MAINTENANCE MANUAL
EDACS™ M-PA™ 800 MHz
SERVICE SECTION

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INTRODUCTION

This manual outlines service procedures for the EDACS M-PA 800 MHz portable radio. Troubleshooting information presented in this manual will help localize trouble to the board and/or component level. Alignment procedures will aid a technician adjust the radio to factory specifications.

Information is presented for tracking/channel data and surface mount component replacement. Preventive maintenance information includes weatherproofing procedures and service data on the batteries. Module and integrated circuit data sheets are listed at the end of this manual.

In order to perform many of the following alignments, tests and troubleshooting checks, it will be necessary to (re)program the radio. Further programming information can be found in the EDACS programming Manual and software TQ-3340.

It is suggested that an improperly operating radio be first bench tested thoroughly in the conventional mode. This allows the technician, using standard test equipment, to insure the majority of the radio's circuitry is functional. Any necessary repairs can be completed and the radio can then be tested in trunked mode using an available site.

Conventional mode testing can (and will) verify proper operation of all of the radio's circuitry with the following exceptions:

- modem IC operation
- data modulation circuity (transmit mode only)
- data demodulation circuitry (receive mode only)
- trunked mode associated areas of the radio's memory

CAUTION

ALWAYS remove the battery pack before disassembling the unit to avoid blowing the fuse or causing other component damage.

This radio contains CMOS ICs that can be damaged by static electricity. Observe static handling precautions.

TEST EQUIPMENT

The following is a list of test equipment which may be required to troubleshoot and/or align the radio.

GENERAL

- RF Signal Generator
- RF Wattmeter with 5 Watt capability
- Audio Distortion Analyzer with Vu Meter
- Oscilloscope with x1 and x10 Probes
- Audio Oscillator
- Frequency Counter
- Modulation Analyzer
- SINAD Meter
- Adjustable Regulated DC Power Supply, 5 - 9 Vdc, 5 amperes
- Digital Multimeter

SPECIALIZED

K19/A4WX01542	RF Test Cable (UDC mount)
K19/A4WX01543	Battery Eliminator ("Dummy Battery")
K19/A4WX01544	RF/Logic Extender Cable
K19/A4WX01604	Discharge Analyzer (checks battery pack capacity and battery chargers)
LBI-38518	Front Cover Test Accessory Kit Manual
SPK9010	Front Cover Test Accessory Kit; Includes: 19D902562P5 Front Cover Test Cable 19D902562P1 LCD Extender Plate & Clamp 19D902562P2 LCD Test Cable 19D902562P6 Test Program Diskette
SPK9011	Front Cover Test Accessory Kit; Includes: 19D902562P3 Adapter Board 19D902562P4 Control Board Extender

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- ST3559P2 — RF Antenna Adapter (top jack to BNC female)
- TQ-0609 — Test Box (simulates all external UDC options)
- 19B219079P1 — Alignment Tool, 0.1" slotted (metal) tips
- 19B801640P1 — Alignment Tool, 0. 1" slotted tips

In addition to the above listed equipment, access to a local trunked site and a second portable or mobile (trunked) radio will be necessary to test trunked mode operation.

PROGRAMMING

- IBM PC Compatible Computer
- TQ-3340 — Programming Manual and Software (includes 5 1/4" and 3 1/2" disks)
- TQ-3310 — PC Programming Adapter (Serial Adapter Box and PC-to-Adapter Box Interface Cable)
- TQ-3311 — Radio Programming Cable (Adapter Box-to-radio Cable)

FRONT COVER TEST ACCESSORY KIT

A Front Cover Test Accessory Kit is available for exercising and troubleshooting the circuits in the front cover. Connection to an IBM PC or compatible computer (parallel printer port) allows all of the circuits in the front cover, less Control Board, to be exercised via the PC computer.

An adapter and extender board in the kit allows the Control Board to be extended out of the case for troubleshooting access. See the TEST EQUIPMENT section of this manual for a breakdown of the kit.

KEYPAD FLEX AND LCD BOARD TESTING

(IN CASE)

The Keypad Flex and LCD Board can be exercised while still in the radio's case. These tests are made without the Control Board. All of the switches and the logic circuitry on the Keypad Flex as well as the Emergency Switch can be tested via the PC connection. Status of the switches is displayed on the PC. The LCD Board can be fully exercised by sending it various patterns from the PC to be displayed. LCD/Keypad backlighting can also be toggled on and off.

Test points are provided for the volume control and microphone audio. A resistor network on the Front Cover Test Cable provides a dc bias to the mic in the absence of the Control Board's bias.

LCD BOARD TESTING

(REMOVED FROM CASE)

The LCD Board can be tested with the kit and PC after it has been removed from the front cover. A test cable is provided in the kit that interconnects the board and PC computer. Complete display and backlight functions can be exercised.

TROUBLESHOOTING SOFTWARE

The Control Board contains extensive diagnostic capabilities within its operating system. A troubleshooting program (actually several small programs) is included with the Programming Software. This program gives the service technician the ability to quickly isolate many failures in the radio.

The PC computer communicates with the radio via the UDC. Necessary hardware items include the standard PC Programming Adapter Box and PC Interface Cable (TQ-3310), the Radio Programming Cable (TQ-3311), and a PC computer. The Troubleshooting Software program that runs on the PC utilizes the Adapter Box and cables as an interface between the PC computer and the radio.

Connect the Adapter Box and associated cables in the same manner as if the radio were to be programmed. Execute the Troubleshooting Software as follows:

- At the DOS prompt, log-on to the drive that contains the PC Programming Software (and Troubleshooting Software).
- Execute the program by typing MPATEST <CR> at the DOS prompt.

A menu screen will appear that will prompt the technician to select a test routine. Test routines include:

- various receive and transmit audio path tests
- tone (CG, T99, etc.) path tests
- a squelch circuit test
- a synthesizer serial loading test
- a volume, keypad and UDC test

- various D/A and A/D circuit tests such as TX Power Set and battery voltage
- a RAM test
- Modem TX and RX Data Path tests including a loop-back test

If there is a communication problem between the computer and radio after a selection is made, the message "No response from radio", "Press Enter to continue" will be displayed on the computer. Check cable connections or troubleshoot the Front Cover Assembly if this message is displayed. There may be a problem with the UDC Flex or the TX DATA/RX DATA circuity.

Follow the instructions given with each test routine to isolate a failure to a particular circuit or component.

FUNCTIONAL TESTS

The following test procedure outlines a functional bench test of the radio. It may be necessary to (re)program the radio before proceeding with this test.

1. Power the radio up using the Dummy Battery and the bench power supply. See Table 6 for supply current demands for all operating modes.

2. Rotate the Control Knob and verify the display changes and indicates the proper programmed information. On Scan and System models, press the STEP key to scroll through various groups or channels.

3. Connect a wattmeter and frequency counter to the radio and select a conventional (test) channel. Press the PTT Button to key the transmitter and measure RF power and frequency. See Table 4 for transmitter power specs. See Table 3 for transmitter frequency error specs. The TX flag should appear in the display when the radio is transmitting.

4. Select a channel that has been programmed for receive only. Press the PTT Button. The radio should beep and the display should flash.

5. Select a conventional channel that has been programmed for Channel Guard decode operation. The CG flag should appear. Press the Monitor Button to unsquelch the radio. Receiver noise should be heard from the internal speaker and the noise level should follow the rotation of the Volume Control. Hold the Monitor Button and verify that the CG flag disappears after two seconds. Release the button and then press it again. Channel Guard operation should return after two seconds as indicated by the CG flag.

6. Remove the wattmeter and connect the radio to an RF signal generator. Test several conventional channels. Verify receiver specifications.

7. Verify proper scan operation on Scan and System model radios. The SCN flag should appear when the radio is scanning. See the operating procedures for complete details.

8. Verify DTMF keypad operation on System model radios. Each character (0-9, * and #) should be displayed when the corresponding key is pressed. See the operating procedures for complete details.

9. Remove the signal generator and install an antenna. Select a local trunked site which is programmed into the radio. Transmit a group call from a second mobile or portable radio set to the same group. Verify the BSY flag turns on, the radio unsquelches, and receives the call.

10. Transmit a group call from the radio under test. Verify the TX and BSY flags turn on and the call is heard in the second mobile or portable radio.

DISASSEMBLY / REASSEMBLY

In the event internal service is required, disassemble the radio in accordance with the below outlined steps. See Figures 1 - 6.

Reassemble the unit by following the steps in reverse order. Observe screw lengths and do not over tighten the screws when reassembling the unit. Torque specifications are listed in Table 1.

TOOLS REQUIRED

- TORX® T6 Driver
- M1.5 Hex Driver or Wrench
- Needle-nose Pliers
- Small Flat-Blade Screwdriver

Table 1 - Torque Specifications

LOCATION	QUANTITY	LB-IN.
Rear/Front Cover Assembly Screws	4	5.0
Rear Cover Assembly		
Antenna Insert	1	10.0
UDC RF Connector	1	10.0
RF Board/Eggcrate Screws	13	4.0
PA Support Screws	2	10.0
Antenna Switch (SW1) Screw	1	1.5
Front Cover Assembly		
Knob Set Screws	2	3.0
Control/Volume Control Nuts	2	8.0
UDC Ground Screw	1	3.0
All M1.6 and M2 Screws	29	3.0

CAUTION

ALWAYS remove the battery pack before disassembling the unit to avoid blowing the fuse or causing other component damage.

This radio contains CMOS ICs that can be damaged by static electricity. Observe static handling precautions.

FRONT AND REAR COVER SEPARATION

Lay the radio face down and loosen the four Torx® screws (**A**) on the back of the radio. Separate the two halves by carefully lifting the Rear Cover Assembly straight-up to avoid bending the connector pins between the RF and Control Boards.

When reassembling the unit, be sure the rubber gasket surrounding the perimeter of the cover is in good condition and it is in the groove. Also insure the connector pins align properly. For proper operation the four screws should be tightened so there is no gap between the covers. It is recommended that the two top screws be tightened first while squeezing the radio together to ensure the gap is completely closed. The bottom screws can then be tightened.

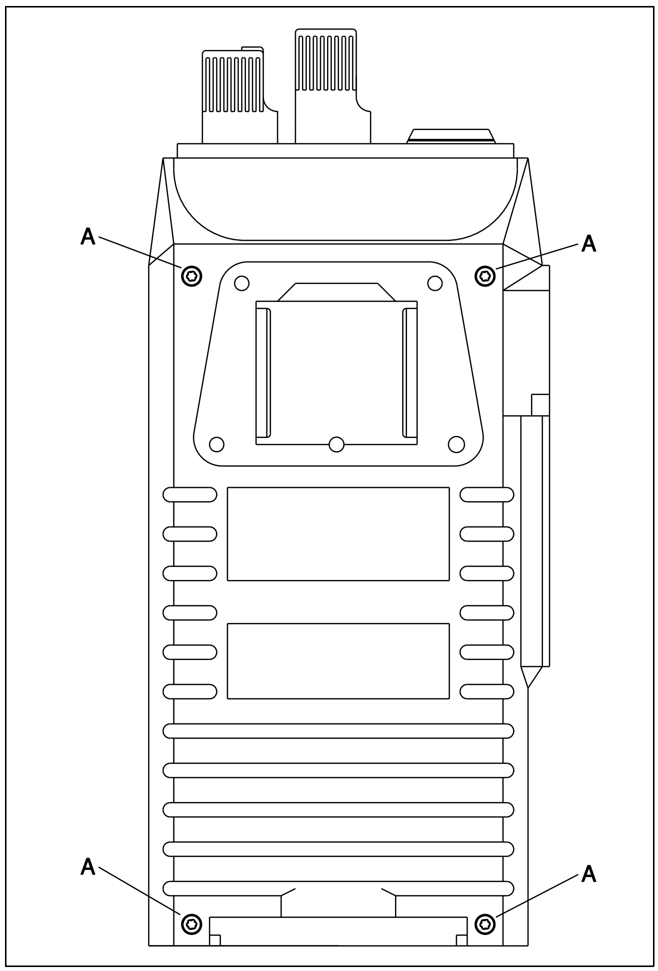


Figure 1 - Front And Rear Cover Separation

RF BOARD ACCESS

If removal of the RF Board from the case is necessary, remove the UDC antenna jack and the top RF antenna jack (**B**). Next, remove the eight Torx® screws (C). The RF Board and eggcrate casting may now be lifted from the rear cover. Two PA mounting Torx® screws and five Torx® screws on the under-side secure the board to the eggcrate casting.

NOTE

The RF shield used in the 800 MHz M-PA radio is a press-fit metallized elastomer design. This shield is not held in place with screws and it remains in the radio's Front Cover Assembly when the covers are separated. When reassembling the radio, make sure the metallized surface of the shield faces the RF assembly.

CONTROL BOARD ACCESS

Remove the six screws (**D,DD**) securing the shield and Control Board to gain access to the board. Remove the shield.

To remove the Control Board, remove the two Torx® screws (**E,EE**). Lift the board and carefully unplug the Speaker Flex from J3. Avoid bending this or any other flex circuits at sharp angles. The Control Board may now be removed. Note the battery power and ground connections at the bottom of the board where the screws have been removed.

NOTE

Many of the test points on the Control Board are accessible at this point; however, the Front Cover Assembly should not be powered-up without first installing a screw in the lower right-hand hole to ground the board. Also, the three screws securing the top flex connectors need to be installed for good flex connections. USE CAUTION: Excess screw length may damage the flex circuits or the case threads. The lower left-hand screw will also have to be in place to supply battery power to the board.

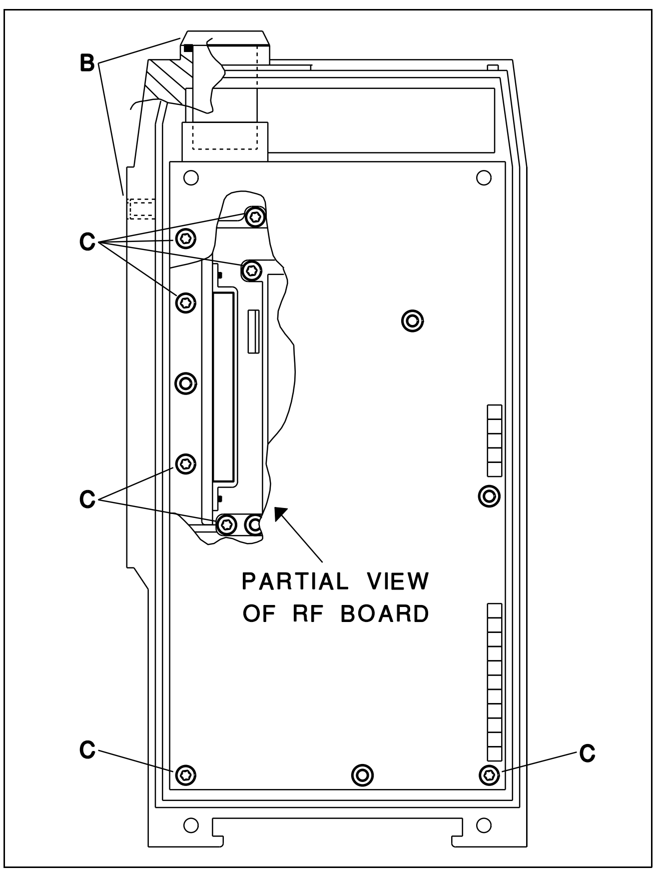


Figure 2 - RF Board Access

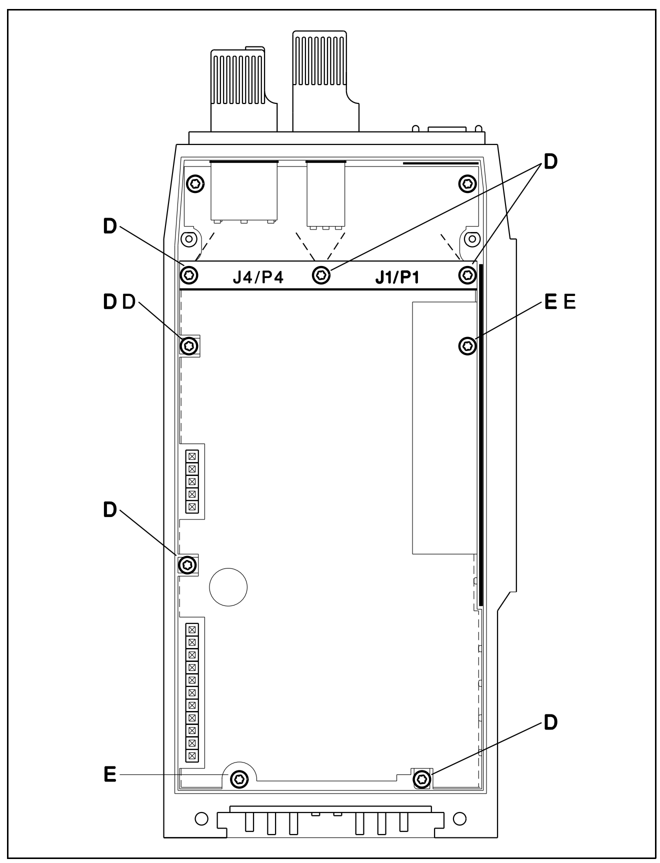


Figure 3 - Control Board Access

SPEAKER, MICROPHONE AND FLEX CIRCUIT ACCESS

Remove the Control Board and the six die-cast shield screws. Remove the die-cast shield by lifting the top end first and sliding it towards the top of the radio. The internal speaker, microphone, Keypad and UDC Flex circuits are now accessible.

If UDC Flex removal is necessary, first un-solder the microphone. Remove the UDC securing screw (the UDC ground pin). Lift the UDC/Monitor Button/PTT Switch assembly from the side of the case and slide the flex through the slot.

To remove the Keypad Flex, first remove the Flex/UDC/Monitor Button/PTT Switch assembly as previously stated. Next remove the knobs using the hex driver. Unscrew the two screws (**F**) securing the top panel and remove the panel. Lift the Emergency Button Board by carefully unplugging J6 from P6. Remove the nuts securing the volume and channel controls. Unscrew the two screws (**GG**) and remove the J10/P10 Zebra strip securing plate (**HH**). The Keypad Flex is now free for removal. Additional screws (**J** & **JJ**) secure the LCD Board used with the M-PA series radios.

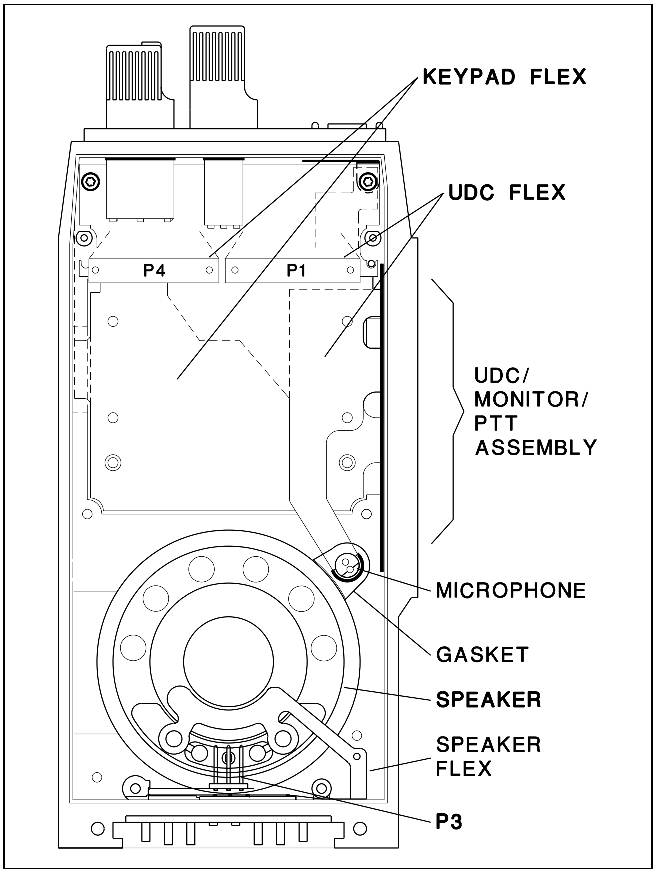


Figure 4 - Speaker, Microphone And Flex Circuit Access

In order to replace the Speaker Flex, it must be Unsoldered from the speaker and the Battery Plate.

LCD BOARD

After the Keypad Flex has been removed, the LCD Board assembly can be removed by removing the two remaining screws (**J**).

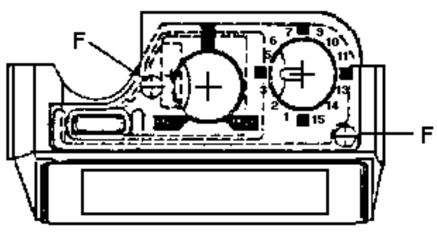


Figure 5 - Top Panel And Knobs

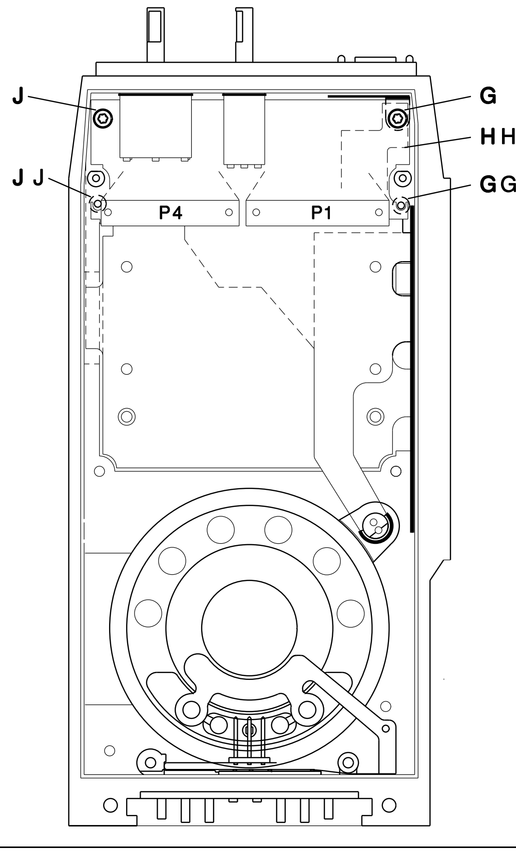


Figure 6 - Keypad And LCD Board Access

ALIGNMENT PROCEDURES

This section outlines alignment procedures for the 800 MHz RF Board located in the Rear Cover Assembly. Several test procedures are presented which will help isolate a problem if it exists.

The circuits in the Front Cover Assembly contain no adjustments and therefore no alignment is necessary. See the TROUBLESHOOTING section for test information if a problem is suspected in the control circuits.

Alignment procedures must be performed in the order presented to insure proper radio operation.

SERVICE NOTES

Throughout the service procedures presented in this manual, the following information should be observed:

- The bench power supply should be set for 7.5 ±0.1 Vdc (unless otherwise noted) during troubleshooting procedures presented in this manual. If a battery pack is used, it should be fully charged. Typical battery pack voltage will be 7.5 Vdc ±20 % over its full discharge cycle.
- Logic Levels:
  Logic 1 = high = greater than 4.5 Vdc
  Logic 0 = low = less than 0.5 Vdc
- The modules are not field repairable. Schematics and Outline diagrams for the modules are presented in this manual as a troubleshooting reference only.
- The Front Cover Test Accessory Kit allows the Control Board to be extended out of the case for troubleshooting access. The LCD and Keypad circuits can be tested in the case via a PC computer connection.
- The personality information stored in the radio should be backed-up on the PC computer before any service procedure is performed.

SET-UP PROCEDURE

1. Separate the Front and Rear Cover Assemblies and connect the RF/Logic Extender cable between the RF Board and the Control Board. See Figure 7. Use caution when working with these connectors.
2. Slide the Dummy Battery onto the Front Cover and connect the audio output leads to the distortion analyzer. Place the Dummy Battery ON/OFF switch in the OFF position to direct the speaker audio to the distortion analyzer. Connect the PC Programmer to the UDC.
3. Set the power supply to 7.5 ±0.1 Vdc and connect the Dummy Battery supply leads to the power supply. See Table 6 for current consumption data.
4. Program the radio with the LOW, MIDDLE and HIGH-side test channels listed in Table 2. To fully test the transmitter, program a channel pair for each frequency, one at high power and one at low power. It may be desirable to program more test channels into the unit.

Table 2 - RF Test Channels

RF BAND	TEST FREQUENCY (MHz)		
	LOW	MIDDLE	HIGH
806-824 MHz*	806.0125	815.5125	824.0000
851-869 MHz	851.0125	860.5125	869.0000

*Transmit only (RX channels are 45 MHz higher)

5. Remove power from the radio and replace the PC programming cable with the TQ-0609 Test Box.

NOTE

LBI-38203 contains detailed information on the TQ-0609 Test Box.

6. Connect the radio to the wattmeter using the RF Antenna Adapter. Couple a small amount of the RF signal to the frequency counter.

TRANSMITTER ALIGNMENT

The following information can be used to test and align the transmitter's output frequency and its modulation characteristics. Completion of these tests/alignments will verify a near 100% operating synthesizer and transmitter stages.

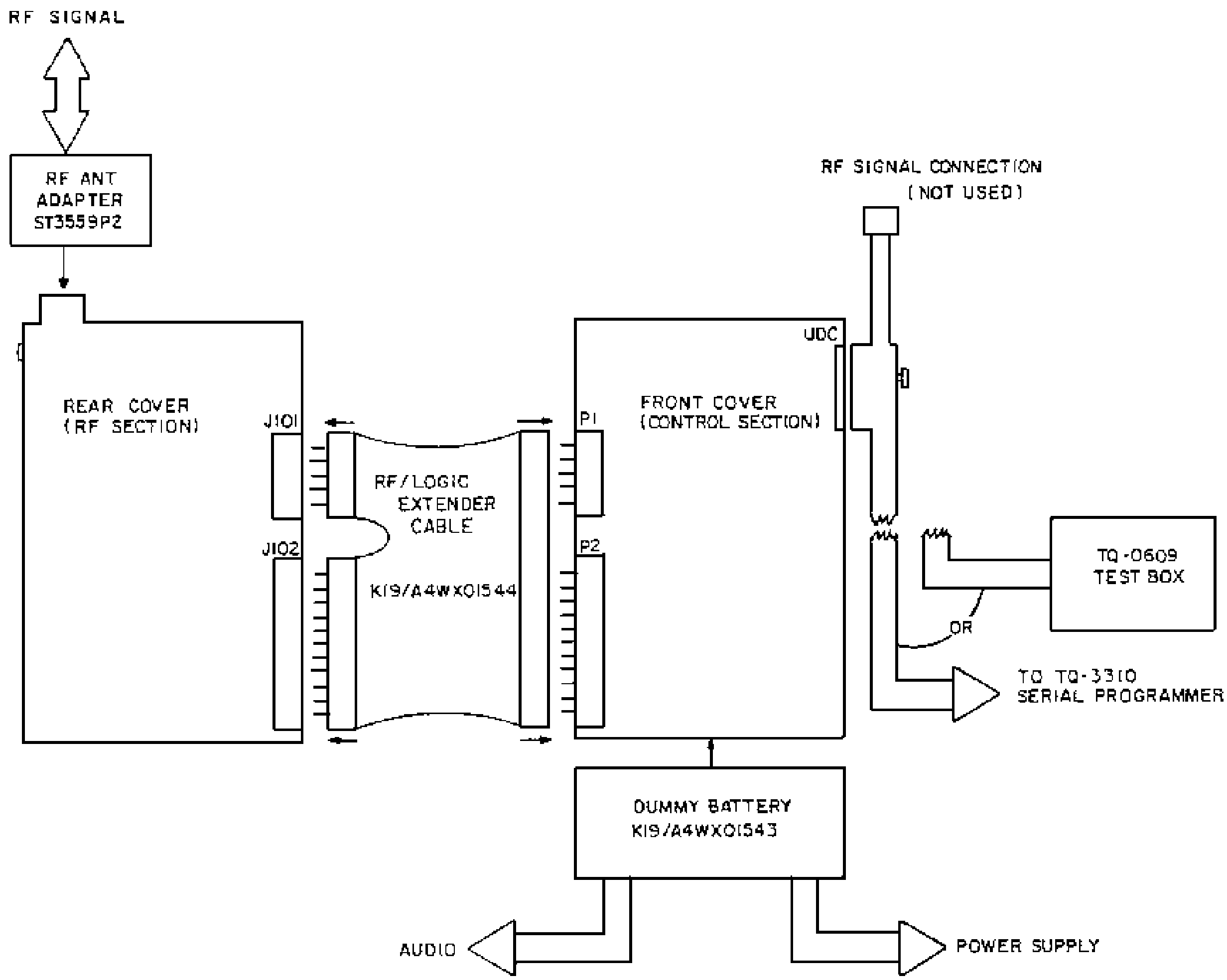


Figure 7 - Test Set-Up

REFERENCE OSCILLATOR

1. On the TQ-0609 Test Box, select UDC switch position 6 and apply power to the radio. This enables the radio's control circuits for an external microphone and its internal speaker amplifier.

2. Channel the Unit to 860.5125 MHz (low power) and key the transmitter using the TQ-0609. DO NOT apply any modulation at this time.

3. Monitor the transmitter frequency and adjust Reference Oscillator U4 to obtain a frequency reading of 860.5125 MHz ±100 Hz (a small trimmer hole is located on top of module). If the ±100 Hz maximum error (at room temperature) can not be secured, Reference Oscillator replacement may be necessary. Table 3 list maximum transmitter errors for the specified temperature range.

> **NOTE**
>
> Reference Oscillator U4 is factory adjusted and should not normally need readjustment. **Use a recently calibrated and stable frequency counter to determine if oscillator adjustment is needed**. The above test/alignment should be done at a room temperature of 25°C ±5°C.

4. Check all TX test channels for an error of less than ±100 Hz.

VCO MODULATION

> **NOTE**
>
> VCO Modulation adjustment should only be necessary if changes in the Tracking Data values will not compensate deviation levels to within specifications. Adjustment of R5 will obsolete all Tracking and Channel Data modulation values. See the TRACKING AND CHANNEL DATA section in this manual for further details.
>
> R5 "course aligns" the VCO modulation level. The Audio Processor IC will perform "fine level adjustment" of TX deviation via the Tracking and Channel Data.

1. To align R5 it will be necessary to modify the RF/Logic Extender cable as follows:
   - Add two 10K ohm resistors in series from 5.4 Vdc (J102 pin 6) to ground (J102 pin 7).
   - Break the connection at TX AUDIO, J102/P2 pin 1.
   - Bias TX AUDIO into the RF Board to 2.7 Vdc by connecting the junction of the 10K resistors to J102 pin 1.
2. Using a 100 µF (or greater) capacitor, couple a 1 kHz, 600 mV rms audio signal into TX AUDIO, J102 pin 1.
3. Connect the radio to the modulation analyzer and key the transmitter at 815.5125 MHz.
4. Adjust the R5 for a deviation of 4.3 kHz ±100 Hz. Unkey the radio.
5. Check low-frequency modulation as follows:
   - Remove the 1 kHz signal and apply a 20 Hz, 1 Vp-p square wave. NOTE: The modulation analyzer should have a low-frequency response of less than 1 Hz for this test.
   - Key the transmitter and monitor the demodulated output from the modulation analyzer. Check for a good square wave response at 860.5125 MHz. If the modulation peaks are not flat, slightly readjust R5 for a good demodulated square wave. If this readjustment causes the 1 kHz modulation set in step 4 to go outside of the specified window, U4 may need to be replaced.

Table 3 - Maximum Transmitter Frequency Error*
And Typical VCO (TP2) TX Tuning Voltages

CHANNEL (MHz)	TOLERANCE (Hz)	LOWEST (MHz)	HIGHEST (MHz)	VCO TUNING VOLTAGE	BAND SWITCH (J102 pin 3)
806.012500	±1209	806.011291	806.013709	1.5 Vdc	low
815.512500	±1223	815.511277	815.513723	2.9 Vdc	low
824.000000	±1236	823.998764	824.001236	4.2 Vdc	low
851.012500	±1277	851.011223	851.013777	1.9 Vdc	high
860.512500	±1291	860.511209	860.513791	3.1 Vdc	high
869.000000	±1304	868.998696	869.001304	4.2 Vdc	high

*Based on specified ± 1.5 PPM over the entire operating temperature range

DISTORTION TEST

1. Measure transmitter audio distortion on the LOW, MIDDLE and HIGH-side test channels. Distortion readings should be less than 3% at 3 kHz deviation with a 1000 Hz tone.

RECEIVER ALIGNMENT

The following information can be used to check and align the receiver circuits. Successful completion of these alignment procedures will verify a near 100% operating synthesizer and receiver stages.

NOTE

There are no front-end filter, mixer or high-IF adjustments.

2ND LOCAL OSCILLATOR

1. Check Reference Oscillator alignment as outlined in the TRANSMITTER ALIGNMENT section.
2. Channel the unit 860.5125 MHz.
3. Set the RF signal generator 860.5125 MHz, -20 dBm and no modulation. Apply this signal to the radio.
4. To measure the IF signal, connect the frequency counter to TP1 on the RF Board or to the collector of Q1 on Back-End Module Ul4. Use an appropriate high impedance probe (or amp).
5. Adjust the signal generator level to achieve accurate counting of the IF signal; the RF signal generator should be set 10 dBm above the lowest level which gives accurate counting.
6. Adjust the 2nd local oscillator via L13 for 455.000 kHz ±90 Hz.

QUADRATURE DETECTOR

1. Modulate the signal generator with a 1 kHz tone, 3 kHz deviation at 860.5125 MHz. Set RF level to -50 dBm.
2. Adjust Ll4 for maximum audio level at J101/Pl pin 4.

12DB SINAD AND DISTORTION TESTS

1. Connect the distortion analyzer or SINAD meter to the speaker load (in Dummy Battery).
2. With the RF signal generator and radio set to 860.5125 MHz, modulate the generator with a 1 kHz tone at 3 kHz deviation. Measure the 12 dB SINAD sensitivity. This reading should be $\leq$ -116 dBm (0.35 μV).
3. Return the signal level to -50 dBm.
4. Check audio distortion. Readings should be $\leq$ 5% at rated audio output. Audio amplitude should be 100 - 150 mV rms ($\approx$ 350 mV p-p) at J101/P1 pin 4.
5. Repeat the 12 dB SINAD sensitivity and distortion check for the LOW and HIGH-side channels. See Table 2.

TRACKING AND CHANNEL DATA

The personality RAM memory map includes distinct areas which are reserved for Tracking and Channel Data.

Tracking Data establishes individual radio parameters and tailors the operation of the unit across the band. The four parameters include high RF power, low RF power, modulation level and receiver squelch opening. This data is programmed into the RAM at the factory after the front and rear covers are "married". The PC Programmer allows alteration of this data if necessary.

Channel Data is the individual channel information such as TX and RX frequencies, CG information, CCT information, and the four previously mentioned parameters. This data is stored in the RAM on a per channel basis as each channel is programmed. The PC Programmer allows alteration of this data (on a per channel basis) if necessary.

Low, medium and high-side of the band values are programmed into the radio for each Tracking parameter per band (806-825 and 851-870). When a channel is added to the radio, the Programmer reads the Tracking values and calculates necessary values for each channel using a linear interpolation technique. The Programmer stores the newly calculated values in the Channel Data area of memory along with the associated channel information.

Changing the Tracking Data will not alter Channel Data of previously programmed channels. Tracking Data should not normally be altered; however, it may be necessary to reprogram some of the values after aligning circuitry, or replacing modules or other components which obsolete the previously programmed values. Settings for each parameter are listed in Table 4. If Tracking Data is altered for the above reason, it will be necessary to reprogram all channels to establish the new default data for each channel. See the Programming Manual for further information on altering Tracking and Channel Data.

Digital values stored for the POWER SET analog voltage are one example of tracking information. As no two transmitter stages are exactly matched, the POWER SET dc voltage will be slightly different with any two radios to produce the same power output. Tracking and Channel Data allows the microprocessor to tailor the POWER SET line for the RF stage difference from unit-to-unit and across the band.

Table 4 - Tracking Data Parameters

PARAMETER	FACTORY SETTING	HEX VALUE*
High Power	3.0 Watts	85
Low Power	1.0 Watt	50
Modulation	4.3 kHz **	0A
Squelch Opening	8 dB SINAD	A0

* Listed values are approximate; final programmed values will vary from unit-to-unit and will need to be adjusted as such.

** EXT MIC HI = 1 kHz, 110 mV rms

TROUBLESHOOTING

The following procedures are designed to quickly lead the service technician to the area of trouble. Rear and Front Cover Assembly troubleshooting procedures are outlined. The test set-up should be identical to the set-up used in the ALIGNMENT PROCEDURES section in this manual.

Table 5 lists common problems and most likely problem areas.

SERVICE NOTES

Throughout the service procedures presented in this manual, the following information should be observed:

- The bench power supply should be set for 7.5 ± 0.1 Vdc (unless otherwise noted) during troubleshooting procedures presented in this manual. If a battery pack is used, it should be fully charged. Typical battery pack voltage will be 7.5 Vdc ±20% over its full discharge cycle.
- Logic Levels:
  Logic 1 = high = greater than 4.5 Vdc
  Logic 0 = low = less than 0.5 Vdc
- The modules are not field repairable. Schematics and Outline diagrams for the modules are presented in this manual as a troubleshooting reference only.
- The Front Cover Test Accessory Kit allows the Control Board to be extended out of the case for troubleshooting access. The LCD and Keypad circuits can be tested in the case via a PC computer connection.
- The personality information stored in the radio should be backed-up on the PC computer before any service procedure is performed.
- The Large-Scale Integration IC's located on the Control Board (U4, U7 and Ul8) are very reliable devices. Replace these integrated circuits only after troubleshooting all associated circuitry and resoldering the leads. Faulty solder connections will cause inoperative or intermittent operation.

Table 5 - General Troubleshooting

SYMPTOM	POSSIBLE CAUSES
Completely inoperative (no audio and no LCD indication)	1. Dead Battery Pack. 2. Fuse blown: Check radio fuse in Battery Plate. 3. Control circuit problem: Troublehsoot Front Cover Assembly.
At power-up, radio beeps: a. twice (once in addition to power-up beep) b. continuously at an ≈ 2 Hz rate c. continuously at an ≈ 2 Hz rate and "NO LOCK" is displayed.	1a. Weak Battery Pack. 1b. Unit is not programmed: Program radio - See TQ-3340. 2b. Lithium battery (BT1) on Control Board defective. 1c. Synthesizer is not locked: Check LOCK detect line, synthesizer loading and VCO tuning voltage.
At power-up, display: a. flashes "PERS ERR" b. flashes all segments and the radio beeps	1a. Internal lithium battery failure. 2a. RAM failure: Troubleshoot Front Cover. 1b. Interprocessor communication failure: Troubleshoot Front cover Assembly.
Receiver inoperative or weak.	1. Squelch levels programmed too high: Press Monitor Button to disable squelch. 2. Channel Guard or Type 99 Enabled: See Operators Manual. 3. Defective antenna. 4. RF Board problem: Troubleshoot Rear Cover Assembly.
Transmitter inoperative or low range.	1. Power levels programmed low: Check RF output and reprogram unit if necessary. 2. Weak battery. Note "BAT" flag. 3. Defective antenna. 4. RF Board problem: Troubleshoot Rear Cover Assembly.
TX and RX inoperative on some channels only	1. Programming incorrect: Reprogram unit - See TQ-3340. 2. Synthesizer problem (VCO or prescaler): Check LOCK detect (high = lock), VCO tuning voltage and modulas control line. 3. RAM Problem: Troubleshoot Front Cover.
TX and RX inoperative on all channels	1. Programming incorrect: Reprogram unit - See TQ-3340. 2. Synthesizer problem: Check LOCK detect (high = lock), VCO tuning voltage and modulas control line. 3. Control circuit problem: Troubleshoot Front Cover Assembly. 4. Check SW1, U2 and U5 on RF Board.
Trunk Mode Problem	1. Modem circuitry problem: Check U5, U6.1 and U17.3 on Control Board. 2. Low-speed data problem.

REAR COVER ASSEMBLY

The troubleshooting procedures that follow primarily assume a problem has been narrowed to a problem on the RF Board. Transmitter, receiver and synthesizer symptoms/causes are outlined.

Troubleshooting procedures for the Front Cover Assembly list appropriate techniques for locating a problem with the circuits in this assembly.

TRANSMITTER TROUBLESHOOTING

Inoperative Or Low Power

Power sources and regulated power supplies should be one of the first areas to check before troubleshooting any transmitter problem. The radio's power source, whether it be a battery or a bench power supply, is especially critical when troubleshooting a portable radio. Current consumption is an excellent troubleshooting tip when troubleshooting a dead or weak transmitter. See Table 6 for details. See the Front Cover

Assembly TROUBLESHOOTING procedures if there is a problem in any of the dc supplies to the RF Board.

If the synthesizer is not locked, the radio should be beeping, and flashing "NOLOCK" in the display. See Synthesizer Troubleshooting.

NOTE

If the synthesizer does not lock or stay locked at the start of or during a transmission, I/O Microcontroller will not enable or continue the transmission. Check LOCK detect at J102/P2 pin 8 for a low or pulsing (not locked) condition.

1. Check for battery power on J102/P2 pin 2.

2. Check 5.4V REG from the Control Board at J102/P2 pin 6 with the transmitter enabled. It should be within ±0. 1 Vdc. Also check the operation of the TX 5.4V switch (D14.2 and Q4 on Control Board) to insure 5.4 Vdc is being delivered to the RF Board at J101/P1 pin 5 when the PTT button is pressed.

3. Battery power (7.5 Vdc) should be present at the Power Amplifier module pins 3 and 4. If current consumption appears normal (See Table 6) for both high and low power modes, the problem may be Antenna T/R Switch module U2, the Low-pass Filter module U5 or the antenna switch SW1. If the Low-pass Filter module or the antenna switch have problem, generally the receiver will also be weak. A shorted or open pin diode inside the Antenna T/R Switch module may cause transmitter and/or receiver problems.

4. If low RF power is a symptom, check the operation of Power Controller A2 and Q4. POWER SET on J101/P1 pin 1 should be approximately 1.8 Vdc in low power mode and 2.9 Vdc in high power mode. If Q4 is saturated (collector voltage is ≈ 7.5 Vdc), troubleshoot the PA U1 and Exciter U9 for a gain problem. Also check VCO and Q6 for low RF drive. Buffer Q6 supplies ≈ 0 dBm to U9. Exciter U9 has an approximate gain of 23 dB and PA UI has an approximate gain of 16 dB.

5. Check Tracking and Channel Data. Reprogram if necessary.

Excessive Power Output

Short battery life and possible damage to the PA module may result if this problem occurs in the power controlling circuitry.

1. Check POWER SET from the Control Board. POWER SET on J101/PI pin 1 should be approximately 1.8 Vdc in low power (1 Watt) mode and 2.9 Vdc in high power (3 Watts) mode. If incorrect, troubleshoot the D/A converter circuits (in Audio Processor U7) on the Control Board. Check Tracking and Channel Data. Reprogram if necessary.

2. The collector of Q4 should be approximately 3.5 Vdc in low power mode and 5.5 Vdc in high power mode. If Q4's collector stays near 7.5 Vdc in receive mode, it is most likely shorted. Temporarily short the emitter and base while monitoring the collector voltage. If the collector voltage falls, there is a problem in Power Controller A2.

Will Not Lock Or Stay Locked, Receiver OK

1. Check programming.

2. Check regulated supplies to the synthesizer when PTT is pressed.

3. See Synthesizer Troubleshooting.

Frequency Error

If transmit frequency error exists (greater than 1.5 PPM) and the synthesizer stays locked, Reference Oscillator U4 alignment or replacement is necessary. See ALIGNMENT PROCEDURES for details.

The I/O Microcontroller will not enable a transmission if the synthesizer is not locked.

Modulation Problems

Modulation problems can be caused by failures in the audio circuits in the front cover or the modulating circuitry of the RF Board.

1. Insure modulating audio is present on J102/P2 pin 1. A 1 kHz, 600 mV rms TX AUDIO signal should produce 4.3 kHz deviation.

   Improper modulation from 300 - 3000 Hz points to a VCO modulation problem. Check VCO Y2 pin 2 for the TX AUDIO signal. Suspect Y2 if the signal is present and incorrect modulation exists.

2. If improper low-frequency (Channel Guard) modulation exists, first check J102 pin 1 for the proper tone. Next check U4 pin 3 for the tone; suspect C11 if the tone is not present. Replace U4 if the tone is present on pin 3 and incorrect low-frequency modulation exists. See the ALIGNMENT PROCEDURES for details.

3. Check Tracking and Channel Data. Reprogram if necessary.

4. See TROUBLESHOOTING the Front cover Assembly.

Modulation Distortion

Check TX AUDIO for an undistorted signal to the RF Board. The audio signal on J102/P2 pin 1 should appear undistorted at maximum deviation and it should be riding on a 2.7 Vdc bias from U6.2 on the Control Board.

1. If TX AUDIO distortion is minimal and transmitter distortion is excessive, suspect the VCO or the Reference Oscillator on the RF Board.

2. If TX AUDIO is distorted, suspect a defective microphone, mic amps, modulation limiting, or pre-emphasis circuity.

If audio sensitivity is good the microphone, amplifiers and limiters are probably OK. Regeneration from an open decoupling capacitor or a stage gain too high may make the unit appear to be too sensitive. See TROUBLESHOOTING the Front Cover Assembly.

RECEIVER TROUBLESHOOTING

Inoperative

1 Press the Monitor Button, if receiver noise is heard, it can be assumed that most of the receiver's circuitry is good.

2. If the synthesizer is not locked, the radio should be beeping and flashing "NO LOCK" in the LCD. See Synthesizer Troubleshooting.

3. Check RX AUDIO for signal and/or noise. With an RF input modulated at 1 kHz, 3 kHz deviation, RX AUDIO should be 100 - 150 mV rms (≈ 350 mV p-p). If the 1 kHz audio is present, troubleshoot the audio circuits in the Front Cover Assembly. Noise only levels on RX AUDIO should be approximately 700 mV p-p.

4. Check for 7.5 Vdc at RF Amp U10 pin 5 and IF Amp U11 pin 1. Check U14 pin 7 for 5.8 Vdc (±0.2 Vdc) from A1 pin 10. Insure TX 5.4V is low in receive mode.

5. Insure the mixer injection through Q2 from the VCO is present at TP7. Check the VCO output with a frequency counter at TP7. The VCO should be running 45.0125 MHz below the RX frequency. VCO output power level is typically + 4 dBm at TP7 into 50 ohms (mixer still connected).

6. To eliminate a problem in the back-end circuits, follow the below procedure:

   - Insure 5.8 Vdc (±0.2 Vdc) is present on U14 pin 1 and 7.

   - Connect a frequency counter to TP1 to monitor the IF. Use an appropriate high impedance probe (or amp).

   - Couple a 45.0125 MHz signal (no modulation) from an HF signal generator to TP4. Adjust the signal generator level to achieve accurate counting of the IF; the signal generator should be set 10 dBm above the lowest level which gives stable counting of the 455 kHz IF. See ALIGNMENT PROCEDURES if the 2nd IF is in error by more than 90 Hz.

   - Modulate the HF signal generator and observe the recovered audio on U14 pin 2 and J101 pin 4.

Low Sensitivity

Low receiver sensitivity and/or failure of a modulation acceptance bandwidth test indicates a receiver gain or selectivity problem in the IF stages. A bandwidth that is too wide will cause unnecessary noise, detracting from the receiver quieting. If the bandwidth is too narrow squelching could occur at the modulation peaks. Suspect a defective IF filter if one of the above symptoms occurs.

A 12 dB SINAD sensitivity of around -90 dBm indicates a problem with High-IF Amp U 11. The module provides a nominal gain of around 17 dB.

A 12 dB SINAD sensitivity of around -100 dBm could be caused by a problem with RF Amp U10. This module provides 10 dB of gain.

Squelch Problem

A squelch circuit problem (assuming good signal and/or noise is present at J101 pin 4) indicates a problem with the Audio Processor chip on the Control Board. Troubleshooting should begin at the discriminator output. Signal trace through the discriminator amp to the Audio Processor. Check the operation of the noise rectifier to be sure the noise is being converted into the proper dc voltage.

See TROUBLESHOOTING the Front Cover Assembly for details on receiver audio failures. Check Tracking and Channel Data.

Excessive Distortion

If the measured distortion exceeds the rated specification signal trace starting at the discriminator output and through the audio stages until the fault is isolated. Signal tracing with an oscilloscope proves very useful in locating the trouble areas.

SYNTHESIZER TROUBLESHOOTING

Will Not Lock Or Stay Locked

Each time the channel is changed, the PTT Button is pressed or the PTT Button is released, Synthesizer IC U3 is serially loaded with new TX or RX data. If the synthesizer does not lock or stay locked, the following will be observed:

- the radio continuously or intermittently beeps
- "NO LOCK" will flash in the display
- LOCK detect (J102 pin 8) will be low or pulsing to flag the I/O Microcontroller of the unlocked condition

If the above condition occurs, the I/O Microcontroller will continue to try to reload U3 with data until the synthesizer locks.

1. Insure the 5.4 Vdc supply to the RF Board is within ±0 1 Vdc 7.5V BATT is present, and TX 5.4 V is low (receive mode only).
2. Monitor CLOCK, DATA and ENABLE (on J102 pins 11, 10 and 9 respectively) for pulse activity when a channel is changed. See Figure 8. If these signals are not present, suspect a defective I/O Microcontroller.
3. Check A1 pin 9 for 5.8 Vdc (±0.2 Vdc) to U3, U4, U8 and Y2. If this power source is not present, check A1 pin 7 for 5.8 Vdc (±0.2 Vdc) from Q201 and check A1 pin 11 for 7.5 Vdc. Replace A1 if the two inputs are good and the output is not.
4. Using a frequency counter with a high impedance probe or amp, check TP8 for the 13.2 MHz (±20 Hz at 25°C) signal from Reference Oscillator U4. Replace U4 if this signal is not present and pin 1 is 5.4 Vdc. Also insure the signal is present on U3 pin 2. See ALIGNMENT PROCEDURES for oscillator alignment details.
5. Insure BAND SWITCH (J102 pin 3) is at the correct logic level. It should be low for transmit frequencies of 806 - 825 MHz and high for transmit frequencies of 851 - 870 MHz. BAND SWITCH should remain low for all receive frequencies. (The VCO operates 45.0125 MHz below the 851 - 870 MHz receive frequencies.) Suspect the I/O Microcontroller if there is a problem with this signal.

   Check Y3 pin 5 for an inversion of this logic level via Q5. If the inverted signal is present on both bands and the synthesizer will not lock on one band only, replace VCO Y2.

6. If LOCK detect is low and not pulsing, temporarily pull it high by connecting J102 pin 6 to J102 pin 8. If the radio now operates normally on all test TX and RX channels, replace U3 - the output on pin 9 is defective.
7. Check the VCO output with a frequency counter at TP7 or by tuning a service monitor to the radio's local oscillator (VCO) signal and loosely coupling the VCO signal into the service monitor. The VCO should be running 45.0125 MHz below the RX frequency. VCO output power level is typically + 4 dBm at TP7 into 50 ohms (mixer still connected).

   The VCO tuning voltage can be monitored at TP2 or Y2 pin 1. See Table 3 for details.
8. If a synthesizer lock problem can not be narrowed to a problem in the Rear Cover Assembly, reprogram the inoperative channels and test the unit again. Also see the TROUBLESHOOTING procedures for the Front Cover Assembly.

Excessive Switching Time

The synthesizer should generally lock within 10 milliseconds after a frequency change.

1. Suspect leaky low-pass filter capacitors C57 or C58 if slow switching time is a symptom. Replace these components with original equipment parts only. See the RF Board parts list for part numbers.
2. Module A1 also influences switching time. Insure the ENABLE pulse is present at A1 pin 4. See Figure 8 for details.

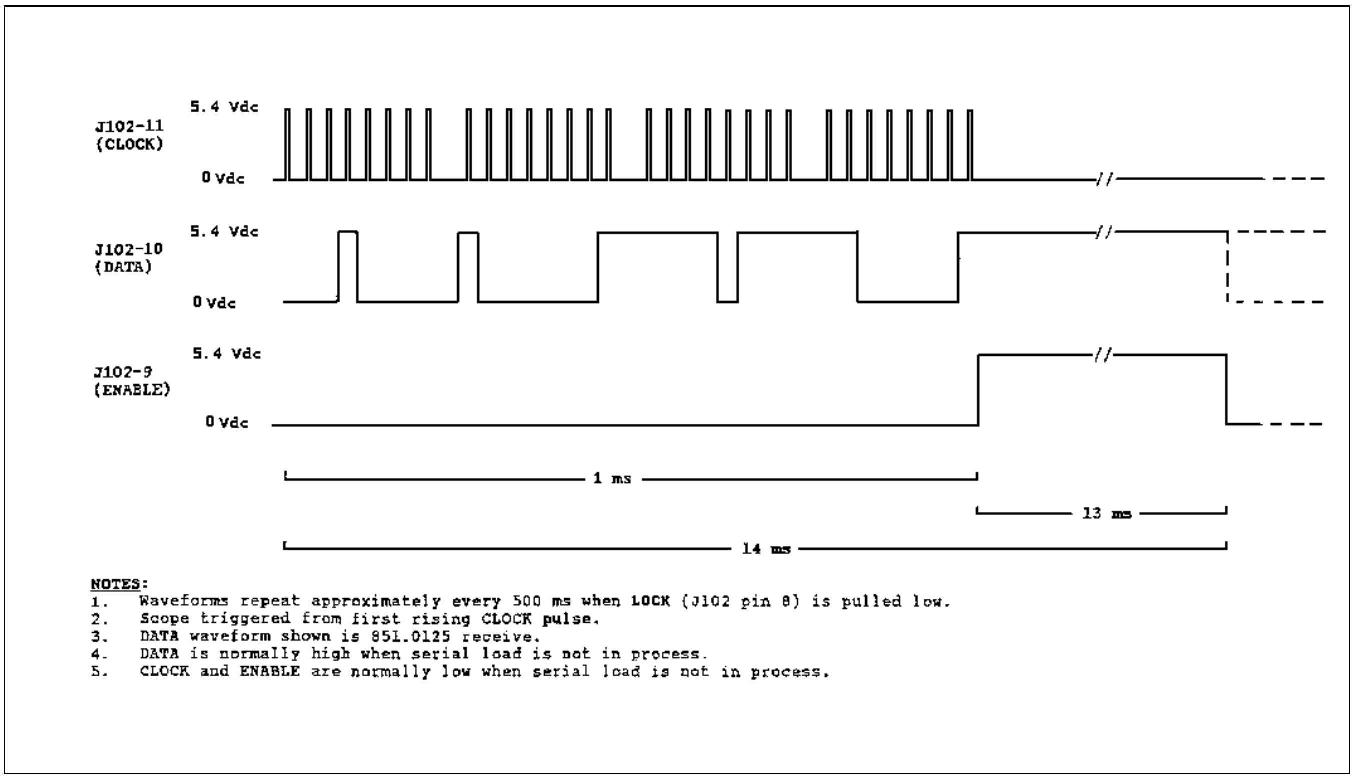


Figure 8 - CLOCK, DATA And ENABLE Pulses

TP1 = 455 kHz IF Output From Receiver Back-End U14

TP2 = VCO Tuning Voltage From PLL Filter A1

TP 3 = 45.0125 MHz Input To Receiver Back-End U14

TP 4 = 45.0125 MHz Output From IF Filter FLB1

TP5 = 45.0125 MHz Input To IF Filter FLB1

TP6 = Band-Switch Input To VCO
(High = TX 806 - 825 MHz)
(Low = TX 851 - 870 MHz)

TP7 = LO Injection To Mixer U7

TP8 = 13.2 MHz Output From Reference Oscillator U4

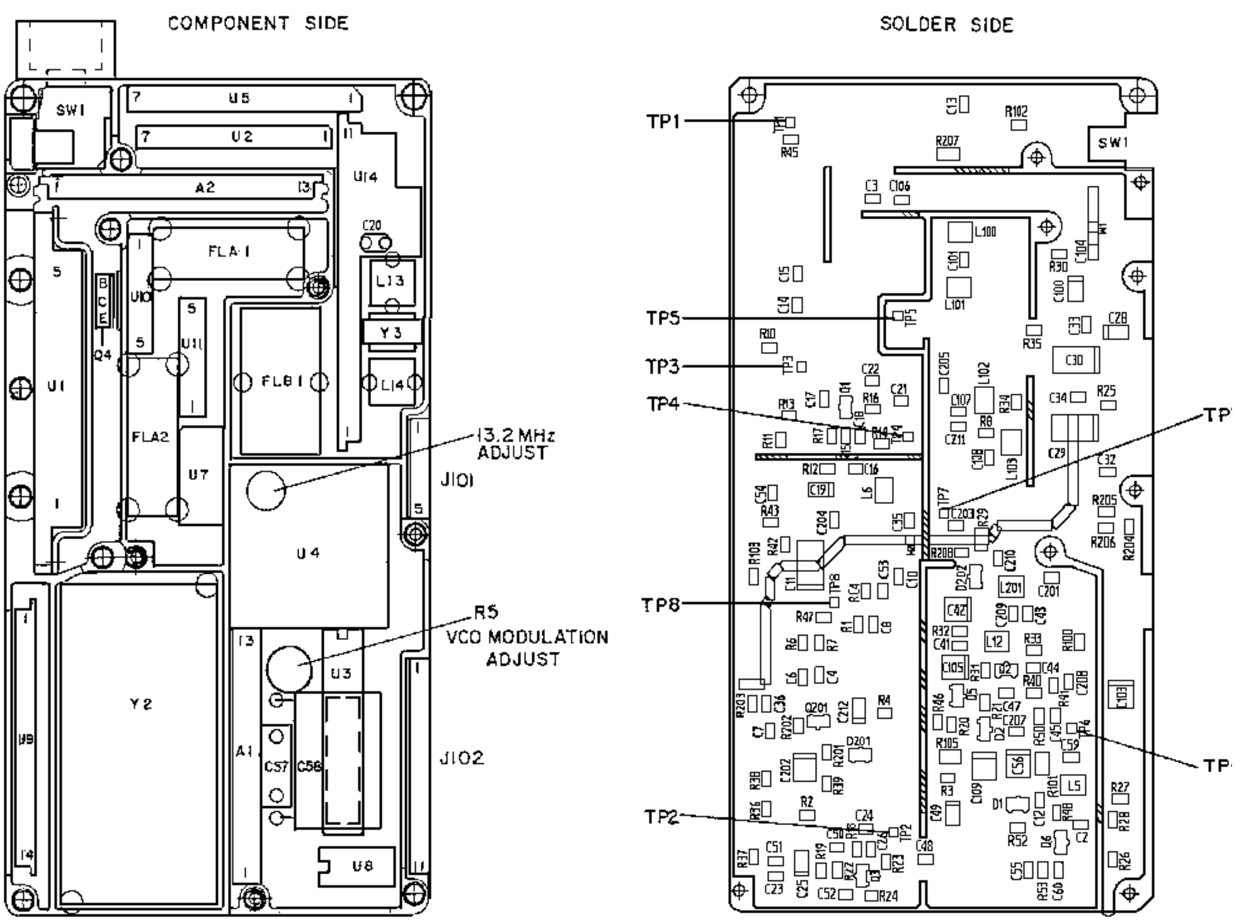


Figure 9 - RF Board Test Point Locations

FRONT COVER ASSEMBLY

The following outline will help lead the service technician to a problem with the Control board or other associated control circuits. The Control Board should be removed and electrically extended from the front cover for troublehsooting access. Use the Front cover Test Accessory Kit adapter and extender cable.

NOTE

Failure of the lithium battery B1 on the Control Board will erase all personality data stored in the radio.

Use caution when handling the Control Board. Shorting B1 (+), U1 pin 28 or D2 to ground will result in loss of personality.

COMPLETELY INOPERATIVE RADIO

Check Power Supplies

Power supplies should be the first area to check in the event of a completely inoperative unit. The battery fuse is located in the Battery Plate on the bottom of the radio. If the radio is dead, check the fuse. Table 6 lists supply current for various operating modes.

DC power into the radio (7.5 Vdc battery voltage) can be tested by monitoring the input connections (screw mounting points) located on the bottom of the Control Board. If dc power is not present at this point, suspect fuse F1 or the battery plate connections.

Voltage regulators for the Front Cover Assembly circuits are the 5.0 Vdc (+5V) and the 5.4 Vdc (V1) sources. The RF 5.4 Vdc supply (RF5.4) delivers dc power to the RF Board only. Supply outputs can be tested at collector (center terminal) of the associated pass transistor (Q3, Q10 and Q13). The regulated supplies should be stable to within 0. 1 Vdc during each operating mode (transmit, receive, standby, program). If all of the regulated supplies are in error check zener reference CR5. Pin 8 of CR5 should be 2.5 Vdc ±0.05 Vdc.

A failure of R133 or R57 most likely indicates a shorted decoupling capacitor on the associated supply rail. Temporarily remove the flex connections to assure there is no short on the flex strips or the LCD Board.

Table 6 - Typical Battery Current

OPERATING MODE	BATTERY CURRENT (at 7.5 Vdc)
Program	< 100mA
Receive (Squelched)	< 100 mA
Receive (Rated Audio)	< 300 mA
Transmit (Low Power)	<1250 mA
Transmit (High Power)	<1900 mA

Check Reset Logic

Monitor RSTOUT at TP2 from the modem IC as the unit is powered up. Trigger the scope on the rising 7.5 Vdc power supply. RSTOUT should stay high for 400 - 600 ms then transition and stay low. If TP2 remains high the radio will be inoperative since the microprocessors are not released from reset.

Check VCB at TP4 if a problem exists with RSTOUT. TP4 should also stay high for 400 - 600 ms after turn on. If this signal is OK, suspect a problem in the modem IC or a shorted input on U11.2. Also check CPURST at U18 pin 25 and verify it is low. If TP4 is not OK, troubleshoot the reset comparators U17.2, U17.1 and the associated RC networks. NOTE: U17 has open-collector outputs. If TP4 remains high, it can be shorted to ground to eliminate a problem with the reset comparator circuit.

Slowly lower the battery supply voltage until TP4 transitions high. This should occur at an approximate battery voltage of 5.4 Vdc. Next, slowly raise the supply voltage and verify that TP4 returns low. There should be less than 0.1 Vdc hysteresis.

Monitor U7 pin 49 when the unit is powered-up; C46's charge should be seen. Pin 49 should reach a final value of 5.4 Vdc within 100 milliseconds after power-up.

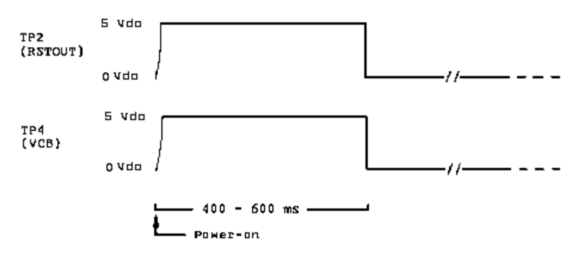


Figure 10 - Reset Waveforms

Table 7 - Clock Test Points

TEST POINT	CRYSTAL/IC	FREQUENCY (MHz)	MAX. ERROR (Hz)
OS1	Y4/U18	2.0000	±200
TP1	Y1/U5	11.0592	±1100
TP7	Y3/U7	8.0000	±800

Check Clocks

Monitor Test Point OS 1 near crystal Y4 on the component side of the printed wire board. NOTE: Use an oscilloscope with a x10 probe or a frequency counter that has a high input impedance (at least 10M ohms). OS1 is the 2.00 MHz clock for the I/O Microcontroller. Replace Y4 if this clock frequency is in error. Suspect Y4 or U18 if no signal is present. Generally, if the crystal is defective (open), ≈2.5 Vdc will be present at OS1 and no signal will be present.

Check TP1, OSCOUT, for an 11.059 MHz clock from the modem IC to the Personality Microprocessor. NOTE: Use an oscilloscope or a frequency counter that has a high input impedance. U1 1 pin 13 should be low and pin 12 should be high. Suspect Y1 if this clock frequency is in error. Suspect YI or U5 if no signal is present.

The Audio Processor's clock will also have to be operating for proper audio and A/D converter operation. Monitor TP7 for an 8 MHz square-wave output from U7. Replace crystal Y3 if this clock frequency is in error. Suspect Y3 or U7 if the signal is not present.

Check Keypad Scanning

Approximately every 50 milliseconds pulse activity should be present on the serial lines to and from the Keypad Flex. See Figure 11. These pulses are loading a data byte into shift register U2 and reading UI on the Keypad Flex. The Audio Processor is also being read and written to at this time. If these signals are not present, the I/O Microcontroller is not operating properly and it may not be communicating with the Personality Microprocessor.

1. Insure U18 pin 44 is 5 Vdc. Troubleshoot the + 5V regulator if it is not.
2. Insure all clocks are operating.
3. Reset the radio by turning it off and back on. Check U18 pin 1 and insure RSTOUT on TP2 is being inverted by U1 1.2; U18 pin 1 is high when the radio is operating normally.
4. See "Check Inter-processor Communication".

For further troubleshooting procedures related to keypad specific problems, see Keypad Flex Failures.

Check Inter-processor Communication

The I/O (68HC705) and Personality (80C52) Micros communicate via four lines. UPHSOUT, UPH-SIN, UP-DATA and UPCNTRL provide all handshake, data and control signals for message transfers between the two chips. Messages transfers consist of one or more byte transfers.

Each processor has a handshake input and a hand-shake output. A common bidirectional data line, UP-DATA, is shared by the chips. A control line, UPCNTRL, is an output from the Personality Micro to the I/O Micro.

Message transfers from the Personality Micro to the I/O Micro are primarily commands which cause the I/O Micro to execute a commanded function. Some examples include power-up status, Keypad Flex scan, LCD load, Audio Processor A/D converter write/read, synthesizer load and tone generation. All Personality to I/O Micro message transfers are initiated by a low pulse on the UPCNTRL.

Message transfers from the I/O Micro to the Personality Micro include status data such as power-up status report, key(s) pressed, UDC device connected, volume control position, synthesizer lock status and squelch status. I/O Micro to Personality Micro transfers are initialized by the I/O Micro pulling its handshake output (UPHSIN) low.

Inter-processor communication failure will generally cause the unit to appear dead at power-up or flash all of the segments in the display and beep.

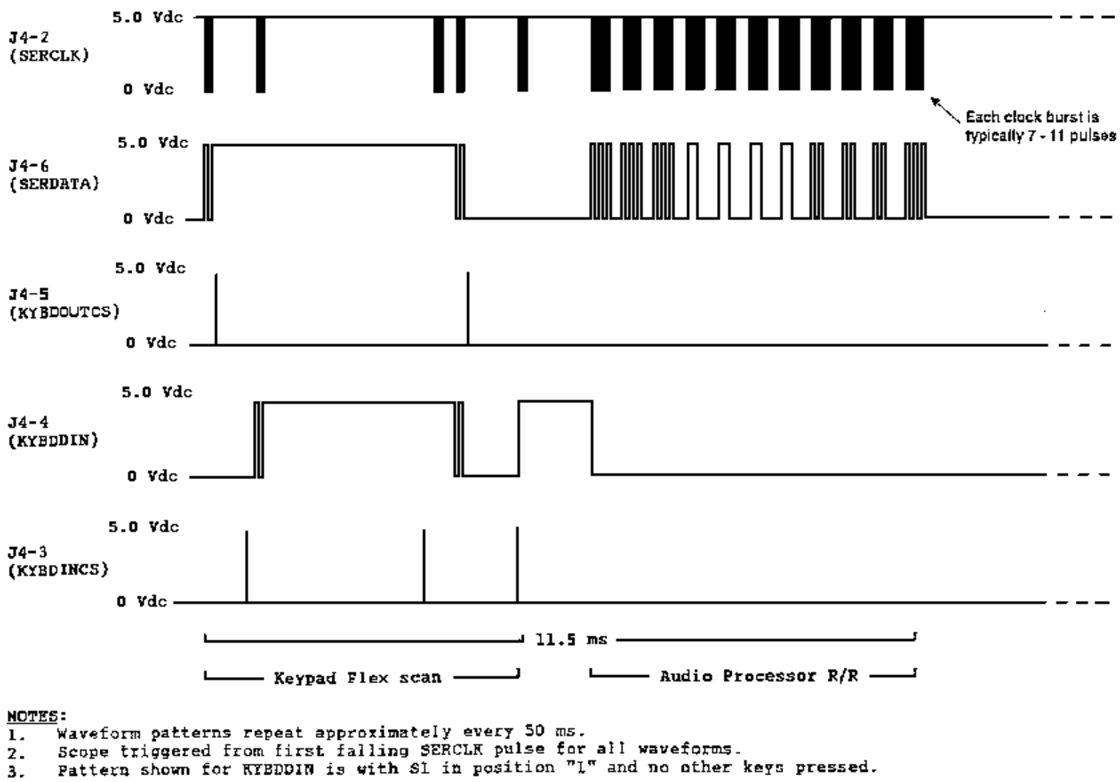


Figure 11 - Keypad Scanning Waveforms

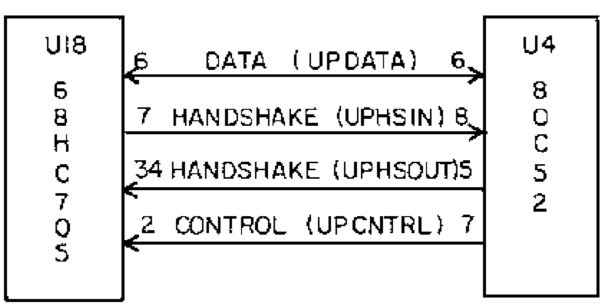


Figure 12 - Inter-Processor Communication

SYNTHESIZER LOCK FAILURE

Each time the channel is changed, the PTT Button is pressed or the PTT Button is released, the I/O Microcontroller serially loads U3 on the RF Board with new TX or RX data. If the synthesizer does not lock or stay locked, the following should be observed:

- the radio continuously or intermittently beeps
- "NO LOCK" flashes in the display
- LOCK detect (J102 pin 8) is low or pulsing flagging the I/O Microcontroller of the unlocked condition

If the above condition occurs, the I/O Microcontroller should continue to try to reload U3 with data until the synthesizer locks.

Synthesizer lock failure can be caused by a problem on the RF or Control Boards. If the radio locks only on some frequencies (for example high-side channels) the problem is most likely on the RF Board (the VCO or prescaler circuits for example). The following checks deal with problems associated with the Control Board.

1. Read the radio personality with the PC Programmer and reprogram the unit to insure there is good Channel Data for each channel programmed into the radio. Check the lithium battery.

2. Insure the 5.4 Vdc supply to the RF Board is within ±0.1 Vdc, 7.5V BATT is present, and TX 5.4 V is low (RX mode).

3. Monitor CLOCK, DATA and ENABLE (on J102/P2 pins 11, 10 and 9 respectively) for pulse activity when a channel is changed. See Figure 8. If these signals are not present, suspect a defective I/O Microcontroller. A failure of only one signal points to an open series resistor on the Control Board or a defective output from U18. NOTE: Temporarily connect LOCK (J102/P2 pin 8) to ground to view these waveforms.

4. Insure BAND SWITCH (J102/P2 pin 3) is at the correct logic level. It should be low for transmit frequencies of 806 - 825 MHz and high for transmit frequencies of 851 - 870 MHz. BAND SWITCH should remain low for all receive frequencies. (The VCO operates 45.0125 MHz below the 851 - 870 MHz receive frequencies.) Suspect the I/O Microcontroller if there is a problem with this signal.

5. Suspect a problem on the RF Board if all of the above outputs to it are good. See Rear Cover Assembly TROUBLESHOOTING for details.

RADIO WILL NOT PROGRAM

Check PC Programmer Power

The Control Board must first recognize the programming resistor (short to ground at UDC pin 9) with the PC Interface connected. It should then supply 7.5 Vdc (battery power, current limited by Q9.2) to the PC Interface via UDC pin 4 (UDC SW BATT).

1. Attempt to reprogram the unit with the external PC Interface power adapter; if successful, suspect transistors DI5.1, Q2 or the SW1 output from U7 pin 34. U7 pin 34 should be ≈ 0.5 Vdc in programming mode and less than 0. 1 Vdc otherwise.

2. Less than 0.6 Vdc should be on U7 pin 58 with the PC Interface connected to enable programming mode. If incorrect suspect R47, R91 or the UDC Flex. Most of the A/D conversion circuitry is operational if the volume control and low battery detector is functional.

3. Check RX and TX DATA from/to the radio and PC Programmer. See below.

Check TX Data

To check the TX DATA input, connect the PC Interface and computer and proceed as follows:

1. Check for logic 0 at J1 pin 5 (UDCTXDATA). Pulses should be seen here when a radio read is attempted. Suspect the UDC Flex if pulses are not present and the pin is high all the time.

2. Check for logic 1 at U4 pin 11 (inverted UDCTXDATA). Pulses should be seen when a radio read is attempted. Suspect U11.3, R7, R8, or CR1 if they are not. If pulses are present on U4, suspect U4 or the A/D converter circuits of U7; the Control Board may not be recognizing program mode.

Check RX Data

Attempt to read the radio repeatedly and check for a short serial data burst at the following points:

- U4 pin 13 (signal origin)
- Inverter U1 1.5 pin 10 (UDCRXDATA)
- P1 pin 7 (RX DATA).

Check UDC Flex continuity from P1 pin 7 to UDC J101 pin 7. The short data burst should be present at the UDC pin.

TRANSMIT AUDIO FAILURES

Internal Microphone Audio Failure

With no external option connected to the UDC, U7 pin 58 should be 5.4 Vdc. The I/O Microcontroller should enable the internal mic circuit via the Audio Processor when the radio is turned on.

1. Check J1/P1 pin 14 for an internal mic dc bias of ≈2.2 Vdc. If this voltage is near 2.7 Vdc, suspect an open UDC Flex or MK1.

2. Average speech into the front cover should produce 10 - 30 mV rms at J1/P1 pin 14.

3. Op Amp U19.2 should provide a signal (BUFINTMIC) level 7 to 10 times greater than the mic audio. Diode D1 begins limiting at about 350 mV rms output.

Table 8 - Transmitter Audio Signal Levels With 110mV rms, 1 kHz EXT MIC Input

TEST LOCATION	LEVEL (mV p-p)	COMMENT
U19 pin 1 (TP9)	260	External Mic Amp Output (BUFEXTMIC)
U7 pin 13	260	Audio Processor External Mic Input
U7 pin 26	2700 *	Audio Processor TX Audio Output
U6 pin 7 (P2 pin 1)	1800 *	TX Audio To RF Board (RFTXAUD)

*Signal levels with no Channel Guard modulation.

External Microphone Audio Failure

1. Insure the I/O Microcontroller is recognizing the externally connected option. The voltage on U7 pin 58 should be approximately 2.5 Vdc with the external mic connected. This voltage is developed from voltage divider R91, R47 and the resistor in the external option.
2. Check for ≈2.7 Vdc microphone bias at UDC pin 12 and J1/P1 pin 12. (≈2.2 Vdc with the external microphone attached). If this bias is incorrect, suspect resistor R69.
3. If the internal microphone is operating normally, suspect the UDC Flex or Op Amp U19.1. Connect an external microphone and check the audio level at JI pin 12. Average speech in the microphone should produce 10 - 30 mV rms here. Signal on U19.l pin 1 (BUFINTMIC) should be 7 to 10 times greater than EXT MIC HI.

Complete Mic Audio Failure

If both the external and internal microphones are not functioning apply an ac coupled 110 mV rms, 1 kHz tone to the UDC EXT MIC HI input using the TQ-0609 Test Box. Select switch position 6 (external mic) on the Test Box and turn the radio off and back on so it will recognize the external option. Key the radio. Typical signal levels with radio keyed are shown in Table 8.

Transmit Channel Guard or Trunked Low-Speed Data Problems (Encode Mode)

1. Channel the radio to a conventional channel that has tone Channel Guard encode programmed.
2. Monitor U7 pin 5. There should be a 400 mV p-p staircase wave here when the radio is keyed. This signal is generated from the two walsh bit outputs from U4 (pins 3 and 4) and resistors R66 and R42. This point is dc biased approximately 2.7 Vdc by R40 and R63. U4 pins 3 and 4 should both be toggling high and low.
3. Check U7 pins 6 and 20. There should be a 400 mV p-p sine wave here. The filtered output (pin 6) is connected directly to the input (pin 20). This input is then summed with the microphone audio within the Audio Processor. The external components are not used in encode mode.
4. Channel the radio to a conventional channel that has Digital Channel Guard encode programmed.
5. Key the radio and monitor U4 pins 3 and 4. Only pin 3 should be toggling for DCG or trunked low-speed data transmissions.

RECEIVE AUDIO FAILURES

Verify that discriminator audio from the RF Board is present at Jl01/P1 pin 4. Typical signal level is 100 - 150 mVrms (≈350 mV p-p) for 1 kHz tone, 3 kHz deviation. Noise only levels on RX AUDIO will typically be 700 mV p-p.

Table 9 - Approximate Noise And Signal Levels

TEST LOCATION	NO RF SIGNAL (noise levels)	STRONG RF SIGNAL (no modulation)
J101/P1 pin 4	700 mV p-p	0 V p-p
U8 pin 8	2100 mV p-p	0 V p-p
U7 pin 3	650 mV p-p	0 V p-p
U7 pin 56	3.2 Vdc	2.7 Vdc
U7 pin 55	3.5 Vdc	2.7 Vdc

Table 10 - Typical Receiver Audio Levels At Full Volume

TEST LOCATION	LEVEL mV p-p	COMMENT
J101/P1 pin 4	300	RX Output (RXDISCOUT)
U8 pin 8	900	RX Buffer Output (BUFDISC)
U7 pin 18	450	Audio Processor Output
U7 pin 19	120	Audio Processor Input
U7 pin 27	530	Audio Processor RX Output
U8 pin 14	290	Audio Preamp Output (BUFRXOUT)
U10 pin 7	50	Speaker Audio Amp Input
U10 pin 1	3700	Speaker Audio Amp Output (Differential)
U10 pin 3	3700	Speaker Audio Amp Output (Differential)

Squelch Circuits

There should be a dc voltage on U7 pin 4 between 2.7 Vdc and 5.0 Vdc (proportional to receiver noise).

Check the squelch opening Tracking Data parameters using the PC Programmer. Higher numbers should make squelch open at lower signal levels, and lower numbers should make squelch open at higher signal levels. Typical squelch opening Tracking Data values are 90 to C0 hex. Values below 78 should always squelch the radio and values above E0 should always unsquelch the radio. If the radio does not operate as described, suspect C86, C92 or the Audio Processor IC.

Audio Path

Typical audio levels with the volume control fully clockwise and 100 mV rms, 1 kHz tone from the discriminator are shown in Table 10.

Volume Control

The volume control operates by digitizing the dc voltage from the volume potentiometer wiper and varying the digital attenuator in the Audio Processor.

1. Check the dc voltage at J4/P4 pin 9. It should be near 0 Vdc with the volume control fully counterclockwise and near 5.0 Vdc with the control fully clockwise. If not, check the volume control and Keypad Flex.

2. The volume control wiper voltage should also be present at U7 pin 59. If not, suspect J4/P4 or R111.

3. If there is a problem with volume control and wiper voltage is present at U7 pin 59, suspect the U7.

Speaker Amplifier

1. Check the Battery Plate speaker contacts for proper connections.

2. If the speaker is inoperative and audio is present on UDC pin 3 (or U7 pin 27 and U8 pin 14, see Table 10), check U10 pin 2 for battery power from Q11. Audio should be on U10 pin 7.

3. Using a scope, check U10's differential outputs on pins 1 and 3. Replace U10 if power and audio inputs are good and the differential outputs are not.

The internal speaker can be quickly tested by applying audio from a signal generator to the appropriate pins on the Battery Plate with the battery removed. With the Front Cover face-down on the bench, apply audio from a signal generator to the second and third pins from the left. The speaker impedance is 24 ohms and it is a 1/2 Watt device.

Receive Channel Guard Or Trunked Low-Speed Data Problems (Decode Mode)

Filtering and limiting of Channel Guard and trunked low-speed data occurs in Audio Processor U7. A Channel guard Signal is decoded by I/O Microcontroller U18. Microprocessor U4 decodes trunked low-speed data that the radio receives.

1. Channel the radio to a conventional test channel that has CG decode programmed. Apply an on frequency RF signal from a signal generator.

2. Modulate the signal generator with a CG tone. Set CG deviation to 0.750 kHz.

3. Monitor U7 pin 6. The CG tone should be present at a level of 300 mV p-p. The pin is biased to 2.5 Vdc. If the signal or the dc bias is incorrect, suspect Audio Processor U7.

4. Check U7 pins 7 and 9 for a dc level of 2.7 Vdc.

5. Monitor U7 pin 11 (CGLIM) for a 0-to-5 Volt squarewave at the CG frequency. This is the output of the CG demodulator circuit in the Audio Processor. This signal is applied to I/O Microcontroller U18 pin 39 for decoding via CGLIM.

6. Trunked low-speed data the radio receives also appears on U7 pin 11 (CGLIM). These 0-to-5 Volt square-waves are applied to U4 pin 14 for decoding.

KEYPAD FLEX FAILURES

The keypad is arranged as a matrix of 4-columns by 8-rows. Columns 0 (C0) through 2 (C2) are connected to the buttons on the flex. Column 3 (C3) is connected to S1's common terminal (the Control Knob switch). See the charts on the Keypad Flex schematic for details on column-to-row connections and the coding of S1.

The I/O Micro serially reads the matrix as follows (See Figure 11):

- Using SERCLK (CLOCK) and SERDATA (DATA OUT), a byte is clocked into U2 on the Keypad Flex.

- The byte is then latched to the Q outputs of U2 via KYBDOUTCS (SR STB), the strobe pulse; one of the C0 - C3 columns is set low.

- KYBDINCS (SER ENA) is pulsed to latch new instantaneous row data into shift register U1 on the Keypad Flex. (Any row with a closed switch contact will latch a 0 into U1 for that row. NOTE: Switch S1 is gray-coded; see the chart on the schematic.)

- Using SERCLK (CLOCK) and KYBDDIN (DATA IN), the I/O Micro clocks the new row data into itself.

- This process is repeated twice every 50 ms, with the I/O Micro scanning each column by setting its column output low.

Shift register U2 also contains outputs for LCD command/data selection (DISP C/D) and backlight control (DISP LIGHT). They are clocked-out as part of the same byte that sets column outputs.

The Keypad Flex circuitry can be easily tested using the Front Cover Test Accessory Kit. Troubleshooting information is presented below.

1. Insure the flex is properly connected to the Control Board.

2. Insure 5.0 Vdc is present on pin 16 of U1 and U2.

3. Verify the C0 - C3 outputs of U2 on the flex are being sequentially set to logic 0. If they are not and the serial inputs are good, replace U2. See Figure 11.

4. Suspect D5, D6 or D8 if all rows on a single column are inoperative and the corresponding U2 output is OK. For example, if D8 opens, the Monitor and PTT Buttons will not operate, but the Control Knob will operate normally.

5. Suspect one of the series connecting 1K resistors, the 100K pull-ups or an input of U1 on the Keypad Flex if the same row in each column is inoperative. For example, if R9 opens, PTT and some positions of the Control Knob will not operate, but the Monitor Button will operate normally.

6. Monitor KYBDDIN (DATA IN) for a change of pulse pattern when a button is pressed or the Control Knob is rotated. See Figure 11.

LCD BOARD FAILURES

Follow the below steps if a problem on the LCD Board is suspected. Remove the board and use the Front Cover Test Accessory Kit if it is necessary to gain access to all of the test locations. See LBI-38518 for details.

1. Since the Keypad Flex interconnects the LCD Board to the Control Board, check associated flex connections first. Failures of the LCD Board are generally due to a problem with J10/P10, J4/P4 or DS3.

> **NOTE**
>
> Avoid touching the J10/P10 Zebra connector. Body oils and/or dirt may contaminate the contacts.

2. Insure 5.0 Vdc is on J10 pin 1. The display board consumes less than 1.5 mA with all segments and backlighting off.

3. Inspect display DS3 and insure it is tightly secured and there are no cracks in it.

4. U2 on the Keypad Flex must be operating properly for the display to function. The Q5 output from U2 is the Command/Data (DISP C/D) line to the display controller chip. Check JIO/P10 pin 2 for pulse activity when the display is updated.

5. Check voltage divider R2 - R5 and insure proper LCD reference voltages are being delivered to U1 pins 3, 4 and 5. The measurements should be within ±0.3 Vdc of the values listed on the Keypad Flex schematic.

6. Monitor UI pin 2 with an oscilloscope. A test pad is provided. Negative-going pulse pairs should be present spaced 4 milliseconds apart. The pulses will be approximately 30 µs wide. Suspect R1 or U1 if this signal is not present.

7. Monitor J10/P10 pin 4 and 5 for pulse activity. See Figure 11. SERDATA (DATA OUT) and SERCLK (CLOCK) from the Control Board should be seen here. These signals from the I/O Micro are writing/reading the Keypad Flex, writing/reading the Audio Processor IC and writing to the LCD controller/driver IC.

DISPLAY/KEYPAD BACKLIGHTING PROBLEMS

1. With the PC Programmer, insure backlighting is enabled for the particular channel(s).

2. Monitor J10/P10 pin 3 (DISP LIGHT). It should go high when the Control Knob is rotated. Suspect U2 on the Keypad Flex if this signal does not change.

3. On the LCD Board, check Q2's collector. It should be less than 1.0 Vdc with backlighting on.

4. On the LCD Board, check Q1's collector. It should be greater than 4.0 Vdc with backlighting on.

5. If there is a problem with keypad backlighting on Scan and System model radios (with LCD backlighting OK), suspect the J10/P10 pin 8 contact.

TRUNKED MODE PROBLEMS

The below troubleshooting procedure assumes all conventional mode functions are operating properly and a trunk mode problem exits. This procedure gives basic signal tracing steps.

Modem TX Data

1. Monitor modem U5 pin 21 (MODTXDATA) for 9600 baud pulses when a trunk call is attempted. Signal level should be >3 Vp-p with rise and fall times <100 microseconds. If no pulses are present there is a communication problem between U4 and U5, or U5 is defective.

2. Check U14 pin 9. It should be high for 800 MHz EDACS applications.

3. Stage U6. 1 and associated RC networks filter or "round" the digital pulses to a signal which can modulate the FM transmitter. Check U6 pin 1 for a 9600 baud "rounded" signal at 12 mV p-p. Suspect C42, C81 or U6 if this signal is incorrect. Suspect C42, C81 or C88 if the output is skewed.

4. Ensure the 9600 baud signal is on U7 pin 26 at a level of 2.0 Vp-p. Suspect U7 if the signal level is incorrect.

5. Check U6 pin 7 (RFTXAUD) for the 9600 baud signal to the RF Board. Signal into the RF Board should be 800 mV p-p.

Modem RX Data

1. Monitor U5 pin 19 (MODRXDATA) for demodulated data when the radio is receiving 9600 baud data transmissions. Signal level should be approximately 5.0 Vp-p. If pulses are not present, suspect comparator U1 7.3 or integrating capacitor C80.

2. U5 should interrupt U4 when it receives valid data. Check U5 pin 24 for low going pulses when the radio is receiving data transmissions. Suspect U4 if the data pulses are present and U5 does not interrupt U4.

3. If U4 is being interrupted by U5 when a valid data transmission is received and the radio does not recognize the transmission, suspect U4.

Low-Speed Data

If the radio can initiate trunked mode transmissions but they are dropped by the system, suspect a problem with the radio's low-speed data encoding circuitry. See the information in **Transmit Audio Failures** relating to low-speed data encode problems.

If the radio initially receives trunked mode transmissions but reception is quickly lost, suspect a problem with the radio's low-speed data decoding circuitry. See the information in **Receive Audio Failures** relating to low-speed data decode problems.

OS1 = 2.0 MHz Clock From I/O Microcontroller U18

TP1 = 11.0592 MHz Clock From Modern U5 (OSCOUT)

TP3 = 5.0 Vdc Regulated Supply (+5V)

TP2 = Reset Output From Modem U5

TP4 = Reset Comparator Output (VCB)

TP5 = DTMF Tones

TP6 = 2.7 Vdc Reference Supply (VCC/2)

TP7 = 8 MHz Clock Output From Audio Processor U7

TP8 = Internal Mic Amp Output (BUFINTMIC)

TP9 = External Mic Amp Output (BUFEXTMIC)

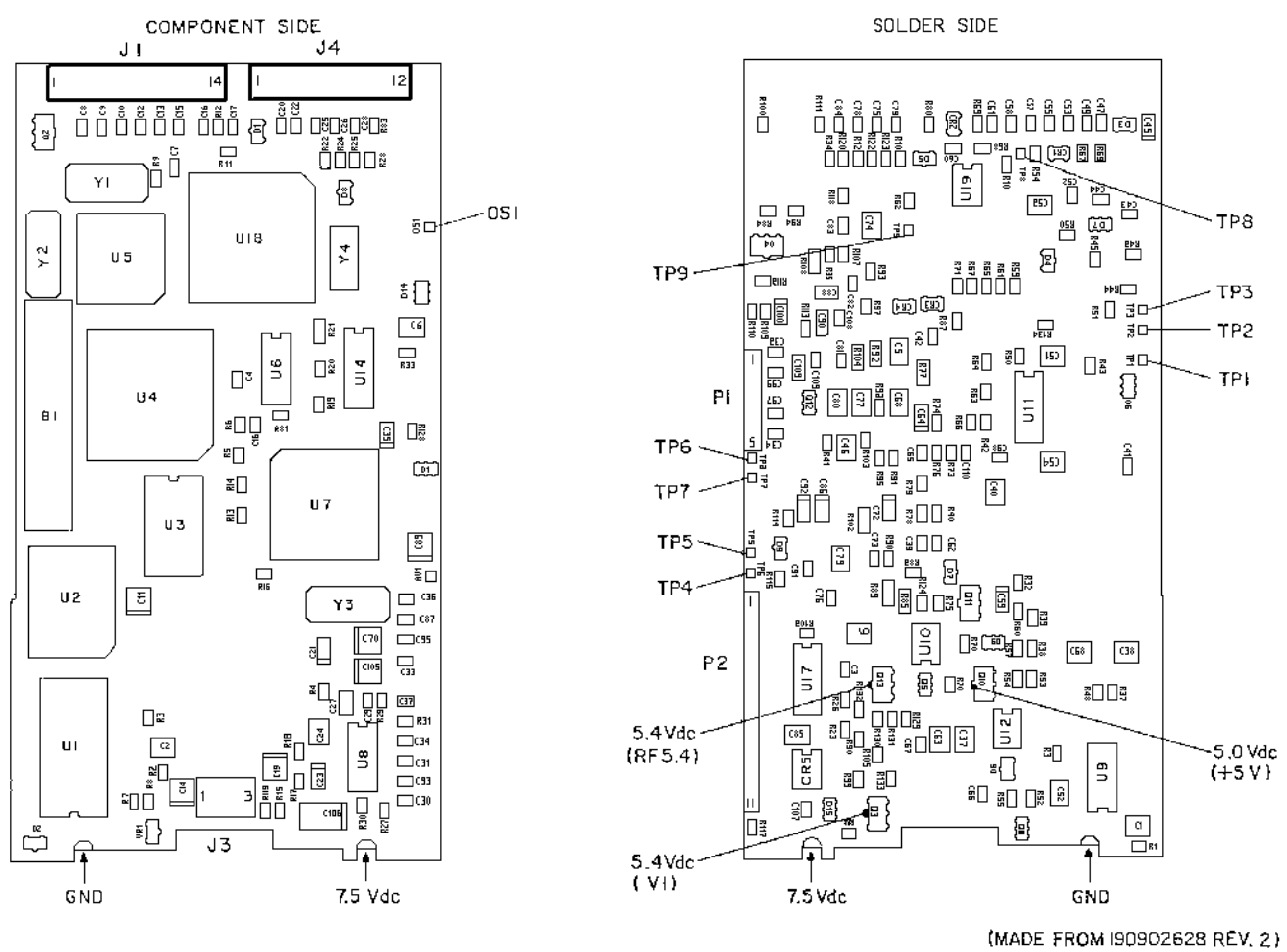


Figure 13 - Control Board Test Point Locations

COMPONENT REPLACEMENT

SURFACE MOUNTED COMPONENTS

Surface mounted "chip" components should always be replaced using a temperature-controlled soldering system. The soldering tools may be either a temperature-controlled soldering iron or a temperature-control-led hot-air soldering station. A hot-air system is recommended for the removal of components on the multi-layer boards utilized throughout the radio. With either soldering system, a temperature of 700°F (371°C) should be maintained.

The below procedures outline the removal and replacement of surface mounted components. If a hot-air soldering system is employed, see the manufacture's operating instructions for detailed information on the use of your system.

CAUTION

Avoid applying heat to the body of any chip component when using standard soldering methods. Heat should be applied only to the metallized terminals of the components. Hot-air systems do not damage the components since the heat is quickly and evenly distributed to the external surface of the component.

CAUTION

As the radio contains many static sensitive components, observe static handling precautions during all service procedures.

SURFACE MOUNTED COMPONENT REMOVAL

1. Grip the component with tweezers or small needle-nose pliers.

2. Alternately heat the metallized terminal ends of the component with the soldering iron. If a hot-air system is used, direct the heat to the terminals of the component. Use extreme care with the soldering equipment to prevent damage to the printed wire board (PWB) and the surrounding components.

3. When the solder on all terminals is liquefied, gently remove the component. Excessive force may cause the PWB pads to separate from the board if all solder is not completely liquefied.

4. It may be necessary to remove excess solder using a vacuum de-soldering tool or Solderwick®. Again, use great care when de-soldering or soldering on the printed wire boards. It may also be necessary to remove the epoxy adhesive that was under the component.

SURFACE MOUNTED COMPONENT REPLACEMENT

1. "Tin" one terminal end of the new component and the corresponding pad on the PWB. Use as little solder as possible.

2. Place the component on the PWB pads, observing proper orientation for capacitors, diodes, transistors, etc.

3. Simultaneously touch the "tinned" terminal end and the "tinned" pad with the soldering iron. Slightly press the component down on the board as the solder is liquefied. Solder all terminals, allowing the component time to cool between each application of heat. Do not apply heat for an excessive length of time and do not use excessive solder.

   With a hot-air system, "tin" all terminals and apply heat until all "tinned" areas are melted and the component is seated in place. It may be necessary to slightly press the component down on the board. Touch-up the soldered connections with a standard soldering iron if needed. Do not use excessive solder.

4. Allow the component and the board to cool and then remove all flux from the area using alcohol or another approved flux remover.

CAUTION

Some chemicals may damage the internal and external plastic and rubber parts of the radio.

SURFACE MOUNTED INTEGRATED CIRCUIT REPLACEMENT

Soldering and de-soldering techniques of the surface mounted ICs are similar to the above outlined procedures for the surface mounted chip components. Use extreme care and observe static precautions when removing or replacing the defective (or suspect) ICs. This will prevent any damage to the printed wire board or the surrounding circuitry.

Replacement of the surface mounted ICs is best completed using a hot-air soldering system. The ICs can easily be removed and installed using hot-air. See the manufacturers instructions for complete details on tip selection and other operating instructions unique to your system.

If a hot-air system is not available, the service technician may wish to clip the pins near the body of the defective IC and remove it. The pins can then be removed from the PWB with a standard soldering iron and tweezers, and the new IC installed. It should not be necessary to "tin" any of the IC pins before the installation process.

MODULE REPLACEMENT

The modules, all of which are located on the RF Board, are very reliable devices. Before replacing any of the modules, check the associated circuitry thoroughly to insure there is not a problem elsewhere. If replacement is necessary, follow the below procedures.

All of the component lead holes on the RF Board for the modules are plated through from the top to the bottom of the board. This allows for easy removal and replacement of the modules as long as appropriate soldering techniques are observed. Always observe static precautions when handling the board.

To remove the PA module, it is first necessary to remove the hardware which supports it. Two Torx® screws and a support bracket secure the module to the component side eggcrate casting.

To remove a module, position the RF Board in a work vice (face down, chip components up) and remove the solder from the plated-through points at the appropriate pins. If a hot-air system is employed, use an appropriate tip that will localize the heat on the pins and not on surrounding chip components. Solderwick® or a vacuum de-soldering iron will also remove the solder if a hot-air station is notavailable. When all solder has been removed or liquefied, the module should drop out of the eggcrate casting.

To install a module, clean any solder from the plated-through holes and clean all flux from the board. Next, install the replacement module making sure that all pins align in the proper holes. Resolder the pins to the board. Clean the flux from the board using an approved solvent and clip any excess lead length.

WEATHERPROOF INTEGRITY

The M-PA radio is designed to meet the MIL-810C & D environmental specifications. The internal circuitry is protected from moisture by appropriate seals. Rear Cover Assembly seals include the Front/Rear Cover Assembly gasket and the antenna insert gaskets. Front Cover Assembly seals include the speaker/microphone seal, the battery plate seal, and the volume and channel control seals. The UDC/Monitor Button/PTT Assembly is also designed to seal out moisture.

These seals should be inspected during any disassembly/reassembly process for cracks and tears. A defective seal warrants replacement. See the Mechanical Parts breakdown drawings and the Parts Lists for locations and part numbers for these seals. When installing a new seal, make sure it is seated properly before reassembly.

INTERNAL LITHIUM BATTERY

All personality data is stored in RAM IC U1 on the Control Board. This data includes TX and RX operating frequencies, Channel Guard tones, CCT in-formation, Tracking Data, etc. The lithium battery on the Control Board supplies keep-alive power to this RAM IC when the radio is turned off. This battery should be changed every 3 to 5 years.

Before replacing the battery, copy the personality data to the PC computer. The battery can be replaced without losing the personality data stored in the radio by following the below procedure.

1. Remove the Control Board. See DISASSEMBLY/REASSEMBLY instructions. Use caution when handling the board; do not short the connections between the lithium battery, D2 and the RAMIC. Also observe static handling precautions.
2. Using clip leads, apply power (7.0 - 9.0 Vdc) to the Control Board at the bottom mounting holes. OBSERVE POLARITY. See Figure 13.
3. Remove the plastic cover from the lithium battery. This battery's case is positive polarity, opposite of what would be expected.
4. Unplug and remove the battery from the support and contact.
5. Carefully install the new battery in the support, plugging the negative terminal into the contact. Record installation date.
6. Install the plastic cover over the new battery.
7. Remove power from the board.
8. Reassemble the radio and test for proper operation.

BATTERY PACKS

Rechargeable battery packs available for use with the portable radio include high and extra high capacity units. All of the packs are factory sealed and are not field serviceable other than properly charging, and cleaning the contacts.

Radio contacts located on the top of the pack include switched power, ground, the speaker enabling contacts and a continuous power contact. Four charging contacts are located on the rear side of the battery pack. These four contacts provide connections to the slip-in type chargers or vehicular chargers/repeaters while the battery pack is still connected to the unit. These battery charging contacts are diode protected from external shorts.

Chargers are available with nominal charge times of 1 (rapid) and 14 (standard) hours. Combinations include single (1) and multi (5) position, standard and rapid charge units. The chargers utilize an internal thermistor in the battery pack to sense temperature and automatically control charge rate of the battery. This allows for a maximum charge rate without overheating the battery pack. All battery packs can be charged in less than 1 1/2 hours with the rapid type chargers. Nominal full charge time in a standard charger is 14 hours. Figure 14 outlines a typical battery pack.

CHARGING THE BATTERY PACKS

After receiving a new battery pack from the factory, it should be fully charged before it is placed into service. This also applies to batteries that have been stored for long periods. For specific instructions for the particular charger, refer to the applicable charger's Operating Manual.

A fully charged battery pack should provide an open terminal voltage greater than 7.5 Vdc (typically 9 Vdc).

A fully discharged battery pack should be no less than 6 Vdc. When the battery pack drops below 6.8 Vdc the radio will warn the operator with an alert tone.

Rechargeable batteries can develop a condition of reduced capacity sometimes called "Memory Effect". This condition can occur when a battery is continuously charged for long periods of time or when a regularly performed duty cycle allows the battery to expend only a limited portion of its capacity.

If the battery pack is seldom used and left on a continuous charge for long periods, it may develop reduced capacity. On the first discharge cycle, the capacity may be significantly lowered, reducing useful service hours.

Any rechargeable battery pack showing signs of reduced capacity should be checked before being replaced. If reduced capacity is in fact a problem, the following procedure may restore capacity:

1. Discharge the battery pack at a normal discharge rate until the output voltage is approximately 1 Volt per cell. This equals 6 Volts output for the M-PA battery packs. Refer to Figure 15. Note the flatness of the discharge curve from 0% - 90%. Experience shows discharging below the "knee" is not necessary.

2. Complete a full charge cycle using a charger.

3. Repeat steps 1 and 2. Performing this deep cycle at least twice should be sufficient to restore battery pack capacity.

NOTE

The above procedure is easily completed using Discharge Analyzer 19B801506P9 and Rapid Multi-Charger 19B801506P16 or P18.

DISPOSAL OF RECHARGEABLE BATTERIES

Under specific state laws, it may be illegal to dispose of rechargeable batteries, rechargeable battery packs and/or products powered by rechargeable batteries except in accordance with specific procedures. Special collection systems are in place in certain states. Call Toll Free 1-800-822-9362 for specific procedures for returning rechargeable batteries in your state.

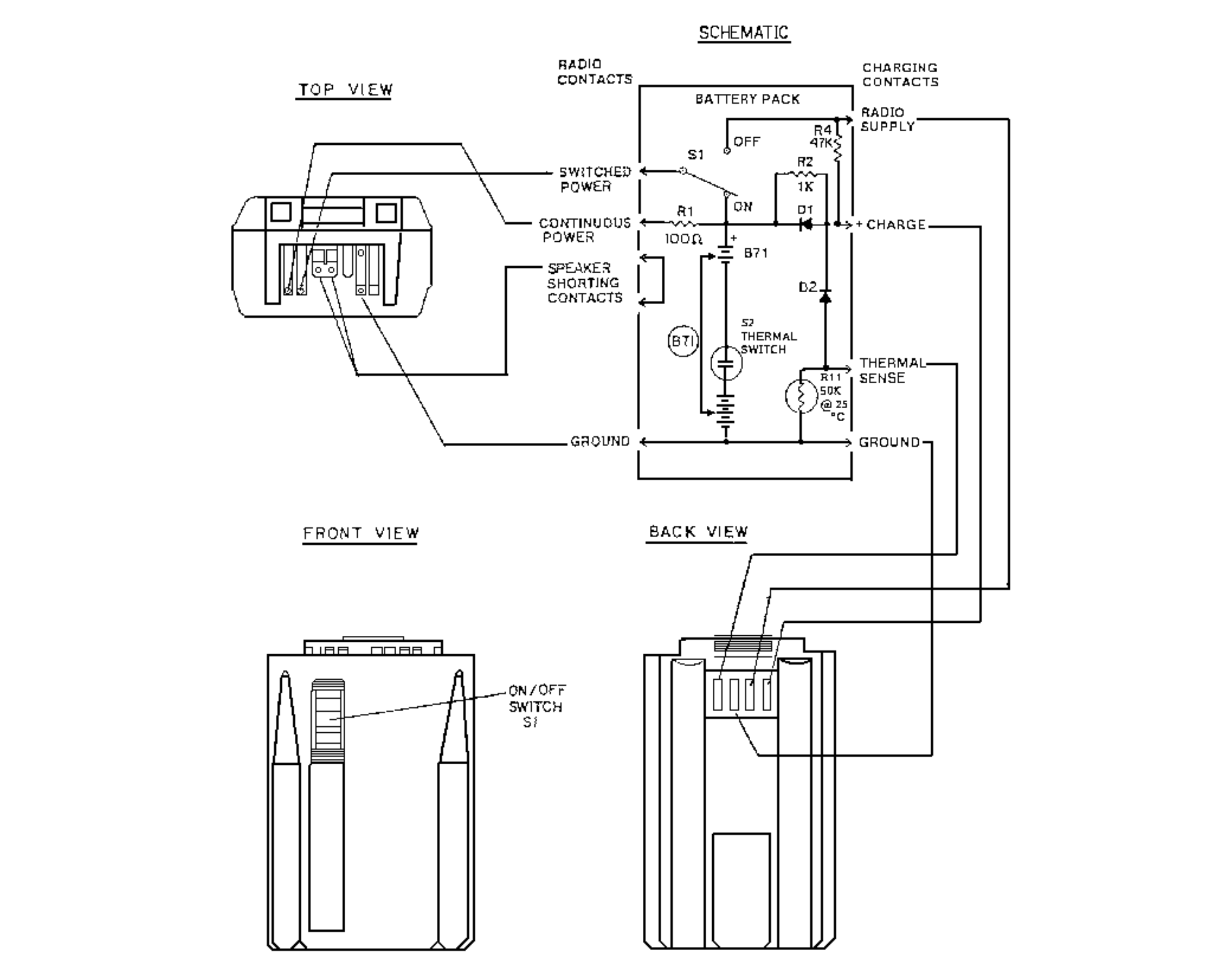


Figure 14 - Battery Packs

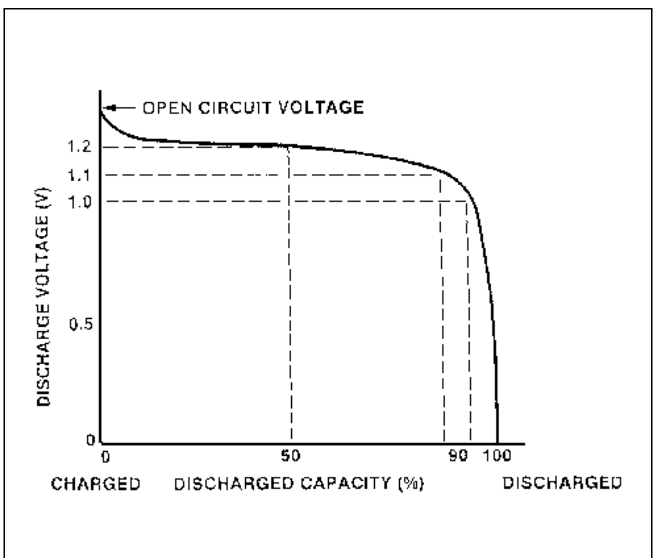


Figure 15 - Typical Ni-Cad Cell Discharge Curve

CONTROL KNOB STOP PLATE

A stop plate is located under the Control Knob. This plate can be repositioned, if desired, to limit the number of unique Control Knob positions. The stop plate is factory placed for 15 positions unless 16 unique factory programmed positions are ordered.

MODIFICATION PROCEDURE

The following procedure outlines the steps necessary to reposition the stop plate.

1. Remove the Control Knob using an M1.5 hex wrench.
2. Lift the stop plate using small needle-nose pliers.
3. Reposition the stop plate by aligning the raised bar to the channel marking one number higher than the number of positions required. For example, if 8 unique positions are required, align the bar to the "9". See Figure 16. If 16 positions are required, do not reinstall the stop plate.
4. Replace the Control Knob and torque the set screw to 3 lb./in. The set screw must align on the flat area of the switch shaft. Test for proper operation.

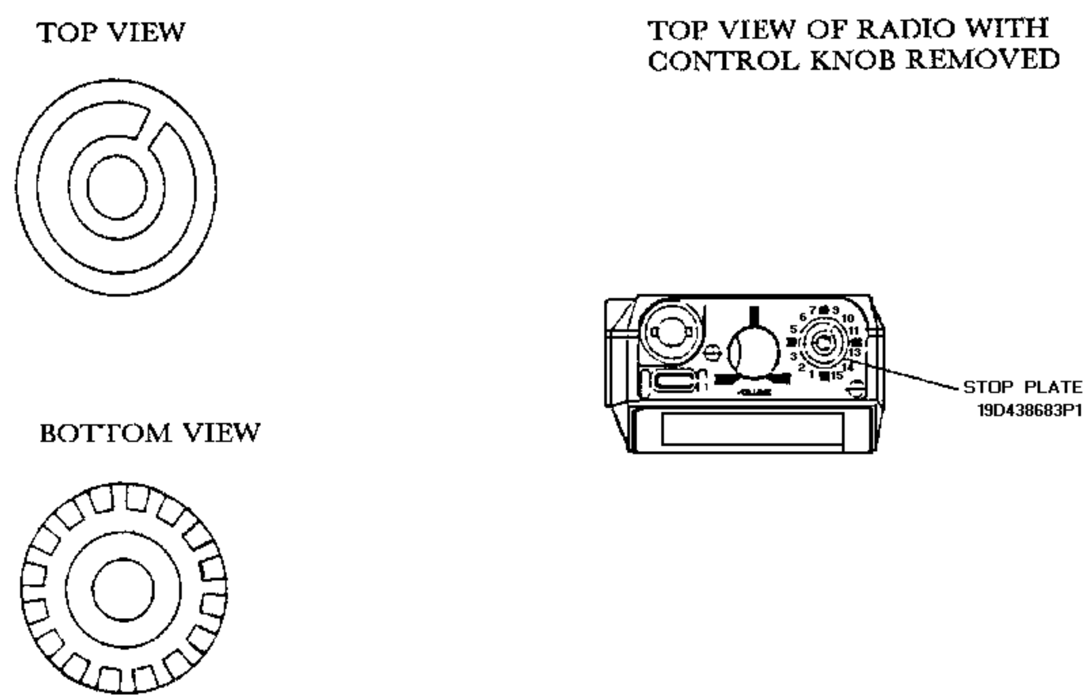
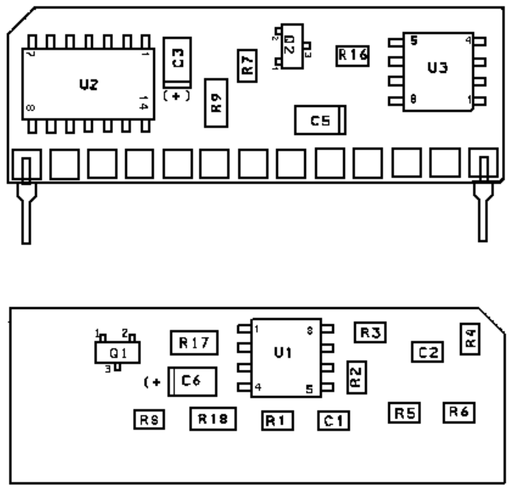


Figure 16 - Control Knob Stop Plate 19D438683P1

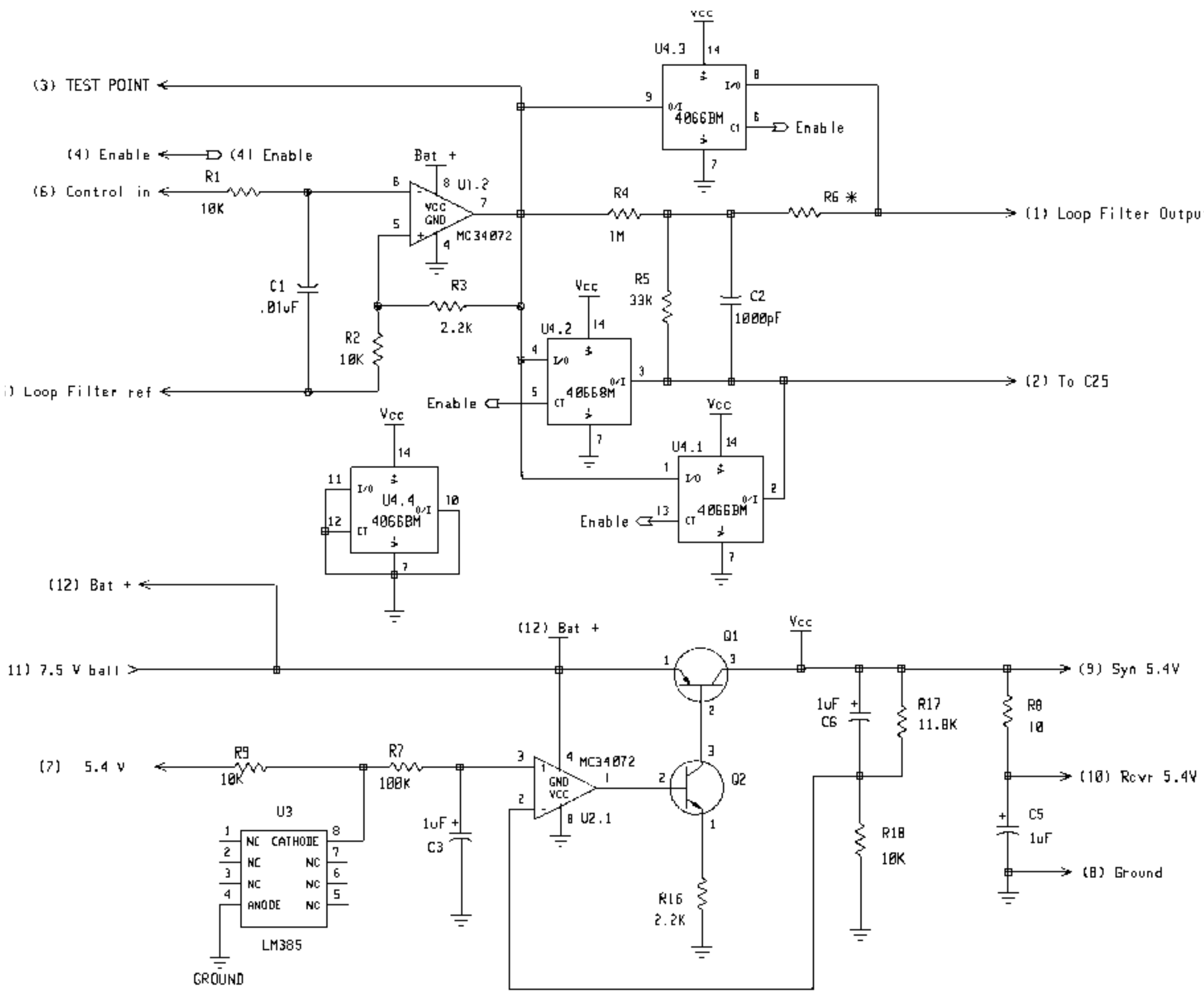
Ericsson GE Mobile Communications Inc.
Mountain View Road • Lynchburg, Virginia 24502

Printed in U.S.A.

A1



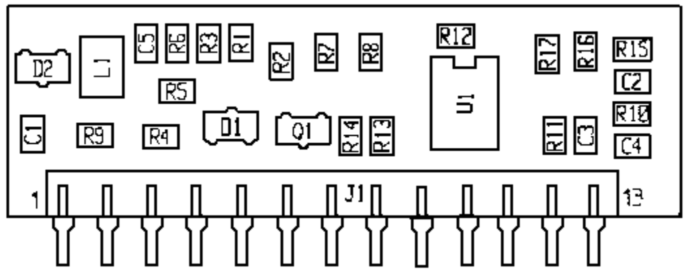
(19C852056, Sh. 1, Rev. 0)

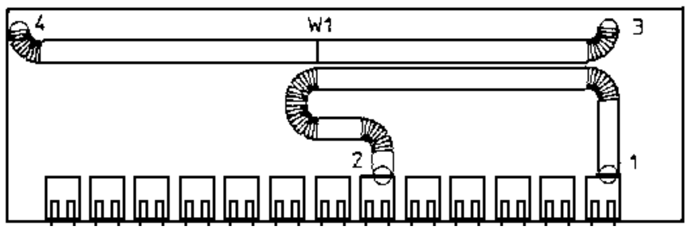


(19C852057, Sh. 1, Rev. 0)

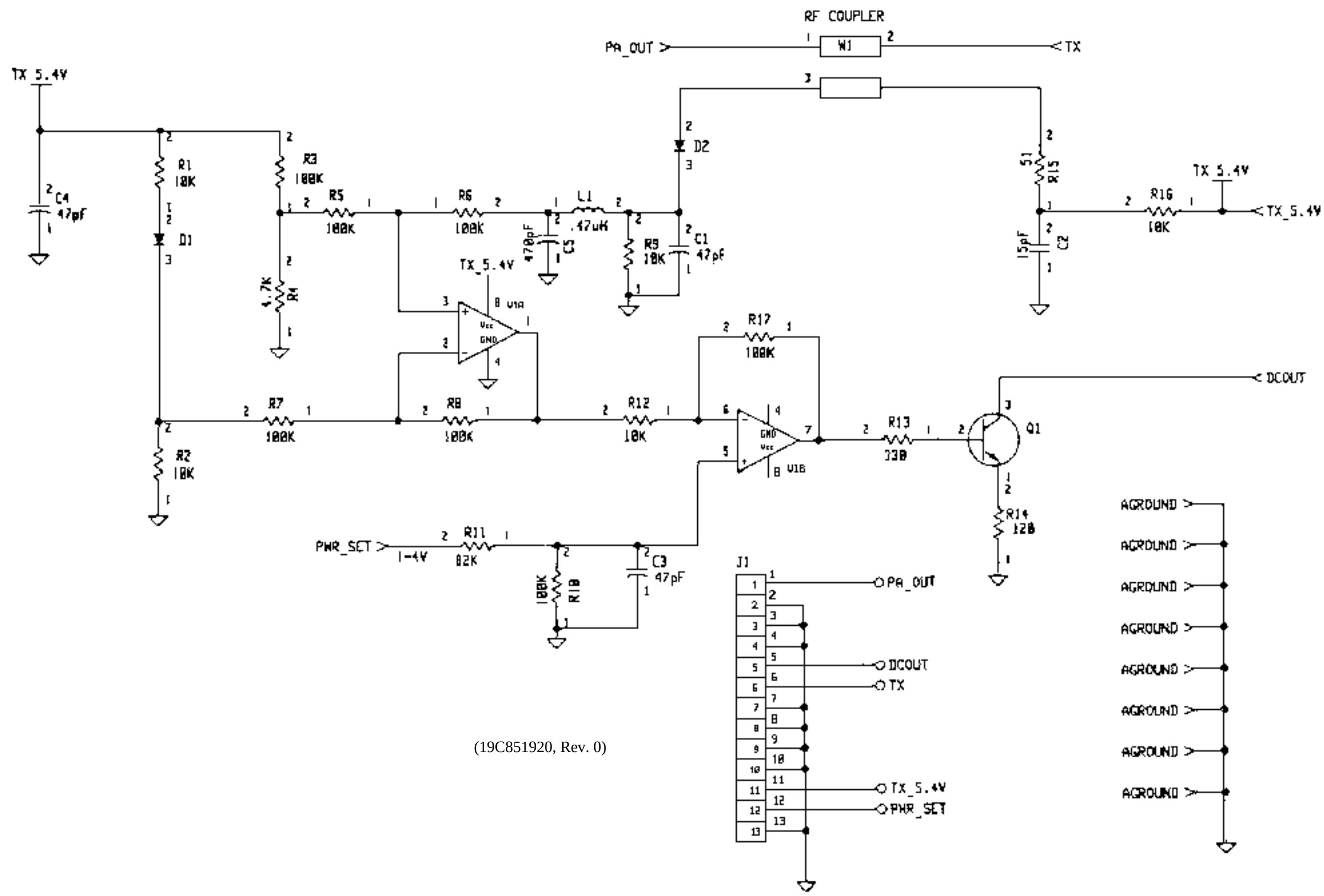
RF BOARD
PLL FILTER/REGULATOR
19C852056G1

A2





(19C851922, Rev. 2)

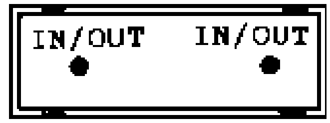


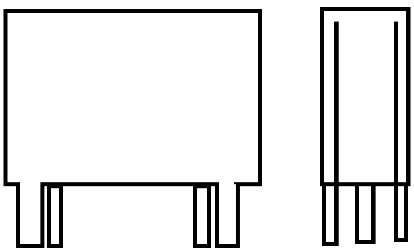
(19C851920, Rev. 0)

RF BOARD
POWER CONTROLLER
19C851922G1

FLA1, FLA2

PASSBAND LOSS = 2.0 - 2.5 dB (Max.)
STOPBAND LOSS = 35 dB (Min.)
INPUT Z = 50 ohms
OUTPUT Z = 50 ohms



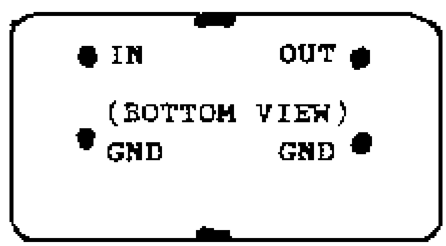


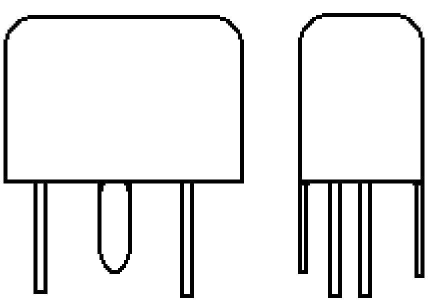
PART #	PASSBAND
P1	851 - 871 MHz
P2	933 - 942 MHz
P3	754 - 781 MHz
P4	824 - 851 MHz

RF BOARD
RF BANDPASS FILTER
19A704888P1

FLB1

PASSBAND LOSS = 4.0 dB (Max.)
3 dB BANDWIDTH = ±7.5 kHz (Min.)
3 dB BANDWIDTH = ±5.0 kHz (Min.),(P4)
35 dB SELECT. = ±25 kHz (Max.)
35 dB SELECT. = ±20 kHz (Max.),(P4)
INPUT Z = 50 ohms
OUTPUT Z = 50 ohms

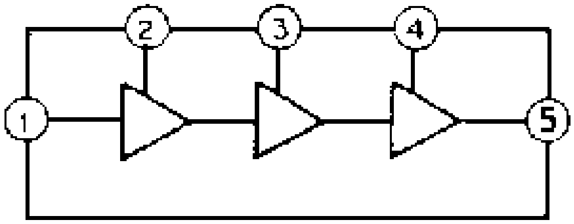


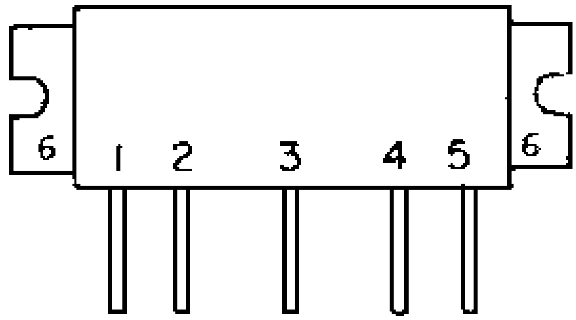


PART #	CENTER FREQ.
P3	45.0000 MHz
P4	39.5000 MHz
P5	45.0125 MHz
P6	45.0000 MHz

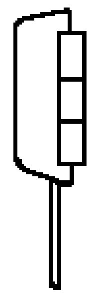
RF BOARD
IF MONOLITHIC CRYSTAL FILTER
19A705328P5

U1



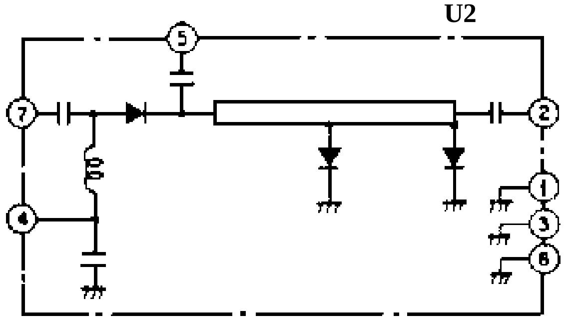


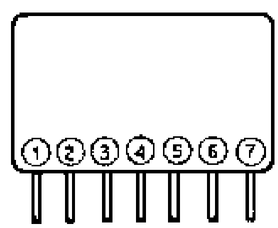
PIN	FUNCTION
1	RF INPUT
2	V_{cc1}
3	V_{cc2}
4	V_{cc3}
5	RF OUTPUT
6	FLANGE (Ground)



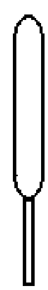
RF BOARD
806-870 MHz POWER AMPLIFIER
19A705962P1

U2



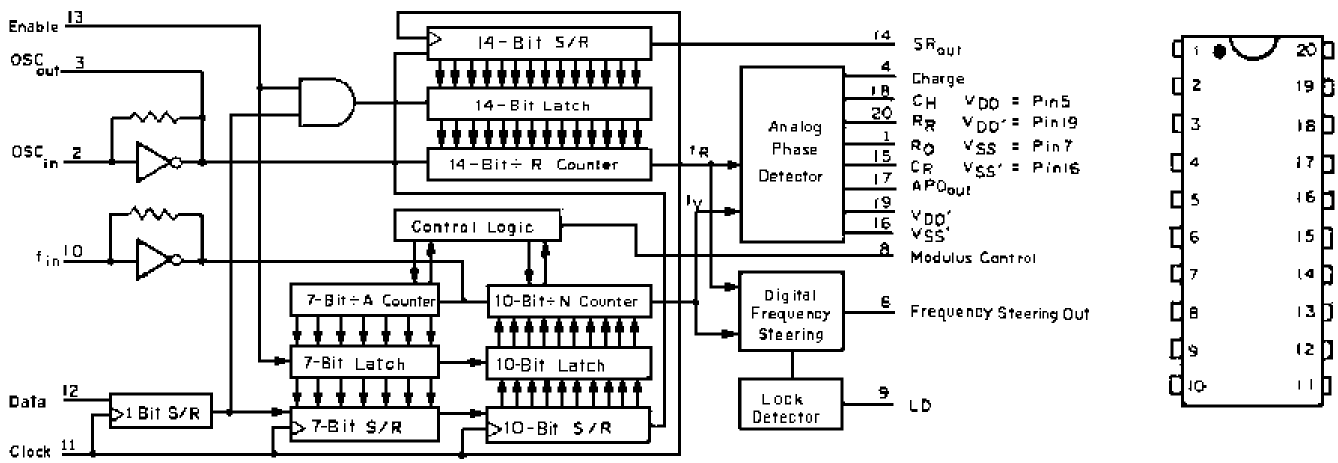


PIN	FUNCTION
1	GROUND
2	RECEIVER
3	GROUND
4	T/R BIAS
5	ANTENNA
6	GROUND
7	TRANSMITTER



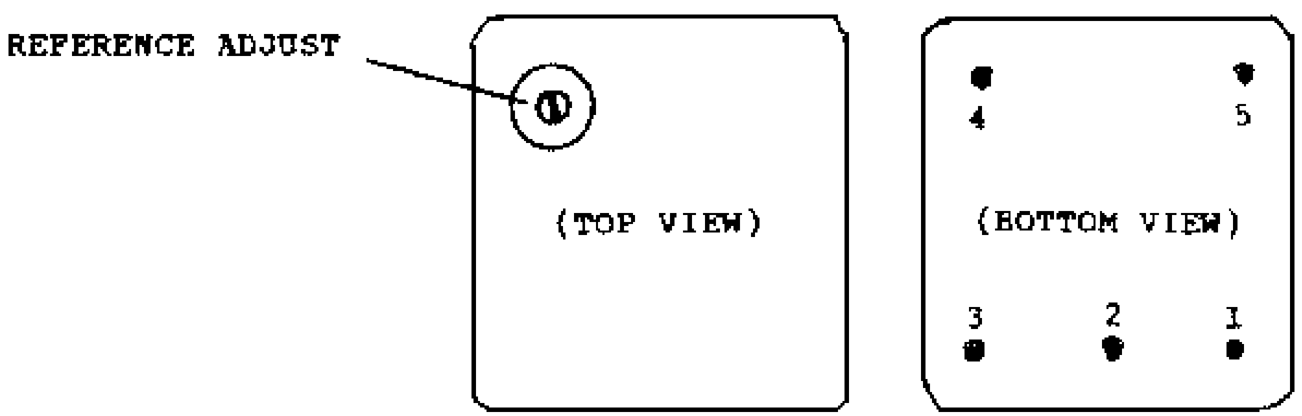
RF BOARD
ANTENNA T/R SWITCH
19A149809P1

U3



RF BOARD SYNTHESIZER
19B800902P4

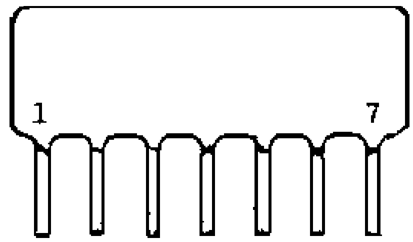
U4



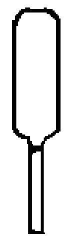
PIN	FUNCTION
1	Vcc (5.4 Vdc)
2	OUT (1 Vp-p Min.)
3	MOD. AUDIO IN
4	GROUND (Case)
5	GROUND (Case)

RF BOARD 13.2 MHz REFERENCE OSCILLATOR
19B235948G1

U5

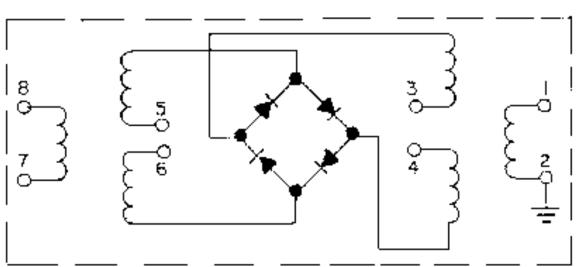


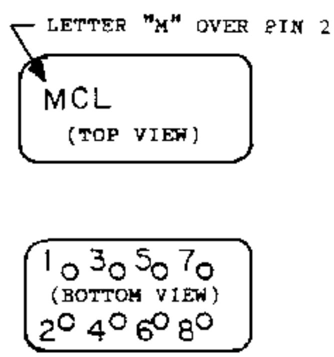
PIN	FUNCTION
1	INPUT/OUTPUT
2	GROUND
3	GROUND
4	GROUND
5	GROUND
6	GROUND
7	INPUT/OUTPUT



RF BOARD
LOW-PASS FILTER
19A149810P1

U7

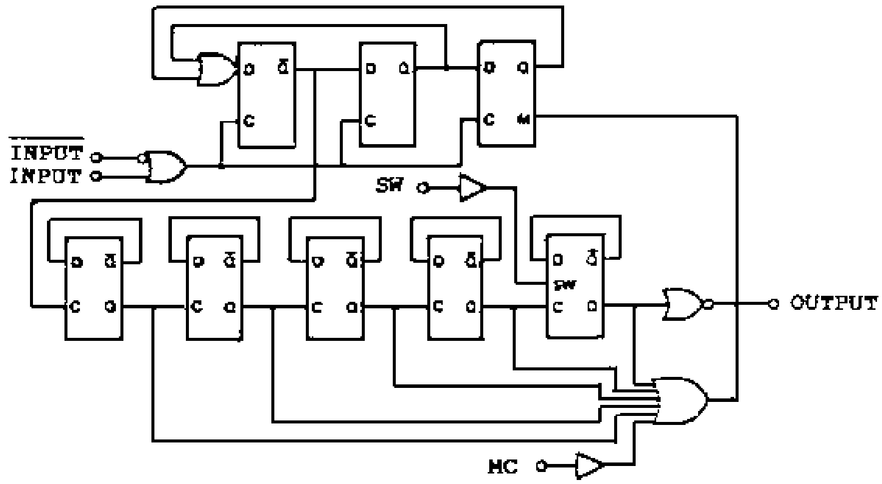


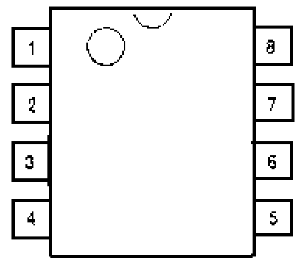


PIN	FUNCTION
1	RF INPUT
2	GROUND (Case)
3	IF OUTPUT
4	IF OUTPUT
5	GROUND
6	GROUND
7	GROUND
8	LO INPUT

RF BOARD
800 MHz MIXER
19A705706P3

U8





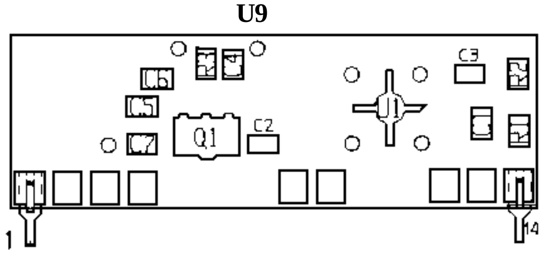
TRUTH TABLE

SW	MC	DIVIDE RATIO
H	H	1/64
H	L	1/65
L	H	1/128
L	L	1/129

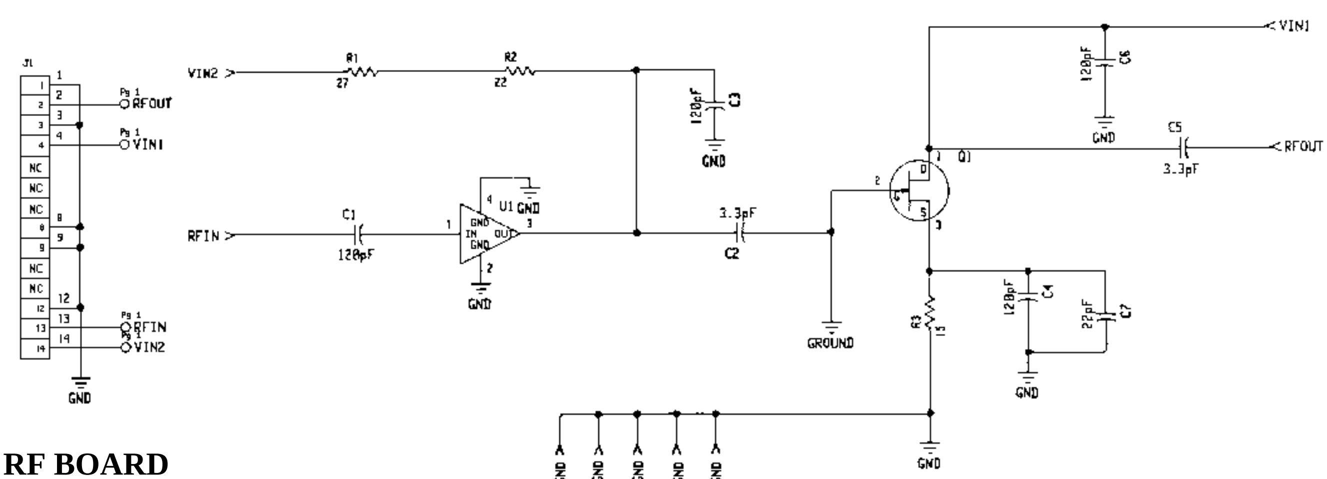
PIN	FUNCTION
1	INPUT
2	Vcc
3	SW INPUT
4	OUTPUT
5	GROUND
6	MC INPUT
7	N/C
8	INPUT

RF BOARD
PRESCALER
19A705985P1

U9

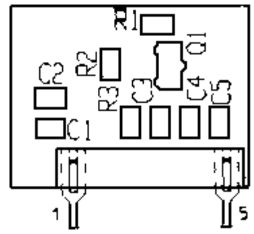


(19C851848, Rev. 0)

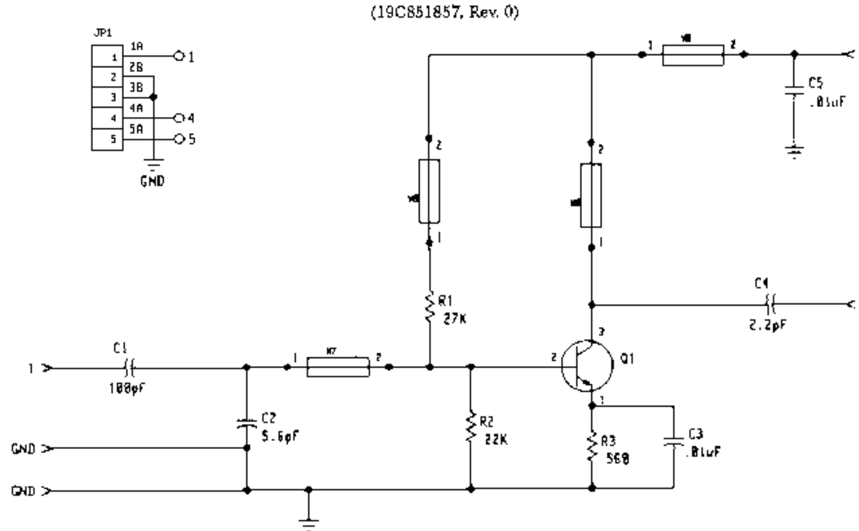


RF BOARD
800 MHz EXCITER
19C851848G1

U10

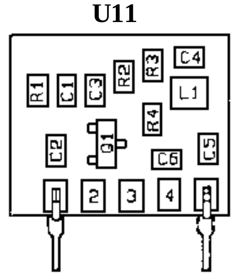


(19C851857, Rev. 0)

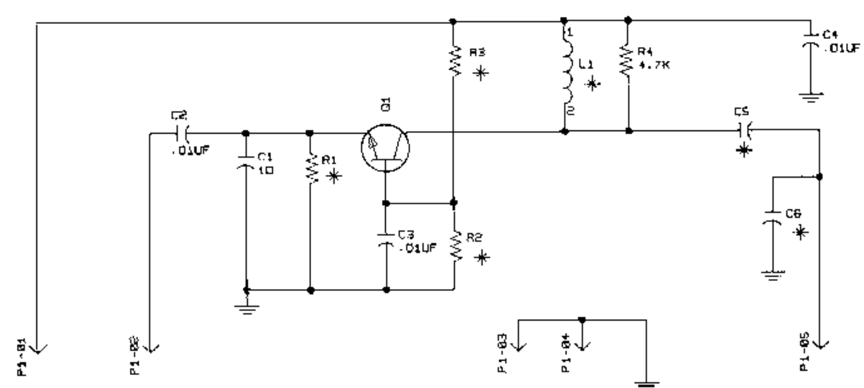


RF BOARD
800 MHz RF AMPLIFIER
19C851857G1

U11

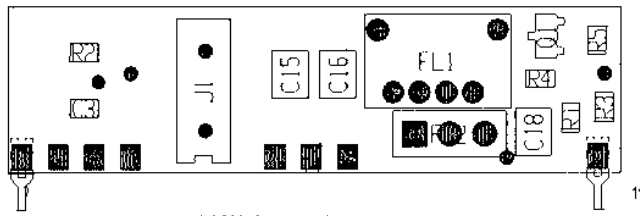


(19C336876, Rev. 0)

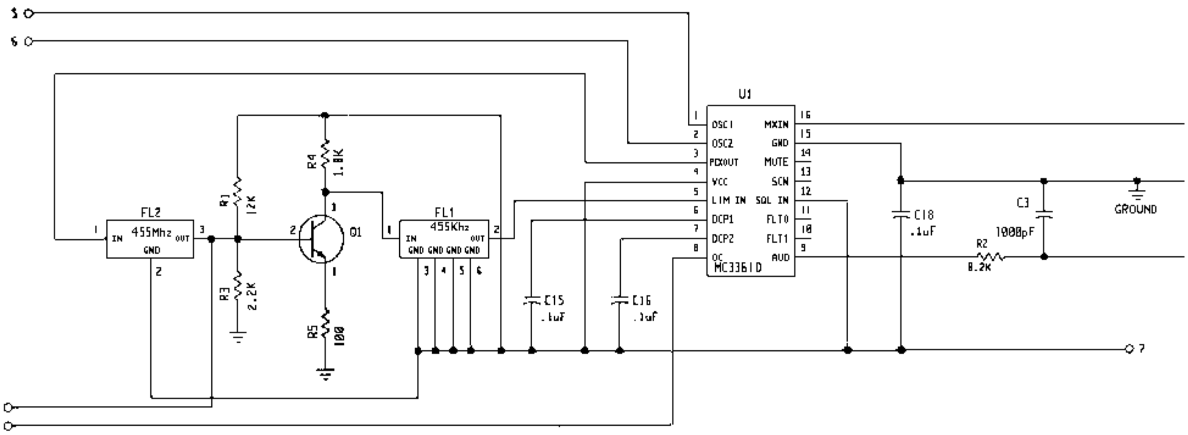


RF BOARD
45.0125 MHz IF AMPLIFIER
19C336876G1

U14



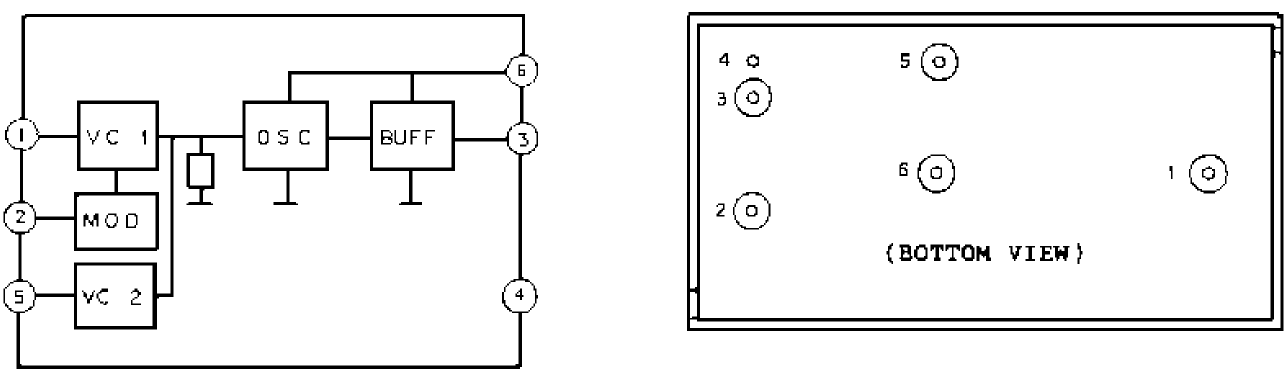
(19C801642, Rev. 1)



RF BOARD
RECEIVER BACK-END
19B801642G1

(19C337500, Rev. 2)

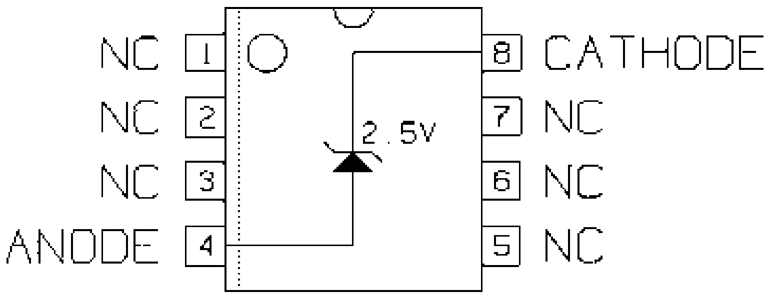
Y2



PIN	FUNCTION
1	CONTROL VOLTAGE
2	MOD. INPUT
3	RF OUTPUT
4	GROUND
5	BAND SWITCH
6	Vcc (5.4 Vdc)

RF BOARD
VCO
19A235947G1

CR5



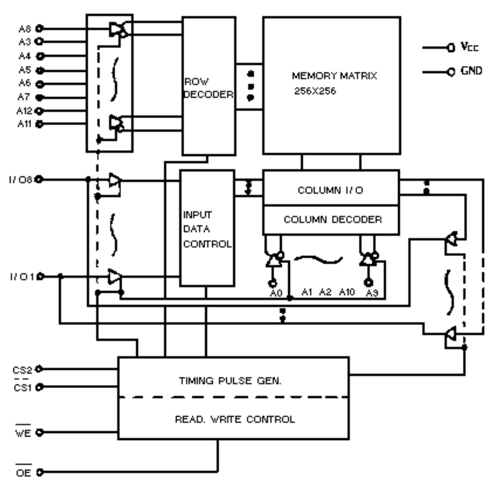
CONTROL BOARD
2.5 VOLT REFERENCE
19A149634P1

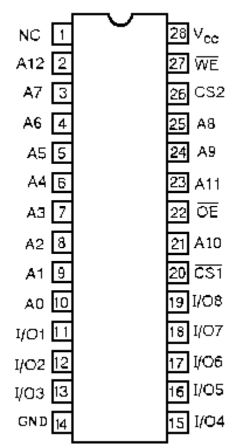
U1

TRUTH TABLE

$\overline{WE}$	$\overline{CS_1}$	CS_2	$\overline{OE}$	Mode	I/O	Icc
X	H	X	X	Not Selected	High Z	Standby
X	X	L	X	Not Selected	High Z	Standby
H	L	H	H	Output Disabled	High Z	Active
H	L	H	L	Read	Dout	Active
L	L	H	H	Write	Din	Active
L	L	H	L	Write	Din	Active

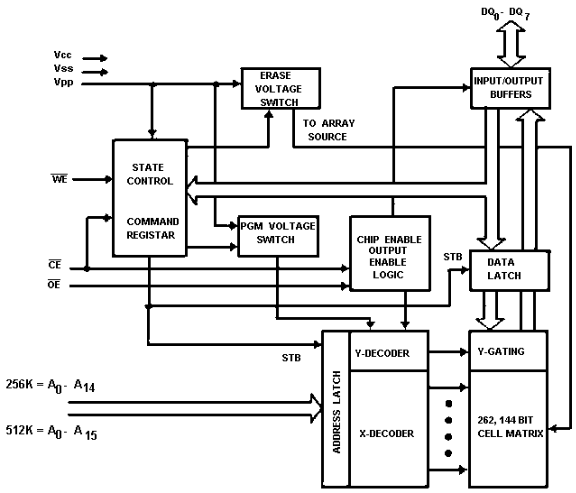
X= H or L

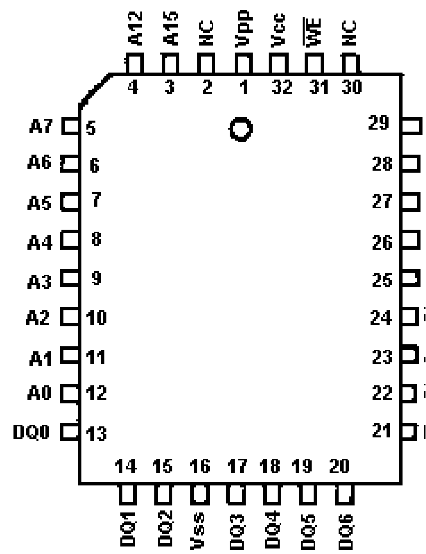




CONTROL BOARD
8K x 8-BIT STATIC RAM
19A705603P2

U2





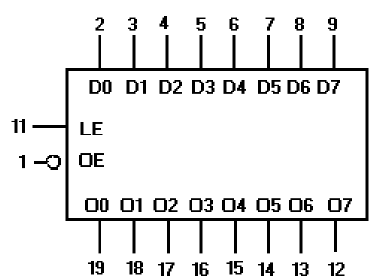
CONTROL BOARD
64K x 8-BIT EPROM
19A705963P2

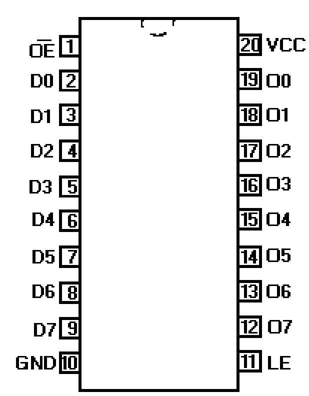
U3

TRUTH TABLE

INPUTS			OUTPUTS
$\overline{OE}$	LE	D	O0 - O7
L	H	H	H
L	H	L	L
L	L	X	NO CHANGE
H	X	X	HIGH Z

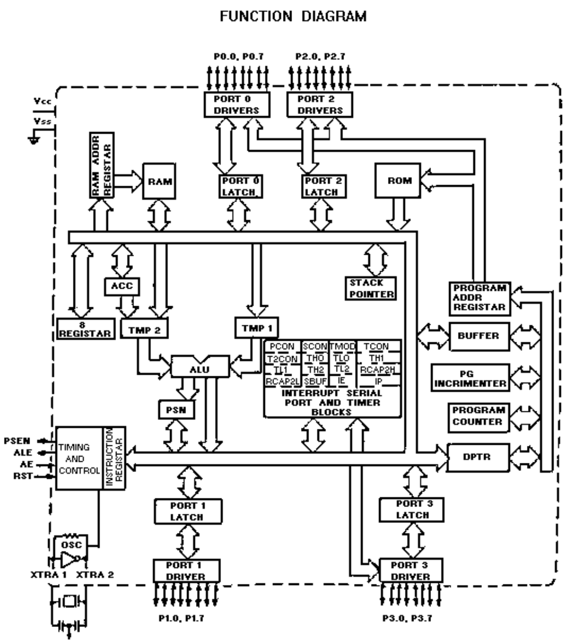
X = H or L

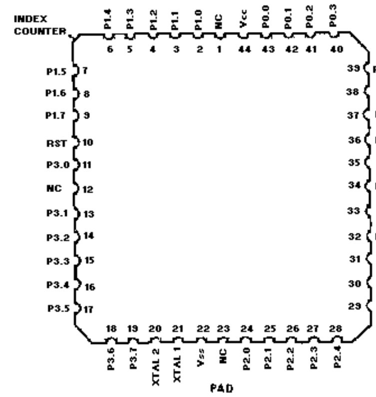




CONTROL BOARD
TRI-STATE TRANSCEIVER
19A703471P118

U4



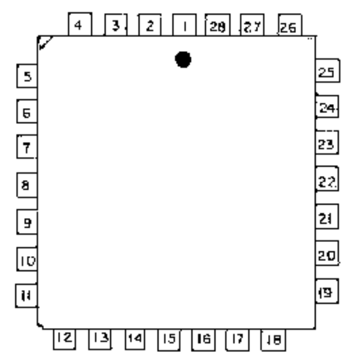


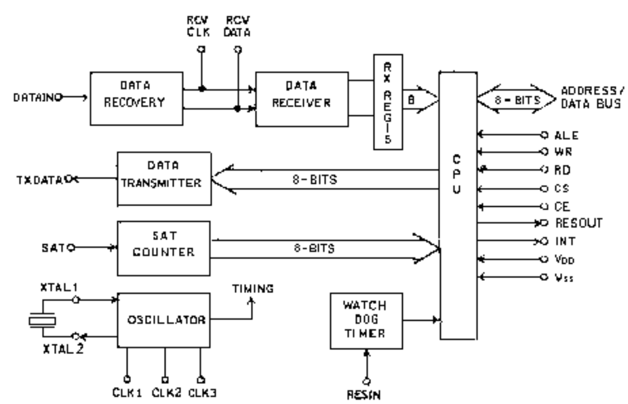
VSS		CIRCUIT GROUND POTENTIAL
VCC		+5V POWER SUPPLY
PORT 0		8—BIT OC BI-DIRECTIONAL I/O PORT.
PORT 1		8—BIT QUASI-BIDIRECTIONAL I/O PORT.
PORT 2		8—BIT QUASI-BIDIRECTIONAL I/O PORT.
PORT 3		8—BIT QUASI-BIDIRECTIONAL I/O PORT.
	3.0	RXD — SERIAL PORT RECEIVER DATA.
	3.1	TXD — SERIAL PORT TRANSMITTER DATA.
	3.2	INT0 — INTERRUPT 0 INPUT.
	3.3	INT1 — INTERRUPT 1 INPUT.
	3.5	T1 — COUNTER 1 INPUT.
	3.6	WR — WRITE CONTROL.
	3.7	RD — READ CONTROL.
RST		RESET.
ALE		ADDRESS LATCH ENABLE.
PSEN		PROGRAM STORE ENABLE OUTPUT.
EA		INTERNAL/EXTERNAL INSTRUCTION FETCH.
XTAL1		INPUT TO OSCILLATOR AMPLIFIER.
XTAL2		OUTPUT FROM OSCILLATOR AMPLIFIER.

CONTROL BOARD
8-BIT MICROCOMPUTER
19A705557P3

U5

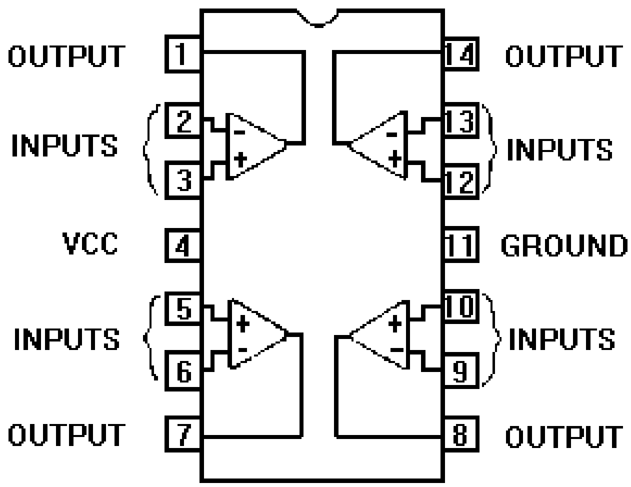
PIN	NAME	FUNCTION
1	RD	READ ENABLE (ACTIVE LOW)
2	CE	CHIP ENABLE (ACTIVE LOW)
3	RESOUT	RESET OUTPUT (ACTIVE HIGH)
4	AD0	BI-DIRECTIONAL A/D BUS
5	AD1	BI-DIRECTIONAL A/D BUS
6	AD2	BI-DIRECTIONAL A/D BUS
7	AD3	BI-DIRECTIONAL A/D BUS
8	AD4	BI-DIRECTIONAL A/D BUS
9	AD5	BI-DIRECTIONAL A/D BUS
10	AD6	BI-DIRECTIONAL A/D BUS
11	AD7	BI-DIRECTIONAL A/D BUS
12	ALE	ADDRESS LATCH ENABLE (ACTIVE HIGH)
13	V_{SS}	GROUND
14	CLK1	BUFFERED OSCILLATOR OUTPUT
15	V_{DD}	+5 VOLT SUPPLY
16	XTAL1	OSCILLATOR INPUT
17	XTAL2	OSCILLATOR OUTPUT
18	CLK2	CLOCK OUTPUT
19	RXDATA	RECEIVED DATA INPUT
20	SAT	RECEIVED SAT INPUT
21	TXDATA	TRANSMIT DATA OUTPUT
22	RCVCLK	RECOVERED CLOCK OUTPUT
23	RCVDAT	RECOVERED DATA OUTPUT
24	INT	INTERRUPT REQUEST (ACTIVE LOW)
25	RESIN	RESET INPUT (ACTIVE HIGH)
26	CS	CHIP SELECT (ACTIVE LOW)
27	CLK3	TRANSMIT CLOCK OUTPUT
28	WR	WRITE ENABLE (ACTIVE LOW)





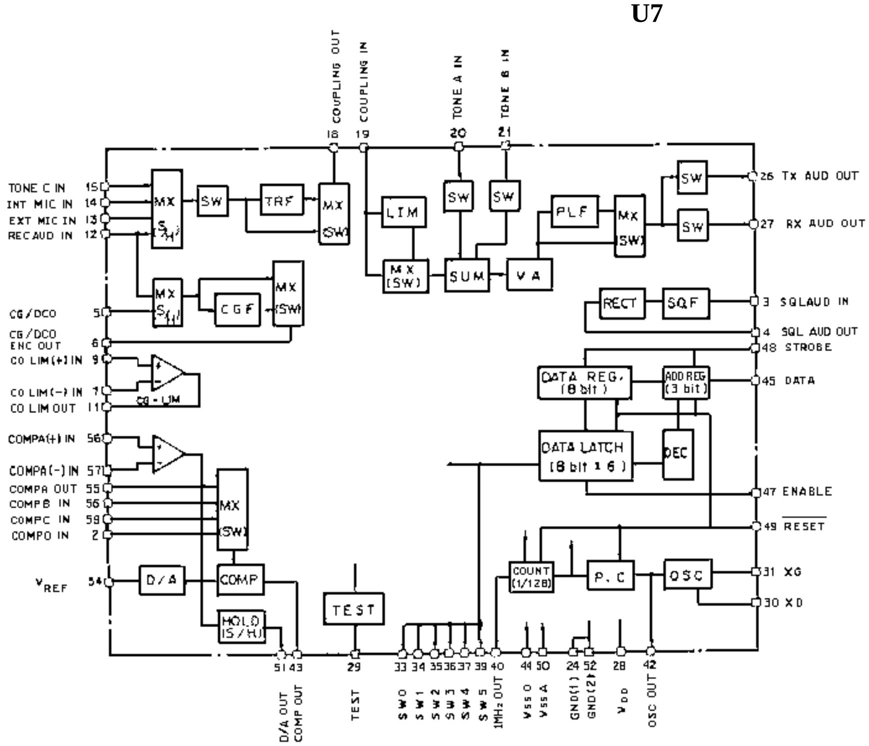
CONTROL BOARD
MODEM
19A704727P1

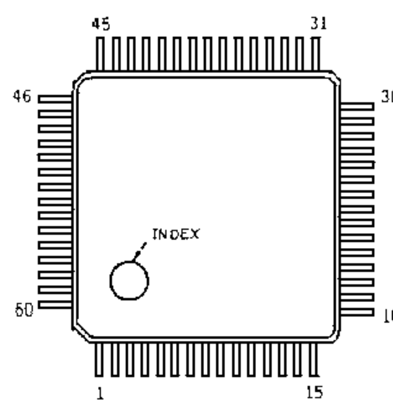
U6, U8



CONTROL BOARD
QUAD OP AMP
19A702293P1

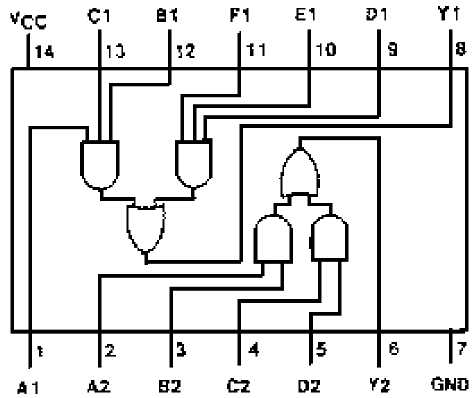
U7





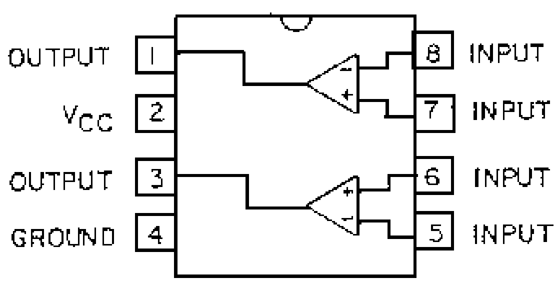
CONTROL BOARD
AUDIO PROCESSOR
19A705851P1

U9



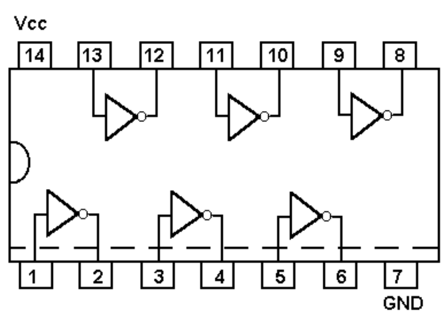
CONTROL BOARD
DUAL AND/OR GATE
19A703483P113

U10



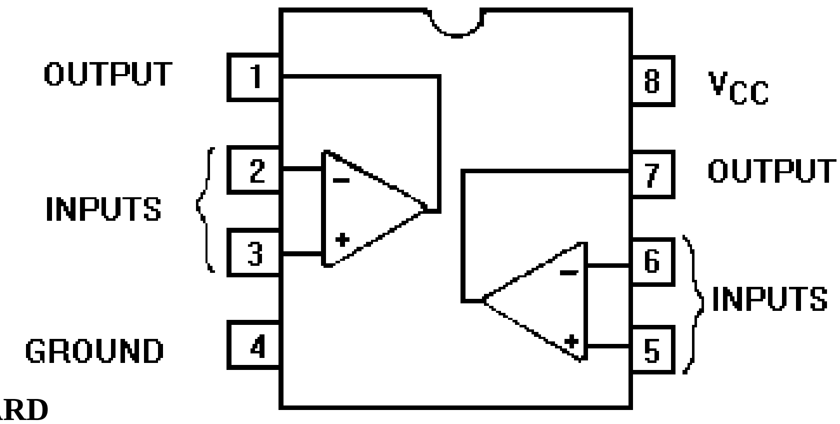
CONTROL BOARD
AUDIO AMPLIFIER
19A705452P2

U11



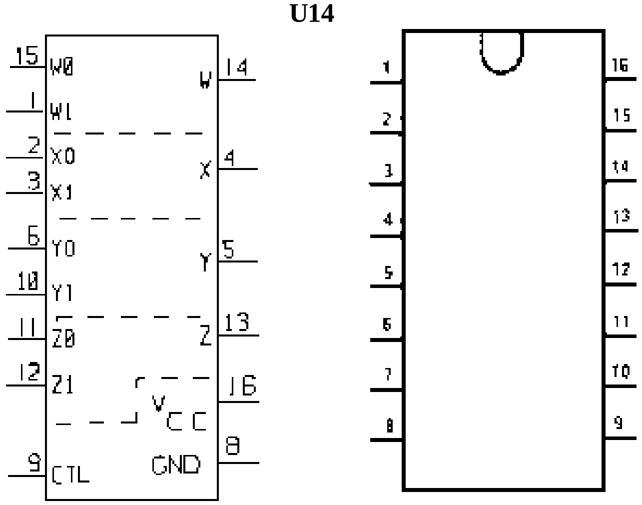
CONTROL BOARD
HEX INVERTER
19A703483P104

U12



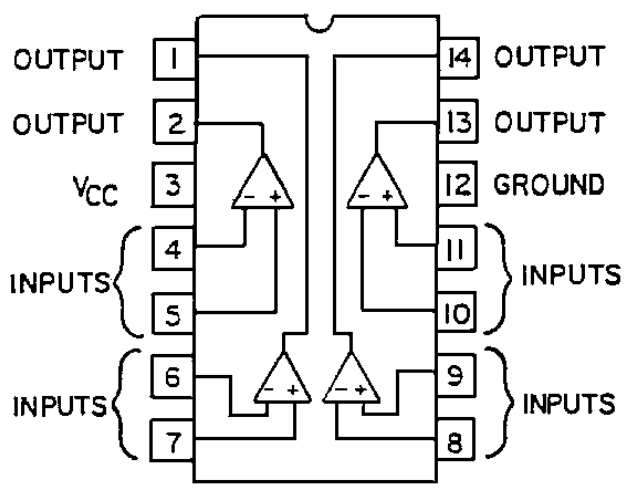
CONTROL BOARD
DUAL OP AMP
19A702293P2

U14



CONTROL BOARD
QUAD MULTIPLEXER
19A700029P633

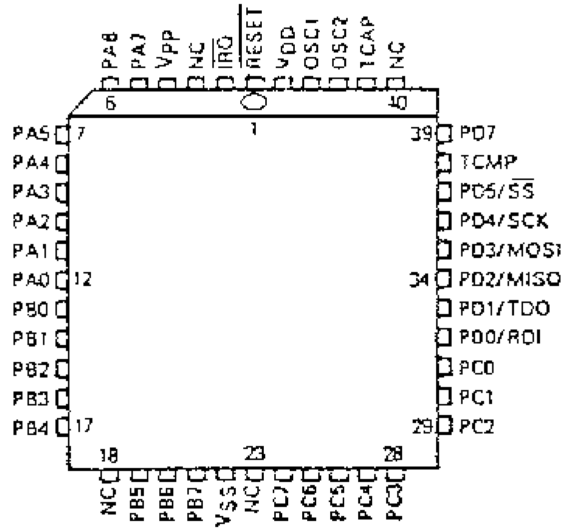
U17

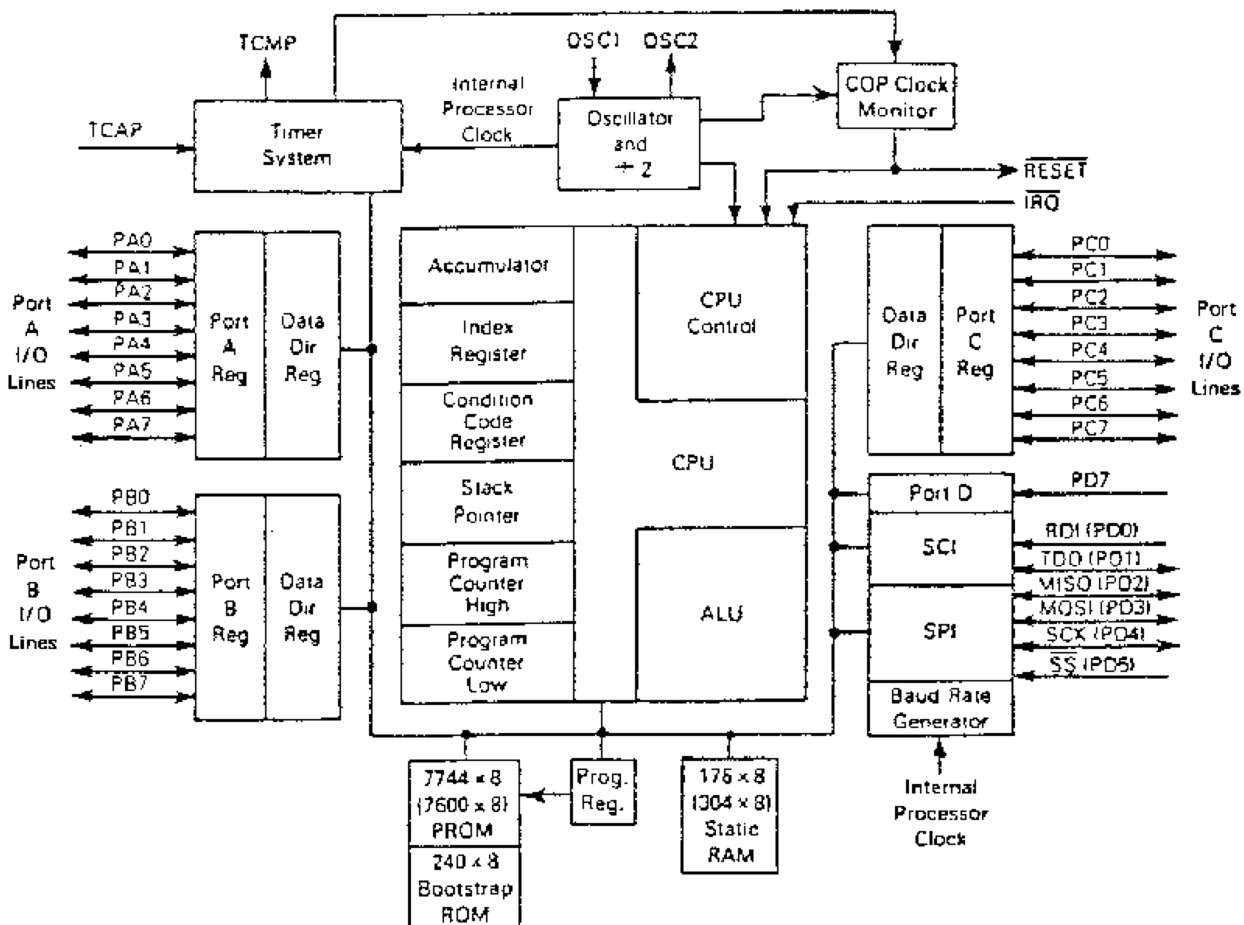


NOTE: OUTPUTS ARE OPEN COLLECTOR

CONTROL BOARD
QUAD COMPARATOR
19A704125P1

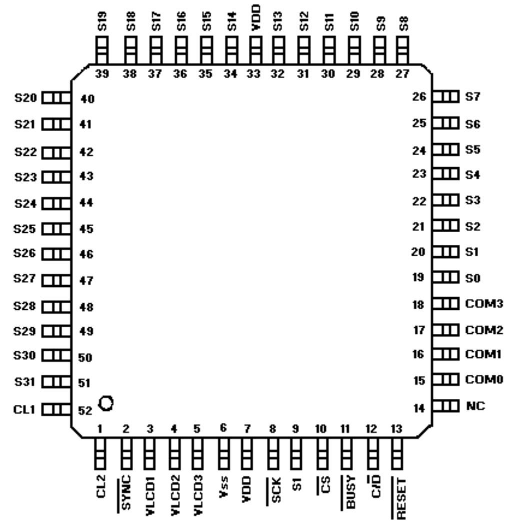
U18

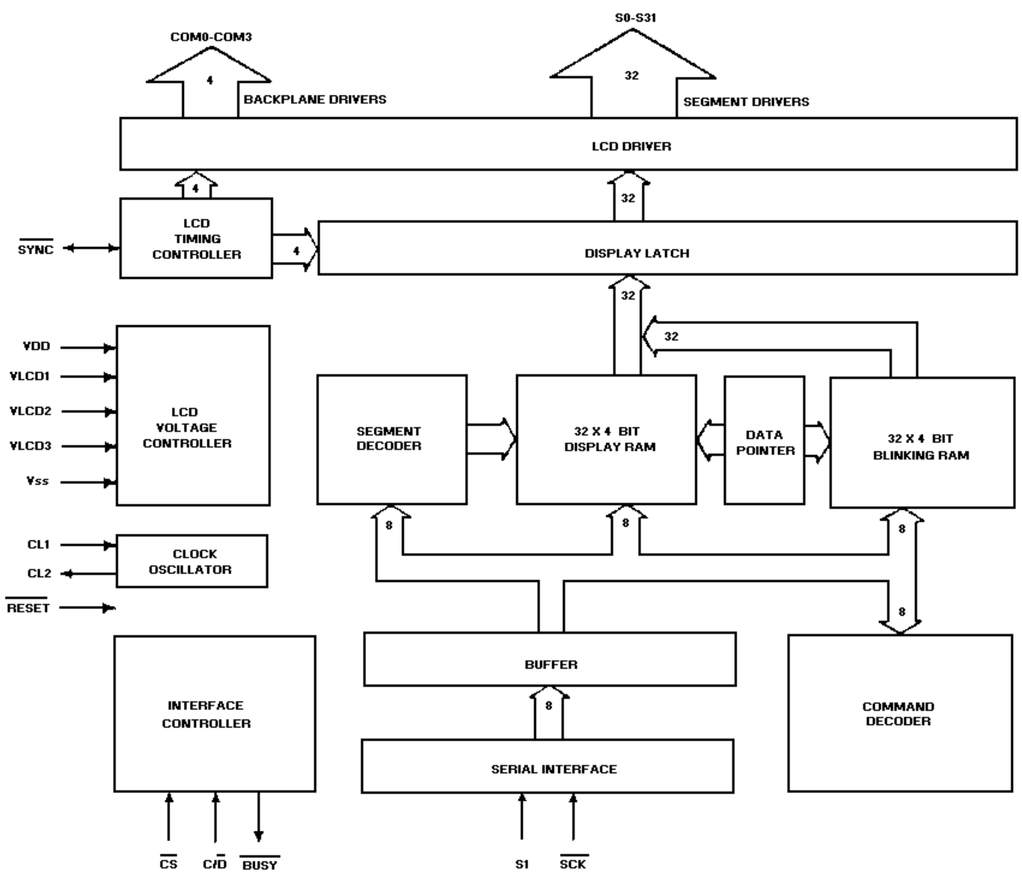




CONTROL BOARD MICROPROCESSOR
19A149861

U1



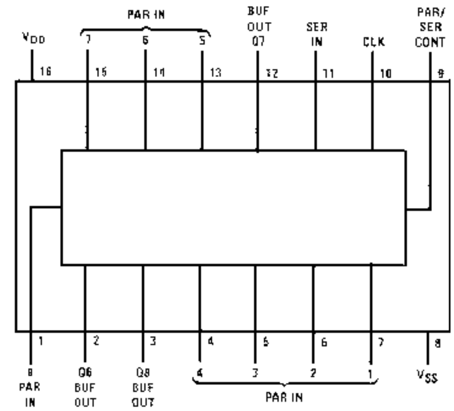


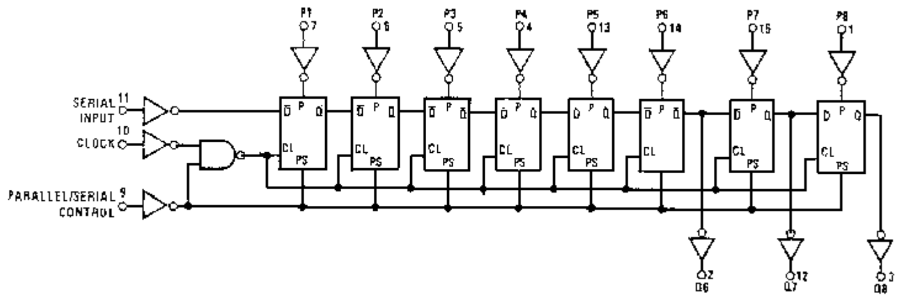
LCD BOARD
LCD CONTROLLER/DRIVER
19A705799P1

U1

CL*	Serial Input	Parallel/ Serial Control	PI 1	PI n	Q1 (Internal)	Q_n	
X	X	1	0	0	0	0	
X	X	1	0	1	0	1	
X	X	1	1	0	1	0	
X	X	1	1	1	1	1	
↑	0	0	X	X	0	Q_{n-1}	
↑	1	0	X	X	1	Q_{n-1}	
↓	X	0	X	X	Q1	Q_n	No Change

* Level change
X = Don't care case



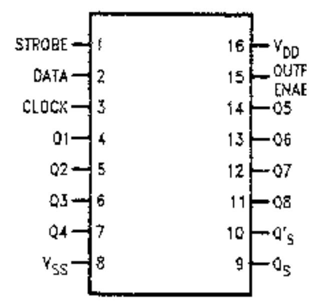


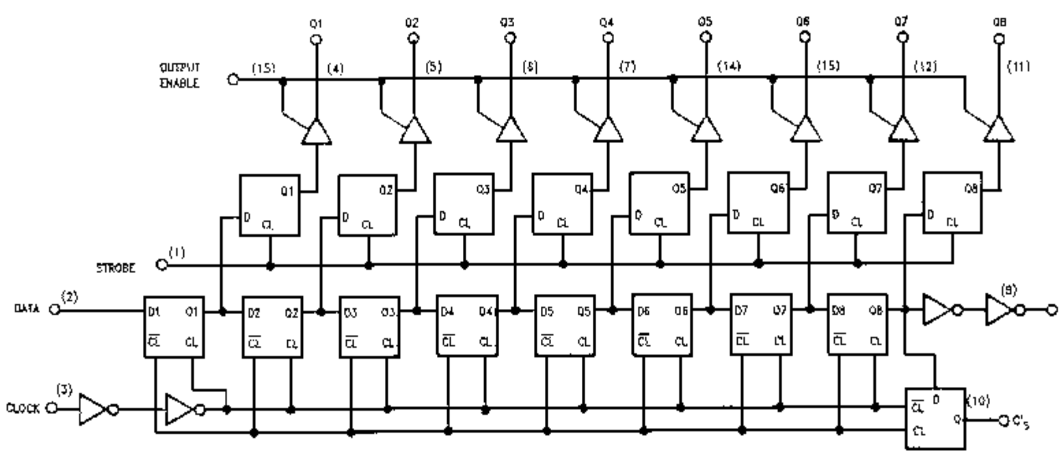
KEYPAD FLEX
8-BIT SHIFT REGISTER
19A704423P2

U2

Clock	Output Enable	Strobe	Data	Parallel Outputs		Serial Outputs	
				Q1	Q_N	Q_S*	Q'_S
↑	0	X	X	Hi-Z	Hi-Z	Q7	No Chg.
↓	0	X	X	Hi-Z	Hi-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

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





KEYPAD FLEX
8-BIT LATCHING SHIFT REGISTER
19A704423P3