ASTRO® Digital Spectra®
Clean Cab Railroad Radio

MOTOROLA
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Detailed Service Manual

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Clean Cab Railroad Radio
Detailed Service Manual

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FORWARD

This manual provides details on radio operation and sufficient information to enable qualified service technicians to troubleshoot and repair ASTRO® Digital Spectra® Clean Cab Railroad radios to the component level. For the most part, the information in this manual pertains the unique boards and functionality of the Clean Cab Railroad radio. Detailed information on the ASTRO® Digital Spectra® transceiver module can be found in the ASTRO® Digital Spectra® Basic and Detailed Service Manuals. A list of related publications is provided in section **1.2 Related Publications**.

Product Safety and RF Exposure Compliance

Caution

Before using this product, read the RF energy awareness information and operating instructions in the Product Safety and RF Exposure booklet enclosed with your radio.

ATTENTION!

This radio is restricted to occupational use only to satisfy FCC RF energy exposure requirements. Before using this product, read the RF energy awareness information and operating instructions in the Product Safety and RF Exposure booklet enclosed with your radio (Motorola Publication part number 68P81095C99) to ensure compliance with RF energy exposure limits.

Manual Revisions

Changes which occur after this manual is printed are described in FMRs (Field Manual Revisions). These FMRs provide complete replacement pages for all added, changed, and deleted items, including pertinent parts list data, schematics, and component layout diagrams.

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C. Defects or damage from improper testing, operation, maintenance, installation, alteration, modification, or adjustment.
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F. Product which has had the serial number removed or made illegible.
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I. the damage or defect is caused by charging or using the battery in equipment or service other than the Product for which it is specified.
J. Freight costs to the repair depot.
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PART 1. INTRODUCTION

1.1 SCOPE OF MANUAL

This manual contains installation, operation and service information for the ASTRO Spectra Clean Cab Railroad Radio. The service information allows for troubleshooting and repair to the component level of ASTRO Clean Cab specific boards. Reference the following ASTRO Spectra Mobile Service Manuals for detailed service of the internal ASTRO mobile transceiver.

Also included on this disk is a copy of the ASTRO Spectra Clean Cab CPS. This CPS allows for programming of the Clean Cab specific user fields and is a supplement to the ASTRO Mobile CPS. Refer to **Part 7 Radio Programming Users Guide** for further details.

1.2 RELATED PUBLICATIONS

ASTRO Clean Cab Quick Reference Card
68P81097C37

ASTRO Digital Spectra Basic Service Manual
68P81076C20

This manual includes all the information necessary to maintain peak product performance and maximum working time, using levels 1 and 2 maintenance procedures. This level of service goes down to the board replacement level and is typical of some local service centers, self-maintained customers, and distributors.

ASTRO Digital Spectra Detailed Service Manual
68P81076C25

This manual contains electrical and mechanical details specific to the ASTRO Spectra transceiver unit which is an integral part of the ASTRO Spectra railroad radio. Information given in this manual is required for servicing the ASTRO Spectra transceiver to the component level.

Any references made to the “ASTRO Service Manual” refer to these manuals.

1.3 RADIO OVERVIEW

The ASTRO Spectra Clean Cab Railroad Radio (hereafter referred to as ASTRO Clean Cab) is a multi-channel analog/digital mobile radio capable of operating on 255 independent TX and RX frequencies, including all frequencies specified by the American Association of Railroads (AAR). In addition, the radio supports DTMF signaling, MDC, conventional ASTRO digital, 12.5kHz channel spacing, ASTRO packet data and 3600 baud digital trunking.

The ASTRO Clean Cab supports current ASTRO mobile CPS for programming radio frequencies and other parameters hereafter referred to as ASTRO Mobile CPS. A separate ASTRO Spectra Clean Cab CPS is required for specific railroad features and home mode programming.

The ASTRO Clean Cab features differ from the Spectra Clean Cab by the following:

- An **A / D** button has been added to select analog or digital voice operation on conventional channels.
- LEDs have been added to indicate analog or digital operation.
- An additional DB-9 connector has been added to support ASTRO packet data.
- A **TRNK** button has been added to support 3600 baud trunking.
- Remote mount control head capability is standard.
- Isolated auxiliary speaker output is now standard.
- TX LED has been changed to red.
- AAR Singletones are not supported.
- AAR 12-10 Control Head interface is not supported.

All Spectra Clean Cab external cabling and connectors are compatible with ASTRO Clean Cab. The older Spectra Clean Cab control heads will also function with an ASTRO Clean Cab but they will not support analog/digital operation, the **TONE** button would access 3600 baud trunking if programmed and the display graphics may be incorrect. Likewise, the ASTRO Clean Cab controlheads will function with older Spectra Clean Cab radios but the **TRNK** button would access singletone and the **A/D** button would be non-functional.

The following is a list of backward compatible internal boards with existing Spectra Clean Cab:

- VLN5247C Control Head Display Board
- VLN5284D Control Head Logic Board
- VLN5250A 72V Converter Board
- VLN5412A 36V Converter Board
- VLD4122B RF PA Board

1.4 RAILROAD RADIO MODEL CHART

Model/Option Number	Description
R04KKH9PW9AN	ASTRO® Digital Specta® Clean Cab Railroad Radio
MBW13	36VDC / 12 VDC Converter
MBW80	Keyless Thumbwheel Latch
MBW35	12V Only Operation
MBW81	Ear Bracket for Padlock
MBW261	30 Watt RF Power (Canada)
MBW330	PA/Intercom Interface (Single and Dual configurations)
MBW496	Remote Control Head
MBW654	Dual Control Panels with Two Remote Control Heads
MBW892	Dual Control Panels with One Remote Control Head
G498	Delete Control Head

											Item No.	Description
X											VLD1201	ASTRO Mobile Transceiver (refer to ASTRO Service Manuals)
X						O	O	O		O	VLN1370	Standard Control Head
							X	2X	X		VLN1371	Remote Control Head
						X					VLN1372	Standard Control Head (PA/IC)
											VLN1373	Remote Control Head (PA/IC) (MBW330 & Dual CH options)
X											VLN5738	Rear Panel Interconnect Board
X											VLN5739	Translator Board
X											VLN5736	Top Panel Interconnect Board
X											VLN5737	ASTRO Adaptor Board
X											VLN4122	VHF RF Power Amplifier Board
X								O			VLN5773	AAR Auxilliary Connector
								X			VLN5747	Dual Remote Control Head Connector
X	O		O								VLN5745	72 VDC / 12 VDC Power Converter (or VLN5250)
	X										VLN5746	36 VDC / 12 VDC Power Converter (or VLN5412)
		X									VLN5742	Bottom Panel w/ Thumbwheel
X		O									VLN5741	Bottom Panel w/ Lock
				X							VLN5334	Padlock Kit
			X								VFN4004	12 VDC Filter Board
							X	X		X	6402007A02	Blank Front Panel
					X						(Reference)	Factory Tuning (TX set to 30 Watts)

X Item Included
O Item Deleted

	Control Head Piece Parts
VLN5247	Front Panel Display Board (version D or later)
VLN5284	Front Panel Microcomputer Board (version E or later)
7502001A04	DTMF Keypad
7502000A05	Function Keypad
7502000A06	Function Keypad (PA/IC)
6102000A04	Front Panel VFD Lens
6102000A05	Front Panel VFD Lens (PA/IC)
	Clean Cab Piece Parts
0102702A18	Antenna Connector and Coax
5502002A01	Handle
	Control Head Remote Mount Parts
1502017A01	Back Panel
0702011A01	Remote Mounting Frame
0102702A44	Remote Handeset Connector
0102702A45	Remote Connector
0310943J10	Screw, Connector
0300040M11	Screw, Back Panel

Figure 1-1 ASTRO Clean Cab Railroad Radio Model Chart

1.5 PERFORMANCE SPECIFICATIONS

GENERAL	RECEIVER	TRANSMITTER
FCC Designator: AZ492FT3772	**Frequency Range:**	**Frequency Range:**
	Range 1: 146-174 MHz	Range 1: 146-174 MHz
Temperature Range:		
Operating: -30ºC to +60ºC	**Channel Spacing:** 12.5kHz, 25 kHz	**Channel Spacing:** 12.5 kHz, 25 kHz
Storage: -40ºC to +85ºC		
	Input Impedance: 50 Ohm	**Channel Increment Step:** 2.5kHz
Power Supply:		
72Vdc,	**Frequency Separation:** 28 MHz	**Output Impedance:** 50 Ohm
36Vdc (optional)		
12Vdc Negative Ground Only	**Sensitivity:** (per EIA spec. RS204C)	**Frequency Separation:** 28 MHz
	20dB Quieting	
Maximum Current Drain:	(25/30 kHz Channel Spacing): 0.30 µV	**Rated Output Power:**
13.8V operation:	12dB Quieting	USA: 40 Watts
Standby: 1.5A	(12.5 kHz Channel Spacing): 0.20 µV	Canada: 30 Watts
Receive at Rated Audio: 4.0A		
Transmit at 40 W: 15.0A	**Selectivity:**	**Frequency Stability:** ±0.00025%
Transmit at 30 W: 13.0A	(Measured in Analog Mode)	(-30ºC to +60ºC, 25ºC Reference)
72V operation:	(per EIA Specifications)	
Standby: 0.8A	25/30 kHz Channel Spacing: -80 dB	**Modulation Limiting:**
Receive at Rated Audio: 1.0A	12.5 kHz Channel Spacing: -70 dB	25 kHz/ 30 kHz Channel Spacing:
Transmit at 40 W: 4.0A	(pre-amp)	±5.0 kHz
Transmit at 30 W: 3.5A		12.5 kHz Channel Spacing:
	Intermodulation: -70.0 dB	±2.5 kHz
Dimensions (H x W x D):	(Measured in Analog Mode)	
4.54" x 11.25" x 12"	(per EIA Specifications)	**FM Hum and Noise:** -45 dB
121mm x 285mm x 305mm		(Measured in the Analog Mode)
	Spurious Rejection: -80.0 dB	
Weight: 18lb (8kg)		**Spurious Emissions**
	Frequency Stability: ±0.00025%	(Conducted and Radiated): -75 dB
	(-30ºC to +60ºC, 25ºC Reference)	
		Audio Sensitivity: 0.08V ±3 dB
	Audio Output:	(For 60% Max. Deviation at 1 kHz):
	(Measured in Analog Mode)	
	(per EIA Specifications)	**Audio Response:** +1, -3 dB
	Front Panel Speaker:	(Measured in the Analog Mode)
	10 watts @ less than 3% Distortion	(6dB/Oct Pre-Emp 300 to 3000 Hz)
	Auxiliary Connector:	
	5 watts @ less than 3% Distortion	**Emissions Designators:**
		8K10F1E, 11K0F3E, 15K0F2D,
		16K0F3E, 20K0F1E, 15K0F1D,
		10K0F1D, 10K0F2D

Figure 1-2 Performance Specifications

PART 2. INSTALLATION AND OPERATION

2.1 INSTALLATION

2.1.1 GENERAL

The ASTRO railroad radio is designed to install in a standard AAR 12-2 clean cab mounting tray, and is fastened to the tray by a security lock located at the rear of the unit.

The radio is completely aligned, tested, and inspected before shipment. However, FCC regulations state that a station license must be obtained for each radio (mobile or base) installation by the owner of the equipment. The station licensee is responsible for ensuring the transmitter power, frequency, and deviation are within the limits permitted under the station license by checking the frequency and deviation of the transmitter upon installation and at least once yearly (refer to next paragraph). No operator's license is required to install or operate the radio.

2.1.2 PRE-INSTALLATION TESTS

It is advisable that a pre-installation check be performed to ensure proper operation. Any adjustments to the transmit power, frequency, or deviation requires the use of a computer, radio-to-computer interface, and the ASTRO Mobile CPS. Complete information for performing the recommended tests and adjustments is provided in **PART 5, MAINTENANCE AND ALIGNMENT**.

For a complete pre-installation test, perform the following steps using the ASTRO Mobile CPS:

1. Check the test mode transmit frequency and adjust the reference oscillator if required. This adjustment also corrects any receive frequency errors caused by a reference oscillator offset.
2. Measure the transmit power output and adjust if required.
3. Measure the transmit deviation on the low, mid, and high test modes and adjust if required.
4. Measure the transmit frequency on each channel.
5. Measure the receive frequency on each channel.
6. Measure the 12 dB SINAD signal level.
7. Check the antenna VSWR after installing the radio set.

2.1.3 ANTENNA INSTALLATION

Installation instructions are supplied with all Motorola antenna kits. Refer to the instruction sheet for your particular installation.

2.1.4 CLEAN CAB MOUNTING TRAY INSTALLATION

Motorola recommends using the clean cab mounting tray for installation of the ASTRO railroad radio. In most installations, the adaptor tray will already be secured to the control stand mounting brackets. In this case, follow the procedure outlined in **2.1.5, RADIO MOUNTING**.

To install the clean cab mounting tray onto the control stand brackets or other mounting surface, carry out the following steps (refer to Figure 2-1-1):

NOTE

The radio set is installed, removed and serviced from the rear. In any installation, be sure to pick a suitable location that allows easy access to both the front and rear of the radio set.

1. Using the clean cab tray (1) as a template, locate and drill four holes using a 7/32” drill bit (hole sized for a 10-32 screw).

2. Mount the tray using four 10-32 flat head screws (2) which have been cut to length needed. Due to the clips on the underside of the clean cab tray, four 3/8" high spacer washers (3) must be used.

3. Install the lock washers (4) and hex nuts (5) as shown in Figure 2-1-1 Clean Cab Mounting Tray Detail. Tighten all nuts and screws securely.

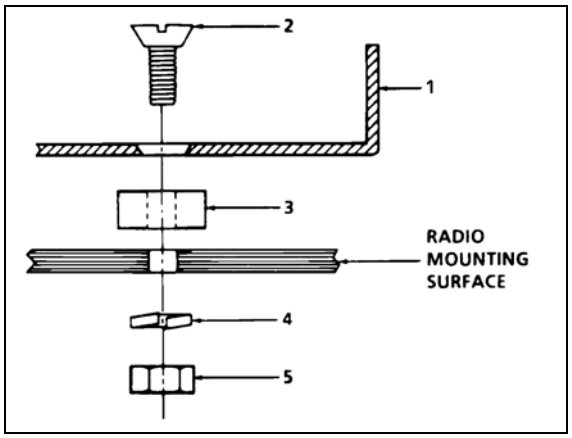


Figure 2-1-1 Clean Cab Mounting Tray Detail

Other mounting configurations may be implemented; however, these installations are the responsibility of the owner. Contact your Motorola Service Representative regarding your particular application.

2.1.5 RADIO MOUNTING

To install the ASTRO railroad radio within the clean cab mounting tray, carry out the following steps (refer to Figure 2-1-3):

Caution

Never install or remove a radio from a tray with the primary power applied. Contact burning will result if power to the radio set is not disabled first.

1. Position the radio set (1) onto the rear of the clean cab mounting tray (2). Slide the radio down and into the tray until the extruded pockets on the underside of the radio engage into the tabs on the clean cab tray. Slide the radio forward so that the pins on the sides of the radio engage into the slots on the tray.

2. Lock the radio set into the tray by inserting the key into the lock (3) at the rear of the radio and turning the key counter-clockwise until it engages the latch into the slot on the clean cab tray and the key rotation is tight. (The key is removable at 90° increments.)

3. Attach the antenna connector to the antenna jack (4).

4. Attach handset (if so equipped) to the handset connector (5).

5. With the primary power off, attach primary power connector to power connector (6) of radio.

6. Turn on primary power. Radio set is now operational.

A metal clip (Motorola part no. 0702010A01) is located on the bottom panel assembly. The clip is secured directly to the bottom panel housing when the keylock cylinder is installed. When the radio is installed into a standard clean cab mounting plate, the clip provides pry protection to the keylock latch, giving added security to the installation.

2.1.6 RADIO REMOVAL AND REPLACEMENT

The radio may be removed and replaced for servicing only through the rear of the clean cab control stand. To remove the radio from the clean cab tray, perform the following procedure:

1. Turn off the primary power.

2. Remove all cables connecting to radio set.

3. Unlock the radio by inserting key in the rear panel lock and turning clockwise.

4. Slide the radio up and out from the clean cab tray through the rear of the control stand.

To replace the radio in the tray, follow the Radio Mounting procedure described above.

2.1.7 AUXILLARY CONNECTOR

The radio is equipped with a 12-pin auxiliary connector, J3010, which is located between the antenna and power connectors. The auxiliary connector provides the signals for connecting an external device to the radio such as a speaker, handset, or handset hang-up switch.

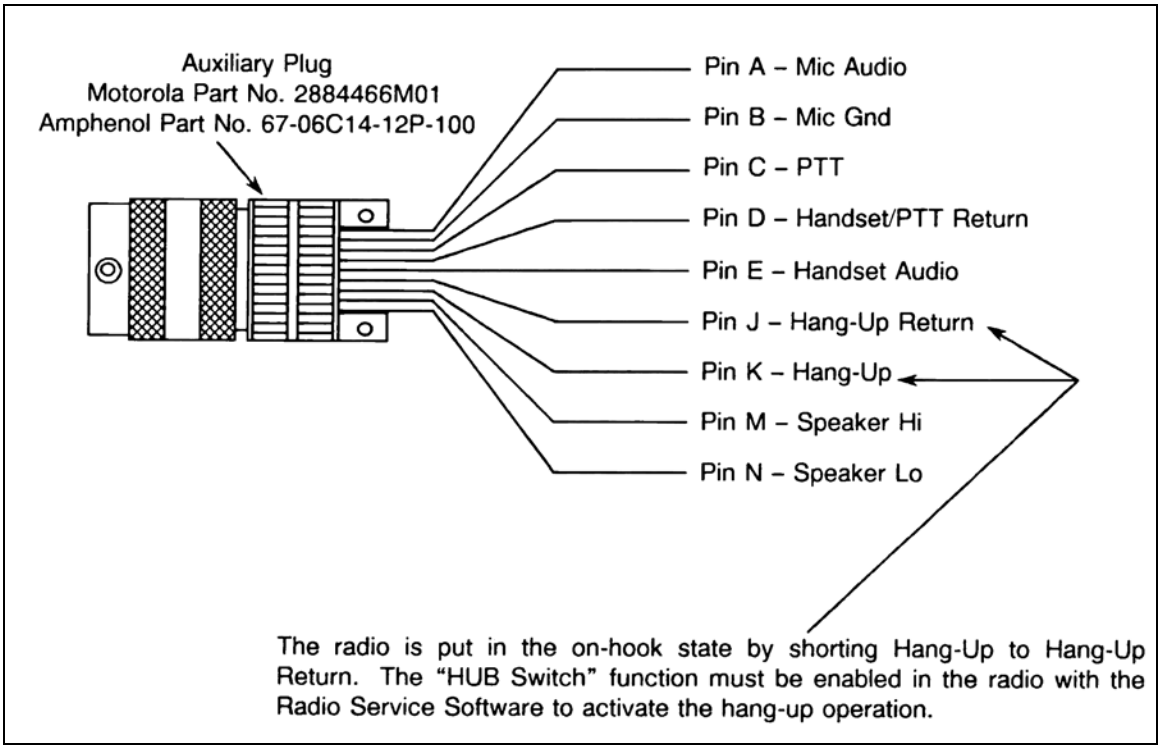


Figure 2-1-2 Typical Connections to Auxiliary Connector

Figure 2-1-2 indicates the plug required to connect with the auxiliary connector, and the main signals provided by the connector. For example, the handset or microphone is placed in the on-hook state by shorting Hang-Up (pin K) to Hang-Up Return (pin J) through a hang-up switch. (The HUB SWITCH function must be enabled with the Radio Service Software to activate operation with the hang-up switch.)

External speaker connections are made to pins M and N. The speaker output provides up to 5 watts of audio power when connected to an 8Ω load. Using the Radio Service Software, the audio output from the auxiliary connector can be set to either track the front panel speaker output, or provide a fixed-level output.

Connector Pin	**Description**	**Level**
Pin M/N	Speaker Hi/Lo	Balanced, Fixed or Variable, 5W max.
Pin A	Mic Audio	630-680mV RMS
Pin B	Mic Gnd	
Pin E	Handset Audio	250-300mV RMS
Pin C	PTT	Short to Pin D for Push-to-Talk
Pin D	Handset/PTT Return	
Pin K	Hang-Up	Short to Pin J for On-Hook (PL Enable)
Pin J	Hang-Up Return	

Note: All RMS voltages based on Ref:1KHz Modulation, 3kHz Deviation at 25kHz channel spacing.

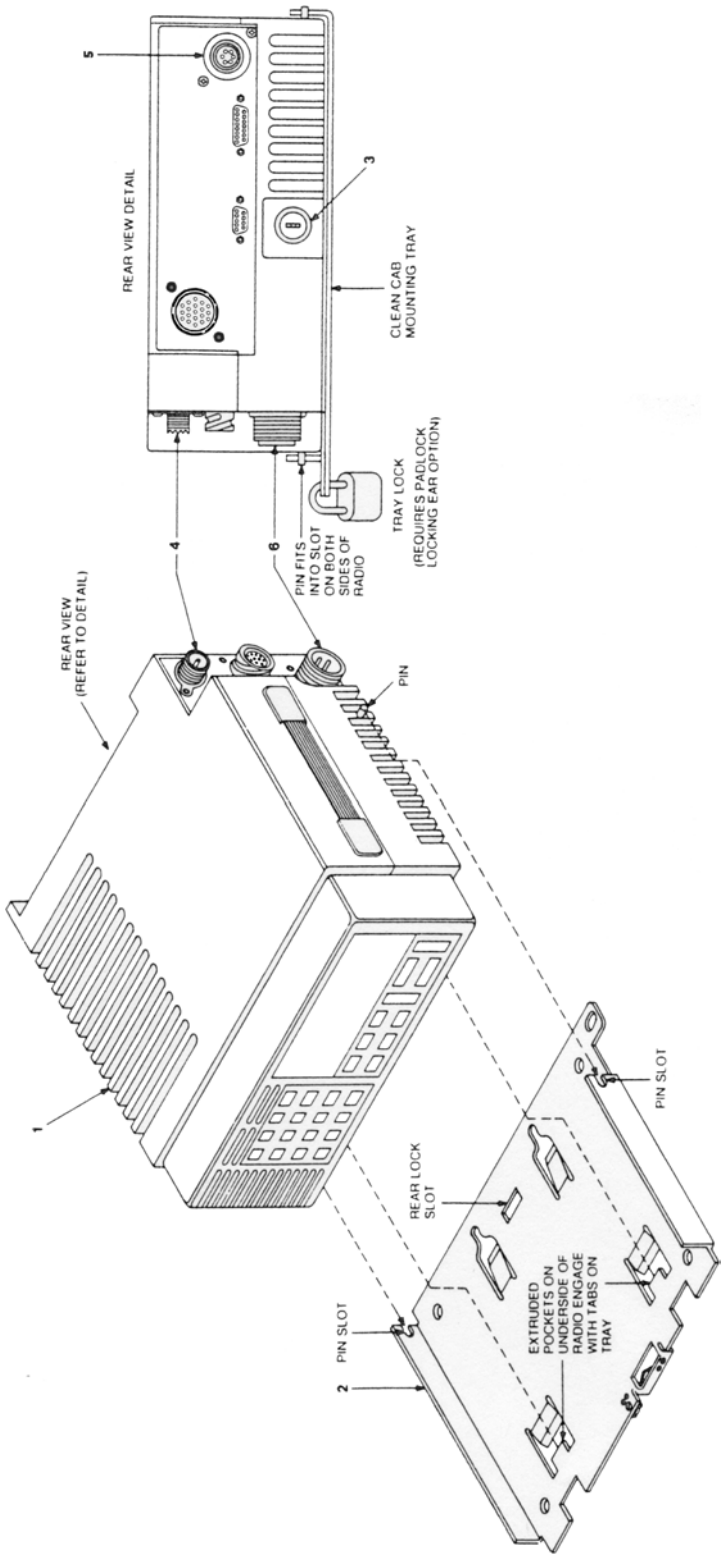


Figure 2-1-3 Radio Mounting in Clean Cab Tray

2.1.8 REMOTE CONTROL HEAD INSTALLATION

The Remote (Secondary) Control Head Connector (J3007) is always available on the rear panel of the ASTRO Clean Cab. The Remote (Primary) Control Head Connector (J3011) is only available with the MBW654 option. See Figure 2-1-4 for locations of control head connectors.

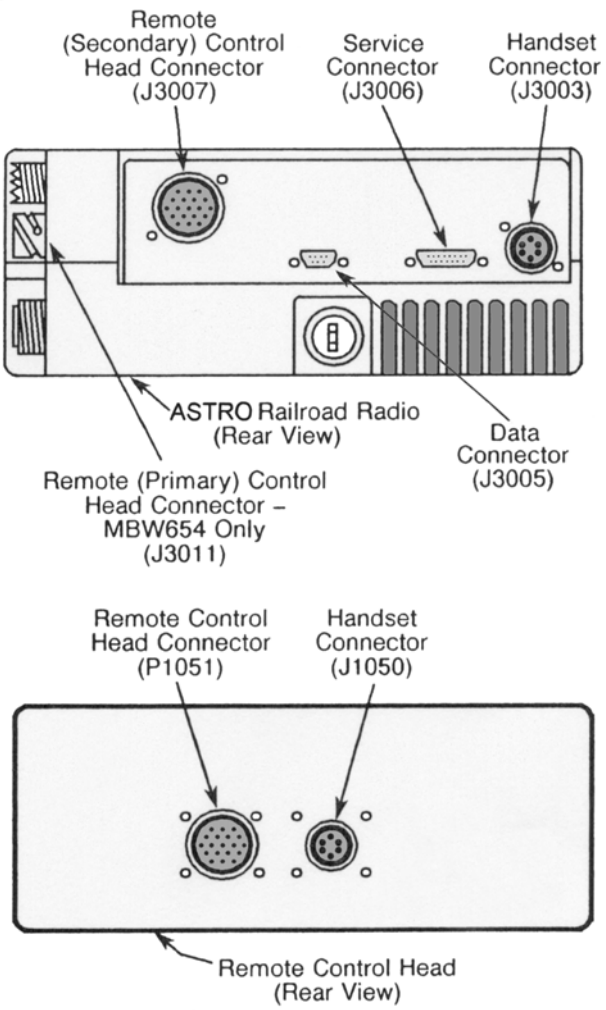


Figure 2-1-4 Radio and Control Head Connectors

AAR 12-2 Control Stand Installation

Figure 2-1-5 illustrates the control head installation into the standard 4" x 10" (10.16 cm x 25.4 cm) AAR 12-2 control stand opening. The front panel of the control head is passed through the control stand opening and is secured to the control stand using four M5.0 x 0.8 machine screws (the control head bracket has pre-threaded holes). Adequate space must be left behind the control head to allow for access to the two cable connectors. Refer to 5.1, Control Head Cable, for information concerning the cable connections.

Surface-Mount Installation

Figure 2-1-6 illustrates a surface-mount installation of the remote control head, which is performed as follows:

1. Pick a suitable location for installation, observing cabling and connector requirements, and drill four holes in the mounting surface using a #4 drill bit (use the control head as a template, or refer to the dimensions given in Figure 2-1-5).
2. Cut out a 48 mm x 92 mm section of the mounting surface at the location specified in Figure 2-1-5, to accommodate the two control head connectors.
3. Locate the holes in the control head bracket over the mounting surface holes, and secure the control head by either: Method 1 -passing four M5.0 x 0.8 machine screws through the mounting surface from behind and tightening them into the pre-threaded holes on the control head bracket, or; Method 2 -passing four M5.0 x 0.8 machine screws through the control head bracket then through the holes in the mounting surface and securing them with four M5 lock washers and nuts.

Remote Control Head Cable

The same remote control head units and control head cable kits are used for all control head options. Figure 2-1-7 and 2-1-8 provides a schematic and parts list for the remote control head cable kit, VKN4342, compatible with all control head options. A control head cable of appropriate length must be ordered as a separate item. The remote control head cable is available in the following standard lengths:

- VKN4342BT - 10 foot length
- VKN4342AC - 20 foot length
- VKN4342AE - 30 foot length
- VKN4342AJ - 50 foot length

Caution

The cable shield is connected to the connector housings at both ends of the cable. If the remote control head is connected directly to the locomotive chassis upon installation, the shield connection should be removed at the control head end to avoid the creation of ground loops.

At one end of the cable is J1051, a 19-pin receptacle which connects to P1051 on the back of the control head unit. At the opposite end of the cable is plug P3007, which mates with either connector J3007 on the rear panel of the radio (secondary control head connection for all control head options), or to the connector, J3011, on the side of the radio (primary control head connection for option MBW654 only).

There is no programming required to add a second control head to the ASTRO Clean Cab via connector J3007. The controlheads and cables are identical and interchangeable for the dual controlhead (MBW654) option.

The control head cable has two additional 6-foot lengths of wire connected to J1051 pins G and H (HANG-UP and HANG-UP RET). These wires can be connected to the handset hang-up switch for the purpose of controlling the hang-up line to the control head micro board.

NOTE

The Hang-Up Box (HUB) feature must be enabled via the ASTRO Mobile CPS for the hang-up line to have any effect. Refer to the referenced ASTRO Mobile CPS User's manual for details concerning this feature.

Remote Control Head Assembly

The remote control head assembly, VLN1259A, contains the following kits and assemblies:

- VLN1219C Remote-compatible C/H assembly
- VLN5455A Remote C/H hardware kit

VLN1219C is identical to the standard front panel assembly and is described in **Part 4, Section 1** of this manual. VLN5455A provides the hardware, connectors and internal cabling required to convert the standard front panel assembly into a remote control head unit. Figures 2-1-9 and 2-1-10 provide a schematic of the internal cabling which connects the control head micro board to the handset and control head connectors and parts list for this kit.

2.1.9 RS232 DATA PORT CONNECTOR

The ASTRO Clean Cab radio features a data port which allows communication between a device connected to the port (for example a laptop computer) and equipment at a remote site. Data from the local device on the data port is relayed over the air to equipment at another site, and data received from the remote site is echoed to the local device.

The data capability may be used with any channel configured for digital or mixed-mode operation. Data capability must be enabled in the ASTRO Mobile CPS for any personality with which the feature is to be used.

The data port, located on the rear of the unit, is a female DB-9 connector which makes use of the standard EIA-232 asynchronous serial data interface. The radio uses Serial Line Internet Protocol (SLIP), Internet Protocol (IP), and User Datagram Packets (UDP) to communicate with equipment connected to the data port. Any software which is to communicate via the data port must utilize these protocols.

A personal computer may be connected to the data port using a straight 9-pin female to 9-pin male EIA-232 cable (Motorola part number 30-80390B48) available from the Accessories and Aftermarket Product Division (AAD). Alternatively, a cable may be constructed using the wiring diagram in Figure 2-1-4-1. Note that if a different type of device is connected to the data port, the wiring of the cable may vary. The signals in Figure 2-1-4-1 are named with respect to the local device (e.g., TXD carries outbound data from the local device).

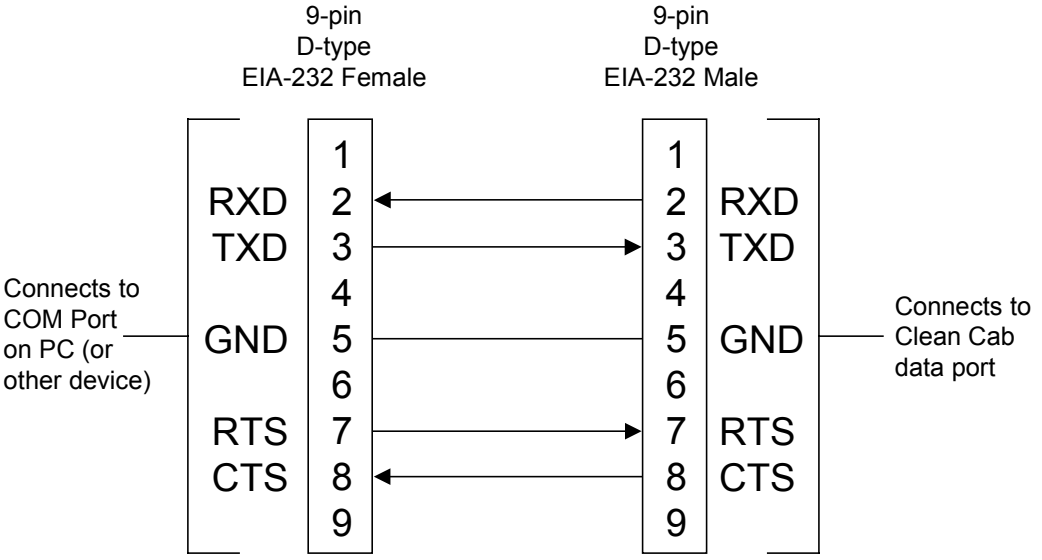


Figure 2-1-4-1 Data Cable Wiring Diagram (Motorola PN 30-80390B48)

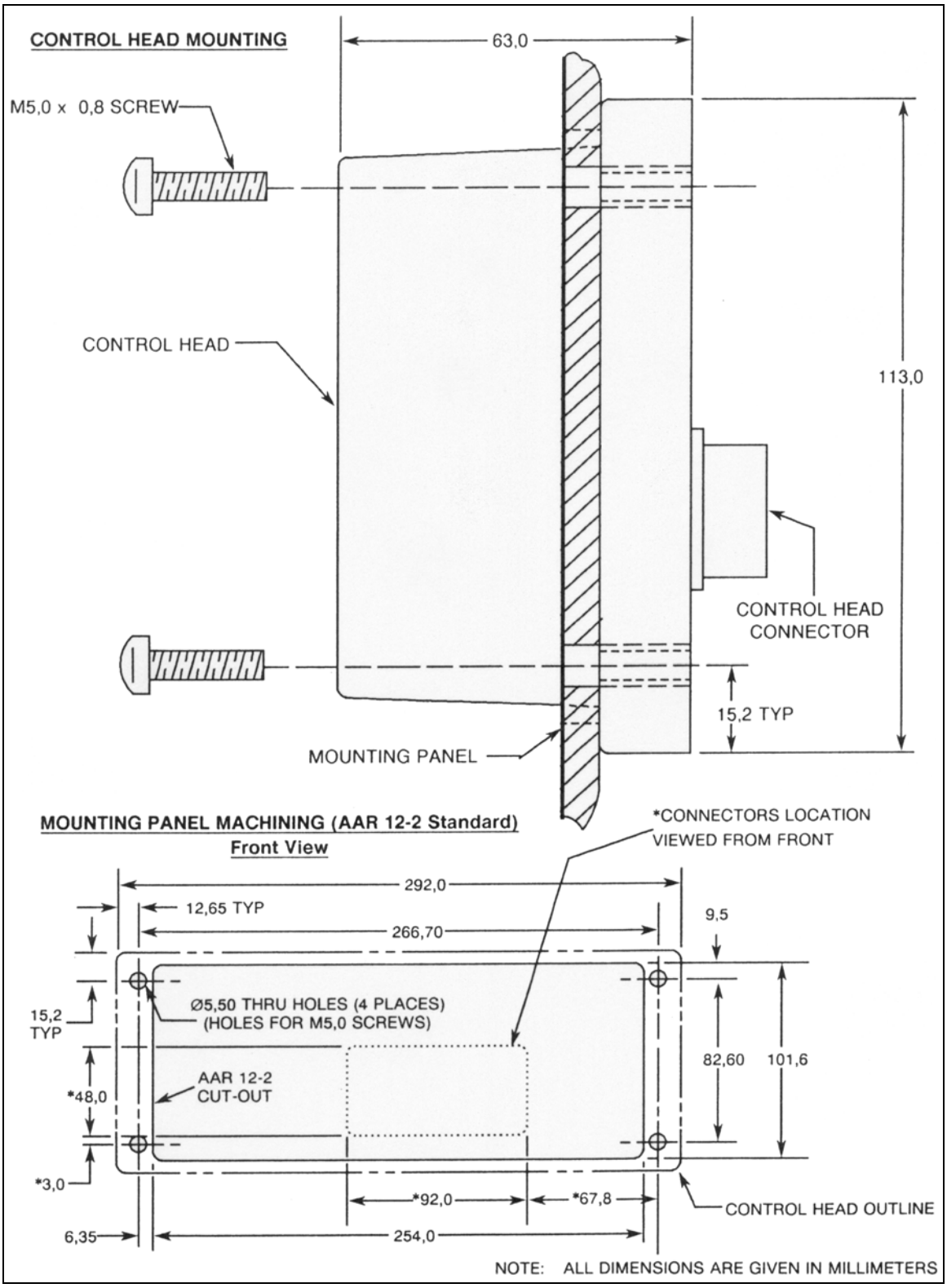


Figure 2-1-5 Remote Control Head Thru-Hole Mounting

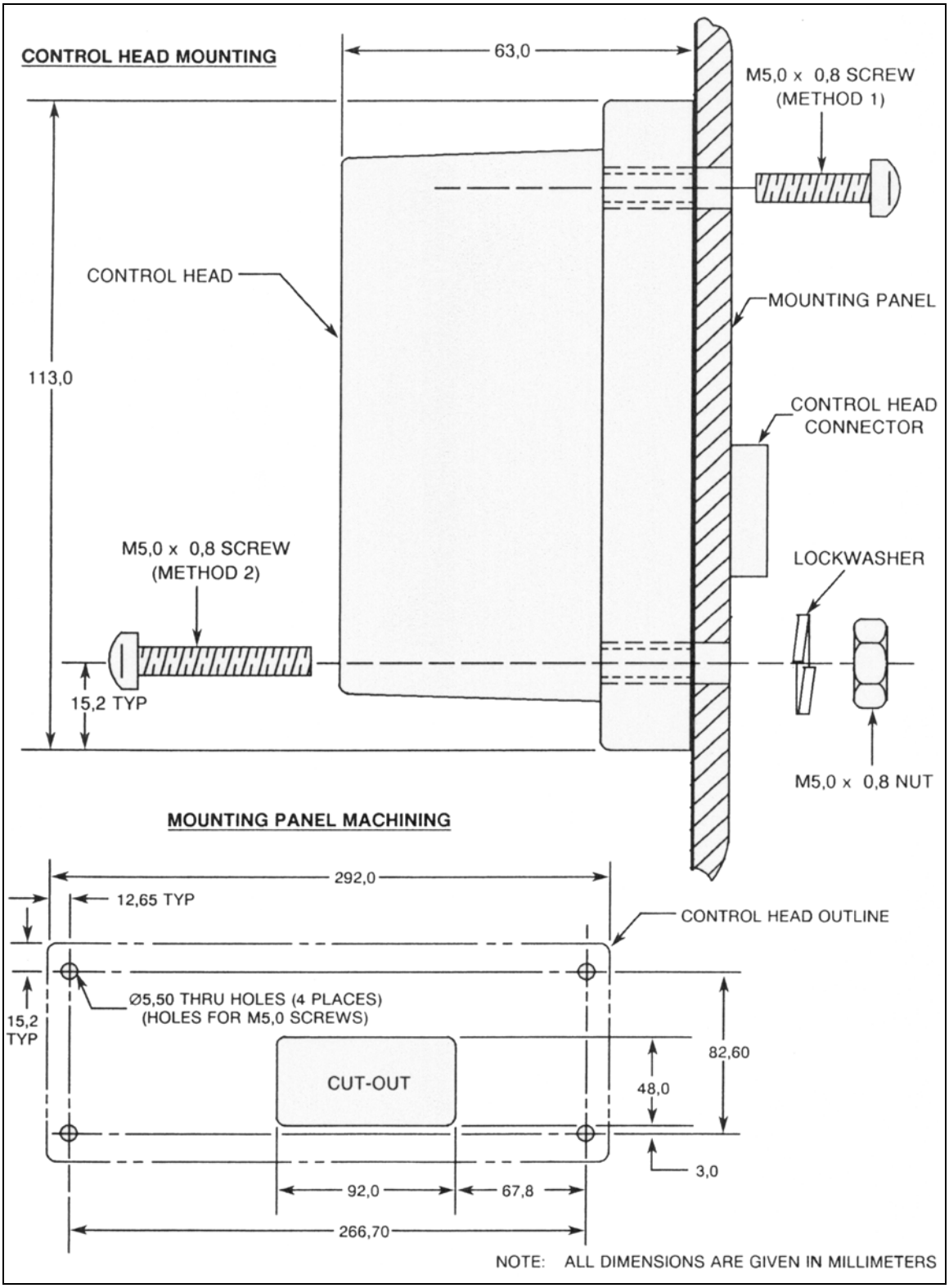


Figure 2-1-6 Remote Control Head Surface Mounting

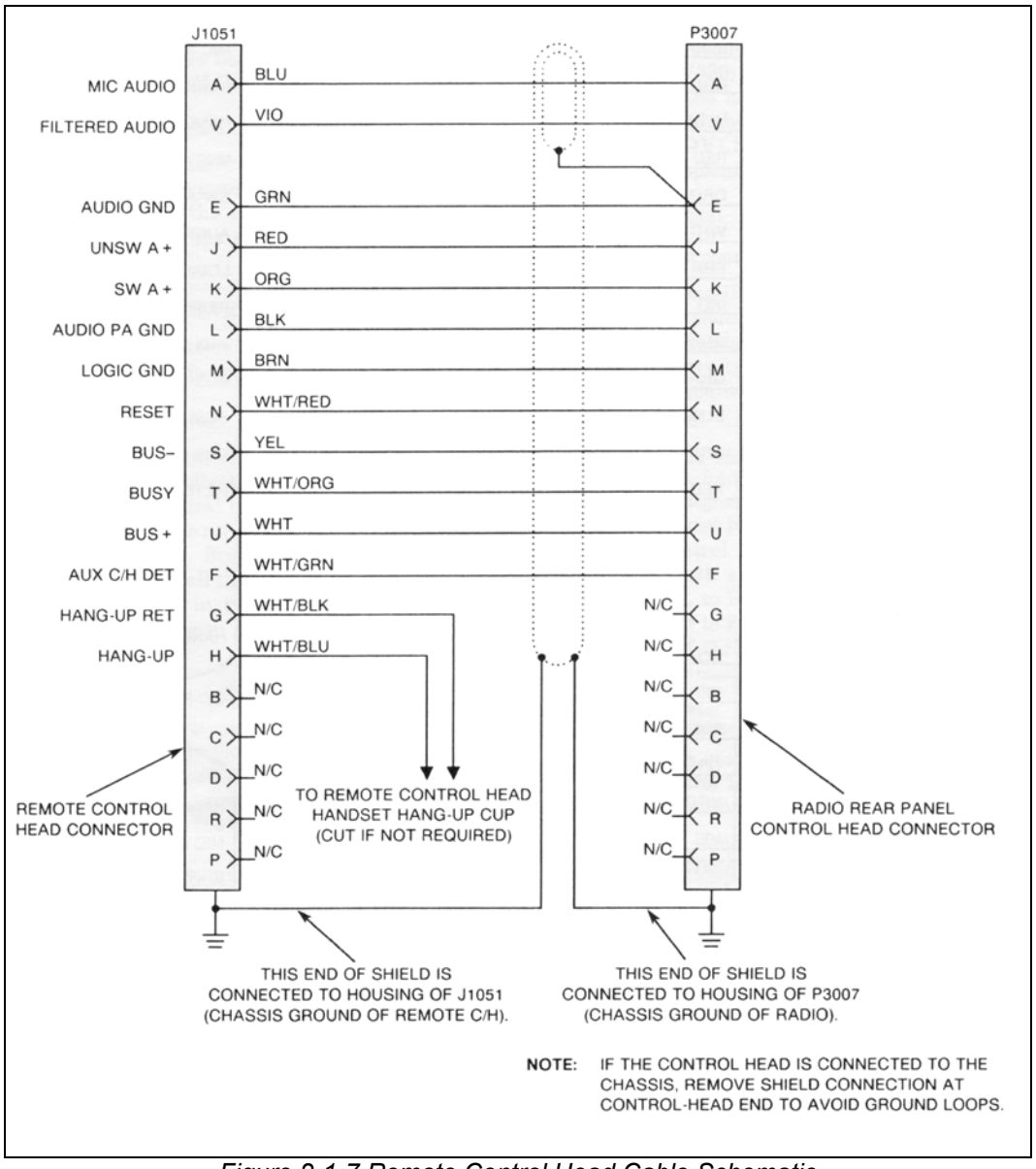


Figure 2-1-7 Remote Control Head Cable Schematic

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	0582050H03	EYELET, tin (2 used)
J1051	0902008A02	RECEPTACLE, 19-pin circular
P3007	2802010A02	CONNECTOR, 19-pin circular
	2900008S03	LUG, ring tongue #8 (2 used)
	3002009A01	CABLE, 12-conductor EXANE
	3002010A05	WIRE, #18 EXANE wht-grn 9 inches
	3002010A06	WIRE, #18 EXANE wht-blu 72 inches
	3002010A10	WIRE, #18 EXANE wht-blk 72 inches
	3700132526	TUBING, heat-shrink 1/32 0.75 inches
	3700132562	TUBING, heat-shrink 1/8 2 inches
	4200069M02	BOOT, strain relief #8
	4202004A01	CLAMP, circular conn., size 14 (2 used)
	4210217A26	TIE WRAP, nylon natural (4 used)

Figure 2-1-8 Remote Control Head Cable Parts List

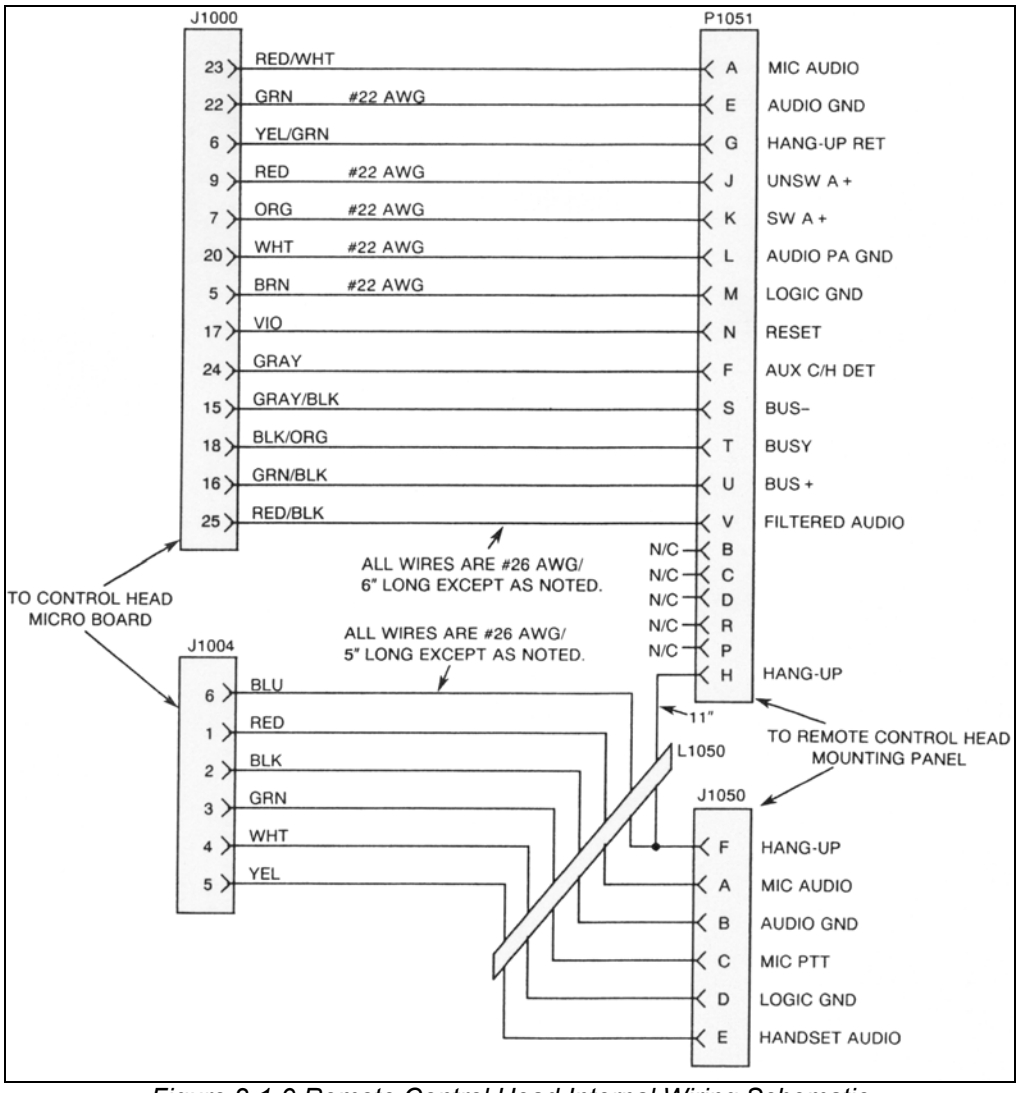


Figure 2-1-9 Remote Control Head Internal Wiring Schematic

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	0102702A44	**R/R Remote Handset Conn. Assembly**
	0900848764	RECEPTACLE 6-contact
	0980133M01	CONNECTOR, receptacle (6 used)
	1580075M03	HOUSING, connector
	4210217A26	TIE WRAP, nylon natural, (2 used)
L1050	7602001A01	BEAD, ferrite
	0102702A45	**R/R Remote C/H Conn. Assembly**
	0984279D03	CONNECTOR, crimp (13 used)
	1402006A01	HOUSING, connector 30-position
	2802009A01	CONNECTOR, 19-pin circular solder plug
	4210217A26	TIE WRAP, nylon natural, (2 used)
	0300040M11	SCR, M4 x 0.7 x 8.0mm intstar (4 used)
	0310943J10	SCR, tpg TT3 x 0.5 x 8 starpan (8 used)
	0702011A01	BRACKET, mounting remote C/H
	1502017A01	PANEL, mounting remote C/H

Figure 2-1-10 Remote Control Head Parts List

2.2 OPERATION

2.2.1 GENERAL

The ASTRO Clean Cab is shipped factory programmed with the following channels:

Channels 1-97	Standard AAR frequencies (25kHz)	
Channels 98-100	NOAA Weather Channels (RX Only)	
	WX4(98)	162.425 MHz
	WX3(99)	162.475 MHz
	WX1(100)	162.550 MHz
Channels 101-197	Standard AAR frequencies (12.5kHz)	
Channels 198-200	NOAA Weather Channels (RX Only)	
	WX4(198)	162.425 MHz
	WX3(199)	162.475 MHz
	WX1(200)	162.550 MHz
Channels 201-207	7 NOAA Weather Radio Channels (RX Only)	
	WX2 (201)	162.400 MHz
	WX4 (202)	162.425 MHz
	WX5 (203)	162.450 MHz
	WX3 (204)	162.475 MHz
	WX6 (205)	162.500 MHz
	WX7 (206)	162.525 MHz
	WX1 (207)	162.550 MHz

Each of the AAR channels will be programmed with mixed-mode RX and ASTRO TX if ordered with ASTRO CAI. This is necessary for the **A / D** button functionality. If ordered as analog only, the channels will be programmed for standard analog.

Before operating the radio, the operator should become familiar with the various controls, indicators and alert tones which allow the operator to monitor and change the operating status of the radio. A brief overview of the controls, indicators, displays and alert tones is given in the next paragraph.

2.2.2 CONTROLS, INDICATORS, DISPLAYS AND ALERT TONES

For a summary list of the standard controls, indicators and displays and their functions, refer to Figure 2-2-1.

A photo-detector circuit in the radio automatically adjusts the intensity of the displays to match the surrounding light conditions.

Alert Tones

The following audible tones are used to alert the operator to certain system conditions:

Configuration Good Alert - momentary high-pitched alert tone indicates the valid entry of a channel pair, trunking talk-group, DTMF dispatch tone, A/D switch or Home channel change.

Invalid Key Alert - momentary low-pitched alert tone indicates that the operator has made an invalid keypad entry.

Time-Out Timer Alert – momentary low-pitched tone indicates that the present transmission will soon be disabled. This tone is generated 4 seconds before the TOT expires. After 4 seconds, the transmitter will be shut off and a continuous low-pitched tone will be generated until the **PTT** key (or the PTT switch on the optional handset) is released.

Trunking Tones - three distinct trunking tones may be heard while on a trunking talkgroup.

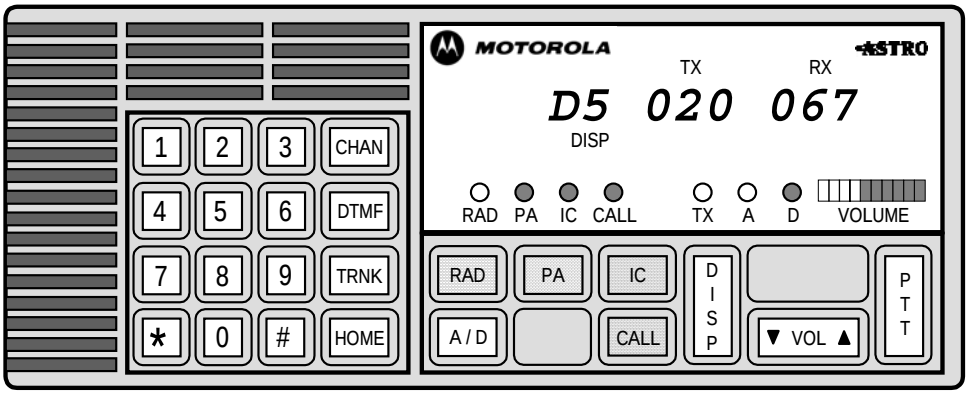
Talk-Permit	a quick multi-tone chirp that indicate a voice channel has been granted.
Talk-Prohibit	a continuous low pitched alert tone that indicates that a voice channel or system is unavailable.
System Busy	a low pitched repeating tone that indicates the system has no voice channels available.

2.2.3 POWER-UP PROCEDURES

Locomotive power is supplied to the radio via an AAR-specified power connector (J4000) at the back of the unit. The radio is operational whenever locomotive power is supplied to the power connector. When the radio is initially powered up, it executes a brief self-diagnostics routine which lasts a few seconds. During this time, all front panel displays and indicators light, immediately followed by a display of "SELF CHECK". Once the self-check routine is finished (and no problems are detected), the display indicates the dispatch tone, transmit, and receive channels of the previously selected channel. If this is the first time the radio has been powered up following programming, the default channel of TX 001 RX 001 and no dispatch tone will be selected.

NOTE

If "FAIL xx/xx" appears continuously in the display, a power-up failure has been encountered. The radio will not function until corrective action is taken. If "ERROR xx/xx" appears briefly in the display, a non-critical error condition has been encountered (i.e. the radio will still operate) and the radio will produce an invalid-key-alert tone. In either case, servicing is required. For a listing of power-up messages, refer to **PART 5, MAINTENANCE AND ALIGNMENT PROCEDURES.**



CONTROLS AND INDICATIONS

▼ VOL ▲	VOLUME ROCKER SWITCH	·	Sets receiver volume.
CHAN	CHANNEL BUTTON	·	Initiates Channel Select mode for selecting a transmit and receive frequency pair using the numbers on the 12 digit keypad.
DTMF	DTMF BUTTON	·	Initiates Dispatch DTMF Select mode for selecting and transmitting a DTMF dispatch call tone using the 12 digit keypad.
TRNK	TRNK BUTTON	·	Initiates Talkgroup Select mode for selecting a programmed trunking talkgroup. Enabled only with ASTRO 3600 baud trunking option.
HOME	HOME BUTTON	·	Initiates Home Select mode for selecting a programmed combination of transmit/receive frequencies and dispatch DTMF tone (if applicable) or a trunking talkgroup.
A / D	A / D BUTTON	·	Toggles between analog and digital modes. Only available on non-trunking channels.
	PA / IC BUTTONS	·	These buttons and associated LEDs are only available with MBW330 option. Information on usage is found in the specific PA/Intercom equipment documentation.
1	12 DIGIT KEYPAD	·	Normally selects DTMF tones directly. Configured to enter Channel, DTMF, Trunking Talkgroup and Home numbers in the four select modes.
D I S P	DISPATCH BUTTON	·	Transmits selected DTMF tone or tone sequence if enabled.
P T T	PTT BUTTON	·	Press to transmit voice via the front panel microphone.
TX 020	TX / RX DISPLAY	·	Displays selected transmit and receive channels. On a trunking mode, the display will show “TRUNK xxx” where xxx is the trunking talkgroup. When a home mode is selected, the programmed home mode name will be displayed.
D5 DISP	DISPATCH TONE	·	Indicates the selected DTMF tone “Dx” where x is the dispatch DTMF character. If tone sequence is enabled the “D” is omitted and only the selected DTMF character sequence is displayed, “xxx”.
VOLUME	VOLUME DISPLAY	·	10-segment bar graph indicates relative volume level within range of programmed minimum volume level to full volume.
○ TX	LED Indicators	·	“TX” will illuminate red whenever radio is transmitting. “A” or “D” will illuminate yellow to indicate analog or digital channel mode. On a trunking mode, neither will illuminate.

Figure 2-2-1 Standard Controls, Indicators and Displays

2.2.4 NORMAL MODE

At all times, the ASTRO Clean Cab radio operates either in the "Normal" mode or one of four “Select” modes (CHAN, DTMF, TRNK and HOME). In Normal mode, the basic radio operations are performed. The speaker volume can be adjusted. The display indicates the selected dispatch tone(s), Home channel (if any), and transmit (TX) and receive (RX) channels on which dispatch and voice messages will be sent and received.

The numeric keypad, 0 through 9, # and *, represents the traditional telephone-type keypad. When the radio is in the Normal mode, this keypad is used to send standard DTMF tones.

The **DISP** button is used to transmit the selected dispatch DTMF indicated in the DISP display. The selected DTMF tone will be indicated by a “D” followed by a number. If dispatch tone sequence is enabled, the “D” is omitted and only the selected DTMF character sequence is displayed.

The **A / D** button is used to toggle between analog and digital transmit operation. This only functions if the selected channels are programmed for mixed-mode receive and digital transmit. The LEDs above the A or D on the display will indicate which mode is selected.

The radio can be field programmed to transmit an MDC1200 format PTT-ID. MDC is only available on analog channels. ASTRO channels use an embedded mobile ID in the digital bit stream that is always present. ASTRO and MDC received PTT-ID can be displayed if enabled in ASTRO Mobile CPS.

2.2.5 SELECT MODES

For changing channel selections and dispatch DTMF, the radio has four Select modes as follows:

- Channel Select mode - allows the operator to change the selected TX/RX channel pair. Initiated using the **CHAN** button.
- Dispatch DTMF Select mode - allows the operator to select and transmit dispatch DTMF tone(s). Initiated using the **DTMF** button.
- Trunking Select mode - allows the operator to select the Trunking talkgroup number. Initiated using the **TRNK** button.
- Home Select mode - allows the operator to change the selected Home channel. Initiated using the **HOME** key.

For any Select mode, the numeric keypad is reconfigured for number entry. Normally, separate alert tones indicate either success or failure in entering numbers. Conditions which apply to each of the four Select modes are outlined below. Operating procedures for Select modes are covered in **2.2.7 Changing Channels**.

Channel Select Mode

The operator can select up to 255 independent preprogrammed TX and RX channels using the Channel Select mode. Channels must be selected as pairs (i.e. 6 digits must be entered, including leading zeros). To allow convenient selection of the traditional channel range of 01-97, 4 digit channel entry may be enabled in the ASTRO Clean Cab CPS. When enabled, if the user enters 4 digits and pauses the radio will assume a leading zero before each digit pair, thus an entry of 1212 will be interpreted as 012 012.

For valid completion of the Channel Select Mode, the selected TX and RX channels must be within the available range of preprogrammed channels.

Dispatch DTMF Select Mode

The radio is capable of transmitting up to twelve DTMF tones (DO to D9, D# and D*). The DISP display indicates the currently selected DTMF tone (if any) as a "D" followed by a single digit. This represents the DTMF tone which is transmitted upon selection of a particular tone, and re-transmitted using the DISP key.

If Dispatch Tone Sequence is enabled in ASTRO Clean Cab CPS, the radio is capable of transmitting a sequence of DTMF tones. The control head display will indicate the tone sequence by displaying “xxx” in the DISP area where “xxx” is the sequence of up to three DTMF tones.

NOTE

DTMF is unavailable on trunking modes. The radio will generate a invalid key alert when attempting to access DISP DTMF or Hot Keypad.

For valid completion of the Dispatch DTMF Select Mode, the selected DTMF tone must be allowed by ASTRO Clean Cab CPS programming.

Trunking Select Mode

The operator can select the 3 digit mode number of a trunking talkgroup. The selected talkgroup will be displayed as “TRUNK xxx” where xxx is the talkgroup number.

For valid completion of the Trunking Select Mode, the selected trunking talkgroup number must be within the range of preprogrammed talkgroup channels.

Home Select Mode

Home modes are field-programmed via the ASTRO Clean Cab CPS to allow the operator access to specific combinations of transmit, receive and (optionally) dispatch DTMF tones, or trunking talkgroup. The radio may be programmed for a maximum of 200 Home channels (99 with 2K EEPROM translator board see 7.3.2).

When a Home Mode is selected, the Home name (max 8 character, programmed via the ASTRO Clean Cab CPS) is displayed on the control head rather than the TX and RX information. Home mode channel numbers are not automatically displayed on the display unless manually made a part of the Home name. If dispatch tone sequence is enabled, Home names are limited to a maximum of 7 characters. Existing 8 character Home names will be truncated.

If Home Mode Fixed Tone option is disabled via the ASTRO Clean Cab CPS, entering a valid Home mode selection updates the TX and RX channels while the selected dispatch DTMF remains unaffected. The current DISP DTMF tone will be displayed. The DISP tone may be changed without affecting the Home Mode.

If Home Mode Fixed Tone option is enabled, entering a valid Home mode selection updates the TX and RX channels and DISP DTMF tone. Entering a new DISP tone will exit the Home Mode and revert to a standard TX/RX channel display.

For valid completion of the Home Select Mode, the selected Home mode number must be within the range of preprogrammed Home modes. If more than 9 Home modes are programmed, a leading 0 is required to access Home modes 1-9.

2.2.6 BASIC OPERATIONS

Basic operations are identical for all front panel configurations. Any changes to the front panel operation are noted in the appropriate section. After power-up, the radio is ready to receive calls on the displayed RX channel. However, it may become necessary to adjust the speaker volume level as described below.

To Adjust the Volume

To adjust the volume to a comfortable level, execute the following:

1. Momentarily press the **VOL** rocker switch to the right to increase the volume level by one step, or to the left to decrease the volume level by one step.

   The VOLUME bar graph display indicates the relative speaker audio level (each LED segment corresponds to two steps in the twenty-step range). If there is no voice audio being received, a volume-set tone is heard, while the volume switch is pressed, to provide an audible feedback to the operator.

2. Alternately, press and hold the **VOL** rocker switch to the right (to increase) or to the left (to decrease) until the desired volume level is set.

   Holding the rocker switch causes the volume level to increase (or decrease) at a two-steps-per-second rate, until the maximum (or minimum) volume level is reached. The VOLUME bar graph display increments (or decrements) every other volume step to indicate the relative speaker audio level.

To Transmit Voice Messages

Before starting transmission, monitor the traffic on the selected channel to ensure that it is not in use.

To transmit voice messages, execute the following:

1. Press and hold the **PTT** key.

   The radio is keyed and the TX indicator lights.

   NOTE

   The radio has a Time-Out Timer (TOT) to limit the duration of a transmission to 60 seconds (typically), or as set via the ASTRO Mobile CPS. A low-frequency, alert tone signals the operator that the transmitter will be disabled in four seconds. Once the TOT expires, the radio stops transmitting and a continuous low-frequency tone is generated until the **PTT** key is released.

2. Speak clearly in the direction of the front grill of the radio set with mouth 8 to 12" away.

   Voice message is transmitted.

3. After finishing your message, release the **PTT** key and wait for a reply.

   Radio is dekeyed and TX indicator goes out.

Sending DTMF Dispatch Tones

For analog DTMF tones, the minimum and maximum duration times, pre-time and hang time are programmable via ASTRO Clean Cab CPS. In digital mode, the durations are not programmable.

To select and transmit a DTMF tone for dispatch calls, execute the following:

1. Momentarily press the **DTMF** button to initiate the Dispatch DTMF Select mode. The DISP display changes to a "D" followed by a flashing underscore. The numeric keypad is configured for number entry.

2. Before the 10-second time-out period, enter the new DTMF number using the numeric keypad. After 10 seconds, the radio reverts to Normal mode.

NOTE

The # key and/or the * key, or the entire DTMF keypad, may be disabled via the ASTRO Clean Cab CPS for one or both control heads. If the operator attempts to select a disabled DTMF tone, the radio produces an invalid-key-alert tone and the Dispatch DTMF Select mode is re-initiated. The operator must enter a new digit or exit the Select mode in one of the ways described in **2.2.7 Changing Channels.**

When a valid key is pressed, the flashing underscore in the DISP display changes to indicate the keypad entry. The TX indicator lights and the selected tone is transmitted for the programmed duration and is also heard at the speaker. The Dispatch DTMF Select mode is then terminated. If in digital mode, the tone heard at the speaker will only be a configuration-good-alert tone; the selected DTMF tone will not be heard.

3. To retransmit the displayed DTMF tone, press the **DISP** button.

The transmitter is enabled, the TX indicator lights, and the displayed DTMF tone is transmitted for the programmed duration. The transmitted tone is also heard at the speaker output to confirm transmission. If in digital mode, the only tone heard at the speaker will be a configuration-good-alert tone, the selected DTMF tone will not be heard.

The displayed tone is broadcast for as long as the **DISP** button is pressed (for analog modes only), within the limits of the programmed minimum and maximum duration times.

Sending DTMF Dispatch Tone Sequences

If Dispatch Tone Sequence is enabled in CPS, then tone sequences may be stored for later use with the **DISP** button. For analog DTMF, inter-tone and duration of the tones are programmable via CPS.

To select and transmit a DTMF tone sequence for dispatch calls, execute the following:

1. Momentarily press the **DTMF** button to initiate the Dispatch DTMF Select mode. The DISP display changes to "_ - - " where the "_" is a flashing underscore. The numeric keypad is configured for number entry.

2. Before the 10-second time-out period, enter one, two or three DTMF numbers using the numeric keypad. After 10 seconds, the radio reverts to Normal mode.

NOTE

The # key and/or the * key, or the entire DTMF keypad, may be disabled via the ASTRO Clean Cab CPS for one or both control heads. If the operator attempts to select a disabled DTMF tone, the radio produces an invalid-key-alert tone and the Dispatch DTMF Select mode is re-initiated. The operator must enter a new digit or exit the Select mode in one of the ways described in **2.2.7 Changing Channels.**

When a valid key is pressed, the flashing underscore in the DISP display will shift to the right. If the third DTMF tone is entered, the sequence will be stored and the entry mode will return to normal operation and the DTMF sequence will not be transmitted. For less than three DTMF tones, the **DISP** button must be pressed to end the entry mode. Once the **DISP** button is pressed, the DTMF tone sequence will be transmitted.

The DISP area of the control head display will indicate the tone sequence stored. For less than three DTMF tones, it will display the DTMF tone followed by one or two blanks.

3. To retransmit the displayed DTMF tone sequence, press the **DISP** button.

   The transmitter is enabled, the TX indicator lights, and the displayed DTMF tone sequence is transmitted for the programmed duration. The transmitted tones are also heard at the speaker output to confirm transmission. If in digital mode, the only tone heard at the speaker will be a configuration-good-alert tone, the selected DTMF tone will not be heard.

   The displayed tone sequence is transmitted once each time the **DISP** button is pressed. If **DISP** button, or any other button except for **PTT**, is pressed again or held down during a transmit sequence it will be ignored.

Sending DTMF Tone Using the Numeric Keypad

The programming features of the DTMF numeric keypad are identical to those described for the DTMF dispatch tones above.

To transmit a DTMF tone using the numeric keypad, execute the following:

NOTE

The # key and/or the * key, or the entire DTMF keypad, may be disabled via the ASTRO Clean Cab CPS for one or both control heads. If the DTMF keypad is disabled, it will continue to operate in the Select modes. If the operator attempts to send a disabled DTMF tone, the radio will produce an invalid-key-alert tone and the radio will not transmit.

1. Press the appropriate key on the numeric keypad to transmit the required DTMF tone.

   The transmitter is keyed for the programmed duration, the TX indicator lights, and the DTMF tone corresponding to the key pressed is broadcast. The transmitted tone is also heard at the speaker output to confirm transmission. If in digital mode, the only tone heard at the speaker will be a configuration-good-alert tone, the selected DTMF tone will not be heard.

NOTE

In analog mode, the DTMF tone is transmitted for as long as the corresponding key is pressed, within the limits of the programmed minimum and maximum duration times. The total transmit time includes any programmed pre-time and hang time intervals. In digital mode, extended button presses and timing parameters have no effect.

2. If necessary, repeat the above step for each additional DTMF tone.

   The above result is repeated for each corresponding key pressed. If the second DTMF key is pressed before the first tone has completed its tone duration, the first tone is terminated and the second tone immediately starts broadcasting for its programmed duration. This operation is repeated for any subsequently pressed digits.

2.2.7 CHANGING CHANNELS

Common Select Mode Conditions

In general, to enter a Select mode, the pertinent Select mode key is pressed. The corresponding display(s) change to dashes, with the data entry location being indicated by a flashing underscore. The numeric keypad is now configured to enter numbers.

NOTE

When the radio is in any Select mode, it continues to receive messages on the last selected RX channel.

Any Select mode is automatically terminated after one of the following conditions occurs:

a. Completion of a valid Select mode entry .The corresponding displays are updated and a configuration-good-alert tone is heard at the speaker.

b. After ten seconds of no keypad activity. The display reverts to the last selected display and an invalid-key-alert tone is heard at the speaker.

c. If after initiating a Select mode, the same Select mode key is pressed again before complete entry of the number information, then the display reverts to the last selected display.

d. If after initiating a Select mode, another Select mode key is pressed, then the display changes to the new Select mode display.

Selecting TX and RX Channels

To select a new TX and RX channel pair, execute the following:

1. Momentarily press the **CHAN** button to initiate the Channel Select state. The TX and RX displays become dashes, with a flashing underscore appearing in the leftmost (TX hundreds) position. The numeric keypad is now configured for number entry.

2. Enter the first digit using the numeric keypad, including a leading zero if required (The operator has 10 seconds after a key is pressed to press the next key before Select mode time-out occurs). The keypad number entry replaces the flashing underscore which moves right to the next position.

3. Enter the remaining five digits using the numeric keypad. When 4 digit channel entry is enabled in the ASTRO Clean Cab CPS, if the user enters 4 digits and pauses the radio will assume a leading zero before each digit pair. Thus an entry of 1212 will be interpreted as 012 012.

   For a valid keypad sequence, the TX and RX displays are updated to indicate the keypad entries. A configuration-good-alert tone sounds when the sixth digit has been entered successfully or when the 4 digit channel is auto entered after a few seconds. The Channel Select mode is terminated and the radio now transmits and receives on the new channel assignments.

   If either the TX or RX channel is invalid (not a valid preprogrammed conventional channel or a trunking mode) an invalid-key-alert tone sounds when the sixth digit has been entered or when the 4 digit channel is auto entered after a few seconds. The TX and RX displays become dashes as before. If either the TX or RX channel is a trunking talkgroup, the display will also show “ERROR TRUNK” before returning to display dashes. The operator may enter new digits or exit the Channel Select mode in one the ways described under **Common Select Mode Conditions** above.

Selecting a Trunking Channel

To select a new trunking talkgroup, execute the following:

1. Momentarily press the **TRNK** button to initiate the Trunking Select state. The TX and RX displays become “TRUNK” followed by dashes, with a flashing underscore appearing in the leftmost (hundreds) position. The numeric keypad is now configured for number entry.

2. Enter the first digit using the numeric keypad, including a leading zero if required (The operator has 10 seconds after a key is pressed to press the next key before Select mode time-out occurs). The keypad number entry replaces the flashing underscore which moves right to the next position.

3. If the talkgroup is invalid (not a valid preprogrammed trunking talkgroup, or a conventional channel) an invalid-key-alert tone sounds when the third digit has been entered. The TX and RX displays become “TRUNK” followed by dashes as before. The operator may enter new digits or exit the Trunking Select mode in one the ways described under **Common Select Mode Conditions** above.

Selecting a Home Channel

To select a programmed Home channel, execute the following:

NOTE

If there are no Home channels programmed in the radio, pressing the HOME key causes an invalid-key-alert to sound and the Home Select mode is not entered.

Momentarily press the **HOME** button to initiate the Home Select mode. The TX and RX channel displays are replaced by the word "HOME". Either a single flashing underscore (in radios with 9 or fewer Home channels), or a flashing underscore followed by a dash(es) (in radios with 10 to 200 Home channels) appears in the HOME display.

Enter the required number of digits (one or two), including a leading zero if necessary, using digits 0 through 9 of the numeric keypad. In the case where two digits are required, the flashing underscore moves right to the next data-entry position after the first digit is entered.

NOTE

The # and * digits (and 0 as a single entry) are invalid Home channel identifiers.

When the valid digit, or pair of digits, is entered, the HOME display is updated to reflect the keypad selection. A configuration-good-alert tone is heard at the speaker and the Home Select mode is terminated. The eight-character maximum (seven if dispatch sequence is enabled) alphanumeric name representing the selected Home channel appears in the TX, RX and DISP channel display fields. The Home mode numbers are not displayed on the display unless manually made part of the Home name. Refer to section **2.2.5 Home Mode Select** for more information.

If an error is made (i.e. digits entered are not a valid programmed Home channel), an invalid-key-alert tone sounds when the last digit is entered and the flashing underscore returns to the first data-entry position. The operator must enter a new digit (or digits) or exit the Home Select mode in one of the ways described under **Common Select Mode Conditions** above.

After valid completion of the Home Select mode, the radio transmits and receives on the new channel assignments, and the selected dispatch call tone (if applicable) is updated.

2.2.8 SELECTING ANALOG AND DIGITAL CONVENTIONAL OPERATION

The **A / D** button on the control head allows the operator to toggle the transmitter between analog or digital (ASTRO CAI) voice operation on the selected TX channel. The Mixed-Mode RX channel will receive both analog and digital transmissions. The A LED will be illuminated if analog operation is currently selected. The D LED will illuminate if digital operation is selected.

NOTE

This feature only operates if the currently selected TX and RX channels are each programmed in CPS for ASTRO TX and Mixed-Mode RX. Any other combination will cause the **A / D** button to be disabled and a bad tone to sound if pressed.

Changing channels will automatically switch to analog operation unless slaved to analog or digital. If the conventional channel selected is programmed for analog only or digital only, the LED will be automatically slaved to the appropriate indication and the **A / D** button will be disabled. If on a trunking channel, both LEDs will be off and the **A / D** button will be disabled.

2.2.9 PA / INTERCOM

When the MBW330 PA/Intercom option is ordered, this option modifies the radio control panel to include four new pushbuttons, identified as **RAD** (radio), **PA** (public address), **IC** (intercom) and **CALL**. The status of each button function is also indicated by an associated LED on the display. Refer to Figure 2-2-1 for the location of the buttons and indicators. The function of the four buttons is to control the state of the three Vehicle Interface Port (VIP) output lines available on the radio service connector. The VIP outputs control external customer-specific equipment.

To use the PA / Intercom feature, execute the following:

1. Pressing one of the four buttons (**RAD**, **PA, IC** and **CALL**) will turn on the associated LED indicator on the display panel and set the VIP output lines to the appropriate levels, according to the information found in **4.2.2 REAR PANEL BOARD**. If another VIP function is active when a button is pressed, that function will automatically deactivate and the new VIP function will activate.

2. To deactivate a VIP function, press the associated button again.

3. All VIP output states can be reset by momentarily applying logic Low to the VIP IN 1 input line on the service connector.

NOTE

The CALL function is slaved to the IC function. Pressing the **CALL** button will activate both the CALL function and the IC function (if it is not already active) and both LEDs will be on. However, pressing the **CALL** button again will deactivate only the CALL function, not the IC function. The **IC** button (or another function button) can be pressed to deactivated the IC function.

PART 3. RADIO FUNCTIONAL OVERVIEW AND BLOCK DIAGRAMS

3.1 GENERAL

This part presents a functional overview of the ASTRO Clean Cab Railroad Radio. The material is divided into two levels: Simplified Description and Functional Description. The Simplified Description provides a general overview of the modules and circuit boards in the radio. The Functional Description divides the circuits comprising the radio set into eleven functional groups and provides a brief description of each group.

For a detailed electrical description of each circuit board and module, refer to **PART 4, THEORY OF OPERATION.**

3.2 SIMPLIFIED DESCRIPTION

Refer to Figure 3-1 for a simplified functional block diagram of the radio set. The circuitry of the radio set is essentially contained within three major assemblies:

- Clean Cab Front Panel Assembly
- Clean Cab Bottom Panel Assembly
- Clean Cab VHF Top Panel Assembly

Clean Cab Front Panel Assembly

The front panel assembly consists of the control head microcomputer board, display board, keypad, and the front-panel speaker and built-in microphone assemblies. Operator key presses and display updates are processed by a 68HCO5 microcomputer and support circuitry on the microcomputer board. In addition, this microcomputer maintains serial bus communications with the translator board in the Bottom Panel Assembly via a ribbon cable assembly and the rear panel interconnect board.

Clean Cab Bottom Panel Assembly

The bottom panel assembly contains the rear panel interconnect board, translator board, auxiliary connector, and the power converter. The power converter is specific to the power source available from the locomotive, usually 72 Vdc. The source voltage is converted and filtered to the nominal 13.8 Vdc required by the radio. For information regarding other available power conversions, refer to the Power Converter section in **Part 4, THEORY OF OPERATION.**

The rear panel interconnect board provides the necessary connectors and signal paths to support the local control head (internal connector), remote control head connectors, RS232 data connector, programming connector, auxiliary connector and handset connector. In addition, it receives filtered 13.8 Vdc from the converter board which it distributes to the remaining circuit boards.

The translator board is an extension of the rear panel interconnect board and contains the microprocessor and other interface circuitry that allows the ASTRO Spectra transceiver to communicate with the control head(s). The translator board firmware also provides for the unique railroad ergonomics, I/O and audio routings. The translator board includes an CPS programmable codeplug, to allow user configuration of the unique features of the ASTRO Cleancab radio

Clean Cab VHF Top Panel Assembly

The top panel assembly is divided into three parts: the top panel interconnect board, the ASTRO VHF transceiver module, and the VHF power amplifier (PA).

Most of the receiver, transmitter injection, synthesizer, and associated control circuits are contained within the transceiver module. The serial-bus communications between the transceiver and the translator board are accomplished via the rear and top panel interconnect boards, and the ASTRO adaptor board.

The ASTRO transceiver module consists of five major assemblies:

- Command Board – microcomputer, memory, support ICs, voltage regulators and miscellaneous audio and control stages.
- VOCON Board – DSP and audio processing.
- VHF Receiver Front End Assembly
- VHF RF Board - receiver IF, demodulator, and the synthesizer logic and filtering.
- VHF VCO / Buffer Divider Board

The VHF PA assembly connects to the transceiver module via a ribbon cable and two coaxial cables (one for RX and one for TX). It provides the necessary gain at the transmitter frequency to produce rated RF power at the antenna, and carries receiver RF to the transceiver module. For additional block diagrams and complete servicing information for the ASTRO transceiver assemblies, refer to the corresponding section of the ASTRO Service Manual.

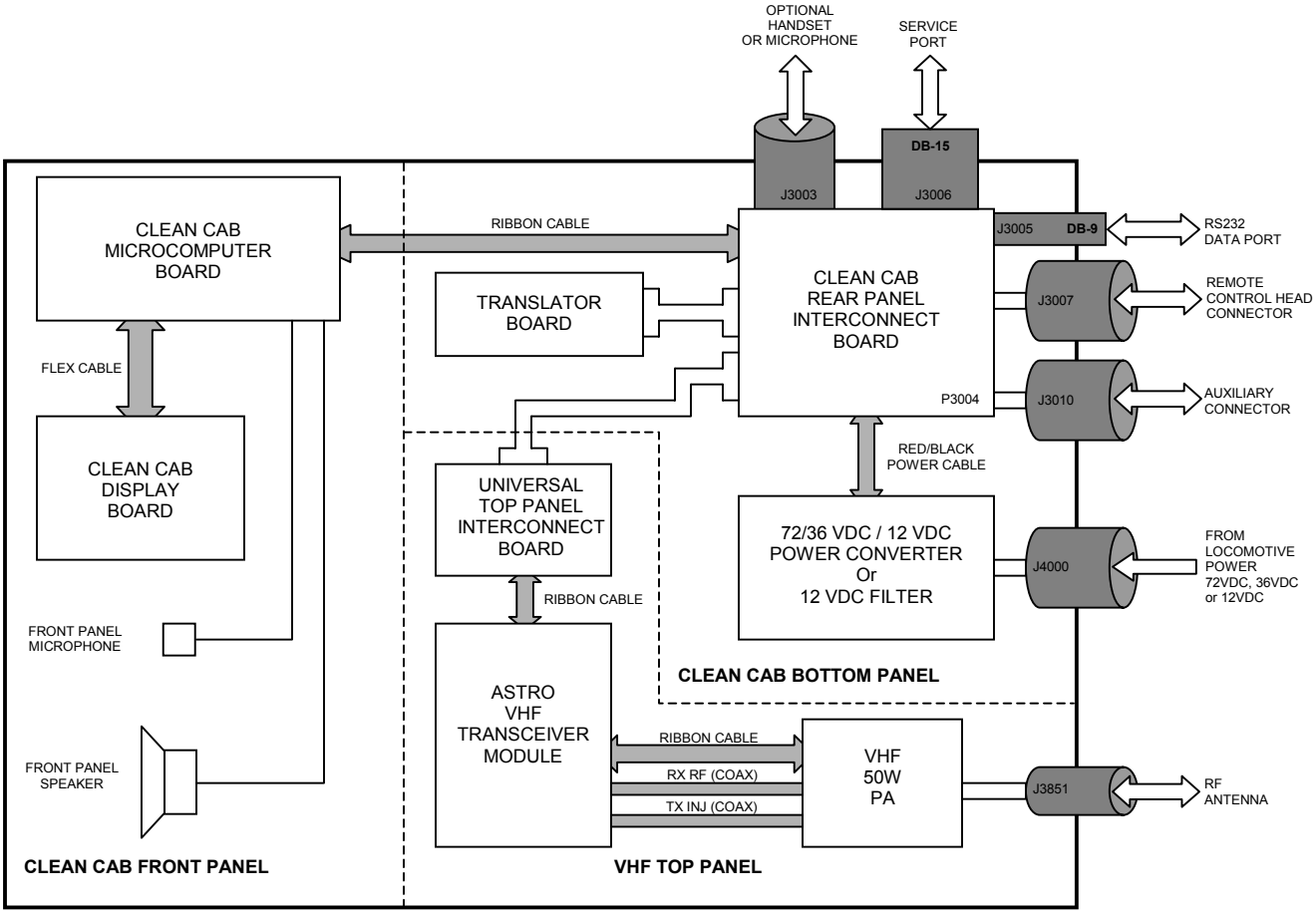


Figure 3-1 ASTRO Clean Cab Railroad Radio – Simplified Block Diagram

3.3 FUNCTIONAL DESCRIPTIONS

The following is a functional description of the ASTRO CleanCab radio. To support discussion, refer to Figure 3-2, Radio Block Diagram, which appears at the end of this section. This discussion is not intended to be a comprehensive theory of operation for the circuits, but a brief description of the functional groupings within the radio.

Analog Operation

When the radio is receiving, the signal comes from the antenna/antenna-switch on the power amplifier board to the front-end receiver assembly. The signal is then filtered, amplified, and mixed with the first local-oscillator signal generated by the voltage-controlled oscillator (VCO). The resulting intermediate frequency (IF) signal is fed to the IF circuitry on the RF board, where it is again filtered and amplified. This amplified signal is passed to the digital back-end IC, where it is mixed with the second local oscillator to create the second IF at 450 kHz. The analog IF is processed by an analog-to-digital (A/D) converter, where it is converted to a digital bit stream and divided down to a baseband signal, producing digital samples. These samples are converted to current signals and sent to the digital-signal-processor (DSP) support IC. The DSP support IC digitally filters and discriminates the signal, and passes it to the digital-signal processor (DSP). The DSP decodes the information in the signal and identifies the appropriate destination for it. For a voice signal, the DSP will route the digital voice data to the DSP-support IC for conversion to an analog signal. The DSP-support IC will then route the signal via the rear panel interface board to the front panel controller board audio power amplifier which drives the speaker. For signaling information, the DSP will decode the message and pass it to the microcomputer.

When the radio is transmitting, microphone audio is passed via the rear panel interface board to the command board limiter and then to the DSP-support IC, where the signal is digitized. The DSP-support IC passes digital data to the DSP, where pre-emphasis and low-pass (splatter) filtering are done. The DSP returns this signal to the DSP-support IC, where it is reconverted into an analog signal and scaled for application to the voltage-controlled oscillator as a modulation signal. Transmitted signaling information is accepted by the DSP from the microcomputer, coded appropriately, and passed to the DSP-support IC, which handles it the same as a voice signal. Modulation information is passed to the synthesizer along the modulation line. A modulated carrier is provided to the power amplifier (PA) board, which transmits the signal under dynamic power control.

Digital Operation

In the ASTRO mode (digital mode) of operation, the transmitted or received signal is limited to a discrete set of deviation levels, instead of continuously varying. The receiver handles an ASTRO mode signal identically to an analog-mode signal up to the point where the DSP decodes the received data. In the ASTRO receive mode, the DSP uses a specifically defined algorithm to recover information. In the ASTRO transmit mode, microphone audio is processed identically to an analog mode with the exception of the algorithm the DSP uses to encode the information. This algorithm will result in deviation levels that are limited to discrete levels.

ASTRO Mobile Functional Groups

The nine functional groups which make up the ASTRO railroad radio are the:

- ASTRO Front End Receiver
- ASTRO RF Board
- ASTRO Voltage Controlled Oscillators
- RF PA
- ASTRO Command Board
- ASTRO Vocoder/Controller Board
- Translator Board
- Front Panel
- Power converter/filter circuits

A brief description of each functional group is given in the following paragraphs.

ASTRO Front-End Receiver

The receiver front-end consists of a preselector, a mixer circuit, and an injection filter. The receiver injection (1st local oscillator) comes from the VCO assembly through a coax cable. The injection filter is either fixed-tuned or tuned at the factory depending upon the bandsplit. The output of the filter is connected to the mixer.

The preselector is a fixed-tuned filter. The receiver signal is fed to the preselector from the VHF preamp output. The signal is then sent to the mixer integrated circuit where it is connected to the mixer transistor. The receiver injection is also fed to this point. The mixer output is at the 1st IF center frequency of 109.65 MHz. This signal is sent to the 1st IF amplifier stage on the RF board through a coaxial cable.

RF Board

The RF board contains the common synthesizer circuits, dual IF receiver and demodulation circuits. A 4-pole crystal filter at 109.65 MHz provides first IF selectivity. (For HRN6014D, HRN6020C, HRN6019C, HRN4009D, HRN4010C and later RF board kits, two 2-pole crystal filters provide first IF selectivity at 109.65 MHz.) The output of the filter circuit is fed directly to the custom digital back-end circuit module. An amplification circuit at 109.65 MHz, the second mixer, the second IF amplifiers (at 450 kHz), the IF digital-to-analog converter, and the baseband down converter comprise the digital back-end circuit module.

Synthesizing for the first and second VCO is performed by the prescaler and synthesizer ICs. These ICs are programmed through a serial data bus from signals generated on the VOCON board. A DC voltage generated on the command board sets the synthesizer's reference oscillator frequency of 16.8 MHz. This voltage is controlled by the digital-to-analog converter (D/A), and is the only element of the RF board requiring alignment.

The second local oscillator runs at 109.2 MHz (low-side injection), or 110.1 MHz (high-side injection) and consists of a VCO which is frequency-locked to the reference oscillator. Part of the local oscillator's circuitry is in the prescaler IC.

A clamp and rectifier circuit on the RF board generates a negative DC voltage of -4 V (nominal) for increasing the total voltage available to the first VCO and second local oscillator's VCO. The circuit receives a 300 kHz square wave output from the prescaler IC, then clamps, rectifies, and filters the signal for use as the negative steering line for the two VCOs.

ASTRO Voltage Controlled Oscillators

The voltage-controlled oscillator (VCO) assembly utilizes a common-gate Field Effect Transistor (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. A third varactor is used in a modulation circuit to modulate the oscillator during transmit.

The VCO output is coupled to a transistor for amplification and for impedance buffering. The output of this stage passes through a low-pass filter where the signal is split into three paths. One path feeds back to the synthesizer prescaler; the other two provide injection for the RX and TX amplification strings. The receive injection signal is further amplified and passed to the RX front end injection filter. The transmit signal goes to an analog divider, which divides the signal by two. The signal is amplified and buffered and then injected into the transmitter's low-level amplifier.

All transmit circuitry operates from keyed 9.4 V to reduce current drain while the radio is receiving. A transistor/resistor network drives the PIN diodes in the VCO tank. These driver networks provide forward bias current to turn diodes on and reverse the bias voltage to turn the diodes off. AUX 1 and AUX 2 lines control the PIN diode driver networks.

RF PA

The power amplifier is a four-stage, discrete-transistor RF amplifier. The PA amplifies the RF signal from 10 mW to the desired RF level at the antenna.

The first stage buffers the RF signal and acts as a variable amplifier to boost the signal from 10 mW to approximately 100 mW. The second stage amplifies the signal to the 1-watt level. The driver stage amplifies the signal to the 8 to 12-watt level. The final stage is capable of amplifying the signal to approximately 65 watts (maximum). Following the final gain stage, PIN diodes switch the transmit signal to the antenna through a low-pass filter.

A directional-coupler and detector network controls power. It senses forward power from the last gain stage and feeds the detected voltage back to the command board control circuitry where it is compared to a reference voltage set during power-set procedures. The DC feed voltage is corrected and supplied to the "controlled" buffer stage on the power amplifier via the PA/command interconnect board. Circuits on the power amplifier control the gain of the first stage in proportion to the DC control voltage.

An antenna fault detector circuit detects major RF mismatch by measuring reflected power and generates a signal that causes an error message to be displayed on the control head.

ASTRO Command Board

The serial input/output IC provides command board functions including buffers for PTT, channel active, squelch mute, busy, and data transmission, and logic functions for switched B+, emergency, reset, and power control.

The regulator and power control circuits include an unswitched +5 V discrete circuit and the regulator/power control IC, which produces both switched +5 V and +9.6 V. The unswitched +5 V source is used as a reference for its switched +5V source. Filtered unswitched +5 V is used for the microcontroller circuits. Switched +5 V and +9.6 V are controlled by a digital transistor from the serial input/output IC. The power control circuitry receives power set and limit inputs from the digital-to-analog IC, and feedback from the RF power amplifier. Based on those inputs, the power control circuitry produces a control voltage to maintain a constant RF power level to the antenna.

The reset circuits consist of the power-on reset, high/low power source voltage reset, and the external bus system reset. The reset circuits allow the microcomputer to recover from an unstable situation; for example, no power source, power source voltage too high or too low, and remote devices on the external bus not communicating.

Communication in RS-232 protocol is provided by an IC which interfaces to the ASTRO CleanCab rear panel interconnect board.

ASTRO Vocoder/Controller Board

The Vocoder/Controller (VOCON) board, located on the top side of the radio housing, contains a microcontroller unit (MCU) with its flash memory, DSP, and DSP support ICs. The VOCON board controls receive/transmit frequencies, the display, and various radio functions, using either direct logic control or serial communication to external devices.

The VOCON board executes a stored program located in the FLASH ROM. Data is transferred to and from memory by the microcontroller unit data bus. The memory location from which data is read, or to which data is written, is selected by the address lines.

The support-logic IC acts as an extension of the microcontrol unit by providing logic functions such as lower address latch, reset, memory address decoding, and additional control lines for the radio. The VOCON board controls a crystal-pull circuit to adjust the crystal oscillator frequency on the microcontrol unit, so that the E-clock harmonics do not cause interference with the receive channel.

The vocoder circuitry on the VOCON board is powered by a switched +5 V regulator located on the command board. This voltage is removed from the board when the radio is disconnected from the locomotive power.

The DSP (digital-signal processing) IC performs signaling, voice encoding/decoding, audio filtering, and volume control functions. This IC performs Private-Line/Digital Private Line (PL/DPL) encode and alert-tone generation. The DSP IC transmits pre-emphasized analog signals and applies a low-pass (splatter) filter to all transmitted signals. It requires a 33 MHz crystal to function. An 8 kHz interrupt signal generated by the DSP-support IC is also required for functionality. This device is programmed using parallel programming from the microcontrol unit and the DSP-support IC.

The DSP-support IC performs analog-to-digital and digital-to-analog conversions on audio signals. It contains attenuators for volume, squelch, deviation, and compensation, and it executes receiver filtering and discrimination. The IC requires a 2.4 MHz clock to function (generated by the digital back-end IC) and is programmed by the microcontrol unit's Serial Peripheral Interface (SPI) bus.

Translator Board

The translator board is an extension of the rear panel interconnect board that contains all of the ASTRO CleanCab specific microprocessor logic and control circuitry. It translates serial bus messages between the control head microprocessor and the Astro mobile. The translator board firmware provides the unique railroad ergonomics.

Transmit and receive data are handled by a Dual Universal Asynchronous Receiver/Transmitter (DUART). The microprocessor and DUART communicate via the external parallel address/data bus. Bus and Busy driver circuits for the radio and control head SB9600 serial busses are contained on the translator board.

A 128k Flash ROM and a 32k SRAM are accessed through the microprocessor external address/data bus and contain the translator board firmware. The Translator Board codeplug information is stored on an external 4K serial EEPROM (2k on earlier boards). The microprocessor accesses the EEPROM through the Serial Peripheral Interface port.

A 68HC11F1 microprocessor running at a 2MHz clock speed is the heart of the translator board. All serial bus messages are passed through the microprocessor to and from the ASTRO transceiver and control heads. The microprocessor also handles several sources of hardware I/O including the VIP outputs, VIP inputs, handset PTT and Hang-Up-Box (HUB), and auxiliary PTT and HUB.

Front Panel Board

The front panel circuits, which provide the visual and control interface between the operator and the radio set, are controlled and monitored by the microcomputer, U1000. This microcomputer communicates with the translator board via the serial bus, scans the front panel keypad for activity, generates display information for the Vacuum Fluorescent Display (VFD) and indicator LEDs, and digitally controls the output level of the audio PA.

When a key is pressed on the front panel, the microcomputer, U1000, identifies which particular key is pressed and sends a serial bus message to the translator board microcomputer. This device then determines and coordinates the appropriate action to be taken and sends a serial bus response back to the front panel. Microcomputer U1000 then interprets this response and displays the corresponding message on the display board, if required. Serial Bus Interface circuits, on the translator

board and on the front panel microcomputer board, control the communications between the microcomputers.

SW A + is applied to two regulators on the microcomputer board which supply this board and the display board with + 5 V dc and + 9.6 V dc. Also, the microcomputer board contains a handset audio amplifier which provides the optional handset earpiece with a fixed-gain volume level.

Situated on the display board, the VFD is an eleven-character, fourteen segment, alphanumeric device used to display channel, tone, and diagnostics information. The anodes and the grids operate at approximately 40 Vdc when on, and 0 Vdc when off. The filaments operate at approximately 2.4 Vac rms. The necessary voltages for the VFD are generated by a fixed-frequency, variable duty-cycle controlled fly-back voltage converter on the microcomputer board.

A ten-element LED bar graph display is used to indicate the relative speaker volume. Each element is driven by a separate transistor driver. Similarly, up to eight discrete LEDs are used to indicate the operating status of certain radio features (TX, A/D, etc…).

Three cascaded shift registers and two VFD drivers use serial data from the microcomputer to update the VFD, bar graph display, and indicator LEDs. The display board also contains backlights for the keypad which, under microcomputer control, are either on or off.

Power Converter/Filter

A functional block diagram of the power converter is found in **PART 4, THEORY OF OPERATION**. Depending on the module ordered, it is either a 72 Vdc-to-12 Vdc converter, 36 Vdc-to-12 Vdc converter or a simple 12 Vdc LC filter module.

The circuit design of the power converters is that of a forward converter employing current-mode control. Both modules include filtering, transient protection, and fuses. In addition, the power converter modules also includes over-current and over-voltage protection circuitry. The 13.8 Vdc output provides source voltage for the radio circuits. It enters the rear panel interconnect board at P3002, via the ASTRO power cable assembly, for distribution to the remaining radio circuits.

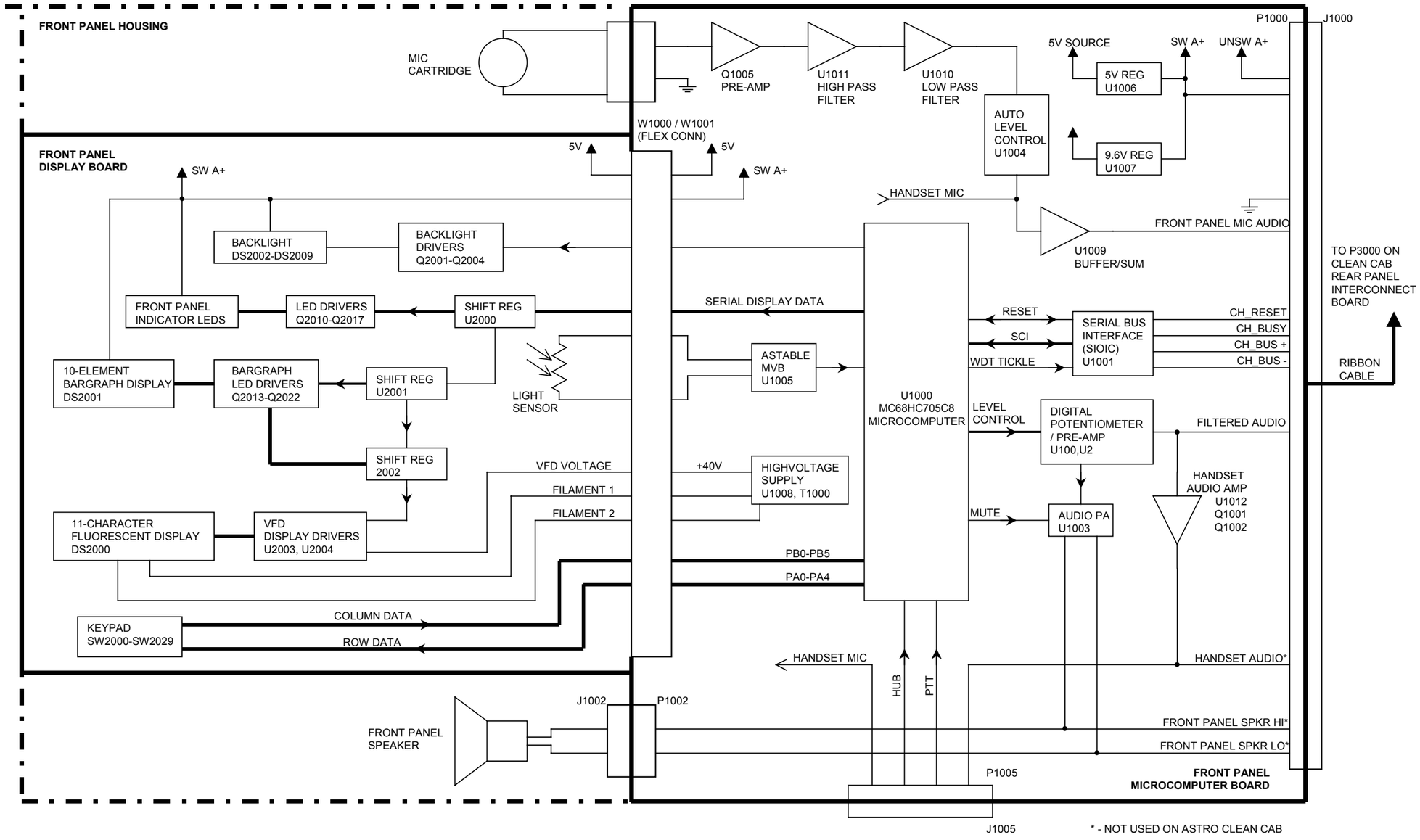


Figure 3-2
ASTRO Clean Cab
Railroad Radio
Functional Block Diagram: Control Head
(Sheet 1 of 4)

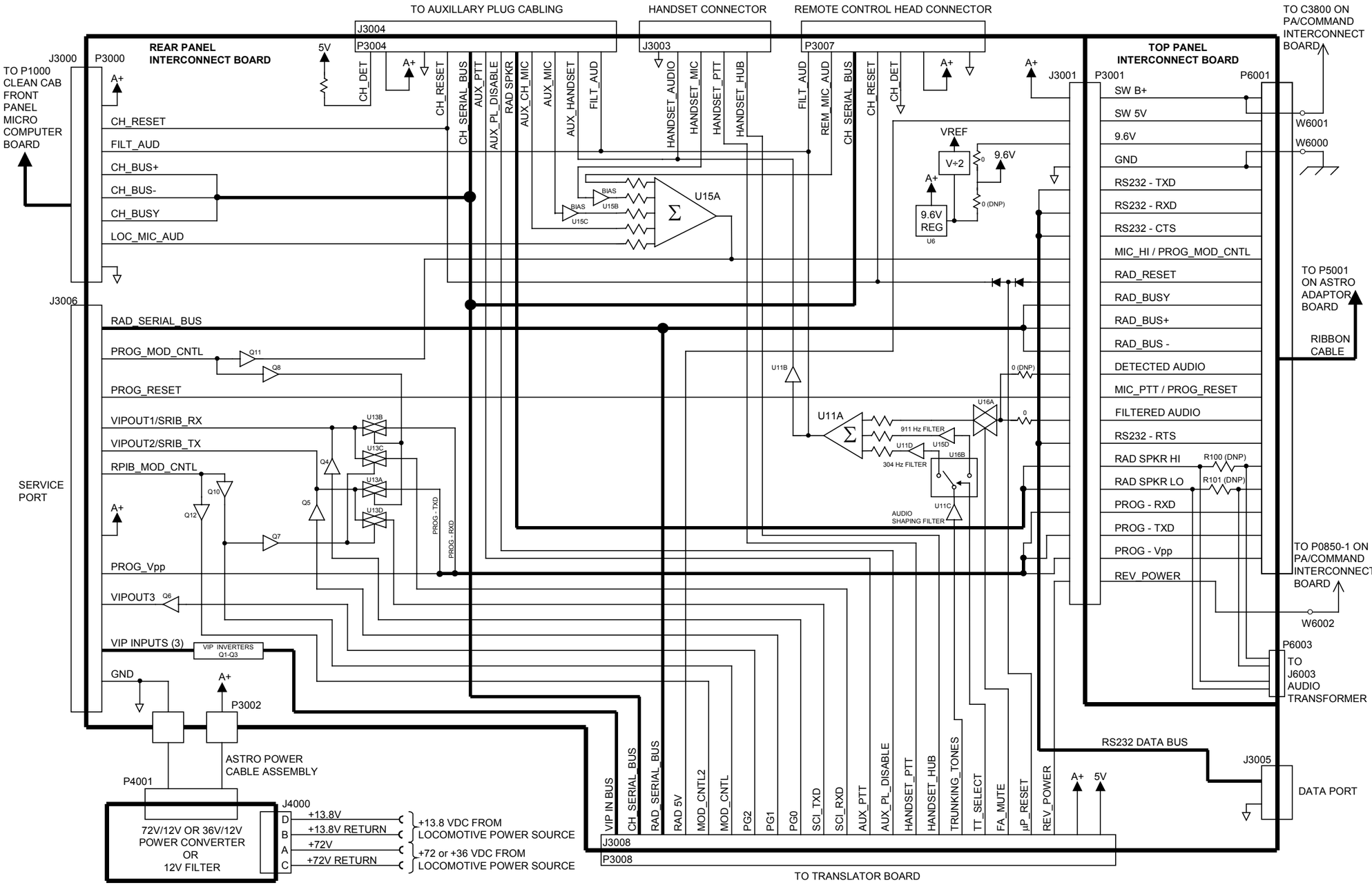


Figure 3-2
ASTRO Clean Cab
Railroad Radio
Functional Block Diagram: Rear Panel Interconnect Board
(Sheet 2 of 4)

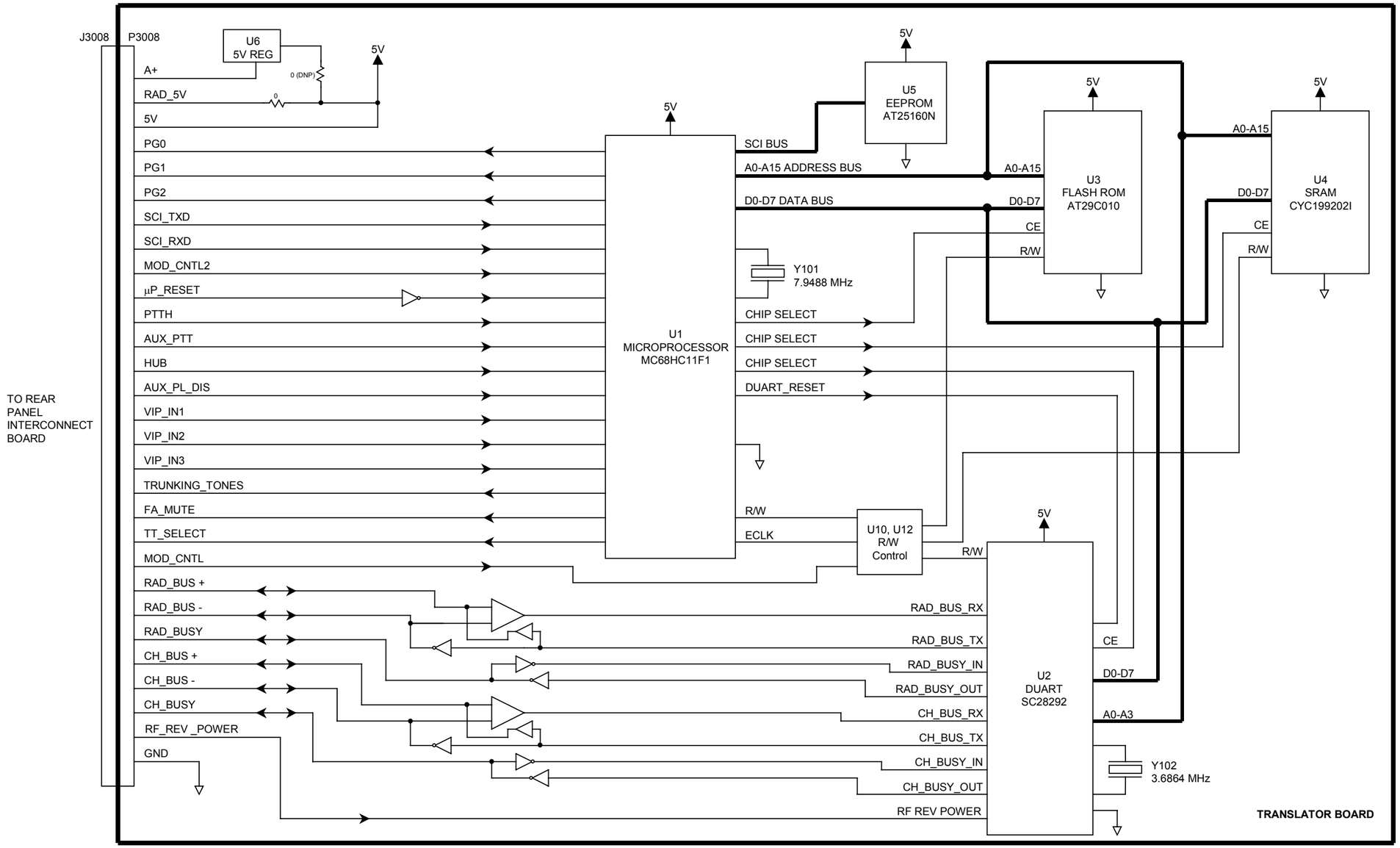


Figure 3-2
ASTRO Clean Cab
Railroad Radio
Functional Block Diagram: Translator Board
(Sheet 3 of 4)

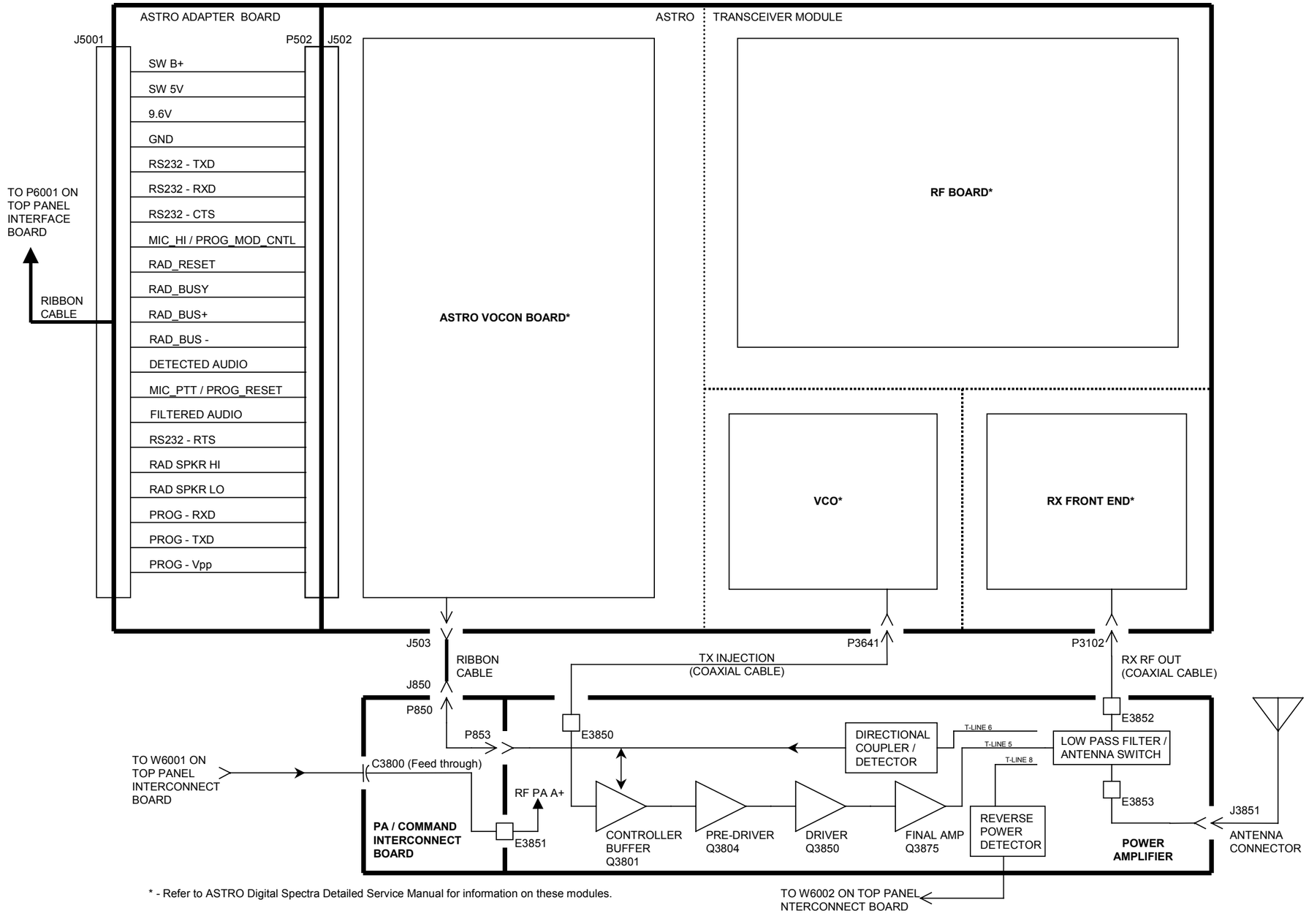


Figure 3-2
ASTRO Clean Cab
Railroad Radio
Functional Block Diagram: ASTRO Transceiver/RF PA
(Sheet 4 of 4)

PART 4. THEORY OF OPERATION

4.1 FRONT PANEL CIRCUITS

4.1.1 GENERAL

This section describes the electrical details for the circuits contained within the Clean Cab Front Panel Assembly of the ASTRO Clean Cab Railroad Radio. The front panel circuits provide the control interface between the operator and the ASTRO transceiver module. The assembly houses a speaker, built-in microphone, display board, microcomputer board, and keyboard hardware. Central to the discussion are the following two printed circuit board assemblies:

- Clean Cab Front Panel Microcomputer Board
- Clean Cab Display Board

The relationship of the front panel circuits to the other radio functions is shown in **PART 3, RADIO FUNCTIONAL OVERVIEW AND BLOCK DIAGRAMS**.

4.1.2 MICROCOMPUTER BOARD

The Clean Cab Front Panel Microcomputer Board (hereafter referred to as "microcomputer board") is the printed circuit board assembly containing the control circuitry for the keypad switches, microphone, 11-character display, indicators, handset amplifier, and audio PA required for the operator interface. Board layout, schematic and parts list for the microcomputer board are provided in Figures 4-1-3 to Figure 4-1-5 at the end of this section.

Microcomputer (U1000)

The microcomputer board includes the microcomputer, U1000, which controls serial bus communication, keypad scanning, display processing, and digital volume control.

This microcomputer is an MC68HC705C8 8-bit microcomputer unit (MCU) using HCMOS technology and housed in a 44-pin PLCC package. It contains 176 bytes of internal RAM, 4k bytes of internal ROM, an on-board oscillator and 24 bi-directional I/O lines.

The microcomputer operates at a crystal frequency of 4.00 MHz, supplied by Y1000 and an internal oscillator. The internal clocks are derived from a divide-by-two of the internal oscillator frequency.

Figure 4-1-1 provides a table which summarizes the current functional assignments for the micro-computer pins.

Power Supply and Voltage Sensing

Primary power for the microcomputer board is supplied by the SW A+ line (P1000 pins 7 and 8) which comes directly from the power converter board via the rear panel interconnect board. The radio is on whenever the +72 Vdc source is connected to the radio (on the rear panel interconnect board UNSW A+ is connected directly to SW A+). SW A+ sources the +5 Vdc and +9.6Vdc regulators. Jumper JU1008 is installed, connecting +5 Vdc to the microcomputer and the serial input/output IC (as UNSW5V).

SW A+ is applied to the input of a +5 Vdc regulator (U1006-8), This regulator is a low-dropout fixed-output device (input/output differential < 600 mVdc) which supplies +5 Vdc to the display and microcomputer board circuitry. With this type of regulator, load circuits are protected from excessive input transients during load dump. SW A+ is also applied to the input of a +9.6 Vdc regulator (U1007-8). This regulator is a low-dropout adjustable-output device with the output biased to +9.6 Vdc by the voltage biased to +9.6 Vdc by the voltage divider created by R1001/R1002. This regulator supplies the audio circuits on the microcomputer board with +9.6 Vdc (except the audio PA U1003 which is supplied by SW A+ and UNSW A+). Zener diode VR1000 provides over-voltage protection at the input to the two regulators. D1008 prevents filter capacitor C1100 from discharging during negative-going input voltage transients.

PIN(s)	LABEL	DESCRIPTION
1	RESET	This line is pulled LOW to reset the microcomputer.
2	IRQ	Interrupt request pin normally pulled HIGH through R1034.
4	Vpp	This pin must be connected directly to Vdd on the EEPROM version microcomputer - MC68HC705C8.
5	PA7	Microcomputer output to control status of BUSY line.
6, 7	PA5-PA6	Momentarily inputs after reset cycles to read status of group selection Jumpers.
8-12	PA0-PA4	Outputs to pulse (LOW) keyboard rows on the Display Board.
13-17, 19	PB0-PB5	Inputs to read key presses from the Display Board keyboard columns.
20	PB6	Microcomputer output used as latch clock for Display Board shift registers and VFD drivers.
21	PB7	Not used
22	GND	Logic Ground
24	PC7	Microcomputer output used to enable SW A+ via Q1003. (Used only when radio has an on/off function.)
25	PC6 (BUSY IN)	Microcomputer Input to read status of BUSY line.
26	PC5	Microcomputer output pulls line LOW after RESET to read status of group selection Jumpers.
27	PC4	Microcomputer Input to read status of handset PTT.
28	PC3	Microcomputer output pulls line LOW to mute audio PA IC.
29	PC2	Microcomputer output used for Digital Soft Pot IC Chip Select U100-15.
30	PC1	Microcomputer output used to transmit digital volume level data to U100-2.
31	PC0	Microcomputer output used to clock digital volume level data to U100-1.
32	RDI (PD0)	SCI Receive Serial Data Input.
33	TDO (PD1)	SCI Transmit Serial Data output.
34	MISO (PD2)	Microcomputer Input (Master In, Slave Out) configured to read LDR information from U1005 (see text).
35	MOSI (PD3)	SPI Data output transmits serial data to the Display Board shift registers and VFD drivers.
36	SCK (PD4)	SPI Serial Clock (62.5 KHz) used to clock serial data to the Display Board shift registers and VFD drivers.
37	SS (PD5)	SPI Slave Select Pulled to +5 V through R1035.
38	TCMP (PD6)	Microcomputer outputs 1 kHz "tickle" pulse for watchdog circuitry and to set display intensity (strobe).
39	PD7	Microcomputer Input to read status of handset hang-up switch.
41	TCAP	Input to microcomputer Input Capture Register used to synchronize serial bus data packets (via BUSY).
42	OSC1	Crystal input 1
43	OSC2	Crystal input 2
44	Vdd	+5 volts DC supply pin

Figure 4-1-1 Microcomputer I/O Lines Descriptions

Serial Input/Output IC

The Serial Input/Output IC (SIOIC-U1001) performs the following functions:

1. Buffer/inverter for the DISPLAY STROBE signal (U1001, pins 21 and 23). Refer to the display board theory for a description of this signal.

2. Inverter for the AUXILIARY DETECT signal (U1001, pins 35 and 36). A LOW from U1000-26 is inverted by the SIOIC, which biases Q1006 and enables the microcomputer to read jumpers JU1005 and JU1006 for the presence of certain options.

3. Watchdog timer.

4. Buffer for serial bus communications from the translator board microcomputer to the front panel microcomputer and back again.

5. Reset circuits for the front panel microcomputer and external serial bus.

Reset Circuitry

When SW A+ is initially applied, the RESET line to U1000-1 is held low for approximately 120 milliseconds before going HIGH. This HIGH resets U1000 which begins to operate properly. A resultant signal at U1000-38 provides a 1 kHz "tickle" pulse to the watchdog timer circuit in the SIOIC via U1001-2. This pulse also enters a buffer/inverter in the SIOIC via U1001-21, exiting at U1001-23, to provide a DISPLAY STROBE signal to the VFD via W1000-10. If the tickle pulse disappears for more than 120 milliseconds, the reset sequence is initiated and U1001-9 (L/H RESET) goes high, producing an external serial bus reset.

Serial Data Bus Circuitry

The serial data bus controls all communications between the front panel and the translator board. Serial data bus communications are accomplished using three bi-directional lines: BUS+ (P1000-16), BUS- (P1000-15), and BUSY (P1000-18). All microcomputers monitor the bus while data is being transmitted (at 9600 baud). Examples of the different types of data are front panel display data and key closure data.

DATA LINE	NO BUS ACTIVITY (Normal)	BUS ACTIVITY (Sending or Receiving Data)	IN RESET*
BUSY	Low	High	Low
BUSY IN	High	Low	High
BUSY OUT	High	Low	High
BUS +	High	Low and High	High
BUS -	Low	High and Low	Low
TX DATA	High	Low and High**	High
RX DATA	High	Low and High	High
L/H RESET	Low	Low	High
RESET	High	High	Low
* - Bus activity will occur immediately after a reset ** - Sending only			

Figure 4-1-2 Serial Data Bus Logic

BUS+ and BUS- form a differential pair (there is always a difference of 5V between the two lines, that is, when one is HIGH the other is LOW). Their idle states are: BUS+ = HIGH (+5V); BUS- = LOW (0V). Figure 4-1-2 summarizes the serial data bus logic states.

In a typical transmission from the front panel, U1000 examines the BUSY line (PI000-18) via U1001 pins 10 and 11, and UI000-41. If the BUSY line is in an idle state (LOW), U1000 sets U1000-5 (BUSY -OUT) LOW. This sets the BUSY line HIGH via U1001 pins 10 and 13. The microcomputer then transmits the data message. At the end of the transmission, the BUSY –OUT line (UI000-5) goes HIGH, returning the BUSY line to idle.

Data transmissions are sent on the bus asynchronously. When the microcomputer, U1000, sends data onto the bus, it also monitors the transmitted data as a collision-detection measure. When a collision is detected, U1000 will stop transmission and try again. It monitors and receives data via BUS+ (P1000-16) to U1001-17 , and BUS- (P1000-15) to U1001-16. These differential signals go to a comparator inside U1001, with the output being passed to U1000-32 via U1001-20 (RX-DATA). Data is transmitted via U1000-33 to U1001-19 and through the SIOIC to BUS+ and BUS-.

VFD Converter Circuitry

The voltage to operate the Vacuum Fluorescent Display (VFD) is generated by a fixed frequency, variable duty-cycle, flyback voltage converter made up of U1008, transformer T1000, and associated circuitry. One half of U1008 (pins 5, 6, and 7) is designed as a 200 kHz (approximately) sawtooth oscillator. The sawtooth waveform is generated at U1008-6 and applied to the positive input of a duty-cycle controlled comparator at U1008-3.

Caution

Do not probe U1008 pin 5 with power applied or damage to the circuitry may occur.

When power is first applied, U1008-2 is biased by R1010 and R1011 to about 1.6 V. U1008-1 and R1012 begin to switch Q1004 on and off at 200 kHz which alternately builds up and collapses a magnetic field in the primary winding of T1000 as the winding current is switched on and off. When the field collapses, the back EMF (flyback) forward biases D1005 and charges (after a few cycles) C1027 to about 40 V, causing zeners VR1015 and VR1016 to conduct. Regulation is maintained by the effect that the two zeners have on the bias point U1008-2. If the high voltage increases VR1015 and VR1016 pull U1008-2 higher, reducing the on-time of Q1004, and thereby reducing the voltage that is up-converted by T1000.

The voltage converter also produces a VFD filament voltage across T1000 pins 4 and 6. R1020 drops the filament voltage to about 2.4 Vrms. R1019 produces a positive dc offset voltage for the ac filament voltage, dependent on the brightness level. This dc offset ensures that any display grid which should be off will be reverse-biased with respect to the filament. This prevents character "ghosting".

Audio PA Circuitry

The audio PA, U1003, is a dc-coupled, class B bridge amplifier which can supply 22W of audio power. The input is at U1003-3 with two floating, out-of-phase outputs at U1003 pins 9 and 11. The gain of the amplifier is internally set at 36 dB. The amplifier input is received from the volume control circuit comprising operational amplifier U2 and digital potentiometer U100 (Analog Devices AD5232 dual 10k Ohm). This circuit sets the level of FILTERED AUDIO (P1000-25) that is fed into the Audio PA. The potentiometer wiper (U100-7) is connected to the inverting input of the op-amp (U2-2). The potentiometer terminals (U2-6 and U2-8) are connected such that the resistances on either side of the wiper make up the feedback and input resistors of the op-amp gain circuit.

Caution

The Audio PA (U1003) is a dc-coupled bridge-type amplifier with its outputs connected directly to the speaker. Therefore the speaker outputs must never be grounded. Use an audio isolation transformer (e.g. Motorola Part No. SLN6435A) to isolate test equipment from the Audio PA/speaker.

The differential output is routed to the internal front panel speaker via P1002 pins 1 and 2. Alternately, the audio is routed through P1000 pins 1 to 4 to the rear panel interconnect board; however, the front panel speaker signals are no longer routed to the top panel interconnect board. Only the speaker signals from the Astro mobile can be coupled to an externally-connected speaker (through an audio transformer) via the top panel interconnect board. The speaker connections to P1000 remain for compatibility with Spectra Clean Cab models. To mute the amplifier output, U1003-1 is pulled to +5 V through R1006, as controlled by PC3 on the microcomputer (U1000-28).

Microphone Audio Circuitry

Audio from the built-in microphone cartridge enters the microcomputer board via P1001, where it is routed through preamplifier Q1005 to help reduce the noise level to the filter stages. Microphone audio is then routed through a multiple 5-pole high-pass filter made up of both halves of U1011 and associated circuitry. The 3 dB cutoff frequency is approximately 300 Hz. The signal is then routed through a multiple 5-pole low-pass filter with a cutoff frequency of approximately 3 kHz.

From U1010-1 the audio signal is routed to U1004, U1009, and associated circuitry. U1004 is a dual-channel compander, one channel of which is used for automatic level control of the microphone audio signal. With this device, a widely varying input signal is converted into a fixed amplitude output signal without distortion or clipping.

Essentially, U1004 contains a full-wave rectifier, a variable-gain cell (ΔG), and a dynamic time constant buffer. The rectifier detects the peak level of input signal and converts this to a control current for the variable-gain cell. The variable-gain cell (U1004 pins 5 and 7) is placed in the feedback loop of operational amplifier U1009. The buffer enables separate control of the attack and recovery times through the use of two external capacitors (C1076 and C1077 respectively). Whenever the front panel PTT function is initiated, U1000-7 (PA5) goes LOW, turning off Q1007 and Q1009. Turning off Q1007 causes Q1008 to turn on, routing microphone audio from the automatic level control output to buffer U1009 and onto the rear panel interconnect board (via P1000-23). When Q1009 turns off, the effect of R1090 on the recovery time constant capacitor (C1077) is eliminated. This changes the recovery time of the automatic level control to approximately 1 second (determined by C1077 and an internal resistor). Whenever PTT is not activated, Q1009 is on to shorten the recovery time via R1090. This ensures that whenever PTT is initiated, the level control starts from a proper gain level.

Handset Audio Circuitry

To provide audio for the optional handset, FILTERED AUDIO (P1000-25) is routed through C1106 to a fixed-gain push-pull audio amplifier composed of U1012, Q1001, Q1002 and associated circuitry. R1005 provides feedback for the amplifier circuitry. The amplifier output is capacitively coupled to P1000-26 as HANDSET AUDIO where it is routed to the auxiliary connector, J3010-E (P1005-5).

Keypad Scanning

U1000 uses five pins of Port A to scan for button presses by sending out periodic low-going pulses in sequence on pins 8 through 12. Key-sense inputs connect back to the microcomputer via pins 13 to 19.

Resistors R1072 through R1077 ensure that the input lines are held high until a key press. When a particular key is pressed, the key pad contacts close, allowing the low-going pulse to return to U1000 via the corresponding sense line. U1000 then sends a serial bus message to the translator board processor, identifying which key has been pressed.

Ambient Light Detection

U1005 is a timer circuit operating in the astable mode. A light dependent resistor (LDR2000) on the display board varies between 500Ω and 300kΩ, depending on ambient light conditions, to control the duty-cycle of the timer circuit. The output of the timer, U1005-3, is routed to U1000, which in turn uses the duty-cycle information to control the display intensity (refer to display board theory for more information). An output timing diagram for U1005 is included on the microcomputer board schematic diagram, Figure 4-1-4.

4.1.3 DISPLAY BOARD

The Clean Cab Display Board is connected to, and controlled by, the front panel microcomputer board. It provides the visual read-outs and keyboard entry interface for direct operator control of the railroad radio. The display board is connected to the microcomputer board via two 12-wire flex cable W1000 and W1001. Board details, schematic and parts lists for the Clean Cab Display Board are provided in Figures 4-1-6 to 4-1-8. Timing diagrams for various display functions can be found on the microcomputer board schematic, Figure 4-1-4.

Indicator and Volume Level LED Circuitry

The volume level indicator (DS2001) is a 10-element bar graph LED display which emits yellow light. Display elements are sequentially lighted from left to right, under radio software control, to indicate the relative volume level at the speaker. LED DS2015, which emits a red light, is used to indicate to the operator that the radio is transmitting. LED DS2016 and DS2017, which emit a yellow light, are used to indicate analog or digital conventional operation.

Each indicator and bar graph LED is driven by a separate transistor which acts as a constant current source (Q2010 for the TX indicator LED, Q2011 and Q2012 for the A and D indicators and Q2013 to Q2022 for the bar graph display). Three cascaded 8-bit serial-in/parallel-out shift registers are used to provide the base drive to enable each LED/transistor combination individually.

To turn on DS2015, DS2016 and DS2017, serial data is sent from the front panel microcomputer (U1000) via W1000-7 to U2000-14 (DISPLAY DATA), where it is latched to the output pin (i.e. U2000-5 goes high). The data is clocked into the register by each low-to-high transition at U2000-11 (DISPLAY CLOCK). The data is then latched by a low-to-high transition on U2000-12 (DISPLAY LE). The front panel microcomputer pulls U2000-13 (DISPLAY STROBE) low which allows latched data to be presented at the output to the drive transistors, providing a constant-current drive for the LEDs.

To turn on the bar graph transistor drivers, serial data from the microcomputer is clocked into two cascaded shift registers (U2001 and U2002) via U2000 in the same manner as that described for the indicator LED.

Vacuum Fluorescent Display Circuitry

The Vacuum Fluorescent Display (VFD) is an 11-character, 14-segment device. Anodes are the actual phosphorescent segments and grids are the wire-mesh structures located over each character. Characters are multiplexed to reduce the number of interconnecting lines between the driver ICs (U2003 and U2004) and the VFD, such that only one character is on at any given instant.

To light a particular character segment, that anode and grid are pulled about 37 V higher than the filament, causing electrons emitted by the filament to accelerate toward the anode. Electrons hitting the phosphor coating on the anode cause visible light to be emitted. The high voltage is necessary to ensure that the display will be visible in high ambient light conditions.

Two cascaded driver ICs are required to control the VFD. Each device consists of a 12-bit series in/parallel-out shift register with high-voltage output stages. The VFD driver ICs share the microcomputer-controlled CLOCK, serial DATA, DISPLAY LE, and STROBE lines with the three shift registers. Serial data to enable the various characters is clocked and latched in the same manner as that described for the indicator and bar graph LEDs.

Since the VFD has 25 control pins and the combined VFD drivers have only 24 output pins available, a high-voltage driver is created by Q2023 and Q2024 to drive the remaining segment. The base drive for this transistor pair is provided when the appropriate serial data causes U2002-5 to go high, pulling DS2000-9 high (to about 37V) to light the segment.

Display Dimming

Dimming of the LEDs and VFD is accomplished by duty-cycle modulation of the STROBE line (W1000-10). Whenever this line is high, all LEDs and characters are off (shift register outputs are in high-impedance state).

Keypad Switches

The keypad switches are normally-open switches which allow for changes to the status of the individual radio functions. The switches are arranged electrically in a 6-row by 5-column matrix. Each keypad switch consists of a carbon-impregnated rubber pad which, when pushed, connects the associated carbon-ink switch pattern on the display board surface, thereby closing the switch. One side of each switch pattern in a particular row is connected to one of five possible outputs on the microcomputer (U1000 pins 8 through 12). The other side of each switch pattern is connected to one of six columns. Each column is connected to a separate input line of the microcomputer (U1000 pins 13 through 17 and pin 19). Refer to the theory for the microcomputer board for a description of keypad scanning.

Backlight LEDs

Eight LEDs, DS2002 to DS2009, are paired to provide backlighting of the front panel buttons to enhance button viewing in dim light conditions. A fixed current level is controlled through each LED pair by one of four transistor drivers, Q2001-Q2004. The transistors are either on or off as controlled by U1000-21 (PB7) on the front panel microcomputer board (the microcomputer does not dim the backlight LEDs by duty-cycle changes).

PA/Intercom LEDs

Four LEDs, DS2010 to DS2013, are used when MBW330 is present. To turn on one of the VIP LEDs serial data is sent from the control head microcomputer (U1000) via W1000-7 (DATA) to U2000-14, where it is latched to the appropriate output pin (i.e. U2000 pin 1,2,3 or 15 goes high). The data is clocked into the register by each low-to-high transition on U2000-12 (LATCH ENABLE). The control head microcomputer pulls U2000-13 (DISPLAY STROBE) low which allows latched data to be presented at the output to turn on one of the driver transistors (Q2005-Q2008), providing a constant-current drive for the associated LED.

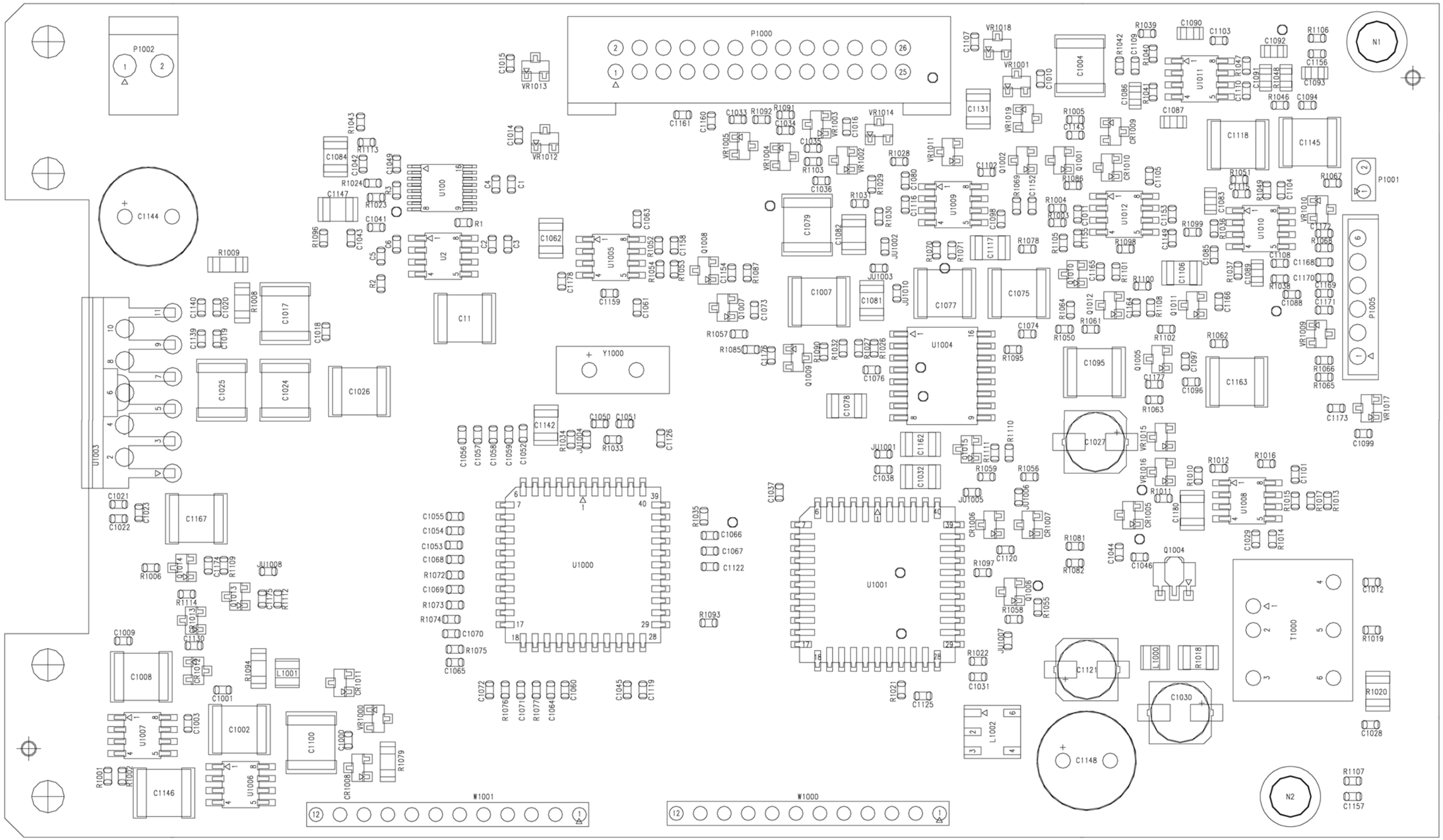
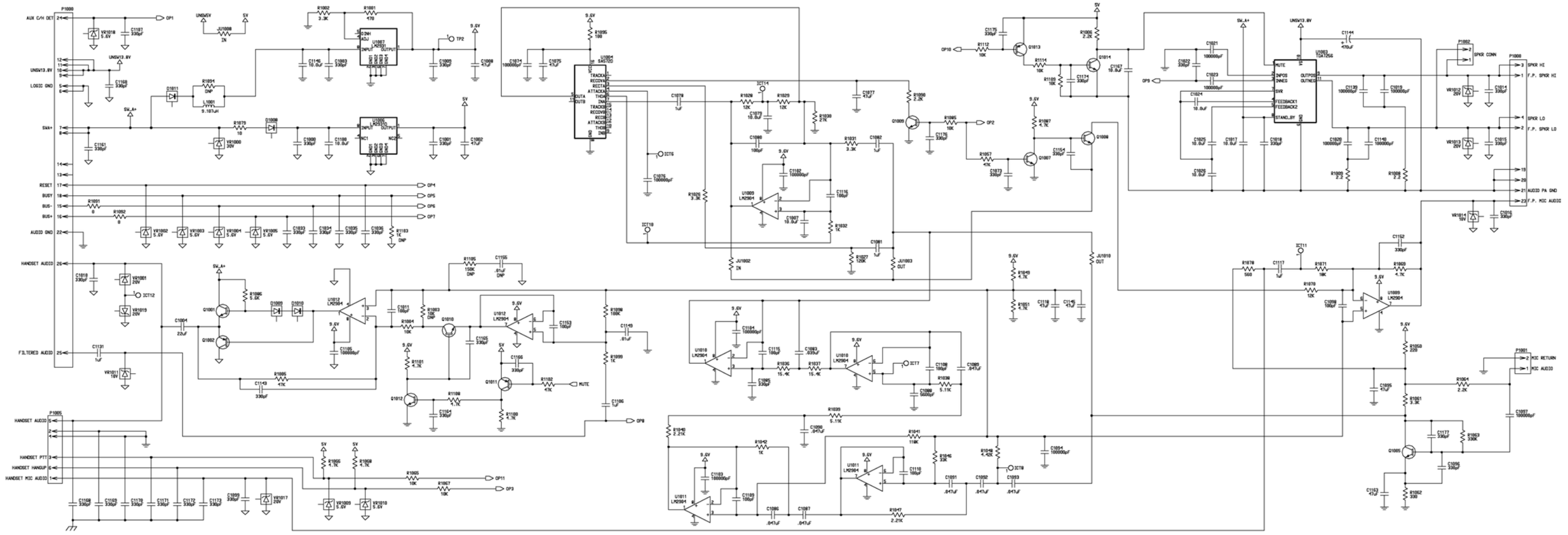
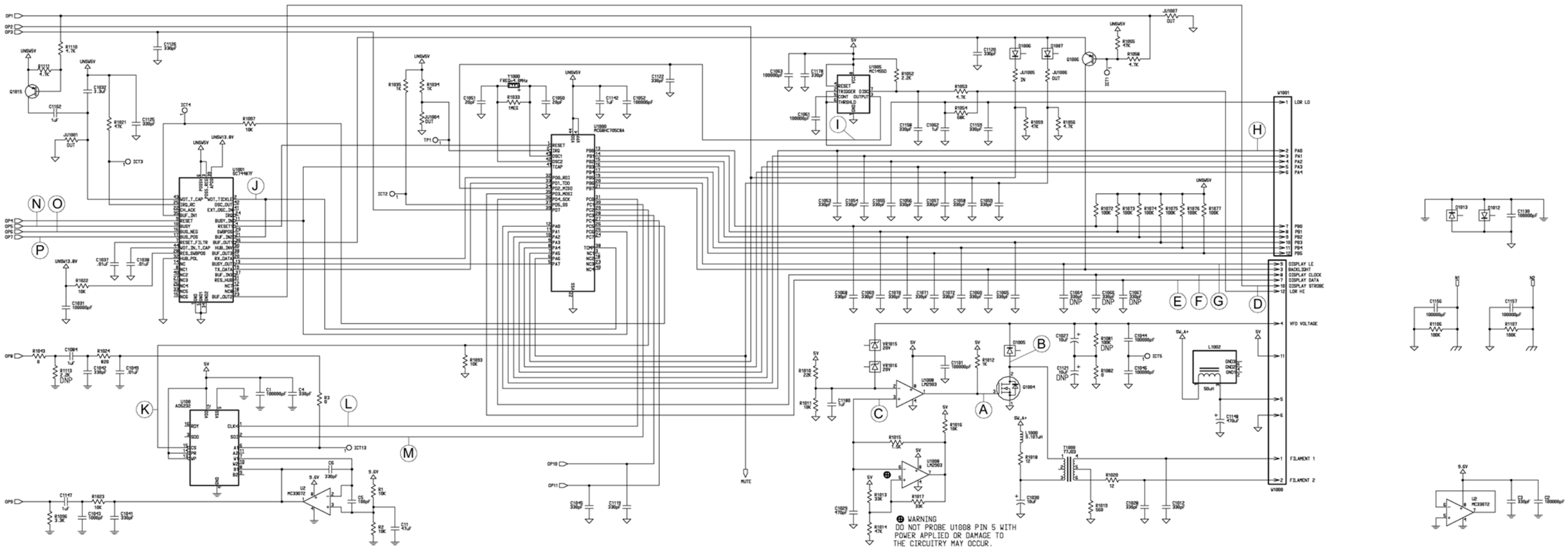


Figure 4-1-3 Clean Cab Front Panel Microcomputer Board Overlay VLN5284E



Jumper	Purpose
JU1002	NORMALLY IN; OUT TO DISABLE AUDO LEVEL CONTROL
JU1003	NORMALLY OUT; IN TO DISABLE AUTO LEVEL CONTROL
JU1008	ALWAYS IN
JU1010	NORMALLY OUT; IN FOR MIC AUDIO FILTER BYPASS

Figure 4-1-4 Clean Cab Front Panel Microcomputer Board Schematic VLN5284E (Sheet 1 of 4)



Jumper	Purpose
JU1001	NORMALLY OUT; SHORTED TO DISABLE WATCHDOG
JU1004	NORMALLY OUT; SHORTED MOMENTARILY TO BEGIN DIAGNOSTIC MODE
JU1005	NORMALLY IN; GROUP ADDRESS JUMPER
JU1006	NORMALLY OUT; GROUP ADDRESS JUMPER
JU1007	NORMALLY OUT; GROUP ADDRESS JUMPER

Figure 4-1-4 Clean Cab Front Panel Microcomputer Board Schematic VLN5284E (Sheet 2 of 4)

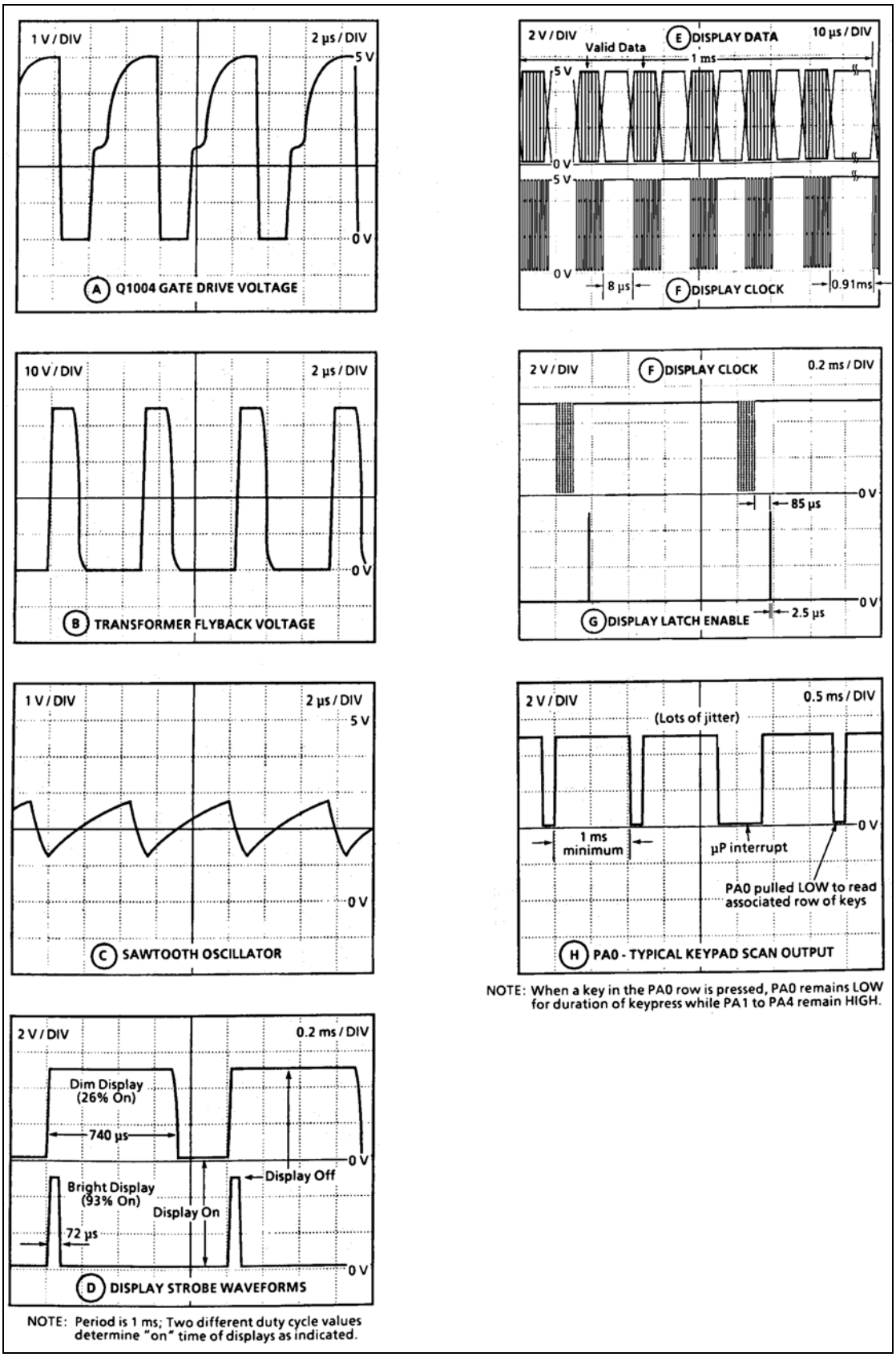


Figure 4-1-4 Clean Cab Front Panel Microcomputer Board Schematic (Sheet 3 of 4)

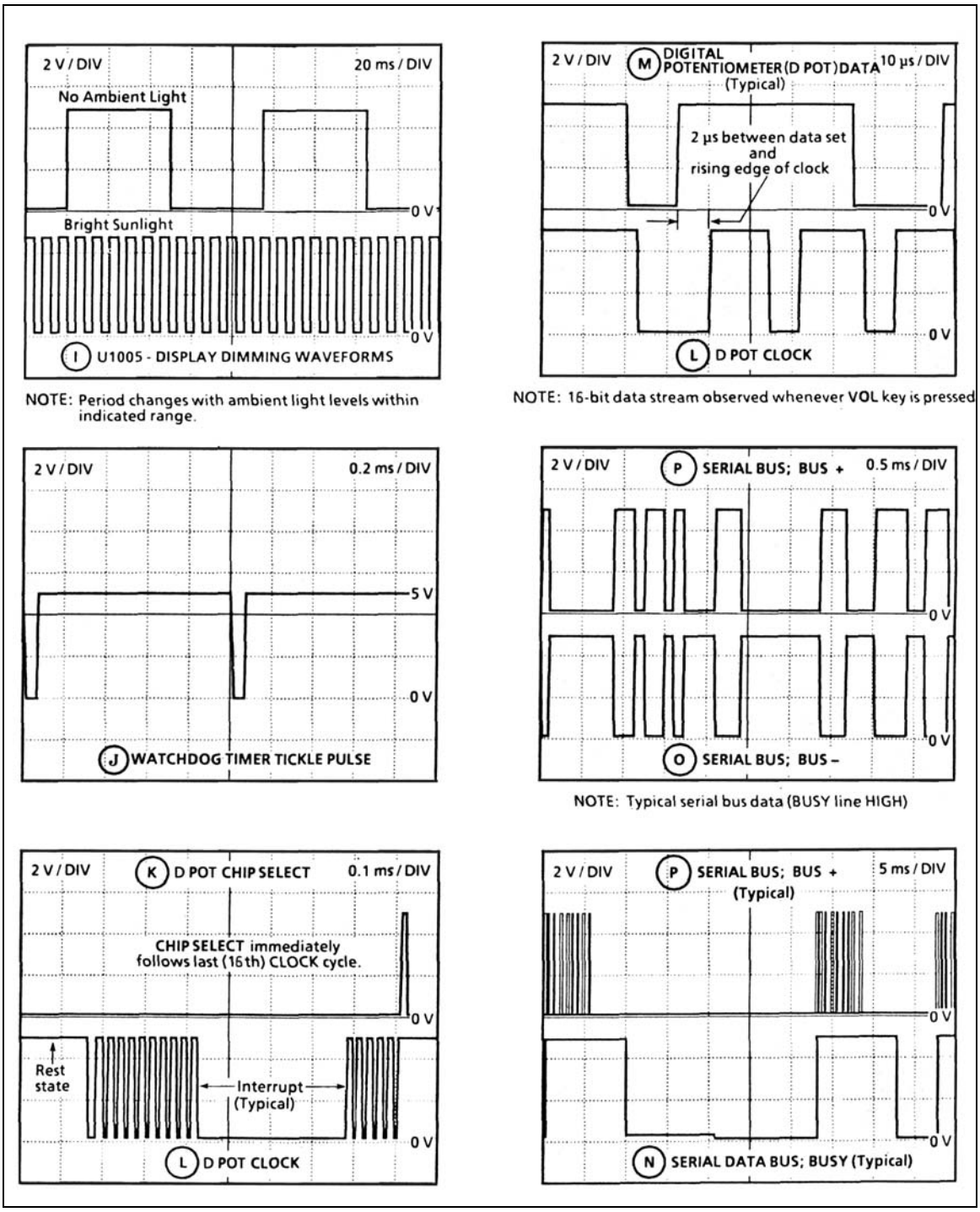


Figure 4-1-4 Clean Cab Front Panel Microcomputer Board Schematic (Sheet 4 of 4)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	0102702A08	**F/P Heatsink Assembly**
		consists of:
	0310943J04	SCR, tpg TT2.5 x 0.45 x 8 starpan
	0402003A01	WASHER, shoulder
	1402005A01	INSULATOR, audio PA
	2602002A01	HEAT SINK, R/R micro brd.
U1003	5102015A01	AUDIO AMPLIFIER, TDA7256, bridge 11-pin
		Capacitor, chip, 5%, X7R, 50V
		(unless otherwise stated)
C1-C2	2113741Z49	100000pF
C3-C4	2113740F63	330pF
C5	2113740F51	100pF
C6	2113740F63	330pF
C11	2109822S08	47uF
C1000-C1001	2113740F63	330pF
C1002	2109822S08	47uF
C1003	2113740F63	330pF
C1004	2109822S07	22uF
C1007	2109822S04	10.0uF
C1008	2109822S08	47uF
C1009-C1010	2113740F63	330pF
C1011	2113740F51	100pF
C1012-C1016	2113740F63	330pF
C1017	2109822S04	10.0uF
C1018	2113740F63	330pF
C1019-C1021	2113741Z49	100000pF
C1022	2113740F63	330pF
C1023	2113741Z49	100000pF
C1024-C1026	2109822S04	CAP,10.0uF
C1027	2380090M24	10uF
C1028	2113740F63	330pF
C1029	2113740F67	470pF
C1030	2380090M24	10uF
C1031	2113741Z49	100000pF
C1032	2113946J01	3.3uF
C1033-C1036	2113740F63	330pF
C1037-C1038	2113741F49	.01uF
C1041-C1042	2113740F63	330pF
C1043	2113741F25	1000pF
C1044	2113741Z49	100000pF
C1045	2113740F63	330pF
C1046	2113741Z49	100000pF
C1049	2113741F49	.01uF
C1050-C1051	2113740F34	20pF
C1052	2113741Z49	100000pF
C1053-C1060	2113740F63	330pF
C1061	2113741Z49	100000pF
C1062	2113741Y32	1uF
C1063	2113741Z49	100000pF
C1064-C1073	2113740F63	330pF
C1074	2113741Z49	100000pF
C1075	2109822S08	47uF
C1076	2113741Z49	100000pF
C1077	2109822S08	47uF
C1078	2113741Y32	1uF
C1079	2109822S04	10.0uF
C1080	2113740F51	100pF
C1081-C1082	2113741Y32	1uF
C1083	2113741A59	.039uF
C1084	2113741Y32	1uF
C1085	2113740F63	330pF
C1086-C1087	2113741A61	.047uF
C1088	2113741F43	5600pF
C1089-C1093	2113741A61	.047uF
C1094	2113741Z49	100000pF
C1095	2109822S08	47uF
C1096	2113740F63	330pF
C1097	2113741Z49	100000pF
C1098	2113740F51	100pF
C1099	2113740F63	330pF
C1100	2109822S04	10.0uF
C1101-C1105	2113741Z49	100000pF
C1106	2113741Y32	1uF
C1107	2113740F63	330pF
C1108-C1110	2113740F51	100pF
C1115-C1116	2113740F51	100pF
C1117	2113741Y32	1uF
C1118	2109822S08	47uF
C1119-C1120	2113740F63	330pF
C1121	2380090M24	10uF
C1122	2113740F63	330pF
C1125-C1126	2113740F63	330pF
C1130	2113741Z49	100000pF
C1131	2113741Y32	1uF
C1139-C1140	2113741Z49	100000pF
C1142	2113741Y32	1uF
C1143	2113740F63	330pF
C1144	2313748E23	470uF, leaded, 25V
C1145	2109822S08	47uF
C1146	2109822S04	10.0uF
C1147	2113741Y32	1uF
C1148	2313748E23	470uF, leaded, 25V
C1149	2113741F49	.01uF
C1152	2113740F63	330pF
C1153	2113740F51	100pF
C1154	2113740F63	330pF
C1155	2113741F49	.01uF
C1156-C1157	2113741Z49	100000pF
C1158-C1161	2113740F63	330pF
C1162	2113741Y32	1uF
C1163	2109822S08	47uF
C1164-C1166	2113740F63	330pF
C1167	2109822S04	10.0uF
C1168-C1178	2113740F63	330pF
C1180	2113741Y32	1uF
		Diode, signal, SOT-23
		(unless otherwise stated)
CR1005-CR1007	4813833C09	MMBD914
CR1008	4813825A05	MMBD301, schottky
CR1009-CR1010	4813833C09	MMBD914
CR1011	4813825A05	MMBD301
CR1012-CR1013	4813833C09	MMBD914, schottky
		Jumper, chip, 0 ohm
JU1001-JU1008	0662057B47	
JU1010	0662057B47	
		Inductor, chip
L1000-L1001	2480140E16	9.107uH
L1002	2402000A02	50uH
		Connector
P1000	2802003A01	HEADER, mail 26 pos. polar w/ eject
P1001	0902006A03	SOCKET, 2-pin
P1002	2882984N01	PLUG, 2-pos. locking header
P1005	2880128M03	PLUG, 6-pos.
W1000-W1001	0902006A04	SOCKET, 12-pin
		Transistor, bi-polar, SOT-23
		(unless otherwise stated)
Q1001	4813824A10	MMBT3904, NPN
Q1002	4813824A17	MMBT3906, PNP
Q1004	4880053M03	TMOS, n-channel, TO-226AE
Q1005	4813824A10	MMBT3904, NPN
Q1006	4813824A17	MMBT3906, PNP
Q1007-Q1010	4813824A10	MMBT3904, NPN
Q1011	4813824A17	MMBT3906, PNP
Q1012	4813824A10	MMBT3904, NPN
Q1013	4813824A17	MMBT3906, PNP
Q1014	4813824A10	MMBT3904, NPN
Q1015	4813824A17	MMBT3906, PNP

Figure 4-1-5 Clean Cab Front Panel Microcomputer Board Parts List (Sheet 1 of 2)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Resistor, chip, 5%, 1/8W
		(unless otherwise stated)
R1-R2	0662057A73	10K
R3	0662057B47	0
R1001	0662057A41	470
R1002	0662057A61	3.3K
R1003-R1004	0662057A73	10K
R1005	0662057A89	47K
R1006	0662057A57	2.2K
R1008-R1009	0611077A10	2.2
R1010	0662057A81	22K
R1011	0662057A73	10K
R1012	0662057A49	1K
R1013	0662057A85	33K
R1014	0662057A89	47K
R1015	0662057A53	1.5K
R1016	0662057A73	10K
R1017	0662057A85	33K
R1018	0662057K03	12
R1019	0662057A43	560
R1020	0662057K03	12
R1021	0662057A89	47K
R1022-R1023	0662057A73	10K
R1024	0662057A47	820
R1026	0662057A61	3.3K
R1027	0662057A99	120K
R1028-R1029	0662057A75	12K
R1030	0662057A83	27K
R1031	0662057A61	3.3K
R1032	0662057A49	1K
R1033	0662057B22	1MEG
R1034-R1035	0662057A49	1K
R1036-R1037	0662057P72	15.4K, 1%
R1038-R1039	0662057P62	5.11K, 1%
R1040	0662057P49	2.21K, 1%
R1041	0662057P87	118K, 1%
R1042	0662057A49	1K
R1043	0662057B47	0
R1046	0662057A85	33K
R1047	0662057P49	2.21K, 1%
R1048	0611079F63	4.42K, 1%
R1049	0662057A65	4.7K
R1050	0662057A33	220
R1051	0662057A65	4.7K
R1052	0662057A57	2.2K
R1053	0662057A65	4.7K

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Resistor, chip, 5%, 1/8W
		(unless otherwise stated)
R1054	0662057A93	68K
R1055	0662057A89	47K
R1056	0662057A65	4.7K
R1057	0662057A89	47K
R1058	0662057A65	4.7K
R1059	0662057A89	47K
R1061	0662057A61	3.3K
R1062	0662057A37	330
R1063	0662057B10	330K
R1064	0662057A57	2.2K
R1065	0662057A73	10K
R1066	0662057A65	4.7K
R1067	0662057A73	10K
R1068-R1069	0662057A65	4.7K
R1070	0662057A75	12K
R1071	0662057A79	18K
R1072-R1077	0662057A97	100K
R1078	0662057A43	560
R1079	0611077A26	10
R1081	0662057A97	100K
R1082	0662057B47	0
R1085	0662057A73	10K
R1086	0662057A67	5.6K
R1087	0662057A65	4.7K
R1090	0662057A57	2.2K
R1091-R1092	0662057B47	0
R1093	0662057A73	10K
R1094	0611077A26	10
R1095	0662057A25	100
R1096	0662057A61	3.3K
R1097	0662057A73	10K
R1098	0662057A97	100K
R1099	0662057A49	1K
R1100-R1101	0662057A65	4.7K
R1102	0662057A89	47K
R1103	0662057A49	1K
R1105	0662057B02	150K
R1106-R1107	0662057A97	100K
R1108	0662057A65	4.7K
R1109	0662057A73	10K
R1110-R1111	0662057A65	4.7K
R1112	0662057A73	10K
R1113	0662057A57	2.2K
R1114	0662057A73	10K

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Transformer
T1000	2580277J03	voltage converter
		Integrated Circuits
U2	5113818A03	MC33072
U100	5185718D01	SRAM, AD5232
U1000	5167408D05	MICROCOMPUTER, 68HC705C8
U1001	5180057S04	DIGITAL POTENTIOMETER, SC74487F
U1004	5164015H37	AUDIO COMPANDER, SA572D
U1005	5113815G02	TIMER, MC1455D
U1006	5113816A02	5 VOLT REGULATOR, LM2931D
U1007	5113816A01	ADJ VOLTAGE REG, LM2931
U1008	5113820A02	DUAL COMPARATOR, LM2903
U1009-U1012	5113818A01	DUAL OP-AMP, LM2904
		Diode, zener, SOT-23
VR1000	4813830A39	MMBZ5256B, 30V
VR1001	4813830A33	MMBZ5250B, 20V
VR1002-VR1005	4813830A15	MMBZ5232B, 5.6V
VR1009-VR1010	4813830A15	MMBZ5232B, 5.6V
VR1011	4813830A23	MMBZ5240B, 10V
VR1012-VR1013	4813830A33	MMBZ5250B, 20V
VR1014	4813830A23	MMBZ5240B, 10V
VR1015-VR1017	4813830A33	MMBZ5250B, 20V
VR1018	4813830A15	MMBZ5232B, 5.6V
VR1019	4813830A33	MMBZ5250B, 20V
		Resonator, ceramic
Y1000	4802017A01	4.0 MHz
		Non-referenced items
	0310943J10	SCR, tpg TT3 x 0.5 x 8 intstarpan (2)
	8402022A05	PCB, front panel microcomputer

Figure 4-1-5 Clean Cab Front Panel Microcomputer Board Schematic (Sheet 2 of 2)

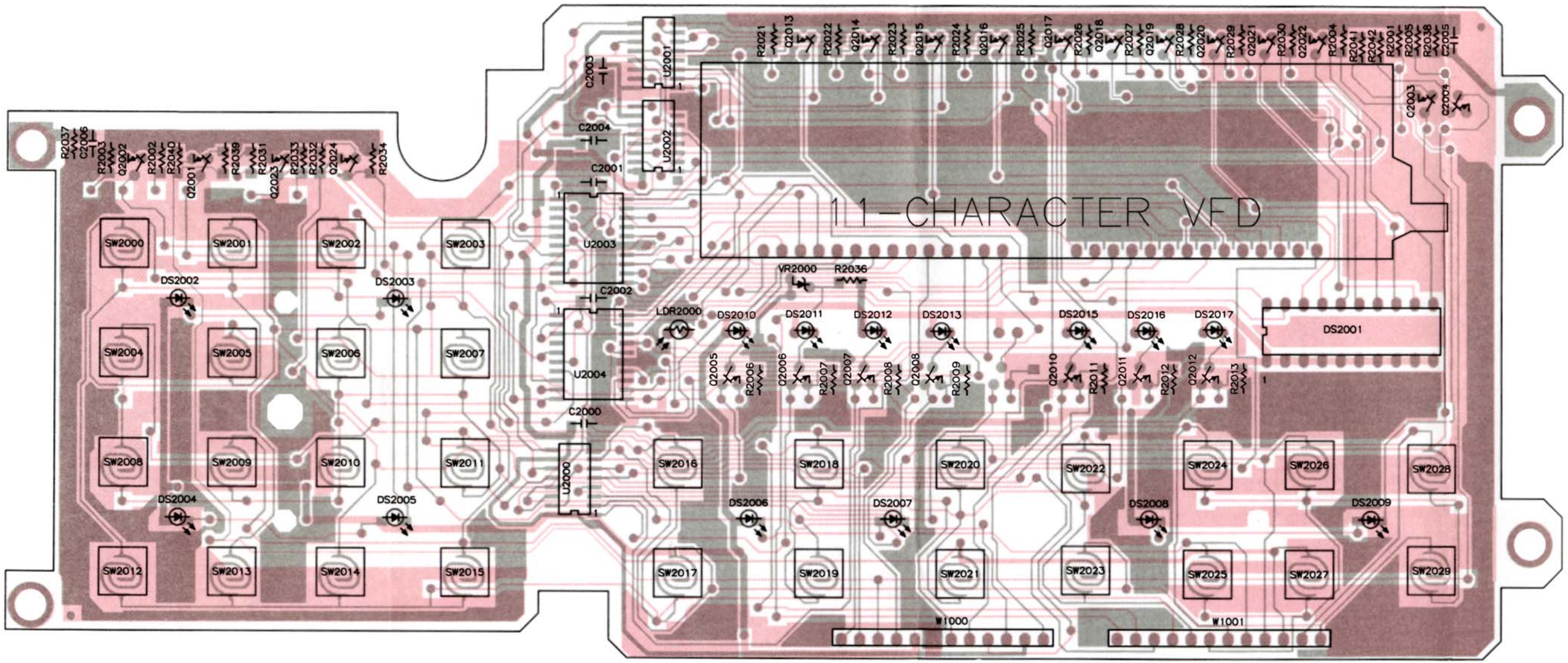


Figure 4-1-6
Clean Cab Front Panel
Display Board Overlay
VLN5247D

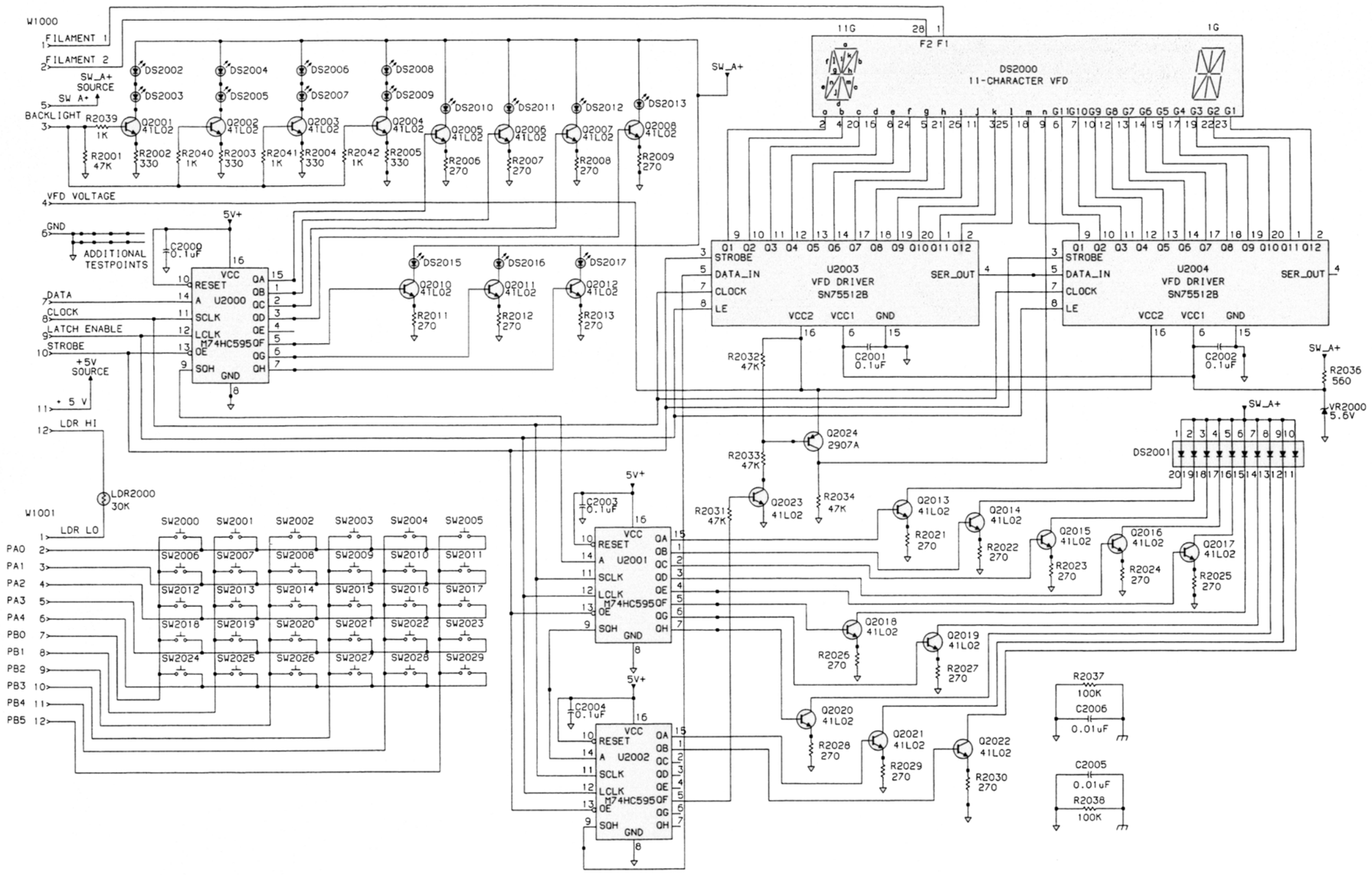


Figure 4-1-7
ASTRO Clean Cab Front
Panel Display Board Schematic VLN5247D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Capacitor, chip, uF, 5%, X7R, 50V
C2000-C2004	2113741B69	0.1
C2005-C2006	2113741B45	0.01
		LED
DS2002-DS2005	4802018A01	CHIP, GREEN
DS2006-DS2009	4802018A02	CHIP, YELLOW
DS2010-DS2013	4880058K03	YELLOW INDICATOR, (only placed with MBW330)
DS2015	4884404E07	RED INDICATOR
DS2016-DS2017	4880058K03	YELLOW INDICATOR
DS2001	4802011A01	LED Bar Graph, Yellow
		Vacuum Fluorescent Display
DS2000	7280242J01	VFD, 11-char
		Photo-resistor
LDR2000	0600018M01	30k
		Resistor, chip 5%, 1/8W
R2001, R2031-R2034	0611077B15	47K
R2002-R2005	0611077A62	330
R2006-R2009	0611077A62	330 (only placed with MBW330)
R2011-R2013, R2021-2030	0611077A60	270
R2037-R2038	0611077B23	100K
R2039-R2042	0611077A74	1K

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Transistor
Q2001-Q2004,	4813824A10	NPN, chip, SOT-23
Q2010-Q2022	4813824A10	NPN, chip, SOT-23
Q2005-Q2008,	4813824A10	NPN, chip, SOT-23 (only placed with MBW330)
Q2023	4880947V01	NPN, SOT with bias resistor
Q2024	4813824A21	PNP, SOT 2907A
		Diode
VR2000	4880140L07	Diode, zener, 5.6V, SOT
		Integrated Circuits
U2000-U2002	5113805A75	SHIFT REGISTER, ser-in, para-out 8-bit
U2003-U2004	5102019A01	DRIVER, VFD, SOIC
		Flex Cable
W1000-W1001	3000059M04	12 POS 3IN
		Non-referenced items
	0982808R06	SOCKET, IC 20-pin
	6102002A01	SPACER, LED
	7580184J01	SHOCK PAD, VFD
	8402021A03	PCB, R/R display board

Figure 4-1-8 Clean Cab Front Panel Display Board Parts List VLN5247D

4.2 REAR PANEL, TOP PANEL INTERCONNECT AND TRANSLATOR BOARDS

4.2.1 GENERAL

This section describes the electrical details for the Clean Cab Rear Panel Interconnect Board, Translator Board and the Universal Top Panel Interconnect Board. The functional relationship of these boards to the other radio circuits is shown in **Figure 3-2, Radio Functional Block Diagram**.

4.2.2 REAR PANEL INTERCONNECT BOARD

The rear panel interconnect board is vertically-mounted at the rear of the bottom housing assembly. This board primarily provides signal paths and support circuitry for the following:

- handset connector (J3003)
- remote control head connector (J3007) (P3007 on schematic)
- service port (J3006)
- auxiliary connector (J3010) (P3004 on schematic)
- RS232 data port (J3005)

The rear panel interconnect board works in close conjunction with the translator board. The two boards are joined at connector J3008/P3008. The translator board provides all of the microprocessor logic and control circuitry for the ASTRO Clean Cab. The rear panel interconnect board provides the signal paths for the audio, serial bus, control signal and power distribution lines between the front panel circuits, translator board and the ASTRO transceiver module.

Board layout, schematic and parts list for the rear panel interconnect board are provided in Figure 4-2-1 to Figure 4-2-3 at the end of this section.

Handset / Auxiliary Logic

The handset and auxiliary control lines for push-to-talk and HANGUP are fed from their respective connectors (J3003 and P3004) to the microprocessor on the translator board. The translator board microprocessor senses these inputs and activates or deactivates the PTT and HUB functions accordingly. J3003-C (MIC PTT) is normally held at +5V by R120. When a push-to-talk is activated from the handset, MIC PTT goes low, pulling the line low to the microprocessor. Similarly, HANGUP (J3003-F) goes low when the handset is in the hang-up cup. This functionality is duplicated at the rear panel board auxiliary connector for Aux PTT (P3004-4) and Aux HUB (P3004-11) (or PL disable).

Microphone / Handset Audio

Transmit audio can enter the rear panel board from either of the three control head sources or two handset sources. The control head sources are LOC_MIC_AUDIO from the front panel built in microphone via P3000-23, REM_MIC_AUD from the secondary remote control head connector via P3007-A or AUX_CH_MIC_AUD from the auxiliary/primary remote control head connector via P3004-14. The handset microphone sources are HNDST_MIC_AUD via the handset connector J3003-A and AUX_MIC_AUD via the auxiliary connector P3004-1. In all cases, the audio signal enters a summing amplifier, U15, which combines the microphone sources before passing the signal through the top panel board to the ASTRO mobile module MIC_HI via J3001-27. An 80-90mVrms signal at MIC_HI will produce rated transmit audio (3kHz deviation at 25kHz channel spacing).

The control head microphone sources (LOC_MIC_AUDIO, REM_MIC_AUD, and AUX_CH_MIC_AUD) do not require additional buffering or biasing. They are coupled through a capacitor to the summer U15.

The handset microphone sources require biasing and buffering on the rear panel board. R15, R16 and C33 provide bias voltage for the AUX_MIC_AUDIO condenser element. This signal is then passed to an additional buffering stage (U15-8,9,10) before the summer. This additional buffering serves to prevent voltage spikes present on the microphone audio path from reaching the transceiver MIC_HI input. When

the handset or auxiliary microphone PTT is pressed the mechanical switch can generate voltage spikes in excess of the MIC_HI bootstrap voltage threshold (approx 13Vdc). These spikes could cause the ASTRO mobile transceiver to briefly enter and exit bootstrap mode causing a system reset. Identical circuitry is present for rear panel board handset connector microphone audio (HNDST_MIC_AUD).

Receive Audio and Alert Tones

Received audio from the ASTRO transceiver is brought to the rear panel board at J3001-28 (RAD_FILT_AUDIO) through the top panel interconnect board. Filtered audio is selected by the jumper R108 before passing through the audio gate U16A.

NOTE

Det Audio (J3001-22) and Filtered Audio are essentially the same signals from the ASTRO transceiver command board except Filtered Audio is coupled through a capacitor on the command board.

The audio gate mutes or un-mutes the filtered audio under the control of the translator board microprocessor (J3008-12, FA_MUTE). Due to digital modulation present on the filtered audio signal when the receiver is idle, this path is muted unless there is qualified receive audio or alert tones present. After the audio gate, this signal is passed through the gain/filter stage at U11. The output of this stage (FILT_AUD) is passed to the control heads at 80mVrms with rated receive audio (e.g. 3kHz deviation, 25kHz channel spacing). The output of this stage also feeds the local and auxiliary handset audio driver, U11, Q21, Q22 and associated circuitry. This driver is identical to the handset driver on the front panel microcomputer board: See section **4.1.2 Handset Audio Circuits**.

The ASTRO transceiver is incapable of generating all of the necessary alert tones required by the Clean Cab radio. The translator board microprocessor output compare function is used to generate alert and trunking tones as necessary. Alert/trunking tones consist of one of two frequencies: 911Hz ('beep' or good tone) and 304Hz ('bonk' or bad tone). The tones enter the rear panel board from the translator board at J3008-7 as a 0-5Vpp square waveform. The op-amp U11-pins 12,13,14 attenuate the signal to approximately 500mVpp. Following the gain stage, the tones pass through the audio gate U16B. R158, R162 and R163 prevent audio switching noise by biasing the gate terminals at VREF (4.8V). The audio gate selects one of two second-order low-pass filters, depending on the frequency of tone being generated. The translator board microprocessor signal (TT_SELECT) selects either the U15 filter (304Hz corner frequency) or the U11 filter (911Hz corner frequency). The tone filters have the effect of shaping the tone into an approximate sine wave by smoothing the sharp edges of the microprocessor generated square waveform. The filter outputs are summed with filtered audio at U11-1,2,3. The values of the summing resistors R153 and R126 are selected to provide a level equivalent to the level of receive filtered audio – approximately 80mVrms.

NOTE

If speaker audio from the ASTRO transceiver (SPKR_HI, SPKR_LO) is used at the auxiliary connector by an external accessory, some audio alerts will not be heard. Other audio alerts (i.e. Trunking tones) may be of a slightly different pitch or timing than those heard at the Clean Cab front panel or remote control head speakers.

Remote Controlhead Connectors

The Remote (Secondary) Control Head Connector (J3007) allows for the connection of a remote control head. This connector provides power (A+), ground, serial bus, reset, received audio (FILT_AUDIO) and microphone audio for the remote control head.

A Dual Remote (Primary) Control Head Connector (J3004) replaces the Auxiliary Connector (J3010) when the dual remote controlhead option is ordered. Refer to figure 4-2-8 and 4-2-9 for pin outs.

Caution

The Dual Remote Control Head Connector (J3004) kit is not interchangeable with the Spectra Clean Cab radio. Using the wrong kit may cause radio damage.

Reset

The system reset bus ties the ASTRO transceiver module, translator board microprocessor, and control head microprocessor(s) reset lines together. Diodes D1 and D2 establish a system reset priority. The ASTRO transceiver can cause a system reset by pulling the reset line high (+5V), resetting both the translator microprocessor and the control head(s). D1 prevents the translator microprocessor or control head(s) from hardware resetting the ASTRO transceiver. D2 prevents the control head(s) from hardware resetting the translator microprocessor. The translator microprocessor can, however, detect a control head reset through the serial bus and can cause the ASTRO transceiver to reset by broadcasting a power-up status message on the serial bus. In this manner, the translator microprocessor can cause a system reset through the ASTRO transceiver.

Power A+ / 9.6V

Power from the DC-DC converter is connected directly to the rear panel interconnect board at P3002 as A+ (13.8Vdc). All other boards and components of the Clean Cab radio are powered through the rear panel board, including the ASTRO transceiver, RFPA and the control head(s). There are two sources of 9.6V for the rear panel interconnect board. A programmable 9.6V regulator (U6) is included on the rear panel board, if required, for future revisions. The resistor network R95, R96 and R97 select the output voltage of the U6 regulator. Regulated 9.6V is also brought from the ASTRO transceiver. R101 selects the ASTRO transceiver 9.6V source to power the audio circuits on the rear panel board. R102 selects the rear panel +9.6Vdc source and is not placed by factory default.

Service Port (VIP I/O)

The service port, J3006, provides the serial-bus and power connection required for the operator to change the operator-specified codeplug information, and to perform certain alignment procedures as described in **PART 5, MAINTENANCE AND ALIGNMENT PROCEDURES**. The signals BUS+ (J3006-14), BUS- (J3006-10) and BUSY (J3006-9) allow the programming of both the ASTRO transceiver codeplug and the translator board codeplug. A standard ASTRO mobile programming cable (see section 7.1) is used to program both codeplugs.

The service port also provides the necessary connections for FLASH programming the ASTRO transceiver ROM and DSP firmware and the translator board firmware. The service port signals used to FLASH the ASTRO transceiver are PROG_RESET (J3006-1), SRIB_TX (J3006-3), PROG_MOD_CNTL (J3006-6), PROG_VPP (J3006-11) and SRIB_RX (J3006-12). The service port signals used to FLASH the translator board are SRIB_TX (J3006-3), RPTB_MOD_CNTL (J3006-7) and SRIB_RX (J3006-12). Refer to figure 4-2-13 for a diagram for this cable. Contact your service representative for availability.

The MOD_CNTL signals in both cases provide a dual functionality. When FLASHing, the MOD_CNTL signal is active at A+. The signal serves the purpose of bootstrapping the target processor as well as selecting the correct path for the multiplexed SRIB_RX and SRIB_TX serial data signals.

When FLASHing the ASTRO transceiver, the PROG_MOD_CNTL signal (RPTB_MOD_CNTL is not connected) becomes active, grounding the drain of Q9. This causes the drain of Q8 to pull up to A+, enabling the mux control signals U13-13 and U13-5 and routing SRIB_RX and SRIB_TX to the ASTRO transceiver via the top panel board at J3001-21 and J3001-29. In addition, Q11 is turned on connecting

A+ to J3001-27 (MIC_HI-PROG_MOD_CNTL). This signal causes the ASTRO transceiver processor to bootstrap.

Similarly, when FLASHing the translator board the RPTB _MOD_CNTL signal (PROG_MOD_CNTL is not connected) becomes active grounding the drains of Q10 and Q12. These signals (J3008-16 and J3008-22) go to the translator board's microprocessor and chip enable logic causing it to bootstrap. In addition, the drain of Q7 is pulled up to A+ enabling the mux control signals U13-12 and U13-6, routing SRIB_RX and SRIB_TX to the translator board microprocessor (J3008-3 and J3008-5).

The service port also provides the connections for the Vehicle Interface Port (VIP) input and output lines. The VIP allows the radio to control outside circuits and to receive inputs from outside the radio. There are three VIP outputs and one VIP input which can be used by the Intercom/PA MBW330 option. The three VIP outputs used in this option are available on the service port, J3006, as VIP OUT 1, VIP OUT 2 and VIP OUT 3. These outputs allow the radio to control external circuits, dependent on the state of the four optional control head buttons (**PA**, **IC**, **RAD** and **CALL**).

The VIP outputs are controlled directly by the translator board microprocessor PORT G general purpose outputs PG0, PG1 and PG2. Any high level causes the associated transistor, Q4, Q5, or Q6 to conduct, "0" state and to sink up to 300mA of current. The "1" state is high impedance. VIP_OUT1 and VIP_OUT2 share the service connector pins with SRIB_RX and SRIB_TX respectively.

Active VIP Function (LED ON)	**Output Logic States**		
	VIP 1	**VIP 2**	**VIP 3**
Radio	0	1	1
PA	1	0	1
Intercom	0	0	1
Call (and IC)	0	0	0
None	1	1	1

The three VIP inputs of the service/data port are applied through transistor inverters (Q1 to Q3) directly to the translator board microprocessor PORT E general purpose inputs PE0, PE1 and PE2. The microprocessor periodically polls these inputs for state changes. External to the radio, a VIP input is connected to ground (J3006-8) via a normally-open switch. The first VIP input, labeled VIP IN 1 (J3006-5) can be momentarily connected to logic ground to reset all three VIP outputs to the inactive state.

NOTE

The Clean Cab VIP inputs and VIP outputs do not have the functionality of the ASTRO transceiver VIP inputs and outputs that are accessible through ASTRO mobile CPS. Their functionality is not programmable.

Auxiliary / Primary Remote Control Head Connector

Connector P3004 is used for the mutually exclusive auxiliary connector and dual remote control head connector kits.

The AAR auxiliary connector (J3010) consists of a wire / connector assembly, which provides the operator with access to power, handset and speaker lines from the rear panel interconnect board. In this way, the auxiliary connector can be used to connect an external speaker to the radio, as an alternative handset connector, or for other operator-specified applications (refer to Figure 2-1-2). Only pins 1-14 of P3004 are used when the auxiliary connector is used. A schematic and parts list for this kit are provided in Figure 4-2-4 at the end of this section.

The full P3004 connector is used with the control head adaptor. The Remote (Primary) Control Head Connector (J3011) is only placed with the MBW654 option and replaces the Auxiliary Connector (J3010). This header connects with a new auxiliary cable kit, VLN5282A, to bring the signals out of the radio. This provides power (A+), ground, serial bus, reset, received audio (FILT_AUDIO) and microphone audio for the remote control head. Refer to Figures 4-2-8 and 4-2-9 for a schematic and parts list of the auxiliary cable kit for the dual remote control head option.

RS232 Data Port

The rear panel interconnect board data port (J3005) is a standard DB9 connector that allows the Clean Cab to support the RS232 APCO data feature. The RS232 data signals (RXD, TXD, RTS and CTS) are passed from the data port to the ASTRO transceiver module through the top panel interconnect board at connector J3001. The data port is wired with standard pin assignments for DB9 RS232 so that a straight 9-pin data cable can be used from the computer or data terminal (see **2.1.9 RS232 Data Port Connector** for details).

4.2.3 TOP PANEL BOARD

The top panel interconnect board provides the power and signal interface between the rear panel interconnect board and the ASTRO adaptor board. The top panel interconnect board plugs directly into the rear panel interconnect board through a 37-pin floating connector, P/J 3001. A 26-wire ribbon cable assembly is soldered onto the top panel board at P6001. At the other end of the assembly is a keyed header connector (J5001), which plugs into P5001 on the ASTRO adaptor board.

A wire-and-lug assembly provides a ground for the radio logic circuits. One end of the assembly is soldered to the board at W6000 (GND), with the lugged end being secured directly to the top panel housing. In addition, UNSW A+ is carried to the VHF power amplifier via a wire soldered to W6001 on the top panel board and C3800 on the PA / command interconnect board. The REV_POWER signal from the PA / command interconnect board is soldered to W6002 on the top panel board.

The top panel board also contains the speaker configuration jumpers, R100 to R101. These jumpers are not placed by factory default. An audio transformer (T6000) is connected at P6003 as a standard option from the factory. The audio transformer is attached to the top panel housing and isolates the external auxiliary SPKR_HI/SPKR_LO connections from the ASTRO transceiver command board circuits. If the audio transformer is not used, R100 and R101 should be placed if SPKR_HI/SPKR_LO is required at the auxiliary connector.

Caution

Damage to the ASTRO transceiver command board audio PA circuit can occur if the SPKR_HI or SPKR_LO leads are grounded without the audio transformer present.

Board layout, schematic and parts list for the top panel interconnect board are provided in figures 4-2-5, 4-2-6 and 4-2-7 at the end of this section.

4.2.4 TRANSLATOR BOARD

The translator board works in close conjunction with the rear panel interconnect board and contains the microprocessor and other logic circuitry. The ASTRO transceiver and control head SB9600 buses are brought to the translator board. The translator board firmware supports the unique railroad ergonomics and I/O. The translator board includes its own CPS programmable codeplug that allows the user to configure the features of the CleanCab radio.

Microprocessor

The microprocessor, U1 (Motorola 68HC11F1), operating at an approximate 2MHz clock speed, is the heart of the translator board. All serial bus messages are passed through the microprocessor to and from the ASTRO transceiver and control head(s) via the DUART.

The microprocessor also handles several sources of hardware I/O. General purpose PORTG outputs (PG0-2) drive the VIP outputs. General purpose PORTE inputs (PE0-2) receive the VIP inputs. These logic outputs and inputs are connected to the drivers located on the rear panel interconnect board. Four microprocessor PORTA input pins, PA0-3, are configured for input capture. These inputs detect transitions on the handset PTT and HUB and auxiliary PTT and HUB inputs.

When FLASH programming the translator board, the MOD_CNTL2 signal (P3008-19) is pulled low grounding the MODA and MODB microprocessor pins 2 and 3. When the microprocessor is reset during the FLASHing process and both of these pins are grounded, it powers up in bootstrap mode and waits to receive data. At the same time, the signal MOD_CNTL (P3008-25) is pulled low at the Read/Write enable circuitry for the FLASH ROM. The effect is that the Flash ROM can only be write enabled during FLASHing. Serial data for FLASH programming reaches the microprocessor Serial Communication Interface (or SCI), PORTD pins PD0 and 1, via the signals SCI_RXD and SCI_TXD (P3008-36,30).

Other miscellaneous microprocessor I/O includes the control signals for filtered audio mute (FA_MUTE), audio filter select (TT_SELECT) and the alert tone generator output (TRUNKING_TONES). General purpose PORTG outputs, PG3 and PG5, are used for the logic signals for filtered audio mute and audio filter select. The alert tone generator uses the output compare function (OC1) to generate a 0-5V, square wave tone on PORTA (PA7). These tones are passed to the rear panel interconnect board for filtering.

System reset is inverted at U10-13,12 and connected to the microprocessor reset. This allows the ASTRO transceiver to reset the translator board microprocessor. Separate from the system reset bus, the DUART reset is controlled by the microprocessor. During its power-up initialization routine, the microprocessor resets the DUART by momentarily pulling the general-purpose PORTA output PA6 high (+5V).

DUART/Serial Bus

The translator board microprocessor receives serial data from, and transmits serial data to, both the ASTRO transceiver and the control heads through the DUART (Philips SC28L92). The microprocessor and DUART communicate via the external parallel address/data bus at address $1800-$1FFF. The DUART uses the microprocessor I/O chip select 2 (CSIO2). The DUART interrupts the microprocessor via the IRQ line for received serial bus data and input port changes. The DUART converts the serial data that it receives from the bus-to-SCI converters into parallel data, which the microprocessor reads through the data/address bus. The DUART also converts parallel data, which it receives from the microprocessor, to serial data and transmits to the SCI-to-bus converters.

Each serial bus consists of three lines. The RAD_BUS+, RAD_BUS- and RAD_BUSY are used to support the ASTRO transceiver bus, and the CH_BUS+, CH_BUS-, and CH_BUSY signals are used to support the control head bus.

All bus- / bus+ signals are balanced lines to form a complementary signal (bus- is inverted from the state of bus+) for noise rejection. The idle states are: bus+, a logic high; and bus-, a logic low. The drivers are designed so that any of the devices on the bus can drive these lines to their non-idle state without loading problems. The bus+ / bus- signals are used to transmit to and receive data from the devices on the bus.

All busy signals are active high and bi-directional, and mainly serve to indicate when a message exists on the bus. The busy idle state is a logic low (0V).

In a typical transmission, the translator board microprocessor examines the busy line of the bus interface through which it wants to transmit. If the busy line is in the idle state, the microprocessor sets the busy line and then transmits. At the end of transmission, the microprocessor returns the busy line to idle. The bus+ / bus- and busy lines are bi-directional, 0 to 5V. Numerous devices can be in parallel on the bus. All devices monitor the bus while data is being transmitted (at 9600 baud).

The microprocessor sets and monitors the RAD_BUSY line via the DUART's general-purpose output and input ports. The RAD_BUSY out signal is driven by DUART pin 27 (OP0) via the open collector driver transistor, Q15. The DUART monitors the RAD_BUSY in signal, which enters from P3008-20 through transistor Q14, at DUART pin 2 (IP0). Transistor Q14, the RAD_BUSY receiver, is configured as an inverter with a pull-up resistor.

For CH_BUSY, the microprocessor sets and monitors the CH_BUSY line via the DUART's general-purpose output and input ports. The CH_BUSY out signal is driven by DUART pin 7 (OP1) via the open collector driver transistor, Q19. The DUART monitors the CH_BUSY in signal, which enters from P3008-33 through transistor Q18, at DUART pin 43 (IP1). Transistor Q18, the CH_BUSY receiver, is configured as an inverter with a pull-up resistor.

Data transmission is sent onto the bus asynchronously. When the translator board microprocessor sends data onto the bus via the DUART, it also monitors the transmitted data as a collision measure. The microprocessor monitors and receives data from the ASTRO transceiver bus via the DUART pin 29; channel A receiver (RXDA). The differential RAD_BUS+ line (P3008-22) and RAD_BUS- line (P3008-21) are routed to pins 2 and 3 of the op-amp U9, which converts the differential signal pairs into a single-ended signal. The single-ended data is sent to the DUART.

Transmitting the ASTRO transceiver data is the reverse. The microprocessor writes to the DUART via the address/data bus. The DUART converts the parallel data into serial data and transmits the data from the DUART pin 28; channel A transmitter (TXDA). The transmit data goes to the inverter U10, pin 1, then from the inverter to the base of transistor Q12 to drive the RAD_BUS+. Transmit data also goes to transistor Q13 to drive the RAD_BUS-.

For the control head bus, the microprocessor monitors and receives data via the DUART pin 5; channel B receiver (RXDB). The differential CH_BUS+ line (P3008-35) and CH_BUS- line (P3008-18) are routed to pins 5 and 6 of the op-amp U9, which converts the differential signal pairs into a single-ended signal. The single-ended data is sent to the DUART.

As for the transmit path to the control head(s), the single-ended serial data is driven by the DUART pin 6; channel B transmitter (TXDB). The transmit data goes to the inverter U10, pin 3, then from the inverter to the base of transistor Q16 to drive the CH_BUS+. Transmit data also goes to transistor Q17 to drive the CH_BUS-. Zener protection diodes (5.6V) are placed at the control head bus signals to provide Electro Static Discharge protection to the DUART.

The antenna fault reverse power detect (REV_POWER, P3008-23) is connected to the DUART's input port pin 34 (IP2). This signal originates from the ASTRO Spectra RFPA board and connects through the

top panel and rear panel interconnect boards. An input port change interrupt will signal to the microprocessor that the PA has detected excess reflected RF power.

RAM / ROM / EEPROM

The translator board includes a 32k x 8 SRAM (Cypress CY7C199) for additional microprocessor memory. The SRAM is accessed through the external address/data bus. Using the microprocessor's general-purpose chip select (CSGEN), the SRAM resides at address $4000-$7FFF in the memory map. Jumper R65 is placed by factory default so that only 16k of the SRAM is accessed. There are provisions for paging using DUART pin 10 (OP7) and jumper R129, if required for future revisions.

The translator board firmware is stored on a 128kx8 Flash ROM (Atmel AT29C010). The ROM is accessed through the external address/data bus. Using the microprocessor's programmable chip select (CSPROG), the ROM resides at address $8000-$FFFF in the memory map. Jumpers R61 and R63 are placed by factory default, allowing only 32k of the ROM to be accessed. There are provisions for paging using DUART pin 24 (OP6) and jumper R62, if required for future revisions. The ROM Read and Write Enable decoding is provided for by the U10 (inverter) and U12 (NAND) gates.

NOTE

After replacing a Translator Board, it is essential to verify that the latest version of firmware is programmed. Refer to section 5.5 for determining the version number of the installed board. Go to the Motorola Online service web site https://businessonline.motorola.com to determine the latest version. If the firmware needs to be updated, follow the online instructions for downloading and FLASHing the latest version. The 3085864F01 FLASH cable also needs to be purchased. This cable allows FLASHing of both the ASTRO transceiver (with FLASHport) and the Translator Board with (SPLASH). Refer to section 7.3.3 for detailed instructions.

The translator board codeplug information is stored on an external 4k x 8 serial EEPROM (Atmel AT25320). Clean Cab user configurable items such as button enables, HUB enables, DTMF timers and home modes are stored in the translator board codeplug. The microprocessor accesses the EEPROM through the Serial Peripheral Interface (SPI) port. The EEPROM is selected with the Slave Select (SS) line from the microprocessor. The clock signal is generated at the serial clock output (SCK). Serial data is output at the master-out-slave-in (MOSI) pin and received at the master-in-slave-out (MISO) pin. In general, the codeplug information stored on the EEPROM is accessed only during programming and at powerup. During the microprocessor's initialization sequence, a copy of the codeplug information is read from the EEPROM and stored in SRAM for quicker access during program runtime. A small section of data stored at the end of the codeplug block contains information about the Clean Cab's state, which is preserved when the radio is off (i.e. the last selected channel and dispatch tone). This area of the code-plug is updated throughout program runtime whenever a user makes a state change to the radio.

5V Regulator

Similar to the +9.6Vdc regulator on the rear panel interconnect board, there are provisions for a +5Vdc regulator circuit (U6, C90 and C34) if required in future revisions; however, the parts are currently not placed on the board. The jumper R105, placed by factory default, selects the regulated +5Vdc source from the ASTRO mobile. The jumper R106 (not factory placed) is available to select the translator board +5Vdc source, if required.

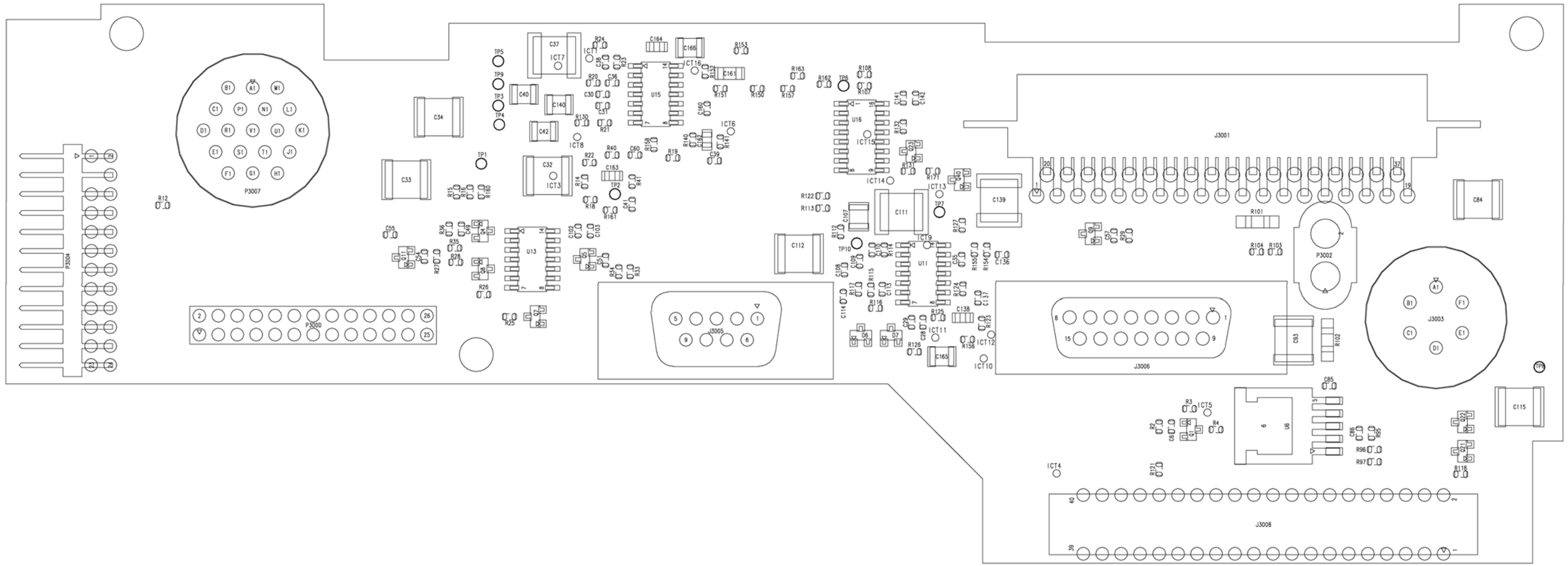


Figure 4-2-1 Clean Cab Rear Panel Interconnect Board Overlay (Front) VLN5738A

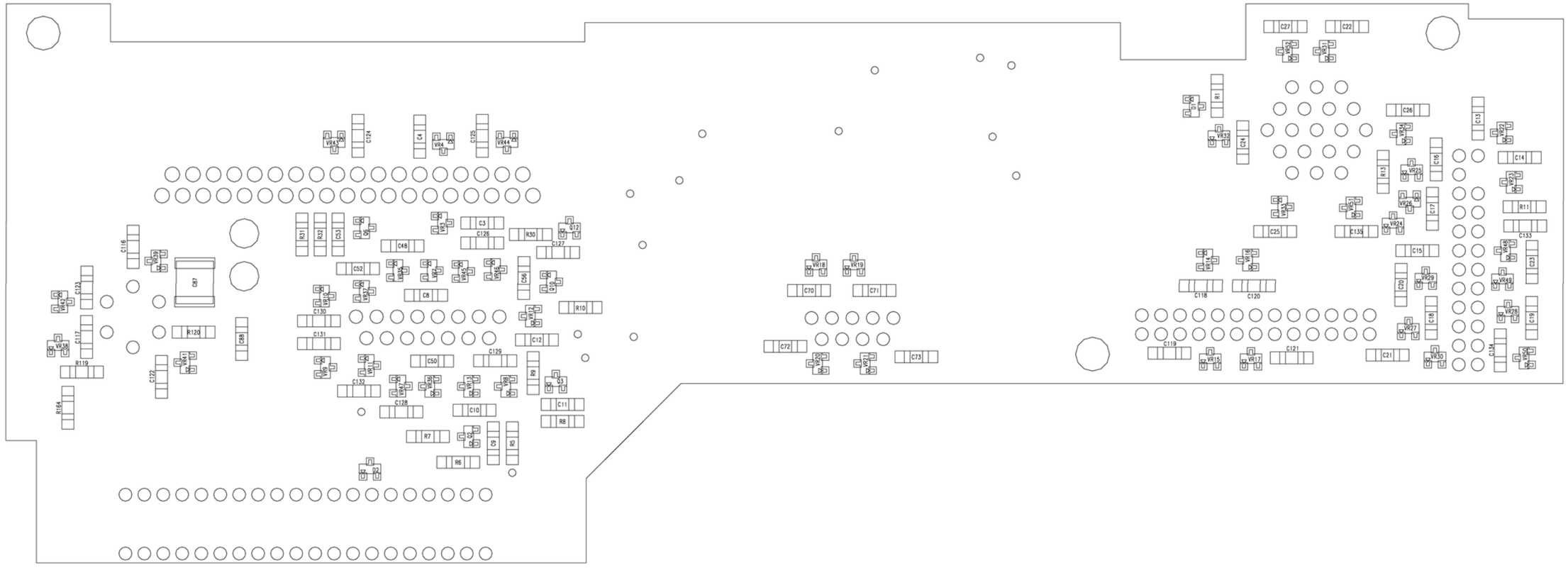


Figure 4-2-1 Clean Cab Rear Panel Interconnect Board Overlay (Back) VLN5738A

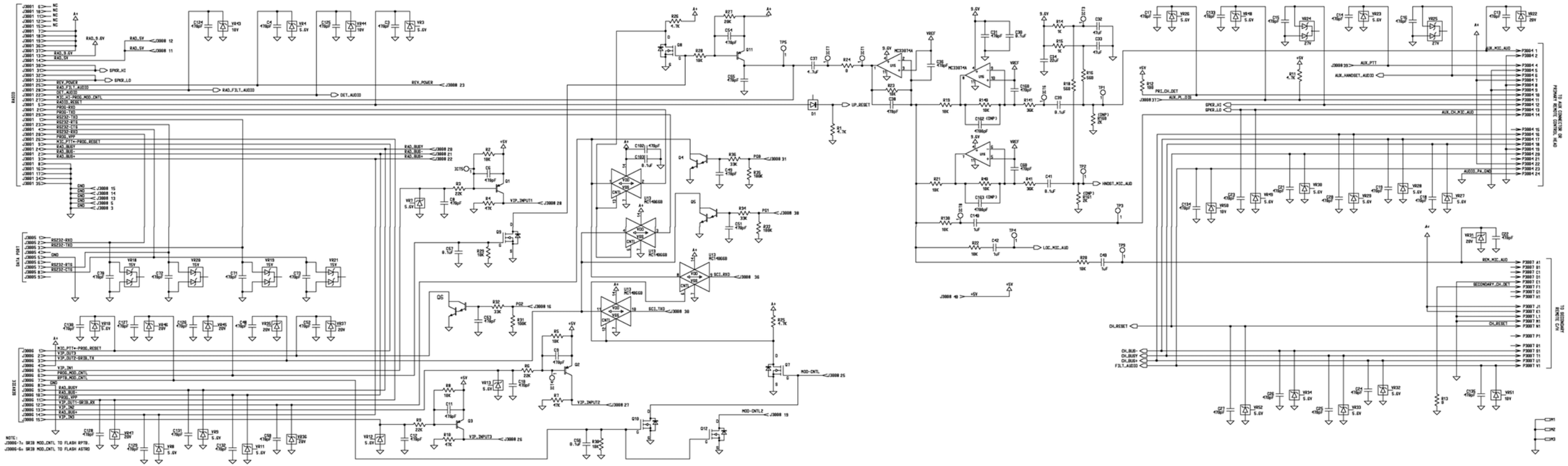


Figure 4-2-2 Clean Cab Rear Panel Interconnect Board Schematic (Sheet 1 of 2) VLN5738A

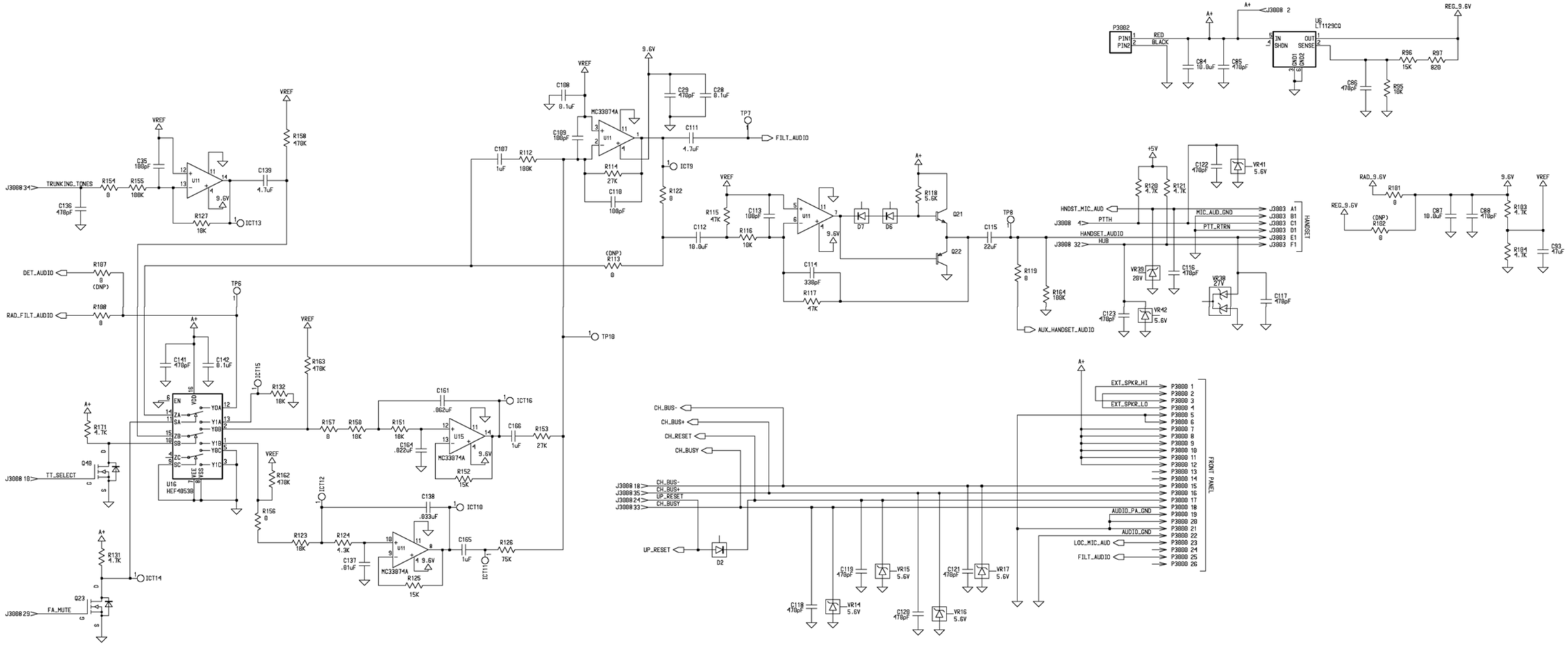


Figure 4-2-2 Clean Cab Rear Panel Interconnect Board Schematic (Sheet 2 of 2) VLN5738A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Capacitor, chip, 5%, X7R, 50V
		(unless otherwise stated)
C3-C4	2113741B13	470pF
C6	2113740F67	470pF
C8-C27	2113741B13	470pF
C28	2113741Z49	0.1uF
C29	2113740F67	470pF
C30	2113741Z49	0.1uF
C31	2113740F67	470pF
C32-C33	2109822S08	47uF, 16V X5R
C34	2109822S07	22uF, 16V
C35	2113740F51	100pF
C36	2113740F67	470pF
C37	2109822S05	4.7uF
C38	2113740F67	470pF
C39	2113741Z49	0.1uF
C40	2113741Y32	1uF
C41	2113741Z49	0.1uF
C42	2113741Y32	1uF
C48	2113741B13	470pF
C49	2113740F67	470pF
C50	2113741B13	470pF
C51	2113740F67	470pF
C52-C53	2113741B13	470pF
C54-C55	2113740F67	470pF
C56	2113741B69	0.1uF
C57	2113741Z49	0.1uF
C60	2113740F67	470pF
C70-C73	2113741B13	470pF
C84	2109822S04	10.0uF, 35V
C85-C86	2113740F67	470pF
C87	2109822S04	10.0uF, 35V
C88	2113741B13	470pF
C93	2109822S08	47uF, 16V X5R
C102	2113740F67	470pF
C103	2113741Z49	0.1uF
C107	2113741Y32	1uF
C108	2113741Z49	0.1uF
C109-C110	2113740F51	100pF
C111	2109822S05	4.7uF
C112	2109822S04	10.0uF, 35V
C113	2113740F51	100pF
C114	2113740F63	330pF
C115	2109822S07	22uF, 16V
C116-C135	2113741B13	470pF
C136	2113740F67	470pF
C137	2113741F49	.01uF
C138	2113741A57	.033uF
C139	2109822S05	.033uF
C140	2113741Y32	1uF
C141	2113740F67	470pF
C142	2113741Z49	0.1uF
C160	2113740F67	470pF
C161	2113741B64	.062uF
C162-C163	2113741A37	4700pF (DNP)
C164	2113741A53	.022uF
C165-C166	2113741Y32	1uF
		Diode, signal, SOT-23
		(unless otherwise stated)
D1-D2	4813833C10	MMBD6050
D6-D7	4813833C09	MMBD914
		Connector
J3001	0902005A01	DC 37, Right Angle Female
J3003	0902002A02	CONN, R/R Handset, 6 Pos
J3005	0902003A08	CONN, DB 9
J3006	0902003A01	CONN, DB 15
J3008	0905802V01	RECEPTACLE, Brd Mount Dbl Row
P3000	2880001S13	CONN, 26 Pos
P3002	3002004A01	PWR_CABLE
P3004	2880001Y12	CONN, 23 Pos
P3007	0902001A04	CONN, 19 Pos
		Transistor, bi-polar, SOT-23
		(unless otherwise stated)
Q1-Q3	4813824A17	MMBT3906
Q4-Q6	4805128M19	MMBTA13
Q7-Q10	4813823A13	MMBF0202
Q11	4813824A17	MMBT3906
Q12	4813823A13	MMBF0202
Q21	4813824A10	MMBT3904
Q22	4813824A17	MMBT3906
Q23	4813823A13	MMBF0202
Q40	4813823A13	MMBF0202
		Resistor, chip, 5%, 1/16W
		(unless otherwise stated)
R1	0611077A90	4.7K, 1/8W
R2	0662057A73	10K
R3	0662057A81	22K
R4	0662057A89	47K
R5	0611077A98	10K, 1/8W
R6	0611077B07	22K, 1/8W
R7	0611077B15	47K, 1/8W
R8	0611077A98	10K, 1/8W
R9	0611077B07	22K, 1/8W
R10	0611077B15	47K, 1/8W
R11	0611077A90	4.7K, 1/8W
R12	0662057A25	100
R13	0611077A01	0 ohm
R14-R15	0662057A49	1K
R16	0662057A43	560
R18	0662057A43	560
R19-R23	0662057A73	10K
R24	0662057B47	0 ohm
R25-R26	0662057A65	4.7K
R27	0662057A80	20K
R28-R29	0662057A73	10K
R30	0611077A98	10K, 1/8W
R31	0611077B23	100K, 1/8W
R32	0611077B11	33K, 1/8W
R33	0662057A97	100K
R34	0662057A85	33K
R35	0662057A97	100K
R36	0662057A85	33K
R40	0662057A73	10K
R41	0662057A86	36K
R95	0662057A73	10K
R96	0662057A77	15K
R97	0662057A47	820
R101	0611077A01	0 ohm
R102	0611077A01	0 ohm (DNP)
R103-R104	0662057A65	4.7K

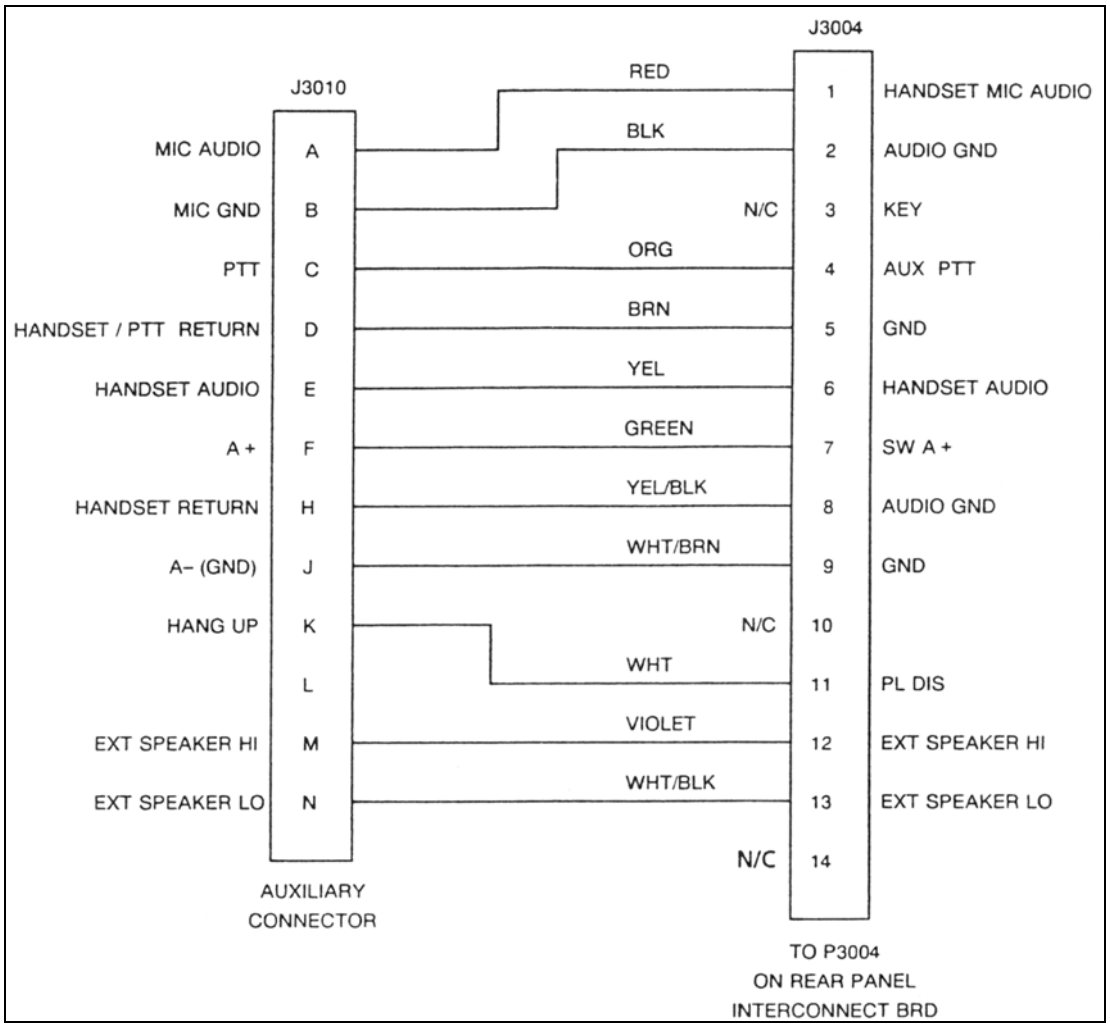
Figure 4-2-3 Clean Cab Rear Panel Interconnect Parts List (Sheet 1 of 2) VLN5738A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Resistor, chip, 5%, 1/16W
		(unless otherwise stated)
R107	0611077A01	0 ohm (DNP)
R108	0611077A01	0 ohm
R112	0662057A97	100K
R113	0662057B47	0 ohm (DNP)
R114	0662057A83	27K
R115	0662057A89	47K
R116	0662057A73	10K
R117	0662057A89	47K
R118	0662057A67	5.6K
R119	0611077A01	0 ohm
R120	0611077A90	4.7K, 1/8W
R121	0662057A65	4.7K
R122	0662057B47	0 ohm
R123	0662057A73	10K
R124	0662057A64	4.3K
R125	0662057A77	15K
R126	0662057A89	47K
R127	0662057A73	10K
R130	0662057A73	10K
R131	0662057A65	4.7K
R132	0662057A73	10K
R140	0662057A73	10K
R141	0662057A86	36K
R150-R151	0662057A73	10K
R152	0662057A77	15K
R153	0662057A83	27K
R154	0662057B47	0 ohm
R155	0662057A97	100K
R156-R157	0662057B47	0 ohm
R158	0662057B14	470K
R160-R161	0662057A56	2K (DNP)
R162-R163	0662057B14	470K
R171	0662057A65	4.7K

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Integrated Circuits
U6	5105109Z13	LT1129CQ
U11	5113819A05	MC33074A
U13	5113806A21	MC14066B
U15	5113819A05	MC33074A
U16	5184704M60	HEF4053B
		Diode, zener, SOT-23
VR3-VR4	4813830A15	MMBZ5232B
VR7-VR17	4813830A15	MMBZ5232B
VR18-VR21	4813832C28	MMBZ15,15V
VR22	4813830A33	MMBZ5250B
VR23	4813830A15	MMBZ5232B
VR24-VR25	4813832C29	MMBZ27VCLT1,27V
VR26-VR30	4813830A15	MMBZ5232B
VR31	4813830A33	MMBZ5250B
VR32-VR34	4813830A15	MMBZ5232B
VR35-VR37	4813830A33	MMBZ5250B
VR38	4813832C29	MMBZ27VCLT1,27V
VR39	4813830A33	MMBZ5250B
VR41-VR42	4813830A15	MMBZ5232B
VR43-VR44	4813830A23	MMBZ5240B
VR45-VR47	4813830A33	MMBZ5250B
VR48-VR49	4813830A15	MMBZ5232B
VR50-VR51	4813830A23	MMBZ5240B
VR52	4813830A15	MMBZ5232B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Non-referenced items
	0102702A09	FR-Rear PNL Int Cab Assy Univ
	300002951	SCR, mch 4-40x1/4 Phlbin Stl
	0310943J10	SCR, tpg TT3x0.5x8
	0310943J15	SCR, tpg TT3x0.6x8
	1585718E01	panel
	4302004A01	SPACER DB-15
	4385163F01	SPACER 19 Pin Conn
	4385712A01	SPACER Handset
	4385297E01	SPACER DB-9
	5502003A01	STANDOFF, 9 & 15 pin conn
	8485153C01	PCB

Figure 4-2-3 Clean Cab Rear Panel Interconnect Parts List (Sheet 2 of 2) VLN5738A



REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	0310943J10	SCR, tpg TT3 x 0.5 x 8 intstarpan (4 used)
	0702009A03	PLATE, mounting aux connector
J3004	0984279D03	CONNECTOR, crimp (10 used)
J3010	0984465M01	CONNECTOR, AAR standard 12 cont
	1110019C21	GLUE, hot melt
	1484277D15	HOUSING, connector 2 x 7
	2284835F01	PLUG, nylon white
	3010286L60	WIRE, 26 AWG str orn 2.5 in.
	3010286L61	WIRE, 26 AWG str yel 2.5 in.
	3010286L62	WIRE, 26 AWG str grn 2.5 in.
	3010286L66	WIRE, 26 AWG str brn 2.5 in.
	3010286L67	WIRE, 26 AWG str blk 2.5 in.
	3010286L69	WIRE, 26 AWG str vio 2.5 in.
	3010286L75	WIRE, 26 AWG str yel/blk 2.5 in.
	3010286L81	WIRE, 26 AWG str wht/blk 2.5 in.
	3010286L82	WIRE, 26 AWG str wht/brn 2.5 in.
	3010286M10	WIRE, 26 AWG str wht 2.5 in.
	3010286M11	WIRE, 26 AWG str red 2.5 in.
	4210217A02	TIE WRAP, nyl wht

Figure 4-2-4 AAR Auxiliary Connector Schematic and Parts List VLN5773B

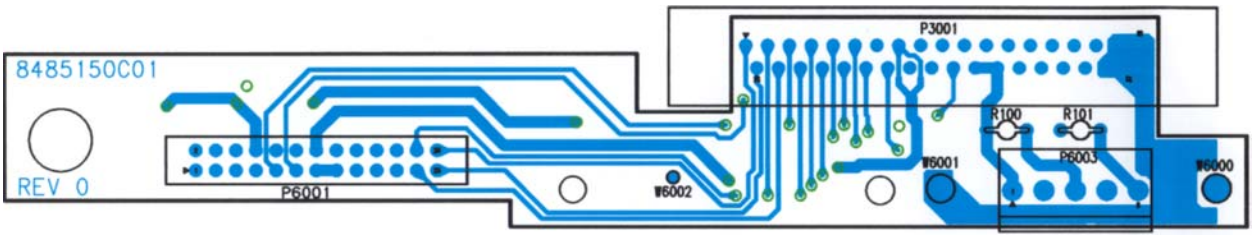


Figure 4-2-5 Top Panel Interconnect Board Overlay VLN5736A

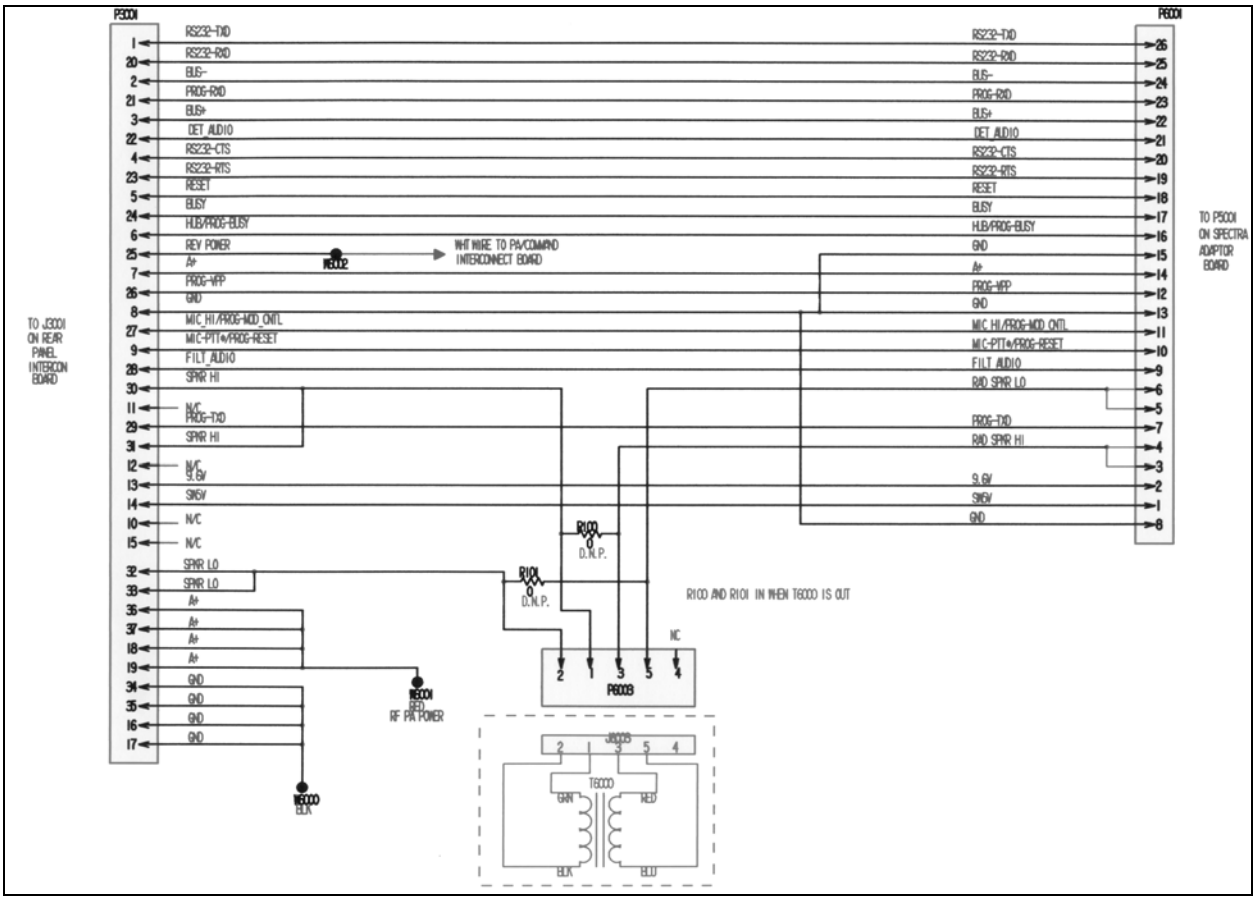


Figure 4-2-6 Top Panel Interconnect Board Schematic VLN5736A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	0102702A10	**Top Panel Interconnect Board Cable Assembly:** consists of
P6001	0982061P07	RECEPTACLE, IDC female 25 pos. polar
	3000029M06	CABLE, ribbon 28 AWG 26 pos. 12 in.
W6000	**0102702A12**	**Wire and U-Lug Assembly:** consists of
	2900008S03	LUG, ring tongue #8
	3010286A12	WIRE, PCV 16 AWG str blk 3 in.
		Connector
P3001	2802004A01	DC-37, male floating 37 pos.
P6003	2882984N05	PLUG, 5-pin
		Non-referenced items
	3010286A14	WIRE, PCV 16 AWG str red 6 in.
	3010286B01	WIRE, PCV 24 AWG str wht 5.5 in.
	4302002A01	SPACER, pcb
	8485150C01	PCB, top panel interconnect

Figure 4-2-7 Top Panel Interconnect Board Parts List VLN5736A

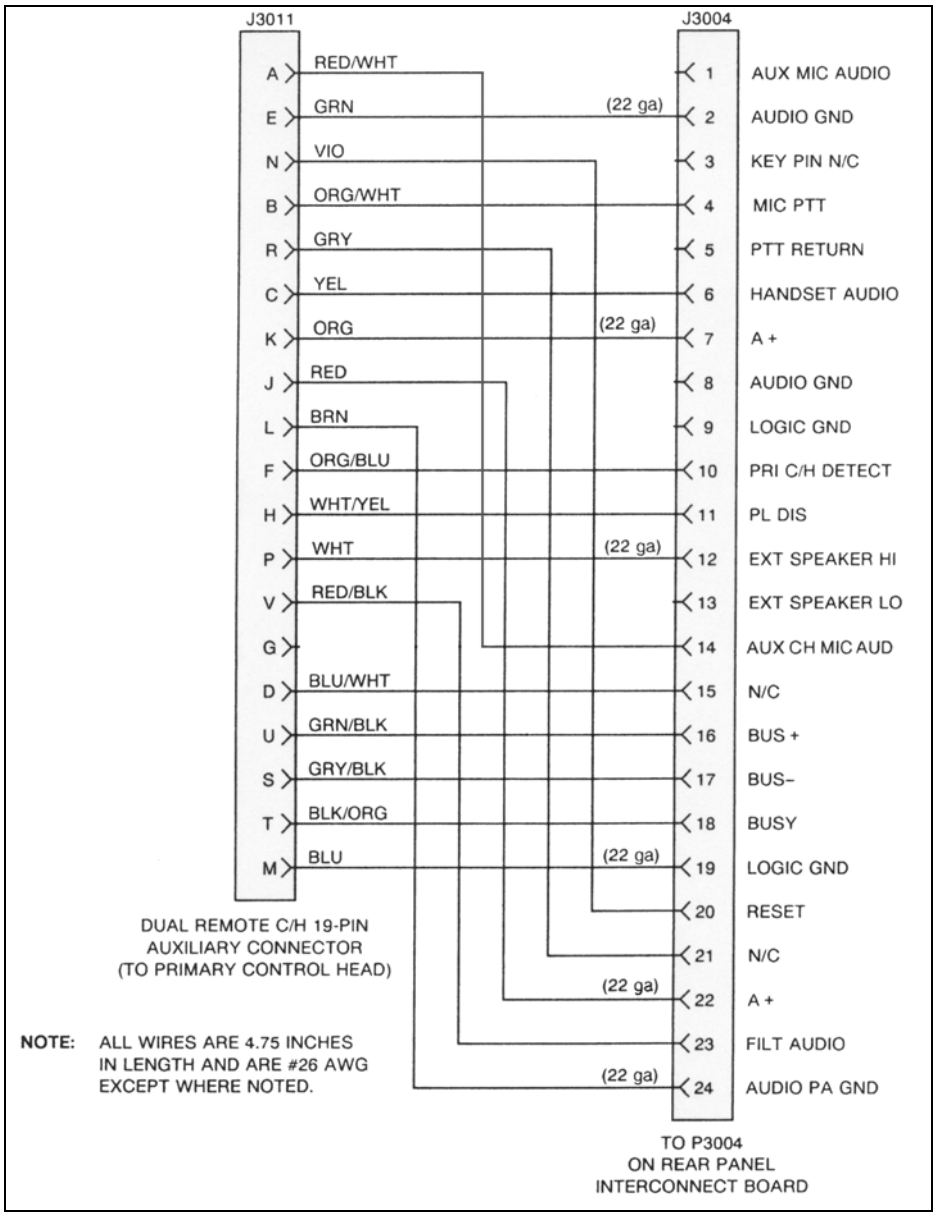


Figure 4-2-8 Dual Remote Control Head Connector Schematic VLN5747A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	0310943J10	SCR, tpg 3 x 0.5 x 8 intstarpan (4 used)
	0702009A03	PLATE, mounting aux. connector.
J3011	0902001A03	RECEPTACLE, 19-pin
J3004	0984279D03	CONNECTOR, crimp (19 used)
	1484277D38	HOUSING, connector 24 position
	2284835F01	PLUG, nylon white
	3700132626	TUBING, heat shrink 3/32 4.75 inches
	4210217A02	TIE WRAP, nylon wht (2 used)

Figure 4-2-9 Dual Remote Control Head Connector Parts List VLN5747A

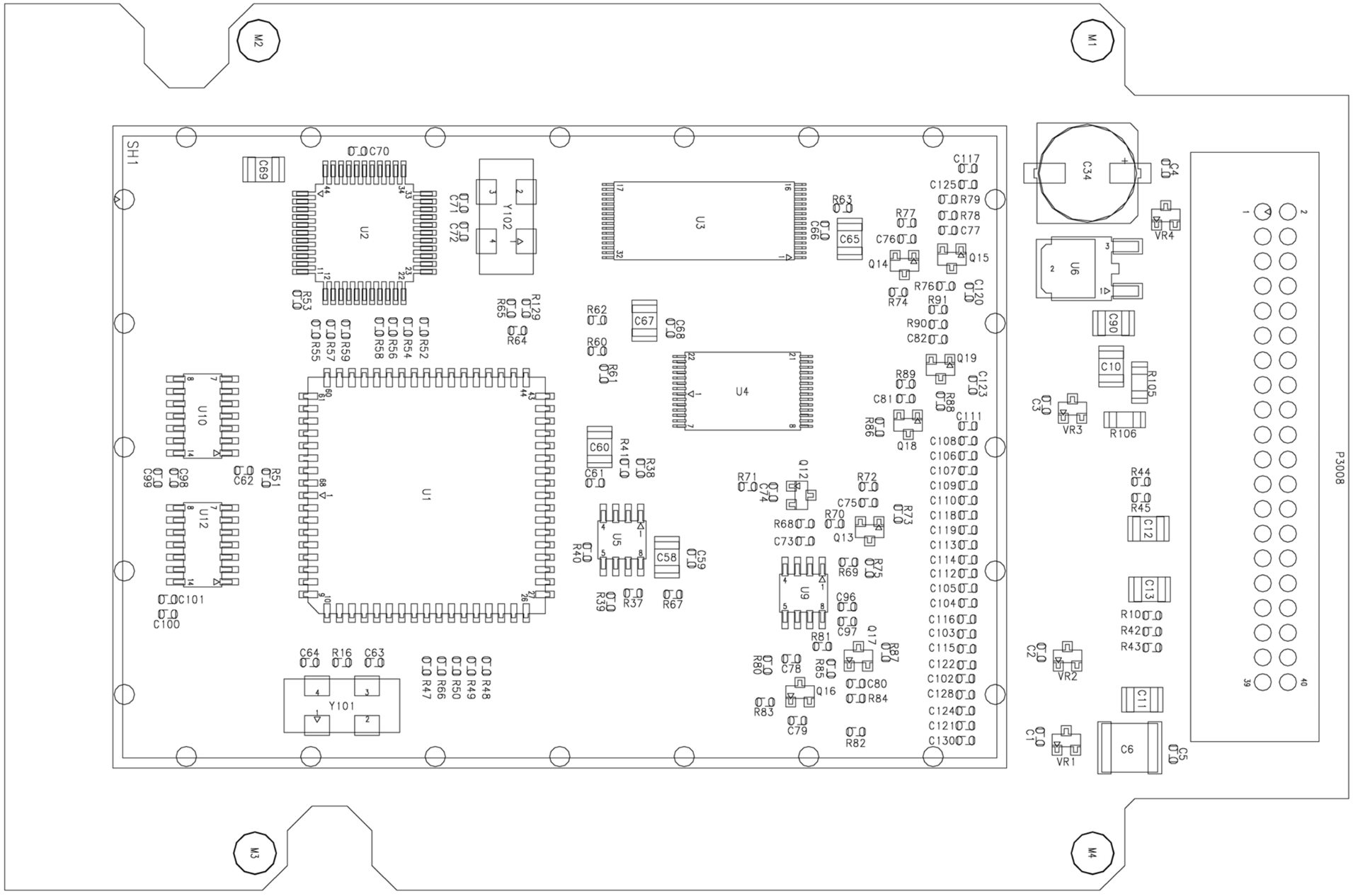


Figure 4-2-10
Translator Board
Overlay VLN5739A

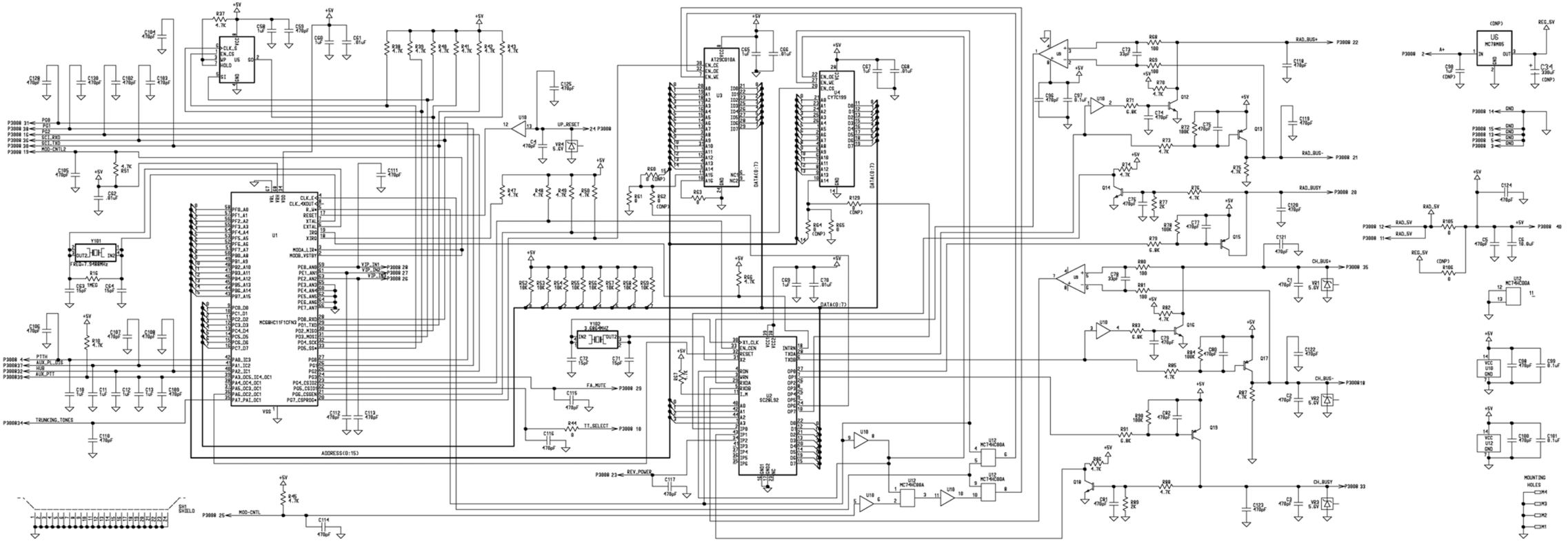


Figure 4-2-11
Translator Board
Schematic VLN5739A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Capacitor, chip, 5%, X7R, 50V
		(unless otherwise stated)
C1-C5	2113740F67	470pF
C6	2109822S04	10.0uF, 35V
C10-C13	2113741Y32	1uF
C34	2380090M33	330uF (DNP)
C58	2113741Y32	1uF
C59	2113740F67	470pF
C60	2113741Y32	1uF
C61-C62	2113741F49	.01uF
C63-C64	2113740F31	15pF
C65	2113741Y32	1uF
C66	2113741F49	.01uF
C67	2113741Y32	1uF
C68	2113741F49	.01uF
C69	2113741Y32	1uF
C70	2113741F49	.01uF
C71-C72	2113740F31	15pF
C73	2113740F39	33pF
C74-C77	2113740F67	470pF
C78	2113740F39	33pF
C79-C82	2113740F67	470pF
C90	2113741Y32	1uF (DNP)
C96	2113740F67	470pF
C97	2113741Z49	0.1uF
C98	2113740F67	470pF
C99	2113741Z49	0.1uF
C100	2113740F67	470pF
C101	2113741Z49	0.1uF
C102-C125	2113740F67	470pF
C128	2113740F67	470pF
C130	2113740F67	470pF
		Transistor, bi-polar, SOT-23
		(unless otherwise stated)
Q12	4813824A10	MMBT3904
Q13	4813824A17	MMBT3906
Q14	4813824A10	MMBT3904
Q15	4813824A17	MMBT3906
Q16	4813824A10	MMBT3904
Q17	4813824A17	MMBT3906
Q18	4813824A10	MMBT3904
Q19	4813824A17	MMBT3906

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Connector
P3008	2805801V01	CONN_P
		Resistor, chip, 5%, 1/8W
		(unless otherwise stated)
R10	0662057A65	4.7K
R16	0662057B22	1MEG
R37-R43	0662057A65	4.7K
R44	0662057B47	0 ohm
R45	0662057A65	4.7K
R47-R51	0662057A65	4.7K
R52-R59	0662057A73	10K
R60	0662057B47	0 ohm (DNP)
R61	0662057B47	0 ohm
R62	0662057B47	0 ohm (DNP)
R63	0662057B47	0 ohm
R64	0662057B47	0 ohm (DNP)
R65	0662057B47	0 ohm
R66-R67	0662057A65	4.7K
R68-R69	0662057A25	100
R70	0662057A65	4.7K
R71	0662057A69	6.8K
R72	0662057A97	100K
R73-R76	0662057A65	4.7K
R77	0662057A56	2K
R78	0662057A97	100K
R79	0662057A69	6.8K
R80-R81	0662057A25	100
R82	0662057A65	4.7K
R83	0662057A69	6.8K
R84	0662057A97	100K
R85-R88	0662057A65	4.7K
R89	0662057A56	2K
R90	0662057A97	100K
R91	0662057A69	6.8K
R105	0611077A01	0 ohm
R106	0611077A01	0 ohm (DNP)
R129	0662057B47	0 ohm (DNP)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Integrated Circuits
U1	5113802A27	MC68HC11F1CFN3
U2	5185143E29	DUART SC28L92
U3	5185956E67	EEPROM AT25320AN-10SJ-2.7
U4	5105457W74	SRAM CY7C199
U5	5185368C52	52968
U6	5113816A07	MC78M05 (DNP)
U9	5113818A03	MC33072
U10	5113805A04	MC74HC04A
U12	5113805A01	MC74HC00A
		Diode, zener, SOT-23
VR1-VR4	4813830A15	MMBZ5232B
		Resonator, ceramic
Y101	4805574W03	74W03
Y102	4805574W04	74W04
		Non-referenced items
	2605455Z05	Shield Fence
	2605455Z06	Shield Cover
	8485152C01	PCB

Figure 4-2-12
Translator Board
Parts List VLN5739A

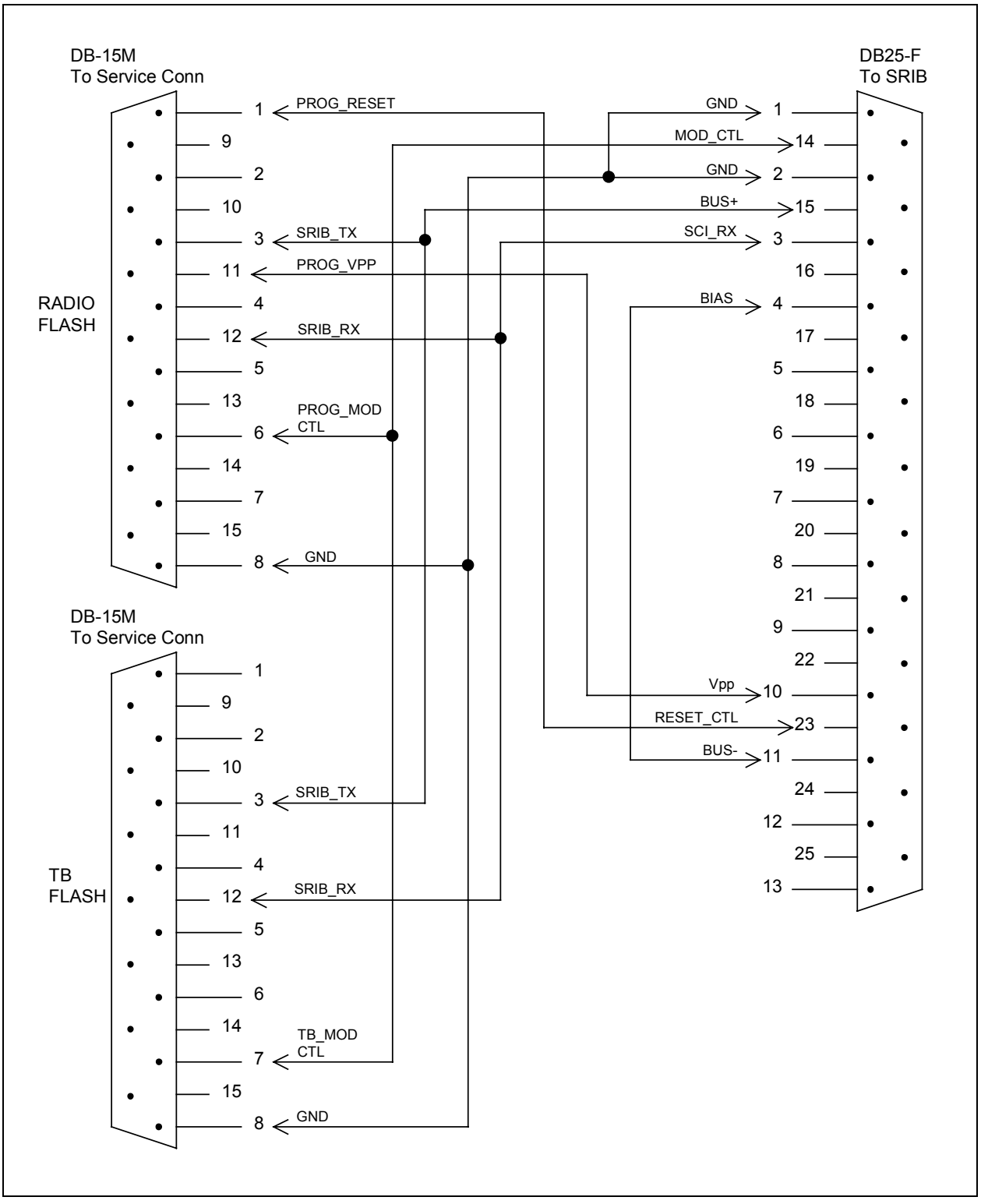


Figure 4-2-13 FLASH Cable Diagram (3085864F01)

4.3 POWER CONVERTER AND FILTER MODULES

4.3.1 GENERAL

This section describes the electrical details for the Universal 72/12V Power Converter Board (VLN5745A) (hereafter referred to as the "power converter"), the (optional) 36/12V Power Converter Board (VLN5746A) and the (optional) Universal 12V Filter Board (VFN4004B). The power converter (or filter board) is housed within a section of the bottom panel assembly, beneath a metal cover. Depending on the module ordered, it is either a +72 Vdc to +13.8 Vdc converter, +36 Vdc to +13.8 Vdc converter or a simple +13.8 Vdc L-C filter module. Board layout, schematic and parts list for the 12 V filter board are provided in Figure 4-3-2 to Figure 4-3-4 at the end of this section. Board layout, schematic and parts list for the +72 V and +36 V power converters are provided in Figure 4-3-5 to Figure 4-3-10 at the end of this section.

4.3.2 THEORY OF OPERATION

12 V Filter Board

For locomotives which supply a +13.8 Vdc source voltage, this voltage is applied to P4000-D and P4000-B and is filtered by an L-C filter comprised of L4003, C4006, and C4007. CR4004 provides reverse-voltage protection.

Power Converter Board

For locomotives which supply a +72 Vdc source voltage, the 72/12V power converter provides the +13.8 Vdc required by the radio. Figure 4-3-1, 72/12V Power Converter Board Block Diagram, supports the discussion which follows.

The circuit design of the power converter is that of a forward converter employing current-mode control, and includes over-current and over-voltage protection circuitry, filtering, and transient protection.

The 72/12V power converter receives +72 Vdc from connector P4000 (pins A and C) located at the rear of the radio. The +72 Vdc is filtered, applied to a voltage chopper, stepped down, rectified, filtered, and applied to the radio circuits as +13.8 Vdc via J4001. The 36/12V power converter theory of operation is the same.

4.3.3 POWER CONVERTER DETAILED DESCRIPTION

72 V Transient Filter

The +72 Vdc incoming power, voltage chopper, and switching circuitry are floating since the input ground lead is electrically isolated from the +13.8 Vdc output ground. The voltage applied to P4000 pins A and C is filtered by a 72 V transient filter composed of L4001, L4002, C4001, C4002, and C4003. The filter is used to limit the peak amplitude and increase the rise time of line-to-line transients, as well as reduce the amount of 40 kHz ripple present on the input leads. Spark gap E4001 and metal oxide varistors E4002 and E4003 provide protection from high voltage line-to-chassis and line-to-line transients respectively. Fuse F4001 provides protection when excessive input current is drawn.

13.2 V Regulator

Q4004, VR4003 and associated circuitry compose a +13.2 Vdc series pass regulator which supplies a regulated voltage for U4001, U4001, U4003 and U4004.

Voltage Chopper, Rectifiers and 13.8 V Filters

Filtered +72 Vdc is applied to the primary winding of T4001. Current flow through the primary of T4001 is controlled by two parallel-connected MOSFET voltage choppers, Q4001 and Q4002. Q4001 and Q4002 are switched on and off at 40 kHz by current-mode controller U4001. The on-time of the voltage chopper

is controlled by U4001 on a pulse-by-pulse basis to achieve the desired output level. As a forward converter, this circuit uses the transformer in the forward mode, meaning that power is delivered to the load every time the voltage chopper is on and current is allowed to flow in the primary. When Q4001 and Q4002 are on, a voltage is developed across the secondary winding. Diode CR4003 is forward biased, current flows through L4003, and a positive voltage is developed across the +13.8 Vdc filter. When primary current is interrupted (Q4001 and Q4002 are off) stored magnetic energy in the transformer core is returned to the input line through CR4002 and the reset winding. Simultaneously, the secondary winding forward biases CR4004, effectively holding the voltage at the cathode to zero volts. Current continues to flow through L4003 via CR4004. Since it takes the same time to set and reset the core, the duty-cycle of the voltage chopper cannot exceed 50%.

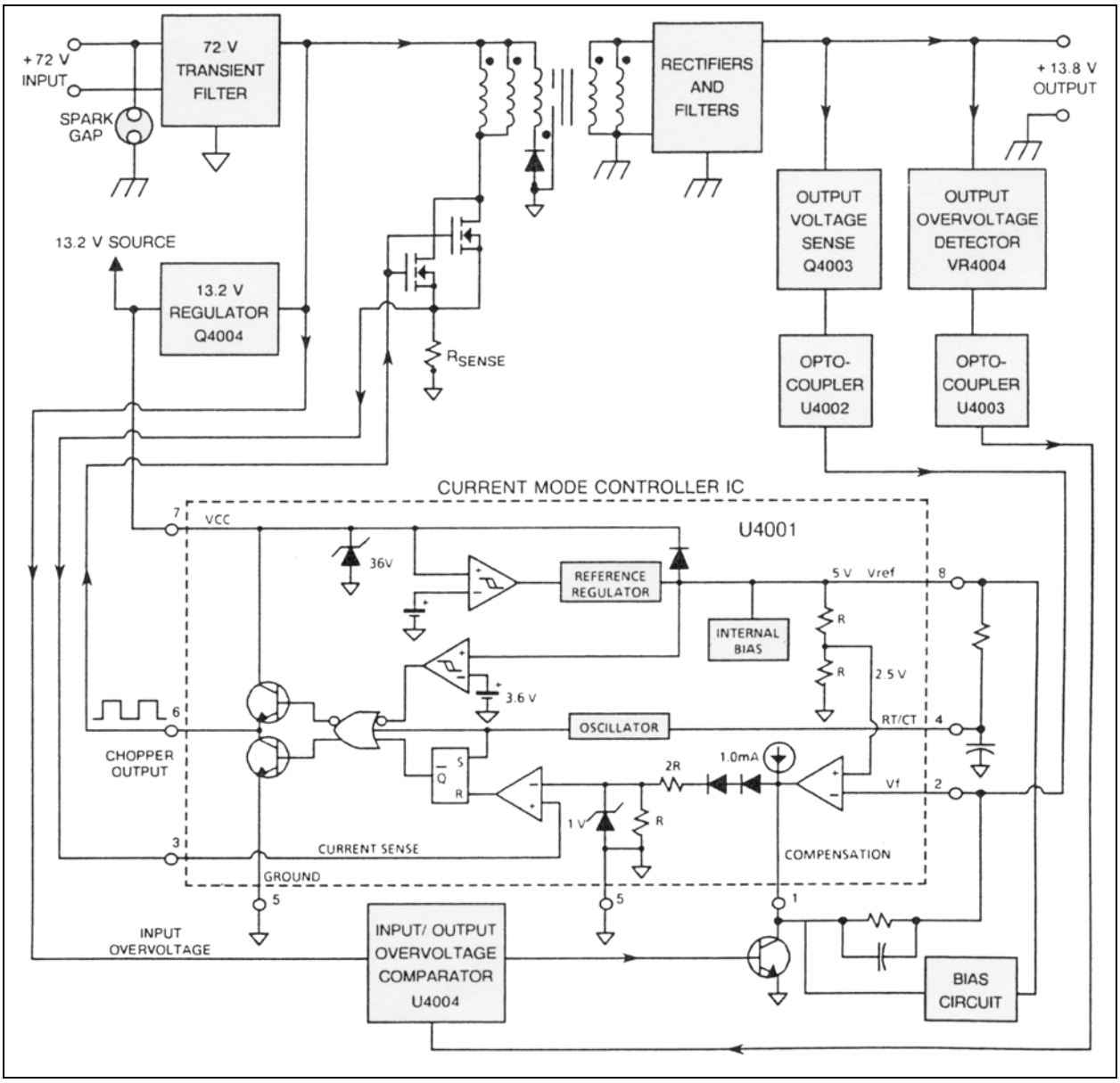


Figure 4-3-1 72/12 V Power Converter Board Block Diagram

As a result of the switching action, a square wave with an amplitude of approximately +35 Vdc is applied to the input of the filter to provide a +13.8 Vdc output. By controlling the on-time of the voltage chopper

through feedback loops, the output can be regulated for varying load conditions. The regulation process is described in the following paragraphs dealing with sensing and fault detector circuitry, and under-voltage lockout circuitry.

The voltage chopper circuitry includes a snubber circuit composed of CR4005, R4017, and C4019 which controls voltage spikes which are due to the leakage inductance of T4001. Gate protection from switching transients is provided by zener diode VR4002. On the secondary side, two RC snubbers consisting of C4004, R4001, C4005, and R4002 protect each rectifier pair by reducing the peak amplitude of high voltage switching transients. The +13.8 Vdc filter is a simple L-C filter consisting of L4003, C4006, and C4007.

Current Mode Controller Oscillator and Output

The current mode controller IC U4001 contains, among other things, a fixed frequency oscillator, a high current totem pole output stage, and variable deadtime control circuitry to determine the specific on-time of the voltage chopper.

The oscillator frequency of U4001 is determined by timing components C4011 and R4012. When +13.2 Vdc from the emitter of Q4004 is applied to U4001-7, U4001 generates a +5 Vdc reference internally which appears at U4001-8. C4011 is charged through R4012 by the reference voltage to approximately +2.8 Vdc and discharged to +1.2 Vdc by an internal current sink. During the discharge interval of C4011, the oscillator generates a blanking pulse which holds one input of the internal NOR gate high, causing the output at pin 6 to be low for a controlled period of deadtime. Consequently, the output switches at one-half the oscillator frequency. Under normal operating conditions (i.e. +13.8 Vdc at the output of the power converter), the minimum output deadtime of U4001-6 is approximately 54%.

Sensing and Fault Detector Circuitry

The power converter contains circuits for voltage and current sensing which provide feedback control of U4001. It also contains two fault detectors: an output over-voltage detector and an input over-voltage detector. When a fault is detected, a low signal is applied to U4001-1 via Q4005 to turn off the power supply.

U4001 contains an error amplifier, a current sense comparator, and a PWM latch which process voltage and current feedback in order to control voltage chopper switching. Output switch conduction is initiated by the oscillator and is terminated when the peak primary current of T4001 (sensed as a voltage across R4010) reaches the error voltage level established at the output of the error amplifier (U4001-1).

Any increase in the output voltage increases the voltage across the voltage divider R4005, R4006, and R4007. This increases the current through the collector of Q4003 and the opto-isolator diode of U4002. As the collector current of Q4003 increases, the collector current through the phototransistor of U4002 increases. This causes an increase in the feedback voltage applied to U4001-2. The feedback voltage is applied to the inverting input of the error amplifier which provides an error voltage (clamped at 1 volt maximum) used as a reference for the inverting input of the current sense comparator.

If the switching current through the primary becomes excessive, a corresponding voltage is developed across R4010 which is fed back to the current sense comparator inside U4001 (via pin 3) for comparison with the error voltage developed at the output of the error amplifier. R4016 and C4013 form an RC filter at the input of the current sense comparator which reduces leading-edge current spikes to an acceptable level in order to prevent switching instability. The current sense comparator/PWM latch configuration within U4001 ensures that only a single pulse appears at the output (U4001-6) during any given oscillator cycle.

When the output voltage exceeds +19 Vdc, VR4004 and the diode in opto-isolator U4003 conduct causing the phototransistor to conduct, pulling U4003-4 high. This signal is passed on to the input/output

over-voltage comparator, U4004, turning on Q4005. This pulls U4001-1 low which disables the internal error amplifier, thereby turning off the power converter.

The 72 V input voltage is applied to voltage divider R4021 and R4023, with the divided voltage being applied to comparator U4004-3. A reference voltage of 6.3 V is applied to the negative input of the comparator (U4004-2). When the power supply input voltage exceeds about 105 volts, the voltage at U4004-3 is high enough to cause a low at U4004-1 which turns on Q4005 and shuts down the power supply until the input voltage drops below 100 volts. VR4005 clamps the comparator input to protect it from high-voltage transients.

Undervoltage Lockout

Within U4001, the VCC terminal (pin 7) and the reference regulator output (pin 8) are monitored by separate undervoltage lockout comparators which guarantee that the output stage is not turned on unless the IC is fully operational. Each comparator has built-in hysteresis to prevent erratic output behavior as the respective thresholds are crossed. The start-up threshold voltage of pin 7 (VCC) is 8.4 V (typical), and the minimum operating voltage after turn-on is 7.6 V (typical). The corresponding upper and lower thresholds of pin 8 are 3.6 V/3.4 V.

NOTE

Other than part values and some topology, the 36/12V Power Converter is identical in operation to the 72/12V Power Converter.

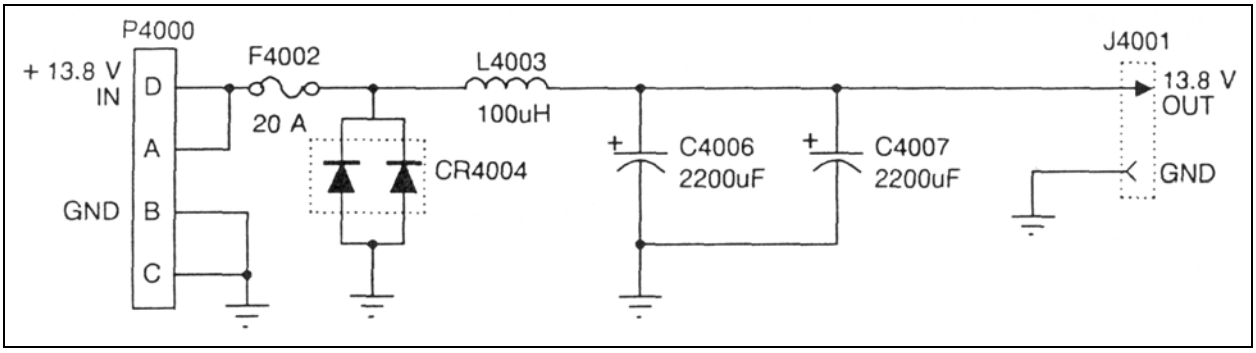


Figure 4-3-2 Universal 12V Filter Board Schematic

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C4066, C4007	2313748E31	CAPACITOR, electrolytic, uF 2200uF, 20%, 50V
CR404	4802012A01	DIODE, rectifier, 20A, 100V Schottky
F4002	6500004637	FUSE, 20A, 32V
L4003	2584696M01	COIL, 100uH, 16A
J4001	0980255E01	RECEPTACLE, power, 2 connector
P4000	2884468M01	RECEPTACLE, male, 4 connector
		Non-referenced items
	0200021M01	NUT, lock M35
	0300035M06	SCR, machine 6-32 x 38 pn
	0310943J04	SCR, tpg TT2.5 x 0.45 x 8 starpan
	0310943J10	SCR, tpg TT3 x 0.5 x 8 starpan
	0400007607	WASHER, flat stl cad (2 used)
	0400028M02	WASHER, insulator
	0400029M01	WASHER, flat 1.63 .145
	0402002A01	O-RING
	0402003A01	WASHER, shoulder nylon
	0702008A02	PLATE, feed through
	1402000A01	FUSEHOLDER
	1402005A01	INSULATOR, audio PA
	2602003A01	HEAT SINK, aluminum
	3010286A12	WIRE, 16 AWG blk 5.5 inches
	3010286G44	WIRE, 16 AWG org 12 inches
	3700122979	TUBING, Teflon nat 2.25 inches
	4200076M02	TIE-WRAP, nylon blk
	8402024A03	PCB, power converter

Figure 4-3-3 Universal 12V Filter Board Parts List

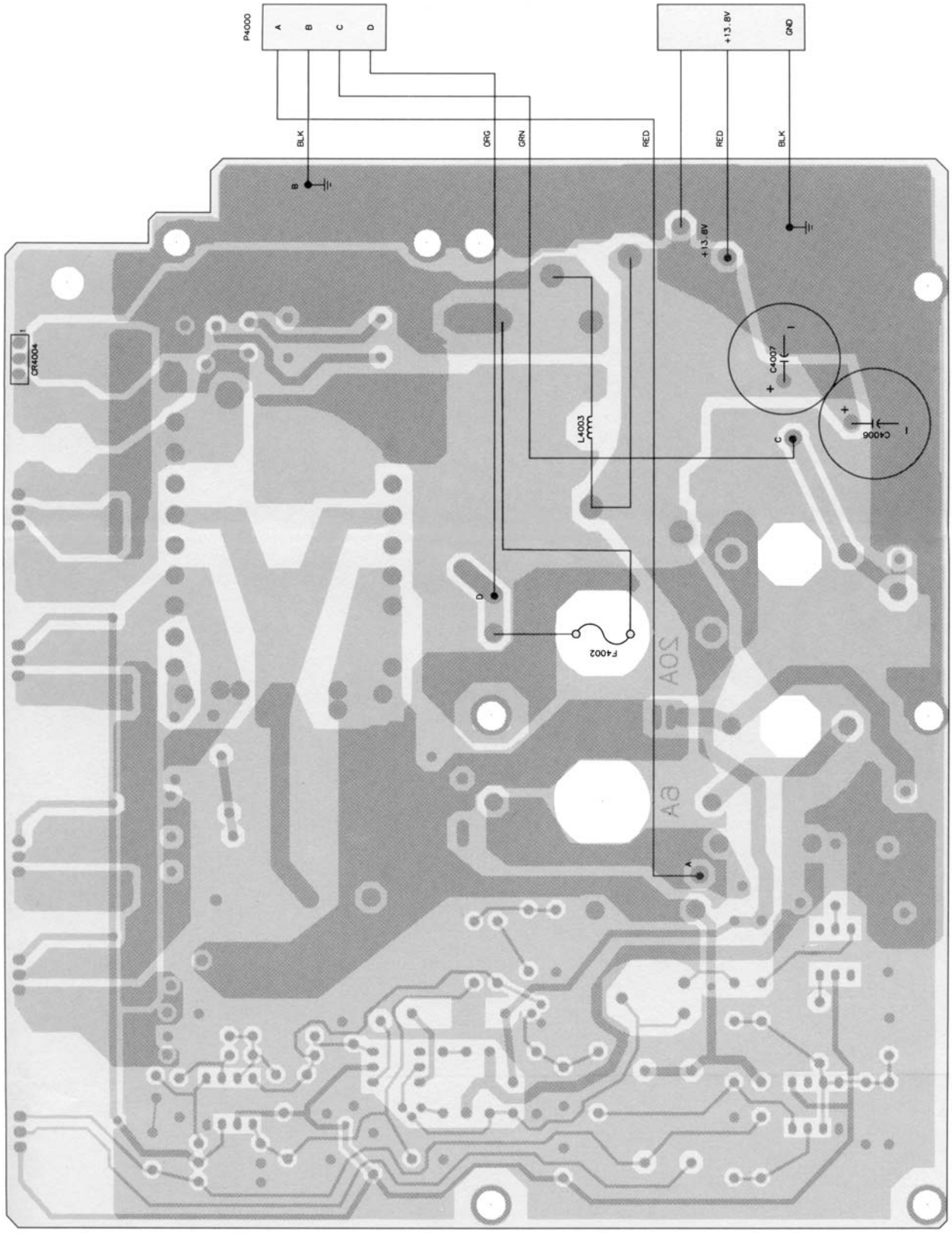


Figure 4-3-4 Universal 12V Filter Board Overlay

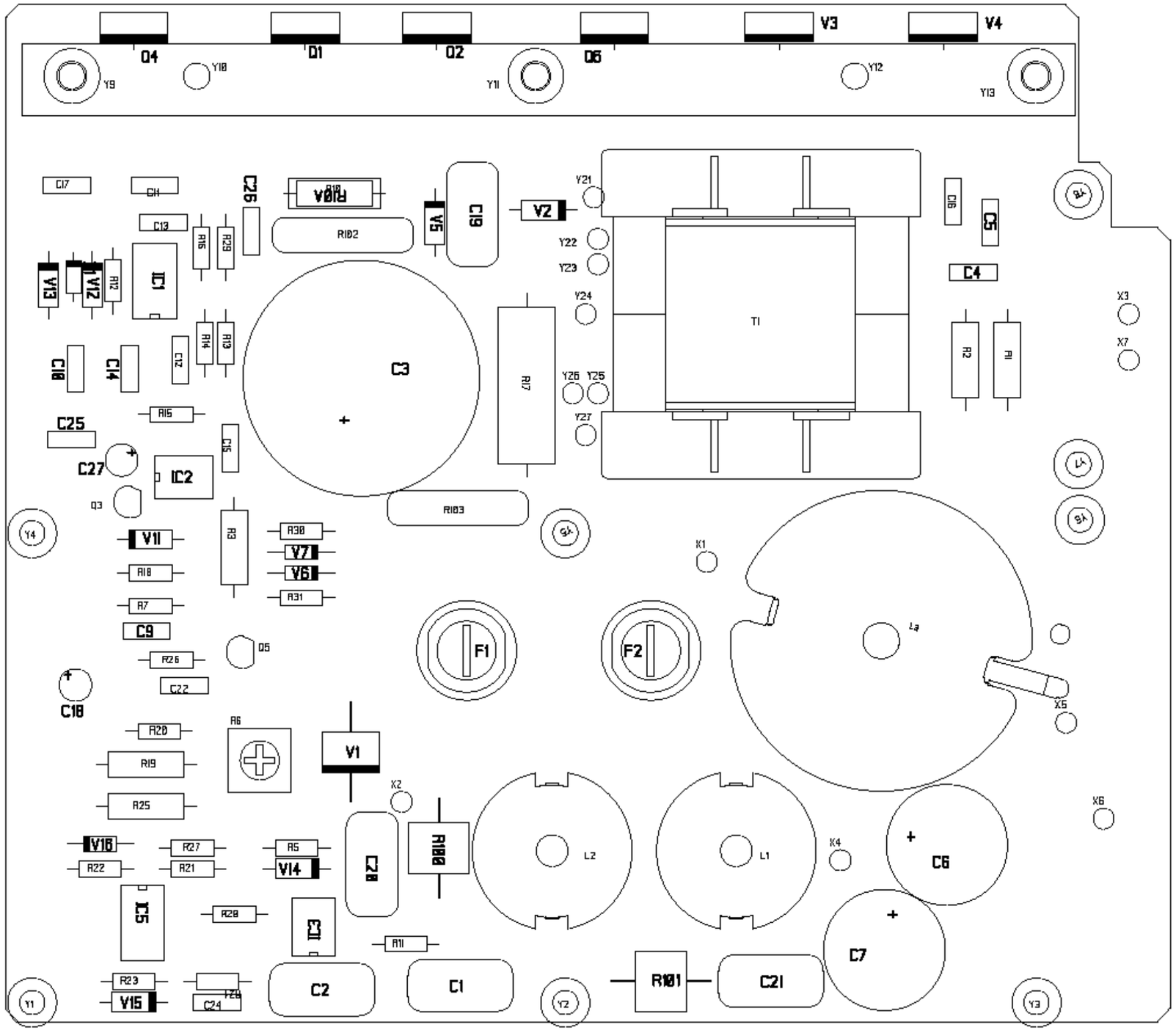


Figure 4-3-5
Universal 72/12 V
Power Converter Board
Overlay

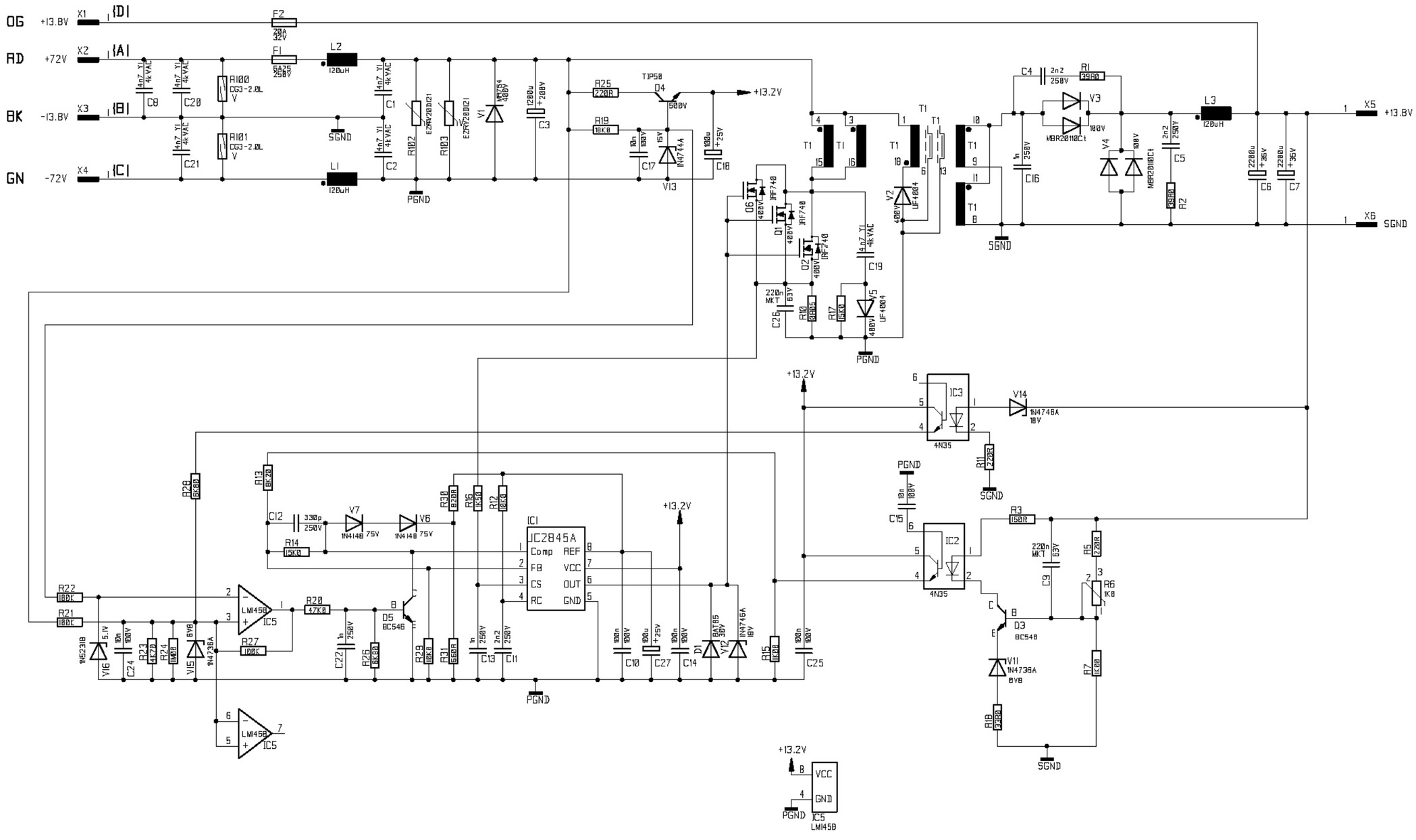


Figure 4-3-6
Universal 72/12 V
Power Converter Board
Schematic

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Capacitor
C1-C2		4.7n, 4kVAC
C3		ELEC 1200uF 20% 200V
C4-C5		POLY FKS2 2.2nF 10% 250V
C6-C7		ELEC 2200uF 20% 35V
C8		4.7n 4kVAC
C9		POLY 220nF 10% 63V
C10		POLY 100nF 10% 100V
C11		POLY FKS2 2.2nF 10% 250V
C12		POLY FKS2 330pF 10% 250V
C13		POLY FKS2 1nF 10% 250V
C14		POLY 100nF 10% 100V
C15		POLY 10nF 10% 100V
C16		POLY FKS2 1nF 10% 250V
C17		POLY 10nF 10% 100V
C18		ELEC 100uF 20% 25V
C19-C20		4.7n 4kVAC
C22		POLY FKS2 1nF 10% 250V
C24		POLY 10nF 10% 100V
C25		POLY 100nF 10% 100V
C27		ELEC 100uF 20% 25V
		Inductor
L1-L2		8.5A, 120uH
L3		18A, 120uH
		Diode
V1		400V 6A MR754
V2		600V 1A
V3-V4		100V 2x10A
V5		600V 1A
V6-V7		75V 0.2A 1% 1N4148
D1		SCHOTTKY 30V 200mA

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Zener Diode
V11		1N4736A 6.8V 1W 5%
V12		1N4746A 18V 250mA
V13		1N4744A 15V 1W 5%
V14		1N4746A 18V 250mA
V15		1N4736A 6.8V 1W 5%
V16		1N5231B 5.1V 500mW 1%
		Resistor
R1-R2		39 5% 2W
R3		FUSE 150 OHM 1W 5%
R5		220 1% 0.6W
R6		TRIMMER 1k
R7		1K 1% 0.6W
R10		0.05 OHM 3W 1%
R11		220 1% 0.6W
R12		10K 1% 0.6W
R13		8.2K 1% 0.6W
R14		15K 1% 0.6W
R15		1K 1% 0.6W
R16		1.5K 1% 0.6W
R17		15. 5% 5W
R18		33 1% 0.6W
R19		FUSE 18.0K 1W 5%
R20		47K 1% 0.6W
R21-R22		100K 1% 0.6W
R23		4.7K 1% 0.6W
R25		FUSE 220 OHM 1W 5%
R26		6.8K 1% 0.6W
R27		100K 1% 0.6W
R28		6.8K 1% 0.6W
R29		10K 1% 0.6W
R30		820 1% 0.6W
R31		470 1% 0.6W

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Fuse
F1		FUSE 6.25A 250V 3453QS1,
F2		FUSE 20A 32V SFE20
		Gase Tube Arrester
R100-R101		2000V/DC CG3-2.0L
		Varistor
R102-R103		120V/DC
		Transformer
T1		TR-M VLN ETD44
		Transistor
Q1-Q2		FET IRF740
Q3		NPN BC546
Q4		NPN 500V
Q5		NPN BC546
		Integrated Circuits
IC1		UC2845A CURRENT MODE PWM
IC2-IC3		OPTO 4N35
IC5		OP LM1458 0°C/+70°C

Figure 4-3-7
Universal 72/12 V
Power Converter Board
Parts List

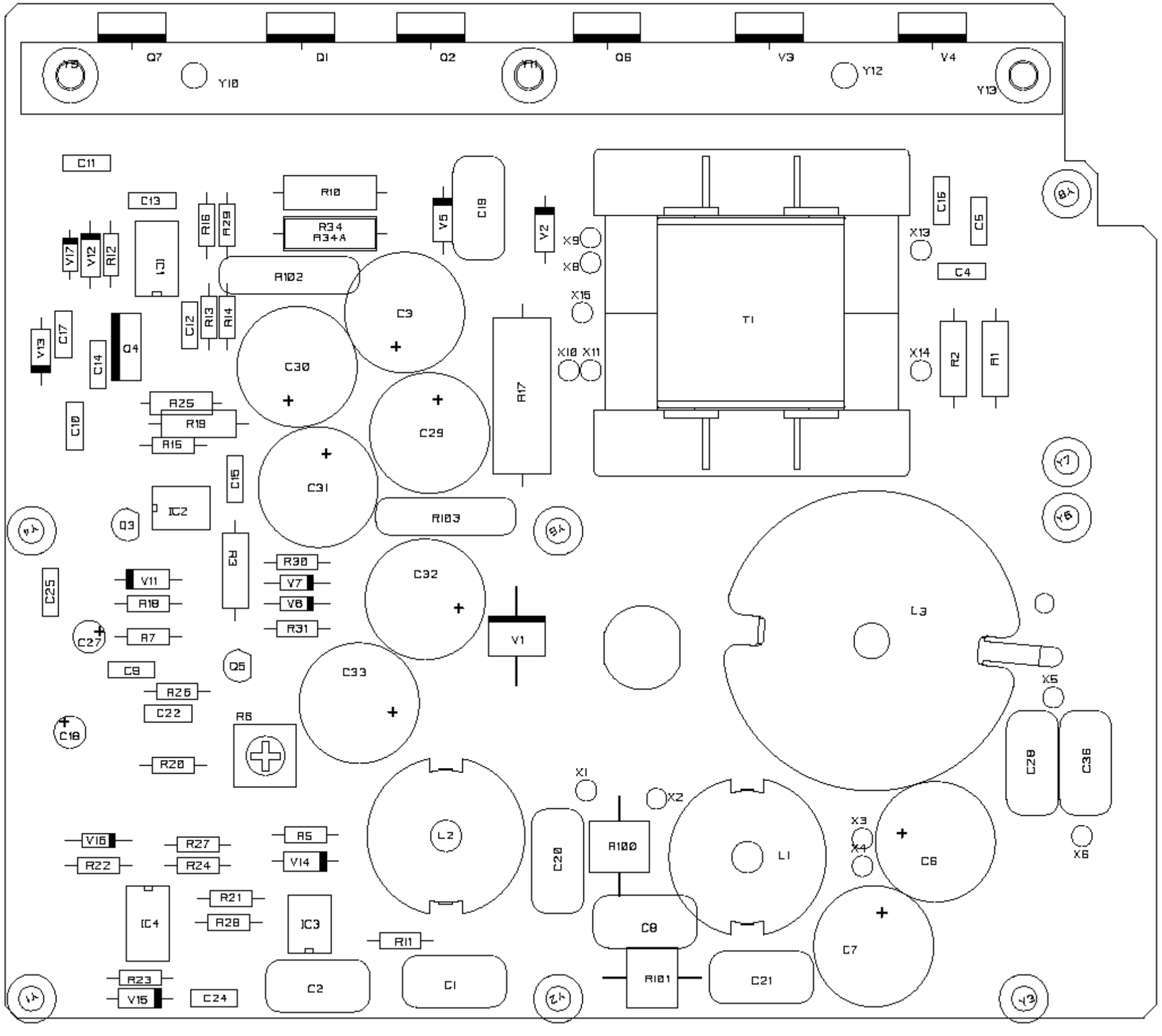


Figure 4-3-8
Universal 36/12 V
Power Converter Board
Overlay

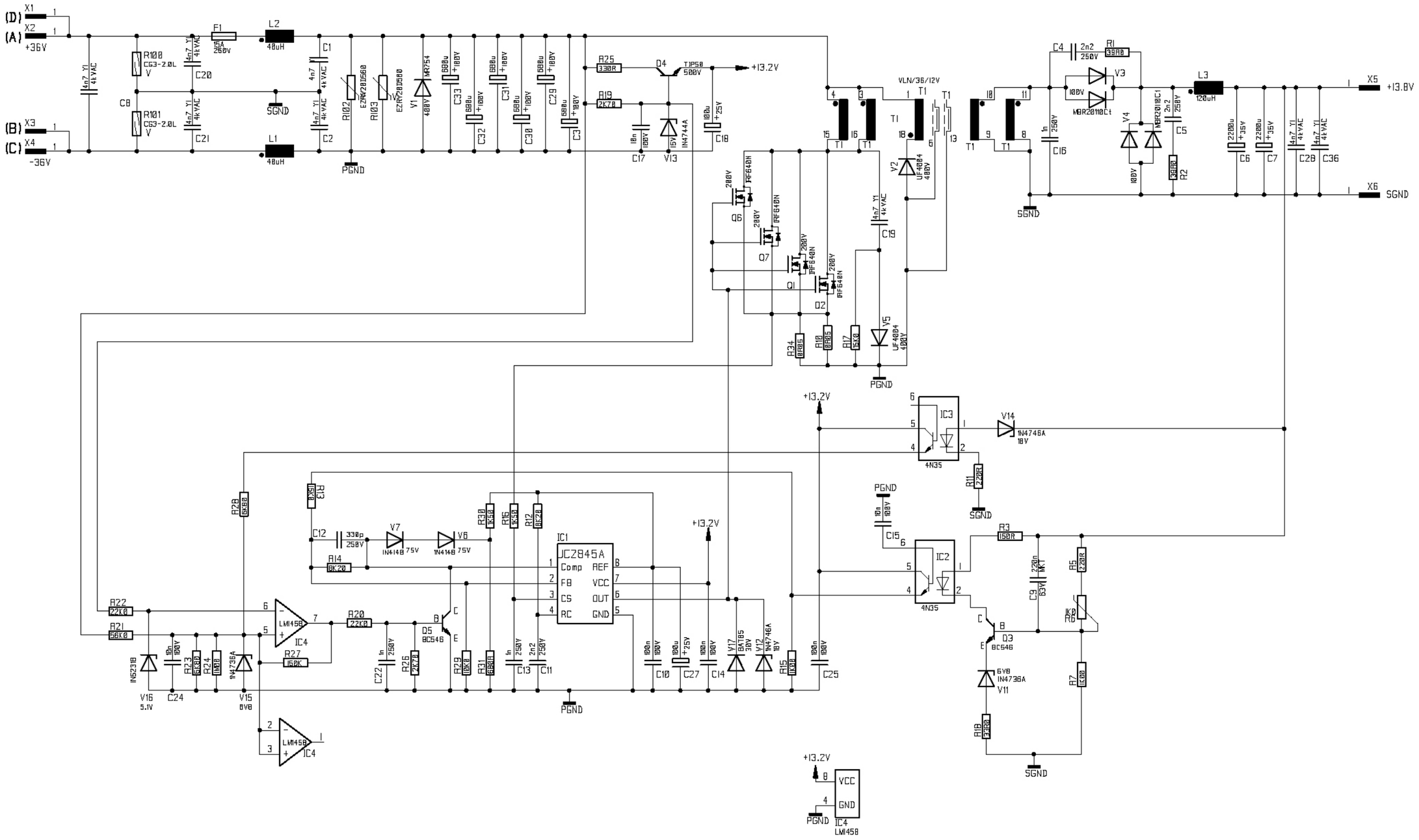


Figure 4-3-9
Universal 36/12 V
Power Converter Board
Schematic

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Capacitor
C1-C2		4.7n 4kVAC
C3		ELEC 680u 100V 20%
C4-C5		POLY FKS2 2.2nF 10% 250V
C6-C7		ELEC 2200uF 20% 35V
C8		4.7n 4kVAC
C9		POLY 220nF 10% 63V
C10		POLY 100nF 10% 100V
C11		POLY FKS2 2.2nF 10% 250V
C12		POLY 330pF 10% 250V
C13		POLY 1nF 10% 250V
C14		POLY 100nF 10% 100V
C15		POLY 10nF 10% 100V
C16		POLY 1nF 10% 250V
C17		POLY 10nF 10% 100V
C18		ELEC 100uF 20% 25V
C19-C21		4.7n 4kVAC
C22		POLY 1nF 10% 250V
C24		POLY 10nF 10% 100V
C25		POLY 100nF 10% 100V
C27		ELEC 100uF 20% 25V
C28		4.7n 4kVAC
C29-C33		ELEC 680u 100V 20%
C36		4.7n 4kVAC
		Inductor
L1-L2		CHOKE 40uH 12A
L3		120uH, 18A
		Diode
V1		400V 6A MR754
V2		600V 1A
V3-V4		MBR20100CT
V5		600V 1A
V6-V7		75V 0.2A 1% 1N4148
V17		SCHOTTKY 30V 200mA

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Zener Diode
V11		1N4736A 6.8V 1W 5%
V12		1N4746A 18V 250mA
V13		1N4744A 15V 1W 5%
V14		1N4746A 18V 250mA
V15		1N4736A 6.8V 1W 5%
V16		1N5231B 5.1V 500mW 1%
		Resistor
R1-R2		FUSE 39 OHM 1W 5%
R3		FUSE 150 OHM 1W 5%
R5		220 1% 0.6W 0207
R6		TRIMMER 1k
R7		1K 1% 0.6W 0207
R10		WW 0.05 OHM 3W 1%
R11		220 1% 0.6W 0207
R12		8.2K 1% 0.6W 0207
R13		15K 1% 0.6W 0207
R14		8.2 1% 0.6W 0207
R15		1K 1% 0.6W 0207
R16		1.5K 1% 0.6W 0207
R17		CER 15K 5% 5W
R18		33 1% 0.6W 0207
R19		2.7 1% 0.6W 0207
R20		22K 1% 0.6W 0207
R21		56K 1% 0.6W 0207
R22		22K 1% 0.6W 0207
R23		6.8K 1% 0.6W 0207
R24		1M 1% 0.6W 0207
R25		FUSE 330 OHM 1W 5%
R26		2.7K 1% 0.6W 0207
R27		150K 1% 0.6W 0207
R28		6.8K 1% 0.6W 0207
R29		10K 1% 0.6W 0207
R30		1.5K 1% 0.6W 0207
R31		680 1% 0.6W 0207
R34		WW 0.05 OHM 3W 1%

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Fuse
F1		FUSE 15A 250V 3453QS1
		Gase Tube Arrester
R100-R101		2000V/DC CG3-2.0L
		Varistor
R102-R103		56V/DC
		Transformer
T1		TR-M VLN ETD44
		Transistor
Q1-Q2		FET IRF640N
Q3		NPN BC546
Q4		NPN 500V
Q5		NPN BC546
Q6		FET IRF640N
		Integrated Circuits
IC1		UC2845A CURRENT MODE PWM
IC2-IC3		OPTO 4N35
IC5		OP LM1458 0°C/+70°C

Figure 4-3-10
Universal 36/12 V
Power Converter Board
Parts List

4.4 ASTRO TRANSCEIVER MODULE AND RF POWER AMPLIFER

4.4.1 ASTRO TRANSCEIVER MODULE

The ASTRO transceiver module, located in a casting within the top panel assembly, contains most of the receiver, transmitter injection, synthesizer, and associated control circuits for the ASTRO railroad radio. For further detail, refer to the ASTRO Service Manual referenced in **Part 1.2 RELATED DOCUMENTS**.

4.4.2 ASTRO ADAPTOR BOARD

The Universal ASTRO Adaptor Board is used to provide signal path connections between the command board in the transceiver module and the top panel interconnect board. The adaptor board plugs directly into PS02 on the command board via a 38-pin header. The top panel interconnect board connects to P5001 on the adaptor board via a 26-wire ribbon cable assembly.

A board detail, schematic and parts list for the ASTRO adaptor board is provided in figures 4-4-2, 4-4-3 and 4-4-4 at the end of this section.

4.4.3 VHF RF POWER AMPLIFER

The VHF 50 Watt Power Amplifier Assembly connects to the transceiver module via a ribbon cable and two coaxial cables (one for RX and one for TX). It provides the necessary gain at the transmitter injection frequency to produce the rated RF power at the antenna, and carries receiver RF to the transceiver module.

PA Ribbon Cable Assembly

The Command Board / RF PA Ribbon Assembly carries sensed voltages for power and protection to the command board from the power amplifier board via the PA/command interconnect board (refer to next paragraph). It also carries dc control voltage from the command board to the PA. A schematic for this ribbon cable assembly is given in Figure 4-4-1.

PA/Command Interconnect Board

The VHF PA/Command Interconnect Board replaces the feed-thru plate used with the ASTRO VHF 50 W power amplifier. By-pass capacitors C3890 to C3899 provide RF by-passing on the sense and control voltage lines which run between the command board and the power amplifier. Board detail, schematic and parts list for the PA/command interconnect board are provided in figures 4-4-5, 4-4-6 and 4-4-7 at the end of this section.

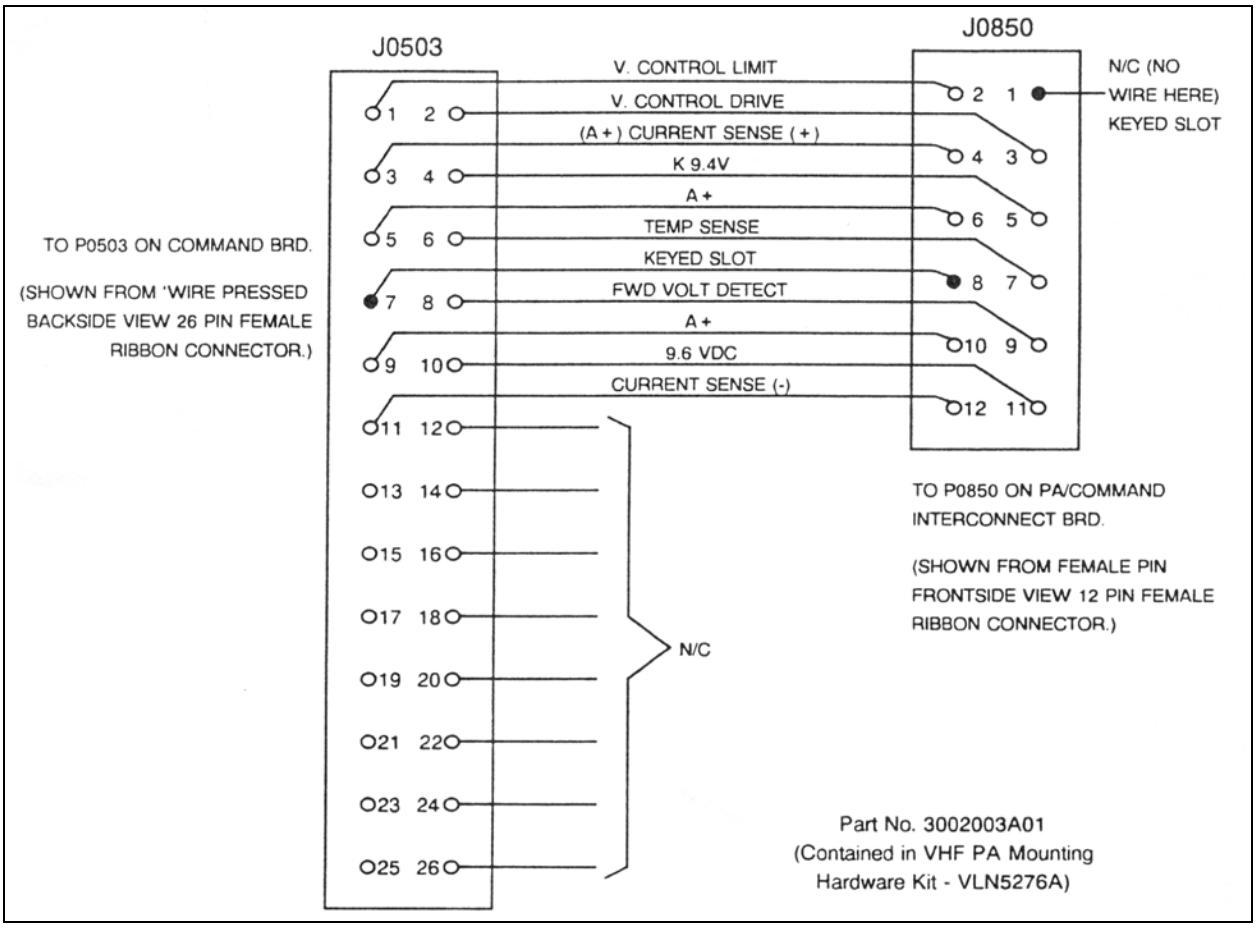


Figure 4-4-1 Command Board /RF PA Ribbon Cable Assembly

4.4.4 ANTENNA FAULT DETECTOR

The ASTRO Clean Cab radio equipped with the VLD4122B VHF RF Power Amplifier is capable of detecting faults in the antenna system external to the radio. This is accomplished by sensing the reverse power which is produced by impedance mismatches in a faulty antenna system.

The antenna fault detector circuit, which is incorporated into the PA circuitry, is intended to alert the user to major flaws in the antenna system, and the absence of an alarm condition does not necessarily imply a perfectly matched antenna system.

In general, the probability of detecting a fault decreases with its distance from the radio, because the loss of a long cable will tend to absorb the reflected power. For example, antenna coax completely disconnected from the radio will always be detected as a fault, but a thirty foot length of RG58/U cable which is open-circuited at its end may not always be detected as a fault, because the power reflected by the open circuit could be attenuated by cable loss.

The use of low-loss cable, such as RG8/U, is recommended in the antenna installation, if there exists the possibility of antenna or cable faults more than a few feet distant from the radio.

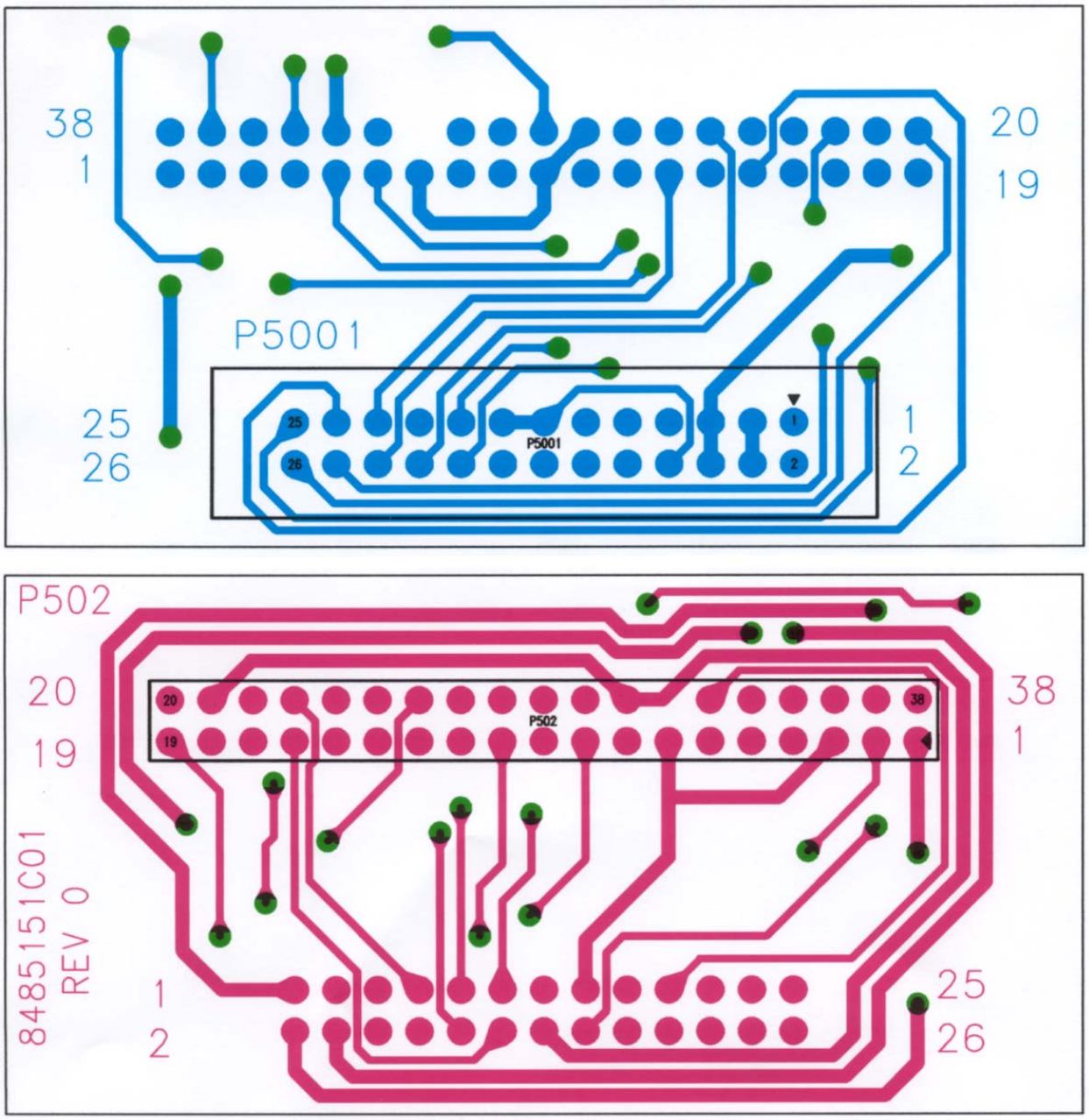
Theory of Operation

Board detail, schematic and parts list for the RF PA board with Antenna Fault Detector are provided in figures 4-4-8, 4-4-9 and 4-4-10 at the end of this section. For servicing information on the RF amplifier stages on this board, refer to the VHF PA section in the ASTRO Service Manual.

The VLD4122B PA board contains a dual directional coupler consisting of microstrip transmission lines 5, 6 and 8. T-line 5 and CR3900 detect forward power, while T-line 8 and CR3950 detect reverse power. T-line 5 is the main 50Ω transmission line. In a perfectly matched 50Ω system, there will be no reflected power and the voltage at comparator U3950 pin 3 will be close to zero. When reverse power is present in the dual directional coupler, a voltage at pin 3 of U3950 will appear. If this voltage due to reverse power exceeds a predetermined threshold, pin 1 of the comparator will go to 9.3 V. This voltage is sensed by the radio software through the DUART on the translator board.

The reverse power threshold of approximately 0.7 V is set by temperature-compensated resistor network R3952, RT3950, R3953 and R3956. The threshold voltage changes with temperature to track the characteristics of detector diode CR3950. R3957 provides a small amount of positive feedback around the comparator to ensure a clean switching transition.

Sensitivity of the antenna fault detector can be reduced by cutting JU2 on the RF PA board. This may be desirable if a 45 W radio is intentionally being used in a mismatched antenna system, to avoid receiving the alert tone and alert message every time the transmitter is keyed up. Operation of the antenna fault detector can be completely disabled by means of the ASTRO Cleancab RSS.



COMPONENT SIDE – BLUE (top)
SOLDER SIDE – RED (bottom)

Figure 4-4-2 ASTRO Adaptor Board Detail VLN5737A

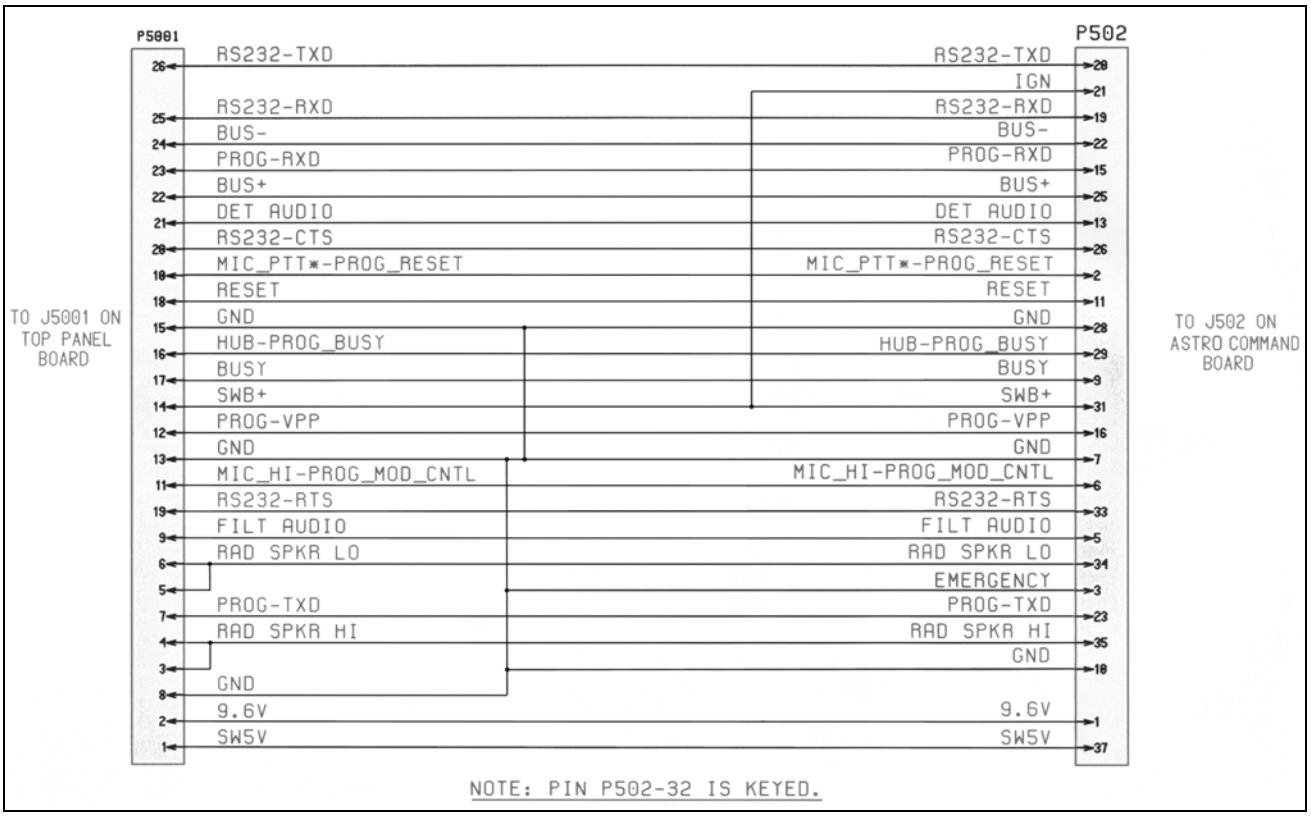


Figure 4-4-3 ASTRO Adaptor Board Schematic VLN5737A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Connector
P5001	2802003A01	HEADER, male 26-pin, pos. polar, w/ eject
P502	2880102M08	HEADER, male 37-pin
		Non-referenced items
	8485151C01	PCB, ASTRO Adaptor

Figure 4-4-4 ASTRO Adaptor Board Parts List VLN5737A

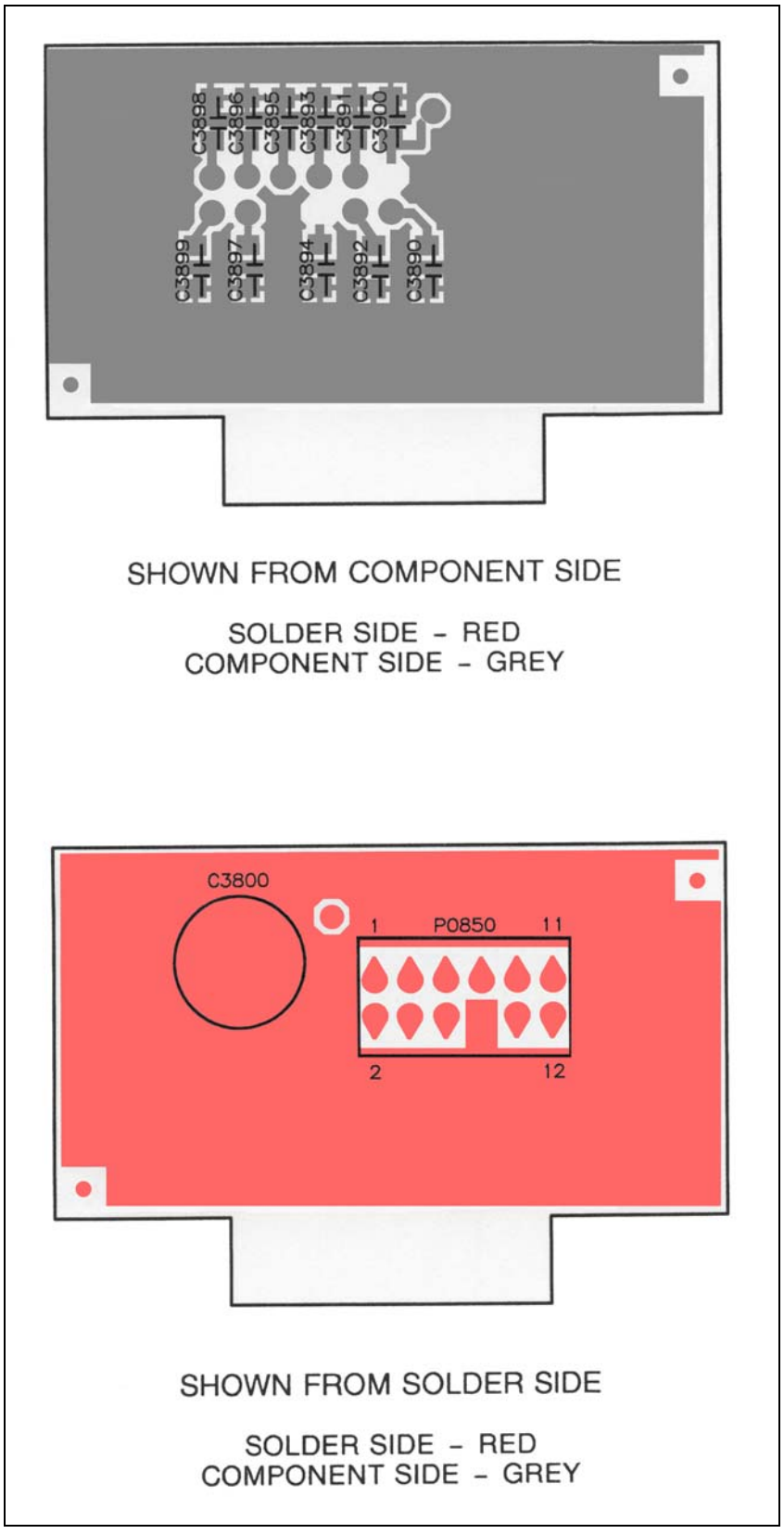


Figure 4-4-5 VHF PA/Command Interconnect Board Detail

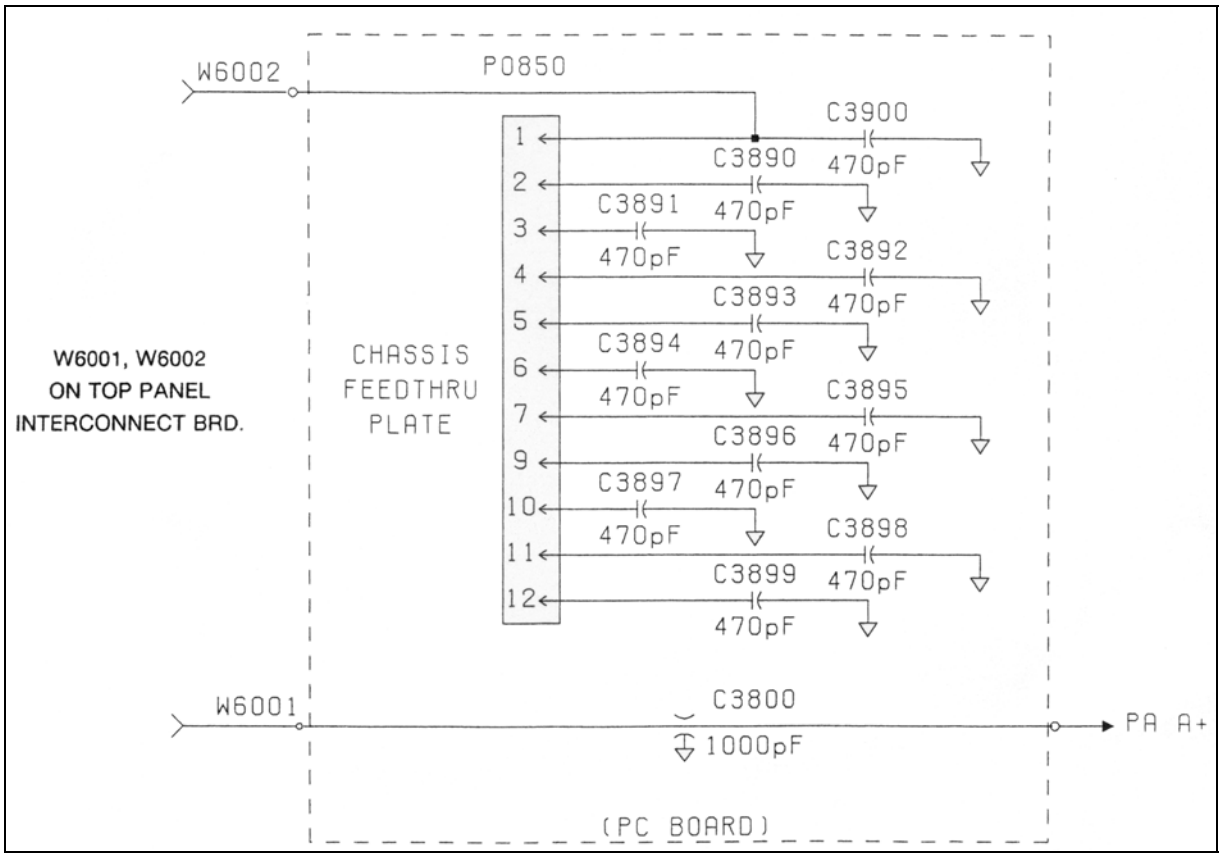
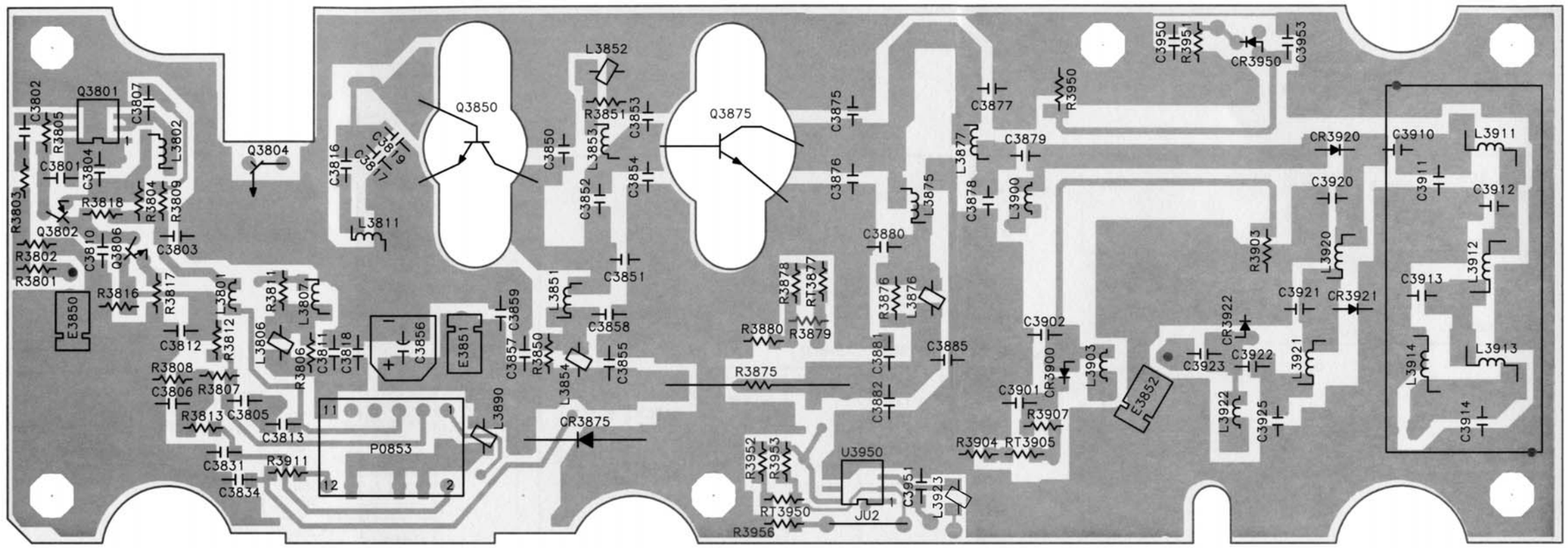


Figure 4-4-6 VHF PA/Command Interconnect Board Schematic

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, chip, pF, 5%, NPO, 50V (unless otherwise stated)
C3890 - 3900	2113740B65	470
C3800	2182812H03	1000, –0/+100, 500V, feed through cer
P850	2802007A01	PLUG, vertical 12 pos.
		Non-referenced items
	8402028A02	PCB, PA/command interconnect

Figure 4-4-7 VHF PA/Command Interconnect Board Parts List



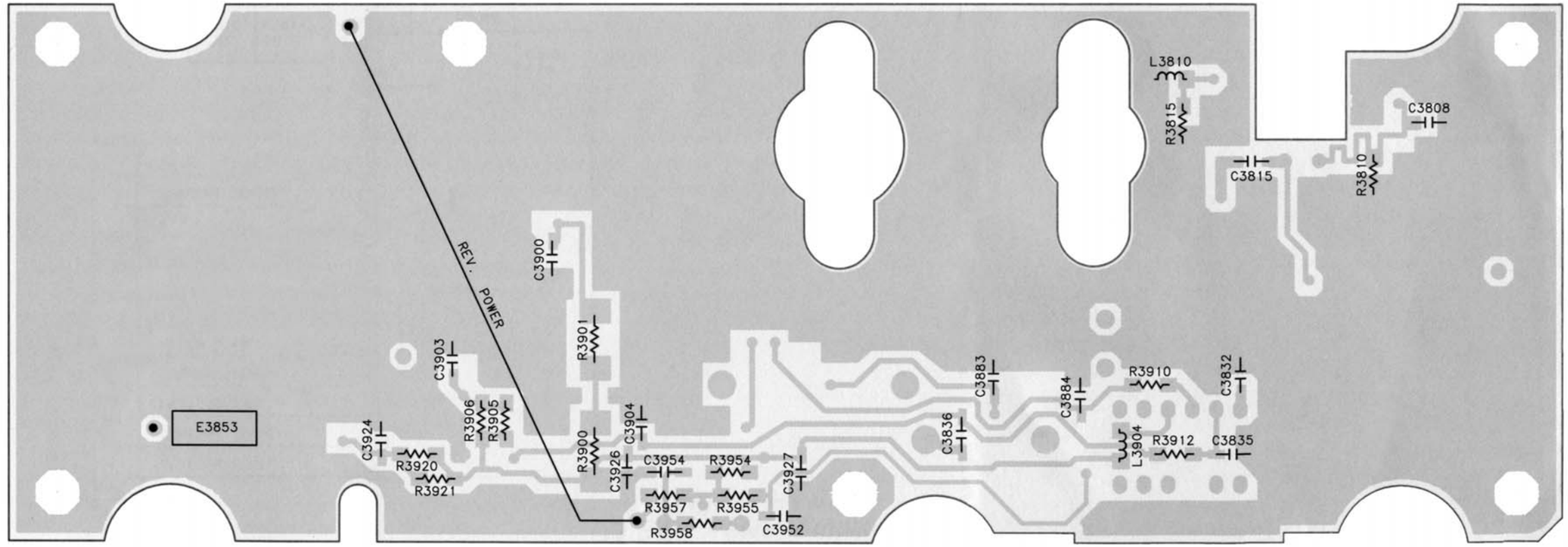


Figure 4-4-8
VHF RF Power Amplifier
Board Detail VLN4122B

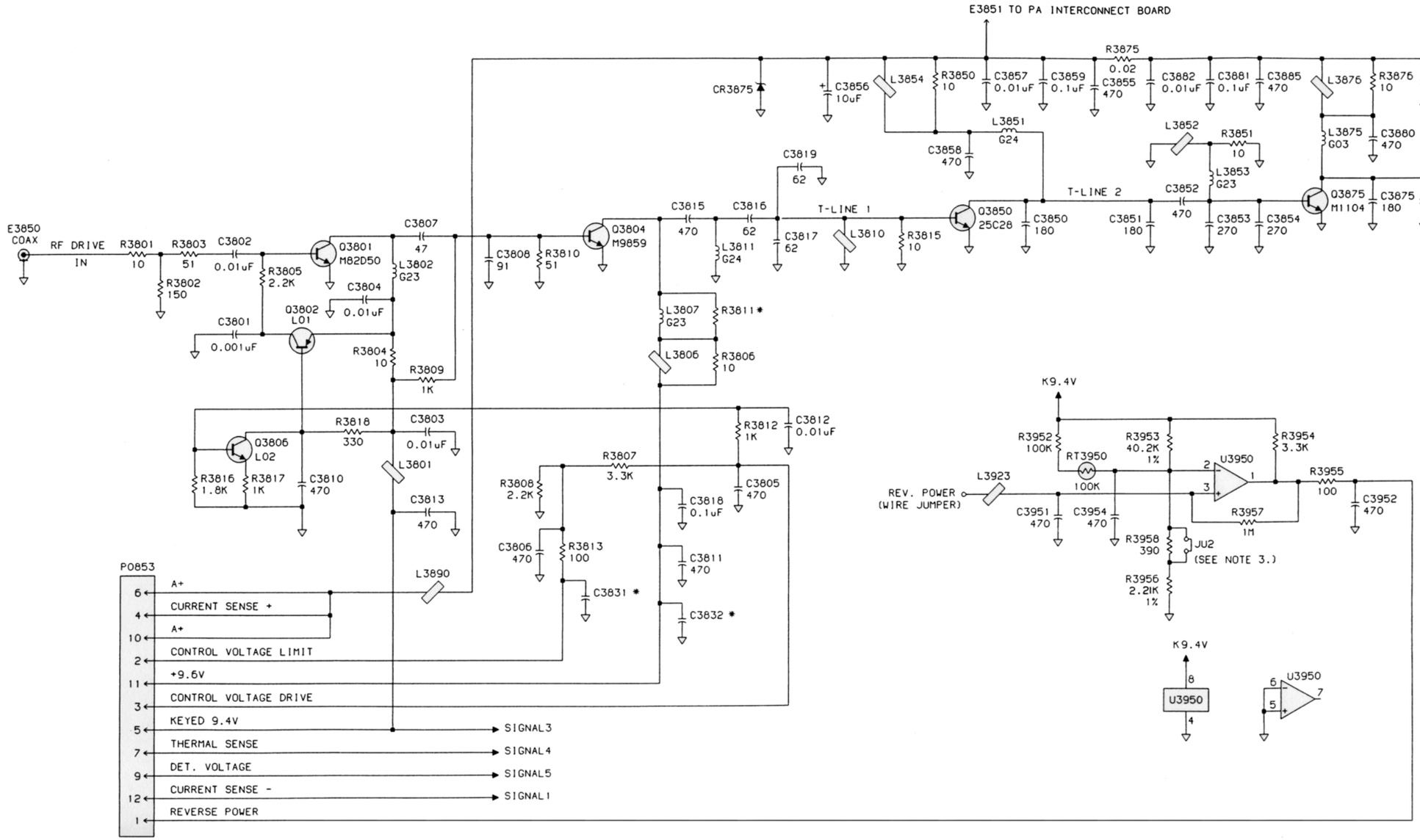
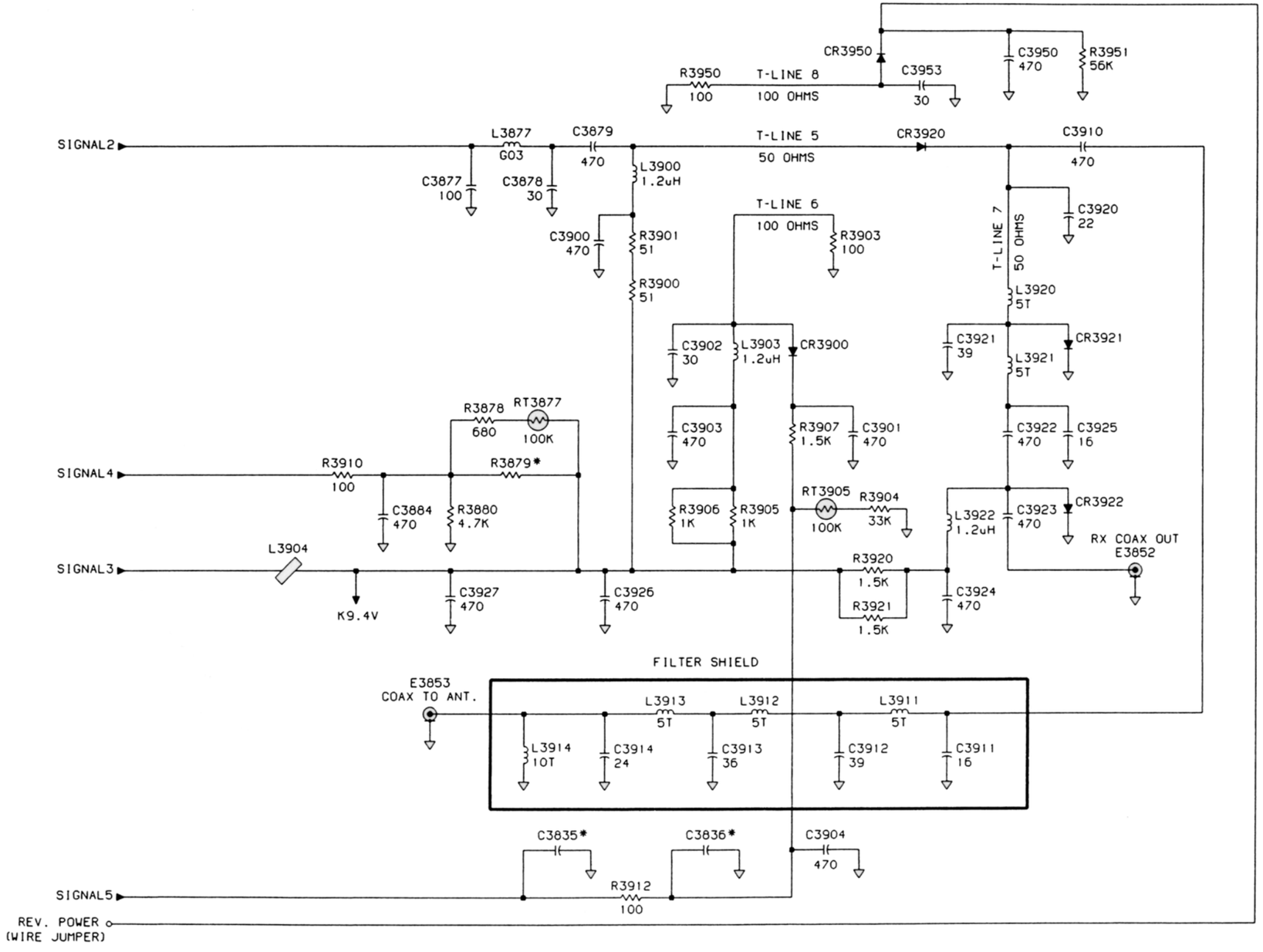


Figure 4-4-9
VHF RF Power Amplifier
Schematic (Sheet 1 of 2) VLN4122B



NOTES:

1. ALL RESISTANCE IS IN OHMS. ALL CAPACITANCE IS IN PICOFARADS UNLESS NOTED OTHERWISE.
2. ASTERISK (•) DENOTES CONTINGENCY PARTS.
3. CUT JU2 FOR REDUCED SENSITIVITY TO ANTENNA MISMATCH.

Figure 4-4-9
VHF RF Power Amplifier
Schematic (Sheet 2 of 2) VLN4122B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Capacitor, chip, pF, 5%, NPO,50V
		(unless otherwise stated)
C3801	2113741N21	0.001uF, 10%
C3802-C3804	2113741N45	0.01uF, 10%
C3805-C3806	2113740B65	470
C3807	2113740B41	47
C3808	2113740B48	91
C3810-C3811	2113740B65	470
C3812	2113741N45	0.01uF
C3813,C3815	2113740B65	470
C3816-C3817	2113740B44	62
C3818	2113741N69	0.1uF, 10%
C3819	2113740B44	62
C3832-C3836	2113740B65	470
C3835-C3836	2113740B65	470
C3850-C3851	2111078B49	180, 100V
C3852	2111078B59	470, 100V
C3855	2113740B65	470
C3856	2380090M24	10uF, 20%, polarized
C3857	2113741N45	0.01uF, 10%
C3858	2113740B65	470
C3859	2113741N69	0.1uF, 10%
C3875-C3876	2111078B49	180
C3877	2111078B42	100
C3878	2111078B27	30
C3879	2111078B59	470
C3880	2113740B65	470
C3881	2113741N69	0.1uF
C3882	2113741N45	0.01uF
C3883-C3885	2113740B65	470
C3900-C3901	2113740B65	470
C3902	2113740B36	30
C3903-C3904	2113740B65	470
C3910	2111078B59	470, 100V
C3911	2111078B19	16, 100V
C3912	2111078B32	39, 100V
C3913	2111078B31	36, 100V
C3914	2111078B23	24, 100V
C3920	2111078B22	22, 100V
C3921	2111078B32	39, 100V
C3922-C3924	2113740B65	470
C3925	2111078B19	16
C3926-C3927	2113740B65	470
C3950-C3952	2113740B65	470
C3953	2113740B36	30
C3954	2113740B65	470
		Diode
CR3875	4880236E07	ZENER, transient suppressor, 28V
CR3900	4813825A05	HOT CARRIER, SOT-23,10V

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Diode
CR3920-CR3921	4880236E24	PIN
CR3922	4880142L01	PIN, SOT-23
CR3950	4813825A05	HOT CARRIER, SOT-23, 10V
		Inductor
L3801	2480067M01	CHIP FERRITE BEAD
L3802	2480091G23	CHIP AIRWOUND, 7T
L3806	2484657R01	COIL FERRITE BEAD
L3807	2480091G23	CHIP AIRWOUND, 7T
L3810	2480067M01	CHIP FERRITE BEAD
L3811	2480091G24	COIL AIRWOUND, 5T
L3851	2480091G24	COIL AIRWOUND, 5T
L3852	2484657R01	COIL FERRITE BEAD
L3853	2480091G23	CHIP AIRWOUND, 7T
L3854	2484657R01	COIL FERRITE BEAD
L3875	2480090G03	COIL AIRWOUND, 3T
L3876	2484657R01	COIL FERRITE BEAD
L3877	2480090G03	COIL AIRWOUND, 3T
L3890	2484657R01	COIL FERRITE BEAD
L3900	2480140E01	CHIP, 1.2UH
L3903	2480140E01	CHIP, 1.2UH
L3904	2480067M01	CHIP FERRITE BEAD
L3911	2480090G15	COIL AIRWOUND, 5T
L3912	2480090G10	COIL AIRWOUND, 5T
L3913	2480090G15	COIL AIRWOUND, 5T
L3914	2480090G13	COIL AIRWOUND, 10T
L3920-L3921	2480090G14	COIL AIRWOUND, 5T
L3922	2480140E01	CHIP, 1.2UH
L3923	2480067M01	CHIP FERRITE BEAD
		Connector
P0853	0980103m04	RECEPTACLE, right angle, 12 pos
E3850-E3853	2980014a03	CLIP, coax terminal
		Transistor, bi-polar
		(unless otherwise stated)
Q3801	4880182D50	NPN, M82D50, 4V, 450mW
Q3802	4813824A17	PNP, SOT-23 low-profile
Q3804	4800869859	NPN, M9859
Q3806	4813824A10	NPN
Q3850	4880225C28	NPN, RF
Q3875	4884411L04	NPN, RF, M1104
		Thermistor
RT3877	0680149M02	100K
RT3905	0680149M02	100K
RT3950	0680149M02	100K
		Integrated Circuit
U3950	5102005A01	COMPARATOR

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		Resistor, chip, 5%, 1/8W
		(unless otherwise stated)
R3801	0611077A26	10
R3802	0611077A54	150
R3803	0611077A43	51
R3804	0611077A26	10
R3805	0611077A82	2.2K
R3806	0611077A26	10
R3807	0611077A86	3.3K
R3808	0611077A82	2.2K
R3809	0611077A74	1K
R3810	0611077A43	51
R3811	0611077A10	0 (DNP)
R3812	0611077A74	1K
R3813	0611077A50	100
R3815	0611077A26	10
R3816	0611077A80	1.8K
R3817	0611077A74	1K
R3818	0611077A62	330
R3850-R3851	0611077A26	10
R3875	1780228N02	0.02, 10%, 2W
R3876	0680195M01	10
R3878	0611077A70	680
R3879	0611077A10	0 (DNP)
R3880	0611077A90	4.7K
R3900-R3901	0680194M18	51
R3903	0680195M25	100, 1/2W
R3904	0611077B11	33K
R3905-R3906	0611077A74	1K
R3907	0611077A78	1.5K
R3910-R3912	0611077A50	100
R3920-R3921	0611077A78	1.5K
R3950	0680195M25	100, 1/2W
R3951	0611077B17	56K
R3952	0611077B23	100K
R3953	0611077G50	40.2K, 1%
R3954	0611077A86	3.3K
R3955	0611077A50	100
R3956	0611077F28	2.21K, 1%
R3957	0611077B47	1M
R3958	0611077A64	390
		Non-Referenced items
100000518		WIRE, #22, sol tinned
2680187N02		HEATSINK, TO-39
2680188N02		SHIELD, harmonic filter
3080152M09		ASSEMBLY, coax cable
3010286B01		WIRE, #24 str pvc white 3.25 in.
8402035A03		PCB, 40W RF PA

Figure 4-4-10 VHF RF Power Amplifier Parts List VLN4122B

PART 5. MAINTENANCE AND ALIGNMENT

5.1 GENERAL

This section contains information on channel setup, troubleshooting, disassembly/assembly and board replacement. Information on radio tuning and alignment can be found in the ASTRO Service Manual referenced in **Part 1.2 RELATED DOCUMENTS** of this manual. All assemblies are repairable to the kit level.

Caution

Most of the ICs are static-sensitive devices. Do not attempt to troubleshoot or disassemble a board without first referring to the following **Handling Precautions** section.

Handling Precautions

Complementary metal-oxide semiconductor (CMOS) devices and other high-technology devices are used in this family of radios. While the advantages of these devices are many, their characteristics make them susceptible to damage by electrostatic discharge (ESD) or high-voltage charges. Damage can be latent, resulting in failures occurring weeks or months later. Therefore, special precautions must be taken to prevent device damage during disassembly, troubleshooting, and repair. Handling precautions are mandatory for this radio, and are especially important in low humidity conditions. DO NOT attempt to disassemble the radio without observing the following handling precautions.

1. Eliminate static generators (plastics, Styrofoam, etc.) in the work area.

2. Remove nylon or double-knit polyester jackets, roll up long sleeves, and remove or tie back loose hanging neckties.

3. Store and transport all static-sensitive devices in ESD-protective containers.

4. Disconnect all power from the unit before ESD-sensitive components are removed or inserted unless otherwise noted.

5. Use a static-safeguarded workstation, which can be accomplished through the use of an antistatic kit (Motorola part number 01-80386A82). This kit includes a wrist strap, two ground cords, a static-control table mat and a static-control floor mat.

6. Always wear a conductive wrist strap when servicing this equipment. The Motorola part number for a replacement wrist strap that connects to the table mat is 42-80385A59.

WARNING

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

Removal and Replacement of Chip Components On Circuit Boards

Caution

Special techniques are used when removing or installing chip-type components. If these techniques are not implemented correctly, serious damage may occur to the chip component and/or the performance of the circuitry associated with the chip component may be degraded.

Refer to publication 68P81113E77, Removal and Replacement of Chip Components on Circuit Boards for more detailed information on this subject. This free publication can be ordered using the “Available Background Reference Publications” order form (Motorola part number, 68P80200W02) located at the back of this manual.

5.2 CHANNEL FREQUENCIES

The ASTRO CleanCab is factory-programmed with 188 transmitter/receiver channels in accordance with the frequencies established by the North American Frequency Allocation Plan (FAP) from the AAR (refer to figure 5-2-2). In addition, nine receive-only channels have been programmed with the NOAA weather service frequencies (refer to figure 5-2-1).

Channel Number	Frequency (MHz)
98	162.4250
99	162.4750
100	162.5500
198	162.4250
199	162.4750
200	162.5500
201	162.4000
202	162.4250
203	162.4500
204	162.4750
205	162.5000
206	162.5250
207	162.5500

Figure 5-2-1 NOAA Receive Only Weather Channels

For ASTRO CleanCabs with the ASTRO CAI option, channels 1-97 are programmed as mixed-mode receive and selectable transmit (analog or digital) with 25kHz bandwidth. Channels 107-197 are programmed as mixed-mode receive and selectable transmit with 12.5 kHz bandwidth. For ASTRO CleanCabs without the ASTRO CAI option, the channels are all programmed as analog receive and transmit. For details on adding, modifying or deleting channels refer to the ASTRO Spectra CPS Mobile Radio Users Guide and **Section 7 ASTRO SPECTRA CLEANCAB RADIO PROGRAMMING**.

Channel Number	Frequency (MHz)	Channel Number	Frequency (MHz)	Channel Number	Frequency (MHz)	Channel Number	Frequency (MHz)
1	159.8100	50	160.8600	101	159.8100	150	160.8600
2	159.8100	51	160.8750	102	159.8100	151	160.8750
3	159.9300	52	160.8900	103	159.9300	152	160.8900
4	160.0500	53	160.9050	104	160.0500	153	160.9050
5	160.1850	54	160.9200	105	160.1850	154	160.9200
6	160.2000	55	160.9350	106	160.2000	155	160.9350
7	160.2150	56	160.9500	107	160.2150	156	160.9500
8	160.2300	57	160.9650	108	160.2300	157	160.9650
9	160.2450	58	160.9800	109	160.2450	158	160.9800
10	160.2600	59	160.9950	110	160.2600	159	160.9950
11	160.2750	60	161.0100	111	160.2750	160	161.0100
12	160.2900	61	161.0250	112	160.2900	161	161.0250
13	160.3050	62	161.0400	113	160.3050	162	161.0400
14	160.3200	63	161.0550	114	160.3200	163	161.0550
15	160.3350	64	161.0700	115	160.3350	164	161.0700
16	160.3500	65	161.0850	116	160.3500	165	161.0850
17	160.3650	66	161.1000	117	160.3650	166	161.1000
18	160.3800	67	161.1150	118	160.3800	167	161.1150
19	160.3950	68	161.1300	119	160.3950	168	161.1300
20	160.4100	69	161.1450	120	160.4100	169	161.1450
21	160.4250	70	161.1600	121	160.4250	170	161.1600
22	160.4400	71	161.1750	122	160.4400	171	161.1750
23	160.4550	72	161.1900	123	160.4550	172	161.1900
24	160.4700	73	161.2050	124	160.4700	173	161.2050
25	160.4850	74	161.2200	125	160.4850	174	161.2200
26	160.5000	75	161.2350	126	160.5000	175	161.2350
27	160.5150	76	161.2500	127	160.5150	176	161.2500
28	160.5300	77	161.2650	128	160.5300	177	161.2650
29	160.5450	78	161.2800	129	160.5450	178	161.2800
30	160.5600	79	161.2950	130	160.5600	179	161.2950
31	160.5750	80	161.3100	131	160.5750	180	161.3100
32	160.5900	81	161.3250	132	160.5900	181	161.3250
33	160.6050	82	161.3400	133	160.6050	182	161.3400
34	160.6200	83	161.3550	134	160.6200	183	161.3550
35	160.6350	84	161.3700	135	160.6350	184	161.3700
36	160.6500	85	161.3850	136	160.6500	185	161.3850
37	160.6650	86	161.4000	137	160.6650	186	161.4000
38	160.6800	87	161.4150	138	160.6800	187	161.4150
39	160.6950	88	161.4300	139	160.6950	188	161.4300
40	160.7100	89	161.4450	140	160.7100	189	161.4450
41	160.7250	90	161.4600	141	160.7250	190	161.4600
42	160.7400	91	161.4750	142	160.7400	191	161.4750
43	160.7550	92	161.4900	143	160.7550	192	161.4900
44	160.7700	93	161.5050	144	160.7700	193	161.5050
45	160.7850	94	161.5200	145	160.7850	194	161.5200
46	160.8000	95	161.5350	146	160.8000	195	161.5350
47	160.8150	96	161.5500	147	160.8150	196	161.5500
48	160.8300	97	161.5650	148	160.8300	197	161.5650
49	160.8450			149	160.8450		

Figure 5-2-2 AAR Channel Plan

5.3 RECOMMENDED TEST EQUIPMENT

Refer to the ASTRO Service Manual for a detailed list of test equipment and cables.

Motorola Model Number	Description	Characteristics	Application
R-1013_* or R-1370_*	SINAD Meter SINAD Meter with RMS Voltmeter	w/o RMS audio voltmeter w/RMS audio voltmeter	Receiver sensitivity measurements
R-1074_*	Fluke 87 Digital Multimeter	True RMS metering, 200kHz frequency counter, 32-segment bar graph with backlit display	Recommended for ac/dc voltage and current measurements
R-1151_*	Code Synthesizer 2, Expanded		Injection of audio and digital signaling codes
R-1377_*	AC Voltmeter	1mV to 300V, 10-Megohm input impedance	Audio voltage measurements
R-1439_ or R-1440_	BIRD Wattmeter BIRD Wattmeter	Power range: 100 mW to 100W, 2MHz to 1GHz, UHF-F connector Power range: 100 mW to 100W, 2MHz to 1GHz, N-female connector	Transmitter power measurements w/ Plug-In element 01-80305F32
R-1611_	Dual-Channel 100Mhz Oscilloscope (Agilent)	Two-channel, 100MHz bandwidth, 200 M sample rate/ sec., 2MB memory/channel	Waveform measurements
R-2600	Series System Analyzer	This item will substitute for items with an asterisk (*).	Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment
S-1339_	RF Millivolt Meter	100µV to 3V RF 10 kHz to 1GHz	RF-level measurements
S-1348_	DC Power Supply, Programmable	0-20 Vdc, 0-5 Amps current limited	Bench supply
SLN-6435	Audio Isolation Transformer		Audio measurements (audio PA must NOT be grounded)
VKN4293	Top/Bottom Housing Extension Cable	See section 6.2.8	Allow access to internal boards while radio is powered

Figure 5-3-1 Recommended Test Equipment

5.4 POWER-UP SELF-CHECK

Each time the radio is turned on the microprocessors in the ASTRO transceiver module, translator board and front panel control board(s) perform internal diagnostics. These diagnostics consist of checking the programmable devices such as the FLASH ROMs, DSP, internal and external EEPROMs, SRAM devices, and ADSIC configuration bus checksum. At the end of the power-up self-check routines, if an error exists, the appropriate error code is shown on the display. Self-test errors are classified as either “fatal” or “non-fatal.” Fatal errors will inhibit user operation; non-fatal errors will not.

Display	Possible Cause	Remedy
(Fatal)		
FAIL 01/02	External EEPROM checksum non-fatal error	Refer to ASTRO Digital Service Manuals
FAIL 01/81	ROM checksum failure	"
FAIL 01/82	External EEPROM checksum failure	"
FAIL 01/84	EEPROM is blank	"
FAIL 01/88	RAM failure - Note: Not a checksum failure	"
FAIL 01/90	General hardware failure	"
FAIL 01/92	Internal EEPROM checksum failure	"
FAIL 02/81	DSP ROM checksum failure	"
FAIL 02/82	DSP RAM 1 failure	"
FAIL 02/84	DSP RAM 2 failure	"
FAIL 02/88	DSP RAM failure - Note: Not a checksum failure	"
FAIL 02/90	General DSP hardware failure	"
FAIL 02/A0	ADSIC checksum failure	"
FAIL 05/81	Translator Board Flash memory failure	Replace Translator Board
FAIL 05/84	Translator Board EEPROM failure	Replace Translator Board
FAIL 05/88	Translator Board internal RAM failure	a. Reprogram using ASTRO Clean Cab RSS/CPS. b. Replace Translator Board if failure continues.
FAIL 05/90	Translator Board DUART failure	Replace Translator Board
FAIL 05/A0	Translator Board External RAM failure	Replace Translator Board
FAIL 05/C0	Translator Board CONFIG failure	Replace Translator Board
FAIL 25/10	Primary Control Head serial bus error	Verify Front Panel, RPIB and Translator Board serial bus circuits, interconnect cables and replace the appropriate board or cable. Refer to sections 4.1.2, 4.2.2 and 4.2.4.
FAIL 25/81	Primary Control Head ROM is defective	a. Replace Front Panel Microcomputer IC b. Troubleshoot Front Panel Microcomputer Board
FAIL 25/88	Primary Control Head RAM is defective	a. Replace Front Panel Microcomputer IC b. Troubleshoot Front Panel Microcomputer Board
FAIL A5/10	Secondary Control Head serial bus error	Verify Front Panel, RPIB and Translator Board serial bus circuits, interconnect cables and replace the appropriate board or cable. Refer to sections 4.1.2, 4.2.2 and 4.2.4.
FAIL A5/81	Secondary Control Head ROM is defective	a. Replace Front Panel Microcomputer IC b. Troubleshoot Front Panel Microcomputer Board
FAIL A5/88	Secondary Control Head RAM is defective	a. Replace Front Panel Microcomputer IC b. Troubleshoot Front Panel Microcomputer Board

Figure 5-4-1 Fatal Power-Up Self Check Displays

Display	Possible Cause	Remedy
(Non-Fatal)		
ERROR 05/02	Last User States Codeplug failure	Cleancab automatically uses default Last User State & resets
ERROR 25/50	Button Stuck	a. Control head button actuated during powerup. b. Replace Front Panel Display Board.
ERROR A5/50	Button Stuck	a. Control head button actuated during powerup. b. Replace Front Panel Display Board.

Figure 5-4-2 Non-Fatal Self Check Displays

Figure 5-4-1 and 5-4-2 lists the error messages. Unique message to the ASTRO Clean Cab radio will list possible causes and remedies. All other message troubleshooting can be found in the ASTRO Service Manual referenced in **1.2 RELATED PUBLICATIONS**.

In the case of multiple errors, the codes are logically OR'ed and the results displayed. As an example, in the case of an ADSIC checksum failure and a DSP ROM checksum failure, the resultant code would be 02/A1.

5.5 FRONT PANEL SERVICE MODE

To aid in testing the radio may be placed in service mode from the control head. The service mode has various menus for selecting specific test modes.

Controls

The following control head buttons are used to initiate and the control the front panel service mode.

HOME	Used to toggle between frequency select and mode select (CSQ, TPL, etc…)
#	Used to scroll up through the menu choices.
*****	Used to scroll down through the menu choices.

The flashing character (cursor) or display indicates that an operator-initiated change is expected.

Entering Service Mode

To enter the front panel service mode, turn power to the radio OFF then ON and press **HOME** five times within 6 seconds after power up. “SELF CHECK” display goes away, normal radio operation ceases and the display message changes to “TEST MODE” briefly and will display the following information sequentially. Once at RF TEST, or anytime during this list, HOME may be pressed to go directly to the “1 CSQ” menu.

TEST MODE	
SERVICE	
Rxxxxxx	ASTRO Mobile Firmware Number (xxxxxx)
Nxxxxxx	ASTRO Mobile DSP Version Number (xxxxxx)
CNTLHDxx	Translator Board Firmware Version Number (xx)
T04KKH9PW9A	Radio Model Number
N	cont…
494ACN2705	Radio Serial Number
1MEG	FLASH Memory Size
FLSHCD	FLASH Code Serial Number (Varies depending on options)
Sxxxxx-	cont…
xxxxxx-x	cont…
RF TEST	

Service Mode

Three test mode channels are available for use in the ASTRO CleanCab. Once “1 CSQ” is displayed, the **HOME**, **#**, and ***** buttons may be used to navigate the test mode selection. The test mode channel indicated by the flashing character in “1 CSQ”, can be changed to 1, 2 or 3 using the **#** and ***** buttons. The corresponding test mode frequency is listed in figure 5-5-1.

Test Freq.	RX Freq.	TX Freq.
1	146.025 MHz	146.050 MHz
2	160.025 MHz	160.050 MHz
3	173.975 MHz	173.950 MHz

Figure 5-5-1 Service Mode Frequencies

Pressing the HOME button will toggle the flashing character between the number and the first letter of the mode name (i.e. “1 CSQ”). The menu can be changed to the following using the **#** and ***** buttons.

CSQ	Carrier Squelch
TPL	Tone PL (Code: 7A - 192.8 Hz)
AST	ASTRO Deviation (Transmits a 1200 Hz analog tone for testing deviation level, receive is disabled)
USQ	Unsquelched

Refer to the ASTRO Service Manual for all radio alignment and tuning procedures.

5.6 TROUBLESHOOTING AND REPAIR

Failure messages, “FAIL xx/xx”, or error messages, “ERROR xx/xx”, are related to either the ASTRO transceiver, Front Panel Microcomputer Board(s) or the Translator Board. Refer to Figure 5-4-1 to determine the source of the failure or error.

NOTE

When probing internal connectors and components it may be necessary to us a Top/Bottom Housing Extension Cable (VKN4293), as described in 6.2.8.

Front Panel Troubleshooting

The following symptoms may be caused by a front panel problem:

- Flickering “SELF CHECK” but no failure message.
- Front panel power up, but button presses have no effect.
- A few segments (or characters) will not light up on display.
- Very bright display; varies with supply voltage.
- Very dim display.

If the display does not function or if button presses have no effect, remove the front panel and connect it to a radio that is operational. If the front panel fails to operate on the new radio, replace or troubleshoot the front panel microcomputer board or display board as required (the microcomputer board schematic in PART 4, Section 1 contains waveform diagrams to assist in troubleshooting). If the front panel operates on the new radio, check for cabling/connector, translator board or command board problems on the original radio.

Rear Panel Interconnect / Translator Board Troubleshooting

Failure messages or error messages not attributable to the Front Panel or ASTRO Transceiver may indicate a problem with the Translator Board. Refer to Figure 5-4-1 for a list of error messages. Problems with low, distorted, or no microphone transmit audio from handset or control head sources may indicate a problem with the Rear Panel Interconnect or Translator Boards. Problems with low, distorted, or no receive handset, auxiliary speaker, or control head speaker audio may also be attributable to the Rear Panel Interconnect Board or Translator Board.

It is recommended to first verify the control head front panel circuits are properly functioning before beginning to troubleshoot the RPIB and TB circuits. This can be accomplished by connecting the control head to a known working Clean Cab. Refer to figures 4-2-1(2,3) and 4-2-11(11,12) for the RPIB and TB schematics, respectively.

NOTE

If speaker audio from the ASTRO transceiver (SPKR_HI, SPKR_LO) is used at the auxiliary connector by an external accessory, some audio alerts will not be heard. Other audio alerts (i.e. Trunking tones) may be of a slightly different pitch or timing than those heard at the Clean Cab front panel or remote control head speakers.

Symptom	Possible Cause	Correction or Test (Measurements Taken at 20°C)
Missing or no alert tones (trunking tones)	1. Setup and programming	Check CH volume. Verify Alert Tones are enabled and minimum alert tone volume is properly set in ASTRO Spectra CPS. Some tones are not heard at Auxiliary SPKR outputs, other tones may not match those heard at the CH speaker and handsets. Refer to 4.2.2 for more information about alert/trunking tones.
	2. RPIB and Translator Board(s)	Make sure the RF antenna port is conencted to a 50 ohm load with the correct power rating (>50 watts). Choose a conventional channel for this test. Press and hold handset PTT. Press channel button in order to produce the 'bonk' tone (repeat as necessary). Verify J3008 pin 34 toggles between 0-5Vdc (304Hz) for 60msec. If not replace the TB. If pin 34 is seen toggling, replace the RPIB.
Hubs not working properly	1. Setup and programming	Verify proper PL programming of radio personalities and verify 'HUB Defeats PL' is enabled in the radio codeplug using ASTRO Spectra CPS.
	2. RPIB and Translator Board(s)	Verify that grounding J3003 pin "F" causes P3008 pin 32 to go from 5V to 0V. If not, replace the RPIB, otherwise replace the TB. For the Auxiliary Hub, verify that grounding P3004 pin 11 causes P3008 pin 37 to go from 5V to 0V. If not, replace the RPIB, otherwise replace the TB.
APCO Data feature not functioning	1. Setup and programming	Verify programming and system configuration.
	2. RPIB, ASTRO Adaptor or Top Panel Interconnect Board	Verify continuity of the RS232 Data signals (RXD, TXD, CTS, RTS) between the Data connector (J3005 pins 2, 3, 8 and 7) and the ASTRO Adaptor Board (P502 pins 19, 20, 26 and 33). If there is a discontinuity replace the appropriate board (RPIB, Top Panel, or ASTRO Adaptor board).
	3. ASTRO Transceiver	Refer to ASTRO Service Manual for HW troubleshooting.
VIPs not functioning	Setup and programming	Ensure the Cleancab is equipped with a PA/IC type Control Head and all external PA/IC equipment is functioning properly.
VIP OUTs do not function	RPIB and Translator Board(s)	Activate the CALL function at the Control Head (all VIP Outputs active). Verify J3008 pins 31, 38 and 18 (PG0-2) are 5Vdc. If not, replace the TB. All VIP Outputs (J3006 pins 12, 3 and 2) should be grounded through RPIB transistors Q4, Q5 and Q6 respectively. If not, replace the RPIB.
VIP INs do not function	RPIB and Translator Board(s)	Ground the VIP1 Input (J3006 pin 5) and verify that J3008 pin 28 is 5Vdc. If not replace the RPIB. If J3008 pin 28 is 5Vdc, replace the TB.

Figure 5-6-1 Translator Board / Rear Panel Interconnect Board Troubleshooting

Transmitter Troubleshooting

When setting or measuring RF power at VHF, follow these guidelines to avoid measurement errors due to cable losses or non-50 ohm connector VSWR.

1. All cables should be as short as possible and have Teflon dielectric.

2. Attenuators and 50 ohm loads should have at least 25 dB return loss.

3. A “UHF” to “N” adapter can be used at the antenna connector. All other connectors should be “N” type. No other adapter, barrel connectors, etc. should be used.

Figure 5-6-2 shows the preferred test set-up using no cables.

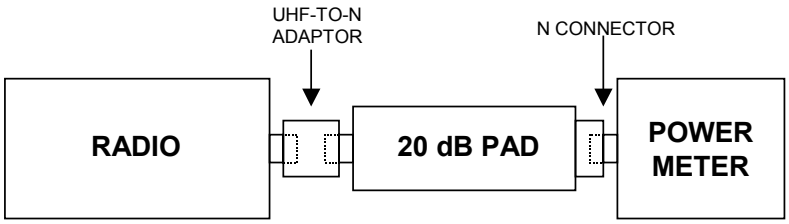


Figure 5-6-2 Transmitter Troubleshooting Preferred Test Setup

Figure 5-6-3 lists a number of transmitter-related symptoms which may occur that interrupt normal radio operation. Refer to this figure to assist in troubleshooting and repairing transmitter problems to the board level. For further transmitter servicing information (i.e. to the component level), refer to the appropriate section in the ASTRO Service Manual or **PART 4 THEORY OF OPERATION**.

Symptom	Possible Cause	Correction or Test (Measurements Taken at 20°C)
No RF power out (No TX light)	1. No front panel PTT	Disconnect power. Reconnect power while pressing and holding the PTT button. Verify that the message ERROR 25/50 (or ERROR A5/50) is displayed. If message is NOT displayed then replace the front panel display board. Otherwise, verify Front Panel, RPIB and TB serial bus circuits and replace the appropriate board. Refer to sections 4.1.2, 4.2.2 and 4.2.4 respectively.
	2. No handset PTT (RPIB)	Does pin C of J3003 go low during handset PTT? If not, replace handset; if it does, verify that the TB microprocessor (U1) pin 42 also goes low during a handset PTT. If it does replace the TB. If not verify continuity of the PTTH (P/J3008) signal from J3003-C to TB U1-42 and Replace RPIB or TB if necessary. Follow the same logic for Auxiliary Handset PTT (P3004-4).
No RF power out. (TX light on)	1 RX Only Channel	If the radio generates a "bonk" tone, change channels to verify not on a RX only channel.
	2. TX power level	Check TX power level programming using ASTRO Spectra CPS Tuner.
	3. No keyed 9.4V from command board	Refer to ASTRO Service Manual for troubleshooting.
	4. No injection to power amplifier	Refer to ASTRO Service Manual for troubleshooting.
	5. Power amplifier	Measure PA control voltage (Pin 2 of P503); if > 7V replace RF PA board.
	6. Power control circuit (on command board)	If PA control voltage above was < 7V, refer to ASTRO Service Manual for troubleshooting.
No modulation	1. From built-in microphone/front panel microcomputer board.	Speaking or whistling loudly in to the microphone, monitor the output voltage @ pin 1 of P1001; if no signal, replace microphone; If signal is there but not at pin 23 of P1000; replace front panel microcomputer board.
	2. From handset (RPIB)	a. Except when testing the front panel circuits, all modulation testing should be done w/ the radio keyed and a 1 kHz tone @ 660 mVrms modulating the handset microphone audio line. b. Inject a signal at pin A of J3003 and monitor the output voltage @ pin 27 of J3001 (approx 90 mVrms) ; if no signal, replace rear panel interconnect board. Repeat with pin 1 of P3004 for Auxiliary Handset mic.
	3. VCO Board	Refer to ASTRO Service Manual for troubleshooting.
	4. Command board	Refer to ASTRO Service Manual for troubleshooting.

Figure 5-6-3 Transmitter Troubleshooting (Continued on next page)

Symptom	Possible Cause	Correction or Test (Measurements Taken at 20°C)
Distorted modulation	1. From built-in microphone/front panel microcomputer board.	Inject a 1kHz tone @ at approximately 1mVrms (adjust for 3kHz Tx deviation) into P1001 and measure output distortion @ pin 23 of P1000; If > 3% replace front panel microcomputer board.
	2. From handset (RPIB)	If < 3% replace the microphone; continue if no improvement. Inject a 1kHz tone @ 660 mVrms into pin A of J3003 and measure output distortion @ pin 27 of J3001; If > 3% replace the rear panel interconnect board. Repeat with pin 1 of P3004 for Auxiliary Handset mic.
	3. Command board	Refer to ASTRO Service Manual for troubleshooting.
	4. VCO Board	Refer to ASTRO Service Manual for troubleshooting.
Bad microphone sensitivity	1. Check deviation	Check deviation using ASTRO CPS Tuner.
	2. From built-in microphone/front panel microcomputer board.	Speak or whistle loudly in the microphone, monitor the output voltage @ pin 23 of P1000; if < 300 mVpp then replace the front panel microcomputer board.
	3. From handset (RPIB)	Inject a 1 kHz tone @ 660 mVrms into pin A of J3003 and measure output @ pin 27 of J3001; If <75 mVrms replace the rear panel interconnect board. Repeat with pin 1 of P3004 for Auxiliary Handset mic.
	4. Command board	Refer to ASTRO Service Manual for troubleshooting.
	5. VCO Board	Refer to ASTRO Service Manual for troubleshooting.
No / Low signaling (PL, MDC, etc…)	1.. Check programming	Ensure that the correct PL, MDC, PTT ID programming information has been entered.
	2. Command board.	Refer to ASTRO Service Manual for troubleshooting.

Figure 5-6-3 Transmitter Troubleshooting (Continued)

Receiver Troubleshooting

The receiver RF conversion, demodulation and signal processing occurs in the ASTRO Spectra transceiver module. Figure 5-6-4 lists a number of receiver-related symptoms that may interrupt normal radio operation. Refer to this figure to assist in troubleshooting and repairing receiver problems to the board level. For further receiver servicing information (i.e. to the component level), refer to the appropriate section in the ASTRO Service Manual. The audio PA for the radio is located on the front panel microcomputer board (Refer to **PART 4 THEORY OF OPERATION** for servicing information).

Caution

The Audio PA (U1003) on the front panel microcomputer board is a dc-coupled bridge-type amplifier with the outputs connected directly to the speaker. Therefore the speaker outputs must never be grounded. Use an audio isolation transformer (e.g. Motorola Part No. SLN6435A or equivalent) to isolate test equipment from the Audio PA/speaker.

Symptom	Possible Cause	Correction or Test (Measurements Taken at 20°C)
Radio dead; display does not light up	1. Blown fuse	Check fuses (F4001 and F4002) on power converter board
	2. Power Converter / RPIB	Verify A+ (13.8Vdc) is present at P3002-1; if not, check power converter circuitry. Verify A+ is present at J3001-1,18,19,36,37 and J3008-2; if not, replace RPIB.
	3. Regulators (command board)	Verify 9.6V is present at J3001-13 and jumper R101 on the RPIB; if not the transceiver 9.6V regulator is defective. Verify 5V is present at J3001-14 and jumper R105 on the TB; if not, the transceiver 5V regulator is defective. Refer to the ASTRO Service Manual for troubleshooting the regulators.
Radio dead; display lights up	1. Power-up self check failure ("FAIL xx/xx")	Refer to Figure 5-3 Power-Up Self-Check Displays and follow instructions given.
	2. Synthesizer (RF Board)	Refer to the ASTRO Service Manual for troubleshooting.
	3. 9.6V regulator (command board)	Verify 9.6V is present at J3001-13 and jumper R101 on the RPIB; if not the transceiver 9.6V regulator is defective. Refer to the ASTRO Service Manual for troubleshooting the regulator.
No receiver audio or receiver does not unsquelch	1. Front Panel Audio PA, RPIB, TB	a. Run these tests with 1 mV RF, 1 kHz tone @ 3.0 kHz deviation into the antenna connector.
		b. Is PL enabled? If so check with PL. Verify HUB programming and on/off hook state
		c. Check FILTERED AUDIO @ pin 25 of P1000; if present, is pin 1 of U1003 low? If so, replace front panel microcomputer board.
		d. Check FILTERED AUDIO @ pin 28 of J3001 on the RPIB; if not present, check transceiver (continue below). If present check signal path to front panel microcomputer board(s); pin 25 of J3000, pin 23 of P3004 and pin "V" of P3007 (should measure approximately 80mVrms). Also verify Handset audio (pin E of J3003) and Auxiliary Handset audio (pin 6 of P3004) at approximately 370mV rms. If FILTERED AUDIO is ok, replace front panel microcomputer board; if not, replace the RPIB.
		e. If FILTERED AUDIO is present at TP6 (or pin 28 of J3001) and pin 11 of U16 is at A+ (J3008-29 is 0V), replace the TB.
	2. Regulators (command board)	Verify 9.6V is present at J3001-13 and jumper R101 on the RPIB; if not the transceiver 9.6V regulator is defective. Verify 5V is present at J3001-14 and jumper R105 on the TB; if not, the transceiver 5V regulator is defective. Refer to the ASTRO Service Manual for troubleshooting the regulators.
	3. RF Board	Refer to the ASTRO Service Manual for troubleshooting.
	4. Command Board	Refer to the ASTRO Service Manual for troubleshooting.

Figure 5-6-4 Receiver Troubleshooting (Continued on next page)

Symptom	Possible Cause	Correction or Test (Measurements Taken at 20°C)
Audio distorted or not loud enough	1. Synthesizer not on frequency/working	Refer to the ASTRO Service Manual for troubleshooting.
	2. RF Board	Refer to the ASTRO Service Manual for troubleshooting.
	3. Command Board	Is the voltage @ pin 28 of J3001 (FILTERED AUDIO) > 75 mVrms and < 3% distortion? If not, refer to the ASTRO Service Manual to verify the transceiver command board.
	4. Front Panel Audio PA/ RPIB	If the audio at pin 28 of J3001 is ok, then verify pin 25 of J3000, pin 23 of P3004 and pin "V" of P3007 are approximately 80mVrms and < 3% distortion. Also verify Handset audio (pin E of J3003) and Auxiliary Handset audio (pin 6 of P3004) are approximately 370mVrms and < 3% distortion. If FILTERED AUDIO is ok, replace front panel microcomputer board; if not, replace the RPIB.
Radio will not squelch	RF board or command board	Refer to the ASTRO Service Manual for troubleshooting.
Excessive noise in fading conditions	1. Check programming	Verify frequency programming and tuning.
	2. RF board	Refer to the ASTRO Service Manual for troubleshooting.
RF sensitivity poor	1. Antenna switch (RF PA board)	Check insertion loss from antenna connector to RX front end coax from the PA; If loss is < 1.5 dB, the problem is in the transceiver, otherwise check cabling and RF PA.
	2. Mobile transceiver	Refer to the ASTRO Service Manual for troubleshooting.

Figure 5-6-4 Receiver Troubleshooting (Continued)

5.7 RADIO SET DISASSEMBLY / ASSEMBLY

The procedures described in this section detail the disassembly and reassembly of the ASTRO Clean Cab. When executing the following procedures, refer to the exploded view diagrams located at the end of this part.

Caution

Disconnect all DC power to the radio before removing any boards from the radio. Failure to remove power can result in damage to the circuits caused by transients or accidental shorts.

Fastener Torque Specifications

Figure 5-7-1 lists the various fasteners, followed by their respective torque values, and where each is used in the ASTRO Clean Cab. When assembling the radio, the torque of all mounting screws should be set to the specified value using the driver indicated in Figure 5-7-1.

Part Number	Description	Repair Torque (in.-lbs.)	Driver	Where Used
300002951	Screw, machine 4-40 x 1/4	6	Phillips	Rear Panel Interconnect Board CH connector
0300040M06	Screw, tapping M4 X 0.7 X 9	12	T-20	Front panel speaker
0310907A33	Screw, machine M3.5 x 0.6 x 30	12	T-15	Power converter shield and front panel microcomputer board audio PA heatsink
0300040M10	Screw, tapping M2 x 0.4 x 8	6	T-8	Top Panel Interconnect Board
0300040M11	Screw, tapping M4 x 0.7 x 8	24	T-15	Transceiver mounting brackets
0300040M12	Screw, tapping M3.5 x 0.6 x 13	20	T-20	Radio handle
0302001A01	Screw, M4 x 0.7 x 60	16	3 mm Hex (internal)	Secures top and bottom assemblies
0310943J04	Screw, tapping TT2.5 x 0.45 x 8	8	T-8	Power converter heatsink
0310943J10	Screw, tapping TT3 x 0.5 x 8	10	T-10	Power converter connectors and all PC board attachments (except ASTRO transceiver)
0310907A20	Screw, machine TT3 x 0.5 x 10	12	T-10	Power converter shield and rear panel
0310943J15	Screw, tapping TT3.5 x 0.6 x 8	12	T-15	Antenna and handset connectors
0310943M15	Screw, tapping TT3.5 x 0.6 x 8	8	T-15	All transceiver PC board attachments
0310943R55	Screw, tapping TT3 x 0.5 x 8	10	T-10	Ribbon cable clamp
0380114M02	Screw, machine M5 x 0.8 x 10	24	T-25	Transceiver mounting
0383498N14	Screw, tapping M4 x 0.7 x 18	12	T-20	Mounting tray clips

Figure 5-7-1 Fastener Torque Specifications

Disassembly of Radio Housing

1. With the radio turned on the side opposite the handle, remove the four screws located on the corners of the bottom panel.

2. Place the radio upright and locate the slot at the rear of the radio. Placing a suitable blade screwdriver in the slot, carefully pry the top and bottom panels apart slightly.

3. Lift the top panel housing vertically until the connectors J/P3001 on the rear and top panel interconnect boards completely disengage.

Removal of Front Panel Assembly

Refer to figure 5-7-2 for the following:

1. Disconnect ribbon cable (P/J1000) from front panel microcomputer board by applying even pressure on the two ejectors. The ribbon cable connector should come straight out.

2. Lift the front panel housing from the slot in the bottom panel housing.

Front Panel Disassembly/Assembly

Refer to figure 5-7-2 for the following:

1. Disconnect microphone 2-wire flex cable from microcomputer board connector (P/J1001).

2. Disconnect speaker cable from microcomputer board connector (P/J1002).

3. Remove two screws securing audio amplifier heat sink to front panel housing.

4. Remove four screws from front panel microcomputer board.

5. Carefully remove the microcomputer board.

6. Disconnect both 12-wire flex cables (W1000 and W1001) from microcomputer board by applying even pressure along width of each cable and gently pulling straight from board.

7. Remove three screws securing speaker to front panel housing and remove speaker.

8. Remove eight screws securing display board to front panel housing.

9. Carefully remove the display board.

10. Remove light pipes and keypads from housing, if required.

To reassemble the front panel, reverse the above procedure. When installing a new circuit board, begin threading all screws before any torque is applied. This helps assure proper board alignment with the housing.

Rear Panel Interconnect Board Disassembly

Refer to figure 5-7-2 for the following:

1. Disconnect ribbon cable connector from front panel (P/J3000).

2. Disconnect auxiliary or secondary remote CH connector cable (P/J3004).

3. Remove nine screws securing power converter cover and remove cover (these screws also secure power converter/filter board).

4. Disconnect power cable (P/J4001) from power converter board.

5. Remove three screws securing mounting bracket to the bottom panel housing, remove RPIB and bracket from housing.

6. Remove two screws securing handset connector (J3003) to the mounting bracket.

7. Remove two screws securing DC-37 connector (J3001) to the mounting bracket.

8. Remove two screws securing service connector (J3006) to the mounting bracket.

9. Remove the two screws securing the data connector (J3005) to the mounting bracket.

10. Remove the two screws securing the remote control head connector (J3007) to the mounting bracket.

11. Remove three screws securing printed circuit board to mounting bracket standoffs, remove board from bracket.

To reassemble the rear panel interconnect board, reverse the above procedure (except do step #7 first), ensuring that the correct torque is applied to the fasteners as specified in Figure 5-7-1.

Translator Board Replacement

The RPIB must be removed first per the previous section. Refer to figure 5-7-2 for the following:

1. Remove the four screws securing the translator board to the bottom, panel housing.

2. Remove the translator board.

3. To access the circuitry under the shield, use a small screwdriver to carefully pry at the four corners of the shield cover from the fence.

To reassemble the translator board, reverse the above procedure. Refer to Section 4.2.4 for firmware version and programming information.

Power Converter Replacement

Refer to figure 5-7-2 for the following:

1. Refer to steps 1-4 of Rear Panel Interconnect Board Disassembly and remove the power converter cover, rear panel board and mounting bracket.

2. Remove the power converter board from its compartment.

3. Remove two screws securing auxiliary or secondary remote CH connector bracket and remove assembly.

4. To install the power converter, position the power converter assembly in the bottom panel housing compartment.

5. Reconnect power cable (P/J4001) to the power converter board from the rear panel board.

6. Replace cover over power converter.

7. Start all nine mounting screws before applying any torque (the three long screws go through the power converter heat sink). Tighten power converter screws.

8. Position rear panel board assembly into its slot in the bottom panel housing and ensure that P/J3008 mates with P/J3008 on Translator Board.

9. Install three screws securing rear panel bracket to bottom panel housing.

10. Install two screws securing auxiliary connector bracket to power converter bracket, and reconnect keyed auxiliary connector (P/J3004) to rear panel board.

ASTRO Transceiver Removal/Replacement

Refer to figure 5-7-4 for the following:

1. Remove four screws and lock washers that secure transceiver module to brackets.

2. Lift transceiver enough to disconnect ribbon cable connector (P/J850) from PA/command interconnect board, and unplug the two coaxial cables from their respective boards in the transceiver chassis.

3. Disconnect ribbon cable (P/J5001) from ASTRO adaptor board by applying even pressure to the two ejectors.

4. To install the transceiver back into the top panel housing, reconnect the ribbon cable to the ASTRO adaptor board, then reconnect the receiver RF and transmitter injection coaxial cables into their respective boards in the chassis (the cables and the chassis are labeled "TX" and "RX" to assist in making proper connections). Reconnect the PA/command ribbon cable to the rear of the transceiver chassis.

5. Position the transceiver into the mounting brackets and secure with four screws and lock washers.

For further repair of the ASTRO Transceiver refer to the ASTRO Service Manual noted in **1.2 Related Documents**.

Power Amplifier Board Replacement

Refer to figure 5-7-4 for the following:

NOTE

Before attempting to remove the board, the ASTRO transceiver must be removed as described in the previous paragraph.

1. Remove the PA shield.

2. Remove the three grounding clips which secure the three RF coaxial cables.

3. De-solder the red wire (UNSW A+) that runs from the feed through capacitor (C3800) to the PA board at the point where it connects to the solder post (E3851) on the PA board.

4. Remove the grounding bracket securing the PA/command interconnect board to the housing by removing the two screws and disconnect the interconnect board from the PA board.

5. Remove the five screws securing the PA transistors and the six screws securing the PA board to the top panel housing.

6. Remove the two screws that secure the antenna connector.

Caution

Do not bend or twist the PA board as this may crack the surface mount components and hybrid circuits.

7. Carefully lift the PA board from the housing.

If the PA board is to be replaced, carefully de-solder the antenna coax from solder post (E3853) on the underside of the PA board and re-solder to the new PA board.

To reinstall the power amplifier board, perform the following:

1. Apply a thin coat of thermal compound (e.g. Motorola part number 11-83166A01) to the pre-driver, driver and final device heat sink mounting surfaces.

Caution

Do not use a thick coating of compound as this will degrade the thermal efficiency of the heat sink.

2. Replace the PA board in its compartment in the top panel housing.

3. Install the six screws securing the PA board, but do not tighten them yet.

4. Install the five mounting screws on the pre-driver, driver and final device and apply a torque of 6 to 8 in.-lbs. This is important for insuring proper thermal conduction.

5. Tighten the PA board mounting screws.

6. Connect the PA/command interconnect board via P/J853, install the grounding bracket, and secure with two screws.

7. Re-solder red wire (UNSW A+) to solder post (E3851) on the PA board.

8. Plug the ribbon cable connector (P/J850) into the PA/command interconnect board from the transceiver module. Connect the RF cables to their respective boards in the transceiver module (both the coaxial cables and the transceiver chassis are labeled RX and TX to ensure proper connections).

9. Secure transceiver module to mounting brackets with four screws.

10. Install PA shield over compartment.

NOTE

After replacing or repairing the power amplifier board, you must ensure its proper operation by performing the specified RF alignments found in the ASTRO Service Manual.

Top Panel Interconnect Board Replacement

Refer to figure 5-7-4 for the following:

1. Before attempting to remove the top panel board, the ASTRO transceiver must be removed as described previously.

2. Remove two screws securing ribbon cable clamp to top panel housing.

3. Remove screw securing ground lug (black wire) to the housing.

4. De-solder red wire (which runs from W6001 to capacitor C3800 on the PA/command interconnect board) from the lead of C3800.

5. Remove two screws securing DC-37 connector (P3001) to the housing.

6. Remove screw and flat washer securing top panel board to the housing and remove board.

To reinstall the board, reverse the above procedure.

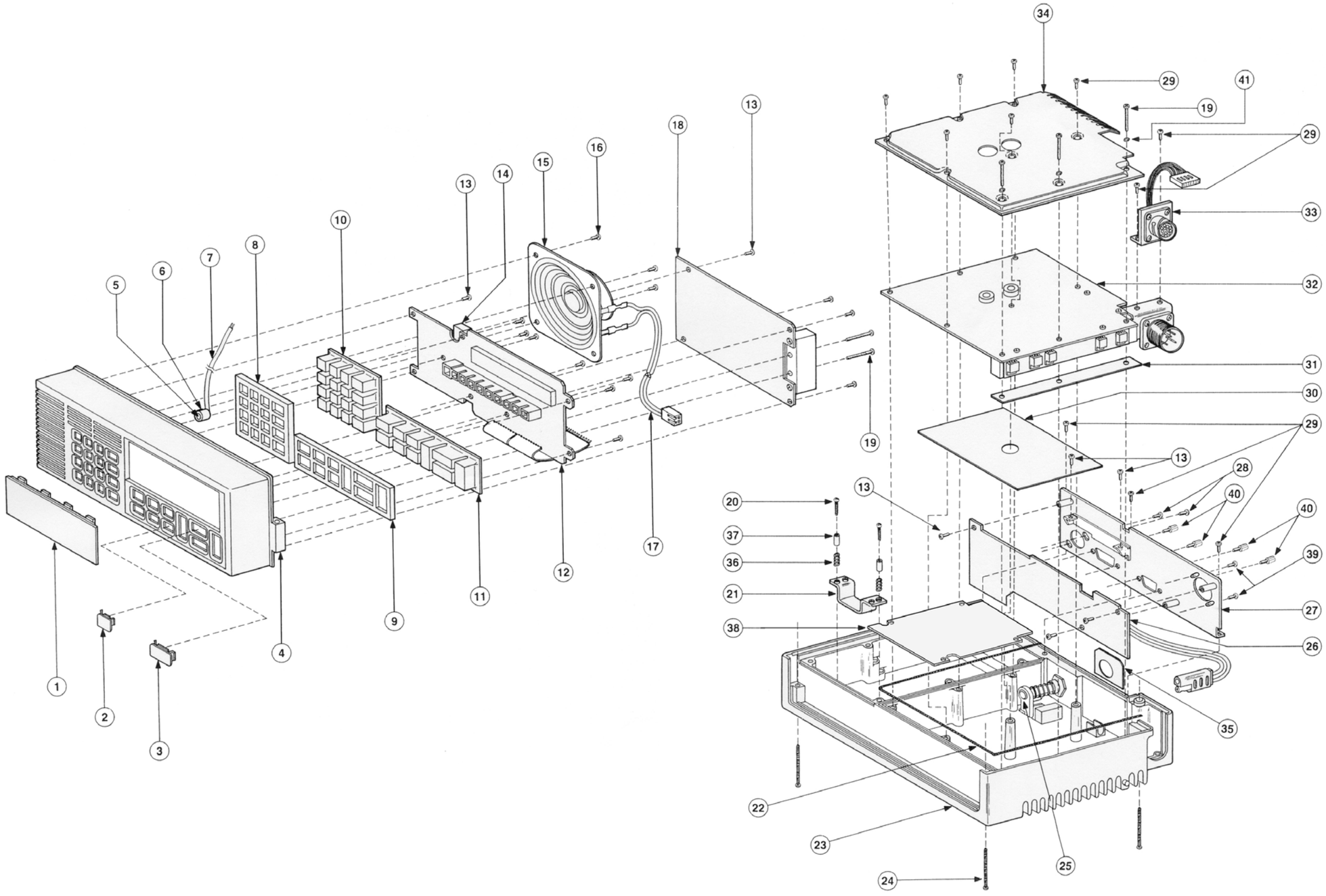
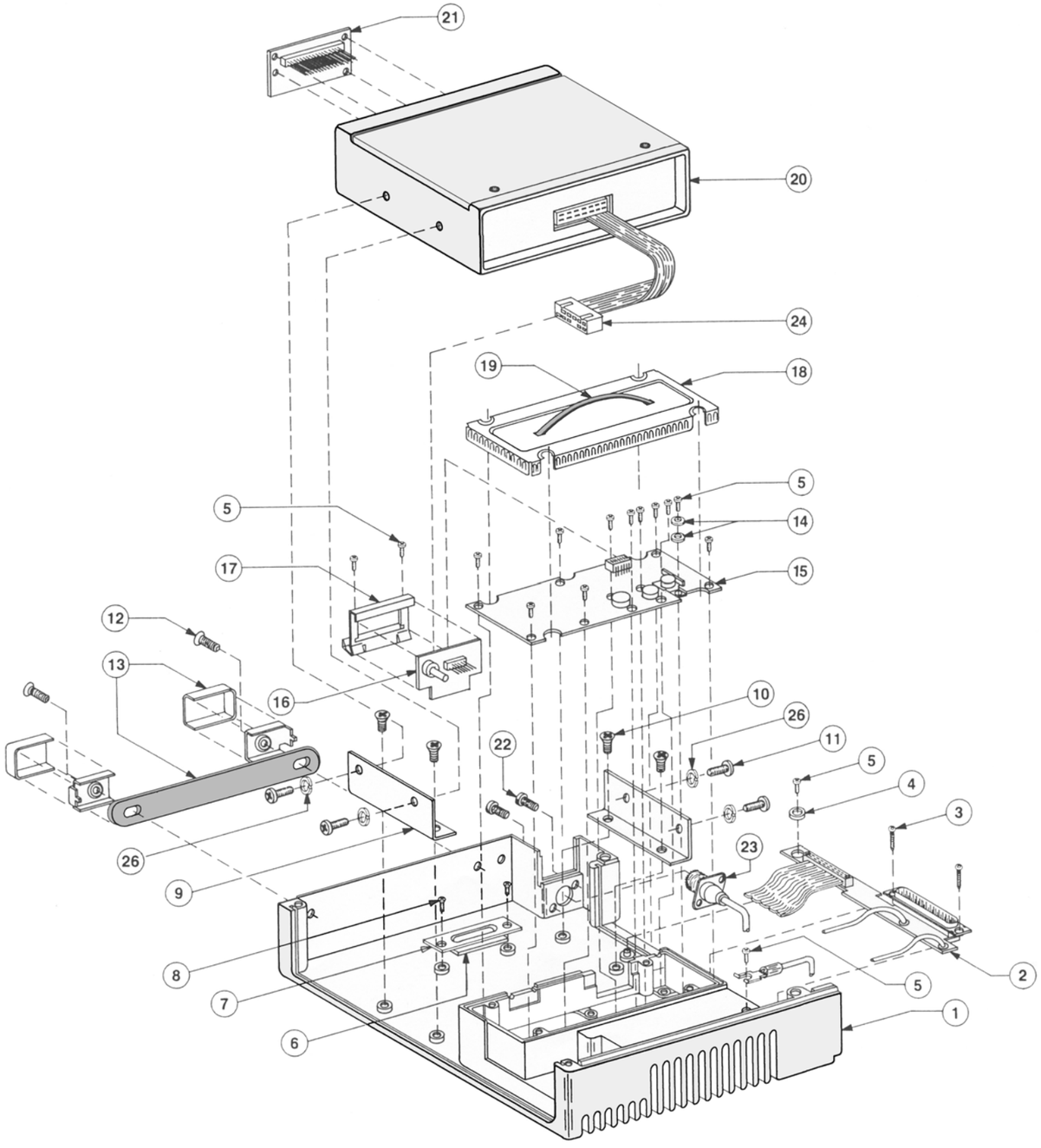


Figure 5-7-2
ASTRO Railroad Radio
Front and Bottom Panel
Exploded View

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	0102702A29	**Lens Assembly - Clean Cab**
		consists of:
	1110019A88	ADHESIVE, RTV
	3282172J01	GASKET
	6102000A04	LENS, front panel clean cab <OR>
	6102000A05	*LENS, front panel clean cab (PA/IC)*
2	3802000A01	INSERT, blank key small (as required)
3	3802000A02	INSERT, blank key large (as required)
4	1502007A01	HOUSING, front panel Spectra
5	5080258E05	CARTRIDGE, microphone
6	7502002A01	GROMMET, microphone
7	3000059M03	JUMPER, flex 2 cond. 2.5 in.
8	6102003A01	LIGHTPIPE, DTMF
9	6102001A01	LIGHTPIPE, Function
10	7502001A04	KEYPAD, DTMF clean cab
11	7502000A05	KEYPAD, Function clean cab <OR>
11	*7502000A06*	*KEYPAD, Function PA/IC*
12	VLN5247D	Clean Cab Display Board
13	0310943J10	SCR, tpg TT3 x 0.5 x 8 intstarpan (24 used)
14	7502003A01	GASKET, speaker
15	5000007M04	SPEAKER, 4.0 ohm 15 watt
16	0300040M06	SCR, M4 x 0.7 x 9 stl (3 used)
17	0102702A07	**Speaker Cable Assembly (P1002)**
		consists of:
	1583498F38	HOUSING, connector 2 pos.
	2910134A50	LUG, speaker push-on (2 used)
	2983499F01	TERMINAL, female (2 used)
	3083155H01	CABLE, 2 conductor 8 in.
	3700132251	TUBING, hs 3/16 blk 1.5in.

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
18	VLN5284E	Clean Cab Microcomputer Board
19	0310907A33	SCR, tpg TT3.5 x 0.6 x 30 intstarpan (5 used)
20	0383498N14	SCR, M4 x 0.7 x 8 mm instar (4 used)
21	0702000A01	CLIP, mtng tray (2 used)
22	3284178M01	GASKET, RF (0.4 meters)
23	1502005A02	HOUSING, bottom panel
24	0302001A01	SCR, M4 x 0.7 x 60 mm (4 used)
25	5502001A01	KEYLOCK ASSEMBLY with key (#2135)
26	VLN5738A	Clean Cab Rear Panel Interconnect
27	1585718E01	PANEL, rear connect w/ cab
28	0310943J15	SCR, tpg TT3.5 x 0.6 x 8 intstarpan (2 used)
29	0310907A20	SCR, tpg TT3 x 0.5 x 12 intstarpan (9 used)
30	1484170M01	INSULATOR, self-adhesive mylar
31	1402002A01	INSULATOR, heat sink
32	VLN 5745A	72V / 12V Converter <OR>
32	*VLN5746A*	*36V / 12 V Converter <OR>*
32	*VFN4004B*	*12V DC Filter Board*
33	VLN5273B	AAR Auxiliary Connector
34	6402002A01	COVER, power converter
35	3302007A01	LABEL, lock rotation
36	4102001A01	SPRING, compression (4 used)
37	4302007A01	SPACER, rolled (4 used)
38	VLN5739A	Clean Cab Translator Board
39	0300002951	SCR, 4-40 x 1/4, phlbinstl
40	5502003A01	SCR / NUT Assem D-SUB (4 used)
41	0400009795	WASHER, lock (3 used)
		Non-referenced items
	12M05062A15	NAMEPLATE, FCC.DOC R/R
	3300255M04	LABEL, instruction

Figure 5-7-3 Front and Bottom Panel Hardware Parts List



REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	1502004A02	HOUSING, top panel
2	VLN5736A	Top Panel Interconnect Board
3	0300040M10	SCR, M2 x 0.4 x 8 mm instar (2 used)
4	0482318N01	WASHER, flat
5	0310943J10	SCR, tpg TT3 x 0.5 x 8 intstarpan (15 used)
6	7502002A03	PAD, cable clamp
7	4202001A01	CABLE, ribbon clamp
8	0310943R55	SCR, tpg TT3 x 0.5 x 8 sraflt chs (2 used)
9	0702001A01	BRACKET, Spectra mtg
10	0300040M11	SCR M4 x 0.7 x 8 mm instar (4 used)
11	0380114M02	SCR, mch M5 x 0.8 x 10 mm pancbn (4 used)
12	0300040M12	SCR, tpg M3.5 x 0.6 x 13.0 instflt (2 used)
13	5502002A01	Handle, chassis
14	0400007607	WASHER, flat stl cad (2 used)
15	VLD4122B	VHF PA Board 50 Watt
16	VLN5278A	PA/Command Interconnect Board
17	4202000A01	BRACKET, PA/Command Int Brd
18	2602005A01	SHIELD, mid-pwr PA
19	5584300B04	HANDLE
20	VLD1200A	ASTRO Transceiver Unit
21	VLN5737A	ASTRO Adapter Board
22	0310943J15	SCR, tpg TT3.5 x 0.6 x 8 intstarpan (2 used)
23	**0102702A18**	**Coax Hood and Antenna Connector Assembly**
		consists of:
	0500135025	EYELET, .130 x .107 brs cad
	0982442E11	RECEPTACLE, coax bulkhead mtg
	1584630L01	RECEPTACLE, hood
	2910134A89	LUG, crimp coax
	3083794C01	CABLE, coaxial RG316/U 14.5 in.
	7582200H01	PAD, rubber (2 used)
24	3002003A01	ASSEMBLY, cable IDC 12 cond.
26	0484366M01	WASHER, split lock M5 (4 used)
		Non-referenced items
	2680286N01	SHIELD, antenna coax
	3010286A14	WIRE, #16 red 2.5 in.
	3080152M11	COAX, assembly TX injection to PA
	7502002A04	PAD, PA shield rubber

Figure 5-7-4 ASTRO Railroad Radio Top Panel Exploded View and Parts List

PART 6. OPTIONS AND ACCESSORIES

6.1 OPTIONS

The following options are available for the ASTRO Clean Cab Railroad Radio.

6.1.1 MBW13 36 /12 V Converter

This option replaces the standard 72/12 Vdc power converter with a 36/12 Vdc power converter for applications which have a locomotive source power of 36 Vdc. For more information, including a schematic, parts list, and board detail, refer to 4.3.

6.1.2 MBW80 Keyless Thumbwheel Latch

This option replaces the standard keylock assembly with a thumbwheel-operated lock assembly for securing the radio to the mounting tray without the use of a key.

To secure the radio with this assembly, turn the thumbwheel counter-clockwise until it engages the latch into the mounting tray and the rotation is tight. To remove the radio, turn the thumbwheel clockwise until it completely disengages the latch from the tray.

The thumbwheel-operated lock assembly (0102702A39) contains the following parts:

0302006A01	Screw, latching
0402004A01	Washer, curved spring
5502001A02	Keyless lock assembly

6.1.3 MBW35 12V Only Operation

This option replaces the standard 72/12 Vdc power converter with a 12 Vdc filter board for applications which have a locomotive source power of 13.8 Vdc. For more information, including a schematic, parts list, and board detail, refer to **PART 4, THEORY OF OPERATION** under the section which describes the power converter and filter board.

6.1.4 MBW81 Ear Bracket for Padlock

This option provides an ear bracket (Motorola part no. 0702006A02) and the necessary screws (Motorola part no. 0300040M11) to fasten the bracket to the bottom panel housing of the radio, directly below the power connector. When the radio is installed into a standard clean cab mounting plate, the ear bracket lines up with a similar ear on the plate. This allows for securing the radio directly to the plate by means of a padlock.

6.1.5 MBW261 30 Watt RF power (Canada)

This option provides factory-setting of the RF power output to 30 Watts to meet Department of Communications (Canada) requirements.

6.1.6 MBW330 PA/Intercom Interface

This option modifies the radio control panel to include four new pushbuttons, identified as **RAD** (radio), **PA** (public address), **IC** (intercom), and **CALL**. The status of each button function is also indicated by an associated LED on the display. The function of the four pushbuttons is to control the state of the three Vehicle Interface Port (VIP) output lines available on the radio data connector. The VIP outputs control external customer-specific equipment. Also, momentarily grounding the first VIP input will reset all VIP outputs to the OFF state. Refer to section 4.2.

6.1.7 MBW496 Remote Control Head

This option replaces the front panel of the radio with a blank panel and adds a single remote-mount control head to the radio. The control head operates in the same manner as the standard front panel controls. Cables sold separately, see **6.2.7**.

The remote-mount control head can be installed into the standard 4" X 10" AAR 12-2 control stand opening, or surface-mounted in another suitable location. The auxiliary connector remains unchanged (i.e. is compatible with the standard AAR auxiliary connector). No Radio Service Software (RSS) programming is necessary. However, the RSS may be used to program the remote control head for limited functionality, if desired. Limited functionality includes disabling the entire DTMF keypad, as well as disabling the programming buttons (**CHAN, DTMF, TRNK, HOME**) on an individual basis.

6.1.8 MBW654 Dual Control Panels With Two Remote Control Heads

This option replaces the front panel of the radio with a blank panel and adds two remote control heads. The remote control heads are essentially self-contained duplicates of the standard front panel assembly, complete with handset connectors, allowing the radio to be operated from either remote control panel. The secondary control head is attached, via a control head cable, to the rear panel board connector, and the primary control head is connected to a new 19-pin auxiliary connector on the radio via an identical control head cable. (Note: This version of the auxiliary connector is then no longer compatible with the standard AAR auxiliary connector.) Cables sold separately, see **6.2.7**.

The control heads can be installed into the standard 4" X 10" AAR 12-2 control stand opening, or surface-mounted in another suitable location. No special programming is required to make the control heads operate. They will operate in the same manner as the standard front panel controls (except that the volume control on each control head operates its own audio amplifier independently). However, the RSS may be used to program either control head for limited functionality, if desired. Limited functionality includes disabling the entire DTMF keypad, as well as disabling the programming buttons (**CHAN**, **DTMF**, **TRNK**, **HOME**) on an individual basis.

6.1.9 MBW892 Dual Control Panels With One Remote Control Head

This option adds an additional set of controls to the radio in the form of a remote control head. The secondary control head is essentially a self-contained duplicate of the radio front panel assembly, complete with its own handset connector, allowing the radio to be operated from the standard front panel or remote panel controls. It is attached, via a control head cable, to a new connector on the rear panel of the radio. The auxiliary connector remains unchanged (i.e. is compatible with the standard AAR auxiliary connector). Cables sold separately, see **6.2.7**.

The remote control head can be installed into the standard 4" x 10" AAR 12-2 control stand opening, or surface-mounted in another suitable location. No additional programming is required to make the secondary control head operate - simply plug it in to have duplicate functionality to the front panel controls (except that the volume control on each control head operates its own audio amplifier independently). However, the RSS is used to program either control head for limited functionality, if desired. Limited functionality includes disabling the entire DTMF keypad, as well as disabling the programming buttons (**CHAN**, **DTMF**, **TRNK**, **HOME**) on an individual basis.

6.2 ACCESSORIES

The following accessories are available for the ASTRO Clean Cab Railroad Radio. All items marked with an asterisk (*) are available from Motorola RPSD. The remaining accessories can be obtained from the factory at the time the order is placed (all accessories must be ordered separately). For radio service programming accessories, refer to **6.3 PROGRAMMABLE FEATURES**.

6.2.1 *TDN6581 Clean Cab Mounting Plate

The TDN6581 mounting plate is designed to meet AAR 12-2 specifications for clean cab locomotives. It is secured to the control stand mounting brackets to provide a convenient method of installing the clean cab railroad radio.

6.2.2 *TLN6489 Handset Hang-up Cup

The TLN6489 Handset Hang-up Cup provides a convenient hang-up device for the handset. The hang-up cup should be located such that it is convenient for the operator while not applying undue stress to the coiled cord of the handset.

6.2.3 *TLN6490 Handset Hang-up Cup with Hang Up Box Switch

The TLN6490 Handset Hang-up Cup is similar to the TLN6489 model except that it contains a hang-up switch to control the HUB feature of the radio. The Hang-up Box (HUB) must be enabled via the ASTRO CPS. Refer to **6.3 PROGRAMMABLE FEATURES** for details concerning these features.

Before mounting the hang-up cup, make the connections indicated by the wiring diagram in Figure 6-1.

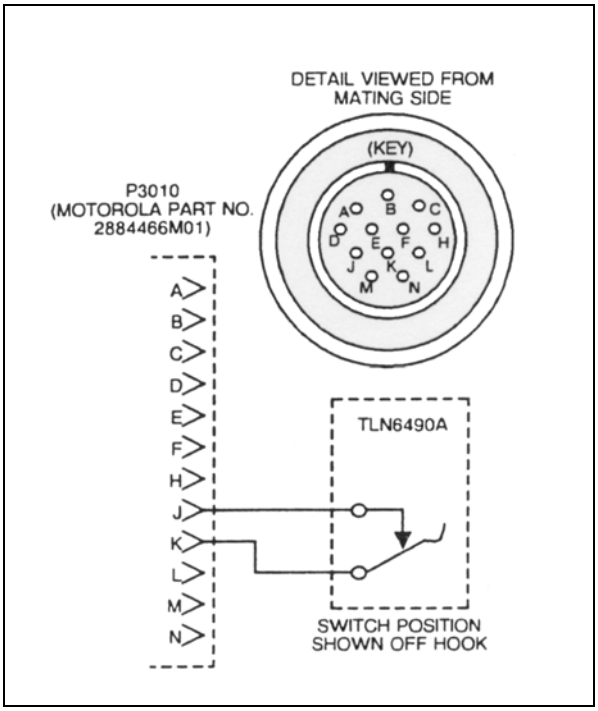


Figure 6-1 Hang-up Cup Wiring Diagram

6.2.4 *TMN6082 Handset with AAR Connector

The TMN6082 is a telephone type dynamic handset designed for use in railroad installations. The handset is equipped with a conventional neoprene coiled cord which is terminated in an AAR-specified connector. The connector mates with the handset connector (J3003) at the rear of the ASTRO railroad radio.

The handset includes a dynamic microphone cartridge with a built-in preamplifier stage, a conventional magnetic receiver cartridge, and a push-to-talk (PTT) switch. The microphone receives operating power only when the PTT switch is depressed. Otherwise, it does not load the power source. The microphone output impedance is 500 ohms at 1000 Hz. Its frequency response is essentially flat between 300 and 3000 Hz. The receiver cartridge input impedance is 125 ohms ±10% at 1000 Hz.

An exploded view diagram, parts list, and schematic of the handset are provided in Figures 6-2 and 6-3.

6.2.5 VKN4125F Power Cable with AAR Connector

The VKN4125F Cable Kit provides 72 V/36 V power connections for the ASTRO railroad radio. The 128 inch length of shielded cable is terminated by an AAR-specified power connector. A shield drain wire is provided for grounding purposes, if desired. For a wiring diagram of this cable, refer to the 72 V power converter board schematic found in **PART 4, Section 3**.

6.2.6 VKN4365A Power Cable with AAR Connector

The VKN4365A Cable Kit provides 12 V (13.8 V nominal) power connections for the ASTRO railroad radio. The 128 inch length of shielded cable is terminated by an AAR-specified power connector. A shield drain wire is provided for grounding purposes, if desired.

6.2.7 Remote Control Head Cable Kits

Remote control head cables are not a part of the Remote Control Head options (MBW496, MBW654 and MBW892) and must be ordered as a separate item. The length of the cable is determined by the suffix of the kit number.

VKN4342BT - 10 foot length
VKN4342AC - 20 foot length
VKN4342AE - 30 foot length
VKN4342AJ - 50 foot length

6.2.8 VKN4293 Top/Bottom Housing Extension Test Cable

The VKN4293 Test Cable is a 15 inch extension cable used to connect the top and bottom housing assemblies after separation of the two assemblies. The cable maintains the necessary electrical connections, allowing the technician to test an operating radio which is in a partially disassembled state. The cable extends the 37-pin connection between P3001 on the top panel interconnect board and the mating connector, J3001, on the rear panel interconnect board on a pin-to-pin basis. The cable consists of the following parts:

0902007A01 - SOCKET, 37-pin D-type female
2802006A01 - PLUG, 37-pin D-type male
3002005A01 - CABLE, shielded 37-cond 22 AWG
4302006A01 - FERRULE, crimp.(2 used)

6.2.9 *VMN1033 Palm Microphone with AAR Connector

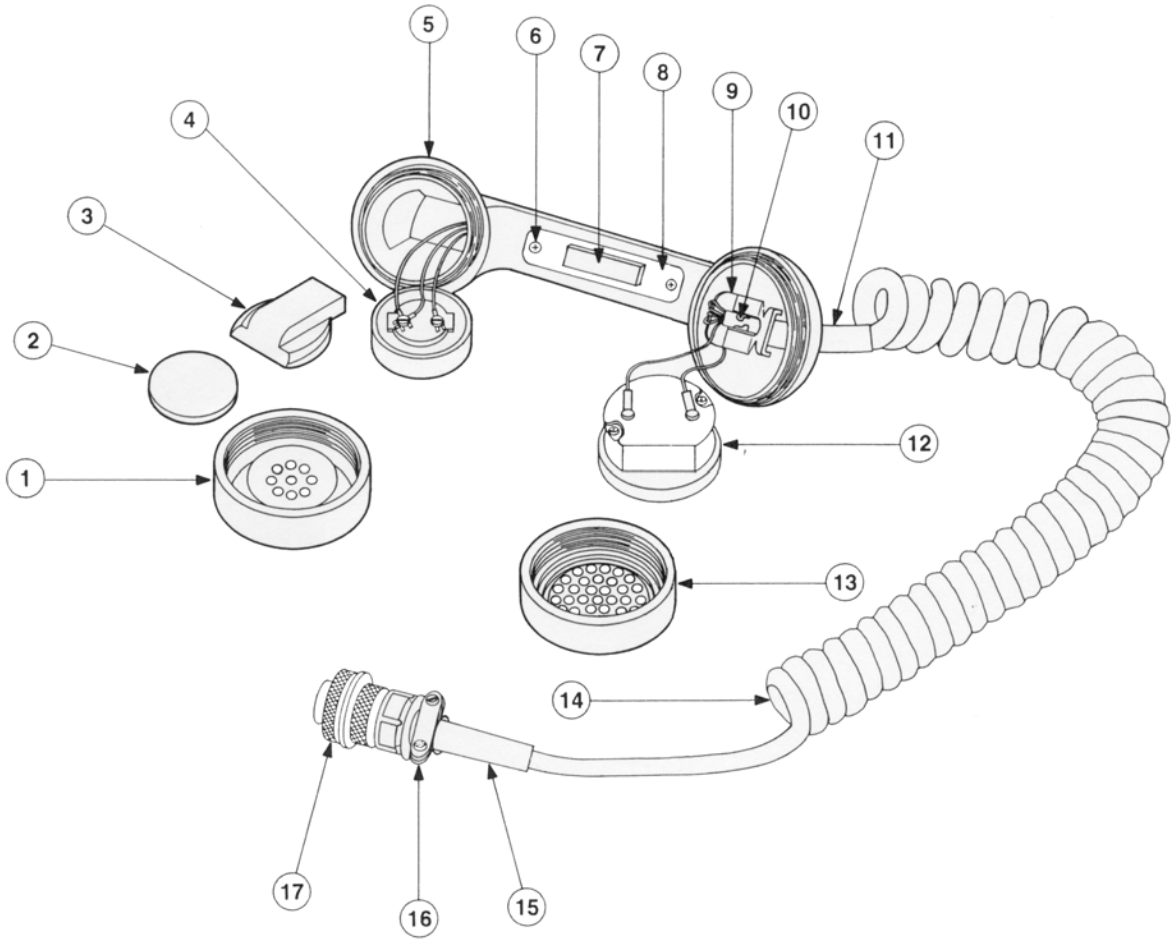
The VMN1033 is a hand-held microphone with an AAR-specified connector designed for use with the ASTRO railroad radio.

This microphone utilizes a high-efficiency electret cartridge and includes an amplifier board designed to interface the electret cartridge into existing carbon-microphone installations. An exploded view diagram

and parts list are provided in Figure 6-4. Board detail, schematic, and parts list are provided in Figures 6-5 to 6-7.

6.2.10 *Antennas: (specify frequency)

TAD6010	Rigid "Firecracker" Flange Mount
TAD6020	Conduit Mounting Whip
TDD6110	4" Train Antenna Sinclair 221



REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	1583982F01	CAP, receiver
2	1480368B67	INSULATOR, handset
3	4680368B66	WEIGHT, handset
4	5984058A01	CARTRIDGE, receiver
5	1584605F01	HOUSING, handset w/ transmitter cap
6	0300124432	SCR, mch 4-40 x ¼ phl stl (2 used)
7	4083985F01	SWITCH, PTT
8	1584053A01	COVER, switch
9	4283980F01	RETAINER, coiled cord
10	4282782A01	CLAMP, grid pltd
11	3784826G02	SLEEVE, strain relief blk
12	5982933C02	CARTRIDGE, transmitter
13		Part of ref #5
14	3082565B33	CORD, coiled
15	3783826G01	SLEEVE, strain relief blk
16	4284825G01	CLAMP, cable
17	2800848760	PLUG, 6-pin
		Non-referenced items
	0300002950	SCR, mch 4-40 x ¼ slt stl
	2900847033	INSULATOR, lug (3 used)
	3700001506	TUBING, vinyl blk (2 used)
	3700132626	TUBING, heat shrink 3/32 clr (2 used)

Figure 6-2 Railroad Handset Exploded View and Parts List

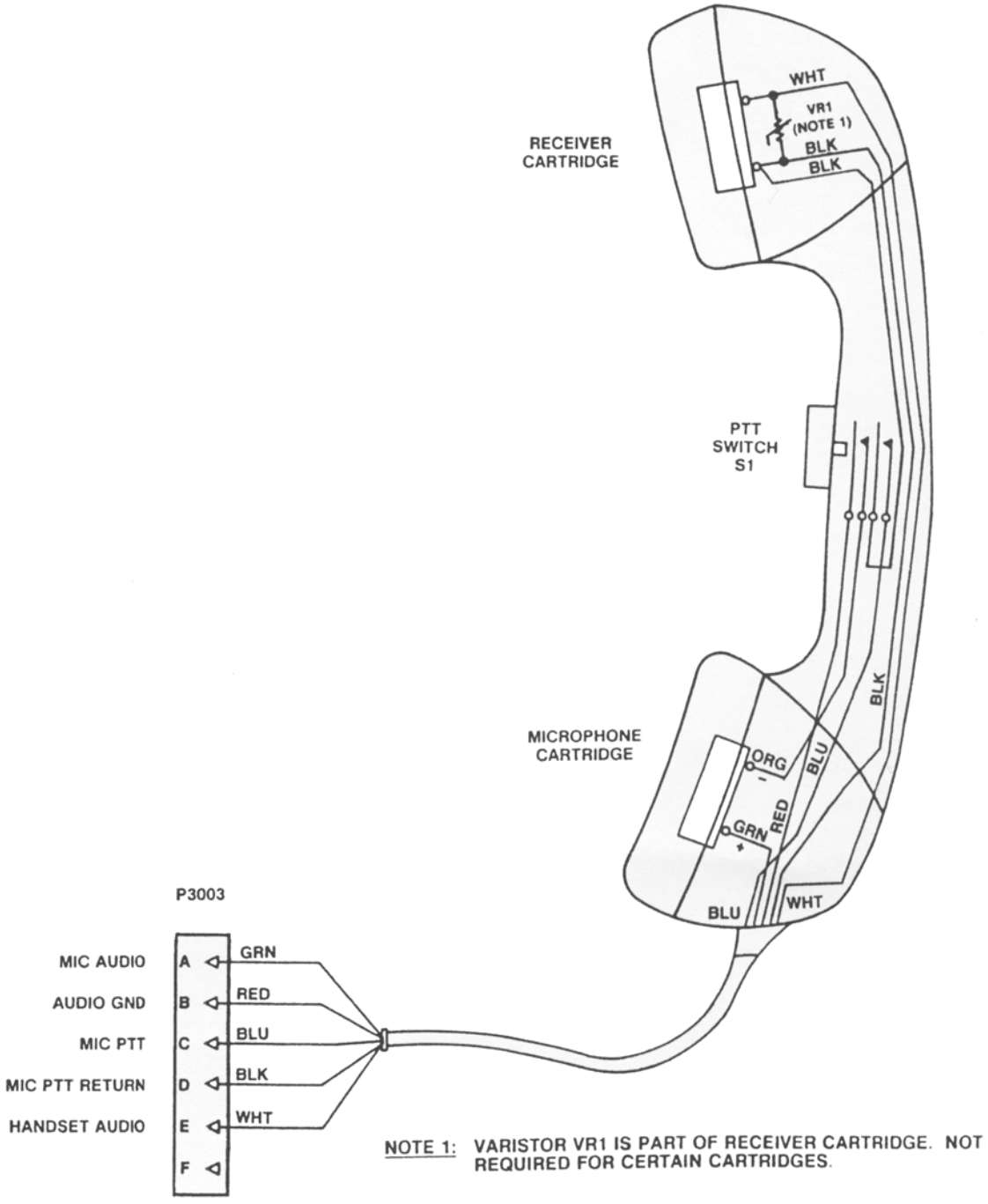


Figure 6-3 Railroad Handset Schematic

PART 7. ASTRO SPECTRA CLEANCAB RADIO PROGRAMMING

7.1 INTRODUCTION

7.1.1 Programming

The ASTRO CleanCab railroad radio contains EEPROM memory to store operator-specific radio data and other parameters. Through the use of a Windows computer, interface hardware, and Codeplug Programming Software (CPS), the radio can be reprogrammed in the field any number of times to allow for changes to transmit and receive frequencies, trunking and conventional channel assignments, Home channel configurations, dispatch tone durations, and controlhead configurations.

The radio can be reprogrammed by any authorized Motorola Service Shop. Alternately, the radio can be field programmed by connecting a Windows computer, using the appropriate interface hardware, to connector J3006 on the CleanCab and following the prompts and help screens contained within the CPS.

The ASTRO CleanCab radio provides the advanced features of an APCO Project 25 compatible radio with the familiar ergonomics of the CleanCab railroad radio. There are a wide selection of programmable parameters in this radio, which can be divided into two groups: those features relating to the ASTRO Project 25 radio, and those features relating to the CleanCab ergonomics. Two programming software packages are provided to handle these two feature sets. Programming typically consists of two stages: first by programming the general radio parameters using the ASTRO Spectra CPS, and second by programming the CleanCab unique parameters using the ASTRO CleanCab CPS.

NOTE

The initial release of ASTRO CleanCab used a DOS RSS for programming the unique CleanCab features. It is highly recommended to upgrade the translator board firmware (refer to CleanCab flash utility in Section 7.3.3) which will allow the use of the ASTRO CleanCab CPS enclosed on the CDROM. Any future versions of the ASTRO CleanCab firmware can only be programmed with the new ASTRO CleanCab CPS.

Section 7.2 of this manual provides recommendations for programming the ASTRO radio. Section 7.3 provides guidance for programming the CleanCab features using the provided CleanCab CPS. A detailed description of the general radio programming process is included in the ASTRO Spectra CPS User's Manual, and the help screens and tutorial which accompany the ASTRO Spectra CPS.

7.1.2 Required Equipment

ASTRO Spectra CPS	RVN4183
ASTRO CleanCab CPS	(included on CD with this manual)
Radio Interface Box (RIB)	RLN1015
ASTRO programming cable	3080369B73
RIB to PC cable	3080390B48
Windows computer	(400MHz CPU, 128MB RAM, 300MB free hard drive space, 98/ME/XP/NT or 2000)

NOTE

ASTRO CleanCab RSS is also provided on this CD as a convenience for use with ASTRO CleanCab radios that have not been upgraded.

7.1.3 Setup

The same setup is used for programming with both the ASTRO Spectra CPS and the CleanCab CPS. Connect the RIB to a serial port (COM1 or COM2) on your computer. Connect the programming cable from the RIB to the 15 pin service connector J3006 on the back of the ASTRO CleanCab radio.

The RIB can receive its power from the radio, however it is recommended that the RIB be powered from an AC adapter, when AC line power is available.

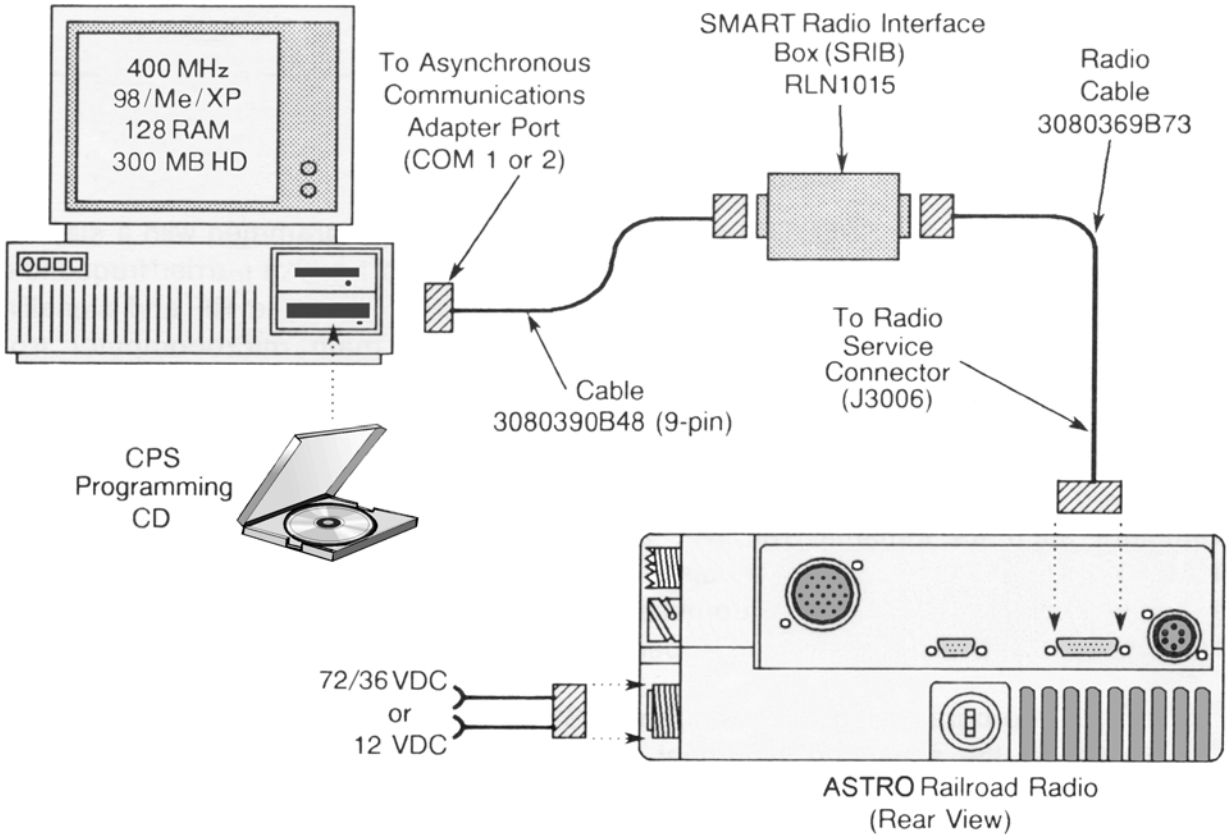


Figure 7-1 PC-SRIB-Radio Connection Diagram (CPS)

7.2 PROGRAMMMING GUIDELINES

There are a wide selection of features which are programmable in the ASTRO transceiver contained in the ASTRO CleanCab radio. Some of these features are not compatible with the ASTRO CleanCab radio controlhead and ergonomics, and others are not appropriate for typical railroad use. This section will provide guidelines for programming the radio for railroad use. For full details on the ASTRO Spectra CPS and the programmable features in the radio, refer to the help files and tutorial supplied with the CPS.

In the following paragraphs, it is assumed that the radio codeplug has been read into the ASTRO CPS for editing. Refer to the help files and tutorial if guidance is needed to read the codeplug from the radio.

7.2.1 Frequency and Channel Programming

Channel programming in the ASTRO CleanCab radio is a two-stage process. First it is necessary to define "personalities". A personality contains all the information necessary to define how the radio should operate: whether it is trunked or conventional, the frequency, PL code, trunking talkgroup, etc. The second stage consists of assigning personalities to zone/channel numbers.

Conventional Personality Programming

In the tree view, expand Conventional, then Conventional Personality, then double click the personality to be edited. A "tabbed" view of the personality parameters will appear. If desired, additional personalities can be added using the "+" and "++" buttons.

General tab
In this tab, enter the frequency and PL code (if any) to be used. If the frequency is to be receive-only, click the <*Receive-Only Personality*> box.

The factory default programming places the 97 AAR channel frequencies in the first 97 personalities. The next seven personalities are NOAA weather stations. And the next 97 personalities are the new narrowband AAR channels. Refer to section **2.2.1** for details.

Rx Options tab
In this tab, set the options which control the reception of signals.

It is recommended that the <*RX Voice/Signal*> type be set to Mixed Mode. This setting allows the reception of both analog and digital transmissions. A setting of Mixed Mode is required to enable the analog/digital (A/D) button on the CleanCab controlhead.

The setting for <*Busy LED*> is ignored by the CleanCab controlhead.

TX Options tab
In this tab, set the options which control the transmission of signals.

It is recommended that the <*TX Voice/Signal*> type be set to ASTRO. A setting of ASTRO is required to enable the analog/digital (A/D) button on the CleanCab controlhead. Select Non-ASTRO if this personality is to be used only for analog voice transmissions.

Direct/Talkaround tab
The settings on this tab are ignored by the ASTRO CleanCab radio.

Signaling tab
Use this tab to enable MDC signaling on analog-only channels if desired. MDC is not compatible with channels using the **A / D** button.

The CleanCab radio does not provide an Emergency switch, thus the setting of the Emergency PTT ID box is ignored.

MDC tab
These options are not supported in the CleanCab radio, and should be unchecked.

ASTRO tab
Use this tab to set the Network ID and other options related to ASTRO digital voice transmissions.

ASTRO Call tab
These options are not supported in the CleanCab radio, and should be unchecked.

ASTRO Talkgroup tab
These options are not supported in the CleanCab radio, and should be unchecked.

Secure tab
These options are not supported in the CleanCab radio, and should be unchecked.

Secure II tab
These options are not supported in the CleanCab radio, and should be unchecked.

Phone tab
In this tab, <*Phone Operation*> **must** be set to Unlimited. Keypad dialing will not function correctly on personalities where <Phone Operation> has any other setting.

The remaining fields on this tab are ignored by the CleanCab radio. DTMF timing is set with the CleanCab CPS (see section **7.3.2 – Tones dialog**).

Smart PTT tab
This tab can be used to set the Smart PTT option if desired. The Smart PTT option prevents the user from transmitting while the channel is busy.

Scan tab
These options are not supported in the CleanCab radio, and **must** be unchecked. Unpredictable operation will result if scan is enabled.

Advanced tab
It is recommended that these options not be checked.

Trunked Personality Programming

In the tree view, expand Trunking, then Trunking Personality, then double click the personality to be edited. A "tabbed" view of the personality parameters will appear. If desired, additional personalities can be added using the "+" and "++" buttons.

General tab
Select the system number and time-out-timer setting to be used on this personality.

Emergency tab
These options are not supported by the CleanCab radio. It is recommended that all boxes be unchecked.

Secure tab
This option is not supported in the CleanCab radio.

Scan tab
This option is not supported in the CleanCab radio, and "none" **must** be selected. Unpredictable operation will result if scan is enabled.

Phone tab
In this tab, <*Phone Interconnect*> should be set to Unlimited.

WAC_AMSS tab
If WAC-AMSS is enabled, set the frequencies on this tab. WAC-AMSS may be enabled on the failsoft tab.

Failsoft tab
Select the failsoft type and failsoft frequency on this tab.

Emergency Revert tab
This option is not supported in the CleanCab radio.

Preferred Sites tab
Define the SmartZone or Omnilink preferred sites list on this tab.

Call/Page tab
These options are not supported by the CleanCab radio. It is recommended that both be set to Disabled.

Talkgroup tab
Use this tab to define the talkgroups associated with this personality. Each trunking personality may have multiple talkgroups associated with it. Each personality/talkgroup combination may be assigned to a separate channel number (Zone/Channel Assignment, below).

Advanced tab
Select the Conversation Type on this tab.

The <*Hot Keypad*> box should be checked.

The <*Message*> and <*Status*> boxes should be unchecked.

Zone/Channel Assignment

Zone tab
Use this tab to define the number of zones in the radio.

It is recommended that only 1 zone be enabled in the CleanCab radio. The selection of channels by number on the CleanCab controlhead may be confusing to users if there is more than one zone.

Channels tab
Use this tab to assign channel numbers to personalities/talkgroups. The channel numbers defined in this tab are the numbers the user will use to select the radio channel from the CleanCab controlhead.

NOTE

It is possible to have the same personality assigned to more than one channel.

It is suggested for ease of maintenance that the channel numbers and personality numbers be assigned in a predictable sequence. The default factory programming assigns the first 97 conventional personalities to the first 97 channels, the next 10 personalities to NOAA channels and the remaining 97 conventional personalities to the last 97 channels. Refer to section **2.2.1** for details.

7.2.2 Other Programmable Parameters

Radio Wide Parameters

In the tree view, expand Radio Configuration, then double click the Radio Wide line. A "tabbed" view of the Radio Wide parameters will appear.

General tab
This tab contains miscellaneous parameters.

The <*Out Of Range*> indicator selection is ignored by the CleanCab radio.

Emergency tab
The CleanCab radio does not provide an Emergency switch, thus the settings of this tab are ignored.

Alert Tones tab
This tab allows enabling or disabling various alert tones. It is recommended that alert tones be enabled to ensure consistent behavior. Some CleanCab alert tones cannot be disabled via the CPS.

Time-Out Timers tab
This tab defines the duration of the four Time-Out timers. Each personality may have one of the 4 timers assigned as the transmitter time-out.

Alarm tab
These options are not supported in the CleanCab radio, and should be unchecked.

VRS Private Line tab
These options are not supported in the CleanCab radio, and should be unchecked.

VRS Advanced tab
These options are not supported in the CleanCab radio, and should be unchecked.

VRS Personality tab
These options are not supported in the CleanCab radio, and should be unchecked.

PA/Siren tab
These options are not supported in the CleanCab radio, and should be disabled.

Advanced tab
<*Ultra Narrow Intermediate Freq Filter*> may be set to eliminate interference in areas where the adjacent channel is active. It is recommended that this parameter not be changed from the factory default.

The remaining options are not supported in the CleanCab radio, and should be unchecked.

Advanced II tab
The key press duration settings are not directly used by the CleanCab radio, and **should not** be changed from the factory default.

All CleanCab radios are dual controlhead capable. The Dual Controlhead box **should not** be checked.

The remaining options are not supported in the CleanCab radio, and should be unchecked.

VRS tab
These options are not supported in the CleanCab radio, and should be unchecked.

Home Mode tab
This option is not supported in the CleanCab radio, and should be unchecked.

Audio Gain Options tab
This tab can be used to adjust the audio levels from the mic to the transmitter.

NOTE
The CleanCab controlhead mic has a hardware AGC circuit. Enabling AGC or compression in the ASTRO Spectra radio may have undesirable results.

Digital Audio Options tab
This tab can be used to enable audio indicators of interference on digital voice channels (the radio will normally mute if a digital signal is excessively degraded).

VRS Parameters

This option is not supported in the CleanCab radio, and all these parameters should be left disabled.

Controls Parameters

The CleanCab controlhead is not configured using the CPS. All the parameters in this section should be left at the factory default values.

Display & Menu Parameters

In the tree view, expand Radio Configuration, then double click the Display & Menu item. A "tabbed" view of the parameters will appear.

General tab
These parameters are ignored by the CleanCab controlhead.

Advanced tab
These parameters are ignored by the CleanCab controlhead.

PTT ID tab
The <*ID Display*> box may be checked to cause received radio IDs to be displayed on the radio controlhead if G114 ID Display option is ordered.

The remaining parameters in this tab are ignored by the CleanCab controlhead.

Phone

Phone Configuration
This selection offers two tabs, which should be configured as follows:

General tab
The <*Manual Access Live Dialing*> box **must** be checked.

The <*Display Format*> and <*ASTRO 25 Display*> fields are not used by the CleanCab radio and should be set to None.

Dialing tab
<*Phone Dialing*> **must** be set to Immediate Live.

<*Phone Overdial Type*> **must** be set to Live.

The remaining parameters in this tab are ignored by the CleanCab controlhead. DTMF timing is set with the CleanCab RSS (see section **7.3.2 F6 – Tones dialog**).

DTMF Codes
These parameters are ignored by the CleanCab controlhead.

Phone List
These parameters are ignored by the CleanCab controlhead.

Secure Parameters

This option is not supported in the CleanCab radio, and all these parameters should be left disabled.

Conventional Configuration

General tab
<*HUB Defeats PL*> should be checked if any of the HUB inputs are enabled with the CleanCab RSS.

<*Direct Frequency*> should be unchecked.

Smart PTT
This tab can be used to set the timing for the Smart PTT feature, if it is enabled on any personalities.

Message Alias List

This option is not supported in the CleanCab radio, and all these parameters should be left disabled.

Status Alias List

This option is not supported in the CleanCab radio, and all these parameters should be left disabled.

MDC Call List

This option is not supported in the CleanCab radio, and all these parameters should be left disabled.

MDC System Parameters

General tab
If MDC PTT ID is enabled, enter the radio's ID number on this tab. It is recommended that the same ID be used here as is used for the radio's ID in the ASTRO System Parameters.

Other options may be enabled as desired. The CleanCab radio does not support Status or Message features, and these two boxes should be left unchecked.

DOS tab
<*Data Operated Squelch*> may be enabled if desired.

Emergency Revert tab
These options are not supported in the CleanCab radio, and should be disabled.

Emergency tab
These options are not supported in the CleanCab radio, and should be disabled.

TX Multiplier tab
This option is not supported in the CleanCab radio, and should be disabled.

Mode Steering tab
This option is not supported in the CleanCab radio, and should be disabled.

Advanced tab
System pre-time for MDC IDs may be set on this tab.

It is recommended that the remaining parameters be left at the factory defaults.

ASTRO Configuration Parameters

This selection contains three tabs, which contain parameters relevant to the APCO packet data option. If this option is present in the radio, it may be configured here.

ASTRO System Parameters

General tab
Enter the radio's unit ID here.

Other options may be enabled as desired. The CleanCab radio does not support Status or Message features, and these two boxes should be left unchecked.

Emergency tab
These options are not supported in the CleanCab radio, and should be disabled.

Emergency Options tab
These options are not supported in the CleanCab radio, and should be disabled.

Advanced tab
These options may be enabled as desired.

ASTRO Call List

This option is not supported in the CleanCab radio, and all these parameters should be left disabled.

ASTRO Talkgroup List

This option (for conventional, non-trunked talkgroups) is not supported in the CleanCab radio, and all these parameters should be left disabled.

Trunking Configuration Parameters

General tab
This tab allows setting general trunking parameters.

The *<RF Modem>* box should not be checked for normal operation. Checking this box enables the radio to act as a modem for certain trunking diagnostics. This box should not be checked for normal APCO packet data operation.

SmartZone tab
This tab allows setting SmartZone parameters.

RSSI Thresholds
This tab allows setting RSSI thresholds for site selection.

Filter Constants
This tab allows setting the site selection filter constants.

VOC
This tab allows setting parameters for Voice on Control operation.

Phone
These parameters are ignored by the CleanCab radio, and it is recommended they be left at the factory defaults.

Trunking System Parameters

In the tree view, expand Trunking, then Trunking System, then double click the system to be edited. A "tabbed" view of the parameters will appear. If desired, additional systems can be added using the "+" and "++" buttons. Note that many of the trunking system parameters can only be altered after entering a System Key.

General tab
This tab allows selecting the system type and setting general system parameters.

Type II/IIi tab
This tab allows setting parameters relating to Type II trunking systems.

Channel Assignment tab
This tab defines the frequency range within which the trunking channels may be assigned.

DTMF tab
These parameters are ignored by the CleanCab radio, and it is recommended they be left at the factory defaults.

Aliasing tab
These options are not supported by the CleanCab radio, and all boxes should be left unchecked.

Message Alias tab
This option is not supported by the CleanCab radio, and should be left blank.

Status Alias tab
This option is not supported by the CleanCab radio, and should be left blank.

Site Alias tab
This option is not supported by the CleanCab radio, and should be left blank.

Advanced tab
This tab allows setting various advanced system parameters.

Control Channels tab
The control channel frequencies are defined on this tab.

Dynamic Regrouping tab
The dynamic grouping option may be enabled on this tab.

Digital tab
Parameters relating to operation on ASTRO digital trunking channels are set on this tab.

Trunking Call List

This option is not supported in the CleanCab radio, and all these parameters should be left disabled.

Scan Parameters

Scan is not compatible with the CleanCab radio and **must** be disabled on all personalities.

7.3 ASTRO SPECTRA CLEANCAB CPS

This section covers the programming of the parameters which are unique to the CleanCab radio, using the CleanCab CPS. CleanCab CPS is a Windows program used to select the unique CleanCab features in the ASTRO Spectra CleanCab radio. To install the CPS, simply change to the CPS directory on the CD-ROM, and run the setup.exe program. When the Windows InstallShield installer prompts, select "install ASTRO CleanCab CPS". To uninstall the CPS, run the setup.exe program and select "remove ASTRO CleanCab CPS".

7.3.1 CPS Operation 

Running CPS

To run the CPS, double click on the CPS icon  , or select CC_CPS from the program menu. You can also start the CPS by double clicking on a CPS archive file. It is necessary to load a codeplug into the CPS before you can access the CPS "programming screens". To load a codeplug, you must either read a codeplug from a radio, or load a codeplug archive.

Reading CleanCab parameters from a radio 

With the computer, RIB, and radio connected as described in section 7.1.3, either select "Read Device" from the File menu, or click on the Read button on the toolbar (the Read button is the leftmost button, with a right-pointing arrow). An hourglass cursor will be displayed while the radio is read, then the CPS splash screen will appear, followed by the tree-view of the codeplug.

If "Read Device" is selected from the File menu, you will be prompted to select the serial port (COM1 thru COM4) to use. If the Read button on the toolbar is used, the CPS will select the last-used serial port, defaulting to COM1 if no serial port has previously been selected.

Reading CleanCab parameters from an archive file

Select "Open" from the File menu, or click on the Open button on the toolbar (the Open button is the second button on the toolbar, which looks like an open folder). Select the desired archive file from the file dialog. The CPS splash screen will appear, followed by the tree-view of the codeplug.

Writing CleanCab parameters to a radio 

With the computer, RIB, and radio connected as described in section 7.1.3, either select "Write Device" from the File menu, or click on the Write button on the toolbar (the Write button is the third button on the toolbar, with a left-pointing arrow). An hourglass cursor will be displayed while the radio is written, followed by a "codeplug write successful" notification.

If "Write Device" is selected from the File menu, you will be prompted to select the serial port (COM1 thru COM4) to use. If the Write button on the toolbar is used, the CPS will select the last-used serial port, defaulting to COM1 if no serial port has previously been selected.

Writing CleanCab parameters to an archive file

Select "Save As" from the File menu. Enter the desired archive file name in the file dialog (or select an existing name to overwrite that file). Click Save to save the file.

Selecting "Save" from the File Menu, or clicking on the Save button (the Save button is the fourth button on the toolbar, which looks like a floppy disk), will save the codeplug using the previously selected archive name.

Help

Extensive help text is included in the CPS. Select "Help" from the Help menu, click on the Help button in any editing screen, or press F1 to access the help screens.

7.3.2 Editing CleanCab parameters

The CleanCab parameters are presented in several editing dialogs, which are displayed in a tree view. Initially the tree view is collapsed; clicking on the + symbol will expand the tree view.

The CPS dialogs in the tree view are:

- General Options
- Controlhead Buttons
- Tones
- Hub Inputs
- Advanced Options

There is also a subsidiary tree view for the Home Mode dialogs. Click the + symbol to expand the tree view of the Home Modes. If there are no Home Modes in this codeplug, the + symbol will not be present.

To edit the parameters on any dialog, double click on the dialog's title in the tree view.

General Options dialog

Controlhead Minimum Volume

This sets the minimum volume level the user can select (which prevents the user setting the volume so low that messages are not heard). The same value is used for both controlheads.

Fixed Auxiliary Volume

The speaker output on the auxiliary connector may be set to a fixed level, or may track the setting of the controlhead volume control. If this box is checked, the auxiliary speaker level will be set to a fixed level.

Auxiliary Conn Volume

This sets the level of the auxiliary connector speaker output, when Fixed Auxiliary Volume is selected.

Antenna Fault Detector

When enabled, a message will be displayed on the controlhead and an audible alert tone is generated if a serious fault is detected with the antenna when transmitting. The radio will continue to transmit, however range may be reduced.

Four Digit Channel Entry

The CleanCab radio supports up to 255 channels. Selecting a channel requires the user to enter 6 digits to fully specify the TX and RX channels. If 4 Digit Channel Entry is enabled, the radio will assume leading zeros if the user pauses after entering 4 digits (e.g. if the user enters 1212, the radio will interpret it as 012 012). If 4 Digit Channel Entry is disabled, the user must enter all 6 digits, including leading zeros. This feature is provided as a convenience, since the traditional 97 AAR channels require 4 digits.

Keypad Dialing on Digital Modes

When enabled, this allows keypad dialing when Digital transmit is selected (using APCO over-the-air signaling, which is converted to DTMF by the base station).

NOTE

Disabling keypad dialing also disables dispatch tones and sequences while in Digital mode.

Dispatch Sequences
When enabled, allows the user to enter a 1- to 3- digit dispatcher call sequence, which will be transmitted when the DISP button is pressed. When disabled, only a single digit may be entered.

Fixed Home Mode Dispatch Tones
If Fixed Home Mode Dispatch Tones is enabled, a dispatch tone is assigned to each Home Mode by the CPS programming. If the user selects a dispatch tone using the radio keypad, the radio will exit the Home Mode. If Fixed Home Mode Dispatch Tones is disabled, the user may select the dispatch tone using the radio keypad.

Controlhead Buttons dialog

This screen allows enabling or disabling various buttons on the main and second controlhead. Checking a box enables the associated button.

NOTE

Disabling the keypad by unchecking Keypad (all) will also disable the * and # keys on the keypad.

Tones dialog

DTMF Minimum Duration <analog mode only>
This timer sets the minimum length of time in milliseconds a DTMF tone will be transmitted, if the user presses and immediately releases a keypad button. This timer may be disabled by checking the associated box. If the timer is disabled, the tone will transmit only while the keypad button is depressed.

DTMF Maximum Duration <analog mode only>
This timer sets the maximum length of time in seconds a DTMF tone will be transmitted, if the user presses and holds a keypad button. This timer may be disabled by checking the associated box. If the timer is disabled, the tone will transmit for as long as the keypad button is pressed (subject to the radio's transmit time-out-timer expiring).

NOTE

If the Minimum and Maximum duration are set to the same value (or if Maximum is inadvertently set less than Minimum) the radio will actually use a Maximum value 50ms greater than the Minimum.

DTMF Pretime Duration <analog mode only>
This timer sets the length of time in seconds blank carrier will be transmitted prior to the start of the DTMF tone (which is sometimes needed to allow a receiver to unsquelch). This timer may be disabled by checking the associated box.

DTMF Hangtime Duration <analog mode only>
This timer sets the time in seconds the radio will remain keyed after the user releases a keypad button. This allows the user to press the next digit without the radio dekeying and rekeying. This timer may be disabled by checking the associated box.

DTMF Sequence Individual Tone Duration <analog mode only>
If DTMF sequences are enabled (on the General Options screen) this timer sets the length of time in milliseconds each DTMF tone in the sequence will be transmitted.

DTMF Sequence Intertone Interval <analog or digital mode>
If DTMF sequences are enabled (on the General Options screen) this timer sets the length of time in milliseconds blank carrier between each DTMF tone in the sequence.

HUB Inputs dialog

This screen allows individually enabling or disabling the HUB inputs associated with the 4 handset connections on the radio.

Advanced Options dialog

It is recommended that the default values in this section not be changed.

Keypad Entry Timer

This timer sets the length of time in milliseconds the radio will wait for a user to complete entering a value in a select state (e.g. when entering the digits of a channel number).

Digital Dialing Hangtime

This timer sets the length of time in seconds the radio will remain in digit entry mode while sending keypad digits in Digital mode.

Antenna Fault Debounce

This timer sets the length of time in seconds needed for a fault condition to exist before being recognized by the radio.

Ant Fault Text

This is the message displayed while an antenna fault condition is detected.

PA/IC buttons

This checkbox enables recognizing the PA/Intercom buttons on controlheads equipped with those buttons.

Home Mode dialog 

If there are no Home Modes present in the codeplug, select Home Mode on the Feature menu to create the first Home Mode in the codeplug. If one or more Home Modes exist, the add (+), delete (X), and add multiple (++) buttons on the Home Mode dialog can be used to add & delete Home Modes from the list.

When editing Home Modes, it may be necessary to widen the dialog box (or to maximize it), to see all the buttons at the bottom of the dialog. When there are a large number of Home Modes, it may be convenient to view them in table view (by pressing the table view button, which is the rightmost button at the bottom of the Home Mode dialog).

NOTE

The translator board has two versions, a 2K and a 4K EEPROM. The 2K version can only support 99 HOME modes. The 4K version can support 200 HOME modes. Contact your dealer/salesperson for information on upgrading to the 4K part if more than 99 HOME modes is required.

Home Mode Name

An 8-character string which is displayed when the Home Mode is selected (note - if Dispatch Sequences are enabled, only the first 7 characters will be displayed).

Home Mode Channel - Trunked

If checked, identifies the Home Mode as a trunked channel.

Home Mode Channel - TX Chan and RX Chan

Enter the channel numbers to use for TX and RX on this Home Mode. These selections are not available if the Home Mode is trunked. The radio will not work correctly if a Home Mode attempts to select channels which are not in the radio's programming or are trunked.

Home Mode Channel - Trunked Chan

Enter the trunked channel number to use for this Home Mode. This selection is not available if the Home Mode is not trunked. The radio will not work correctly if a Home Mode attempts to select a channel which is not in the radio's programming or is conventional.

NOTE

The CPS does not verify that these channel numbers are actually present in the radio's programming.

Home Mode Dispatch Tone

Enter the DTMF digit to be sent when the DISP button is pressed in this Home Mode. This selection is not available if Dispatch Sequences has been enabled on the General Options screen.

Home Mode Dispatch Sequence

Enter the 1- to 3- digit sequence of DTMF digits to be sent when the DISP button is pressed in this Home Mode. This selection is only available if Dispatch Sequences has been enabled on the General Options screen.

7.3.3 Utility Programs

CleanCab Squelch Tuner

The standard ASTRO radio CPS tuner does not include a function to adjust the radio's squelch setting. To provide a means to do so with the ASTRO CleanCab radio, the CleanCab Squelch Tuner applet is supplied on the CDROM.

Installation

To install this applet, simply copy the file CleancabSquelchTuner.exe to a convenient directory.

NOTE

This applet requires certain DLL files which are part of the ASTRO Spectra radio CPS and the ASTRO CleanCab CPS installations. These CPS applications must be installed on the computer before the Squelch Tuner applet can be run.

Operation

To use the applet, connect the radio and RIB in the same manner as for CPS programming. Double-clicking the squelch tuner icon  will start the applet. A small dialog will appear, with **Read** and **Write** buttons, and an edit box.

Click the **Read** button to read the current squelch setting from the radio. The current squelch value will appear in the edit box. You must read the current value from the radio before you can change it or write to the radio. Adjust the value to the desired setting using the up/down controls or by typing the desired value (in the range 0-15) into the edit box. Click the **Write** button to write the new value to the radio.

For convenience, a **Reset** button is provided. Clicking on this button will reset the radio (return it to normal operating mode), thus avoiding the need to power-cycle the radio. Also, a **Default** button is provided, which will set the edit box to the factory default value of 8 (you must still write this to the radio if you wish to set the radio to the default value).

CleanCab Flash Utility

This program will update the ASTRO CleanCab Translator Board (VLN5739) firmware in the event that an updated release is required for feature enhancements or fixes.

NOTE

This tool is ONLY used to upgrade the CleanCab Translator Board firmware. The internal ASTRO transceiver Host/DSP firmware is upgraded using the

FLASHport process; refer to the ASTRO Service Manual for instructions.

Installation

To install the ASTRO CleanCab Translator Board Updater (SPLASH) on your PC simply extract the following files from splash.zip to your computer's hard drive:

splash.cfg
splash.exe
cc.bat
cc_boot.s
mastodon.s (latest firmware release [R02.00] as of the release of this manual)

NOTE

All of the above files must reside in the same directory, or the updater will not work properly. Splash.zip is located on the CleanCab CPS/Manual CDROM (9985809F01-A).

Setup

The following equipment is required to FLASH upgrade the translator board:

PC or Laptop Computer
SRIB: RLN1015
12VAC Adaptor: 0180302E27
9-to-9 pin cable
CleanCab Flash cable: 3085864F01

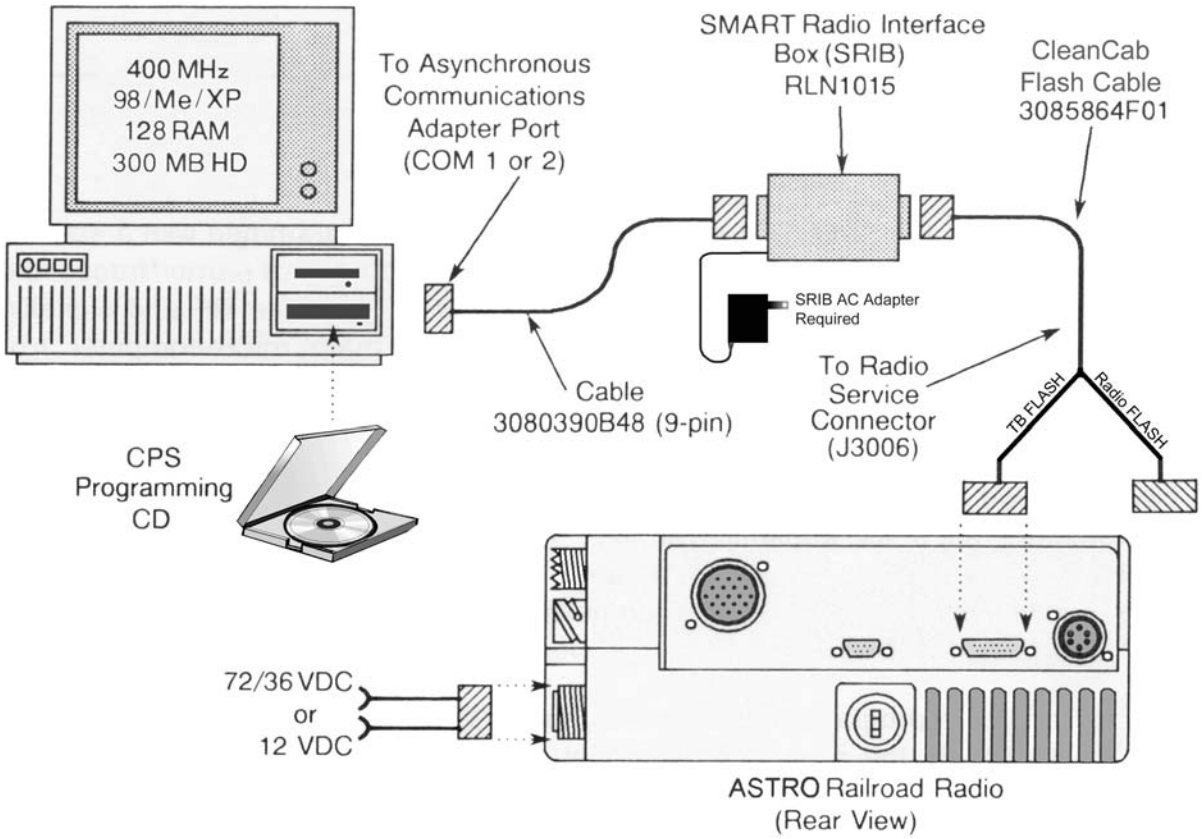


Figure 7-2 PC-SRIB-Radio Connection Diagram (FLASH upgrading Translator Board)

Operation

The following instructions detail the operations of the upgrade kit:

1. Turn on the CleanCab.
2. Connect the SRIB, PC or laptop computer, and station as shown in Figure 7-2**.** Splash will use Comm port 1 by default.
3. Type “SPLASH” at the same DOS prompt where the above files are located.
4. Enter the following password: m0t0r0l@
5. Select and execute the “CC.BAT” batch file.
6. Cycle power on the CleanCab when requested to do so.
7. Wait for “FAIL 01/90” to be displayed on the Control Head before continuing. (If the 01/90 error is not displayed the radio did not enter bootstrap mode. Verify the SRIB and computer connections and retry.)
8. Verify SPLASH reports “Programming Successful”.
9. Disconnect SRIB from the CleanCab.
10. Reset the CleanCab.
11. While in Self-Test Mode, depress the HOME button 5 times.
12. Check display for the correct firmware version: CNTLHDxx. (xx will be the abbreviated firmware version number, e.g. xx = 20 for firmware version R2.0)
13. Reset the CleanCab.

NOTE

In the event of any future updates to the translator board firmware, a new splash.zip package will be distributed via the Motorola Online service web site https://businessonline.motorola.com

Appendix A Replacement Parts Ordering

A.1 Basic Ordering Information

When ordering replacement parts or equipment information, the complete identification number should be included. This applies to all components, kits, and chassis. If the component part number is not known, the order should include the number of the chassis or kit of which it is a part, and sufficient description of the desired component to identify it. Crystal orders should specify the crystal type number, crystal and carrier frequency, and the model number in which the part is used.

A.2 Transceiver Board and VOCON Board Ordering Information

When ordering a replacement Transceiver Board or VOCON Board, refer to the applicable Model Chart in the front of this manual, read the Transceiver Board or VOCON Board note, and include the proper information with your order.

A.3 Motorola Online

Motorola Online users can access our online catalog at

https://www.motorola.com/businessonline

To register for online access, please call 800-814-0601.

A.4 Mail Orders

Send written orders to the following addresses:

Replacement Parts/ Test Equipment / Manuals/ Crystal Service Items:

Motorola Inc.
Radio Products Services Division
(United States and Canada)
Attention: Order Processing
2200 Galvin Dr.
Elgin, IL 60123

Federal Government Orders:

Motorola Inc.
U.S. Federal Government Markets Division
Attention: Order Processing
7230 Parkway Drive
Landover, MD 21076
U.S.A.

International Orders:

Motorola Inc.
Radio Products Services Division
(United States and Canada)
Attention: Order Processing
2200 Galvin Dr.
Elgin, IL 60123

A.5 Telephone Orders

Radio Products Services Division
(United States and Canada)
7:00 AM to 7:00 PM (Central Standard Time)
Monday through Friday (Chicago, U.S.A.)
800-422-4210
847-538-8023 (International Orders)
U.S. Federal Government Markets Division (USFGMD)
800-826-1913 Federal Government Parts - Credit Cards Only
8:30 AM to 5:00 PM (Eastern Standard Time)

A.6 Fax Orders

Radio Products Services Division
(United States and Canada)
800-622-6210
847-576-3023 (International)
USFGMD
(Federal Government Orders)
800-526-8641 (For Parts and Equipment Purchase Orders)

A.7 Parts Identification

Radio Products Services Division
(United States and Canada)
800-422-4210, menu 3

A.8 Product Customer Service

Customer Response Center
(Non-technical Issues)
800-247-2346
FAX:800-247-2347

Motorola, Inc.
8000 West Sunrise Boulevard
Ft. Lauderdale, FL 33322

9985809F01-A