at Pin 2. Due to the fixed output current of the power–set buffer, the control loop can maintain 3.2 volts at Pin 2 only by reducing the forward–power detect voltage and, therefore, reducing the PA output power. Since power output is reduced, the generated heat is reduced to a safe level. If temperature decreases, the power output of the PA gradually increases to its nominal value. Temperature cutback should occur at about 140 degrees F (60 deg C).

The temperature sense circuitry can easily be tested by placing an ordinary leaded 6.8k ohm resistor across RT5875. PA output power should drop significantly if this circuit is working properly.

Note

Under severe environmental conditions, more than one circuit may be attempting to reduce power output at the same time (i.e., during high VSWR conditions, the current limiter may initially reduce power, but eventual heat build–up will cause further power reduction by the thermal cut–back circuit).

4. Transmitter Troubleshooting

This information will help field service technicians troubleshoot the *SPECTRA* radio. Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, this section includes troubleshooting information that will help you test and check the circuits to localize and isolate problems.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at UHF frequencies, measurements must be taken very carefully. Notes and cautions are added to the text to alert the reader to this need in areas of greatest sensitivity. However, the need for extreme care does exist in all measurements and tests at UHF frequencies.

4.1 GENERAL TROUBLESHOOTING AND REPAIR NOTES

Most of the common transmitter symptoms are caused by either failure of the power amplifier or a failure in the control circuitry. The initial troubleshooting effort should be toward isolating the problem to one of those two areas. If either the control voltage or keyed 9.4 volts are zero, then the problem is likely to be in the control circuit. If those voltages are present, then the problem is more likely in the power amplifier circuit.

If, for diagnostic reasons, a chip component needs to be removed to facilitate testing, such as a series capacitor removed to allow for signal insertion, then the component(s) returned to the circuit should be new parts. The application of a soldering iron to many chip components will tend to cause leaching which could lead to failure.

If the harmonic filter is damaged and needs to be replaced, then removal and replacement requires the use of a hot–air source capable of reflowing the solder beneath the filter hybrid. When replacing it, add small amounts of fresh solder paste to the silver regions beneath the ceramic to assure adequate electrical ground contact. Save the original input and output connectors (J–straps); these are not included with the replacement kit. No tuning is required. The harmonic filter may be ordered separately, but if the PA kit is ordered, a filter kit comes with the PA kit.

After a PA board is replaced, or if any power control circuitry components are replaced, readjust the power according to instructions in the Service Manual.

Important

Due to high operating frequencies, you must use specified Motorola parts when component replacement is necessary. Substitute components may not work. It is also critical that you use great care when replacing parts. Excessive solder or flux, longer than original leads on coax connectors, mis–orientation of parts, and other commonly benign imperfections may cause the radio's performance to degrade.

4.2 PA FUNCTIONAL TESTING

Test the PA assembly for proper operation as follows:

(1) Disassemble the PA assembly from the radio, leaving the power cable connected to the rear connector. Replace the PA shield and cover. Disconnect the coax connectors and the ribbon cable. Connect a power meter to the antenna port using minimum cable length.

Notes

(a) When setting or measuring RF power at UHF, follow these guidelines to avoid measurement errors due to cable losses or non 50–ohm connector VSWR:

- All cables should be very short and have Teflon dielectric.
- Attenuators and 50–ohm loads should have at least 25 dB return loss.
- 'Mini UHF to 'N' adapter, P/N 58–80367B21, should be used at the antenna connector. All other connectors should be 'N' type. No other adapters, barrel connectors, etc. should be used.

(b) Maximum input level to the PA is 50 milliwatts. Too much input power could result in damage to the LLA stage.

Table 1. DC Voltages and Input Power Chart

TEST	KEYED 9.4 V	9.6 V	CONTROL VOLTAGE	POWER IN (mW)	A+ V
Transmit	9.4	9.6	See note	30	13.0
Receive	0	9.6	0	0	13.0

Note: Set initially to zero. Increase value until power equals 46 watts or 10.0 volts maximum. Do NOT exceed 10.0 volts.

(2) Apply the input power and DC voltages indicated in Table 1 to the power amplifier assembly. To make the DC connections, use small spring–clips or make a test adapter similar to that shown in Figure 2.

(3) Apply the required input power via an adapter cable. For this application, non 'N' type connectors are acceptable.

(4) With the applied control voltage initially at zero volts, slowly increase the voltage until power out equals 46 watts. Power should rise smoothly with control voltage once the turn–on threshhold is reached. Control voltage should not exceed 10.0 volts.

(5) If 10.0 volts does not produce 46 watts, then a failure exists in the power amplifier circuit.

(6) Refer to the voltage chart (See Table 2). Measure the indicated voltages. If they are not within the limits shown in the chart, then a failure exists in the PA assembly.

(7) If the voltages in the chart are correct, verify that the injection is at least 30 milliwatts. (See the VCO troubleshooting section.)

(8) If no failure is located from the previous checks, troubleshoot the power control circuitry.

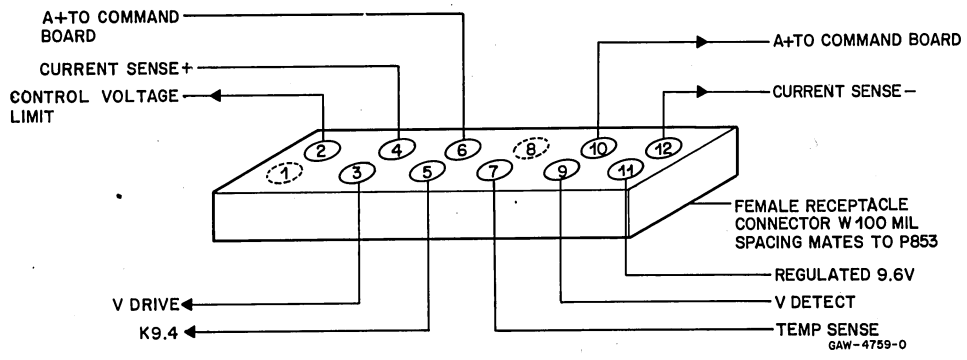


Figure 2. PA Test Adapter.

LOCATION	RX MODE			TX MODE			
LOCATION	LOW	TYP	HI	LOW	TYP	HI	COMMENTS
P0853							
1	——	——	——	——	——	——	KEY (NO PIN OR WIRE)
2		0		0	2.0	3.2	CONTROL VOLTAGE LIMIT
3		0		2.0	7.0	10.0	DRIVE VOLTAGE
4	10.8	13.6	16.5	10.0	13.0	16.0	CURRENT SENSE +
5	0	0	0	9.2	9.4	9.8	KEYED 9.4
6	10.8	13.6	16.5	10.0	13.0	16.0	A+ TO COMMAND BOARD
7		0			1.2		TEMP SENSE (CUTBACK BEGINS AT 3.3V)
8	——	——	——	——	——	——	KEY (NO PIN)
9		0		13.0	9.3	5.0	FORWARD DETECT VOLTAGE
10	10.8	13.6	16.5	10.0	13.0	16.0	A+ TO COMMAND BOARD
11	9.4	9.6	9.9	9.4	9.6	9.9	9.6V SUPPLY FROM COMMAND BOARD
12	10.8	13.6	16.5	9.8	12.8	15.8	CURRENT SENSE—(VOLTAGE DELTA 150mV)
U0500							
1	0	0	0	0	0	0	GROUND
2		0			3.2		CONTROL AMP INPUT
3	0	0	0	0	0	0	CONTROL AMP INPUT (NOT USED)
4		0		0	2	3.2	CONTROL VOLTAGE LIMIT (CUTBACK AT 3.3V)
5		0			0	N.C.	
6	1.5	3.0	4.5	1.5	3.0	4.5	POWER SET FROM D–A (MAX POWER AT 1.5V)

Table 2. Power Control DC Voltage Chart

Table 2. Power Control DC Voltage Chart (continued)

LOCATION	RX MODE			TX MODE			
LOCATION	LOW	TYP	HI	LOW	TYP	HI	COMMENTS
7		0		1.5	3.0	4.5	POWER SET BUFFER OUT
8		0		1.3	3.5	6.0	COUPLER BUFFER OUT
9		0		1.3	3.5	6.0	FORWARD DETECT VOLTAGE
10		0			0		REFLECTED POWER DETECT (NOT USED)
11		0		1.3	3.5	6.0	SAME AS PIN 8 (NOT USED)
12		0		0	1.2	6.0	THERMISTER BUFFER OUT (INCREASES AS PA GETS HOT)
13		0		0	1.2	6.0	THERMISTER BUFFER IN
14		5.0			5.0		5V SENSE INPUT (FOLLOWS PIN 20 ±0.1V)
15	4.9	5.0	5.7	4.9	5.0	5.7	5V CURRENT LIMIT (LIMITS AT 5.7V)
16	5.0	5.7	6.4	5.0	5.7	6.4	5V SERIES PASS DRIVE (6.4V AT MAX CURRENT)
17	9.5	9.6	9.9	9.5	9.6	9.9	9.6 VOLT SENSE INPUT
18		7			7		5V REG. COMPENSATION CAPACITOR
19		5.7			5.7		N.C.
20	4.9	5.0	5.1	4.9	5.0	5.1	5V REFERENCE INPUT (UNSW5V)
21		1.2			1.2		9.6V REG. COMPENSATION CAPACITOR
22		0			0		N.C.
23		0.9	9.6		1.2	9.6	9.6V SERIES PASS DRIVE
24		2.9			3.3		REGULATOR ENABLE/COMPENSATION
25	—	—	—	—	—	—	9.6V PROGRAMMING (N.C.)
26		0			0		N.C.
27		13.6			13.6		N.C.
28	—	—	—	—	—	—	9.6V PROGRAMMING (N.C.)
29	—	—	—	—	—	—	9.6V PROGRAMMING (N.C.)
30	—	—	—	—	—	—	9.6V PROGRAMMING (N.C.)
31	0	0	0	0	0	0	GROUND
32	10.8	13.6	16.5	10.0	13.0	16.0	DECOUPLED A+
33	4.0	5.0			0	0.2	$\overline{\text{TX PA ENABLE}}$ (FROM U520–25)
34		0			1.3		CONTROL AMP ONE–SHOT
35		0			0		$\overline{\text{LOCK}}$ (5V OF SYNTH OUT OF LOCK)
36		0			0.8		CONTROL AMP ONE–SHOT
37	10.8	13.6	16.3	10.0	13.0	16.0	A+ (CURRENT SENSE +)
38	10.8	13.6	16.3	10.0	13.0	16.0	CURRENT SENSE—VOLTAGE DELTA 150mV (30 WATT ONLY)
39		0		9.2	9.4	9.8	KEYED 9.4V IN
40	1.5	3.0	4.5	1.5	3.0	4.5	CURRENT LIMIT D–A (MAX CURRENT AT 4.5V)
41	0	0	0	0	0	0	GROUND
42		0			2.2	9.6	CONTROL AMP OUTPUT (APPX 1/2 V CONTROL)
43		1.3			7.0		LOOP INTEGRATOR CAPACITOR
44		2.1			3.2		CONTROL AMP REFERENCE
Q0500E		13.0			13.0		A+ —CR0500 DROP
Q0501C		12.3			12.3		VQ0500E—B/E DROP
Q0501E		0.2			0.2		V PIN 23—B/E DROP
Q0503E		0			1.5		V PIN 42—B/E DROP (TX)
Q0503C		13.6			9.0		
Q0504B		13.6			12.9		A+ —B/E DROP (TX)

Note: For antenna switch transmit bias conditions, RF drive must be removed from PA.

Table 2. Power Control DC Voltage Chart (continued)

LOCATION		TYPICAL RX	TYPICAL TX NO PRE–DRIVE	COMMENTS
CR5920	ANODE	0	1.6	
	CATHODE	0	0.8	
CR5921	ANODE	0	0.8	
	CATHODE	——	——	
CR5922	ANODE	0	<0.8	
	CATHODE	——	——	

4.3 LOCALIZING PROBLEMS

Failure locations often can be determined by externally measured symptoms. Basic symptoms are noted below with probable failure locations.

(1) Low Power and High Current

- Check for improper load conditions caused by high VSWR external to the radio.
- Check output coax and mini–UHF connector.
- Check harmonic filter and J–straps for opens and/or shorts.
- Check output impedance–matching circuitry from the final device to the harmonic filter.

(2) Low Power and Low Current

- If control voltage is equal to 10.0 volts, then check per the above.
- If control voltage is less than 10.0 volts, then check the control circuitry.

(3) Power Intermittently Low (or Zero) and Current Less than 1–Amp When Power Drops

- Check LLA stage.

(4) Power Zero and Current Greater Than 2 amps

- Check harmonic filter, antenna switch, matching circuits between driver and final stages, and matching circuits beyond final stage.

(5) Power Zero and Current Less Than 1 Amp

- Check LLA/pre–driver circuitry.

4.4 ISOLATING FAILURES

Methods of analyzing individual stages of the Power Amplifiers are detailed below. Most of the stages are class C and must be analyzed under relatively high RF power levels. Generators capable of such levels may not be available in all service shops, therefore the tests below are arranged in order of ascending power. This tends to allow the preceding stage to be the source of RF power for testing the next stage.

(1) Testing Low–Level Amplifier (LLA) Circuitry

The required DC and RF conditions are defined in Table 1. Measure LLA voltages according to Table 3.

Table 3. LLA and Pre–driver Typical Voltages

CONTROL	RF DRIVE OFF		RF DRIVE ON	
VOLTAGE	10.0 V	6.0 V	10.0 V	6.0 V
Q5801	——	——	——	——
BASE	0.7	0.7	0.7	0.3
COLLECTOR	8.1	9.1	8.0	8.8
Q5800	——	——	——	——
BASE	7.6	8.5	7.4	8.3
COLLECTOR	2.3	1.4	2.8	1.1
EMITTER	8.1	9.1	8.0	8.8
Q5806	——	——	——	——
BASE	6.4	3.8	6.4	3.9
COLLECTOR	7.6	8.5	7.4	8.3
EMITTER	5.7	3.2	5.7	3.2
Q5803	——	——	——	——
BASE	0.6	0.6	0.0	0.3
COLLECTOR	9.6	9.6	9.5	9.5

Note: The LLA voltages change with different control voltages. An example of LLA voltages with control voltage equal to 10 volts and 6 volts is shown.

If the above DC bias conditions are correct, check to see if the LLA is providing drive power to the pre–driver, Q5803. Do so by checking Q5803's collector current under normal drive conditions, as follows:

- Remove R5810 and L5806 (Be sure to reinstall after testing.)
- Solder wires to the remaining pads.
- Place an ammeter in series with Q5803 collector.
- Check for 0.2 to 0.5 amps (depending on control voltage).

Note

With no RF drive to the input of the PA, Q5803's collector current should be zero.

If Q5803 draws no current under normal conditions, then check for short or open input cable, or for defective parts in the

transmit injection filter or matching circuitry between Q5801 and Q5803. If all of the above check out OK, then replace Q5803.

(2) Testing Pre–Driver Circuitry.

The pre–driver is a typical class–C stage, except the base is biased with resistors R5809 and R5806. The necessary conditions for proper operation of this stage are input drive power, and bias conditions as shown in Table 3, above.

Note

If it is necessary to replace Q5803, use a hot–air blower to remove and replace the part. It is important that the replacement device's case be properly soldered to its heatsink. Do so by flowing a small bead of solder around the rim of the device while it is clamped in the hot–air soldering device. The base and collector leads must be hand–soldered on the bottom side of the board.

(3) Troubleshooting the Driver Stage

- Make sure A+ is at the collector.
- Check for shorts and/or opens in the matching circuitry. Also look for faulty components. (Cracked parts or parts not properly soldered).
- Measure the DC resistance from Base to Emitter. It should be less than 1–ohm. If not, check L5851 and L5852 for proper soldering, and replace if faulty.
- Check the current drain of the driver. It should be around 1.5 to 2.0 amps for 40 watt operation. If current drain is low, go to next step.
- Remove L5851 from the board and check the Base–Emitter and Base–Collector junction diode drops. Normal voltage drop should be between 0.4 and 1.0 volts. If either junction reads outside this range, replace the driver device.

(4) Troubleshooting the Final Device

- Make sure A+ is at the final's collector; if not, check for shorts and/or opens. If A+ is shorted, check C5877 and C5878 first for shorts, by lifting L5878 and measuring the resistance from collector to ground.
- Check the matching circuitry for shorts and/or opens. Also, check for faulty components. (Cracked parts or parts not properly soldered.)
- Measure the resistance from base to emitter; it should be less than 1 ohm. If not, check for proper soldering on L5875, L5876, and L5883; replace faulty component(s).
- Current drain on the final device should be >5 amps for 40 watt operation. If low current, go on to the next step.
- Remove L5875 from the board and check the Base–Emitter and Base–Collector junction diode drops. Normal voltage drop should be between 0.4 and 1.0 volts. If either junction is outside this range, replace the final device.

Note

The position of capacitors C5875, C5876, C5877, and C5878 is critical to the performance of the circuit. If they are removed for any reason, they must be re–installed as close to the cap of the final device as possible.

When replacing either the driver or final device, apply thermal compound on the heatsink surface. Torque the screws to the correct value (See Service Manual).

(5) Testing the Antenna Switch and Harmonic Filter

Verify that most of this circuit is functioning properly by testing the receiver insertion loss as follows:

- Apply a low–level signal source at the antenna connector.
- Apply the conditions indicated in Table 1 for RX tests.
- Measure the power at the receive coax.
- If the difference between the input and output (insertion loss) is less than 1 dB, then the circuitry is functioning properly.

Additional antenna switch tests are

- Check CR5920, CR5921, and CR5922 with an ohmmeter for forward and reverse continuity.
- In the transmit mode, adjust control voltage for 44 watts at the antenna connector. Check for less than 10 mW at the end of the receive input cable. If power exceeds 10 mW, then check CR5922 and associated circuitry. Receiver sensitivity can degrade if power at this port exceeds 10 mW.
- Check for proper DC current through the PIN diodes; correct current is indicated if approximately 1.5 volts is present at the junction of C5920 and L5920 during transmit mode.

WARNING

DO NOT measure bias directly at the PIN diodes while in transmit mode unless TX injection is removed.

4.5 POWER CONTROL AND PROTECTION CIRCUITRY

(1) Localizing Problems to a Circuit

Power leveling and current limiting are set to values detailed in the Service Manual. These values will vary from unit to unit, depending on the unique variations of each unit. If

symptoms indicate that either of these circuits have failed, verify that the radio has been properly aligned before investigating the circuitry.

Temperature sense and control voltage limit are fixed by design and are not influenced by the alignment of the radio. If symptoms indicate that these circuits have failed, then troubleshoot the circuit.

The tests that follow are intended to provide a convenient means of verifying that a particular circuit is functioning properly. These tests will isolate the failure to a minimum number of components. Refer to the theory of operation and the schematic for information needed to identify the failed component(s).

(2) Temperature Sense Circuit Test

Temporarily install a 6.8k ohm resistor in parallel with RT5875. Key the transmitter and monitor the output power. The power meter should read approximately one–half the rated power (25 watts).

(3) Control Voltage Limit Circuitry Test

Disconnect J5901 (transmitter injection) from the internal transceiver chassis. This will require removal of the power amplifier assembly. With all other connections in normal condition, key the transmitter and monitor the control voltage at the node of R5811, C5814, L5808, and R5808. If the voltage exceeds 10.0 volts, troubleshoot the control voltage limit circuitry.

(4) Current Limiting Circuitry Test

Refer to Section 2 of the Service Manual for current limit setting instructions. When ready to adjust current limit, decrease the relative current limit value with the keyboard per instructions. After several decrements, the current limit should begin to reduce power in 0.1 to 0.5 watt increments. After this test, reset the current limit to its original value. If the circuitry does not perform as indicated, troubleshoot the current limit circuitry.

(5) Power Leveling Circuitry Test

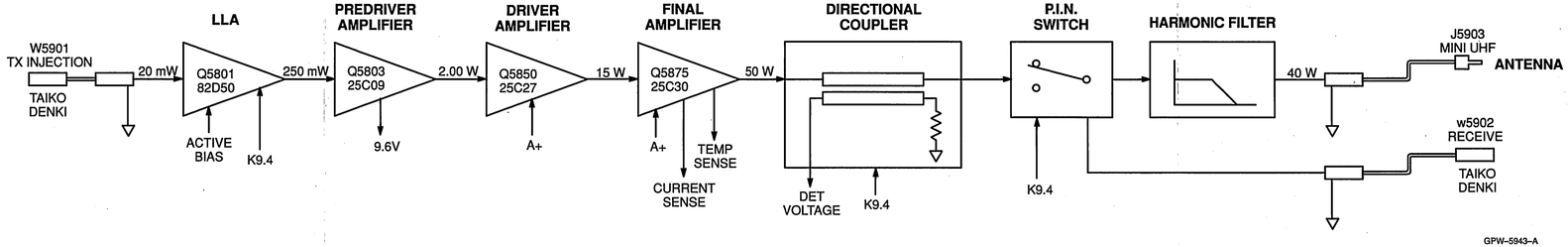
With the radio connected for power measurements, vary the line voltage from 12.5 to 16 volts. The power should not vary more than 2 watts. At a line voltage of 13.6 volts, vary the frequency using the three test modes. If power varies more than 2 watts, measure the detected voltage on P0853, Pin 9. If this voltage varies more than 0.2 volts over line and frequency variations, the power control circuitry (most of which is located on the command board) may be malfunctioning. If the detected voltage varies less than 0.2 volts, the problem is likely in diode CR5900, the harmonic filter, the antenna switch, or the output coax. Check continuity through the 12–pin DC connector P0853 on the PA board; check digital/analog circuitry, and check 5V regulator operation. See Table 2, DC Voltage Chart, for typical values.

With the radio connected for power measurements and a disconnected TX injection coax, the detected voltage at P0853, Pin 9, should measure approximately 1.3 volts.

Note

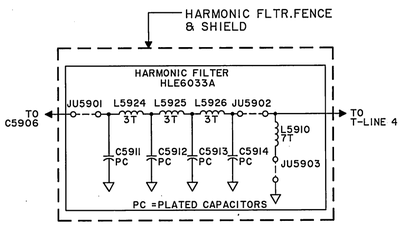
If any part of the power leveling circuitry is replaced, perform the power set procedure. See the Service Manual for details.

SPECTRA 40–WATT UHF AMPLIFIER

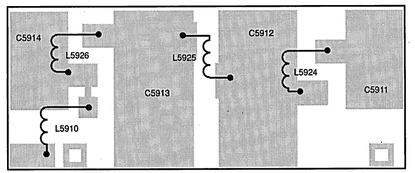


Block Diagram for
SPECTRA 40–Watt PA
PW–5942–A
3/31/89

HLE6043A (RANGE 3) AND HLE6044A (RANGE 4)
40–WATT PA SCHEMATIC



GXW-5944-O



SUBSTRATE GPW-5908-O
OVERLAY GPW-5909-O

HARMONIC FILTER BOARD

parts list

HLE6033A Harmonic Filter Hybrid UHF Range 3 & Range 4 — MXW-5907-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
connector receptacle		
J5901–J5903	07–80299L01	frame lead, j–strap
coil, RF		
L5910	24–80091G36	7 turns, airwound
L5924	24–80090G03	3 turns, airwound
L5925	24–80090G04	3 turns, airwound
L5926	24–80090G03	3 turns, airwound

9/15/88

RANGE MARKER TABLE

RANGE	1	2	3	4
R5931	X		X	X
R5932		X	X	X
R5933	X	X	X	
R5934	X	X		X

X=MARKER ON
BLANK=MARKER OUT

* CONTINGENCY PART

1. R5931,R5932,R5933 AND R5934 ARE USED AS RANGE MARKERS. SEE TABLE FOR MARKERS USED IN EACH RANGE.
2. PART VALUES IN PARENTHESIS ARE FOR RANGE IX (482–512 MHZ)

GXW-5903-A

Schematics, Circuit Board Diagrams, and Parts Lists for
HLE6043A (Range 3) and HLE6044A (Range 4)
SPECTRA 40–Watt Power Amplifier
PW–5902–A
(Sheet 1 of 2)
3/31/89

parts list

HLE6043A UHF 40–watt Power Amplifier (Range 3) MXW–5921–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C5801	21–13741N45	0.01 uF, ±10%
C5804	21–13741N45	0.01 uF, ±10%
C5805	21–13740B21	6.8, ±.25 pF
C5806	21–13740B31	18
C5807,5808	21–13740B49	100
C5810	21–13741N69	0.1 uF, ±10%
C5811	21–13740B49	100
C5813	21–13741N45	0.01 uF, ±10%
C5820,5821	21–13740B25	1.5, ±.25 pF
C5822	21–13740B05	1.5, ±.25 pF
C5823	21–13740B21	6.8, ±.25 pF
C5824	21–13740B27	12
C5826	21–13741N45	0.01 uF, ±10%
C5827	21–13741N45	0.01 uF, ±10%
C5828	21–13740B24	10
C5829	21–13740B49	100
C5830,5931	21–13740B49	100
C5850	21–13740B21	6.8, ±.25 pF
C5858	21–13740B17	4.7, ±.25 pF
diode (see note)		
CR5875	48–80236E07	zener, 28V
CR5900	48–80236E05	Schottky
CR5920,5921	48–80236E20	pin
CR5922	48–80142L01	pin
coil, rf		
L5801	24–80067M01	chip bead
L5802	24–80091G21	4 turns, airwound
L5804	24–80067M01	chip bead
L5805	24–80091G23	7 turns, airwound
L5806	24–80067M01	chip bead
L5808,5809	24–80067M01	chip bead
L5810	24–80132N01	ferrite bead
L5820,5821	24–80091G21	4 turns, airwound
L5850	24–80091G23	7 turns, airwound
L5851	24–80132N01	ferrite bead
L5852	24–80132N01	ferrite bead
L5853	24–80091G21	4 turns, airwound
L5854	24–80132N01	ferrite bead
L5855	24–80091G21	4 turns, airwound
L5856	24–80091G36	7 turns, airwound
L5857	24–80091G36	7 turns, airwound
L5859	24–80090G05	airwound
L5880–5882	24–80067M01	chip bead
L5883	24–80091G36	7 turns, airwound
L5900	24–80091G06	2 turns, airwound
L5902,5903	24–80091G24	5 turns, airwound
L5904	24–80091G36	7 turns, airwound
L5920	24–80091G36	7 turns, airwound
L5921,5922	24–80090G03	3 turns, airwound
L5923	24–80091G36	7 turns, airwound
L5930	24–80067M01	chip bead
connector plug		
P853	09–80103M04	right angle, 12 contacts
transistor (see note)		
Q5800	48–80141L01	PNP
Q5801	48–80182D50	NPN
Q5803	48–80225C09	NPN
Q5806	48–80141L02	NPN
Q5850	48–80225C27	NPN
Q5875	48–80225C30	NPN
thermistor		
RT5875	06–80149M02	100k ohm
RT5904	06–80149M02	100k ohm

HLE6043A UHF 40–watt Power Amplifier (Range 3) MXW–5921–A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R5801	06–11077A26	10
R5803	06–11077A82	2.2k
R5805	06–11077A26	10
R5806	06–11077A50	100
R5807	06–11077A82	2.2k
R5808	06–11077A90	4.7k
R5809	06–11077A78	1.5k
R5810	06–11077A26	10
R5811	06–11077A74	1k
R5812	06–11077A01	0
R5816	06–11077A80	1.8k
R5817	06–11077A74	1k
R5818	06–11077A62	330
R5850	06–11077A10	2.2
R5875	17–80228N01	shunt
R5876	06–11077B11	33k
R5877	06–11077A94	6.8k
R5878	06–11077A86	3.3k
R5879,5880	06–11077A10	2.2
R5881,5882	06–80195M01	10, 1/2W
R5883,5884	06–11077A10	2.2
R5900,5901	06–80194M18	51, 1W
R5904	06–11077A80	1.8k
R5905	06–11077B11	33k
R5920,5921	06–80194M18	51, 1W
R5922,5923	06–11077A78	1.5k
R5931–5933	06–11077A01	0
mechanical parts		
26–80187N01	heatsink, transistor	
26–80188N01	shield, harmonic filter	
26–80286N01	shield, coax	
28–80102M06	connector, 12 position	
29–80014A01	clip, coax (3 used)	
42–80281L01	clip, ground (2 used)	

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

parts list

HLE6044A UHF 40–watt Power Amplifier (Range 4) MXW–5934–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C5801	21–13741N45	0.01 uF, ±10%
C5804	21–13741N45	0.01 uF, ±10%
C5805	21–13740B21	6.8
C5806	21–13740B30	16
C5807,5808	21–13740B49	100
C5810	21–13741N69	0.1 uF, ±10%
C5811	21–13740B49	100
C5813	21–13741N45	0.01 uF, ±10%
C5816	21–13740B49	100
C5820,5821	21–13740B24	9.1
C5822	21–13740B05	1.5, ±.25%
C5823	21–13740B21	6.8, ±.25%
C5824	21–13740B27	12
C5826	21–13741N45	0.01 uF, ±10%
C5851	21–13740B34	24
C5852	21–13740B31	18
C5853	21–11078B19	16, 100V
C5854	21–11078B42	100, 100V
C5855	21–11078B22	22, 100V
C5856	21–13740B49	100
C5857	21–13741N45	0.01 uF, ±10%
C5860–5869	21–13740B49	100
C5875,5876	21–11078B32	39, 100V
C5877,5878	21–84366F08	40, 250V
C5880	21–11078B08	6.2 pF, ±.25 pF, 100V
C5881	21–13740B49	100
C5883	21–13741N45	0.01 uF, ±10%
C5884	21–13741N69	0.1 uF, ±10%
C5885	23–80090M24	10 uF, ±20%, electrolytic
C5886	21–13741N21	1000, ±10%
C5888–5890	21–13740B49	100
C5891	21–13740B17	4.7, ±.25 pF
C5892	21–11078B08	6.2, ±.25 pF, 100V
C5893	21–13741N45	0.01 uF, ±10%
C5895	21–13741N21	1000, ±10%
C5901,5902	21–13740B49	100
C5903	21–13740B17	4.7, ±.25 pF
C5904	21–13740B25	10
C5905	21–13740B21	6.8, ±.25 pF
C5906	21–13740B49	100
C5920	21–13740B49	100
C5922	21–11078B01	3.3, ±.25 pF, 100V
C5924	21–11078B05	4.7, ±.25 pF,100V
C5926,5927	21–11078B42	100, 100V
C5928	21–13740B34	24
C5930,5931	21–13740B49	100
C5858	21–13740B17	4.7, ±.25 pF

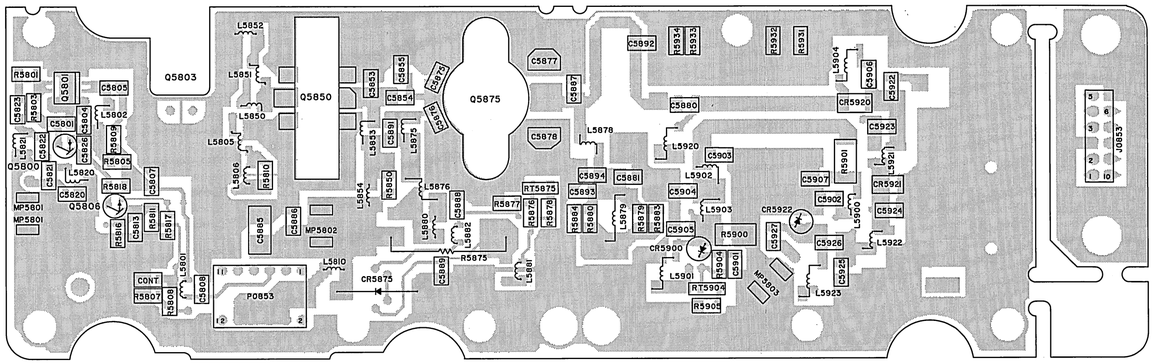
HLE6044A UHF 40–watt Power Amplifier (Range 4) MXW–5934–A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
diode (see note)		
CR5875	48–80236E07	zener, 28V
CR5900	48–80236E05	Schottky
CR5920,5921	48–80236E20	pin
CR5922	48–80142L01	pin
coil, rf		
L5801	24–80067M01	chip bead
L5802	24–80091G21	4 turns, airwound
L5804	24–80067M01	chip bead
L5805	24–80091G23	7 turns, airwound
L5806	24–80067M01	chip bead
L5808,5809	24–80067M01	chip bead
L5810	24–80132N01	ferrite bead
L5820,5821	24–80091G21	4 turns, airwound
L5850	24–80091G21	4 turns, airwound
L5851	24–80091G23	7 turns, airwound
L5852	24–80132N01	ferrite bead
L5853	24–80091G21	4 turns, airwound
L5854	24–80132N01	ferrite bead
L5855	24–80091G21	4 turns, airwound
L5856	24–80091G36	7 turns, airwound
L5857	24–80091G36	7 turns, airwound
L5859	24–80090G05	airwound
L5880–5882	24–80067M01	chip bead
L5883	24–80132N01	ferrite bead
L5900	24–80091G06	2 turns, airwound
L5902,5903	24–80091G24	5 turns, airwound
L5904	24–80091G36	7 turns, airwound
L5920	24–80091G36	7 turns, airwound
L5921,5922	24–80090G03	3 turns, airwound
L5923	24–80091G36	7 turns, airwound
L5930	24–80067M01	chip bead
connector plug		
P853	09–80103M04	right angle, 12 contacts
transistor (see note)		
Q5800	48–80141L01	PNP
Q5801	48–80182D50	NPN
Q5803	48–80225C09	NPN
Q5806	48–80141L02	NPN
Q5850	48–80225C27	NPN
Q5875	48–80225C30	NPN
thermistor		
RT5875	06–80149M02	100k ohm
RT5904	06–80149M02	100k ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R5801	06–11077A30	15
R5802	06–11077A50	100
R5803	06–11077A82	2.2k
R5805	06–11077A26	10
R5806	06–11077A50	100
R5807	06–11077A82	2.2k
R5808	06–11077A90	4.7k
R5809	06–11077A78	1.5k
R5810	06–11077A26	10
R5811	06–11077A74	1k
R5812	06–11077A01	0
R5816	06–11077A80	1.8k
R5817	06–11077A74	1k
R5818	06–11077A62	330
R5850	06–11077A10	2.2
R5872	06–11077A50	100
R5873	06–11077A00	100
R5975	17–80228N01	shunt
R5876	06–11077B11	33k
R5877	06–11077A94	6.8k
R5878	06–11077A86	3.3k
R5879,5880	06–11077A10	2.2
R5881,5882	06–11077A19	5.1
R5883,5884	06–11077A10	2.2
R5900,5901	06–80194M18	51, 1W
R5904	06–11077A80	1.8k
R5905	06–11077B11	33k
R5906	06–11077A50	100
R5920,5921	06–80194M18	51, 1W
R5922,5923	06–11077A78	1.5k
R5931–5932	06–11077A01	0
R5934	06–11077A01	0
mechanical parts		
26–80187N01	heatsink, transistor	
26–80188N01	shield, harmonic filter	
26–80286N01	shield, coax	
28–80102M06	connector, 12 position	
29–80014A01	clip, coax (3 used)	
42–80281L01	clip, ground (2 used)	

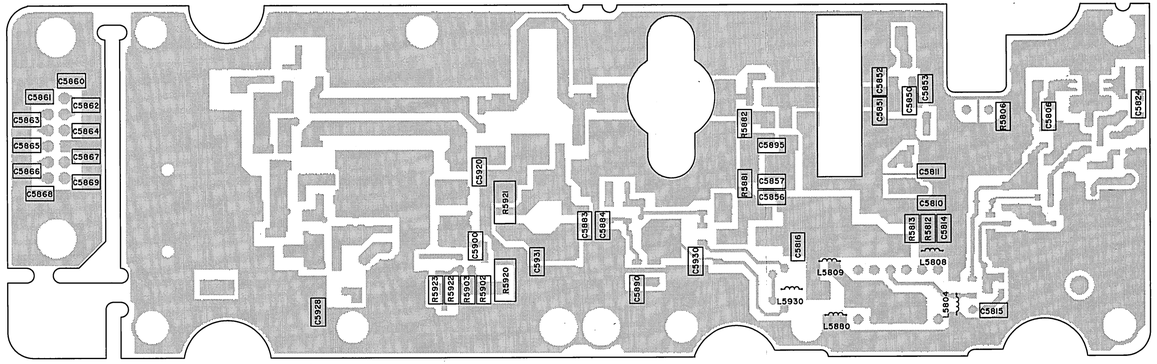
3/31/89

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

HLE6043A (RANGE 3) AND HLE6044A (RANGE 4) 40–WATT PA CIRCUIT BOARD



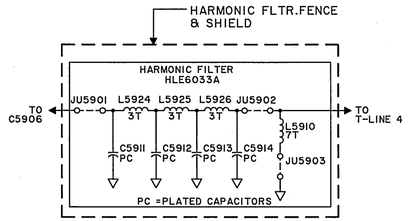
COMPONENT SIDE VIEW

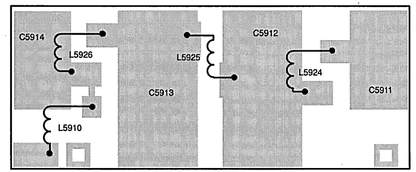


SOLDER SIDE VIEW

Schematics, Circuit Board Diagrams, and Parts Lists for
HLE6043A (Range 3) and HLE6044A (Range 4)
SPECTRA 40–Watt Power Amplifier
PW–5902–A
(Sheet 2 of 2)
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HLE6043B (RANGE 3) AND HLE6044B (RANGE 4)
40–WATT UHF POWER AMPLIFIER SCHEMATIC





HARMONIC FILTER BOARD

parts list

HLE6033A Harmonic Filter Hybrid UHF Range 3 & Range 4 — MXW-5907-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
connector receptacle		
J5901–J5903	07–80299L01	frame lead, j–strap
coil, RF		
L5910	24–80091G36	7 turns, airwound
L5924	24–80090G03	3 turns, airwound
L5925	24–80090G04	3 turns, airwound
L5926	24–80090G03	3 turns, airwound

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RANGE MARKER TABLE

RANGE	1	2	3	4
R5931	X		X	X
R5932		X	X	X
R5933	X	X	X	
R5934	X	X		X

X=MARKER ON
BLANK=MARKER OUT

• CONTINGENCY PART

1. R5931,R5932,R5933 AND R5934 ARE USED AS RANGE MARKERS. SEE TABLE FOR MARKERS USED IN EACH RANGE.
2. PART VALUES IN PARENTHESIS ARE FOR RANGE IX (482–512 MHZ)

GXW-6534-O

Schematic, Circuit Board Diagrams, and Parts Lists
for HLE6043B (Range 3) and HLE6044B (Range 4)
SPECTRA 40–Watt Power Amplifier
PW–6533–O
(Sheet 1 of 2)
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parts list

HLE6043B UHF 40-watt Power Amplifier (Range 3) — MXW–6539–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C5801	21–13741N45	0.01 uF, ±10%
C5804	21–13741N45	0.01 uF, ±10%
C5805	21–13740B31	6.8, ±.25 pF
C5806	21–13740B31	18
C5807,5808	21–13740B49	100
C5810	21–13741N69	0.1 uF, ±10%
C5811	21–13740B49	100
C5813	21–13741N45	0.01 uF, ±10%
C5816	21–13740B49	100
C5820,5821	21–13740B25	10
C5822	21–13740B05	1.5, ±.25 pF
C5823	21–13740B21	6.8, ±.25 pF
C5824	21–13740B27	12
C5826	21–13741N45	0.01 uF, ±10%
C5851	21–13741N74	1k
C5852	21–13740B31	18
C5853	21–13741N45	0.01 uF, ±10%
C5854	21–13740B49	100
C5855	21–13741N21	1000, ±10%
C5856	21–84366F08	40, 250V
C5857	21–13741N45	0.01 uF, ±10%
C5860–5869	21–13740B49	100
C5875,5876	21–13708B13	43, 100V
C5877,5878	21–84366F08	40, 250V
C5889	21–13708B15	12, ±.5 pF, 100V
C5881	21–13740B49	100
C5883	21–13741N45	0.01 uF, ±10%
C5884	21–13741N69	0.1 uF, ±10%
C5885	23–80090M24	10 uF, ±20%, electrolytic
C5886	21–13741N21	1000, ±10%
C5887	21–13708B18	16, 100V
C5888–5890	21–13740B49	100
C5891	21–13740B17	4.7, ±.25pF
C5892	21–13708B13	10, 100V
C5893	21–13741N45	0.01 uF, ±10%
C5895	21–13741N21	1000, ±10%
C5901,5902	21–13740B49	100
C5903	21–13740B17	4.7, ±.25 pF
C5904	21–13740B27	12
C5905	21–13740B21	6.8, ±.25 pF
C5906	21–13740B49	100
C5920	21–13740B49	100
C5922	21–13708B42	100, 100V
C5923	21–13708B05	4.7, ±.25, 100V
C5924	21–13708B08	6.2 pF, ±.25, 100V
C5926,5927	21–13708B42	100, 100V
C5928	21–13740B34	24
C5929	21–13740B49	100
C5930,5931	21–13740B49	100
C5850	21–13740B01	1.0 ±.25 pF
C5858	21–13740B17	4.7, ±.25 pF
diode (see note)		
CR5875	48–80236E07	zener, 28V
CR5900	48–80236E05	Schottky
CR5920,5921	48–80236E20	pin
CR5922	48–80142L01	pin
coil, rf		
L5801	24–80067M01	chip bead
L5802	24–80091G21	4 turns, airwound
L5805	24–80091G23	7 turns, airwound
L5806	24–80067M01	chip bead
L5809	24–80067M01	chip bead
L5810	24–80132N01	ferrite bead
L5820,5821	24–80091G21	4 turns, airwound
L5850	24–80091G21	4 turns, airwound
L5851	24–80091G23	7 turns, airwound
L5852	24–80132N01	ferrite bead
L5853	24–80091G21	4 turns, airwound
L5854	24–80132N01	ferrite bead
L5875	24–80091G21	4 turns, airwound
L5878	24–80091G36	7 turns, airwound
L5879	24–80090G03	3 turns, airwound
L5883	24–80090G05	airwound
L5900	24–80132N01	ferrite bead
L5902,5903	24–80091G06	2 turns, airwound
L5904	24–80091G24	5 turns, airwound
L5920	24–80091G36	7 turns, airwound
L5921,5922	24–80091G03	3 turns, airwound
L5923	24–80091G36	7 turns, airwound
connector plug		
P853	09–80103M04	right angle, 12 contacts
transistor (see note)		
Q5800	48–80141L01	PNP
Q5801	48–80182D50	NPN
Q5803	48–80225C09	NPN
Q5806	48–80141L02	NPN
Q5850	48–80225C27	NPN
Q5875	48–80225C30	NPN
thermistor		
RT5875	06–80149M02	100k ohm
RT5904	06–80149M02	100k ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R5801	06–11077A26	10
R5802	06–11077A50	100
R5803	06–11077A82	2.2k
R5805	06–11077A26	10
R5806	06–11077A50	100
R5807	06–11077A62	2.2k
R5808	06–11077A90	4.7k
R5809	06–11077A78	1.5k
R5810	06–11077A26	10
R5811	06–11077A74	1k
R5812	06–11077A01	0
R5816	06–11077A80	1.8k
R5817	06–11077A74	1k
R5818	06–11077A62	330
R5850	06–11077A10	2.2
R5852	06–11077A50	100
R5873	06–11077A50	100
R5875	17–80228N01	shunt
R5876	06–11077B11	33k
R5877	06–11077A94	6.8k
R5878	06–11077A86	3.3k
R5879,5880	06–11077A10	2.2
R5881,5882	06–11077A19	5.1
R5900,5901	06–11077A10	2.2
R5902,5903	06–80194M18	51, 1W
R5904	06–11077A80	1.8k
R5905	06–11077B11	33k
R5906	06–11077A50	100
R5920,5921	06–80194M18	51, 1W
R5922,5923	06–11077A78	1.5k
R5931–5933	06–11077A01	0
mechanical parts		
	26–80187N01	heatsink, transistor
	26–80188N01	shield, harmonic filter
	26–80286N01	shield, coax
	28–80102M06	connector, 12 position
	29–80014A01	clip, coax (3 used)
	42–80281L01	clip, ground (2 used)

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

parts list

HLE6044B UHF 40-watt Power Amplifier (Range 4) — MXW–6539–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C5801	21–13741N45	0.01 uF, ±10%
C5804	21–13741N45	0.01 uF, ±10%
C5805	21–13740B21	6.8
C5806	21–13740B30	16
C5807,5808	21–13740B49	100
C5810	21–13741N69	0.1 uF, ±10%
C5811	21–13740B49	100
C5813	21–13741N45	0.01 uF, ±10%
C5816	21–13740B49	100
C5820,5821	21–13740B24	0.1
C5822	21–13740B05	1.5, ±.25%
C5823	21–13740B21	6.8, ±.25%
C5824	21–13740B27	12
C5826	21–13741N45	0.01 uF, ±10%
C5851	21–13740B34	24
C5852	21–13740B31	18
C5853	21–11078B19	16, 100V
C5854	21–11078B42	100, 100V
C5855	21–11078B32	22, 100V
C5856	21–13740B49	100
C5857	21–13741N45	0.01 uF, ±10%
C5860–5869	21–13740B49	100
C5875,5876	21–11078B32	39, 100V
C5877,5878	21–84366F08	40, 250V
C5880	21–11078B08	6.2 pF, ±.25 pF, 100V
C5881	21–13740B49	100
C5883	21–13741N45	0.01 uF, ±10%
C5884	21–13741N69	0.1 uF, ±10%
C5885	23–80090M24	10 uF, ±20%, electrolytic
C5886	21–13741N21	1000, ±10%
C5891	21–13740B49	100
C5892	21–11078B08	6.2, ±.25 pF, 100V
C5893	21–13741N45	0.01 uF, ±10%
C5895	21–13741N21	1000, ±10%
C5901,5902	21–13740B49	100
C5903	21–13740B17	4.7, ±.25 pF
C5904	21–13740B25	10
C5905	21–13740B21	6.8, ±.25 pF
C5906	21–13740B49	100
C5920	21–13740B49	100
C5922	21–11078B42	100, 100V
C5923	21–11078B01	3.3, ±.25 pF, 100V
C5924	21–11078B05	4.7, ±.25 pF,100V
C5926,5927	21–11078B42	100, 100V
C5928	21–13740B34	24
C5930,5931	21–13740B49	100
C5858	21–13740B17	4.7, ±.25 pF
diode (see note)		
CR5875	48–80236E07	zener, 28V
CR5900	48–80236E05	Schottky
CR5920,5921	48–80236E20	pin
CR5922	48–80142L01	pin

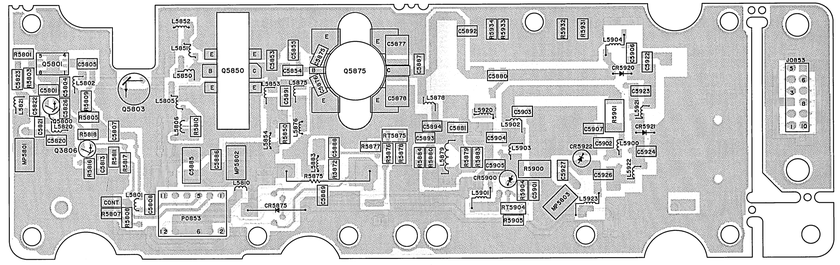
HLE6044B UHF 40-watt Power Amplifier (Range 4) — MXW–6539–O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
coil, rf		
L5801	24–80067M01	chip bead
L5802	24–80091G21	4 turns, airwound
L5805	24–80091G23	7 turns, airwound
L5806	24–80067M01	chip bead
L5809	24–80067M01	chip bead
L5810	24–80132N01	ferrite bead
L5820,5821	24–80091G21	4 turns, airwound
L5850	24–80091G23	7 turns, airwound
L5851	24–80091G21	4 turns, airwound
L5852	24–80132N01	ferrite bead
L5853	24–80091G21	4 turns, airwound
L5854	24–80132N01	ferrite bead
L5875	24–80091G21	4 turns, airwound
L5878	24–80091G36	7 turns, airwound
L5879	24–80090G03	3 turns, airwound
L5883	24–80090G05	airwound
L5900	24–80132N01	ferrite bead
L5902,5903	24–80091G06	2 turns, airwound
L5904	24–80091G24	5 turns, airwound
L5920	24–80091G36	7 turns, airwound
L5921,5922	24–80090G03	3 turns, airwound
L5923	24–80091G36	7 turns, airwound
connector plug		
P853	09–80103M04	right angle, 12 contacts
transistor (see note)		
Q5800	48–80141L01	PNP
Q5801	48–80182D50	NPN
Q5803	48–80225C09	NPN
Q5806	48–80141L02	NPN
Q5850	48–80225C27	NPN
Q5875	48–80225C30	NPN
thermistor		
RT5875	06–80149M02	100k ohm
RT5904	06–80149M02	100k ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R5801	06–11077A30	15
R5802	06–11077A50	100
R5803	06–11077A82	2.2k
R5805	06–11077A26	10
R5806	06–11077A50	100
R5807	06–11077A62	2.2k
R5808	06–11077A90	4.7k
R5809	06–11077A78	1.5k
R5810	06–11077A26	10
R5811	06–11077A74	1k
R5812	06–11077A01	0
R5816	06–11077A80	1.8k
R5817	06–11077A74	1k
R5818	06–11077A62	330
R5850	06–11077A10	2.2
R5872	06–11077A50	100
R5873	06–11077A50	100
R5875	17–80228N01	shunt
R5876	06–11077B11	33k
R5877	06–11077A94	6.8k
R5878	06–11077A86	3.3k
R5879,5880	06–11077A10	2.2
R5881,5882	06–11077A19	5.1
R5883,5884	06–11077A10	2.2
R5900,5901	06–80194M18	51, 1W
R5904	06–11077A80	1.8k
R5905	06–11077B11	33k
R5906	06–11077A50	100
R5920,5921	06–80194M18	51, 1W
R5922,5923	06–11077A78	1.5k
R5931–5932	06–11077A01	0
R5934	06–11077A01	0
mechanical parts		
	26–80187N01	heatsink, transistor
	26–80188N01	shield, harmonic filter
	26–80286N01	shield, coax
	28–80102M06	connector, 12 position
	29–80014A01	clip, coax (3 used)
	42–80281L01	clip, ground (2 used)

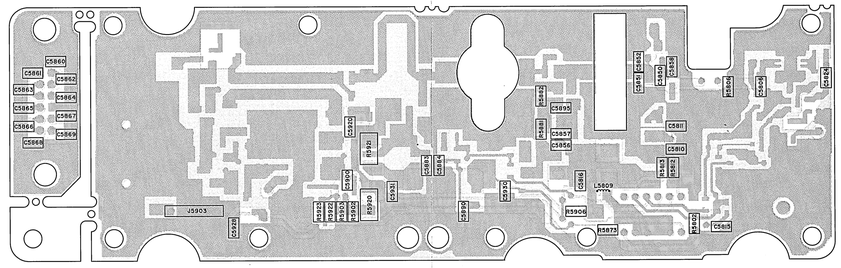
3/31/89

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

HLE6043B (RANGE 3) AND HLE6044B (RANGE 4) 40–WATT UHF POWER AMPLIFIER



COMPONENT SIDE VIEW



SOLDER SIDE VIEW

Schematic, Circuit Board Diagrams, and Parts Lists
for HLE6043B (Range 3) and HLE6044B (Range 4)
SPECTRA UHF 40–Watt Power Amplifier
PW–6533–O
(Sheet 2 of 2)
3/31/89

15 and 35–Watt Power Amplifiers (800 MHz)

1. Transmitter

The 15–watt and 35–watt *SPECTRA* power amplifiers are discussed in the following text. Block diagrams of both circuits are shown in the foldout drawing PW–6628.

1.1 TRANSMIT BUFFER

The PA receives 18 to 23 dBm (60 to 200 mW) at the transmit injection (TX INJ) coax. The first stage, TX BUFFER, uses adaptive biasing which varies the base voltage inversely proportional to the input drive level. With Keyed 9.4 volts (K9.4) ON and NO DRIVE, Q9800 base voltage should equal the voltage drop across CR9800. R9801 sets the diode current, and R9802 sets the base voltage referenced from CR9800. At the input, L9804, C9801, and C9800 are for matching while C9808 and R9806 prevent interfacing instability. L9800 is the base feed choke and L9801 is the collector choke. R9800 parallels L9800 for added stability. L9805, and C9803 are on the buffer's supply (K9.4) for stability. C9802 and L9802 are for output matching. L9803 and C9804 are added as a "suckout" for half carrier. Like the input, C9807 and R9805 were added at the output to help prevent interfacing instability. The power output of this stage should be greater than 325 milliwatts (25 dBm).

The TX Buffer applies the modulated RF signal to Pin 1 of U9850, the Power Amplifier Module, which is a 5–pin, 20–watt, three stage amplifier. The control voltage from the power control series–pass transistor, Q9500, controls the gain of the first two amplifier stages of U9850, through Pin 2 and Pin 3. Battery voltage (A +), connected to Pin 4, powers the third stage.

1.2 POWER MODULE

The power module (U9850) is the major gain block for both the 15 and 35–watt amplifiers. The 50–ohm input and output impedances connect to adjacent power stages via 50–ohm microstrip lines. The parallel resistor, R9805, and capacitor C9807, on the input, reduce circuit response at lower frequencies and improve stability. The 350 milliwatt (typical) input power is increased to approximately 15–watts. The amplifier power is monitored by the power control IC on the command board and adjusted by controlling the voltage on U9850, Pins 2 and 3. (Pow er control is described in the Power Control Section.) A+ is applied directly to the final stage inside the power module via Pin 4. No repairs can be made to the module; damaged or failed units must be replaced.

CAUTION
The power module leads will not tolerate undue stress; handle carefully when repairing.

1.3 FINAL STAGE (35–WATT ONLY)

On the 15–watt radio, the transmit RF signal from U9850, Pin 5, is applied to the 50–ohm microstrip directional coupler. On the 35–watt radio, the transmit RF signal is applied to the emitter of the final power amplifier Q9880 through the coupling capacitor C9856, the 50–ohm quarter–wave matching transmission line, and the matching capacitors C9875 and C9876. The 100–ohm coupling line, L9930, R9930, R9931, CR9930, and C9930 form an interstage power detector between U9850 and Q9880 to limit the drive into Q9880 to about 17 watts. L9875, the emitter choke, is also the emitter DC return. The final power amplifier, Q9880, is a 45–watt, 800 MHz, common–base NPN devise. The Q9880 output match consists of C9877, C9878, a section of the 50–ohm microstrip line, C9879 and the DC blocking capacitor, C9883. L9876 isolates the RF signal from A+. C9880 and C9884 are signal frequency bypass capacitors. L9877 presents a high impedance at low RF frequencies; therefore the collector of Q9880 is resistively loaded by R9876 at low frequencies where the gain is much greater. C9881 and C9882 are low frequency bypass capacitors.

2. Antenna Switch and Harmonic Filter

2.1 ANTENNA SWITCH

2.1.1 35–watt Power Amplifier

The antenna switch's impedance inverter circuit, made up of C9922 and L9921, takes the place of a quarter–wave

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microstrip line. During transmission, K9.4 volts forward–biases CR9921, producing a low impedance at its anode end, and a high impedance at the node of C9922 and L9921, to effectively isolate the transmitted power from the receiver. C9921 couples the power to the harmonic filter and on to the antenna.

The impedance inverter contributes approximately 30 dB to transmit isolation. Additional isolation is obtained by the series switch made up of CR9922, L9925, and associated DC bias components. During transmit, CR9922 is reverse–biased, thus creating a small series capacitor that is tuned out by L9923. C9925 is a DC blocking capacitor. The high impedance of the series arm works against the low impedance of the shunt arm (CR9921) to provide approximately 10 to 15 dB additional isolation. Total TX to RX isolation is in excess of 40 dB from 935–941 MHz. The preselector provides over 50 dB isolation from 896–901 MHz.

When receiving, CR9920 has an off capacitance of approximately 1 pF which is turned out by L9926. CR9921, with similar off capacitance, is incorporated in the RX match. CR9922 is forward–biased with an ON resistance of approximately 1 ohm. The signal passes CR9922 and through L9922, a series inductor used to complete the RX match. Capacitor C9929 blocks DC.

L9920, at the node of the antenna and harmonic filter, protects the PA from static discharge.

2.1.2 12–watt Power Amplifier

The theory for the 12–watt antenna switch is exactly the same as the 30–watt except that some of the components are labeled with different numbers. C9921, in the 12–watt PA, is located after the harmonic filter.

L9922, at the node of the antenna and capacitor C9921, protects the PA from static discharge.

2.2 HARMONIC FILTER

The 12 and 30–watt harmonic filters are 7–pole, low–pass filters implemented with screened plate capacitors and discrete inductors (L9910, L9911, and L9912) on a 35 mil (0.035") alumina substrate. The filter's ground plane is attached to the PA printed circuit board with solder, while input and output connections are made via "J"–straps MP9856 and MP9857. The filter's primary function is to attenuate harmonic spurs generated by the transmitter and to provide additional low–pass selectivity for the receiver.

Note

When removing any of the discrete coils, take care to avoid leaching the plate capacitor metalization. Removal of the entire hybrid is best accomplished by heating hybrid/PC board assembly with a heat gun or heat blower until solder joint reflows.

3. Power Control Circuitry

3.1 COMMAND BOARD CIRCUITRY

Inside U500, the Regulator Power Control IC (See Figure 1, RPCIC Block Diagram), is an operational amplifier that has four inverting inputs, and one non–inverting input (at Pin 44) which is the reference input for the entire power control loop of the power amplifier. The 3.2V reference voltage at U500, Pin 44, is produced by dividing SW + 5V with the voltage divider circuit. R514 and R515.

The power control loop is controlled by the microprocessor, U520, on the command board. The microprocessor enables the RPCIC by pulling TX PA ENABLE BAR low while the radio synthesizer is locked. Each is felt on Pins 33 and 35 respectively. U520 writes data to a Digital to Analog converter, U502, to change and control the power–set voltage from Pin 10 of U502 to Pin 6 of U500. The voltage on this line, 1.5 to 5 volts, will be inversely proportional to the power out of the Pa, with 5 volts producing the lowest power output. This voltage may be set with an IBM PC or with a built–in program operated through the radio's control head. On U500, the voltage at Pin 6 is buffered internally and exits on Pin 7. Through R507, it is summed at the node connected to Pin 2, one of the inverting inputs.

3.2 POWER MODULE CONTROL VOLTAGE LIMITER

R9562 and R9563 connect in series to the emitter of Q9500. The ratio of R9563 and R9562 feed a portion of the control voltage (U9850, Pins 2 and 3) to U500, Pin 4. When Pin 4 exceeds 3.2 volts, the output of the control op–amp (U500, Pin 42) is reduced. Eventually, this reduces the control voltage available to the power module (U9850).

The input RF power to the 45–watt amplifier (Q9880) must stay below 18 watts. Power is coupled from the inter–stage 50–ohm transmission line to a 100 ohm transmission line and rectified by CR9930 on the PA, producing a DC voltage on U500, Pin 4. IF this voltage exceeds 3.2 volts, the output voltage on U500, Pin 42, is reduced, lowering the control voltage and reducing U9850's gain until its RF output power is approximately 18 watts.

3.3 CURRENT LIMITER

U520, the processor on the command board, sends data to U502, the digital to analog converter, to properly set the voltage on U502, Pin 15, which is the TX CURRENT LIMIT control line to the RPCIC (U500, Pin 40). Sixteen different voltages, ranging from 1.5 to 4.5 volts, can be programmed from U502.

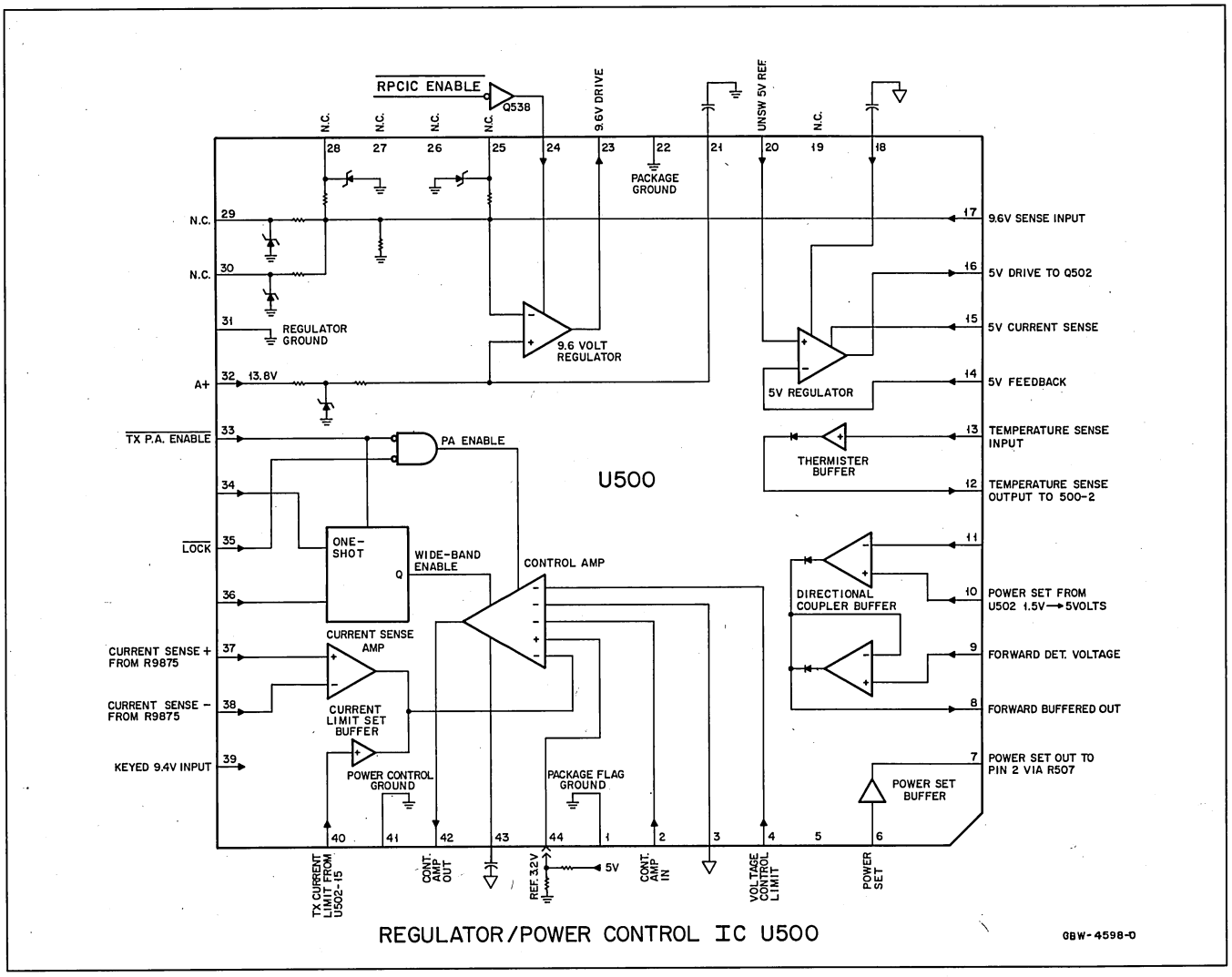


Figure 1. RPCIC Block Diagram

The collector current of the 45–watt final amplifier (in the 30–watt PA only) is monitored by sensing the voltage across R9875. CURRENT SENSE + connects to one end of R9875 and CURRENT SENSE – connects to the other end. These lines connect to the command board on U500, Pins 37 and 38, respectively. If the TX CURRENT LIMIT is set for 1.5 volts, then the voltage difference between U500, Pins 37 and 38 must be .1 volts before the current through R9785 is reduced. If U500, Pin 40 is programmed for 4.5 volts, then the difference of potential between Pins 37 and 38 must exceed .3 volts before current limiting begins. The voltage across R9875, where current sense occurs, can be determined by multiplying the voltage on U500, Pin 40, by 0.067. When current is being limited, the output of the op–amp (U500, Pin 42), begins shutting down the conduction of Q503 and Q504, reducing base drive to Q9500, reducing drive to the final amplifier to, effectively, control the final amplifier's maximum current.

3.4 FORWARD POWER LIMITER

The parallel pair of microstrip lines after the final amplifier, form a forward power sensing directional coupler. Because the coupling increases with frequency, the compensation network of R9900 and C9901 is used. CR9900 rectifies the signal, C9900 filters it, and R9905 and R9904 form a voltage divider. During normal transmission, the DC voltage from the forward detect line to the RPCIC ranges from 2 to 4.5 volts. This voltage connects to U500, Pin 9, the input to the directional coupler buffer.

The directional coupler's output, U500, Pin 8, is summed to Pin 2 with the digital/analog buffer's output through R509 and R507, respectively. Closed loop operation reduces the control amp's output (Pin 42), reduces the power module's gain, and reduces power output to maintain the coupler buffer output U500, Pin 2) at 3.2 volts regardless of the d/a voltage level. If the d/a voltage is high (4.5 volts), little detected voltage is needed to keep Pin 2 at 3.2 volts, and the power, consequently, is low. If the d/a voltage is low (1.5 volts), a large forward detected voltage is needed to keep Pin 2 at 3.2 volts and power, consequently, is at maximum value. The voltage at Pin 2 drops below 3.2 volts under proper operation during low line voltage conditions where the PA cannot produce rated power, or if, under any conditions, either the

inter–stage power (in 30–watt models only), the control voltage, or the final device current exceeds safe levels.

3.5 TEMPERATURE SENSING

When the radio is keyed, K9.4V is applied to Pin 5 of the PA connector and on one side of thermistor RT9560. As the temperature increases, the resistance of RT9560 decreases, creating more voltage across R9561. This temperature voltage is routed via PA connector Pin 7 back to U500, pin 13, which is the input to a thermistor buffer. The thermistor buffer's output on pin 12 is summed to U500, pin 2, and passes throughits scaling resistor, R508. When the temperature of the RT9560 causes its value to change enough that the voltage exceeds 3.2 volts, the thermister buffer starts supplying current to the node at pin 2. Due to the fixed output of the d/a, the control loop can maintain 3.2 volts at pin 2 only by reducing power out and reducing the forward detected voltage. Since output is reduced, the generated heat is held to a safe level. As temp decreases, the power output of the PA gradually increases to its nominal value.

Q9515 and Q9510 switch A+ to one side of R9513. R9513 sums the A+ voltage into the same node as TEMP–SENSE. Together with temp–sense the circuitry protects the power amplifier from unsafe operating conditions of high line and high temp.

Note

Under severe environmental conditions more than one circuit may be attempting to reduce power output at the same time (i.e., during high VSWR conditions, the inter–stage power limit may initially reduce power, but eventual heat build–up will cause further power reduction by the thermal cut–back circuit).

4. Transmitter Troubleshooting

This information will help field service technicians troubleshoot the *SPECTRA* radio. Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, this section includes troubleshooting information that will help you test and check the circuits to localize and isolate problems.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at 800 MHz, measurements must be taken very carefully. Notes and cautions are added to the text to alert the reader to this need in areas of greatest sensitivity. However the need to extreme care does exist in all measurements and tests at 800 MHz.

4.1 GENERAL TROUBLESHOOTING AND REPAIR NOTES

Most of the common transmitter symptoms are caused by either failure of the power amplifier or a failure in the control circuitry. The initial troubleshooting effort should be toward isolating the problem to one of those two areas. If either the control voltage or keyed 9.4 volts are zero, then the problem is likely to be in the control circuit. If those voltages are present, then the problem is more likely in the power amplifier circuit.

If for diagnostic reasons, a chip component needs to be removed to facilitate testing, such as a series capacitor removed to allow for signal insertion, then the component(s) returned to the circuit should be new parts. The application of a soldering iron to many chip components will tend to cause leaching which could lead to failure.

If the harmonic filter is damaged and needs to be replaced, then removal and replacement requires the use of a hot air source capable of reflowing the solder beneath the filter hybrid. When replacing it, add small amounts of fresh solder paste to the silver regions beneath the ceramic to assure adequate electrical ground contact. Save the original input and output connectors ('J' straps); these are not included with the replacement kit. No turning is required. The harmonic filter may be ordered separately, but if the PA kit is ordered, a filter kit comes with the PA kit.

The pass device may be ordered separately or may be received as part of the hardware kit – it is not part of the PA kit. The PA kit comes with all surface–mount components, including the harmonic filter hybrid, but the harmonic filter cover is not included. Neither does the PA kit include the Power Module, nor, on 35–watt models, the final device and associated matching capacitors.

After a PA board is replaced, or if any power control circuitry components are replaced, readjust the power according to instructions in the Service Manual.

Important

Due to the high frequency of operation, it is imperative that you use specified Motorola parts when component replacement is necessary. At these frequencies, second and third order properties of the components are very important and are part of the circuit's design. Substitute components may not work. It is also critical that you use great care when replacing parts. Excessive solder or flux, longer than original leads on coax connectors, mis–orientation of parts, and other commonly benign imperfections may cause the radio's performance to degrade.

4.2 PA FUNCTIONAL TESTING

To test the PA assembly for proper operation, perform the following steps:

Note

The following instructions pertain to both the 12–watt and 30–watt power amplifiers. A distinction between the two PA's is given only where necessary.

(1) Disassemble the PA assembly from the radio, leaving the power cable connected to the rear connector. Replace the 12–watt PA shield (or the 30–watt PA shield and cover). Disconnect the coax connectors and the ribbon cable. Connect a power meter to the antenna port using minimum cable length.

Notes

(a) When setting or measuring RF power at 900 MHz, follow these guidelines to avoid measurement errors due to cable losses or non 50–ohm connector VSWR:

- All cables should be very short and have Teflon dielectric.
- Attenuators and 50–ohm loads should have at least 25 dB return loss.
- 'Mini UHF' to 'N' adapter, P/N 58–80367B21, should be used at the antenna connector. All other connectors should be 'N' type. No other adapters, barrel connectors, etc. should be used.

(b) Maximum input level to the PA is 200 milliwatts. Over driving the buffer could result in damage to the PA buffer stage.

(2) Apply the input power and DC voltages indicated in Table 1 to the power amplifier assembly. To make the DC connections, use small spring–clips or make a test adapter similar to that shown in Figure 2.

Table 1. DC Voltages & Input Power Chart

Test	Keyed 9.4v	9.6V	Control Voltage	Power in (W)	A+ V
Transmit	9.4	9.6	See note	0.1	13.0
Receive	0	9.6	0	0	13.0

Note: Set initially to zero. Increase value until power equals 13–watts (12–watt radio) or 34 watts (30–watt radio) or 11.0 volts maximum.

Table 2. Power Control DC Voltage Chart

LOCATION	RX MODE			TX MODE			COMMENTS
	LOW	TYP	HI	LOW	TYP	HI	
P0853							
1	—	—	—	—	—	—	KEY (NO PIN OR WIRE)
2		0		0	2.0	3.2	CONTROL VOLTAGE LIMIT
3		0		2.0	7.0	13.0	DRIVE VOLTAGE
4	10.8	13.6	16.5	10.0	13.0	16.0	CURRENT SENSE +
5	0	0	0	9.2	9.4	9.8	KEYED 9.4
6	10.8	13.6	16.5	10.8	13.6	16.5	A+ TO COMMAND BOARD
7		0			1.2		TEMP SENSE (CUTBACK BEGINS AT 3.3V)
8	—	—	—	—	—	—	KEY (NO PIN)
9		0		1.3	3.5	6.0	FORWARD DETECT VOLTAGE
10	10.8	13.6	16.5	10.8	13.6	16.5	A+ TO COMMAND BOARD
11	9.4	9.6	9.9	9.4	9.6	9.9	9.6V SUPPLY FROM COMMAND BOARD
12	10.8	13.6	16.5	10.0	13.0	16.0	CURRENT SENSE—(VOLTAGE DELTA 150mV)
U0500							
1	0	0	0	0	0	0	GROUND
2		0			3.2		CONTROL AMP INPUT
3	0	0	0	0	0	0	CONTROL AMP INPUT (NOT USED)
4		0		0	2	3.2	CONTROL VOLTAGE LIMIT (CUTBACK AT 3.3V)
5		0			0	N.C.	
6	1.5	3.0	4.5	1.5	3.0	4.5	POWER SET FROM D–A (MAX POWER AT 1.5V)
7		0	0	1.5	3.0	4.5	POWER SET BUFFER OUT
8		0		1.3	3.5	6.0	COUPLER BUFFER OUT
9		0		1.3	3.5	6.0	FORWARD DETECT VOLTAGE
10		0			0		REFLECTED POWER DETECT (NOT USED)
11		0		1.3	3.5	6.0	SAME AS PIN 8 (NOT USED)
12		0		0	1.2	6.0	THERMISTER BUFFER OUT (INCREASES AS PA GETS HOT)
13		0		0	1.2	6.0	THERMISTER BUFFER IN

Table 2. Power Control DC Voltage Chart (Continued)

LOCATION	RX MODE			TX MODE			
	LOW	TYP	HI	LOW	TYP	HI	COMMENTS
14		5.0			5.0		5V SENSE INPUT (FOLLOWS PIN 20 ±0.1V)
15	4.9	5.0	5.7	4.9	5.0	5.7	5V CURRENT LIMIT (LIMITS AT 5.7V)
16	5.0	5.7	6.4	5.0	5.7	6.4	5V SERIES PASS DRIVE (6.4V AT MAX CURRENT)
17	9.5	9.6	9.9	9.5	9.6	9.9	9.6 VOLT SENSE INPUT
18		7			7		5V REG. COMPENSATION CAPACITOR
19		5.7			5.7		N.C.
20	4.9	5.0	5.1	4.9	5.0	5.1	5V REFERENCE INPUT (UNSW5V)
21		1.2			1.2		9.6V REG. COMPENSATION CAPACITOR
22		0			0		N.C.
23		0.9	9.6		1.2	9.6	9.6V SERIES PASS DRIVE
24		2.9			3.3		REGULATOR ENABLE/COMPENSATION
25	——	——	——	——	——	——	9.6V PROGRAMMING (N.C.)
26		0			0		N.C.
27		13.6			13.6		N.C.
28	——	——	——	——	——	——	9.6V PROGRAMMING (N.C.)
29	——	——	——	——	——	——	9.6V PROGRAMMING (N.C.)
30	——	——	——	——	——	——	9.6V PROGRAMMING (N.C.)
31	0	0	0	0	0	0	GROUND
32	10.8	13.6	16.5	10.0	13.0	16.0	DECOUPLED A+
33	4.0	5.0			0	0.2	TX PA ENABLE (FROM U520–25)
34		0			1.3		CONTROL AMP ONE–SHOT
35		0			0		LOCK (5V OF SYNTH OUT OF LOCK)
36		0			0.8		CONTROL AMP ONE–SHOT
37	10.8	13.6	16.3	10.0	13.0	16.0	A+ (CURRENT SENSE +)
38	10.8	13.6	16.3	10.0	13.0	16.0	CURRENT SENSE—VOLTAGE DELTA 150mV (30 WATT ONLY)
39		0		9.2	9.4	9.8	KEYED 9.4V IN
40	1.5	3.0	4.5	1.5	3.0	4.5	CURRENT LIMIT D–A (MAX CURRENT AT 4.5V)
41	0	0	0	0	0	0	GROUND
42		0			2.2	9.6	CONTROL AMP OUTPUT (APPX 1/2 V CONTROL)
43		1.3			7.0		LOOP INTEGRATOR CAPACITOR
44		2.1			3.2		CONTROL AMP REFERENCE
Q0500E		13.0			13.0		A+ —CR0500 DROP
Q0501C		12.3			12.3		VQ0500E—B/E DROP
Q0501E		0.2			0.2		V PIN 23—B/E DROP
Q0503E		0			1.5		V PIN 42—B/E DROP (TX)
Q0503C		13.6			9.0		
Q0504B		13.6			12.9		A+ —B/E DROP (TX)

Note: For antenna switch transmit bias conditions, RF drive must be removed from PA.

LOCATION		TYPICAL RX	TYPICAL TX NO PRE–DRIVE	COMMENTS
CR9920	ANODE	0	1.6	TX SERIES P.I.N. DIODE
	CATHODE	0	0.8	(ON IN TX MODE)
CR9921	ANODE	0	0.8	TX SHUNT P.I.N. DIODE
	CATHODE	——	——	(ON IN TX MODE)
CR9922	ANODE	5.15V	<0.2	RX SERIES P.I.N. DIODE
	CATHODE	4.45V	8.7	(OFF IN TX MODE)
Q9920	COLLEC	5.15V	<0.2	

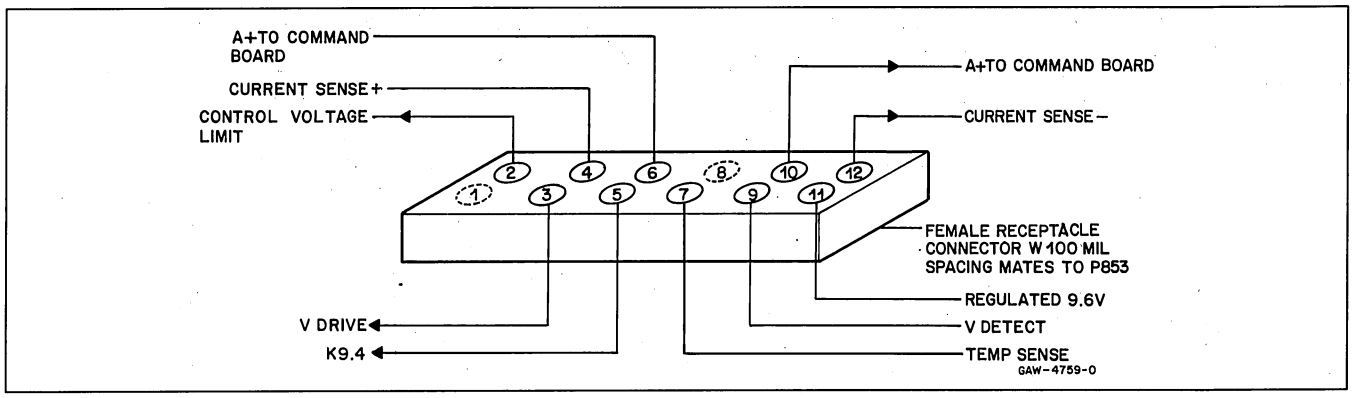


Figure 2. PA Test Adapter

(3) Apply the required input power via adapter cable 30–80373B27 or equivalent. For this application, non 'N' type connectors are acceptable.

(4) With the applied control voltage initially at zero volts, slowly increase the voltage until power out equals 17–watts (15–watt radio) or 38–watts (38–watt radio). Power should rise smoothly with control voltage once the turn–on threshold is reached. Control voltage should not exceed 11.0 volts.

(5) If 11.0 volts does not produce 17 (or 38) watts, then a failure exists in the power amplifier circuit.

(6) Refer to the voltage chart (See Table 2). Measure the indicated voltages. If they are not within the limits shown in the chart, then a failure exists in the PA assembly.

(7) If the voltages in the chart are correct, verify that the injection is at least 75 milliwatts. (See the VCO troubleshooting section.)

(8) If no failure is located from the previous checks, troubleshoot the power control circuitry.

4.3 LOCALIZING PROBLEMS

Failure locations often can be determined by externally measured symptoms. Basic symptoms are noted below with probable failure locations.

(1) Low Power and High Current

- Check for improper load conditions caused by high VSWR external to the radio.
- Check output coax and mini–UHF connector.
- Check harmonic filter and J–straps.
- Check output impedance–matching circuitry from the final device to the harmonic filter.

(2) Low Power and Low Current

- If control voltage is greater than 10 volts, then check per the above.
- If control voltage is less than 10 volts, then check the control circuitry.

(3) Power Intermittently Low (or zero) and Current less Than 1 Amp When Power Drops

- Check Buffer Stage

(4) Power Zero and Current Greater Than 5 Amps

- Check harmonic filter, antenna switch, and matching circuits beyond final stage.

(5) Power Zero and Current Between 2 and 5 Amps

- Check Power Module

(6) Power Zero and Current Less Than 1 Amp

- Check input coax
- Check Buffer Stage

4.4 ISOLATING FAILURES

Methods of analyzing individual stages of the Power Amplifiers are detailed below. Most of the stages are class C and must be analyzed under relatively high RF power levels. Generators capable of such levels may not be available in all service shops, therefore the tests below are arranged in order of ascending power. This tends to allow the preceding stage to be the source of RF power for testing the next stage. If adequate power sources are available, then any stage may be tested with external signal injection.

(1) Testing Buffer Circuitry

The required DC and RF conditions are defined in Table 1. With no RF input applied, the collector voltage of Q9800 should be 9.4V. If not, check L9805, L9801, and the feed runners. The base voltage should be 0.6V (0.7V without RF). If not, check R9801, CR9800, and related adaptive bias circuitry.

To check for power out, remove R9805 and lift the output end of C9807. Solder the center conductor of a small diameter 50–ohm coax to the vacated pad on the buffer side. Solder the coax's shield to ground. Under the conditions specified in Table 1, the measured power should be at least 350 milliwatts. After output power has been tested, replace the resistor and capacitor with new parts.

An alternate method of testing the buffer's power out is to carefully lift the input lead of the power module (Pin 1) from the circuit board and replace it with the center conductor of a small diameter coax. Solder the shield of the coax. Solder the shield of the coax to the adjacent ground pad.

To test the input VSWR of the circuit, apply 70 mW to the input. Using a directional coupler, verify that the reflected power is less than 20 mW.

(2) Testing the Power Module (U9850)

The power module is a packaged gain block with 50–ohm input and output impedances. It has three gain stages, the first two of which have controlled voltage applied (for regulating power) and the final stage has A+ applied.

If the buffer stage has not been confirmed in "working order," an external 400 milliwatts must be injected. Do this by carefully lifting Pin 1 of the power module and soldering the center conductor of a small diameter coax to the pin. Solder the shield to the ground pad adjacent to Pin 1. To this cable, inject 400 mW. (This application is not so critical to require an 'N' connector on the loose end of the coax.)

If the buffer stage is confirmed in "working order," then provide 100 mW drive to the buffer (K9.4V must be applied) to drive the module.

To measure the output power from the module, remove the series DC blocking capacitor C9879 (15W) or C9856 (35W), then connect a 39 pF blocking capacitor from the center conductor of a small diameter coax to the vacated pad, and finally, ground the shield of the output coax. Use this coax to measure output power.

Control voltage (Pins 2 and 3) should be 10 volts; A+ (Pin 4) should be 13.0 volts. Apply voltages through the DC connector on the PA board.

With either 100 mW applied to the buffer or 400 mW applied to the module input, the output power should be at least 15 watts. If power out is less than 15 watts, the module is defective and must be replaced.

Note

When replacing the module, apply thermal compound on the heatsink surface. Torque the screws to the correct value (See Service Manual).

When testing is complete, replace any capacitors or resistors that were removed for testing with new parts.

(3) Testing the Final Stage (35–Watt Models Only)

CAUTION

The final stage is capable of producing over 50 watts. Be sure to protect power measuring equipment with series attenuation. 30 dB is usually adequate.

15 watts are needed to drive the final stage. Because this may exceed the power available at 800 MHz in many repair facilities, these tests consider the module stage as the drive source for the final stage. Therefore, check out the module first to ensure that it operates properly.

In the course of testing the final stage with the module as the power source, begin with control voltage at zero and increase control voltage smoothly until output of the final stage reaches 40 watts. If control voltage reaches 10 volts but the power out does not reach 40 watts, the final stage is defective. Under normal conditions, the protection circuitry limits the power to the final stage to approximately 17 watts maximum, protecting it from overdrive and damage. Under test conditions, however, the protection circuitry is disabled. Observe the above caution; the power module can produce in excess of 25 watts.

Measure the output power by lifting the output side of C9856 and connecting to the center conductor of a small diameter coax which has its shield grounded. If the output stage does not produce 40 watts (at 10 volts control voltage), then remove the RF drive and perform the following tests:

- Check continuity from the collector lead to the A+ connector on the back of the radio.
- Examine the solder connections on all leads of the device (Q9880) and the clamped mica capacitors.

Note

The position of the clamped capacitors adjacent to the device is critical to the performance of the circuit. If they are removed for any reason, they must be re–installed with their leads approximately 70 mil s (0.070 inches) from the final device cap.

(4) Testing the Antenna Switch and Harmonic Filter

Verify that most of this circuit is functioning properly by testing the receiver insertion loss as follows:

- Apply a low–level signal source at the antenna connector.
- Apply the conditions indicated in Table 1 for RX tests.
- Measure the power at the receive coax.
- If the difference between the input and output (insertion loss) is less than 2 dB, then the circuitry is functioning properly.

Additional antenna switch tests are:

Additional antenna switch tests are

- Check CR3920, CR3921, and CR3922 with an ohmmeter for forward and reverse continuity.
- In the transmit mode, adjust control voltage for 55 watts at the antenna connector. Check for less than 10 mW at the end of the receive input cable. If power exceeds 10 mW, then check CR3922 and associated circuitry. Receiver sensitivity can degrade if power at this port exceeds 10 mW.
- Check for proper DC current through the PIN diodes; correct current is indicated if approximately 1.5 volts is present at the junction of C3900 and L3900 during transmit mode.

WARNING

DO NOT measure bias directly at the PIN diodes while in transmit mode unless TX injection is removed.

4.5 POWER CONTROL AND PROTECTION CIRCUITRY

(1) Localizing Problems to a Circuit

Power leveling and current limiting are set to values detailed in the Service Manual. These values will vary from unit to unit, depending on the unique variations of each unit. If symptoms indicate that either of these circuits have failed, verify that the radio has been properly aligned before investigating the circuitry.

Temperature sense and control voltage limit are fixed by design and are not influenced by the alignment of the radio. If symptoms indicate that these circuits have failed, then troubleshoot the circuit.

The tests that follow are intended to provide a convenient means of verifying that a particular circuit is functioning properly. These tests will isolate the failure to a minimum number of components. Refer to the theory of operation and the schematic for information needed to identify the failed component(s).

(2) Temperature Sense Circuit Test

Temporarily install a 6.8k ohm resistor in parallel with RT3875. Key the transmitter and monitor the output power. The power meter should read approximately one–half the rated power (25 watts).

(3) Control Voltage Limit Circuitry Test

Disconnect the transmitter injection from the internal transceiver chassis. This will require removal of the power amplifier assembly. With all other connections in normal condition, key the transmitter and monitor the control voltage. If the voltage exceeds 9.0 volts, troubleshoot the control voltage limit circuitry.

(4) Current Limiting Circuitry Test

Refer to Section 2 of the Service Manual for current limit setting instructions. When ready to adjust current limit, decrease the relative current limit value with the keyboard per instructions. After several decrements, the current limit should begin to reduce power. After this test, reset the current limit to its original value. If the circuitry does not perform as indicated, troubleshoot the current limit circuitry.

(5) Power Leveling Circuitry Test

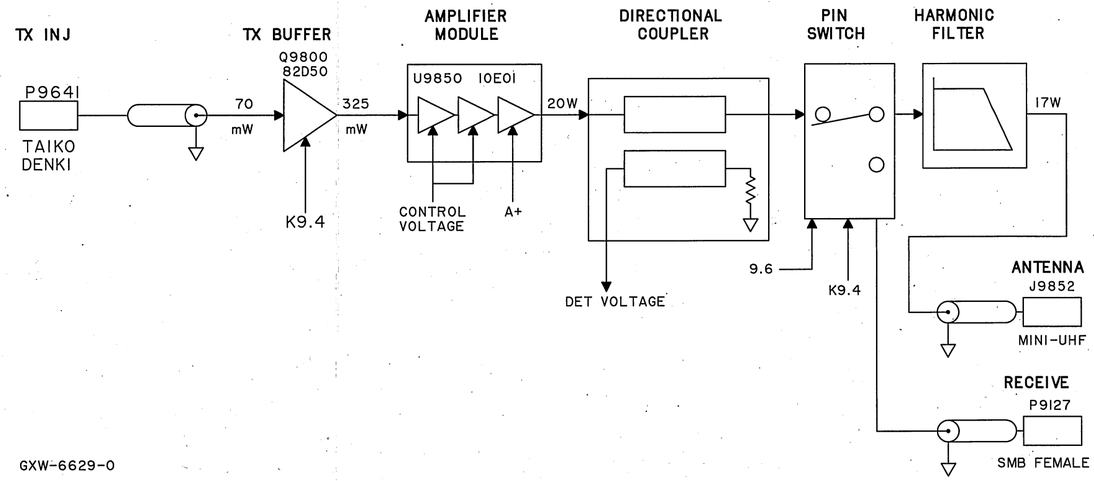
With the radio connected for power measurements, vary the line voltage from 12.5 to 16 volts. The power should not vary more than 2 watts. At a line voltage of 13.6 volts, vary the frequency using the three test modes. If power varies more than 2 watts, measure the detected voltage on P0853, Pin 9. If this voltage varies more than 0.2 volts over line and frequency variations, the power control circuitry (most of which is located on the command board) may be malfunctioning. If the detected voltage varies less than 0.2 volts, the problem is likely in diode CR3900, the harmonic filter, the antenna switch, or the output coax. Check continuity through the 12–pin DC connector P0853 on the PA board; check digital/analog circuitry, and check 5V regulator operation. See Table 2, DC Voltage Chart, for typical values.

With the radio connected for power measurements and a disconnected TX injection coax, the detected voltage at P0853, Pin 9, should measure approximately 1.3 volts.

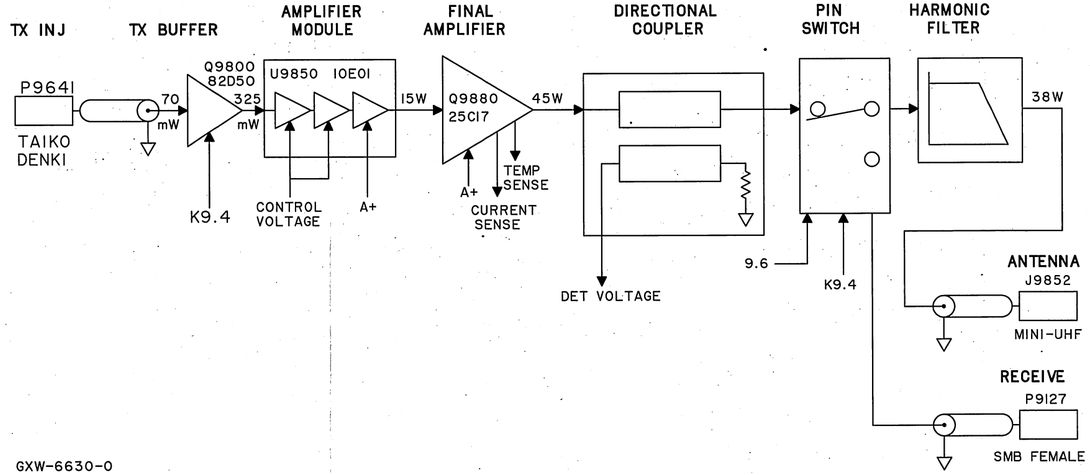
Note

If any part of the power leveling circuitry is replaced, perform the power set procedure. See the Service Manual for details.

SPECTRA 15 WATT 800 MHz AMPLIFIER

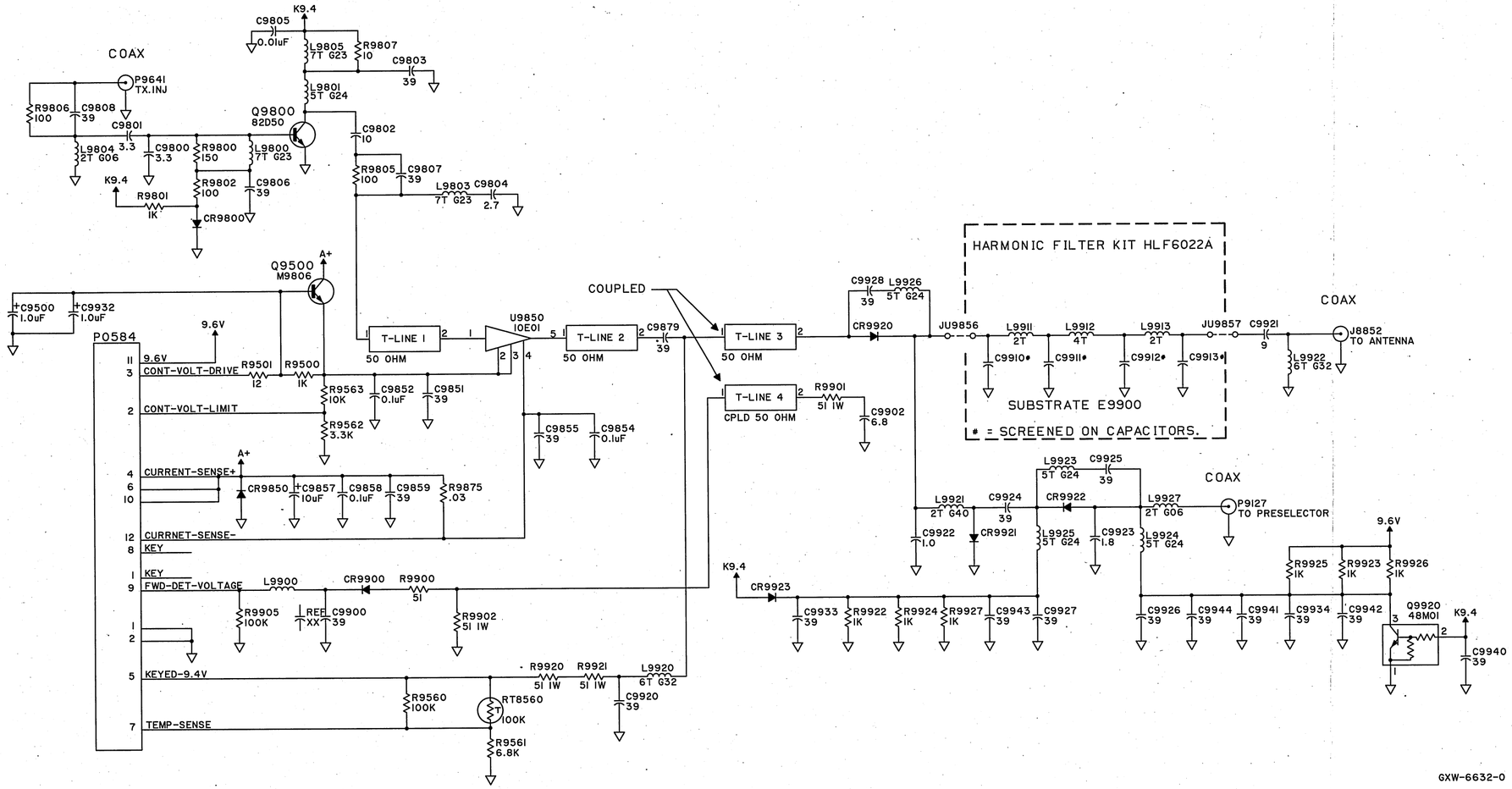


SPECTRA 35 WATT 800 MHz AMPLIFIER



SPECTRA 15 and 35 Watt
Power Amplifier Block Diagrams
PW-6628-O
3/31/89

HLF6078A 15 WATT PA SCHEMATIC



Schematic, Circuit Board Diagrams, and Parts List
for HLF6078A *SPECTRA* 15 Watt Power Amplifier
PW-6631-O
(Sheet 1 of 2)
3/31/89

parts list

HLF6078A 800 MHz 15 Watt Power Amplifier — MXW–6636–O

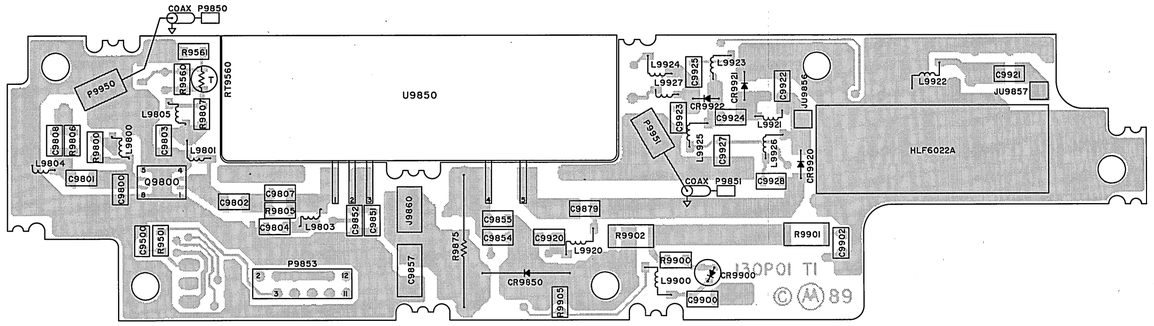
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C9500	23–11049A37	1 uF, ±30%, 25V
C9800,9801	21–13740B13	3.3, ±.25 pF, 50V
C9802	21–13740B25	10, 50V
C9803	21–13740B39	39, 50V
C9804	21–13740B11	2.7, ±.25 pF, 50V
C9805	21–13741N45	0.01 uF, ±10%
C9806–9808	21–13740B39	39, 50V
C9851	21–13740B39	39, 50V
C9852	21–13741N69	0.1 uF, ±10%
C9854	21–13741N69	0.1 uF, ±10%
C9855	21–13740B39	39, 50V
C9857	23–80090M24	10, ±20%, 50V
C9858	21–13741N69	0.1 uF, ±10%
C9859	21–13740B39	39, 50V
C9900	21–13740B39	39, 50V
C9902	21–13740B21	6.8, ±.25 pF, 50V
C9920	21–13740B39	39, 50V
C9921	21–11078B32	39
C9922	21–13740B01	1.0, ±.25 pF, 50V
C9923	21–13740B07	1.8, ±.25 pF, 50V
C9924–9928	21–13740B39	39, 50V
C9932	23–11049A37	1, ±20%, 25V
C9933,9934	21–13740B39	39, 50V
C9940–9944	21–13740B39	39, 50V
diode (see note)		
CR9800	48–80066M01	signal, RLS4148
CR9850	48–80236E07	zener, 28V
CR9900	48–80236E05	hot carrier
CR9920,9921	48–80236E20	pin
CR9922	48–80236E22	pin
CR9923	48–80066M01	signal, RLS4148
connector receptacle		
J9860	29–80014A01	coax terminal clip
jumper		
JU9856,9857	07–80299L01	lead frame, J–strap
coil, RF		
L9800	24–80091G23	airwound, 7 turns
L9801	24–80091G24	airwound, 5 turns
L9803	24–80091G23	airwound, 7 turns
L9804	24–80091G06	airwound, 2 turns
L9805	24–80091G23	airwound, 7 turns
L9900	24–80091G32	airwound, 6 turns
L9920	24–80091G32	airwound, 6 turns
L9921	24–80091G40	airwound, 2 turns
L9922	24–80091G32	airwound, 6 turns
L9923–9926	24–80091G24	airwound, 5 turns
L9927	24–80091G06	airwound, 2 turns
connector plug		
P9853	64–80262N01	feedthru plate assembly
P9950,9951	29–80014A01	coax terminal clip
transistor (see note)		
Q9800	48–80182D50	NPN
Q9920	48–80048M01	NPN
thermistor		
RT9560	06–80149M02	100k ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9500	06–11077A74	1k
R9501	06–11077A28	12
R9560	06–11077B23	100k
R9561	06–11077A94	6.8k
R9562	06–11077A86	3.3k
R9563	06–11077A98	10k
R9800	06–11077A54	150
R9801	06–11077A74	1k
R9802	06–11077A50	100
R9805,9806	06–11077A50	100
R9807	06–11077A26	10
R9875	17–80228N01	resistor shunt
R9900	06–11077A43	51
R9901,9902	06–80194M18	51, 1 Watt
R9905	06–11077B23	100k
R9920,9921	06–80194M18	51, 1 Watt
R9922–9927	06–11077A74	1k
R9990–9995	06–11077A01	0
integrated circuit (see note)		
U9850	51–80110E01	800 mH, 20 Watt
mechanical parts		
	26–80084N01	harmonic filter shield
	26–80013M01	power module shield
	54–80004N01	barcode label

3/31/89

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

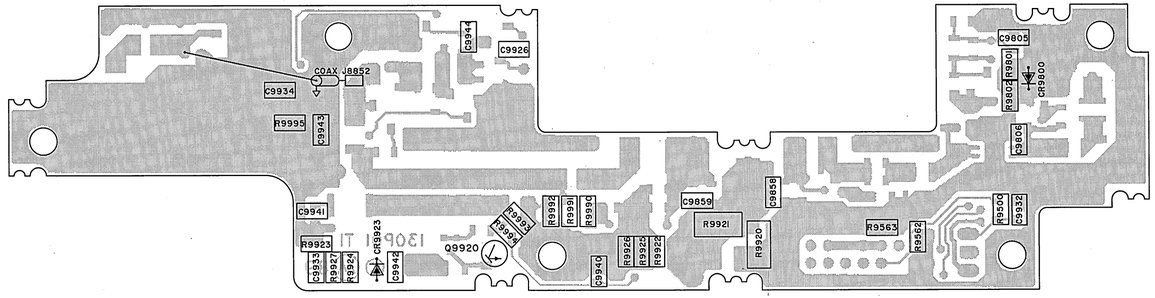
HLF6078A 15 WATT PA CIRCUIT BOARDS

COMPONENT SIDE



SOLDER SIDE — GPW–6591–O
COMPONENT SIDE — GPW–6592–O
OVERLAY — GXW–6564W01–O

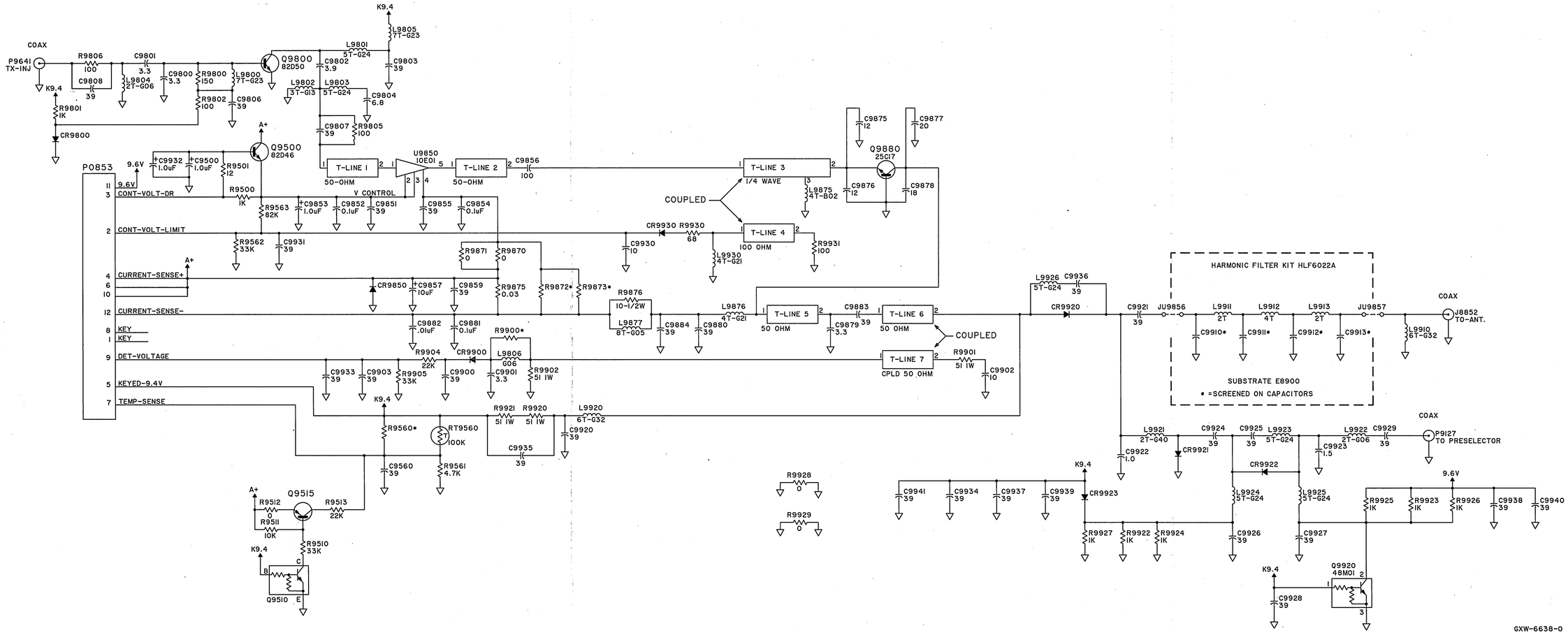
SOLDER SIDE



SOLDER SIDE — GPW–6591–O
COMPONENT SIDE — GPW–6592–O
OVERLAY — GXW–6564W02–O

Schematic, Circuit Board Diagrams, and Parts List
for HLF6078A *SPECTRA* 15 Watt Power Amplifier
PW–6631–O
(Sheet 2 of 2)
3/31/89

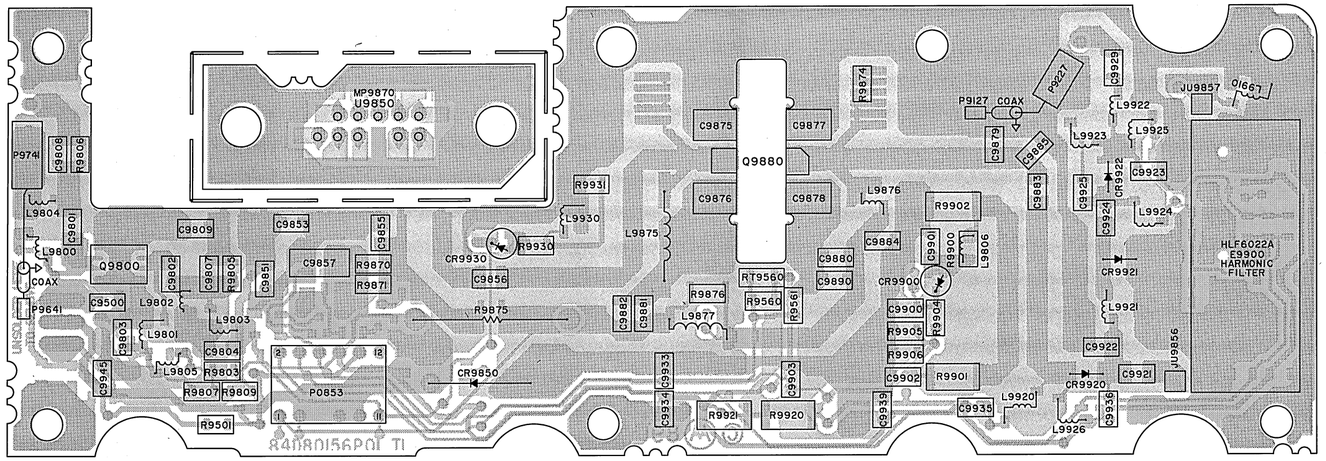
HLF6077A 35 WATT PA SCHEMATIC



Schematic, Circuit Board Diagrams, and Parts List
for HLF6077A *SPECTRA* 35 Watt Power Amplifier
PW–6637–O
(Sheet 1 of 2)
3/31/89

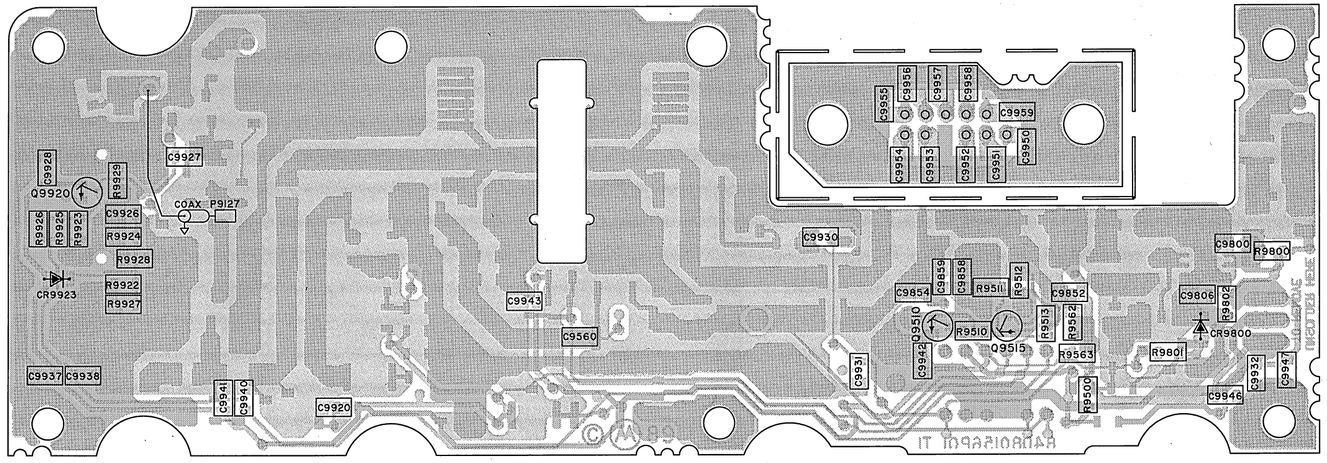
HLF6077A 35 WATT PA CITCUIT BOARD
COMPONENT SIDE

SOLDER SIDE GPW-6639-O
COMPONENT SIDE GPW-6640-O
OVERLAY GXW-6641W01-O



SOLDER SIDE GPW-6639-O
COMPONENT SIDE GPW-6640-O
OVERLAY GXW-6641W02-O

SOLDER SIDE



parts list

HLF6077A 800 MHz 35 Watt Power Amplifier MXW-6642-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 100V (unless otherwise stated)		
C9500	23-11049A37	1 uF, ±20%, 25V
C9560	21-13740B39	39, 50V
C9800,9801	21-13740B13	3.3, ±.25 pF, 50V
C9802	21-13740B15	3.9, ±.25 pF, 50V
C9803	21-13740B39	39, 50V
C9804	21-13740B21	6.8, ±.25 pF, 50V
C9806–9808	21-13740B39	39, 50V
C9851	21-13740B39	39, 50V
C9852	21-13741N69	0.1 uF, ±10%
C9853	23-11049A37	1 uF, ±20%, 25V
C9854	21-13741N69	0.1 uF, ±10%
C9855	21-13740B39	39, 50V
C9856	21-11078B42	100
C9857	23-80090M24	10 uF, ±20%, 50 V
C9859	21-13740B39	39, 50V
C9875,9876	21-80240G20	12, ±1.0 pF, 250V
C9877	21-80240G24	20, 250V
C9878	21-80240G23	18, ±1.0 pF, 250V
C9879	21-80240G69	3.3 pF, ±7.6%, 250V
C9880	21-13740B39	39, 50V
C9881	21-13741N69	0.1 uF, ±10%
C9882	21-13741N45	0.01 uF, ±10%
C9883	21-11078B32	39
C9884	21-13740B39	39, 50V
C9900	21-13740B39	39, 50V
C9901	21-13740B13	3.3, ±.25 pF, 50V
C9902	21-13740B25	10, 50V
C9903	21-13740B39	39, 50V
C9920	21-13740B39	39, 50V
C9921	21-11078B32	39
C9922	21-13740B01	1.0, ±.25 pF, 50V
C9923	21-13740B05	1.5, ±.25 pF, 50V
C9924–9929	21-13740B39	39, 50V
C9930	21-13740B25	10, 50V
C9931	21-13740B39	39, 50V
C9932	23-11049A37	1 uF, ±20%, 25V
C9933–9941	21-13740B39	39, 50V
C9945	21-13740B39	39, 50V
C9947	21-13740B39	39, 50V
diode (see note)		
CR9800	48-80066M01	signal, RLS4148
CR9850	48-80256E07	zener, 28V
CR9900	48-80236E05	hot carrier
CR9920,9921	48-80236E20	pin
CR9922	48-80236E22	pin
CR9923	48-80066M01	signal, RLS4148
CR9930	48-80236E05	hot carrier
connector receptacle		
J9001	29-80014A01	coax terminal clip
jumper		
JU9856,9857	07-80299L01	lead frame, J-strap
coil, RF		
L9800	24-80091G23	airwound, 7 turns
L9801	24-80091G24	airwound, 5 turns
L9802	24-80091G13	airwound, 3 turns
L9803	24-80091G24	airwound, 5 turns
L9804	24-80091G06	airwound, 2 turns
L9805	24-80091G23	airwound, 7 turns
L9875	24-80202B02	choke
L9876	24-80091G21	airwound, 4 turns
L9877	24-80090G05	airwound, surface mount
L9910	24-80091G32	airwound, 6 turns
L9920	24-80091G32	airwound, 6 turns
L9921	24-80091G40	airwound, 2 turns
L9922	24-80091G06	airwound, 2 turns
L9923–9926	24-80091G24	airwound, 5 turns
L9930	24-80091G21	airwound, 4 turns
connector plug		
P853	09-80103M04	right angle, 12 contact
P9227	29-80014A01	coax terminal clip
P9741	29-80014A01	coax terminal clip
transistor (see note)		
Q9510	48-80048M01	NPN
Q9515	48-80141L01	PNP
Q9800	48-80182D50	NPN
Q9880	48-80225C17	NPN
Q9920	48-80048M01	NPN
thermistor		
RT9560	06-80149M02	100k ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9500	06-11077A74	1k
R9501	06-11077A28	12
R9510	06-11077B11	33k
R9511	06-11077A98	10k
R9512	06-11077A01	0
R9513	06-11077B07	22k
R9561	06-11077A90	4.7k
R9562	06-11077B11	33k
R9563	06-11077B21	82k
R9800	06-11077A54	150
R9801	06-11077A74	1k
R9802	06-11077A50	100
R9805,9806	06-11077A50	100
R9870,9871	06-11077A01	0

MXW-6642-O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R9874	06-11077A01	0
R9875	17-80228N01	resistor shunt
R9876	06-80195M01	10, .5 Watt
R9901,9902	06-80194M18	51, 1 Watt
R9904	06-11077B07	22k
R9905	06-11077B11	33k
R9920,9921	06-80194M18	51, 1 Watt
R9922–9927	06-11077A74	1k
R9928,9929	06-11077A01	0
R9930	06-11077A46	68
R9931	06-11077A50	100
integrated circuit (see note)		
U9850	51-80110E01	800 mH, 20 Watt
mechanical parts		
	26-80090N01	mid power fence shield
	26-80013M01	PA module shield
	54-80004N01	barcode label
	42-80281L01	ground clip (2 used)

05/17/89

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

Schematic, Circuit Board Diagrams, and Parts List
for HLF6077A *SPECTRA* 35 Watt Power Amplifier
PW–6637–O
(Sheet 2 of 2)
3/31/89

12 and 30–Watt Power Amplifiers (900 MHz)

1. Transmitter

The 12–watt and 30–watt *SPECTRA* power amplifiers are discussed in the following text. Block diagrams of both circuits are shown in the foldout drawing PW–4601.

1.1 TRANSMIT BUFFER

The PA receives 18 to 23 dBm (60 to 200 mW) at the transmit injection (TX INJ) coax. The first stage, TX BUFFER, uses adaptive biasing which varies the base voltage inversely proportional to the input drive level. With Keyed 9.4 volts (K9.4) ON and NO DRIVE, Q9800 base voltage should equal the voltage drop across CR9800. R9801 sets the diode current, and R9802 sets the base voltage referenced from CR9800. At the input, L9804, C9801, and C9800 are for matching while C9806 and R9806 prevent interfacing instability. L9800 is the base feed choke and L9801 is the collector choke. R9800 parallels L9800 for added stability. C9805, L9805, and C9803 are on the buffer's supply (K9.4) for stability. C9802 is for output matching and L9803 and C9804 are added as a "suckout" for half carrier. Like the input, C9807 and R9805 were added at the output to help prevent interfacing instability. The power output of this stage should be greater than 325 milliwatts (25 dBm).

The TX Buffer applies the modulated RF signal to Pin 1 of U9850, the Power Amplifier Module, which is a 5–pin, 18–watt, three stage amplifier. The control voltage from the power control series–pass transistor, Q9500, controls the gain of the first two amplifier stages of U9850, through Pin 2 and Pin 3. Battery voltage (A +), connected to Pin 4, powers the third stage.

1.2 POWER MODULE

The power module (U9850) is the major gain block for both the 13 and 30–watt amplifiers. The 50–ohm input and output impedances connect to adjacent power stages via 50–ohm microstrip lines. The parallel resistor, R9850, and capacitor C9807, on the input, reduce circuit response at lower frequencies and improve stability. The 350 milliwatt (typical) input power is increased to approximately 18–watts. The amplifier power is monitored by the power control IC on the command board and adjusted by controlling the voltage on U9850, Pins 2 and 3. (Power control is described in the Power Control Section.) A + is applied directly to the final stage inside the power module via Pin 4. No repairs can be made to the module; damaged or failed units must be replaced.

CAUTION
The power module leads will not tolerate undue stress; handle carefully when repairing.

1.3 FINAL STAGE (30–WATT ONLY)

On the 12–watt radio, the transmit RF signal from U9850, Pin 5, is applied to the 50–ohm microstrip directional coupler. On the 30–watt radio, the transmit RF signal is applied to the emitter of the final power amplifier Q9880 through the coupling capacitor C9856, the 50–ohm quarter–wave matching transmission line, and the matching capacitors C9875 and C9876. The 100–ohm coupling line, L9930, R9930, R9931, CR9930, and C9930 form an interstage power detector between U9850 and Q9880 to limit the drive into Q9880 to about 19 watts. L9875, the emitter choke, is also the emitter DC return. The final power amplifier, Q9880, is a 45–watt, 900 MHz, common–base NPN devise. The Q9880 output match consists of C9877, C9878, a section of the 50–ohm microstrip line, C9879 and the DC blocking capacitor, C9803. L9876 isolates the RF signal from A+. C9880 is a signal frequency bypass capacitor. L9877 presents a high impedance at low RF frequencies; therefore the collector of Q9880 is resistively loaded by R9876 at low frequencies where the gain is much greater. C9881 and C9882 are low frequency bypass capacitors.

2. Antenna Switch and Harmonic Filter

2.1 ANTENNA SWITCH

2.1.1 30–watt Power Amplifier

The antenna switch's impedance inverter circuit, made up of C9922 and L9921, takes the place of a quarter–wave

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microstrip line. During transmission, K9.4 volts forward–biases CR9921, producing a low impedance at its anode end, and a high impedance at the node of C9922 and L9921, to effectively isolate the transmitted power from the receiver. C9921 couples the power to the harmonic filter and on to the antenna.

The impedance inverter contributes approximately 30 dB to transmit isolation. Additional isolation is obtained by the series switch made up of CR9922, L9923, and associated DC bias components. During transmit, CR9922 is reverse–biased, thus creating a small series capacitor that is tuned out by L9923. C9925 is a DC blocking capacitor. The high impedance of the series arm works against the low impedance of the shunt arm (CR9921) to provide approximately 10 to 15 dB additional isolation. Total TX to RX isolation is in excess of 45 dB from 851–870 MHz. The preselector provides over 50 dB isolation from 806–824 MHz.

When receiving, CR9920 has an off capacitance of approximately 1 pF which is tuned out by L9926. CR9921, with similar off capacitance, is incorporated in the RX match. CR9922 is forward–biased with an ON resistance of approximately 1 ohm. The signal passes CR9922 and through L9922, a series inductor used to complete the RX match. Capacitor C9929 blocks DC.

L9910, at the node of the antenna and harmonic filter, protects the PA from static discharge.

2.1.2 15–watt Power Amplifier

The theory for the 15–watt antenna switch is exactly the same as the 35–watt except that some of the components are labeled with different numbers. C9921, in the 15–watt PA, is located after the harmonic filter.

L9922, at the node of the antenna and capacitor C9921, protects the PA from static discharge.

2.2 HARMONIC FILTER

The 15 and 35–watt harmonic filters are 7–pole, low–pass filters implemented with screened plate capacitors and discrete inductors (L9911, L9912, and L9913) on a 35 mil (0.035") alumina substrate. The filter's ground plane is attached to the PA printed circuit board with solder, while input and output connections are made via "J"–straps MP9856 and MP9857. The filter's primary function is to attenuate harmonic spurs generated by the transmitter and to provide additional low–pass selectivity for the receiver.

Note

When removing any of the discrete coils, take care to avoid leaching the plate capacitor metalization. Removal of the entire hybrid is best accomplished by heating hybrid/PC board assembly with a heat gun or heat blower until solder joint reflows.

3. Power Control Circuitry

3.1 COMMAND BOARD CIRCUITRY

Inside U500, the Regulator Power Control IC (See Figure 1, RPCIC Block Diagram), is an operational amplifier that has four inverting inputs, and one non–inverting input (at Pin 44) which is the reference input for the entire power control loop of the power amplifier. The 3.2V reference voltage at U500, Pin 44, is produced by dividing SW + 5V with the voltage divider circuit. R514 and R515.

The power control loop is controlled by the microprocessor, U520, on the command board. The microprocessor enables the RPCIC by pulling TX PA ENABLE BAR low while the radio synthesizer is locked. Each is felt on Pins 33 and 35 respectively. U520 writes data to a Digital to Analog converter, U502, to change and control the power–set voltage from Pin 10 of U502 to Pin 6 of U500. The voltage on this line, 1.5 to 5 volts, will be inversely proportional to the power out of the PA, with 5 volts producing the lowest power output. This voltage may be set with an IBM PC or with a built–in program operated through the radio's control head. On U500, the voltage at Pin 6 is buffered internally and exits on Pin 7. Through R507, it is summed at the node connected to Pin 2, one of the inverting inputs.

3.2 POWER MODULE CONTROL VOLTAGE LIMITER

R9562 and R9563 connect in series to the emitter of Q9500. The ratio of R9563 and R9562 feed a portion of the control voltage (U9850, Pins 2 and 3) to U500, Pin 4. When Pin 4 exceeds 3.2 volts, the output of the control op–amp (U500, Pin 42) is reduced. Eventually, this reduces the control voltage available to the power module (U9850).

The input RF power to the 45–watt amplifier (Q9880) must stay below 17 watts. Power is coupled from the inter–stage 50–ohm transmission line to a 100 ohm transmission line and rectified by CR9930 on the PA, producing a DC voltage on U500, Pin 4. IF this voltage exceeds 3.2 volts, the output voltage on U500, Pin 42, is reduced, lowering the control voltage and reducing U9850's gain until its RF output power is approximately 17 watts.

3.3 CURRENT LIMITER

U520, the processor on the command board, sends data to U502, the digital to analog converter, to properly set the voltage on U502, Pin 15, which is the TX CURRENT LIMIT control line to the RPCIC (U500, Pin 40). Sixteen different voltages, ranging from 1.5 to 4.5 volts, can be programmed from U502.

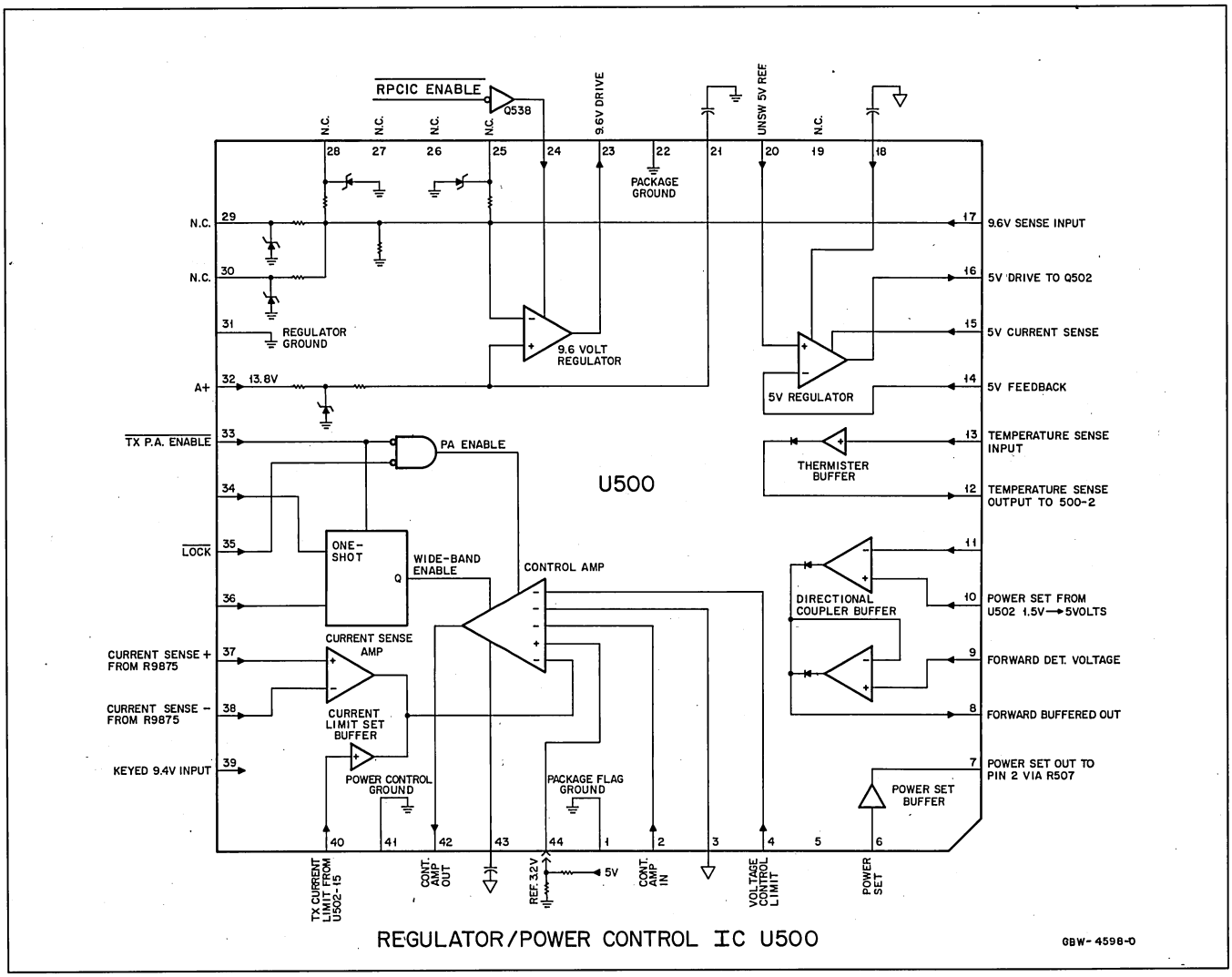


Figure 1. RPCIC Block Diagram

The collector current of the 45–watt final amplifier (in the 35–watt PA only) is monitored by sensing the voltage across R9875. CURRENT SENSE + connects to one end of R9875 and CURRENT SENSE – connects to the other end. These lines connect to the command board on U500, Pins 37 and 38, respectively. If the TX CURRENT LIMIT is set for 1.5 volts, then the voltage difference between U500, Pins 37 and 38 must be .1 volts before the current through R9785 is reduced. If U500, Pin 40 is programmed for 4.5 volts, then the difference of potential between Pins 37 and 38 must exceed .3 volts before current limiting begins. The voltage across R9875, where current sense occurs, can be determined by multiplying the voltage on U500, Pin 40, by 0.067. When current is being limited, the output of the op–amp (U500, Pin 42), begins shutting down the conduction of Q503 and Q504, reducing base drive to Q9500, reducing drive to the final amplifier to, effectively, control the final amplifier's maximum current.

3.4 FORWARD POWER LIMITER

The parallel pair of microstrip lines after the final amplifier, form a forward power sensing directional coupler. Because the coupling increases with frequency, the compensation network of L9806 and C9901 is used. CR9900 rectifies the signal, C9900 filters it, and R9905 and R9904 form a voltage divider. During normal transmission, the DC voltage from the forward detect line to the RPCIC ranges from 2 to 4.5 volts. This voltage connects to U500, Pin 9, the input to the directional coupler buffer.

The directional coupler's output, U500, Pin 8, is summed to Pin 2 with the digital/analog buffer's output through R509 and R507, respectively. Closed loop operation reduces the control amp's output (Pin 42), reduces the power module's gain, and reduces power output to maintain the coupler buffer output U500, Pin 2) at 3.2 volts regardless of the d/a voltage level. If the d/a voltage is high (4.5 volts), little detected voltage is needed to keep Pin 2 at 3.2 volts, and the power, consequently, is low. If the d/a voltage is low (1.5 volts), a large forward detected voltage is needed to keep Pin 2 at 3.2 volts and power, consequently, is at maximum value. The voltage at Pin 2 drops below 3.2 volts under proper operation during low line voltage conditions where the PA cannot produce rated power, or if, under any conditions, either the

inter–stage power (in 30–watt models only), the control voltage, or the final device current exceeds safe levels.

3.5 TEMPERATURE SENSING

When the radio is keyed, K9.4V is applied to the PA connector Pin 5 and on to one side of thermistor RT9560. Resistor R9560, in parallel with RT9560, controls the slope of the cutback; its value changes depending on what frequency or power range the radio is working in. As the temperature increases, the resistance of RT9560 decreases, creating more voltage across R9561. This temperature voltage is routed via PA connector Pin 7 back to U500, Pin 13, which is the input to a thermistor buffer. The thermistor buffer's output on Pin 12 is summed to U500, Pin 2, and passes through its scaling resistor, R508. When the temperature of the thermistor causes its value to change enough that the thermistor voltage exceeds 3.2 volts, the thermistor buffer starts supplying current to the node at Pin 2. Due to the fixed output of the d/a, the control loop can maintain 3.2 volts at Pin 2 only by reducing power output and reducing the forward detected voltage. Since power output is reduced, the generated heat is held to a safe level. As temperature decreases, the power output of the PA gradually increases to its nominal value. Temperature cutback should occur at about 85 degrees C. The temperature sense circuitry can easily be tested by placing an ordinary leaded 6.8k ohm resistor across RT9560. This simulates its hot resistance. The TX power out should drop to approximately half of that measured normally if thermal cutback is OK.

Note

Under severe environmental conditions, more than one circuit may be attempting to reduce power output at the same time (i.e., during high VSWR conditions, the inter–stage power limit may initially reduce power, but eventual heat build–up will cause further power reduction by the thermal cut–back circuit).

4. Transmitter Troubleshooting

This information will help field service technicians troubleshoot the *SPECTRA* radio. Use this information, along with the theory of operation, to diagnose and isolate the cause of failures. The principle tools needed to troubleshoot a circuit to the component level are the schematic and the theory of operation.

In addition to the schematic and theory, this section includes troubleshooting information that will help you test and check the circuits to localize and isolate problems.

Prior to troubleshooting, it is important to review the theory of operation, including specific precautions and troubleshooting methods. Because much of the radio's circuitry operates at 900 MHz, measurements must be taken very carefully. Notes and cautions are added to the text to alert the reader to this need in areas of greatest sensitivity. However the need to extreme care does exist in all measurements and tests at 900 MHz.

4.1 GENERAL TROUBLESHOOTING AND REPAIR NOTES

Most of the common transmitter symptoms are caused by either failure of the power amplifier or a failure in the control circuitry. The initial troubleshooting effort should be toward isolating the problem to one of those two areas. If either the control voltage or keyed 9.4 volts are zero, then the problem is likely to be in the control circuit. If those voltages are present, then the problem is more likely in the power amplifier circuit.

If for diagnostic reasons, a chip component needs to be removed to facilitate testing, such as a series capacitor removed to allow for signal insertion, then the component(s) returned to the circuit should be new parts. The application of a soldering iron to many chip components will tend to cause leaching which could lead to failure.

If the harmonic filter is damaged and needs to be replaced, then removal and replacement requires the use of a hot air source capable of reflowing the solder beneath the filter hybrid. When replacing it, add small amounts of fresh solder paste to the silver regions beneath the ceramic to assure adequate electrical ground contact. Save the original input and output connectors ('J' straps); these are not included with the replacement kit. No turning is required. The harmonic filter may be ordered separately, but if the PA kit is ordered, a filter kit comes with the PA kit.

The pass device may be ordered separately or may be received as part of the hardware kit – it is not part of the PA kit. The PA kit comes with all surface–mount components, including the harmonic filter hybrid, but the harmonic filter cover is not included. Neither does the PA kit include the Power Module, nor, on 30–watt models, the final device and associated matching capacitors.

After a PA board is replaced, or if any power control circuitry components are replaced, readjust the power according to instructions in the Service Manual.

Important

Due to the high frequency of operation, it is imperative that you use specified Motorola parts when component replacement is necessary. At these frequencies, second and third order properties of the components are very important and are part of the circuit's design. Substitute components may not work. It is also critical that you use great care when replacing parts. Excessive solder or flux, longer than original leads on coax connectors, mis–orientation of parts, and other commonly benign imperfections may cause the radio's performance to degrade.

4.2 PA FUNCTIONAL TESTING

To test the PA assembly for proper operation, perform the following steps:

Note

The following instructions pertain to both the 15–watt and 35–watt power amplifiers. A distinction between the two PA's is given only where necessary.

(1) Disassemble the PA assembly from the radio, leaving the power cable connected to the rear connector. Replace the 15–watt PA shield (or the 35–watt PA shield and cover). Disconnect the coax connectors and the ribbon cable. Connect a power meter to the antenna port using minimum cable length.

Notes

(a) When setting or measuring RF power at 800 MHz, follow these guidelines to avoid measurement errors due to cable losses or non 50–ohm connector VSWR:

- All cables should be very short and have Teflon dielectric.
- Attenuators and 50–ohm loads should have at least 25 dB return loss.
- 'Mini UHF' to 'N' adapter, P/N 58–80367B21, should be used at the antenna connector. All other connectors should be 'N' type. No other adapters, barrel connectors, etc. should be used.

(b) Maximum input level to the PA is 200 milliwatts. Over driving the buffer could result in damage to the PA buffer stage.

(2) Apply the input power and DC voltages indicated in Table 1 to the power amplifier assembly. To make the DC connections, use small spring–clips or make a test adapter similar to that shown in Figure 2.

Table 1. DC Voltages & Input Power Chart

Test	Keyed 9.4v	9.6V	Control Voltage	Power in (W)	A+ V
Transmit	9.4	9.6	See note	0.1	13.0
Receive	0	9.6	0	0	13.0

Note: Set initially to zero. Increase value until power equals 17–watts (15–watt radio) or 38 watts (35–watt radio) or 11.0 volts maximum.

Table 2. Power Control DC Voltage Chart

LOCATION	RX MODE			TX MODE			
	LOW	TYP	HI	LOW	TYP	HI	COMMENTS
P0853							
1	—	—	—	—	—	—	KEY (NO PIN OR WIRE)
2		0		0	2.0	3.2	CONTROL VOLTAGE LIMIT
3		0		2.0	7.0	13.0	DRIVE VOLTAGE
4	10.8	13.6	16.5	10.0	13.0	16.0	CURRENT SENSE +
5	0	0	0	9.2	9.4	9.8	KEYED 9.4
6	10.8	13.6	16.5	10.8	13.6	16.5	A+ TO COMMAND BOARD
7		0			1.2		TEMP SENSE (CUTBACK BEGINS AT 3.3V)
8	—	—	—	—	—	—	KEY (NO PIN)
9		0		1.3	3.5	6.0	FORWARD DETECT VOLTAGE
10	10.8	13.6	16.5	10.8	13.6	16.5	A+ TO COMMAND BOARD
11	9.4	9.6	9.9	9.4	9.6	9.9	9.6V SUPPLY FROM COMMAND BOARD
12	20.8	13.6	16.5	10.0	13.0	16.0	CURRENT SENSE—(VOLTAGE DELTA 150mV)
U0500							
1	0	0	0	0	0	0	GROUND
2		0			3.2		CONTROL AMP INPUT
3	0	0	0	0	0	0	CONTROL AMP INPUT (NOT USED)
4		0		0	2	3.2	CONTROL VOLTAGE LIMIT (CUTBACK AT 3.3V)
5		0			0	N.C.	
6	1.5	3.0	4.5	1.5	3.0	4.5	POWER SET FROM D–A (MAX POWER AT 1.5V)
7		0	0	1.5	3.0	4.5	POWER SET BUFFER OUT
8		0		1.3	3.5	6.0	COUPLER BUFFER OUT
9		0		1.3	3.5	6.0	FORWARD DETECT VOLTAGE
10		0			0		REFLECTED POWER DETECT (NOT USED)
11		0		1.3	3.5	6.0	SAME AS PIN 8 (NOT USED)
12		0		0	1.2	6.0	THERMISTER BUFFER OUT (INCREASES AS PA GETS HOT)
13		0		0	1.2	6.0	THERMISTER BUFFER IN

Table 2. Power Control DC Voltage Chart (Continued)

LOCATION	RX MODE			TX MODE			
	LOW	TYP	HI	LOW	TYP	HI	COMMENTS
14		5.0			5.0		5V SENSE INPUT (FOLLOWS PIN 20 ±0.1V)
15	4.9	5.0	5.7	4.9	5.0	5.7	5V CURRENT LIMIT (LIMITS AT 5.7V)
16	5.0	5.7	6.4	5.0	5.7	6.4	5V SERIES PASS DRIVE (6.4V AT MAX CURRENT)
17	9.5	9.6	9.9	9.5	9.6	9.9	9.6 VOLT SENSE INPUT
18		7			7		5V REG. COMPENSATION CAPACITOR
19		5.7			5.7		N.C.
20	4.9	5.0	5.1	4.9	5.0	5.1	5V REFERENCE INPUT (UNSW5V)
21		1.2			1.2		9.6V REG. COMPENSATION CAPACITOR
22		0			0		N.C.
23		0.9	9.6		1.2	9.6	9.6V SERIES PASS DRIVE
24		2.9			3.3		REGULATOR ENABLE/COMPENSATION
25	——	——	——	——	——	——	9.6V PROGRAMMING (N.C.)
26		0			0		N.C.
27		13.6			13.6		N.C.
28	——	——	——	——	——	——	9.6V PROGRAMMING (N.C.)
29	——	——	——	——	——	——	9.6V PROGRAMMING (N.C.)
30	——	——	——	——	——	——	9.6V PROGRAMMING (N.C.)
31	0	0	0	0	0	0	GROUND
32	10.8	13.6	16.5	10.0	13.0	16.0	DECOUPLED A+
33	4.0	5.0			0	0.2	TX PA ENABLE (FROM U520–25)
34		0			1.3		CONTROL AMP ONE–SHOT
35		0			0		LOCK (5V OF SYNTH OUT OF LOCK)
36		0			0.8		CONTROL AMP ONE–SHOT
37	10.8	13.6	16.3	10.0	13.0	16.0	A+ (CURRENT SENSE +)
38	10.8	13.6	16.3	10.0	13.0	16.0	CURRENT SENSE—VOLTAGE DELTA 150mV (30 WATT ONLY)
39		0		9.2	9.4	9.8	KEYED 9.4V IN
40	1.5	3.0	4.5	1.5	3.0	4.5	CURRENT LIMIT D–A (MAX CURRENT AT 4.5V)
41	0	0	0	0	0	0	GROUND
42		0			2.2	9.6	CONTROL AMP OUTPUT (APPX 1/2 V CONTROL)
43		1.3			7.0		LOOP INTEGRATOR CAPACITOR
44		2.1			3.2		CONTROL AMP REFERENCE
Q0500E		13.0			13.0		A+ —CR0500 DROP
Q0501C		12.3			12.3		VQ0500E—B/E DROP
Q0501E		0.2			0.2		V PIN 23—B/E DROP
Q0503E		0			1.5		V PIN 42—B/E DROP (TX)
Q0503C		13.6			9.0		
Q0504B		13.6			12.9		A+ —B/E DROP (TX)

Note: For antenna switch transmit bias conditions, RF drive must be removed from PA.

LOCATION		TYPICAL RX	TYPICAL TX NO PRE–DRIVE	COMMENTS
CR9920	ANODE	0	1.6	TX SERIES P.I.N. DIODE
	CATHODE	0	0.8	(ON IN TX MODE)
CR9921	ANODE	0	0.8	TX SHUNT P.I.N. DIODE
	CATHODE	——	——	(ON IN TX MODE)
CR9922	ANODE	5.15V	<0.2	RX SERIES P.I.N. DIODE
	CATHODE	4.45V	8.7	(OFF IN TX MODE)
Q9920	COLLEC	5.15V	<0.2	

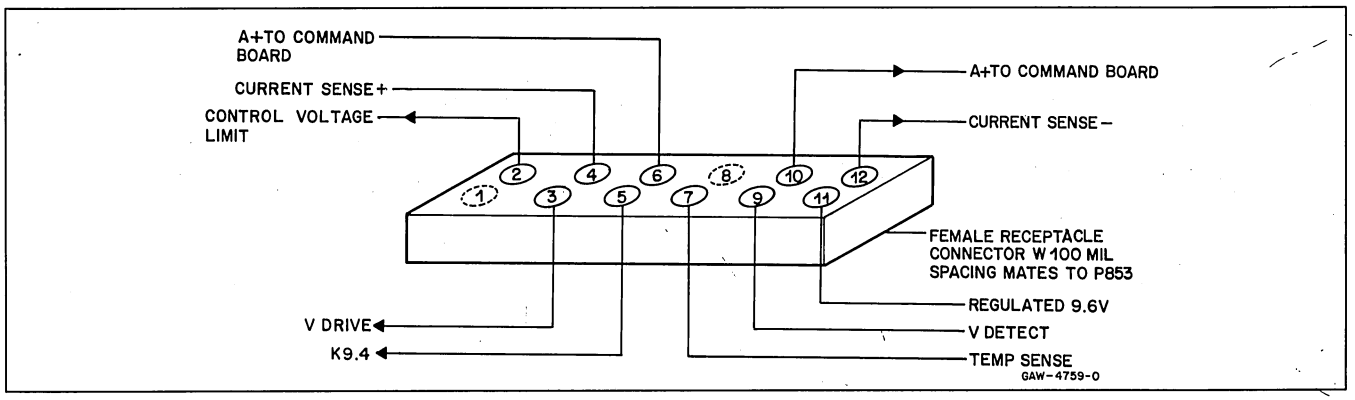


Figure 2. PA Test Adapter

(3) Apply the required input power via adapter cable 30–80373B27 or equivalent. For this application, non 'N' type connectors are acceptable.

(4) With the applied control voltage initially at zero volts, slowly increase the voltage until power out equals 14–watts (12–watt radio) or 34–watts (30–watt radio). Power should rise smoothly with control voltage once the turn–on threshold is reached. Control voltage should not exceed 11.0 volts.

(5) If 11.0 volts does not produce 14 (or 34) watts, then a failure exists in the power amplifier circuit.

(6) Refer to the voltage chart (See Table 2). Measure the indicated voltages. If they are not within the limits shown in the chart, then a failure exists in the PA assembly.

(7) If the voltages in the chart are correct, verify that the injection is at least 75 milliwatts. (See the VCO troubleshooting section.)

(8) If no failure is located from the previous checks, troubleshoot the power control circuitry.

4.3 LOCALIZING PROBLEMS

Failure locations often can be determined by externally measured symptoms. Basic symptoms are noted below with probable failure locations.

(1) Low Power and High Current

- Check for improper load conditions caused by high VSWR external to the radio.
- Check output coax and mini–UHF connector.
- Check harmonic filter and J–straps.
- Check output impedance–matching circuitry from the final device to the harmonic filter.

(2) Low Power and Low Current

- If control voltage is greater than 10 volts, then check per the above.
- If control voltage is less than 10 volts, then check the control circuitry.

(3) Power Intermittently Low (or zero) and Current less Than 1 Amp When Power Drops

- Check Buffer Stage

(4) Power Zero and Current Greater Than 5 Amps

- Check harmonic filter, antenna switch, and matching circuits beyond final stage.

(5) Power Zero and Current Between 2 and 5 Amps

- Check Power Module

(6) Power Zero and Current Less Than 1 Amp

- Check input coax
- Check Buffer Stage

4.4 ISOLATING FAILURES

Methods of analyzing individual stages of the Power Amplifiers are detailed below. Most of the stages are class C and must be analyzed under relatively high RF power levels. Generators capable of such levels may not be available in all service shops, therefore the tests below are arranged in order of ascending power. This tends to allow the preceding stage to be the source of RF power for testing the next stage. If adequate power sources are available, then any stage may be tested with external signal injection.

(1) Testing Buffer Circuitry

The required DC and RF conditions are defined in Table 1. With no RF input applied, the collector voltage of Q9800 should be 9.4V. If not, check L9805, L9801, and the feed runners. The base voltage should be 0.6V (0.7V without RF). If not, check R9801, CR9800, and related adaptive bias circuitry.

To check for power out, remove R9805 and lift the output end of C9807. Solder the center conductor of a small diameter 50–ohm coax to the vacated pad on the buffer side. Solder the coax's shield to ground. Under the conditions specified in Table 1, the measured power should be at least 350 milliwatts. After output power has been tested, replace the resistor and capacitor with new parts.

An alternate method of testing the buffer's power out is to carefully lift the input lead of the power module (Pin 1) from the circuit board and replace it with the center conductor of a small diameter coax. Solder the shield of the coax to the adjacent ground pad.

To test the input VSWR of the circuit, apply 70 mW to the input. Using a directional coupler, verify that the reflected power is less than 20 mW.

(2) Testing the Power Module (U9850)

The power module is a packaged gain block with 50–ohm input and output impedances. It has three gain stages, the first two of which have controlled voltage applied (for regulating power) and the final stage has A+ applied.

If the buffer stage has not been confirmed in "working order," an external 400 milliwatts must be injected. Do this by carefully lifting Pin 1 of the power module and soldering the center conductor of a small diameter coax to the pin. Solder the shield to the ground pad adjacent to Pin 1. To this cable, inject 400 mW. (This application is not so critical to require an 'N' connector on the loose end of the coax.)

If the buffer stage is confirmed in "working order," then provide 100 mW drive to the buffer (K9.4V must be applied) to drive the module.

To measure the output power from the module, remove the series DC blocking capacitor C9879 (12W) or C9856 (30W), then connect a 30 pF blocking capacitor from the center conductor of a small diameter coax to the vacated pad, and finally, ground the shield of the output coax. Use this coax to measure output power.

Control voltage (Pins 2 and 3) should be 10 volts; A+ (Pin 4) should be 13.0 volts. Apply voltages through the DC connector on the PA board.

With either 100 mW applied to the buffer or 400 mW applied to the module input, the output power should be at least 15 watts. If power out is less than 15 watts, the module is defective and must be replaced.

Note

When replacing the module, apply thermal compound on the heatsink surface. Torque the screws to the correct value (See Service Manual).

When testing is complete, replace any capacitors or resistors that were removed for testing with new parts.

(3) Testing the Final Stage (30–Watt Models Only)

CAUTION

The final stage is capable of producing over 50 watts. Be sure to protect power measuring equipment with series attenuation. 30 dB is usually adequate.

15 watts are needed to drive the final stage. Because this may exceed the power available at 900 MHz in many repair facilities, these tests consider the module stage as the drive source for the final stage. Therefore, check out the module first to ensure that it operates properly.

In the course of testing the final stage with the module as the power source, begin with control voltage at zero and increase control voltage smoothly until output of the final stage reaches 40 watts. If control voltage reaches 11 volts but the power out does not reach 40 watts, the final stage is defective. Under normal conditions, the protection circuitry limits the power to the final stage to approximately 18 watts maximum, protecting it from overdrive and damage. Under test conditions, however, the protection circuitry is disabled. Observe the above caution; the power module can produce in excess of 23 watts.

Measure the output power by lifting the output side of C9856 and connecting to the center conductor of a small diameter coax which has its shield grounded. If the output stage does not produce 40 watts (at 11 volts control voltage), then remove the RF drive and perform the following tests:

- Check continuity from the collector lead to the A+ connector on the back of the radio.
- Examine the solder connections on all leads of the device (Q9880) and the clamped mica capacitors.

Note

The position of the clamped capacitors adjacent to the device is critical to the performance of the circuit. If they are removed for any reason, they must be re–installed with their leads approximately 70 mils (0.070 inches) from the final device cap.

(4) Testing the Antenna Switch and Harmonic Filter

Verify that most of this circuit is functioning properly by testing the receiver insertion loss as follows:

- Apply a low–level signal source at the antenna connector.
- Apply the conditions indicated in Table 1 for RX tests.
- Measure the power at the receive coax.
- If the difference between the input and output (insertion loss) is less than 2 dB, then the circuitry is functioning properly.

Additional antenna switch tests are:

- Check CR9922 with an ohmmeter for forward and reverse continuity.
- In the transmit mode, adjust control voltage for 38 watts at the antenna connector. Check for less than 10 mW at the end of the receive input cable. If power exceeds 10 mW, then check CR9922 and associated circuitry. Receiver sensitivity can degrade if power at this port exceeds 10 mW.
- Check for proper DC current through the PIN diodes; correct current is indicated if approximately 1.5 volts is present at the junction of C9920 and L9920 during transmit mode.

WARNING

DO NOT measure bias directly at the pin diodes while in transmit mode unless TX Injection is removed.

4.5 POWER CONTROL AND PROTECTION CIRCUITRY

(1) Localizing Problems to a Circuit

Power leveling and current limiting (35–watt models only) are set to values detailed in the Service Manual. These values will vary from unit to unit, depending on the unique variations of each unit. If symptoms indicate that either of these circuits have failed, verify that the radio has been properly aligned before investigating the circuitry.

Temperature sense, voltage control limit, and interstage drive limit (on 35–watt only) are fixed by design and are not influenced by the alignment of the radio. If symptoms indicate that these circuits have failed, then troubleshoot the circuit.

The tests that follow are intended to provide a convenient means of verifying that a particular circuit is functioning properly. These tests will isolate the failure to a minimum number of components. Refer to the theory of operation and the schematic for information needed to identify the failed component(s).

(2) Temperature Sense Circuit Test

Temporarily install a 6.8k ohm resistor in parallel with RT9650. Key the transmitter and monitor the output power. The power meter should read approximately 1/2 the rated power (7.5 watts or 17.5 watts).

(3) Control Voltage Limit Circuitry Test

Disconnect P9641 (Transmitter injection) from the internal transceiver chassis. This will require removal of the power amplifier assembly. With all other connections in normal condition, key the transmitter and monitor the control voltage on Pin 2 of the power module. If the voltage exceeds 12.5 volts, troubleshoot the control voltage limit circuitry.

(4) Interstage drive Limiter Circuitry Test (35–watt models)

Check this circuit only when the final device (Q9880) has failed. With the radio off, check CR9930 and associated components.

(5) Current Limiting Circuitry Test (35–watt models)

Refer to section 2 of the Service Manual for current limit setting instructions. When ready to adjust current limit, decrease the relative current limit value with the keyboard per instructions. After several decrements, the current limit should reduce power from 0.1 watt to 0.5 watt. After this test, reset the current limit. If the circuitry does not perform as indicated, troubleshoot the current limit circuitry.

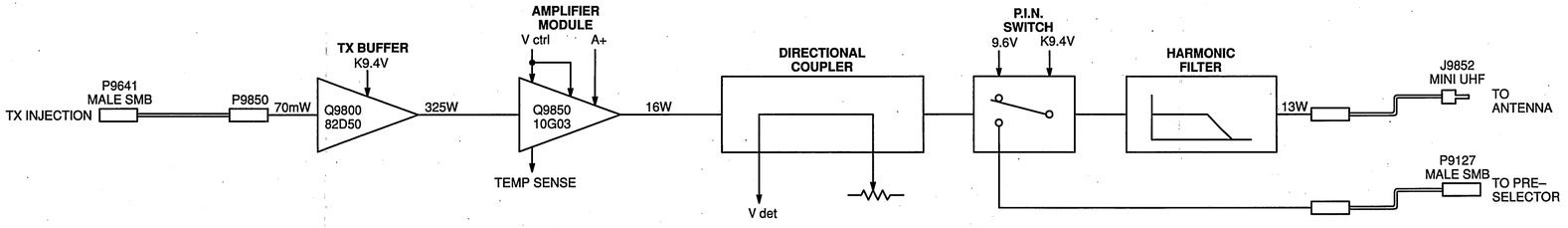
(6) Power Leveling Circuitry Test

With the radio connected for power measurements, vary the line voltage from 12.5 to 16 volts. The power should not vary more than 3 watts. At a line voltage of 13.6 volts, vary the frequency using the three test modes. If power varies more than 3 watts, measure the detected voltage on P0853, Pin 9. If this voltage varies more than 0.2 volts over line and frequency variations, the power control circuitry (most of which is located on the command board) may be malfunctioning. If the detected voltage varies less than 0.2 volts, the problem is likely in CR9900, the harmonic filter, the antenna switch, or the output coax. Check continuity through 12 pin DC connector P0853 on the PA board; check digital/analog circuitry, and check 5V regulator operation. See the Table 2, DC Voltage Chart, for typical values.

Note

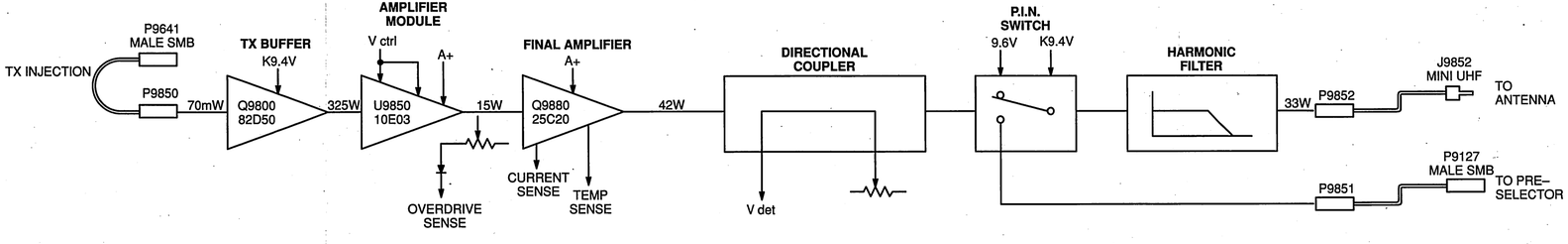
If any part of the power leveling circuitry is replaced, perform the power set procedure. See the Service Manual for details.

SPECTRA 12 WATT 900 MHz AMPLIFIER



GPW–4600–B

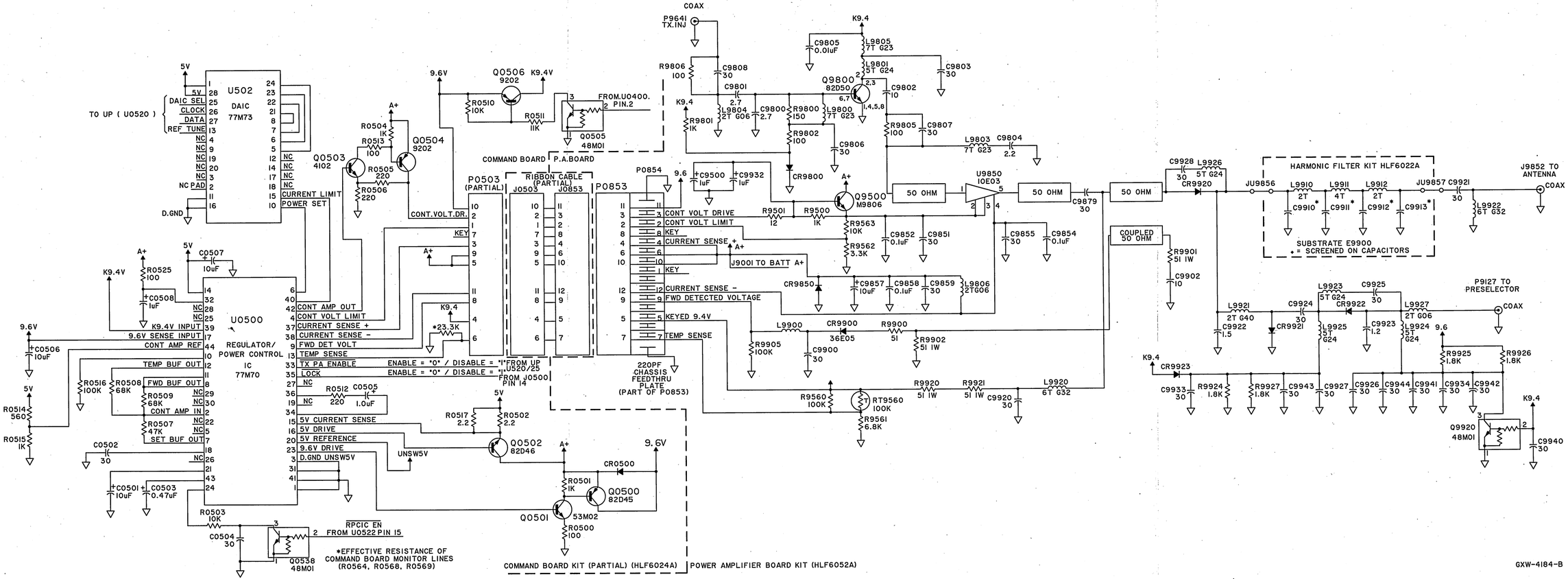
SPECTRA 30 WATT 900 MHz AMPLIFIER



GPW–4599–A

SPECTRA 12 and 30 Watt
Power Amplifier Block Diagrams
PW–4601–B
3/31/89

HLF6052A/HLF6074A 12 WATT PA SCHEMATIC



Schematic, Circuit Board Diagrams, and Parts Lists
for HLF6052A and HLF6074A *SPECTRA*
12 Watt Power Amplifier
PW–4710–C
(Sheet 1 of 2)
3/31/89

parts list

HLF6052A 12 Watt PA Board, 900 MHz
HLF6074A 12 Watt PA Board, 900 MHz — MXW–4653–C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C9500	23–62998B59	1 uF, ±20%, 16V, tantalum
C9800,9801	21–11031A06	2.7
C9802	21–11031A15	10
C9803	21–11031A26	30
C9804	21–11031A05	2.2
C9805	21–11032A21	0.01 uF, ±10%
C9806–9808	21–11031A26	30
C9851	21–11031A26	30
C9852	21–11032A33	0.1 uF, ±10%
C9854	21–11032A33	0.1 uF, ±10%
C9855	21–11031A26	30
C9857	23–80090M24	10 uF, ±20%, electrolytic
C9858	21–11032A33	0.1 uF, ±10%
C9859	21–11031A26	30
C9879	21–11078B27	30, 100V
C9900	21–11031A26	30
C9902	21–11031A15	10
C9920	21–11031A26	30
C9921	21–11078B27	30, 100V
C9922	21–11031A03	1.5, ±.25 pF
C9923	21–11031A02	1.2, ±.25 pF
C9924–9928	21–11031A26	30
C9932	23–62998B59	1 uF, ±20%, 16V, tantalum
C9933,9934	21–11031A26	30
C9940–9944	21–11031A26	30
diode (see note)		
CR9800	48–80066M01	signal, type RSL4148
CR9850	48–80236E07	hot carrier, zener, 28V
CR9900	48–80236E05	hot carrier, Schottky
CR9920,9921	48–80236E20	pin, 1.0W type MA47059
CR9922	48–80142L01	pin, type MMBV3401
CR9923	48–80066M01	signal, type RSL4148
connector receptacle		
J9001	39–80112M01	contact, power tap
J9852	30–80261M01	cable assembly, mini UHF
jumper		
JU9856,9857	07–80299L01	frame, lead J–strap
coil, RF		
L9800	24–80091G23	7 turns, airwound
L9801	24–80091G24	5 turns, airwound
L9803	24–80091G23	7 turns, airwound
L9804	24–80091G06	2 turns, airwound
L9805	24–80091G23	7 turns, airwound
L9806	24–80091G06	2 turns, airwound
L9900	24–80091G32	6 turns, airwound
L9920	24–80091G32	6 turns, airwound
L9921	24–80091G40	2 turns, airwound
L9922	24–80091G32	6 turns, airwound
L9923–9926	24–80091G24	5 turns, airwound
L9927	24–80091G06	2 turns, airwound
connector plug		
P9853	64–80262N01	plate, low power feedthru
P9127	30–80152M03	cable assembly, coax
P9227	29–80014A01	clip, coax terminal
P9641	30–80152M02	cable, assembly, coax
P9741	29–80014A01	clip, coax terminal
transistor (see note)		
Q9500	48–00869806	NPN, audio power, type M9806 (p/o HLN6007A)
Q9800	48–80162D50	NPN, type MRF8372, 750MW, 960 MHz
Q9920	48–80048M01	NPN, type 48M01
thermistor		
RT9560	06–80149M02	100k ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9500	06–11077A74	1k
R9501	06–11077A28	12
R9560	06–11077B23	100k
R9561	06–11077A94	6.8k
R9562	06–11077A86	3.3k
R9563	06–11077A98	10k
R9800	06–11077A54	150
R9801	06–11077A74	1k
R9802	06–11077A50	100
R9805,9806	06–11077A50	100
R9909	06–11077A43	51
R9901,9902	06–80194M18	51, 1 Watt
R9905	06–11077B23	100k
R9920,9921	06–80194M18	51, 1 Watt
R9924–9927	06–11077A80	1.8k
R9950–9995	06–11077A01	jumper
integrated circuit (see note)		
U9850	51–80110E03	power module, RF, 900 MHz, 18 Watt
	mechanical parts	
	26–80084N01	harmonic filter shield
	26–80013M01	PA module shield
	54–80004N01	barcode label

9/15/88

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

parts list

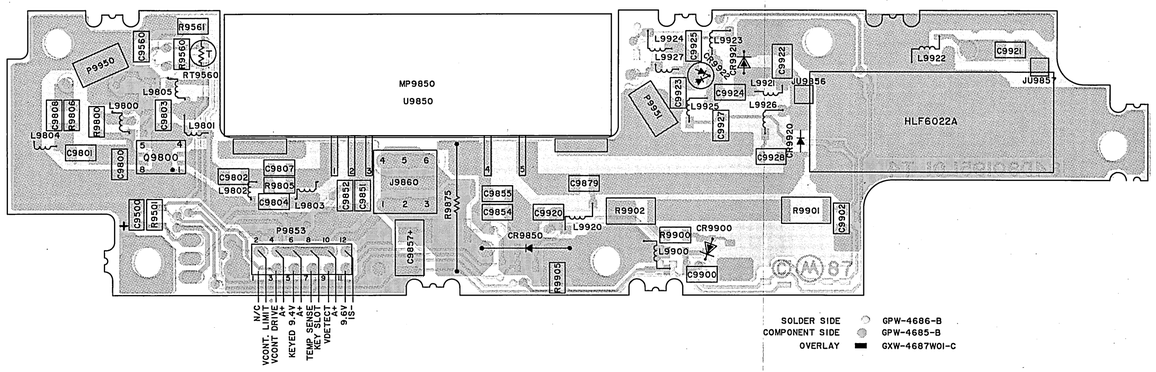
HLF6022A Harmonic Filter Hybrid Board — MXW–4652–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
coil, rf		
L9910	24–80091G40	2 turns, airwound
L9911	24–80091G21	4 turns, airwound
L9912	24–80091G40	2 turns, airwound

9/21/88

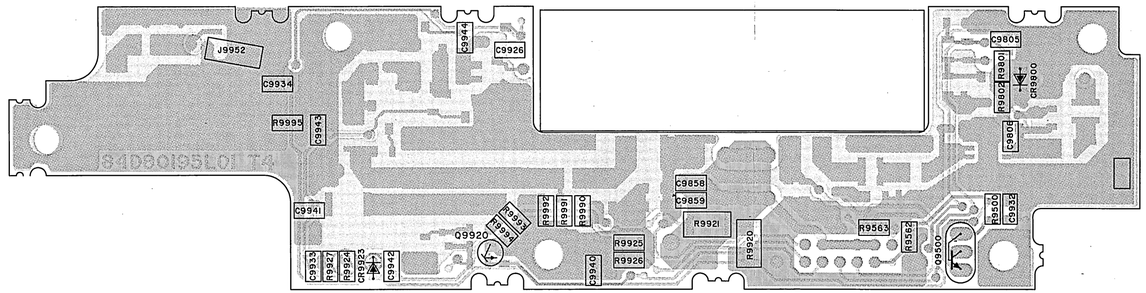
HLF6052A/HLF6074A 12 WATT PA CIRCUIT BOARDS

COMPONENT SIDE



SOLDER SIDE — GPW–4686–B
COMPONENT SIDE — GPW–4685–B
OVERLAY — GXW–4687W01–C

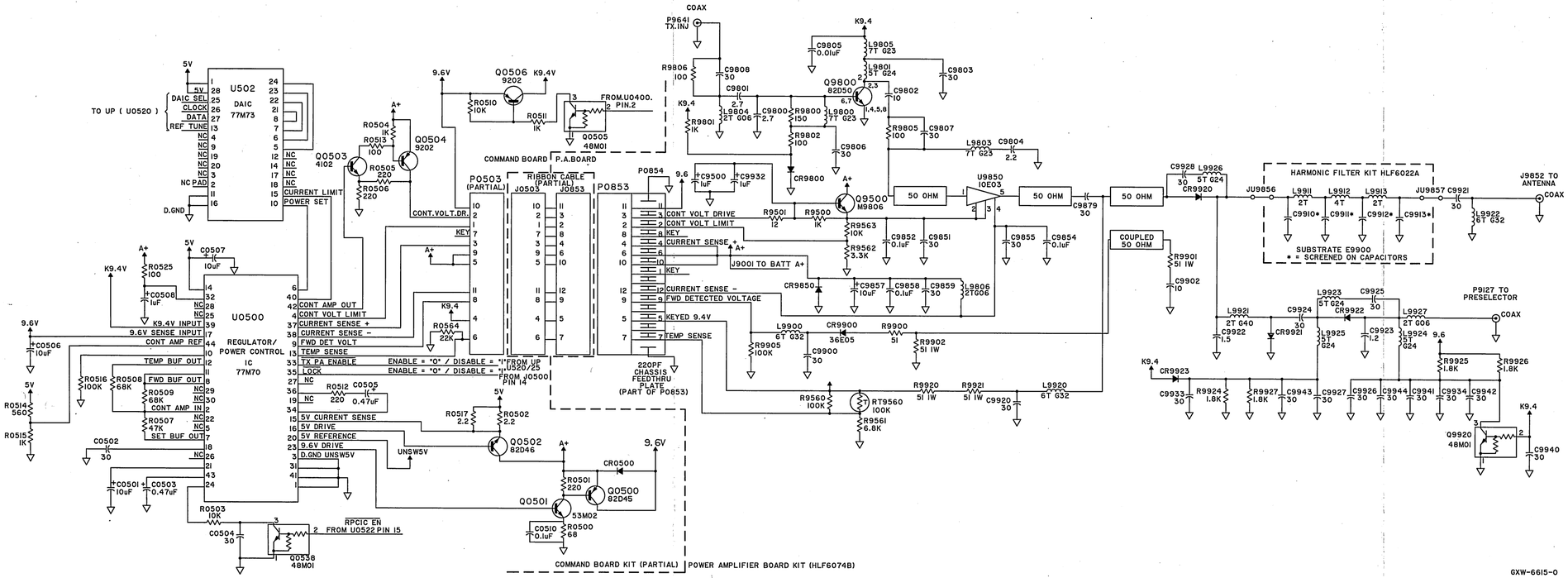
SOLDER SIDE



SOLDER SIDE — GPW–4686–B
COMPONENT SIDE — GPW–4685–B
OVERLAY — GXW–4687W02–C

Schematic, Circuit Board Diagrams, and Parts Lists
for HLF6052A and HLF6074A *SPECTRA*
12 Watt Power Amplifier
PW–4710–C
(Sheet 2 of 2)
3/31/89

HLF6074B 12 WATT PA SCHEMATIC



parts list

HLF6022A Harmonic Filter Hybrid Board (Later Version) MXW–4652–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
coil, rf		
L9911	24–80091G40	2 turns, airwound
L9912	24–80091G21	4 turns, airwound
L9913	24–80091G40	2 turns, airwound

3/31/89

note: designators L9910,I9911,L9912 for HLF6052A and HLF6062A

parts list

HLF6074B 12 Watt PA Board, 900 MHz MXW–5894–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C9500	23–11049A37	1 uF, ±20%, 25V, tantalum
C9800,9801	21–13740B11	2.7, ±.25 pF
C9802	21–13740B25	10
C9803	21–13740B36	30
C9804	21–13740B09	2.2, ±.25 pF
C9805	21–13741N45	0.01 uF
C9806–9808	21–13740B36	30
C9851	21–13740B36	30
C9852	21–13741N69	0.1 uF
C9854	21–13741N69	0.1 uF
C9855	21–13740B36	30
C9857	23–80090M24	10 uF, ±20%, electrolytic
C9858	21–13741N69	0.1 uF
C9859	21–13740B36	30
C9879	21–11078B27	30, 100V
C9900	21–13740B36	30
C9902	21–13740B25	10
C9920	21–13740B36	30
C9921	21–11078B27	30, 100V
C9922	21–13740B05	1.5, ±.25 pF
C9923	21–13740B03	1.2, ±.25 pF
C9924–9928	21–13740B36	30
C9932	23–11049A37	1.0 uF, ±20%, 25V
C9933,9934	21–13740B36	30
C9940–9944	21–13740B36	30
diode (see note)		
CR9800	48–80066M01	signal, type RSL4148
CR9850	48–80236E07	transient suppressor, 28V
CR9900	48–80236E05	hot carrier, Schottky
CR9920,9921	48–80236E22	pin, 1.0W type MA47059
CR9922	48–80142L01	pin, type MMBV3401
CR9923	48–80066M01	signal, type RSL4148
connector receptacle		
J9852	30–80261M01	mini–UHF coax
J9860	29–80014A01	clip, coax terminal
jumper		
JU9856,9857	07–80299L01	frame, lead J–strap
coil, RF		
L9800	24–80091G23	7 turns, airwound
L9801	24–80091G24	5 turns, airwound
L9803	24–80091G23	7 turns, airwound
L9804	24–80091G06	2 turns, airwound
L9805	24–80091G23	7 turns, airwound
L9806	24–80091G06	2 turns, airwound
L9900	24–80091G32	6 turns, airwound
L9920	24–80091G32	6 turns, airwound
L9921	24–80091G40	2 turns, airwound
L9922	24–80091G32	6 turns, airwound
L9923–9926	24–80091G24	5 turns, airwound
L9927	24–80091G06	2 turns, airwound
connector plug		
P9850	30–80152M02	TX INJ. coax
P9951	30–80152M03	RX coax
P9853	64–80262N01	plate, low power feedthru
P9950	29–80014A01	clip, coax terminal
transistor (see note)		
Q9800	48–80182D50	NPN, type MRF8372, 750MW, 960 MHz
Q9920	48–80048M01	NPN, type 48M01
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9500	06–11077A74	1k
R9501	06–11077A28	12
R9560	06–11077B23	100k
R9561	06–11077A94	6.8k
R9562	06–11077A86	3.3k
R9563	06–11077A98	10k
R9800	06–11077A54	150
R9801	06–11077A74	1k
R9802	06–11077A50	100
R9805	06–11077A50	100
R9806	06–11077A50	100
R9900	06–11077A43	51
R9901,9902	06–80194M18	51, 1 watt
R9905	06–11077B23	100k
R9920,9921	06–80194M18	51, 1 watt
R9924–9927	06–11077A80	1.8k
R9990–9995	06–11077A01	jumper
thermistor		
RT9560	06–80149M02	100k ohm
Integrated circuit (see note)		
U9850	51–80110E03	power module, RF, 900 MHz, 18 watt
mechanical parts		
	26–80084N01	harmonic filter shiled
	26–80013M01	PA module shield
	54–80004N01	barcode label

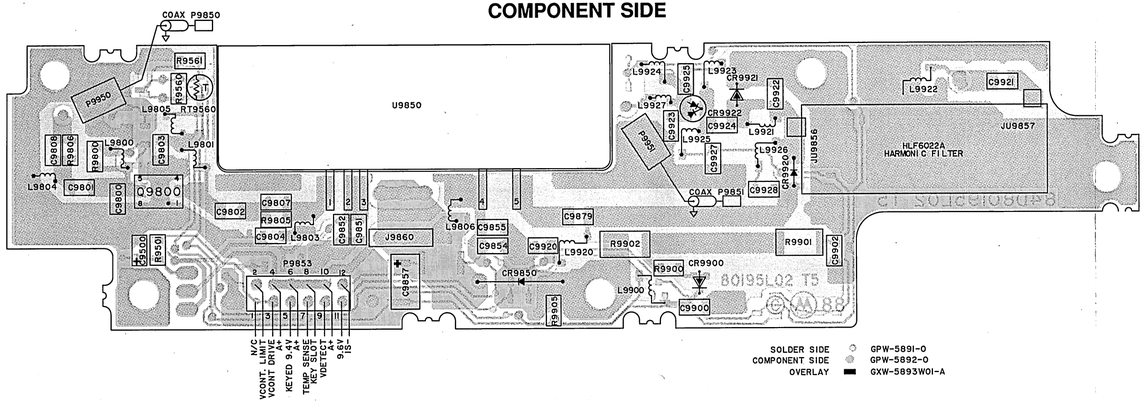
03/01/89

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

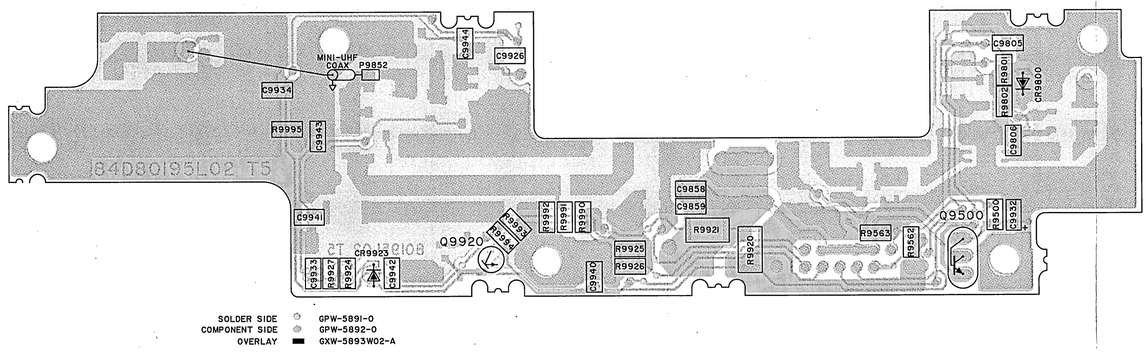
Schematic, Circuit Board Diagrams, and Parts Lists
for HLF6074B *SPECTRA* 12 Watt Power Amplifier
PW–6614–O
(Sheet 1 of 2)
3/31/89

HLF6074B 12 WATT PA CIRCUIT BOARD
EARLY VERSION

COMPONENT SIDE

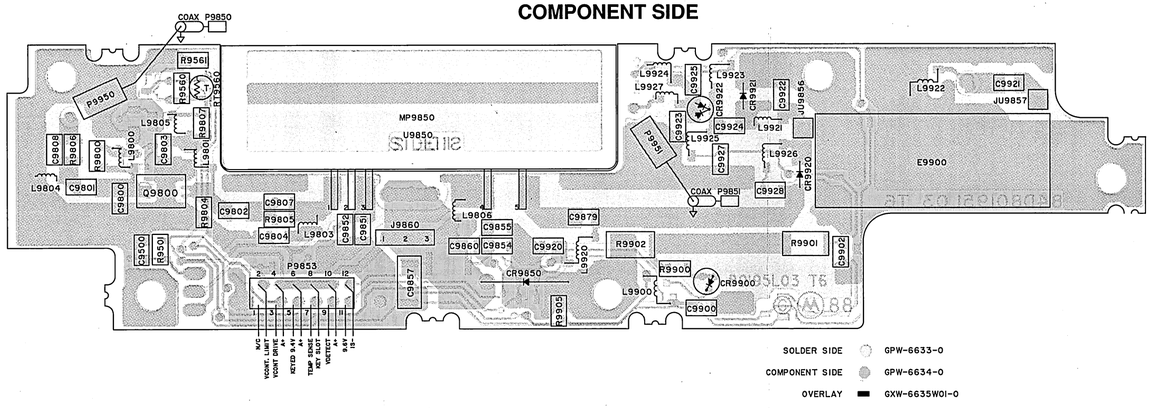


SOLDER SIDE

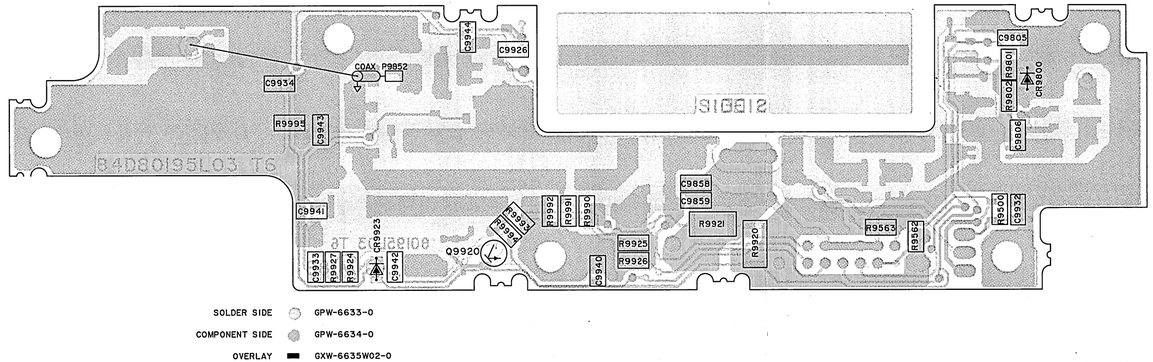


HLF6074B 12 WATT PA CIRCUIT BOARD
LATER VERSION

COMPONENT SIDE

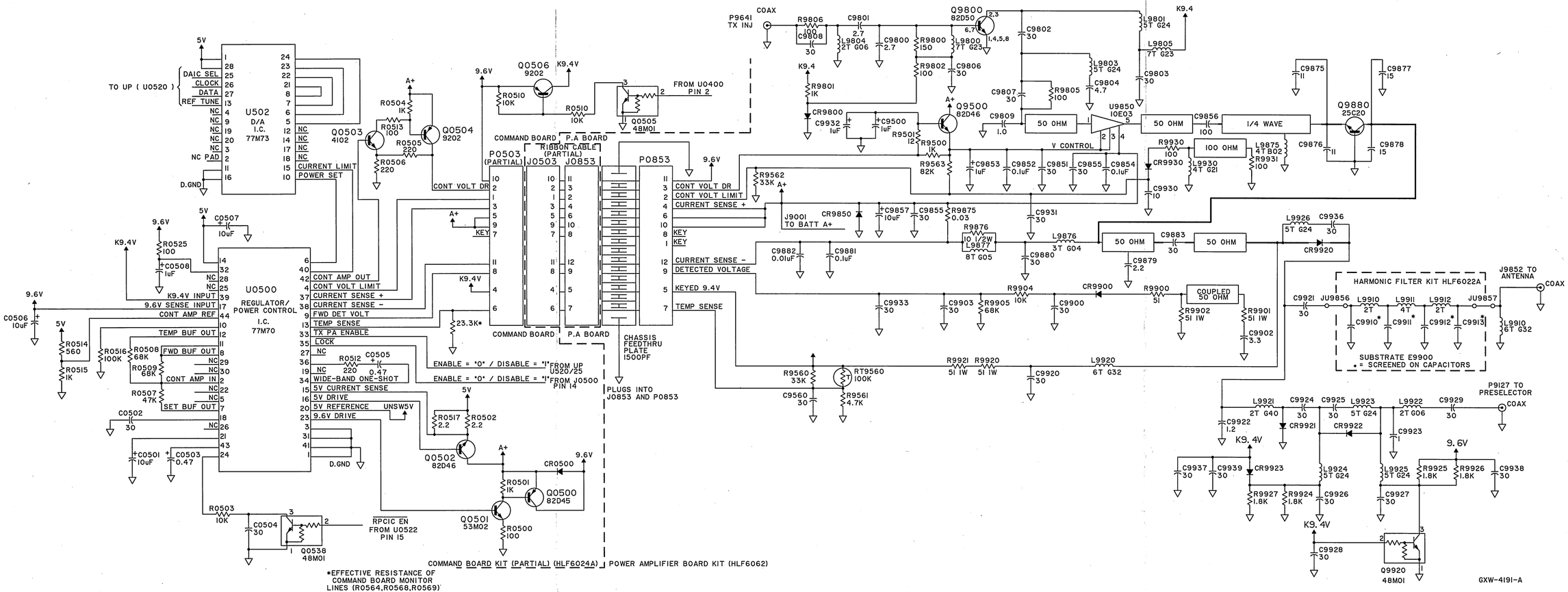


SOLDER SIDE



Schematic, Circuit Board Diagrams, and Parts Lists
for HLF6074B *SPECTRA* 12 Watt Power Amplifier
PW–6614–O
(Sheet 2 of 2)
3/31/89

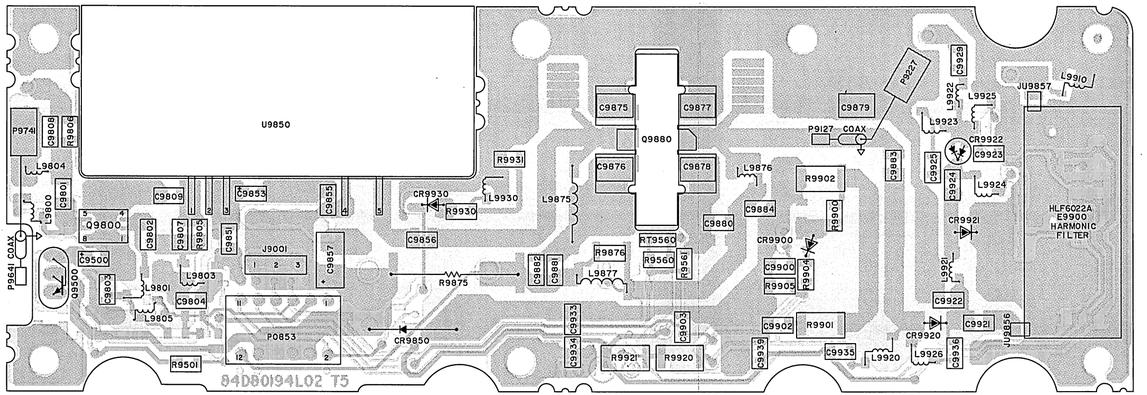
HLF6062A 30 WATT PA SCHEMATIC



Schematic, Circuit Board Diagrams, and Parts Lists
for HLF6062A *SPECTRA* 30 Watt Power Amplifier
PW–4711–C
(Sheet 1 of 2)
3/31/89

HLF6062A 30 WATT PA CITCUIT BOARD
COMPONENT SIDE

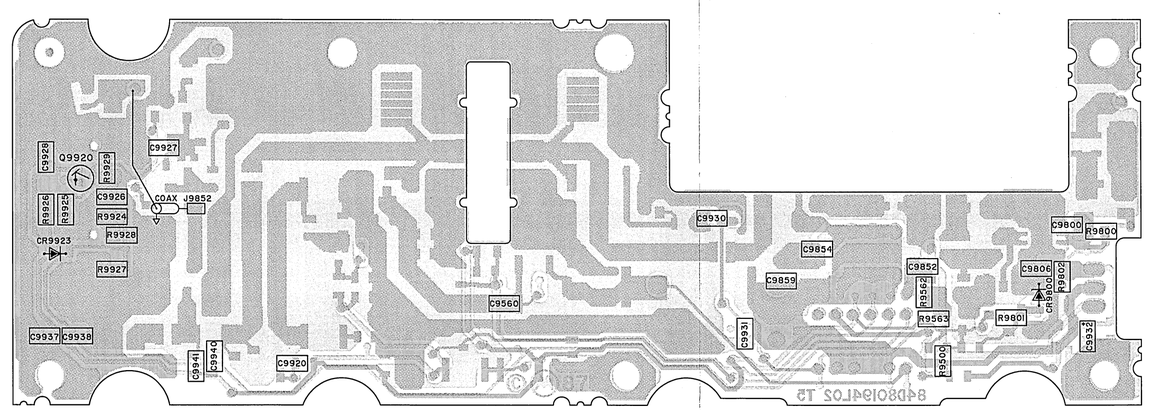
SOLDER SIDE — GPW-4698-B
COMPONENT SIDE — GPW-4697-B
OVERLAY — GXW-4699W01-C



84D80194L02 T5

SOLDER SIDE — GPW-4698-B
COMPONENT SIDE — GPW-4697-B
OVERLAY — GXW-4699W02-C

SOLDER SIDE



84D80194L02 T5

parts list

HLF6062A 30 Watt PA Board, 900 MHz — MXW–4654–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C9500	23–62998B59	1 uF, ±20%, 16V, tantalum
C9560	21–11031A26	30
C9800,9801	21–11031A06	2.7, ±.25 pF
C9802,9803	21–11031A26	30
C9804	21–11031A09	4.7, ±.25 pF
C9806–9808	21–11031A26	30
C9809	21–11031A01	1.0, ±.25 pF
C9851	21–11031A26	30
C9852	21–11032A33	0.1 uF, ±10%
C9853	23–62998B59	1 uF, ±20%, 16V, tantalum
C9854	21–11032A33	0.1 uF, ±10%
C9855	21–11031A26	30
C9856	21–11078B42	100, 100V
C9857	23–80090M24	10 uF, aluminum, +20–10%
C9859	21–11031A26	30
C9875,9876	21–80240G64	11
C9877,9878	21–80240G66	15
C9879	21–80240G67	2.2
C9880	21–11031A26	30
C9881	21–11032A33	0.1 uF, ±10%
C9882	21–11032A21	0.01 uF, ±10%
C9883	21–11078B27	30, 100V
C9884	21–11031A26	30
C9900	21–11031A26	30
C9902	21–11031A07	3.3
C9903	21–11031A26	30
C9920	21–11031A26	30
C9921	21–11078B27	30, 100V
C9922	21–11031A02	1.2
C9923	21–11031A01	1.0, ±.25 pF
C9924–9929	21–11031A26	30
C9930	21–11031A15	10
C9931	21–11031A26	30
C9932	23–62998B59	1 uF, ±20%, 16V, tantalum
C9933–9941	21–11031A26	30
diode (see note)		
CR9800	48–80066M01	signal, type RSL4148
CR9850	48–80236E07	hot carrier, zener, 28V
CR9900	48–80236E05	Schottky
CR9920,9921	48–80236E20	pin, 1.0W, type MA47059
CR9922	48–80142L01	pin, type MMBV3401
CR9923	48–80066M01	signal, type RSL4148
CR9930	48–80236E05	Schottky
connector receptacle		
J9001	29–80014A01	clip, coax terminal
jumper		
JU9856,9857	07–80299L01	frame lead, J–strap
coil, RF		
L9800	24–80091G23	7 turns, airwound
L9801	24–80091G24	5 turns, airwound
L9803	24–80091G24	5 turns, airwound
L9804	24–80091G06	2 turns, airwound
L9805	24–80091G23	7 turns, airwound
L9875	24–80202B02	RF choke
L9876	24–80090G04	3 turns, airwound
L9877	24–80090G05	8 turns, airwound
L9910	24–80091G32	6 turns, airwound
L9920	24–80091G32	6 turns, airwound
L9921	24–80091G40	2 turns, airwound
L9922	24–80091G06	2 turns, airwound
L9923–9926	24–80091G24	5 turns, airwound
L9930	24–80091G21	4 turns, airwound
connector plug		
P853	09–80103M04	receptacle, right angle, 12 position
P9127	30–80152M03	cable assembly, coax
P9227	29–80014A01	clip, coax terminal
P9641	30–80152M02	cable assembly, coax
P9741	29–80014A01	clip, coax terminal
transistor (see note)		
Q9500	48–00869806	NPN, audio power, type M9806 (p/o HLN6006A)
Q9800	48–80182D50	NPN, type MRF9372, 960 MHz
Q9920	48–80048M01	NPN, type 48M01
Q9880	48–80225C20	NPN, type CS12, 900 MHz, 45W
thermistor		
RT9560	06–80149M02	100k ohm

MXW–4654–A (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
resistor, fixed, ohm, ±5%, 1/4 watt (unless otherwise stated)		
R9500	06–11077A74	1k
R9501	06–11077A28	12
R9560	06–11077B11	33k
R9561	06–11077A90	4.7k
R9562	06–11077B11	33k
R9563	06–11077B21	82k
R9800	06–11077A54	150
R9801	06–11077A74	1k
R9802	06–11077A50	100
R9805,9806	06–11077A50	100
R9875	17–80228N01	resistor shunt
R9876	06–80195M01	10, .5 watt
R9900	06–11077A43	51
R9901,9902	06–80194M18	51, 1 watt
R9904	06–11077A98	10k
R9905	06–11077B19	68k
R9920,9921	06–80194M18	51, 1 watt
R9924–9927	06–11077A80	1.8k
R9928,9929	06–11077A01	jumper
R9930,9931	06–11077A50	100
integrated circuit (see note)		
U9850	51–80110E03	power module, RF, 900 MHz, 18–Watt
mechanical parts		
	26–80090N01	mid power fence shield
	26–80013M01	PA module shield
	54–80004N01	barcode label
	42–80177N01	ground clip (2 used)

9/21/88

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

parts list

HLF6022A Harmonic Filter Hybrid Board — MXW–4652–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
coil, rf		
L9910	24–80091G40	2 turns, airwound
L9911	24–80091G21	4 turns, airwound
L9912	24–80091G40	2 turns, airwound

9/21/88

Schematic, Circuit Board Diagrams, and Parts Lists
for HLF6062A *SPECTRA* 30 Watt Power Amplifier
PW–4711–C
(Sheet 2 of 2)
3/31/89

HLF6075A/HLF6082A 30 WATT PA SCHEMATIC

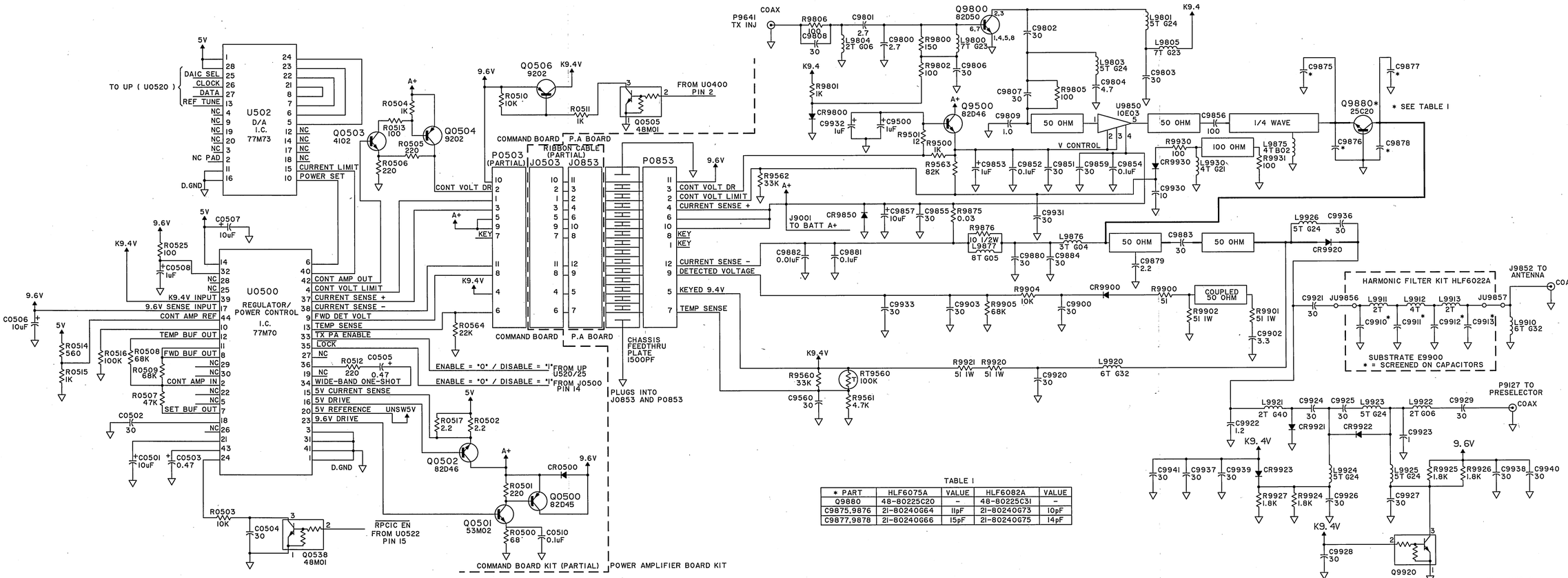


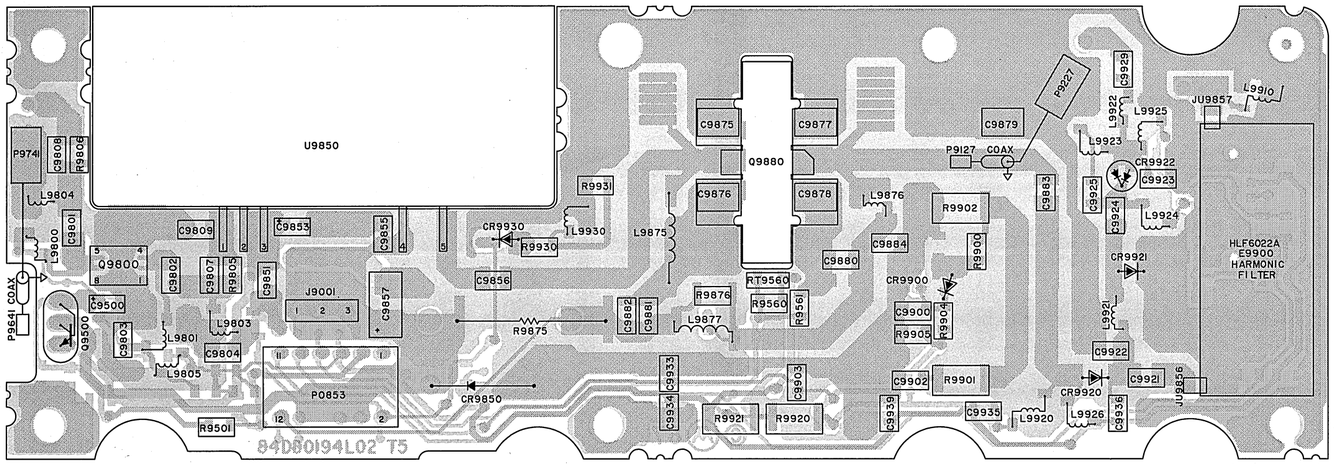
TABLE I

* PART	HLF6075A	VALUE	HLF6082A	VALUE
Q9880	48-80225C20	-	48-80225C31	-
C9875,9876	2I-80240G64	IIpF	2I-80240G73	I0pF
C9877,9878	2I-80240G66	I5pF	2I-80240G75	I4pF

Schematic, Circuit Board Diagrams, and Parts Lists for HLF6075A/HLF6082A
SPECTRA 30 Watt Power Amplifier
PW–6618–O
(Sheet 1 of 2)
3/31/89

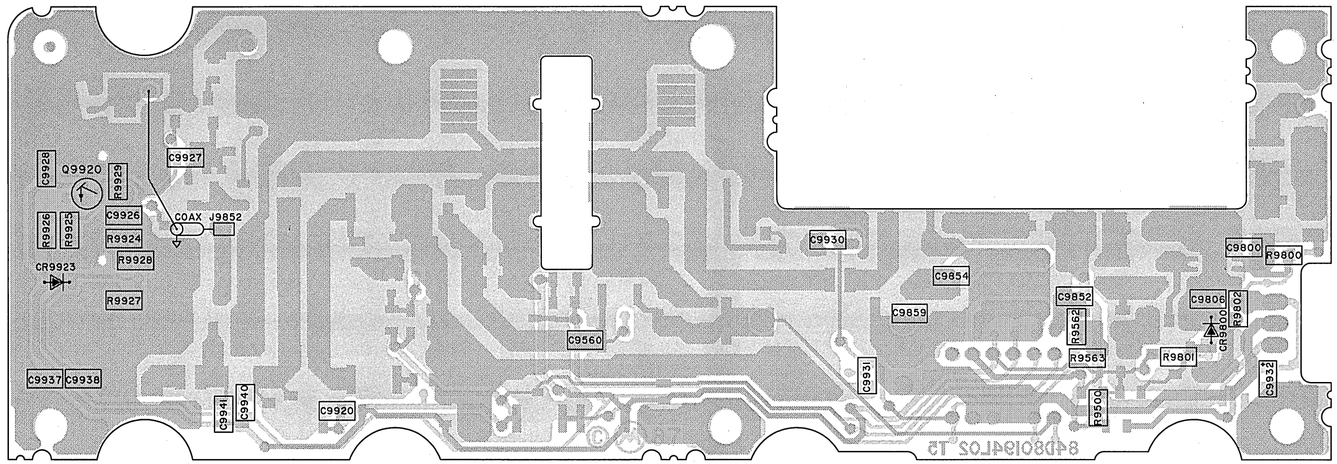
HLF6075A/HLF6082A 30 WATT PA CITCUIT BOARD
COMPONENT SIDE

SOLDER SIDE GPW-4698-B
COMPONENT SIDE GPW-4697-B
OVERLAY GXW-4699W01-C



SOLDER SIDE GPW-4698-B
COMPONENT SIDE GPW-4697-B
OVERLAY GXW-4699W02-C

SOLDER SIDE



parts list

HLF6075A/HLF6082A 900 MHz 30 Watt PA MXW–6620–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
capacitor, fixed, pF, ±5%, 50V (unless otherwise stated)		
C9500	23–11049A37	1 uF, ±20%, 25V
C9560	21–13740B36	30
C9800,9801	21–13740B11	2.7, ±.25 pF
C9802,9803	21–13740B36	30
C9804	21–13740B17	4.7, ±.25 pF
C9806–9808	21–13740B36	30
C9809	21–13740B01	1.0, ±.25 pF
C9851	21–13740B36	30
C9852	21–13741N69	100 uF, ±10%
C9853	23–11049A37	1 uF, ±20%, 25V
C9854	21–13741N69	100 uF, ±10%
C9855	21–13740B36	30
C9856	21–11078B42	100, 100V
C9857	23–80090M24	10, ±20%, 50V
C9859	21–13740B36	30
C9875,9876	—	250V (see Table 1 on schematic)
C9877,9878	—	250V (see Table 1 on schematic)
C9879	21–80240G67	2.2, ±11.4%, 250V
C9880	21–13740B36	30
C9881	21–13741N69	100 uF, ±10%
C9882	21–13741N45	0.01 uF, ±10%
C9883	21–11078B27	30, 100V
C9884	21–13740B36	30
C9900	21–13740B36	30
C9902	21–13740B13	3.3, ±.25 pF
C9903	21–13740B36	30
C9920	21–13740B36	30
C9921	21–11078B27	30, 100V
C9922	21–13740B03	1.2, ±.25 pF
C9923	21–13740B01	1.0, ±.25 pF
C9924–9929	21–13740B36	30
C9930	21–13740B25	12
C9931	21–13740B36	30
C9932	23–11049A37	1 uF, ±20%, 25V
C9933–9941	21–13740B36	30
diode (see note)		
CR9800	48–80066M01	signal, type RSL4148
CR9850	48–80236E07	hot carrier, zener, 28V
CR9900	48–80236E05	hot carrier, Schottky
CR9920,9921	48–80236E22	pin
CR9922	48–80142L01	pin, type MMBV3401
CR9923	48–80066M01	signal, type RLS4148
CR9930	48–80236E05	hot carrier, Schottky
connector receptacle		
J9001	29–80014A01	clip, coax terminal
jumper		
JU9856,9857	07–80299L01	frame, lead J–strap
coil, RF		
L9800	24–80091G23	airwound, 7 turns
L9801	24–80091G24	airwound, 5 turns
L9803	24–80091G24	airwound, 5 turns
L9804	24–80091G06	airwound, 2 turns
L9805	24–80091G23	airwound, 7 turns
L9875	24–80202B02	choke
L9876	24–80090G04	airwound, 3 turns
L9877	24–80090G05	airwound, 8 turns
L9910	24–80091G32	airwound, 6 turns
L9920	24–80091G32	airwound, 6 turns
L9921	24–80091G40	airwound, 2 turns
L9922	24–80091G06	airwound, 2 turns
L9923–9926	24–80091G24	airwound, 5 turns
L9930	24–80091G21	alrouwnd, 4 turns
connector plug		
P853	09–80103M04	right angle receptical
P9227	29–80014A01	clip, coax terminal
P9741	29–80014A01	clip, coax terminal
translstor (see note)		
Q9800	48–80182D50	NPN
Q9880	—	NPN (see Table 1 on schematic)
Q9920	48–80048M01	NPN
thermistor		
RT9560	06–80149M02	100k ohm
resistor, fixed, ohm, ±5%, 1/8 watt (unless otherwise stated)		
R9500	06–11077A74	1k
R9501	06–11077A28	12
R9560	06–11077B11	33k
R9561	06–11077A90	4.7
R9562	06–11077B11	33k
R9563	06–11077B21	82k
R9800	06–11077A54	150
R9801	06–11077A74	1k
R9802	06–11077A50	100
R9805	06–11077A50	100
R9806	06–11077A50	100
R9875	17–80228N01	resistor shunt
R9876	06–80195M01	10, .5 watt
R9900	06–11077A43	51
R9901,9902	06–80194M18	51, 1 watt
R9904	06–11077A98	10k
R9905	06–11077B19	68k
R9920,9921	06–80194M18	51, 1 watt
R9924–9927	06–11077A90	1.8k
R9928,9929	06–11077A01	jumper
R9930,9931	06–11077A50	100

MXW–6620–O (2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
integrated circuit (see note)		
U9850	51–80110E03	power module, RF, 900 MHz, 18 watt
	mechanical parts	
	26–80090N01	mid power fence shield
	26–80013M01	PA module shield
	54–80004N01	barcode label
	42–80177N01	ground clip (2 used)

05/11/89

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

parts list

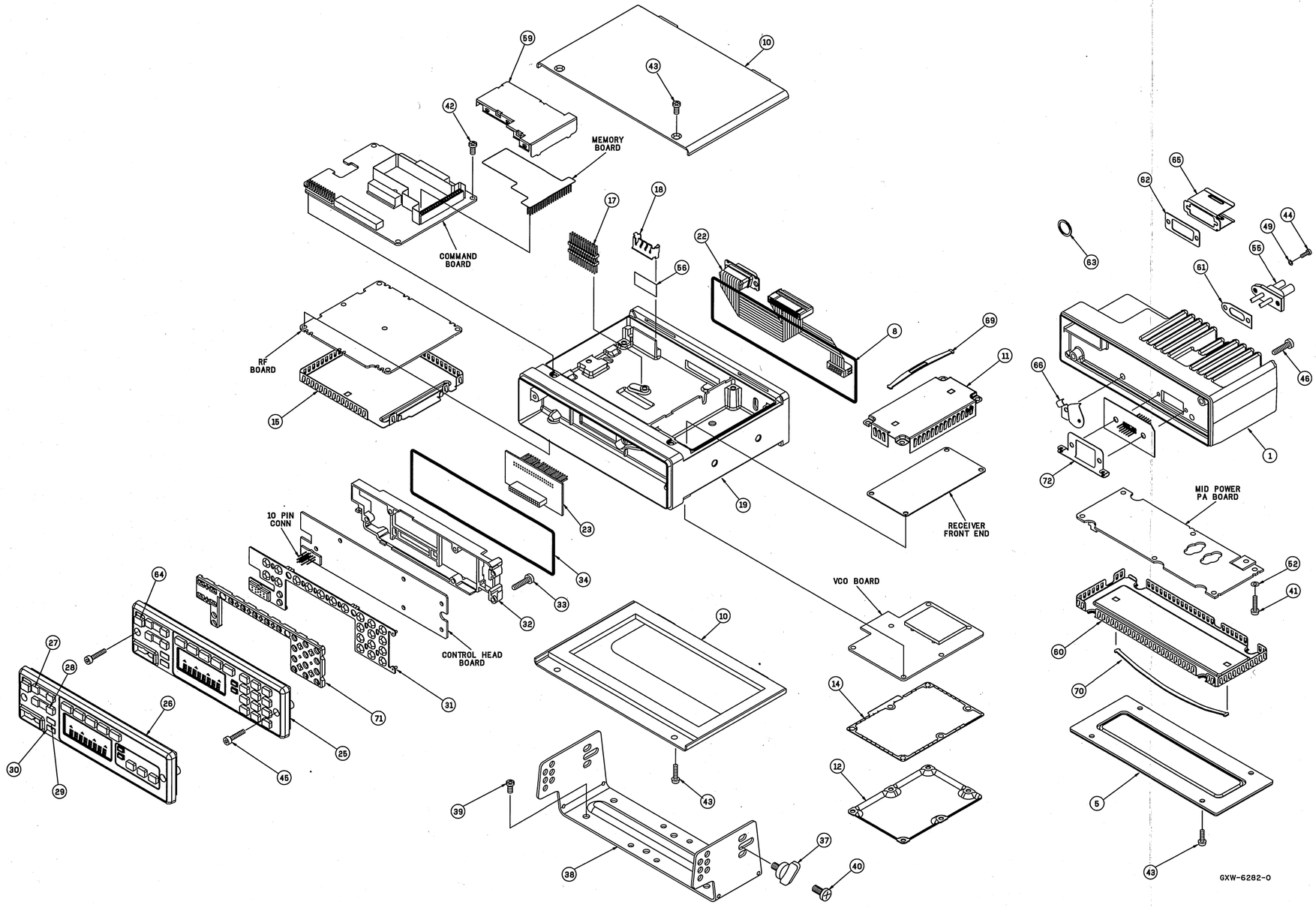
HLF6022A Harmonic Filter Hybrid Board (Later Version) MXW–4652–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
coil, rf		
L9911	24–80091G40	2 turns, airwound
L9912	24–80091G21	4 turns, airwound
L9913	24–80091G40	2 turns, airwound

3/31/89

note: designators L9910,l9911,L9912 for HLF6052A and HLF6062A

Schematic, Circuit Board Diagrams, and Parts Lists for HLF6075A/HLF6082A *SPECTRA* 30 Watt Power Amplifier
PW–6618–O
(Sheet 2 of 2)
3/31/89



parts list

VHF *SPECTRA* Mechanical Parts Exploded View (BK Model) MXW–6283–O

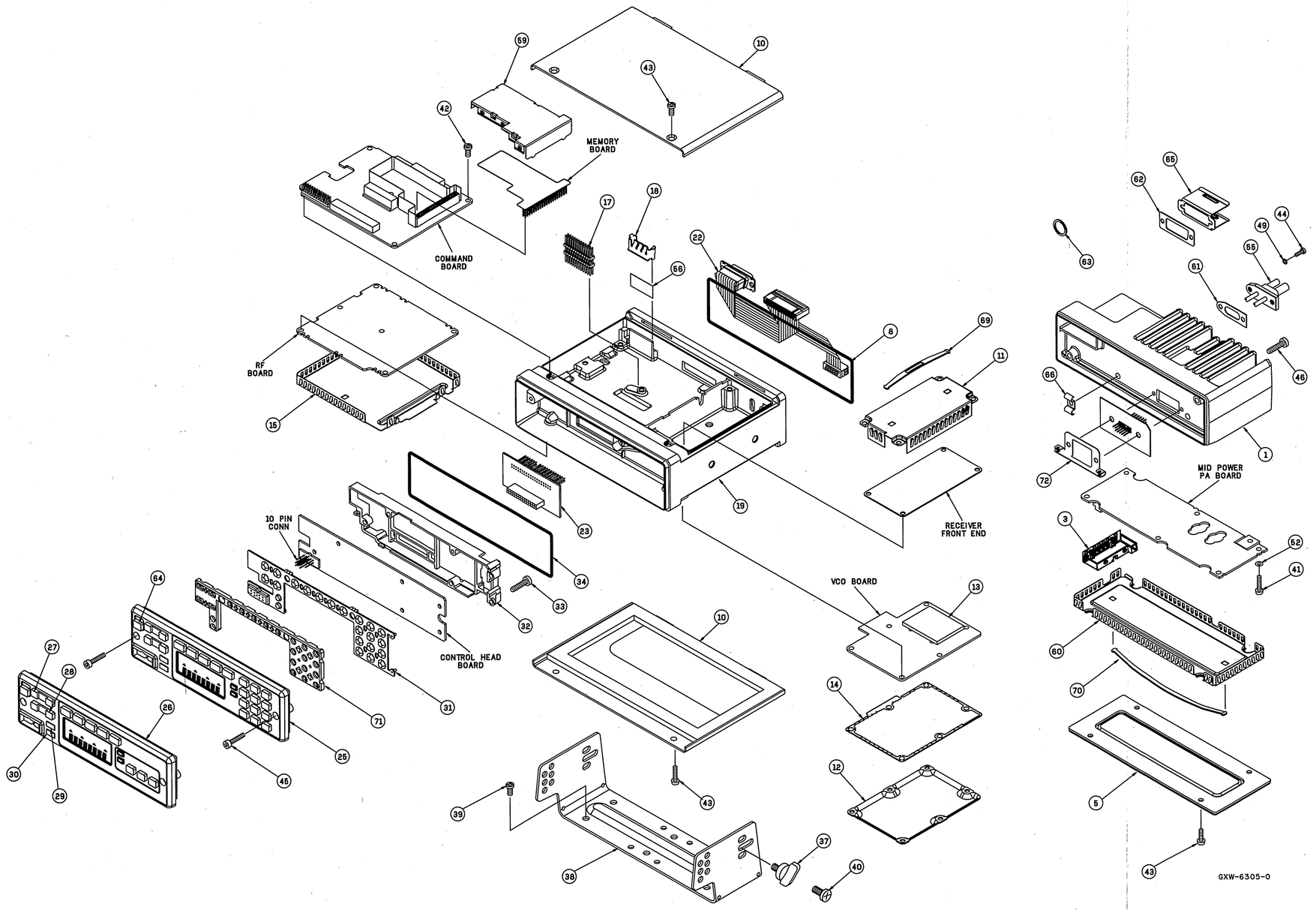
ITEM	MOTOROLA PART NO.	DESCRIPTION
1	26–80010M02	heatsink, mid–power
5	15–80048N01	cover, mid–power PA
8	32–80059P01	gasket, heatsink
10	15–80264N01	cover, includes gasket
11	15–80098L01	shield, receiver front–end
12	15–80097L01	cover, VCO board
14	32–80247N01	gasket, VCO
15	15–80099L01	shield, RF board
17	28–80260M01	header, floating
18	42–80007M01	clip, regulator
19	27–80082N01	chassis, consolidated
22	30–80239N02	cable, PA ribbon
23	HLN6066A	interconnect board
25	15–80010P01	housing, front cover, with keypad
26	15–80010P02	housing, front cover, without keypad
27	38–80009P01	pushbutton rocker, MODE
28	38–80009P02	pushbutton rocker, VOLUME
29	38–80092J01	pushbutton key, DIM
30	38–80092J02	pushbutton key, HOME
31	75–80189L03	keypad
32	43–80269N01	spacer, internal frame
33	03–10945A14	screw, tapping (6 used)
34	32–80289L01	gasket, housing
37	03–84244C06	screw, machine, wing 5.0 x 0.8 x 10
38	07–80086N01	trunnion, mounting
39	03–00136756	screw, tapping, 10–16 x 5/8 (6 used)
40	03–80114M02	screw, machine, 5 x 0.8 x 10 (4 used)
41	03–10911A10	screw, machine, 3.5 x 0.5 x 6
42	03–10943M15	screw, tapping, 3.5 x 0.6 x 8 (board mtg)
43	03–80102P01	screw, tapping, 3.5 x 0.6 x 10 (8 used)
44	03–80043L01	screw, metric, 3.0 x 10 (4 used)
45	03–80077M01	screw, control head mounting (2 used)
46	03–80077M02	screw, hex socket (2 used)
52	04–80217E01	washer, compression
55	09–80272N01	connector, power
56	14–80001M01	insulator, regulator
59	26–80118M01	shield, command board
60	26–80186M01	shield, PA
61	32–80015M01	gasket, power connector
62	32–80088M01	gasket, accessory connector
63	32–80089M02	gasket, antenna
64	38–80227M02	cap, on/off switch
65	42–80016M03	clip, accessory connector
66	42–80264M02	clip, coax, PA
69	55–84300B01	handle (2 used)
70	55–84300B04	handle
71	61–80186L01	lightpipe
72	42–80192N01	clip, coax

non–referenced parts

	26–80119M01	shield, command board fence
	75–05295B01	pad, crystal
	75–80094M03	shock pad, VF display (3 used)

2/15/89

Mechanical Exploded View and Parts List for
SPECTRA VHF Radios (BK Suffixed Models)
PW–6281–O
2/15/89



parts list

UHF *SPECTRA* Mechanical Parts Exploded View (BK Suffixed Models) MXW–6304–O

ITEM	MOTOROLA PART NO.	DESCRIPTION
1	26–80010M02	heatsink, mid–power
3	26–80189N01	shield, PA board
5	15–80048N01	cover, mid–power PA
8	32–80053P01	gasket, heatsink
10	15–80264N01	cover, includes gasket
11	15–80098L01	shield, receiver front–end
12	15–80097L01	cover, VCO board
13	15–80223N02	cover, VCO hybrid
14	32–80247N01	gasket, VCO
15	15–80099L01	shield, RF board
17	28–80260M01	header, floating
18	42–80007M01	clip, regulator
19	27–80082N01	chassis, consolidated
22	30–80239N02	cable, PA ribbon
23	HLN6066A	interconnect board
25	15–80010P01	housing, front cover, with keypad
26	15–80010P02	housing, front cover, without keypad
27	38–80009P01	pushbutton rocker, MODE
28	38–80009P02	pushbutton rocker, VOLUME
29	38–80092J01	pushbutton key, DIM
30	38–80092J02	pushbutton key, HOME
31	75–80198L03	keypad
32	43–80269N01	spacer, internal frame
33	03–10945A14	screw, tapping (6 used)
34	32–80289L01	gasket, housing
37	03–84244C06	screw, machine, wing 5.0 x 0.8 x 10
38	07–80086N01	trunnion, mounting
39	03–00136756	screw, tapping, 10–16 x 5/8 (6 used)
40	03–80119M02	screw, machine, 5 x 0.8 x 10 (4 used)
41	03–10911A10	screw, machine, 3.5 x 0.5 x 6
42	03–10943M15	screw, tapping, 3.5 x 0.6 x 8 (board mtg)
43	03–80102P01	screw, tapping, 3.5 x 0.6 x 10 (8 used)
44	03–80043L01	screw, metric, 3.0 x 10 (4 used)
45	03–80077M01	screw, control head mounting (2 used)
46	03–80077M02	screw, hex socket (2 used)
49	04–00131974	washer, flat
52	04–80217E01	washer, compression
55	09–80272N01	connector, power
56	14–80001M01	insulator, regulator
59	26–80118M01	shield, command board
60	26–80186M01	shield, PA
61	32–80015M01	gasket, power connector
62	32–80088M01	gasket, accessory connector
63	32–80089M02	gasket, antenna
64	38–80227M02	cap, on/off switch
65	42–80016M03	clip, accessory connector
66	42–80281N01	clip, coax, PA
69	55–84300B01	handle (2 used)
70	55–84300B04	handle
71	61–80186L01	lightpipe
72	42–80192N01	clip, coax
	non–referenced parts	
	75–05295B01	pad, crystal
	75–80094M03	shock pad, VF display (3 used)

9/15/88

Mechanical Exploded View and Parts List
for *SPECTRA* UHF Radio (BK Suffixed Models)
PW–6303–O
2/20/89

parts lists

HLN6080A Remote Mount Kit Mechanical Parts Exploded View — MXW–5434–B

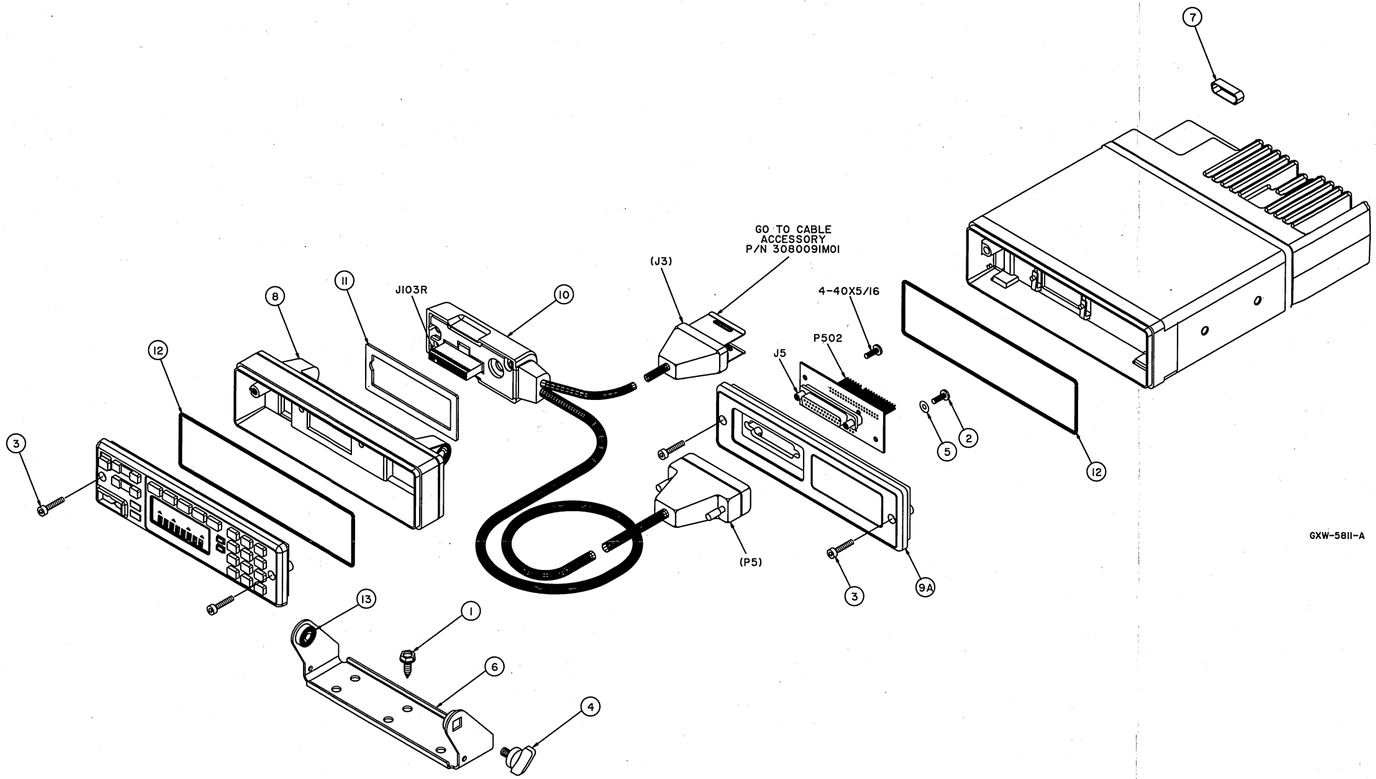
ITEM NO.	MOTOROLA PART NO.	DESCRIPTION
1	03–00136756	screw, tapping, 10–16 x 5/8 (6 used)
2	03–10945A11	screw, tapping, P3.12 x 1.27 x 8 (2 used)
3	03–80077M01	screw, front mounting (2 used)
4	03–80160E01	screw, wing, M5.0 x 0.8 x 10 (2 used)
5	04–83045H01	thrust washer (2 used)
6	07–80127N01	trunnion, remote dash
7	15–80005G01	cover, dust
8	15–80293L01	housing, back remote
9A	15–80062P04	housing, front remote
10	30–80157M01	control cable assembly
11	32–80231M01	gasket, connector
12	32–80289L01	gasket, housing
13	43–80128N01	spacer, trunnion (2 used)

10/5/88

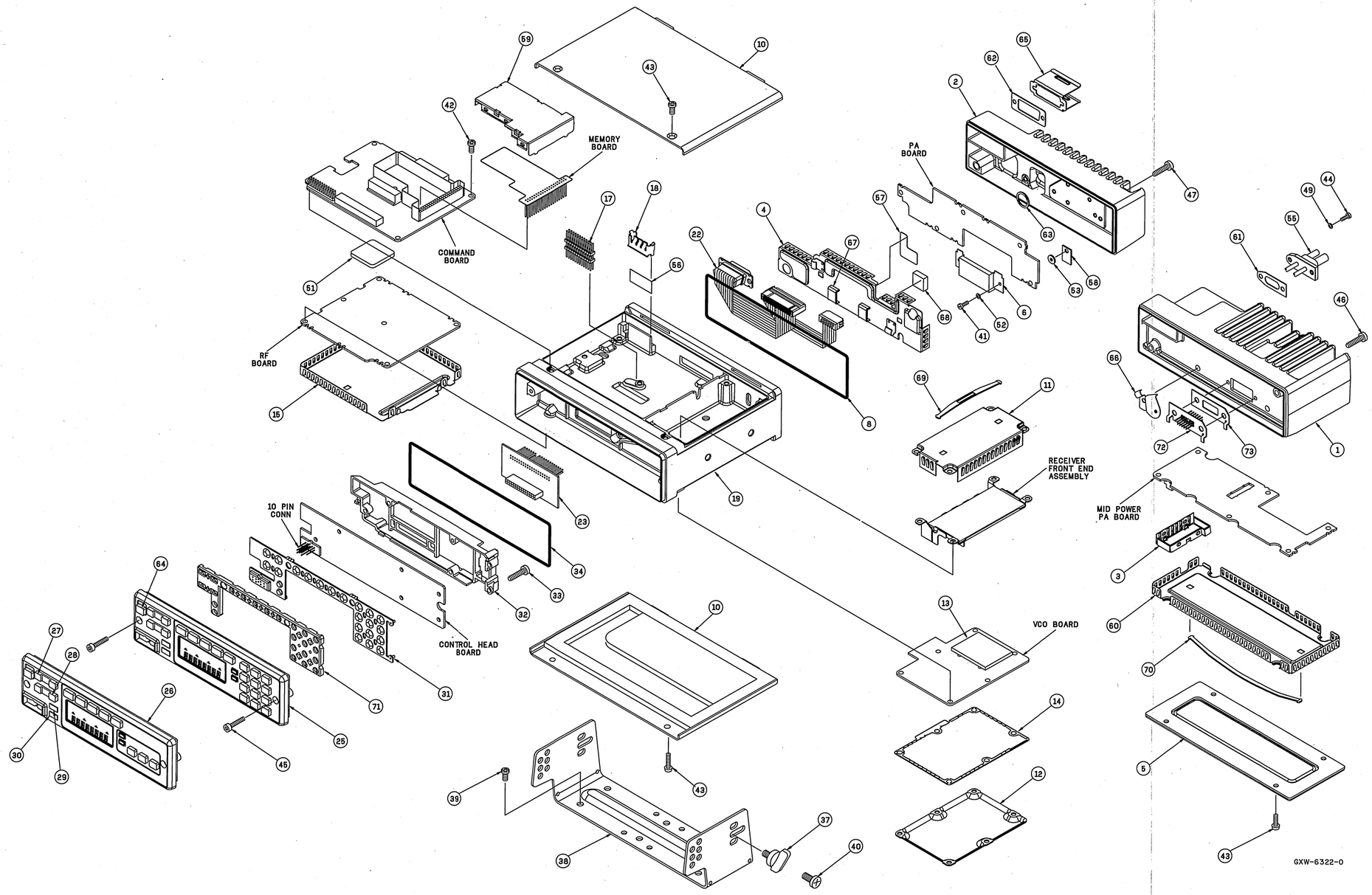
HKN4192A 17' Mobile Power Cable — MXW–5107–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
fuse		
F2	65–80236E06	blade type, 15 A
	mechanical part	
	29–00832116	lug ring (2 used)

8/26/88



Mechanical Exploded View and Parts Lists
for Remote Mount Control Head
for *SPECTRA* VHF and UHF Radio
PW–5810–B
2/15/89



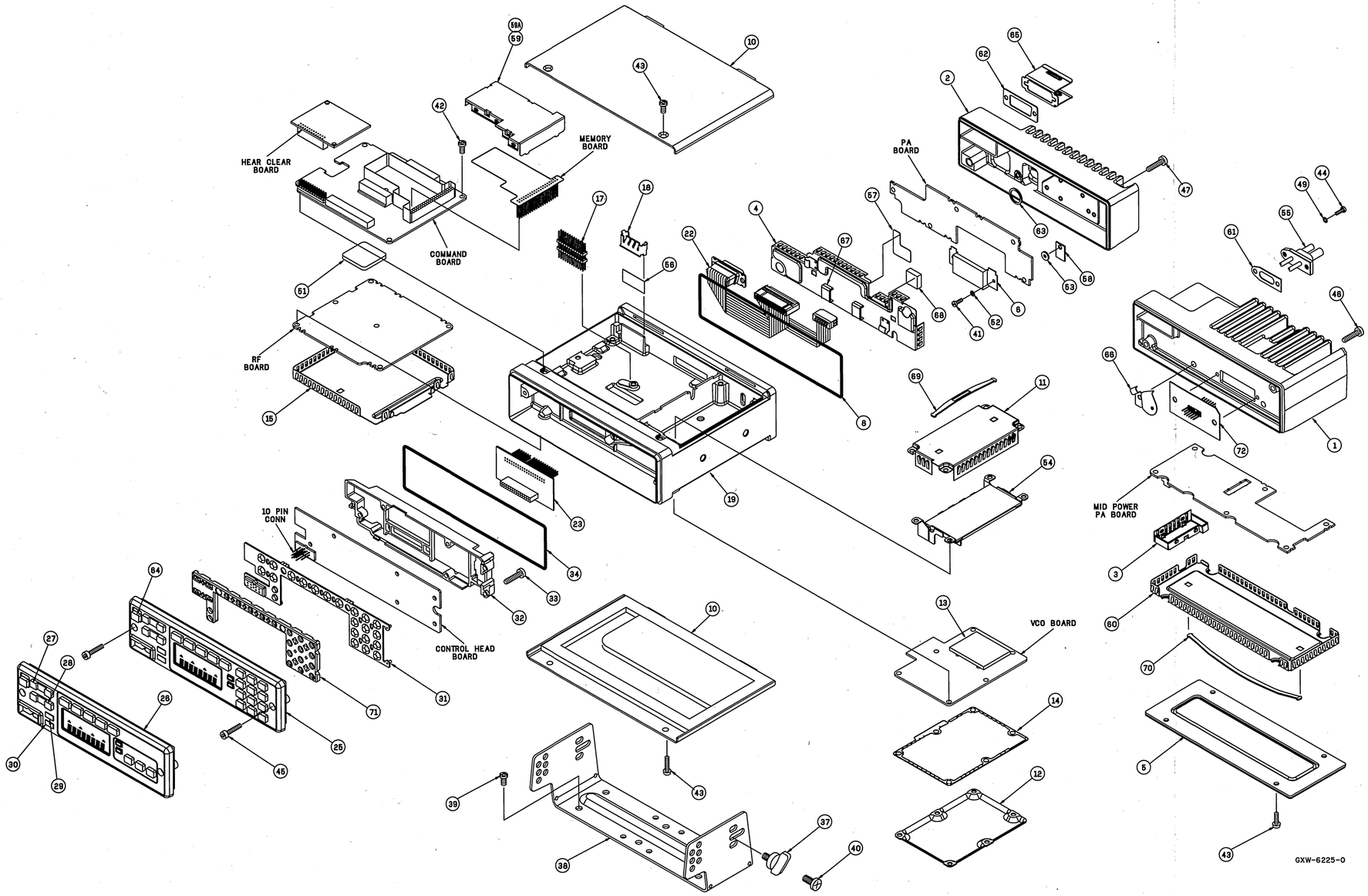
parts list

SPECTRA Mechanical Parts Exploded View — MXW–6321–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	26–80010M02	heatsink 35–watt
2	26–80009M02	heatsink 15–watt
3	26–80105N01	shield, 35–watt PA board
4	26–80099P01	shield, 15–watt PA board
5	15–80048N01	cover, 35–watt PA
6	26–80013M01	shield, power module
8	32–80053P01	gasket, heatsink
10	15–80264N01	cover, includes gasket (2 used)
11	15–80098L01	shield, receiver front end
12	15–80097L01	cover, VCO board
13	15–80239N02	cover VCO hybrid
14	32–80247N01	gasket, VCO
15	15–80099L01	shield RF board
17	28–80260M01	header, floating
18	42–80007M01	clip, regulator
19	27–80082N01	chassis, consolidated
22	30–80239N02	cable, PA ribbon
23	HLN6066A	interconnect board
25	15–80010P01	housing, front cover, with keypad
26	15–80010P02	housing, front cover, without keypad
27	38–80009P01	pushbutton rocker, "MODE"
28	38–80009P02	pushbutton rocker, "VOLUME"
29	38–80092J01	key, "DIM"
30	38–80092J02	key, "HOME"
31	75–80189L03	keypad
32	43–80269N01	spacer, internal frame
33	03–10945A14	screw, tapping (6 used)
34	32–80289L01	gasket, housing
37	03–84244C06	screw, machine, wing 5.0 x .8 x 10
38	07–80086N01	trunnion, mounting
39	03–00136756	screw, tpg, instl hrdwr 10–16 x 5/8 (6)
40	03–80114M02	screw, mach, instl hrdwr 5 x .8 x 10 (4)
41	03–10911A11	screw, mach, 3 x .5 x 8 (35W–4; 15W–2)
42	03–10943M15	screw, tpg, 3.5 x .6 x 8 (board mtg)
43	03–80102P01	screw, tpg, 3.5 x .6 x 10 (35W–8; 15W–4)
44	03–80043L01	screw, metric, 3 x 10 (4 used)
45	03–80077M01	screw, control head mount (2 used)
46	03–80077M02	screw, hex socket (35W; 2 used)
47	03–80077M03	screw, hex socket (15W; 2 used)
49	04–00131974	washer, flat, .13 x .312 x .03 (2 used)
51	75–82200H01	pad
52	04–80217E01	washer, compression (3 used)
53	04–84180C01	washer, shoulder
55	09–80272N01	connector, power
56	14–80001M01	insulator, regulator
57	14–80143M01	insulator, shield
58	14–80179A01	insulator, alumina
59	26–80118M01	shield, command board
60	26–80186M01	shield, 35W PA
61	32–80015M01	gasket, power connector
62	32–80088M01	gasket, accessory connector
63	32–80089M02	gasket, antenna
64	38–80227M02	cap, on/off switch
65	42–80016M03	clip, accessory connector
66	42–80264M02	clip, coax 35W PA
67	42–80265M02	clip, coax 15W PA (2 used)
68	43–80104N01	spacer, 15W PA shield
69	55–84300B01	handle (2 used)
70	55–84300B04	handle
71	61–80186L01	lightpipe
72	64–80261N01	PA feed–thru assembly, 35W
73	42–80169P01	feed–thru clip
	non–referenced parts	
	03–10911A12	screw, machine, 3 x .5 x 10
	26–80090N01	shield, 35W fence
	26–80119M01	shield, command board fence
	75–05295B01	pad, crystal
	75–80094M03	shock pad, VF display (3 used)

3/01/89

Mechanical Exploded View and Parts list for *SPECTRA 800* Radio
PW–6323–O
3/01/89



parts list

SPECTRA Mechanical Parts Exploded View — MXW–6224–O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	26–80010M02	heatsink 30–watt
2	26–80009M02	heatsink 12–watt
3	26–80105N01	shield, 30–watt PA board
4	26–80011M01	shield, 12–watt PA board
5	15–80048N01	cover, 30–watt PA
6	26–80013M01	shield, power module
8	32–80038N01	gasket, heatsink
10	15–80264N01	cover, includes gasket (2 used)
11	15–80098L01	shield, receiver front end
12	15–80097L01	cover, VCO board
13	15–80223N02	cover VCO hybrid
14	32–80247N01	gasket, VCO
15	15–80099L01	shield RF board
17	28–80260M01	header, floating
18	42–80007M01	clip, regulator
19	27–80082N01	chassis, consolidated
22	30–80239N02	cable, PA ribbon
23	HLN6066A	interconnect board
25	15–80010P01	housing, front cover, with keypad
26	15–80010P02	housing, front cover, without keypad
27	38–80009P01	pushbutton rocker, "MODE"
28	38–80009P02	pushbutton rocker, "VOLUME"
29	38–80092J01	key, "DIM"
30	38–80092J02	key, "HOME"
31	75–80189L03	keypad
32	43–80268N01	spacer, internal frame
33	03–10945A14	screw, tapping (6 used)
34	32–80289L01	gasket, housing
37	03–84244C06	screw, machine, wing 5.0 x .8 x 10
38	07–80086N01	trunnion, mounting
39	03–00136756	screw, tpg, instl hrdwr 10–16 x 5/8 (6)
40	03–80114M02	screw, mach, instl hrdwr 5 x .8 x 10 (4)
41	03–10911A11	screw, mach, 3 x .5 x 8 (12W–2; 30W–4)
42	03–10943M15	screw, tpg, 3.5 x .6 x 8 (board mtg)
43	03–80102P01	screw, tpg, 3.5 x .6 x 10 (30W–8; 12W–4)
44	03–80043L01	screw, metric, 3 x 10 (4 used)
45	03–80077M01	screw, control head mount (2 used)
46	03–80077M02	screw, hex socket (30W; 2 used)
47	03–80077M03	screw, hex socket (12W; 2 used)
49	04–00131974	washer, flat, .13 x .312 x. .03 (2 used)
51	75–82200H01	pad
52	04–80217E01	washer, compression (3 used)
53	04–84180C01	washer, shoulder
54	07–80031P01	bracket, receiver front–end
55	09–80272N01	connector, power
56	14–80001M01	insulator, regulator
57	14–80143M01	insulator, shield
58	14–80179A01	insulator, alumina
59	26–80118M01	shield, command board
60	26–80186M01	shield, 30W PA
61	32–80015M01	gasket, power connector
62	32–80088M01	gasket, accessory connector
63	32–80089M02	gasket, antenna
64	38–80227M02	cap, on/off switch
65	42–80016M03	clip, accessory connector
66	42–80264M02	clip, coax 30W PA
67	42–80265M01	clip, coax 12W PA (2 used)
68	43–80104N01	spacer, 12W PA shield
69	55–84300B01	handle (7 used)
70	55–84300B04	handle
71	61–80186L01	lightpipe
72	64–80261N01	PA feed–thru assembly, 30W

non–referenced parts

03–10911A12	screw, machine, 3 x .5 x 10
07–80259M01	frame, preselector lead, RXFE
07–80299L01	frame, lead, J–strap
26–80002M01	shield, injection filter
26–80010N01	shield, receiver front–end
26–80084N01	shield, harmonic filter
26–80090N01	shield, 30W fence
26–80119M01	shield, command board fence
29–84985K01	lug, solder, RXFE
29–80258M01	lug, solder, RXFE
30–80138M11	cable, coax, RXFE
43–80121M01	spacer, HearClear board
64–80262N01	low–power feed–thru assembly
75–05295B01	pad, crystal
75–80094M03	shock pad, VF display (3 used)

2/15/89

Mechanical Exploded View and Parts list for *SPECTRA 900* Radio
PW–6226–O
2/15/89

parts lists

HKN4192A 17' Mobile Power Cable — MXW–5107–D

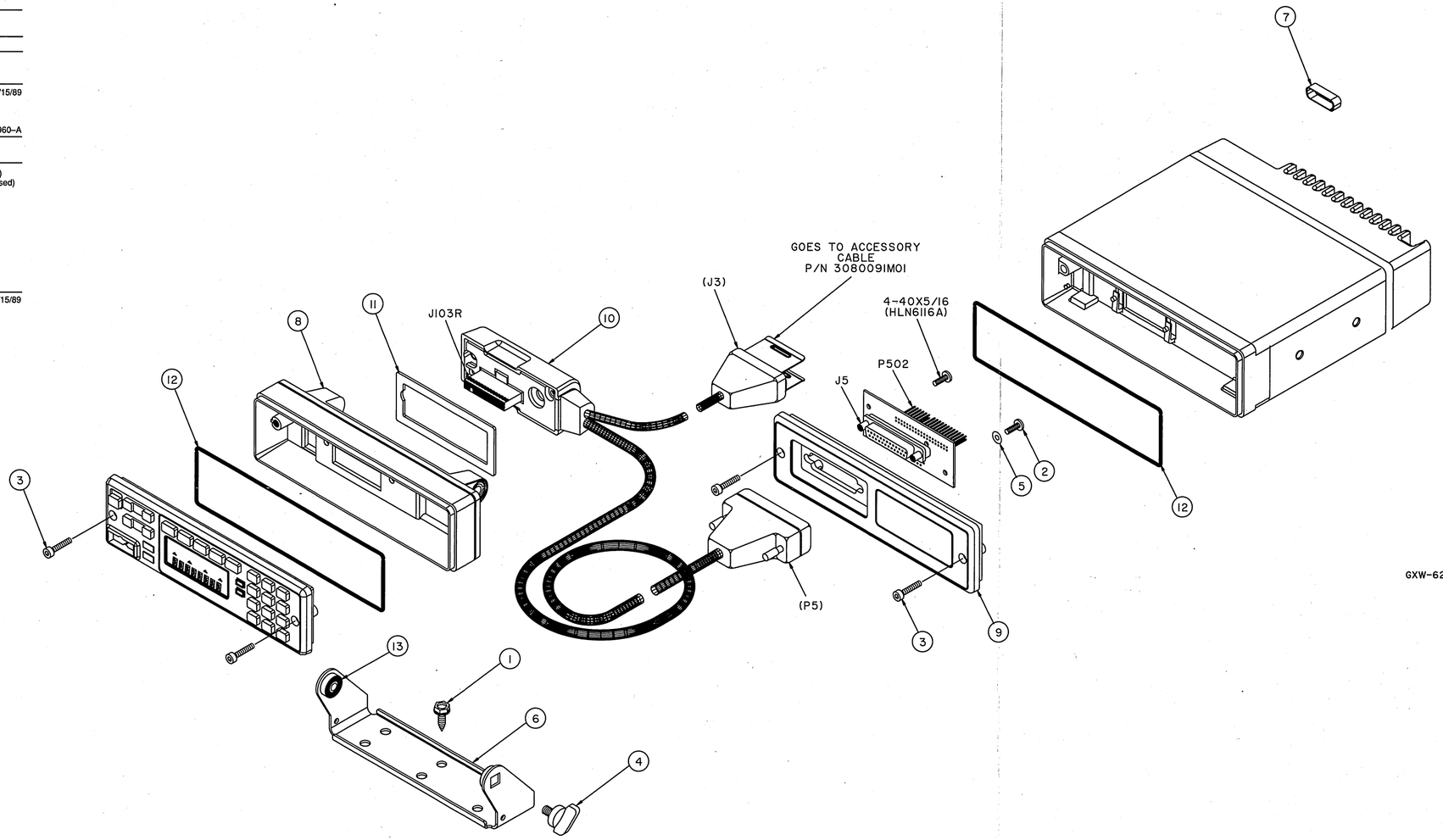
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
fuse		
F2	65–80236E06	blade type, 15 A
	mechanical part	
	29–00832116	lug, ring (2 used)
	30–80094G01	cable, power adapter
	30–80095G04	cable, power

2/15/89

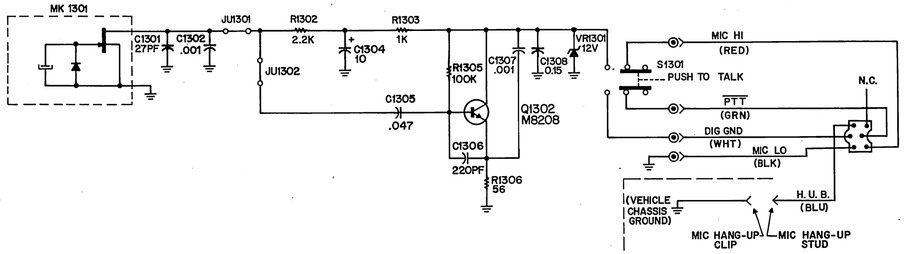
HLN6080A Remote Mount Kit Mechanical parts Exploded View — MXW–5960–A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	03–00136756	screw, machine, 10–16 x 5/8 (4 used)
2	03–10945A11	screw, tapping, P3.12 x 1.27 x 8 (2 used)
3	03–80077M01	screw, front mount (2 used)
4	03–84244C06	screw, wing (2 used)
5	04–83045H01	washer, thrust (2 used)
6	07–80127N01	trunnion, remote mount
7	15–80005G01	cover, dust
8	15–80293L01	housing, back remote
9	15–80062P04	housing, front remote
10	30–80157M01	control cable assembly
11	32–80231M01	gasket connector
12	32–80289L01	gasket, housing
13	43–80128N01	spacer, trunnion (2 used)

2/15/89

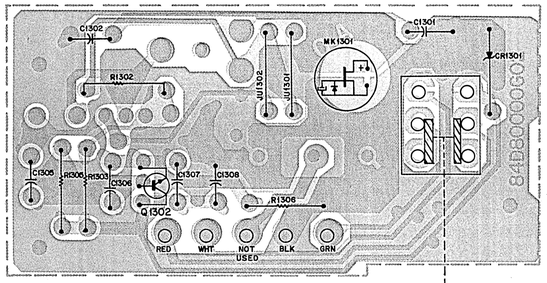


Mechanical Exploded View and Parts Lists
for Remote Mount Control head
for *SPECTRA* Radio
PW–6228–O
2/15/89



GCW-2050-A

MICROPHONE CONNECTOR J104 (DETAIL SHOWN FROM CONNECTOR FRONT VIEW)



SHOWN FROM SOLDER SIDE

S1301 PTT.

COMPONENT SIDE GBW-3447-A
SOLDER SIDE GBW-3448-A
OVERLAY – GBW-3449-A

parts list

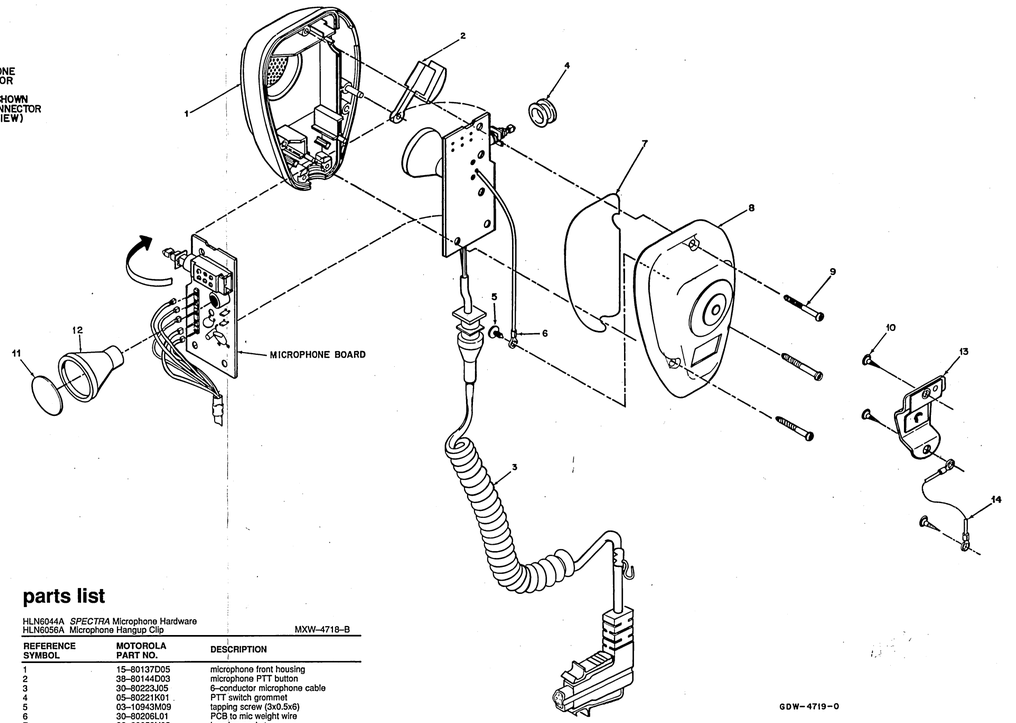
HLN4384B Microphone Circuit Board — MXW–2051–C

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.

EARLY VERSION MICROPHONE



GDW–4719–O

parts list

HLN6044A *SPECTRA* Microphone Hardware
HLN6056A Microphone Hangup Clip — MXW–4718–B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	15–80137D05	microphone front housing
2	38–80144D03	microphone PTT button
3	30–80223J05	6–conductor microphone cable
4	05–80221K01	PTT switch grommet
5	03–10943M09	tapping screw (3x0.5x6)
6	30–80206L01	PCB to mic weight wire
7	32–80058H03	housing gasket
8	01–80750T91	microphone rear housing
9	03–80076E04	hi–lo metruc screw
10	03–00139913	tapping screw (3 used)
11	35–80089D01	microphone felt baffle
12	05–80148D01	microphone grommet
13	01–80743T91	hangup clip
14	01–80736T05	ground wire

8/26/88

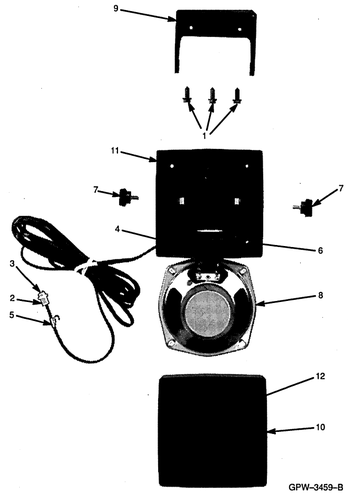
SPEAKER

parts list

HSN4018A Speaker — MXW–2053–D

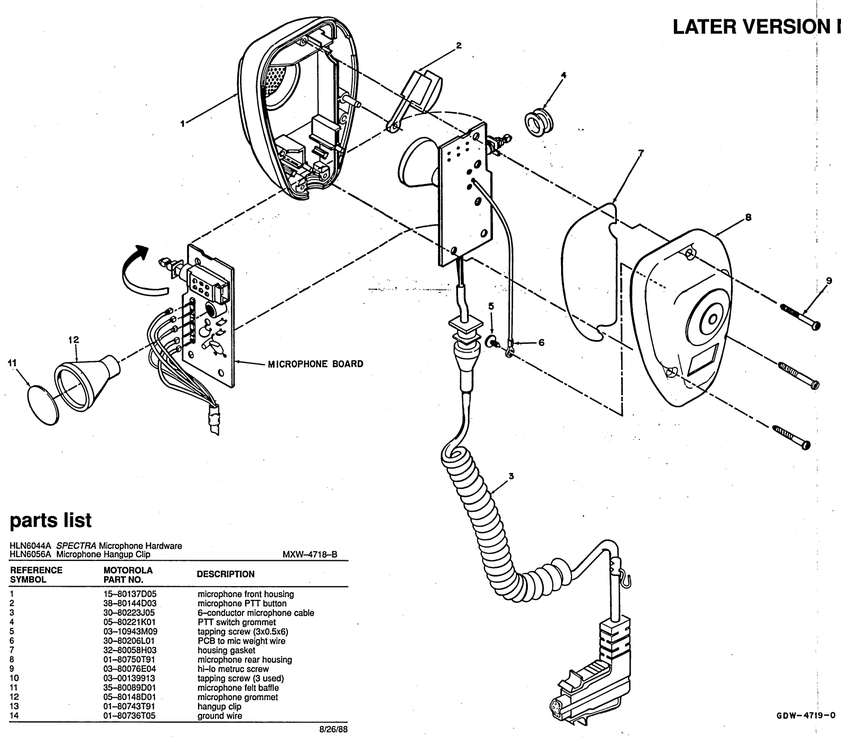
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	03–00136756	tapping screw (10–16x 5/8)
2	15–10183A18	connector housing plug, 2–contact
3	39–10184A45	contact plug, 2 used
4	42–82018H05	cable retainer
5	42–84081A03	wire clamp with S–hook
6	03–00140001	tapping screw (6–19 x 7/8), 4 used
7	03–84244C03	black shadow wing screw, 2 used
8	50–84561B01	speaker
9	07–80200E01	black speaker trunnion bracket
10	13–82671M04	bezel
11	15–84981B07	speaker base cover
12	32–84564B01	speaker gasket

3/31/89



GPW–3459–B

Schematic, Circuit Board Diagram,
Exploded Views and Parts Lists for Accessories
68P80102W17–B
(Sheet 1 of 2)
3/31/89



GDW-4719-O

parts list

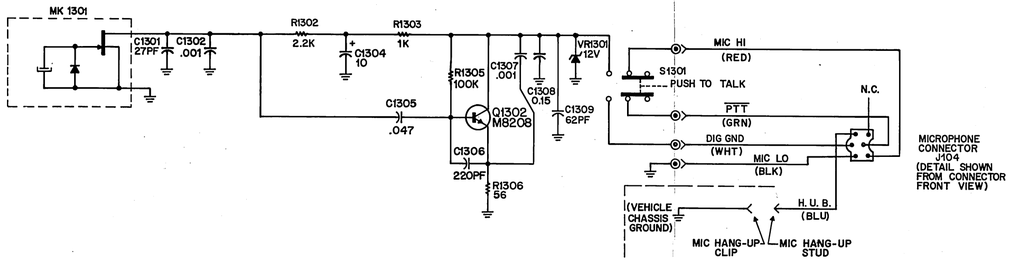
HLN6044A *SPECTRA* Microphone Hardware
HLN6056A Microphone Hangup Clip — MXW-4718-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	15-80137D05	microphone front housing
2	38-80144D03	microphone PTT button
3	30-80223J05	6-conductor microphone cable
4	05-80221K01	PTT switch grommet
5	03-10943M09	tapping screw (3x0.5x6)
6	30-80206L01	PCB to mic weight wire
7	32-80058H03	housing gasket
8	01-80750T91	microphone rear housing
9	03-80076E04	hi-lo metruc screw
10	03-00139913	tapping screw (3 used)
11	35-80089D01	microphone felt baffle
12	05-80148D01	microphone grommet
13	01-80743T91	hangup clip
14	01-80736T05	ground wire

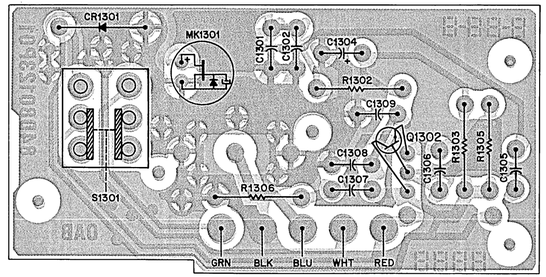
8/26/88

Schematic, Circuit Board Diagram,
Exploded Views and Parts Lists for Accessories
68P80102W17-B
(Sheet 2 of 2)
3/31/89

LATER VERSION MICROPHONE



GCW-6290 O



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	21-11038B13	.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.