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

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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 net bias network is defective. Aftet 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 VTFM, 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 AC power cord.
(2) Unfasten the two large fastening screws (near the left rear and right front corners of the turntable baseplate) fully out to lock the changer 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 (changer attached) and unplug power and audio cables from underside of changer.
50: Remove two additional screws located between changer and recorder. Lift motorboard at rear (changer and recorder attached) and unplug power and audio cables from underside of changer. 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 mounts, 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 (ASA403-108).

REPLACING DIAL LAMPS
(1) Remove dress panel. Refer to REMOVING DRESS PANEL procedure.
(2) Remove metal shade and defective lamp. Install replacement lamp (A1847 D.P.; FR 15000-8). 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) Unfasten 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) Unfasten 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 AS51314) 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 Starting 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 CW around drum. Guide cord around pulley "A", and wrap 2 full turns (CCW) around back of pulley.
(7) Guide cord over "B", and around pulleys "C" and "D". Rotate gear fully CCW, allowing cord to wind on drum.
(8) Run cord over top of drum, around the other side, into rim slot. Tie a half-knot around FINISH screw.
(9) Pull cord taut and tighten screw. Turn tuning shaft CW and CCW to eliminate tension.
(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 10 mark and cement to cord.
(12) Check dial calibration.
(13) Reinstall dress panel, side panel, and motorboard.

CAUTION:
A) Measure the power of one channel at a time.
B) Limit measurements to 10 minutes.
C) Use a precision load with a 50-watt minimum rating.
Sw BALANCE, BASS, and TREBLE controls to NORMAL. Set SELECTOR switch to AUX. Degree MAIN SPEAKER switch. Unplug AC power cord.
(1) Connect a low-distortion audio generator to the LEFT AUX. 1 kHz, 1000 Hz, and output level to minimum.
(2) Connect an 8-ohm load between the LEFT SPEAKER MAIN and COM main terminals. In parallel with the load, connect the inputs of an HD analyzer and a calibrated AC VTM.
(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. Connect jumper between P3 and P4 to defeat AFC.
(4) Connect DC VTM to P5. Reconnect top corner of L9 for 0 VDC. Disconnect sweep generator and DC VTM. Connect FM RF generator through 120-ohm carbon composition resistors to FM ANT terminals. Reconnect sweep generator to P5.
(5) Set generator frequency and dial pointer accurately to 98MHz. Modulate generator with 400Hz ±75kHz deviation. Bend oscillator coil L3 and RF coil L2 for maximum amplitude at P5.
(6) Set generator frequency and dial pointer accurately to 100MHz. Adjust oscillator trimmer T3C, antenna trimmer T1C, and RF trimmer T2C for maximum amplitude at P5.
(7) Repeat (2) and (7) for maximum sensitivity and accurate dial calibration.
(8) Disconnect DC VTM to P5. Set generator level to 1mV. Tune receiver to generator frequency 100MHz for OVDC at P8.
(9) Disconnect AC VTM to the RIGHT RDR OUT jack, and another AC VTM to the LEFT RDR OUT jack.
(10) Connect MPX generator composite output to FM generator EXTERNAL MODULATION input. Modulate left and right channels with 400Hz ±75kHz deviation (90%), and 18kHz input (±5kHz deviation (10%) at least 20dB below left channel output.
(11) Modulate left channel only. Right channel AC VTM should indicate at least 20dB below left channel output.
(12) Modulate right channel only. Left channel AC VTM should indicate at least 20dB below right channel output.
(13) Disconnect MPX generator. Set RF generator output to 20mV, and modulate with 400Hz ±75kHz deviation.
(14) Detune generator frequency for -0.5VDC at P9. Disconnect jumper between P3 and P4 to turn AFC on. DC VTM should indicate between +0.5 and -0.5VDC.
(15) Reconnect jumper between P3 and P4. Detune generator frequency for -0.5VDC at P5. Remove jumper. Meter should indicate between +0.5 and -0.5VDC. Disconnect test equipment.

AM ALIGNMENT

(1) Set SELECTOR switch to AM. Turn VOLUME control to minimum.
(2) Connect 450kHz sweep generator through 0.1µF to P19. Connect scope through 220k to P6.
(3) Adjust corners of L14, L13, L11, and L10 for maximum gain and symmetry.
(4) Disconnect sweep generator. Connect AM signal generator through 220µF to P19. Connect scope and AC VTM to RIGHT RDR OUT jack.
(5) Set generator frequency and dial pointer accurately to 600kHz. Modulate generator with 400kHz, 30% modulation. Connect a short jumper between P21 and chassis. Adjust oscillator coil L12 for maximum amplitude.
(6) Set generator frequency and dial pointer accurately to 1400kHz. Adjust oscillator trimmer T3C for maximum amplitude.
(7) Repeat (3) and (6) for accurate dial calibration and maximum gain.
(8) Disconnect jumper connection P21 and chassis. Reconnect AM signal generator to AM ANT terminal. Open-GND link. Tune receiver to generator frequency at 600kHz. Modulate generator with 400kHz, 30% modulation.
(9) Shunt the wire holding the coil to the ferrite antenna. Shift the coil for maximum audio indication. To secure coil in position, connect wire.
(10) Tune receiver to generator frequency at 1400kHz. Adjust antenna trimmer T4C for maximum audio.
CENTER VOLTAGE TEST

Turn VOLUME to minimum. Degree MAIN SPEAKS switch.
1. Connect an ohm meter between LEFT SPINDL MAIN and CD (27 cm position), and between SPINDL and CD (27 cm position). The meter should indicate 0VDC (±1.5 Vrms). 
2. Connect the meter to pin 100 of the meter to pin 80. Meter should indicate 0VDC (±1.5 Vrms). 
3. Disconnect the 10K resistors.

IDLING CURRENT ADJUSTMENT

Turn unit on. Turn VOLUME control to minimum. Warm-up unit about 10 minutes.
1. Connect the meter to pin 80 of the meter to pin 9. Meter should indicate 0VDC (±1.5 Vrms). 
2. Adjust R208 for the least Idling current. 
3. Connect the meter to pin 80 of the meter to pin 85. Meter should indicate 10mW to 15mW. 
4. Adjust R32 for the least Idling current.