## 1. Recommended Test Equipment for Servicing *SYNTOR X* Radios

| General Type | Application | Recommended Model | Minimum Specifications |
|---|---|---|---|
| AC-DC VOM | DC voltage measurements, general | Motorola T1009A | Measurement range: 0–15 V dc<br>Sensitivity: 20,000 ohms/volt |
| DC Multimeter | DC voltage readings requiring a high-input-resistance meter | Motorola S1063B | Measurement range: 0–15 V dc<br>Input resistance: 11 megohms |
| AC Voltmeter | Audio voltage measurements | Motorola S1053C | Measurement range: 0–1 mV ac<br>Input resistance: 1 megohm |
| RF Voltmeter | RF voltage measurements | Motorola S1339 | Measurement range: 100 μV–3 V from 1 MHz to 512 MHz<br>Inputs: 50-ohm and high-impedance |
| Oscilloscope, Dual-Trace | Waveform observation | Motorola R1004A | Vertical sensitivity:<br>5 mV–10 V/division<br>Horizontal time base: 0.2 μsec–0.5 sec/division |
| RF Wattmeter | Transmitter output power measurement | Motorola S1350 with appropriate element and T1013 RF dummy load | Measurement range: 0–250 watts |
| Frequency Meter | Transmitter frequency measurement | Model R1200 Service Monitor with high-stability oscillator (X suffix) option. Frequency calibration recommended every 6 months or less. | Measurement range: 403–512 MHz<br>Frequency resolution: 10 Hz |
| Deviation Meter | Transmitter modulation deviation measurement | Motorola R1200 Service Monitor with SLN6350 Deviation Meter and SLN6381 Audio Frequency Synthesizer (*audio synthesizer required only for DPL radios*) | Measurement range: 0–10 kHz deviation<br>Frequency range: 403–512 MHz |
| RF Signal Generator | Receiver alignment and troubleshooting | Motorola R1200 Service Monitor with attenuator | Frequency range: 403–512 MHz<br>Output Level: 0.1 μV–100,000 μV<br>Must be capable of at least ±3 kHz deviation when modulated by 1-kHz tone. |
| Audio Signal Generator | Audio circuit troubleshooting | Motorola S1067B | Frequency range: 20 Hz–20 kHz<br>Output level: 50 mV–1 V |
| ■Logic Probe | Checking of various digital devices | Motorola RTL-4014 | |
| PL Tone Generator* | Tone-coded *Private-Line* decoder troubleshooting | Motorola S1333B | Frequency range: 10 Hz–9999 Hz<br>Output level: 0–3 V rms |
| ■DPL Test Set** | *Digital Private-Line* encoder-decoder troubleshooting | Motorola SLN6413A | |
| Radio Test Set | Meter readings at circuit metering points for alignment and troubleshooting | Motorola S1056 Portable Test Set with a TEK-37 or TEK-37A Test Set Adapter or a Motorola TEK-5 Meter Panel with a TEK-40 Cable | |

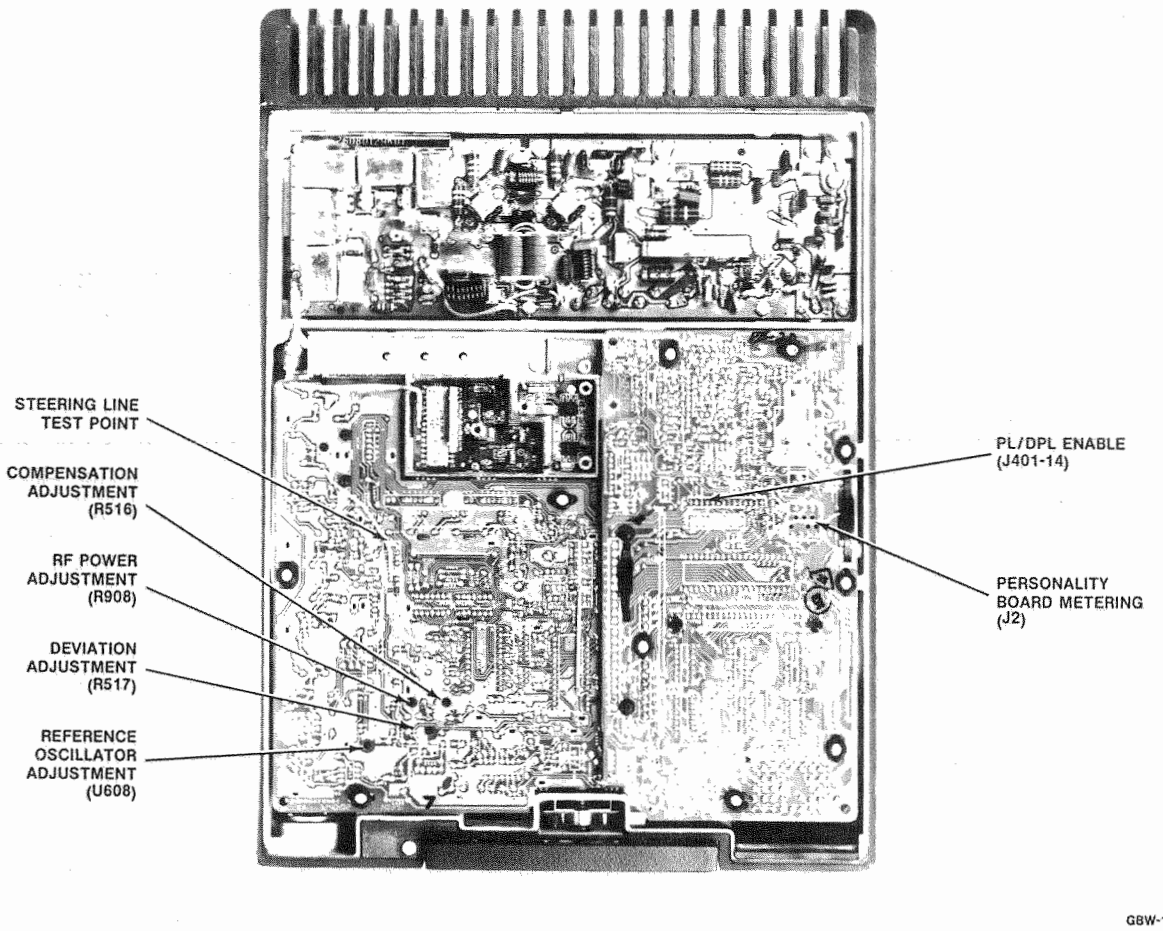



*Figure 1. Radio Adjustments (Top View)*

## 1. Recommended Test Equipment for *SYNTOR X* Radio Servicing (continued)

| General Type | Application | Recommended Model | Minimum Specifications |
|---|---|---|---|
| ■Tuning Tool Kit | Receiver and transmitter alignment | Motorola HLN4262A | |
| ■DC Power Supply | DC power for shop service | Motorola R1011AA | 1–20 V dc<br>0–40 A |

*Required for tone-coded *Private-Line* models only
**Required for *Digital Private-Line* models only

**Note**

The Motorola R2001 System Analyzer replaces all the test equipment listed above except that marked with ■.

**Caution**

In positive-ground systems, the case of the TEK-5 Meter Panel and Portions of the S1056B Portable Test Set are hot with respect to the vehicle chassis. Take precautions to prevent the test equipment from touching the vehicle chassis.

## 2. Radio Alignment and Adjustments

### 2.1 INTRODUCTION

2.1.1 You can adjust the following items on the low-band *SYNTOR X* radio:

- oscillator frequency
- deviation
- compensation
- transmitter output
- transmitter power amplifier current limit
- extender receive frequency

2.1.2 You can adjust the oscillator frequency, deviation, modulation compensation, and transmitter power through holes in the RF board, as shown in Figure 1.

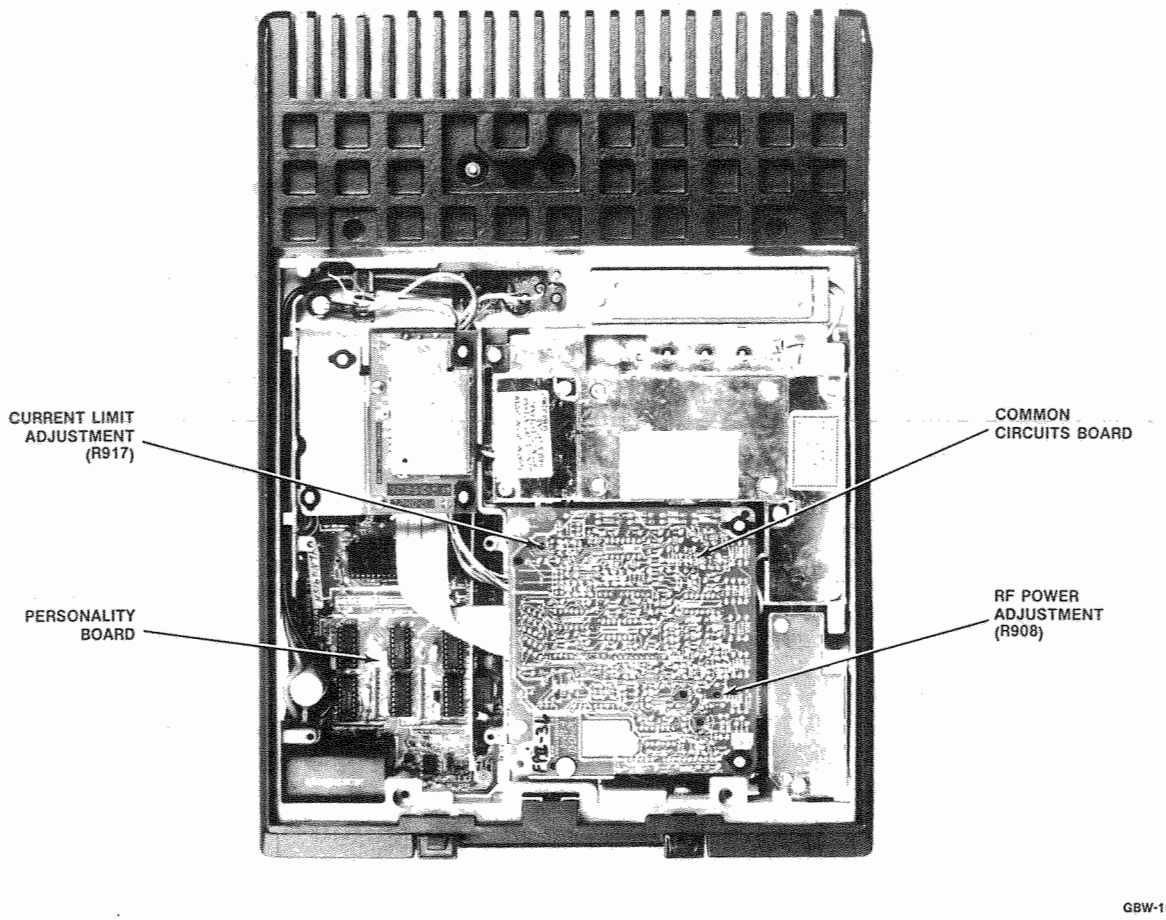



*Figure 2. Radio Adjustments (Bottom View)*

2.1.3 You can adjust the current limit for the transmitter power amplifier through a hole in the common circuits board, once you have removed the bottom cover. (See Figure 2.)

**Important**

Readjustment of the *SYNTOR X* receiver is NOT recommended, since the receiver is preadjusted at the factory to have a wide passband for all frequencies between 33 and 50 MHz.

**Note**

See the list of recommended test equipment in this section of the manual.

2.2 OSCILLATOR FREQUENCY

**Note**

Adjust the oscillator frequency before checking or setting the deviation.

(1) Set the mode selector switch to Mode 1.

(2) Using the portable test set, key the transmitter without modulation. On *Private-Line* and *Digital Private-Line* radios, disable the encoder output by shorting the PL/DPL ENABLE line (J401-4) to ground. J401-4 is on the personality board.

(3) Adjust the reference oscillator (U608) warp control (Figure 1) until the proper indication shows on the frequency meter.

(4) Set the mode selector switch (for multiple-mode units only) to each of the remaining positions and check the transmitter frequency. (No further oscillator frequency adjustments are required.)

2.3 DEVIATION

**Note**

While setting deviation, be sure to check deviation on all transmit channels. This ensures that the radio will not over-deviate.

(1A) (For PL or DPL radios only) Using deviation adjustment potentiometer R517, set the deviation on the highest PL or DPL customer transmit frequency, to ±4.7 kHz.

(1B) (For radios without PL or DPL) Using deviation potentiometer R517, set the deviation on the highest customer transmit frequency, to ±4.7 kHz.

(2) Check the deviation on each mode and reset it to ±4.7 kHz on the frequency with the highest deviaiton.

(3) Check the deviation on each transmit frequency to be sure that it does not exceed 5 kHz.

2.4 COMPENSATION

**Note**

The compensation adjustment potentiometer (R516) is set at the factory and does not normally require readjustment. Nevertheless, you should use this compensation adjustment procedure whenever any of the following conditions occur: (a) if DPL transmit (encode) performance is poor, (b) if the VCO reference oscillator or common circuits board is replaced, (c) if the compensation potentiometer is replaced or inadvertently adjusted, (d) if the phase modulator is replaced. This procedure balances the transmit audio signal fed to the VCO and reference oscillator, thus insuring good DPL waveform fidelity and flat modulation response.

(1A) (For PL or DPL radios only) Turn the deviation potentiometer (Figure 1) one-half turn clockwise.

(1B) (For radios without PL or DPL) Set the compensation potentiometer to the middle of its range. Go to Step 5B.

(2) (For PL or DPL radios only) Set the mode selector to the highest PL/DPL customer transmit frequency (closest to 50 MHz).

(3) (For PL or DPL radios only) Connect the center lead of the shielded cable of an ac voltmeter to the modulation compensation test point (Figure 1) and connect the shield to the radio ground (A –). Set the voltmeter to the 1-mV range.

(4) (For PL or DPL radios only) Modulate the PL or DPL and adjust the compensation potentiometer until you see a null indication on the voltmeter. Cover the hole with tape to prevent accidental adjustment of this control.

(5A) (For PL or DPL radios only) Carry out Step 1A of Section 2.3, above.

(5B) (For radios without PL or DPL) Carry out Step 1B of Section 2.3, above.

2.5 TRANSMITTER POWER

**Note**

Do not use coaxial cable adapters to connect different-sized cables. If you do, it may increase the output VSWR and cause protection circuitry to reduce output power. Use only cables that connect directly to the test equipment. See the Transmitter Section of this manual for information about the operation of the VSWR protection circuitry.

**Note**

There is a list of recommended test equipment earlier in this section of the manual. Use only the recommended equipment for making these adjustments to get the best results.

**Note**

You can make all the transmitter adjustments described here through holes in the common circuits board. (See Figures 1 and 2.)

(1) Turn R917 clockwise to the stop.

(2) Select a mode with a middle customer frequency.

(3) Adjust R908 to get a power level of 105 watts.

(4) Verify that the power level on all customer frequencies is 105 ±5 watts.

2.6 RECEIVER TUNING

No field tuning of the receiver is required.

## 3. Radio Disassembly

3.1 GENERAL

3.1.1 You can reach the solder side of the RF board, personality board, and the power amplifier deck from the top of the radio after removing the top cover. Remove the top cover by turning the key to release the front handle and then pushing the button under the

handle. This allows the top cover to pop up, giving you access to the boards. For access to the PA deck, remove the five screws securing the PA shield and lift the shield out by its handle.

3.1.2 To remove the radio from the vehicle, first release the handle, as described above. Now slide the radio forward (about an inch) and lift it out. Disconnect the cables to remove the radio from the trunk.

3.1.3 You can reach the rest of the radio by removing the four screws that secure the skid plate to the bottom of the radio. This gives you access to the metering socket of the common circuits board (J952). The common circuits board is hinged so that you can open it out to gain access to its component side and to the component side of the RF board. (See Figures 1 and 2 in the Description Section of this manual.) To turn the common circuits board on its hinge, remove two screws on the board as well as one additional screw on the regulator heat sink.

**Warning**

When operating the radio with the regulator heat sink screw removed, avoid the exposed hot flange.

**Note**

All serviceable mounting screws have posidrive heads that can be serviced with standard Phillips screwdrivers. To improve driver engagement, use posidrive tools (available through National Parts, Motorola part numbers 66-80344A57 and 66-80344A58).

**Note**

Black plastic captivators identify the mounting screws for the common circuits board, personality board, and RF board.

## 3.2 COMMON CIRCUITS BOARD

To turn the common circuits board on its hinges, remove three screws. To remove the board from the radio, remove the two hinge screws also and unplug the ribbon cable between the common circuits board and the personality board, and the wires between the common circuits board and the PA deck. When putting the common circuits board back into the radio, pass the cable and the wires between the two board hinges.

## 3.3 PERSONALITY BOARD

To remove the personality board from the radio: (a) remove the seven screws that secure the board to the radio, (b) disconnect the cable from the front plug, (c) disconnect the ribbon cable from the common circuits board, (d) remove any connectors to the interface board, and (e) pull the board away from the radio to disconnect the connectors to the RF board. When putting the board back into the radio, insure that the front plug gasket is properly seated. (Silicone compound, Motorola part number 1100834678, helps in this procedure.)

## 3.4 RF BOARD

To remove the RF board: (a) remove the personality board, as explained above, (b) remove the six retention screws, (c) disconnect a coaxial cable between the RF board and the internal casting, and (d) disconnect the wires near the antenna switch. To reach some segments of the solder side of the RF board, you must remove shields screwed to the board. Remove the two large cans on the component side of the board by simply pulling them off the board; other cans must be unsoldered to be removed.

**Important**

To reinstall the RF board, align the board guide posts and the internal casting carefully. Match the spring connectors on the board precisely with those in the internal casting.

## 3.5 INTERNAL CASTING

### 3.5.1 General

To remove the internal casting from the radio:

(1) Remove the radio covers.

(2) Remove three screws to allow the common circuits board to hinge.

(3) Remove the four casting mounting screws (bottom side of radio).

(4) Remove the input coax from the high-pass filter board.

(5) Unsolder the output coax from the RF board.

(6) Remove the TX buffer and disconnect the TX mixer output coax.

(7) Disconnect the remaining coax from the RF board.

(8) Disconnect P200 and P201 from the RF board.

(9) Remove three screws from the RF board (top side of radio).

**Note**

During reassembly, be sure that J650 is aligned correctly with the VCO assembly.

3.5.2 First Mixer

To remove the first mixer from the radio:

(1) Remove the cover and three gasket mounting screws.

(2) Unsolder the RF input wire coming from the extender front end board.

(3) Unsolder the coax from the first injection filter board.

(4) Unsolder the output wire going to the high IF board.

(5) Remove the three mounting standoffs.

**Caution**

Do not use excessive heat. If you do, the tap leads will come off the filter.

3.5.3 First Injection Filter

To remove the first injection filter from the radio:

(1) Remove the cover mounting screw and cover.

(2) Unsolder the input wire from J125.

(3) Unsolder the output coax going to the RX first mixer board.

3.5.4 VCO

To remove the VCO from the radio:

(1) Remove the four screws from the VCO cover.

(2) Remove the cover.

(3) Remove the screw from the center of the VCO hybrid circuit module.

(4) Remove the coaxial cable from the VCO hybrid. Use a low-wattage iron.

(5) Pull J650 upward, removing it, the VCO, from the radio.

To install the VCO, reverse the procedure given above.

**Note**

If you replace the VCO assembly with a new one, readjust the compensation level, following the procedure given in the Maintenance and Troubleshooting Section of this manual.

3.5.5 Extender Front End Board

To remove the extender front end board from the radio:

(1) Remove the two cover mounting screws and the cover.

(2) Unsolder the input wire from J300 (phono plug).

(3) Unsolder the output wire going to the first mixer board.

(4) Unsolder the dc feed wire from the high IF board.

(5) Unsolder the board from the three mounting tips.

(6) Unsolder the output coax leading to the extender back end board.

3.5.6 Extender Back End Board

To remove the extender back end board from the radio:

(1) Remove the cover mounting screws and the cover.

(2) Unsolder the board from the three feedthroughs.

(3) Unplug connector J200 from the RF board.

(4) Unsolder the input coax from the extender front end board.

(5) Remove the board mounting screws.

3.5.7 High IF Board

To remove the high IF board from the radio:

(1) Remove the cover and gasket mounting screw.

(2) Unsolder the output coax from the RF board.

(3) Unsolder the input wire from the first mixer.

(4) Unsolder the wire leading from the front end extender board.

(5) Unsolder the board from the six mounting tips.

(6) Remove the board mounting screw (standoff).

*Table 1. General System Troubleshooting Guide*

| Symptom | Possible Source of Trouble | Chart or Diagram to be Referred to |
|---|---|---|
| No Receive Audio | Red or green lead fuse | None (Check the fuses.) |
| | Audio PA | Voltages and waveforms on audio schematic |
| | Audio enable switch | Squelch troubleshooting chart |
| | Squelch | Squelch troubleshooting chart |
| | Regulator | Regulator troubleshooting guide |
| | Synthesizer (not locking) | Synthesizer troubleshooting chart |
| | Microcomputer | Microcomputer troubleshooting chart |
| | Quad detector | Receiver section schematic |
| Distorted Receiver Audio | Audio PA | Audio schematic for voltages and waveforms |
| | Quad detector | Receiver section schematic |
| | IF | Receiver section schematic |
| Low Audio Power | Audio PA | Audio schematic |
| | Red lead fuse | None (Check fuse.) |
| | Quad detector | Receiver section schematic |
| | IF | Receiver section schematic |
| Failure to Squelch | Squelch | Squelch troubleshooting chart |
| | Microcomputer | Microcomputer troubleshooting chart |
| | Audio enable switch | Squelch troubleshooting chart |
| Failure to Unsquelch | Refer to *No Receive Audio* Symptom Above | |
| Improper Squelch Sensitivity | IF | Receiver section schematic |
| | Quad detector (low recovery) | Receiver section schematic |
| | Squelch | Squelch troubleshooting chart |
| Absence of PL/DPL Encode | I/O board | I/O board schematic |
| | Microcomputer | Microcomputer troubleshooting chart |
| | IDC | IDC portion of synthesizer troubleshooting chart |
| Absence of PL/DPL Decode | I/O board | I/O board schematic |
| Absence of Regulated 9.6 V or 5.0 V | Short on printed circuit board | — |
| | Regulator | Regulator troubleshooting guide |
| Absence of RF Power Output | PA enable switch | Microcomputer schematic |
| | Keyed 9.4 switch | Microcomputer schematic |
| | Synthesizer (out of lock) | Synthesizer troubleshooting chart |
| | Red or orange lead fuse | None (Check fuses.) |
| | Power control | Microcomputer schematic (PTT isolation circuit) |
| | PA | PA troubleshooting chart |
| Absence of Power Control | Power control | Power control troubleshooting chart |
| Low RF Power Output | Power Control | Power control troubleshooting chart |
| | PA | PA troubleshooting chart |
| | Antenna switch | Antenna switch test procedure |
| Absence of Transmitter Modulation | IDC | IDC portion of synthesizer troubleshooting chart |
| | Power control | IDC portion of synthesizer troubleshooting chart |
| Distorted Transmitter Modulation | Misadjusted compensation | Compensation adjustment procedure (in radio alignment and adjustment) |
| | IDC (PL/DPL distortion only) | IDC portion of synthesizer troubleshooting chart |
| | I/O board | I/O board schematic |
| | Reference oscillator | IDC portion of synthesizer troubleshooting chart |
| | VCO | IDC portion of synthesizer troubleshooting chart |
| Improper Microphone Sensitivity | IDC | IDC portion of synthesizer troubleshooting chart |
| | VCO | |
| | Reference oscillator | |
| Transmitter Frequency Shift with High-Level Modulation | IDC | IDC portion of synthesizer troubleshooting chart |
| Failure of Synthesizer to Lock | Synthesizer | Synthesizer troubleshooting chart |
| | Microcomputer | Microcomputer troubleshooting chart |
| | Memory module | Programing section of synthesizer troubleshooting chart |

*Table 1. General System Troubleshooting Guide (continued)*

| Symptom | Possible Source of Trouble | Chart or Diagram to be Referred to |
|---|---|---|
| Reference Frequency (6.25 kHz) in Speaker or on Transmitted Audio | Adaptive filter | Synthesizer troubleshooting procedure |
| Synthesizer Locking on Wrong Frequency | Synthesizer | Synthesizer troubleshooting chart |
| | Microcomputer | |
| | Memory module | |
| | Adjustment of reference oscillator | |
| Long Synthesizer Lock Time | Synthesizer | Synthesizer troubleshooting chart |
| | VCO | |
| Poor Receive Sensitivity | High IF | Receiver troubleshooting chart and receiver section schematic |
| | Low IF | |
| | Quad detector | |
| | Preamplifier | |
| | First mixer | |
| | Second mixer | |
| | Antenna switch | Antenna switch test procedure |
| Alternator Whine | Short, chassis to A – | None (Disconnect control cable and check for a short between chassis and A – .) |
| | Excessive whine in vehicle | Manual 68P81116A74 |

3.5.8 TX Mixer

To remove the TX mixer from the radio:

(1) Remove three screws to allow the common circuits board to hinge.

(2) Remove the TX buffer and unfasten the TX mixer output coax from the TX buffer board.

(3) Remove the remaining two coax cables from the RF board.

(4) Unsolder the two dc voltage supply wires from the TX mixer hybrid.

(5) Remove the two TX mixer hybrid plate mounting screws.

(6) Remove the input coax from the VCO.

3.6 REPLACEMENT OF TRANSISTOR DEVICES

3.6.1 Driver Device (Q802)

To remove the driver device (Q802) from the PA board:

(1) Remove the hex nut from the stud of Q802. The hex nut is in a depression on the bottom of the radio.

(2) Unsolder the flanges of the device from the board. Use a four-pronged soldering iron if one is available. If not, heat up each flange with a soldering iron and use a sharp object such as a pick to pry up the flange from the board. When all the flanges are clear of the board, lift the device out of it.

To replace the driver device in the PA board:

(1) If you are reinstalling the old Q802, clean old thermal compound off the bottom of the device with a tissue or a rag. Also clean that part of the chassis exposed through the hole cut in the board for Q802 as well as possible. If you are installing a new Q802, just clean the chassis.

(2) Put a new, thin, even layer of thermal compound (Wakefield 120-8 or equivalent) on the bottom of Q802.

(3) Drop Q802 through the hole in the board, with the angled flange pointing towards L807. Screw the hex nut finger tight on the stud. (Be careful not to strip the threads on the stud.)

(4) Solder the flanges of Q802 to the board. Q802 will not operate properly unless these flanges are well soldered.

(5) Tighten the hex nut to 6–8 inch-pounds.

3.6.2 Final Devices (Q803, Q804)

To remove Q803 and Q804:.

(1) Remove the flange screws (two per device) from Q803 and Q804.

(2) Lift up one end of R808 to make it easier to remove Q804.

(3) Unsolder the flanges, using the procedure given in Step 2 of Section 3.6.1, above.

To replace the final devices:

(1) If you are replacing old devices, clean off the old layer of thermal compound with a tissue or a rag. Also clean the chassis exposed through the hole in the board as well as possible.

(2) Apply a new, thin, even layer of thermal compound (Wakefield 120-8 or equivalent) to the bottoms of the devices and drop them into their holes, making sure that the angled flange of each is pointing towards T802.

(3) Install the flange screws. (Be sure to replace the thermistor bracket, Part No. 07-80078A01, on Q803.) Tighten the screws to 6–8 inch-pounds.

**Caution**

Tighten the flange screws before soldering the transistor tabs to the circuit board. *Do not use more than six to seven inch-pounds of torque,* or you may damage the transistor.

## 3.7 RF POWER AMPLIFIER CIRCUIT BOARD

To remove the PA circuit board:

(1) Unsolder the coaxial cable from the output connector (MP801) on the PA board.

(2) Disconnect the input cable (from the synthesizer) from input connector J801 on the PA board.

(3) Remove the hex nut from the stud of Q802 on the bottom of the radio.

(4) Remove the four flange screws from the final devices (Q803 and Q804).

(5) Remove the screw from the collar heatsink of Q801.

(6) Take the nex nut off the standoff on the PA board (next to T801).

(7) Remove the six remaining board screws.

(8) Unsolder all nine feedthroughs, removing the solder with a solder sucker.

(9) Lift the board out.

To reinstall the PA board:

(1) Clean all old thermal compound off the bottoms of Q802, Q803, and Q804. Also clean the chassis, removing any thermal compound, dirt, grit, or other contamination.

(2) Apply a thin, even layer of thermal compound to Q802, Q803, and Q804.

(3) Resolder the coaxial cable to the output connector (MP801) while the board is still loose.

(4) Put the board back in the chassis, making sure it is in properly.

(5) Install the flange screws in Q803 and Q804, making sure that the thermistor bracket (Part No. 07-80078A01) is on Q803. Tighten to 6–8 inch-pounds.

(6) Install the screw for the collar heatsink of Q801, making sure that the square plastic insulator (Part No. 14-80103B01) is under the heatsink. Also make sure that the plastic shoulder washer (Part No. 04-82345A01) is under the screw. Tighten the screw to 8–10 inch-pounds.

(7) Reinstall the hex nut on the standoff near T801. Tighten it to 6–8 inch-pounds.

(8) Install the remaining six board screws and tighten them to 8–10 inch-pounds.

(9) Resolder *all* feedthroughs. Do not flow excessive solder.

(10) Reconnect the input cable (from the synthesizer) to input connector J801 on the PA board.

## 3.8 FRONT LATCH

To remove the front latch key mechanism, insert the key into the lock, turn the key about 45 degrees clockwise, and insert the special removal tool (Part No. 66-84909B01) with the point directed away from the lock. Twist the tool 180 degrees clockwise. This releases the key mechanism, which you can then remove. To remove the black plastic part, remove the single screw securing it.

## 3.9 DIRECTIONAL COUPLER

### 3.9.1 Directional Coupler Circuit Board

To remove the directional coupler circuit board:

(1) Remove the cover of the coupler casting and its gasket.

(2) Unsolder the three feedthrough capacitor leads.

(3) Unsolder the input and output coax leads.

(4) Remove the board.

To replace the directional coupler board, reverse the removal procedure.

3.9.2 Directional Coupler Casting

**Note**

You should be able to solve most board-related electrical problems without removing the directional coupler casting from the radio chassis.

To remove the directional coupler casting:

(1) Unsolder the output coax from the PA board output.

(2) Remove plug P953 from J953 on the common circuits board.

(3) Remove the retaining nut from the antenna connector.

(4) Remove the two screws securing the coupler casting to the chassis.

(5) Pull the coupler and antenna connector assembly out of the chassis.

To reinstall the directional coupler casting, reverse the removal procedure.

3.10 PREAMP CIRCUIT BOARD

To remove the high-pass filter circuit board:

(1) Remove the two screws holding the circuit board cover to the radio housing.

(2) Unsolder the input coax from the PA board and slide it through the HUB1077A radio housing.

(3) Disconnect the output coax from the internal casting.

(4) Remove the two remaining screws.

## 4. Troubleshooting the General System

Table 1 is a guide to troubleshooting the general system. It lists the symptoms of various malfunctions, possible sources of the trouble, and the chart or diagram that is most likely to be of service in clearing the fault.

## 5. Antenna Switch Test Procedure

5.1 INTRODUCTION

When the radio is in the receive mode, the antenna switch connects the antenna to the receiver via the receiver reed, coaxial cable, and phono plug; in the transmit mode, it connects the antenna to the transmitter via the transmitter reed, coaxial cable, directional coupler, and harmonic filter. (See Figure 3.)

5.2 TEST EQUIPMENT

Use a regular analog VOM for checking continuity paths or short circuits. The list at the beginning of Section 1 recommends the Motorola T1009A ac-dc VOM.

5.3 PROCEDURE

This procedure consists of a receive signal path test and a transmit signal path test. Before conducting either, *disconnect the coaxial cable from the LLA deck input*. This allows the antenna switch to change from one condition to the other (from receive to transmit or vice versa) without causing the PA to generate power output.

5.3.1 Receive Signal Path Test

(1) Disconnect the receive cable plug from the internal casting socket. Use an ohmmeter to verify continuity between the center pin of the plug and the center pin of the antenna connector. Verify no continuity between the center pin of the plug and the plug shield (or radio chassis).

(2) Key up the radio and verify that 9.4 VDC is present at the antenna switch coil. Under this condition, the receive reed opens. Verify no continuity between the center pin of the antenna switch and that of the receive cable plug.

5.3.2 Transmit Signal Path Test

(1) Verify that the coaxial cable is still disconnected from the PA deck input.

(2) Key up the transmitter and verify continuity between the center conductor of the coaxial cable and the center pin of the antenna switch. If there is continuity, check other points along the transmit path to locate any possible open circuits (Figure 3). If there is no continuity, replace the antenna switch.

(3) Verify that the resistance of the transmitter path to the radio chassis is 50 kilohms or more.

**Important**

Field servicing of the antenna switch assembly is NOT recommended. Replace the entire unit if it is defective.

## 6. Extender Tuneup Procedure

(1) If the tuneup frequency is higher than 40 MHz, remove chip resistors (zero-ohm) R300, R301, and R302 from the extender front-end board. Replace them with wire jumpers if necessary.

(2) Preset L300, L301, and L302. (See Figure 4.)

(3) Set the frequency generator to the tuneup frequency and connect it to the radio. Set the generator ¼ MHz below the tuneup frequency if you intend to use the metal-tipped tuning tool on C321.

(4) Set the trim capacitor on the back-end board (C321) for peak voltage at the extender-tune test point. Use a hard plastic tuning tool, if possible. Do not use a screwdriver. During the tuneup process, adjust (and readjust as required) the generator RF level to maintain the voltage at the extender-tune test point in its active region.

(5) After removing the tuning tool from the trim capacitor, adjust the generator frequency for peak output at the extender-tune test point. (Little or no adjustment should be required.)

(6) Adjust L300 and L302 for peak voltage at the extender-tune test point.

(7) Adjust L301 for peak voltage at the extender-tune test point.

(8) Repeak L300 and L302.

(9) Repeak L301.

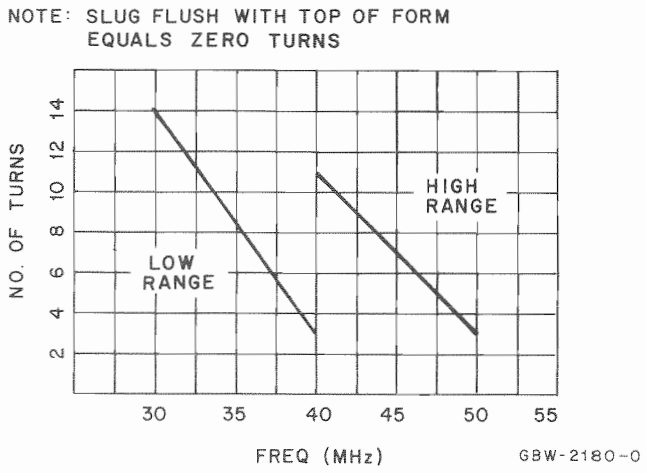



*Figure 4. Preset Chart for L300–L303.*

After completing the above procedure, you may be able to get 2 or 3 dB additional sensitivity by doing the following:

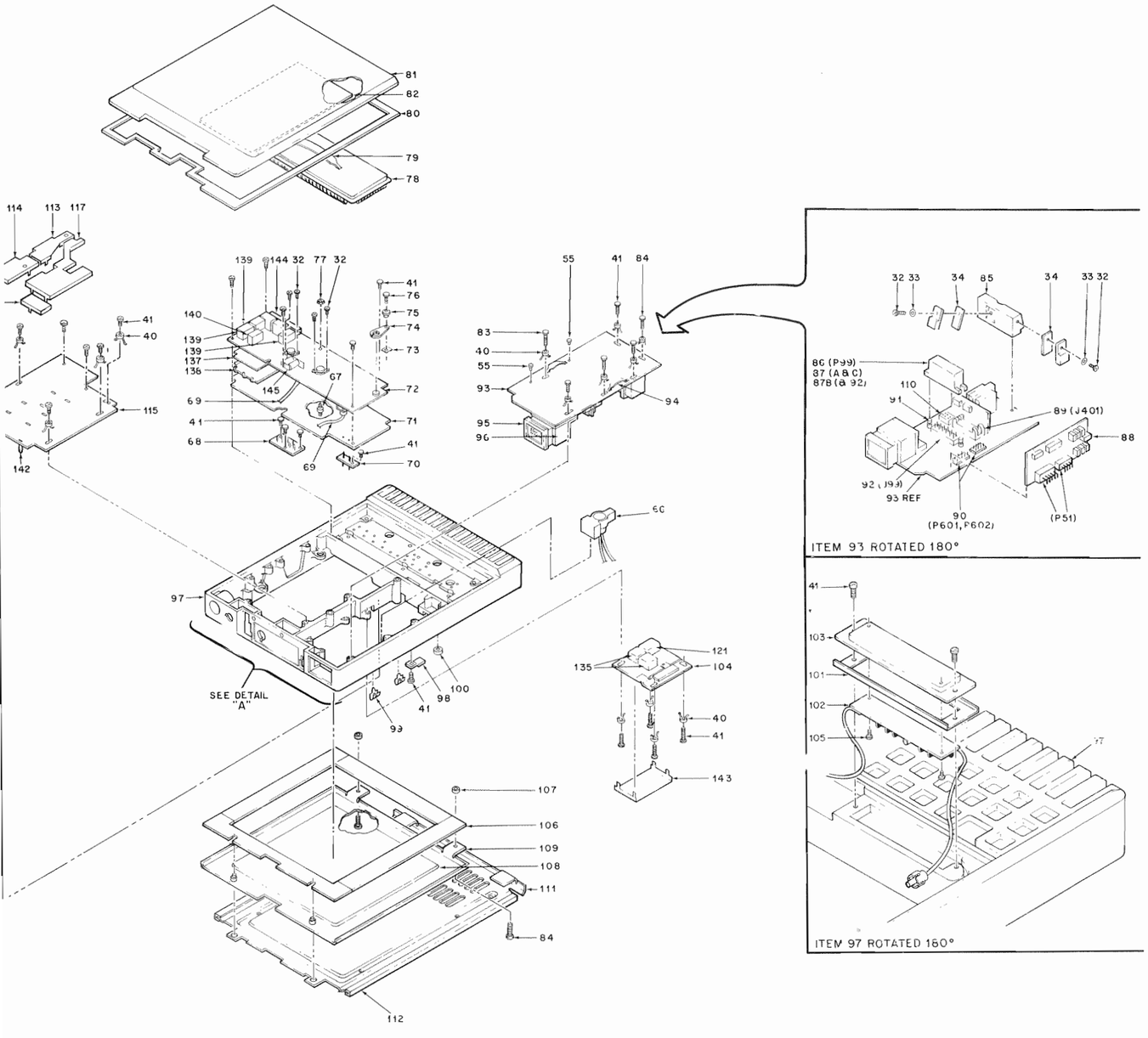
(1) Hook up a pulse generator to the radio connector.

(2) Monitor the pulse output at J200-1 with an oscilloscope with a 2-µs-per-division sweep. Have it externally triggered by the pulse generator, if possible.

(3) Decrease the pulse generator amplitude until the J200-1 waveform starts to disappear.

(4) Tune L301, L302, L303, and C321 until the waveform is triggered solidly.

(5) Repeat Steps 3 and 4 until the procedure gives no further improvement.







ITEM 93 ROTATED 180°




ITEM 97 ROTATED 180°

# parts list

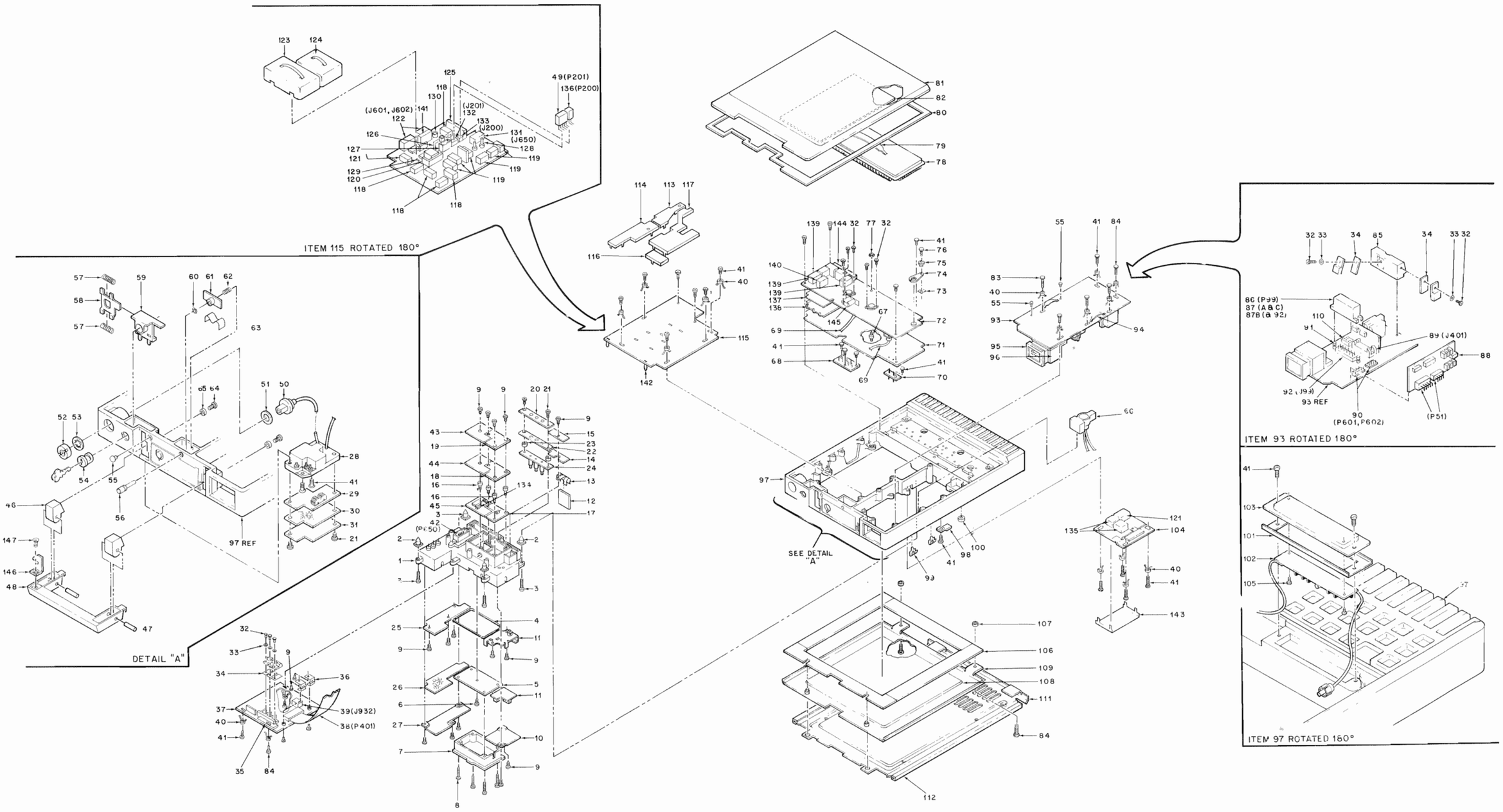
Low-Band *SYNTOR X* Exploded View — MXW-2154-O

| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| 1 | 15-84776M11 | internal casting housing |
| 2 | 14-80212B01 | expansion nut, 4 used |
| 3 | 03-80157J01 | tapping screw (4.55 × 1.59 × 19 mm), 4 used |
| 4 | 32-82796H01 | wire mesh gasket |
| 5 | HLB4086A | VCO substrate |
| 6 | 03-10943M10 | tapping screw (3 × .5 × 8 mm) |
| 7 | 15-84817M01 | VCO cover |
| 8 | 03-80132J02 | tapping screw (3.5 × .6 × 23 mm), 4 used |
| 9 | 03-10943M14 | tapping screw (3.5 × .6 × 6 mm), 19 used |
| 10 | 15-84851M01 | buffer cover |
| 11 | HLB1021A | transmit buffer, substrate and carrier |
| 12 | HFB4001A | injection filter board |
| 13 | 42-80194H01 | grounding clip |
| 14 | 32-80207H01 | injection filter gasket |
| 15 | 15-80203H01 | injection filter cover |
| 16 | 43-80190A03 | standoff (3.5 × .6 × 7 mm), 4 used |
| 17 | HLB4085A | receiver mixer board |
| 18 | 32-80132K01 | receiver mixer gasket |
| 19 | 15-80126K01 | receiver mixer cover |
| 20 | 15-80204H01 | RF extender cover |
| 21 | 03-10943M16 | tapping screw (3.5 × .6 × 10 mm), 4 used |
| 22 | 32-80208H01 | extender front end gasket |
| 23 | 43-80294H01 | board mounting spacer, 2 used |
| 24 | HLB4090A | extender front end board |
| 25 | HLB4091A | extender back end (pre-amp) board |
| 26 | 32-80043D01 | pre-amp gasket |
| 27 | 15-84853M01 | pre-amp cover |
| 28 | 15-80107H01 | directional coupler housing |
| 29 | HLB4092A | directional coupler board |
| 30 | 32-80284H01 | directional coupler gasket |
| 31 | 15-80108H01 | directional coupler cover |
| 32 | 03-10911A11 | machine screw (3 × .5 × 8 mm), 9 used |
| 33 | 04-84180C01 | shoulder washer, 5 used |
| 34 | 14-83820M02 | transistor insulator, 5 used |
| 35 | 26-84835M01 | regulator heatsink |
| 36 | 55-83493M01 | hinge, 2 used |
| 37 | HLN4817A | common circuits board |
| 38 | 30-83602M01 | cable (includes P401) |
| 39 | 28-80052D01 | 10-contact right-angle connector |
| 40 | 42-83503M01 | screw retainer, 19 used |
| 41 | 03-10943M15 | tapping screw (3.5 × .6 × 8 mm), 33 used |
| 42 | HLN4251A | VCO feedthrough plate |
| 43 | 15-80125K01 | high IF cover |
| 44 | 32-80131K01 | high IF gasket |
| 45 | HLB4098A | high IF board |
| 46 | 07-80152B01 | handle pivot bracket, 2 used |
| 47 | 22-83491M01 | spring pin, 2 used |
| 48 | 55-80242D01 | handle |
| 49 | 01-80739T21 | interconnect cable assembly |
| 50 | 01-80739T01 | antenna connector and cable |
| 51 | 32-80080A01 | antenna connector gasket |
| 52 | 02-80006A01 | spanner nut |
| 53 | 04-00114522 | 5/8" internal lock washer |
| 54 | 55-84101B01 | lock with key |
| 55 | 75-80194G01 | rubber bumper, 3 used |
| 56 | 38-80154B01 | cover release button |
| 57 | 41-80160B01 | lock spring, 2 used |
| 58 | 55-80161B01 | lock catch |
| 59 | 15-80159B02 | lock housing |
| 60 | 42-81056B01 | retainer ring |
| 61 | 55-80157B01 | cover release catch |
| 62 | 41-80155B01 | cover release spring |
| 63 | 41-80206F01 | cover lift spring |
| 64 | 03-10908A46 | machine screw (M5 × .8 × 16 mm), 2 used |
| 65 | 04-00007652 | 5/16" lock washer, 2 used |
| 66 | HLN4461A | PA wiring bus |
| 67 | 43-80013B01 | PA board standoff |
| 68 | HLN4913A | power amplifier feedthrough board |
| 69 | 29-83897M01 | wire receptacle terminal, 2 used |
| 70 | HLN 4914A | IPA feedthrough board |
| 71 | 14-80297H01 | PA insulator |
| 72 | HLN4094A | power amplifier circuit board |
| 73 | 14-80103B01 | IPA heatsink insulator |
| 74 | 26-80016B01 | IPA heatsink |
| 75 | 04-84152B01 | shoulder washer |
| 76 | 03-10943M17 | tapping screw (3.5 × .6 × 13 mm) |
| 77 | 02-10971A63 | machine nut (M3.5 × .6 mm) |
| 78 | 01-80244H01 | PA shield |
| 79 | 55-84300B04 | PA shield handle |
| 80 | 32-80226D01 | top cover gasket |
| 81 | 15-84075N01 | top cover |
| 82 | 14-84691M01 | top cover insulator |
| 83 | 03-80132J01 | tapping screw (3.5 × .6 × 28 mm), 2 used) |
| 84 | 03-10943M18 | tapping screw (3.5 × .6 × 16 mm), 6 used |
| 85 | 26-83498M01 | audio PA heatsink |
| 86A | TRN8864A | 8 and 16-mode PROM |
| 86B | TRN8865A | 32-mode PROM |
| 86C | TRN8866A | 64-mode PROM |
| 87A | 15-80155D01 | right half PROM housing |
| 87B | 15-83494M01 | left half PROM housing |
| 87C | 54-84392M02 | direction label |
| 88 | TRN8876A | input/output board |
| 89 | 28-83603M01 | 20-contact male connector |
| 90 | 28-82647K02 | 10-contact male connector, 2 used |
| 91 | 46-83821M01 | memory module alignment pin, 2 used |
| 92 | 28-82622L03 | 22-contact connector, male |

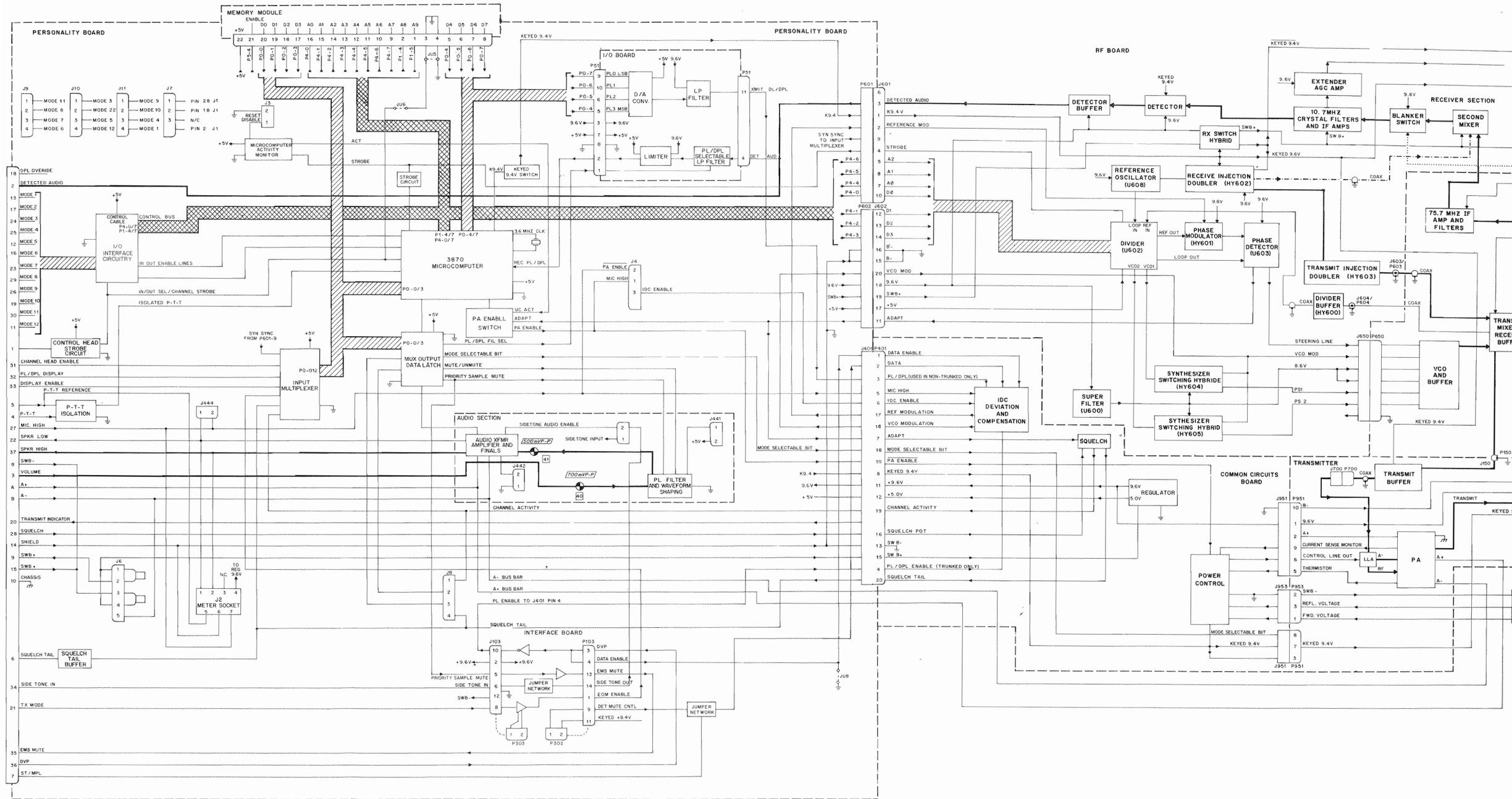
MXW-2154-O (2)

| REFERENCE SYMBOL | MOTOROLA PART NO. | DESCRIPTION |
|---|---|---|
| 93 | HLN4915A | personality board |
| 94 | 55-84300B03 | short handle, 2 used |
| 95 | 32-80219B01 | front connector gasket |
| 96 | 01-80739T06 | 37-contact male front connector assembly |
| 97 | 15-84763M01 | radio housing |
| 98 | 42-80201B01 | bus wire clip |
| 99 | 42-84367M01 | wire hold-down clip, 2 used |
| 100 | 02-00007003 | nut (8-32 × 5/16 × 1/8) |
| 101 | HLB4000A | high-pass filter preamp board |
| 102 | 32-80283H01 | high-pass filter preamp gasket |
| 103 | 15-80192H01 | high-pass filter preamp cover |
| 104 | HLB4083A | transmitter buffer board |
| 105 | 03-10943M09 | tapping screw (3.5 × .5 × 6 mm), 2 used |
| 106 | 32-80225D01 | bottom cover gasket |
| 107 | 04-80149A01 | captive washer, 4 used |
| 108 | 14-84691M02 | bottom cover insulator |
| 109 | 15-80174B01 | bottom cover |
| 110 | 08-84207B01 | 7-contact metering socket |
| 111 | 07-80208G02 | mounting tray |
| 112 | 07-80173B01 | guide rail, 2 used |
| 113 | 26-80199K01 | second mixer shield, solder side |
| 114 | 26-80198K01 | low IF shield, solder side |
| 115 | HLB4087A | RF board |
| 116 | 26-80289H01 | RF board detector shield |
| 117 | 26-80137K01 | synthesizer divider shield |
| 118 | 26-83596M01 | RF board shield, component side, 5 used |
| 119 | 26-84898M01 | RF board shield, component side, 7 used |
| 120 | 26-80288H01 | fence shield, component side |
| 121 | 26-83595M01 | quad detector shield, component side, 2 used |
| 122 | 09-83445L09 | 10-contact female connector, 2 used |
| 123 | 26-80127K01 | RF synthesizer shield |
| 124 | 26-80292H01 | RF adaptive filter shield |
| 125 | 26-80296H01 | transmit doubler hybrid shield |
| 126 | 26-80293H01 | receive injection double hybrid shield |
| 127 | 26-80299H01 | AGC extender fence shield |
| 128 | 46-83948M01 | guide post, 2 used |
| 129 | 42-82160N01 | speed clip, 7 used |
| 130 | 09-80001F01 | female phono connector, 2 used |
| 131 | 09-83730M01 | 7-contact socket |
| 132 | 28-84324M03 | 5-contact connector |
| 133 | 28-84324M01 | 2-contact connector |
| 134 | 26-80238K01 | RF board high IF coil shield |
| 135 | 26-80121A01 | transmitter buffer board shield, 2 used |
| 136 | HKN4202A | 2-contact interconnect cable assembly |
| 137 | 14-80165K01 | harmonic filter shield insulator |
| 138 | 26-80287H01 | harmonic filter shield |
| 139 | 26-80298H01 | harmonic filter coil shield, 5 used |
| 140 | 26-80149J01 | PA board capacitor shield |
| 141 | 26-80237K01 | synthesizer divider hybrid shield |
| 142 | 29-80146B01 | amp mod terminal, 23 used |
| 143 | 26-80189M01 | transmit buffer shield |
| 144 | 26-80129K01 | harmonic filter shield |
| 145 | 25-80229J02 | power transformer |
| 146 | 55-80244C02 | handle latch |
| 147 | 03-10943R21 | tapping screw (4 × .7 × 8 mm) |

Exploded View, Mechanical Parts List, and Functional Block Diagram for *SYNTOR X* Low-Band Radio
**PDW-1645-O**
(Sheet 1 of 2)
8/28/85


123
124
125
118
130
(J601, J602)
141
122
126
127
121
129
120
118
118
118
(J201)
132
133
(J200)
131
(J650)
128
119
119
119
49(P201)
136(P200)
81
82
80
79
78
114
113
117
116
115
142
41
40
139
144
32
77
32
140
139
139
137
136
145
67
69
41
68
41
76
75
74
73
72
71
41
70
55
41
84
83
40
55
93
95
96
94
32 33
34
85
34
33 32
86 (P99)
87 (A & C)
87B (& 92)
110
91
89 (J401)
88
92 (J99)
93 REF
90
(P601, P602)
(P51)
ITEM 93 ROTATED 180°
ITEM 115 ROTATED 180°
57
59
60
61
62
58
57
63
65
64
51
50
52
53
54
55
56
28
41
29
30
31
21
97 REF
46
147
146
48
47
DETAIL "A"
9
9
20
21
43
19
44
18
16
16
45
3
42
(P650)
2
1
9
15
23
22
14
24
13
134
12
17
2
3
25
4
11
9
26
5
11
6
27
10
7
9
8
32
33
9
34
36
37
39(J932)
40
38(P401)
41
35
84
97
SEE DETAIL "A"
60
121
135
104
40
41
143
107
106
109
108
111
84
112
99
41
98
100
103
101
102
105
97
ITEM 97 ROTATED 180°

GEW-1646-0




Exploded View, Mechanical Parts List, and
Functional Block Diagram for
*SYNTOR X* Low-Band Radio
**PDW-1645-O**
(Sheet 2 of 2)
8/28/85

PERSONALITY BOARD

I/O BOARD

RF BOARD

RECEIVER SECTION

TRANSMITTER

COMMON CIRCUITS BOARD

INTERFACE BOARD

INTERNAL CASTING

KEYED 9.4V

+5V 9.6V

P51

PO-7 PO-6 PO-5 PO-4

PLO LSB PL1 PL2 PL3 MSB

D/A CONV

LP FILTER

XMIT DL/DPL

DET AUD

LIMITER

PL/DPL SELECTABLE LP FILTER

KEYED 9.4V SWITCH

SYN SYNC TO INPUT MULTIPLEXER

P601 J601

DETECTED AUDIO

K9.4V

REFERENCE MOD

STROBE

A2 A1 A0 D0

P602 J602

D1 D2 D3

VCO MOD

9.6V

SWB+

+5V

ADAPT

3.6 MHZ CLK

REC PL/DPL

UC ACT

PA ENABLE

MIC HIGH

IDC ENABLE

J4

DETECTOR BUFFER

DETECTOR

EXTENDER AGC AMP

10.7MHZ CRYSTAL FILTERS AND IF AMPS

BLANKER SWITCH

SECOND MIXER

EXTENDER TEST POINT

J201 P201

AGC

RX SWITCH HYBRID

SWB+

REFERENCE OSCILLATOR (U608)

RECEIVE INJECTION DOUBLER (HY602)

COAX

75.7 MHZ IF AMP AND FILTERS

DIVIDER (U602)

LOOP REF IN

REF OUT

LOOP OUT

VCO2 VCO1

PHASE MODULATOR (HY601)

PHASE DETECTOR (U603)

TRANSMIT INJECTION DOUBLER (HY603)

J603/P603

DIVIDER BUFFER (HY600)

J604/P604

TRANSMIT MIXER/RECEIVER BUFFER

EXTENDER BACK END BOARD

EXTENDER FRONT END BOARD

P125 J125

1st INJECTION FILTER

1st MIXER

J401 P401

DATA ENABLE

DATA

PL/DPL (USED IN NON-TRUNKED ONLY)

MIC HIGH

IDC ENABLE

REF MODULATION

VCO MODULATION

ADAPT

MODE SELECTABLE BIT

PA ENABLE

KEYED 9.4V

+9.6V

+5.0V

CHANNEL ACTIVITY

SQUELCH POT

SW B-

SW B+

PL/DPL ENABLE (TRUNKED ONLY)

SQUELCH TAIL

IDC DEVIATION AND COMPENSATION

SQUELCH

SUPER FILTER (U600)

SYNTHESIZER SWITCHING HYBRIDE (HY604)

SYTHESIZER SWITCHING HYBRID (HY605)

STEERING LINE

VCO MOD

8.6V

PS1

PS2

J650 P650

VCO AND BUFFER

KEYED 9.4V

SIDETONE AUDIO ENABLE

SIDETONE INPUT

500mVP-P

700mVP-P

J441 J442

PL FILTER AND WAVEFORM SHAPING

REGULATOR

9.6V

5.0V

POWER CONTROL

J951 P951

SWB-

9.6V

A+

CURRENT SENSE MONITOR

CONTROL LINE OUT

THERMISTOR

LLA

PA

J953 P953

REFL. VOLTAGE

FWD. VOLTAGE

TRANSMIT

RECEIVE

ANTENNA SWITCH

HARMONIC FILTER PRESELECTOR

DIRECTIONAL COUPLER

FRONT CONNECTOR

SHIELD REF TO CHASSIS

J150 P150

2700 P700

TRANSMIT BUFFER

MP801

HIGH PASS FILTER AND PREAMP

P103

DVP

DATA ENABLE

EMS MUTE

SIDE TONE OUT

EOM ENABLE

DET MUTE CNTL

KEYED +9.4V

JUMPER NETWORK

P303 P302

J08

LEGEND

BLANKING PULSE PATH

SECOND MIXER INJECTION

MAIN SIGNAL FLOW

GEW-1649-0

## 1. Ceramic Microstrip Substrates

1.1 You should not attempt to repair the ceramic microstrip substrates of the radio. If a module has a faulty component, replace the whole module. Not only are repairs to the substrates and replacements of substrate components difficult to make without damaging the module, but also the factory uses special fixtures in building and testing the radio to make certain that each module operates properly. Field repairs to the microstrip substrates negate that initial factory adjustment.

1.2 The ceramic materials of the radio have properties similar to those of glass, and sharp blows and heat affect them the same way they affect glass. Therefore, if you must solder anything to ceramic microstrip modules, use as little heat and pressure as possible. You must also use solder with a high percentage of silver to avoid leaching the capacitors and non-copper runners.

## 2. Chip Capacitors

2.1 The radio uses many chip capacitors as circuit elements. They are extremely sensitive to heat and must not be re-used. Be very careful when making repairs to circuits near these components. Heat from a soldering iron being applied to a nearby component may "leach" the end metalization (terminals) of a chip capacitor. Figure 1 shows what a leached capacitor looks like.

2.2 To remove a chip capacitor, apply heat to both connecting terminals simultaneously, either with two soldering irons or a single iron with a special tip (Motorola Part No. ST-1160). When the connecting solder melts, lift the chip. Figures 2 and 3 illustrate this removal technique.

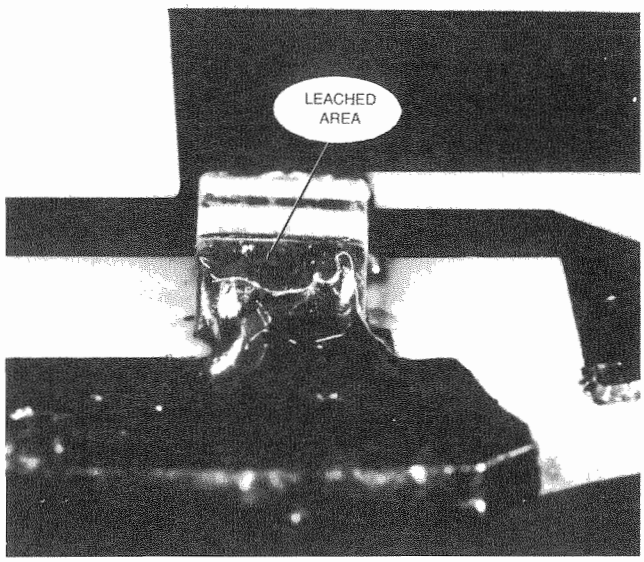
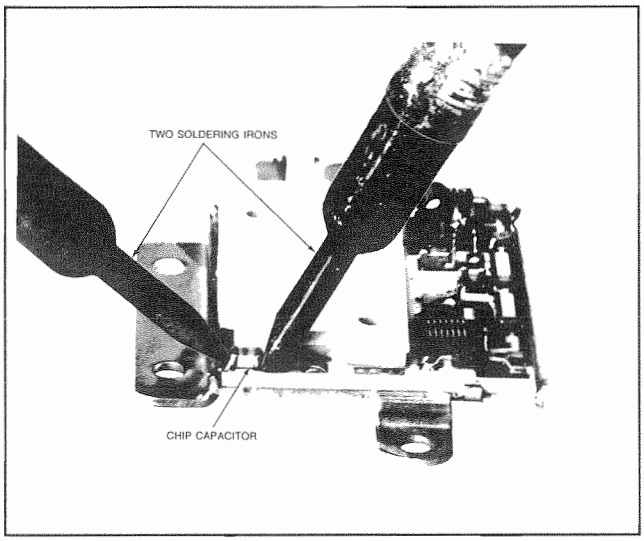



*Figure 1.*
*Example of "Leached" Chip Capacitor*

## 3. Replacing Transistors in the Power Amplifier

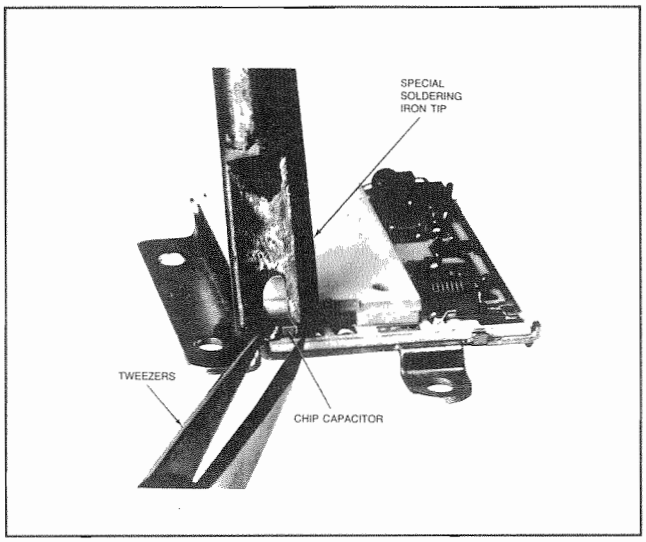
3.1 To remove the power transistors, remove two transistor mounting screws or one stud nut (accessible from the chassis bottom). Unsolder and remove the clamped mica capacitors, then unsolder and remove the transistors. (Special soldering iron tips ST1160 and ST1161, available from Motorola parts offices, make it easier to remove capacitors and transistors.)

3.2 When replacing RF power transistors, you *must* take the following steps. First, use a soft cloth or paper towel to remove all thermal compound and residue from *both the chassis and the transistor* . Then apply a thin film of Wakefield thermal compound to the bottom of the transistor mounting flange. Replace the transistor in the center of the printed circuit board




FAEPS-30533-O

*Figure 2. Removal of Chip Capacitors with Two Soldering Irons*




FAEPS-30534-O

*Figure 3. Removal of Chip Capacitor with Special Soldering Iron Tip*

cutout, tightening the mounting hardware to a *maximum* of seven inch-pounds. With a low-power soldering iron (40–60 W) solder the leads, using enough solder to completely cover the lead and solder pad. *Make sure* that the solder is flowing freely both *over* and *under* the lead before removing the heat. If a lead tends to spring away from the printed circuit board, use the tips of a pair of pliers to hold the far end of the lead down against the board until the solder hardens. After replacing the transistors, replace the clamped mica capacitors, *being sure* to position them *exactly* as they were with respect to the transistor body.