

**T M C** (*Canada*) **LIMITED**  
Communications ★ Engineers

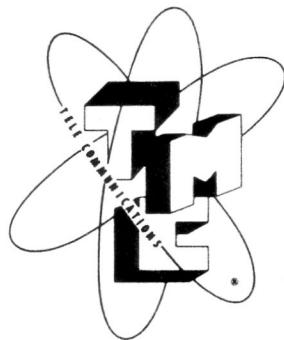
OTTAWA      ONTARIO  
NAVSHIPS 93210

UNCLASSIFIED

TECHNICAL MANUAL

*for*

**SINGLE SIDEBAND  
CONVERTER  
CV-591A/URR  
MODEL MSR-4**



THE TECHNICAL MATERIEL CORPORATION  
MAMARONECK, N. Y.      OTTAWA, ONTARIO

BUREAU OF SHIPS  
DEPARTMENT OF THE NAVY



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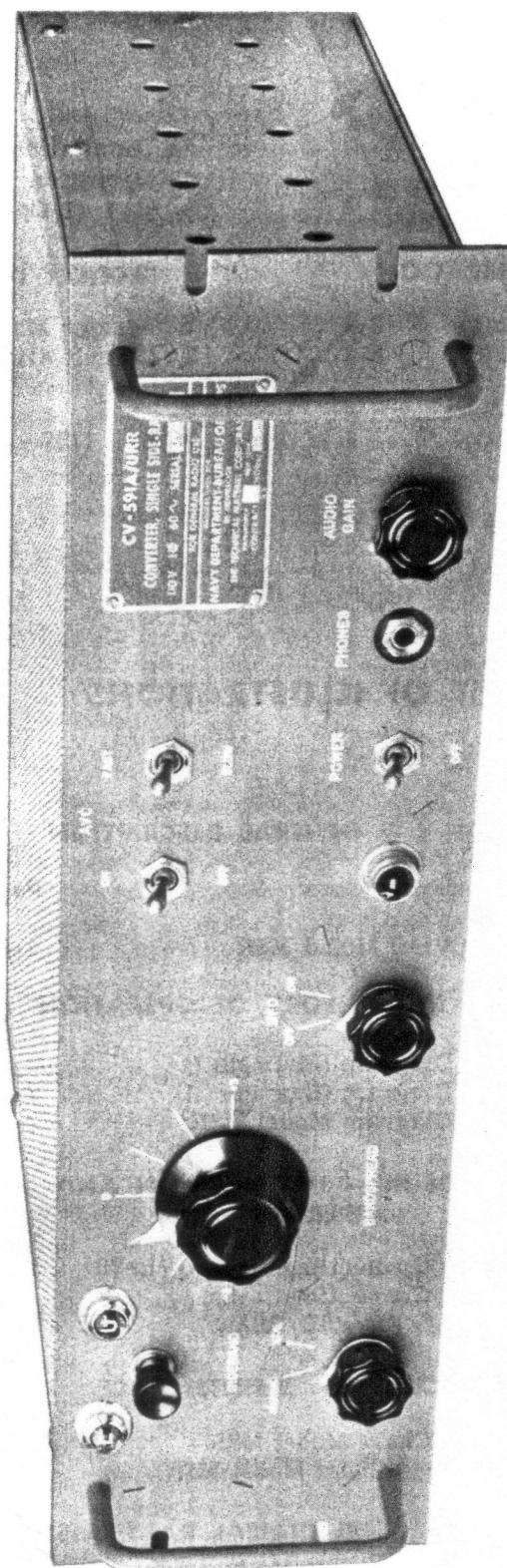


Figure 1-1. Front View Model MSR

## SECTION I GENERAL DESCRIPTION

### 1. PURPOSE AND BASIC PRINCIPLES

The TMC Model MSR, Single Sideband Converter 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 detrimental effect to the desired signal. The tuning of single sideband signals is greatly simplified since the final tuning is done at the MSR, not the receiver. A mechanical and electrical bandspread 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, either with the bandpass tuning feature or by inverting the osc. 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.

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 inserted, most any receiver I. F. may be accommodated. The required I. F. connection between the receiver and MSR through a low loss coaxial cable is as follows:

AN/FRR-49(v) to MSR, BNC connector to BNC.

R-840/URR to MSR, Phono connector to BNC.

R-390/URR to MSR, BNC connector to BNC.

R-274B/URR to MSR, UHF connector to BNC.

The audio output is available in three levels:

1. 2 watts for 600 ohm line or 8 ohm loudspeaker.
2. 150 milliwatts for 600 ohm line or 8 ohm loudspeaker.
3. 0 dbm/1 milliwatt for 600 ohm telephone line.

Terminals at the rear panel provide the simple connections for remote control of the main features of the MSR without modifications or the use of additional lines or tones when used

in the TMC RCR system. By this means it is possible to remotely or locally tune the MSR across the receiver I. F. passband, select sidebands with a remote indication of which sideband is in use, and still retain all of the remote control features of the RCR system.

### 2. DESCRIPTION OF UNIT

The Model MSR is shown in Figure 1-1. The panel is 3/16 inch thick by 19 inches long by 5-1/4 inches high and finished in TMC grey enamel. The chassis extends 13-1/2 inches behind the panel and is self supporting.

All operational controls are located on the front panel. These controls are similar in function and effect to those found on any receiver. The BANDSPREAD control tunes the MSR over a limited frequency range. A MANUAL/XTAL switch sets the first oscillator to either variable or fixed crystal operation. The BFO, AVC and AUDIO GAIN controls perform similar functions as on a receiver.

Input and output connections are made on the rear apron.

### 3. TECHNICAL SPECIFICATIONS

#### Types of Reception:

SSB-Selectable Sideband  
CW-MCW  
AM-Selectable Sideband  
Exalted Carrier AM  
Simultaneous AM-FS

#### Sideband Selection:

Upper or Lower Sideband by means of Crystal or Calibrated Bandspread Oscillator.

#### Remote Control Features:

Selection of Upper or Lower Sideband  
Selection of Mode of Operation  
AM-CW-MCW-SSB and Exalted Carrier  
±3 kc Bandspread Tuning  
AVC ON/OFF  
BFO ON/OFF

#### Remote Control Facilities:

May be used with AN/FRA-19 (V) or AN/FRA-501-Remote Control Systems and AN/FRR-49(V) or AN/FRR-502-Receiving Systems without any system modification.

**Input Frequency Range:**

- (a) 452-458 Kc (when MSR oscillator is variable or normal crystal is used).
- (b) 225 kc to 1.5 mc when MSR oscillator is crystal controlled only.

**Input Voltage Range:**

0.1-10 Volts RMS.

**Input Impedance:**

240 K ohms

**Filter Characteristics:**

- 3.2 kc at 3 db Points
- 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

**Noise Limiter:**

Balanced Type

**Output:**

- High; 2 watts, 600 ohms, 8 ohms.
- Low; 0 dbm, 600 ohms.
- 150 mw, 600 ohm, 8 ohm.

**Output Impedances:**

- Loudspeaker 8 ohms
- Line 600 ohms
- Head Set-High or Low

**Front Panel Control:**

- POWER/OFF
- AUDIO GAIN Control
- SIDEBAND UPPER/LOWER Switch
- SIDEBAND Indicator Lighting
- MANUAL/XTAL Switch
- BANDSPREAD Control
- AVC ON/OFF Switch

**AVC FAST/SLOW Switch**

**BFO ON/OFF Switch**

**PHONES Jack**

**Power Indicator**

**Rear Panel Facilities:**

- IF Input Jack**
- Threshold Control**
- AC Power Input**
- Audio Output Terminal**
- Remote Control Terminal**
- High/Low Output Level Control**

**Input Power Requirements:**

110/220 Volts 50/60

Cycles, 65 watts

**Size:**

5-1/4" high x 19" wide x 13-1/2" deep

**Mounting:**

Standard WE Rack

**Weight:**

24 lbs. net

**Tube Complement:**

- 12AU7 Relay Driver
- 12AU7 Amplifier and Rectifier
- 12AT7 17 kc Oscillator & Audio Amplifier
- 6J6 Reactance Tube
- 6AG5 1st Oscillator
- 6BA6 IF Amplifier
- 6BE6 1st Mixer
- 6BE6 2nd Mixer
- 6AL5 Noise Limiter
- 6AQ5 Audio Power Amplifier
- 5Y3 Power Rectifier
- OA2 Voltage Regulator

**Components and Construction:**

Equipment manufactured in accordance with JAN/MIL Specifications wherever practicable.

## **SECTION II**

# **THEORY OF OPERATION**

## 1. GENERAL DESCRIPTION OF CIRCUITS

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  $\pm 3$  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 2-1 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 above 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 2-1, 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 III.

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

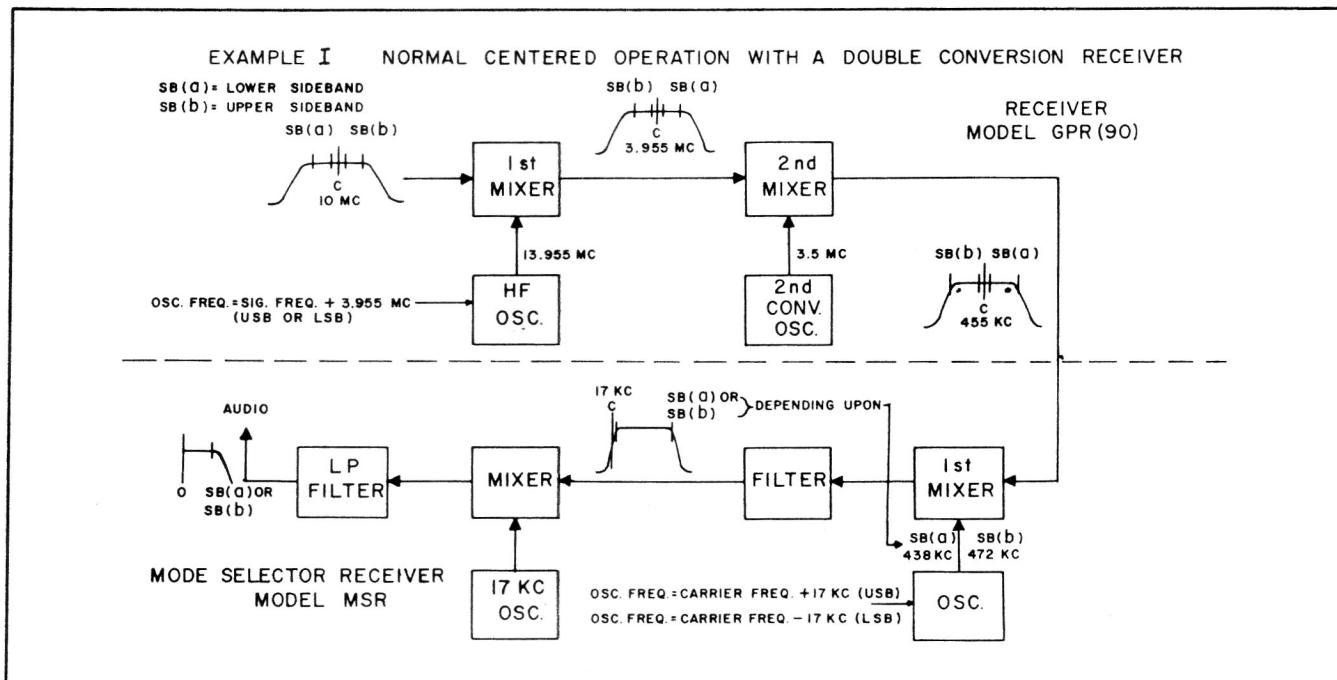
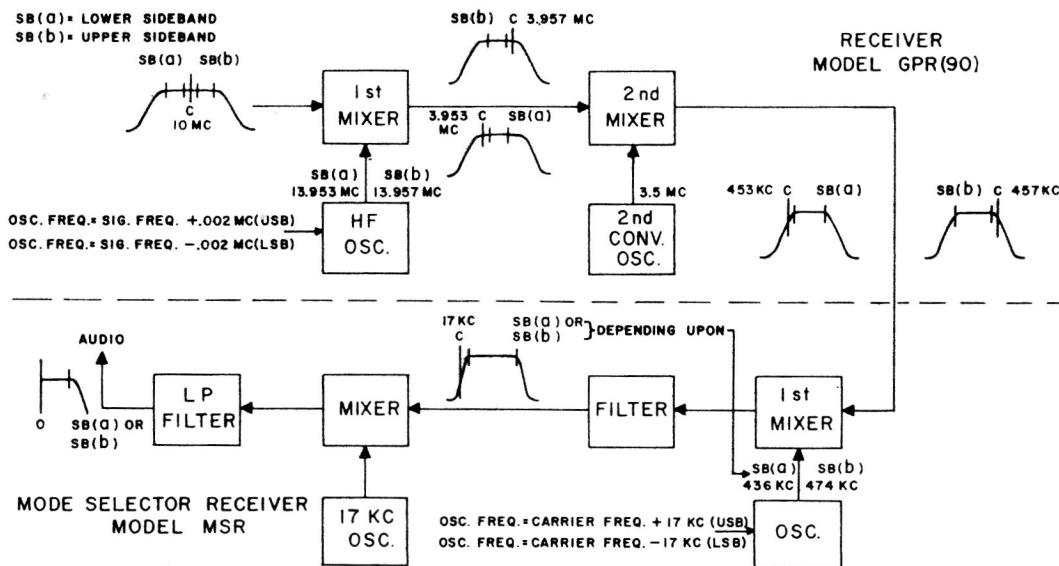


Figure 2-1. Block Diagram (Example I) MSR/GPR-90

EXAMPLE II — SHIFTED OPERATION WITH A DOUBLE CONVERSION RECEIVER



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Figure 2-2. Block Diagram (Example II) MSR/GPR-90

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 of the single conversion type (such as the TMC Model FFR) 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 position, a crystal may be chosen which will permit operation with almost any I. F. (Using the equations of Figure 2-1 or 2-2).

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  $\pm 4$  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  $\pm 2.5$  kc at the 6 db points) then the system bandpass be-

comes 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. It has been determined that for a combination of the Model FFR or GPR-90 with the Model MSR, the optimum shift is 2 kc and an illustration of such a set-up is shown in Figure 2-2.

1. FOR UPPER SIDEBAND RECEPTION.

- Receiver - choose the oscillator injection frequency (variable or crystal) to be 2 kc above the normal injection frequency.
- MSR - use 474 kc crystal in socket Y2 or set BANDSPREAD tuning dial 2 kc above center.

2. FOR LOWER SIDEBAND RECEPTION.

- Receiver - choose the oscillator injection frequency (variable or crystal)

to be 2 kc below the normal injection frequency.

**B. MSR** - use 436 kc crystal or set BANDSPREAD tuning dial 2 kc below center.

For example, suppose normally centered operation (Figure 2-1) is desired with a double conversion 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.

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 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 the 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 will produce a space at 2125 cps and a mark at 2975. Then standard mark and space beat tones are used and the amount of oscillator shift will, of course, be determined by the tones required.

## 2. CIRCUIT ANALYSIS

The Block Diagram Figure 2-3 presents a simplified outline of the functions of the MSR and how they are accomplished.

**THE AVC SYSTEM (V1A, B).** - The AVC Amplifier and Rectifier provides two kinds of control on the first amplifier. A fast time constant is used to control signals which have an ever present component, i.e. AM, MCW, FS. A slow time constant will hold the amplifier gain steady for a longer period for SSB and CW signals. The gain of the amplifier is wide open when the AVC is OFF.

**THE FIRST MIXER (V3).** - The incoming signal is mixed with the First Oscillator to place it in proper position relative to the bandpass filter. Since the filter extends from 17.3 kc to 20.5 kc and the 17 kc BFO follows, the signal carrier position must be placed at 17 kc to produce the correct tone.

**THE FIRST OSCILLATOR (V8).** - Provides the tunable frequency source for correctly tuning the signal in the bandpass filter. It may be either variable or crystal controlled. When variable it is tuned with the front panel BANDSPREAD control or with the reactance control.

**THE REACTANCE MODULATOR (V9).** - The reactance placed across the first oscillator tuned circuit is varied to change frequency. A  $\pm 4.5$  VDC input to the reactance stage is sufficient to vary the oscillator  $\pm 3$  kc. The voltage is obtained from the BFO channel of the TMC Model RCR Remote Control Receiver System.

**RELAY DRIVER (V10A).** - As the R. F. gain control on the RCR system is turned to reduce the gain of the FFR receiver the required voltage out of the 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 (V10A) and deenergize K3. This action in turn trips the sideband two step relay K2.

**SIDEBAND SELECTOR RELAY (K2).** - Operation of the relay driver or the front panel push-button advances the sideband selector relay one position. This changes the first oscillator frequency from upper to lower sideband selecting frequency or vice versa.

**BANDPASS FILTER (Z1).** - After the First Mixer, the filter passes a band of frequencies between 17.3 kc and 20.5 kc. The skirts provide the sharpness required for attenuation of unde-

sirable adjacent signals. See Block Diagram Figure 2-3.

**THE SECOND MIXER (V4).** - The signal passed by the bandpass filter 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.

**THE BFO (V6A).** - A stable 17 kc oscillator provides the reinserted carrier for SSB, exalted AM and produces the beat note for CW and FS signals.

**THE BFO RELAY (K1).** - The BFO is turned on or off by proper actuation of the relay. The front panel BFO switch or a remote paralleled switch actuates the relay.

**SIDEBAND TONE GENERATOR (V9B).** - By proper manipulation of the R. F. gain control of the RSC this circuit generates a tone, high or low, which will indicate to the remote operator which sideband (upper or lower) is in use. The tone be-

comes strong enough to be heard only after the R. F. gain has succeeded in fully silencing the normal receiver action.

**LOW PASS FILTER (Z2).** - Following the second mixer the low pass filter attenuates any products above 5 kc. The resultant is the desired audio.

**AUDIO AMPLIFIERS (V5B, V6).** Three levels of output are provided. The output level control in the HIGH position permits the full two watts of the amplifier to be available for the 600 ohm line or 8 ohm loudspeaker. In the LOW position, the gain of the amplifier is reduced so that 150 milliwatts is available for the 600 ohm line or 8 ohm loudspeaker, and 0 dbm or 1 milliwatt for 600 ohm telephone line. A phone jack on the front panel permits monitoring of the output without disabling.

**POWER SUPPLY (V10).** - The power supply is self contained and provides the necessary AC filament and DCB+ voltages. A regulated +150 V. stabilizes the First Oscillator and BFO.

#### LIST OF CROSS REFERENCES BETWEEN COMMERCIAL DESIGNATIONS AND GOVERNMENT NOMENCLATURE

DESIGNATION	NOMENCLATURE
FFR	AN/FRR-49 (V)
RCR	AN/FRA-501
RSC	C-5027 thru C-5031/FRA-501
GPR-90	R-840/URR
RSD	CV-5013 thru CV-5017/FRA-501
MSR-4	CV-591A/URR

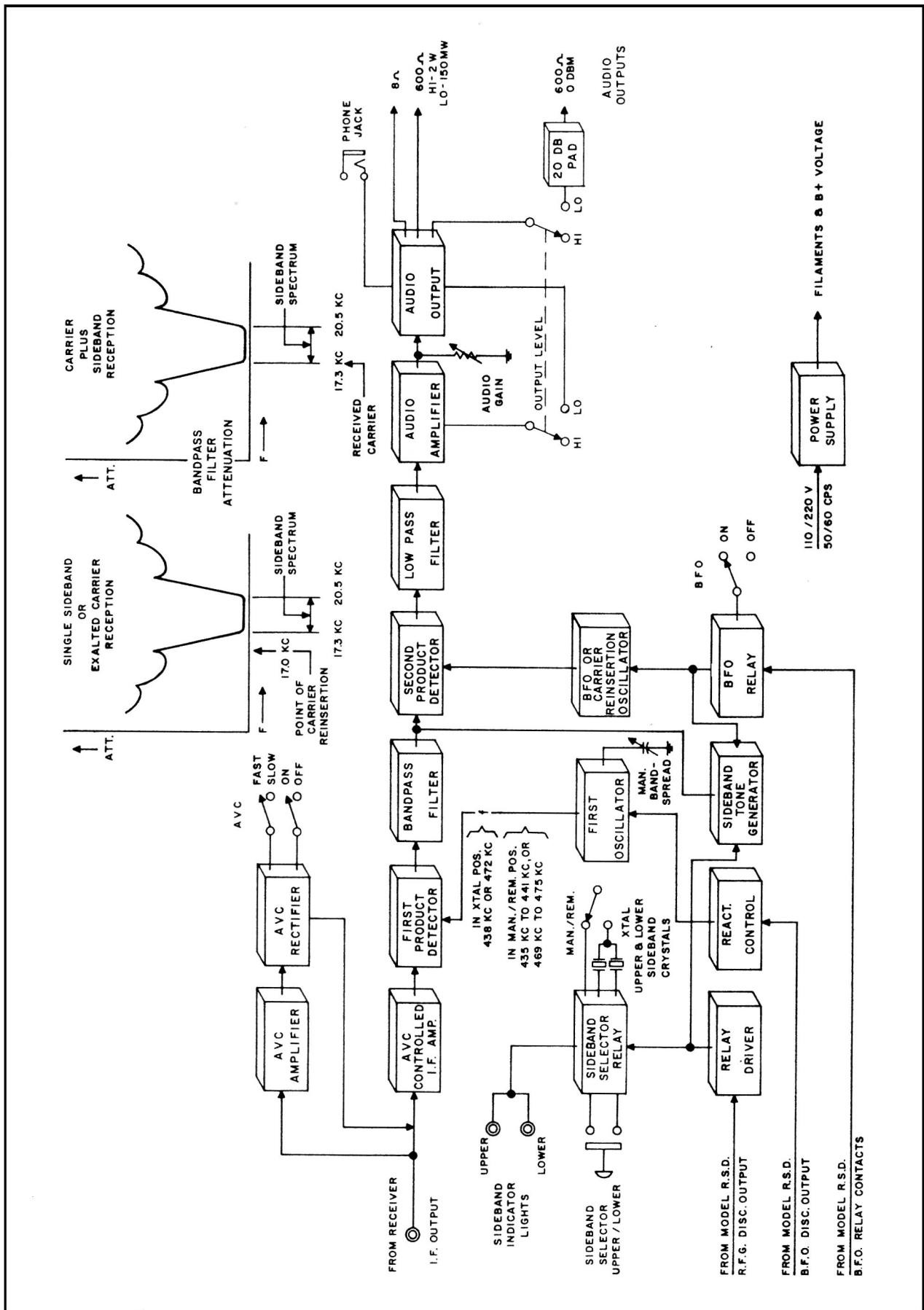


Figure 2-3. Block Diagram Model MSR

## SECTION III

### INSTALLATION AND OPERATION

#### 1. INSTALLATION

##### A. UNPACKING

The TMC Model MSR, Mode Selector, Receiving has been designed for ease of installation and minimum effort in operation. The unit is packed in an individual shipping container and should be carefully unpacked. A close visual inspection should be made to determine any physical damage due to rough handling during shipment. If damage is found notify carrier immediately.

##### B. POWER SUPPLY

The unit is designed for operation from 110 volts, 50/60 cycle source, unless specifically ordered for 220 volt, 50/60 cycles. The unit is shipped wired for 110 volt AC operation. A simple wiring change in the tapped primary circuit of the power transformer is necessary to change the Model MSR to 220 volt AC operation see Figure 5-5. This change is made directly on the power transformer terminal lugs as follows:

Remove switch lead from terminal 2 of T5 and connect it to terminal 3. Change fuse value to 1-1/2 amp. A three wire line cord (CA-385) which connects to J2 (rear of chassis) is supplied. The free end of this cable has a 2 prong male plug with a pigtail lead for grounding purposes. If the use of this ground lead is required, loosen one of the screws on the convenience outlet face plate and insert the spade lug under the screw head. Tighten the screw to secure the ground lead, and insert plug into outlet.

##### C. ELECTRICAL CONNECTIONS

The proper electrical connections are made at the rear of the chassis. A lowloss coaxial cable is required to connect the I. F. output of the receiver into the MSR. 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 through a 47 mmfd capacitor.

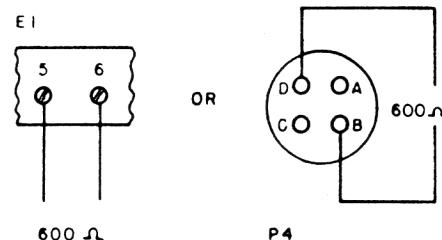
The audio output connections are made on the rear apron at terminal strip E1 or the chassis connector J4, for which a mating cable connector is supplied. Since three levels of output are available, the connections to P4 must be made as follows.

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

E1 Terminals 5 and 6.

or

P4 Pins B and D

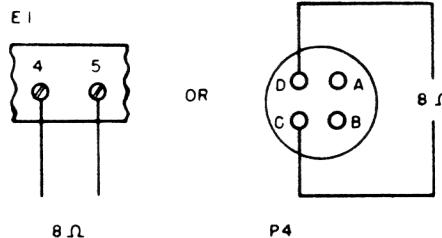


2 watt, 8 ohm output. Output Level switch in HIGH position.

E1 Terminals 4 and 5.

or

P4 Pins C and D.

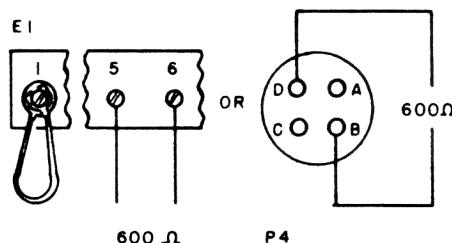


150 milliwatt, 600 ohm output. Output level switch in LOW position. Note position of jumper which is normally between terminals 1 and 3.

E1 Terminals 5 and 6.

or

P4 Pins B and D.

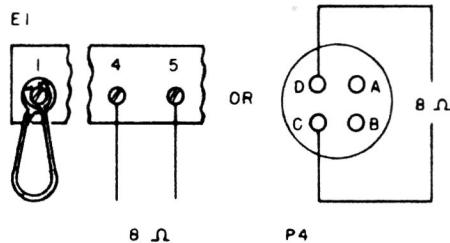


150 milliwatt, 8 ohm output. Output Level switch in LOW position. Note position of jumper which is normally between terminals 1 and 3.

E1 Terminals 4 and 5.

or

P4 Pins C and D.

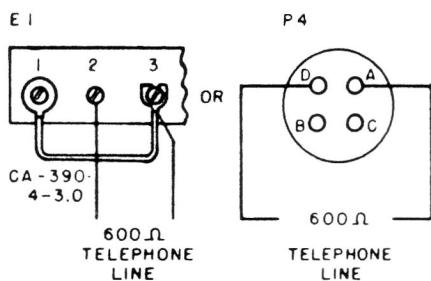


1 milliwatt, 600 ohm telephone line only. Output Level switch in LOW position. Note normal position of jumper.

E1 Terminals 2 and 3.

or

P4 Pins A and D.



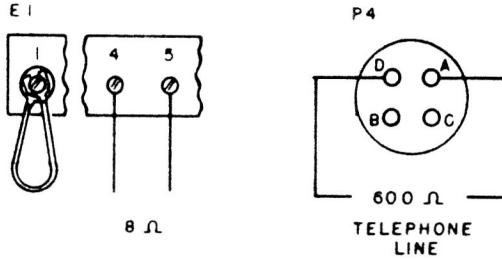
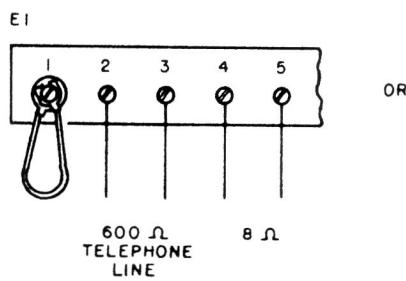
Simultaneous use of telephone line at 1 milliwatt, 600 ohms, or 8 ohm loudspeaker at 150 milliwatts. Note position of jumper.

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.



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 halved. 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 3-1.

The control voltages for remote operation may be obtained from the TMC Model RCR, Remote Control Receiver System which controls the TMC Model FFR, Communication Receiver. The following leads are removed from the Model FFR and connected to the Model MSR.

See Figure 3-2 for proper cabling.

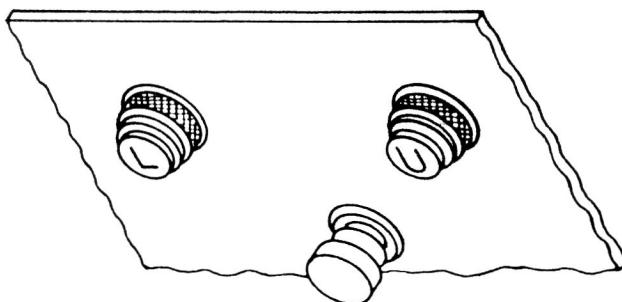
1. Remove the BFO relay leads on terminals 5 and 6 of E102 of the FFR and replace to terminals 9 and 10 of E1 of the MSR.

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

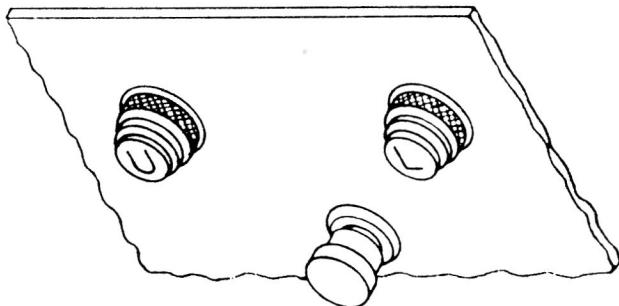
3. A shielded lead is connected from terminal 3 of E102 of the FFR to terminal 8 of the MSR.

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 Model MSR front panel sideband indicators are positioned as follows.



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 as above.

## 2. OPERATION

### A. DESCRIPTION OF CONTROLS

All operating controls are located on the front panel and perform similar functions to those found on any receiver.

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

**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.

**UPPER/LOWER SIDEBAND** - Either sideband is selected by pushing and releasing the button. A panel light indicates which sideband will pass through the filter. See Page 3-2 for correct placement of indicators.

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

**AVC ON/OFF** - This switch permits 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**.

**OUTPUT LEVEL CONTROL:** (Rear deck). Control **HIGH/LOW** output level. Disconnects telephone lines when in **HIGH** position.

**AUDIO GAIN** - This control adjusts the output of the audio amplifier.

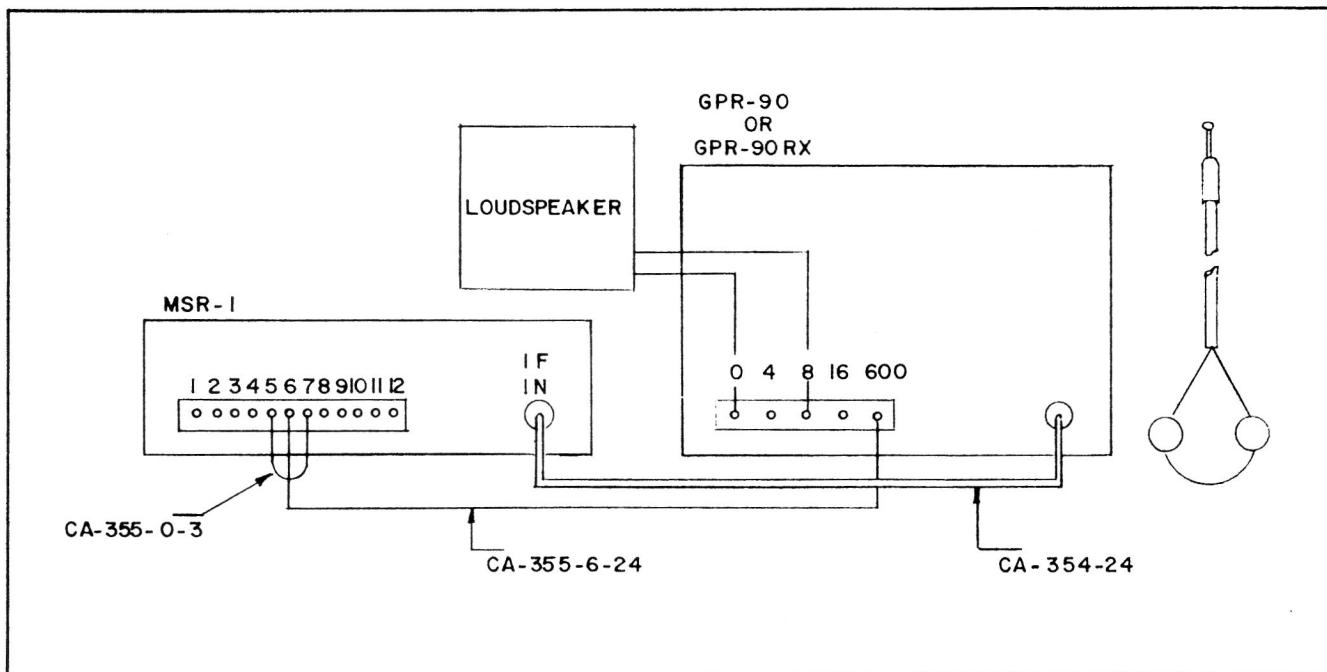


Figure 3-1. Cabling Connections Models MSR/GPR-90  
for Single Loudspeaker Operation

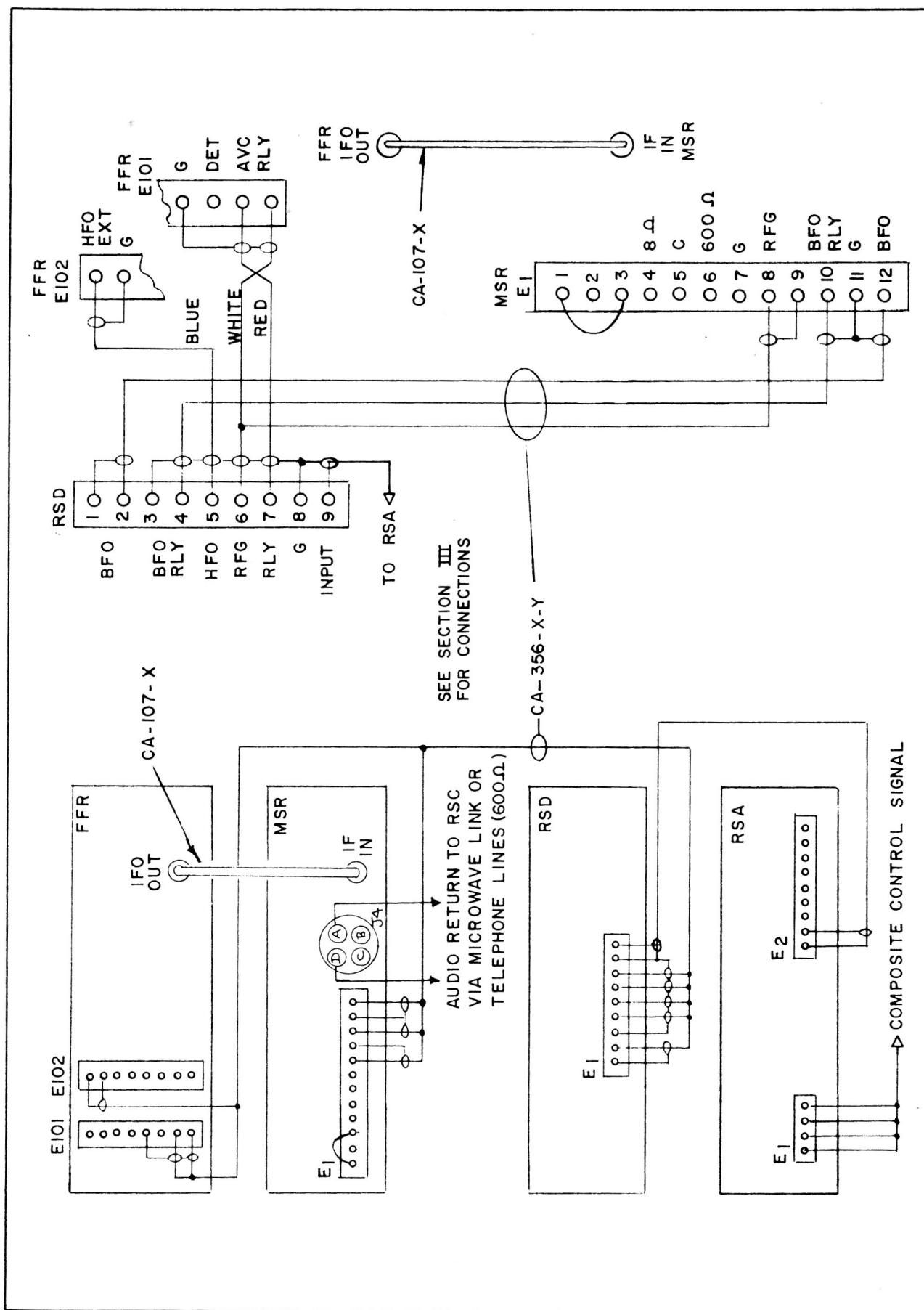


Figure 3-2. Cabling Connections Models MSR/FFR/RSD/RSA

**PHONES** - This jack permits monitoring the audio output without cutting off the output.

**POWER/OFF** - This switch applies power to the unit.

## B. TUNING PROCEDURE

### (1) 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 receiver instruction manual (FFR or GPR-90) 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 (2) below.

#### (a) Reception of Single Sideband Signals.

1. Tune receiver to signal frequency.
2. MSR and receiver AVC ON and SLOW.
3. MSR BFO switch ON.
4. MSR MANUAL/XTAL switch on MANUAL.
5. Upper Sideband reception.
  - a. MSR on UPPER.
  - b. Tune MSR BANDSPREAD control to zero center position for intelligibility.
  - c. For crystal operation set MANUAL/XTAL switch on XTAL and place a 472 kc crystal in socket Y2.
6. Lower Sideband reception.
  - a. MSR set on LOWER.
  - b. Tune MSR BANDSPREAD control to zero center for intelligibility.
  - c. For crystal operation set MANUAL/XTAL switch on XTAL and place a 438 kc crystal in socket Y2. Tune receiver for intelligibility.

#### (b) Reception of AM Signals.

1. Tune receiver to signal frequency.
2. MSR and receiver AVC ON and FAST.
3. MSR BFO switch OFF.
4. MSR MANUAL/XTAL switch on MANUAL.
5. Reception of both sidebands.
  - a. MSR set on UPPER.
  - b. Tune MSR BANDSPREAD control +2 kc above zero center.
  - c. For crystal operation use a 474 kc crystal in socket Y2 with MANUAL/XTAL switch on XTAL.

#### 6. Reception of Upper Sideband.

- a. MSR set on UPPER, MANUAL/XTAL switch on MANUAL.
- b. Tune MSR BANDSPREAD control + .4 kc above zero center.
- c. 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 pull the crystal frequency approximately 400 cps. with the crystal adjust control.

#### 7. Reception of Lower Sideband.

- a. MSR set on LOWER, MANUAL/XTAL switch on MANUAL.
- b. Tune MSR Bandspread control -.4 kc below zero center.
- c. 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 pull the crystal frequency approximately 400 cps with the crystal adjust control.

#### (c) Exalted Carrier Operation.

1. Tune receiver to signal frequency.
2. MSR and receiver AVC ON and FAST.
3. MSR BFO switch ON.
4. MSR MANUAL/XTAL switch on MANUAL.
5. Tune MSR as for SSB.

#### (d) CW and FS Operation.

1. Tune receiver to signal frequency.
2. MSR and receiver AVC ON and SLOW.
3. MSR BFO switch to ON.
4. MSR MANUAL/XTAL switch on MANUAL.
5. Tune MSR BANDSPREAD control to obtain desired pitch of signal.
6. 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.

### (2) OFF CENTER TUNING OF RECEIVER.

Off center tuning of receiver to increase 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 by detuning the receiver 2 kc in the appropriate direction, above the signal fre-

quency for the upper sideband and below the signal frequency for the lower sideband. The MSR must also be adjusted accordingly to realign the signal. The correct method follows:

- (a) Reception of Single Sideband Signals.
  1. MSR and receiver AVC ON and SLOW.
  2. MSR BFO switch ON.
  3. MANUAL/XTAL switch on MANUAL.
  4. Upper Sideband Reception.
    - a. Tune receiver 2 kc above signal frequency.
    - b. Tune MSR BANDSPREAD control +2 kc above zero center for intelligibility.
    - c. Crystal operation - set MANUAL/XTAL switch on XTAL and place a 474 kc crystal in socket Y2. Tune receiver for intelligibility.
  5. Lower Sideband Reception.
    - a. Tune receiver -2 kc below signal frequency.
    - b. Tune MSR BANDSPREAD control to -2 kc below zero center for intelligibility.
    - c. For crystal operation set MANUAL/XTAL switch on XTAL and place a 436 kc crystal in socket Y1. Tune receiver for intelligibility.
- (b) Reception of AM Signals.
  1. MSR and receiver AVC ON and FAST.
  2. MSR BFO switch OFF.
  3. MSR MANUAL/XTAL switch on MANUAL.
  4. Reception of Upper Sideband.
    - a. Tune receiver 1.6 kc above signal frequency.
    - b. MSR set on UPPER.
    - c. Tune MSR BANDSPREAD control +2 kc above zero center.
    - d. 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.
  5. Reception of Lower Sideband.
    - a. Tune receiver 1.6 kc below signal frequency.
    - b. MSR set on LOWER.
    - c. Tune MSR BANDSPREAD control -2 kc below zero center.
    - d. 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.
- (c) Exalted Carrier Operation.

1. MSR and receiver AVC ON and SLOW.
2. MSR BFO switch ON.
3. Reception of sidebands. See B-(2) - (a) above.

### 3. REMOTE OPERATION

#### A. FUNCTIONS.

The TMC Model RCR Remote Control Receiver System will control the MSR in conjunction with the TMC Model FFR communication 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:

- (1) Turn RSC AVC switch to OFF.
- (2) Turn RF GAIN control fully clockwise to 10. This advances the switching relay to the next sideband.
- (3) Turn RF GAIN control fully counter-clockwise to zero and hold for one second. This releases the sideband switching relay. Switching is now completed.
- (4) Return control to normal position for desired gain.

The sideband in use is indicated in the loud-speaker as an audible tone; low pitch for lower sideband, high pitch for upper sideband. If the sidebands have been reversed according to Page 3-2 the Sideband Tone Generator must also be adjusted to produce the correct tone. See Page 4-2. 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.

#### B. 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 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 Functions Part A above. 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.

## SECTION IV MAINTENANCE

### 1. SERVICE MAINTENANCE

#### A. GENERAL

The Model MSR has been designed for long term trouble free duty. Little attention beyond normal maintenance is required. It is recommended that any maintenance to the equipment be performed by a competent technician.

Should normal operation procedure 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 then the UPPER/LOWER SIDEBAND switch should be operated as an alternate means of checking since the sideband switching relay operates directly off of the 110 volt line. If no power is evident then check the fuse on the rear apron. 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 cause of operational failure is usually tube failure. Checking the tubes will often save many hours of unnecessary troubleshooting.

#### B. PREVENTIVE

All components in this unit have been carefully selected to assure maximum efficiency in operation. If the sensitivity should drop and tube failure is suspected, test each tube in a reliable tube tester. The measured characteristics of the tube should be within the manufacturers tolerances (usually  $\pm 20\%$  from tube manual tolerances). No special selection is necessary in the event of tube replacement, but the operator should remember that tubes of the same type will vary slightly in their individual characteristics.

Failure may occur due to breakdown of capacitors or resistors. Test all AC and DC voltages as indicated on Tube Voltage and Resistance charts, and investigate any serious discrepancies.

A faulty capacitor may cause overload of associated resistors, which should be checked for any change in resistance value. A shorted resistor may be detected by scorching or discoloration marks on the surface of the resistor. An open capacitor may cause unwanted oscillations and may be checked by connecting a good capacitor across it.

In order to prevent failure of the equipment due to corrosion, dust, and other destructive ambient conditions, it is recommended that the inside of the chassis be thoroughly inspected for signs of dirt, dampness, molding, charring or corrosion every 6 months. Correct any defect with cleaning agent of proven quality. When placing the unit in the rack, the operator should make certain that all terminal screw connections are tight.

### 2. 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 the signal source.

#### A. ALIGNMENT WITH SIGNAL GENERATOR.

##### Equipment Required

RF Signal Generator  
Audio Generator  
Vacuum Tube Volt Meter  
Oscilloscope  
DC Source 0 to  $\pm 10$  volts.

1. Alignment of Bandspread Oscillator-Upper Sideband.
  - a. Feed a 472.00 kc signal from the RF signal generator to the IF input jack J1.
  - b. Connect the oscilloscope to pin 5 of V3 the 1st Mixer.
  - c. Switch sideband to UPPER.
  - d. To assure a zero potential at terminal 12 of E1, short terminals 11 and 12.
  - e. Set BANDSPREAD control to zero.
  - f. Adjust the core of T2 for a zero beat on scope (steady horizontal trace).
2. Alignment of Bandspread Oscillator-Lower Sideband.
  - a. Switch sideband to LOWER.
  - b. Set RF signal generator to 438.00 kc.
  - c. Adjust C29 for a zero beat on scope (steady horizontal trace).
  - d. Remove short from terminals 11 and 12 of E1.

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

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Figure 4-1. Voltage Chart Model MSR

3. Bandspread Oscillator Remote Control.
  - a. Connect the variable DC supply to terminal 12 of E1.
  - b. Varying the DC voltage  $\pm 4.5$  volts should produce a balanced shift of approximately  $\pm 4$  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 the scope to pin 5 of V4.
  - c. Set the BFO switch to ON.
  - d. Adjust the C40 (mounted on top of Z4) for a zero beat on the scope.
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 volts should increase the output of the oscillation to approximately 2.5 volts.

NOTE: Oscillator will start at two positions of threshold. 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.

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

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Figure 4-2. Resistance Chart Model MSR

7. When the sidebands are reversed as explained on Page 3-6 the above procedure is reversed as shown below.
  - d. Set sideband to UPPER.
  - e. Adjust C55 on Z5 for 500 cps note.
  - f. Set sideband to LOWER.
  - g. 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 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.

SYM.	DESCRIPTION	FUNCTION	TMC DWG OR PT NO.
XY1	SOCKET, crystal: 2 contacts; 0.486 in. spacing for .050 in. pin diam; steatite body.	Socket for Y1	TS-104-1
XY2	SOCKET, crystal: 2 contacts; 0.486 in. spacing for .050 in. pin diam; steatite body. (Same as XY1)	Socket for Y2	TS-104-1
Y1	CRYSTAL UNIT, quartz: 438 kc, $\pm 0.01\%$ ; includes holder HC-6/U.	438 kc Crystal	CR46/U-.4380-P
Y2	CRYSTAL UNIT, quartz: 472 kc, $\pm 0.01\%$ ; includes holder HC-6/U.	472 kc Crystal	CR46/U-.4720-P
Z1	FILTER, bandpass: 19.1 kc; 3.4 kc bandwidth; 10,000 ohms impedance.	Bandpass Filter	FX-153
Z2	FILTER, low-pass: 3500 cps cut-off frequency.	Low-pass Filter	FX-152
Z3	TRANSFORMER, radio frequency: 790 kc; (consists of C32 & T2).	First Osc. Tank	A-1387
Z4	OSCILLATOR NETWORK, audio frequency: 17 kc; (consists of C38, 39, 40, 50, R41 & T3).	Second Osc. Tank	A-1381
Z5	OSCILLATOR NETWORK, audio frequency: 43.5 millihenries (consists of C53,55, T4).	Side Tone Gen. Tank	A-1384

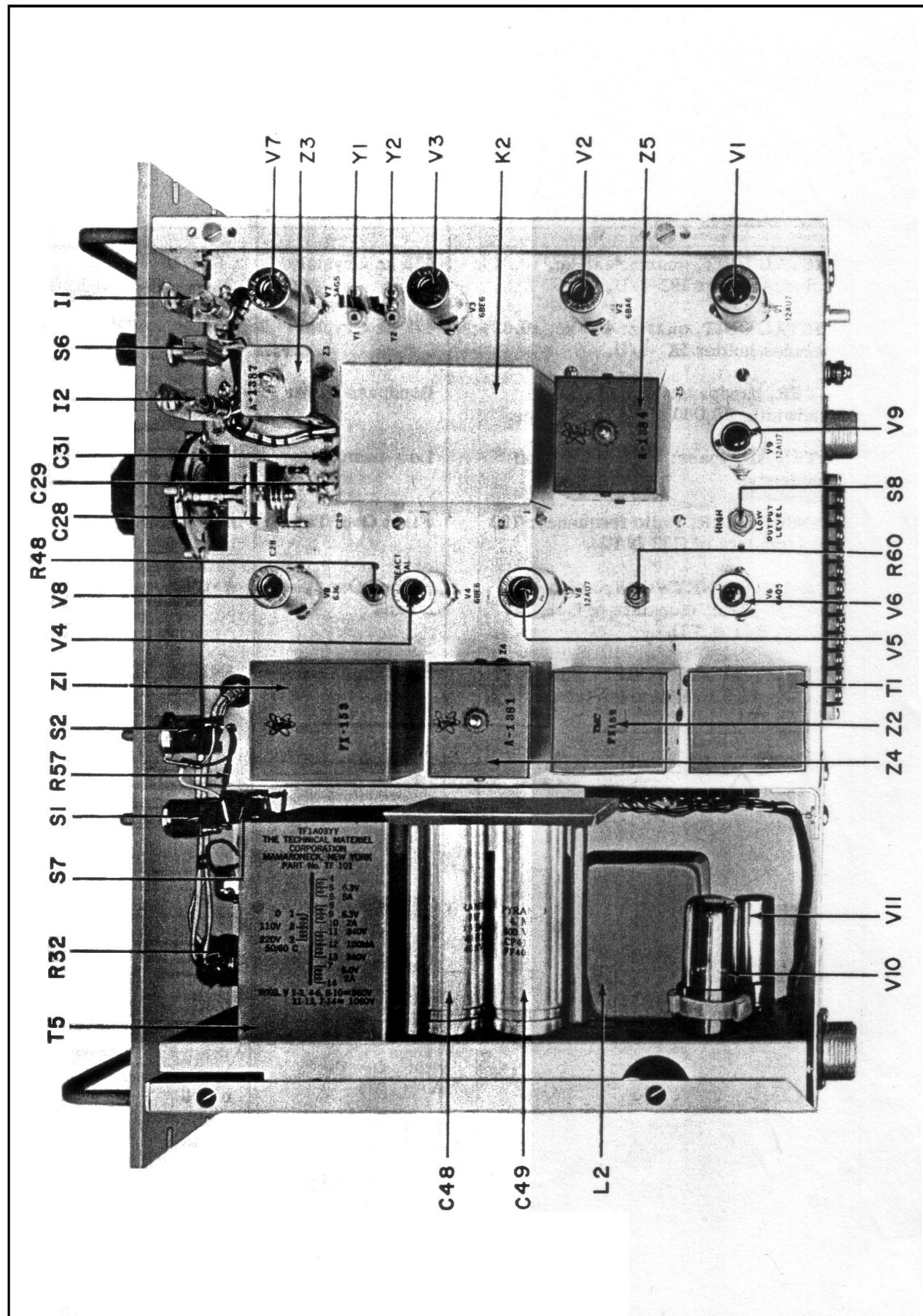


Figure 5-1. Top View Model MSR

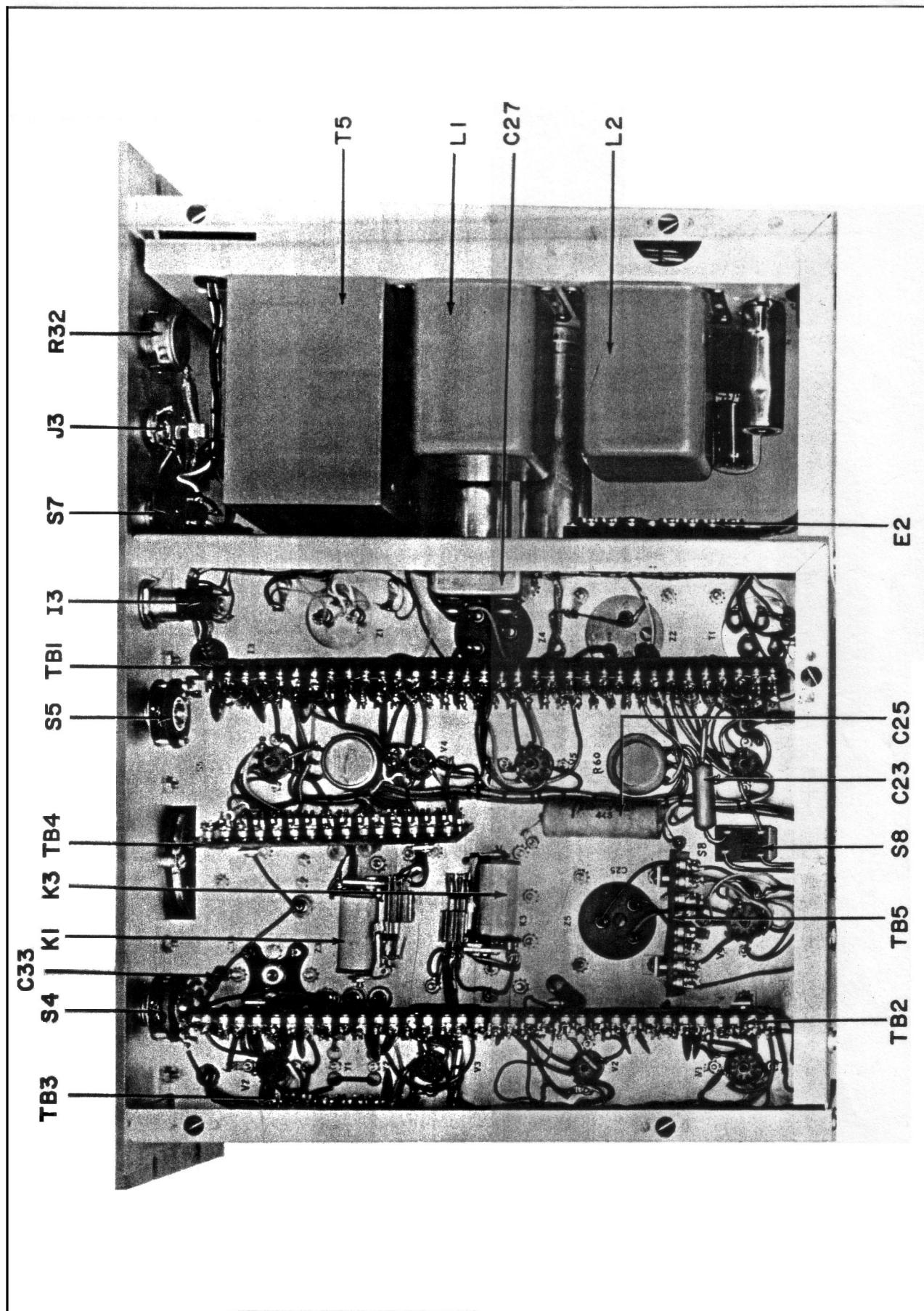
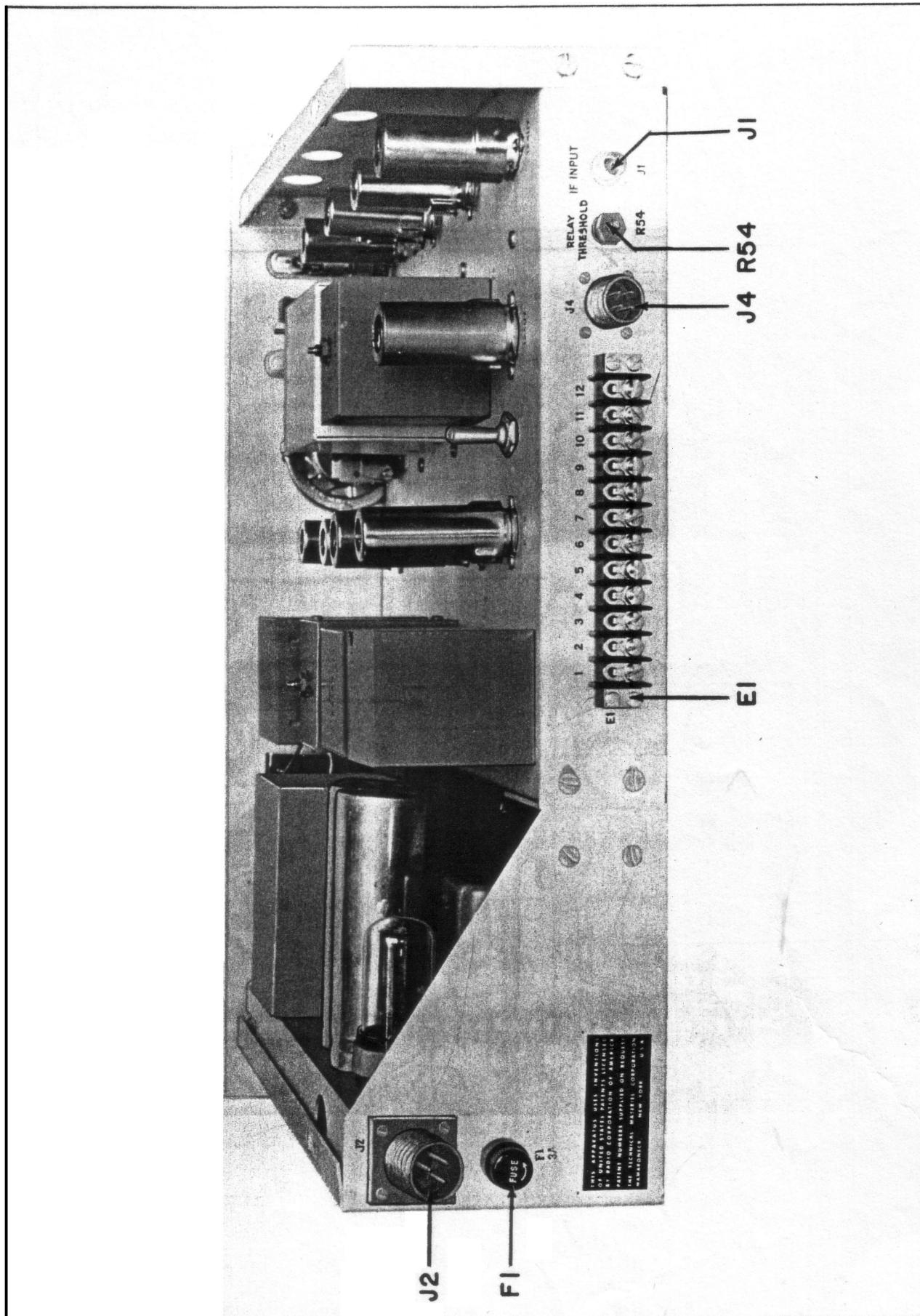
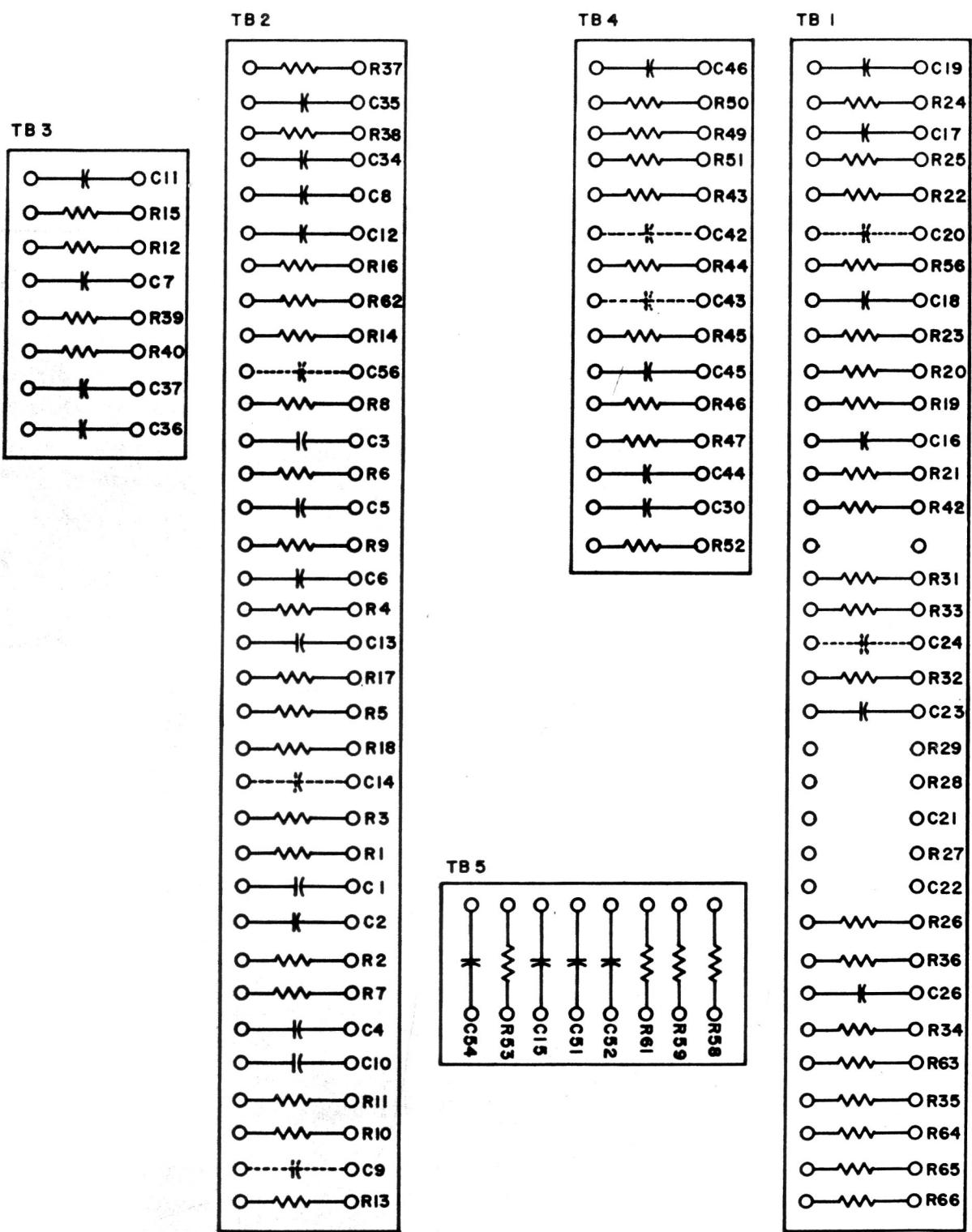


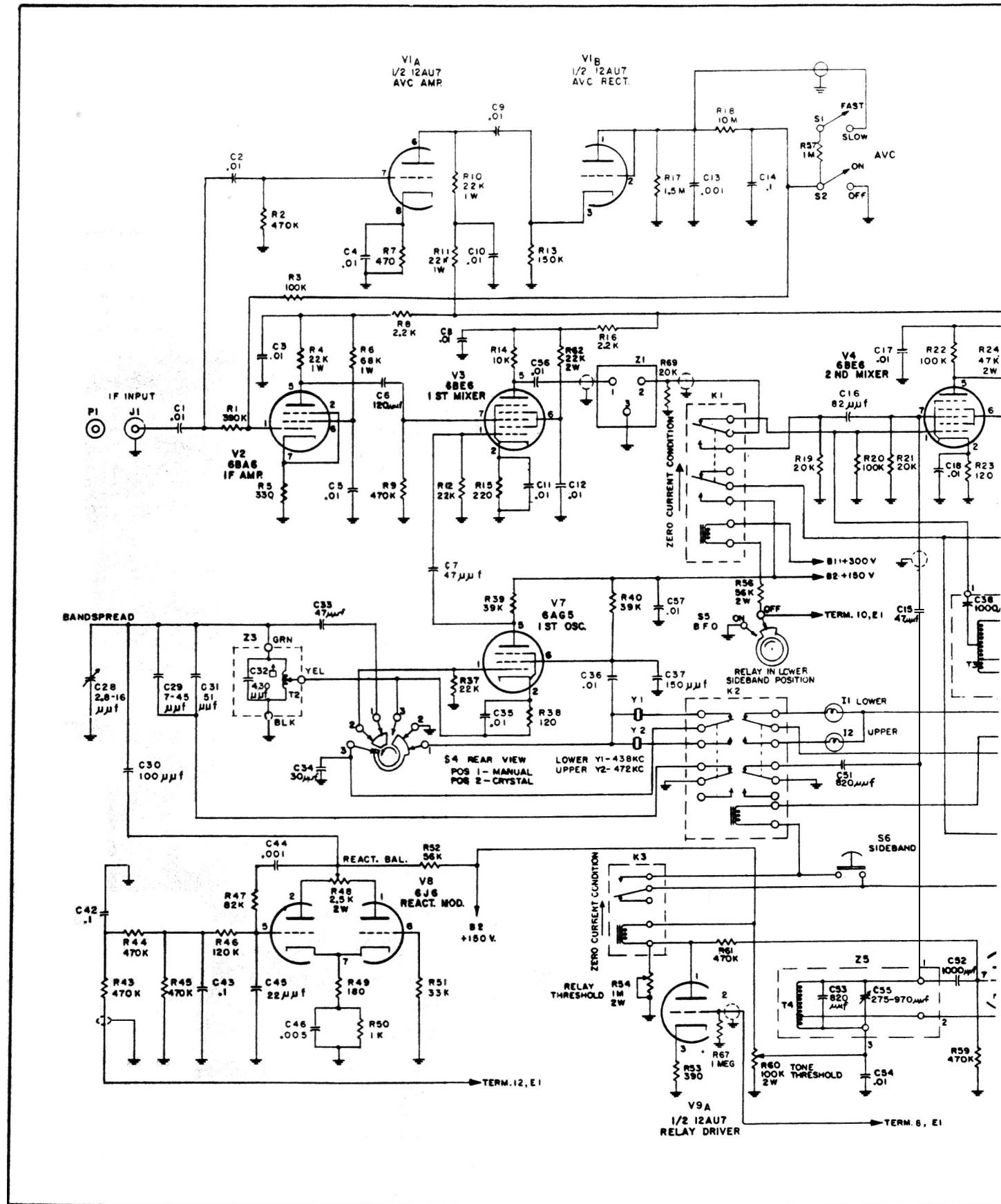
Figure 5-2. Bottom View Model MSR

Figure 5-3. Rear View Model MSR





NOTE: COMPONENTS SHOWN IN DOTTED LINES ARE ON REAR OF BOARD.



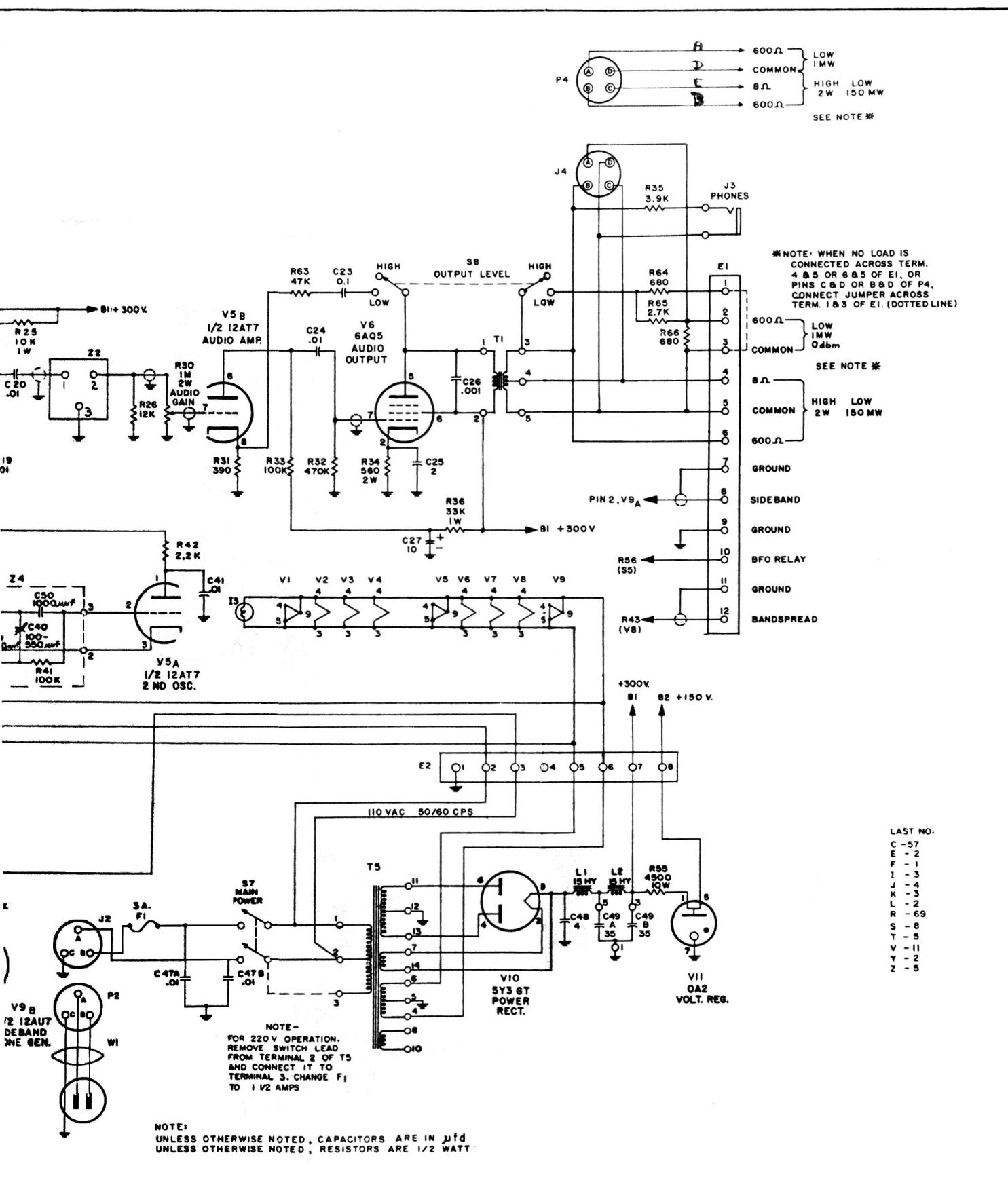


Figure 5-5. Schematic Diagram Model MSR-4

Army-Navy-Air Force Nomenclature has been assigned to the Models MSR as follows:

TMC No.	Description	Nomenclature	Noun
MSR-1	Single Sideband Converter	CV-591/URR	Single Sideband Converter
MSR-3	Single Sideband Converter	CV-657/URR	Single Sideband Converter
MSR-4	Single Sideband Converter	CV-591A/URR	Single Sideband Converter

The Model MSR-3 is for use with receivers having an intermediate frequency range of 197 - 203 kc when the MSR-3 oscillator is variable or normal crystal is used. Or, 200 kc to 1.5 mc when the MSR-3 oscillator is crystal controlled only.

The Models MSR-1 and MSR-4 are for use with receivers having an intermediate frequency range of 452 - 458 kc when the MSR oscillator is variable or normal crystal is used. Or, 225 kc to 1.5 mc when the MSR oscillator is crystal controlled only.

The MSR-4 being an improved version of the MSR-1, the units are interchangeable electrically and mechanically in any installation.

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