

Figure 1-1. Mode Selector Receiving, Model MSR-9

SECTION 1 GENERAL DESCRIPTION

1-1. FUNCTIONAL DESCRIPTION.

The TMC Model MSR-9 Mode Selector Receiving (figure 1-1) will in a number of ways, improve and simplify operation of a receiver for various modes of operation. Designed especially for the detection of single sideband signals, the MSR will also provide improved reception of CW, MCW, AM, FSK and sideband signals with any degree of carrier insertion. This is accomplished by the combination of a specially designed filter circuit and a frequency bandsread oscillator which provides sharp discrimination between a desired signal and undesired adjacent interference.

Two MSR units, both operating from the I. F. output of the same receiver, will provide complete reception of independent (separate information) sideband.

A front panel bandsread control tunes over the I. F. bandpass. This effective vernier easily tunes SSB or exalted carrier AM signals within cycles of correct tone. Either sideband is selectable, with the bandpass tuning feature or by inverting the oscillator separation. CW, MCW and FSK signals are easily tunable with the bandsread feature.

For extreme stability, the first oscillator is switched to crystal control for both upper and lower sideband positions.

The local or remote tuned VFO feature of the MSR permits operation with any receiver having an I. F. nominally centered at 455 kc. However, when the oscillator is switched to crystal control and the proper crystals installed, most any receiver I. F. may be accommodated. The required I. F. connections between the receiver and MSR are further explained in Section 2.

1-2. PHYSICAL DESCRIPTION.

The MSR is equipped with a 19 inch wide rack panel designed to be mounted in any standard width equipment rack. The front panel measures 19 inches wide x 5-1/4 inches high x 3/16 inch thick and is finished in TMC gray enamel. The chassis extends 13-1/2 inches behind the panel and is self supporting.

All operating controls and indicating devices are readily accessible on the front panel and are similar in function and effect to those found on any receiver. Input and output connections are made on the rear panel terminal board. Table 1-1 lists the tube complement of the MSR.

TABLE 1-1. VACUUM TUBE COMPLEMENT

REFERENCE DESIGNATION	TUBE TYPE	FUNCTION
V1	6BE6	Mixer
V2	6AG5	1st Oscillator
V3a	1/2-12AX7	1st I. F. Amplifier
V3b	1/2-12AX7	2nd I. F. Amplifier
V4a	1/2-12AU7	3rd I. F. Amplifier
V4b	1/2-12AU7	AVC Amplifier
V5	1/2-12AT7	Audio Amplifier
V6	6J6	Reactance Modulator
V7	6BE6	Product Detector
V8	6AQ5	Output
V9	12AT7	2nd Oscillator
V10	5Y3	Power Rectifier
V11	0A2	Voltage Regulator

1-3. TECHNICAL SPECIFICATIONS.

INPUT FREQUENCY:	455 kc
MODES OF RECEPTION:	SSB upper or lower, AM, CW, FSK, FAX
INPUT VOLTAGE:	1 to 100 mv RMS
INPUT IMPEDANCE:	50 ohms
TUNING BANDSPREAD:	±3 kc
AUDIO FILTER CHARACTERISTICS:	-3 db point at 5 kc ±500 cps, maximum attenuation equal to or more than -50 db at 17 kc, maximum passband ripple ±0.5 db between 300 and 3500 cps.
AVC CHARACTERISTICS:	With 40 db change in input, output remains constant within ±4.5 db.
AVC SPEEDS:	Slow/Fast
AUDIO DISTORTION:	Less than 5%
AUDIO OUTPUT:	High-2 watts-600 ohms-8 ohms Low-1 mw-600 ohms, 150 mv- 600 ohms and 8 ohms.
OUTPUT IMPEDANCE:	Loudspeaker - 8 ohms Line - 600 ohms Headset - High or low impedance headset may be used.
HUM LEVEL:	At least 50 db down from full audio output.
PRIMARY POWER REQUIREMENTS:	115/230 volts, 50/60 cps, single phase, 65 watts.
PHYSICAL DIMENSIONS:	5-1/4 inches high x 19 inches wide x 13-1/2 inches deep.
WEIGHT:	24 lbs. net.
TEMPERATURE AND HUMIDITY:	0 to 50° C, up to 90° humidity.
COMPONENTS AND CONSTRUCTION:	All equipment manufactured in accordance with JAN/MIL specifications wherever practicable.

SECTION 2 INSTALLATION

2-1. INITIAL INSPECTION.

Each MSR has been thoroughly checked and tested at the factory before shipment. Upon arrival at the operating site, inspect the packing case and its contents immediately for possible damage. Unpack the equipment carefully. Inspect all packing material for parts which may have been shipped as "loose items".

With respect to damage to the equipment for which the carrier is liable, The Technical Materiel Corporation will assist in describing methods of repair and the furnishing of replacement parts.

The equipment is shipped with all tubes and other plug-in components installed. Check that all such components are properly seated in their sockets.

2-2. MECHANICAL INSTALLATION.

The MSR is equipped with a 19 inch wide rack panel, designed to be mounted in any standard width equipment rack. For mounting and outline dimensions, refer to paragraph 1-3.

2-3. ELECTRICAL INSTALLATION.

The MSR is designed to operate from any suitable power source providing 115 or 230 volts a-c, 50/60 cps, single phase power. The MSR is factory wired for 115 volts a-c operation and may be converted for 230 volts a-c operation by making the necessary changes shown in figure 2-1. After converting to 230 volt operation replace the 3 ampere fuse F1 with a 1.5 ampere fuse.

The necessary electrical interconnections are made at the rear of the MSR chassis. A low loss coaxial cable is required to connect the I. F. output of the receiver into the MSR I. F. INPUT jack J1. If no I. F. output jack is available on the receiver, the proper connection may be made at the plate of the last I. F. amplifier of the receiver through a 47 mmfd capacitor.

The audio output connections are made on the rear apron at terminal board E1 or the chassis connector J4, for which a mating cable connector is supplied. Since three levels of output are available, the connections to P4 (mating connector to J4) and terminal board E1 must be made as shown in figure 2-3.

Single loudspeaker monitoring for both the MSR and receiver is possible by paralleling the loudspeaker output connections of both units as shown in figure 2-2. This feature enables the operator to monitor either the MSR or receiver output simply by increasing the audio gain of the unit to be monitored and reducing the audio gain of the unit to be silenced.

When this unit is used in remote operation with the TMC Model RCR system, the control voltages for remote operation may be obtained from the TMC Model RCR, Remote Control Receiver System which controls the TMC Model FFR Communications Receiver. The following leads are removed from the Model FFR and connected to the Model MSR. See figures 2-4 and 2-5 for proper cabling.

a. Remove the BFO relay leads from terminals 5 and 6 of E102 on the Model FFR and connect to terminals 9 and 10 of E1 on the MSR.

b. Remove the BFO control leads from terminals 7 and 8 of E102 on the Model FFR and connect to terminals 11 and 12 of E1 on the MSR.

c. Connect a shielded lead from terminal 7 of E1 of the RSD to terminal 8 of the MSR.

The audio return from the MSR at the remote site back to the control site is taken from pins A and D on P4, the one milliwatt level 600 ohm telephone line. The Output Level switch S8 must be in the LOW position.

When shipped, the front panel sideband indicators are positioned with the Lower sideband indicator on the left and the Upper sideband on the right. This position is for use with receivers which have a reversal of sidebands in the I. F. due to a conversion process where the oscillator frequency is about the R. F. signal. If a succeeding conversion process has the oscillator below the I. F., no change takes place in the sideband relationship.

If, however, a second or third conversion oscillator frequency is above the I. F., a reversal of sideband positioning takes place. It then becomes necessary to reverse the sideband indicator jewels. Pull them out and replace so that the Upper sideband indicator is on the left and the Lower sideband indicator is on the right.

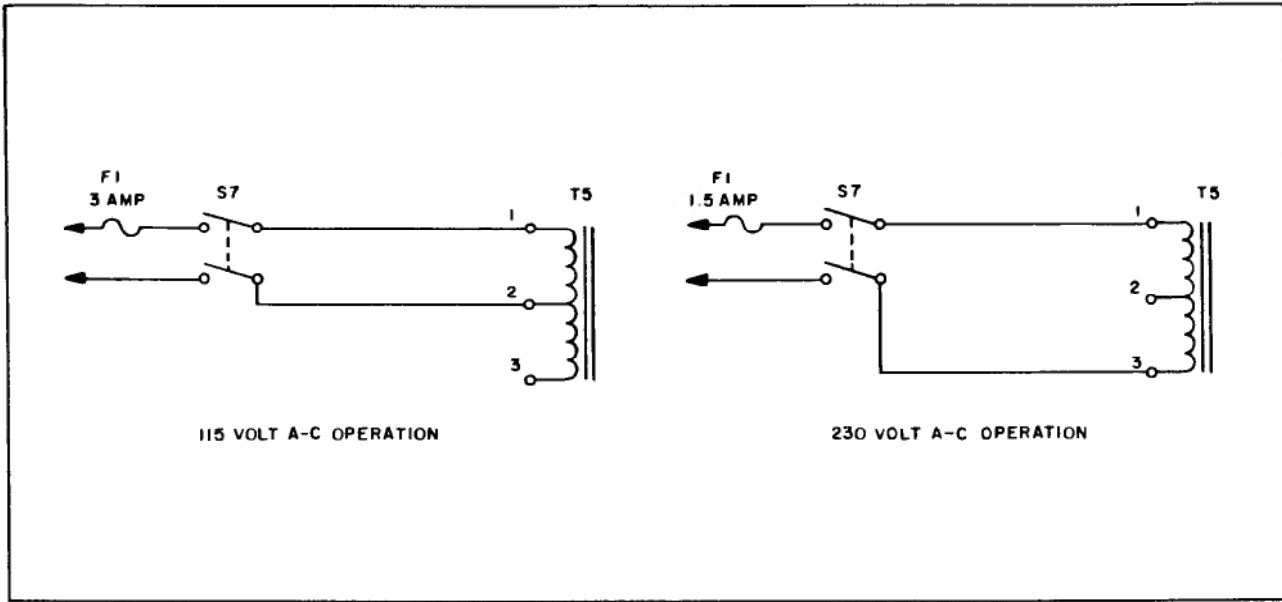


Figure 2-1. Power Supply Changeover Connections

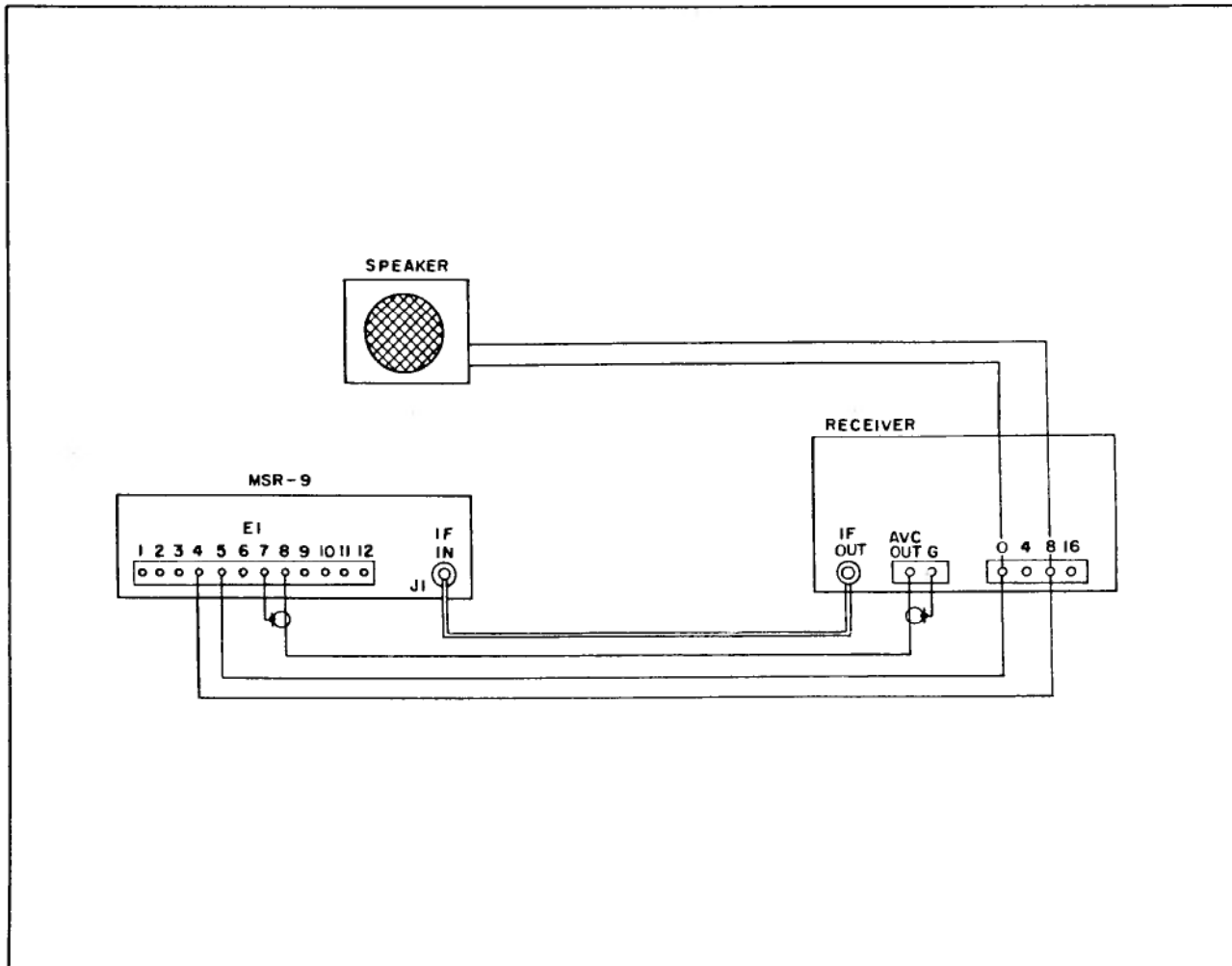


Figure 2-2. Cable Connections for Single Loudspeaker and Receiver

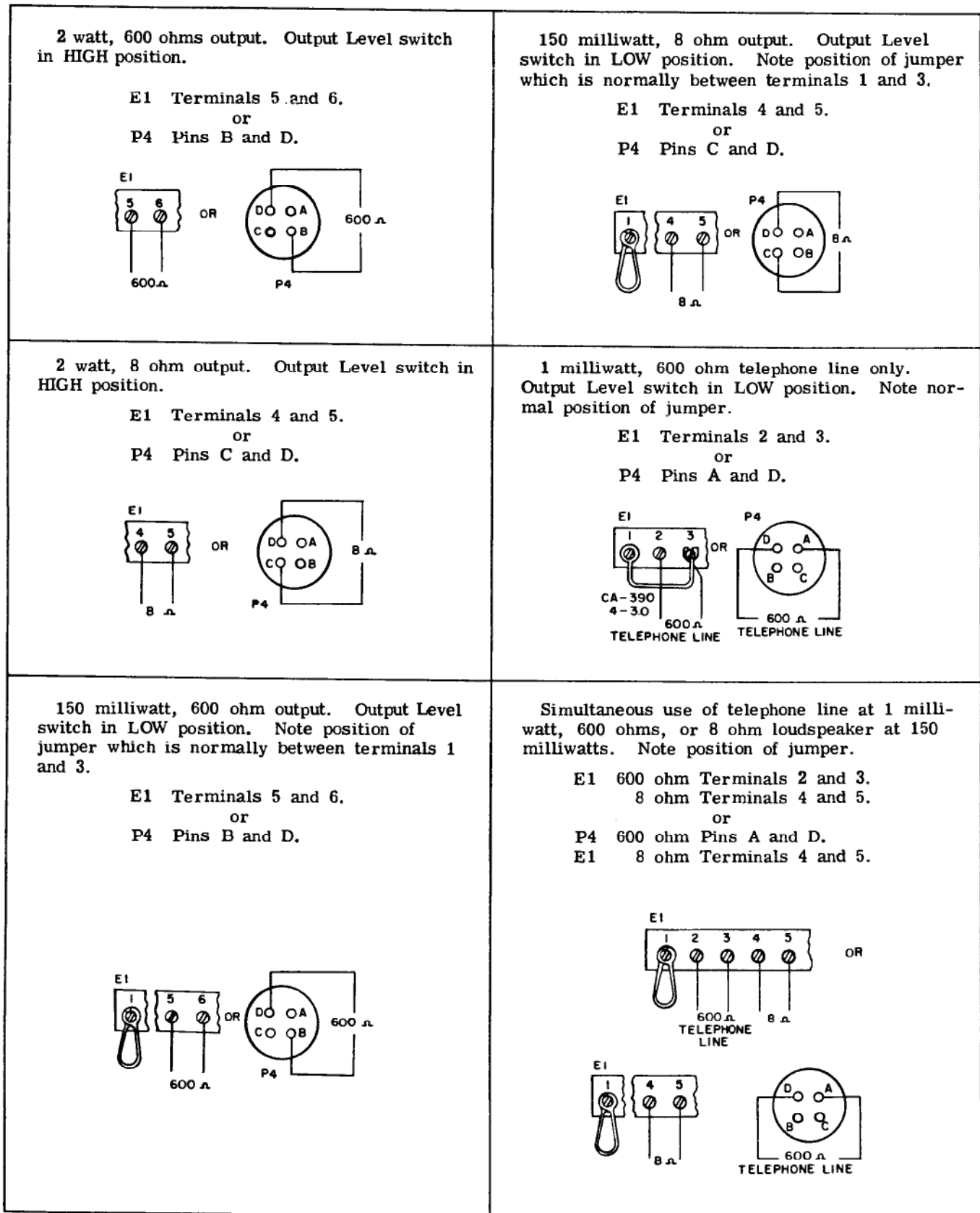


Figure 2-3. Audio Output Connections

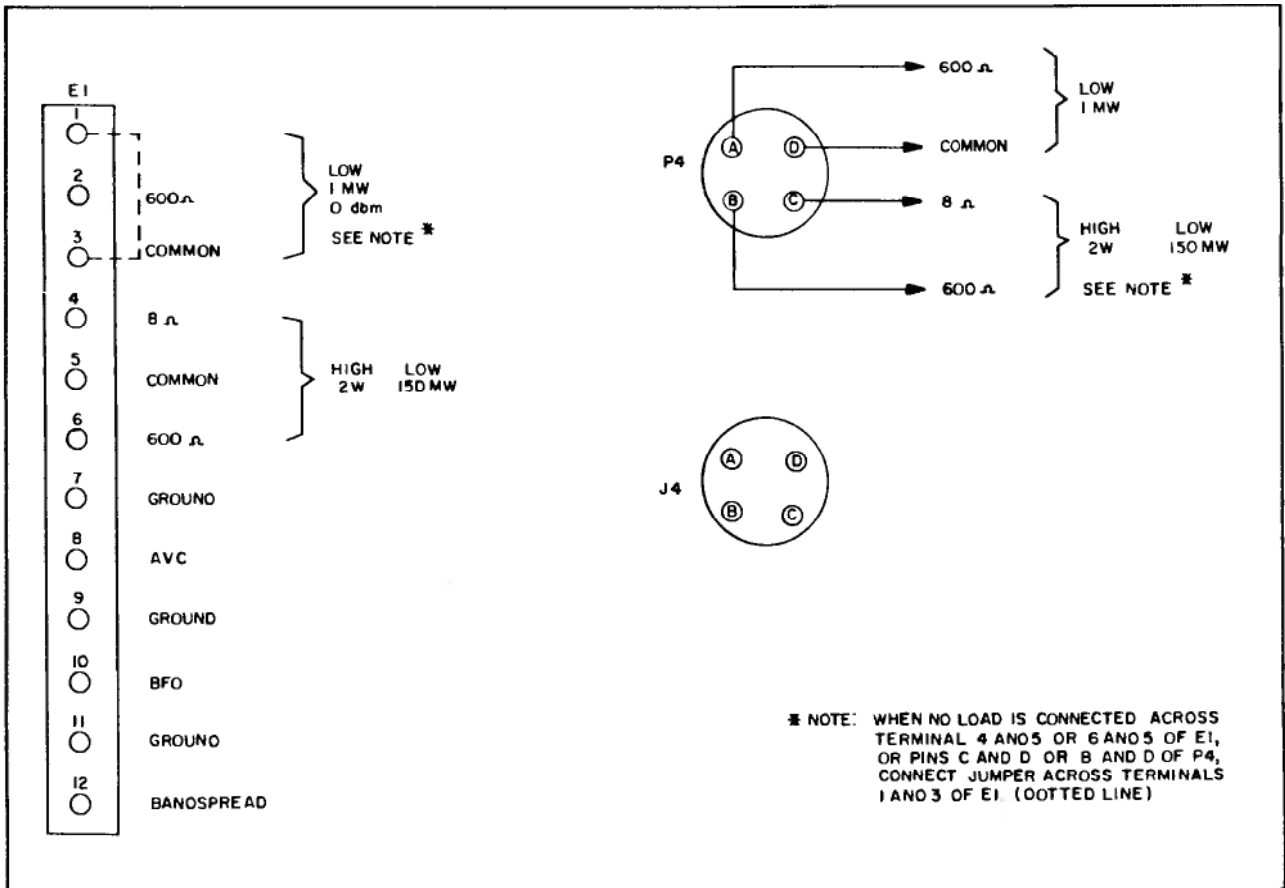


Figure 2-4. Rear Panel Connections, Model MSR-9

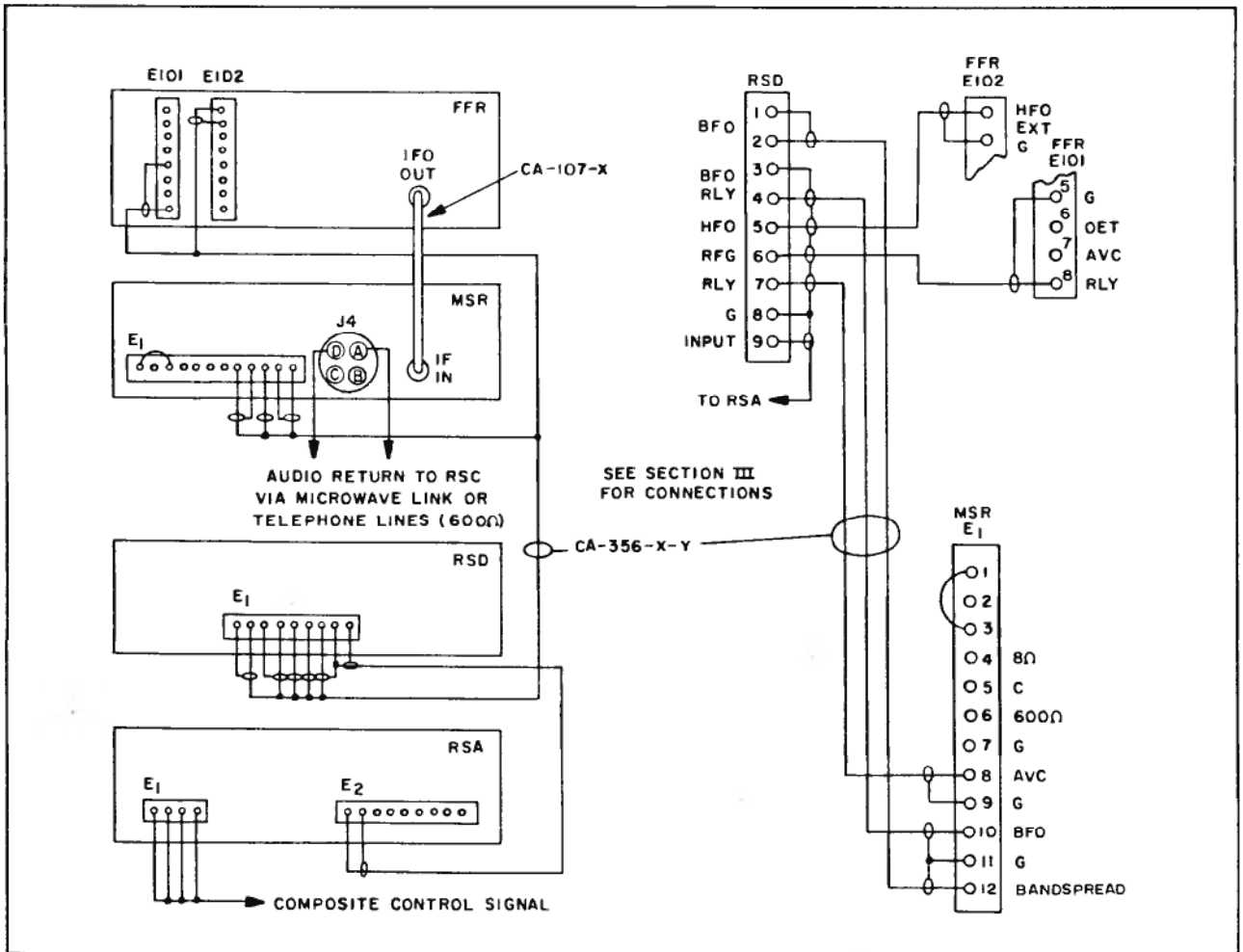


Figure 2-5. Cabling Connections Models MSR/FFR/RSK/RSA

SECTION 3 OPERATOR'S SECTION

3-1. GENERAL.

Operation of the MSR has been designed for a high degree of simplicity and versatility, requiring a minimum of operator effort and skill. The necessary operating controls and indicating devices are all readily accessible on the front panel. All controls requiring only initial settings, the protective fuse and interconnection points are located on the rear of the chassis.

3-2. OPERATING INSTRUCTIONS.

Before attempting to operate the unit, the operator should have a basic knowledge of its function and capabilities. Therefore, it is advisable that the operator familiarize himself with the contents of this manual and making use of the various charts and diagrams provided.

Table 3-1 lists the front panel control designations and their functions, to be used in conjunction with figure 3-1.

a. **NORMAL TUNING OF RECEIVER TO SIGNAL FREQUENCY** - This method is used when the receiver bandwidth is sufficient to pass the sideband with no decrease of sideband amplitude. Employ the normal oscillator frequency equations as described in the associated receiver instruction manual to tune the receiver to the signal frequency.

If the receiver is 5 kc or lower and the unimpaired passage of the desired sideband is required, then the receiver must be tuned off the signal frequency. This method is described in paragraph b. of this section.

(1) Reception of Single Sideband Signals.

- (a) Tune receiver to signal frequency.
- (b) Set MSR and receiver AVC ON and SLOW.
- (c) Set MSR BFO switch ON.
- (d) Set MSR SIDEBAND switch to MANUAL.
- (e) Upper Sideband Reception.

1. Set MSR SIDEBAND switch for upper sideband, indicated by illumination of U-upper sideband indicator lamp.

2. Tune MSR BANDSPREAD control to zero center position for intelligibility.

3. For crystal operation, set MSR SIDEBAND switch to XTAL and place a 472 kc crystal in socket Y2. Tune receiver for intelligibility.

(f) Lower Sideband Reception.

1. Set MSR SIDEBAND switch for lower sideband, indicated by illumination of L-lower sideband indicator lamp.

2. Tune MSR BANDSPREAD control to zero center for intelligibility.

3. For crystal operation, set MSR SIDEBAND switch to XTAL and place a 438 kc crystal in socket Y1. Tune receiver for intelligibility.

(2) Reception of AM Signals.

- (a) Tune receiver to signal frequency.
- (b) Set MSR and receiver AVC ON and FAST.
- (c) Set MSR BFO switch OFF.
- (d) Set MSR SIDEBAND switch to MANUAL.
- (e) Reception on both sidebands.

1. Set MSR SIDEBAND switch for upper sideband, indicated by illumination of U-upper sideband indicator lamp.

2. Tune MSR BANDSPREAD control +2 kc above zero center.

3. For crystal operation, use a 474 kc crystal in socket Y2 with SIDEBAND switch on XTAL.

(f) Reception of Upper Sideband.

1. Set MSR SIDEBAND switch to MANUAL, upper sideband, indicated by illumination of U-upper sideband indicator lamp.

2. Tune MSR BANDSPREAD control +.4 kc above zero center.

3. For crystal operation, set MSR SIDEBAND switch to XTAL and place a 472 kc crystal in socket Y2. Retune receiver .4 kc below the signal frequency. If receiver is crystal controlled, adjust the crystal frequency approximately 400 cps with the crystal adjust control.

TABLE 3-1. OPERATING CONTROLS

SERIAL DESIGNATION	SERIAL DESIGNATION	FUNCTION
FRONT PANEL		
1	L, Lower sideband indicator lamp, DS 1	Indicates selection of lower sideband.
2	U, Upper sideband indicator lamp, DS 2	Indicates selection of upper sideband.
3	BANDSPREAD, variable capacitor, C34	Tunes incoming signals across the band of the bandpass filter. Varies oscillator frequency ± 3 kc.
4	LIMITER ON/OFF, toggle switch, S6	When in ON position, noise limiter circuit is employed to suppress unwanted noise.
5	AVC ON/OFF, toggle switch, S2	When in OFF position, AVC signal at terminal board E1 is grounded.
6	AVC FAST/SLOW, toggle switch, S1	This switch permits selection of AVC time constant. In SLOW position, a slow time constant is selected for SSB, CW and FSK signals. In FAST position, a fast time constant is selected for AM and MCW signals.
7	SIDEBAND MANUAL/XTAL, 4-position selector switch, S4	The bandspread oscillator is variable either with BANDSPREAD control or remotely when in MANUAL position. When in XTAL position, the oscillator is fixed to the frequency of the crystal within the unit. Either upper or lower sidebands are selected by this control.
8	BFO ON/OFF, 2-position rotary selector switch, S5	This switch controls the second oscillator which reinserts the carrier for suppressed carrier operation or the tone for CW operation.

TABLE 3-1. OPERATING CONTROLS (CONT)

SERIAL DESIGNATION	SERIAL DESIGNATION	FUNCTION
9	Power ON indicator lamp, DS 3	Indicates power is applied to MSR.
10	POWER, toggle switch, S7	Applies power to MSR.
11	PHONES, jack J3	Permits monitoring of the audio output without interrupting MSR output.
12	AUDIO GAIN, potentiometer R28	Adjusts level to audio amplifiers.
REAR PANEL		
13	POWER INPUT, 3 male round contact connector, J2	Primary input power connector.
14	Fuse, 3 A/115v, 1.5A/230v, F1	Main input power fuse.
15	Terminal Board, 12 terminals, E1	Tie points for input and output connections.
16	AUDIO OUTPUT, 4 male round contact connector, J4	Audio output connector, mates with plug P2 supplied as loose item.
17	AVC ADJ, potentiometer, R35	Adjust AVC level.
18	INPUT ADJ, potentiometer, R1	Adjusts receiver input level.
19	IF IN, RF connector, J1	Receiver IF input to MSR.
20	OUTPUT LEVEL, DPST toggle switch, S8 (rear chassis apron)	HIGH position - full 2 watts output available for 600 ohm line or 8 ohm loudspeaker. LOW position - 150 milliwatts available for 600 ohm line and 8 ohm loudspeaker, and 0 dbm or 1 milliwatt for 600 ohm telephone line.

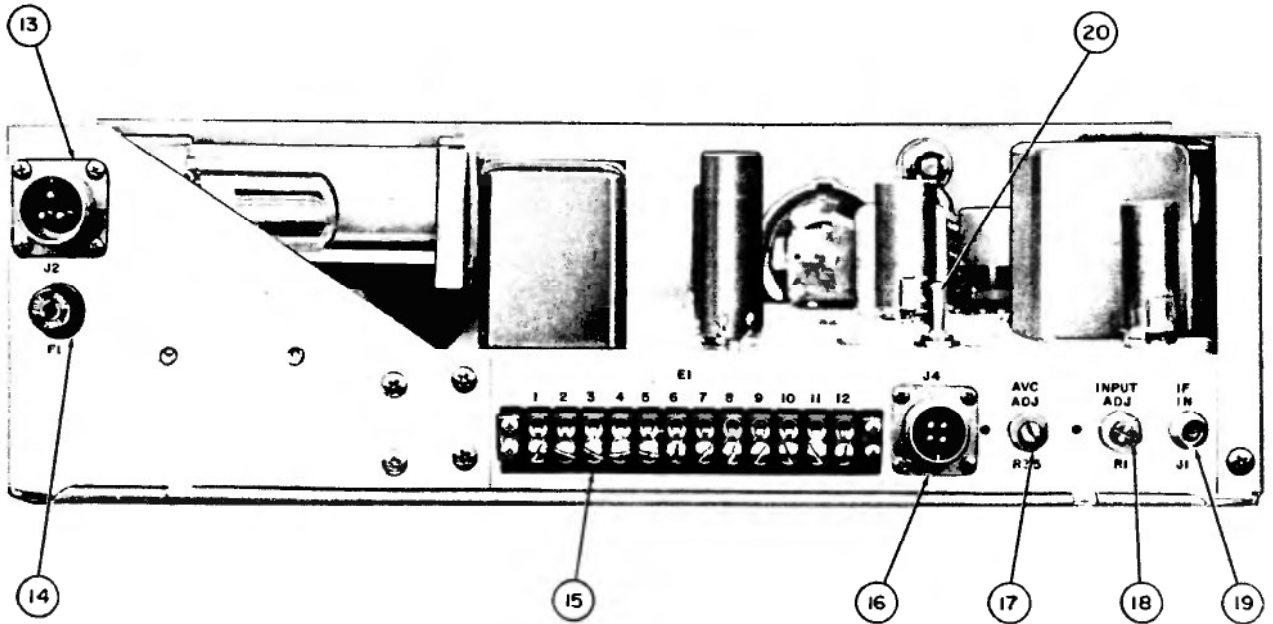
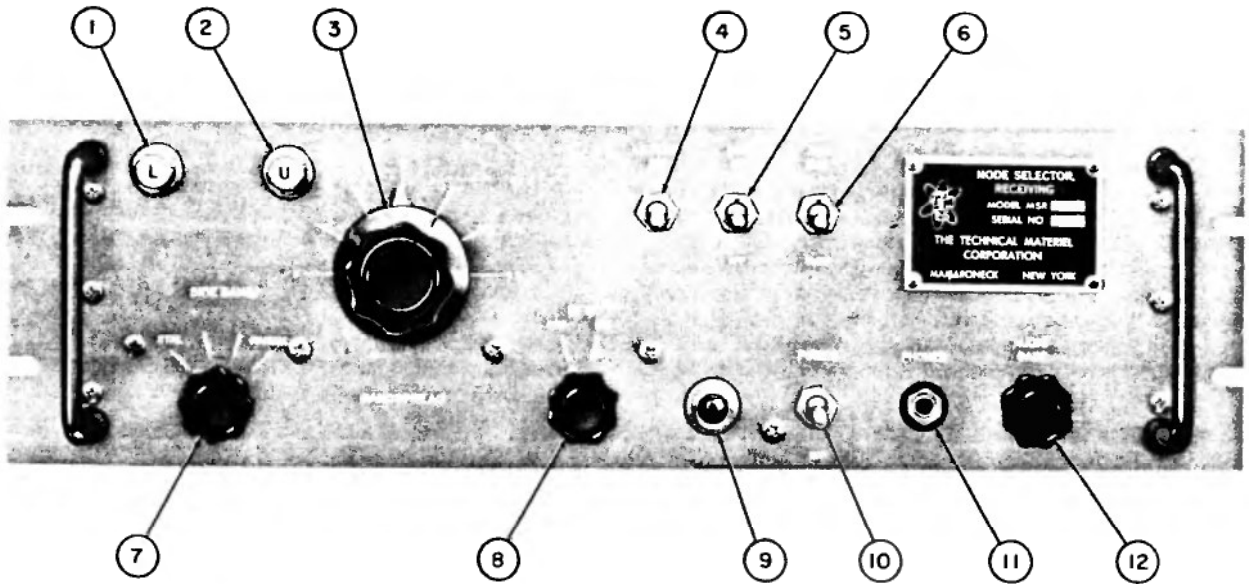


Figure 3-1. Model MSR-9, Operating Controls and Connectors

(g) Reception of Lower Sideband.

1. Set MSR SIDEBAND switch to MANUAL, lower sideband, indicated by illumination of L-lower sideband indicator lamp.

2. Tune MSR BANDSPREAD control -.4 kc below zero center.

3. For crystal operation, set MSR SIDEBAND switch to XTAL and place a 438 kc crystal in socket Y1. Retune receiver .4 kc above the signal frequency. If receiver is crystal controlled, adjust the crystal frequency approximately 400 cps with the crystal adjust control.

(3) Exalted Carrier Operation.

(a) Tune receiver to signal frequency.

(b) Set MSR and receiver AVC ON and FAST.

(c) Set MSR SIDEBAND switch to MANUAL.

(d) Tune MSR as for SSB.

(4) CW and FSK Operation.

(a) Tune receiver to signal frequency.

(b) Set MSR and receiver AVC ON and SLOW.

(c) Set MSR BFO switch ON.

(d) Set MSR SIDEBAND switch to MANUAL.

(e) Tune MSR BANDSPREAD control to obtain desired pitch of signal.

(f) For crystal operation, set MSR SIDEBAND switch to XTAL (upper sideband) and place a 474 kc crystal in socket Y2 for a 2 kc CW note. Tune receiver for any other desired beat note.

b. OFF CENTER TUNING OF RECEIVER - Off center the tuning of the receiver to increase the receiver bandwidth to sideband reception. This method will permit the maximum bandwidth of the system to pass the sideband of the desired signal in the I. F. passband. This is accomplished by detuning the receiver approximately 2 kc in the appropriate direction, above the signal frequency for the upper sideband and below the signal frequency for the lower sideband. The MSR must also be adjusted accordingly to realign the signal.

(1) Reception of Single Sideband Signals.

(a) Set MSR and receiver AVC ON and SLOW.

(b) Set MSR BFO switch ON.

(c) Set MSR SIDEBAND switch to MANUAL.

(d) Upper Sideband Reception.

1. Tune receiver +2 kc above signal frequency.

2. Tune MSR BANDSPREAD control +2 kc above zero center for intelligibility.

3. For crystal operation, set MSR SIDEBAND switch to XTAL and place a 474 kc crystal in socket Y2. Tune receiver for intelligibility.

(e) Lower Sideband Reception.

1. Tune receiver -2 kc below signal frequency.

2. Tune MSR BANDSPREAD control -2 kc below zero center for intelligibility.

3. For crystal operation, set MSR SIDEBAND switch to XTAL and place a 436 kc crystal in socket Y1. Tune receiver for intelligibility.

(2) Reception of AM Signals.

(a) Set MSR and receiver AVC ON and FAST.

(b) Set MSR BFO switch OFF.

(c) Set MSR SIDEBAND switch to MANUAL.

(d) Reception of Upper Sideband.

1. Tune receiver 1.6 kc above signal frequency.

2. Set MSR SIDEBAND switch for upper sideband, indicated by illumination of U-upper sideband indicator lamp.

3. Tune MSR BANDSPREAD control +2 kc above zero center.

4. For crystal operation, set MSR SIDEBAND switch to XTAL and place a 474 kc crystal in socket Y2. Retune receiver 1.6 kc above the signal frequency.

(e) Reception of Lower Sideband.

1. Tune receiver 1.6 kc below signal frequency.

2. Set MSR SIDEBAND switch for lower sideband, indicated by illumination of L-lower sideband indicator lamp.

3. Tune MSR BANDSPREAD control -2 kc below zero center.

4. For crystal operation, set MSR SIDEBAND switch to XTAL and place a 436 kc crystal in socket Y1. Retune receiver 1.6 kc below the signal frequency.

(3) Exalted Carrier Operation.

- (a) Set MSR and receiver AVC ON and SLOW.
- (b) Set MSR BFO switch ON.
- (c) Reception of sidebands. See paragraph

(1).

c. REMOTE OPERATION.

(1) FUNCTIONS.

When this unit is used in remote operation with the TMC Model RCR Remote Control Receiver System, the RCR will control the MSR in conjunction with the TMC Model FFR communications receiver in a remote installation.

(2) REMOTE TUNING.

Remote operation of the MSR in the RCR system requires that the RSC, MSR and FFR be aligned correctly to the desired signal. In setting up the system, the methods described in the RCR instruction manual are followed, keeping in mind, the functions of the various controls on the RSC which operate the MSR. When it is determined that the RCR system is operating correctly, align the RSC, MSR and FFR to receive the desired signal. At the control site set the RSC controls as follows:

- HFO control - Centered at 0
- BFO switch - ON
- BFO control - Centered at 0
- AVC switch - ON

At the remote site, tune the MSR and the FFR receiver as described in the tuning procedure. Once the receiver is tuned, lock its tuning dial in position. Control of the equipment is now returned to the control site.

At the control site, the RSC controls now perform the functions as described in paragraph c. (1). When receiving AM signals, the MSR BANDSPREAD control is inoperative since the BFO switch is OFF. Operation of the HFO control is required to tune the desired AM signal into the MSR.

3-3. OPERATOR'S MAINTENANCE.

The operator may, at certain times, be required to perform various aspects of operator's maintenance. This type of maintenance may consist of simply keeping the unit clean and observing for tight inter-connecting cable connections.

However, should normal operating procedures produce unsatisfactory results, a quick check of the power supply will very often determine the cause of trouble. A pilot light indicates when power is being applied to the unit. Should the pilot lamp fail to light, check the fuse at the rear of the chassis. A blown fuse should be replaced with one of equal value. If the fuse blows again, the unit should be checked for shorts. The most common causes of operational failure is usually due to tube failure. Checking the tubes will often save many hours of unnecessary troubleshooting.

SECTION 4

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

The combination of a specially designed filter circuit and a frequency bandsread oscillator provides sharp discrimination between a desired signal and undesired adjacent interference. This is accomplished by easy tuning of the bandsread oscillator. The BANDSPREAD control tunes this oscillator over a restricted range of ± 3 kc from its center frequency. Remote tuning of this function is accomplished with a reactance circuit. The frequency of the 1st oscillator is centered at 472 kc for reception of the upper sideband and 438 kc for reception of the lower sideband. These frequencies can be made more stable by switching in crystals with the SIDEBAND switch.

The selection of upper or lower sideband is also made with the SIDEBAND switch. The indication of the sideband selected is shown by front panel lamps.

The carrier for SSB, exalted AM or CW is reinserted at the product detector by the second oscillator or BFO. This fixed oscillator is turned on or off by the front panel BFO switch or a remotely controlled switch. A low pass filter passes the desired products which are now at audio frequency. The audio amplifier stages provide a high level output, 2 watts for a 600 ohm line or 8 ohm loudspeaker; and two low level outputs, 0 dbm for telephone lines and 150 milliwatts for 600 ohm line or 8 ohm loudspeaker.

Figure 4-1 is a simplified picture of how the MSR operates in combination with a double conversion receiver. Note that in the receiver conversion process, when the 1st oscillator is shown the RF signal frequency, a reversal of sideband positioning occurs in the IF, which places the lower sideband on the upper side of the carrier and the upper sideband on the lower side. In any subsequent conversion process a reversal again occurs if the oscillator is above the IF, however, no reversal occurs if the oscillator is below the IF. With a normal single or double conversion receiver, the sidebands are as shown in figure 4-1. But, where the sidebands are reversed, it is necessary to remove and switch the front panel sideband indicators as explained in Section 2.

The receiver chosen is one in which the 1st IF is 3.955 mc, however, other combinations are also usable. For example, had the receiver 1st IF been 2.5 mc and the incoming signal still centered at 10 mc, the HF oscillator would have been at 12.5 mc. Still further, had the receiver been of the single conversion type, then the HF oscillator would have

been at $10 \pm .455$ or 10.455 mc. In each case, the end result is the injection of a signal centered at 455 kc into the MSR. The MSR then beats its internal 1st oscillator with the input signal so that the imaginary or real carrier appears at 17 kc and one or the other sideband fits within the filter limits.

The same result can be obtained with the internal frequency except that now the MSR 1st oscillator has to be shifted to a new point which will still result in the real or imaginary carrier appearing at 17 kc. Since the MSR oscillator, in the MANUAL position, will produce products in the filter region only when the signal input is near 455 kc, it cannot be used with other IF's. However, in XTAL position, a crystal may be chosen which will permit operation with almost any IF (using the equations of figures 4-1 or 4-2).

Each mixer, in both the receiver or MSR, operates in such a way that a band of frequencies representing the carrier and its sidebands is simply shifted so that they appear within the bandpass of the circuits which follow. If the receiver has a wide IF (perhaps 14 kc at the 3 db points) then the system bandpass will be that of the MSR filters (-3 db at 350 cps and 3.2 kc). If on the other hand, the receiver is of the Navy IF type (perhaps +2.5 kc at the 6 db points) then the system bandpass becomes that of the receiver IF, because it is the narrowest. The MSR filter accepts only one sideband at a time, therefore, the other sideband is simply occupying receiver IF space which is not being used. In the case of single sideband, this waste of receiver bandwidth is even more apparent because a segment of the receiver IF is completely unoccupied. If, on the other hand, the receiver is tuned so that the unused sideband slides off the edge of the bandpass curve and the desired sideband occupies the center of the bandpass, then the most efficient use is being made of the spectrum available. In this case, more information may be transmitted and receiver (for example, in the form of more FSK channels) or improved audio quality will result.

a. FOR UPPER SIDEBAND RECEPTION.

(1) Receiver - Choose the oscillator injection frequency (manual or crystal) to be 2 mc above the normal injection frequency.

(2) MSR - Use 474 kc crystal or set BANDSPREAD tuning dial 2 kc above center.

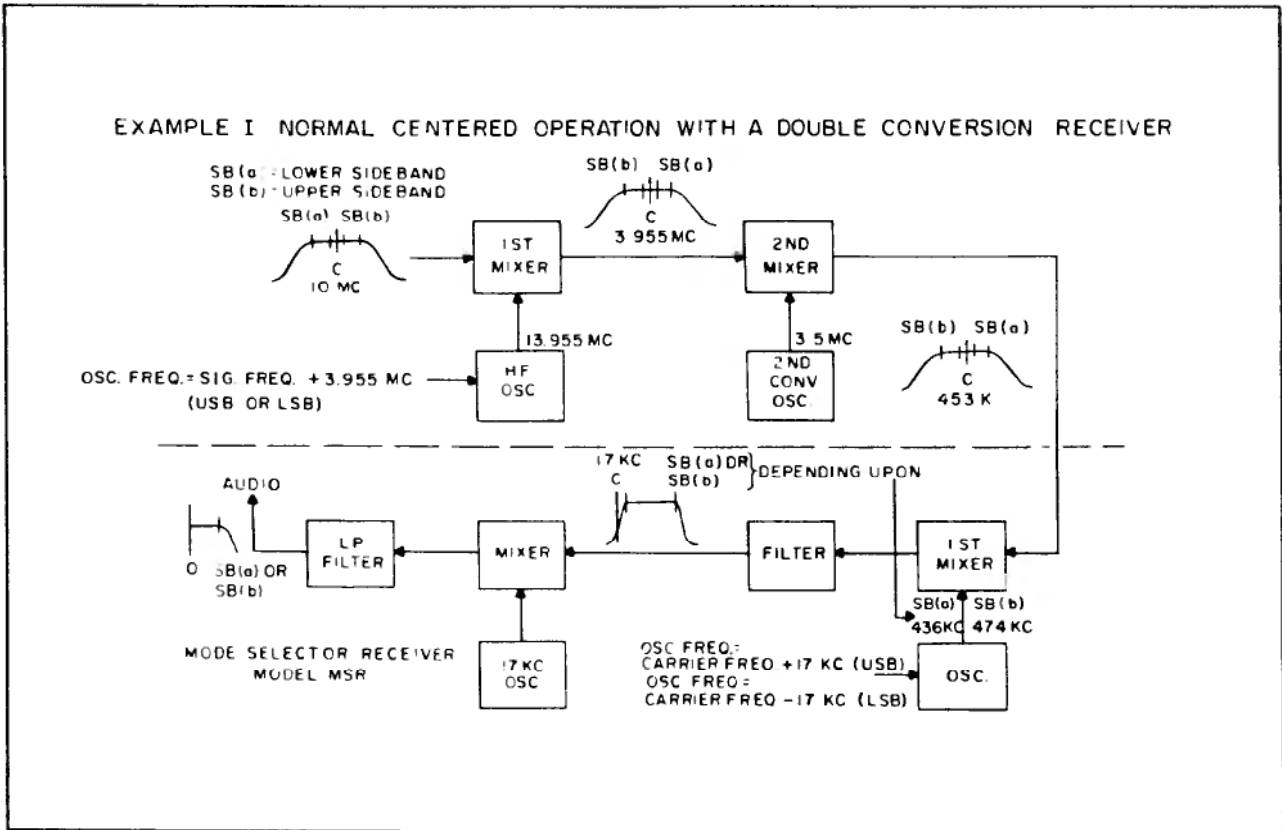


Figure 4-1. Block Diagram (Example 1) MSR/Double Conversion Receiver

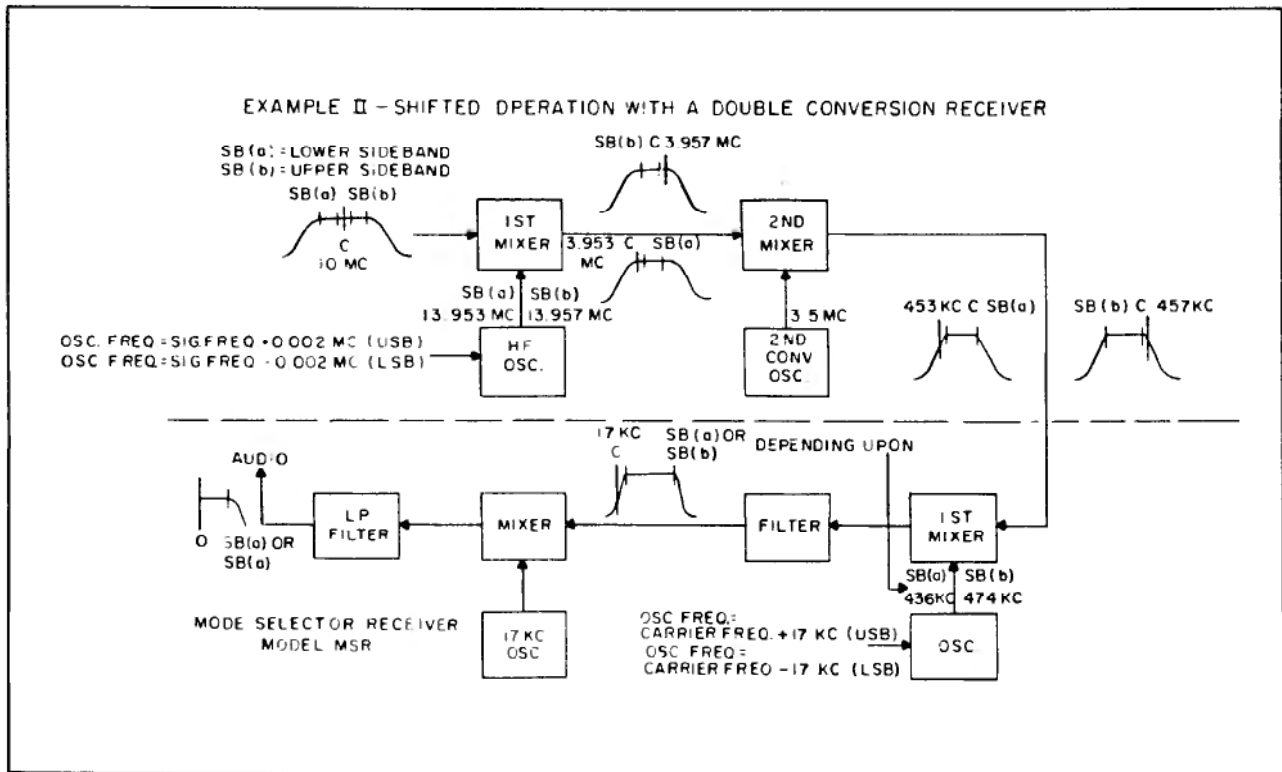


Figure 4-2. Block Diagram (Example 2) MSR/Double Conversion Receiver

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b. FOR LOWER SIDEBAND RECEPTION.

(1) Receiver - Choose the oscillator injection frequency (manual or crystal) to be 2 kc below the normal injection frequency.

(2) MSR - Use 436 kc crystal or set BAND-SPREAD tuning dial 2 kc below center.

For example, suppose normally centered operation (figure 4-1) is desired with a double conversion receiver having a 1st IF of 3.5 mc, a 2nd IF of 350 kc and the received signal is centered at 10 mc, the HF oscillator must then be at $10 + 3.5$ or 13.5 mc. The second oscillator must be at 3.15 mc to produce the 350 kc 2nd IF. Then, in order to bring the real or imaginary carrier to 17 kc, a 367 kc ($350 + 17$) or a 333 kc ($350 - 17$) crystal must be inserted in the MSR to produce the upper or lower sideband.

c. In all the preceding paragraphs, the assumption has been made that the real or imaginary carrier will appear at 17 kc within the MSR. This will be so in all cases of single sideband or exalted carrier operation. However, in normal AM, CW or FS operation, the incoming signal must be shifted for several reasons:

(1) Normal AM Operation.

In this case, the 17 kc local oscillator within the MSR is turned off and the signal must supply its own carrier. If the carrier were brought in at 17 kc, it would be down on the slope of the filter and proper sideband to carrier amplitude relationship would be disturbed. For this reason, the carrier must be off-set by about 400 cps (to 17.4 kc). This may be done by means of the variable 1st oscillator within the MSR or by shifting the receiver by the same amount if crystals are used in the MSR.

(2) CW Operation.

If the signal were centered at 17 kc, a zero beat would result with the MSR 17 kc oscillator and nothing would be heard. For this reason, either the receiver oscillator or the MSR oscillator must be shifted by an amount equal to the beat note required (usually about 1 kc).

(3) FS Operation.

As in CW operation (above), the receiver oscillator or MSR must be shifted, but in this case, by an amount which would produce a space at 2125 cps and a mark at 2975 cps. The standard mark and space beat notes are used and the amount of oscillator shift will, of course, be determined by the tones required.

4-2. CIRCUIT DESCRIPTION.

The block diagram, shown in figure 4-3, presents a simplified outline of the functions of the MSR unit. Detailed circuitry descriptions of the unit are also

provided, supported by simplified schematic diagrams (figures 4-4 through 4-9).

MXER V1, 1st and 2nd IF AMPLIFIERS V3a, V3b (figure 4-4).

A 455 kc IF input signal from a receiver is applied at IF INPUT connector J1 where it is coupled through and controlled by INPUT ADJ potentiometer R1. This input signal is applied to Mixer V1 where it is mixed with the output of 1st Oscillator V2.

The mixed or difference of the two frequencies is coupled through a bandpass filter Z1 to the input of 1st IF Amplifier V3a and on to 2nd IF Amplifier V3b.

The amplified output of V3b is then distributed to 3rd IF Amplifier V4a, AVC Amplifier V4b and to a noise limiter circuit.

1st OSCILLATOR V2, REACTANCE MODULATOR V6 (figure 4-5).

The 1st Oscillator V2 provides a tunable frequency source for correctly tuning the signal in the bandpass filter Z1. It may be accomplished either manually with BANDSPREAD control C34 or crystal controlled, selected by SIDEBAND MANUAL/XTAL switch S4.

For remote tuning, a ± 4.5 vdc input to the Reactance Modulator V6 via terminal 12 of terminal board E1, is sufficient to vary the oscillator ± 3 kc. This voltage may be obtained from the BFO channel of TMC Model RCR, Remote Control Receiver System.

NOISE LIMITER, 3rd IF AMPLIFIER V4a, AVC AMPLIFIER V4b (figure 4-6).

The output of 2nd IF Amplifier V3b is distributed to a noise limiter circuit controlled by front panel LIMITER switch S6, to the input of 3rd IF Amplifier V4a and to AVC Amplifier V4b and its associated circuitry.

The AVC Amplifier V4b output is coupled to terminal 8 of terminal board E1 for receiver AVC control. With AVC toggle switch S1 in FAST position, a fast time constant is employed to control signals which have an ever present component, i.e. AM, MCW, FS. When in SLOW position, a slow time constant is employed, for SSB and CW signals.

With AVC toggle switch S2 in OFF position, AVC output to receiver is removed.

PRODUCT DETECTOR V7, 2nd OSCILLATOR V9 (figure 4-7).

The 2nd Oscillator V9 is functionally an oven crystal controlled BFO providing a stable 17 kc reinsertion carrier for SSB and Exalted AM, and produces the beat note for CW and FS signals. The 2nd Oscillator V9 and Product Detector V7 are activated either remotely, at terminal 10 of terminal board E1, or by BFO switch S5.

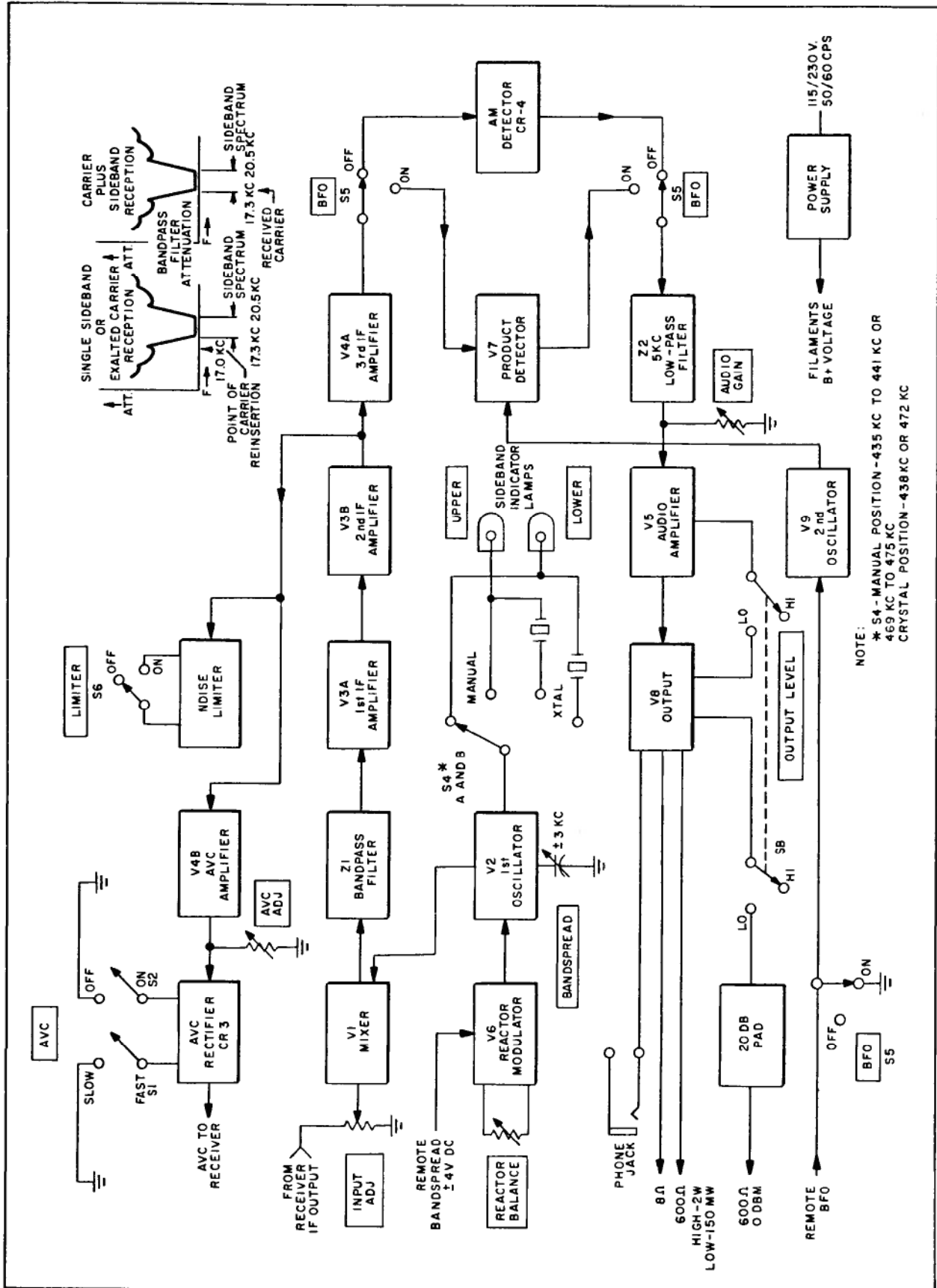


Figure 4-3. Block Diagram, Model MSR-9

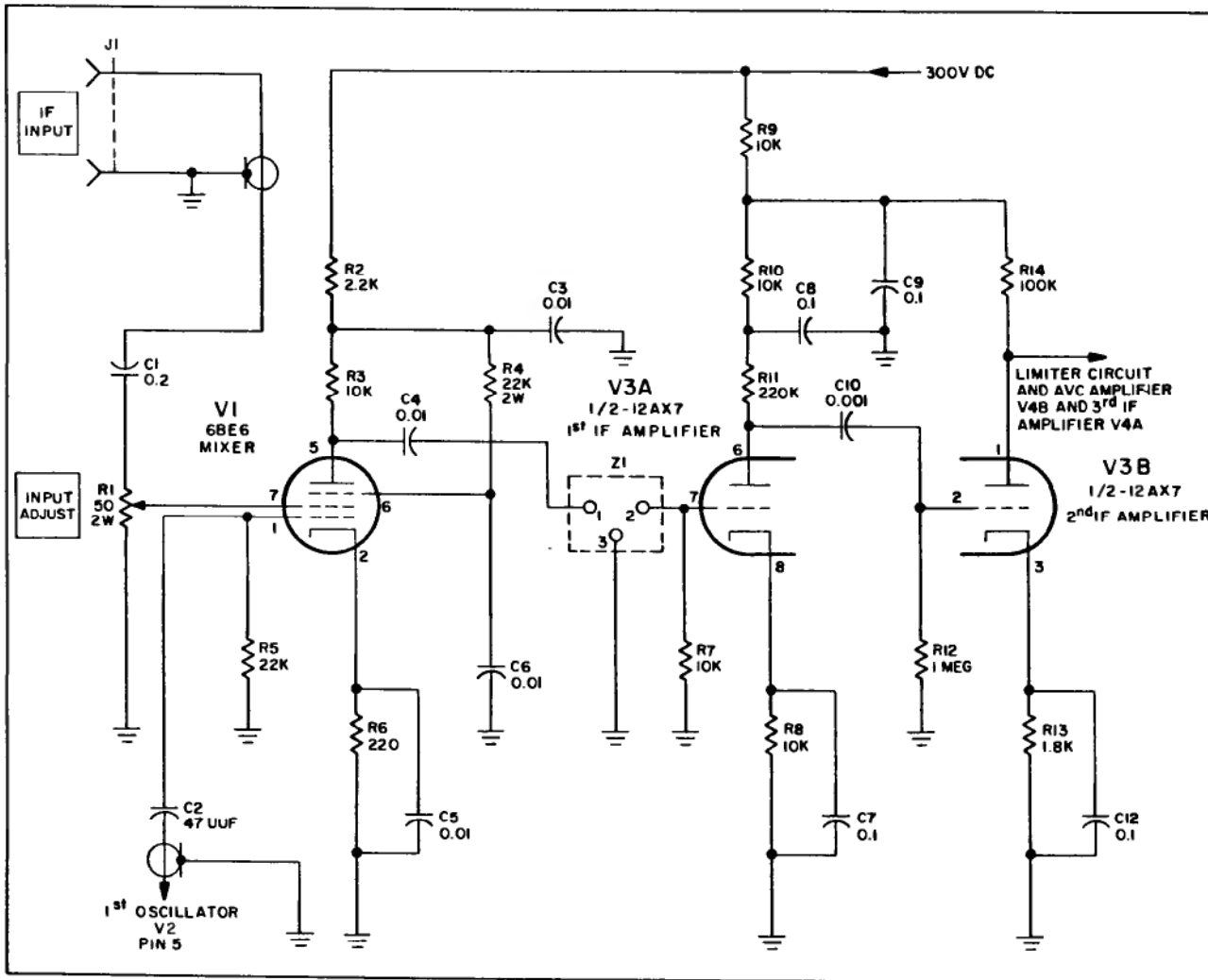


Figure 4-4. Mixer, 1st and 2nd IF Amplifiers, Simplified Schematic Diagram

The 2nd Oscillator V9 output is applied to the input of Product Detector V7 where it is detected with the IF output of V4a and coupled through a 5 kc low-pass filter Z2. The output of Z2 is then coupled through AUDIO GAIN potentiometer R28 to the input of Audio Amplifier V5 for further amplification.

When BFO switch S5 is in ON position, the cathode circuits of V7 and V9 are grounded causing activation.

When BFO switch S5 is in OFF position, the 3rd IF Amplifier V4a output is detected by AM detector CR4.

AUDIO AMPLIFIER, OUTPUT (figure 4-8).

Audio Amplifier V5 receives at its input the resultant MSR output at an audio level, to be amplified. The amplified output is then coupled to Output V8 and its associated circuitry, providing three levels of output.

With the OUTPUT LEVEL switch S8 in the HIGH position, the full 2 watts output is available for the 600 ohm line or 8 ohm loudspeaker. With the OUTPUT LEVEL switch 8 in the LOW position, the gain of the amplifier is reduced so that 150 milliwatts is available for the 600 ohm line and 8 ohm loudspeaker, and 0 dbm or 1 milliwatt for 600 ohm telephone line.

A PHONES jack J3 on the front panel permits monitoring of the output without any circuit interruption.

POWER SUPPLY (figure 4-9).

The MSR employs a standard type full wave rectified, voltage regulated power supply. It is factory wired for 115 vac input power and may be converted for 230 vac operation by making the necessary wiring changes shown in figure 2-1.

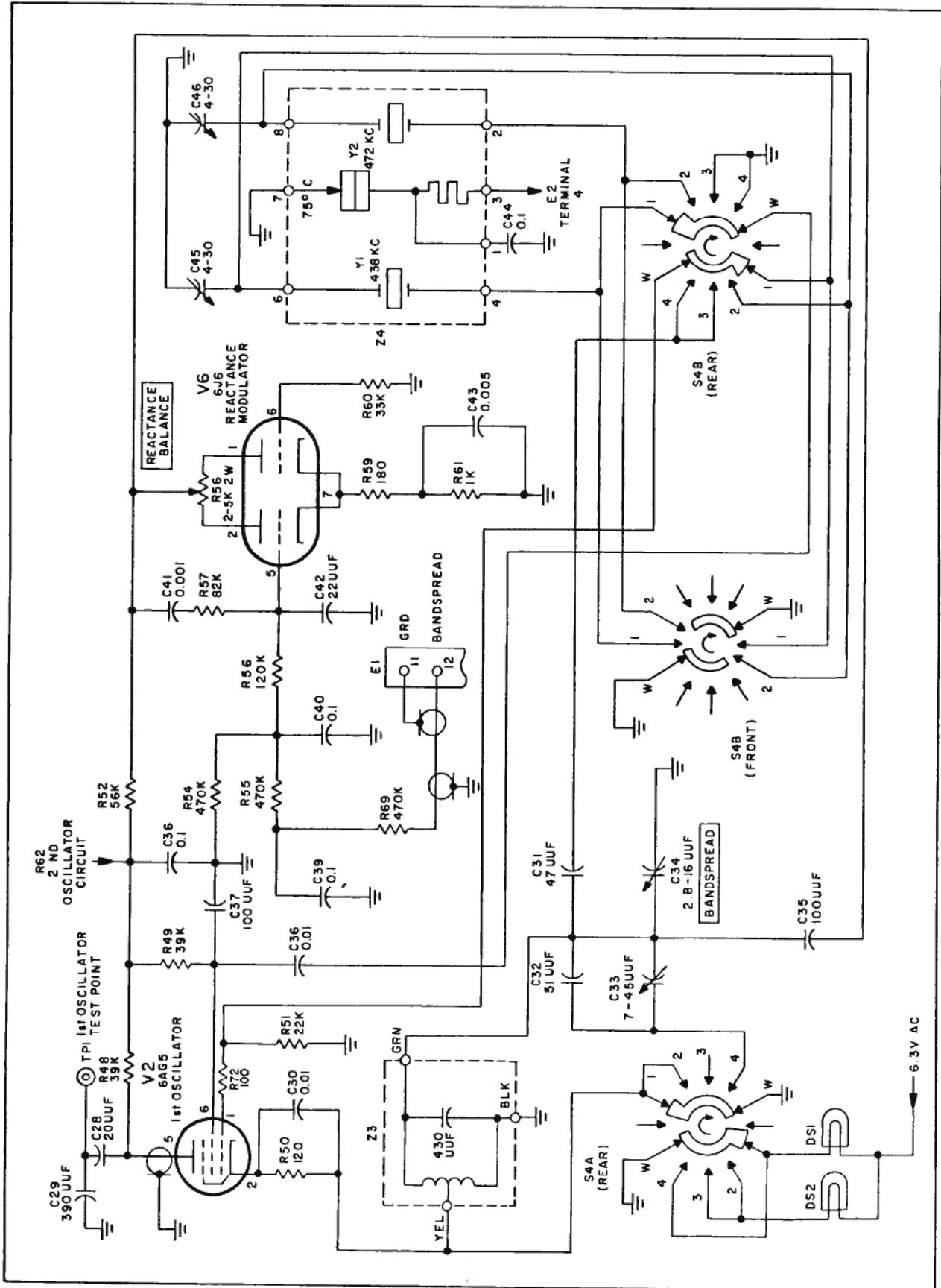


Figure 4-5. 1st Oscillator and Reactance Modulator, Simplified Schematic Diagram

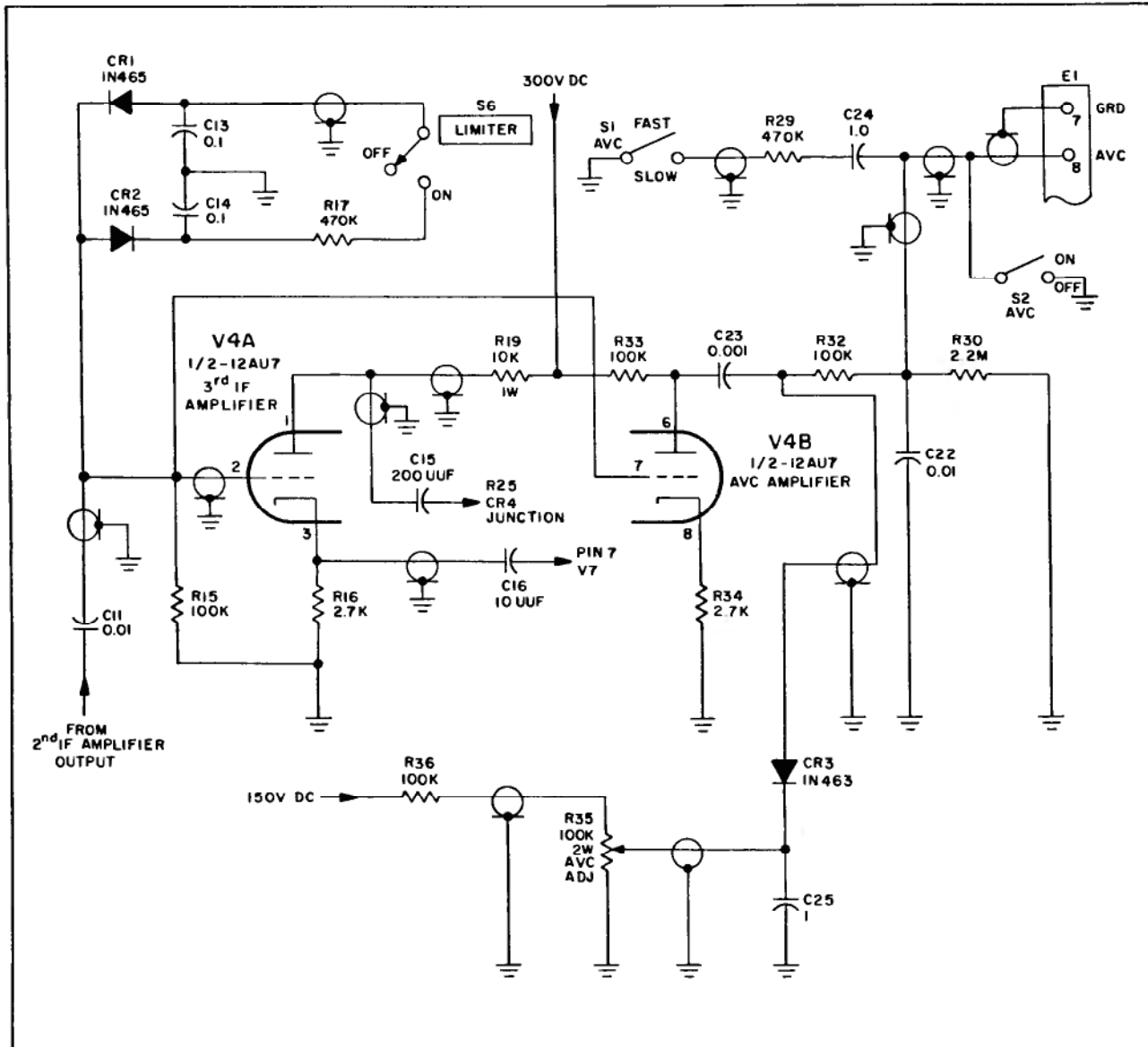


Figure 4-6. Noise Limiter, 3rd IF Amplifier, AVC Amplifier Simplified Schematic Diagram

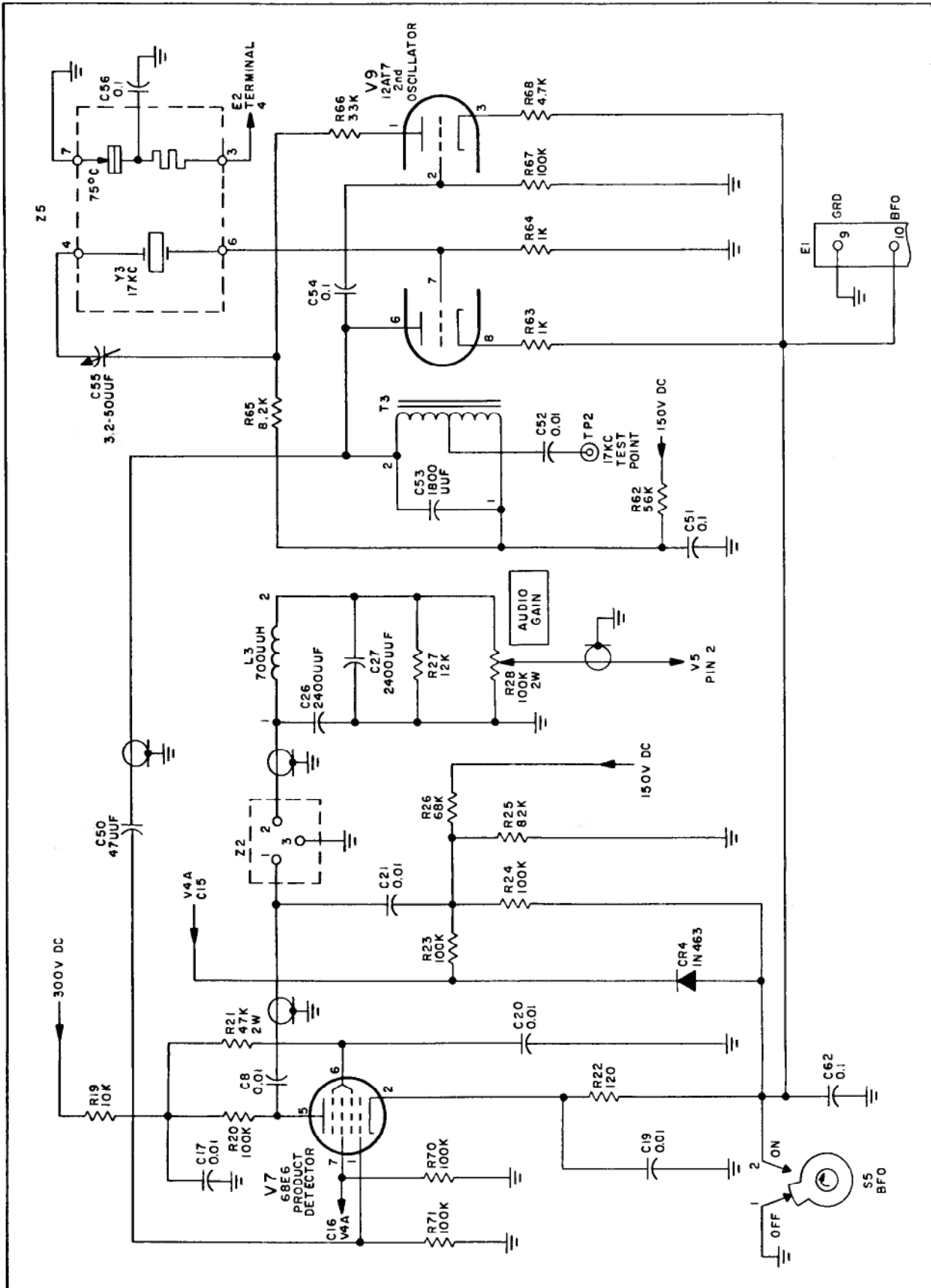


Figure 4-7. Product Detector, 2nd Oscillator, Simplified Schematic Diagram

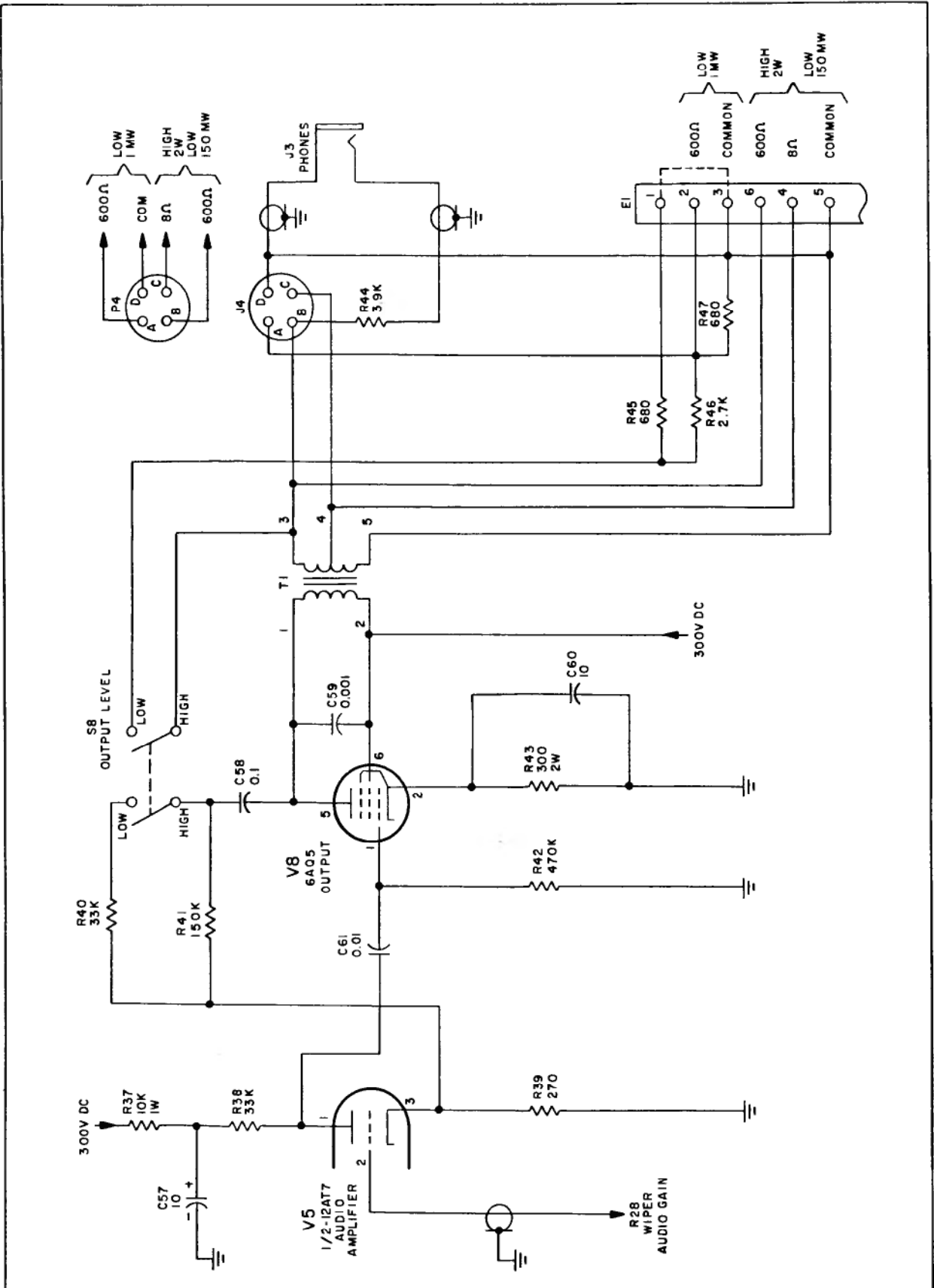


Figure 4-8. Audio Amplifier, Output, Simplified Schematic Diagram

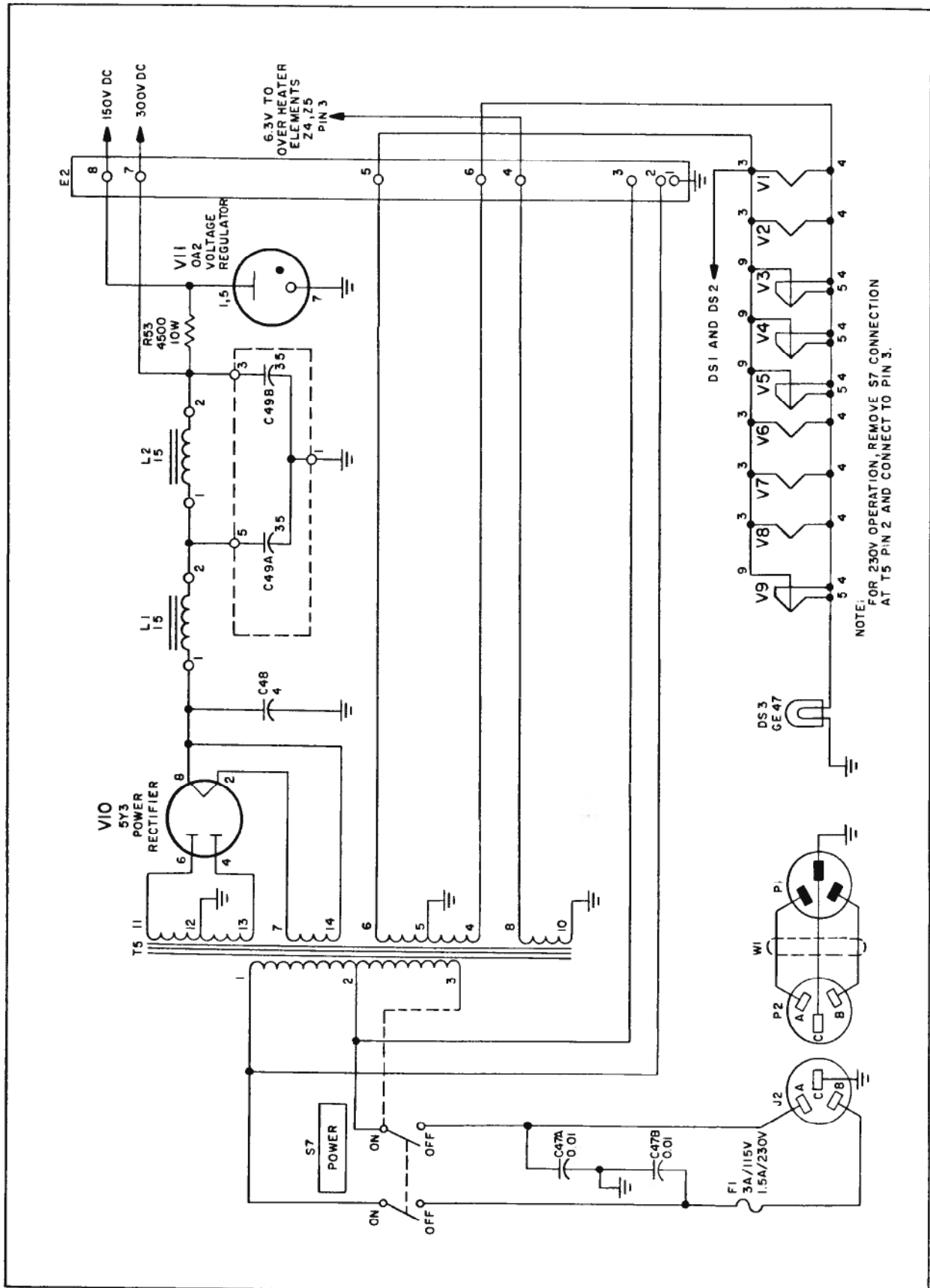


Figure 4-9. Power Supply, Simplified Schematic Diagram

SECTION 5 TROUBLESHOOTING

5-1. INTRODUCTION.

This section explains how to locate and diagnose equipment troubles and maladjustments. By proper use of the various troubleshooting aids shown in this section, the technician can locate and diagnose the particular fault at hand.

The following aids to troubleshooting are provided:

- a. Simplified schematic diagrams (figures 4-4 through 4-9).
- b. Voltage and resistance measurements (tables 5-2 through 5-4).
- c. Troubleshooting procedures (paragraph 5-3).
- d. Component layout diagram (figure 5-1).
- e. List of test equipment required (table 5-1).

5-2. TROUBLESHOOTING TECHNIQUES.

a. GENERAL CONSIDERATIONS - When a piece of equipment has been operating satisfactorily and suddenly fails, the cause of failure may be apparent either because of circumstances occurring at the time of failure or because of symptoms due to past failures. Therefore, the first check is to ascertain that proper equipment operating voltage is present and that all tubes and fuses are in proper operating condition. A visual check for loose or frayed inter-connecting cables may also eliminate further investigation.

If the above mentioned checks fail to locate the fault, the unit should be removed from the equipment rack, dust covers removed, and visually checked, section by section for burned elements, charring, corrosion, arcing, excessive heat, dirt, dampness etc. If the fault is still not located, the technician should then proceed with resistance and voltage checks.

b. VOLTAGE AND RESISTANCE MEASUREMENTS - The voltage and resistance values shown in the voltage and resistance measurement charts (tables 5-2 through 5-4) are nominal measurements taken under the conditions listed below each chart. Large deviations from the normal measurements shown should be carefully investigated. During this process, the use of an accurate schematic diagram, provided in Section 8, will prove to be of great assistance.

5-3. TROUBLESHOOTING PROCEDURES.

The following troubleshooting procedures are derived from factory test procedures, modified for troubleshooting purposes. Table 5-3 lists the necessary test equipment required.

a. POWER SUPPLY - Perform resistance check with line cord disconnected and POWER switch ON. Proceed as follows:

(1) Measure from terminal 2 of E2 to ground. Observe for a normal open indication.

(2) Measure from terminal 3 of E2 to ground. Observe for a normal open indication.

(3) Measure from terminal 7 of E2 to ground. Observe for a normal indication of approximately 40 K ohms.

(4) Measure from terminal 8 of E2 to ground. Observe for a normal indication of approximately 40 K ohms. Perform voltage check with line cord connected to 115 volts a-c source, POWER switch ON. Proceed as follows:

(5) Measure from terminal 2 to terminal 3 of E2. Observe for a normal indication of 115 volts a-c.

(6) Measure from terminal 7 of E2 to ground. Observe for a normal indication of +300 volts d-c.

(7) Measure from terminal 8 of E2 to ground. Observe for a normal indication of +150 volts d-c.

b. AUDIO CHANNEL CHECK - Set MSR controls as listed below:

INPUT ADJ, R1 fully clockwise

AVC ADJ, R35 fully counter-clockwise

BFO, S5 ON

AUDIO GAIN, R28 . . . fully clockwise

OUTPUT LEVEL, S8 . HIGH

Connect a 600 ohm 10 watt load resistor across terminals 5 and 6 of terminal board E1.

Connect a VTVM and oscilloscope across the 600 load.

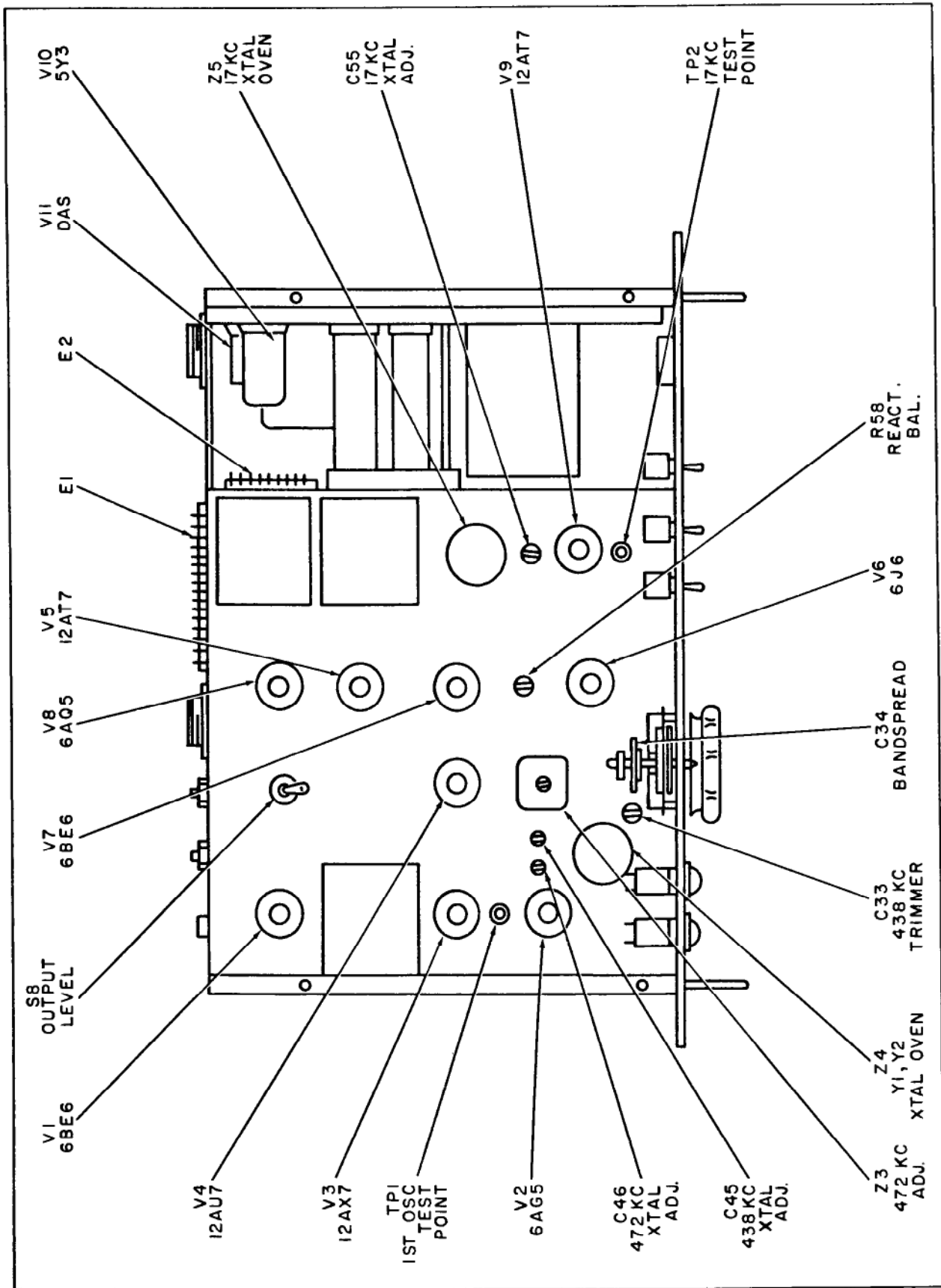


Figure 5-1. Component Layout MSR-9 Top View

(1) Connect audio signal generator, set at 1 kc, to pin 7 of V7.

(2) Adjust input voltage for 36 volts output. Indication on oscilloscope should show waveform just starting to clip.

(3) Measure a-c voltage at pin 7 of V8. Normal indication is between 5.4 and 7.5 volts.

(4) Measure voltage at pin 2 of V5. Normal indication is between .3 and .55 volt.

(5) Measure input voltage at pin 7 of V7. Normal indication is between .1 and .37 volt.

(6) Check frequency response of low-pass filter through audio amplifier keeping the input constant.

(7) The output voltage across the load must be as follows:

1000 cps . . . 36 v

350 cps . . . not less than 30 v

4500 cps . . . not less than 30 v

5000 cps . . . less than 25 v

(8) Disconnect audio signal generator and measure the output voltage. Normal indication is greater than 40 db down.

(9) Reconnect audio signal generator to pin 7 of V7 and adjust for 36 volts output across the load at 1000 cps.

(10) Set OUTPUT LEVEL switch S8 to LOW. Output should drop to a level between 8 and 14 volts.

(11) Connect a 600 ohm, 1 watt load resistor across terminals 2 and 3 of E1. Voltage across the load should be between 0.8 and 1.5 volts.

(12) Set OUTPUT LEVEL switch S8 to HIGH. Voltage across load should drop to zero.

(13) Disconnect audio signal generator.

c. PRODUCT DETECTOR AND SECOND OSCILLATOR.

(1) Connect frequency counter to 17 kc second oscillator test point TP2.

(2) Tune 17 kc adjustment C55 for $17,000 \pm 1$ cps.

(3) Disconnect frequency counter.

d. I. F. AMPLIFIERS.

(1) Connect audio signal generator through a 1 megohm resistor to pin 7 of V3 set at approximately 18.0 kc.

(2) Apply just enough drive to obtain 36 volts output across the load (terminals 5 and 6 of E1).

(3) Measure the following a-c voltages:

pin 7 of V3 0

pin 2 of V3 0.3 ± 0.6 volts

pin 2 of V4 6.8 ± 1.4 volts

pin 7 of V4 6.8 ± 1.4 volts

pin 1 of V4 48 ± 10 volts

pin 3 of V4 2.8 ± 0.6 volts

(4) Disconnect audio signal generator.

e. MIXER OPERATION.

(1) Remove V3, 12AX7.

(2) Set BFO switch S5 OFF.

(3) Connect audio signal generator to IF INPUT connector J1 at a level of 1 volt RMS.

(4) Measure pin 7 of V3, tuning the audio signal generator frequency for a peak reading on meter. The voltage reading a peak should be 1.8 to 3 volts.

(5) Vary the audio signal generator frequency, checking the output drop on the meter as follows:

(a) From 17.4 to 20.5 kc . . not more than 3 db down.

(b) At 16.6 and 21.85 kc . . at least 40 db down.

f. FIRST OSCILLATOR.

(1) Connect frequency counter to 1st oscillator test point TP1.

(2) Set BANDSPREAD dial to zero.

(3) Set REACTANCE BALANCE control R58 to its mid-position.

(4) Set SIDEBAND selector switch S4 to MANUAL USB.

(5) Tune Z3 for $472,000 \pm 100$ cps on frequency counter.

(6) Set SIDEBAND selector switch S4 to MANUAL LSB.

(7) Tune C33 for $438,000 \pm 100$ cps on frequency counter.

(8) Set SIDEBAND selector switch S4 to XTAL LSB.

(9) Tune C45 for 438,000 \pm 1 cps on frequency counter. Crystal must be tunable through at least \pm 5 cps.

(10) Set SIDEBAND selector switch S4 to XTAL USB.

(11) Tune C46 for 472,000 \pm 1 cps on frequency counter. Crystal must be tunable through at least \pm 5 cps.

g. REACTANCE SHIFT.

(1) Connect a variable d-c voltage supply across pins 11 and 12 of E1.

(2) Vary the voltage settings as listed below and check the oscillator frequency with a frequency counter.

(3) Adjust REACTANCE BALANCE control R58 to obtain the following results:

CONTROL VOLTAGE	FREQUENCY SHIFT \pm 10%	
	UPPER KC	LOWER KC
+4.5	+4.077	+3.613
+2.0	+2.809	+2.225
0	0	0
-2.0	-2.414	-2.045
-4.5	-4.567	-3.957

(4) Retune oscillator for 472 kc in upper position and 438 kc in lower position with REACTANCE CONTROL voltage set to zero.

h. BANDSPREAD CONTROL.

(1) Set REACTANCE CONTROL voltage to zero.

(2) Check shift of oscillator with BANDSPREAD control at each mark on panel.

BANDSPREAD DIAL	UPPER KC	LOWER KC
-3	-2.9 to 3.5	-2.2 to 2.8
-2	-2.1 to 2.5	-1.6 to 3.0
-1	-1.0 to 1.2	-0.8 to 1.0
0	0	0
+1	+1.1 to 1.3	+0.9 to 1.1
+2	+2.2 to 2.6	+1.8 to 2.2
+3	+2.9 to 3.3	+2.5 to 3.1

i. SENSITIVITY CHECK.

(1) Replace tube V3, 12AX7.

(2) Connect VTVM across load.

(3) Connect r-f signal generator, set at 455 kc, 1 mv, to IF INPUT connector J1.

(4) Set SIDEBAND selector switch S4 to XTAL LSB.

(5) Set BFO switch S5 ON.

(6) Tune r-f signal generator around 456 kc for maximum output on meter and readjust H. F. attachments for 36 volts output. The r-f input voltage must be between 0.5 and 1 mv.

Return these attachments and frequency settings for the next procedure.

j. ENVELOPE DETECTOR.

(1) Set BFO switch S5 OFF. Output should drop to zero.

(2) Set signal generator for 30% of 1 kc modulation.

(3) Retune signal generator for maximum output. The output voltage should be 7 to 15 volts.

(4) Turn off modulation.

k. AVC CHECK.

(1) Set BFO switch S5 ON.

(2) Adjust signal generator for 1 mv input and tune for maximum output.

NOTE

If the output is higher than 36 volts, readjust AUDIO GAIN control.

(3) Set AVC switch S2 ON.

(4) Set AVC ADJ control R35 fully clockwise.

(5) Connect d-c VTVM to terminal 8 of E1. Observe for a normal indication of -13 to -19 volts.

(6) Set AVC switch S1 to FAST.

(7) Disconnect signal generator from IF INPUT connector J1 and observe the fall of AVC voltage. It should take approximately .1 second for the AVC voltage to return to zero.

(8) Reconnect signal generator and set AVC switch S1 to SLOW.

(9) Disconnect signal generator and observe the fall of AVC voltage. It should take approximately 1-1/2 seconds to lose half the AVC voltage.

l. LIMITER CHECK.

(1) Connect oscilloscope to pin 2 of V4.

(2) Set BFO switch S5 OFF.

(3) Reconnect signal generator to connector J1 and apply 30% of 1 kc modulation. Retune signal generator to obtain maximum output.

(4) Observe the modulation envelope on the oscilloscope screen. The signal should be undistorted.

(5) Set LIMITER switch S6 ON, and observe oscilloscope screen. The signal should now show a slight clipping, indicating proper limiter action.

(6) Disconnect all test equipment.

TABLE 5—1. TEST EQUIPMENT FOR TROUBLESHOOTING

ITEM	MANUFACTURER
AC Vacuum Tube Voltmeter	Ballantine Model 314 or equivalent
Audio Signal Generator	Hewlett-Packard Model 200 CD or equivalent
DC Vacuum Tube Voltmeter	Hewlett-Packard Model 410 B or equivalent
RF Signal Generator	Standard Measurements Model 82 or equivalent
Oscilloscope	Tectronix Model 515 A or equivalent
Eput Counter Mod.	Berkeley Model 5500 or equivalent
Battery, 0- ± 10 v	Any manufacturer meeting the necessary specifications
Resistor, 600 ohm 10 watt	Any manufacturer meeting the necessary specifications
Capacitor, .01 mfd, 400 wvdc	Any manufacturer meeting the necessary specifications

TABLE 5—2. VOLTAGE MEASUREMENTS

TUBE	TYPE	SOCKET PIN NUMBERS									
		1	2	3	4	5	6	7	8	9	
V1	6BE6	DC	-4.9	2.3			256	950			
		AC	6.6	0.34	3.15	3.15	.28	.29	.0012		
V2	6AG5	DC	-1.3	0.56			35.0	88.0	0.56		
		AC	1.65	.11	3.15	3.15	9.4	4.0	.11		
V3	12AX7	DC	205		1.6			150		1.2	
		AC	3.6	.11	.01	3.15	3.15	.12	.003		3.15
V4	12AU7	DC	104		5.0			110		5.0	
		AC	21.0	3.4	1.5	3.15	3.15	23.0	3.4	1.3	3.15
V5	12AT7	DC	150		.97						
		AC	5.8	.38	.25	3.15	3.15				3.15
V6	6J6	DC	54	53					2.0		
		AC	.0085	.0067	3.15	3.15	.003	.0095	.0013		
V7	6BE6	DC	-2.3	0.64			115	51	-0.10		
		AC	3.6	.64	3.15	3.15	4.2	3.4	.28		
V8	6AQ5	DC		17			290	305			
		AC	5.8	.20	3.15	3.15	110	.05	5.8		
V9	12AT7	DC	60	-8.9	2.3			77		0.90	
		AC	24.0	13.0	3.3	3.15	3.15	13.0	0.76	0.36	3.15
V10	5Y3	DC		380						380	
		AC				360		360			
V11	OA2	DC	150				150				
		AC									

Conditions:
 Input: 1.2 mv
 Output: 4 v
 AVC: OFF
 BFO: ON
 XTAL: LSB-438 kc
 LIMITER: OFF

TABLE 5-3. DC VOLTAGE MEASUREMENTS

TUBE	TYPE	SOCKET PIN NUMBERS								
		1	2	3	4	5	6	7	8	9
V1	6BE6	-5.0	2.45			260	96			
V2	6AG5	-1.3	0.56			35	88	0.56		
V3	12AX7	150		1.6			150		1.2	
V4	12AU7	105		5.0			110		5.0	
V5	12AT7	150		1.0						
V6	6J6	54	52					2.0		
V7	6BE6		84			305	305			
V8	6AQ5		17			295	305			
V9	12AT7	150		84			150		84	
V10	5Y3		370						370	
V11	OA2	150				150				

Conditions:
 Input: No signal
 AVC: OFF
 BFO: OFF
 LIMITER: OFF
 XTAL: LSB-438 kc

TABLE 5-6. RESISTANCE MEASUREMENTS

TUBE	TYPE	SOCKET PIN NUMBERS								
		1	2	3	4	5	6	7	8	9
V1	6BE6	25 K	220	FIL	FIL	90 K	100 K	65		
V2	6AG5	24 K	125	FIL	FIL	110 K	110 K	125		
V3	12AX7	190 K	1 MEG	1.7 K	FIL	FIL	340 K	5.5	2 K	FIL
V4	12AU7	200 K	110 K	3 K	FIL	FIL	180 K	110 K	2.8 K	FIL
V5	12AT7	130 K	11 K	300	FIL	FIL				FIL
V6	6J6	100 K	140 K	FIL	FIL	600 K	40 K	1.2 K		
V7	6BE6	110 K	125	FIL	FIL	200 K	140 K	110 K		
V8	6AQ5	525 K	325	FIL	FIL	80 K	80 K	525 K		
V9	12AT7	160 K	100 K	5 K	FIL	FIL	130 K	28 K	1 K	FIL
V10	5Y3		80 K		80		75		80 K	
V11	OA2	75 K				75 K				

Conditions:
 SIDEBAND SELECTOR: Fully clockwise
 POWER: OFF
 BFO: ON
 AVC ADJ: Fully clockwise
 INPUT ADJ: Fully clockwise
 AUDIO GAIN: Fully clockwise
 AVC: ON, SLOW
 LIMITER: ON
 OUTPUT LEVEL: HIGH
 REACTANCE BALANCE: Approx. mid-position.

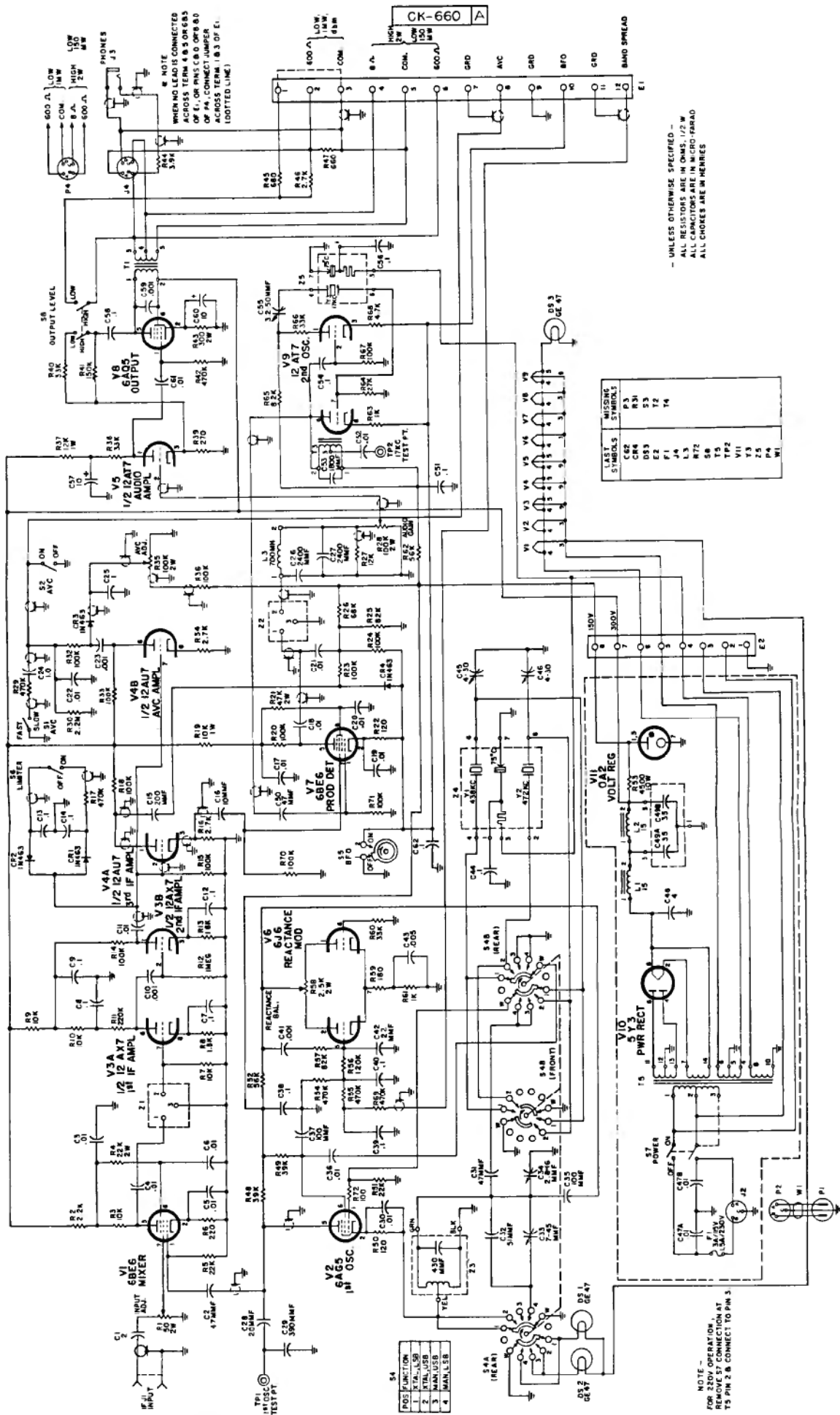
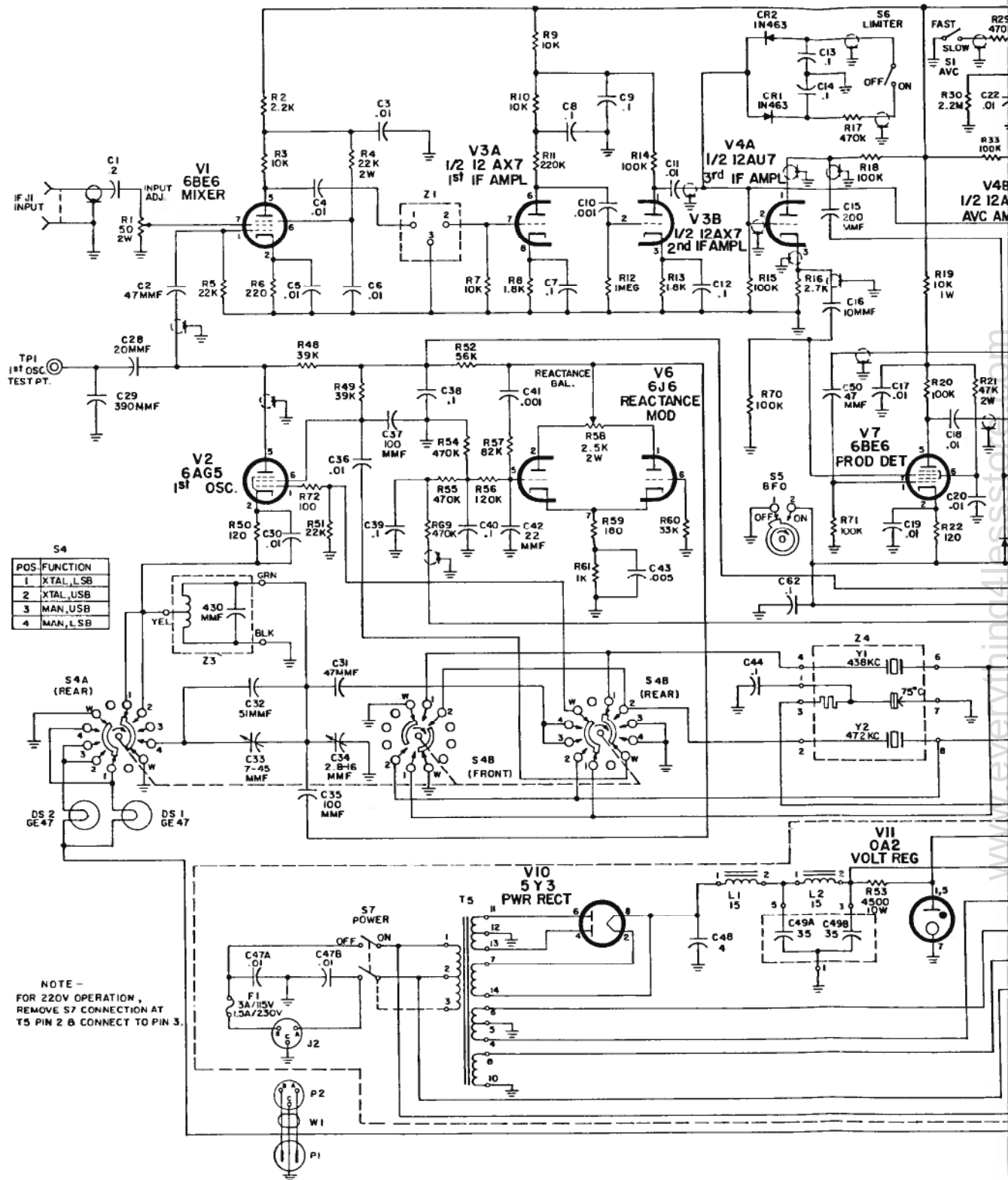
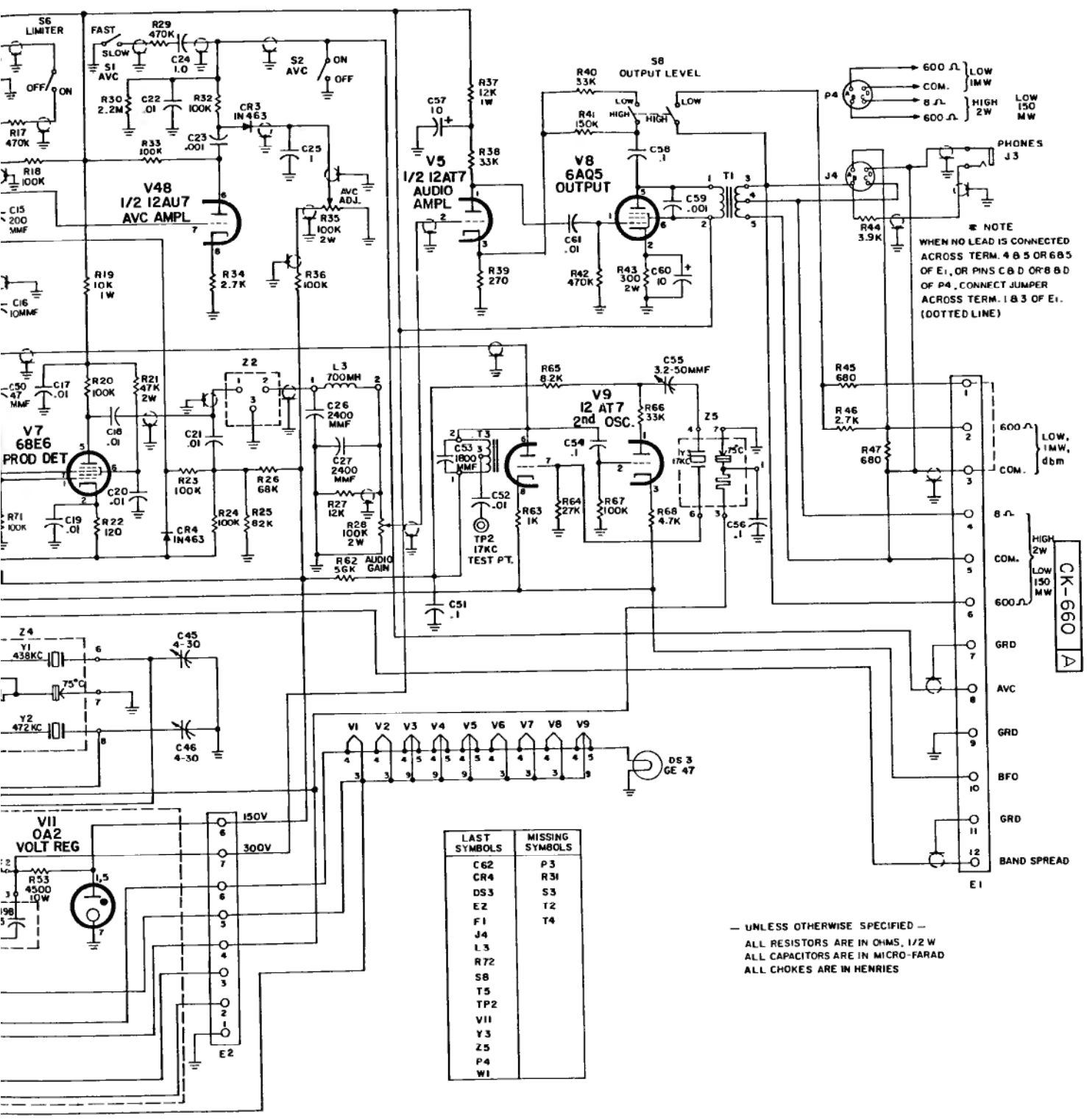


Figure 8-1. Schematic Diagram, Model MSR-9



POS.	FUNCTION
1	XTAL_LSB
2	XTAL_USB
3	MAN_USB
4	MAN_LSB

NOTE -
FOR 220V OPERATION,
REMOVE S7 CONNECTION AT
T5 PIN 2 & CONNECT TO PIN 3.



LAST SYMBOLS	MISSING SYMBOLS
C62	P3
CR4	R31
DS3	S3
E2	T2
F1	T4

Figure 8-1. Schematic Diagram, Model MSR-9