REQUIRED TEST EQUIPMENT

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

- Line Voltage Auto-transformer or Voltage Regulator
- DC Vacuum Tube Voltmeter
- Accuracy Calibrated AC Vacuum Tube Voltmeter
- Oscilloscope (15kHz to 100 kHz Minimum)
- Low-Distortion Audio Sine Wave Generator
- Intermodulation Distortion Analyzer
- Harmonic Distortion Analyzer
- 2 — Load resistors, 8 Ohms, 100 Watt (Minimum Rating)
- AM/FM Signal Generator

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.7 kHz Sweep Generator</td>
<td>10.7 kHz Sine Wave Generator</td>
</tr>
<tr>
<td>Multiplexer Generator (preferably with RF output)</td>
<td>FISHER 300</td>
</tr>
<tr>
<td>455 kHz Sweep Generator</td>
<td>Ferrite Test Loop Stick</td>
</tr>
<tr>
<td>Ferrite Test Loop Stick</td>
<td>2 — Full Range Speakers for Listening Tests</td>
</tr>
<tr>
<td>Stereo Source — Turntable, Tape Recorder, etc.</td>
<td>Soldering Iron with Small Tip, Fully Insulated from AC Line</td>
</tr>
<tr>
<td>Suction Desoldering Tool</td>
<td></td>
</tr>
</tbody>
</table>

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 8x80 watt iron reach temperatures of 1,000°F, while others will hardly melt solder. Small-diameter tip should be used for single solder connections, pyramidal and chisel tips for large areas.

Always disconnect the AC power cord from the line when soldering. Turning the power switch OFF is insufficient. Power-line leakage paths, through the heating element of the iron, may destroy transistors.

PARTS REMOVAL: If a part is not being returned for 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 bare-particle short to destroy a transistor (and others direct-coupled to it). In the time it takes for a dropped machine screw, waxer, or screwdriver, to contact a pair of socket terminals (or semiclad and cheek), 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 selecting 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 pilers 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 (open or short), 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 setting 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 twisted 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 VTVM, with no signal input unless otherwise noted. AC signal voltages are measured under the conditions specified on the schematic.

ALIGNMENT PROCEDURE: DO NOT attempt realignment unless the required test equipment is available, and the alignment procedure is thoroughly understood.

BECAUSE ITS PRODUCTS ARE SUBJECT TO CONTINUOUS IMPROVEMENT, FISHER RADIO CORPORATION RESERVES THE RIGHT TO MODIFY ANY DESIGN OR SPECIFICATION WITHOUT NOTICE AND WITHOUT INFRINGING ANY OBLIGATION.
REMOVING MOTORBOARD

To gain access to the chassis for serviceing, remove the motorboard using the following procedure:
1. Disconnect AC power cord.
2. Unsecure the two shipping 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 six screws in the motorboard and lift the motorboard at the front. Unplug the two audio cables and the power plug from the underside of the changer. Remove the four audio plugs and the power plug from the back of the cassettes recorder. Label the recorder’s audio cables with the appropriate INPUT or OUTPUT designation for easy replacement later.
4. Remove the motorboard (with recoder and changer mounted) from the top of the chassis.
5. To reinstall the motorboard, reverse the procedure. Be sure to reconnect the audio cables with the red plugs to the jacks labeled Rights.

REMOVING DRESS PANEL

1. Disconnect AC power cord.
2. Remove motorboard. Refer to REMOVING MOTORBOARD procedure.
3. Remove dress panel. Refer to REMOVING DRESS PANEL procedure.
4. Prop the unit on its back panel. Remove the two screws near the feed which hold the extension chassis to the main chassis.
5. Set the unit on its feet, Lift the extension chassis and pull forward. Swing the extension chassis away from the main chassis at the front to provide access to the tuning drive.
6. Remove the dial pointer from the dial cord.
7. Rotate the tuning capacitor drive drum to its maximum CW position. Loosen the machine screws in the center of the drum and remove the old dial cord.
8. Tie end of new dial cord to one end of dial spring. Fasten to top right ear inside drive drum. See Figure 1.
9. Run the dial cord through slot in rim of drum and in set in bottom of the cutout groves. Guide the dial cord around pulley “A”, across and underneath the tuning shaft. Wrap 2 1/2 turns ICM around from back around the tuning shaft.
10. Guide the dial cord over pulley “B” across the front, around pulley “C”, and back and around pulley “D”. Keep the dial cord taut during this procedure.
11. Rotate the drive drum to its maximum CCW position, allowing the cord to wind onto the drive drum. Keep the dial cord taut during this procedure.
12. Run the dial cord over the top of the drive drum(S inside grooves) and into the rim slot. Bring the cord around the drive drum and place the cord under the bezel washer.
13. With the machine screw loosened, pull the dial cord taut and tighten the screw.
14. Turn the tuning shaft to rotate the drive drum fully CCW and fully CW to distribute the tensioning along the dial cord. Repeat steps 13 and 14 until spring is tensioned.
15. Place the dial cord over and under the tabs on the rear of the dial pointer, and place the pointer on the top of the dial.
16. Turn the tuning shaft fully CCW. Slide the dial pointer to zero (0) calibration marker on the tuning scale while holding tuning shaft fully CCW. Cement dial pointer to dial cord to prevent slippage. Allow cement to thoroughly dry. Check dial calibration. Refer to FM FRONT END ALIGNMENT.
17. Connect extension chassis. Dress audio cables away from tuning drive and turntable.
18. Reinstall the dress panel.
19. Reinstall the motorboard.

REPLACING DIAL LAMPS

1. Disconnect AC power cord.
2. Remove dress panel. Refer to REMOVING DRESS PANEL procedure.
3. Remove the deflector lamp (with its metal shade) from its bayonet base by pressing the lamp in, and rotating 1/8 turn CCW. Slide the metal shade off the lamp. Install the replacement lamp by pressing in, and turning CCW 1/8 turn. Slide the shade onto the lamp and adjust it to direct the light towards the edge of the dial glass.
4. Reinstall the dress panel.

DIAL STRINGING

(1) Disconnect AC power cord.
(2) Remove motorboard. Refer to REMOVING MOTORBOARD procedure.
(3) Remove dress panel. Refer to REMOVING DRESS PANEL procedure.
(4) Prop the unit on its back panel. Remove the two screws near the feed which hold the extension chassis to the main chassis.
(5) Set the unit on its feet. Lift the extension chassis and pull forward. Swing the extension chassis away from the main chassis at the front to provide access to the tuning drive.
(6) Remove the dial pointer from the dial cord.
(7) Rotate the tuning capacitor drive drum to its maximum CW position. Loosen the machine screws in the center of the drum and remove the old dial cord.
(8) Tie end of new dial cord to one end of dial spring. Fasten to top right ear inside drive drum. See Figure 1.
(9) Run the dial cord through slot in rim of drum and in set in bottom of the cutout grooves. Guide the dial cord around pulley “A”, across and underneath the tuning shaft. Wrap 2 1/2 turns ICM around from back around the tuning shaft.
(10) Guide the dial cord over pulley “B” across the front, around pulley “C”, and back and around pulley “D”. Keep the dial cord taut during this procedure.
(11) Rotate the drive drum to its maximum CCW position, allowing the cord to wind onto the drive drum. Keep the dial cord taut during this procedure.

REPLACING STEREO BEACON LAMP

1. Disconnect AC power cord.
2. Remove motorboard. Refer to REMOVING MOTORBOARD procedure.
3. Unscrew the two leads from the terminals on the rear of the STEREO BEACON lamp assembly. WARNING: Damage to the nylon lamp holder assembly may result from excessive heating of the terminals. Use a pair of pliers (as a heat sink) to hold each terminal when soldering or unsoldering leads.
4. Gently pry off the nylon lamp holder assembly. Press the replacement assembly into the mount and resolder the leads removed previously.
5. Reinstall the motorboard.

REPLACING METER LAMP

(1) Disconnect AC power cord.
(2) Remove motorboard. Refer to REMOVING MOTORBOARD procedure.
(3) Remove the two leads from the terminals on the rear of the STEREO BEACON lamp assembly. WARNING: Damage to the meter may result from excessive heating of the meter terminals. Use a pair of pliers (as a heat sink) to hold each terminal when soldering or unsoldering leads.
(4) Gently pull the meter removers away from the rear of the tuning meter and lift out the meter.
(5) Slide the replacement meter behind the removers and fit meter into panel cutout. Resolder the meter leads removed previously.
(6) Reinstall the motorboard.

CLEANING FRONT PANEL

WARNING: Use only plain lukewarm water for moistening a freshly laundered, soft lint-free cloth to clean the front dress panel.

POWER AMPLIFIER CENTER VOLTAGE TEST

Turn VOLUME control to minimum. Depress MAIN SPKRS pushbutton switch.
(1) Connect an 8-ohm load resistor across the LEFT SPKRS MAIN terminals and a 8-ohm load resistor across the RIGHT SPKRS MAIN terminals.
(2) Connect two 10k. 312 resistors in series across capacitor C93 (1500 uF). Connect the common lead of a DC VTVM to the junction of the two resistors.
(3) Connect the probe of the DC VTVM to Test Point BS (junction of RE32 and RE37) on IChannell of dual channel power amplifier module. Meter should read 0 volt (1.5 volt).
(4) Connect the probe of the DC VTVM to Test Point BS2 (junction of RE32 and RE38) on right channel of power amplifier module. Meter should read 0 volt (1.5 volt).
(5) Disconnect the two 10k resistors.
SERVICES PROCEDURE

POWER AMPLIFIER IDLING CURRENT

NOTE: Power amplifier center voltage test should be performed before starting the following procedure.
1. Connect DC VTM across resistor R385 (10.56 ohms) on left channel of power amplifier module. Meter should read between 10 mV and 35 mV.
2. If necessary, adjust R285 (OUTPUT BIAS ADJUST) port on predriver/driver board for reading between 10 mV and 35 mV on DC VTM. Optimized amplifier performance will be achieved with 15 mV setting.
3. Connect DC VTM across resistor R387 on right channel of power amplifier module. Meter should read between 10 mV and 35 mV. If necessary, adjust R292 port on predriver/driver board for reading between 10 mV and 35 mV on DC VTM.

POWER OUTPUT MEASUREMENT

The output amplifier of this unit is designed to deliver its full-rated power with program material (tives) or musk into 8-ohm loads for an indefinite period of time. When a constant audio tone is used as a signal to measure the maximum continuous RMS power output, the following procedures must be taken:
1. Limit the measurement period to 10 minutes with a load resistance of 8 ohms.
2. Use a low noise resistor with a rating of at least 60 watts.
3. WARNING: If the power output of both channels is measured simultaneously, use a load of 8 ohms per channel and limit measurements to a period not longer than 5 minutes.

INTERMODULATION DISTORTION TEST

Set BALANCE, BASS AND TREBLE controls to their center positions. Set SELECTOR switch to AUX. Depress MAIN SPKR's pushbutton switch. Unplug AC power cord.
1. Connect an 8-ohm, 50-watt resistor across the LEFT SPKR MAIN terminals. In parallel with the load resistor, connect the input leads of an IM distortion analyzer and the output leads of an accurately calibrated AC VTM.
2. Connect IM-analyzer generator output to the LEFT AUX IN jack. Set level of IM-analyzer generator for 300 mV output.
3. Connect AC power cord and adjust VOLUME control for 12 watts output (17.8 V RMS across 8-ohm load). AFTER ONE FULL MINUTE OF WARM-UP, PROCEED TO NEXT STEP.
4. IM meter should read 0.8% or less.
5. Repeat preceding steps for right channel.

NOTE: If this procedure differs from those in the IM analyzer manual, it is best to follow the instructions in the manual. If a load resistor of 500k ohms is used instead of the load resistor, a separate load resistor is not required.

SPKR'S MAIN terminals. In parallel with the load resistor, connect the input leads of an IM distortion analyzer and the output leads of an accurately calibrated AC VTM. IM generator output to the LEFT AUX IN jack. Set level of IM-analyzer generator for 300 mV output. Connect AC power cord and adjust VOLUME control for 12 watts output (17.8 V RMS across 8-ohm load). After one full minute of warm-up, proceed to next step.
4. IM meter should read 0.8% or less.
5. Repeat preceding steps for right channel.

NOTE: If this procedure differs from those in the IM analyzer manual, it is best to follow the instructions in the manual. If a load resistor of 500k ohms is used instead of the load resistor, a separate load resistor is not required.

FM FRONT END ALIGNMENT

NOTE: FM alignment must be performed before starting this procedure.
1. Disconnect the jumper lead from Test Point 301 (pin 3N on FM IF, MPX, METER board) and connect vertical input of scope to Test Point 301. Connect ground lead of scope to nearest chassis ground.
2. Connect an 8k resistor across scope input and set scope input for AC. Adjust scope vertical sensitivity to approximately 100 mV/cm.
3. Connect 10.7 MHz sweep generator to Test Point 501 (pin 5N on FM RF board). Connect ground lead of generator to pin 5G. Adjust generator level and sweep to observe IF response curve.
4. Adjust top and bottom cores of 2305, 2304, and 2302 (on FM IF, MPX, METER board) for symmetry and maximum gain.
5. Adjust top and bottom cores of L505 (on FM RF board) for maximum gain and symmetry. Repeat adjustment until maximum gain and symmetry are observed (see Figure 21). Increase generator level to full output (approximately 100,000 V/cm), if necessary, slightly readjust top core of 2305 to center 10.7 MHz marker (see Figure 3). Reconnect the jumper lead to FM Test Point 301 (pin 3N on FM IF, MPX, METER board) removed previously. Disconnect the 8k resistor across scope input connected previously.
6. Reduce generator sweep to zero (seep off). Adjust FM METER ADJ port, R328 (on FM IF, MPX, METER board) for front panel meter reading of 4.5.
7. Connect vertical input of scope to Test Point 304 (on FM IF, MPX, METER board). Use same scope sensitivity settings as above.
8. Adjust generator level and sweep to observe detector "S" curve. Adjust bottom core of 2300 first, then top core for maximum gain and symmetry (see Figure). Connect DC VTM to Test Point 304. Use same scope sensitivity settings as above.
9. Adjust detector core of 2300 for zero (0) reading (maximizin ±2V volt) on DC VTM.

TUNING METER CALIBRATION

NOTE: If the IF IF and DETECTOR ALIGNMENT procedure (including calibration of metering has been completed, omit the following procedure. Use the following procedure to calibrate the tuning meter without IF alignment; i.e., after meter replacement.
1. Set SELECTOR switch to FM. Turn VOLUME control to minimum.
2. Connect an 8-ohm composition resistor in series with each lead from the generator (see Figure 3). Set generator frequency (range frequency) as receiver.
3. Connect generator output to full output (approximately 100,000 V/cm) with audio modulation off.
4. Adjust generator frequency for peak tuning meter reading.
5. Adjust FM METER ADJ port, R328 (on FM IF, MPX, METER board) for tuning meter reading of 4.5.

MULTIPLEX ALIGNMENT

Two methods of aligning the multiplex decoder are given. The preferred procedure uses a multiplex generator with RF and 19 kHz output frequencies, and with 1 kHz modulation, such as the FISHER 300 Multiplex Generator. This is the better method of alignment from front end and IF stages are also checked through the use of this procedure. An alternative procedure for use with multiplex generators not having an RF output is also given.
PREFERRED ALIGNMENT PROCEDURE

NOTE: Check the alignment of the IF amplifier before aligning the multiplex decoder. Poor IF alignment can make proper MPX adjustment impossible.

Set SELECTOR switch to FM, and VOLUME control to minimum.

1. Connect RF output of multiplexer generator to the FM ANTenna terminals. Use a 125-ohm termination resistor in series with each lead from RF output (see Figure 5). Set MPX generator for external modulation with 15 kHz pilot carrier, ±2.5 kHz deviation (100% pilot, no audio). Tune receiver to IF frequency of MPX generator.

2. Connect DC VTM to Test Point 403 (pin 4G on FM IF, MPX, METER board).

3. Adjust cores of Z401 and Z402 (on FM IF, MPX, METER board) for minimum reading on DC VTM (2.5 to 4 VDC).

4. Connect output of audio generator, set for 1 kHz, to the external modulation input of MPX generator and to external sync input of an oscilloscope. Adjust audio generator level for composite signal ±2.5 kHz deviation (100% pilot, 0% audio). Monitor right channel only.

5. Connect AC VTM to Test Point 403 (pin 8G on FM IF, MPX, METER board).

6. Turn R107 SEPARATION CONTROL (on PREAMP/METEER board) CW to maximum resistance setting. Adjust core of Z403 (on FM IF, MPX, METER board) for maximum gain and as straight a baseline as possible on scope (see Figure 7). AC VTM should read minimum.

7. With MPX generator modulated on right channel only, connect AC VTM to Right OUT TO EXT RCDR jack. Record reading on AC VTM.

8. Set MPX generator to modulate left channel only. Adjust R101 SEPARATION CONTROL (on PREAMP/METEER board) for minimum reading on AC VTM; at least 30 dB below reading recorded in step 7. Record reading.

9. Connect AC VTM to Left OUT TO EXT RCDR jack. Same reading ±2 dB as recorded in step 7.

10. Set MPX generator to modulate right channel only. Same reading ±3 dB as recorded in step 8.

NOTE: If equal readings cannot be obtained in steps 8 and 10, reposition Z402 slightly (on FM IF, MPX, METER board) and repeat steps 7 through 10.

ALTERNATE ALIGNMENT PROCEDURE

Set SELECTOR switch to FM, and VOLUME control to minimum.

1. Disconnect the jumper lead going to pin 4A (on FM IF, MPX, METER board) and connect the output of the multiplex generator through a 10k resistor to pin 4A.

2. Connect AC VTM to Test Point 403 (pin 8G on FM IF, MPX, METER board). Connect the vertical input of the scope to pin 4A.

3. Set MPX generator for 1 kHz pilot carrier output only. Adjust pilot level for approximately 120 mV peak-to-peak input at pin 4A.

4. Adjust cores of Z401 and Z402 (on FM IF, MPX, METER board) for maximum reading on DC VTM (2.5 to 4 VDC).

5. Connect output of audio generator, set for 1 kHz, to the external modulation input of MPX generator and to the external sync input of an oscilloscope. Adjust audio generator level for 1.2 volts peak-to-peak composite MPX input (10% pilot, 90% audio). See Figure 8. Monitor right channel only. Proceed with steps 8 and 10 of PREFERRED ALIGNMENT PROCEDURE.

6. Reconnect the jumper lead going to pin 4A (on FM IF, MPX, METER board) removed previously.