MOBILE RADIO

M-PD
VOICE GUARD PERSONAL RADIO
SERVICE SECTION

TABLE OF CONTENTS

INTRODUCTION

The recommended troubleshooting procedure for the M-PD VOICE GUARD Personal Radio, as illustrated in Figure 1, is to isolate any fault to a specific section of the M-PD Personal radio: the RF section (transmit, receive and synthesizer); the control logic, voice encryption section or the battery pack. Then, in the case of the RF section, to further localize the fault to a specific stage suspected to be defective. The last step is to isolate and identify the defective component.

It is not recomended that any repair work be performed on either the Analog or the Digital Board of the VOICE GUARD section. So, when troubleshooting this section it only necessary to determine if there is a fault with a VOICE GUARD board. The defective board should then be returned to the factory for repairs.

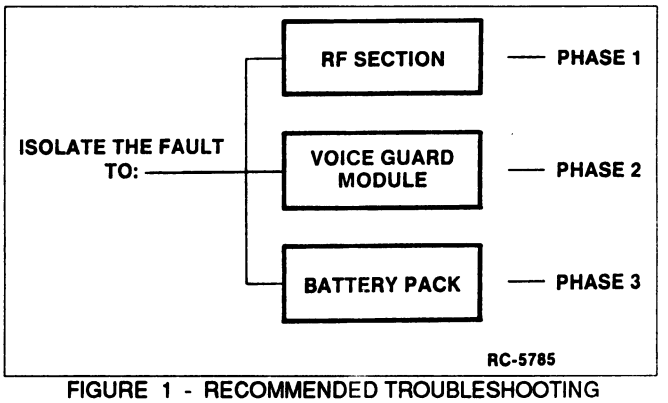


FIGURE 1 - RECOMMENDED TROUBLESHOOTING PROCEDURE

The following list of test equipment is recommended when servicing or troubleshooting the M-PD Personal radio.

Recommended Test Equipment:

- Audio Analyzer
- Digital Voltmeter
- DC Power Supply
- Multimeter
- Oscilloscope

PHASE 1: RF SECTION TROUBLESHOOTING

Functional Troubleshooting

Once the fault has been isolated to the RF Section, the next step is to further isolate the fault to a specific stage of the RF Section; Frequency Synthesizer (SYN), Receive (RX) and Transmit (TX). The flow chart (See Page 3) will assist in isolating the fault to a specific stage of the section.

Troubleshooting and repair:

1. 5.3 Volt Regulator (Refer to Table 1):

The 5.3 volt regulator consists of operational amplifier A104 (1/2) and transistrors Q102 and Q103. A 5.4 volts reference comes from the VOICE GUARD module Analog board through connector J102-6 (5.4V REG). If a fault is found with the regulated 5.3 Volt output line, trace the line back to the regulator. A typical current flowing through resistor R129 is shown in the following Table for the VHF and UHF frequency bands. Typical voltages for the synthesizer are shown in Table 2.

Any repair should be made so that the current and voltage at each assembly and component agrees with the typical values.

Table 1 - Typical 5.3 Volt Regulator Current (milliamperes)

Freq Band	Component
VHF	23
UHF	24

2. Reference Oscillator VCTCXO (A103):

The Voltage Controlled Temperature Compensated reference oscillator (VCTCXO) consists of module A103. If a problem is found with this assembly, replace it with a new one. Typical data, when the reference oscillator is working properly, is shown in the following Table 3.

Table 3 - Typical Data for Reference Oscillator

Item	Typical Value
Supply Voltage	5.4 VDC
Current Drain	1.5 - 1.8 mA
Output Frequency	13.2 MHz
Output Level	1 to 2 Vpp

3. Prescaler A101 Output level

Voltage Controlled Oscillator module (VCO) A106 has an output level of about 0 dBm. Part of the VCO output is applied to the input of buffer amplifier transistor Q101 through capcacitor C117/C118. After amplification the VCO output is applied to the input of the Prescaler A101, which is operating under 128/129 modular control. The input level to the prescaler ranges from 0.2 volts to 0.8 volts peak-peak. A typical prescaler output level is 1 volt peak-peak, which is applied to the input of Phase Lock Loop module (PLL) A102.

When adjusting the prescaler, refer to the typical value listed in Table 2.

4. Phase-Lock-Loop A102 (PLL)

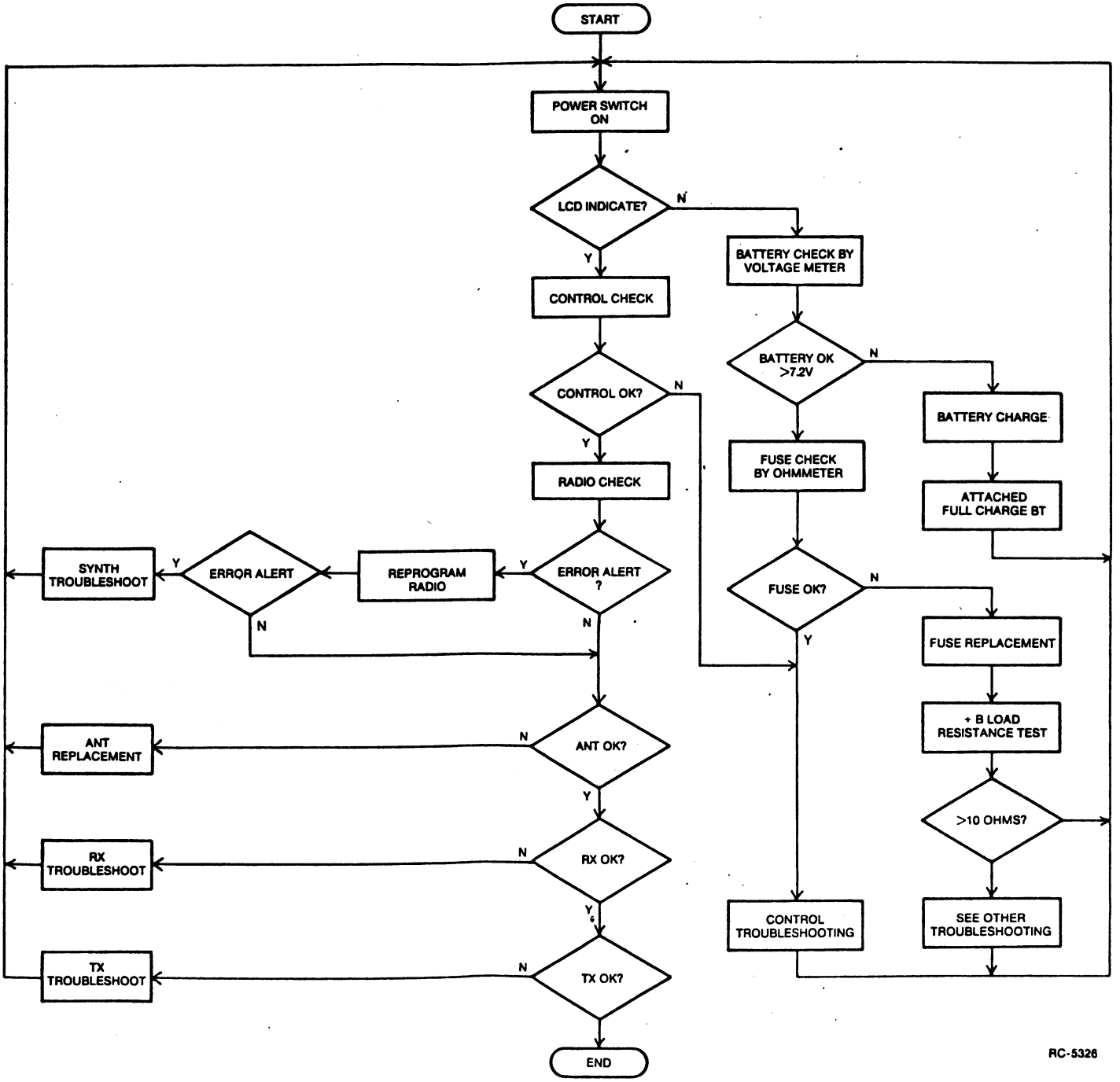
a. Check for approximately 1 to 1.5 Volts peak to peak reference signal input at Pin 2 of A102.

b. Check that the reference signal frequency is 13.2 MHz and that frequency deviation is + 5 PPM.

c. Measure the input from the prescaler at Pin 10 of A102 and verify approximately 1 volt peak to peak input level.

d. Verify that approximately 5 volts peak to peak (Vss-Vcc) control pulse is present at Pin 1 of A101 (Prescaler Control).

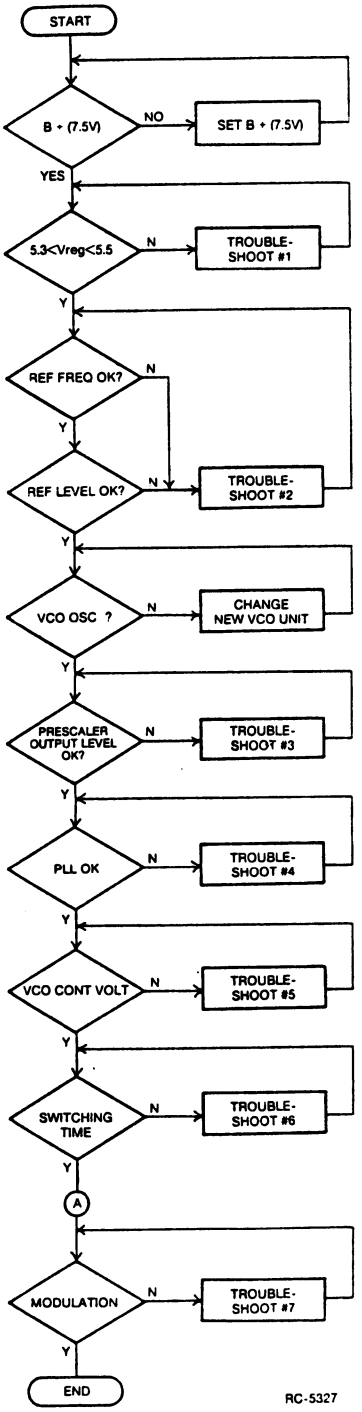
Flow Chart: Functional Troubleshooting



Synthesizer

The following flow chart can be used to isolate a defective stage in the synthesizer circuit.

Flow Chart: Synthesizer



e. Cause the PLL to unlock. Then check for the presence of approximately 5.5 volts peak to peak (Vss-Vcc) PD and FD pulse outputs at Pin 6 and Pin 17 of A102 respectively. Also, check for approximately 7 volts (Vss-Vcc) at the collector connection between transistors Q102 and Q103. If the pulse output is absent or shifted to either the Vss or the Vcc side, the PLL may fail to lock over a certain section of the frequency range or the entire range. If this fault occurs, the possible cause is ramp resistor R108, ramp capacitor C108 or hold capacitor C110.

f. Verify that the local voltages at the test points listed in Table 2 agree with the typical values also listed in Table 2.

g. Verify that the STROBE, DATA and ENABLE signals coming from the Control Unit are at the proper level and the proper duration (refer to Figure 2).

If the STROBE and DATA are improper, the PLL operation will become erratic. If the duration of the ENABLE is shorter than 10 milliseconds, which is the minimum value, the PLL may fail to lock.

NOTE

If parts other than those specified in the parts list are used in the associated circuit of the PLL, the switching time may be affected. Whenever any parts are replaced in the associated circuit, check the switching time.

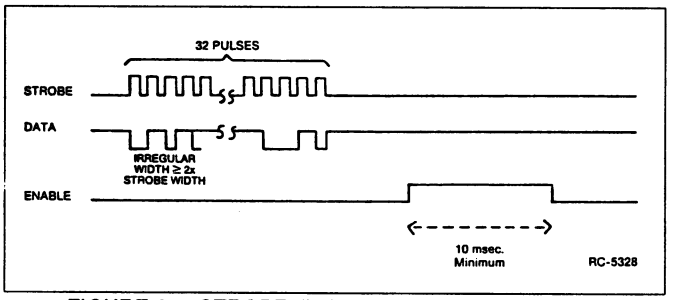


FIGURE 2 - STROBE, DATA AND ENABLE SIGNALS

5. VCO Control Voltage:

a. VCO Control Voltage Should be:

- Approximately 1 volt or more on the lowest channel of any band.
- Approximately 4.5 Volts or less on the highest channel of any band.

Verify the VCO control voltage at the CONT terminal of A106 using a high impedance (5M OHM) oscilloscope.

b. If the VCO control voltage differs from the above values, remove the top cover of VCO assembly A106 and adjust until the voltage does agree.

- Remove the cover.
- Adjust the receive frequency VCO Control.
- Key the radio and adjust the transmit frequency VCO control.

c. After the VCO has been adjusted, replace and bond the cover completely. If the cover is not replaced or bonded properly, howling may be caused when the speaker volume is raised.

d. After the cover is replaced and bonded, again verify the VCO control voltage according to step 5(a).

6. Switching Time:

The channel frequency must be locked within 10 milliseconds, which is the duration of the ENABLE pulse. That is, the switching time is restricted by the ENABLE pulse.

a. Switching time is largely influenced by the leakage current characteristics of capacitors C108, C110, C114 and C115. When replacing these parts, be sure to use parts having the same ratings specified on the Parts List. Also, if moisture collects on the printed wire board, the insulation resistance of the board may be lowered, affecting switching time.

b. The channel switching sequence and the action of the related functions is shown in Figure 3.

Table 2 - Synthesizer Section Typical Voltages

No.	Test Points	Voltage (V)		Remarks
		VHF (5 W)	UHF (4 W)	
1	A101 (1) (PINS)			
2	(2)			
3	(3)	3.81	3.84	
4	(4)			
5	(5)	3.27	3.25	
6	(6)	3.27	3.25	
7	(7)	4.84	4.81	
8	(8)	4.84	4.81	
9	A102 (1)	3.97	4.17	
10	(2)	2.45	2.43	
11	(5) (19)	5.30	5.26	
12	(6) (17)	0.71	0.44	
13	(8)	-	-	
14	(9)	5.29	5.25	
15	(10)	2.57	2.50	
16	(11)	0	0	
17	(12)	4.94	4.94	
18	(13)	0	0	
19	(15)	0.54	146 mV	
20	(18)	1.83	1.07	
21	(20)	3.97	3.95	
22	A103 Vcc	5.42	5.42	
23	A104 (1)	0.78	0.79	
24	(2)	2.73	2.69	

(continued)

Table 2 - Synthesizer Section Typical Voltages

No.	Test Points	Voltage (V)		Remarks
		VHF (5 W)	UHF (4 W)	
25	A104 (3) (PINS)	2.72	2.69	
26	(5)	0.71	0.44	
27	(6)	0.71	0.44	
28	(7)	1.42	1.41	
29	(8)	7.51	7.51	
30	A105 (1) (4)	1.42	1.41	
31	(2) (3)	1.42	1.41	
32	(5) (13)	0	0	
33	(6) (12)	0	0	
34	(7)	0	0	
35	(8) (11)	1.42	0	
36	(9) (10)	1.42	0	
37	(14)	5.30	5.26	
38	A106 CONT	1.42	1.41	
39	MOD	5.29	5.25	
40	RS	68.9 mV	65.2 mV	at RX mode
41	TS	5.04	4.99	
42	BS	-	-	
43	TO	0	0	
44	RO	0	0	
45	OUT	-	-	
46	PS	5.31	5.26	
47	Q101 Base	1.07	0.93	
48	Emitter	0.375	0.402	

(continued)

Table 2 - Synthesizer Section Typical Voltages

No.	Test Points		Voltage (V)		Remarks
			VHF (5 W)	UHF (4 W)	
49	Q101	Collector	4.85	4.81	
50	Q102	Base	6.85	6.85	
51		Emitter	7.51	0.25	
52		Collector	5.42	5.38	
53	Q103	Base	0.78	0.79	
54		Emitter	0.24	0.25	
55		Collector	6.85	6.85	
56	Q104	Base	0.66	0.65	at RX mode
57		Emitter	69 mA	65 mA	"
58	Q105	Base			
59		Collector	5.04	4.99	"
60	Q106	Base	0.60	1.356	
61		Emitter	0	1.14	
62		Collector	6.46	7.09	

7. Modulation Degree vs Modulation Flatness:

The M-PD equipment can be modulated with audio beginning with 1 Hz. For this reason, the same modulation signal is applied to both the VCO and VCTCXO in phase. The modulation signal of low frequencies below 10 to 30 Hz, modulates the VCTCXO output whereas the high frequency signals modulate the VCO. Modulation Characteristics can be adjusted using modulation adjust controls R116 and R117 as follows:

NOTE

1. Adjust modulation flatness with the RF section only.
2. For this adjustment, select the center channel.

Procedure:

1. Apply 0.55 V rms/1 kHz signal at the TX audio terminal and adjust R117 for 3 kHz deviation.

2. Change the signal frequency to to 10 Hz. Adjust R116 for a 3 kHz deviation.

3. Change the signal to a 10 Hz retangular waveform. Then the demodulated output from the modulation analyzer should look like that shown in Figure 4. If the level adjustments under steps 1 and 2 are out of balance, the rectangular wave form will be distorted (again, refer to Figure 4).

NOTE

For this test, the modulation analyzer must have low frequency response to less than 1 Hz.

4. Change the carrier frequency to the highest channel and then to the lowest channel. Check the modulation flatness each time (refer to Figure 5).

If a large level difference is found between the modulation characteristics at 10 Hz and those at 100 Hz when the carrier ferquency is changed from the highest to the lowest, the problem is with the VCO modulation characteristics. Replace the VCO with a new one.

When the waveform of the demodulated output is distorted for a modulation frequency of 10 Hz or lower, the problem is with the VCTCXO. If the distortion is substantial, the carrier fequency may be affected by modulation. It is recommended to replace the VCTCXO with a new one.

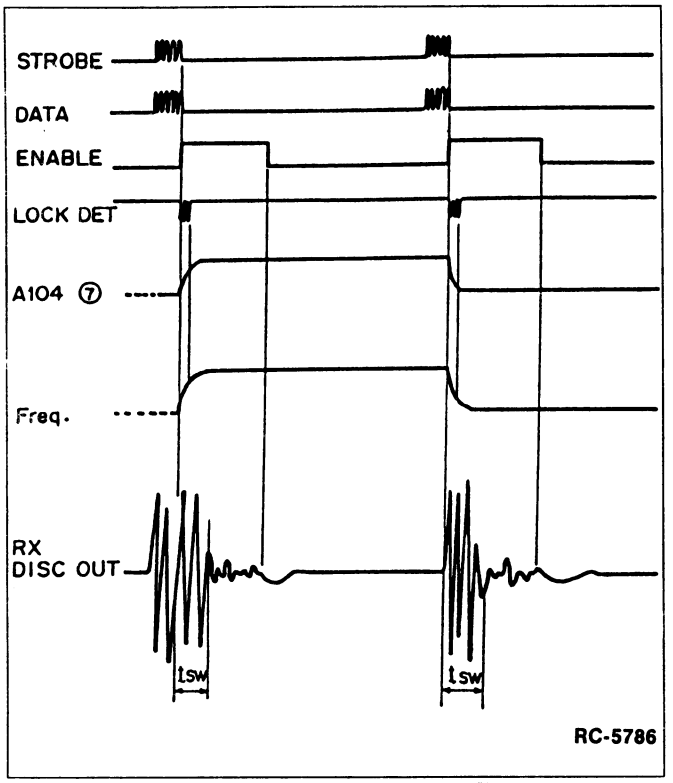


FIGURE 3 - LOGIC FORMAT

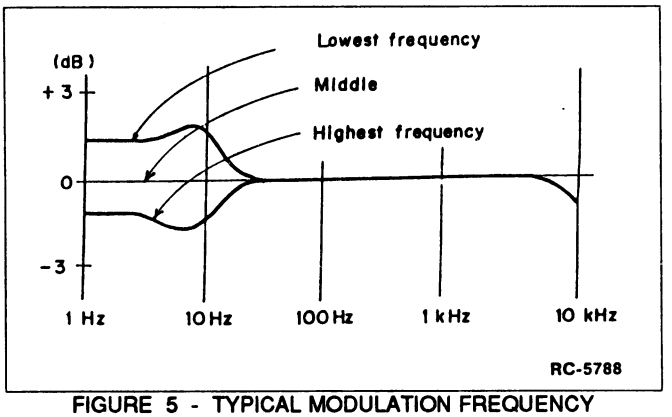


FIGURE 5 - TYPICAL MODULATION FREQUENCY CHARACTERISTICS

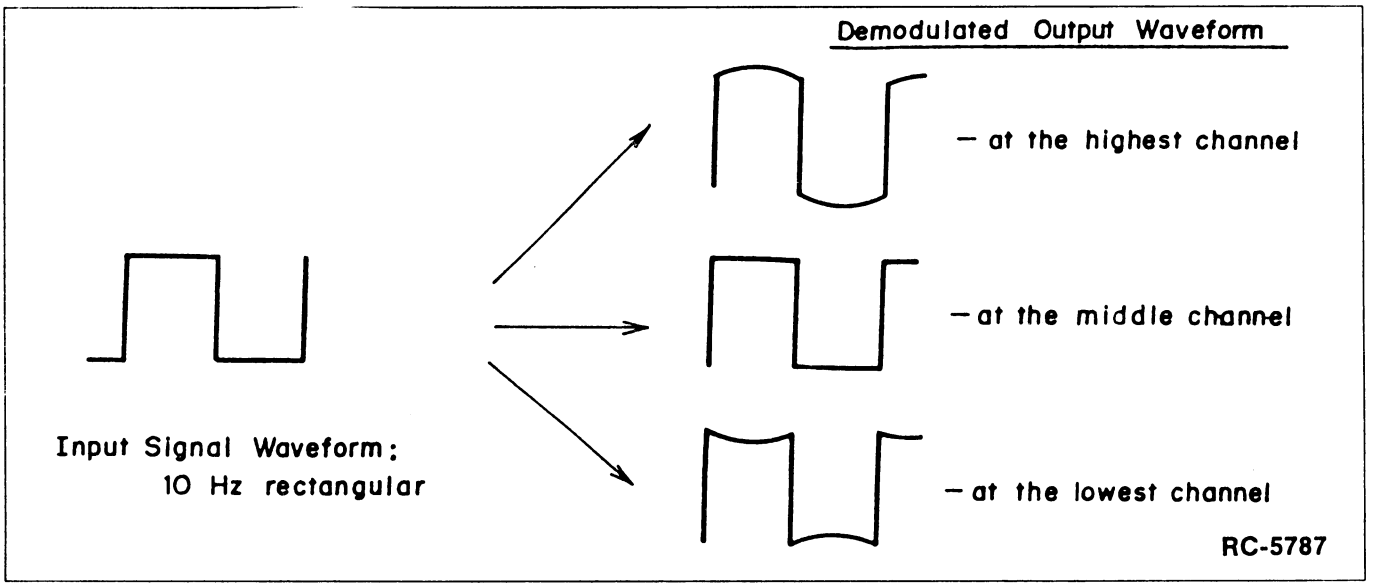
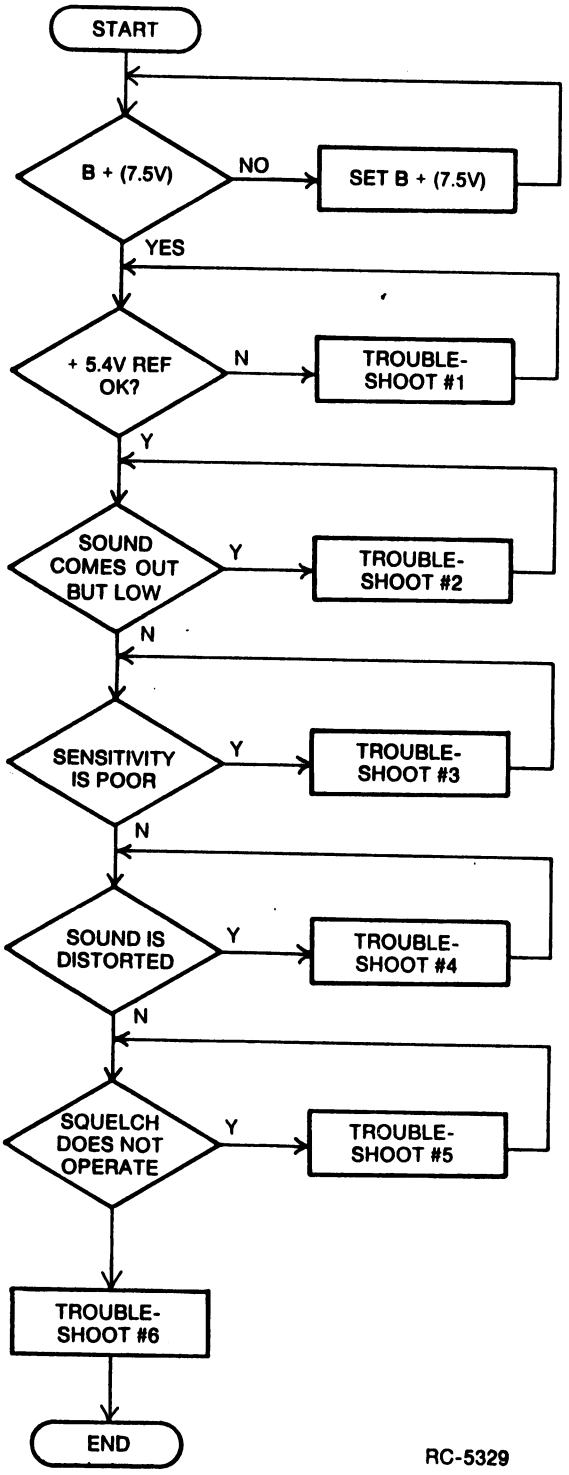


FIGURE 4 - TYPICAL RECTANGULAR WAVEFORM OF DEMODULATED OUTPUT

Receive

The following flow chart can be used to isolate a defective stage in the receive circuit.

Flow Chart: Receive Circuit



Troubleshooting and Repair for the Receive Circuit:

1. Low Voltage: Measure the voltage at J104 (P104), Pin 6. When the voltage is less than 5.4 volts, the 5.4-volt regulator circuit on the Analog Board is probably faulty.

2. No Volume Control: If sound comes out of the receiver, but the volume does not increase, the problem may be due to a fault on either the RF section or the control circuits on the Analog Board.

   a. Receive Section: Check the output signal for about 200 mV peak to peak at the audio terminal of the RX section (J101, Pin 4) when a standard modulated signal (1 kHz at 3 kHz frequency deviation) of 1 mV (-47 dBm) is applied at the antenna terminal or the UDC. If the signal level at the audio terminal of the RX is substantially low, IC A302 is suspected to be defective.

   b. Analog Board: The receive audio signal enters the Analog Board at P101, Pin 4 and connects to J7-13 (RXDISCOUT). The audio enters CAC IC U14 at Pin 12. Inside the CAC the signal is passed through a 300-3000 Hz Band Pass Filter (BPF) and a 46 dB volume level control. The signal at U14, Pin 27 is passed through a de-emphasis circuit and amplified by audio amplifier U27 and SPKR amplifier A15 to drive the speaker. Typical levels needed to obtain a 1 kHz, 0.35 Watt receive rated audio output are shown in Figure 6.

3. Poor Sensitivity: When receive sensitivity is poor, refer to the RF Section Schematic Diagram. The receive section consists of low noise amplifier Q301. Local oscillator amplifier Q106, first IF amplifier Q302 and Q303 and second IF circuit A302.

   a. Level Diagram: A Frequency Relationship Diagram is shown in Figure 7 and a Typical Level Diagram is shown in Figure 8.

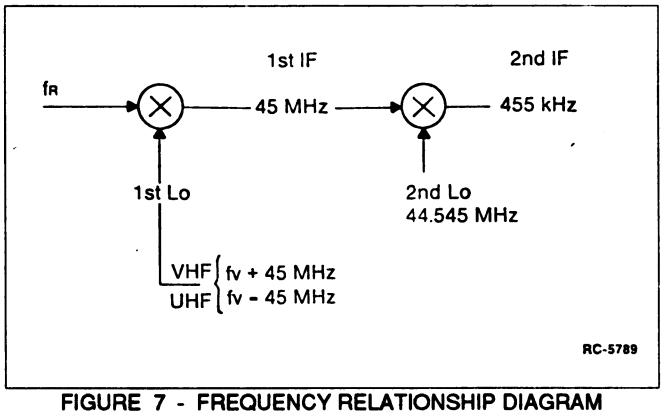


FIGURE 7 - FREQUENCY RELATIONSHIP DIAGRAM

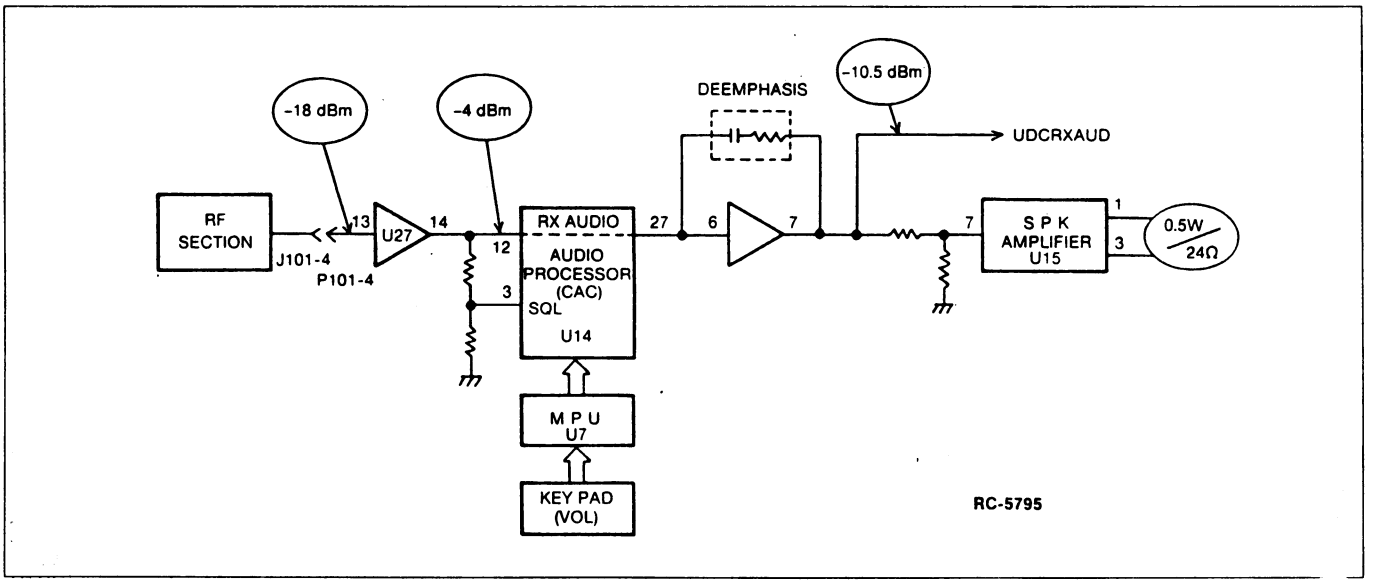


FIGURE 6 - RECEIVE AUDIO OUTPUT

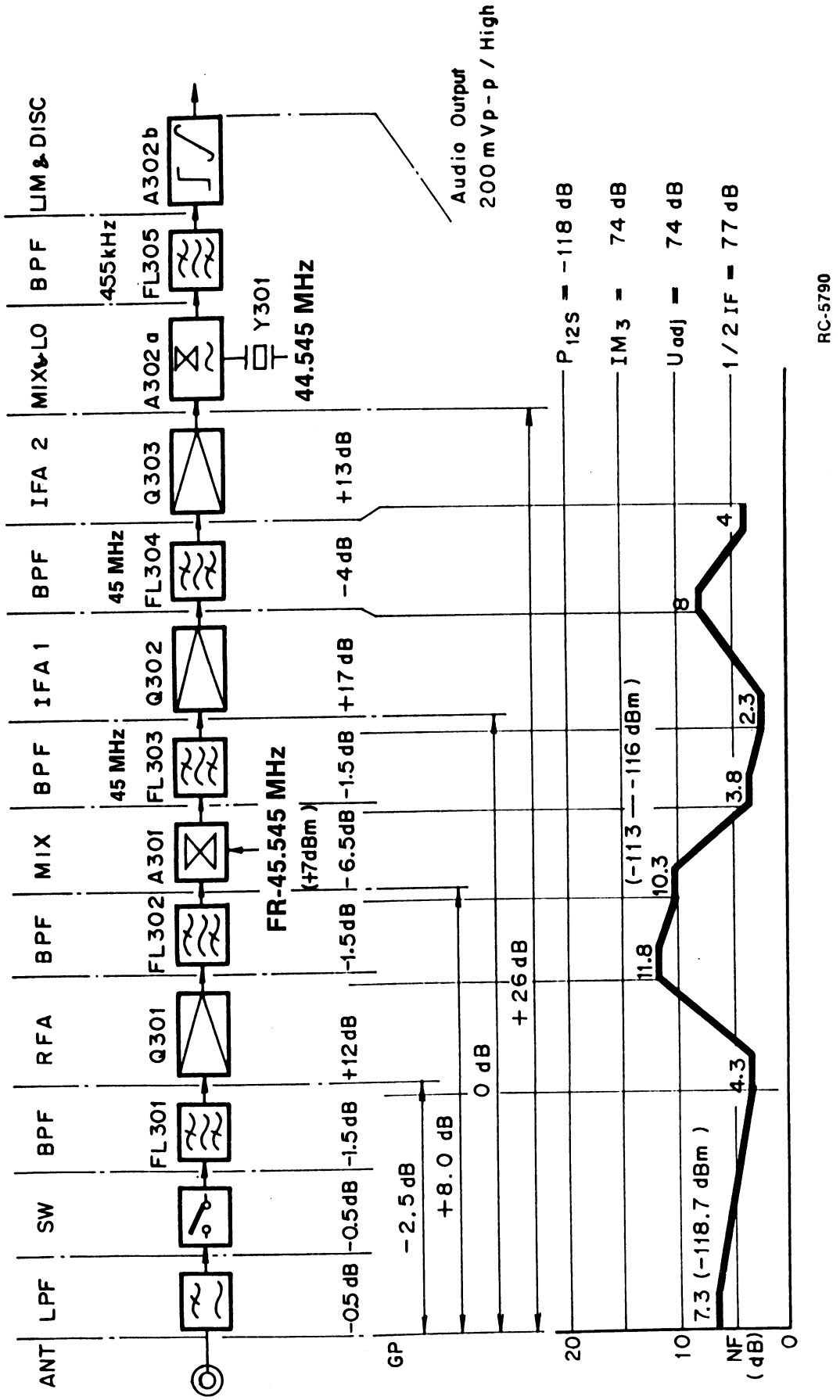


FIGURE 8 - TYPICAL LEVEL DIAGRAM

b. Adjustments:

1. T303 is provided for the adjustment of the second local oscillator. Set the core of T303 to the same level as the top of the case.

2. When the desired channel frequency with standard modulation is applied to the antenna terminal, adjust T304 for maximum output at RX Audio.

3. Adjustment of T301 and T302.

   a. Adjust T301 and T302 in this order to obtain the best SINAD sensitivity.

   b. Next, adjust T302 and T301 in this order to obtain the minimum distortion of RX Audio Output; when receiving a standard modulated signal at 1 mV (-47 dBm).

   c. Repeat steps (a) and (b) two or three times.

   d. If there is more than half a turn difference in the settings of T301 and T302 in the adjustment steps (a) and (b) above, a defective FL303, FL304 or the matching circuit is likely.

c. Receiver First Local Oscillator Level: Local input level to A301 is designed to be +7 dBm/50 ohms. Generally the input level is +2 to +7 dBm. If local input level is 0 dBm or less, sensitivity, intermodulation and second IF spurious will be degraded.

NOTE

The receiver front end filter is pretuned at the factory and does not normally require service. Proper adjustment requires an RF network analyzer or the equivalent of an accurate spectrum analyzer/tracking generator system. The following information is provided for a suitably equipped service shop or service depot.

If the receiver sensitivity changes by more than 5 dB across the band (19 MHz) a circuit defect associated with FL301 and FL302 is likely. The adjustment sequence for the 800 MHz radio is as follows:

1. Apply the output of the network analyzer to the RF coaxial input terminal and connect the loose coupled output from the FL302 output port to the network analyzer input (see Figure 9).

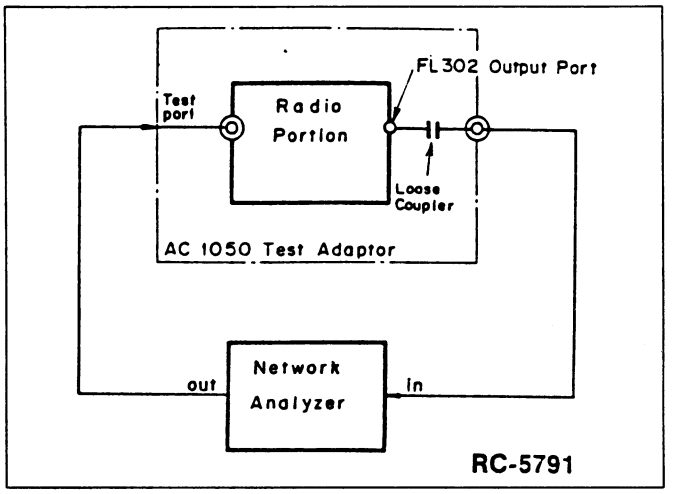


FIGURE 9 - ADJUSTMENT METHOD FOR FL301/FL302

2. Set the sweep frequency of the Network Analyzer to f(M) + 100 MHz and apply markers to f(M), f(L) and f(H) (see Figure 10).

3. Set the level of the Network Analyzer at -20 dB.

4. Set the Network Analyzer to monitor mode S11 and S21.

5. Adjust FL301 for the minimum return loss (S11).

6. Adjust FL302 for optimum gain (S21).

7. Low Noise Amplifier (LNA) is inserted between FL301 and FL302. As S12 is about -15 to -20 dB, FL301 and FL302 have mutual effect. So repeat steps 5 and 6 several times.

8. The guide line for the return loss within the bandwidth is -8 dB or less. The guide line for the gain deviation within the bandwidth is 3 dB or less.

4. High Distortion: If distortion in the received signal is substantially high, try to perform checks with the Radio and Control System individually.

   a. Check the Local Oscillator Frequency: Check the frequency after connecting a frequency counter through a 1 PF capacitor to the collector of transistor Q106. The frequency relation at various stages is shown in Figure 10. If a frequency error is 1 PPM or more in the temperature range of 20 to 25°C, adjust the frequency of TCXO (A103). The frequency of TCXO is 12.8 MHz.

   b. Check the Usable Band Width: Usable band width is generally + 2.5 kHz or more of the desired receiving frequency. If the + balance is greatly different, the received signal may be distorted. This time, the problem is probably caused by FL303, FL304 FL305 or their associated components.

   c. Distortion Check: When the radio receives a standard modulated signal, the audio output at the Audio terminal (J101-4, P101-4) is about 200 mV peak to peak. At this point, the distortion will be about 3%. This is because the receiver discriminator output is connected to the RX Audio terminal and de-emphasis and BP filtering has not at this point, been provided. Because considerable noise is contained from low audio frequencies to high audio frequencies, use test equipment with a high input impedance (>100K ohms) for the distortion measurement.

   d. The audio signal from the RF Board is applied to Analog Board through P101-4 and J7-13 then to the speaker through CAC U14, U27 and A15. Check distortion at each point shown in Figure 11.

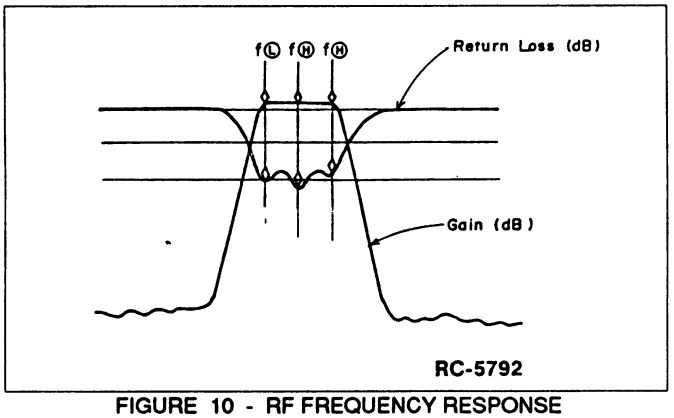


FIGURE 10 - RF FREQUENCY RESPONSE

   e. Even if there are no electrical problems with the audio circuits on the Analog board, the speaker itself may cause distortion mechanically. The voice coil may rub or the diaphragm may be damaged or touching another part of the radio.

5. Noise Squelch Does Not Operate: A part of receiver discriminator output is applied to the Analog Board through J7-13 (P101-4).

   a. The operation of squelch is controlled by CAC IC U14 on the Analog Board.

   b. The squelch operation level is set in the channel data RAM. Set squelch ON level and OFF level in the RAM. (Refer to RAM Programming).

6. Other Problems and Cautions:

   a. Polyimide Flex circuits are used between the VOICE GUARD module and the LCD board. If the VOICE GUARD and LCD Boards are repeatedly disassembled for maintenance, the flex circuits can be damaged. Accordingly, keep disassembly at a minimum.

   b. Tightening clamp screws on the Radio Unit may greatly affect transmitting and receiving spurious. If the Radio Unit is disassembled for maintenance, when assembling, tighten the screws in the unit properly. (Refer to Figure 12).

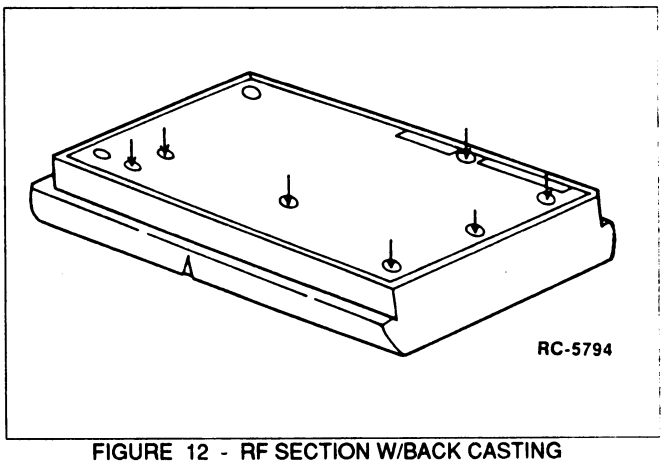


FIGURE 12 - RF SECTION W/BACK CASTING

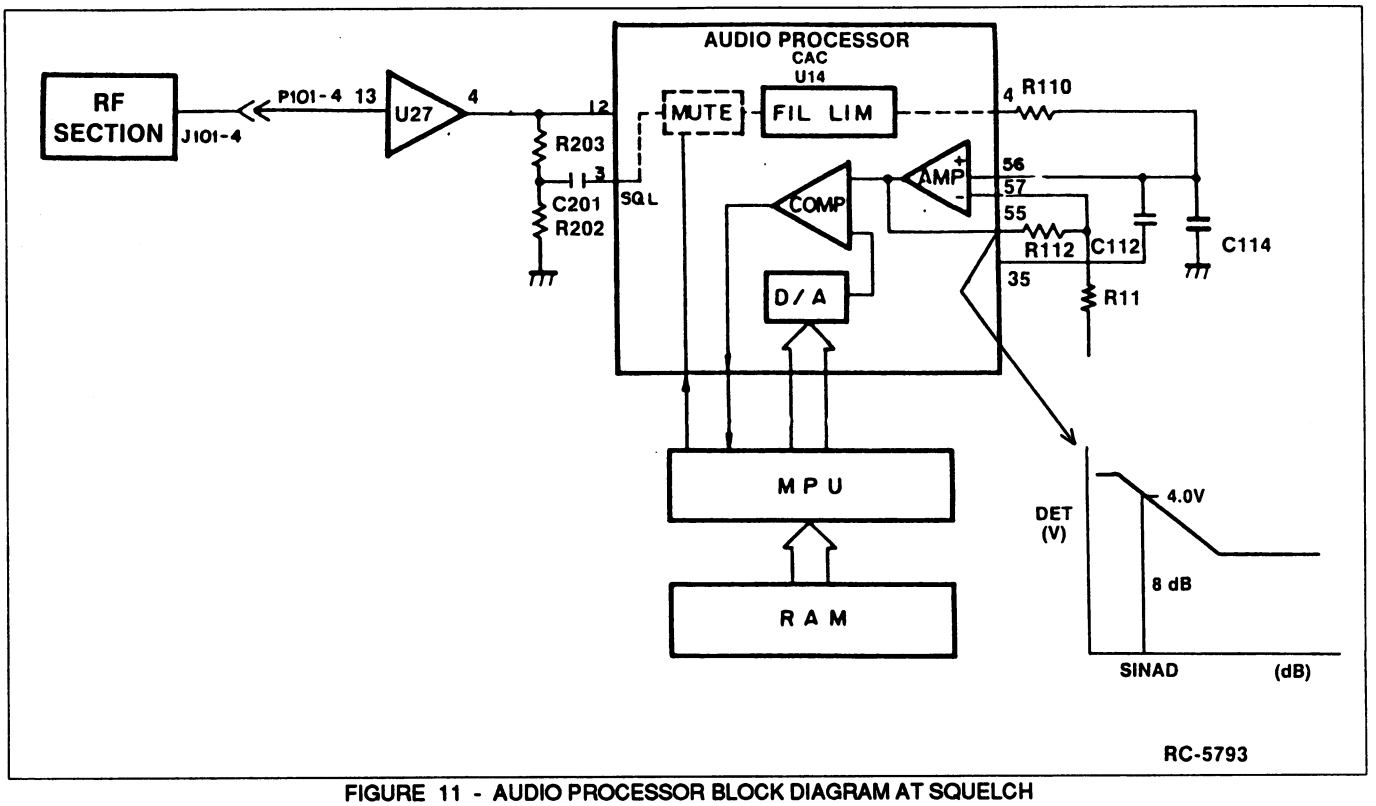
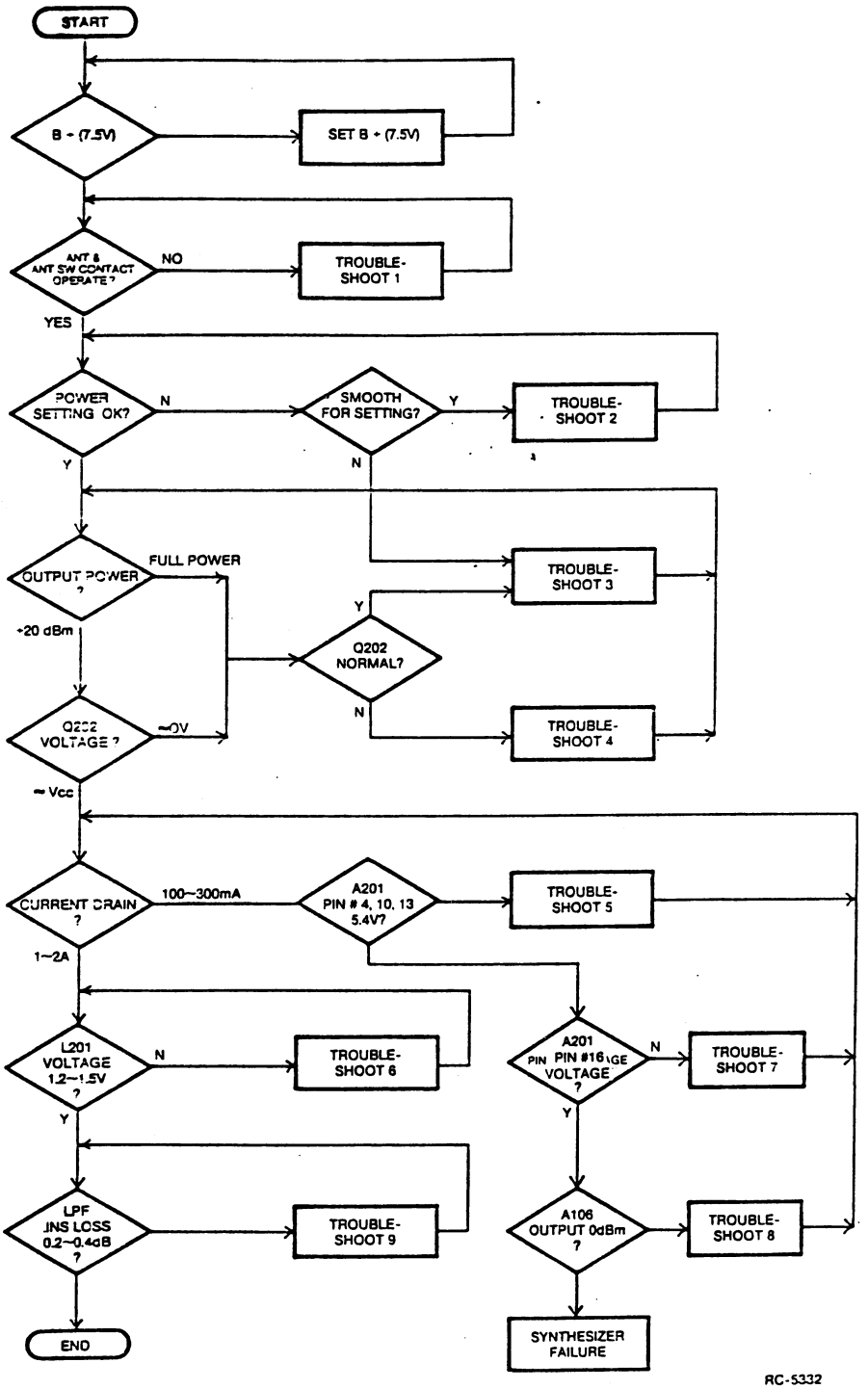


FIGURE 11 - AUDIO PROCESSOR BLOCK DIAGRAM AT SQUELCH

Transmit Circuit

The following Flow Chart and NOTES in the following section: Troubleshooting and Repair for the Transmit Circuit can be used to isolate a defective stage in the transmit circuit.

Flow Chart: (Transmit)



Troubleshooting And Repair For The Transmit Circuit

1. Troubleshooting the Antenna Switch: Antenna switch S101 is a mechanical switch used to switch the RF signal between the antenna and the UDC. Periodically it is necessary to check that the antenna, UDC and the RF Test Adapter (Coaxial Connector) are tightened securely. If the antenna switch does not contact properly even though the antenna and connectors are tightened securely, the contact of S101 may be defective. Replace the switch.

   As prescribed in the Preventive Maintenance section of the applicable maintenance manual, periodically clean the contact of the antenna switch by blowing compressed air on it. Otherwise, dust and dirt will collect on the contact and result in contact failure.

2. Check RF Output: If the transmit circuit can be set for the rated output by adjusting R210, the transmit circuit is working properly.

   Adjustment Procedure

   a. Select the center channel of the frequency range.

   b. Set the power set voltage for 2.5 Volts on J101, Pin 1.

   c. Verify that the transmit RF output is :

      - 5 Watts for VHF
      - 4 Watts for UHF

   Checking

   a. When the rated power output cannot be obtained smoothly with R210, check A203.

   b. If the rated power output cannot be obtained with R210, check transistor Q202.

3. Transistor Q202 Voltage Check: When the collector voltage of transistor Q202 is about 0 volts, Q202 is probably defective. Replace Q202.

4. Voltage Check:

   a. When the collector voltage of Q202 is typically the same as A202, Pin 2, shown in Table 5, verify the voltage has changed by power level.

   b. If the current drain of the battery is in the range of 100 to 300 milliamperes, verify that the voltage on Pins 4, 10 and 13 of A201 is 5.4 volts. If 5.4 volts is not present at these points, the problem is with the TX 5.4 volt supply line (logic). Check to see if there is an open or a short circuit on other lines on the Vcc line.

   c. If 5.4 volts is present on the above pins, check that voltage on Pin 16 of A201 is equivalent to Vcc. If so, then check the output level of A106 (VCO-TO).

   d. When the output of A106 is around 0 dBm, the problem is A201. Replace A201. When the output level is -3 dBm or lower, the VCO in the synthesizer circuit is probably defective. Try the troubleshooting procedure for the Synthesizer to verify the trouble with the VCO. If the VCO is verified to be defective, replace the VCO.

5. Checking Voltage at L201: Under normal conditions, the voltage at the terminal of L201 with respect to ground is 1.2 to 1.5 volts. If this voltage is unusually high or low, the problem is with the diode switch circuit consisting of diodes CR201, CR202, inductor L202 and associated components. Visually check these components for damage or short circuits.

6. Checking the LPF Insertion Loss: If an increase in the insertion loss of the LPF (consisting of L203, L204 and L205, C213-1, C213-2, C214, C215, C216, C2222, C223 and C224) is suspected, the problem is with loose terminal connections of the coils, a short between the coil windings, cracks in the chip capacitors or defective solder connections. Visuslly check for defective components.

PHASE 2: VOICE GUARD MODULE TROUBLESHOOTING

The VOICE GUARD module consists of a board pair: the Analog Board which supports the system control logic and the Digital Board which supports voice encryption. Because of the surface mount technology and the multi layer printed circuit boards which are easily damaged, this module is a **FACTORY REPAIRABLE ITEM ONLY** and repair should **NOT** be attempted **IN THE FIELD.** Therefore troubleshooting is provided only to the level of determining if there is a fault with the VOICE GUARD module. If the module is suspected to be faulty, it may be interchanged with a fully functioning radio for comfirmation. If it is determined that the board pair is faulty, the boards should be returned to the factory for repairs.

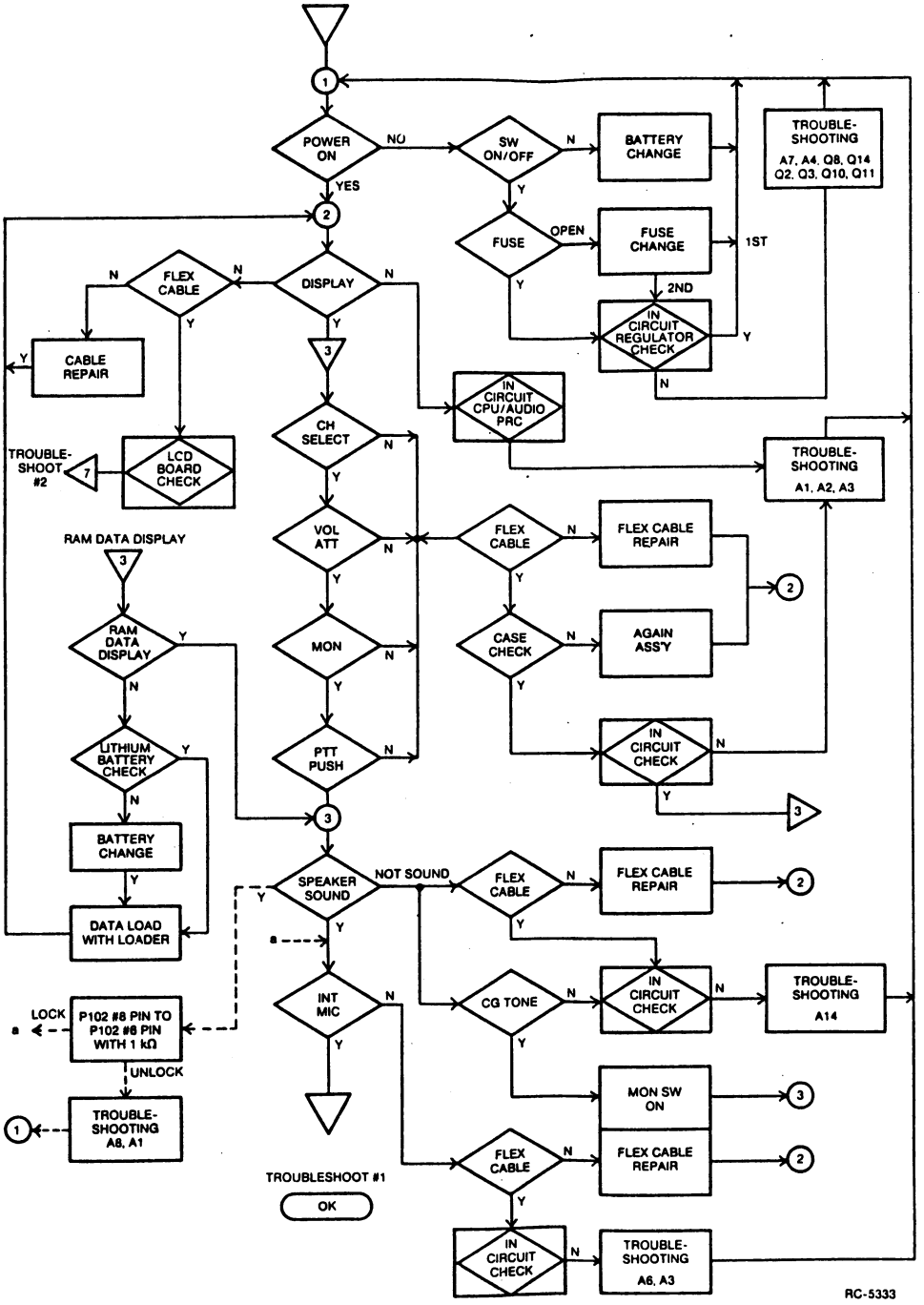
Table 5 - Typical Transmit Voltages

No.	Test Points	Voltage (V)		Remarks
		VHF (5 W)	UHF (4 W)	
1	A201 (15)	0	0	
2	(4)	5.44	5.35	
3	(10)	5.44	5.35	
4	(13)	5.44	5.35	
5	(16)	7.50	7.50	
6	(2)	0	0	
7	A202 (1)	0	0	
8	(2)	<1.13>	<4.15>	Changed by power level
9	(3)	4.84	4.76	
10	(4)	7.50	7.50	
11	(5)	0	0	
12	A203 (3)	0.577	1.48	
13	(5)	6.73	6.54	
14	(6)	7.50	7.50	
15	(11)	5.44	5.34	
16	(14)	0	0	
17				
18				
19				
20				
21				

Troubleshooting:

The following flow chart (Internal Display and Switch Action) can be used to isolate a defective stage located in the Control/Logic on the Analog board.

Flow Chart: (Internal Display and Switch Action)



TROUBLESHOOTING PROCEDURES

These Troubleshooting Procedures are intended to isolate a malfunction to the VOICE GUARD Digital Board, the Interconnect cabling, or to the M-PD radio. Typical problems and possible causes are identified in the following procedures

SYMPTOMS	PROBABLE CAUSES
Transmitter will not key in private mode but will key in clear mode.	• Possible Defective VG module a. Listen for audible alarms. If present, they indicate the absence of a cryptographic key or cryptographic circuitry failure. Cryptographic circuitry failure also produces error messages on the Key Loader display. Try loading a new key. b. Check for proper compression of the anti-tamper switch. c. Check for 7.5VDC (unswitched battery) at P11-4 on top of Analog board, unswitched battery. If all above checks are normal, replace the Analog board.
No TX audio (clear or private)	• Possible defective VG module, microphone, or interconnect cabling. Check the microphone by observing 20-50 mV of audio at P11-6 while transmitting and speaking into the mic. Check the flex strip connections. After the above checks, check the VG module by switching with a known good module.
No private TX audio (clear TX audio OK)	• Possible defective VG module. If the cryptographic key is loaded with no alarms activated and "P_" is visible on the display, a possible Analog Board failure has occurred. Switch the VG module with a known good module.
No RX audio (clear or private)	• Possible defective radio. Check for RX discriminator audio at P101-4. If no audio is present, replace the RF section. If audio is present switch the Analog Board with a known good board.

SYMPTOMS	PROBABLE CAUSES
No clear RX Audio (Private RX audio OK)	• Possible incorrect squelch programming. Monitor Channel by pressing VOL ▲ (up) and VOL ▼ (down) simultaneously. If correct audio is heard, reprogram the radio. • Check for proper CG tone or disable CG.
No private RX Audio	• Check for: distorted output from RX discriminator, wrong data polarity or OA (programming), possible bad Analog module. a. Open the squelch and, if present, disable the Channel Guard so that noise is heard from the speaker. Using a second radio transmit VOICE GUARD speech to the unit. b. Transmit VOICE GUARD to the unit under test again and observe the discriminator output. If it is missing or distorted, the RF unit is defective. c. If VOICE GUARD data is heard from the unit (it sounds similar to discriminator noise), with no breaks, VOICE GUARD did not recognize the data. If there was a brief silent interval at the end of the transmission, data polarity is incorrect in one of the units. d. Check the Outside Addresses. If the system used other than the default "55" OA's, verify that the channel display is correct. e. If the above checks are normal, replace the Analog Board.
Reduced range in the Private mode.	• Possible Analog Board failure. a. Transmit VOICE GUARD data and check deviation and balance. If TX audio eye pattern at J2-1 looks distorted, replace the Analog Board. b. Check for reduced receive range by transmitting VOICE GUARD data to the unit and observe the discriminator output. If the discriminator eye pattern is bad replace the RF section. If it is not distorted, the Analog Board is probably defective.

SYMPTIONS	PROBABLE CAUSES
VG unit looses cryptographic keys when turned off.	• Loss of unswitched battery voltage to the Analog module Turn the power switch off and, with battery installed, check for 7.5 VDC at P11-4. If voltage is not present, check flex circuit and battery connections.
Occasional loss of cryptographic key.	• Possible loose connections. a. Check anti-tamper switch and flex connections to Analog Board. b. Check battery connections.
Radio starts to key then drops out.	• Possible weak battery or bad Analog Board. If battery is normal, check internal power connections. Replace control module.
No display	• No battery voltage to the radio. Check the fuse and the battery pack.
No response to top or front key-pad strokes.	• Possible bad connections to flex strip. Check flex strip for proper installation or broken runs.
Fails to decode Channel Guard tones	• Possible wrong Channel Guard information programmed into radio or bad Analog module. Recheck the Channel Guard information loaded into the radio. If correct information is programmed then replace the Analog board with a known good board.
No TX Channel Guard	Same as above.

SYMPTIONS	PROBABLE CAUSES
Will not operate in PVT mode but clear mode is normal.	• Check for correctly programmed data inversion and OA. • Possible bad Analog Board or wrong Key loaded. Reload with a cryptographic key. If problem still exists change the Analog Board.
Display locks up and can't be changed except by a reset.	• Possible bad Analog Board or short in the flex interconnect. a. Check flex strip interconnection. b. Change board pair with a known good pair.

ERROR MESSAGES

The following is a list of typical error messages that may be shown on the front display of the radio.

ERROR MESSAGE	PROBABLE CAUSE
DES ERROR	Reload the cryptographic key.
RAM FAIL	Reprogram the radio.
KEY ERROR	No Key has been loaded or the wrong key has been loaded. Check the anti-tamper switch.
CH ERROR	Reprogram the radio, a CHECK SUM error has been detected.
BEEPS (Display Flashes)	A synthesizer error has been detected. Try other channels. This indicates a possible bad RF section or need for reprogramming.

REPLACING LITHIUM BATTERY BT1

The M-PD VOICE GUARD Radio Personality Data (operating frequencies, Channel Guard tones, options,...etc.) is programmed into RAM circuit U10 located on the VOICE GUARD Digital board. Lithium battery BT1 is a back up voltage supply for maintaining the data in memory. To prevent loss of this data battery BT1 should be changed on a regularly scheduled basis; about once every three years (under normal conditions the battery should last much longer).

Before attempting to replace the lithium battery, the user may want to copy the Personality Data into a PC/XT preventing any possibility of losing the data during the change over process. However, it is completely possible to accomplish the battery change without loss of data as follows.

Procedure:

1. Separate the front housing from the RF section (refer to the Disassembly Procedure) and remove the five (5) screws holding the VOICE GUARD module in the radio.

2. Unplug the module from the flex strip cables.

3. To maintain the data content in the RAM it is necessary to attach a power source (6.5 -9.0 VDC) to the Digital Board using clip leads. Attach the clip leads to the screw holes at the bottom of the board (refer to the Outline Diagram showing these connections).

WARNING

Be certain supply polarity is correct or damage will occur to the Digital Board.

NOTE

If The RAM data has been copied to the PC and its not necessary to maintain RAM content, the external power supply should not be connected.

4. Remove the plastic cover from the lithium battery.

NOTE

The battery case is positive and the tab is negative (Backwards from what would be expected!).

5. Unsolder the wire from the tab and remove the old battery from the clip.

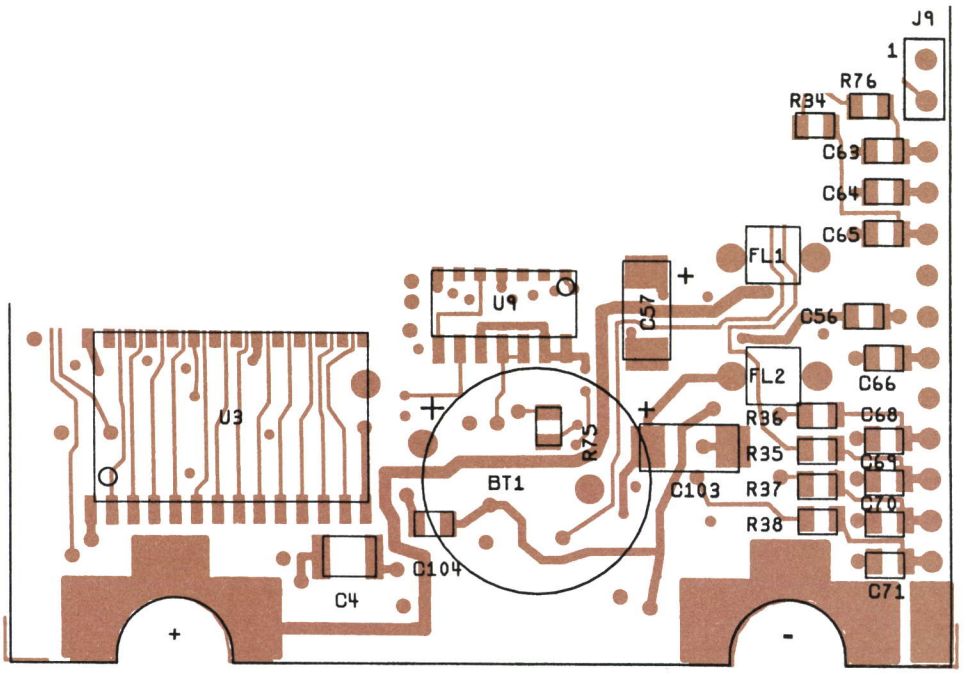
6. Insert the new battery, making sure that the battery case does not touch the ground (refer to the appropriate diagram).

7. Solder the wire to the tab of the new battery.

8. Re-attach the plastic cover to the new battery.

9. Remove the external power supply if one was used.

10. Re-assemble the radio.



Using leads with alligator clips, connect the negative side of the supply voltage to the screw hole on the battery (BT1) side of the Digital Board as shown above. Connect the positive side of the supply voltage to the screw on the opposite side of the board also as shown above.

Outline Diagram for connecting A
Battery supply to the Controller Board

CAUTION

FOR THE VOICE GUARD MODULE. IT IS NOT RECOMMENDED THAT ANY REPAIR WORK BE PERFORMED ON EITHER THE ANALOG BOARD OR THE DIGITAL BOARD. ALL REPAIRS ON THE VOICE GUARD MODULE SHOULD BE DONE AT THE FACTORY.

REPLACING CHIP COMPONENTS

Replacement of chip capacitors should always be done with a temperature - controlled soldering iron, using a controlled temperature of 700°F (371°C). DO NOT touch the black metal film of the resistors of the ceramic body of the capacitors with the soldering iron.

NOTE

The metallized and terminations of these parts may be touched with the soldering iron without causing damage.

REMOVING CHIP COMPONENTS

1. Grip the component with tweezers or needle nose pliers.
2. Alternately heat each end of the chip in rapid succession until solder flows and then remove and discard the chip.
3. Remove excess solder with a vacuum solder extractor or Solderwick®.
4. Carefully remove the epoxy adhesive and excess flux to prevent damage to the printed board.

REPLACING CHIP COMPONENTS

1. Using as little solder as possible, "tin" one end of the component and one of the pads on the printed wiring board.

2. Place the "tinned" end of the component on the "tinned" pad on the board. Simultaneously touch the component and the pad with a well "tinned" soldering iron while pressing the component down on the board.

3. Place the "tinned" soldering iron on the other end of the component and the pad simultaneously. Apply solder to the top of the end of the component until the solder starts to flow. Use as little solder as possible while getting a good solder joint.

4. After the component has cooled, remove all flux from the component and printed wiring board area with denatured alcohol.

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WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U.S.A.

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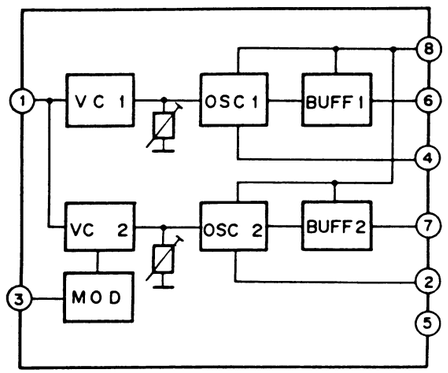
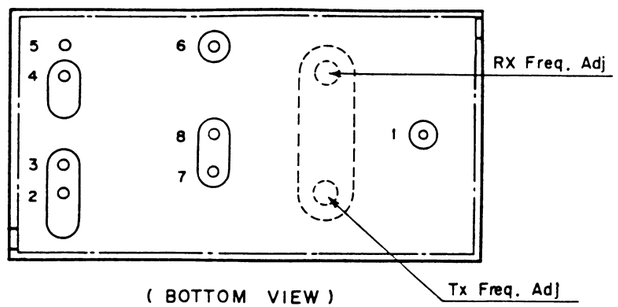
VCO Module / VHF / UHF (T/R)

VCO (VHF) KLH 3551, KLH 3552

(UHF) KLH 3553, KLH 3554, KLH 3555





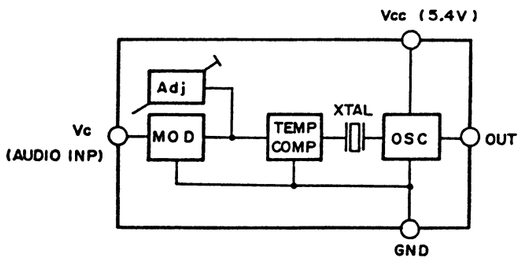
(BOTTOM VIEW)

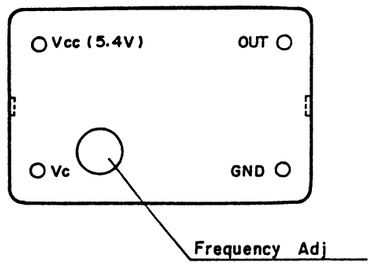
1. Voltage Control
2. TX Switch
3. Modulation Input
4. RX Switch
5. GND
6. RX Output
7. Tx Output
8. 5.4V (Vcc)

RC-5802

VCTCXO / 13.2 MHz

Model 3019 B : (2.5 PPM)

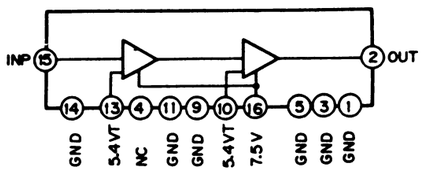




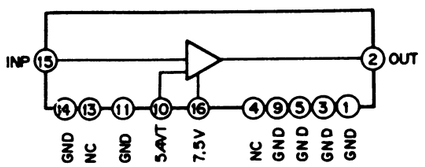
(TOP VIEW)

RC-5634

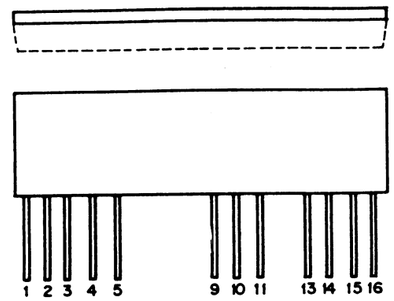
(TX) EXCITER (Gain Hybrid)



KLH 2590
UHF



KLH 2592
VHF

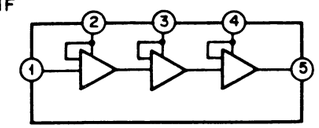


FREQ. RANGE (MHz)	MODEL
403 - 512	KLH-2590
136 - 174	KLH-2592

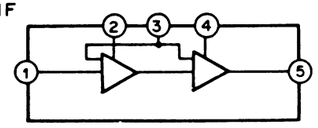
RC-5800

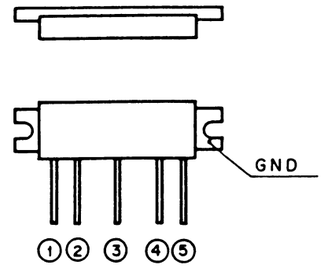
PA-Pack (VHF/UHF/800MHz)

UHF



VHF

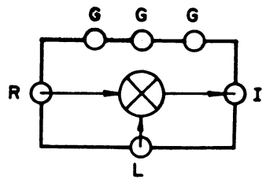


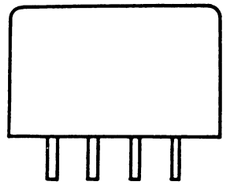


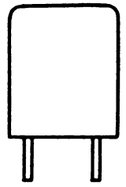
① RF INP (50 ohm)
② Vcc 1 (AGC)
③ Vcc 2 (7.5 V)
④ Vcc 3 (7.5 V)
⑤ RF OUT (50 ohm)

FREQ. RANGE (MHz)	MODEL
470 - 512	M57799H
440 - 470	M57799M
403 - 440	M57799L
150 - 174	M57783H
136 - 160	M57783L

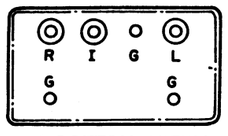
RC-5801







FREQ. RANGE (MHZ)	MODEL
403 – 512	UST - 1L
136 – 174	UST - 2L



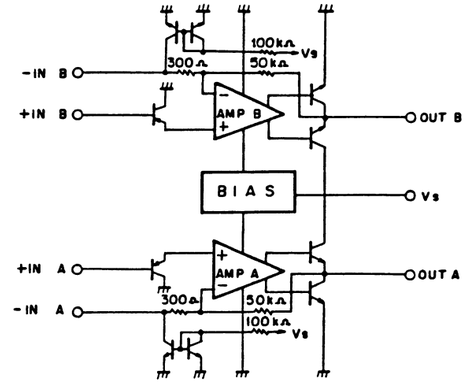
(BOTTOM VIEW)

R : RF INP
I : IF OUT
L : LOCAL OSC INP
G : GND

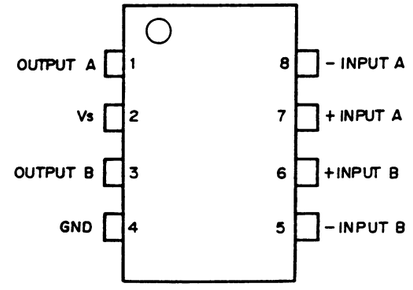
RC-5796

Integrated Circuit / AF Power Amplifier (NJM2073D)

Block Diagram



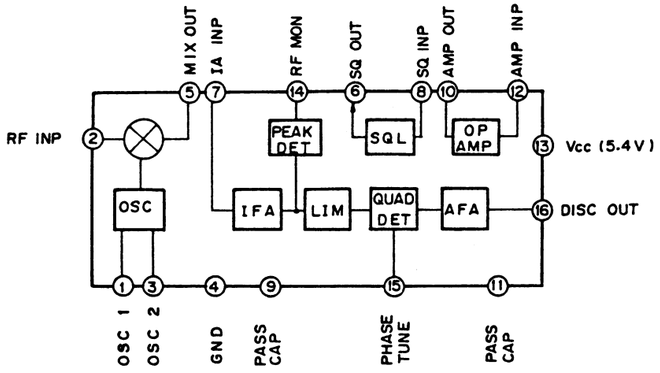
Pin Arrangment



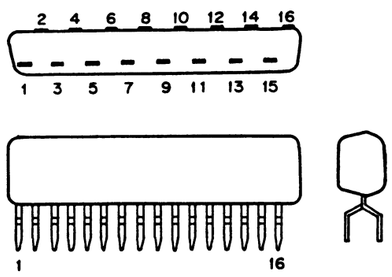
(TOP VIEW)

RC-5639

IF IC A303 HA12442V
K19/2AAJ008089

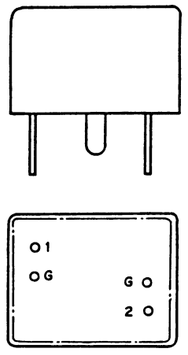


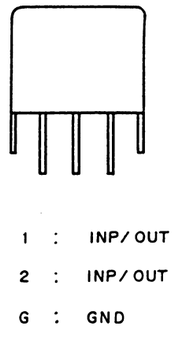
(TOP VIEW)



RC-5637

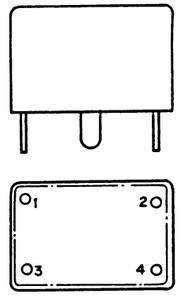
IF FILTER



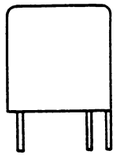


1 : INP/OUT
2 : INP/OUT
G : GND

455kHz IF FILTER



CFX 455E



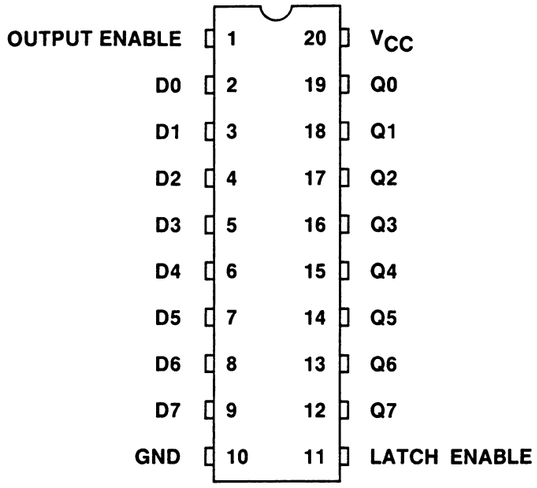
1 : INP / OUT
2 : INP / OUT
3 : GND
4 : GND

RC-5668

NONINVERTING TRANSPARENT LATCH
MC74HC573

U2

PIN ASSIGNMENT

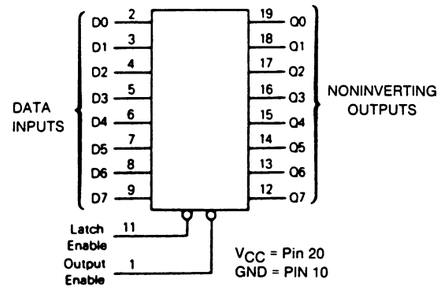


FUNCTION TABLE

INPUTS			OUTPUT
OUTPUT ENABLE	LATCH ENABLE	D	Q
L	H	H	H
L	H	L	L
L	L	X	no change
H	X	X	Z

X= don't care
Z= high impedance

BLOCK DIAGRAM

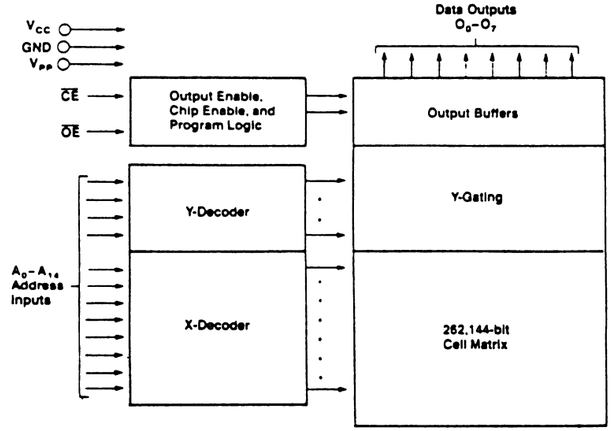


RC-5761

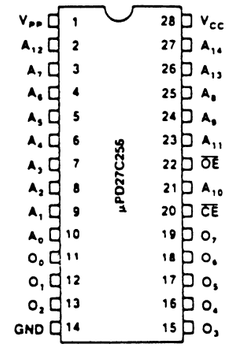
27C256 EPROM

U3

BLOCK DIAGRAM



PIN CONFIGURATION

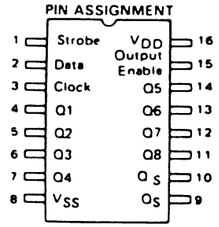


RC-5626

8-STAGE SHIFT/STORE REGISTER MC14094B U6

CAUTION
OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC SENSITIVE DEVICES

PIN ASSIGNMENT



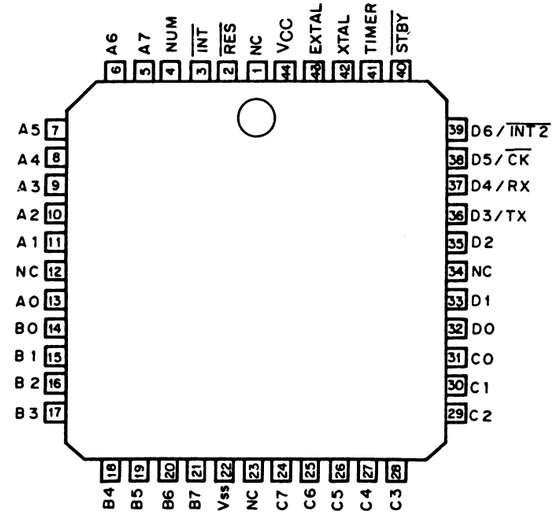
This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range $V_{SS} \leq (V_{in}$ or $V_{out}) \leq V_{DD}$.
Unused inputs must always be tied to an appropriate logic voltage level (e.g. either V_{SS} or V_{DD}). Unused outputs must be left open.

Clock	Output Enable	Strobe	Data	Parallel Outputs Q1	Parallel Outputs Q_N	Serial Outputs Q_S*	Serial Outputs Q'_S
⌐	0	X	X	Z	Z	Q7	No Chg.
¬	0	X	X	Z	Z	No Chg	Q7
⌐	1	0	X	No Chg.	No Chg.	Q7	No Chg.
⌐	1	1	0	0	Q_N-1	Q7	No Chg.
⌐	1	1	1	1	Q_N-1	Q7	No Chg.
¬	1	1	1	No Chg.	No Chg.	No Chg.	Q7

Z = High Impedance
X = Don't Care
* At the positive clock edge, information in the 7th shift register stage is transferred to Q8 and Q_S.

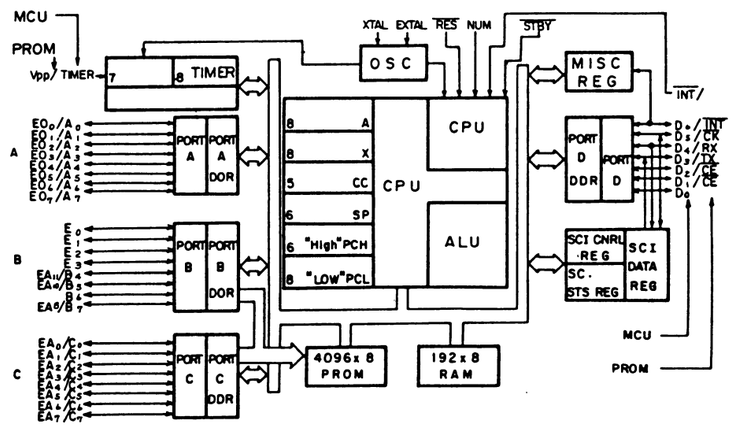
RC-5628

MICROPROCESSOR 63C05 U7



(TOP VIEW)

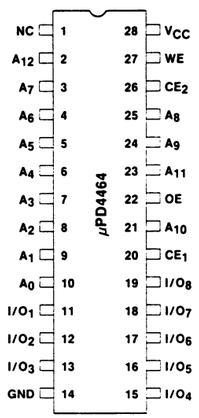
BLOCK DIAGRAM

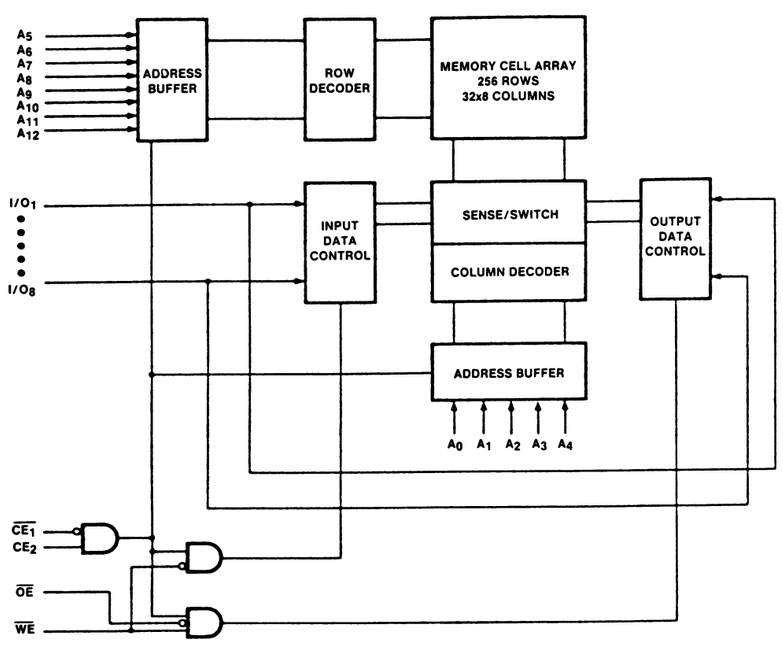


RC-5629

μPD4464
RAM

U10

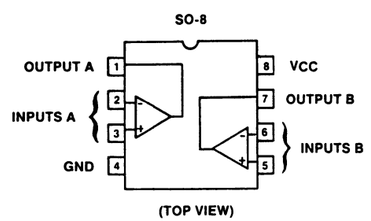




RC-5764

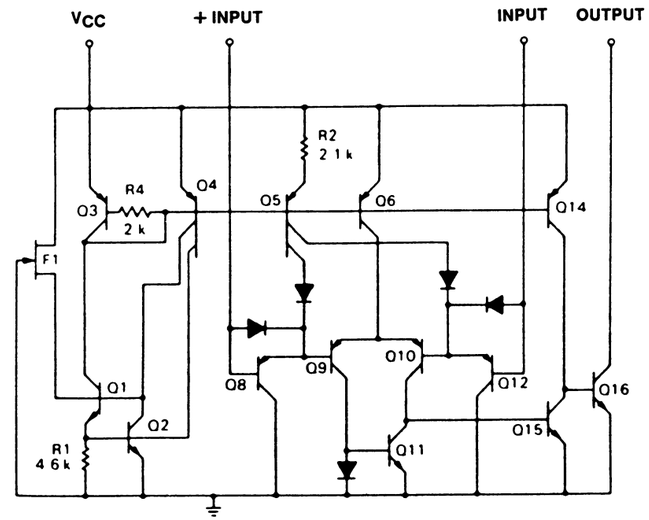
LM2903
DUAL COMPARATORS

U11/U32



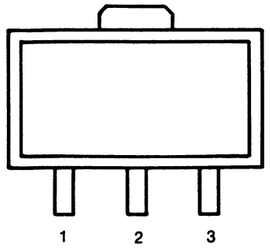
CIRCUIT SCHEMATIC

(Diagram shown is for 1 comparator)



RC-5765

VOLTAGE REGULATOR S-81250HG (A17,A203) U17



(TOP VIEW)

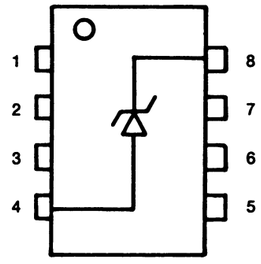
S0T-89 PKG

1. GND
2. V IN
3. V OUT

RC-5623

DIODE PACKAGE LM385-2.5 (A8) U18

PIN ARRANGEMENT

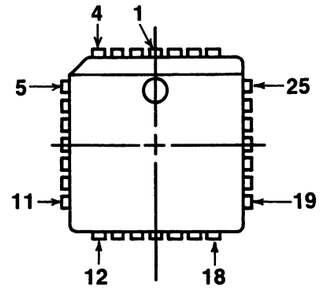


(TOP VIEW)

S0-8 PKG

RC-5622

ENCRYPTION/DECRYPTION DEVICE 19B801375P1 U19



PIN DESCRIPTION FORM

NAME	TYPE	FUNCTION	PIN
		NOT USED	1
		NOT USED	2
		NOT USED	3
DB0	BIDIR	UP DATA BUS BIT 0	4
DB1	BIDIR	UP DATA BUS BIT 1	5
DB2	BIDIR	UP DATA BUS BIT 2	6
DB3	BIDIR	UP DATA BUS BIT 3	7
DB4	BIDIR	UP DATA BUS BIT 4	8
DB5	BIDIR	UP DATA BUS BIT 5	9
DB6	BIDIR	UP DATA BUS BIT 6	10
DB7	BIDIR	UP DATA BUS BIT 7	11
VDD	POWER	+5V	12
		NOT USED	13
		NOT USED	14
		NOT USED	15
		NOT USED	16
		NOT USED	17
$\overline{RD}$	INPUT	UP BUS READ	18
BSY	OUTPUT	DES BUSY	19
		NOT USED	20
$\overline{CLK}$	INPUT	800 kHz CLOCK	21
$\overline{WRT}$	INPUT	UP BUS WRITE LINE	22
$\overline{CS}$	INPUT	CHIP SELECT	23
RS	INPUT	REGISTER SELECT	24
POC	INPUT	POWER ON CLEAR	25
VSS	GROUND	OV	26
		NOT USED	27
		NOT USED	28

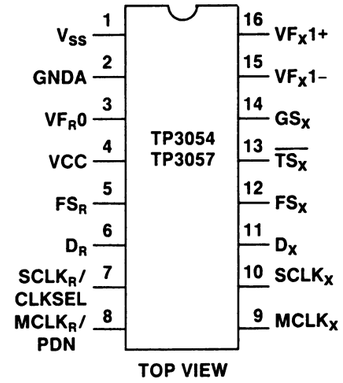
RC-5756

TP3054J
CODEC FILTER

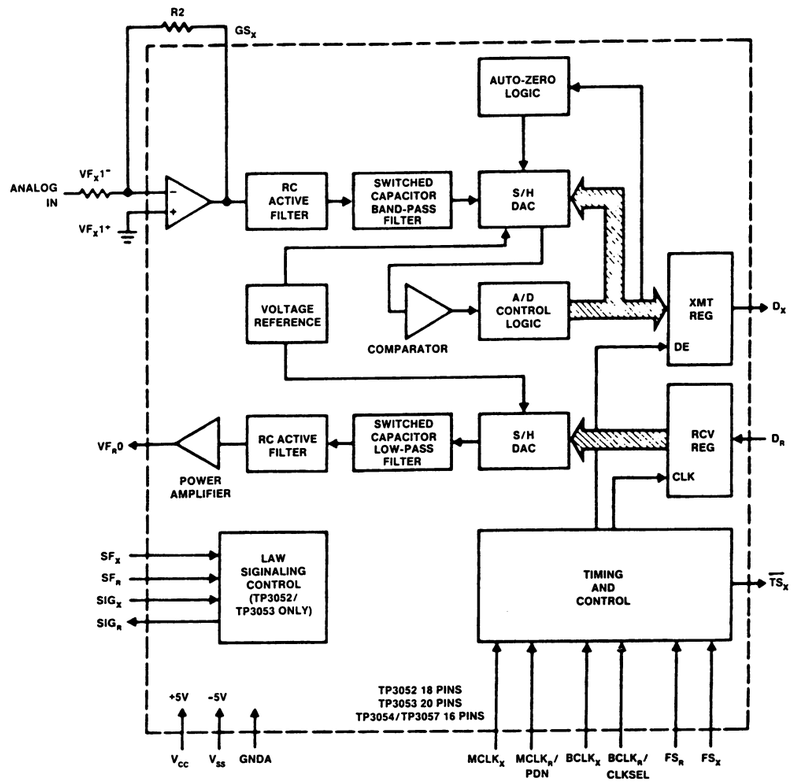
U22

CONNECTION DIAGRAM

DUAL-IN-LINE PACKAGE



TOP VIEW

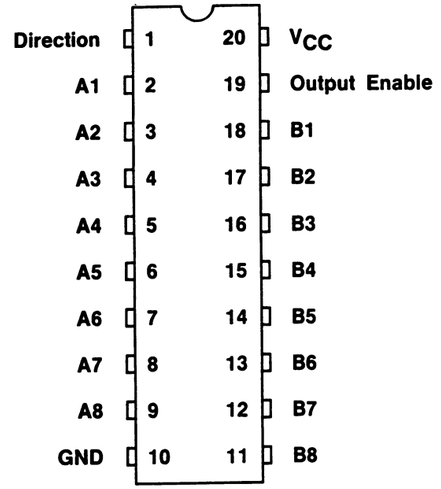


RC-5768

MC54/74HC245
BUFFER

U23

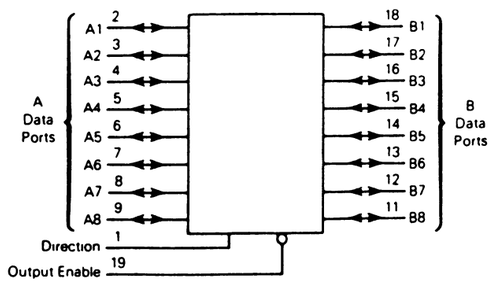
PIN ASSIGNMENT



FUNCTION TABLE

Control Inputs		
Output Enable	Direction	Operation
L	L	Data transmitted from Bus B to Bus A
L	H	Data transmitted from Bus A to Bus B
H	X	Buses Isolated (High-Impedance State)

BLOCK DIAGRAM

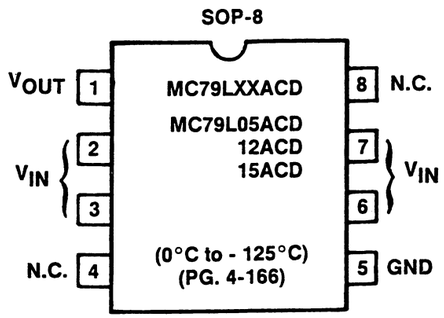


RC-5769

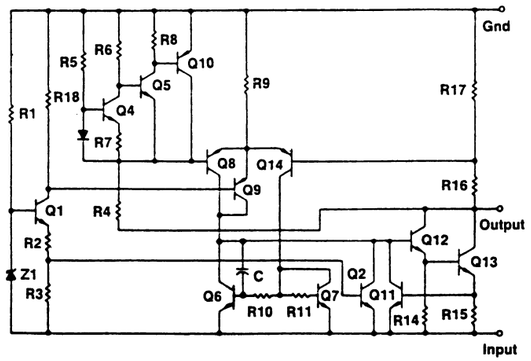
MC79L05ACD
-5 VOLT REGULATOR

U28

SOP-8



REPRESENTATIVE CIRCUIT SCHEMATIC

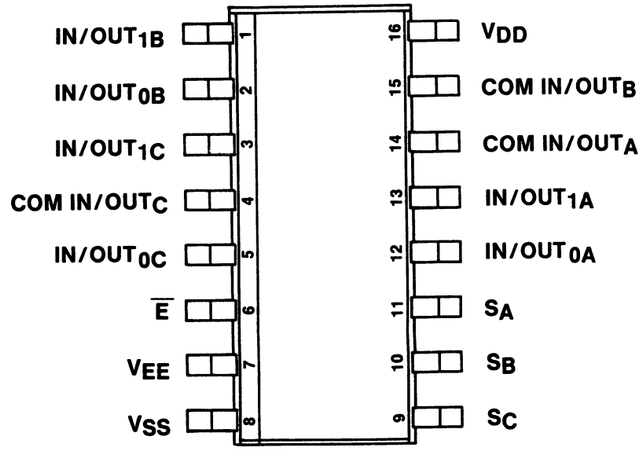


RC-5774

BILATERAL SWITCH 4053BM OR BT
19A702705P2
(TRIPLE 2-CHANNEL ANALOG MDX)

U29

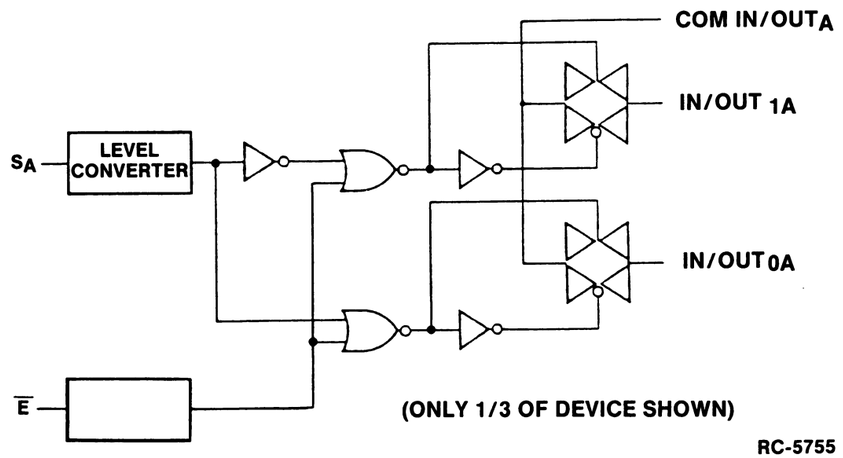
PIN CONFIGURATION



FUNCTION TABLE

INPUTS		CHANNEL ON
$\overline{E}$	S_A	
L	L	IN/OUT_{0A} — COM_A
L	H	IN/OUT_{1A} — COM_A
H	X	NONE

LOGIC DIAGRAM



(ONLY 1/3 OF DEVICE SHOWN)

RC-5755

ADDENDUM NO. 1 TO LBI-31918
(PCPD)

This addendum adds to the **M-PD VOICE GUARD SCAN** Service Section (LBI31918) a maintenance procedure for restoring the weather proof integrity of an M-PD radio after it has been disassembled for repair.

MAINTAINING WEATHERPROOF INTEGRITY

The following maintenance procedure is required in order to assure that the radio housing will continue to meet the weatherproof features as designed.

1. Replace key pads which become damaged or torn (top surface, UDC/PTT side panel and front surface on System Radio).

2. Check the "O" ring at base of the antenna when the antenna is removed. Check the housing seal around flanges of the rear cover when the radio unit is opened. Avoid pinching or abrading seals when assembling. Use a light coating of Silicone Grease (GE Co. #623 Clear Silicone Protector, or equivalent) on sealing surfaces of "O:" rings to provide lubrication and to increase surface tension for waterproofing. **NOTE: Antenna must be assembled securely to the top of the radio. Tighten to two (2) to three (3) inch-pounds torque (40 inch-ounces).**

If Front Housing is Disassembled: (Steps 3 through 6)

3. Check seating of rubber seal under UDC/PTT area if the side panel is removed for repair or replacement.

4. Assure that speaker and other screws which retain the front plastic escutcheon are tight. Replace washers where fitted. A light coat of silicone grease on these screw threads as well as on the surface of the speaker gasket where it seats against the casting is desirable.

5. Check the gasket surrounding the LCD window and the film inside the casting which seals the UDC opening in the casting. Assure an unbroken seal, proper seating and no damage. On the system radio, check seating of the front key pad.

6. A coat of silicone grease should be applied to the dove tail edge of the plastic base plate if removed from the casting during repair or replacement.

continued

Battery Assembly:

7. Replace the battery pack if the housing is cracked or broken.

The contacts of the power on/off switch may be cleaned and burnished by removing the two (2) screws which retain the plastic frame to the battery pack housing. The switch mechanism is not protected against water entry. However, no access to the inside of the battery case is afforded in this area. The screws retaining the plastic frame must be tightened securely, but not over tighten (to avoid stripping) when reassembling.

No other maintenance is possible since the battery pack is a permanently sealed assembly.