The following equipment is required to completely test and align modern high-fidelity amplifiers, tuners, and receivers.

- Line Voltage Autotransformer or Voltage Regulator
- 10.7 MHz Sweep Generator
- DC Vacuum Tube Voltmeter
- Multiplex Generator (preferably with RF output)
- Accurately Calibrated AC Vacuum Tube Voltmeter
- 455 kHz Sweep Generator
- Oscilloscope (IFlat to 100 kHz Minimum)
- Ferrite Test Loop Stick
- Low-Distortion Audio (Sine Wave) Generator
- 2 – Full Range Speakers for Listening Tests
- Intermodulation Distortion Analyzer
- Stereo Source – Turntable, Tape Recorder, etc.
- Harmonic Distortion Analyzer
- Soldering Iron with Small Tip, Fully Insulated from AC Line
- 2 – Load resistors, 8-Ohms, 100 Watt (Minimum Rating)
- Suction Desoldering Tool
- AM/FM Signal Generator

CAUTION: This precision high-fidelity instrument should be serviced only by qualified personnel, trained in the repair of transistor equipment and printed circuitry.

Many of these items are included only as a reminder — they are normal procedures for experienced technicians. Shortcuts may be taken, but these often cause additional damage to transistors, circuit components, or printed circuit boards.

SOLDERING: A well-tinned, hot, clean soldering iron tip will make soldering easier, without causing damage to the printed circuit board or the components mounted on it. Regular use of a sponge cleaner will maintain a clean soldering surface. The heat available at the tip, (not the wattage of the iron) is important. Some 50-watt irons reach temperatures of 1,000° F, while others will hardly melt solder. Small-diameter tips should be used for single solder connections, pyramid and chisel tips for large areas.

Always disconnect the AC power cord from the line when soldering. Turning the power switch OFF is not sufficient. Power-line leakage paths, through the heating element of the iron, may destroy transistors.

PARTS REMOVAL: If a part is not being returned for in-warranty factory replacement, it may be cut in half (with diagonal cutting pliers) to make removal easier. Multiple terminal parts, such as IF transformers, or electrolytic capacitors, should be removed using special de-soldering tips made especially for this purpose. Removing solder from terminals, reduces the possibility of breaking the printed circuit board when the part is removed.

ACCIDENTAL SHORTS: A clean working area, free of metal particles, screws, etc., is an important preventive in avoiding servicing problems. Screws, removed from the chassis during servicing, should be stored in a box until needed. While a set is operating, it takes only an instant for a base-to-collector short to destroy a transistor (and others direct-coupled to it). In the time it takes for a dropped machine screw, washer, or screwdriver, to contact a pair of socket terminals (or terminal and chassis), a transistor can be ruined.

SOLID-STATE DEVICES: Integrated Circuits contain the equivalent of many circuit parts, including transistors, diodes, resistors, and capacitors. The preferred troubleshooting procedure requires isolating the trouble to one stage using AC signal tracing methods. Once the suspected stage is located, the DC voltages at the input and output leads are measured to give an accurate indication of the operating conditions of the IC. DO NOT use an ohmmeter to check continuity with the IC mounted on the printed circuit board. Forward biasing the internal junctions within the IC may burn out the transistors. Do not replace a defective IC until all external resistors, capacitors, and transformers are checked first, to prevent the replacement IC from failing immediately due to a defect in the connecting components. Solder and unsolder each lead separately using a pliers or other heat sink on the lead to prevent damage from excessive heat. Check that the leads are connected to the correct locations on the printed circuit board before turning the set on.

Whenever possible, a transistor tester should be used to determine the condition of a transistor or diode. Ohmmeter checks do not provide conclusive data, and may even destroy the junction(s) within the device.

Never attempt to repair a transistor power amplifier module until the power supply filter-capacitors are fully discharged.

If an output or driver transistor becomes defective (opens or shorts), always check ALL direct-coupled transistors and diodes in that channel. In addition, check the bias pot, and other parts in the bias network, before installing replacement transistors. All output and driver transistors in one channel may be destroyed if the bias network is defective. After parts replacement, always check the bias adjustment for specified idling current.

In some applications, replacement of transistors must be made from the same beta group as the original type. The beta group is indicated by a colored marking on the transistor. Be sure to include this information when ordering replacement transistors.

When mounting a replacement power transistor, be sure the bottom of the flange, mica insulator, and the surface of the heat sink, are free of foreign matter. Dust and grit will prevent flat contact, reducing heat transfer to the heat sink. Metallic particles can puncture the insulator, cause a short, and destroy the transistor.

Silicone grease must be used between the transistor and the mica insulator, and between the mica and the heat sink, for best heat transfer. Use Dow-Corning DC-3, or an equivalent compound made for power transistor heat conduction.

Use care when making connections to speakers and output terminals. To reduce the possibility of shorts, lugs should be used on the exposed ends, or stranded wire should be tinned to prevent frayed wire ends. Current in the speakers and output circuitry is quite high — poor contacts, or small sized wire, can cause significant power losses in the system. For wire lengths greater than 30 feet, 16 AWG, or heavier, should be used.

VOLTAGE MEASUREMENTS: All voltages are measured with the line voltage adjusted to 120 volts. All measured voltages are ±10%. DC voltages are measured to ground with a VTM, with no signal input unless otherwise noted. AC signal voltages are measured under the conditions specified on the schematic.

ALIGNMENT PROCEDURES: DO NOT attempt realignment unless the required test equipment is available, and the alignment procedure is thoroughly understood.
REMOVING MOTORBOARD
To gain access to the chassis for servicing, remove the motorboard using the following procedure:
(1) Unplug the power cord.
(2) Unplug the two large shipping screws (near the left rear and right front corners of the turntable baseplate). Fully out to lock the chassis to the motorboard.
(3) Remove the four screws (two on each side) holding the motorboard to the wood side panels.

30 & 35A. Lift motorboard at rear (charger attached) and unplug power and audio cables from underside of charger.
50. Remove two additional screws located between charger and recorder. Lift motorboard at rear (charger and recorder attached) and unplug power and audio cables from underside of charger. Unplug power and audio cables from back of recorder. Label recorder's audio cables for reference.
(4) Remove motorboard from top of chassis.
(5) To reinstall the motorboard, reverse procedure. Red plugs designate right channels.

REMOVING DRESS PANEL
(1) Unplug AC power cord.
(2) Gently pull VOLUME, BALANCE, BASS, TREBLE, SELECTOR, and TUNING knobs from shafts. Remove hex nuts and remove panel by pulling forward.
(3) Reverse procedure for reassembly.

REMOVING P.C. BOARDS
To remove a board from nylon mounting, squeeze the loop of each mount (using pliers), and lift each corner of board. To remount board, align holes over clips and press firmly.
To remove the TUNER board, remove the seven mounting screws and washers. To gain access to the circuit side, remove cover plates on underside of chassis.
To remove the CONTROL AMPLIFIER board, use the following procedure:
(1) Remove dress panel. Refer to REMOVING DRESS PANEL procedure
(2) Remove hex nuts from BASS, TREBLE, and BALANCE controls and lift out board.
(3) Reverse procedure to reinstall board.
(4) Reinstall dress panel.

REPLACING DIAL GLASS
(1) Remove dress panel. Refer to REMOVING DRESS PANEL procedure.
(2) Carefully remove foam strips at ends of glass. Strips may be reused with replacement glass.
(3) Carefully remove top retaining clips. Slide out glass.
(4) Reverse procedure using replacement glass (A84043-108).

REPLACING DIAL LAMPS
(1) Remove dress panel. Refer to REMOVING DRESS PANEL procedure.
(2) Remove metal shade and defective lamp. Install replacement lamp (A1847 Q.F.: FR 15000-B). Replace and adjust shade to direct light toward edge of glass.
(3) Reinstall dress panel.

REPLACING METER
(1) Remove motorboard. Refer to REMOVING MOTORBOARD procedure.
(2) Unplug the two leads from meter terminals.
WARNING: Damage to the meter may result from excessive heating of terminals. When soldering or unsoldering, use a pair of pliers (as a heat sink) to hold each terminal.
(3) Gently lift meter retainers and remove meter. Slide replacement (FR No. MC21611) behind retainers into panel cutout, Solder meter leads.
(4) Reinstall motorboard.

REPLACING STEREOBEACON LAMP
(1) Remove motorboard. Refer to REMOVING MOTORBOARD procedure.
(2) Unplug the two leads from lamp assembly.
WARNING: Damage to the nylon holder may result from excessive heating of terminals. When soldering or unsoldering, use a pair of pliers (as a heat sink) to hold each terminal.
(3) Pry out nylon holder. Press replacement assembly (FR A851314) into mount and solder leads.
(4) Reinstall motorboard.
(1) Remove motorboard and dress panel. Refer to REMOVING MOTORBOARD and REMOVING DRESS PANEL procedures.
(2) Remove dial pointer from old dial cord.
(3) Prop unit on its left side. Remove the right wood side-panel by removing the two screws near the feet.
(4) Rotate tuning capacitor fully CW. Loosen machine screws in drum and remove old dial cord.
(5) Tie end of new cord to end of spring. Pass spring to START screw inside drum. See illustration.
(6) Run cord through slot in rim and wrap it turn CCW around drum. Guide cord around pulley "A", and wrap 2 full turns (CCW away from back) around tuning shaft.
(7) Guide cord over "B", and around pulleys "C" and "D". Rotate gan fully CCW, allowing cord to wind on drum.
(8) Run cord over top of drum, around the other side, into rim slot. Tie a knot around FINISH screw.
(9) Pull cord taut and tighten screw. Turn tuning shaft CW and CCW to distribute tensioning.
(10) Repeat (9) until spring is tensioned.
(11) Place pointer on rail and slip cord under tab. Turn tuning shaft fully CCW. Slide pointer to 0 mark and cement to cord.
(12) Check dial calibration.
(13) Reinstall dress panel, side panel, and motorboard.

**CAUTION:**
(1A) Measure the power of one channel at a time.
(2A) Limit measurements to 10 minutes.
(3A) Use a precision load with a 50-ohm minimum rating.
(4A) Set BALANCE, BASS, and TREBLE controls to NORMAL. Set SELECTOR switch to AUX. Degree MAINS SPKR: switch. Unplug AC power cord.

(1) Connect a low-distortion audio generator to the LEFT AUX IN jack. Set generator frequency to 1,000 Hz, and output level to minimum.
(2) Connect an 8-ohm load between the LEFT SPKR MAIN and COMmon terminals. In parallel with the load, connect the inputs of an HD analyzer and a calibrated AC VTVM.
(3) Connect AC power cord. Turn VOLUME to maximum.
(4) Increase generator level for 14 watts output (10.6V RMS across 8-ohm load). HD meter should indicate 0-5% or less.
(5) Repeat preceding steps for right channel.
power supply 2076-2

input attenuator 2205-1
FM ALIGNMENT

1. Set SELECTOR switch to FM. Turn VOLUME control to minimum.
2. Connect jumper between P3 and P4 to defeat AFC.
3. Connect 10.7MHz local oscillator to P23. Connect scope through 330kΩ to P28. Open wire leads at P4A.
4. Adjust top and bottom corners of L8, L7, and L6, and bottom corner of L9 for maximum gain and symmetry.
6. Connect DC VTVM to P5. Reconnect top cap of L8 for 0.0VDC. Disconnect sweep generator and DC VTVM. Connect FM RF generator through 120-ohm carbon composition resistor to ANT terminals.
7. Set generator frequency and dial pointer accurately to 98MHz. Modulate generator with 400Hz, 1.75kHz deviation. Bend oscillator coil L3 and RF coil L2 for maximum amplitude at P5.
8. Adjust oscillator trimmer TCS, antenna trimmer TCS, and RF trimmer TCS for maximum amplitude at P5.
9. Repeat (6) and (7) for maximum sensitivity and accurate dial calibration.
10. Connect AC VTVM to the RIGHT RCDR OUT jack, and another AC VTVM to the LEFT RCDR OUT jack.
11. Connect MPX generator composite output to FM generator.
12. Connect LPF 180Hz MODULATION input. Modulate left and right channels with 400Hz, 1.75kHz deviation, and 180Hz point (1.75kHz deviation). Adjust top cap of L17 and L18 for maximum audio.
13. Modulate left channel only. Right channel AG VTVM should indicate at least 0.0188 below left channel output.
14. Modulate right channel only. Left channel AG VTVM should indicate at least 0.0188 below right channel output.
15. Disconnect MPX generator. Set RF generator output to 20mV, and modulate with 400Hz, 1.75kHz deviation.
16. Detune generator frequency for 0.3VDC at P9. Disconnect jumper between P3 and P4 to turn AFC off. DC VTVM should indicate between 0.5 and 0.7VDC.
17. Disconnect jumper between P3 and P4. Detune generator frequency for 0.3VDC at P9. Remove jumper. Meters should indicate between 0.5 and 0.7VDC. Disconnect test equipment.

AM ALIGNMENT

1. Set SELECTOR switch to AM. Turn VOLUME control to minimum.
2. Connect 455kHz local oscillator to 0.1uf to P19. Connect scope through 220kΩ to P6.
3. Adjust values of L14, L15, L11, and L10 for maximum gain and symmetry.
5. Set generator frequency and dial pointer accurately to 800kHz. Modulate generator with 400Hz, 30% modulation. Connect a short jumper between P21 and chassis. Adjust oscillator coil L17 for maximum amplitude.
6. Set generator frequency and dial pointer accurately to 1000kHz. Adjust oscillator trimmer TCS for maximum amplitude.
7. Adjust trimmers T15 and T22 for accurate dial calibration and maximum gain.
8. Disconnect jumper connection P21 and chassis. Connect AM signal generator to AM ANT, terminal. Open-GND link. Tune receiver to generator frequency at 600kHz. Modulate generator with 400Hz, 30% modulation.
9. Mount the coil on the ferrite antenna. Shift the coil for maximum audio indication. Insert coil in position, rerun wax.
10. Tune receiver to generator frequency at 1400kHz. Adjust antenna trimmer TCS2 for maximum audio.
CENTER VOLTAGE TEST

Turn VOLUME to minimum. Degree MAX IN 10K ohm switch.

1. Connect a B-section between LEFT 1 PIN and B+ at 21401 A10 (Main)
   and 21401 A10 (Main). Switch should be OFF. Do not disturb pins 2 and 3.
2. Connect a B-section between TEST 2 and B+ at 21401 A10 (Main).
   Switch should be OFF. Do not disturb pins 2 and 3.
3. Connect a B-section between TEST 2 and B+ at 21401 A10 (Main).
   Switch should be OFF. Do not disturb pins 2 and 3.
4. Connect a B-section between TEST 2 and B+ at 21401 A10 (Main).
   Switch should be OFF. Do not disturb pins 2 and 3.
5. Connect a B-section between TEST 2 and B+ at 21401 A10 (Main).
   Switch should be OFF. Do not disturb pins 2 and 3.
6. Connect a B-section between TEST 2 and B+ at 21401 A10 (Main).
   Switch should be OFF. Do not disturb pins 2 and 3.
7. Connect a B-section between TEST 2 and B+ at 21401 A10 (Main).
   Switch should be OFF. Do not disturb pins 2 and 3.
8. Connect a B-section between TEST 2 and B+ at 21401 A10 (Main).
   Switch should be OFF. Do not disturb pins 2 and 3.
9. Connect a B-section between TEST 2 and B+ at 21401 A10 (Main).
   Switch should be OFF. Do not disturb pins 2 and 3.
10. Connect a B-section between TEST 2 and B+ at 21401 A10 (Main).

IDLING CURRENT ADJUSTMENT

Turn unit on. Turn VOLUME control to maximum. Warm-up unit about 10 minutes.

1. Connect a B-section between TEST 2 and B+ at 21401 A10 (Main).
   Connect probe of meter to pin 14A in B+ at 21401 A10 (Main).
   Meter should indicate 15V to 45V.
2. If necessary, adjust FBS (in B+ at 21401 A10 (Main)).
3. Reconnect B-section between TEST 2 and B+ at 21401 A10 (Main).
   Reconnect probe of meter to pin 14A in B+ at 21401 A10 (Main).
   Meter should indicate 15V to 45V.