4.1 PREPARATION FOR SERVICING

4.1.1 General

Included in this section are signal tracing procedures, alignment and adjustment procedures, voltage and resistance measurements, and replacement procedures. If any soldered parts are removed or replaced at terminals to which any diode or transistor is connected, be sure to attach an alligator clip to the diode or transistor lead. This clip acts as a heat sink to protect the diode or transistor.

Internally generated spurious signals may result from improper placement of certain components and rf leads in the hf oscillator, 17.5-MHz oscillator, and mixer compartments. Maintain proper lead dress and component placement when probing in these compartments. Except for the vfo alignment (paragraph 4.4.14), it is recommended that servicing of the vfo should be performed only by authorized service agencies.

4.1.2 Chassis Removal From Cabinet

a. Disconnect the power plug and all connections to the rear panel jacks.

b. Lift the lid, and remove the two flat screws located at the front edge of the cabinet. (Do not remove the two outer screws.)

c. Remove the four mounting feet and the screw between the rear feet from the bottom of the receiver. (On the 51S-1B, remove the five screws from the bottom of the receiver.)

<table>
<thead>
<tr>
<th>TEST POINT</th>
<th>TEST POINT FREQUENCY</th>
<th>SIGNAL LEVEL</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>J8</td>
<td>1000 Hz</td>
<td>0.22 volt</td>
<td>1-watt af output</td>
</tr>
<tr>
<td>V12-1</td>
<td>1000 Hz</td>
<td>6.0 volts</td>
<td>1-watt af output</td>
</tr>
<tr>
<td>V14-2</td>
<td>1000 Hz</td>
<td>0.2 volt</td>
<td>1-watt af output</td>
</tr>
<tr>
<td>V13-1</td>
<td>1000 Hz</td>
<td>0.45 volt</td>
<td>10 milliwatts in 600 ohms</td>
</tr>
<tr>
<td>V14-7</td>
<td>1000 Hz</td>
<td>0.18 volt</td>
<td>10 milliwatts in 600 ohms</td>
</tr>
</tbody>
</table>

Above measurements with ac vtvm from test point to ground, and audio oscillator connected at test point.

<table>
<thead>
<tr>
<th>TEST POINT</th>
<th>TEST POINT FREQUENCY</th>
<th>SIGNAL LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>V8-1</td>
<td>500 kHz</td>
<td>35,000 microvolts</td>
</tr>
<tr>
<td>V7-1</td>
<td>500 kHz</td>
<td>5000 microvolts</td>
</tr>
<tr>
<td>V6-2</td>
<td>500 kHz</td>
<td>15,000 microvolts</td>
</tr>
<tr>
<td>V5-1</td>
<td>500 kHz</td>
<td>450 microvolts</td>
</tr>
<tr>
<td>V4-2</td>
<td>*2.9 MHz</td>
<td>200 microvolts</td>
</tr>
<tr>
<td>V2-9</td>
<td>*6.1 MHz</td>
<td>30 microvolts</td>
</tr>
<tr>
<td>V2-9</td>
<td>**14.1 MHz</td>
<td>100 microvolts</td>
</tr>
<tr>
<td>V3-9</td>
<td>*14.6 MHz</td>
<td>100 microvolts</td>
</tr>
</tbody>
</table>

For following measurements, signal generator and 51S-1 must be tuned to same frequency.

<table>
<thead>
<tr>
<th>TEST POINT</th>
<th>TEST POINT FREQUENCY</th>
<th>SIGNAL LEVEL</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1-1</td>
<td>14.1 MHz</td>
<td>4.0 microvolts</td>
<td>Agc threshold</td>
</tr>
<tr>
<td>V1-1</td>
<td>6.1 MHz</td>
<td>1.5 microvolts</td>
<td>Agc threshold</td>
</tr>
<tr>
<td>J1</td>
<td>14.1 MHz</td>
<td>1.5 microvolts</td>
<td>Agc threshold</td>
</tr>
<tr>
<td>J1</td>
<td>6.1 MHz</td>
<td>0.5 microvolts</td>
<td>Agc threshold</td>
</tr>
</tbody>
</table>

*Radio tuned to 6.1 MHz
**Radio tuned to 14.1 MHz
d. From the rear, push the receiver chassis forward until the front panel protrudes from the cabinet about an inch.

e. Grasp the front panel at the edges, and slide the chassis out of the cabinet.

4.1.3 Chassis Removal From Rack Mount

a. Disconnect the power plug and all connections to the rear panel jacks.

b. Remove the two inner screws located on the top bracket immediately behind the mounting panel.

c. Remove the five screws that secure the chassis to the shelf of the rack mount.

d. Push the receiver chassis forward until the front panel protrudes about one inch beyond the style frame.

e. Grasp the front panel at the edges, and slide the chassis out of the rack mount.

4.2 RECEIVER SIGNAL TRACING

Table 4-1 lists significant test points and normal signal levels. All rf and if. measurements up to V8-1 are made on USB as follows: A signal generator with calibrated output attenuator is connected at the listed test point. A vacuum-tube voltmeter is connected to the age bus. Signal generator output is increased until the reading on the vtmv just starts to increase (age threshold). The level indicated on the output attenuator at this point is the signal level listed in the table. The signal generator is tuned to the frequencies listed in TEST POINT FREQUENCY column. Signal voltage at V7-1 and all following are measured with age threshold as reference level. Local audio signal levels are measured with 1-watt audio output as reference. Line audio signal levels are measured with 10 milliwatts into a 600-ohm balanced line terminated with a 500-ohm balanced load. All values are nominal and may vary ±20 percent.

4.3 VOLTAGE AND RESISTANCE MEASUREMENTS

4.3.1 Vacuum Tube Measurements

Table 4-2 lists voltage and resistance measurements for all tube sockets of the 51S-1 except those of vfo tube V15. Do not open the vfo oscillator can. Ac voltages shown in table 4-2 apply to 51S-1/1F/1B. These are the voltages for 51S-1A/1AF. Measurements are made under the following conditions:

a. All measurements are made with a vtmv and with all tubes in sockets. All measurements are made with RF GAIN at maximum

<table>
<thead>
<tr>
<th>TUBE</th>
<th>PIN NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>V1</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>11megohm</td>
</tr>
<tr>
<td>V2</td>
<td>164</td>
</tr>
<tr>
<td></td>
<td>8500</td>
</tr>
<tr>
<td>V3</td>
<td>160</td>
</tr>
<tr>
<td></td>
<td>8500</td>
</tr>
<tr>
<td>V4</td>
<td>-1.2</td>
</tr>
<tr>
<td></td>
<td>250k</td>
</tr>
<tr>
<td>V5</td>
<td>-1.2</td>
</tr>
<tr>
<td></td>
<td>500k</td>
</tr>
<tr>
<td>TUBE</td>
<td>PIN NUMBER</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>V6</td>
<td>167</td>
</tr>
<tr>
<td></td>
<td>8500</td>
</tr>
<tr>
<td>V7</td>
<td>-1.2</td>
</tr>
<tr>
<td></td>
<td>390K</td>
</tr>
<tr>
<td>V8</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>900K</td>
</tr>
<tr>
<td>V9</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>100K</td>
</tr>
<tr>
<td>V10</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>8500</td>
</tr>
<tr>
<td>V11</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>V12</td>
<td>-12.3</td>
</tr>
<tr>
<td></td>
<td>240K</td>
</tr>
<tr>
<td>V13</td>
<td>-8.2</td>
</tr>
<tr>
<td></td>
<td>47K</td>
</tr>
<tr>
<td>V14</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>100K</td>
</tr>
<tr>
<td>V15</td>
<td>Dc volt</td>
</tr>
<tr>
<td></td>
<td>Ohms</td>
</tr>
<tr>
<td>V16</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>8500</td>
</tr>
<tr>
<td>V17</td>
<td>-2.3</td>
</tr>
</tbody>
</table>

* Oscillator injection voltage measured with vtm and rf probe.
May vary from band to band.
** With Q-multiplier turned off.
section 4
service instructions

(fully clockwise) setting. All voltage measurements are made with power applied and OFF-STBY-ON-CAL in ON position except for measurements of calibration oscillator V16B. Voltage measurements of V17, bfo, are made with EMISSION switch in USB, LSB, or CW position.

b. Resistances of less than 0.9 ohm are listed as zero. All resistance measurements are made with power plug P10 removed from J10, and EMISSION switch in USB position.

c. All measurements are made from tube socket pin to ground.

d. All measurements are nominal and may vary ±10%.

4.3.2 Transistor Measurements

Make dc voltage measurements for transistor Q1 with a vttm. Apply primary power to the receiver and set OFF-STBY-ON-CAL switch to ON. Operating voltages for Q1 should be as follows:

- Emitter to ground, +1.95 volts dc.
- Base to ground, +2.05 volts dc.
- Collector to ground, +16.5 volts dc.

All measurements are nominal and may vary by ±10 percent.

4.4 ALIGNMENT

Refer to figures 4-1 and 4-2 for adjustment points. For alignment of T9, T11, T12, T13, T1, T2, T3, T14, T15, T7, use Walsco #2543 or General Cement #8282 alignment tool.

4.4.1 100-kHz Calibrator Adjustment

- Tune in Radio Station WWV or WWVH on a convenient frequency, 2.5, 5, 10, 15, 20, or 25 MHz.

- Move the EMISSION switch to AM position.
c. Move the OFF-STBY-ON-CAL switch to CAL position.

d. Adjust C227, CAL ZERO, capacitor near the rear of the chassis to zero beat.

**Note**

Be careful not to zero beat one of the tone sidebands. Wait for the tone modulation of WWV or WWVH to go off before zeroing the calibrator.

### 4.4.2 RF Meter Zeroing

a. Set RF GAIN control, located on the front panel, to maximum (fully clockwise).

b. Move the meter switch to RF position.

c. Tune the 51S-1 to a clear, noise-free frequency and adjust R37, METER ZERO, to obtain an indication of 0 on the rf meter.
4.4.3 IF Alignment

a. Connect a signal generator to the standoff side of R20 (the 33-ohm resistor that connects to pin 2 of V4).

b. Set the 51S-1 EMISSION switch to LSB.

c. Tune the signal generator around 500 kHz to zero beat in the 51S-1. Make sure that the 51S-1 vfo is tuned to a frequency which does not produce spurious signals in the output of the 51S-1.

**Note**

If receiver is equipped with optional 6-kHz mechanical filter in place of 5-kHz AM/if transformer, skip the adjustment of T14 and T15 in step d, and skip steps f and g entirely.

d. Set the EMISSION SWITCH TO AM. Peak transformers T1, T2, T7, T14, and T15 for maximum indication on the 51S-1 rf meter, adjusting the signal generator output for a consistent 20-db reading (as monitored on the 51S-1 rf meter).

e. Turn on the signal generator modulation, and peak T3 for maximum audio output. Turn off modulation.

f. Place swamping tools, composed of a 0.01-uf capacitor in series with a 1000-ohm resistor, across terminals 1 and 2 of transformers T14 and T15 (see figure 4-3 for terminal identification). Tune the top slugs of T14 and T15 for maximum reading on the 51S-1 rf meter, again varying the signal generator output level for a consistent 20-db reading.

g. Move the swamping tools to terminals 3 and 4 of transformers T14 and T15. Tune the bottom slugs of T14 and T15 for maximum reading on the 51S-1 rf meter, again varying the signal generator output level for a consistent 20-db reading. Remove the swamping tools.

h. Set the 51S-1 EMISSION switch to USB and adjust the signal generator frequency to 502.500 kHz. A note of 2500 Hz should be heard at the 51S-1 output.

i. Connect a swamping tool, identical to that used above, across terminals 1 and 2 (primary) of T1.

**Note**

Keep the signal generator output level below that required for age threshold during T1 and T2 tune up.

j. Peak the top slug of T1 (secondary) for maximum audio output. Move swamping tool to terminals 1 and 2 (primary) of T2 and repeat tuning procedure. Remove swamping tool.

k. Set 51S-1 EMISSION switch to LSB and adjust the signal generator frequency to 497.500 kHz. A note of 2500 Hz should be heard at the 51S-1 output.

l. Connect a swamping tool, identical to that used above, across terminals 3 and 4 of transformer T1. Peak the bottom slug of T1 for maximum audio output.

m. Move swamping tool to terminals 3 and 4 of T2 and repeat the tuning procedure (step l). Remove swamping tool.

n. Tune signal generator for a 1500-Hz beat note. Adjust trimmers C258 and C261 for maximum meter indication.

o. Repeat the above step (step n) with the 51S-1 EMISSION switch in the USB position,
except adjust trimmers C257 and C260 instead of C258 and C261.

p. Set the 51S-1 EMISSION switch to CW and tune signal generator for a peak in rf meter reading. Adjust C256 and C259 for maximum 51S-1 rf meter indication.

4.4.4 3- to 2-MHz Variable IF. Alignment

When adjusting C113, an insulated or non-metallic screwdriver should be used to prevent the shorting to ground of the +150 volts present on the capacitor adjustment shaft.

a. Set the MEGACYCLES control of the 51S-1 to 4 MHz and the EMISSION switch to AM.

b. Connect a signal generator to pin 9 of V3.

c. Tune the 51S-1 to 4.9 MHz.

d. Tune the signal generator to 2.1 MHz, the 51S-1 variable if. frequency.

e. Set C113, C117, and C120 to half capacity. See figure 4-4.

f. Adjust L102, L103, and L104 for an indication of maximum on the rf meter. The meter switch should be in the RF position during this operation. Keep the signal generator output level adjusted to obtain an indication of 20 db.

g. Tune the 51S-1 to 4.1 MHz and the signal generator to 2.9 MHz.

h. Adjust C113, C117, and C120 for an indication of maximum on the rf meter of the 51S-1. Maintain an indication of 20 db on the rf meter by adjusting the signal generator output level.

i. Repeat steps c, d, f, g, and h until no increase in rf meter reading can be obtained at either the 4.1- or 4.9-MHz setting.

4.4.5 14.5- to 15.5-MHz Bandpass Alignment

a. Connect a signal generator to pin 9 of V2.

b. Set the frequency of the signal generator to exactly 15 MHz.

c. Tune in the signal on the 51S-1 by setting the tuning dial to 4.5 MHz.

d. Connect a swamping tool, consisting of a 0.01-uf capacitor in series with a 1000-ohm resistor, across each of the primary windings of T12 and T13.

e. Adjust the top slugs, which are associated with the secondary windings, of T12 and T13 for an indication of maximum on the rf meter of the 51S-1. Keep the signal generator output level adjusted for an indication of 20 db on the rf meter.

f. Remove the swamping tools from the primary windings, and place one across each of the secondary windings of T12 and T13.

g. Adjust the bottom slugs, which are associated with the primary windings, of T12 and T13 for an indication of maximum on the rf meter of the 51S-1. Keep the signal generator output level adjusted for an indication of 20 db on the rf meter.

4.4.6 RF Alignment

a. Remove the turret shield on the bottom of the 51S-1.

b. Turn the MEGACYCLES control to 29- to 30-MHz range, and tune the 51S-1 to 29.000 MHz. Move the EMISSION switch to AM position.

c. Set the main tuning slugs, L32, L68, and L72, to 0.794 m (5/16 inch) less than full insertion into the coils as measured from bottom of coil forms.

d. Set the main trimmer capacitors, C40, C71, and C74, to 1/2 capacity. See figures 4-1 and 4-4.

e. Connect a signal generator to ANT, J1, on the rear of the 51S-1. Connect a vttm to the 600Ω UNBAL jack, J11, on rear apron.

f. With the signal generator modulation turned on, tune the signal generator until a 29-MHz signal is heard on the 51S-1.

Note

Throughout rf alignment, keep the output level of the signal generator adjusted to the minimum level that will produce a discernible audio signal at the output of the 51S-1; this level must be below age threshold as indicated by zero reading on rf meter.
g. Insert the tuning tool through the slots in the turret side shield, and tune the slugs of the appropriate turret-mounted coils for maximum 51S-1 audio output.

h. Tune the 51S-1 and the signal generator to 29.9 MHz, and tune the main rf trimmer capacitors, C40, C71, and C74, for maximum 51S-1 audio output on vtvm.

i. Tune the 51S-1 and the signal generator to 29 MHz on the 29- to 30-MHz band, and repeat step g above.

j. Move the MEGACYCLES control of the 51S-1 to the 2.0- to 3.0-MHz band, and tune to 2.0 MHz.

k. Tune the signal generator so as to receive a 2.0-MHz signal on the 51S-1.

l. Place swamping tool across first rf tuned circuit to ground. Adjust 2.0-MHz turret coils L39 and L74 for maximum audio output from the 51S-1.

m. Remove swamping tool and place across second rf tuned circuit to ground. Adjust L2 for maximum audio output from the 51S-1.

n. Tune the 51S-1 and signal generator to 2.9 MHz and adjust slug in L32 for maximum output from the 51S-1.

o. Remove swamping tool and place across first tuned circuit to ground. Adjust slugs in L68 and L72 for maximum output on the 51S-1.

p. Recheck 2.0 MHz and touch up alignment if necessary. The swamping tool must be used on the opposite front end rf stage from the one that is being tuned.

q. All the other bands are aligned by peaking the appropriate turret coil slugs at the low frequency end of the band. The 3.0-, 4.0-, and 5.0-MHz coils must be tuned using the swamping tool. The swamping tool is not needed on the 6- to 29-MHz bands.

r. Repeat for all bands up to and including 29 MHz.

4.4.7 Megahertz Oscillator Alignment

a. Connect the rf probe of a vtvm to pin 8 of V2, and ground the vtvm to the chassis of the 51S-1.

b. Set the MEGACYCLES control of the 51S-1 to the 6- to 7-MHz band.

c. Tune the slug of T9 for maximum rf voltage as indicated on the vtvm. The slug of T9 is the slug farther from the chassis in the T9-T10 assembly.

d. Set the MEGACYCLES control of the 51S-1 to the 14- to 15-MHz band.
e. Tune the slug of T10 for maximum rf voltage as indicated on the vtm. The slug of T10 is the slug closer to the chassis in the T9-T10 assembly.

f. Set the MEGACYCLES control of the 51S-1 to the 29- to 30-MHz band.

g. Tune trimmer C246 for maximum rf voltage as indicated on the vtm.

h. Repeat steps b through g above.

4.4.8 17.5-MHz Oscillator Alignment

a. Connect a vtm with rf probe to pin 8 of V3.

b. Set the MEGACYCLES control of the 51S-1 to the 4.0- to 5.0-MHz band.

c. Adjust T11 for 1.5 volts indicated on the vtm.

d. Loosely couple a carefully calibrated receiver to the shield of V3.

e. Tune the calibrated receiver to 17.5 MHz, and turn on the 100-kHz calibration oscillator of the calibrated receiver.

f. Adjust C233 of the 51S-1 for zero beat as indicated on the calibrated receiver.

4.4.9 LF Oscillator Alignment

a. Set the MEGACYCLES selector on the 51S-1 to the 1.0- to 2.0-MHz band.

b. Connect a vtm probe to pin 8 of V10.

c. Tune the slug of T16 for maximum rf voltage.

d. Couple a pickup loop around V10 and connect to a calibrated receiver.

e. Tune the calibrated receiver to 28.0 MHz and turn on the calibration oscillator of the calibrated receiver.

f. Adjust C2 of the 51S-1 for a zero beat in the calibrated receiver.

4.4.10 Megahertz Injection Frequency Adjustment

**Note**

Be sure the 51S-1 vfo is aligned properly before attempting to adjust the megahertz injection frequency. See paragraph 4.4.13 for vfo alignment.

a. Set the MEGACYCLES control of the 51S-1 to the 2.0- to 3.0-MHz band.

b. Couple a pickup loop around V15. Connect the pickup loop leads to a carefully calibrated receiver.

c. Tune the calibrated receiver to 3.5 MHz. Switch on the 100-kHz crystal calibrator of the calibrated receiver. With the tuning knob on the front of the 51S-1, tune for zero beat between the vfo of the 51S-1 and the crystal calibrator of the calibrated receiver. (The 51S-1 dial will be very near the low end of the band.)

d. Set the hairline of the 51S-1 to read zero on the kilohertz scale.

e. Turn off the calibrated receiver.

f. Move the OFF-STBY-ON-CAL switch of the 51S-1 to CAL position.

g. Set the EMISSION switch of the 51S-1 to USB position.

h. Insert the tuning tool through the slot in the turret side shield, and tune the appropriate turret-mounted, trimmer capacitor for zero beat as heard on the 51S-1.

i. Move the MEGACYCLES switch to the next higher band.

**Note**

Be careful not to disturb the tuning knob which was set in steps b, e, and d above.
j. Repeat steps h and i above until all bands above 2.0 MHz are aligned.

### 4.4.11 Receiver Gain Adjustment

a. Connect a signal generator to J1, ANT, on the rear of the 51S-1 as shown in figure 4.5.

b. Tune the signal generator and 51S-1 to 14.5 MHz.

c. Set the EMISSION switch on the 51S-1 to LSB position.

d. Set the RF GAIN control of the 51S-1 fully clockwise.

e. Set the output level of the signal generator to 15 microvolts (1.5 microvolts at the junction of resistors R1 and R2 of test setup). Adjust receiver tuning for a beat note of approximately 1000 Hz.

f. Connect a dc vtm to the agc line of the 51S-1.

g. Adjust R25, RCVR GAIN, to the setting where the voltmeter indication starts to increase from a steady reading. This is the agc threshold.

h. Repeat paragraph 4.4.2.

### 4.4.12 RF Meter Calibration

a. Perform the alignment procedure of paragraph 4.4.11.

b. Tune the signal generator and 51S-1 to 14.5 MHz. Set signal generator output to 1000 microvolts (100 microvolts at the junction of R1 and R2 of test setup).

c. Set the meter switch of the 51S-1 in the RF position.

d. Adjust R38, METER SENS, to obtain 40 db indicated on the rf meter of the 51S-1.

### 4.4.13 Q-Multiplier Alignment

a. Tune the OFF-STBY-ON-CAL switch to CAL position.

b. Set the EMISSION switch to USB position.

c. Tune to zero beat with the calibrator signal at 6.5 MHz.

---

![Diagram](image)

**Figure 4-5. Receiver Gain Adjustment Test Setup**
d. Set the EMISSION switch to AM position.

e. Turn the REJECTION TUNING on the front of the 51S-1 to the center calibration mark.

f. Set the meter switch to RF position.

g. Adjust L108 and R34 to obtain the lowest reading on the rf meter.

4.4.14 VFO Alignment

Vfo aging may cause a tuning dial calibration error of the same amount in the same direction for both 0 and 1000. To adjust for this condition, proceed as follows:

a. Set the hairline to zero with the ZERO SET knob.

b. Turn the EMISSION switch to LSB.

c. Turn the OFF-ON-STBY-CAL switch to CAL.

d. Set the receiver dial frequency at 7.200 MHz.

e. Locate the vfo shaft collar (just forward of L502). Loosen the pair of setscrews nearest the gear plate on the vfo shaft collar.

f. Align the 0 on the kHz dial with the hairline and lock the tuning control.

g. Manually twist the vfo shaft and collar until a zero beat is heard.

h. Tighten the setscrews. If the setscrews are no longer accessible, mark the collar and the tuning control shaft and move both together until each setscrew is accessible.

i. Check calibration at 0 and 1000.

If the tuning dial does not calibrate at 0 and 1000 ±0.750 kHz without resetting the hairline, the error usually can be compensated with trimmer inductor L502. Proceed as follows:

a. Make sure the 51S-1 calibration oscillator has been aligned to Station WWV or WWVH.

Tune the calibrate signal to zero beat at 1000 on the dial.

b. Set the hairline to zero with the ZERO SET knob.

c. Tune the 51S-1 to zero beat at the low end of the band (near 0 on the dial).

d. Note the dial error in kilohertz.

e. Multiply the dial error frequency noted in step d above by 1.5. Add the dial error to 1.5 times the dial error, and move the dial this compensating amount (passing through zero). For example, if the dial reading noted in step d is 1.0 kHz, 1.0 kHz plus 1.5 kHz equals 2.5 kHz. The dial reading 2.5 kHz lower is 98.5. Conversely, if the step d reading is 99, the compensation point is 2.5 kHz higher, or 001.5.

f. Leave the cial set as above, and adjust inductor L502 to zero beat with the calibration signal.

g. Repeat steps a through f until no error is present at end points.

4.5 MEGACYCLES DRIVE CHAIN REPLACEMENT

Refer to figures 4-6 and 6-6. Figure 4-6 shows the MEGACYCLES dial drive chain properly strung over MEGACYCLES band-switch drive sprocket, idlers, and counter dial drive sprocket. Figure 6-6 shows an exploded view of the complete mechanical band-switching and tuning mechanism.

a. Remove 51S-1 from cabinet. Turn 51S-1 on its side, and remove bottom shield plate from turret. Using a flashlight, locate the turret wafer printed circuit pad having a single round nib. Turn the MEGACYCLES control until this single-nibbed pad of each wafer is connected to the fixed turret contacts. This places the receiver in the 2.0- to 3.0-MHz position.

b. Remove the large tuning knob, the MEGACYCLES knob, and the ZERO SET knob from
their shafts. Remove the two small screws on either side of the tuning shaft. Loosen the coupling on the EMISSION switch shaft behind the detent plate and the first wafer. Remove the screw which secures the front gear plate to the panel, leaving the spacer fastened to the panel as shown in figure 4-6. At the front edge of each chassis side apron, remove the two screws which secure the front panel brackets to the side aprons. Remove the screw that secures the cable protecting rail to the front panel bottom bracket, and swing the rail aside. Move the panel out and down, taking care not to break any of the wiring between the back of the panel and the chassis. Remove zero set crank bar for easy access to the bead chain drive.

c. Remove the old bead chain. Remove the two screws holding the band-switch detent.

d. Thread the new chain over the MEGACYCLES drive sprocket and replace band-switch detent screws.

e. Press the idler bar downward, and thread the chain over the two idlers and under the counter drive sprocket. Release pressure on the idler bar. Idler bar should be horizontal after installation.

f. If the first two counter dials do not read 02., press the idler bar downward with one hand, and turn the counter dials manually with the other hand until the dials read 02. in the windows. Release pressure on the idler bar.

g. Replace panel, screws, knobs, and dust covers.
If dial drive is removed, the antibacklash gear becomes unloaded. To preload, hold dial, and rotate front half of gear clockwise before meshing with drive pinion. Check to make sure EMISSION switch shaft grounding spring is under tension before tightening shaft coupler.

4.6 TURRET WAFER REPLACEMENT

If it is necessary to remove and replace turret wafers, refer to figure 6-6, and proceed as follows:

a. Set MEGACYCLES control to 2 MHz. Remove the 51S-1 from its case, and stand the chassis on its side.

b. Remove the turret bottom shield. Loosen the coupler clamp at the front end of the plastic turret shaft. This is the clamp farthest from the front panel. Do not loosen the clamp nearest the panel, or complete mechanical realignment will be necessary. This clamp is aligned at the factory.

c. Grasp the shaft end near the coupler and push gently toward the rear. The shaft and its rear bearing should slide easily.

Caution

Take care that the shaft does not bind in any one of the turret wafers. Proceed carefully to move the shaft to the rear. Gently loosen any wafer which appears to be binding.

d. Remove the defective wafer by withdrawing it straight out from the chassis.

e. Grasp the replacement wafer edgewise with the thumb and forefinger placed across the wafer diameter, and insert it into the wafer guides. Be careful not to bind or twist the fixed turret contacts. Leave the wafer aligned so that its single-nibbed contact pad is in a row with those of the other turret wafers.

Caution

Do not touch the contact pads with the bare finger tips. Acids and oils normally present on the fingers will cause intermittent operation of the wafer pads and the turret contacts. Wear clean rubber gloves, or handle as described in step e. If such an intermittent occurs, clean wafer with mild soap and warm water. Wipe dry with clean, lint-free cloth and replace.

f. When the wafer or wafers have been replaced and coarsely aligned as to turret position, insert the shaft from the rear, and start it through the rear wafer. As the shaft is brought to the wafer each time, twist the shaft enough to align it with the wafer hole and move it through. Use caution not to place undue stresses on the wafers or their guides.

g. As the shaft proceeds through the turret wafers and the coupler end approaches the coupler, the bearing on the rear end of the shaft will be entering the rear chassis bearing. At this time, grasp the shaft bearing with the fingers of the right hand, and keep the wafers free as necessary with the left hand. Guide the end of the shaft into the coupler with the left hand. Turn the shaft slightly back and forth as necessary with the right hand until the key in the coupler aligns with the keyway in the shaft. Push together until the shaft bearing enters the rear chassis bearing. While pressing the shaft bearing with the fingers of the right hand, rock the MEGACYCLES control with the left hand until the shaft bearing is flush with the rear chassis bearing. Tighten the clamp on the shaft coupler.

h. If two or more of the turret wafers are replaced at the same time, make sure all wafers are placed in the turret in proper order. Refer to figure 6-6. If new or repaired wafers are replaced in the turret, realign according to instructions of paragraph 4.4.6, 4.4.7, or 4.4.9.

Note

Wafers A2, A5, and A6 are identical in appearance as are A1, A4, and A7. However all turret wafers must be replaced in the exact position from which they were removed or complete realignment will be necessary. During removal, mark each wafer with pencil or tape, using care to keep all such foreign material off the circuit printing.

i. Replace the turret bottom shield, and replace the 51S-1 in its cabinet.
4.7 LAMP REPLACEMENT

Dial lamp DS1 is removed from the light reflector by grasping the lamp base at the terminal end and pulling straight out. Slight movement of the lamp holder toward the rear of the unit may be required to clear the retaining screw.

DS2 (meter lamp) is a built-in part of M1. Remove by grasping the lamp holder and pulling straight out until it snaps free.
5.1 51S-1/1A/1F/1AF/1B RECEIVER

The 51S-1/1A/1F/1AF/1B Receiver receives USB, LSB, AM, and CW signals in the range of 0.2 to 30.0 MHz. Coverage is continuous in thirty 1-megahertz bands. The model 51S-1 is mounted in a perforated wrap-around cabinet and equipped with an ac power supply capable of 115- or 230-volt, single-phase, 50- to 400-Hz operation. The 51S-1A is similar, except that it is fitted with a 28-volt dc transistorized power supply. The rack-mounted ac version is model 51S-1F (figure 5-1). The rack-mounted dc version is model 51S-1AF. The 51S-1B (figure 5-2) is similar to the 51S-1, but it has a rear-mounted junction box that provides military-type connectors for power, control, audio, and antenna lines (refer to figure 7-4 for schematic diagram).

5.2 REQUIREMENTS FOR OPERATION

The 51S-1 and 51S-1F Receivers require 115- or 230-volt, single-phase, 50- to 400-Hz power at approximately 125 watts. The 51S-1B requires 115-volt, single-phase, 50- to 400-Hz power at approximately 125 watts. The 51S-1A/1AF Receiver requires 28 volts dc at 4.5 amperes. The 51S-1/1A Receiver may be mounted on table or bench for fixed station operation, or may be mounted with a mounting plate similar to the 351E-4 on shelf, bench, or table in moving aircraft, ground vehicle, or boat. 51S-1/1F/1A/1AF Receivers require a 4- or 600-ohm speaker or headphones for local audio monitoring, but monitoring devices of any impedance may be matched with 600-ohm line-to-monitor transformers at remote locations up to several

*Figure 5-1. 51S-1F in Rack Mount, Overall View*
miles. Alternately, the 600-ohm line termination may be connected to telephone lines, or the 600-ohm local output may be used with a phone patch. The 51S-1B has the same local audio provisions as those described above, but the remote audio line has a 150-ohm impedance (refer to figure 7-5). 51S-1 series receivers require an antenna with 50-ohm unbalanced feed; random length antennas may be used.

5.3 SPECIFICATIONS

Frequency range ..........................................

Modes ....................................................... 

Power consumption ....................................... 

Type of service .......................................... 

Rf input impedance ...................................... 

500-kHz if. output at J9 ................................. 

Matching speaker impedance ............................

0.2 to 30.0 megahertz in thirty 1-megahertz bands continuous coverage.

Upper sideband, lower sideband, AM or CW.

125 watts.

Fixed station attended, or unattended, with provision for remote control of rf gain.

50 ohms, unbalanced.

50 mv minimum into 50-ohm load with 5-uv input signal.

4 or 600 ohms, unbalanced.
Balanced line output impedance

Matching phone patch impedance (local)

Frequency stability

Classification accuracy

Dial backlash

Audio-frequency response AM

SSB (high-frequency limit determined by filter bandwidth)

Audio output distortion (SSB test signal 100-microvolt input, 1.0-watt local output, 1-mw (0 dbm) line output)

Local

Line

Q-multiplier rejection notch depth

Receiver sensitivity (nominal)

AM

600 ohms balanced, center-tap ground reference or floating. (For 51S-1B, 150 ohms floating.)

500 to 600 ohms.

During temperature change from 0 to +50 °C, after 90 minutes warmup, audio output frequency will not vary more than ±885 Hz for carrier frequencies from 2 to 7 MHz. From 7 MHz to 30 MHz, stability varies from 36 PPM ±400 Hz at 7.00 MHz (652 Hz) to 27 PPM ±400 Hz at 30 MHz (1210 Hz). For ±10% line voltage variation, frequency varies not more than ±100 Hz.

When zeroed to nearest 100 kHz calibration point, the frequency will be within ±400 Hz.

Not more than 150 Hz.

100 to 2500 Hz ±6 db (line channel).

200 to 2500 Hz ±6 db (local channel).

350 to 3050 Hz ±3.5 db (line channel).

350 to 3050 Hz ±3.5 db (local channel).

Not more than 10 percent.

Not more than 3.0 percent.

Not less than -40 dB.

3.0 microvolts for not less than 10-db signal + noise/noise (2 to 30 MHz).

15.0 microvolts for not less than 10-db signal + noise/noise (0.5 to 2 MHz).

20.0 microvolts for not less than 10-db signal + noise/noise (0.2 to 0.5 MHz).

With 55G-1 Preselector, 5.0 microvolts for not less than 10-db signal + noise/noise (0.2 to 2.0 MHz).
SSB and CW ........................................ 0.6 microvolt for not less than 10-db carrier on carrier off (2 to 30 MHz).

3.0 microvolts for not less than 10-db carrier on carrier off (0.5 to 2.0 MHz).

4.0 microvolts for not less than 10-db carrier on carrier off (0.2 to 0.5 MHz).

With 55G-1 Preselector, 1.0 microvolt for not less than 10-db carrier on carrier off (0.2 to 2.0 MHz).

Selectivity

CW (at 6 db points) ................................. 800 hertz bandwidth, nominal. (650 Hz minimum, 950 Hz maximum, 300-Hz maximum bandwidth optional).

SSB (at 3.5 db points) ......................... 2.75 or 2.4 kHz bandwidth (3.1 kHz bandwidth optional).

AM (at 6 db points) ............................... 5.0 kHz bandwidth minimum (6.0 kHz optional).

(at 60 db points) ................................. 22.0 kilohertz bandwidth maximum.

Spurious responses (above 2 MHz)

Internal spurious signals ...................... Less than two microvolts equivalent signal.

Other spurious signals ....................... Not less than 70 db down, except from 4.8 to 5.2 MHz, not less than 40 db down.

Image response ................................ Not less than 50 db down from 2 to 25 MHz; not less than 40 db down from 25 to 30 MHz; referenced to midband.

Size ............................................... Cabinet version 196.85 mm (7.750 in) high by 374.65 mm (14.750 in) wide by 335.36 mm (13.203 in) deep. Rack-mounted version 221.44 mm (8.718 in) high by 482.60 mm (19.00 in) wide by 334.187 mm (13.187 in) deep (refer to figures 1-3 and 1-5).

Weight .......................................... 28 pounds (12.70 kg), except 51S-1A/1AF.
### 5.4 TUBE AND SEMICONDUCTOR COMPLEMENT

**Table 5-1. Tube and Semiconductor Complement**

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>FUNCTION</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>RF amplifier</td>
<td>6DC6</td>
</tr>
<tr>
<td>V2</td>
<td>First mixer and hf crystal oscillator</td>
<td>6EA8</td>
</tr>
<tr>
<td>V3</td>
<td>Second mixer and 17.5 MHz oscillator</td>
<td>6EA8</td>
</tr>
<tr>
<td>V4</td>
<td>Third mixer and remote gain gate</td>
<td>6EA8</td>
</tr>
<tr>
<td>V5, V7,</td>
<td>If. amplifiers</td>
<td>6BA6</td>
</tr>
<tr>
<td>V8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V6</td>
<td>Q-multiplier</td>
<td>12AX7</td>
</tr>
<tr>
<td>V9</td>
<td>Agc amplifier</td>
<td>6BA6</td>
</tr>
<tr>
<td>V10</td>
<td>If mixer and If crystal oscillator</td>
<td>6EA8</td>
</tr>
<tr>
<td>V11</td>
<td>If. cathode follower and agc cathode follower</td>
<td>5670</td>
</tr>
<tr>
<td>V12</td>
<td>Second local of af amplifier</td>
<td>6BF5</td>
</tr>
<tr>
<td>V13</td>
<td>Second line of af amplifier</td>
<td>6AK6</td>
</tr>
<tr>
<td>V14</td>
<td>First line of af amplifier and first local of af amplifier</td>
<td>12AX7</td>
</tr>
<tr>
<td>V15</td>
<td>Variable-frequency oscillator</td>
<td>7543</td>
</tr>
<tr>
<td>V16</td>
<td>Lf mixer and calibration oscillator</td>
<td>6EA8</td>
</tr>
<tr>
<td>V17</td>
<td>Beat-frequency oscillator</td>
<td>7543</td>
</tr>
<tr>
<td>CR1 thru</td>
<td>Product demodulator</td>
<td>1N34A</td>
</tr>
<tr>
<td>CR4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR5, CR18, CR19, and CR20</td>
<td>Meter rectifiers</td>
<td>1N270</td>
</tr>
<tr>
<td>CR6 thru</td>
<td>Power supply rectifier</td>
<td>1N1695</td>
</tr>
<tr>
<td>CR13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CR14</td>
<td>Agc rectifier</td>
<td>1N482A</td>
</tr>
<tr>
<td>CR15</td>
<td>AM detector</td>
<td>1N34A</td>
</tr>
<tr>
<td>CR16</td>
<td>Agc stabilizer</td>
<td>1N482A</td>
</tr>
<tr>
<td>CR17</td>
<td>Muting transient suppressor</td>
<td>1N67A</td>
</tr>
<tr>
<td>CR401 thru</td>
<td>Dc power supply rectifier</td>
<td>2N637B</td>
</tr>
<tr>
<td>CR403</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>SSB/CW af amplifier</td>
<td>2N388 or 2N222A</td>
</tr>
<tr>
<td>Q401 thru</td>
<td>Dc power supply switching</td>
<td>2N637B</td>
</tr>
<tr>
<td>Q404</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.5 AVAILABLE ACCESSORIES

<table>
<thead>
<tr>
<th>ITEM</th>
<th>FUNCTION</th>
<th>COLLINS PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>55G-1 Tuner</td>
<td>0.2- to 2.0-MHz IF preselector, with speaker</td>
<td>522-3982-002</td>
</tr>
<tr>
<td>312B-3 Speaker</td>
<td>Cabinet speaker</td>
<td>522-1166-00</td>
</tr>
<tr>
<td>351E-4 Mounting Plate</td>
<td>Mount on table or bench</td>
<td>522-1482-00</td>
</tr>
<tr>
<td>28 volt dc power supply</td>
<td>Converts 51S-1 to 51S-1A</td>
<td>554-8355-00</td>
</tr>
<tr>
<td>conversion kit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>351R-1 Rack Mount</td>
<td>Rack mounts 51S-1/1A Receiver</td>
<td>522-2665-00</td>
</tr>
<tr>
<td>Cabinet assembly</td>
<td>Cabinet mounts 51S-1F/1AF Receiver</td>
<td>553-2449-00</td>
</tr>
<tr>
<td>312C-1 Speaker</td>
<td>Rack-mounted speaker</td>
<td>522-3526-00</td>
</tr>
<tr>
<td>312C-2 Speakers</td>
<td>Two speakers rack mounted</td>
<td>522-3527-00</td>
</tr>
<tr>
<td>312C-3 Speakers</td>
<td>Three speakers rack mounted</td>
<td>522-3528-00</td>
</tr>
<tr>
<td>Shockmounting kit</td>
<td>51S-1/1A Shockmount</td>
<td>757-2787-001</td>
</tr>
<tr>
<td>Headset HS-1 (600 ohms)</td>
<td>Insert in front panel</td>
<td>273-0021-010</td>
</tr>
</tbody>
</table>

5.6 DIFFERENCE DATA

Table 5-3 lists differences and part numbers of various models of the 51S- ( ) communications receivers.

5.7 SCHEMATIC CHANGE INFORMATION

The period covered by this instruction book is 15 January 1974 to 22 September 1975. Each equipment that had circuit changes made during the period of time covered by this instruction book has the changes identified on the applicable sheet of the schematic diagram and in the parts list. Circuit changes are flagged on the schematic with a change identifier ( ) pointed at the component, group of components, or a circuit enclosed by a dashed line. The broken line indicates that the component or circuit has been changed, and the number inside the identifier indexes the specific change. If several components are affected by the change, there will be more than one identifier with the same index number.

The change identification numbers are listed on a schematic changes page that is inserted as sheet A of figure 7-1. The description gives the differences and the reasons for the changes.

The reason for identifying changes in this manner is that the manufacturer has scrambled serial numbers on his amateur products during the period covered by this instruction book.

None of the changes have been made because the equipment has failed to meet the equipment specifications and are not recommended changes for all units. Equipment changes have been made to improve performance or reliability of radios that are built using different fabrication processes. These changes will not necessarily improve the operation of your equipment. The change identification number also is used in the parts list section of this instruction book. However in the parts list the identification number is enclosed in slashes (for example, /2/) instead of the symbol.
Table 5-3. 51S-() Specifications

<table>
<thead>
<tr>
<th>MODEL</th>
<th>DESCRIPTION</th>
<th>COLLINS PART NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>51S-1</td>
<td>Receiver mounted in cabinet complete with tubes and mechanical filters. Operates on 115/230 Vac. Equipped with 2.4-kHz SSB mechanical filter and 800-Hz CW filter. Same as above except equipped with 2.75-kHz SSB mechanical filter.</td>
<td>522-2245-00</td>
</tr>
<tr>
<td>51S-1A</td>
<td>Same as 51S-1 above except operates on 28 Vdc. Equipped with 2.4-kHz SSB mechanical filter. Same as 51S-1A listed above except equipped with 2.75-kHz SSB mechanical filter.</td>
<td>522-2245-030</td>
</tr>
<tr>
<td>51S1-B</td>
<td>Same as the 51S-1 listed above except it has a rear-mounted junction box that provides military-type connectors for power, control, audio, and antenna lines.</td>
<td>522-2546-00</td>
</tr>
<tr>
<td>51S-1F</td>
<td>Same as 51S-1 except for standard 48.260-m (19-in) rack mounting. Equipped with 2.4-kHz SSB mechanical filter and 800-Hz CW filter. Same as 51S-1F listed above except equipped with 2.75-kHz SSB mechanical filter.</td>
<td>522-2498-00</td>
</tr>
<tr>
<td>51S-1AF</td>
<td>Same as 51S-1A except for standard 48.260-m (19-in) rack mounting. Equipped with 2.4-kHz SSB mechanical filter and 800-Hz CW filter. Same as 51S-AF listed above except equipped with 2.75-kHz mechanical filter.</td>
<td>522-2498-030</td>
</tr>
</tbody>
</table>

*All models described in this table are available with the following options:

Option 1: 300-Hz CW filter.

Option 2: 5-kHz mechanical filter in place of 5-kHz AM/if transformer.

Option 3: 3.1-kHz mechanical filters vice either the 2.4- or 2.75-kHz mechanical filters.