UNCLASSIFIED

TECHNICAL MANUAL

for

MODE SELECTOR RECEIVING MODEL MSR-4 MODEL MSR-5

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, CANADA

AARGSX

UNCLASSIFIED

TECHNICAL MANUAL

for

MODE SELECTOR RECEIVING
MODEL MSR-4
MODEL MSR-5

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, CANADA

AAR 65X

IN-196

Issue Date: 1 June 1963
Rev: 15 Jan. 1965

NOTICE

THE TECHNICAL MATERIEL CORPORATION
COMMUNICATIONS ENGINEERS
700 FENIMORE ROAD MAMARONECK, N. Y.

Warranty

The Technical Materiel Corporation, hereinafter referred to as TMC, warrants the equipment (except electron tubes,* fuses, lamps, batteries and articles made of glass or other fragile or other expendable materials) purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purposes for which the same is designed, for a period of one year from the date of delivery F.O.B. factory. TMC further warrants that the equipment will perform in a manner equal to or better than published technical specifications as amended by any additions or corrections thereto accompanying the formal equipment offer.

TMC will replace or repair any such defective items, F.O.B. factory, which may fail within the stated warranty period, PROVIDED:

1. That any claim of defect under this warranty is made within sixty (60) days after discovery thereof and that inspection by TMC, if required, indicates the validity of such claim to TMC's satisfaction.
2. That the defect is not the result of damage incurred in shipment from or to the factory.
3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.
4. That any equipment or accessories furnished but not manufactured by TMC, or not of TMC design shall be subject only to such adjustments as TMC may obtain from the supplier thereof.

Electron tubes*furnished by TMC, but manufactured by others, bear only the warranty given by such other manufacturers. Electron tube warranty claims should be made directly to the manufacturer of such tubes.

TMC's obligation under this warranty is limited to the repair or replacement of defective parts with the exceptions noted above.

At TMC's option any defective part or equipment which fails within the warranty period shall be returned to TMC's factory for inspection, properly packed with shipping charges prepaid. No parts or equipment shall be returned to TMC, unless a return authorization is issued by TMC.

No warranties, express or implied, other than those specifically set forth herein shall be applicable to any equipment manufactured or furnished by TMC and the foregoing warranty shall constitute the Buyers sole right and remedy. In no event does TMC assume any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of TMC Products, or any inability to use them either separately or in combination with other equipment or materials or from any other cause.

*Electron tubes also include semi-conductor devices.

PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT

Should it be necessary to return equipment or material for repair or replacement, whether within warranty or otherwise, a return authorization must be obtained from TMC prior to shipment. The request for return authorization should include the following information:

1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

PROCEDURE FOR ORDERING REPLACEMENT PARTS

When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT

TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION
Engineering Services Department
700 Fenimore Road
Mamaroneck, New York

RECORD OF CORRECTIONS MADE

Change No.	Date of Change	Date Entered	Entered By

TABLE OF CONTENTS

Paragraph		Page
	SECTION 1 — GENERAL DESCRIPTION	
1-1	Functional Description	1-1
1-2	Physical Description	1-1
1-3	Technical Specifications	1-1
	SECTION 2 — INSTALLATION	
2-1	Initial Inspection	2-1
2-2	Mechnical Installation	2-1
2-3	Electrical Installation	2-1
	SECTION 3 — OPERATOR'S SECTION	
3-1	General	3-0
3-2	Operator's Instructions	3-0
3-3	Operator's Maintenance	3-3
	SECTION 4 — PRINCIPLES OF OPERATION	
4-1	Introduction	4-0
4-2	Circuit Description	4-3
	SECTION 5 — TROUBLE SHOOTING	
5-1	Introduction	5-0
5-2	Troubleshooting Techniques	5-0
5-3	Troubleshooting Procedures	5-0
	SECTION 6 — MAINTENANCE	
6-1	Introduction	6-0
6-2	Preventive Maintenance	6-0
6-3	Corrective Maintenance	6-0
6-4	Circuit Alignment	6-0
	SECTION 7 — PARTS LIST	
7-1	Introduction	7-0
	SECTION 8 — SCHEMATIC DIAGRAMS	

LIST OF ILLUSTRATIONS

Figure — Page

SECTION 1 — GENERAL DESCRIPTION

1-1 Mode Selector Receiving, Model MSR, Front View . . . .

SECTION 2 — INSTALLATION

2-1 Power Supply Changeover Connections 2-2
2-2 Outline Dimensional Drawing . . 2-2
2-3 Cable Connections for Single Loudspeaker Operation 2-2
2-4 Audio Output Connections . . . 2-3
2-5 Cabling Connections Models MSR/FFR/RSD/RSA 2-4
2-6 Rear Panel Connections, Model MSR 2-5

SECTION 3 — OPERATOR'S SECTION

3-1 Panel View of MSR, Showing Operating Controls 3-0

SECTION 4 — PRINCIPLES OF OPERATION

4-1 Block Diagram (Example 1) MSR/Double Conversion Receiver 4-0
4-2 Block Diagram (Example 2) MSR/Double Conversion Receiver 4-1
4-3 Block Diagram Model MSR . . 4-2
4-4 AVC Network, Simplified Schematic Diagram 4-3

Figure — Page

SECTION 4 — PRINCIPLES OF OPERATION (Cont'd)

4-5 IF Amplifier and 1st Mixer, Simplified Schematic Diagram . . . 4-4
4-6 2nd Mixer, Simplified Schematic Diagram 4-5
4-7 Audio Amplifier Stages, Simplified Schematic Diagram . . . 4-5
4-8 1st Oscillator and Reactance Modulator, Model MSR-4, Simplified Schematic Diagram . . 4-7
4-9 1st Oscillator and Reactance Modulator, Model MSR-5, Simplified Schematic Diagram . . 4-8
4-10 Relay Driver/Tone Generator, 2nd Oscillator, Model MSR-4, Simplified Schematic Diagram . . 4-9
4-11 Relay Driver/Tone Generator, 2nd Oscillator, Model MSR-5, Simplified Schematic Diagram . . 4-10
4-12 Power Supply, Simplified Schematic Diagram 4-11

SECTION 5 — TROUBLE SHOOTING

5-1 Control Voltage Setting Diagram, Remote Operation 5-6

SECTION 8 — SCHEMATIC DIAGRAMS

8-1 Schematic Diagram, Model MSR-4 . . . . . .8-1/8-2
8-2 Schematic Diagram, Model MSR-5 . . . . . .8-3/8-4

LIST OF TABLES

Table		Page
	SECTION 1 — GENERAL DESCRIPTION	
1-1	Vacuum Tube Complement . . .	1-2
	SECTION 3 — OPERATOR'S SECTION	
3-1	Table of Equivalent Control Designations	3-3
	SECTION 5 — TROUBLE SHOOTING	
5-1	DC Voltage on V8 After All Adjustments Made	5-1
5-2	Tone Generator Output at Grid of V4, Pin 7	5-1
5-3	Test Equipment For Trouble-shooting	5-1
5-4	Voltage Measurement Chart, Model MSR-4	5-2
5-5	Voltage Measurement Chart, Model MSR-5	5-2
5-6	Resistance Measurement Chart, Model MSR-4	5-3
5-7	Resistance Measurement Chart, Model MSR-5	5-3

Table — Page

SECTION 5 — TROUBLE SHOOTING (Cont'd)

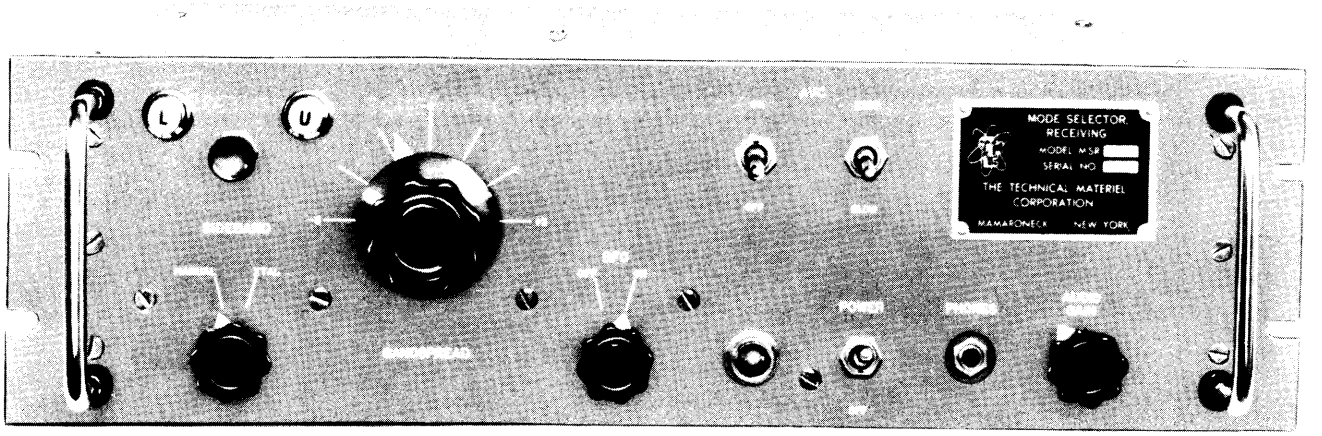


Figure 1-1. Mode Selector Receiving, Model MSR, Front View

SECTION I
GENERAL DESCRIPTION

1-1. FUNCTIONAL DESCRIPTION

The TMC Model MSR Mode Selector Receiving (shown in figure 1-1) will, in a number of ways, improve operation of certain radio receivers for various modes of operation. The overall skirt selectivity of most receiving systems is greatly sharpened, rejecting unwanted adjacent signals or interference with no discrimental effect to the desired signal. The tuning of single sideband signals is greatly simplified since the final tuning is done at the MSR unit, not the receiver.

NOTE

Due to the similarity of construction and operation of the Models MSR-4 and MSR-5, the following text will refer to both models as the MSR unit. The difference in construction and operation of the two units will be indicated where necessary.

A mechanical and electrical bandspread tunes over the I. F. bandpass. This effective vernier easily tunes SSB or exhaulted carrier AM signals within cycles of correct tone. Either sideband is selectable, either with the bandpass tuning feature or by inverting the oscillator separation. CW, MCW and FS signals are easily tunable with the bandspread feature.

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

NOTE

The sideband crystals of the Model MSR-5 are oven-controlled for greater stability, a feature not inherent to the Model MSR-4.

The local or remote tuned VFO feature of the MSR unit 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 unit are further explained in Section 2.

1-2. PHYSICAL DESCRIPTION

The Model MSR Mode Selector Receiver 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. For mounting and outline dimensions, refer to figure 2-2.

All operating controls and indicating devices are readily accessable 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 units.

1-3. TECHNICAL SPECIFICATIONS .

Input Frequency	455 kc
Modes of Operation	SSB upper or lower, AM, CW, FSK, FAX
Input Voltage	0.1 to 10 volts RMS
Input Impedance	240 K ohms
Tuning (Bandspread)	±3 kc
Filter Characteristics	3.2 kc at 3 db points 5.2 kc at 45 db 5.2 kc at 45 db points
AVC Characteristics	With 40 db change in input, output remains constant within 9 db
AVC Speeds	SLOW/FAST
Audio Distortion	Less than 5%

1-3. TECHNICAL SPECIFICATIONS (CONT'D).

Audio Output	High: 2 watts-600 ohms - 8 ohm Low: Odbm-600 ohms, 150 mw-600 ohms and 8 ohms.
Output Impedances	Loudspeaker: 8 ohms Line: 600 ohms Head Set: 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 cycles, single phase, 65 watts.
Noise Limiter	Balanced type.
Size	5-1/4" high x 19" wide x 13-1/2" deep.
Weight	24 lbs net.
Components and Construction	Equipment manufactured in accordance with JAN/MIL specifications wherever practicable.

TABLE 1—1. VACUUM TUBE COMPLEMENT

REFERENCE DESCRIPTION	TUBE TYPE	FUNCTION
V1a	1/2 - 12AU7	AVC Amplifier
V1b	1/2 - 12AU7	AVC Amplifier
V2	6BA6	IF Amplifier
V3	6BE6	1st Mixer
V4	6BE6	2nd Mixer
V5 (Model MSR-5)	12AT7	2nd Oscillator
V5a (Model MSR-4)	1/2 - 12AT7	2nd Oscillator
V5b (Model MSR-4)	1/2 - 12AT7	Audio Amplifier
V6	6AQ5	Audio Output
V7	6AG5	1st Oscillator
V8	6J6	Reactance Modulator
V9a	1/2 - 12AU7	Relay Driver
V9b	1/2 - 12AU7	Sideband Tone Gen.
V10	5Y3 GT	Power Rectifier
V11	0A2	Voltage Regulator
V12 (Model MSR-5) only	12AT7	Audio Amplifier

SECTION 2
INSTALLATION

2-1. INITIAL INSPECTION.

Each MSR unit 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 model 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 figure 2-2.

2-3. ELECTRICAL INSTALLATION

The MSR unit is designed to operate from any suitable power source providing 110 or 220 volts a-c, 50/60 cps, single phase power. The MSR is factory wired for 110 volts a-c operation and may be converted for 220 volts a-c operation by making the necessary changes described below and shown in figure 2-1.

a. Remove wire lead from power switch S7 to terminal 2 of transformer T5.

b. Connect wire lead from power switch S7 to terminal 3 of transformer T5.

c. Replace the 3 amp fuse F1 with a 1.5 amp fuse.

The necessary electrical interconnections are made at the rear of the MSR chassis. A lowloss 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 2-4.

Single loudspeaker operation for both the MSR and the receiver is possible by paralleling the output connections of either the 600 ohm or loudspeaker tap. The output impedance has now been halfed. Therefore, to match the impedance correctly, it must be connected to the next higher impedance on the receiver. The output is then determined by the adjustment of the audio gain control on either unit. See figure 2-3.

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 2-5 and 2-6 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 3 of E102 of the FFR 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 to the left of the SIDEBAND switch and the Upper sideband to the right of the SIDEBAND switch. 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 above 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 to the left of the SIDEBAND switch and the Lower sideband indicator is on the right.

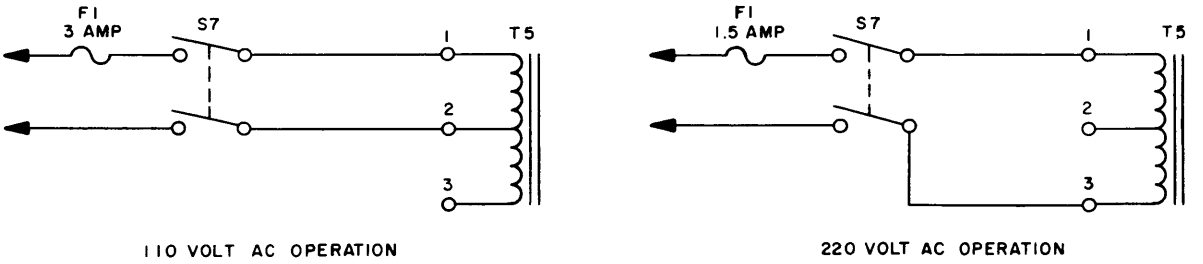


Figure 2-1. Power Supply Changeover Connections

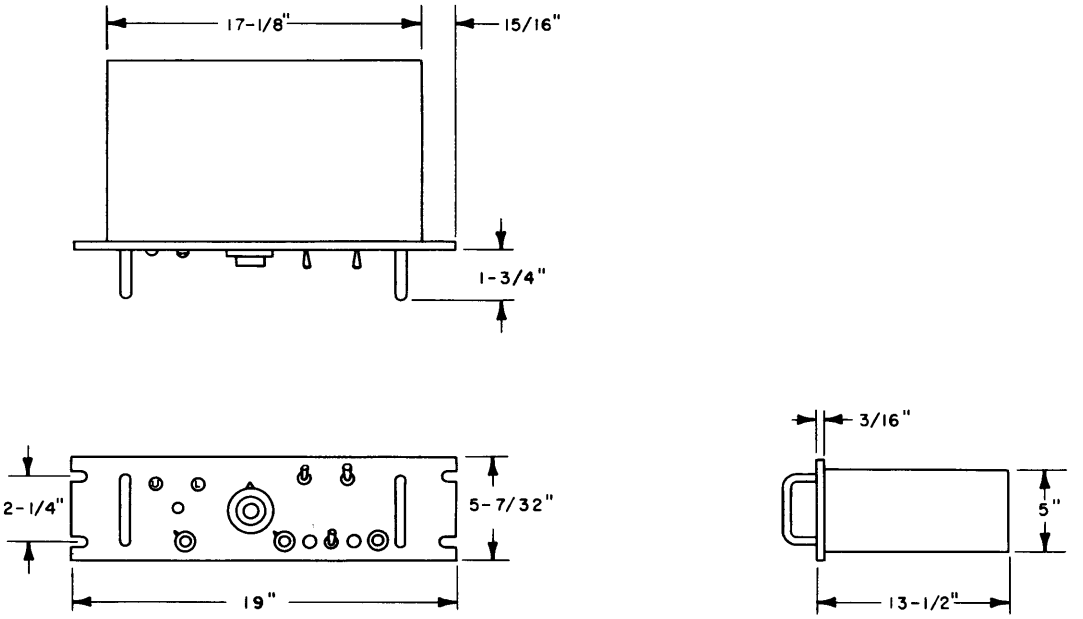


Figure 2-2. Outline Dimensional Drawing

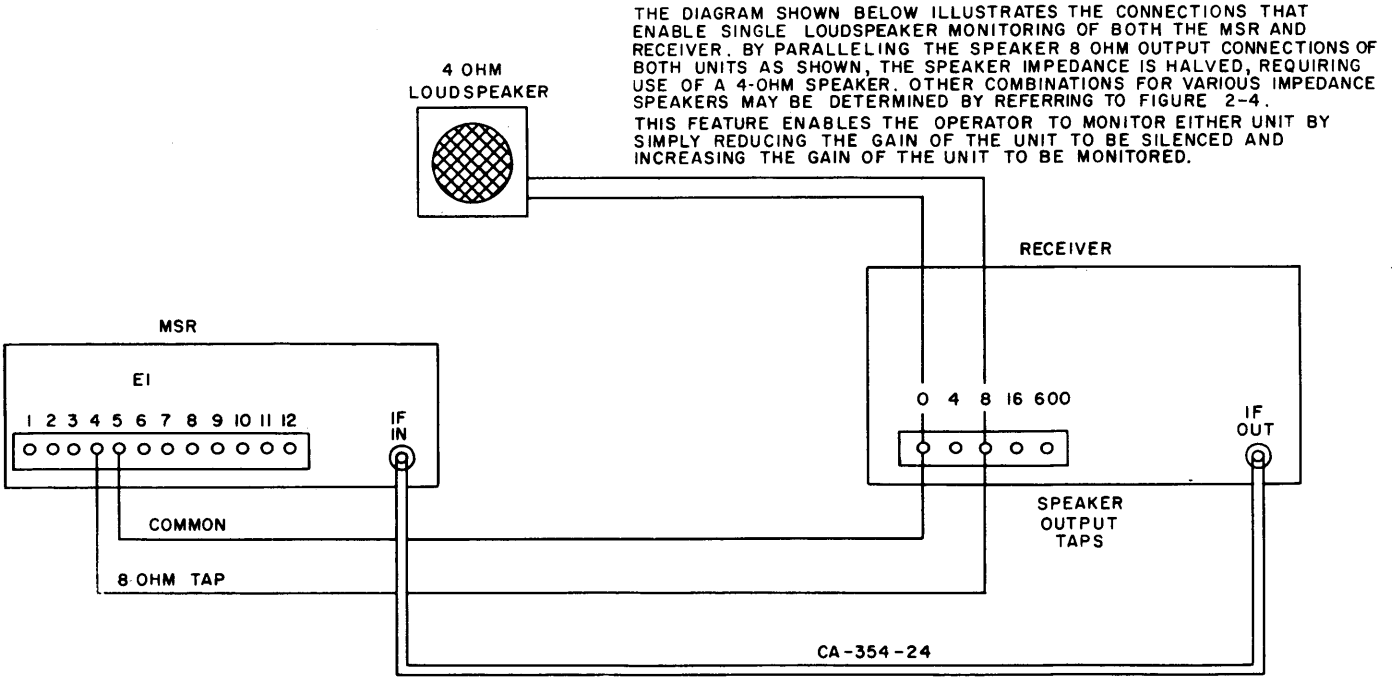
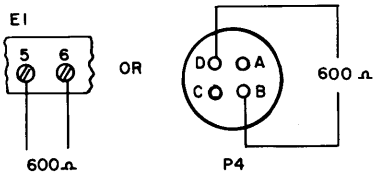


Figure 2-3. Cable Connections for Single Loudspeaker Operation

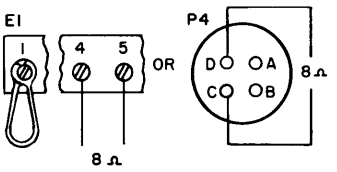
2 watt, 600 ohms output. Output Level switch in HIGH position.

E1 Terminals 5 and 6.
or
P4 Pins B and D.



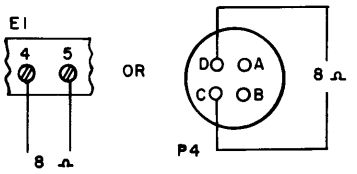
150 milliwatt, 8 ohm output. Output Level switch in LOW position. Note position of jumper which is normally between terminals 1 and 3.

E1 Terminals 4 and 5.
or
P4 Pins C and D.



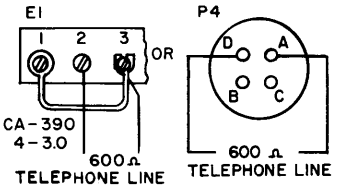
2 watt, 8 ohm output. Output Level switch in HIGH position.

E1 Terminals 4 and 5.
or
P4 Pins C and D.



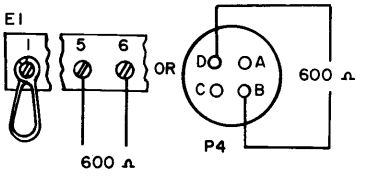
1 milliwatt, 600 ohm telephone line only. Output Level switch in LOW position. Note normal position of jumper.

E1 Terminals 2 and 3.
or
P4 Pins A and D.



150 milliwatt, 600 ohm output. Output Level switch in LOW position. Note position of jumper which is normally between terminals 1 and 3.

E1 Terminals 5 and 6.
or
P4 Pins B and D.



Simultaneous use of telephone line at 1 milliwatt, 600 ohms, or 8 ohm loudspeaker at 150 milliwatts. Note position of jumper.

E1 600 ohm Terminals 2 and 3.
8 ohm Terminals 4 and 5.
or
P4 600 ohm Pins A and D.
E1 8 ohm Terminals 4 and 5.

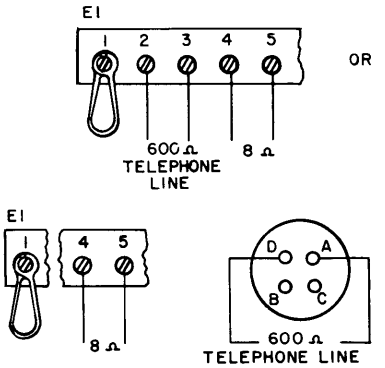


Figure 2-4. Audio Output Connections

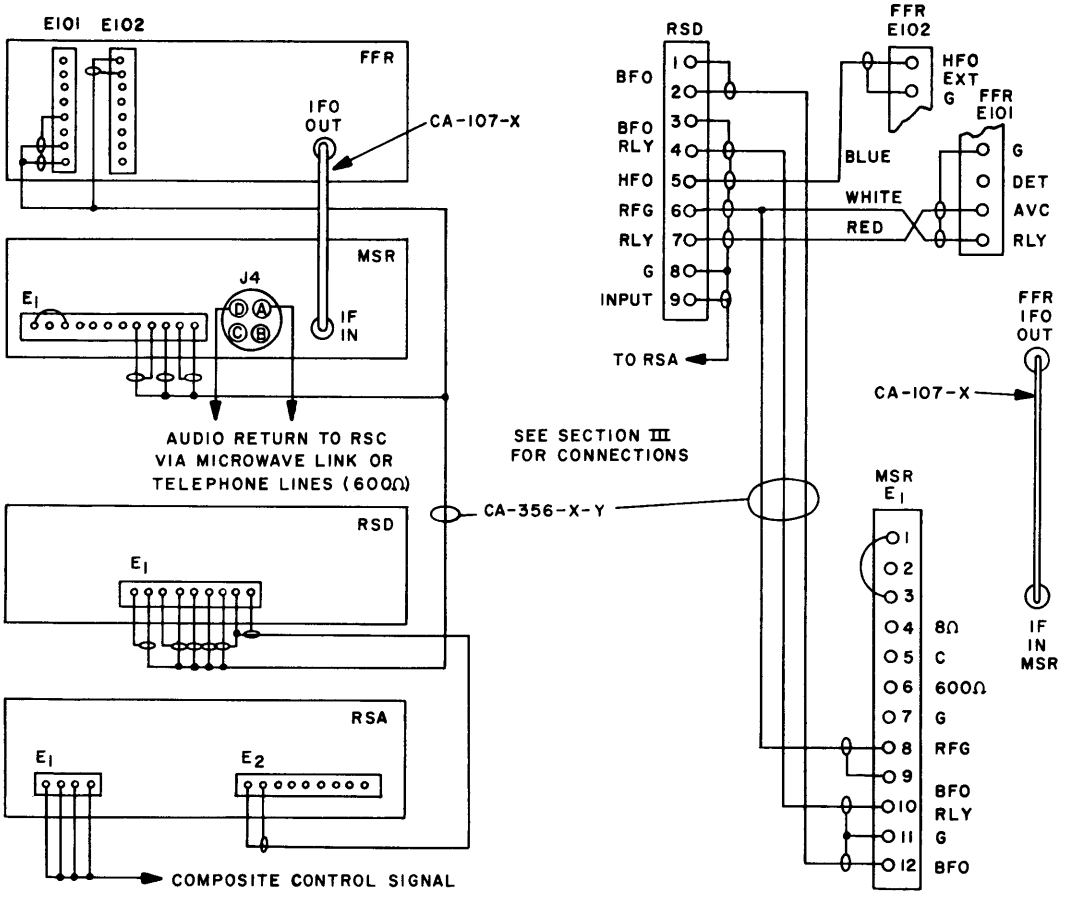


Figure 2-5. Cabling Connections Models MSR/FFR/RSD/RSA

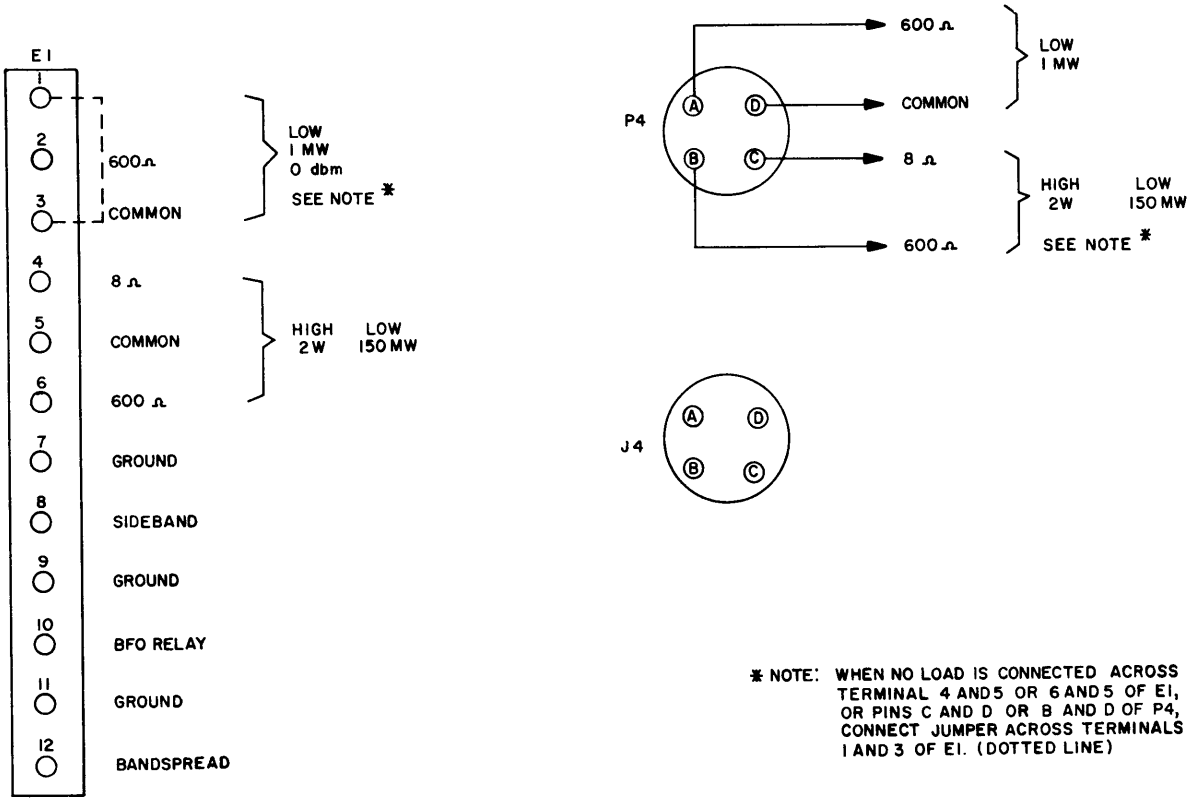


Figure 2-6. Rear Panel Connections, Model MSR

SECTION 3
OPERATOR'S SECTION

3-1. GENERAL.

Operation of the Model MSR has been designed for a high degree of simplicity and versatality, requring 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 line protective fuse and interconnection points are located on the rear of the chassis.

3-2. OPERATOR'S 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 is a list of front panel control designations to be used in conjunction with figure 3-1.

a. OPERATING CONTROLS. - In order to operate the unit properly, a description of the operating controls and their use is provided.

(1) BANDSPREAD. - Tunes the incoming signals across the band of the bandpass filter. Interfering signals are easily placed off the edge of the filter.

(2) MANUAL/XTAL. - The bandspread oscillator is variable either with the BANDSPREAD control or remotely when this switch is in MANUAL position. In XTAL position, the oscillator is fixed to the frequency of the crystal within the unit.

(3) UPPER/LOWER SIDEBAND. - Either sideband is selected by pushing and releasing the SIDEBAND button switch. A panel light indicates which sideband will pass through the filter.

(4) BFO ON/OFF. - This switch controls the second oscillator which reinserts the carrier for suppressed carrier operation or the tone for CW operation.

(5) AVC ON/OFF. - This switch permits the control of signal either with or without carrier. For SSB, CW or FS signals, the switch is set to SLOW. For AM or MCW signals, the switch is set to FAST.

(6) AUDIO GAIN. - This control adjusts the output of the audio amplifier.

(7) OUTPUT LEVEL. - (Rear deck toggle switch) - Controls HIGH/LOW output level. Disconnects telephone lines when in HIGH position.

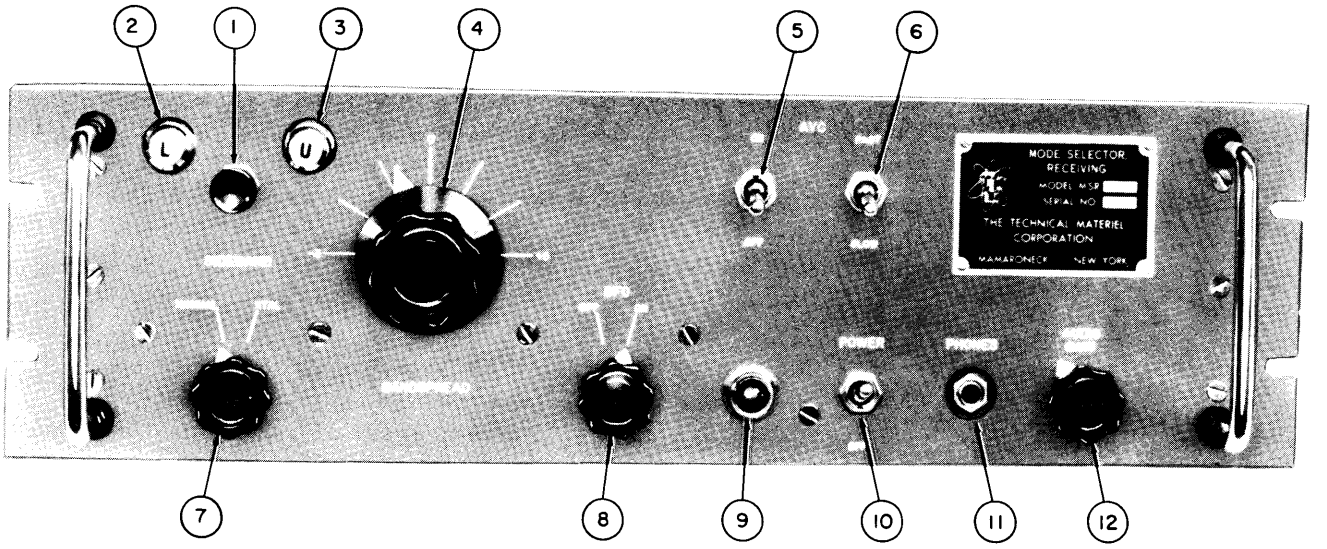


Figure 3-1. Panel View of MSR, Showing Operating Controls

(8) PHONES. - This jack permits monitoring of the audio output without cutting off the output.

(9) POWER/OFF. - This switch applies power to the unit.

b. 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 bandwidth 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 c. of this section.

(1) Reception of Single Sideband Signals.

(a) Tune receiver to signal frequency.

(b) MSR and receiver AVC ON and SLOW.

(c) MSR BFO switch ON.

(d) MSR MANUAL/XTAL switch on MANUAL.

(e) Upper Sideband Reception.

1. MSR on UPPER.

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

3. For crystal operation set MANUAL/XTAL switch on XTAL and place a 472 kc crystal in socket Y2.

(f) Lower Sideband reception.

1. MSR set on LOWER.

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

3. For crystal operation set MANUAL/XTAL switch on 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) MSR and receiver AVC ON and FAST.

(c) MSR BFO switch OFF.

(d) MSR MANUAL/XTAL switch on MANUAL.

(e) Reception on both sidebands.

1. MSR set on UPPER.

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

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

(f) Reception of Upper Sideband.

1. MSR set on UPPER, MANUAL/XTAL switch on MANUAL.

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

3. Xtal operation use a 472 kc crystal in socket Y2 with MANUAL/XTAL switch on XTAL. 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.

(g) Reception of Lower Sideband.

1. MSR set on LOWER, MANUAL/XTAL switch on MANUAL.

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

4. Xtal operation use a 438 kc crystal in socket Y1 with MANUAL/XTAL switch set on XTAL. 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) MSR and receiver AVC ON and FAST.

(c) MSR MANUAL/XTAL switch on MANUAL.

(d) Tune MSR as for SSB.

(4) CW and FS Operation.

(a) Tune receiver to signal frequency.

(b) MSR and receiver AVC ON and SLOW.

(c) MSR BFO switch to ON.

(d) MSR MANUAL/XTAL switch on MANUAL.

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

(f) Crystal Operation. - With MSR set on UPPER and MANUAL/XTAL switch set on XTAL, use a 474 kc crystal in socket Y2 for a 2 kc CW note. Tune receiver for any other desired beat note.

c. 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 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) MSR and receiver AVC ON and SLOW.

(b) MSR BFO switch ON.

(c) MANUAL/XTAL switch on 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. Crystal Operation. - Set MANUAL/XTAL switch on XTAL and place a 474 kc crystal in socket Y2. Tune receiver for intelligibility.

(c) Lower Sideband Reception.

1. Tune receiver -2 kc below signal frequency.

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

3. For crystal operation set MANUAL/XTAL switch on XTAL and place a 436 kc crystal in socket Y1. Tune receiver for intelligibility.

(2) Reception of AM Signals.

(a) MSR and receiver AVC ON and FAST.

(b) MSR BFO switch OFF.

(c) MSR MANUAL/XTAL switch on MANUAL.

(d) Reception of Upper Sideband.

1. Tune receiver 1.6 kc above signal frequency.

2. MSR set on UPPER.

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

4. For Xtal operation place MANUAL/XTAL switch on XTAL and insert a 474 kc crystal in socket Y2. Retune receiver 1.6 kc above the signal frequency.

(c) Reception of Lower Sideband.

1. Tune receiver 1.6 kc below signal frequency.

2. MSR set on LOWER.

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

4. For Xtal operation place MANUAL/XTAL switch on XTAL and insert a 436 kc crystal in socket Y1. Retune receiver 1.6 kc below the signal frequency.

(3) Exalted Carrier Operation.

(a) MSR and receiver AVC ON and SLOW.

(b) MSR BFO switch ON.

(c) Reception of sidebands. See paragraph (1) above.

d. 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.

The HFO control on the RSC tunes the HFO of the FFR within a limited range. There is no change of its function or range.

With the RSC's AVC switch ON, the FFR gain is being controlled by its own AVC. With the RCS's AVC switch OFF, the RF GAIN control determines not only the gain of the FFR but with proper manipulation operates the MSR sideband selector and indicates proper sideband.

The MSR sideband selector is operated as follows:

(a) Turn RSC AVC switch to OFF.

(b) Turn RF GAIN control fully clockwise to 10. This advances the switching relay to the next sideband.

(c) Turn RF GAIN control fully counterclockwise to zero and hold for one second. This releases the sideband switching relay. Switching is now completed.

(d) Return control to normal position for desired gain.

The sideband in use is indicated in the loudspeaker as an audible tone; low pitch for lower sideband, high pitch for upper sideband. If the sidebands have been reversed the Sideband Tone Generator must also be adjusted to produce the correct tone. The

tone becomes audible as the RF GAIN is turned clockwise past 5. The tone increases in volume as the control is advanced until the switching sequence is performed. The tone changes pitch as soon as the switching occurs. Returning the control to zero removes the tone.

(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 nad FFR to receive the desired signal. At the control site set the RSC control 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 d.(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 fight interconnecting cable connections. However, should normal operating procedures produce unsatisfactory results, a quick check of the power supply will very often determine the cause of the trouble. A pilot light indicates when power is being applied to the unit. Should the pilot lamp fail to light, operate the SIDEBAND pushbutton switch as an alternate means of checking since the sideband switching relay operates directly off of the 110 volt line. If no power is evident, check the fuse on the rear apron 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 tube failure. Checking the tubes will often save many hours of unnecessary troubleshooting.

TABLE 3—1. TABLE OF EQUIVALENT CONTROL DESIGNATIONS

SERIAL DESIGNATION	PANEL DESIGNATION	COMPONENT REFERENCE DESIGNATION NUMBER
FRONT PANEL CONTROLS AND INDICATORS		
1	SIDEBAND, spst pushbutton switch	S6
2	L, Lower sideband indicator lamp	I1
3	U, Upper sideband indicator lamp	I2
4	BANDSPREAD, variable capacitor	C29
5	AVC ON-OFF, toggle switch	S2
6	AVC FAST-SLOW, toggle switch	S1
7	MANUAL-XTAL, two position rotary selector switch	S4
8	BFO OFF-ON, two position rotary selector switch	S5
9	Power indicator lamp	I3
10	POWER, on-off toggle switch	S7
11	PHONES, tip-sleeve phone jack	J3
12	AUDIO GAIN, potentiometer	R30

SECTION 4

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

The combination of a specially designed filter circuit and a frequency bandspread oscillator provides sharp discrimination between a desired signal and undesired adjacent interference. This is accomplished by easy tuning of the bandspread 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 on 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 MANUAL/XTAL control.

The selection of upper or lower sideband is made through a relay. Operation is accomplished with a front panel push-button or through remote control of the relay driver stage. The indication of the sideband selected is shown by front panel lamps or remotely by tone pitch.

The carrier for SSB, exalted AM, or CW is reinserted at the second mixer by the BFO. This fixed oscillator is turned on or off by a relay which is operated either with 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 2 low level outputs, 0 dbm for telephone lines and 150 milliwatts for 600 ohm line or 8 ohm loudspeaker.

See figure 4-1 for 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 R. F. signal frequency, a reversal of sideband positioning occurs in the I. F., 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 I. F., however, no reversal occurs if the oscillator is below the I. F. Since, with the normal single or double conversion receiver the sidebands are as shown in figure 4-1, the MSR selects the proper sideband. 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 I. F. is 3.955, however, other combinations are also useable. For example, had the receiver 1st I. F. been 2.5 mcs and the incoming signal still centered at 10 mcs, the H. F. oscillator would have been at 12.5 mcs. Still further, had the receiver been

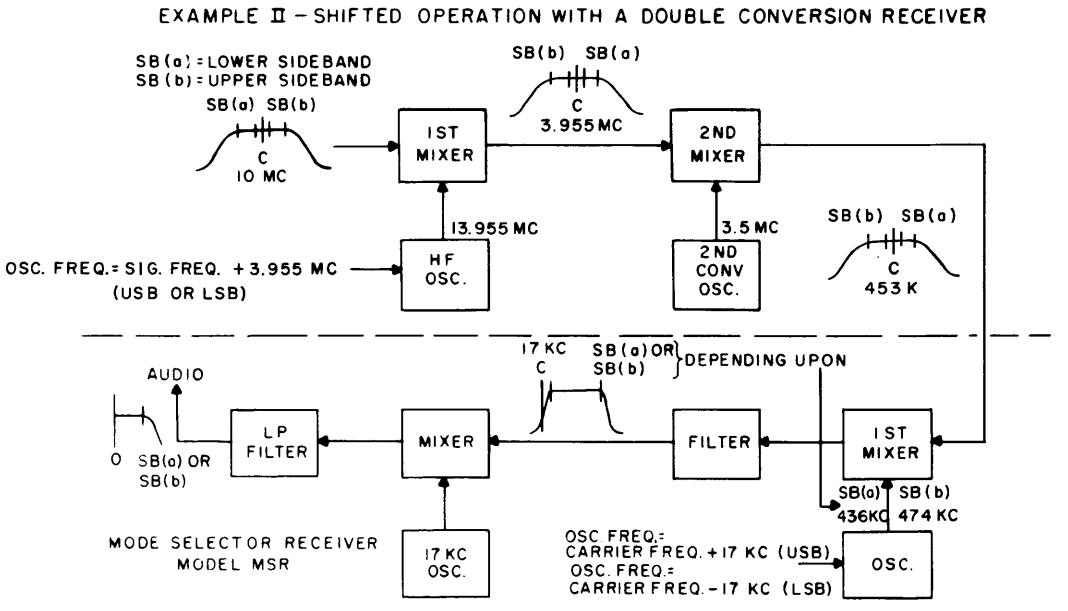


Figure 4-1. Block Diagram (Example 1) MSR/Double Conversion Receiver

of the single conversion type then the H. F. oscillator would have been at 10 +.455 or 10.455 mcs. 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 VAR position, will produce products in the filter region only when the signal input is near 455 kc, it cannot be used with other I. F.'s. However, in crystal positions, a crystal may be chosen which will permit operation with almost any I. F. (using the equations of figure 4-1 or 4-2).

Each mixer, in both the receiver or MSR, operates in such a way that a whole "slot" or 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 I. F. (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 I. F. type (perhaps +2.5 kc at the 6 db points) then the system bandpass becomes that of the receiver I. F. because it is the narrowest. The MSR filter accepts only one sideband at a time, therefore, the other sideband is simply occupying receiver I. F. 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 I. F. 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 received (for example, in the form of more F.S. channels) or improved audio quality will result.

a. FOR UPPER SIDEBAND RECEPTION.

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

(2) MSR. - Use 474 kc crystal in socket Y2 or set BANDSPREAD tuning dial 2 kc above center.

b. FOR LOWER SIDEBAND RECEPTION.

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

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

For example, suppose normally centered operation (Figure 4-1) is desired with a double convertion receiver having a 1st I. F. of 3.5 mcs, a 2nd I. F. of 350 kc, and the received signal is centered at 10 mcs, the H. F. oscillator must then be at 10 +3.5 or 13.5 mcs. The second oscillator must be at 3.15 mcs to produce the 350 kc 2nd I. F. 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

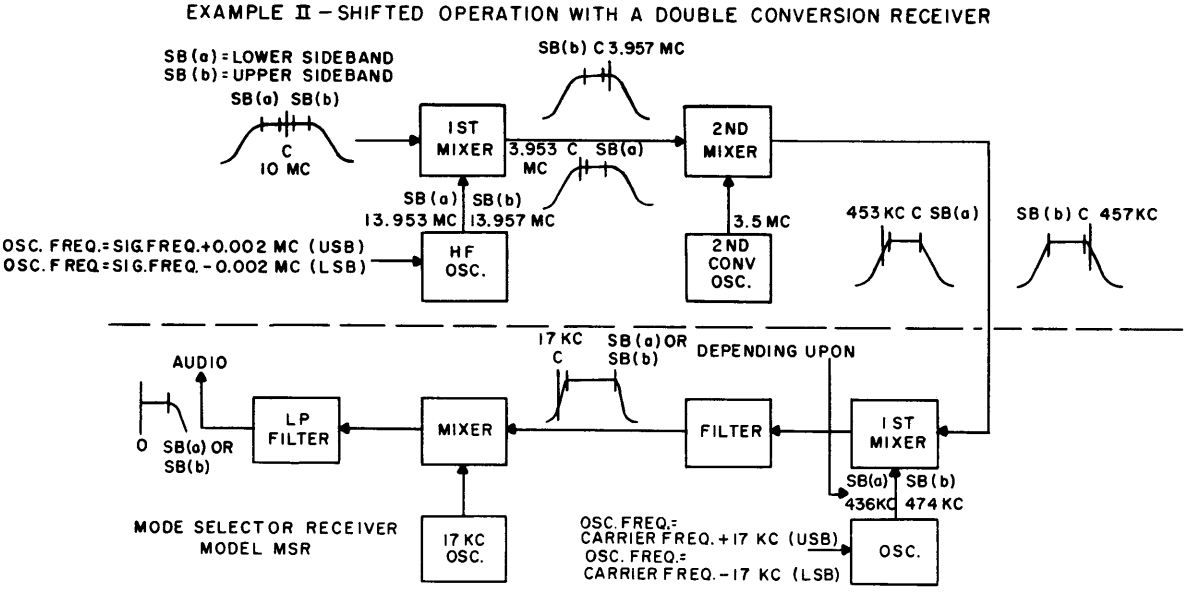


Figure 4-2. Block Diagram (Example 2) MSR/Double Conversion Receiver

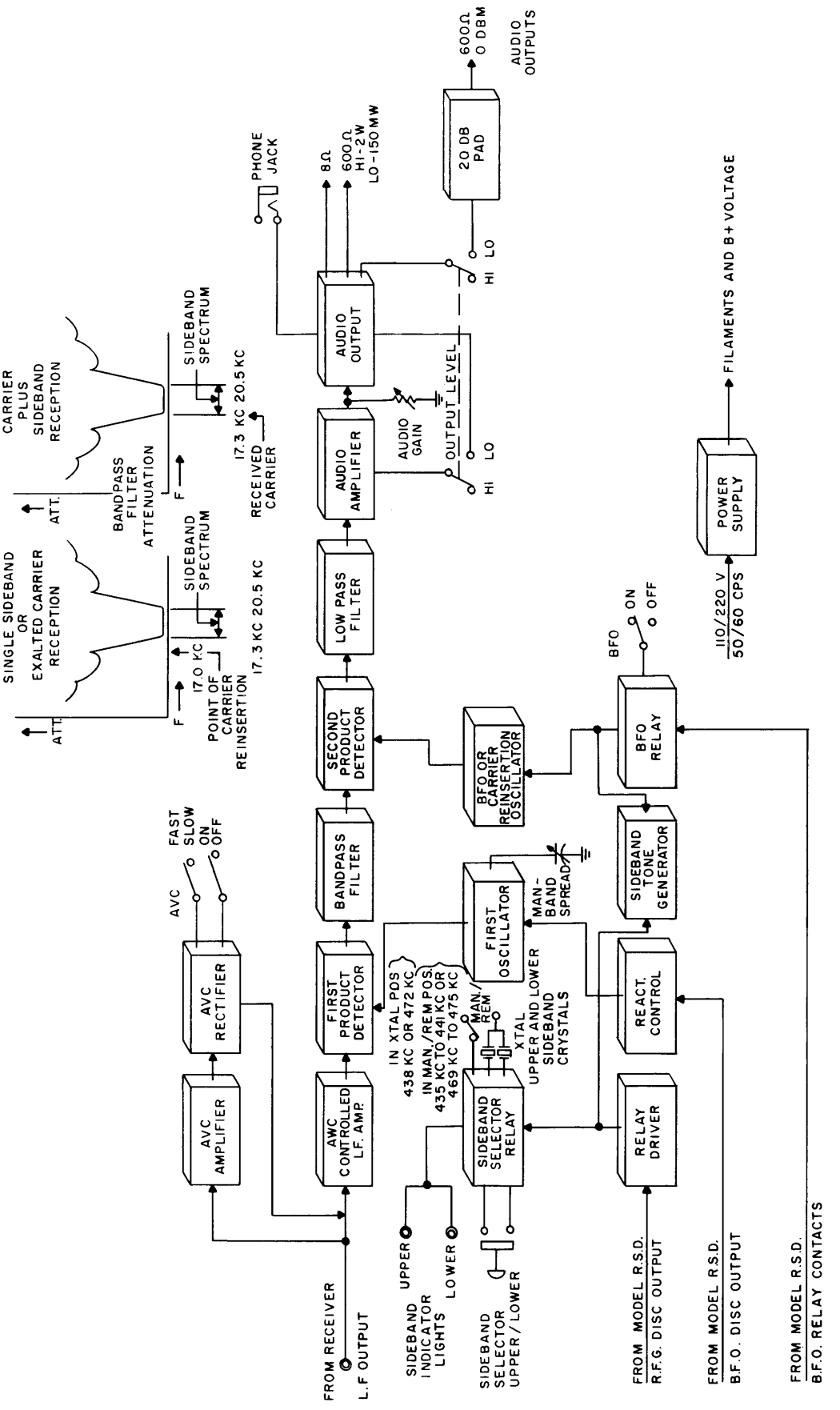


Figure 4-3. Block Diagram Model MSR

carrier will appear at 17 kc within the MSR. This will be so in all cases of single sideband or exaulted carrier operation. However, in normal AM, CW, or FS operation, the incoming signal must be shifted for several reasons:

(1) In 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 xtals 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) F. S. 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. The standard mark and space beat tones 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 4-11.)

Due to the similarity of circuitry design employed in models MSR-4 and MSR-5, many of the simplified schematic diagrams will pertain to both models. However, since the circuit component values may vary, reference to the appropriate schematic diagram in Section 8 or to the parts list in Section 7 will supply the proper component types and values.

a. AVC NETWORK (Figure 4-4). - The AVC Amplifier V1a and AVC Rectifier V1b provide two kinds of control of the IF Amplifier V2. With the AVC toggle switch S1 in the FAST position, a fast time constant is employed to control signals which have an ever present component, i.e. AM, MCW, FS. When the AVC toggle switch S1 is in the SLOW position, a slow time constant will hold the IF Amplifier gain steady for a longer period for SSB and

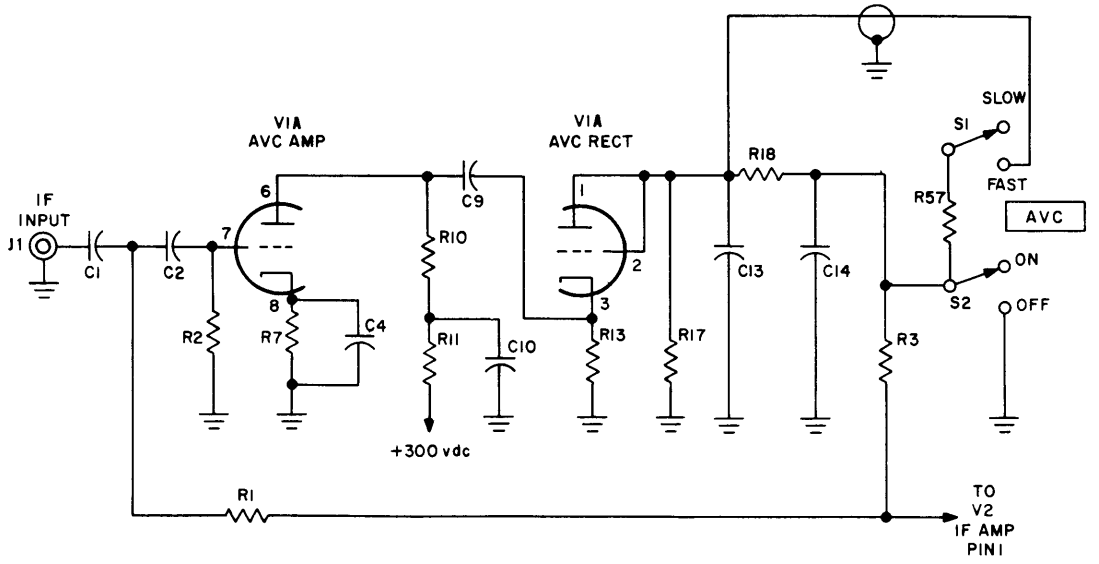


Figure 4-4. AVC Newtork, Simplified Schematic Diagram

CW signals. When the AVC toggle switch S2 is in the OFF position, the gain of the IF Amplifier V2 is wide open.

b. IF AMPLIFIER AND 1st MIXER (Figure 4-5). - The incoming signal from the AVC controlled IF Amplifier V2 is mixed with the 1st Oscillator V7 output to place it in proper position relative to the bandpass filter Z1. The bandpass filter Z1 has a bandwidth of 19.1 kc to 3.4 kc, the output of which is fed to the arm of the BFO relay K1 for application to the 2nd Mixer V4.

c. 2nd MIXER (Figure 4-6). - The signal passed by the bandpass filter Z1 is demodulated in either of two ways. If a carrier is normally present and allowed to pass through the filter, such as AM, normal demodulation will take place. If no normal carrier is present, such as SSB, a carrier is reinserted from the 2nd Oscillator V5. The output of the 2nd Mixer V4 is then coupled through a low-pass filter Z2, having a cutoff frequency of 3500 cps, to the input of the audio amplifier stages via a AUDIO GAIN control R30.

d. AUDIO AMPLIFIER STAGES (Figure 4-7). - The Audio Amplifier stages (V6 and V5b in model MSR-4, and V6 and V12a in model MSR-5) provide three levels of output. The Output Level control S8 in the HIGH position, permits the full 2 watts of the amplifier to be available for the 600 ohm line or 8 ohm loudspeaker. When the Output Level control S8 is in the LOW position, the gain of the amplifier is reduced so that 150 milliwatts is available for the 600 ohm line 8 ohm loudspeaker, and 0 dbm or 1 milliwatt for 600 ohm telephone line. A PHONE jack J3 on the front panel permits monitoring of the output without any circuit interruption

e. 1st OSCILLATOR AND REACTANCE MODULATOR (Figure 4-8, Model MSR-4, Figure 4-9, Model MSR-5). - The 1st Oscillator V7, provides the tunable frequency source for correctly tuning the signal in the bandpass filter. It may be accomplished either manually with the BANDSPREAD control C28 or crystal controlled, selected by the MANUAL/XTAL switch S4. The reactance placed across the 1st Oscillator tuned circuit is varied to change frequency. A ±4.5 vdc input to the Reactance Modulator V8 via terminal board E1 is sufficient to vary the oscillator ±3 kc. This voltage is obtained from the BFO channel of the TMC Model RCR Remote Control Receiver System.

Operation of the Relay Driver V9a or the front panel SIDEBAND pushbutton S6 advances the sideband selector relay K2 one position. This changes the 1st Oscillator frequency from lower to upper sideband frequency or visa versa.

f. RELAY DRIVER/TONE GENERATOR, 2nd OSCILLATOR (Figure 4-10, Model MSR-4, Figure 4-11, Model MSR-5). - As the RF Gain control on the TMC Model RCR system is turned to reduce the gain of the TMC Model FFR receiver, the required output of the TMC Model RSD performing this action reaches a certain level. When the level is such that the receiver is fully silent, its negative level will be sufficient to cut off the Relay Driver V9a, and de-energize relay K3. This action in turn, trips the sideband two-step relay K2.

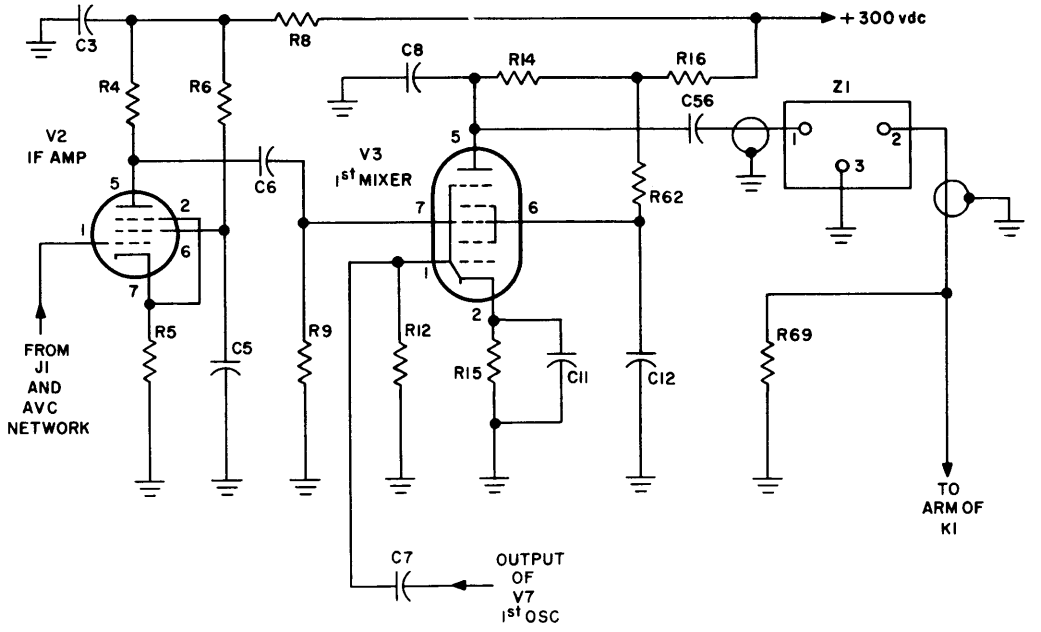


Figure 4-5. IF Amplifier and 1st Mixer, Simplified Schematic Diagram

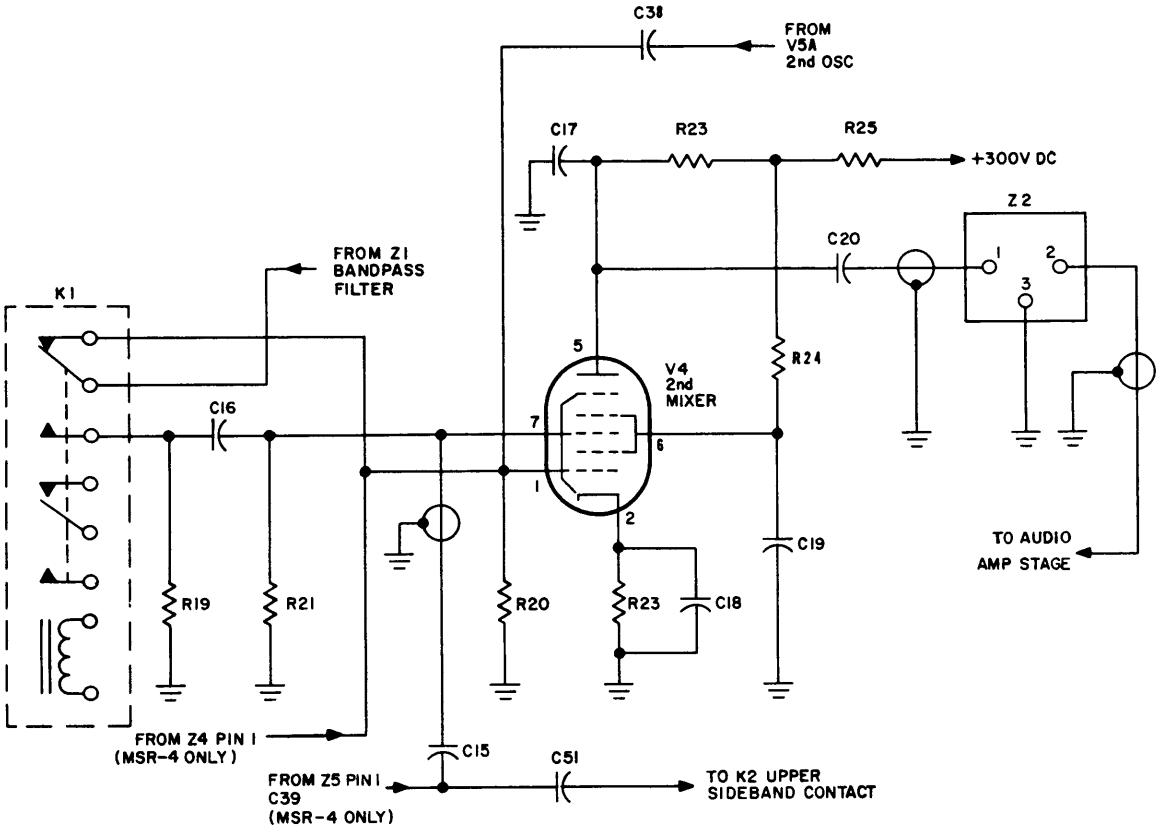


Figure 4-6. 2nd Mixer, Simplified Schematic Diagram

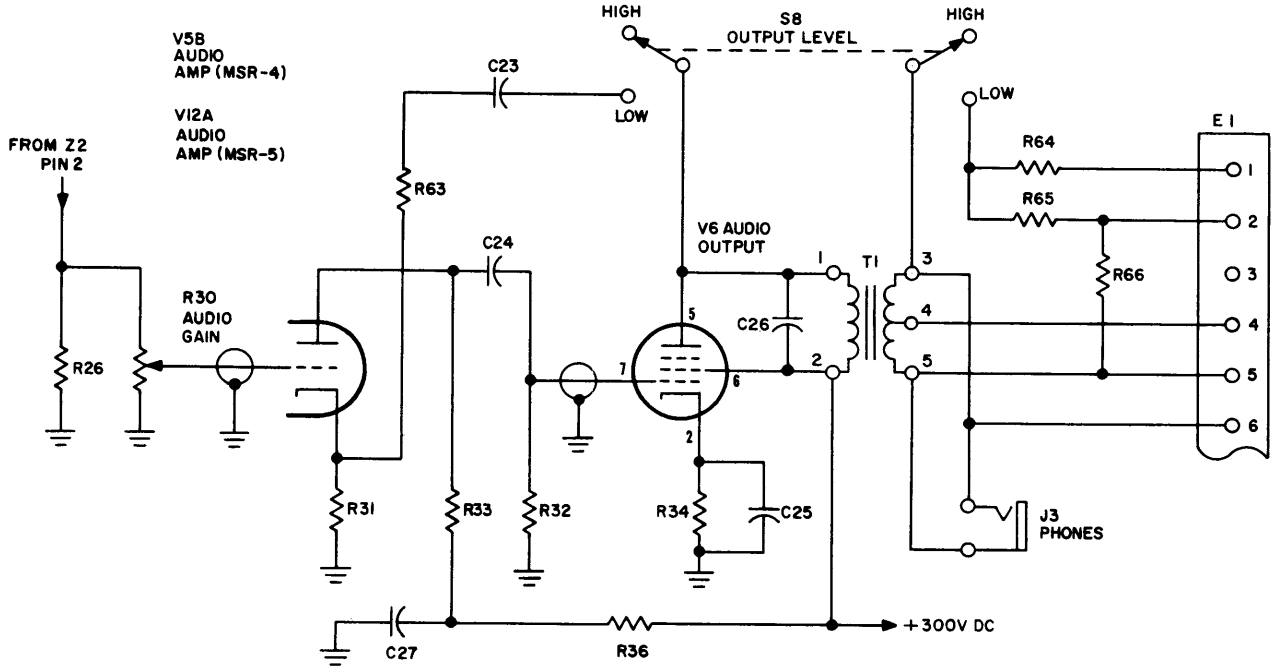


Figure 4-7. Audio Amplifier Stages, Simplified Schematic Diagram

By proper operation of the RF Gain control of the TMC Model RSC, the Sideband Tone Generator V9b generates a tone, high or low, which will indicate to the remote operator, which sideband (upper or lower) is in use. The tone becomes strong enough to be heard only after the RF Gain of the RCR unit had succeeded in fully silencing the normal receiver action.

The 2nd Oscillator V5, provides a stable 12 kc reinsertion carrier (oven crystal controlled in the model MSR-5) for SSB, Exalted AM and produces the beat note for CW and FS signals. A 17 kc Test Point J5 is provided on the Model MSR-5 for sampling purposes.

g. POWER SUPPLY (Figure 4-12). - The MSR unit employs a standard type full wave rectified, voltage regulated power supply. It is factory wired for 110 vac input power and may be converted for 220 vac operation by making the necessary wiring changes as shown in figure 2-1.

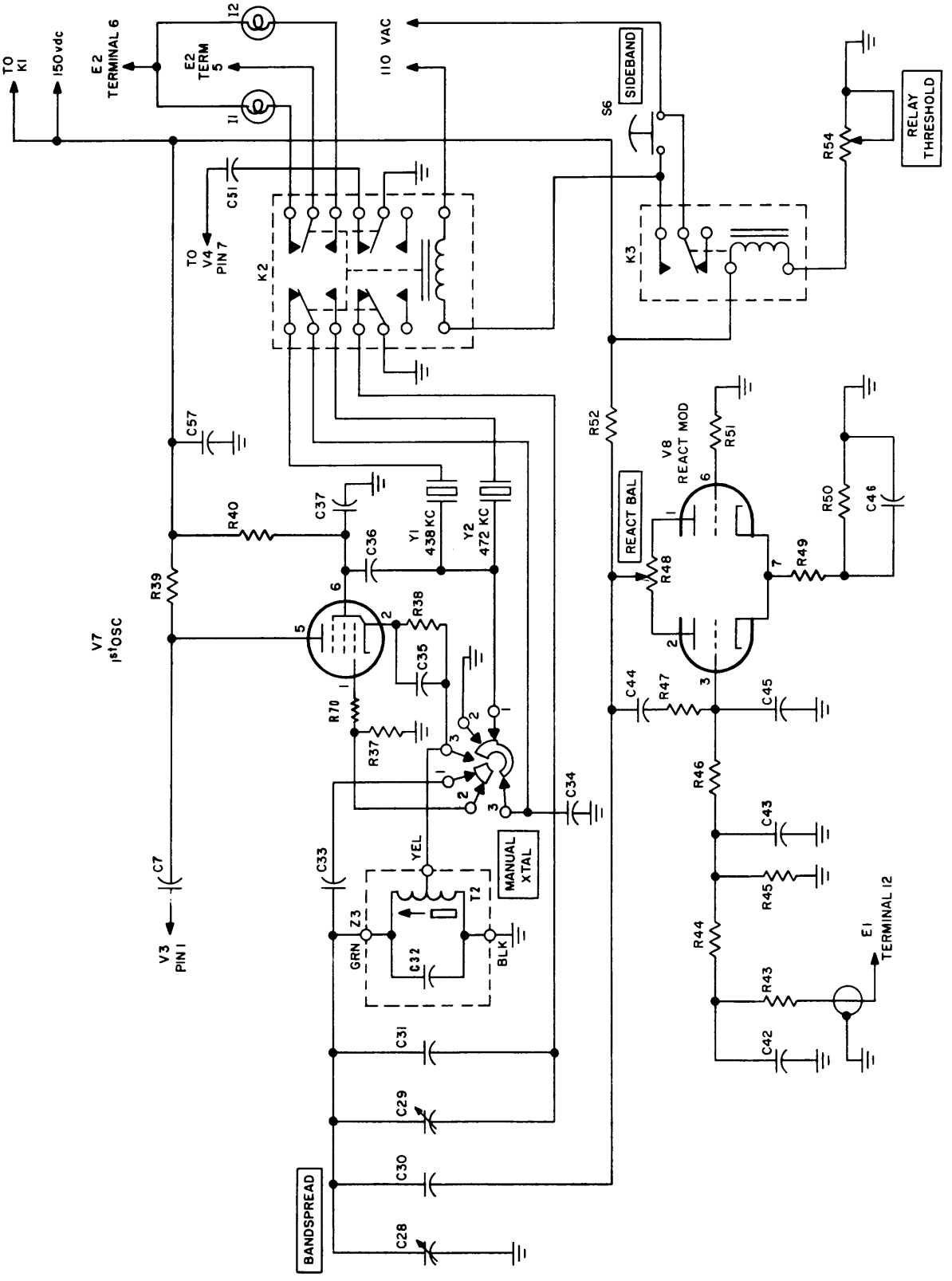


Figure 4-8. 1st Oscillator and Reactance Modulator, Model MSR-4, Simplified Schematic Diagram

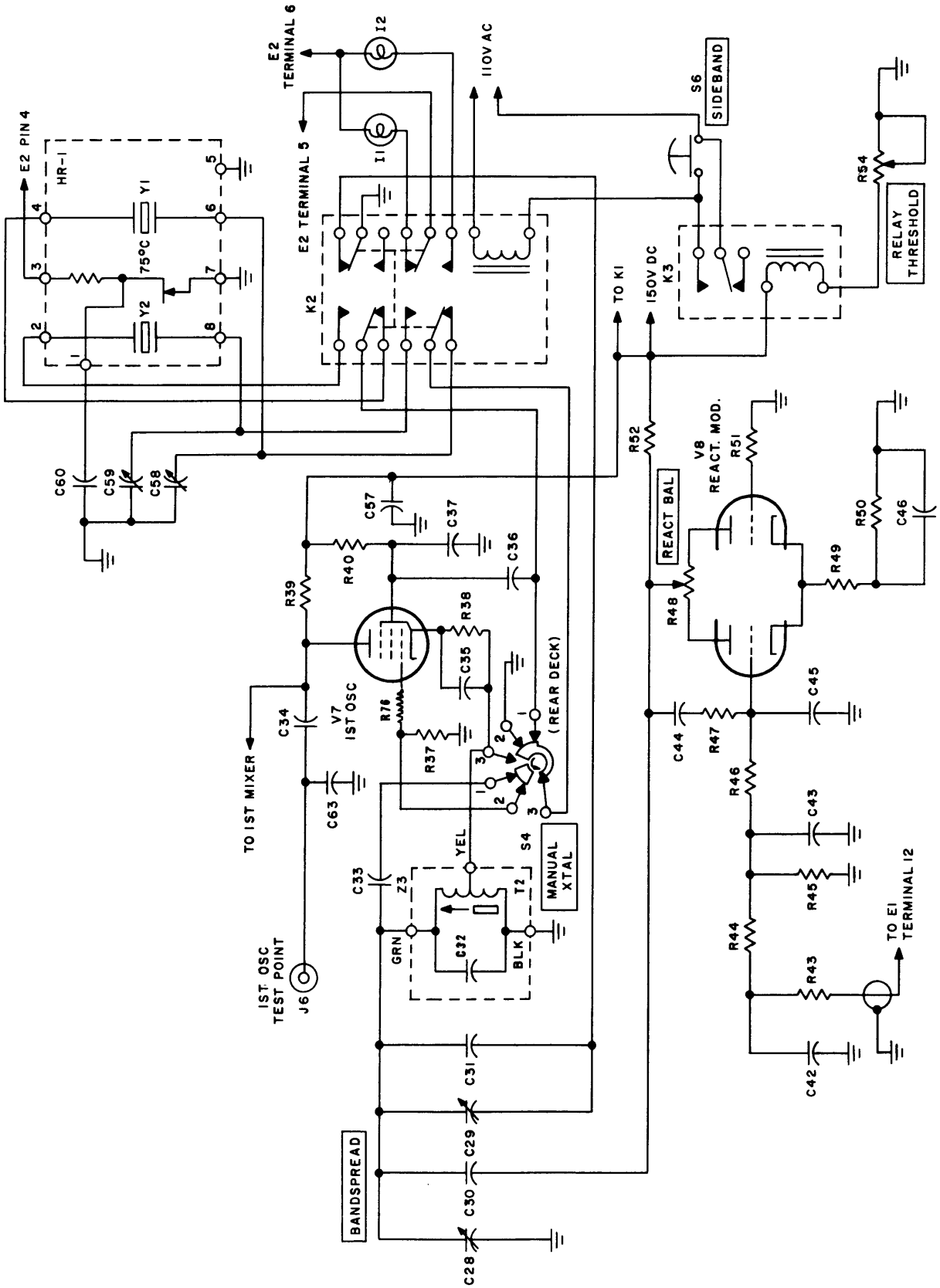


Figure 4-9. 1st Oscillator and Reactance Modulator, Model MSR-5, Simplified Schematic Diagram

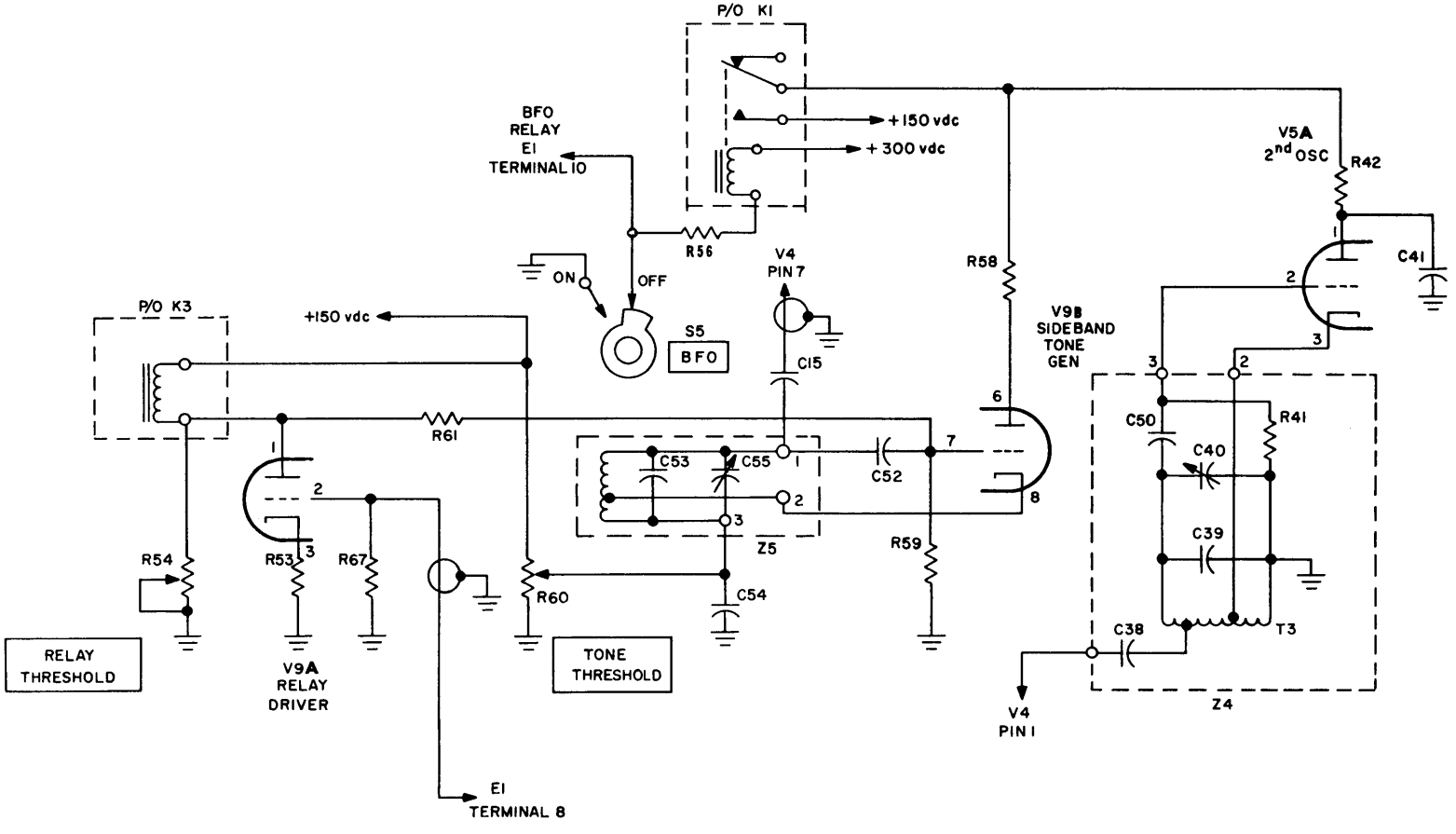


Figure 4-10. Relay Driver/Tone Generator, 2nd Oscillator, Model MSR-4, Simplified Schematic Diagram

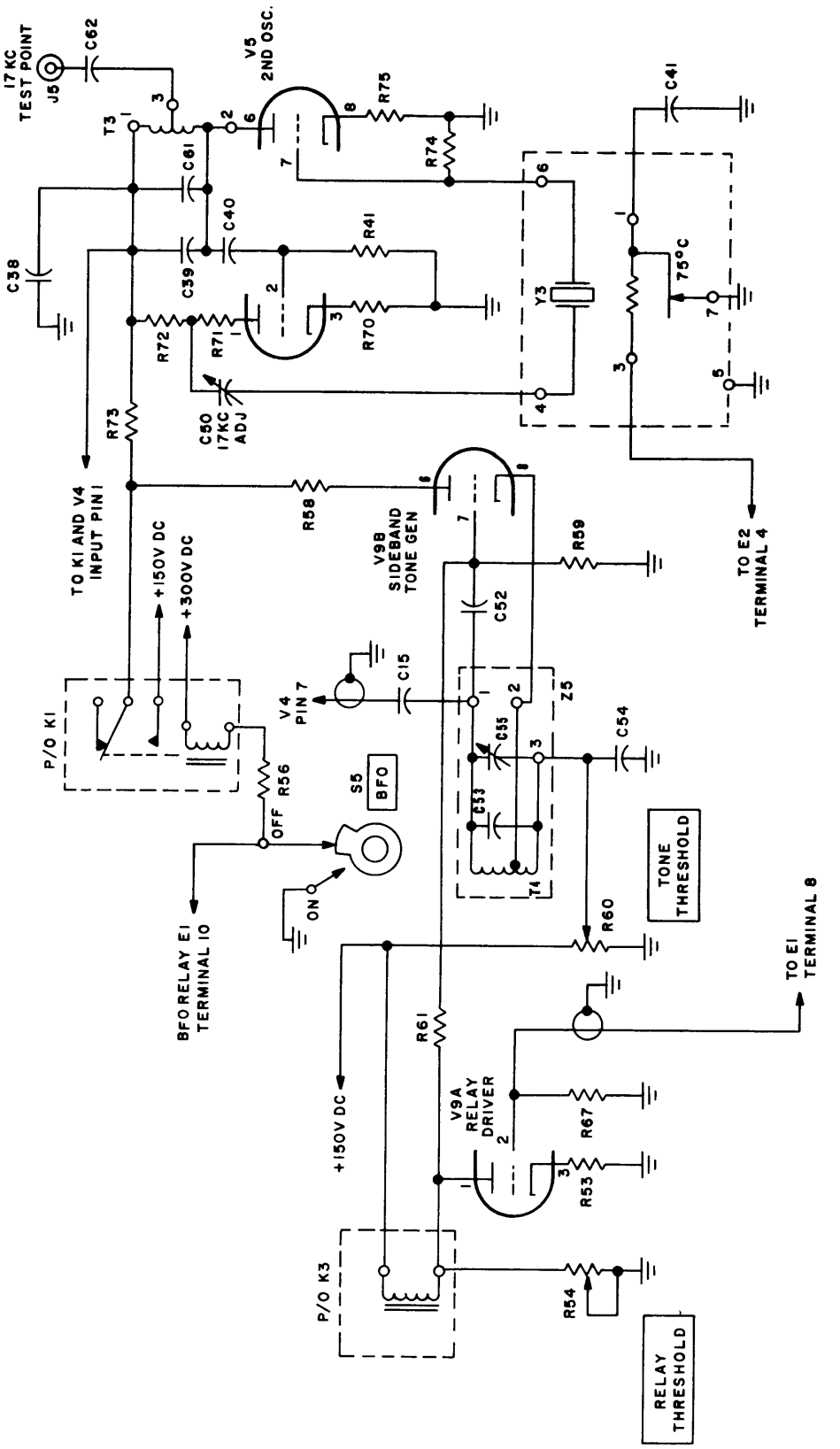


Figure 4-11. Relay Driver/Tone Generator, 2nd Oscillator, Model MSR-5, Simplified Schematic Diagram

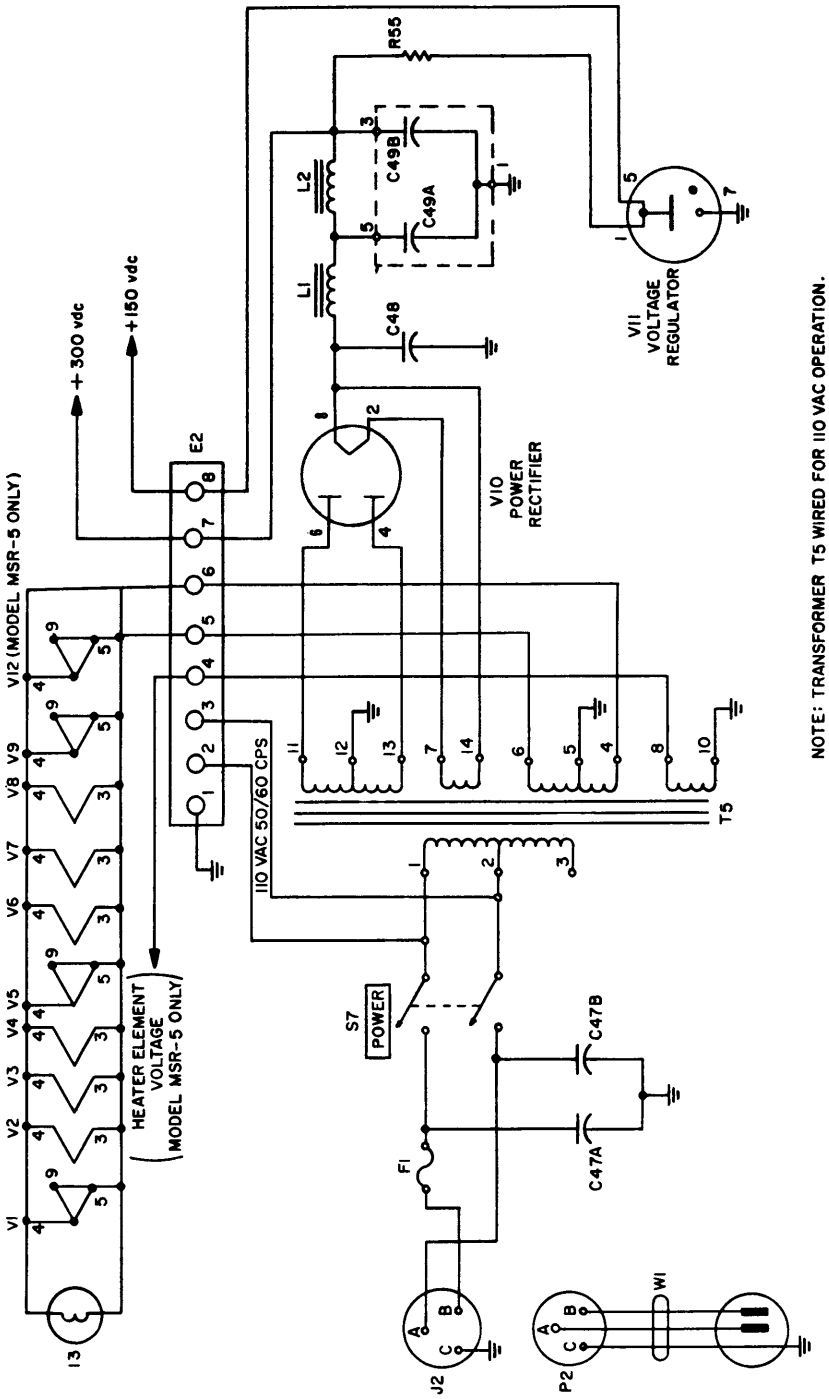


Figure 4-12. Power Supply, Simplified Schematic Diagram

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 4-12).

b. Voltage and resistance measurement charts (Tables 5-4 through 5-7).

c. Troubleshooting techniques (Paragraph 5-2).

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 analogous to past failures. In this case, it is necessary to follow a lengthy and orderly course of troubleshooting in order to localize and isolate the faulty part.

A second shortcut in troubleshooting is to ascertain that all tubes and fuses are in proper operating condition and that the proper equipment operating voltages are present. This may eliminate further investigation.

A third shortcut in troubleshooting is to examine the equipment section by section for burned elements, charring, corrosion, arcing, excessive heat, dirt, dampness, etc.

b. VOLTAGE AND RESISTANCE MEASUREMENTS. - The voltage and resistance values shown in the Voltage and Resistance Measurement Charts (tables 5-4 through 5-7) 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) Perform steps (1) and (2) above with the SIDEBAND pushbutton pressed.

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

(5) 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:

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

(7) Measure from terminal 7 of E2 to ground. Observe for a normal indication of +320 volts d-c.

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

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

BFO	OFF
AUDIO GAIN	Fully clockwise
OUTPUT LEVEL	HIGH

600 ohm, 10 watt resistor across terminals 5 and 6 of E1. AC VTVM across 600 ohm output load. Proceed as follows:

(1) Connect audio signal generator, set at 1 kc, to pin 7 of V4.

(2) Adjust input voltage for 36.0 volts output. Indication on oscilloscope should show waveform just starting to clip.

(3) Measure a-c voltage at pin 7 of V6. Normal indication is between 6.5 volts and 7.5 volts.

TABLE 5—1. DC VOLTAGE ON V8 AFTER ALL ADJUSTMENTS MADE

APPLIED CONTROL VOLTAGE TO PIN 2	TUBE V9 PIN NUMBERS					
	1	2	3	6	7	8
0 VOLTS	+66	0	+1.4	+150	+33	+33
-5 VOLTS	+105	-5	+0.6	+145	+53	+59
-9 VOLTS	+128	-9	+0.14	+128	+60	+66

TABLE 5—2. TONE GENERATOR OUTPUT AT GRID OF V4, PIN 7

APPLIED CONTROL VOLTAGE TO PIN 2	LOWER SIDEBAND (16.5 KC)	UPPER SIDEBAND (14.5 KC)
0 VOLTS	OFF	OFF
-5 VOLTS	.25 VOLTS	.09 VOLTS
-9 VOLTS	.45 VOLTS	.28 VOLTS

TABLE 5—3. TEST EQUIPMENT FOR TROUBLE SHOOTING

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—4. VOLTAGE MEASUREMENT CHART, MODEL MSR-4

TUBE	TYPE	FUNCTION	SOCKET PIN NUMBERS								
			1	2	3	4	5	6	7	8	9
V1	12AU7	AVC AMP.-RECT.	-0.6	-0.6	0.4	6.3*	6.3*	104	0	2.3	6.3*
V2	6BA6	I. F. AMP.	0	2.8	6.3*	6.3*	140	110	2.8		
V3	6BE6	1st MIXER	-11.2	2.2	6.3*	6.3*	255	66	0		
V4	6BE6	2nd MIXER	-4	0.7	6.3*	6.3*	148	75	0		
V5	12AT7	2nd OSC-AUD. AMP.	104	-13	0	6.3*	6.3*	68	0	0.7	6.3*
V6	6AQ5	AUDIO OUT.	NC	19	6.3*	6.3*	300	300	0		
V7	6AG5	1st OSC.	-1.7	0.44	6.3*	6.3*	60	83	NC		
V8	6J6	REACT. MOD.	60	60	6.3*	6.3*	0	0	1.8		
V9	12AU7	RELAY DRIVER-SIDE TONE GEN.	60	0	1.4	6.3*	6.3*	148	30	58	6.3*
V10	5Y3	RECTIFIER	NC	365	NC	365*	NC	365*	NC	365	
V11	OA2	VOLT. REG.	150	NC	NC	NC	150	NC	0		

CONDITIONS:
All measurements taken with V.T.V.M.
BFO - ON
Sideband - Manual
Audio Gain - Clockwise
AVC - Off
No Signal

NC = No Connection
* = AC Voltage

AC Line Voltage - 115 V.
All to ground except AC
Filament Voltages - Across Filaments

TABLE 5—5. VOLTAGE MEASUREMENT CHART, MODEL MSR-5

TUBE	TYPE	FUNCTION	SOCKET PIN NUMBERS								
			1	2	3	4	5	6	7	8	9
V1	12AU7	AVC AMP.-RECT.	-.47	-.47	+.12	3.15	3.15	+95	0	+2.1	3.15
V2	6BA6	I. F. AMP.	0	+2.8	3.15	3.15	+134	+118	+2.8		
V3	6BE6	1st MIXER	-9.2	+2.2	3.15	3.15	+262	+90	0		
V4	6BE6	2nd MIXER	-12.	+.6	3.15	3.15	+170	+62	0		
V5	12AT7	2nd OSC.	+50	-8	+2.4	3.15	3.15	+68	0	+1.16	3.15
V6	6AQ5	AUDIO OUTPUT	NC	+19.5	3.15	3.15	+290	+300	0		
V7	6AG5	1st OSC.	-2	+.54	3.15	3.15	+53	+83	NC		
V8	6J6	REACT. MOD.	+65	+65	3.15	3.15	0	0	+2		
V9	12AU7	RELAY DRIVER SIDE TONE GEN.	+66	0	+1.4	3.15	3.15	+148	+33	+55	3.15
V10	5Y3	RECTIFIER	NC	+360	NC	365	NC	365	NC	+360	

TABLE 5—5. VOLTAGE MEASUREMENT CHART, MODEL MSR-5(C nt'd)

TUBE	TYPE	FUNCTION	SOCKET PIN NUMBERS								
			1	2	3	4	5	6	7	8	9
V11	OA2	VOLTAGE REG.	+150	NC	NC	NC	+150	NC	0		
V12	12AT7	AUDIO AMP.	+64	0	+.75	3.15	3.15	NC	NC	NC	3.15

CONDITIONS:

AC Line Voltage 115V
All Voltages to Ground
Measurements taken with V. T. V. M.
BFO - ON
Manual - Xtal - Manual
Signal Input = 0
AVC - Off and Fast
React. Bal. - Mid Position

*DC Voltages shown are after relay and Tone Threshold Adjustments were made.

TABLE 5—6. RESISTANCE MEASUREMENT CHART, MODEL MSR-4

TUBE	TYPE	FUNCTION	SOCKET PIN NUMBERS								
			1	2	3	4	5	6	7	8	9
V1	12AU7	AVC AMP.-RECT.	1.2M	1.2M	150K	0	0	80K	430K	470	0
V2	6BA6	I. F. AMP.	470K	330	0	0	66K	100K	330		
V3	6BE6	1st MIXER	22K	220	0	0	50K	63K	470K		
V4	6BE6	2nd MIXER	9	120	0	0	150K	90K	20K		
V5	12AT7	2nd OSC.-AUD. AMP.	inf.	100K	1.2	0	0	140K	1.0M	390	0
V6	6AQ5	AUDIO OUT.	NC	560	0	0	38K	38K	470K		
V7	6AG5	1st OSC.	22K	120	0	0	72K	72K	NC		
V8	6J6	REACT. MOD.	90K	90K	0	0	590K	33K	1.5K		
V9	12AU7	RELAY DRIVER-SIDE TONE GEN.	52K	1 M	390	0	0	inf.	220K	30K	0
V10	5Y3	RECTIFIER	NC	38K	NC	100	NC	100	NC	38K	
V11	OA2	VOLT. REG.	38K	NC	NC	NC	38K	NC	0		

CONDITIONS:

Ohmmeter - Simpson 260 or Equivalent
Resistances to Ground
Audio Gain - Clockwise
Manual/Xtal - Manual
Power - Off
AVC - Off
BFO - On

NC = No Connection
K = Thousand
M = Million

TABLE 5—7. RESISTANCE MEASUREMENT CHART, MODEL MSR-5

TUBE	TYPE	FUNCTION	SOCKET PIN NUMBERS								
			1	2	3	4	5	6	7	8	9
V1	12AU7	AVC AMP.-RECT.	1.3M	1.3M	150K	0	0	84.8K	470K	470	0
V2	6BA6	I. F. AMP.	100K	330	0	0	65K	111K	330		
V3	6BE6	1st MIXER	22K	220	0	0	53K	65K	470K		
V4	6BE6	2nd MIXER	5.5	120	0	0	150.8K	97.8K	20K		
V5	12AT7	2nd OSC.	inf.	100K	4.7K	0	0	inf.	27K	1K	0

TABLE 5—7. RESISTANCE MEASUREMENT CHART, MODEL MSR-5 (C nt'd)

TUBE	TYPE	FUNCTION	SOCKET PIN NUMBERS								
			1	2	3	4	5	6	7	8	9
V6	6AQ5	AUDIO OUTPUT	NC	560	0	0	40.8K	40.8K	470K		
V7	6AG5	1st OSC.	22K	120	0	0	80K	80K	NC		
V8	6J6	REACT. MOD.	98.2K	98.2K	0	0	590K	33K	1180		
V9	12AU7	RELAY DRIVER SIDE TONE GEN.	43.8K	1 M	390	0	0	inf.	242K	1.2	0
V10	5Y3	RECTIFIER	NC	41.3K	NC	100	NC	100	NC	41.3K	0
V11	OA2	VOLTAGE REG.	41K	NC	NC	NC	41K	NC	0		
V12	12AT7	AUDIO AMP.	173.8K	10.7K	390	0	0	NC	NC	NC	0

CONDITIONS:

Resistance to Ground
Audio Gain - Clockwise
Manual-Xtal - Manual
Power - Off
Off
AVC - Fast

Tone Threshold - Counterclockwise
Relay Threshold - Clockwise
Reactance Balance - Mid Pos. (Approx.)

(4) Measure a-c voltage at pin 7 of V5 (for MSR-4) or pin 7 of V12 (for MSR-5). Normal indication is between .2 volts and .25 volts.

(5) Measure input voltage at pin 7 of V4. Normal indication is between .03 volts and .04 volts.

(6) Adjust AUDIO GAIN control for 36.0 volts across 600 ohm load.

(7) Adjust audio signal generator for 17 kc output. The output drop across the 600 ohm load with a constant input should be 55 db or greater. If drop is less, filter requires retuning.

(8) With the audio signal generator output set for 36.0 volts across terminals 5 and 6 of E1, set the OUTPUT LEVEL switch to LOW. The output should drop to 8 to 9 volts.

(9) Connect another 600 ohm resistance across terminals 2 and 3 of E1. Voltage across this load should be from 0.7 volts to 0.8 volts.

(10) Set the OUTPUT LEVEL switch to HIGH. Voltage should drop to zero.

c. 2nd MIXER OPERATION, MODEL MSR-4.

(1) Turn BFO switch ON.

(2) Measure d-c bias voltages; should be approximately:

V5, pin 2	30 volts d-c
V4, pin 1	10 volts d-c
V4, pin 7	0

If bias is present at pin 7 of V4, adjust Tone Threshold control R60 for zero bias.

(3) Connect signal generator, set at 17 KC, to pin 7 of V4 (E in = 5.0 volts).

(4) Connect oscilloscope to terminal 2 of Z2.

(5) Tune Z4 trimmer to obtain a zero beat pattern on the oscilloscope screen.

(6) Disconnect signal generator. Measure 17 DC across the 600 ohm load with AUDIO GAIN control set at maximum; should be less than 6.0 volts.

(7) Turn BFO switch OFF.

2nd MIXER OPERATION, MODEL MSR-5.

(1) Turn BFO switch ON.

(2) Measure d-c bias voltages; should be approximately:

V5, pin 2	7 volts d-c
V4, pin 1	11 volts d-c, (10 vac)
V4, pin 7	0

(3) Connect counter to 17 kc 2nd Oscillator Test Point J5. Tune 17 kc ADJ. for 17,000.0 on counter. (After 15 minute warmup period).

(4) Measure output across the 600 ohm load with AUDIO GAIN fully on; should measure less than 6.0 volts.

(5) Turn BFO switch OFF.

d. FIRST MIXER OPERATION (AS AMPLIFIER).

(1) Connect audio signal generator through a .01 mfd. capacitor to pin 7 of V3 (1st Mixer).

(2) Connect a-c VTVM to pin 1 of V4 (2nd Mixer).

(3) Tune the audio signal generator for peak on meter within range of 17 kc to 21 kc. Adjust output to obtain 1.0 volt on meter.

(4) Signal generator input should be approximately .5 volts to .6 volts.

(5) Vary the signal generator frequency checking output drop of filter Z1 as follows:

FREQUENCY	OUTPUT DROP + L DB
17.4 kc	-3 db
20.5 kc	-3 db
16.6 kc	-45 db
21.85 kc	-45 db

e. 1st OSCILLATOR (Variable). - When upper sideband indicator is lit, the oscillator center frequency should be 472.00 kc. When the lower sideband indicator is lit, the oscillator center frequency should be 438.00 kc.

(1) SIDEBAND switch set for Upper.

(2) Measure bias on pin 1 of V7; should be approximately -11.0 ± 1.0 volts in both upper and lower sideband positions.

(3) Connect RF signal to pin 7 of V3.

(4) Connect oscilloscope to pin 5 of V7.

(5) Place Reactance Balance control to mid-position.

(6) Tune the signal generator to 472.00 KC.

(7) Tune the core of Z3 to obtain zero beat on oscilloscope.

(8) SIDEBAND switch set for Lower.

(9) Tune trimmer C29 to frequency of 438.00 KC.

f. 1st OSCILLATOR (Crystal).

(1) Place correct crystals in sockets.

Y1-438.00 KC
Y2-472.00 KC

(2) Turn MANUAL/XTAL switch to XTAL position.

(3) The bias voltage on pin 1 of V8 (Model MSR-4) should be between 5.0 v and 5.5 v in Upper and Lower positions. The bias voltage on pin 1 of V7 (Model MSR-5) should be:

USB	-2.8 v
LSB	-3.4 v
MAN	-5.4 v

(4) Check and adjust, if necessary, the crystal frequencies with a counter.

Upper-472.00 KC
Lower-438.00 KC

g. IF AMPLIFIER AND 1st MIXER.

(1) Connect signal generator to IF INPUT jack J1.

(2) Connect VTVM a-c probe to pin 7 of V3 (1st Mixer).

(3) Set signal generator as follows with unmodulated signal. AVC toggle switch - OFF. Check output at pin 7 of V3.

Frequency - 450 KC

E-In	Model MSR-5 E Out ± 10%	Model MSR-4 E Out ± 10%
0.20	1.55 v	1.1 v
0.50	2.9 v	3.4 v
1.0	5.4 v	7.0 v

(4) AVC toggle switch - ON, FAST.

(5) Set signal generator as follows at 450 KC.

E-In	Model MSR-5 E Out ± 10%	Model MSR-4 E Out ± 10%
0.20	1.2 v	.8 v
0.50	1.5 v	1.8 v
1.0	1.8 v	3.7 v

(6) AVC Check:

(a) Increase generator input to 1 volt.

(b) Set the AVC toggle switch to ON and FAST. Note rate of output drop.

(c) Set AVC toggle switch to OFF and SLOW.

(d) Set AVC toggle switch to ON and SLOW. Note rate of output drop; should be slower than step (b).

h. SENSITIVITY.

(1) Set BFO switch ON.

(2) Set AVC switch OFF.

(3) Set signal generator unmodulated to 454 KC to produce a 1 KC note at output.

(4) Check sensitivity:

INPUT	MODE	E-in
454 KC	MANUAL	.09 v
454 KC	U.S.B.	.09 v
456 KC	L.S.B.	.095 v
456 KC	MANUAL	.10 v

i. REACTANCE SHIFT. - (For remote control operation only see figure 5-1).

(1) Apply DC supply across pins 11 and 12 of E1. Check frequency of oscillator with counter and set voltage by adjusting reactance balance control to obtain the following:

CONTROL VOLTAGE	FREQUENCY SHIFT ± 10% UPPER KC	LOWER KC
+4.5	+4.877	+3.613
+2.0	+2.809	+2.225
0	0	0
-2.0	-2.414	-2.045
-4.5	-4.567	-3.957

(2) Return oscillator for 438.00 KC in Lower sideband position and 472.00 KC in Upper sideband position with reactance control voltage set to zero.

j. BANDSPREAD CONTROL.

(1) Check shift of oscillator with BANDSPREAD control at each mark on panel. Reactance control voltage set to zero.

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 1.5	+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

k. REMOTE CONTROL SIDEBAND SELECTION. - (For remote control operation only see figure 5-1).

(1) RELAY THRESHOLD ADJUSTMENT (K3).

(a) Apply negative voltage supply as shown in figure 5-1, to pin 2 of V9a.

(b) Vary the voltage from zero to -10v while adjusting R54 Relay Threshold control until K3 trips (which in turn trips K2 sideband selector). K3 should trip regularly at -9 volts. K3 should pull in at -3.5 to -4 volts and drop out at -9 to 9.5 volts.

(2) TONE GENERATOR THRESHOLD ADJUSTMENT (R60).

(a) Apply - 5 volts to pin 2 of V9a.

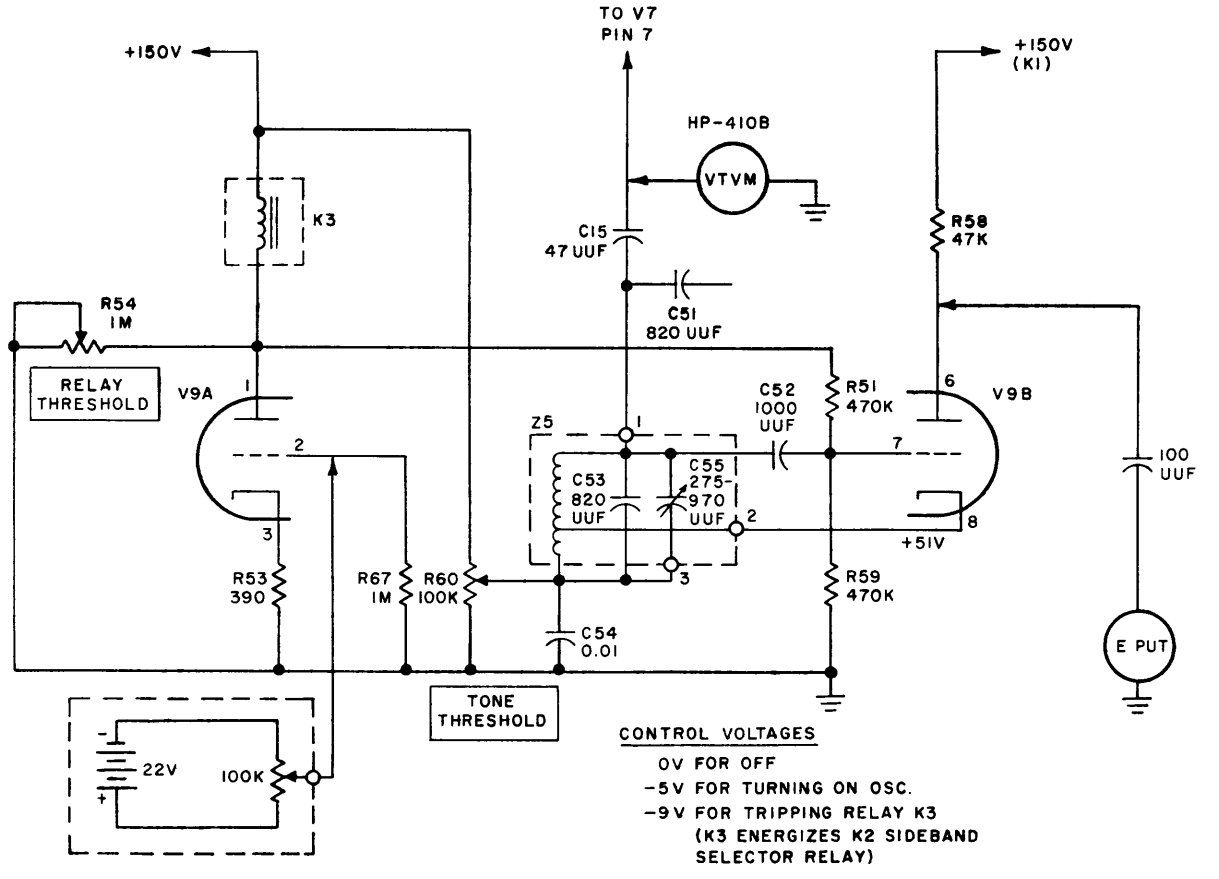


Figure 5-1. Control Voltage Setting Diagram, Remote Operation

(b) Adjust Tone Threshold control until oscillator just starts on Lower and Upper sideband operating position.

(3) TONE GENERATOR FREQUENCY ADJUSTMENT (C55 in Z5).

(a) Connect Eput meter through a 100 mmf capacitor to pin 6 of V9b to observe the frequency of the tone generator.

(b) Select the lower sideband operating position with the SIDEBAND pushbutton.

(c) Adjust C55 in Z5 until Eput meter reads 16,500 cps exactly.

(d) Select upper sideband position and Eput should read 14,500 cps ± 200 cps.

(e) Observe a-c voltage on 2nd mixer grid pin 7 of V4. It should read:

Lower sideband - .25 volts approx.
Upper sideband - .09 volts approx. If it is less, readjust Tone Threshold R60.

NOTE

The use of a speaker or phones is recommended for output tone identication.

(f) Reconnect Eput meter across 600 ohm load on output terminals and observe resultant output frequency. It should read:

Lower sideband - 500 cps exactly.
(Retune C55 of E5 if necessary)
Upper sideband - 2500 cps ± 200 cps.

l. FINAL CHECK.

(1) Connect speaker across terminals 4 and 5 of E1.

(2) Set BFO switch ON.

(3) Set AUDIO GAIN to desired position.

(4) Connect signal generator to IF INPUT jack tuned to 455 KC.

(5) Sideband on Upper/Manual:

(a) Tune BANDSPREAD control to + position and note audio tone.

(b) Tune BANDSPREAD control to - position and note audio tone.

(6) Sideband on Lower/Manual.

(a) Tune BANDSPREAD control to + position and note audio tone.

(b) Tune BANDSPREAD control to - position and note audio tone.

(7) Sideband on Upper/Xtal:

(a) Tune signal generator to 455 KC + audio note.

(b) Tune signal generator to 455 KC - audio note.

(8) Sideband on Lower/Xtal:

(a) Tune signal generator to 455 KC + audio tone.

(b) Tune signal generator to 455 KC - audio tone.

(9) Sideband on Upper/Manual:

(a) Tune signal generator to obtain zero beat.

(b) Switch to Lower sideband. No change of zero beat should occur.

SECTION 6
MAINTENANCE

6-1. INTRODUCTION

Maintenance may be divided into three catagories: operator's maintenance, preventive maintenance and corrective maintenance.

Corrective maintenance is sometimes considered as consisting of information useful in locating and diagnosing equipment troubles and maladjustments, existting and/or pending, and information necessary to remedy the equipment troubles and maladjustments.

The MSR unit has been designed to provide long-term, trouble-free operation under continuous duty conditions. It is recommended that any necessary maintenance be done by a competent maintenance technician familiar with troubleshooting techniques. If the trouble cannot be corrected, it is recommended that the MSR unit be returned to the Technical Materiel Corporation for servicing.

6-2. PREVENTIVE MAINTENANCE.

a. In order to prevent failure of the equipment due to corrosion, tube failure, dust or other destructive elements, it is suggested that a schedule of preventive maintenance be set up and adhered to.

b. At periodic intervals (at least every six months) the equipment should be removed from the rack for cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring or grease. Tube sockets should be carefully inspected for deterioration. Dust may be removed with a soft brush or vacuum cleaner. Remove dirt or grease from other parts with any good dry cleaning fluid.

WARNING

When using carbon tetrachloride, make certain that adequate ventilation exists. Avoid prolonged contact with skin.

c. While unit is out of the rack, check the tubes, all of which are accessible on the top of the chassis.

d. Carefully inspect for loose solder connections or screws, especially those on solder lugs. Recommended time interval is every 6 to 12 months, depending on the amount of vibration encountered in service.

6-3. CORRECTIVE MAINTENANCE

Corrective maintenance of the MSR unit will consist mainly of replacement of tubes and other electrical components. It should be noted that when replacing tubes or other components, the technician should observe for exact or equivalent replacements by referring to the parts list in Section 7. Polarity and positioning of certain components should be observed before removing so that the replacement component will fit and operate properly.

6-4. CIRCUIT ALIGNMENT

The oscillators have been aligned to their correct frequencies at the factory. Readjustment will only be required if the performance of the unit is impaired as when the bandspread oscillator is off scale with a signal centered on 455 kc. The oscillators may be aligned either with an accurate signal generator or with a receiver as a signal source.

a. ALIGNMENT WITH SIGNAL GENERATOR - To perform the following procedure, refer to table 5-3 for the necessary test equipment required.

(1) Alignment of the Bandspread Oscillator-Upper Sideband.

(a) Connect a 472 kc signal from a signal generator to the IF INPUT jack J1.

(b) Connect an oscilloscope to pin 5 of V3, 1st Mixer.

(c) Set SIDEBAND to Upper.

(d) To assure a zero potential at terminal 12 of E1, short terminals 11 and 12 of E1.

(e) Set BANDSPREAD control to zero.

(f) Adjust core of T2 for a zero beat on oscilloscope screen (steady horizontal trace).

(2) Alignment of Bandspread Oscillator-Lower Sideband.

(a) Set SIDEBAND to Lower.

(b) Adjust signal generator for 438 kc output.

(c) Adjust C29 for a zero beat on oscilloscope screen (steady horizontal trace)

(d) Remove short from terminals 11 and 12 of E1.

(3) Bandspread Oscillator Remote Control.

(a) Connect the variable DC supply to terminal 12 of E1.

(b) Varying the DC Voltage ±4.5 volts should produce a balanced shift of approximately ±4.5 kc in either upper or lower sideband position. If not reasonably balanced, adjust Reactance Balance Control, R48 for proper balance.

(4) Alignment of 17 KC Oscillator.

(a) Feed a 17.00 kc audio signal to pin 7 of V4, the 2nd Mixer.

(b) Connect oscilloscope to pin 5 of V4.

(c) Set the BFO switch to ON.

(d) Adjust C40 (mounted on top of Z4, Model MSR-4) or C50 (for Model MSR-5) for zero beat on oscilloscope.

(5) Sideband Selector Remote Operation.

(a) Connect the variable DC source to terminals 7 and 8 of E1 with negative lead on 8.

(b) Vary the DC voltage from zero to -9.0 volts. Switching should occur between -7.5 and -8.0 volts. If not, adjust R54 accordingly.

(6) Alignment of Side Tone Generator.

(a) Set BFO switch to ON.

(b) Connect the VTVM to pin 7 of V4.

(c) Vary the DC supply connected to pins 7 and 8 of E1 from zero to -9.0 volts. As the DC voltage approaches -5.0 volts the side tone oscillator should just start. Decreasing the voltage to -9.0 should increase the output of the oscillation to approximately 2.5 volts.

NOTE

Oscillator will start at two positions of threshhold. Correct position produces increased output as control voltage goes more negative.

(d) Set SIDEBAND to Lower.

(e) Adjust C55 on Z5 for 500 cps note.

(f) Set SIDEBAND to Upper.

(g) Output frequency will be approximately 2.5 kcs.

(7) When the sidebands are reversed as explained in paragraph 2-3 the above procedure is reversed as shown below.

(a) Set SIDEBAND to Upper.

(b) Adjust C55 on Z5 for 500 cps note.

(c) Set SIDEBAND to Lower.

(d) Output frequency will be approximately 2.5 kcs.

b. ALIGNMENT WITH RECEIVER - Tune in a stable signal so that its carrier passes through the center of the IF. If the receiver has a selective IF filter, it should be used in its narrowest position to determine correct placement of the carrier on 455 kc. Place the sideband oscillator of the MSR in the XTAL position at either 472 kc or 438 kc.

(1) Set BFO switch to ON.

(2) Tune 17 KC oscillator (C40) to obtain a zero beat.

(3) Set BANDSPREAD control to zero.

(4) Set SIDEBAND to Upper.

(5) Switch from XTAL to MANUAL.

(6) Adjust T2 of Z3 to obtain a zero beat.

(7) Set SIDEBAND to Lower.

(8) Adjust C29 to obtain zero beat.

The side tone generator is checked as in a.(6) above since no input signal is required.

SECTION 7
PARTS LIST

7-1. INTRODUCTION.

Reference designations have been assigned to identify all component parts of the equipment. They are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams and the parts list. The letters of a reference designation indicate the kind of part (generic group), such as resistor, capacitor, transistor, etc. The number differentiates between parts of the same generic group. Sockets associated with a particular plug-in device, such as a tube or fuse, are identified by a reference designation which includes the reference designation of the plug-in device. For example, the socket for fuse F1 is designated XF1. The parts for each major unit are grouped together. Column 1 lists the reference designations of the various parts in alphabetical and numerical order. Column 2 gives the name and description of the various parts. Column 3 lists each Technical Materiel Corporation part number.

SYM	DESCRIPTION	TMC PART NO.
C1	CAPACITOR, FIXED: CERAMIC; 10,000 uuf, GMV, 500 wvdc.	CC-100-16
C2	Same as C1	
C3	Same as C1	
C4	Same as C1	
C5	Same as C1	
C6	CAPACITOR, FIXED: CERAMIC; 120 uuf, ±24 uuf, 500 wvdc.	CC-101-4
C7	CAPACITOR, FIXED: CERAMIC; 47 uuf, ±10%, 500 wvdc.	CC21SL470K
C8	Same as C1	
C9	CAPACITOR, FIXED: PLASTIC; .01 uf, +40 -10%, 400 wvdc.	CN-100-1
C10	Same as C1	
C11	Same as C1	
C12	Same as C1	
C13	CAPACITOR, FIXED: CERAMIC; 1000 uuf, ±10%, 500 wvdc.	CC-100-9
C14	CAPACITOR, FIXED: PLASTIC: .1 uf, ±5%, 200 wvdc.	CN108C1003J
C15	Same as C7	
C16	CAPACITOR, FIXED: CERAMIC; 82 uuf, ±5%, 500 wvdc.	CC26SL820J
C17	Same as C1	
C18	Same as C1	
C19	Same as C1	
C20	Same as C9	
C21	NOT USED	

SYM	DESCRIPTION	TMC PART NO.
C22	NOT USED	
C23	CAPACITOR, FIXED: CERAMIC; 0.1 uf, +40-10%, 400 wvdc.	CN-100-4
C24	Same as C9. (Model MSR-4)	
C24	Same as C1. (Model MSR-5)	
C25	CAPACITOR, FIXED: PLASTIC; 2 uf, ±10%, 200 wvdc.	CN108C2004K
C26	Same as C13	
C27	CAPACITOR, FIXED: ELECTROLYTIC; 10 uf, 300 wvdc.	CE64C100N
C28	CAPACITOR, VARIABLE: AIR; 2.8-16 uuf, 1200 V RMS.	CB-135-4
C29	CAPACITOR, VARIABLE, CERAMIC; 7-45 uf, 500 wvdc.	CV11C450
C30	CAPACITOR, FIXED: CERAMIC; 100 uuf, ±5%, 500 wvdc.	CC32CH101J
C31	CAPACITOR, FIXED: MICA; 51 uuf, ±5%, 500 wvdc.	CM20E510J
C32	CAPACITOR, FIXED: MICA; 430 uuf, ±2%, 500 wvdc. (Part of Z3)	CM20D431G
C33	CAPACITOR, FIXED: CERAMIC; 47 uuf, ±5%, 500 wvdc.	CC32CH470J
C34	CAPACITOR, FIXED: CERAMIC: 30 mmfd, ±5%, 500 wvdc. (Model MSR-4)	CC21SL300J
C34	CAPACITOR, FIXED: MICA; 20 uuf, ±10%, 300 wvdc. (Model MSR-5)	CM15B200K
C35	Same as C1	
C36	Same as C1	
C37	CAPACITOR, FIXED: CERAMIC; 100 uuf, ±2%, 500 wvdc.	CM15F101G
C38	CAPACITOR, FIXED: MICA; .001 mfd, ±2%, 500 wvdc. (Part of Z4) (Model MRS-4)	CM20D102G
C38	Same as C14. (Model MSR-5)	
C39	CAPACITOR, FIXED: MICA; 1500 mmfd, ±2%, 500 wvdc. (Part of Z4) (Model MSR-4)	CM20D152G
C39	CAPACITOR, FIXED: MICA; .001 uf, ±5%, 500 wvdc. (Model MSR-5)	CM20D102J
C40	CAPACITOR, VARIABLE: MICA; 100-550 mmfd, 250 wvdc. (Part of Z4) (Model MSR-4)	CV-100-304
C40	CAPACITOR, FIXED: CERAMIC DISC; .1 uf, +80-20%, 1000 wvdc. (Model MSR-5)	CC-100-28
C41	Same as C1. (Model MSR-4)	
C41	Same as C40. (Model MSR-5)	
C42	Same as C14	
C43	Same as C14	

PARTS LIST (CONT)

SYM	DESCRIPTION	TMC PART NO.
C44	Same as C13	
C45	CAPACITOR, FIXED: CERAMIC; 22 uuf, ±5%, 500 wvdc.	CC21SL220J
C46	CAPACITOR, FIXED: CERAMIC; .005 uf, GMV, 500 wvdc.	CC-100-15
C47A,B	CAPACITOR, FIXED: CERAMIC: dual unit, 2x10,000 uuf, GMV, 1000 wvdc.	CC-100-23
C48	CAPACITOR, FIXED: PAPER; 4 uf, +20-10%, 600 wvdc.	CP41B1FF405K
C49A, B	CAPACITOR, FIXED: DRY ELECTROLYTIC; dual, 35 uf each section, 450 wvdc, char. F.	CE52F350R
C50	CAPACITOR, FIXED: MICA; .001 mfd, ±2%, 500 wvdc. (same as C38) (Part of Z4) (Model MSR-4)	CM20D102G
C50	CAPACITOR, VARIABLE: AIR DIELECTRIC; 3.2-50 uuf, 19 plates, one section, 2 holes tapped 4-40, 500 wvdc. (Model MSR-5)	CT-104-3
C51	CAPACITOR, FIXED: MICA; 820 uuf, ±2%, 500 wvdc.	CM20D821G
C52	CAPACITOR, FIXED, MICA DIELECTRIC: .001 uuf, ±5%, 500 wvdc. (Model MSR-4)	CM20D102J
C52	Same as C39. (Model MSR-5)	
C53	Same as C51. (Part of Z5)	
C54	Same as C1	
C55	CAPACITOR, VARIABLE: MICA; 275-970 uuf, 250 wvdc. (Part of Z5)	CV-100-306
C56	Same as C9	
C57	Same as C1	
C58	CAPACITOR, VARIABLE: CERAMIC; 4-30 uuf, char. C, 500 wvdc. (Model MSR-5)	CV11C300
C59	Same as C58. (Model MSR-5)	
C60	Same as C1. (Model MSR-5)	
C61	CAPACITOR, FIXED: MICA; 1800 uuf, ±2%, 500 wvdc. (Model MSR-5)	CM20C182G
C62	Same as C1. (Model MSR-5)	
C63	CAPACITOR, FIXED: MICA; 390 uuf, ±10%, 500 wvdc. (Model MSR-5)	CM20B391K
E1	TERMINAL BOARD; barrier type, plastic, 12 terminals, screw with feedthru solder lug type.	TM-100-12
E2	TERMINAL BOARD; barrier type, plastic, 8 terminals, screw with feedthru solder lug type.	TM-100-8
E3	NOT USED	

PARTS LIST (CONT)

SYM	DESCRIPTION	TMC PART NO.
E4	TERMINAL BOARD: fanning; phenolic, 12 terminals, right angle spade lug type. (Supplied as loose item)	TM-105-12-AL
EV1	SHIELD, ELECTRON TUBE: 9 pin miniature.	TS103U02
EV2	SHIELD, ELECTRON TUBE: 7 pin miniature.	TS102U02
EV3	Same as EV2.	
EV4	Same as EV2.	
EV5	Same as EV1.	
EV6	SHIELD, ELECTRON TUBE: 7 pin miniature.	TS102U03
EV7	Same as EV2.	
EV8	Same as EV2.	
EV9	Same as EV1.	
EV10	NOT USED	
EV11	Same as EV6.	
EV12	Same as EV1. (Model MSR-5)	
F1	FUSE, CARTRIDGE; 3 amp, 250 v, instantaneous.	FU-100-3
HR1	OVEN, CRYSTAL; dual, MIL type HC-6/U or HC-13/U, heater voltage -6.3 VAC at 75 watts, warm-up time -6 minutes, nominal temperature $\pm 75^{\circ}$ C, fits standard octal socket. (Model MSR-5)	PO158-1
HR2	OVEN, CRYSTAL: dual, MIL type HC-13/U, heater voltage -6.3 VAC, maximum current - 1.5 amp, attainable stability - $\pm 2^{\circ}$C, fits standard octal socket. (Model MSR-5)	PO-147-1
I1	LAMP, INCANDESCENT; 6-8V, 150 ma, T-3-1/4 clear bulb; bayonet base.	BI-101-47
I2	Same as I1	
I3	Same as I1	
J1	CONNECTOR, RECEPTACLE: ELECTRICAL; 1 female contact; 52 ohms; BNC type.	UG-625/U
J2	CONNECTOR, RECEPTACLE: ELECTRICAL; 3 contacts, male.	MS3102A-16S-5P
J3	JACK, TELEPHONE; tip and sleeve; bushing mounted; fits plug PJ-055.	JJ-034
J4	CONNECTOR, ELECTRICAL; 4 contacts, male.	MS3102A-14S-2P
J5	JACK, TIP; test white, mates with TMC type PL-163. (Model MSR-5)	JJ-114-1
J6	Same as J5. (Model MSR-5)	
K1	RELAY, ARMATURE; DPDT; 80 vdc, 32 w, 20,000 ohms.	RL-105

PARTS LIST (CONT)

SYM	DESCRIPTION	TMC PART NO.
K2	RELAY, ARMATURE; impulse type, 4 PDT, 115 VAC, 60 cps.	RL-118-17A115-60A
K3	Same as K1	
L1	REACTOR, FIXED; 15 henries, 85 ma dc, 285 ohms dc, 2500 v RMS test.	TF-5000
L2	Same as L1	
P1	CONNECTOR; coaxial, male, BNC type. (Supplied as loose item).	UG-260/U
P2	CONNECTOR, PLUG: ELECTRICAL; 4 contacts, female. Part of W1. Mates with J2. (Supplied as loose item).	MS3106A-16S-5S
P3	NOT USED	
P4	CONNECTOR, PLUG: ELECTRICAL; 4 contacts, female. Mates with J4. (Supplied as loose item.)	MS3106A-14S-2S
R1	RESISTOR, FIXED: COMPOSITION; 100,000 ohms, ±10%, 1/2 watt.	RC20GF104K
R2	RESISTOR, FIXED: COMPOSITION; 470,000 ohms, ±10%, 1/2 watt.	RC20GF474K
R3	Same as R1	
R4	RESISTOR, FIXED: COMPOSITION; 22,000 ohms, ±10%, 1 watt.	RC32GF223K
R5	RESISTOR, FIXED: COMPOSITION; 330 ohms, ±10%, 1/2 watt.	RC20GF331K
R6	RESISTOR, FIXED: COMPOSITION; 68,000 ohms, ±10%, 1 watt.	RC32GF683K
R7	RESISTOR, FIXED: COMPOSITION; 470 ohms, ±10%, 1/2 watt.	RC20GF471K
R8	RESISTOR, FIXED: COMPOSITION; 2200 ohms, ±10%, 1/2 watt.	RC20GF222K
R9	Same as R2	
R10	Same as R4	
R11	Same as R4	
R12	RESISTOR, FIXED: COMPOSITION; 22,000 ohms, ±10%, 1/2 watt.	RC20GF223K
R13	RESISTOR, FIXED: COMPOSITION; 150,000 ohms, ±10%, 1/2 watt.	RC20GF154K
R14	RESISTOR, FIXED: COMPOSITION; 10,000 ohms, ±10%, 1/2 watt.	RC20GF103K
R15	RESISTOR, FIXED: COMPOSITION; 220 ohms ±10%, 1/2 watt.	RC20GF221K
R16	Same as R8	

SYM	DESCRIPTION	TMC PART NO.
R17	RESISTOR, FIXED: COMPOSITION; 1.5 megohms, ±10%, 1/2 watt.	RC20GF155K
R18	RESISTOR, FIXED: COMPOSITION; 10 megohms, ±10%, 1/2 watt.	RC20GF106K
R19	RESISTOR, FIXED: COMPOSITION; 20,000 ohms, ±5%, 1/2 watt.	RC20GF203J
R20	Same as R1	
R21	Same as R19	
R22	Same as R1	
R23	RESISTOR, FIXED: COMPOSITION; 120 ohms, ±10%, 1/2 watt.	RC20GF121K
R24	RESISTOR, FIXED: COMPOSITION; 47,000 ohms, ±10%, 2 watts.	RC42GF473K
R25	RESISTOR, FIXED: COMPOSITION; 10,000 ohms, ±10%, 1 watt.	RC32GF103K
R26	RESISTOR, FIXED: COMPOSITION; 12,000 ohms, ±10%, 1/2 watt.	RC20GF123K
R27	NOT USED.	
R28	NOT USED	
R29	NOT USED	
R30	RESISTOR, VARIABLE: COMPOSITION; 1 megohm, ±20%, 2 watts, log taper.	RV4ATRD105D
R31	RESISTOR, FIXED: COMPOSITION; 390 ohms, ±10%, 1/2 watt.	RC20GF391K
R32	Same as R2	
R33	Same as R1	
R34	RESISTOR, FIXED: COMPOSITION; 560 ohms, ±10%, 2 watts.	RC42GF561K
R35	RESISTOR, FIXED: COMPOSITION; 3900 ohms, ±10%, 1/2 watt.	RC20GF392K
R36	RESISTOR, FIXED: COMPOSITION; 33,000 ohms, ±10%, 1 watt.	RC32GF333K
R37	Same as R12	
R38	Same as R23	
R39	RESISTOR, FIXED: COMPOSITION; 39,000 ohms, ±10%, 1/2 watt.	RC20GF393K
R40	Same as R39	
R41	Same as R1. (Part of Z4). (Model MSR-4)	

PARTS LIST (CONT)

SYM	DESCRIPTION	TMC PART NO.
R41	Same as R1. (Model MSR-5)	
R42	Same as R12. (Model MSR-4)	
R42	NOT USED (Model MSR-5)	
R43	Same as R2	
R44	Same as R2	
R45	Same as R2	
R46	RESISTOR, FIXED: COMPOSITION; 120,000 ohms, ±10%, 1/2 watt.	RC20GF124K
R47	Same as R1	
R48	RESISTOR, VARIABLE: COMPOSITION; 2500 ohms, ±10%, 2 watts, linear taper.	RV4ATSA252A
R49	RESISTOR, FIXED: COMPOSITION; 180 ohms, ±10%, 1/2 watt.	RC20GF181K
R50	RESISTOR, FIXED: COMPOSITION; 1000 ohms, ±10%, 1/2 watt.	RC20GF102K
R51	RESISTOR, FIXED: COMPOSITION; 33,000 ohms, ±10%, 1/2 watt.	RC20GF333K
R52	RESISTOR, FIXED: COMPOSITION; 56,000 ohms, ±10%, 1/2 watt.	RC20GF563K
R53	Same as R31	
R54	RESISTOR, VARIABLE: COMPOSITION; 1 megohm, ±20%, 2 watts, linear taper.	RV4ATXA105B
R55	RESISTOR, FIXED: WIREWOUND; 4500 ohms, ±5%, 10 watts.	RW-109-47
R56	RESISTOR, FIXED: COMPOSITION; 56,000 ohms, ±10%, 2 watts.	RC42GF563K
R57	RESISTOR, FIXED: COMPOSITION; 1 megohm, ±10%, 1/2 watt.	RC20GF105K
R58	RESISTOR, FIXED: COMPOSITION; 47,000 ohms, ±10%, 1/2 watt.	RC20GF473K
R59	Same as R2	
R60	RESISTOR, VARIABLE: COMPOSITION; 100,000 ohms, ±10% 2 watts, linear taper.	RV4ATSA104B
R61	Same as R2	
R62	RESISTOR, FIXED: COMPOSITION; 22,000 ohms, ±10%, 2 watts.	RC42GF223K
R63	Same as R58	
R64	RESISTOR, FIXED: COMPOSITION; 680 ohms, ±10%, 1/2 watt.	RC20GF681K

SYM	DESCRIPTION	TMC PART NO.
R65	RESISTOR, FIXED: COMPOSITION; 2700 ohms, ±10%, 1/2 watt.	RC20GF272K
R66	Same as R64	
R67	Same as R57	
R68	NOT USED	
R69	Same as R19	
R70	RESISTOR, FIXED: COMPOSITION; 100 ohms, ±10%, 1/2 watt. (Model MSR-4)	RC20GF101K
R70	RESISTOR, FIXED: COMPOSITION; 4700 ohms, ±10%, 1/2 watt. (Model MSR-5)	RC20GF472K
R71	Same as R51. (Model MSR-5)	
R72	RESISTOR, FIXED: COMPOSITION; 8200 ohms, ±10%, 1/2 watt. (Model MSR-5)	RC20GF822K
R73	Same as R52. (Model MSR-5)	
R74	RESISTOR, FIXED: COMPOSITION; 27,000 ohms, ±10%, 1/2 watt. (Model MSR-5)	RC20GF273K
R75	Same as R50. (Model MSR-5)	
R76	RESISTOR, FIXED: COMPOSITION; 100 ohms, ±10%, 1/2 watt. (Model MSR-5)	RC20GF101K
S1	SWITCH, TOGGLE: SPST; 3 amp at 250 v, bat type toggle.	ST-12A
S2	Same as S1	
S3	NOT USED	
S4	SWITCH, ROTARY; 1 section, 2 position, 2 moving contacts, 6 fixed contacts.	SW-226
S5	SWITCH, ROTARY; 1 section, 2 position, 1 moving contact; 2 fixed contacts.	SW-194
S6	SWITCH, PUSH: SPST; 1 amp at 250 v, normally open.	SW-168-SPST-2-NOBB
S7	SWITCH, TOGGLE: DPST; 2 amp at 250 v, bat type toggle.	ST-22K
S8	Same as S7	
T1	TRANSFORMER, AUDIO FREQUENCY; plate coupling type, primary - 5000 ohms, 35 ma, secondary - 600 ohms, tapped at 8 ohms, 5 watt maximum operating level.	TF-100
T2	TRANSFORMER, RADIO FREQUENCY; 225 microhenries, Q=75, tapped at 115 microhenries, Q=50, tuning core included. (Part of Z3)	p/o A-1387
T3	TRANSFORMER, AUDIO FREQUENCY; input type, 43.5 millihenries, Q=20, 10.5 ohms, 2 taps. (Part of Z4)	TF-177

SYM	DESCRIPTION	TMC PART NO.
T4	TRANSFORMER, AUDIO FREQUENCY: input type, 43.5 millihenries, Q=20, 10.5 ohms, tapped. (Part of Z5)	TF-178
T5	TRANSFORMER, POWER: primary - 105v, 115v, 125v, 210v, 230v, 50/60 cps, single phase, secondary #1 - 6.3 v at 5 amps CT, secondary #2 - 6.3 v at 2 amps CT, secondary #3 - 340-0-340 v RMS, 100 ma dc operating into 4 uf input filter, secondary #4 - 5 v at 2 amps, all windings insulated for 1000 volts. hermetically sealed in rectangular steel case.	TF-196
V1	TUBE, ELECTRON; medium-mu duo triode, 9 pin miniature.	12AU7A
V2	TUBE, ELECTRON; remote cutoff RF pentode, 7 pin miniature.	6BA6
V3	TUBE, ELECTRON; heptode converter, 7 pin miniature.	6BE6
V4	Same as V3	
V5	TUBE, ELECTRON; duo triode, 9 pin miniature.	12AT7
V6	TUBE, ELECTRON; beam power amplifier, 7 pin miniature.	6AQ5
V7	TUBE, ELECTRON; sharp cutoff RF pentode, 7 pin miniature.	6AG5
V8	TUBE, ELECTRON; duo-triode, 7 pin miniature.	6J6
V9	Same as V1	
V10	TUBE, ELECTRON; full-wave rectifier, octal base.	5Y3GT
V11	TUBE, ELECTRON; voltage regulator, 7 pin miniature.	OA 2
V12	Same as V5. (Model MSR-5)	
W1	CABLE ASSEMBLY, POWER: ELECTRICAL; 3 conductor, 6 ft. long, w/integral male plug with pigtail ground lead one end, and MS3106A-16S-5S (P2) with MS3057-8 clamp on other end. (Supplied as loose item).	CA-385
XC49	SOCKET, ELECTRON TUBE; octal.	TS101P01
XF1	FUSEHOLDER, extractor post type, 250 v, 15 amp.	FH-100-2
XHR1	Same as XC49. (Model MSR-5)	
XHR2	Same as XC49. (Model MSR-5)	
XI1	LIGHT, INDICATOR; with green frosted lens, for miniature bayonet base T-3-1/4 bulb.	TS-133
XI2	Same as XI1	

SYM	DESCRIPTION	TMC PART NO.
XI3	LIGHT, INDICATOR; with red frosted lens, for miniature bayonet base T-3-1/4 bulb.	TS-106-1
XV1	SOCKET, ELECTRON TUBE; 9 pin miniature.	TS103P01
XV2	SOCKET, ELECTRON TUBE; 7 pin miniature.	TS102P01
XV3	Same as XV2	
XV4	Same as XV2	
XV5	Same as XV1	
XV6	Same as XV2	
XV7	Same as XV2	
XV8	Same as XV2	
XV9	Same as XV1	
XV10	Same as XC49	
XV11	Same as XV2	
XV12	Same as XV1. (Model MSR-5)	
XY1	SOCKET, CRYSTAL; 2 contacts, 0.486 in. spacing for .050 in. pin diam, steatite body. (Model MSR-4)	TS-104-1
XY1	SOCKET, CRYSTAL; integral part of HR1. (Model MSR-5)	p/o HR1
XY2	Same as XY1. (Model MSR-4)	
XY2	SOCKET, CRYSTAL; integral part of HR1. (Model MSR-5)	p/o HR1
XY3	SOCKET, CRYSTAL; integral part of HR2. (Model MSR-5)	p/o HR2
Y1	CRYSTAL UNIT, QUARTZ; 438 kc, ±0.01%, includes holder HC-6/U. (Model MSR-4)	CR46A/U-438.000KC
Y1	CRYSTAL UNIT, QUARTZ; 438 kc, ±.002%, w/HC-6/U holder. (Model MSR-5)	CR109-79
Y2	CRYSTAL UNIT, QUARTZ, 472 kc, ±0.01%, includes holder HC-6/U. (Model MSR-4)	CR46A/U-472.000KC
Y2	CRYSTAL UNIT, QUARTZ; 472 kc, ±.002%, w/HC-6/U holder. (Model MSR-5)	CR109-80
Y3	CRYSTAL UNIT, QUARTZ; 17 kc, (CR50 case). (Model MSR-5)	CR-107
Z1	FILTER, BANDPASS; 19.1 kc, 3.4 kc bandwidth, 10,000 ohms impedance.	FX-153
Z2	FILTER, LOWPASS, 3500 cps cutoff frequency.	FX-152
Z3	TRANSFORMER, RADIO FREQUENCY; 790 kc, (consists of C32 and T2).	A-1387

PARTS LIST (CONT)

SYM	DESCRIPTION	TMC PART NO.
Z4	OSCILLATOR NETWORK, AUDIO FREQUENCY; 17 kc, (consists of C38, 39, 40, 50, R41 and T3). (Model MSR-4)	A-1381
Z4	NOT USED (Model MSR-5)	
Z5	OSCILLATOR NETWORK, AUDIO FREQUENCY; 43.5 millihenries (consists of C53, 55, T4).	A-1384

SECTION 8
SCHEMATIC DIAGRAMS

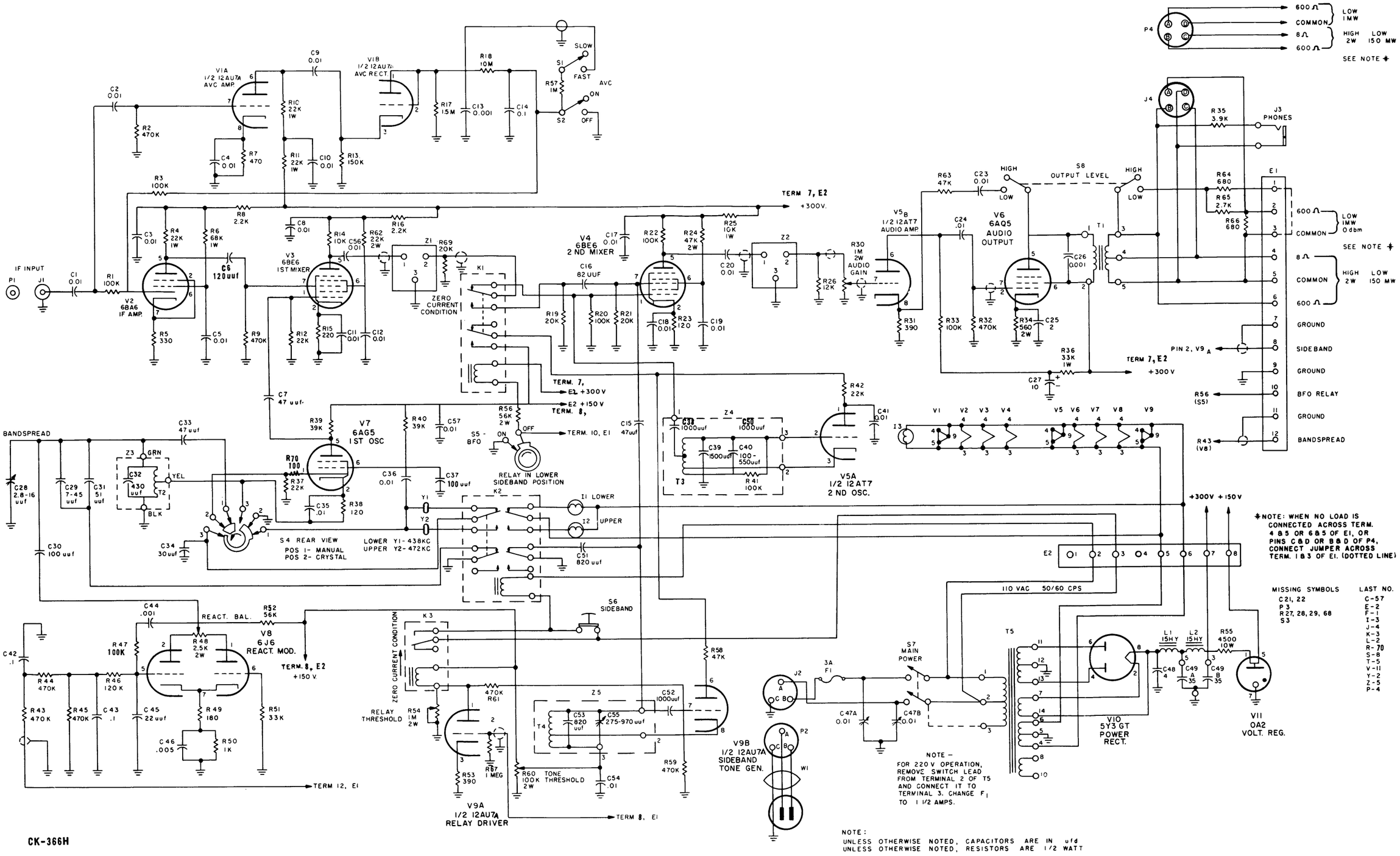
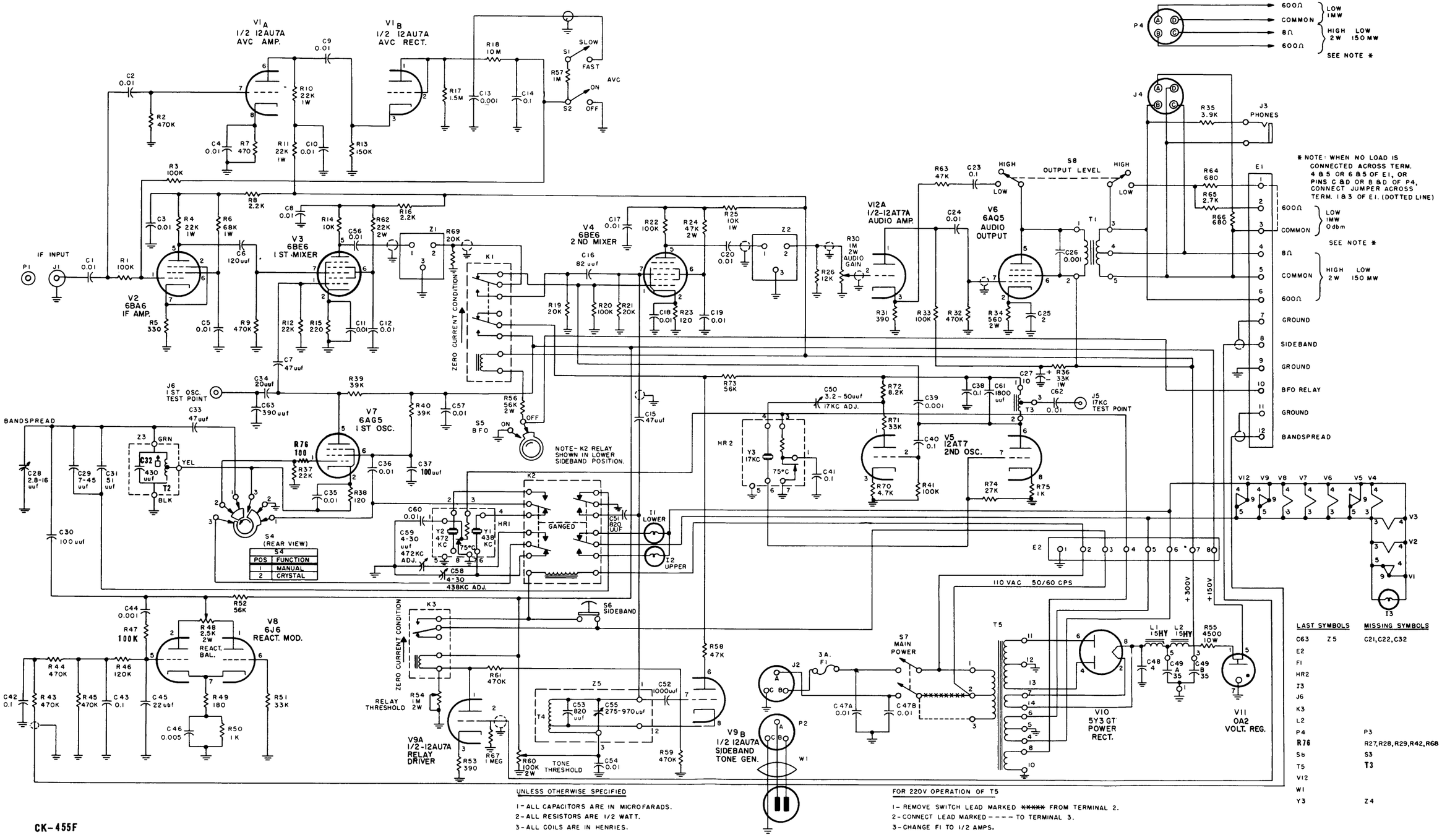


Figure 8-1. Schematic Diagram, Model MSR-4



10165196

Figure 8-2. Schematic Diagram, Model MSR-5