section 2
operation

2.1 GENERAL

Make sure that the 51S-1 is connected to the proper power source. (See installation section.) Check to see that the antenna and speaker (or earphones) are connected to the proper jacks of the 51S-1.

2.2 FREQUENCY READING

Frequency is read on the 51S-1 by adding the indications of the megahertz counter, tenth megahertz counter, and kilohertz dial. See figure 2-1. The frequency indicated is 5.295 megahertz.

2.3 SINGLE-SIDEBAND RECEPTION

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

b. Turn the MEGACYCLES control to obtain an indication on the megahertz counter corresponding to the desired band.

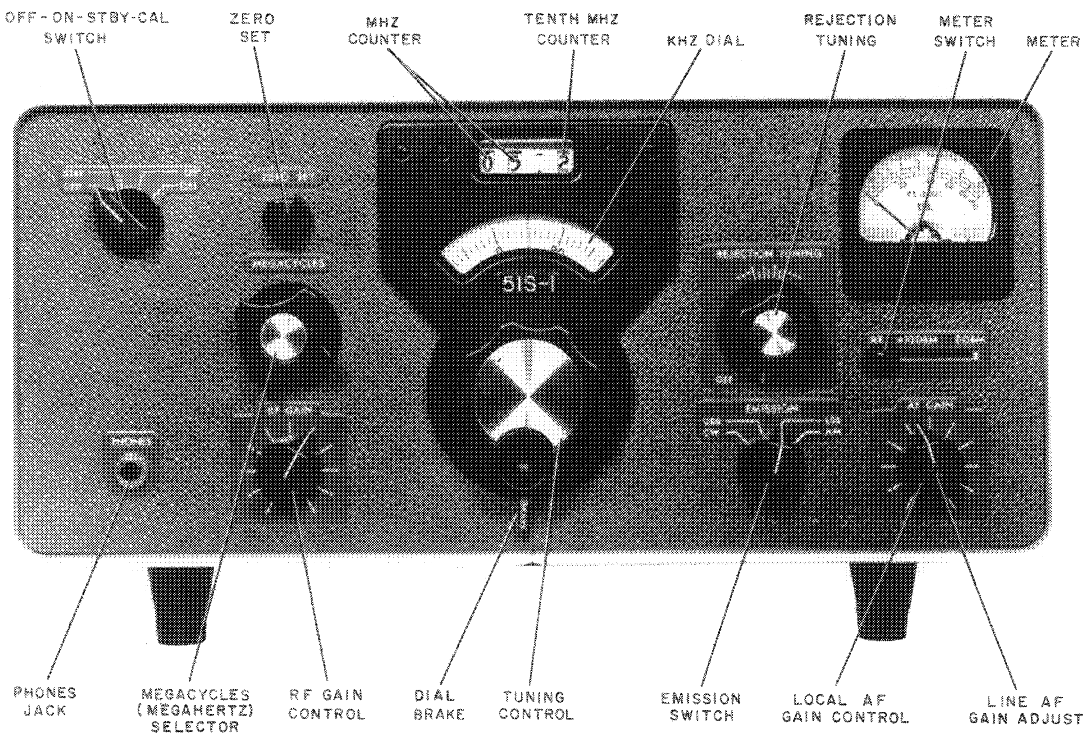

Figure 2-1. Operating Controls

c. Turn the RF GAIN control fully clockwise.

d. Move the EMISSION switch to USB for upper sideband reception or to LSB for lower sideband reception.

e. Set the AF GAIN control for a comfortable listening level.

f. Turn the tuning knob to obtain the most natural-sounding audio output.

g. Adjust the RF GAIN control to the position that yields the best reception to background noise ratio.

h. Readjust the local AF GAIN control if necessary.

An interfering heterodyne may be tuned out by adjusting the REJECTION TUNING control for minimum interference.

Relative rf input levels (signal strengths) may be observed by moving the RF - +10 DBM - 0 DBM selector to RF position. To adjust the LINE AF GAIN, set the meter switch to the 0 or 10 DBM position and set the LINE AF GAIN adjust to the desired level. The LINE AF GAIN adjust is a screwdriver adjustment located in the center of the local AF GAIN control knob (see figure 2-1).

2.4 CW RECEPTION

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

b. Turn the MEGACYCLES control to obtain an indication on the megahertz counter corresponding to the desired band.

c. Turn the RF GAIN control to fully clockwise.

d. Move the EMISSION switch to USB position. If interference is present, move the EMISSION switch to CW for greater selectivity.

e. Tune in the signal by turning the tuning knob. If the EMISSION switch is in the CW position, tune for a definite peak in signal strength.

f. Turn the AF GAIN control to approximately 12 o'clock position, and adjust the RF GAIN control for a comfortable listening level.

2.5 AM RECEPTION

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

b. Turn the MEGACYCLES control to obtain an indication on the megahertz counter corresponding to the desired band.

c. Turn the RF GAIN control fully clockwise.

d. Move the EMISSION switch to AM position.

e. Set the local AF GAIN for a comfortable listening level.

f. Turn the tuning knob to obtain the best reception.

g. Adjust the RF GAIN control to obtain the best reception to background noise ratio.

h. Readjust the local AF GAIN control if necessary. Adjust line AF GAIN control to obtain desired line level.

An interfering heterodyne may be tuned out by adjusting the REJECTION TUNING control for minimum interference.

Note

During AM reception (EMISSION switch in AM position) with an interfering signal present, the resulting heterodyne may be tuned out by either of two settings of the REJECTION TUNING control. However, only one of the settings will allow the desired signal to be detected properly. Select the REJECTION TUNING setting which yields the better intelligibility.

If interference and/or selective fading are present, better reception of AM signals may be obtained by moving the EMISSION switch to USB or LSB position, zero beating the desired carrier and proceeding as in paragraph 2.3, steps f, g, and h. Move the EMISSION switch to either USB or LSB, whichever results in the better reception.

2.6 CALIBRATION

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

b. Move the EMISSION switch to USB or LSB.

c. Turn the tuning knob to obtain an indication of 0 kHz on the kilohertz dial. (The megahertz counter and tenth megahertz counter reading should be close to the desired frequency of operation.)

d. Turn the tuning knob to obtain an indication of zero beat.

e. Using the ZERO SET knob, move the hairline to 0 on the kilohertz dial.

f. Return OFF-STBY-ON-CAL switch to ON position.

2.7 DIAL BRAKE

a. To hold the tuning knob at a particular frequency, move the dial brake mechanism, located under the tuning knob, in a counterclockwise direction.

b. To unlock the tuning knob, turn the dial brake mechanism in a clockwise direction.

section 3

principles of operation

3.1 GENERAL

Figure 3-2 is a block diagram of the 51S-1, and figure 7-1 is a schematic diagram of the 51S-1. Figure 7-2 is a schematic diagram of the 51S-1A. Figure 7-3 is a partial schematic of the receiver, showing the complete front-end switching arrangement. The 51S-1 is a dual- or triple-conversion communications receiver which operates in the range of 0.2 to 30 megahertz. The 0.2- to 2.0-MHz portion of the coverage is intended for laboratory applications and broadcast monitoring. In this range, internally generated spurious whistles occur at 333 kHz, 666 kHz, 1000 kHz, 1500 kHz, and 2000 kHz. Triple conversion is used for the 0.2- to 7.0-MHz bands, and double conversion is used for the 7.0- to 30.0-MHz bands. For 7.0- to 30.0-MHz operation, the 14.5- to 15.5-MHz bandpass network and second mixer are bypassed.

The 51S-1 is basically a 2.0- to 30.0-MHz receiver with a built-in low-frequency converter. The tuning mechanism, counter dials, and turret are arranged so the two lowest bands, 0.2 to 1.0 MHz and 1.0 to 2.0 MHz, use the 28.0- to 29.0- and the 29.0- to 30.0-MHz bands of the receiver as a variable if. (conversion) frequency. As the megahertz counter is reduced in setting below 2.0 MHz (lowest band on the turret), a segment switch, S6, connects the low-frequency converter and its bandpass filter between the antenna and the turret input, which is now the 29.0- to 30.0-MHz band. When the megahertz counter setting is reduced below 1.0 MHz, the segment switch, S6, maintains the low-frequency converter connection, but the turret is changed to the 28.0- to 29.0-MHz band. In this manner, the 28 positions of the turret plus two positions of overtravel provide 30 bands, each 1 megahertz wide. The 0.2-MHz limitation of the lowest band is a function of the frequency roll-off in the bandpass filter and mixer considerations.

3.2 CIRCUIT DESCRIPTIONS

3.2.1 RF Amplifier

Signals from the antenna are fed from J1 through S6 contacts to an impedance-matching transformer, L30. The output of L30 is coupled to the first section of the double-tuned input network. Refer to figure 3-1. The double-tuned input circuits are composed of C40, L33, L32, L31, C71, L69, L68, L67, and the components mounted upon turret wafers A1 through A5. All rf section components and turret wafers are shown in figure 7-3. The first section of this network is tuned by C40, C_p, L_p - L_m and L33-L32-L31. For any position of the turret, L33, L32, L31, and C40 are in the circuit, and the band changing is accomplished by connecting the turret-mounted components in shunt. The tuning slug of L32 is coupled mechanically to the tuning control of the receiver, and is varied to accomplish tuning throughout the 1-MHz band. The second section of the network is tuned by C71, C_n, Ln -L_m and L69-L68-L67. The tuning slug of L68 is ganged to the tuning control of the receiver to accomplish tuning in the same manner as that of L32 in the first section of the network. The turret-mounted components are selected by the MEGACYCLES control. This control positions the turret wafers so that the proper set of components is connected into the circuit according to the megahertz information on the counter dial. Coupling between the two sections of the input network is provided by mutual inductance L_m. The output network consists of a single-tuned system using a band-switching and tuning scheme similar to that of the input network.

3.2.2 First Mixer

The first mixer, V2A, is a triode. The rf signal is fed to the grid, and the hf crystal oscillator signal is injected at the cathode.

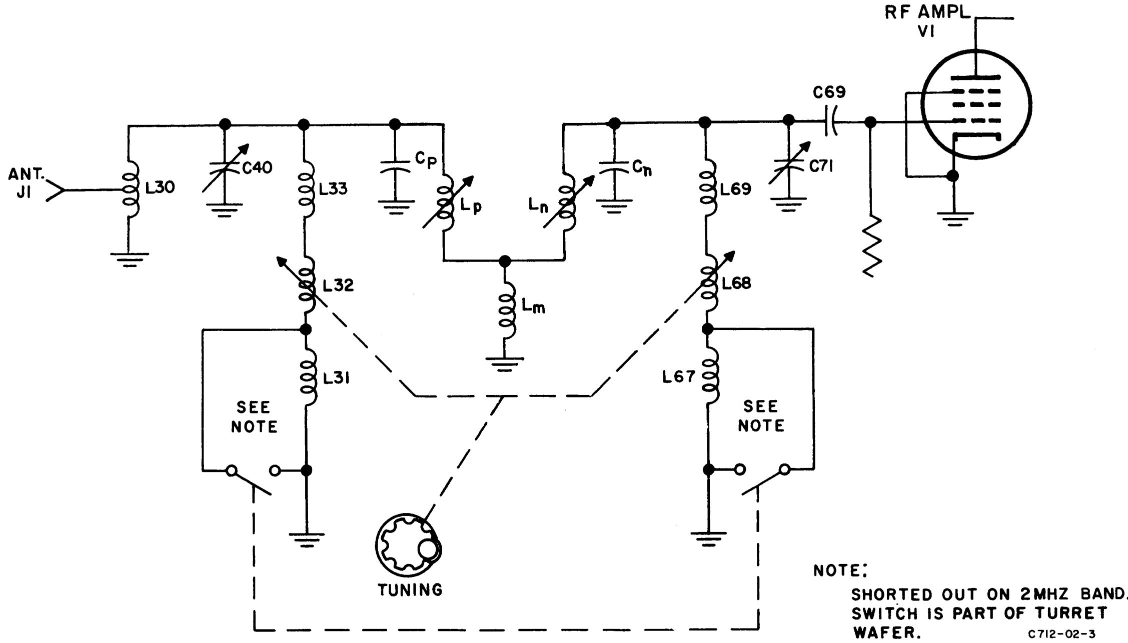

Figure 3-1. RF Input Circuits, Simplified Schematic Diagram

The output network consists of a 14.5- to 15.5-MHz bandpass filter for 2- to 7-MHz operation and a 3- to 2-MHz variable, triple-tuned network for 7- to 30-MHz operation. The slugs of the 3- to 2-MHz variable if. network inductors are coupled mechanically to the tuning control of the receiver and tracked with the slug-tuned inductors' in the rf circuits to produce the 1-MHz coverage for each band.

3.2.3 Second Mixer

During 2- to 7-MHz operation, the second mixer, triode V3A, uses a 3- to 2-MHz variable if. for its output network. This is the same output network that is used by the first mixer during 7- to 30-MHz operation. The signal from the first mixer plate is fed through the 14.5- to 15.5-MHz bandpass filter network, T12 and T13, to the grid of the second mixer. The 17.5-MHz oscillator signal is injected into the cathode circuit of this mixer. The second mixer is inoperative during 7- to 30-MHz operation.

3.2.4 Third Mixer

The third mixer, pentode V4A, receives its input signal from the 3- to 2-MHz variable if. network. The input signal from the first or second mixer is fed to the grid of the third mixer and the vfo signal is injected into its cathode. An external vfo signal may be injected through J6 if external frequency control is desired. Such an external injection signal might also be a selected crystal oscillator frequency if precise fixed channel tuning is desired. In such a case, the tuning dial would have to be set to the channel frequency in order to properly resonate all the rf and if. gang-tuned circuits.

The output network of the third mixer is selected with the EMISSION switch on the front panel. In USB and LSB positions, mechanical filters FL2 and FL3 are used. Depending on the particular model of the receiver or the options selected, (Section 5, Specifications) these mechanical filters provide either a 2.75-, 2.4-, or 3.1-kHz bandwidth for single-sideband reception on upper or lower sideband, respectively. The CW position of the EMISSION switch selects a crystal filter, FL4. The crystal filter provides an 800-Hz (optional 300-Hz) bandwidth for reception of CW signals. The AM position of the EMISSION switch selects a network composed of two lightly coupled 500-kHz if transformers, T14 and T15, which provides a bandwidth of 5 kHz for reception of amplitude-modulated signals. (Optionally, T14 and T15 can be replaced by a mechanical filter providing 6-kHz bandwidth.)

3.2.5 First IF. Amplifier

The first if. amplifier, pentode V5, receives its input signal from the third mixer through one of the four selective networks described in paragraph 3.2.4. The output signal is coupled to the Q-multiplier through if. transformer T1.

3.2.6 Q-Multiplier

The Q-multiplier, V6, is a twin triode. The first triode section is a cathode follower, the output of which is coupled to the cathode of the second triode section. When REJECTION TUNING is being used, the signal from the plate of the second triode is coupled through a parallel-tuned circuit to the grid of the second if. amplifier. The parallel-tuned circuit consists of L108, C145, and C146 and a small voltage sensitive capacitor. These components, plus R33 and R34, form a bridged-T rejection notch filter. The end of the parallel-tuned circuit, away from the plate of the second triode section, is coupled to the grid of the second triode. This feedback arrangement forms a Q-multiplier. The Q of L108 is 250. The feedback loop has a gain of 10, resulting in an overall Q of 2500 and a rejection notch depth of not less then 40 db. Turning the REJECTION TUNING control fully counterclockwise deactivates the rejection network by forward biasing capacitance diode C315 into conduction.

3.2.7 Second IF. Amplifier

The second if. amplifier, pentode V7, receives its input signal from the Q-multiplier network. The output network of the second if. amplifier is if. transformer T2. The secondary of T2 is coupled to the third if. amplifier, V8, and cathode follower V11A.

3.2.8 Third IF. Amplifier

The third if. amplifier, V8, receives its input signal from the second if. amplifier through transformer T2. The third if. amplifier output is coupled to the product demodulator through if. transformer T3 and to the AM detector through C158.

3.2.9 Product Demodulator

The product demodulator is composed of CR1, CR2, CR3, and CR4 in a diode-ring configuration. Signal from the beat-frequency oscillator, V17, is injected into the product demodulator at the junction of R135 and R136. The audio output is fed to the SSB/CW preamplifier, Q1. The bfo supplies a reinserted carrier to replace the suppressed carrier of the SSB signal. The demodulator functions as a mixer, and its output is a full-wave rectified signal consisting of the if. and bfo signals plus their mixing products. C161, L123, and C310 form a low-pass filter that passes the if. and bfo mixing difference frequency and blocks the rest of the demodulator output. The mixing difference frequency is the desired audio signal.

3.2.10 SSB/CW Preamplifier

The output impedance of the diode demodulator is approximately 600 ohms. Transistor Q1 provides impedance match and gain between the product demodulator and the following audio amplifier grid. The SSB/CW preamplifier is an npn transistor, connected in a common emitter configuration. Audio signals from the product demodulator and sidetone signals from the cathode follower, V11B, are coupled to the base of Q1. The SSB/CW preamplifier output signal is coupled from the collector of Q1 through C165 to switch S2C. During SSB and CW operation, the contacts of S2C connect the audio output signal to first local af amplifier, V14B, and the first line amplifier, V14A.

3.2.11 Audio Amplifiers

The 51S-1 includes two, two-stage, audio-frequency amplifiers. The local amplifier, consisting of V14B and V12, provides audio power to local headphones, speaker, or phone patch. The line amplifier, consisting of V14A and V13, provides power for a 600-ohm remote line.

Note

The line output impedance of 51S-1B is 150 ohms. Figure 7-5 is a partial schematic diagram of the 51S-1B output circuit.

The first local and the first line af amplifiers obtain input signal from either the SSB/CW preamplifier, Q1, or from AM detector CR15. The signal source, Q1 or CR15, is selected by contacts of the EMISSION switch, S2. The first local and first line af amplifiers drive their respective second local and line amplifiers V12 and V13. The line amplifier distortion is reduced by use of negative feedback from output transformer T4 to the cathode of V14A.

3.2.12 Low-Frequency Mixer

For receiving signals in the 0.2- to 2.0-MHz range, the 51S-1 uses a low-frequency mixer, V10A-V16A, and converts the signal to the 28- and 29-MHz bands. The low-frequency input to the mixer is passed through a bandpass filter, and the output of the mixer is tuned by the turret and slug-tuned circuits. External tuners for low-frequency operation may be used. Jacks J14 and J13 on the rear apron are provided for this use. When an external low-frequency tuner is used, the jumper between J14 and J13 must be removed. See figure 7-1.

3.2.13 Oscillators

The calibration oscillator, V16B, is a crystal-controlled oscillator operating at 100 kilohertz. Variable capacitor C227 trims the frequency of the oscillator. The output of the calibration oscillator is coupled to the antenna jack, J1.

The low-frequency crystal oscillator, V10B, uses a 14-MHz crystal. The plate circuit of this oscillator is tuned to the second harmonic of the crystal. The low-frequency crystal oscillator operates only when the 51S-1 is receiving signals in the 0.2- to 2.0-MHz bands. The output of this oscillator is coupled to the low-frequency balanced mixer, V10A and V16A. Capacitor C2 trims the crystal oscillator to frequency.

The high-frequency crystal oscillator, V2B, operates on all bands. Frequency of oscillator operation is determined by one of sixteen crystals mounted on a wafer in the turret (see table 3-1). The proper crystal is selected by positioning the band-switch MEGACYCLES control. Individual turret-mounted piston trimmer capacitors trim each crystal to frequency.

The 17.5-MHz oscillator, V3B, is crystal controlled. This oscillator operates only when the 51S-1 is operating in the 2- to 7-MHz range. The crystal may be trimmed to frequency by variable capacitor C233.

The variable-frequency oscillator is a Collins 70K-7 permeability-tuned oscillator. The frequency of this unit is varied by changing the inductance of L501. This change of inductance is accomplished by turning the 51S-1 tuning knob which is coupled mechanically to the slug of L501. The output of the oscillator tube, V15, is coupled to the cathode of the third mixer through T501.

The beat-frequency oscillator, V17, is a 500-kHz crystal-controlled oscillator which operates only when the EMISSION switch of the 51S-1 is in USB, LSB, or CW position. No beat-frequency oscillator is needed for AM operation. The output of the bfo is coupled to the product demodulator. There is no provision for trimming the bfo frequency.

3.2.14 Special Circuits

Cathode follower V11A receives if. excitation from the second if. amplifier. The output of this cathode follower is fed to agc amplifier V9. The output of the agc amplifier is coupled to the agc rectifier, CR14, and to the if. output jack, J9.

The agc rectifier, CR14, rectifies the if. signal from agc amplifier V9. The dc output from the agc rectifier is used for automatic gain control of the rf and if. amplifiers.

Cathode follower V11B receives sidetone signal from J8 on the rear apron of the 51S-1. The sidetone audio output from this stage is fed to the SSB/CW preamplifier, Q1.

Diode CR16 in the rf amplifier grid return line is used to stabilize the agc circuit and prevent agc pumping.

Diode CR17 suppresses transients occurring on the rf gain control bus during mute on-off switching.

Remote gain gate V4B presents a high-impedance isolation between the remote gain line and the agc circuit. This prevents the low-impedance remote gain circuit and the bias supply from loading the high-impedance agc circuits.

Table 3-1. 51S-1 Crystal Utilization

RECEIVER FREQUENCY RANGE IN MEGAHERTZ	TURRET CRYSTAL		HF OSCILLATOR OUTPUT (MHz)	17.5 MHz OSCILLATOR	LF CRYSTAL OSCILLATOR (2 x 14 MHz = 28 MHz)
	SYMBOL	FREQUENCY (MHz)			
0.2- 1.0	Y20	10.333	31.00	Off	On
1.0- 2.0	Y12	16.0	32.00	Off	On
2.0- 3.0	Y1	12.5	12.50	On	Off
3.0- 4.0	Y2	11.5	11.50	On	Off
4.0- 5.0	Y3	10.5	10.50	On	Off
5.0- 6.0	Y4	9.5	9.50	On	Off
6.0- 7.0	Y5	8.5	8.50	On	Off
7.0- 8.0	Y6	10.0	10.00	Off	Off
8.0- 9.0	Y7	11.0	11.00	Off	Off
9.0- 10.0	Y8	12.0	12.00	Off	Off
10.0- 11.0	Y9	13.0	13.00	Off	Off
11.0- 12.0	Y10	14.0	14.00	Off	Off
12.0- 13.0	Y11	15.0	15.00	Off	Off
13.0- 14.0	Y12	16.0	16.00	Off	Off
14.0- 15.0	Y5	8.5	17.00	Off	Off
15.0- 16.0	Y13	9.0	18.00	Off	Off
16.0- 17.0	Y4	9.5	19.00	Off	Off
17.0- 18.0	Y6	10.0	20.00	Off	Off
18.0- 19.0	Y3	10.5	21.00	Off	Off
19.0- 20.0	Y7	11.0	22.00	Off	Off
20.0- 21.0	Y2	11.5	23.00	Off	Off
21.0- 22.0	Y8	12.0	24.00	Off	Off
22.0- 23.0	Y1	12.5	25.00	Off	Off
23.0- 24.0	Y9	13.0	26.00	Off	Off
24.0- 25.0	Y18	13.5	27.00	Off	Off
25.0- 26.0	Y10	14.0	28.00	Off	Off
26.0- 27.0	Y19	14.5	29.00	Off	Off
27.0- 28.0	Y11	15.0	30.00	Off	Off
28.0- 29.0	Y20	10.333	31.00	Off	Off
29.0- 30.0	Y12	16.0	32.00	Off	Off

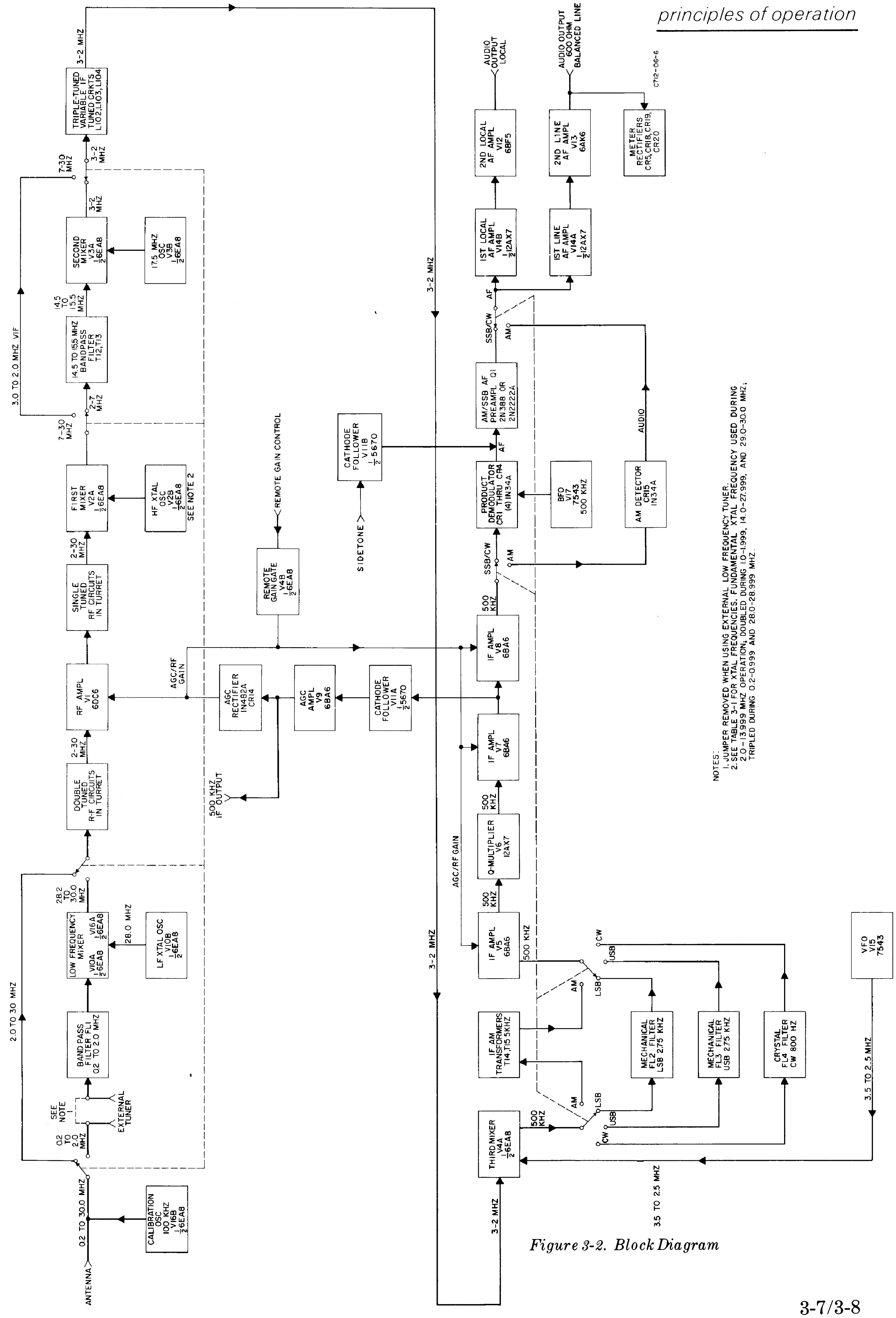

Figure 3-2. Block Diagram