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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 wettability of the iron) is important. Some 50-watt iron tips reach temperatures of 1,000°F, if, while others will hardly melt solder. Small-diameter tips should be used for single solder connections, pyramid and chip 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 elements 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, scraps, etc., is an important precaution in avoiding servicing problems. Screws, removed from the chassis during servicing, should be stored in a box until needed. 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 screw, washer, or screwdriver, to contact a pair of terminals (or transistor 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 pair 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 many even destroy the junction 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 shorted), 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, check bias 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. Include this information when ordering replacements.

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 wires, can cause significant power losses. 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 ± 20%. DC voltages are measured to chassis with a VTVM, 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.

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### FM Alignment — Selectors to FM, MODE, TAPE MONITOR to MONO, MUTING OFF, DIPMETER, VOLUME to 0.

<table>
<thead>
<tr>
<th>GENERATOR</th>
<th>DIAL SETTING</th>
<th>INDICATOR</th>
<th>PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IF</td>
<td></td>
<td></td>
<td>Note: FM IF circuits utilize non-linear ceramic filters which establish the IF bandwidth. To ensure symmetrical tuning and selectivity, the IF must be aligned precisely to the center of the IF responses, rather than at 10.7 MHz as in conventional LC circuits.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1. IF Connect 10 MHz sweep to pin P5, grid to FG. Markers are not required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Position of non-interference</td>
<td>Bridge sweep input to pin P5, grid to FG. Use single detector probe. Adjust FM IF GAIN VRES V9, T1 and T2 for max gain and best symmetry. Keep signal line enough for noise on response as shown in FM IF, RESPONSE A.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Increase output for signal just below full-reading.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Position of non-interference</td>
<td>Sweep sweep input to pin P5, grid to FG. Use single detector probe. If necessary readjust T1 and T2 for best symmetry. See FM IF, RESPONSE B.</td>
</tr>
<tr>
<td>DETECTOR</td>
<td></td>
<td></td>
<td>3. DETECTOR 10.7 MHz sweep to P4, grid to FG. Adjust for Sureone display.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Position of non-interference</td>
<td>Position of non-interference: Sweep sweep input to pin P4 through 10K resistor, grid to FG. Adjust T1, T2 and T3 for max gain and best symmetry. See FM DETECTOR RESPONSE. Note: Minimum THD and Maximum Band alignment must be performed as part of Detecor alignment.</td>
</tr>
<tr>
<td>NOTE:</td>
<td>120 ohm composite resistors in series with each lead from IF generator match minimum output to 360 ohm input impedances. Generator output voltage is reduced to one-half at antenna terminals. Signal voltages are generator output levels, not antenna voltages.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GENERATOR</th>
<th>DIAL SETTING</th>
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<th>PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>METER</td>
<td></td>
<td></td>
<td>4. METER Sweep generator is connected in step 2. FM generator to FM ANTENNA terminals through 1200 ohm resistors. Turn modulation off. Slowly increase output and check frequency for marker at center of IF response curve. Turn off sweep and adjust IF generator output for panel meter reading of approx. 3.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Position of non-interference</td>
<td>Front panel meter Adjust T4 and T5 for max deflection. Reduce generator output to keep meter at approx. 3.</td>
</tr>
<tr>
<td>FRODT END</td>
<td></td>
<td>Tuning knobs fully CW.</td>
<td>Center dial pointer at 50 end cement.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. FRODT END</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Center of 90 MHz calibration mark on dial.</td>
<td>Front panel meter Adjust L4, L5, L6, L7 for max deflection. Reduce generator output to keep meter at approx. 3.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Center of 106 MHz calibration mark on dial.</td>
<td>Front panel meter Adjust TDA, TDC, TCD, TCI for max deflection. Reduce generator output to keep meter at approx. 3. Repeat steps 6 and 7 for max gain and signal versus dial calibration readings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6. FM generator to FM ANTENNA terminals. Set to 90 MHz. Adjust output for approx. 3. meter.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7. Set to 106 MHz</td>
</tr>
<tr>
<td>MAX METER</td>
<td></td>
<td>Tuning generator</td>
<td>8. MAX METER Set to position of non-interference close 98 MHz. Set generator for CW output to 2 mV.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Source sweep input to LEFT RCR OUT jack</td>
<td>Reduce T3 pump and output for max output and minimum distortion. Output should be from 0.0 to 1.0 V RMS, distortion should be below 0.1%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tuning generator</td>
<td>9. Set generator for CW output to 2 mV.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Front panel meter</td>
<td>Meter deflection should be between 4 and 5. (No adjustment.) Note: Do not change generator or reduce tuning proceed with THD adjustment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10. MINIMUM THD Modulate with 480 Hz, +75 Vdc detector.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HD Analyzer to LEFT RCR OUT jack</td>
<td>Adjust T3 pump and output for max output and minimum distortion. Output should be from 0.0 to 1.0 V RMS, distortion should be below 0.1%.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GENERATOR</th>
<th>DIAL SETTING</th>
<th>INDICATOR</th>
<th>PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>11. MUTING Position of non-interference near 98 MHz. Modulate with 400 Hz, +225 for 25 Hz deviation. Set output at 2 mV.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tuning generator</td>
<td>Tune to generator AC VTM and scope input to I FROM RCR OUT jack.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Repeat MUTING OFF calibration. Precise meter reading should be between 4 and 6.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reduce generator output until scope signal disappears in suitable time. Generator output will have to be less than 60 V. Increase generator output to 65 V and adjust should disappear. Repeat MUTING OFF adjustment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12. 19 kHz PILOT FM generator with composite modulator signal at EXTERNAL MODULATING input. Modulated with 19 kHz pilot 100%. 400 Hz audio 80%. Left channel only. Set for 42.5 kHz deviation and 2 mV output.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tuning generator</td>
<td>Tune to generator Scope vert AC input to pin P11.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>See MODE, TAPE MONITOR to STEREO. Adjust T6 and T7 for max amplitude.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13. 38 kHz TRAP, STEREO SEACON FM generator with composite modulator signal at EXTERNAL MODULATING input. Modulated with 19 kHz pilot 190%, 400 Hz audio 80%. Left channel only. Set for 42.5 kHz deviation and 2 mV output.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tuning generator</td>
<td>Tune to generator Scope vert input to P12.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Adjust T8 for max amplitude. STEREOPACON lamp should be on.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14. SEPARATION FM generator with composite modulator signal at EXTERNAL MODULATING input. Modulated with 19 kHz pilot 190%, 400 Hz audio 39%. Left channel only. Set for 42.5 kHz deviation and 2 mV output.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tuning generator</td>
<td>Tune to generator AC VTM of LEFT RCR OUT jack, another to RIGHT RCR OUT jack.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reduce T6 for max left channel. Adjust T6 and VR5 IMPX PHASE (UNSYNC) for best separation. Modulator right channel only. If necessary, readjust T8 and VR2 for best separation.</td>
</tr>
</tbody>
</table>

### AM Alignment — Selectors to AM, MODE, TAPE MONITOR to MONO, VOLUME to 0.

<table>
<thead>
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<th>DIAL SETTING</th>
<th>INDICATOR</th>
<th>PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1. IF 458 kHz sweep generator to pin P1, grid to FG. Use 0.1 V drive to prevent distortion. Use 0.1 V drive to prevent distortion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Position of non-interference</td>
<td>Scope to pin P19, grid to FG. Use low capacitor value.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Adjust both T10 and T7 for max gain and best symmetry. Use 0.1 V drive to prevent distortion. Use 0.1 V drive to prevent distortion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. FRONT END AM generator to EX AM ANTENNA terminals. Open GND line. Set to 600 kHz. Modulate with 400 Hz, 30% modulation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Center of 600 kHz calibration mark on dial.</td>
<td>Front panel meter. Adjust L7 and L8 for max deflection. Reduce generator output to keep panel meter at approx. 3.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Set to 1400 kHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Center of 1400 kHz calibration mark on dial.</td>
<td>Front panel meter. Adjust T7, TCS, TCD for max gain. Repeat steps 2 and 3.</td>
</tr>
</tbody>
</table>
**POWER AMP 2291-1**

**CENTER VOLTAGE TEST**

Slide VOLUME control to 0. Warm-up unit about 10 minutes. Set line voltage to 120 VAC.

Connect common lead of DC VTVM to pin 5R (or chassis).

Connect probe to the junction of RB31 – RB33 (left channel) and RB32 – RB34 (right channel). Meter should indicate 18V ± 3V at each junction.

**IDLING CURRENT ADJUSTMENT**

Slide VOLUME control to 0. Warm-up unit about 10 minutes. Set line voltage to 120 VAC.

1. Connect DC VTVM across RB31 and RB33. See illustration. Set IDLING ADJ RB26 for indication of 15 to 35 mV.
2. Connect DC VTVM across RB32 and RB34 and adjust RB26 for 15 to 35 mV indication.
POWER SUPPLY 2245-3, 4

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Part No.</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>C561</td>
<td>Ceramic, 330pF, ± 20%, 1400V</td>
<td>C56040-3</td>
<td>.45</td>
</tr>
<tr>
<td>C951</td>
<td>Ceramic, 330pF, ± 20%, 400VAC</td>
<td>C51164-1</td>
<td>.00</td>
</tr>
<tr>
<td>C952, 963</td>
<td>Ceramic, 0.01µF, ± 20%, 150V</td>
<td>C56044-4</td>
<td>.50</td>
</tr>
<tr>
<td>C564, 955</td>
<td>Ceramic, 0.02µF, ± 20%, 500V</td>
<td>C960587-3</td>
<td>.25</td>
</tr>
<tr>
<td>C956</td>
<td>Electrolytic, 350µF, 50V</td>
<td>C22333-20</td>
<td>.20</td>
</tr>
<tr>
<td>C957, 960</td>
<td>Electrolytic, 100µF, 250V</td>
<td>C22225-20</td>
<td>.00</td>
</tr>
<tr>
<td>C958</td>
<td>Electrolytic, 22µF, 250V</td>
<td>C523534-20</td>
<td>.20</td>
</tr>
<tr>
<td>C999, 961</td>
<td>Ceramic, 0.01µF, ± 20%, 150V</td>
<td>C508570-1</td>
<td>.40</td>
</tr>
<tr>
<td>C9991, 995</td>
<td>Silicon Diode</td>
<td>50851969-1</td>
<td>.75</td>
</tr>
<tr>
<td>C953, 994</td>
<td>Linear Regulator 12V, 5A, 1W</td>
<td>TR14002-6</td>
<td>1.05</td>
</tr>
<tr>
<td>F851</td>
<td>Fuse, Slow-Blow, 5A, 125V</td>
<td>FL81313-10</td>
<td>.70</td>
</tr>
<tr>
<td>L851</td>
<td>Inductor, 5µH</td>
<td>LC21818-1</td>
<td>.50</td>
</tr>
<tr>
<td>Q901</td>
<td>Transistor</td>
<td>TR91053-1</td>
<td>1.45</td>
</tr>
<tr>
<td>Q902</td>
<td>Transistor</td>
<td>TR91053-1</td>
<td>2.75</td>
</tr>
<tr>
<td>R501</td>
<td>Composition, 820k, 10%, 1/2W</td>
<td>RC2006F284K</td>
<td>.10</td>
</tr>
<tr>
<td>R952</td>
<td>Wirewound, 6.8k, 5%, 2W</td>
<td>RW2006F48J</td>
<td>.02</td>
</tr>
<tr>
<td>R954, 967</td>
<td>Wirewound, 220k, 5%, 2W</td>
<td>RW2006F22JS</td>
<td>.20</td>
</tr>
<tr>
<td>R955, 968</td>
<td>Composition, 100k, 5%, 1/2W</td>
<td>RC2006F103J</td>
<td>.20</td>
</tr>
<tr>
<td>R960, 961</td>
<td>Film, 3300pF, 1/2W</td>
<td>RC2006F122J</td>
<td>.30</td>
</tr>
<tr>
<td>R963</td>
<td>Composition, 12k, 5%, 1/2W</td>
<td>RC2006F122J</td>
<td>.30</td>
</tr>
<tr>
<td>R964</td>
<td>Wirewound, 270k, 5%, 2W</td>
<td>RW2006F271J</td>
<td>.55</td>
</tr>
<tr>
<td>R966</td>
<td>Composition, 100k, 5%, 2W</td>
<td>RC2006F103J</td>
<td>.30</td>
</tr>
</tbody>
</table>

**MISCELLANEOUS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Part No.</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>Fuse, Slow-Blow, 1.5A, 125V</td>
<td>FL81313-20</td>
<td>.65</td>
</tr>
<tr>
<td>*F1</td>
<td>Fuse, Slow-Blow, 800mA, 250V</td>
<td>FS19247-13</td>
<td>.60</td>
</tr>
<tr>
<td>*F1</td>
<td>Fuse, Slow-Blow, 1.5A, 120V</td>
<td>FS19247-17</td>
<td>.60</td>
</tr>
<tr>
<td>S1</td>
<td>Switch, Power On</td>
<td>PS20220-03-1</td>
<td>4.70</td>
</tr>
<tr>
<td>*Switch, Voltage Selector</td>
<td>SR51236-1</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>*AC Outlet</td>
<td>J20266S</td>
<td>.25</td>
<td></td>
</tr>
<tr>
<td>*Connector, twisted, 5-terminal</td>
<td>J00875-4</td>
<td>.48</td>
<td></td>
</tr>
<tr>
<td>*Fuse-holder</td>
<td>X519800</td>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>*Line Cord</td>
<td>WS0222-1</td>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>Transformer, Power</td>
<td>TD487175-1</td>
<td>1.80</td>
<td></td>
</tr>
<tr>
<td>*Transformer, Power</td>
<td>TE48715-1</td>
<td>14.45</td>
<td></td>
</tr>
</tbody>
</table>

*Used in FE2245-4 only*
NOTES:
1. LINE VOLTAGE SET TO 120VAC FOR ALL DC VOLTAGE MEASUREMENTS.
2. EXCEPT AS NOTED, ALL VOLTAGES ZERO.
3. DC VOLTAGES MEASURED WITH DC VTM TO CHASSIS WITH NO INPUT SIGNALS.
4. WORD NOT USED IN ALL UNITS.