M-PD 16 PLUS PERSONAL RADIO SERVICE SECTION

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INTRODUCTION

The recommended troubleshooting procedure, as illustrated in Figure 1, is to isolate the fault to a specific section of the M-PD 16 PLUS Personal radio; the radio section; the control logic section or the battery pack. Then further localize the fault to a specific stage of the suspected section. The last step is to isolate and identify the defective component.

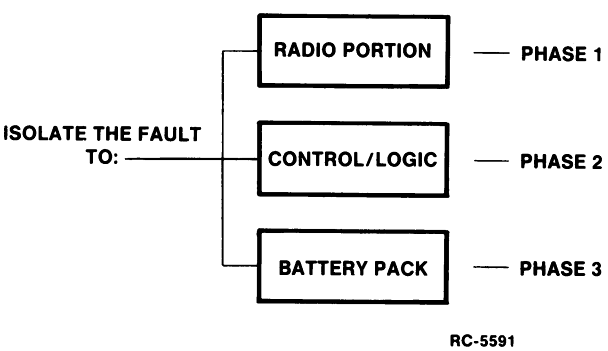


Figure 1 - Recommended Troubleshooting Procedure

The following list of test equipment is recommended when servicing or troubleshooting the M-PD 16 PLUS Personal radio.

Recommended Test Equipment:

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

PHASE 1: RADIO SECTION TROUBLESHOOTING

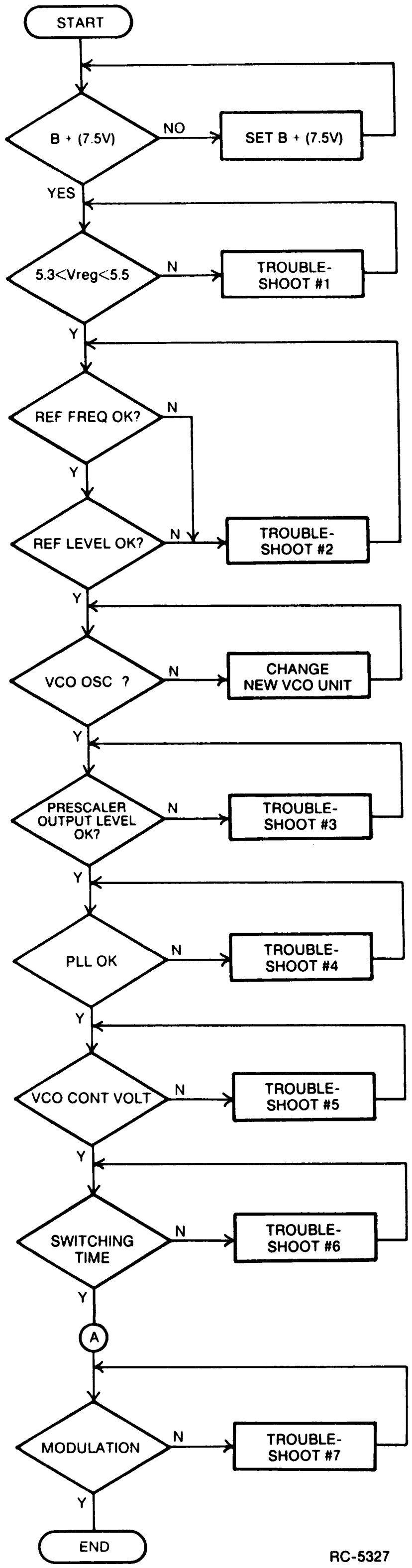
Functional Troubleshooting

Once the fault has been isolated to the radio section, the next step is to further isolate the fault to a specific stage of the radio 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 radio section.

Synthesizer

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

Synthesizer Flow Chart:



Troubleshooting and Repair For the Synthesizer:

1. 5.4 Volt Regulator

The 5.4 Volt regulator consists of operational amplifier A104 (1/2) and transistors Q102 and Q103. Reference voltage 5.4 volts comes from the control board through J102-6. If a fault is found with the regulated 5.4 Volt output line, trace the fault source along this line back to the regulator. A typical current flowing through resistor R129 is 33 mA. Typical voltages for the synthesizer are shown in Table 1 (see Pages 5 & 6).

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

2. Reference Oscillator VCTCXO (A103)

The reference oscillator is contained in one assembly. 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 2.

Table 2 - Typical Data for the Reference Oscillator

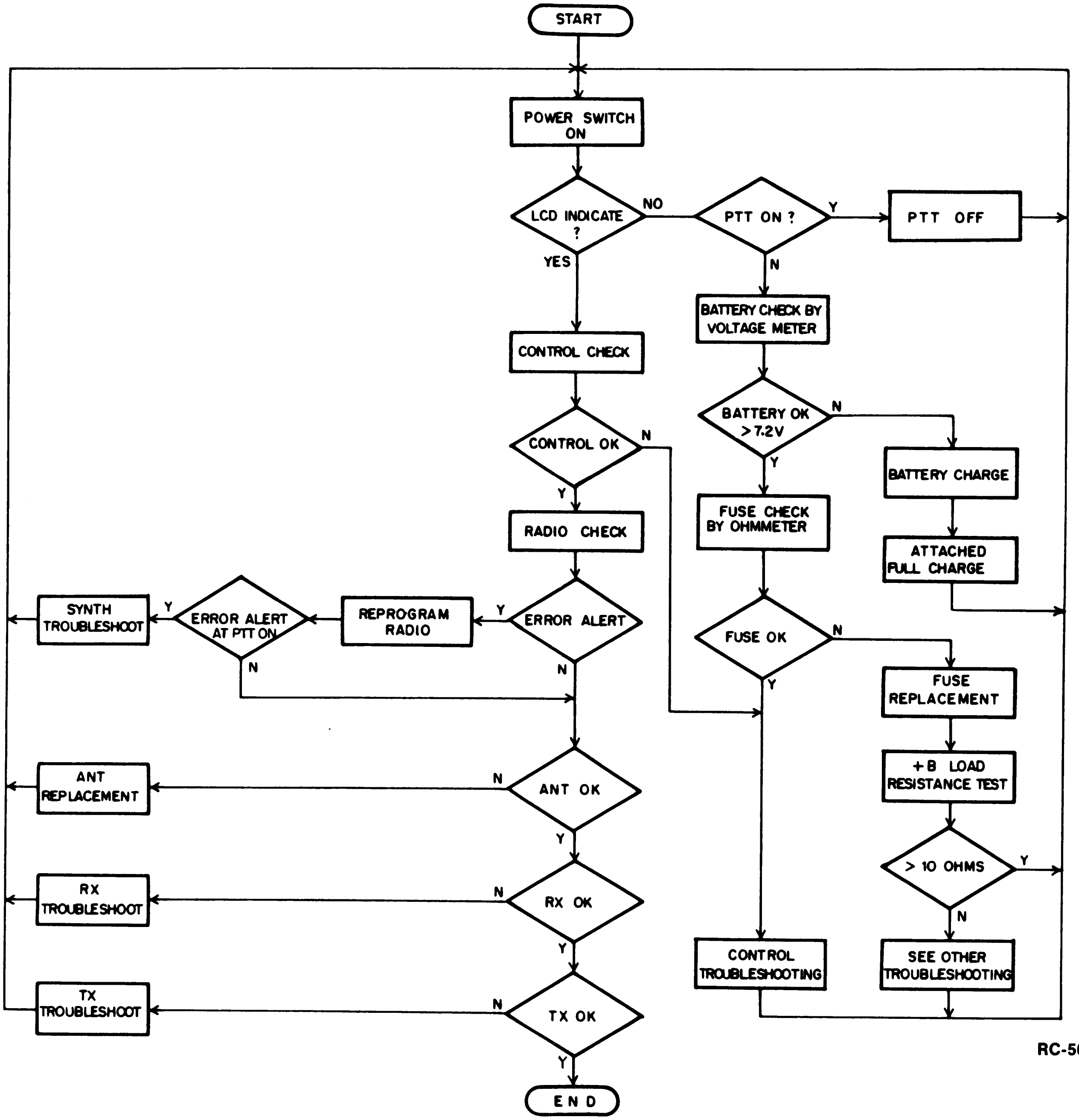
Item	Typical Value	Remarks
Supply Voltage	5.4 VDC	
Current Drain	1.5 to 1.8 mA	2.5PPM
Output Frequency	13.2 MHz	
Output Level	1 to 2 Vp-p	

3. Prescaler Output Level

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 a capacitor. After amplification, the output is applied to the input of the Prescaler, which is operating under 128/129 modulus control. The input level to the prescaler ranges from 0.2 volts to 0.8 volts pp. A typical prescaler output level is 1 volt pp, which is applied to the input of the PLL.

When checking the prescaler, refer to the typical value on Table 1.

Functional Troubleshooting Flow Chart:



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4. Phase-Lock-Loop (A2)

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

b. Check that the reference signal frequency is 13.2 MHz and that frequency is ±2.5 PPM.

c. Measure the input from the prescaler at Pin 10 of A012 and verify approximately 1 volt pp input level.

d. Verify that approximately 5 Volts pp (Vss-Vcc) control pulse is present at Pin 10 of prescaler control A012.

e. Cause the PLL to unlock. Then check for the presence of approximately 5 Volts pp (Vss-Vcc) PD and FD pulse outputs at Pin 6 and Pin 17 of A102 respectively. Also check for approximately 7 Volts (Vss-+B) at Pin 7 of A104. 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 trouble source is ramp resistor R108, ramp capacitor C108 or hold capacitor C110.

f. Verify that the local voltages at the test points listed on Table 1 agree with the typical values also listed on Table 1.

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.

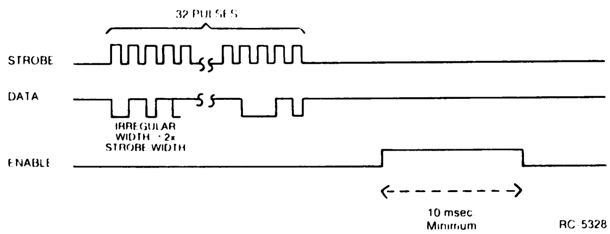


Figure 2 - STROBE, DATA and ENABLE Signals

5. VCO Control Voltage

a. VCO Control Voltage should be:

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

Verify the VCO control voltage at the CONT terminal of A106 using a high impedance 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 Control.
- Key the radio and adjust the transmit VCO.
- The 800 MHz M-PD 16 PLUS without talkaround has only one VCO, adjusted in receive. An 800 MHz M-PD with talkaround has two VCO's.

c. After the adjustments, 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.

Table 1 - Synthesizer Portion Typical Voltage

No.	Test Points	Voltage (V)	Remarks
1	A101 (1)	2.00	
2	" (2)	4.80	
3	" (3)	0	
4	" (4)	2.74	
5	" (5)	-	
6	" (6)	-	
7	" (7)	-	
8	" (8)	2.00	
9	A102 (1)	3.94	
10	" (2)	2.40	
11	" (5)(19)	5.25	
12	" (6)(17)	0.93	
13	" (8)	-	
14	" (9)	5.25	
15	" (10)	2.30	
16	" (11)	0	
17	" (12)	4.94	
18	" (13)	0	
19	" (15)	0.53	
20	" (18)	1.93	
21	" (20)	3.70	
22	A103 VCC	5.41	
23	A104 (1)	0.83	
24	" (2)	2.70	
25	" (3)	2.70	
26	" (5)	0.93	
27	" (6)	0.93	
28	" (7)	2.94	
29	" (8)	7.40	
30	A105 (1)(4)	2.93	
31	" (2)(3)	2.93	

Table 1 - Synthesizer Portion Typical Voltage

No.	Test Points	Voltage (V)	Remarks
32	A105 (5)(13)	0	
33	" (6)(12)	0	
34	" (7)	0	
35	" (8)(11)	0	
36	" (9)(10)	0	
37	" (14)	5.25	
38	A106 CONT	2.90	
39	" MOD	5.10	
40	" RS	-	At RX Mode
41	" TS	-	"
42	" BS	1.53	"
43	" TO	-	
44	" RO	-	
45	" OUT	0	
46	" PS	5.13	
47	Q101 Base	1.08	
48	" Emitter	0.366	
49	Q101 Collector	4.80	
50	Q102 Base	6.73	
51	" Emitter	7.40	
52	" Collector	5.40	
53	Q103 Base	0.83	
54	" Emitter	0.28	
55	" Collector	6.70	
56	Q104 Base	-	At RX Mode
57	" Collector	-	"
58	Q105 Base	0	"
59	" Collector	1.53	"
60	Q106 Base	1.30	
61	" Emitter	0.66	
62	" Collector	6.96	

a. Switching time is largely influenced by the leakage current characteristics of C108, C110, C114 and C116. Be sure to use parts having the ratings specified on the Parts List when replacing these parts. Also, if moisture collects on the printed wire board, the insulation resistance of the board may be lowered, also affecting the switching time.

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

7. Modulation Degree vs Modulation Flatness:

The M-PD 16 PLUS equipment can be modulated with audio beginning with 1 Hz. For this reason, the same modulation signal is applied to both 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 radio section only.
2. For this adjustment, select the center channel.

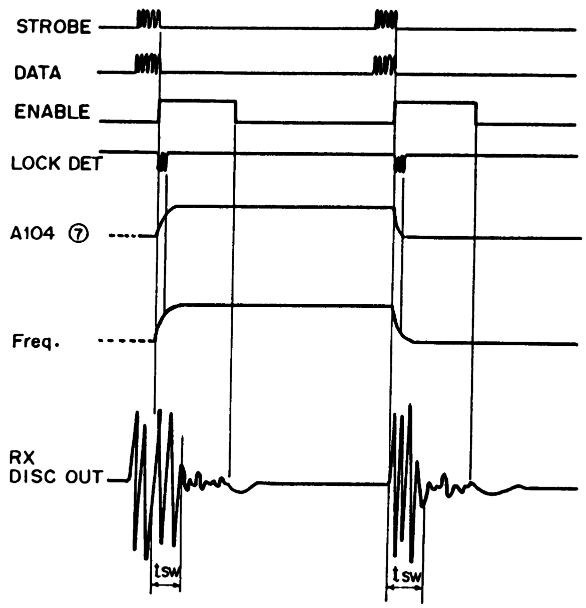


Figure 3 - Logic Format

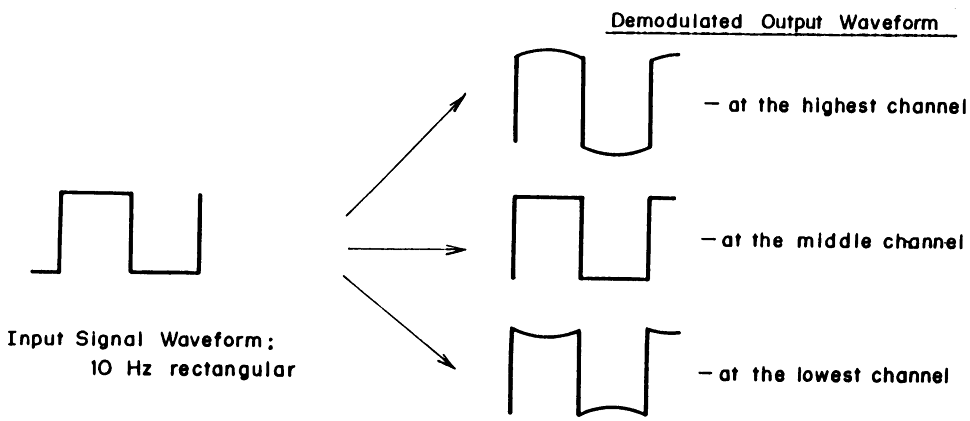


Figure 4 - Typical Rectangular Waveform of Demodulated Output

Procedure:

1. Apply 0.55 Vrms/1 KHz signal at the TX audio terminal and adjust R117 for 3 KHz deviation.

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

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

NOTE

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

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

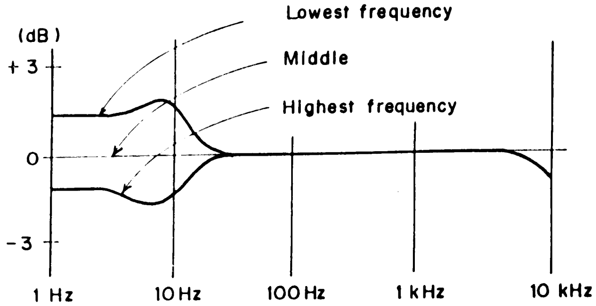


Figure 5 - Typical Modulation Frequency Characteristics

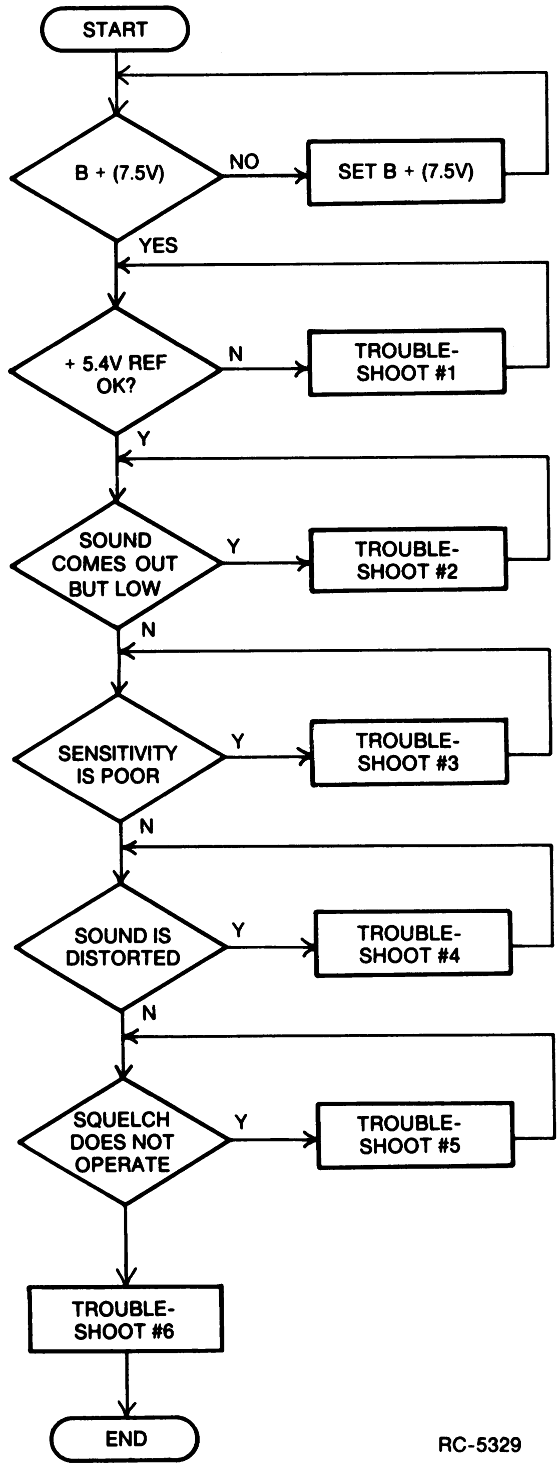
If a large level difference is found between the modulation characteristics at 10 Hz and those at 100 Hz when the carrier freqency is changed from the highest to the lowest, the problem is with the VCO modulation characteristics. Replace the VCO with a new one.

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 frequency may be affected by modulation. It is recommended to replace the VCTCXO with a new one.

Receive

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

Flow Chart:



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Troubleshooting and Repair for the Receiver:

1. Measure the voltage at J102 (P102) Pin 6. When the voltage is less than 5.4 volts, the 5.4 Volt regulator circuit on the System Board is probably faulty. The 5.4 volt regulator circuit consists of precision reference diode A18, operational amplifier A11, and transistor Q2 located on the System Board.

   a. Local voltages are shown on Table 3. Especially check A18, A11, and Q2.

   b. Reference voltage (5.4V) is determined by A18. The 5.0 volt supply to the System Board is provided by A17, Q9 and Q14. Also, the 5.4 volt supply to the radio section is provided by A11, Q2 and Q7.

   c. If local voltages are very different from typical values listed in Table 3, repair that section.

2. If sound comes out of the receiver, but the volume does not increase, the problem may be due to either the Radio section or the Control section.

   a. Radio Section: Check the output signal for about 200 mV p-p 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 supplied at the antenna terminal or UDC RF connector. If the signal level at the audio terminal of the RX is substantially low, IC A302 is suspected to be defective.

   b. System Board: The receive RF signal comes into P101, Pin 4 and is amplified by audio amplifier A13-C. The signal is then applied through a 300-3000 Hz BPF and a 46 dB volume level control. The signal is then amplified by audio amplifier A202-A and SPK amplifier A15 to drive the speaker. Typical levels needed to obtain a 1 KHz, 0.5 Watt receive rated audio output are shown in Figure 6.

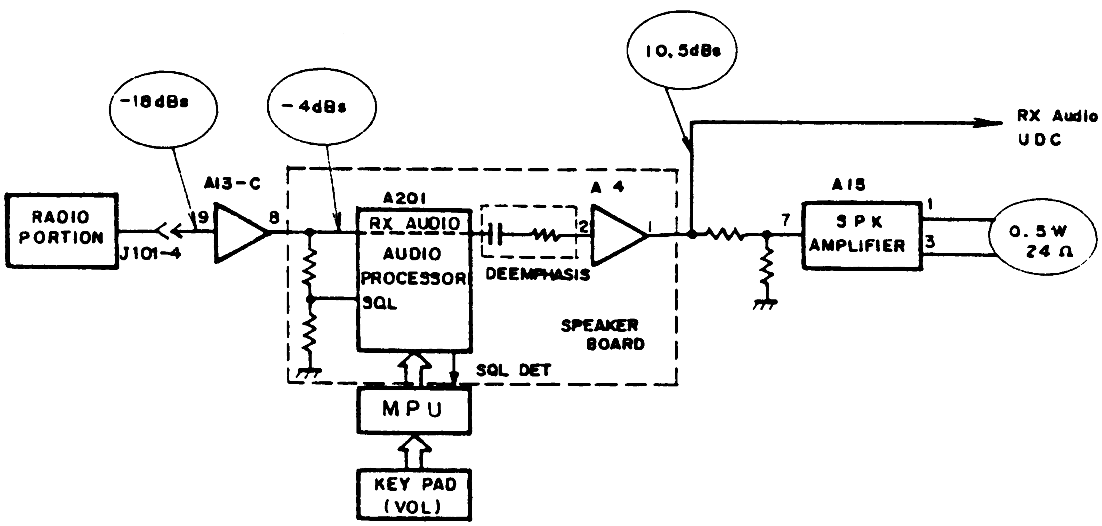


Figure 6 - Receive Audio Output

Table 3 - Receive Section Typical Voltages

No.	Test Points	Voltage (V)	Remarks
1	Q301 Base	0.75	
2	" Collector	6.96	
3	Q302 Base	0.74	
4	" Collector	4.98	
5	Q303 Base	0.74	
6	" Collector	4.93	
7	Q106 Base	1.28	
8	" Collector	6.97	
9	" Emitter	0.66	
10	A302 (1)	1.44	
11	" (2)	5.40	
12	" (3)	0.80	
13	" (5)	5.00	
14	" (7)	4.49	
15	" (9)	4.49	
16	" (11)	4.49	
17	" (13)	5.40	
18	" (14)	2.40	Changed by receiving input level
19	" (15)	5.40	
			at RX input = -47 dBm

3. When receive sensitivity is poor, refer to the radio section Schematic Diagram: A2WE03707 and typical voltages shown on Table 3. The receive section consists of low noise amplifier Q301, local oscillator amplifier Q106, first IF amplifier Q302 and Q303 and second IF circuit IC A302.

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

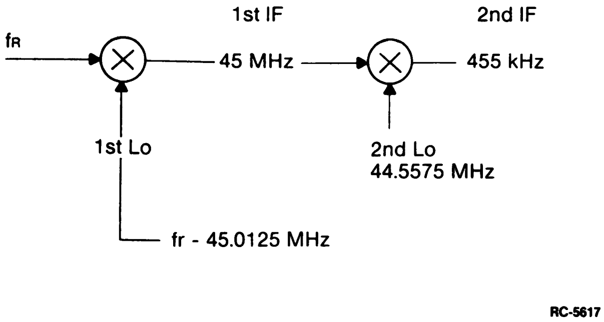


Figure 7 - Frequency Relationship Diagram

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 maxium 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.

(c) If there is more than half a turn difference in the settings of T301 and T302 in the adjustments 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 +6 to +8 dBm. If local input level is 3 dBm or less, sensitivity, intermodulation and IF/2 spurious will be degraded.

d.

NOTE

The receive 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 suitably equipped shops or service depots.

If the receive sensitivity changes by more than 5 dB across the band (19 MHz) a circuit defect associated with FL301 and FL302 is likely.

4. 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 Q106. The frequency relation at various stages is shown in Figure 8. If a frequency error is 1 PPM or more in the temperature range of 20 to 25°C, adjust the frequency of VCTCXO (A103). The frequency of VCTCXO is 13.2 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 its 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 pp. 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

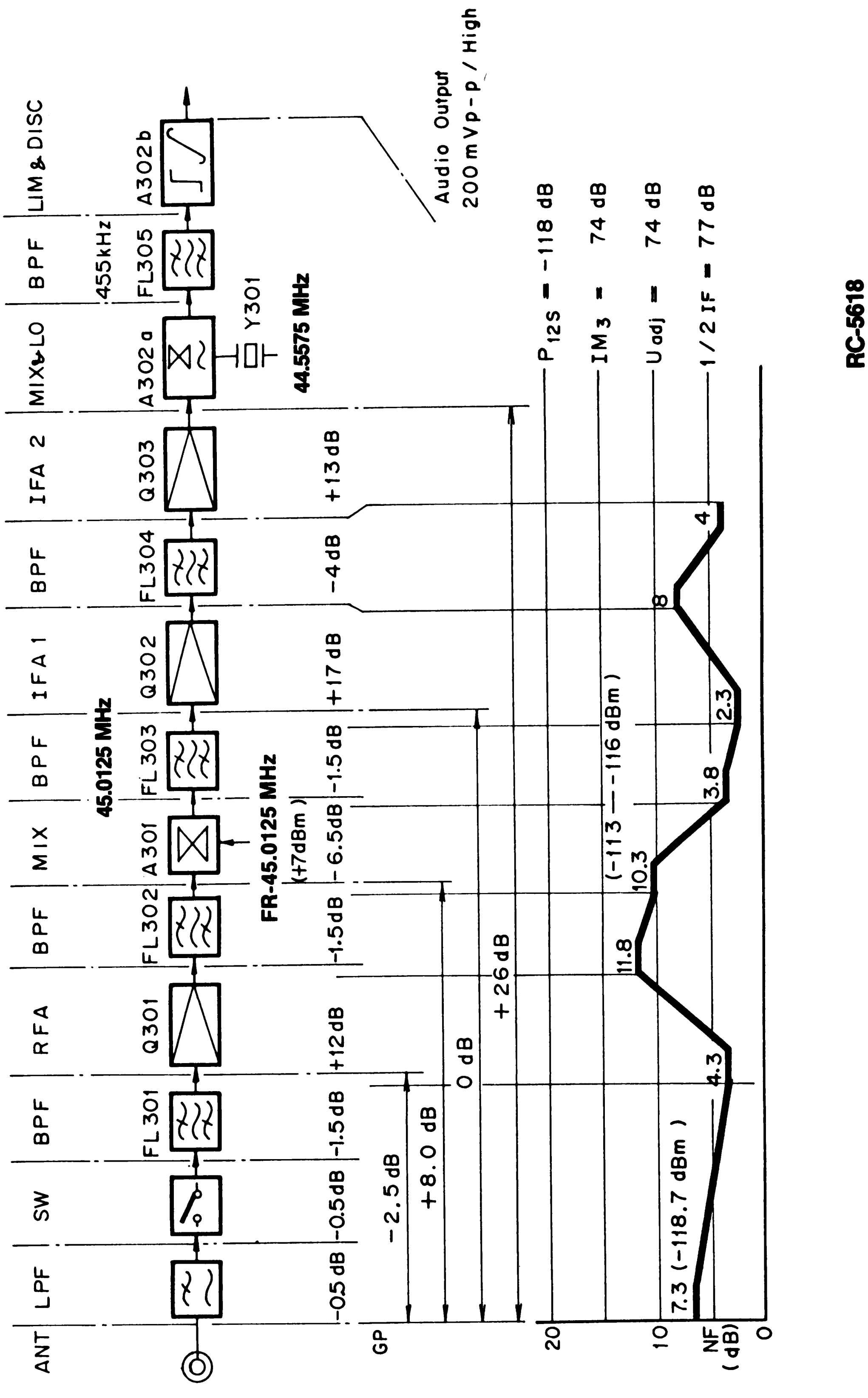


Figure 8 - Typical Level Diagram

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 signal from the Radio Board is applied to the System Board at P101-4 and then to the speaker through A13-C, A201, A202-A and A15. Check distortion at each point shown in Figure 7.

e. Even if there are no electrical problems with the audio circuits on the control board, the speaker itself may cause distortion mechanically. The voice coil may rub or the diaphram 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 System Board through J101-4 (P101-4).

a. The operation of squelch is controlled by Audio Processor A3 on the System Board (refer to Figure 9).

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. A polyimide flex circuit is used at the Control Unit. If the Control Unit is repeatedly disassembled for maintenance, the flex circuit can be damaged. Accordingly, keep disassembly of the Control Unit at a minimum.

b. Tightening clamp screws (seven places) and egg crate mounting screws (three points) on the Radio Unit may greatly affect transmitting and receiving spurious. If the Radio Unit is disassembled for maintenance, when reassembling, tighten the screws in the unit properly (refer to Figure 10).

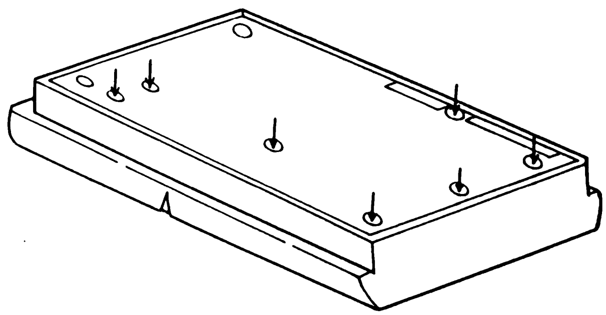


Figure 10 - RF Section W/Back Casting

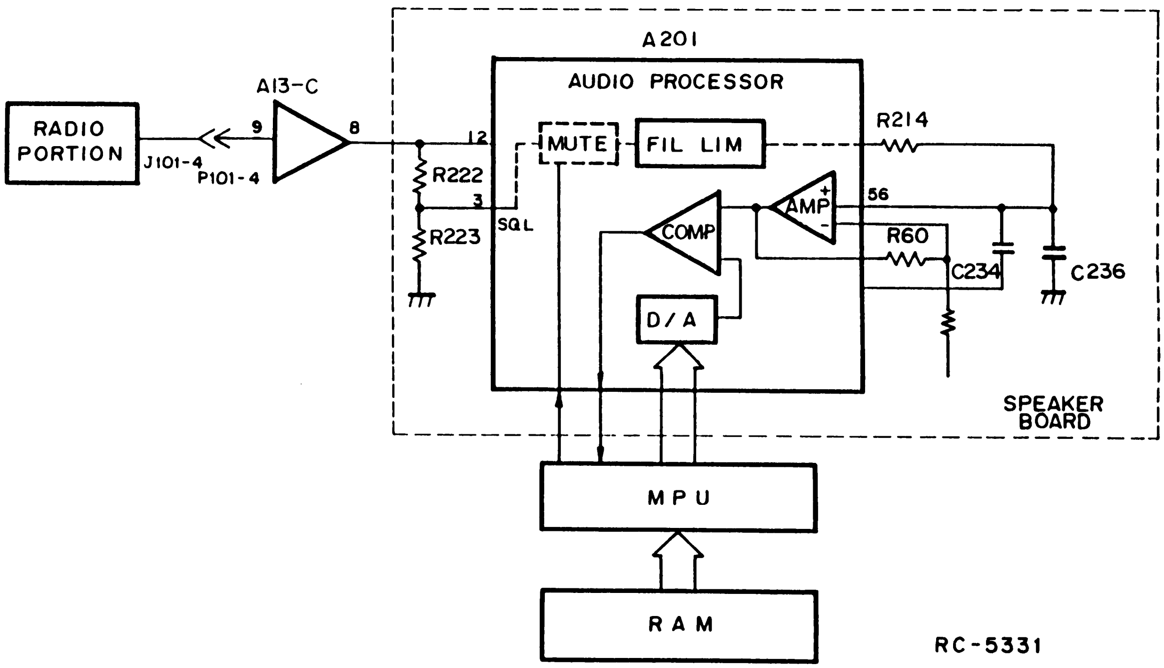
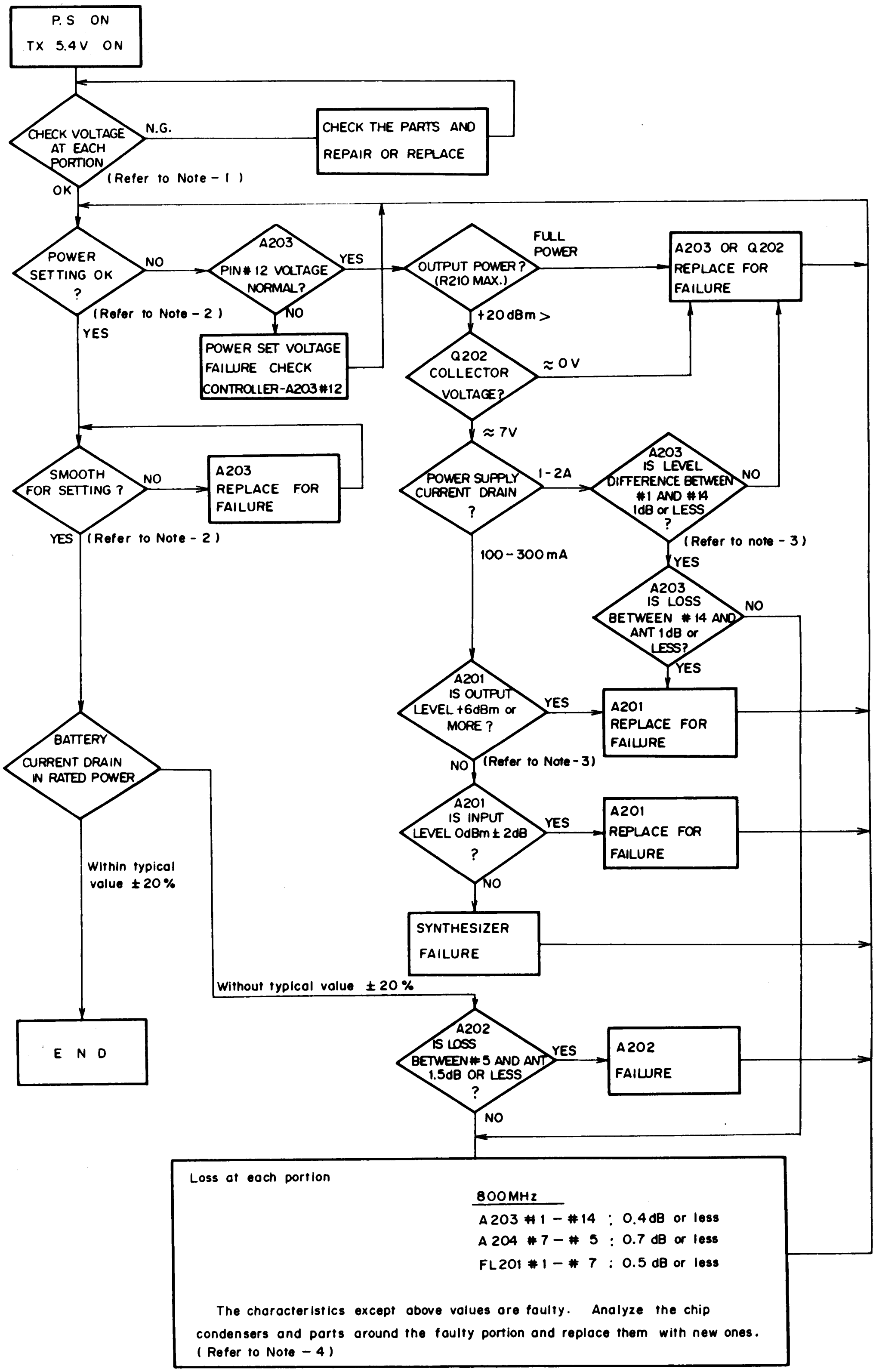


Figure 9 - Audio Processor Block Diagram

Transmit Circuit

The following Flow Chart can be used to isolate a defective stage in the transmit circuit. Also, refer to Table 4 - Typical Transmit Circuit Voltage.

Flow Chart:



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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 RF connector. Periodically it is necessary to check that the antenna, the UDC RF connector and 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 3 Watts.

   Checking

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

   2. 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 4, verify the voltage has changed by power level.

   b. If the current drain of the battery is in 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 at the above pins, check that voltage at 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, C222, 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. Visually check for defective components.

PHASE 2 CONTROL/LOGIC TROUBLESHOOTING

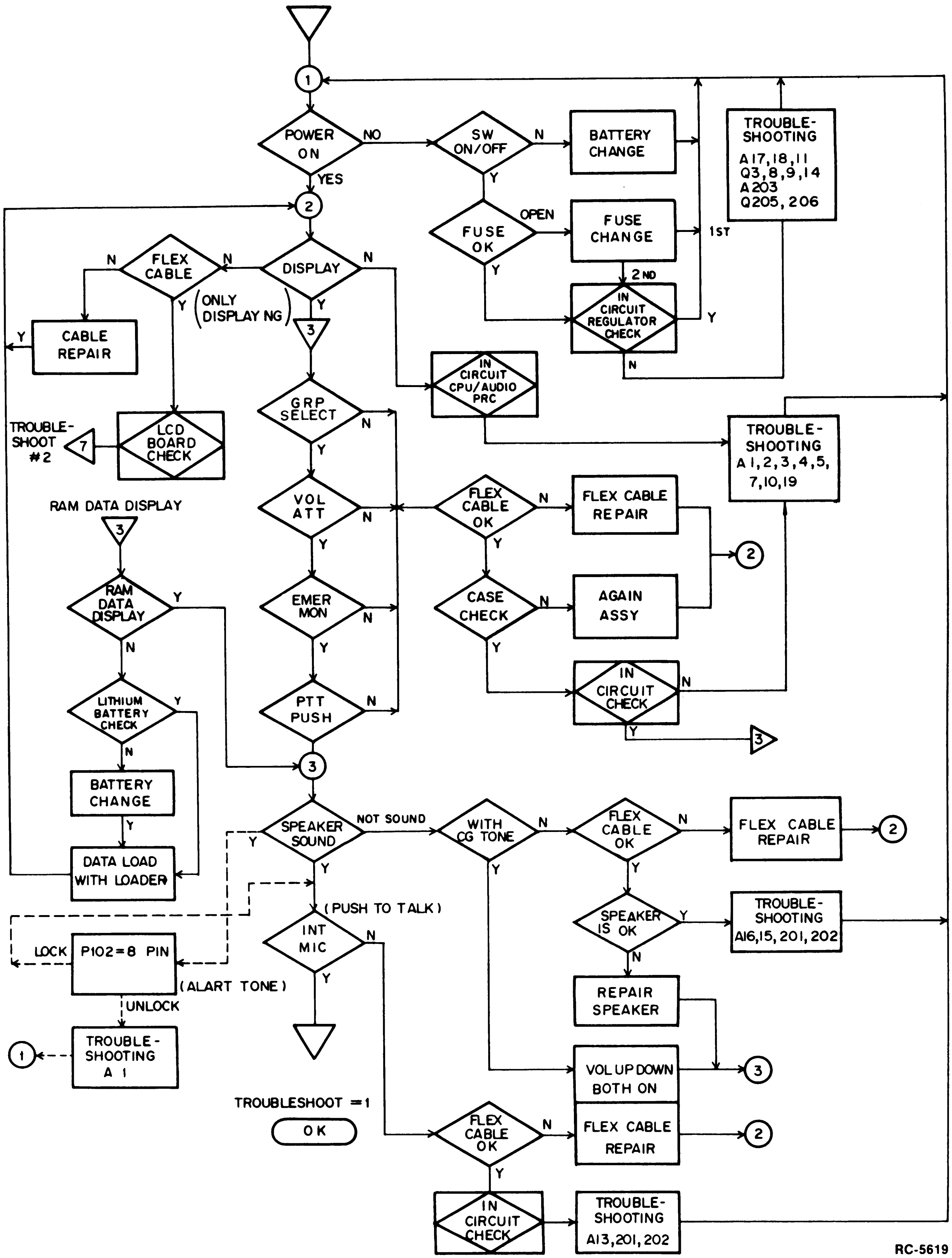
Major Troubleshooting: (Internal Display and Switch Action)

The flow chart (Internal Display and Switch Action) (see Page 16) can be used to isolate any defective stage located on the System Board.

Table 4 - Typical Transmit Voltage

No.	Test Points	Voltage (V)	Remarks
1	A201 (15)	0	
2	" (4)	6.55	
3	" (10)	5.35	
4	" (13)	-	
5	" (16)	7.50	
6	" (2)	0	
7	A202 (1)	0	
8	" (2)	(4.84)	Changed by power level
9	" (3)	7.50	
10	" (4)	7.50	
11	" (5)	0	
12	A203 (3)	0.86	
13	" (5)	6.43	
14	" (6)	7.50	
15	" (11)	5.35	
16	" (14)	0	
17			
18			
19	Q107 Base	0.68	
20	" Collector	4.60	

Flow Chart: (Internal Display and Switch Action)



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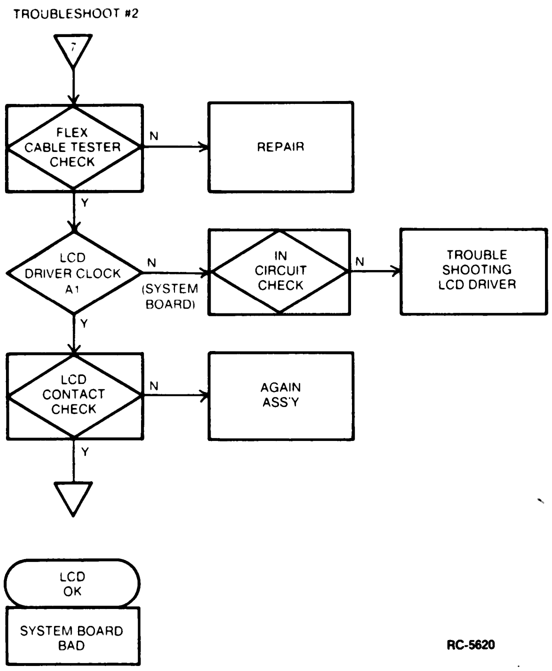
Functional Troubleshooting: (External Input and Output Action)

The flow chart (External Input and Output Action) (see Page 19) can be used to externally function test the Control/ Logic System Board through the UDC connector.

LCD Board: The flow chart (LCD Board) can be used to isolate any defective stage located on the LCD Board.

Flow Chart (LCD Board)



Troubleshooting and Repair for System Board

1. This troubleshooting should be made with the System Board isolated from the Radio Board.

2. If the result is OK at Step 1, the RAM data (Channel No.) is displayed when power is ON. In the unlocked state of the Phase-Lock-Loop (PLL) the 1 KHz is turned on and off at PTT.

3. If the result is OK at Step 2, the display should flicker in the unlocked state.

4. When verification up to Step 3 has been made, connect a 1K ohm resistor between Pin 8 of P102 (LOCK) and Pin 6 of P102 (5.4 volt regulator output) to turn the PLL from "unlock" to "lock".

5. Step 3 indicated that the various switches are actuated in the sequence determined with the RAM data.

6. At Step 4, with 1 KHz, -17 dBm signal applied to DISC IN terminal, check for .5 watt/24 ohm output to be present at the AUDIO OUT terminal.

   It should also be noted that when the initial VOL ATT setting is not at .5 watt/24 ohm, operate the UP/ DOWN of the VOL ramp switch for a volume level of .5 watt. When the VOL ATT is 24, audio output should be .5 watt.

7. At Step 5, when the PTT signal is grounded, the radio set is switched to the TRANSMIT mode (i.e. TX data is grounded). Then the PTT button on the side of the radio should be released.

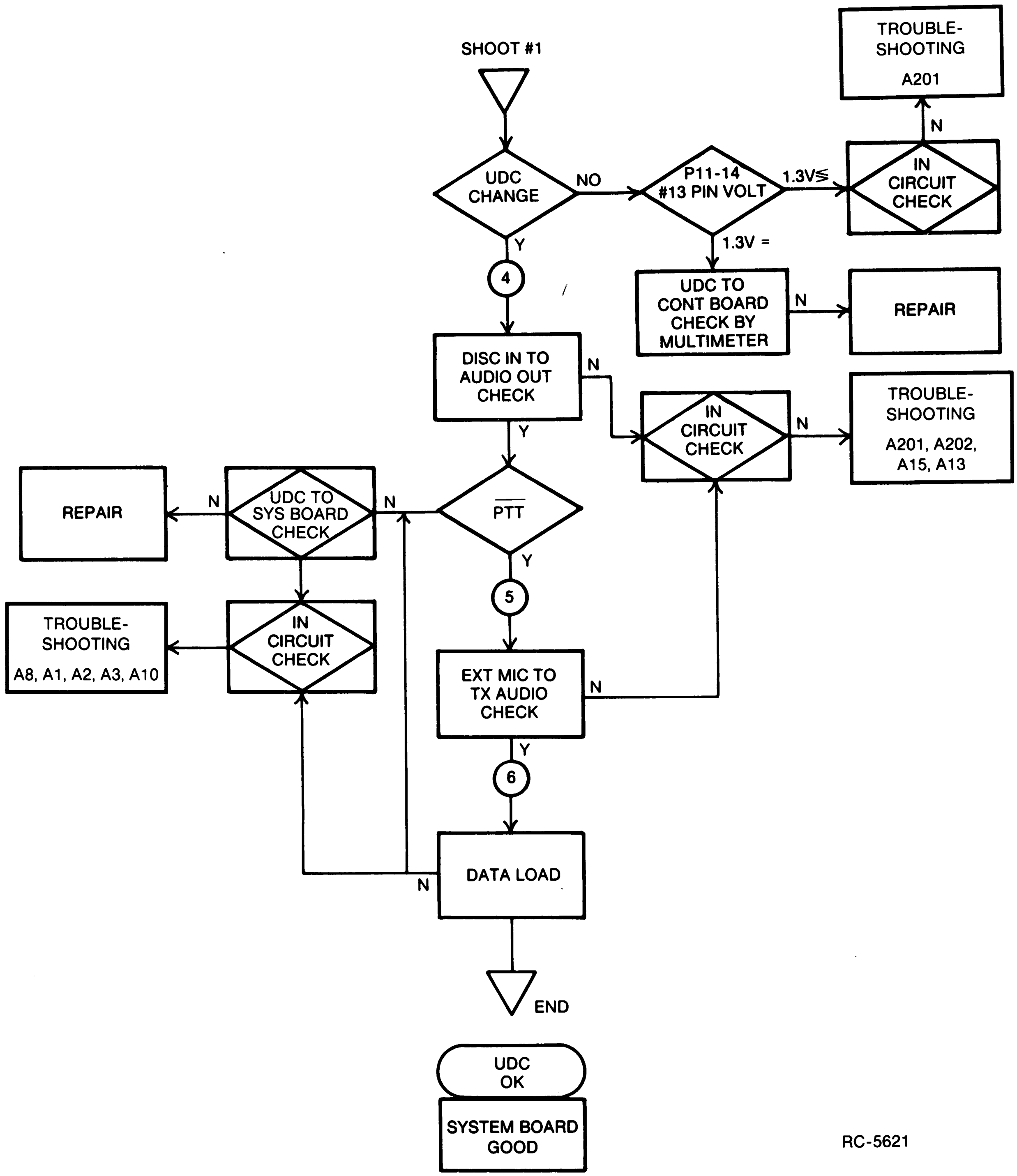
   When the transmit mode is verified, apply 1 KHz, -38 dBm signal to the EXT MIC terminal from the Audio Analyzer. Check that a -4 dBm ± 1 dB signal appears at the TX AUDIO terminal (Pin 1 of P102). Take note that the output at TX AUDIO is not subjected to limiting and without Channel Guard.

8. At Step 6, generate an arbitrary radio data with a data loader and try to load the data in the RAM. Check that data is loaded properly.

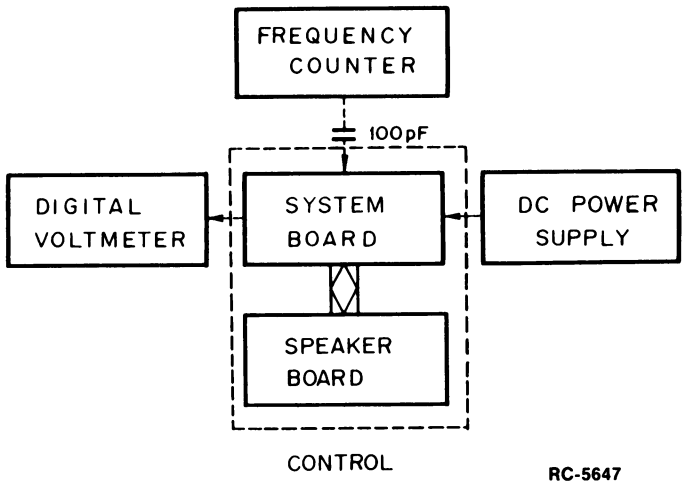
9. To perform an internal microphone (INT MIC) test, press and hold the PTT button and speak into the internal microphone. Check that an audio signal appears at Pin 1 of P102 (TX AUDIO terminal).

10. To check other functions than those mentioned in the flow chart, follow the System Board Alignment Procedure.

Flow Chart: (External Input and Output Action)

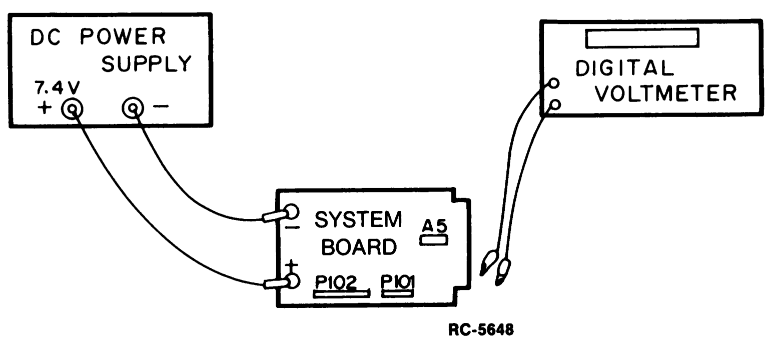


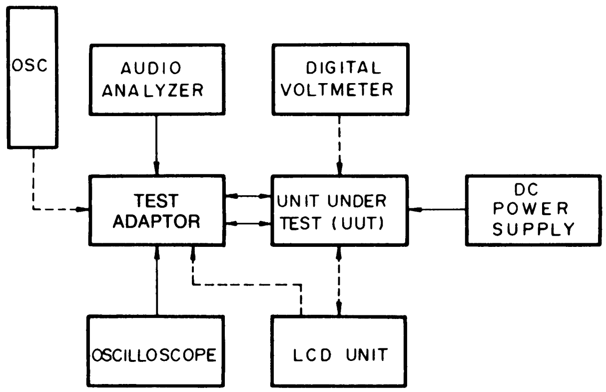
System Board Check List:



Measuring Instrument
Audio Analyzer Digital Voltmeter DC Power Supply Frequency Counter Multimeter Oscilloscope

Item	Test Procedure
1. Preliminary 1-1 Voltage Check	There are three regulated supply lines. Conduct voltage check at each check point as under. Check Point — Rated Voltage P102 - Pin 6 — 5.4 V ±0.2 V for RF ICA17 - Pin 3 — 5.2 V ±0.2 V for Audio ICA203 - Pin 3 — 5.2 V ±0.2 V for Control
1-2 Battery Out Check	Check that the voltage of Battery or DC Power Supply is present at P102-2 and P101-2.
1-3 Oscillator Frequency Check	Check Crystal "Y1" (IC A4 - Pin 17) with Frequency Counter. The frequency should be within 11.0592 MHz ±100 Hz. Check Crystal "Y200" (IC A201 - Pin 42) with frequency counter. Freq = 8.000 MHz ±100 Hz.





RC-5701

Measuring Instrument

OSC
Audio Analyzer
Oscilloscope
Digital Voltmeter
DC Power Supply
Multimeter
Test Adaptor (AC1050)

<u>Note</u>

Refer to Test Adaptor Maintenance Manual LBI-31889.

Item	Test Procedure
1. Preliminary 1-1 LCD Unit Check	1. Checking LCD Unit by turning power supply on.

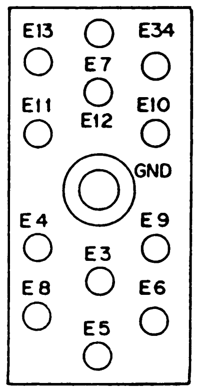
RC-5649

Insert flexible connector (J13) on LCD Unit into P13 (1-10) on System Board. Then turn power on and check that the data from System Board is displayed in the LCD Unit.

Item	Test Procedure
1-2 SW Check and UDC Check	2-a. Operation for each switch. Set LCD Unit in the case, and check whether each SW is operated or not by Multimeter. Check List

SW-Name	Connector Pin No. to be checked
Vol +	P14 No. 10 - 7
Vol -	P14 No. 10 - 6
GRP +	P14 No. 10 - 5
GRP -	P14 No. 10 - 4
EMER	P14 No. 10 - 3
PTT	P14 No. 10 - 2

<table>
<tr><th>Item</th><th>Test Procedure</th></tr>
<tr><td></td><td>2-b UDC Check
Check that UDC is connected to flex circuits in LCD unit.

Check List
<table>
<tr><th colspan="2">Pin No. to be checked</th></tr>
<tr><td>P11</td><td>No. 9 - E12
No. 10 - E34</td></tr>
<tr><td>P12</td><td>No. 11 - E 3
No. 12 - E 4
No. 13 - E 9
No. 14 - E10
No. 15 - E13
No. 16 - E11
No. 17 - E 5
No. 18 - E 8
No. 19 - E 6
No. 20 - E 7</td></tr>
</table>
UDC SIDE VIEW


</td></tr>
<tr><td>2. RX S/N Measurement</td><td>Set Audio Analyzer for 1 KHZ, -17 dBm/0.775 V output. Apply this 1 KHz signal to RX AUDIO IN Terminal of Test Set. Push UP/DOWN of VOL ramp button for a volume display of "24" and check that the level at RX AUDIO OUT of Test Set is -13 dBm on Oscilloscope.

Adjust CAL control on AUDIO Analyzer for "0". Turn 1 KHZ signal off. Check that noise level is 45 dB or more.</td></tr>
<tr><td>3. RX Frequency Response</td><td>Set Audio Analyzer for 1 KHz, -27 dBm/0.775 V output. Apply this 1 KHz signal to RX AUDIO IN Terminal of Test Set. Check that the level at RX AUDIO OUT of Test Set is -13 dBm on Levelmeter and Oscilloscope. Adjust CAL control on Audio Analyzer for "0" to turn 1 KHz signal off. Change the OSC frequency from 210 Hz, 270 Hz, 300 Hz and 310 Hz to 10 KHz. Plot AUDIO OUT level on a graph. Check that the level from 300 Hz to 3 KHz is in the range of -3 dB to +1 dB.</td></tr>
<tr><td>4. RX Audio Distortion Measurement</td><td>Set Audio Analyzer for 1 KHz. Apply this 1 KHz signal to RX AUDIO IN Terminal of Test Set. Adjust VOL ramp button on UUT until Levelmeter and Oscilloscope, show that the SPK OUT is +13 dB.

Check that Audio Analyzer distortion meter shows 5% or less at this time.

Alternatively it is permitted to use SPEAKER AUDIO OUT as the check point.</td></tr>
<tr><td>5. CG Opening Level Measurement</td><td>Set Audio Analyzer for 67 Hz to 210.7 Hz. Apply this 67 Hz signal to RX AUDIO IN Terminal of Test Set. Decrease the level of Audio Analyzer, until the squelch opens. Check that the opening level is -37 dBm ±2 dB.

NOTE: Use the channel with CG tone in this test.</td></tr>
</table>

Item	Test Procedure
6. SQ Operation	Set Audio Analyzer for 10 KHz. Apply this 10 KHz signal to RX AUDIO IN Terminal of Test Set. Check the output voltage for ICA3-Pin 55 on System Board and plot the level on a graph. It is permitted that only the opening level and the closing level of squelch are checked. Opening Level - Open at -13 dBm Closing Level - Close at -12 dBm
7. TX S/N Measurement	On Test Set, set PTT switch to PTT and check that the UNIT goes into transmit mode. Set Audio Analyzer to 1 KHz -38 dBm/0.775 V. Apply this 1 KHz signal to EXT MIC Terminal of Test Set. There should be about -4 dBm ±1 dB signal at TX AUDIO OUT Terminal of Test Set. Adjust CAL control on Analyzer to null. Then turn the Analyzer output off. The S/N ratio should be 30 dB or better. NOTE: With 1 KHz, -35 dBm signal from Analyzer, audio output will be distorted.
8. TX Distortion Measurement	Under the same test condition as with S/N measurement, measure distortion with the Audio Analyzer. The distortion should be less than 3%.
9. TX Frequency Response	Set Audio Analyzer for 1 KHz, -48 dBm/0.775 V. Apply this 1 KHz signal to EXT MIC Terminal of Test Set. Check that -14 dBm ±1 dB signal is present at TX AUDIO OUT Terminal of Test Set. Adjust CAL control on Audio Analyzer for null indication. Turn off the 1 KHz signal from Analyzer. Then change the output frequency of OSC 210 KHz, 270 Hz, 300 Hz to 2.9 KHz and 2.9 KHz to 10 KHz. Plot the changes in the output signal level on a graph. Check that the frequency response curve is within +1, -3 dB over a 300 to 3000 Hz range.
10. Measurement of CG Encode Level and Distortion	Set PTT Switch to OFF on Test Set. Select that channel for which SIG appears on the LCD display. Change PTT Switch to PTT side. Check that either 67 Hz to 210.7 Hz CG waveform is present at TX AUDIO OUT using an oscilloscope. Measure the CG signal level (-17.0 dBm is reference level). Check that the distortion in the CG waveform is less than 5%.
11. TX 5.4 V Supply Check	Set PTT Switch to PTT to get the radio in the transmit mode. Check with digital voltmeter that 5.4 V is present at Pin 5 of P101.
12. Power Set Action	With the PTT Switch in the PTT Position, check with digital voltmeter that 2.5 to 4.0 V is present at Pin 1 of P101.
13. Band Switching	Select a talkaround channel. Then the level at Pin 3 of P102 goes low (0) in the receive mode but goes high (1) in the transmit mode.
14. Syn. Strobe, Syn. Data and Syn. Enable Output	Using an Oscilloscope, check that Enable signal is present at Pin 9 of P102, Data at Pin 10 and Strobe at Pin 11. In this test, LOCK/UNLOCK Switch should be in the UNLOCK position.

M-PD 16 PLUS SYSTEM BOARD TEST DATA

TEST DATE
TEST CONDITION TEMP C
HUMIDITY %
TEST UNIT

NO.	TEST ITEM		STANDARD VALUE	TEST VALUE
		1.	5.4 V ±0.2 V	V
		2.	5.4 V ±0.2 V	V
1	REGULATORS	3.	5.0 V ±0.2 V	V
		1.	7.5 V	V
2	BATTERY OUT	2.	7.5 V	V
3	OSCILLATORS		11.0592 MHz ±100 KHz 8.000 MHz ±800 Hz	MHz
4	LCD CHECK		GOOD/NG	
5	SWITCH CHECK		GOOD/NG	
6	UDC CHECK		GOOD/NG	
7	DATA LOAD		LOAD OK/NG	
8	RX SIG/NOISE		> 45 dB	dB
9	RX FREQ RESPONSE		0.3K - 3 KHZ +2 dB -8 dB	
10	RX DISTORTION		< 3 %	%
11	RX CG OPENING LEVEL		< -37 dBm	dBm
12	RX SQUELCH		OP -13 dB, CL -12 dB	
13	TX SIG/NOISE		> 45 dB	dB
14	TX DISTORTION		< 3 %	%
15	TX FREQ RESPONSE		0.3K - 3 KHz +1 dB -3 dB	
	TX CG ENCODE LEVEL		-16 dBm (Typical)	dBm
16	TX CG DISTORTION		< 5 %	%
17	TX 5.4V CHECK		5.4 V ±0.2 V	V
18	POWER SET		2.5 V - 4.0 V	V
19	BAND SWITCH		RX (0), TX (0), TX Talk Around (1)	
20	SYN STROBE DATA ENABLE OUT		GOOD/NG	

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). However, do NOT touch black metal film of the resistors or the ceramic body of the capacitors with the soldering iron.

NOTE

The metalized end terminations of the parts may be touched with the soldering iron without causing damage.

REMOVING CHIP COMPONENTS

1. Grip the component with tweezers or needle noise 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 Solder-wick®.
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 and 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 joint.
4. After the component has cooled, remove all flux from the component and printed wiring board area with alcohol.

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

The antenna must be assembled securely to the top of the radio. Tighten to within two (2) to three (3) inch-pounds torque (40 in-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.

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 reassembled.

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

REPLACING LITHIUM BATTERY BT1

The M-PD 16 PLUS Radio Personality Data (operating frequencies, Channel Guard tones, options,...etc.) is programmed into RAM circuit A10 located on the System 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 the personal computer (PC) 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 System Board in the radio.

2. Unplus the System Board from the flex strip.

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

CAUTION

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

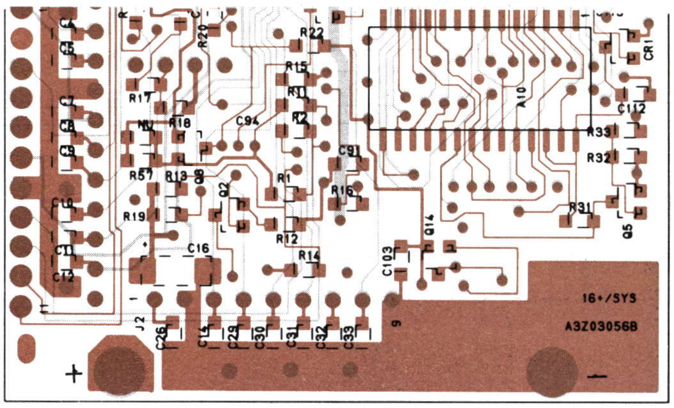
6. Insert the new battery, making sure that the battery case does not touch the ground strap on the side of the System Board.

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

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

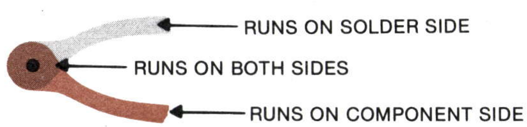
9. Remove the external power supply if one was used.

10. Re-assembly the radio.

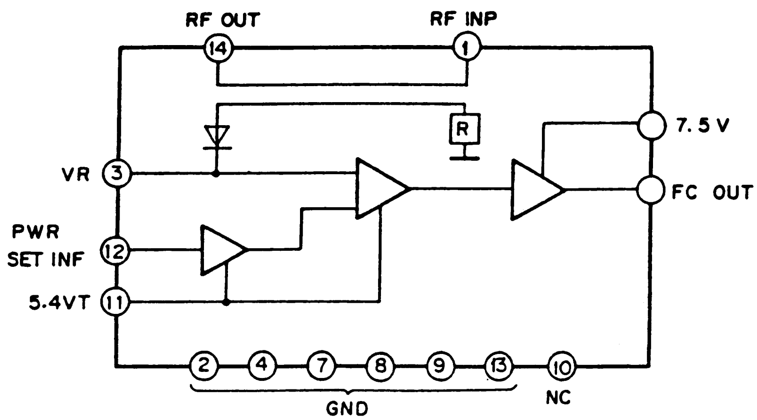


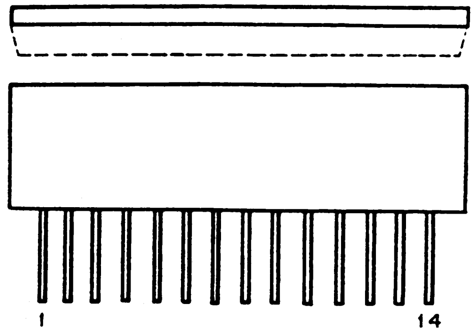
Using leads with alligator clips, connect the negative side of the supply voltage to the screw hole on the battery (BT1) side of the System Board as shown above. Connect the positive side of the supply voltage to the screw on the opposite side of the board also as shown above. The positive side has a metal strip with a piece of tape for insulation.

Figure 11 - Outline Diagram for Connecting a Battery Supply to the System Board



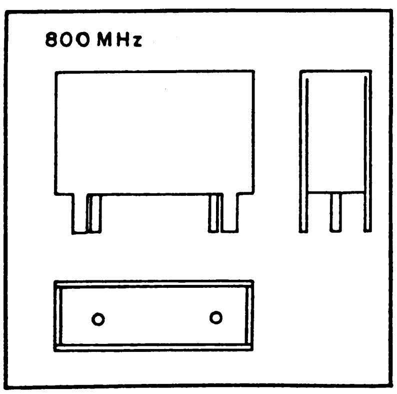
POWER CONT HYBRID





FREQ. RANGE (MHz)	MODEL
806 - 870	KLH 8515

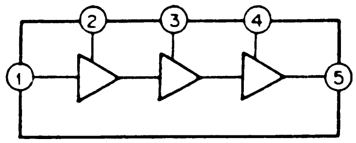
RX BAND PASS FILTER



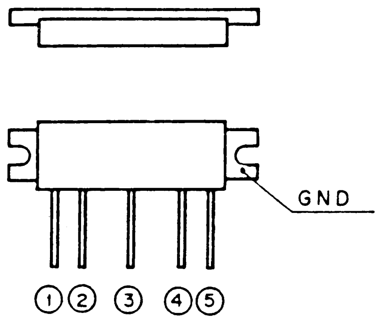
FREQ. RANGE (MHz)	MODEL
851 - 870	A4FX01849 - 1

RC-5632

PA-PACK



FREQ. RANGE (MHz)	MODEL
806 - 870	M67706



① RF INP (50 ohm)

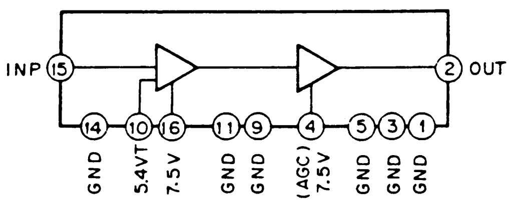
② Vcc 1 (AGC)

③ Vcc 2 (7.5 V)

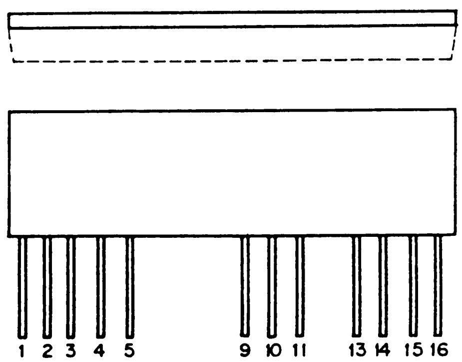
④ Vcc 3 (7.5 V)

⑤ RF OUT (50 ohm)

(TX) EXCITER (Gain Hybrid)



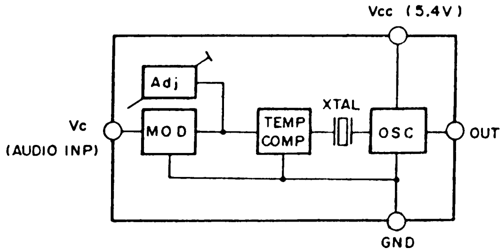
FREQ. RANGE (MHz)	MODEL
806 - 870	KLH - 2591

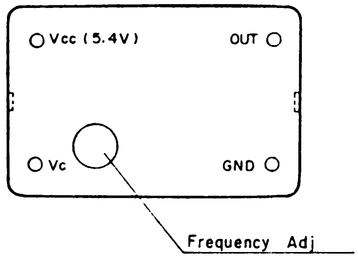


RC-5633

VCTCXO / 13.2 MHz

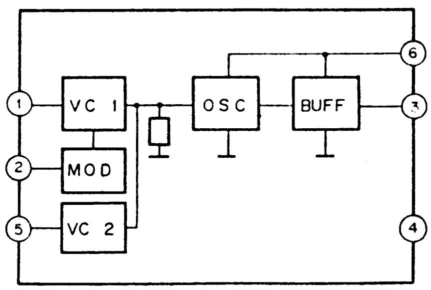
Model 3019 B : (2.5 PPM)

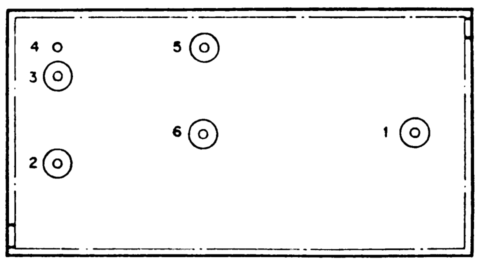




(TOP VIEW)

VCO (800MHz) KLH3556





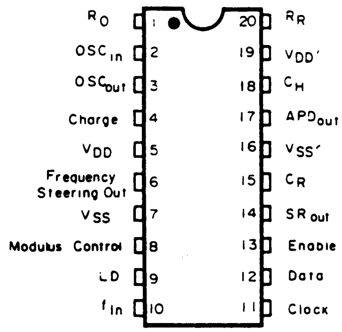
(BOTTOM VIEW)

1. Voltage Control
2. Modulation Input
3. RF Output
4. GND
5. Band Switch
6. 5.4 V (Vcc)

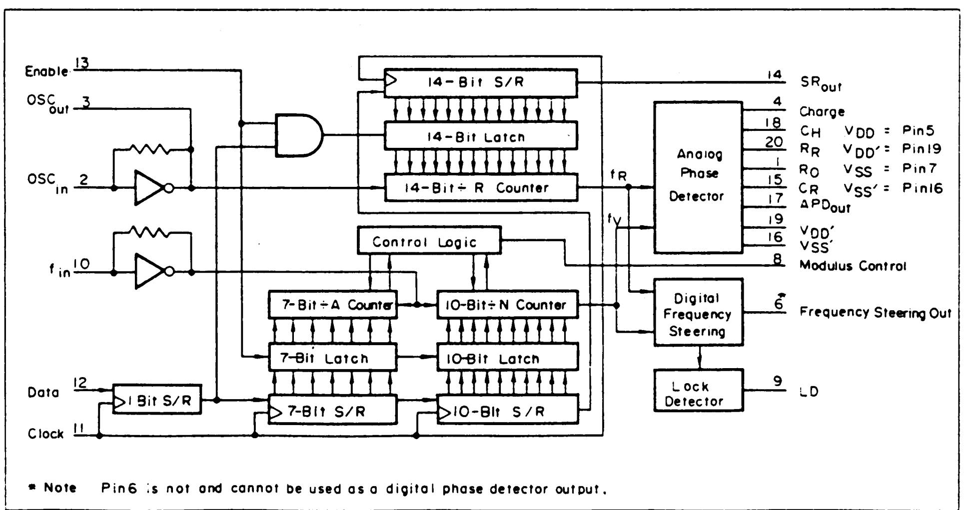
RC-5634

PHASE LOCK LOOP A102 MC145159
K19/2AAJ004062

PIN ASSIGNMENT

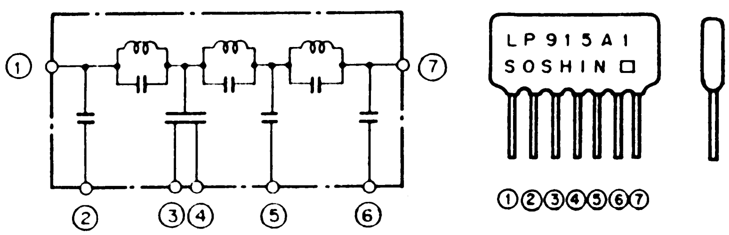


(TOP VIEW)



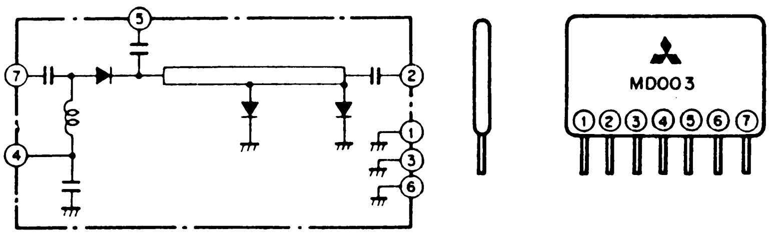
RC-5671

800MHz LPF (LP915A1 A)



1. INP
2. } GND
3.
4.
5.
6.
7. OUT

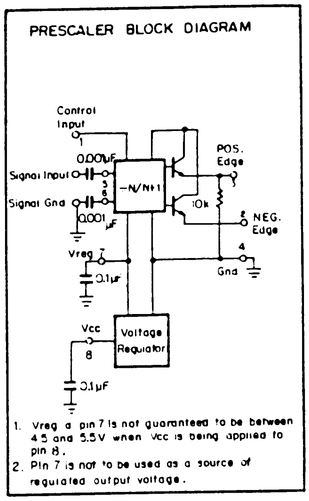
800MHz RF SWITCH (MD003)



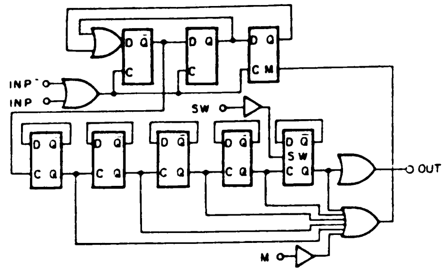
1. GND
2. RECEIVER
3. GND
4. BIAS
5. ANTENNA
6. GND
7. TRANSMITTER

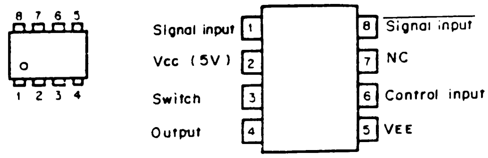
RC-5635

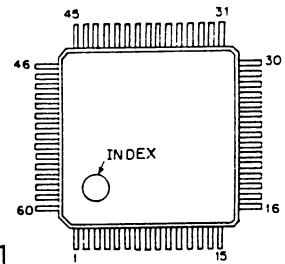
Integrated Circuit / Prescaler (MC12018P)



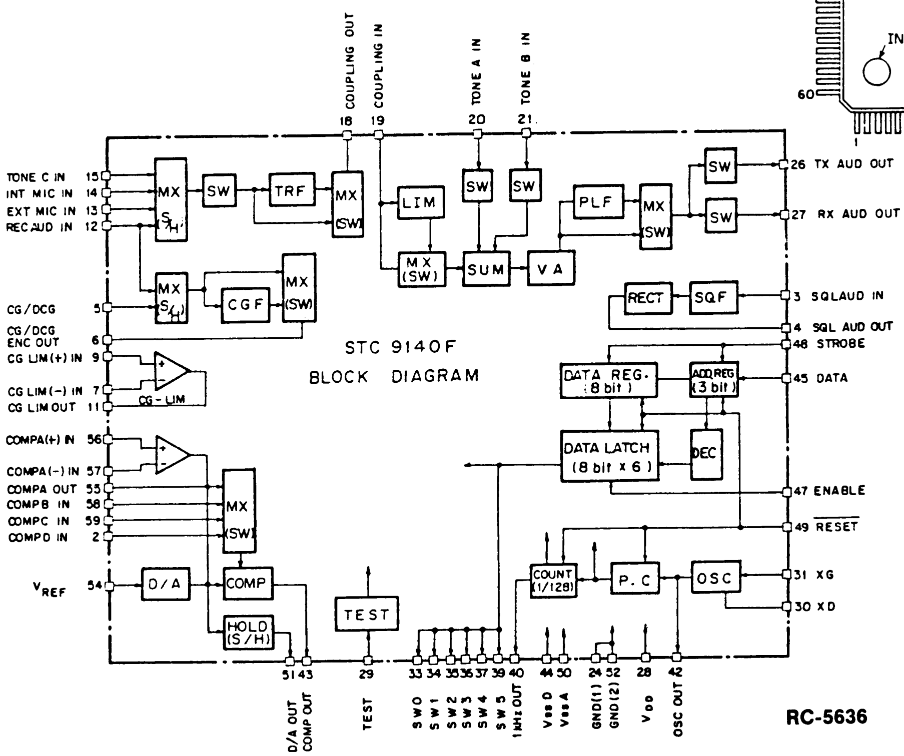
MB501L (Prescaler)



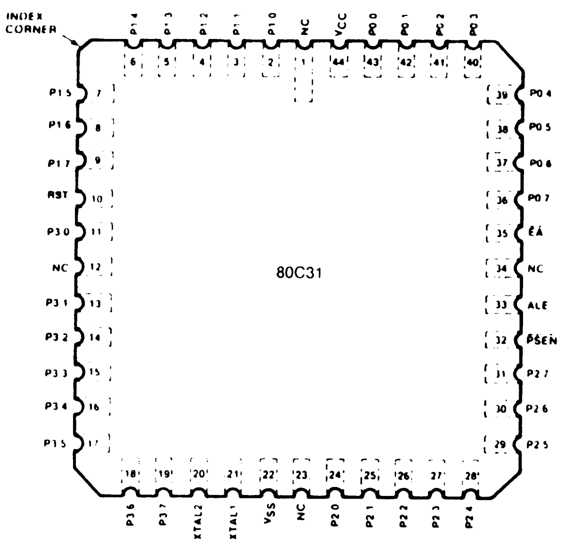




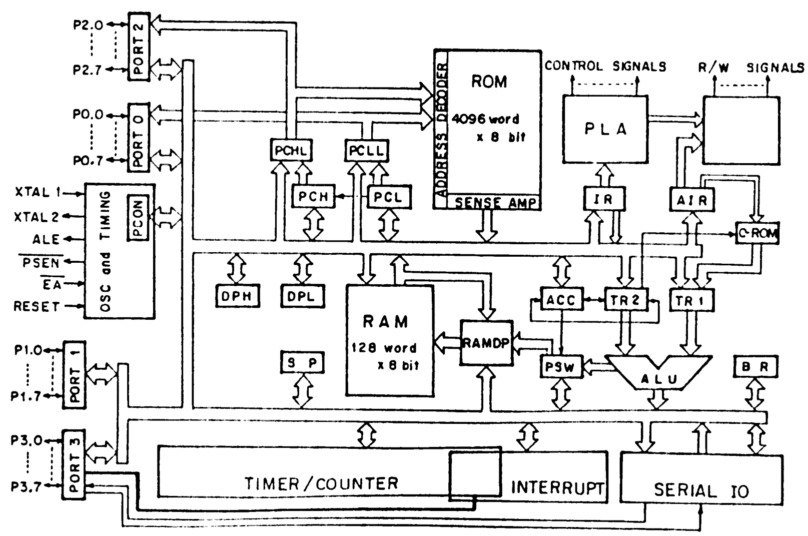
Integrated Circuit / Audio IC (STC9140F)



80C31 MICROPROCESSOR
(A1)

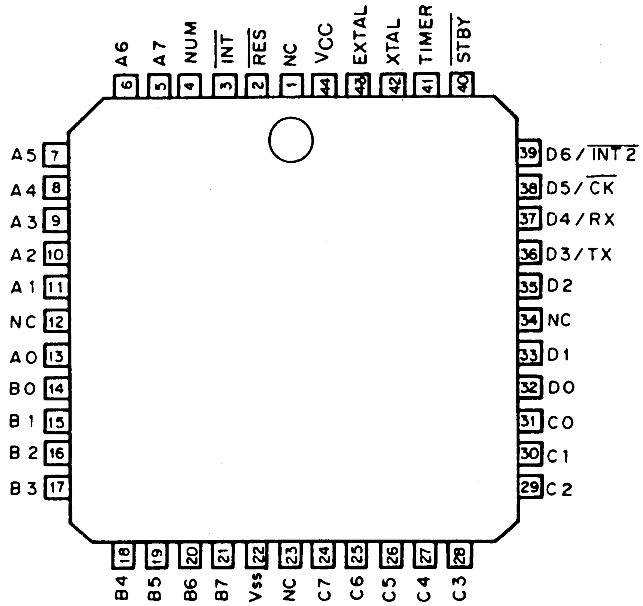


BLOCK DIAGRAM



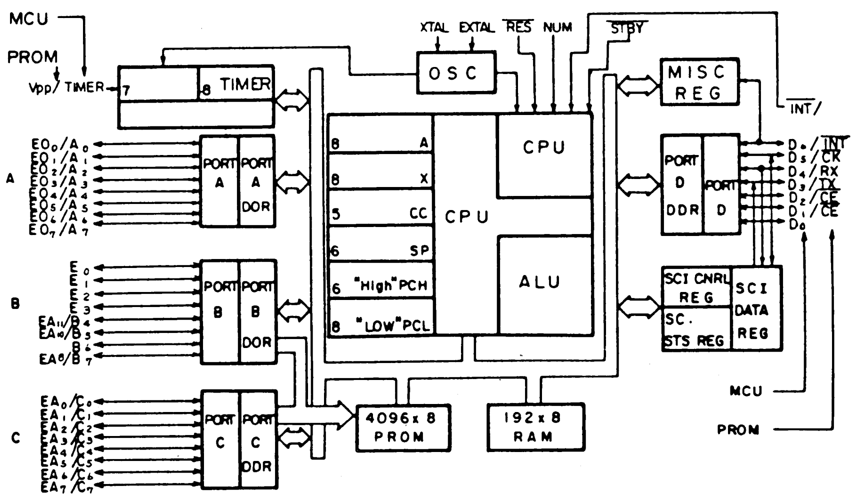
RC-5625

637B05 MICROPROCESSOR
(A7)



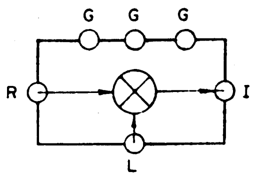
(TOP VIEW)

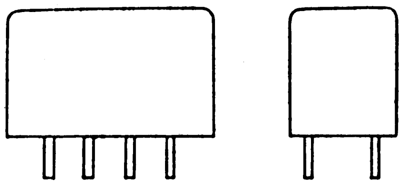
BLOCK DIAGRAM



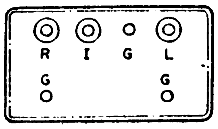
RC-5629

DUAL BALANCED DIODE MIXER (DBM)) A301
K19/5UAY001054





FREQ. RANGE (MHZ)	MODEL
806 – 870	UST- 3L

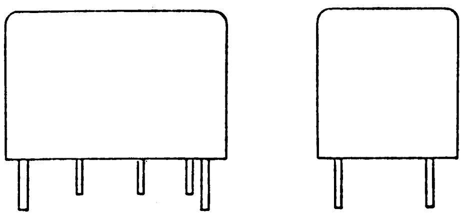


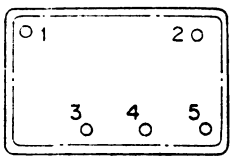
(BOTTOM VIEW)

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

RC-5666

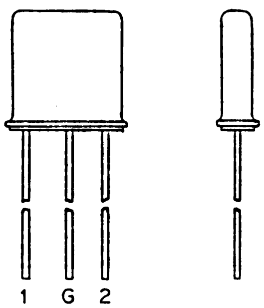
455 kHz IF FILTER FL305 CFWM 455E
K19/2FAD001242

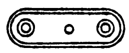




1 : INP / OUT
2 : INP / OUT
3 : GND
4 : GND

1ST IF FILTER (45.0125 MHz) FL303 A4WX01612
K19/2FAA103066

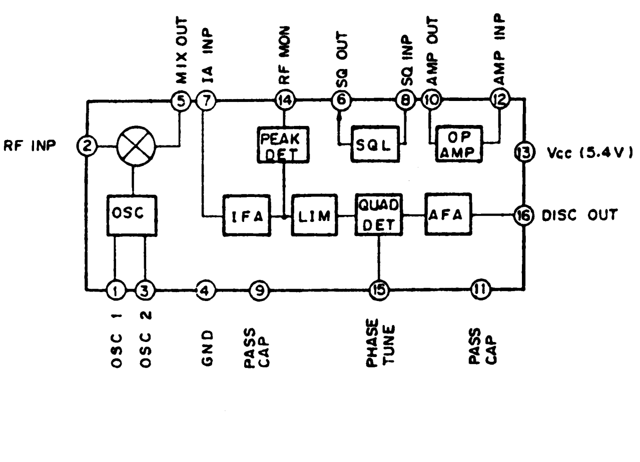




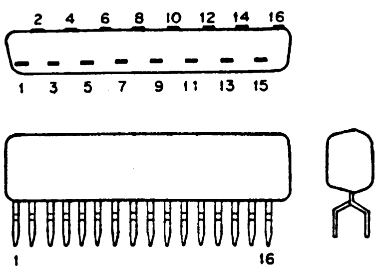
1 : INP / OUT
2 : INP/ OUT
G : GND

RC-5667

IF IC A303 HA12442V
K19/2AAJ008089



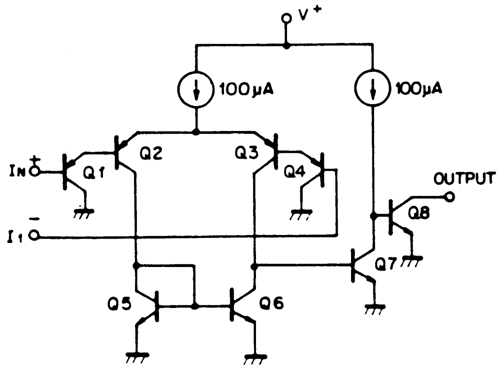
(TOP VIEW)



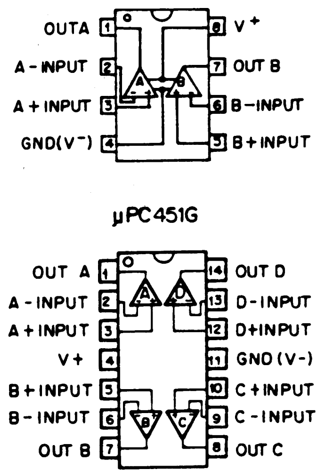
RC-5637

INTEGRATED CIRCUIT / OP-AMPLIFIER (μPC393G/μPC451G)
K19/2AAB004284 (A11,A13)

Equivalent Circuit (1/2 Circuit)



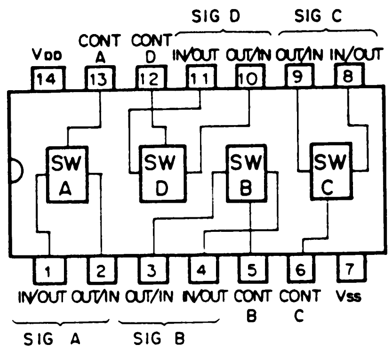
μPC393G



RC-5669

INTEGRATED CIRCUIT/ BI-LATERAL SWITCH (μPD4066BC/4066BG)
(A105) K19/2ABC039105

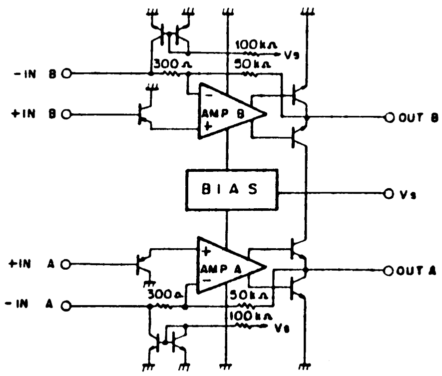
CONNECTION DIAGRAM (TOP VIEW)



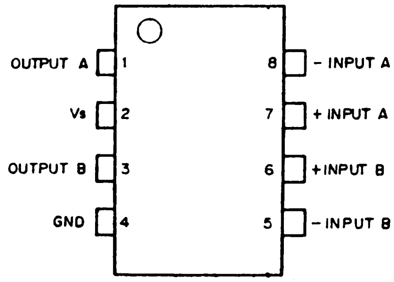
RC-5670

Integrated Circuit / AF Power Amplifier (NJM2073D)

Block Diagram



Pin Arrangment

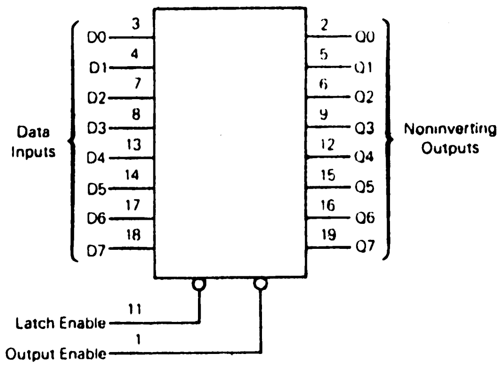


(TOP VIEW)

RC-5639

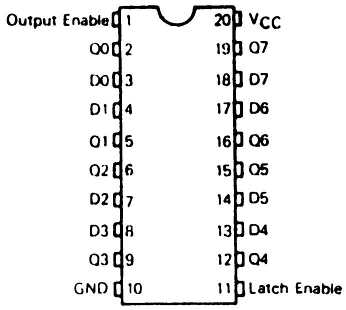
74HC373 LATCH (A2)

BLOCK DIAGRAM



Pin 20 = V_{CC}
Pin 10 = GND

PIN ASSIGNMENT



FUNCTION TABLE

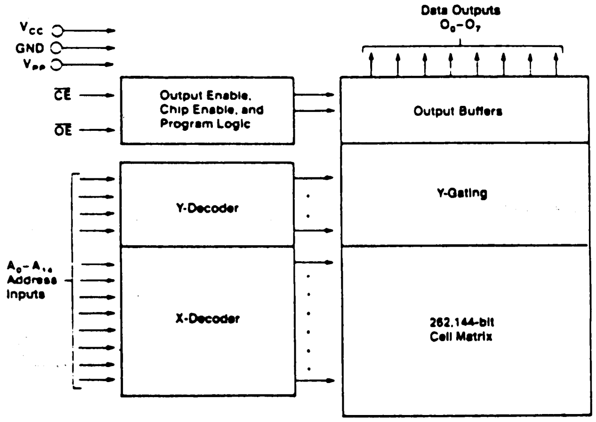
Output Enable	Latch Enable	D	Output
L	H	H	H
L	H	L	L
L	L	X	no change
H	X	X	Z

X = don't care
Z = high impedance

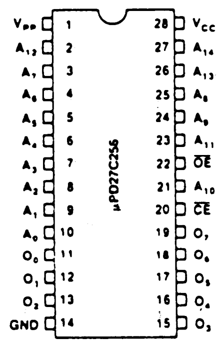
RC-5624

27C256 EPROM
(A3)

BLOCK DIAGRAM

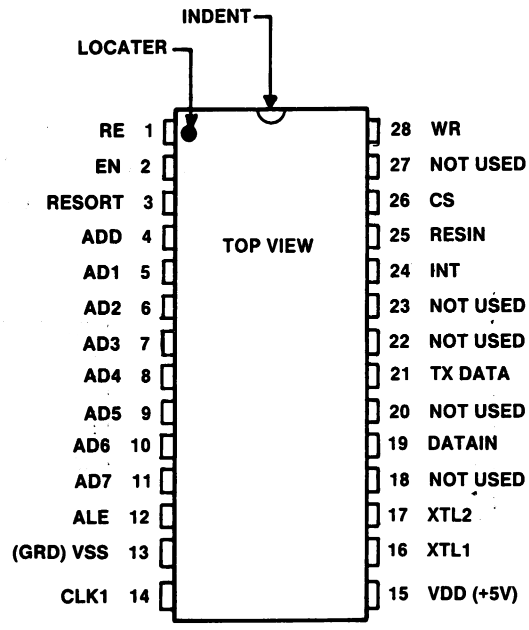


PIN CONFIGURATION



RC-5626

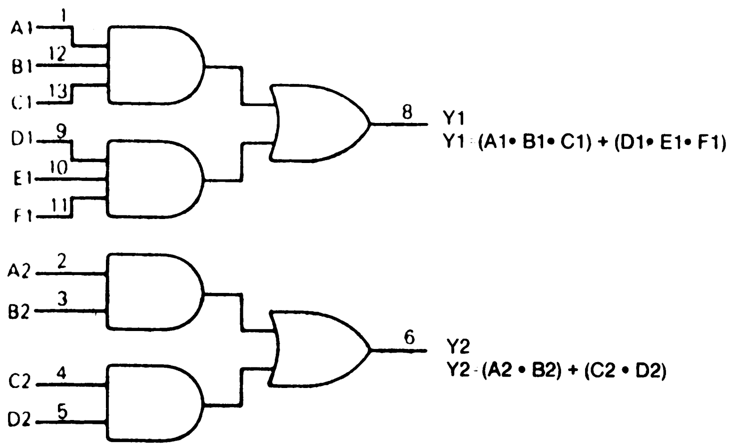
MODEM 19A704727P2
(A4)



RC-5645

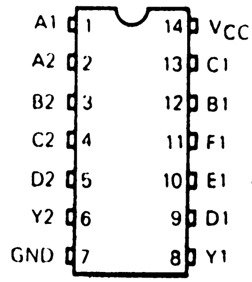
74HC58 CMOS LOGIC
(A5)

LOGIC DIAGRAM



V_{CC} = Pin 14
GND = Pin 7

PIN ASSIGNMENT

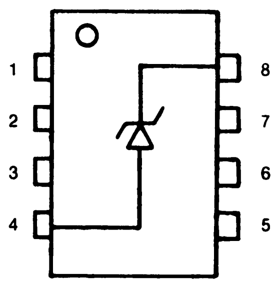


RC-5627

DIODE PACKAGE LM385-2.5
(A8)

PIN ARRANGEMENT

S0-8 PKG

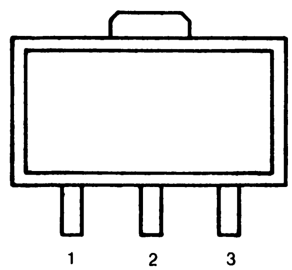


(TOP VIEW)

RC-5622

VOLTAGE REGULATOR S-81250HG
(A17,A203)

S0T-89 PKG



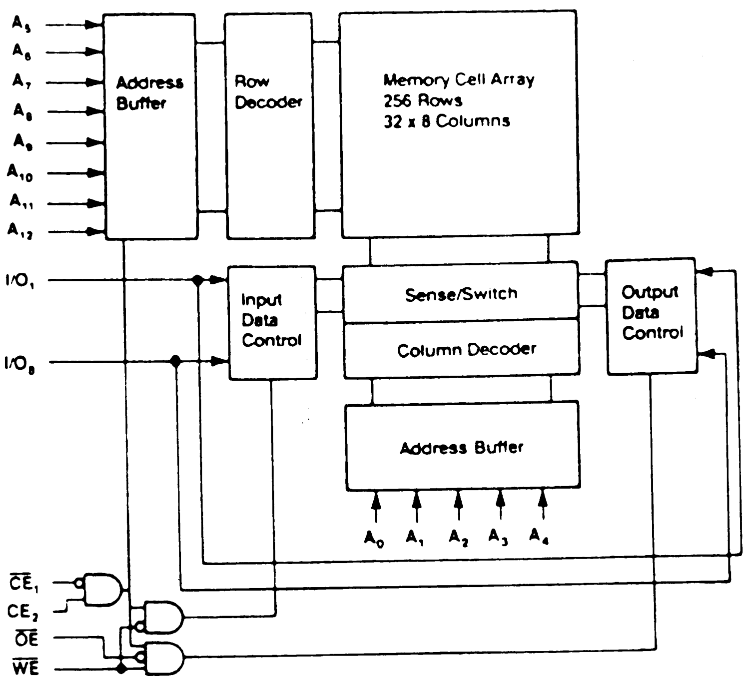
1. GND
2. V IN
3. V OUT

(TOP VIEW)

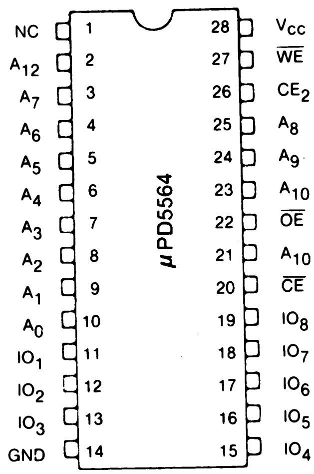
RC-5623

5564 RAM
(A10)

BLOCK DIAGRAM



PIN CONFIGURATION



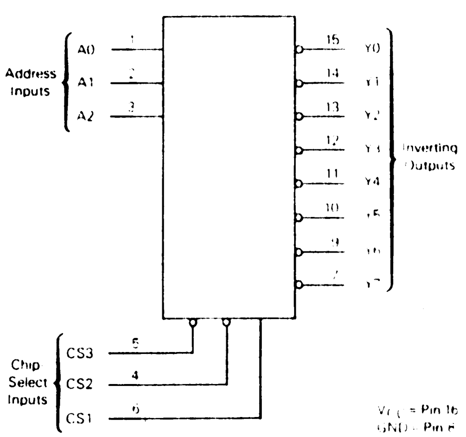
TRUTH TABLE

$\overline{CE_1}$	CE_2	$\overline{OE}$	$\overline{WE}$	Mode	I/O	I_{cc}
H	X	X	X	Not Select	High-Z	Standby
X	L	X	X	Not Select	High-Z	Standby
L	H	H	H	D_{OUT} Disable	High-Z	Active
L	H	L	H	Read	D_{OUT}	Active
L	H	X	L	Write	D_{IN}	Active

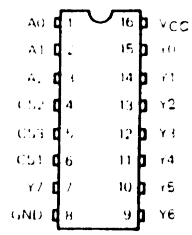
RC-5630

74HC138 DEMULTIPLEXER
(A19)

BLOCK DIAGRAM



PIN ASSIGNMENT



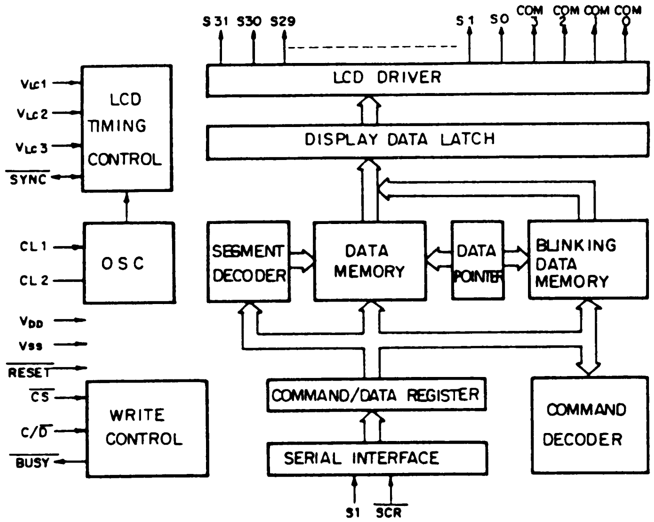
TRUTH TABLE

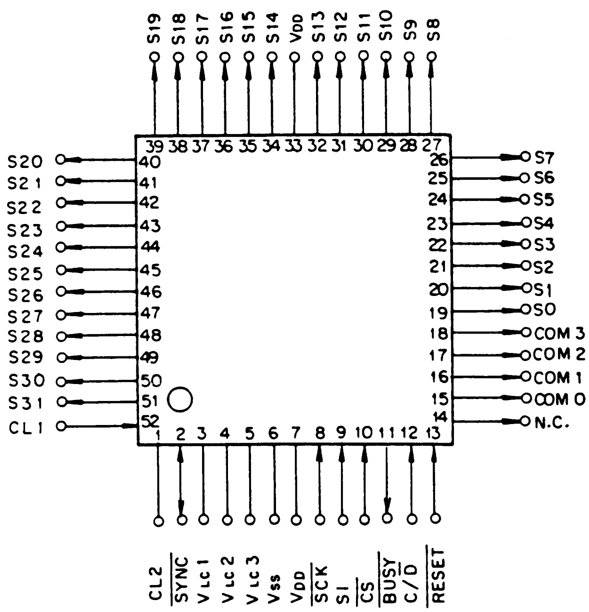
Inputs						Outputs							
CS1	CS2	CS3	A2	A1	A0	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	X	H	X	X	X	H	H	H	H	H	H	H	H
X	H	X	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	L	H	H	H	H	H	L	H	H	H	H
H	L	L	H	L	L	H	H	H	H	L	H	H	H
H	L	L	H	L	H	H	H	H	H	H	L	H	H
H	L	L	H	H	L	H	H	H	H	H	H	L	H
H	L	L	H	H	H	H	H	H	H	H	H	H	L

H = High Level (steady state)
L = Low Level (steady state)
X = Don't Care

RC-5631

LCD CONTROLLER DRIVER A1 (μPD7225G)
K19/2ADC003107

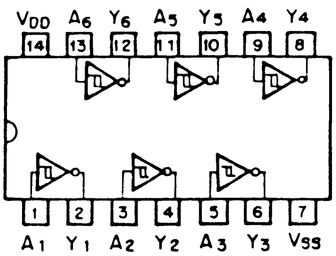




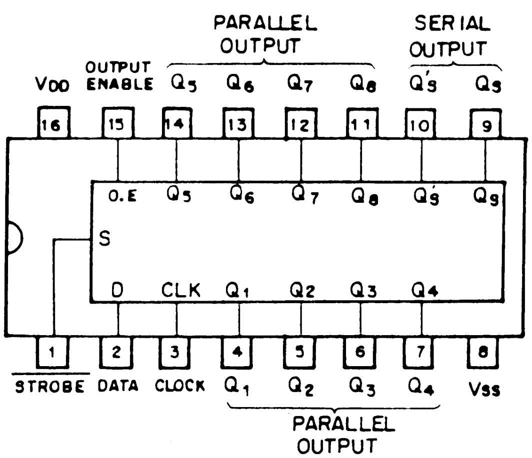
RC-5672

CMOS LOGIC

74HC04G INVERTERS A8 (TOP VIEW)
K19/2ABD025012



74HC4094G SHIFT REGISTER A6 (TOP VIEW)
K19/2ABD025335



RC-5673

<u>Tracking Data</u>:

Tracking data is information stored in the radio personality PROM that sets various transmit and receive parameters to ensure proper performance over the band. If the RF unit, controller or other major assembly in the radio is replaced, this tracking data may need to be changed.

If tracking data is supplied with the replacement RF Unit, use the radio personality programmer (URP or PC) to edit the personality PROM and enter the new tracking data. If tracking data was not supplied with the RF Unit, retain the original data stored in the PROM.