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UNCLASSIFIED

TECHNICAL MANUAL
for
VARIABLE FREQUENCY
OSCILLATOR, VOX-5
(OSCILLATOR, RADIO FREQUENCY
0-330()/FR)



THE TECHNICAL MATERIEL CORPORATION
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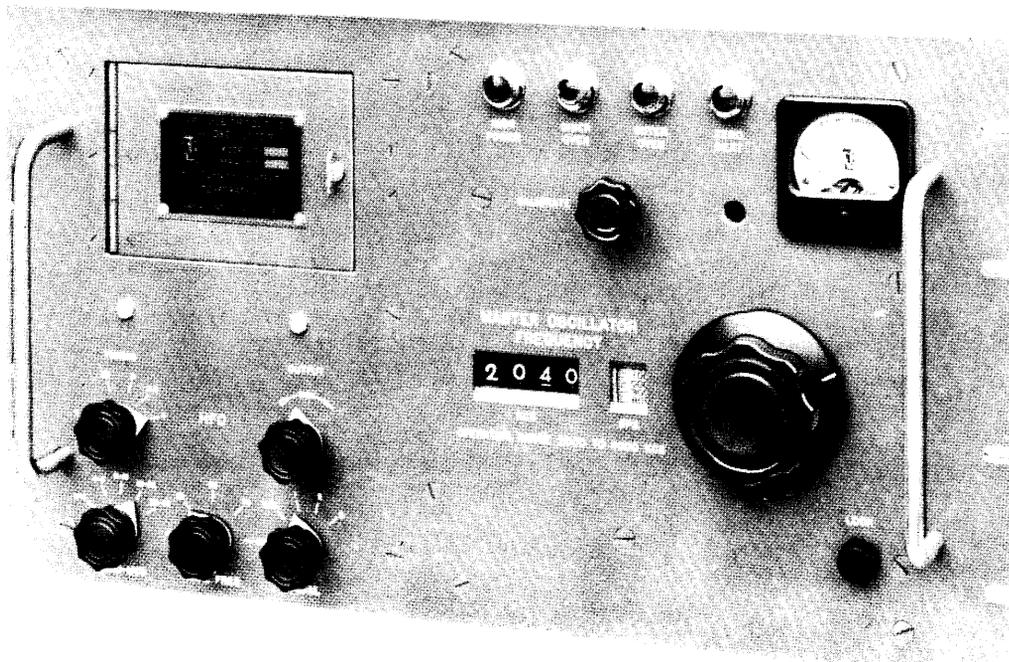
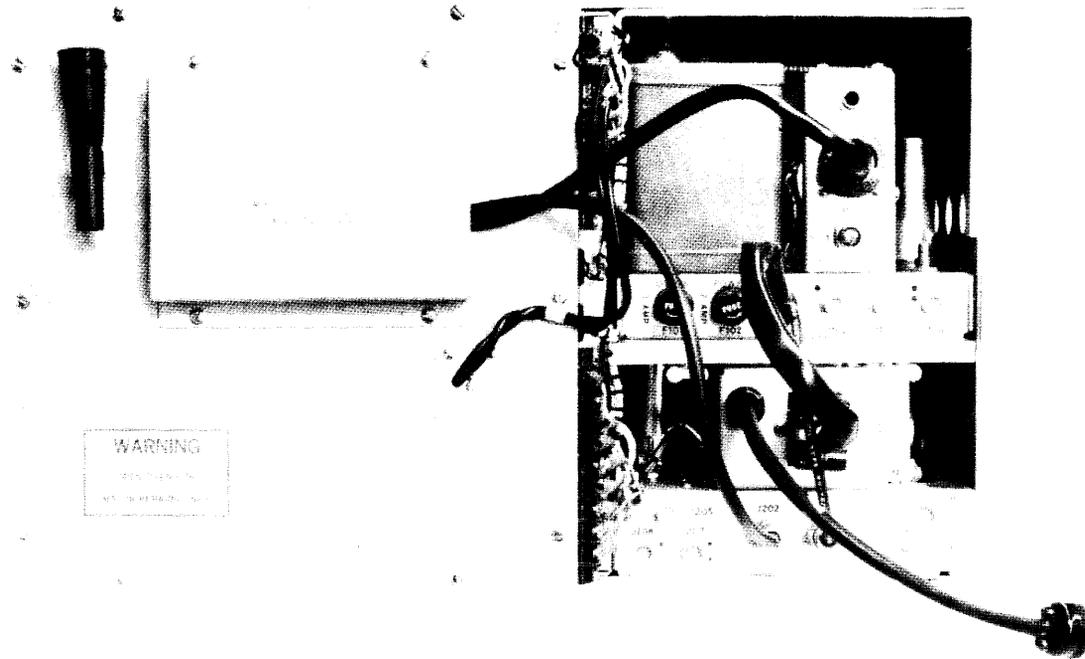


Figure 1-1. Front and Rear Views, Variable Frequency Oscillator, VOX-5

SECTION 1 GENERAL DESCRIPTION

1-1. PURPOSE AND BASIC PRINCIPLES.

Technical Materiel Corporation's Variable Frequency Oscillator, VOX-5, is a precision, direct reading, variable frequency device designed to provide high frequency and medium frequency oscillator injection voltage for the control of one or more receivers or transmitter exciters with extremely high stability.

The VOX provides the following:

a. High frequency RF output voltage, continuously variable over the range of 2 to 64 mc (frequency dependent upon dial settings).

b. Crystal-controlled high frequency output voltage over the range of 2 to 64 mc (frequency dependent upon crystals used).

c. Crystal-controlled BFO voltage over the range of 300 to 500 kc (frequency dependent upon crystals used) for dual-conversion superheterodynes such as the Hammarlund 600 series.

d. Crystal-controlled IFO voltage over the range of 3.2 to 3.9 mc (frequency dependent upon crystals used) for dual-conversion superheterodyne receivers.

Sufficient output is available from any of the foregoing to control up to three receivers in diversity, or the usual requirement of transmitter exciters.

The VOX incorporates a highly stable variable frequency oscillator, a above, with an extremely accurate counter-type dial. Master oscillator frequency-determining elements are contained in a temperature stabilized oven, and these components are carefully selected for high stability operation. In addition to the variable frequency feature, provision is made for up to three crystal-controlled positions for high frequency injection, b above.

Additional crystal oscillators provide crystal-controlled beat frequency oscillator voltage, c above, for use with receivers, and a 3.2- to 3.9-mc crystal-controlled RF output, d above, for dual-conversion receivers.

1-2. DESCRIPTION OF UNIT.

The VOX is shown in figure 1-1. The panel is 3/16 inch thick by 19 inches long and 10-1/2 inches high and is finished in TMC gray enamel. The chassis extends 16 inches behind the panel and is attached to the panel on each side by brackets. The controls most often used are located on the front panel, while seldom-used controls and fuses are located behind an access door on the upper left center of the panel. All vacuum tubes and relays are readily accessible from the rear of the VOX and are mounted in a vertical position.

The direct reading calibration of the unit enables the operator to set the output frequency to within 20 cycles per mc of any desired frequency within the range of the unit at any checkpoint, and the unit is resettable to the same tolerance. A self-contained 100-kc temperature-controlled crystal provides 50-kc check points for calibration of the VOX. All units are isolated with buffer amplifiers, where necessary, to prevent interaction.

1-3. REFERENCE DATA.

The dimensions of the VOX are 19 x 16 x 10-1/2 inches (length, height, depth), and it weighs 157 pounds gross, packed for shipment. The VOX is mounted on a Western Electric Co. relay rack mounting. Equipment is manufactured in accordance with JAN specifications, wherever practicable. Tables 1-1, 1-2, and 1-3 contain additional reference data pertinent to the VOX.

TABLE 1-1. ELECTRICAL CHARACTERISTICS

ITEM	CHARACTERISTIC
HIGH FREQUENCY OSCILLATOR	
Frequency range:	2 to 64 mc continuous, bandswitched.
Output impedance:	75 ohms coaxial.
Output level:	2 watts throughout basic range of 2 to 4 mc and 0.5 watt, 4 to 64 mc, adjustable.
Output connections:	Three BNC RF connectors.
Crystal frequencies:	2 to 4 mc for output frequencies of 2 to 64 mc.
Crystal unit:	CR-18/U
Crystal position:	Three each, available on front panel switch.
Output voltage:	Sinusoidal with no spurious frequencies.
Stability:	20 cycles per mc for 0- to 50-degree change in ambient temperature.
Calibration:	Direct reading calibration in cycles per second from 2 to 4 mc.
Readability:	20 cycles per mc.
Resettability:	20 cycles per mc to a calibrated frequency.
Line voltage change effects:	3 cycles per mc for $\pm 10\%$ change in line voltage.
HF oscillator calibration:	Against 100-kc crystal oscillator at 50-kc points.
BEAT FREQUENCY OSCILLATOR	
Frequency range:	300 to 500 kc.
Output level:	6 volts across 1000 ohms with output level control.
Output connections:	Three BNC RF connectors.
Crystal holders:	CR-45/U
Crystal position:	Two each, available on rear panel switch.
INTERMEDIATE FREQUENCY OSCILLATOR	
Frequency range:	3.2 to 3.9 mc (crystal oscillator).
Output level:	2 volts in 75 ohms.
Crystal type:	CR-18/U
Output connections:	Three BNC RF connectors.
PRIMARY POWER	
Primary power:	115 or 230 volts, 50 or 60 cps. Approximately 100-watt average or 250-watt peak depending upon cycling of oven heating elements.

TABLE 1-2. FRONT PANEL CONTROLS

CONTROL	FUNCTION
BEAT (ON-OFF) switch (compartment behind door):	Supplies B+ to VOX's 100-kc oscillator so that mixer V103 in calibrating chain receives 100-kc and VMO oscillator voltages for production of beat tones.
METER selector switch (compartment behind door):	Enables meter to measure output of HFO, IFO, BFO, and VMO.
PHONES jack (compartment behind door):	Enables plugged-in receiver to receive beat tones.
POWER switch (compartment behind door):	Applies line voltage to or disconnects line voltage from power supply circuit.
HFO switch (compartment behind door):	Applies DC plate voltage to HFO vacuum tubes.
IFO switch (compartment behind door):	Applies DC plate voltage to IFO vacuum tube.
BFO switch (compartment behind door):	Applies DC screen voltage to BFO vacuum tube.
MAIN POWER indicator:	Goes on when VOX is receiving 60-cycle power.
INNER OVEN indicator:	Goes on when inner oven is receiving heat.
OUTER OVEN indicator:	Goes on when outer oven is receiving heat.
ZERO BEAT indicator:	Indicates beat tones when calibrating VMO with 100-kc oscillator at check points.
OUTPUT meter:	Registers level of VOX's RF outputs in line with position of METER selector switch located in compartment behind door.
CALIBRATE knob:	Calibrates VMO with 100-kc oscillator at check points.
MASTER OSCILLATOR FREQUENCY knob:	Controls output frequency of VMO.
MASTER OSCILLATOR FREQUENCY dial:	Registers output frequency of VOX and tunes main oscillator.
OUTPUT potentiometer:	Controls level of output of HFO circuit.
XTAL selector switch:	Determines whether VOX's output is produced by crystals in positions 1, 2, 3, and by its VMO.
XTAL FREQ padding capacitor:	Enables small changes in crystal frequency. Used only when VOX uses a crystal for RF output.
BAND-MCS selector switch:	Controls tuning elements in HFO circuit.
TUNING selector switch:	Tunes HFO output circuit. Used to maximize meter reading with METER selector switch in HFO position.
BFO ADJ potentiometer (chassis mounted at top):	Controls BFO output level.
BFO XTAL SW (chassis mounted at rear):	Determines which of two crystals is used for BFO beats.

TABLE 1-3. VACUUM TUBE COMPLEMENT

SYMBOL	TYPE	FUNCTION
V101	5V4G	High voltage rectifier
V102	OA2	Voltage regulator
V103	6BE6	Mixer
V104	12AU7	Audio amplifier
V105	6AQ5	BFO
V201	12AU7	IFO and amplifier
V202	6C4	Crystal HFO and RF amplifier
V203	6AQ5	RF amplifier
V204	6AQ5	RF amplifier and multiplier
V205	6AQ5	RF multiplier
V206	6AQ5	RF multiplier
V207	6AQ5	RF multiplier
V301	6AB4	VMO
V302	12AU7	Crystal oscillator and cathode follower

SECTION 2 INSTALLATION

2-1. INITIAL INSPECTION.

The VOX has been tested and calibrated before shipment. Only minor preparations are required to put the unit into operation.

Inspect the 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." Although the carrier is liable for any damage in the equipment, Technical Materiel Corporation will assist in describing and providing for repair or replacement of damaged items. The equipment is shipped with all tubes installed. Check that all such components are properly seated in their sockets.

2-2. 115- VS 230-VOLT POWER SUPPLY CONNECTIONS.

VOX's power supply is designed for 115- or 230-volt, 50- or 60-cps, single-phase power; it is factory wired for 115 volts. If 230-volt operation is required (sometimes when VOX is used as an end item), minor wiring changes to VOX's power supply and crystal oven are necessary. These are shown in figure 2-1 below.

2-3. INTERCONNECTING PROCEDURE.

Figure 2-2 shows two cabling arrangements between various sections of the VOX: short cable interconnections under normal operating conditions (when the VOX's assemblies are closely associated physically), and extended cable interconnections used under servicing conditions (when the VOX's power supply section is physically remote from its other two sections).

Connect power supply cord between 115-volt, 50- and 60-cycle power supply and VOX's power supply 115-volt input.

As an "end item," the equipment supplied and the interconnecting instructions are as follows:

<u>Description</u>	<u>Quantity</u>
Variable Frequency Oscillator VOX-5	1
Power Supply-Multiplier Auxiliary Interconnect Cable, 12 contact, CA-109.	1
Power Supply-Master Oscillator Auxiliary Interconnect Cable, 6-contact, CA-502.	1
RF Cable, Power Supply-Multiplier Auxiliary Interconnect, single contact, CA-108.	1
TUBE PULLER GR-104.	1

Nine coaxial connectors provide three IFO outlets, three HFO outlets, and three BFO outlets. Refer to jacks J205, J206, J207, J208, J209, J210, J102, J103, and J104, respectively, on VOX's schematic diagram, figure 8-1.

(Equipment required but not supplied consists of coaxial cable RG-59/U for output connections to associated equipments.)

The VOX may be mounted in a standard 19-inch relay rack or other housing as desired. Figure 2-3 is an outline dimensional drawing of the VOX.

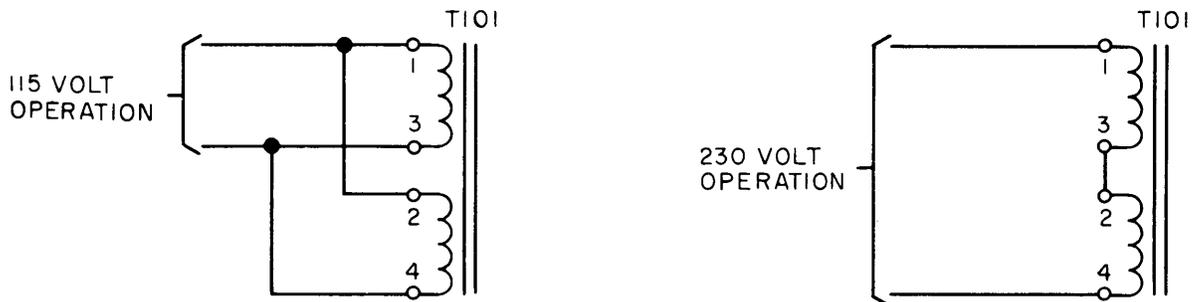


Figure 2-1. Installation Diagram Showing 115-vs 230-Volt Power Supply Connections

Quartz crystal units, supplied only on customer request, are as follows:

Designation	Socket Installed	Type	Freq. Char.	Function	Chassis
Y101	XY 101	CR-25/U	300-500 kc	BFO	Power Supply
Y102	XY 102	CR-25/U	300-500 kc	BFO	Power Supply
Y201	XY 201	CR-18/U	3.2-2.9 mc	IFO	RF
Y202	XY 202	CR-18/U	2-64 mc	HFO	RF
Y203	XY 203	CR-18/U	2-64 mc	HFO	RF
Y204	XY 204	CR-18/U	2-64 mc	HFO	RF
Quartz crystal unit Y301 comes installed in the VOX.					

2-4. INITIAL ADJUSTMENTS.

The VOX has been factory tested and adjusted. Unless damaged in shipment or when unpacked, it is ready for use after the following checkout:

a. The VOX is a high stability precision instrument and requires an initial warm-up period of at least 48 hours of continuous duty. Thereafter, the unit should never be turned off unless detailed repairs become necessary. Failure to comply with this procedure results in degradation of the instrument's accuracy.

b. After the 48-hour warm-up period, the POWER switch (open front panel door) should be in ON position and the ovens should have reached a stable condition.

c. Set the BEAT (ON-OFF) switch (open front panel door) to ON position.

d. Plug a headset into the jack marked PHONES (open front panel door).

e. Turn the BAND-MCS switch on front panel to 2-4 position.

f. Turn the XTAL switch on front panel to VMO position.

g. Turn the MASTER OSCILLATOR FREQUENCY dial to 2000 KCS 000 CPS position.

h. Turn the CALIBRATE dial for zero beat on the phones and also on the ZERO BEAT indicator. The VMO's 2,000,000-cycle output now coincides in frequency with the 100-kc calibrating oscillator's 20th harmonic.

i. Turn the MASTER OSCILLATOR FREQUENCY dial to its 4000 KCS 000 CPS position.

j. Adjust the trimmer capacitor, behind circular disc (located on the front panel) between the CALIBRATE dial and the VOX's meter, to give zero beat on the phones and also on the ZERO BEAT indicator. The VMO's 4,000,000-cycle output now coincides in frequency with the 100-kc calibrating oscillator's 40th harmonic.

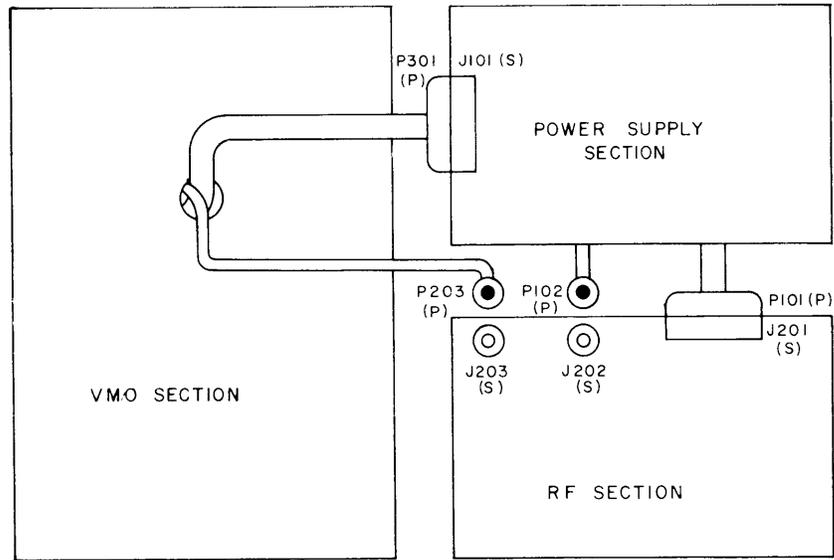
k. Repeat steps g and h to compensate for the newly adjusted position of the trimmer capacitor.

l. Repeat steps i and j to compensate for the newly adjusted position of the CALIBRATE dial.

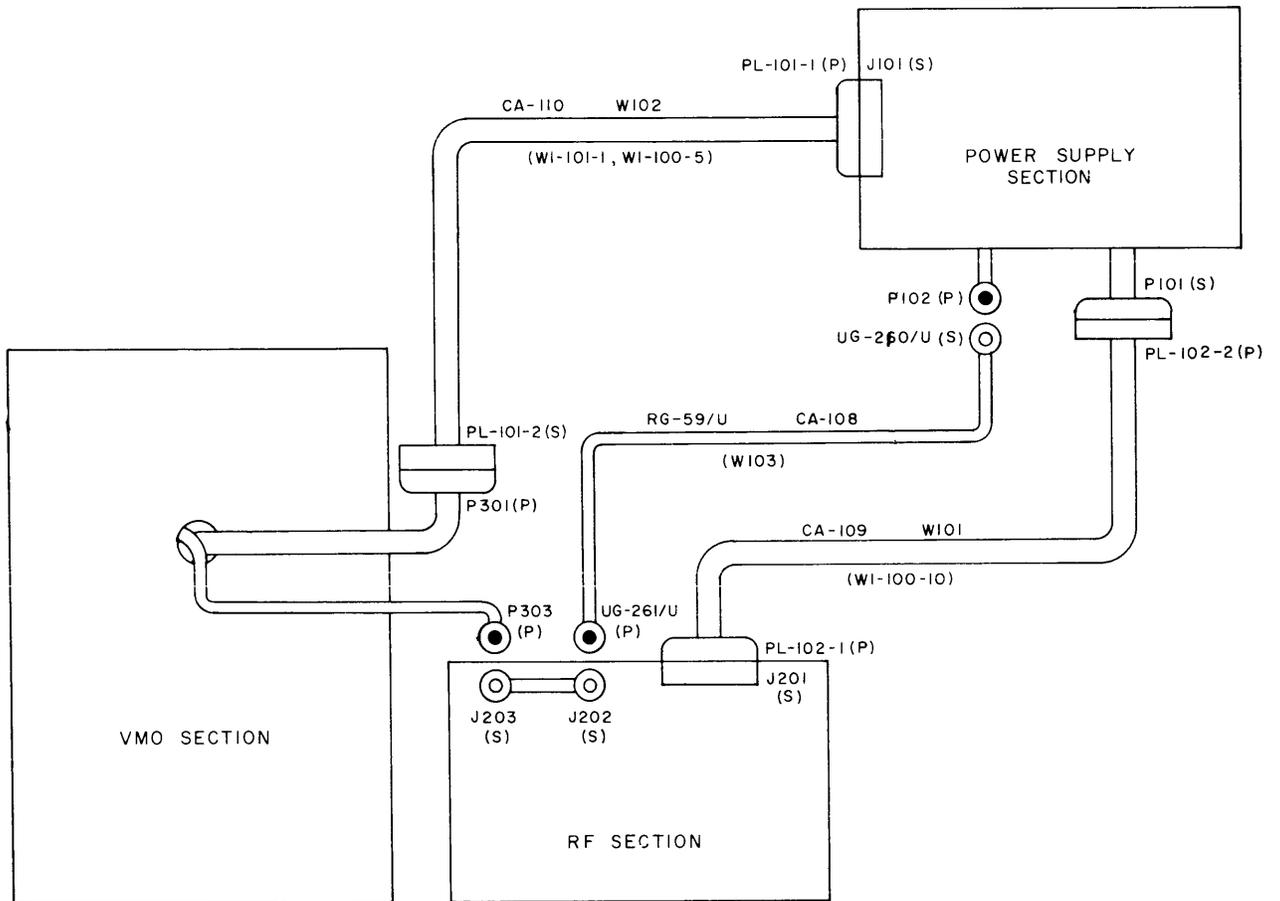
m. Readjust the trimmer capacitor to optimum zero beat condition at the two extremes of the 2- to 4-mc band.

Since other frequency bands are obtained by multiplication of the 2- to 4-mc band, the oscillator is adjusted throughout its entire frequency.

Do not operate the MASTER OSCILLATOR FREQUENCY dial 14 so that the stated frequency range of 200 to 4000 kc is exceeded, in order to prevent VMO cam displacement and possible VMO misalignment.



SKETCH A - CABLES UNDER NORMAL CONDITIONS



SKETCH B - CABLES UNDER SERVICING CONDITIONS

Figure 2-2. Installation Diagram Showing Cabling Under Operating and Servicing Conditions

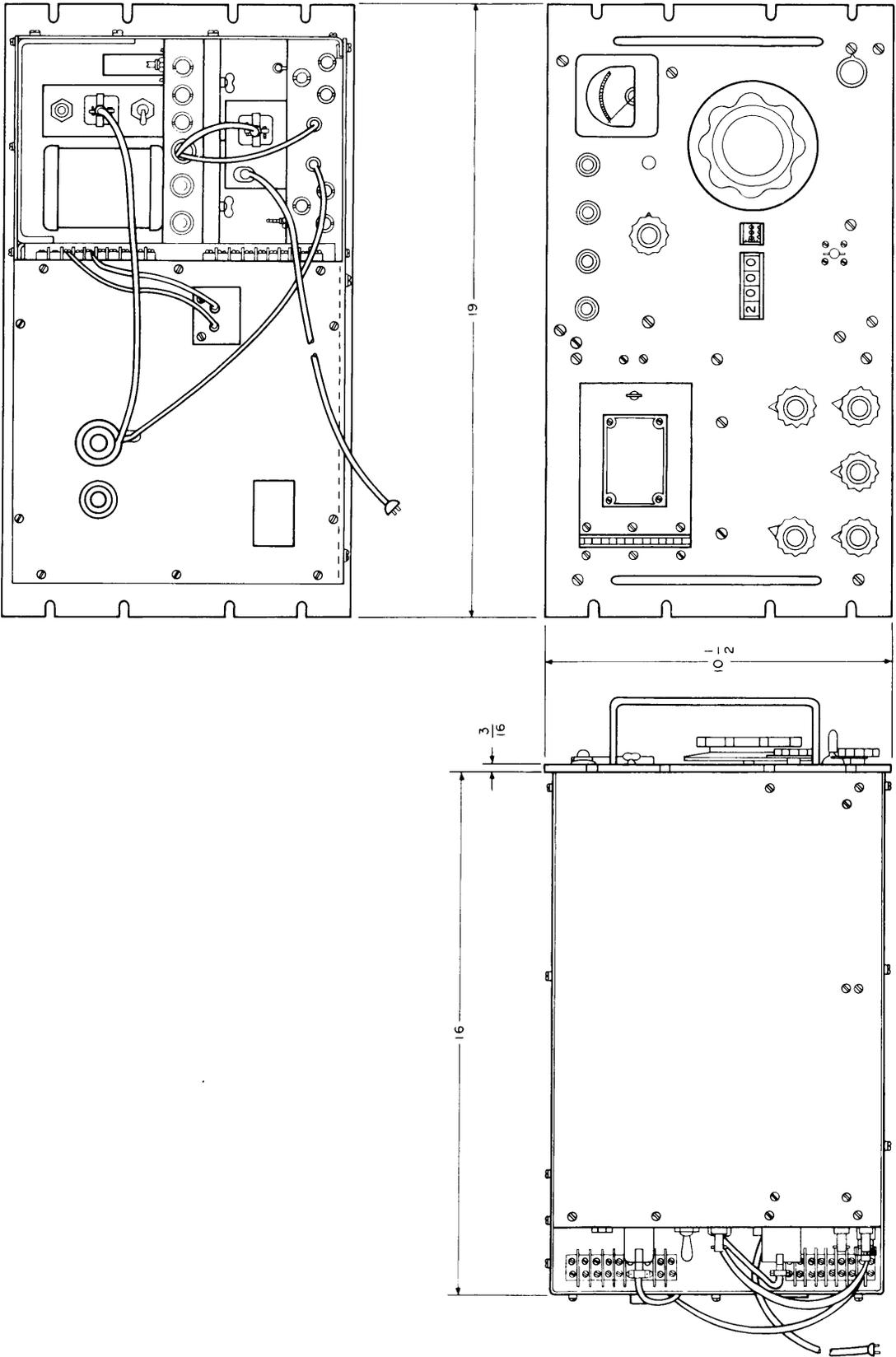


Figure 2-3. Outline Dimensional Drawing

SECTION 3 OPERATOR'S SECTION

3-1. GENERAL INSTRUCTIONS.

For oscillator stability, the VOX must be left turned on continuously and should be turned off only in the event of failure. This means that an independent source of primary power must be supplied to the unit so that when any associated units are turned off, the VOX will continue to operate. Interconnection between the VOX and associated units is accomplished through the use of BNC-type connectors.

The following calibration assumes that the initial adjustments (refer to paragraph 2-4) were previously carried out.

3-2. CALIBRATION.

For maximum accuracy, the VOX must always be calibrated before use as close as practical to the frequency desired and, for this purpose, the VOX is

provided with a calibrating circuit. A VMO and a 100-kc crystal-controlled calibrating oscillator are located within the VOX's oven. At numerous check points, harmonics of the VMO and the 100-kc oscillator correspond; consequently, at these check points, a zero-beat indicating device (phones and/or indicating lamp) may be used to adjust the VMO to its proper frequency. At a VMO frequency of 2,200,000 cps, for example, a check point exists; namely, fundamental of the VMO and 22nd harmonic of the 100-kc oscillator. The 100-kc check points automatically cover 50- and 25-kc check points. A 100-kc crystal generates not only harmonics of the 100-kc fundamental but also harmonics of the 50- and 25-kc subtones. The sub-tone harmonics, however, are considerably weaker than the fundamental harmonics. Similar check points to those indicated in the 2.2- to 2.3-mc range exist in the 2.3- to 2.4-mc range and each higher 0.1-mc range.

To make these checkpoint calibrations, the operator should perform the following functions:

Step	Operation
1	Set POWER switch 4 to ON position. MAIN POWER indicator 8 should go on.
2	Set BEAT (ON-OFF) switch 1 to ON position.
3	Plug a headset into PHONES jack 3.
4	Turn BAND-MCS switch 19 to the desired band and XTAL switch 17 to VMO position. The operator should set MASTER OSCILLATOR FREQUENCY dial 14 which is marked directly in CPS, and turn this control until the dial reads to the nearest 50-kc point of the desired frequency. In order to calculate the correct dial reading, the operator must remember to divide the desired frequency by 2 for the 4- to 8-mc band, by 8 for the 16- to 32-mc band, etc. For accurate calibration and resettability, care must be taken to rotate the dial in the same direction (preferably from a lower dial reading to the higher) in order to prevent any error due to backlash. Then, by varying CALIBRATE control 13, a zero-beat indication will be obtained in the headset and on ZERO BEAT indicator 11. With a little experience, the operator finds that the visual indication alone is adequate, although he may continue to use the phones as an added convenience. The VOX has now been properly corrected for the dial region to be used and should be returned to the required frequency setting.
5	When the calibration procedure has been concluded, the operator must be certain that he sets BEAT (ON-OFF) switch 1 to OFF position. At the same time, METER switch 2 should be turned to HFO and HFO switch 5 turned to ON position.
6	The operator should now rotate TUNING knob 20 to a position roughly approximating the MASTER OSCILLATOR FREQUENCY dial, at which point he obtains a reading on the front panel milliammeter with OUTPUT control 16. TUNING knob 20 has been set properly when the highest milliammeter reading is obtained.

In the event that a HFO crystal is used in place of the variable master oscillator, then proceed as follows:

Step	Operation
1	Set POWER switch 4 to ON position.
2	Set HFO switch 5 to ON position.
3	Turn METER switch 2 to HFO position.
4	Turn XTAL switch 17 to proper position.
5	Turn BAND-MCS switch 19 to proper band.
6	"Trim" the crystal by tuning XTAL FREQ trimmer 18 until the exact frequency is set, and peak with TUNING knob 20 as described above.

**3-3. OPERATING INSTRUCTIONS
AFTER CALIBRATION.**

Switch	Panel Designation	Operation	Result
4	POWER	ON	MAIN POWER indicator 8 goes on.
5	HFO	ON	INNER OVEN/OUTER OVEN indicators indicate a long warm-up period. Refer to CAUTION below.
2	METER	HFO, IFO, BFO, VMO	
17	XTAL	VMO or 1, 2, 3	Selects the source for VOX's 2- to 64-mc output; namely, VOX's master oscillator (VMO) or an alternate VOX oscillator whose frequency is controlled by crystals 1, 2, and 3.
19	BAND-MCS	Proper band	Selects proper multiplier for VOX's master oscillator.
14	MASTER OSCILLATOR FREQUENCY	Desired oscillator frequency	
16	OUTPUT	Desired level	
20	TUNING	Maximize meter reading	May require a decrease in OUTPUT potentiometer 16.

CAUTION

The VOX is a high stability precision instrument and requires an initial warm-up period of at least 48 hours of continuous duty; thereafter, the unit should never be turned off unless detailed repairs become necessary.

Do not operate the MASTER OSCILLATOR FREQUENCY dial 14 so that the stated frequency range of 200 to 4000 kc is exceeded, in order to prevent VMO cam displacement and possible VMO misalignment.

3-4. APPLICATIONS.

a. FOR USE AS A MASTER OSCILLATOR IN ANY DIVERSITY SYSTEM. - The VOX has been designed for use with any properly modified receiver. For diversity reception in any system, the operator must set the VOX frequency dial to a reading equal to the sum of the IFO value of the particular receiver in use, plus the value of the desired signal frequency.

b. FOR USE AS A MASTER OSCILLATOR IN TMC DUAL DIVERSITY RECEIVER DDR-2.

(1) The combination of the VOX and modified Hammarlund SP-600-JX Receiver is the one used in the TMC DDR-2, Dual Diversity System, and constitutes a good illustration of typical master oscillator operation. Since the receivers are either double or single conversion units, depending upon the operation frequency, the VOX must be set accordingly. Below 7.4 mc, the HFO must be 455 kc above the desired carrier, but above 7.4 mc the HFO must be 3.955 mc above the desired carrier. The chart below serves to minimize the small amount of arithmetic involved.

(2) To tune the DDR-2, proceed as follows:

(a) Set power switch 4 to ON position.

(b) Set BFO switch 7 to ON position. (For CW operation, BFO XTAL should be 455 kc ± audio tone desired. For frequency-shift operation, using TMC Model CFA, frequency should be 455 kc + 2550 cps.)

(c) Set IFO switch 6 to ON position.

(d) Plug a headset into PHONES jack 3.

(e) Set MASTER OSCILLATOR FREQUENCY dial 15 to the desired frequency in accordance with the following chart, and proceed with the calibration and peaking instructions as previously described.

(f) To complete the DDR-2 tuning, the operator must set IFO 6 and HFO 5 controls on both receivers to SLAVE position and then tune to the approximate station frequency. Lastly, the BFO output control (located on the rear-top of the power supply chassis) must be set until a solid beat is obtained with a strong carrier.

c. FOR USE AS A TRANSMITTER EXCITER. - There is no essential difference in adjusting the VOX for this service and the procedure followed in the preceding paragraph. All IFO and BFO references may, of course, be neglected, and both the plate switches controlling these sections may be turned to OFF position.

3-5. MAXIMUM CALIBRATION ACCURACY.

The calibration accuracy of the VOX is more than adequate for most general usage. When a particular need arises for the most precise reading, the VOX readily lends itself to such use.

Within this instruction manual reference has been made to 100- or 50-kc checkpoints. After a few minutes of actual experience with the equipment, however, a discerning operator notices intermediate beats. These beats are lower in audio amplitude than the major checkpoints but are extremely useful. In most cases, the operator has to use headphones to utilize these beats since the beat amplitude is not adequate to permit use of the light indicator.

Received Signal Frequency	*VOX-HFO Output	VOX Band	*VOX - VMO Dial Setting
Below 7.4 mc	Fr + 455 kc	2-4 mc	Fr + 455
	Fr + 455 kc	4-8 mc	(Fr + 455)/2
Above 7.4 mc	Fr + 3.955 kc	8-16 mc	(Fr + 3.955)/4
	Fr + 3.955 kc	16-32 mc	(Fr + 3.955)/8
	Fr + 3.955 kc	32-64 mc	(Fr + 3.955)/16

*Fr signifies receiver frequency.

TABLE 3-1. TABLE OF EQUIVALENT CONTROL DESIGNATIONS

SERIAL DESIGNATION (SEE FIGURE 3-1)	PANEL DESIGNATION (SEE FIGURE 3-1)	COMPONENT DESIGNATION ON OVERALL SCHEMATIC DIAGRAM
1	BEAT (ON-OFF)	Toggle switch S104
2	METER	Knob (4-position) selector switch S107
3	PHONES	Telephone jack J105
4	POWER	Toggle switch S101
5	HFO	Toggle switch S103
6	IFO	Toggle switch S102
7	BFO	Toggle switch S106
8	MAIN POWER	Indicator I302
9	INNER OVEN	Indicator I301
10	OUTER OVEN	Indicator I304
11	ZERO BEAT	Indicator I303
12	Output meter (No designation)	Meter M301
13	CALIBRATE	Slug inductance L301
14	MASTER OSCILLATOR FREQUENCY (knob)	Knob variable capacitor C301 and C302
15	MASTER OSCILLATOR FREQUENCY (dial)	_____
16	OUTPUT	Knob potentiometer R215
17	XTAL	Knob (4-position) selector switch S201, A, B, C, and D
18	XTAL FREQ	Knob variable capacitor C210
19	BAND-MCS	Knob (5-position) selector switch S202, A, B, C, and D
20	TUNING	Knob (5-position) selector switch C225, A, B, C, and D

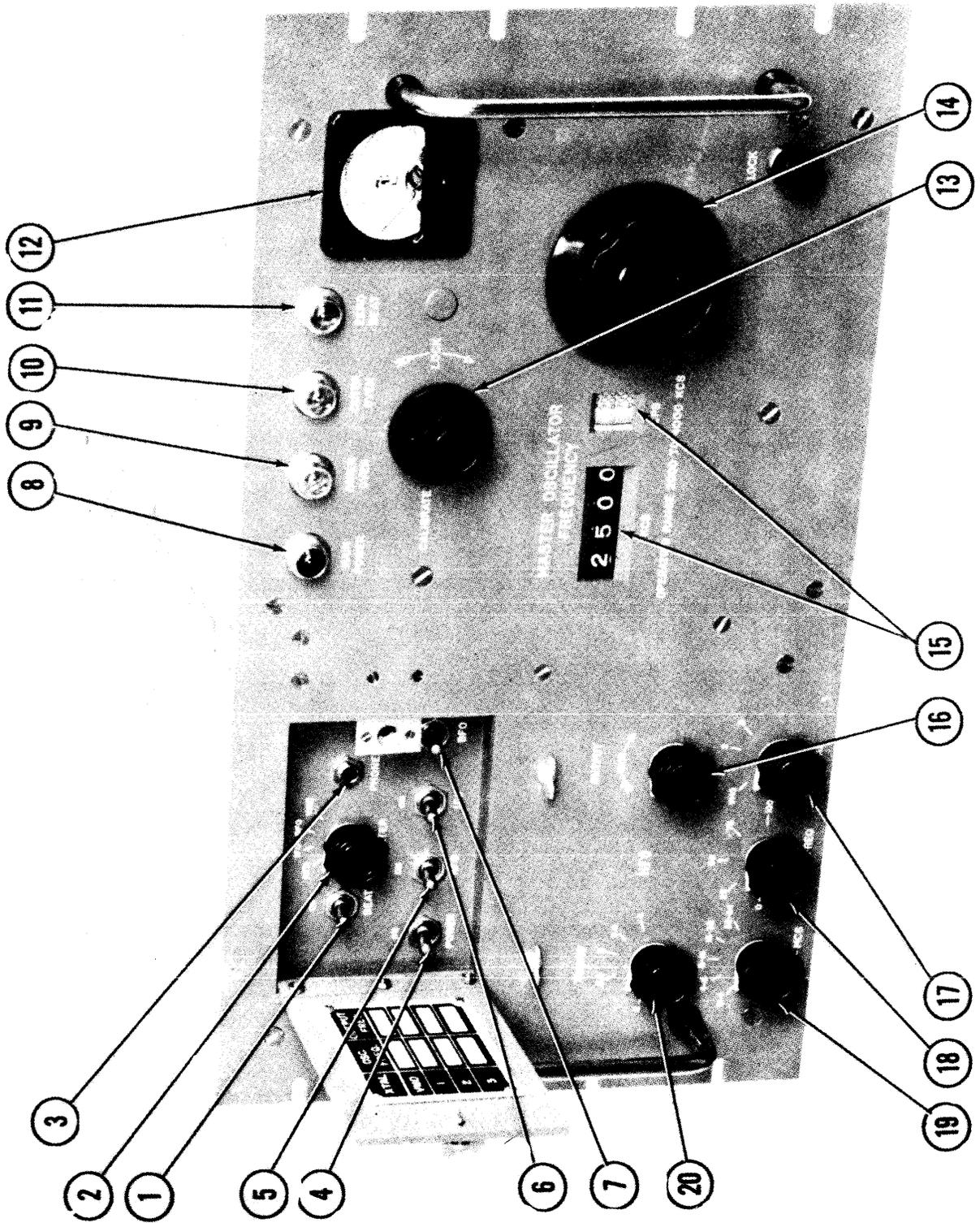


Figure 3-1. Operating Controls

SECTION 4

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

As shown in figure 4-1, the VOX consists of the power supply (section 1), the RF chassis (section 2), and the VMO (section 3). Electrically, the VMO is a precision, variable frequency device that provides 2 to 4 mc to the HFO chain (whose elements are located on the RF chassis) as well as to the mixer in the calibrating chain (whose elements are located on the power supply chassis). The VMO also supplies a standard calibrating frequency of 100 kc to the aforementioned mixer.

The RF chassis extends the 2- to 4-mc oscillator frequencies by multiplication to the 2- to 64-mc range (note following tabulation); it also provides an oscillator circuit (with a socket for crystal CR-18/U that operates in the 3.2- to 3.9-mc intermediate frequency range) for high frequency injection.

The power supply chassis provides a calibrating chain containing the aforementioned mixer, a 300- to 1000-kc beat frequency oscillator circuit (for dual conversion superheterodynes), and the VOX's power supply (+300 volts unregulated, +150 volts regulated, and 6.3 volts filament).

The VMO is a highly stable frequency determining device due to its enclosure in a finely engineered double oven. (See figure 4-2.) As an added precaution, the resonant portion of the circuit is very lightly coupled to its associated vacuum tube element and this, in turn, is isolated from external influences by a cathode follower.

4-2. VMO SECTION. (See figure 4-3.)

VMO tube V301 oscillates at frequencies between 2 and 4 mc and is tuned by capacitors C301, C302, and C303. R320 provides the necessary tube bias; L302 is an RF choke to ground; R301 and C307 provide the necessary decoupling action. Twin triode V302 performs the double function of a cathode follower (to impose less shunting effect on the preceding stage) and a crystal-controlled 100-kc oscillator. R302 is the unbypassed cathode resistor across which the output is taken. L303 and C308 provide filtering action to keep the RF out of the power supply by bypassing it through C308 and offering as high an impedance in L303 as practicable for the 300-volt B+ supply. The output from the second part of V302 is taken across R305. R306 supplies the necessary grid bias. Crystal Y301 resonates near 100 kc and may be

"pulled" by means of adjuster-capacitor C3111 (a screwdriver control mounted on the rear of the oven chassis), which is not to be disturbed after its initial factory setting. R304 is the plate load and C309 is a coupling capacitor.

As figure 4-2 shows, the oven itself is enclosed within an inner and outer shell, each of which is a temperature-controlled entity. The outer shell is maintained, within small limits, at a given temperature by the combination of S303, which is a bimetallic temperature-sensitive switch, and heating elements R309 and R310. The inner shell is a vernier on the outer shell. R307 and R308, the inner shell heating elements, are controlled by an accurate mercury thermostat (S301). The entire assembly contains a large mass of metal and insulating materials distributed throughout its cross section so that its heat inertia is high and, consequently, the oven temperature is extremely stable. Figure 2-1 shows the 115-volt and 230-volt circuits for controlling the VMO's oven temperature.

Functions of front panel controls that apply to this section are as follows:

a. MASTER OSCILLATOR FREQUENCY knob C301 and C302 is a variable capacitor control designated 14 on figure 3-1. It varies the output frequency of the master oscillator within its operating range of 2 to 4 mc. The associated dial, designated 15 on figure 3-1, indicates the oscillator's output frequency. Due to frequency multipliers in the VOX's RF section, the VOX's outputs are as shown in the tabulations on page 4-2.

Do not exceed the operating range of 2000 to 9000 kc. The dial can be turned beyond these limits but, if the departures are appreciable, variable capacitors C301 and C302 may not re-set properly with dial indications and the oscillator may require partial disassembly in order to effect proper readjustment.

b. C303 under small cover plate at left of meter is a screwdriver control (undesignated on figure 3-1). Refer to c below.

c. CALIBRATE L301 is a slug inductance control designated 13 on figure 3-1. The screwdriver control, b above, and CALIBRATE control are used in "zero beating" the output of the master oscillator (2 to 4 mc) against the 100-kc standard oscillator. For example, at 2 mc, the 2-mc fundamental of the master oscillator will "zero beat" with the 20th harmonic of the 100-kc standard oscillator.

BAND-MCS Selector Switch (Figure 3-1, Designation 19)	Master Oscillator Frequency	VOX's Frequency
2-4	f	f
4-8	f	2f
8-16	f	4f
16-32	f	8f
32-64	f	16f

d. ZERO BEAT I303 is an indicator designated 11 on figure 3-1. During calibration of master oscillator vs 100-kc standard oscillator, the indicator goes off when a harmonic of the 100-kc oscillator matches a harmonic of the 2- to 4-mc master oscillator. (See figure 4-6.)

e. INNER OVEN I301 is an indicator designated 9 on figure 3-1. Refer to f below.

f. OUTER OVEN I304 is an indicator designated 10 on figure 3-1. INNER OVEN and OUTER OVEN indicators go on when the ovens are being heated by resistors R307 and R308 and R309 and R310, respectively. This requires closure of switches S301 and S302 and S303, respectively.

g. MAIN POWER I302 is an indicator designated 8 on figure 3-1. It indicates filaments of tubes V103, V104, and V105 contained in power supply chassis are receiving 6.3-volt filament supply (figure 4-8).

h. Output meter M301 is designated 12 on figure 3-1. In conjunction with METER selector switch, designated 2 in figure 3-1, it indicates output level of HFO, IFO, BFO, or VMO.

The chassis-mounted control that applies to this section is the 100KC ADJ vernier capacitor C311 located on rear oven chassis.

4-3. RF SECTION.

a. HFO CHAIN. (See figure 4-4.) - The output of cathode follower, V302, located in the VMO section (figure 4-3), feeds triode V202 which is used either as an amplifier or as a crystal oscillator; the position of XTAL switch S201 is the controlling factor. When it is set on VMO, the tube is an RF amplifier; when it is set on 1, 2, or 3, the stage is a conventional oscillator having three crystal positions. Crystals Y202, Y203, and Y204 may be inserted into the circuit according to the necessary operating conditions required. XTAL FREQ capacitor C210 is a crystal trimmer and R207 provides the necessary grid bias. C243 is a blocking condenser to prevent DC from entering the crystal. R208 is the load resistor while C211 and R209 provide decoupling action. This stage is capacitively coupled by C212 to the grid of tetrode V203.

Tube V203 is also an RF amplifier which features a peaking coil (L202) designed to produce uniform gain over the 2- to 4-mc range. The output of this tube is controlled by variable OUTPUT potentiometer R215 which changes the screen grid bias. R214 and R217 are dropping resistors to provide correct biasing voltage on the screen grids of V203 and also V204. C215 and C216 are bypass capacitors. R213 and C213 provide decoupling action while R212 is the plate load resistor. R210 and R211 provide the necessary bias on the grid and cathode, respectively, while C214 is the conventional cathode bypass to ground. C217 is the coupling capacitor between stages.

Tubes V204, V205, V206, and V207, used in conjunction with BAND-MCS switch S202, are voltage multipliers of the second harmonic of each preceding stage.

S202 is a four-section, five-position, rotary-type switch. The "A" wafer of the switch controls the screen voltage bias on tubes V203 and V204. R216 and R233 are the dropping resistors involved. The "B" wafer of the switch connects either coil L203 or L205 to be used for the proper tank circuit with variable air dielectric tuning capacitor C225 containing four sections, each having two positions; the former for 2-4 mc and the latter for 4-8 mc. The coils, L206, L207, and L298, are also used with variable tuning capacitor C225 to produce outputs of 8-16 mc, 16-32 mc, and 32-64 mc, respectively.

The output in milliamperes is metered by the detector circuit built in around crystal CR202. This crystal also rectifies the RF current; C238 is a coupling capacitor; capacitor C237 provides filtering action; resistor R232 acts as the load resistor of the crystal. C220, C221, and R220 are all decoupling devices while L204 is an RF choke to prevent RF from flowing through the DC power lines. Wafer "C" adds more B+ voltage to each successive multiplier whenever called for in use. The "D" wafer is the output selector. The HFO band may be picked off from 2-4, 4-8, 8-16, 16-32, and 32-64 mc from positions marked A through E, respectively.

Functions of front panel controls that apply to this section are as follows:

(1) XTAL S201. - Switch control designated 17 on figure 3-1. Selects circuit determining VOX's master frequency oscillator. In position VMO, the

VOX's 2- to 4-mc oscillator (located in the oven) is the master oscillator; in positions 1, 2, and 3, the VOX's crystal oscillator stage (V202) is the master oscillator.

(2) XTAL FREQ C210. - Variable capacitor control designated 18 on figure 3-1. When VOX's crystal oscillator stage (V202) is used as the master oscillator, it "pulls" the crystals frequency a limited amount to obtain the desired output frequency.

(3) OUTPUT R215. - Potentiometer control designated 16 on figure 3-1. Controls RF output level of VOX.

(4) BAND-MCS S202. - Switch control designated 19 on figure 3-1. Controls RF multiplying factor of VOX's 2- to 4-mc oscillator; namely, 1 for 2-4 mc output; 2 for 4-8 mc output; 4 for 8-16 mc output; 8 for 16-32 mc output; 16 for 32-64 mc output.

(5) TUNING C225. - Switch control designated 20 on figure 3-1. Tunes HFO output circuits; should be used in conjunction with meter designated 12 on figure 3-1 during tuning operation; that is, maximizing meter deflection.

Chassis-mounted controls that apply to this section are as follows:

(a) Coaxial jacks J208, J209, J210 are located at the rear of the RF chassis.

(b) Coaxial jacks J202 and J203 are located at the rear of the RF chassis.

b. IFO CIRCUIT. (See figure 4-5.) - The IFO uses an oscillator circuit having a socket for a crystal CR-18/U for the range of 3.2 to 3.9 mc (nominally 3.5 mc). C202, C203, and R203 provide a low band-pass filter while C242 is the crystal-coupling capacitor. The second half of the tube is a class C amplifier whose tuned plate circuit is link-coupled to the output jacks. The tank circuit is tuned by L201 near a nominal frequency of 3.5 mc. A germanium-diode rectifier, CR201, and its associated filter network produce a DC level proportional to the RF output voltage. This DC level is fed to front panel meter M301 so that the output indication is available to the operator or technician. (Full-scale deflection is approximately equivalent to 10 volts RMS of RF voltage.)

Chassis-mounted controls that apply to this section are coaxial jacks J205, J206, J207 located at the rear of the RF chassis.

4-4. POWER SUPPLY CHASSIS.

a. CALIBRATING CHAIN. (See figure 4-6.) - Contained within the oven enclosure of the VMO section

(figure 4-3) is a highly stable 100-kc crystal oscillator against which the VMO is calibrated. When the 100-kc oscillator is turned on, both the 100-kc and the VMO oscillator voltages are fed to mixer V103. Here the difference frequency between one of the 100-kc oscillator's harmonics and the VMO's harmonics is passed by filter action of capacitors C111, C112, and resistor R108. This is a low-pass filter with a rising characteristic at very low frequencies. The audio signal is then amplified successively by the first and second halves of V104. Toggle switch S104 turns on or off the 100-kc oscillator's plate supply. This switch is designated 1 on figure 3-1. ZERO BEAT indicator I303 on the front panel (control designated 11 on figure 3-1) is connected into the plate circuit of the final amplifier so that the zero beat may be seen by the flashing of the neon lamp. Earphones may be plugged in at the output of the final amplifier at jack J105, in order to pick up the zero beat frequency audibly. The circuit, built around crystal CR101 containing C105, C106, and R102, is for metering the VMO output.

b. BFO CIRCUIT. (See figure 4-7.) - This stage is also a crystal oscillator but has two crystal positions, either one of which may be chosen by means of BFO toggle switch S106. The output jacks are capacitively coupled to the tank through an output control. The output voltage is controlled by potentiometer R116 mounted on the rear of the power supply chassis. Metering of the outputs is accomplished in the same manner as described in paragraph 4-3a.

c. POWER SUPPLY. (See figure 4-8.) - Transformer T101 supplies the necessary power and filament voltages. V101 is a full-wave vacuum tube rectifier with choke (L101) filter output. C104 provides low impedance paths to grounds for any RF current while R101 is used to limit the current passing through tube V102. This tube is a glow discharge regulator type whose output voltage is held constant and provides +150 volts. R119 is a "ballast lamp" which regulates V301 and V302 filament supply to 450 ma for frequency stabilization purposes.

Functions of front panel controls that apply to this section are as follows:

(1) POWER S101. - Toggle-switch control designated 4 on figure 3-1. Turns power on the VOX.

(2) PHONES J105. - Jack designated 3 on figure 3-1. Audible monitor of "zero beat" between VOX's 100-kc and master frequency oscillators.

(3) BEAT (ON-OFF) S104. - Toggle-switch control designated 1 on figure 3-1. Supplies B+ to VOX's 100-kc oscillator so that mixer V103 in calibrating chain receives 100-kc and VMO oscillator voltages for production of beat tones.

(4) HFO S103. - Toggle-switch control designated 5 on figure 3-1. Connects B+ to HFO tubes V202 through V207.

(5) IFO S102. - Toggle-switch control designated 6 on figure 3-1. Connects B+ to IFO tube V201.

(6) BFO S106. - Toggle-switch control designated 7 on figure 3-1. Connects B+ to BFO tube V105.

Chassis-mounted controls that apply to this section are as follows:

(1) Coaxial jacks J102, J103, J104 are located on the rear of the power supply chassis.

(2) Toggle switch S105 (on the rear of the power supply chassis) selects one of the two crystals (Y101 or Y102) in BFO stage.

(3) Jones-type jack J101 is located on the rear of the power supply chassis.

(4) Potentiometer R116 is located on the rear of the power supply chassis.

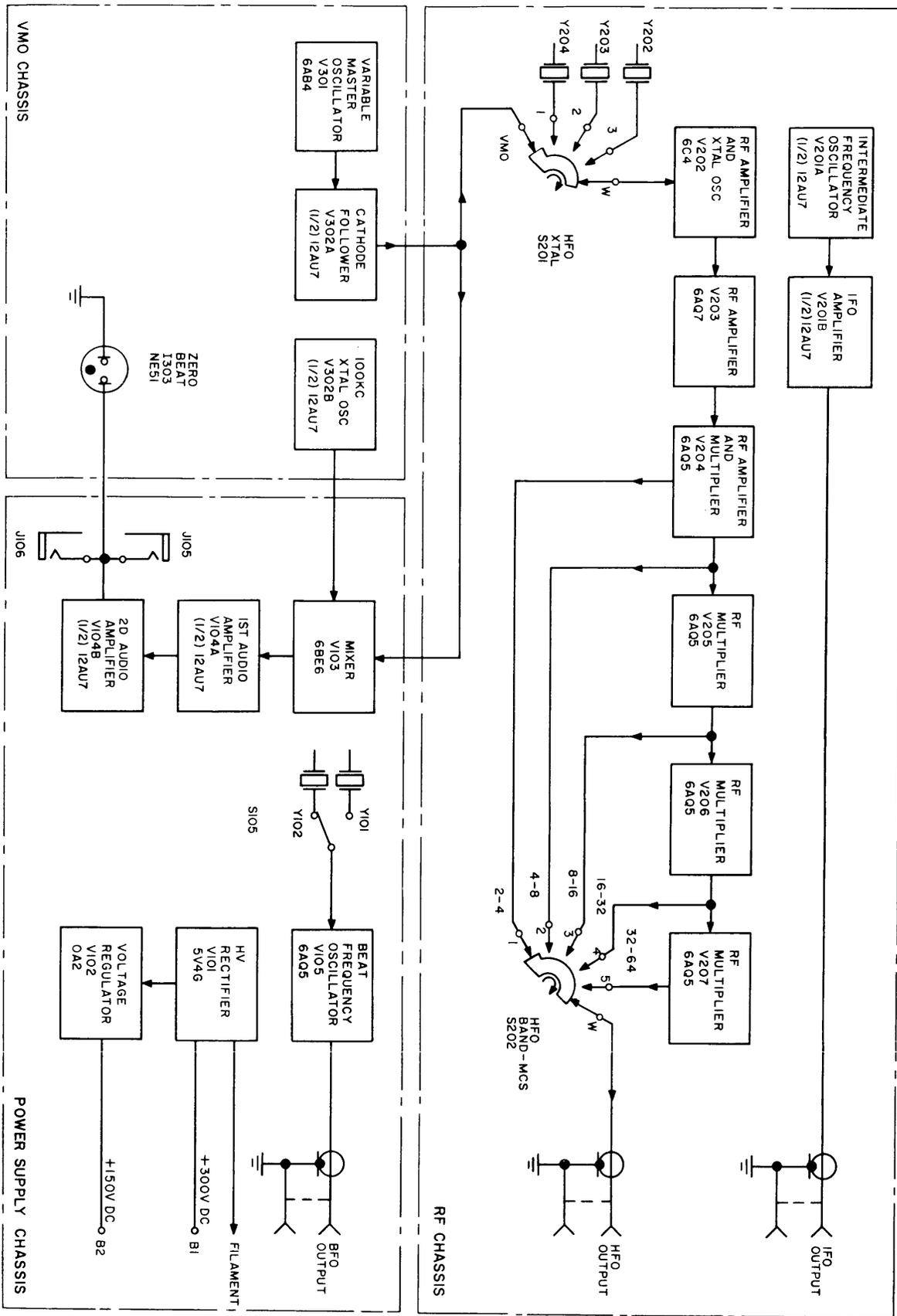
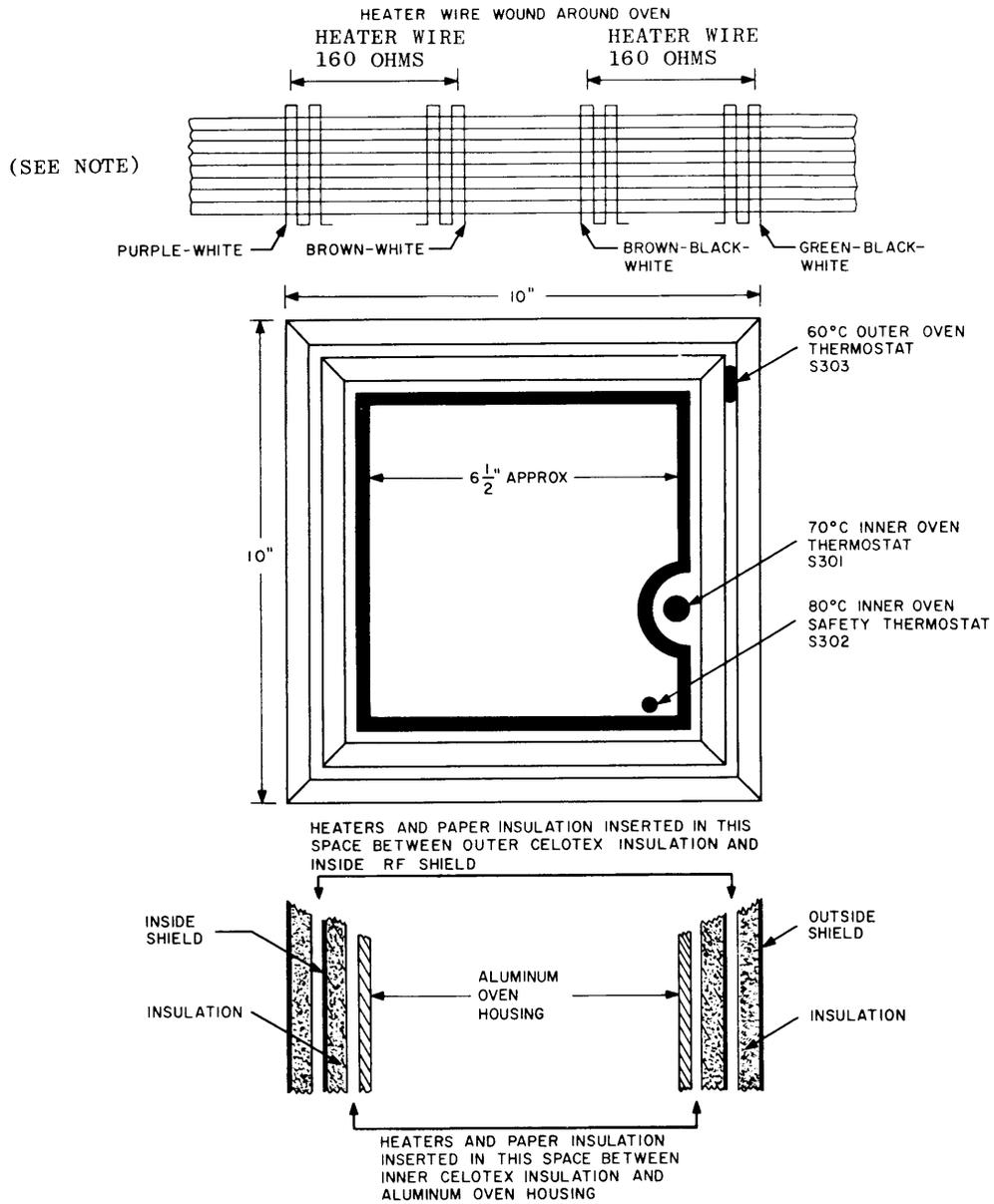


Figure 4-1. Block Diagram



NOTE: OUTER OVEN HEATER WIRES ARE 160 OHMS EACH.
 INNER OVEN HEATER WIRES ARE 1300 OHMS EACH.
 GIRDLE AT TOP OF SKETCH APPLIES TO BOTH
 HEATERS.

Figure 4-2. Diagram Illustrating Oven

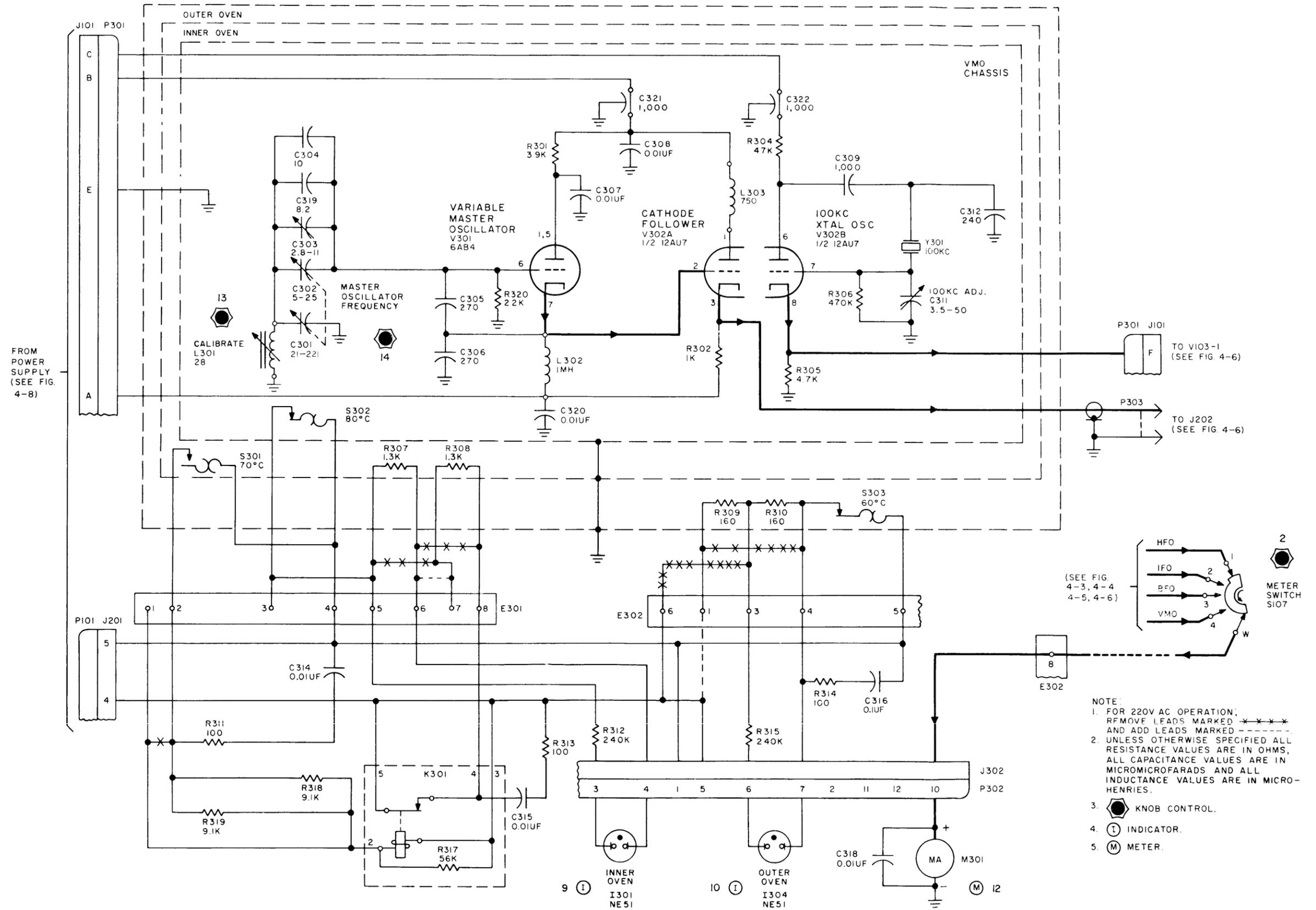


Figure 4-3. Schematic Diagram, VMO Section

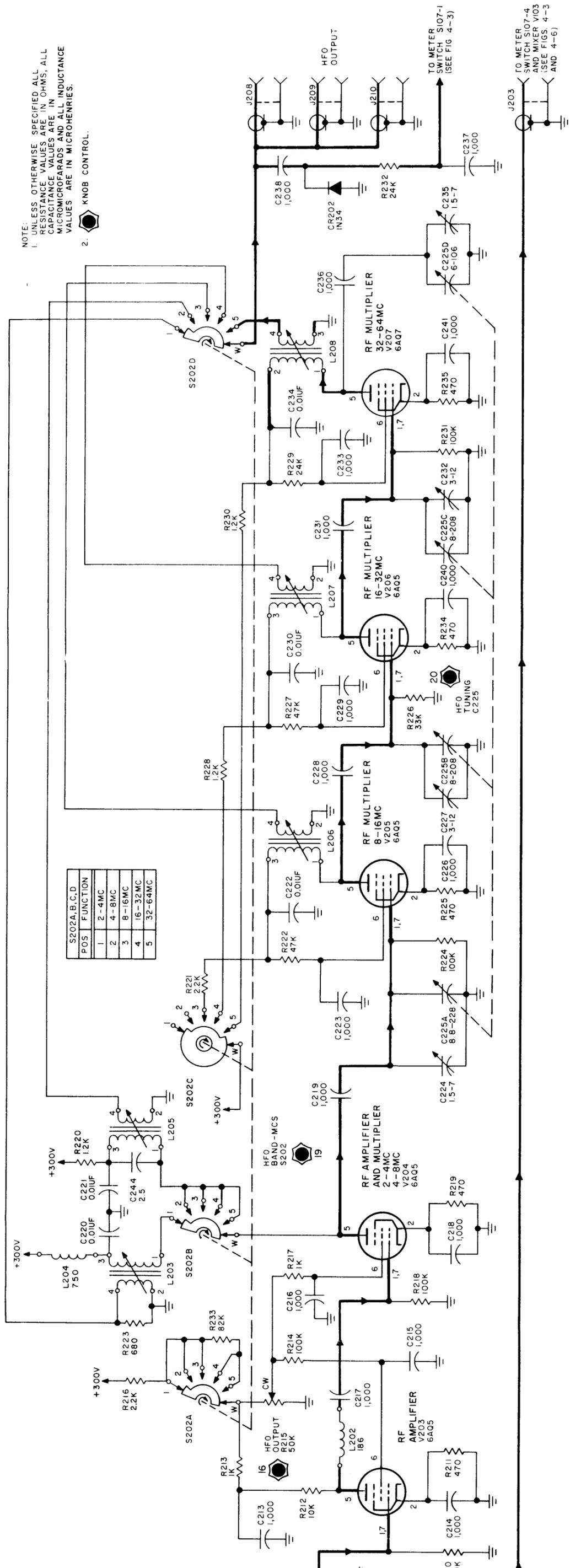
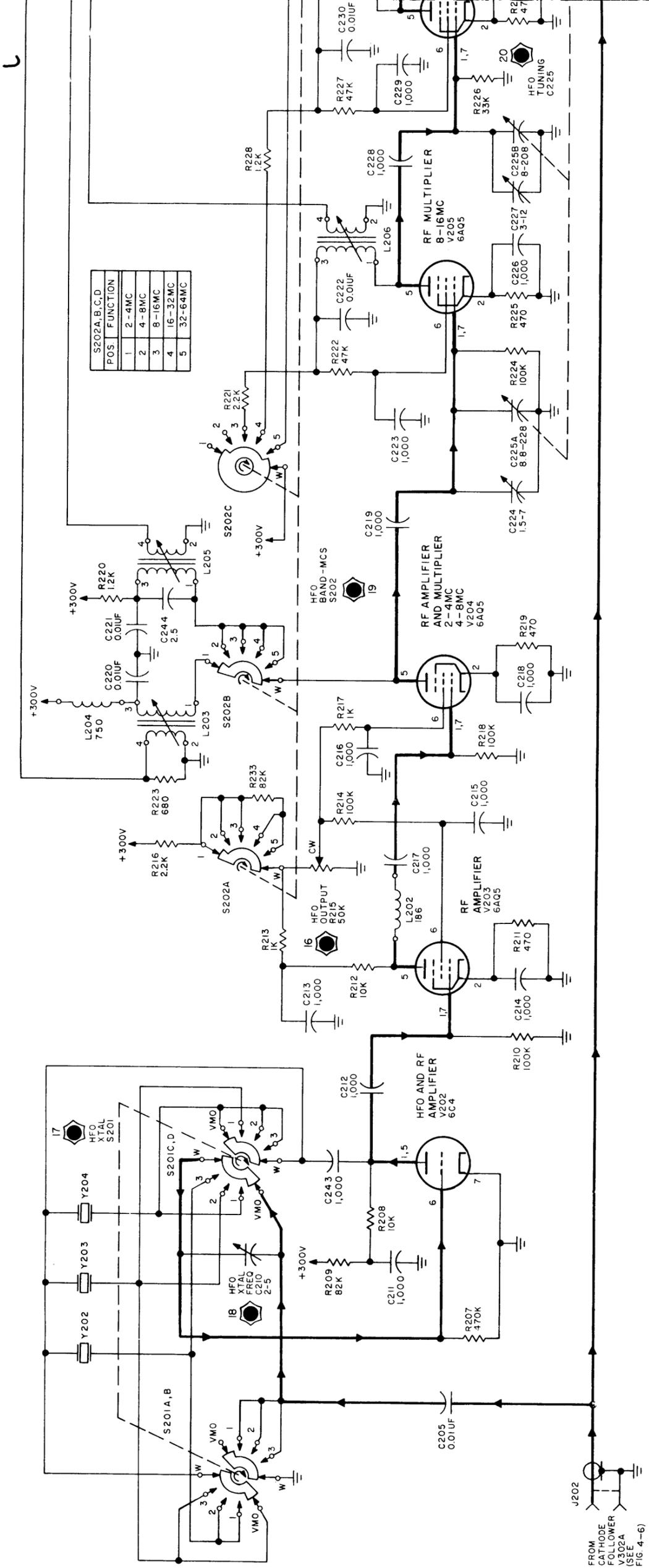


Figure 4-4. Schematic Diagram, HFO Chain



POS	FUNCTION
1	2-4MC
2	4-8MC
3	8-16MC
4	16-32MC
5	32-64MC

FROM CATHODE FOLLOWER V302A (SEE FIG. 4-6)

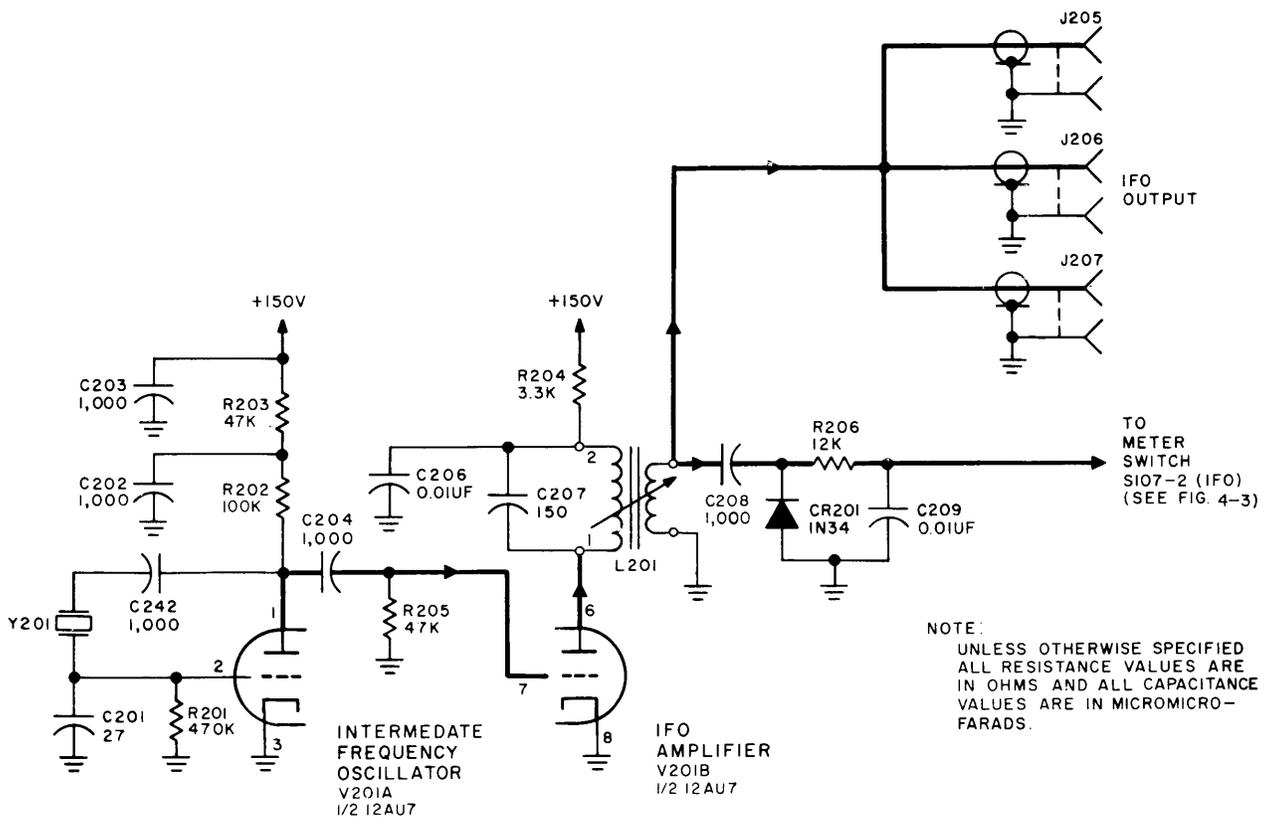


Figure 4-5. Schematic Diagram, IFO Chain

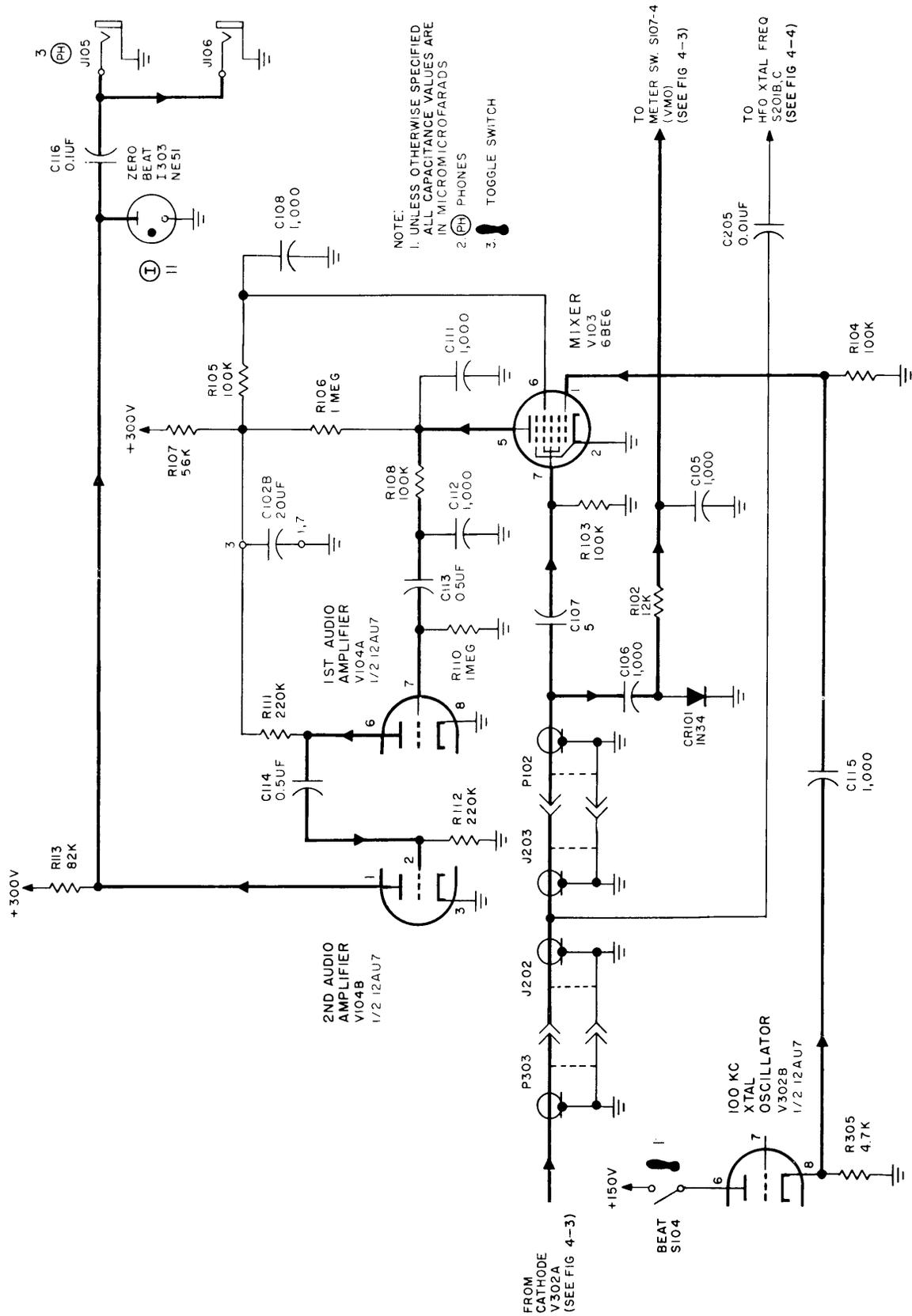


Figure 4-6. Schematic Diagram, Calibrating Chain

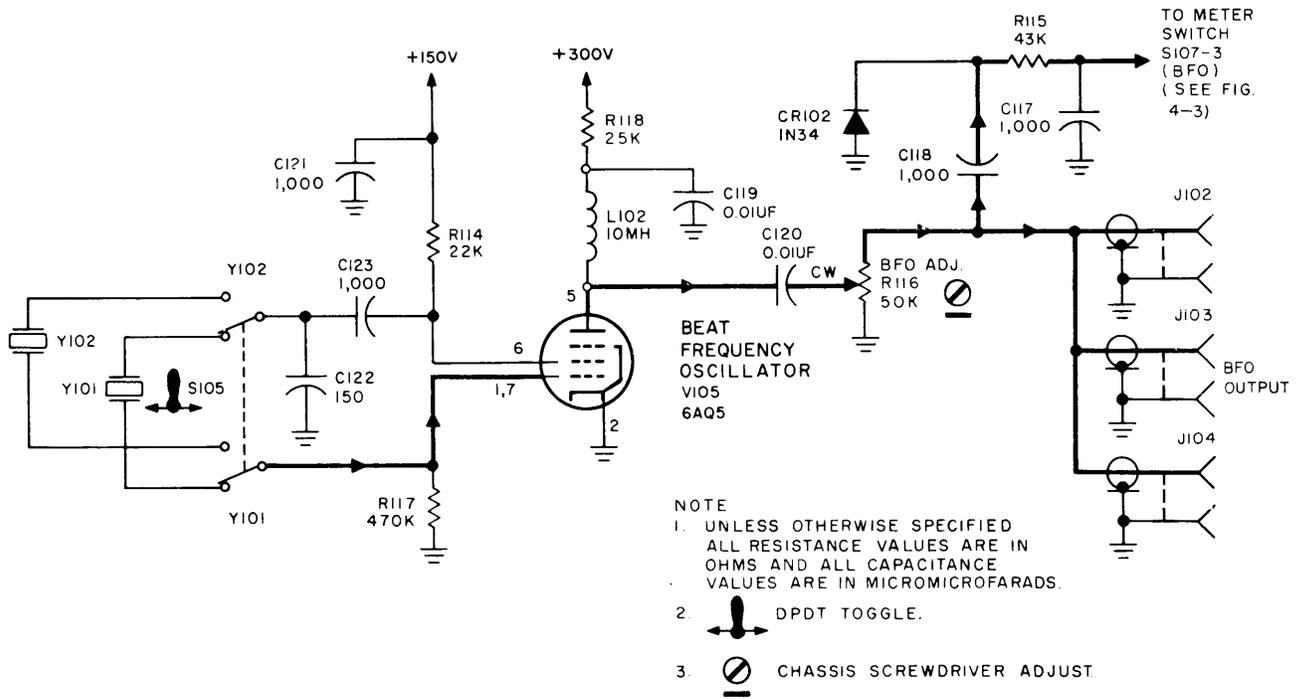


Figure 4-7. Schematic Diagram, BFO Circuit

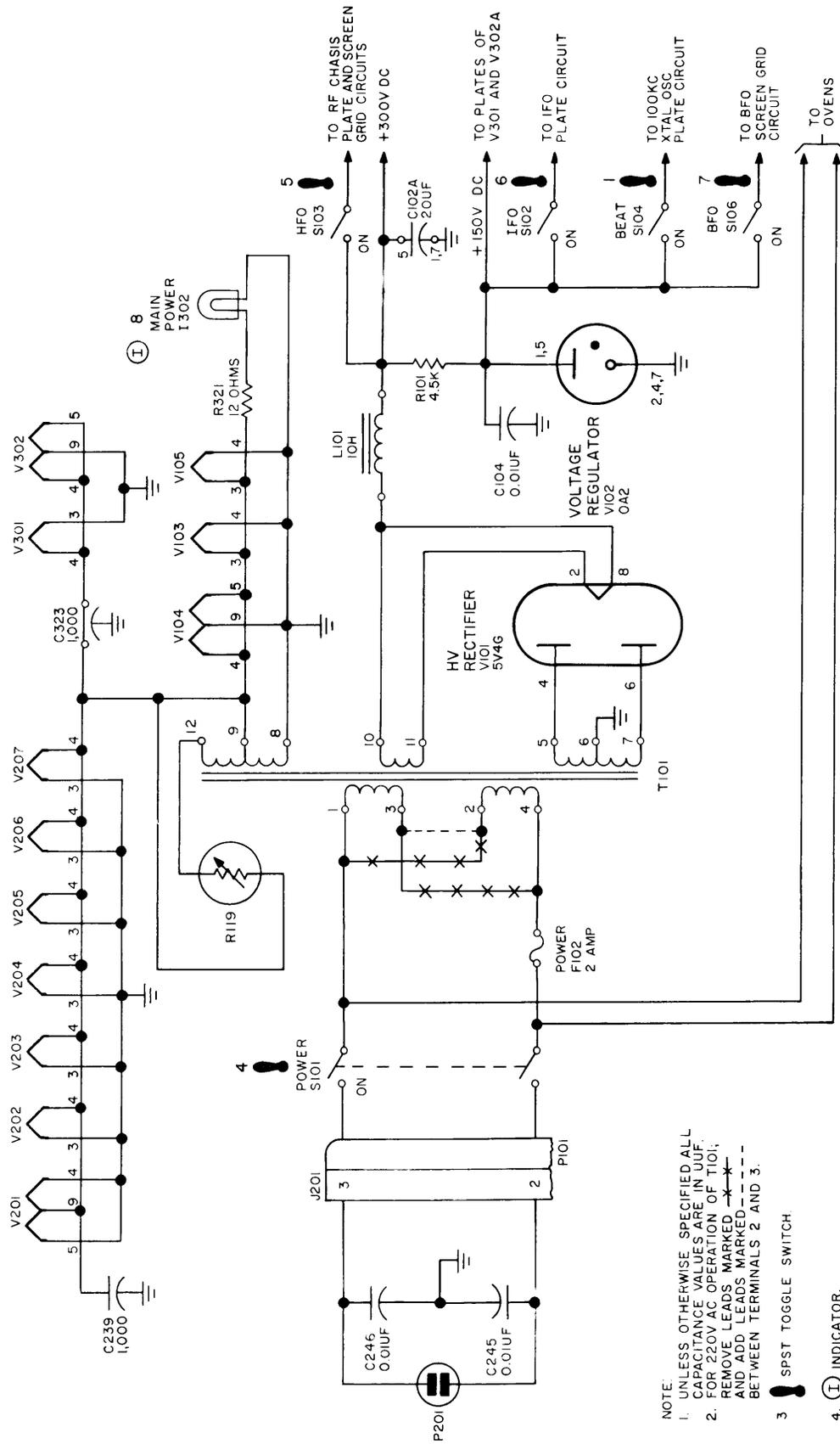


Figure 4-8. Schematic Diagram, Power Supply

SECTION 5

TROUBLE-SHOOTING

5-1. GENERAL.

Trouble-shooting is the art of locating and diagnosing equipment troubles and maladjustments; the information necessary to remedy the equipment troubles and maladjustments is reserved for Section 6 of the manual under the heading "Maintenance."

Trouble-shooting tools may, for convenience, be divided into the following six categories:

- a. Accurate schematic diagrams.
- b. Tables of voltage and resistance; waveform data.
- c. Location data (photographs with callouts of the major electronic equipment elements).
- d. Trouble-shooting techniques.
- e. Trouble-shooting charts based on operating procedures.
- f. Trouble-shooting procedures based on circuit sectionalization.

Trouble-shooting techniques are about the same for all types of electronic equipment and are covered briefly in the following paragraph.

5-2. TROUBLE-SHOOTING TECHNIQUES.

a. GENERAL CONSIDERATIONS. - When a piece of equipment has been working 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 unnecessary to follow a lengthy and orderly course of trouble-shooting in order to localize and isolate the faulty part.

A second short cut in trouble-shooting is to ascertain that all tubes and fuses are in proper working order; also that the equipment receives proper supply voltages. Many times this will eliminate further investigation.

A third short cut is to examine the equipment, section by section, for burned out elements, charring, corrosion, arcing, excessive heat, dirt, dampness, etc.

It is important to recognize that defective elements may have become defective due to their own weakness or to some contributing cause beyond their control.

b. TROUBLE-SHOOTING CHARTS BASED ON OPERATING PROCEDURES. - The general purpose of these charts is to narrow the area of trouble to one or more sections of the equipment in order to minimize the labor of locating the source of trouble. These charts present a prescribed order "to turn on" the equipment, indicate what to expect as each step is taken, and give clues as to possible "troubled areas" when some expectation is not realized.

c. TABLES OF VOLTAGE AND RESISTANCE; WAVEFORM DATA. - These tables give nominal values of voltage-to-frame and resistance-to-frame, generally at tube elements and sometimes at connectors and terminal board elements. Large deviations from the nominal values should be carefully investigated. During this process, accurate schematic diagrams and location data are highly essential.

A good oscilloscope is a good trouble-shooting tool. It may be connected to a number of critical points along a circuit to detect extraneous voltages, distorted waveforms, and other symptoms of trouble.

d. TROUBLE-SHOOTING PROCEDURES BASED ON CIRCUIT SECTIONALIZATION. - Equipments usually consist of a number of subassemblies or sections. It is frequently helpful to treat these subassemblies or sections as independent entities. In so doing, however, they must be properly powered. Observations may then be made with VTVMs, CROs, or other test equipment at selected points under given types and magnitudes of injection voltages. Again, the subassemblies or sections may be examined for rated performance, according to specification, for the presence of extraneous grounds, for opens, or unusual voltages.

5-3. VARIABLE FREQUENCY OSCILLATOR VOX-5.

a. VOLTAGE AND RESISTANCE DIAGRAMS. - Figures 5-1 and 5-2 show voltage-to-chassis and resistance-to-chassis measurements at vacuum tube pins and other selected points in the VOX under the conditions stated. Resistance-to-chassis values at P301 terminals are: infinity (A, B, C, G), 10 (approximately) (D), 0 (E), 4.7 K (F).

b. LOCATION DATA. - Figures 5-3 through 5-5 are layout diagrams with callouts of the major electronic equipment elements of the VOX.

c. TROUBLE-SHOOTING CHART BASED ON OPERATING PROCEDURES. - See figure 8-1 for interpretation of control designations. Refer to table 5-1.

d. TROUBLE-SHOOTING PROCEDURES BASED ON CIRCUIT SECTIONALIZATION. - The following paragraphs present selected specification performance data of the VOX.

(1) HFO CHAIN. - The oven is the heart of the VOX, and improper functioning greatly hampers oscillation stability. The inner and outer ovens are thermostatically controlled to 70°C and 60°C, respectively. An inner oven safety thermostat, S302, set at 80°C, protects the unit in case of excessive temperatures due to sticking or mechanical failure of thermostat S301. Figure 4-2 illustrates the operation of the thermostat switch circuits both for 110 and 220 volts. In normal operation, thermostat S301 is open and relay K301 would be closed. When the temperature reaches 70°C, S301 closes, thus energizing the coil of relay K301, which in turn opens up the contacts of the relay. In the event that S301 should fail due to sticking, etc., safety switch S302 would open at 80°C, thus preventing further current from passing through the heating elements, R307 and R308. The oven neon bulbs on the front panel give good indication as to normal operation of the inner and outer ovens. In normal operation, the operator should see the OUTER OVEN pilot lamp blink alternately "on" for approximately 5 seconds, and "off" for approximately 90 seconds. In the event that thermostat S301 is malfunctioning, the inner oven continues to heat until safety switch S302 is open at 80°C. When the temperature reaches 80°C, the inner oven pilot blinks erratically at short intervals, instead of the usual 90 seconds in normal operation. At this point, the operator should check the thermometer on S301 in the rear of the unit and replace S301 if the thermometer reads well above 70°C.

To check the VMO output, simply turn METER switch S107 to VMO, and notice the deflection of the milliammeter on the front panel which should read approximately 0.9 ma. Next, check the voltages and resistances on tubes V301 and V302. Last, check the circuit components for proper voltages and resistances. R302 is a critical resistor.

Once it has been established that the VMO is operating properly, any succeeding stage to the HFO output may be checked and traced, stage by stage, to its fault. This may be accomplished by the following means:

(a) Turn METER switch to HFO.

(b) Turn MASTER OSCILLATOR FREQUENCY knob to desired output frequency.

Then, notice the deflection in the needle of the milliammeter on the front panel. If, for example, the user wishes to operate on 20 mc, a null reading on the meter indicates a fault somewhere between

the 16- to 32-mc stage (V206, L207, and C225) and/or each preceding stage to initial amplifier V202. Next, the operator should change his dial reading for the 8- to 16-mc band, switch to the 8- to 16-mc bandswitch, and notice any output on the milliammeter. The usual test procedure is recommended for checking the two amplifier output tubes, V203 and V204.

(2) IFO. - The output of the IFO may be checked again by switching METER switch S107 to IFO position and observing the output reading on the milliammeter. The critical components in this circuit are variable condenser C207, coil L201, crystal Y201, and grid bias resistor R205.

(3) BFO. - The BFO output may be checked again in the manner described above for the IFO. Critical components are C120, L102, R117 and variable resistor R116 together with crystals Y101 and Y102.

(4) CALIBRATING CHAIN. - The calibrating chain has been designed for stable and trouble free operation and is the least likely circuit in the unit to develop trouble. The main components of this chain are the VMO output and the 100-kc oscillator circuit. The VMO output may be checked in the manner already described. The 100-kc output may be checked by connecting an oscilloscope to pin 1 of tube V103. Improper mixer action by V103 and faulty low-pass filtering components also contribute to trouble.

(5) POWER SUPPLY. - A major fault in the power supply would abruptly cut off the B+ supply voltages to all the tubes. If there is no reading on the milliammeter for any position on the meter switch of the front panel, this is a good indication of power supply failure. The voltages on transformer T101 and tubes V101 and V102 should be checked to determine if anything is wrong.

NOTE

The front panel milliammeter circuits have been so adjusted that the following relationships exist in each of the METER switch positions:

HFO position - output meter reads 20 volts full scale.

IFO position - output meter reads 10 volts full scale.

BFO position - output meter reads 20 volts full scale.

VFO position - output meter reads 10 volts full scale.

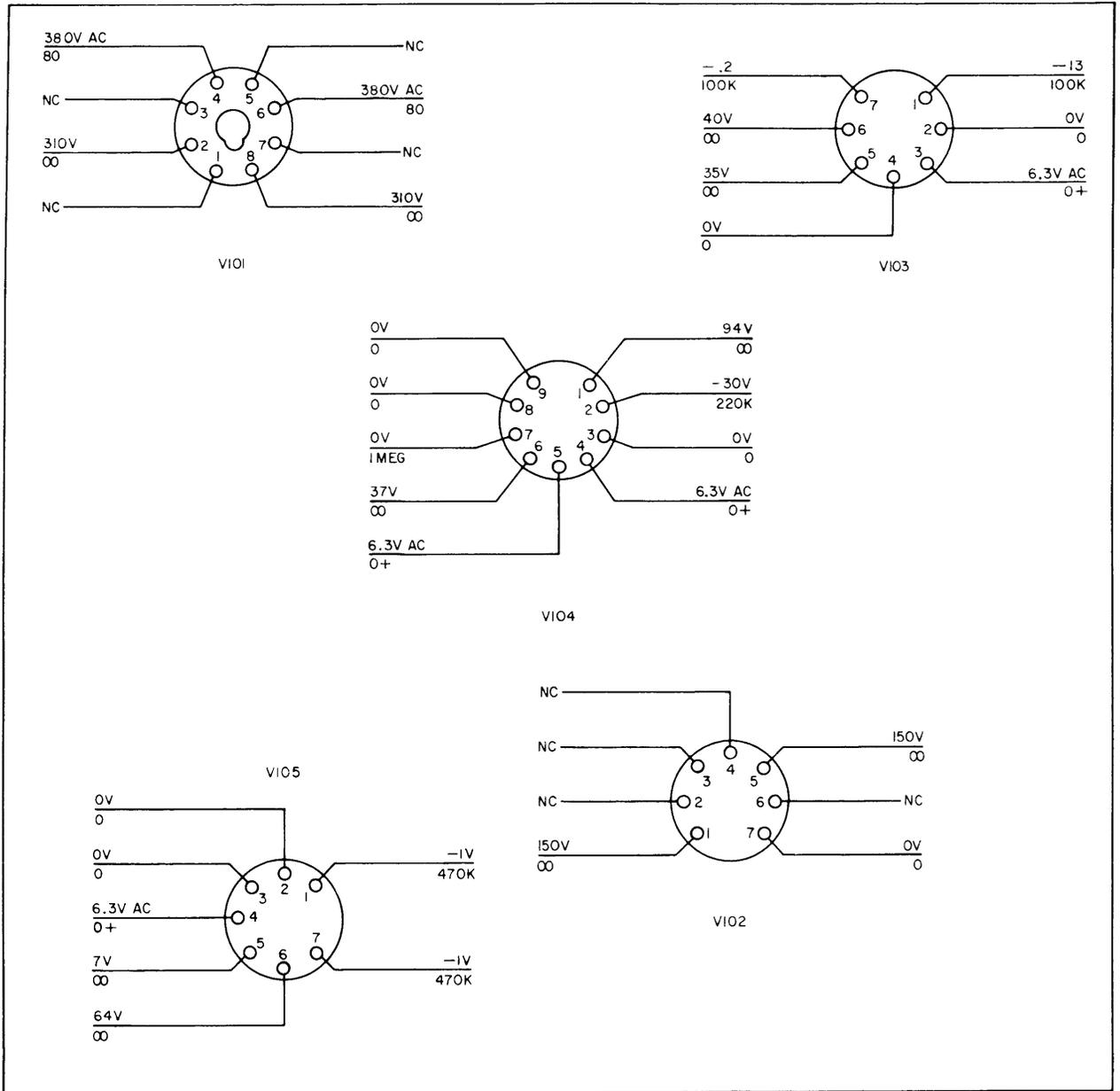
TABLE 5-1. TROUBLE-SHOOTING CHART

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
1	Set POWER switch S101 to ON position.	MAIN POWER (red) indicator I302 and INNER OVEN indicator I301 and OUTER OVEN indicator I304 should all go on. After a sufficient time has elapsed during the warm-up period (approximately 6 hours), the operator observes that the OUTER OVEN pilot indicator alternately goes on: on for approximately 5 seconds and off for approximately 30 seconds. The INNER OVEN pilot indicator should alternately go on for approximately 90 seconds and off for 90 seconds.	Set POWER switch S101 to OFF position. Check continuity of fuses F101, F102, and the power cord. Check the input power. In the event the OUTER OVEN pilot indicator remains on, the 60°C thermostat is sticking (closed). Should the OUTER OVEN pilot indicator not go on, replace the 60°C thermostat or pilot indicator lamp. In the event the INNER OVEN pilot indicator remains on, the 70°C thermostat is sticking or relay K301 is faulty. At 80°C, safety switch opens the circuit to the INNER OVEN; this allows the INNER OVEN pilot indicator to blink erratically instead of the prescribed 90-second interval.
2	Set HFO, IFO, and BFO switches to their ON positions. Turn METER selector switch S107 concurrently to each of the above positions.	Apply power to each section. Monitors the output of each section.	In the event of no output from any section, turn power OFF, and check all connections and continuity of the meter. No output from the HFO section, check continuity of switch S103, plug P101 (pin 11), and jack J201 (pin 8). No output from the IFO section, check continuity of switch S102, and visually inspect all connections. No output from the BFO section, check continuity of switch S106, and visually inspect all connections.
3	Set BEAT (ON-OFF) switch S104 to ON position. Plug headset into PHONES jack J105.	Applies power to the 100-kc calibration oscillator. ZERO BEAT pilot indicator goes on any 100- or 50-kc check point. Monitors ZERO BEAT aurally.	If the beat frequency can be heard aurally and the ZERO BEAT pilot indicator does not go on, the malfunction is either the ZERO BEAT pilot indicator or socket. Check continuity and connections. If the ZERO BEAT pilot indicator does not go on and the beat frequency cannot be heard aurally, the fault is in (1) BEAT (ON-OFF) switch S104 or in the BFO circuit; (2) mixer V103 circuit or; (3) amplifier V104 circuit.

TABLE 5-1. TROUBLE-SHOOTING CHART (Cont.)

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
4	Rotate XTAL selector switch S201 to VMO position. Concurrently rotate METER selector switch S107 to VMO position.	Connects the VOX's VMO output to the HFO input. Notice the deflection of output meter M301 (milliammeter) on the front panel; it should indicate approximately 0.1 ma.	If there is no output from the VMO section indicated on the output meter, visually check the position and connections of METER selector switch S107 and XTAL selector switch S201. Check tubes V301 and V302.
5	Turn BAND-MCS selector switch S202 through the various bands of frequency. Ensure that METER selector switch is positioned at HFO.	Needle deflection of 0.35 ma. on the output meter on all bands.	In the event that there is no needle deflection on any frequency band selected on the BAND-MCS switch, visually check all connections to the BAND-MCS and METER selector switches.
6	Turn MASTER OSCILLATOR FREQUENCY knob C302 to the nearest 100-kc division of the 2- to 4-mc VMO frequency. Plug in headset. Rotate tuning control in one direction only. Vary the calibrate control.	A zero beat is detected in the headset and ZERO BEAT indicator I303 goes on at each 100-kc check point.	If there is no zero beat on the ZERO BEAT pilot indicator or aural indication on the headset, 100-kc oscillator crystal or VMO section may be faulty. Power supply and/or mixer-audio section may be defective.
7	With the HFO switch in the ON position and the METER select switch returned to the HFO position, turn the XTAL switch to the 1 position. Turn the BAND-MCS switch to the 2-4 mcs band. "Trim" the XTAL selected by rotating (tuning) XTAL FREQ knob (trimmer) until the exact frequency is set, and then pick the signal with the TUNING knob.	Maximum nominal deflection on the output meter should be approximately 0.65 ma.	Should there be no needle deflection, visually check all the connections to the No. 1 position on XTAL control. If these are normal, the fault is in the HFO section.
8	Turn TUNING knob to a position approximately that of the MASTER OSCILLATOR FREQUENCY dial. Adjust the TUNING knob to peak output meter.	TUNING KNOB is set properly when the highest needle deflection on the output meter is obtained.	If the meter reading fails to peak, visually check all the connections on TUNING knob. If these are normal, the fault is in the HFO section.
9	Turn OUTPUT knob R215 for a 0.2-mil needle deflection on output meter M301.	Needle deflection on the meter is 0.2 ma.	If this deflection cannot be obtained, visually check all output and output meter connections. If they remain normal, the fault is in the HFO section.
10	Turn TUNING control C225 for maximum deflections on output meter.	Maximum needle deflection on the meter.	In the event of a malfunction, visually check all tuning and meter connections. If they remain normal, the fault is in the HFO section.
11	Repeat the procedure outlined in steps 8 through 10; change XTAL switch to position 2 or 3, respectively.		

FRONT

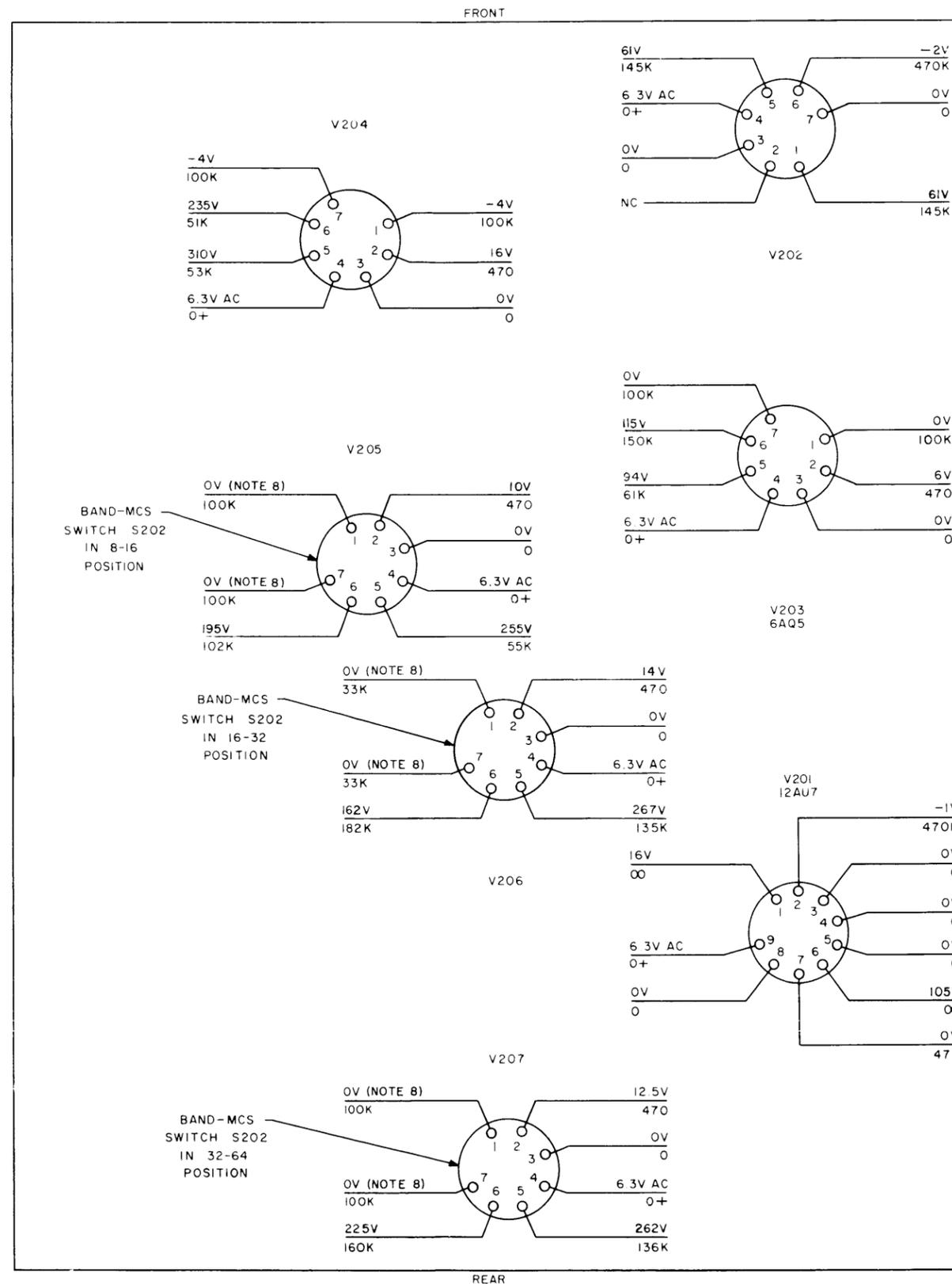


REAR

NOTE:

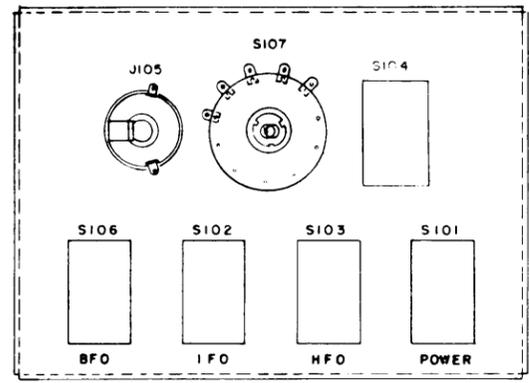
1. UNLESS OTHERWISE SHOWN, RESISTANCES ARE IN OHMS. VOLTAGES AND RESISTANCES ARE MEASURED FROM TUBE SOCKET PINS TO GROUND WITH A 20,000 OHMS-PER-VOLT METER. FOR RESISTANCES ONLY, MEASUREMENTS ARE MADE WITH ALL THE INTER-CHASSIS CONNECTORS DISCONNECTED.
2. UNLESS OTHERWISE NOTED, ALL MEASUREMENTS ARE MADE WITH THE BAND-MCS SWITCH IN THE 2-4 POSITION; POWER, HFO, IFO, AND BEAT SWITCHES IN THE ON POSITION, TUNING CONTROL TO THE APPROXIMATE FREQUENCY OF THE VMO, OUTPUT CONTROL MAXIMUM CLOCKWISE, XTAL SWITCH TO VMO.
3. VOLTAGES ARE DC UNLESS OTHERWISE INDICATED.
4. VOLTAGE READING ABOVE LINE, RESISTANCE READING BELOW LINE.
5. ∞ INDICATES INFINITY.

Figure 5-1. Voltage and Resistance Diagram, Power Supply Chassis

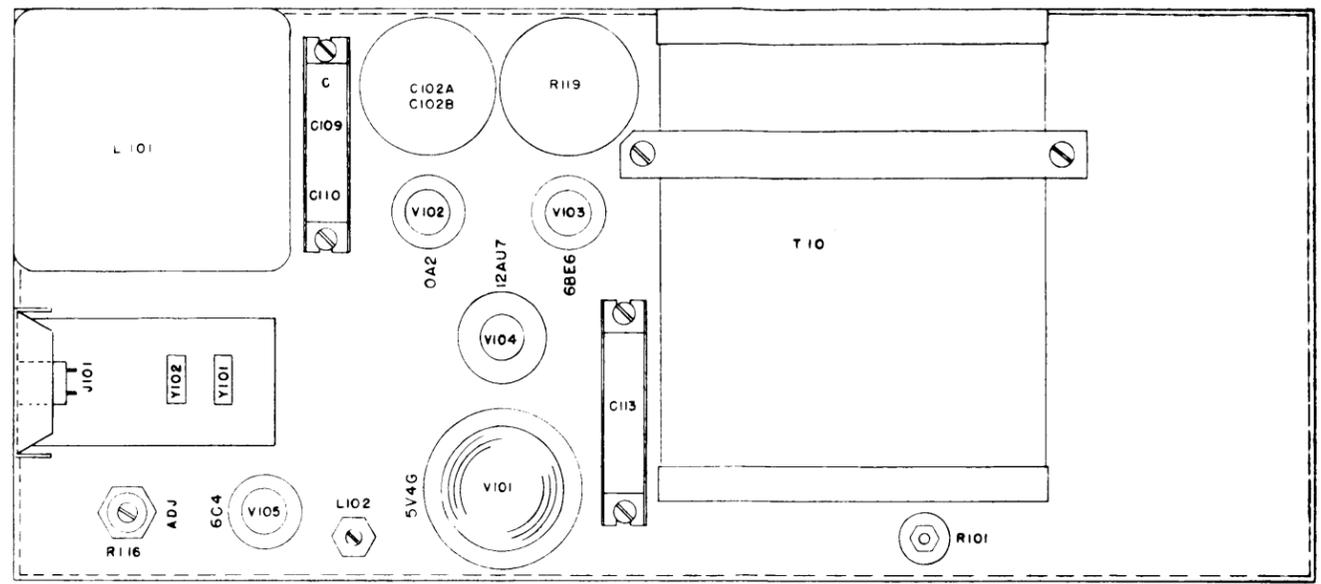


- NOTE:
1. UNLESS OTHERWISE SHOWN, RESISTANCES ARE IN OHMS. VOLTAGES AND RESISTANCES ARE MEASURED FROM TUBE SOCKET PINS TO GROUND WITH A 20,000 OHMS-PER-VOLT METER. FOR RESISTANCES ONLY, MEASUREMENTS ARE MADE WITH ALL THE INTER-CHASSIS CONNECTORS DISCONNECTED.
 2. UNLESS OTHERWISE NOTED, ALL MEASUREMENTS ARE MADE WITH THE BAND-MCS SWITCH IN THE 2-4 POSITION; POWER, HFO, IFO, BFO, AND BEAT SWITCHES IN THE [ON] POSITION, TUNING CONTROL TO THE APPROXIMATE FREQUENCY OF THE VMO; OUTPUT CONTROL MAXIMUM CLOCKWISE; XTAL SWITCH TO VMO.
 3. VOLTAGES ARE DC UNLESS OTHERWISE INDICATED.
 4. VOLTAGE READINGS ABOVE LINE, RESISTANCE READINGS BELOW LINE.
 5. ∞ INDICATES INFINITY.
 6. LINE VOLTAGE IS 115V AC.
 7. VOLTAGE MEASUREMENTS MADE WITH 68-OHM LOAD ON VOX.
 8. RF VOLTAGES PRESENT; MAGNITUDE DEPENDS ON FREQUENCY; MEASURABLE WITH HEWETT PACKARD VTVM; VALUES RANGE DOWN TO -160 VOLTS (RF).

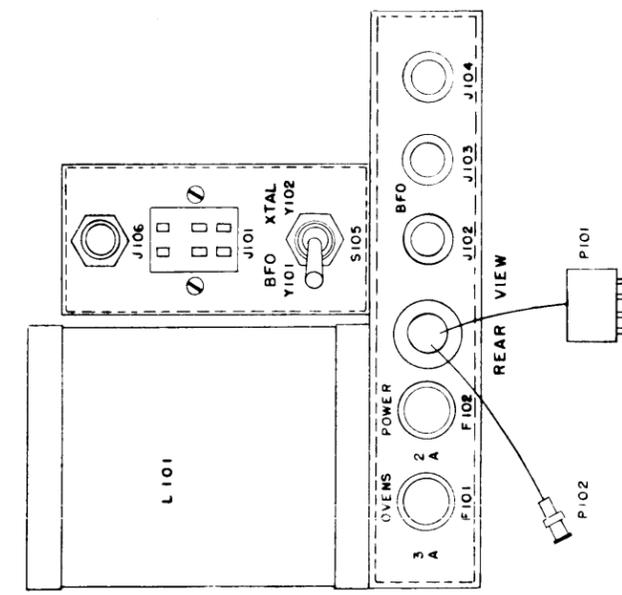
Figure 5-2. Voltage and Resistance Diagram, RF Chassis



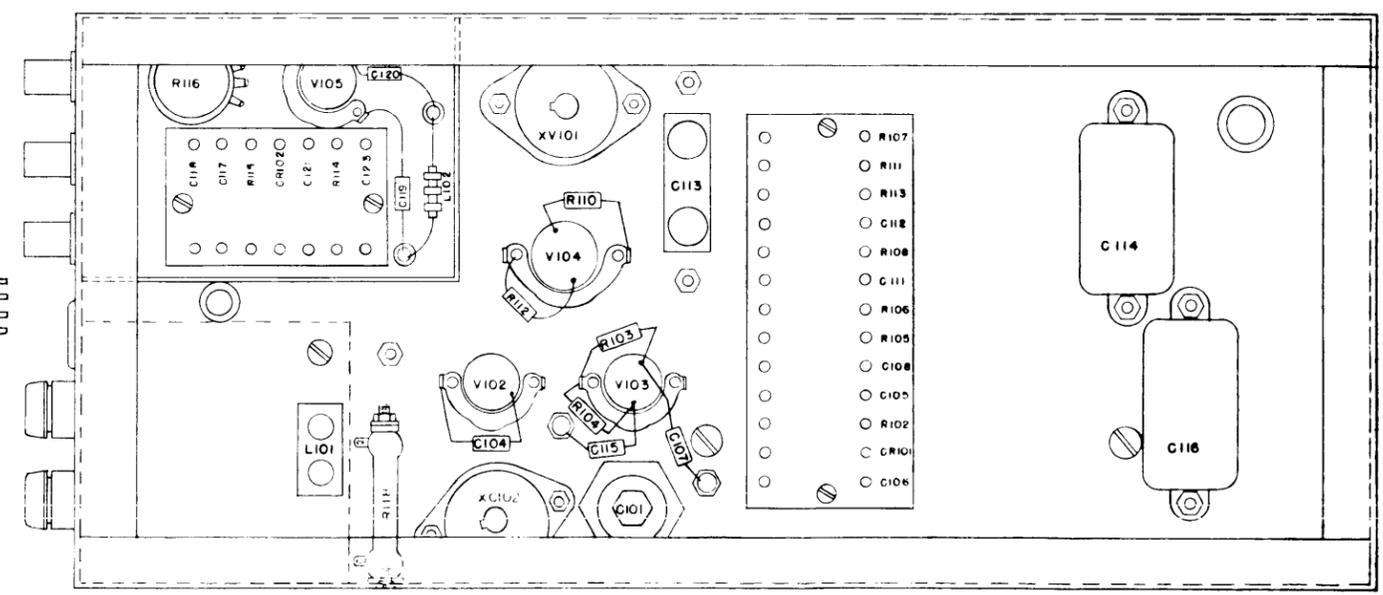
SUB-CONTROL PANEL
REAR VIEW



TOP VIEW



REAR VIEW



BOTTOM VIEW

SUPERCEDES
CMS070-C

NOTE:
R.F. JACKS COLORED AS FOLLOWS:
J102 = BLACK/YELLOW.
J104 = BLACK/GREEN.

Figure 5-4. Layout Diagram,
Power Supply Chassis

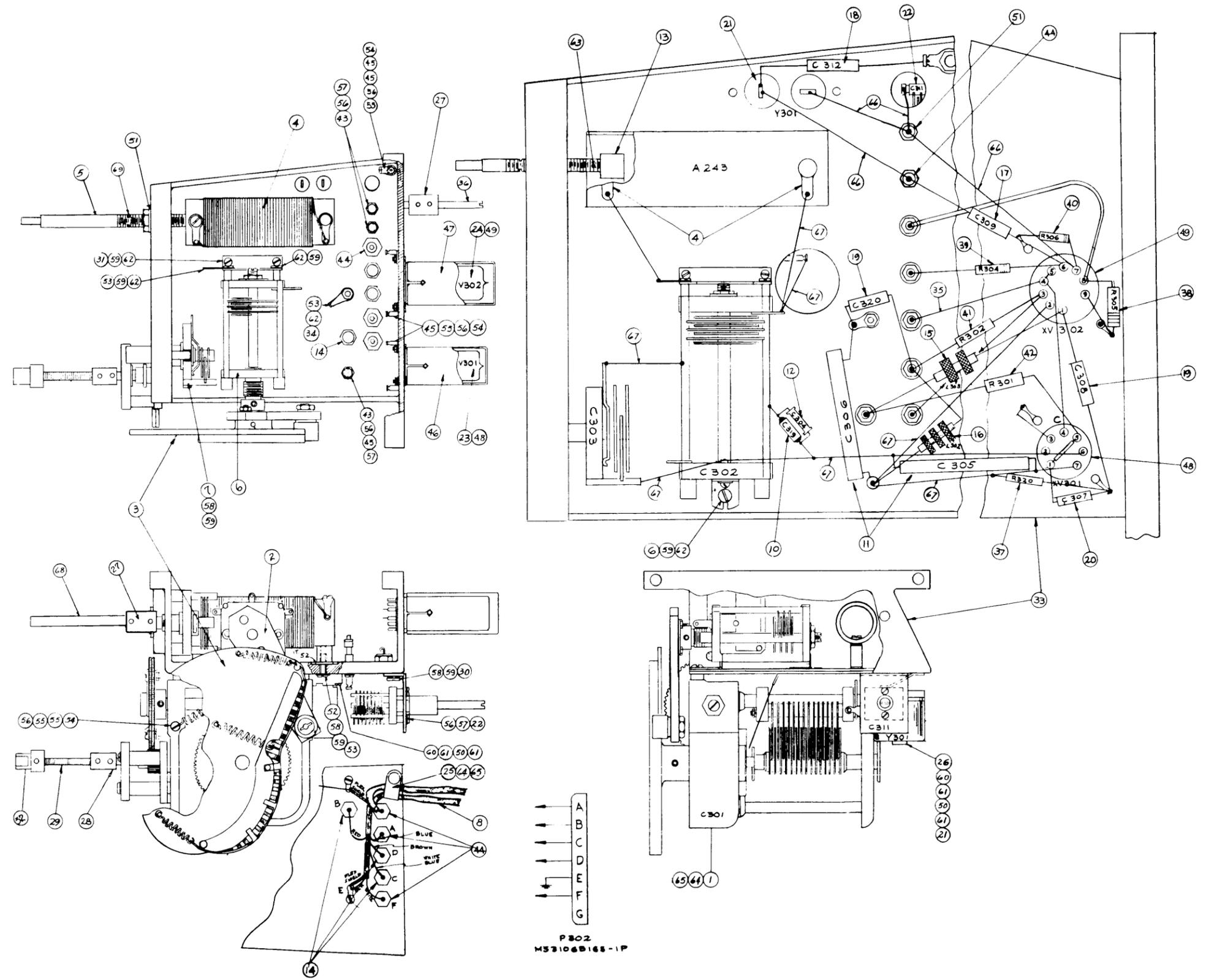


Figure 5-5. Layout Diagram, VMO Chassis

SECTION 6 MAINTENANCE

6-1. GENERAL.

Maintenance may be divided into three categories: 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, existing and/or pending, and information necessary to remedy the equipment troubles and maladjustments. For the reasons stated in Section 5 of this manual, the remedial type of information is presented under corrective maintenance (Section 6) while the diagnosis type of information is presented under trouble-shooting (Section 5).

The VOX has been designed to provide long term, trouble free operation under continuous duty conditions. It is recommended that any maintenance to the equipment be done by a competent technician. The oven and the components contained therein are precision made. The two enclosed tubular thermostats (S302 and S303) and the thermionic switch (S301) may be replaced easily at the rear of the unit (this requires opening up the oven which, however, calls for no special instructions); but in the event that maintenance to the frequency-sensitive units contained within is required, the unit should be returned to the factory for repairs. For maintenance of the RF and power supply sections, three service cable assemblies are supplied to enable the operator to service the VOX while maintaining primary power to the ovens. The cable assemblies supplied with each VOX are as follows:

- | | |
|----------------------------|---|
| a. Part No. CA109,
W101 | Power Supply-Multiplier
Interconnect; Twelve
Contact. |
| b. Part No. CA502
W102 | Power Supply-Master
Oscillator Interconnect;
Six Contact. |
| c. Part No. CA108
W103 | R.F.Cable; Power
Supply-Multiplier
Interconnect; Single
Contact. |

Figure 2-2 shows the three service cables connected properly for maintenance operation, allowing the ovens to function as usual during the maintenance period.

6-2. OPERATOR'S MAINTENANCE.

The operator should make minor adjustments of tuning controls to verify precise oscillator output frequency and level, note general condition of panel switches, observe whether panel indicator lamps light properly, and check the condition of the oven and power fuses as well as that of the tubes. Operators should not perform any emergency measures unless

properly authorized to do so. If such authorization is given, it should be preceded by a short course of instruction.

a. REPLACEMENT OF FUSES.

CAUTION

Never replace a fuse with one of higher rating unless continued operation is more important than probable damage to the equipment. If a fuse burns out immediately after replacement, do not replace it a second time until the cause has been located and corrected.

Two separate fusing systems are incorporated in the VOX: one to protect the ovens, and the other to protect the power supply proper. If the front panel pilot light marked MAIN POWER (control designated 8 on figure 3-1) fails to go on when the unit is turned on, then the fuse marked POWER, on the rear of the power supply chassis, must be changed. (There is a remote possibility that the pilot lamp itself is faulty, but this is rare.)

In the event of an oven fuse failure, both pilot lights referring to the ovens do not go on. The ovens, then, also begin to cool. In this case, the oven fuse, which is on the power supply chassis rear, must be replaced.

b. REPLACEMENT OF TUBES. - The location of all tubes in the VOX is indicated in the layout diagrams, figures 5-3 through 5-5. The tubes may be checked visually to see if they are on or warm. For inspection, the tubes housed in the oven require removal of the shield on the rear of the VOX. (See figure 1-1.) The VOX has been so designed that the power chassis can be completely withdrawn in a matter of seconds. A set of tracks has been provided for this purpose and the operator can slip the unit out by simply half turning four snap fasteners, two of which are located on the front panel and two of which are located under the rear of the power supply chassis. Tube replacement is accomplished by disconnecting the power supply as described above. Such disconnection, which automatically removes power from the oven, should not last for more than approximately 5 minutes, if good oven stability is to be maintained. If more detailed repairs become necessary, the 6-foot extension cables must be used to maintain oven power. Tubes should be carefully removed and tested, and when replaced, care should be taken to install tube shields.

6-3. PREVENTIVE MAINTENANCE.

a. In order to prevent actual 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 of all components inspected for dirt, corrosion, charring, discoloring, or grease; in particular, the tube sockets should be carefully inspected for deterioration. Dust may be removed with a soft brush or a vacuum cleaner if one is available. Remove dirt or grease from electrical parts with trichlorethylene or ethylenedichloride. Remove dirt or grease from other parts with any good dry cleaning fluid.

WARNING

Carbon tetrachloride (CCL₄) may be used if great care is exercised because it is a toxic substance. Do not inhale its fumes. Avoid contact with skin.

c. Test each tube, one at a time, in a reliable tube tester, replacing tube in socket from which it was removed if its measured characteristics are within the manufacturer's tolerances (usually ± 20 percent from tube manual values). Replace only those tubes which are found to be below par; recommended procedure is once every three months.

d. When replacing the VOX in the rack, ensure that all terminal screw connections at the rear of the equipment are tight.

6-4. CORRECTIVE MAINTENANCE.

a. GENERAL. - During its initial calibration, the VOX is set so that relatively little rotation of the CALIBRATE (control designated 13 on figure 3-1) is necessary to correct the dial at any particular check point.

As the unit continues to age and experiences varying degrees of shock and vibration, some increase in this degree of rotation may occur. If, after the dial has been calibrated at 2 mc, more than two complete revolutions of the CALIBRATE control are necessary to calibrate any other 50-kc checkpoint on the dial, then the ends of the dial should be reset by the procedure outlined below.

The continuous natural abuse that a unit receives in the field may also slightly disturb the 100-kc standard. In order to obtain maximum accuracy a recalibration of the crystal standard should be made regularly as outlined below.

NOTE

The following operations should be performed by duly authorized and properly instructed personnel only.

Corrective maintenance is limited to calibrations of the 100-kc standard oscillator and the master oscillator and to test procedures for the RF chassis and the power supply chassis. No maintenance is given for the repair of the oven or oven components because such repair is practical only in the factory.

b. 100-KC STANDARD CALIBRATIONS. - In order to perform this operation correctly it is necessary to obtain either a communications receiver or a primary standard such as a Hewlett-Packard Electronic Counter Model 524C. The receiver must be capable of receiving radio station WWV which is operated by the Central Radio Propagation Laboratory, National Bureau of Standards, Washington, D.C. This station emits a carrier of extreme frequency stability at 2.5, 5, 10, 15, 20, and 25 mc for precisely such purposes as the calibration of communications equipment. Allow at least a 6-hour warm-up period and proceed as follows:

(1) Using the receiver, "pick up" WWV. It is preferable to use the 2.5- or 5-mc signal if either can be obtained at the particular location being used.

(2) Loosely couple the HFO output into the antenna post of the receiver.

(3) Tune the VOX's VMO in the region of 2.5 mc and obtain a "zero beat" between the VOX and the WWV signal on the communication receiver. Since communication receivers are almost never designed for very low frequency audio response, it is useless to attempt to obtain a beat indication through the use of phones. Instead, it is suggested that some form of "S" meter be used. If the receiver has no such self-contained device, it can readily be made by connecting a microammeter in series with a suitable resistance directly across the receiver's detector DC output. When zero beat is approached and the coupling from the VOX to the receiver antenna is proper, deep and clearly discernible dips can be seen on the "S" meter.

(4) Now, while observing the beat indicating lamp on the VOX front panel, set C311, the 100-kc ADJ vernier capacitor located on the rear oven chassis, until a "zero beat" has been obtained between the VOX's VMO and 100-kc standard. When both beats can be observed simultaneously to be within a few cycles of the zero point, then a satisfactory calibration has been made. This means, in reality, that the 100-kc standard has been set against WWV with the VOX's VMO serving only the function of intermediary.

The frequency with which the above operations should be performed is purely a function of the type of service to which the unit is subject. For some base station installations, intervals of six months will be adequate; however, for more rugged conditions, experience may indicate the need for a proportionately shorter interval.

c. MASTER OSCILLATOR. - Before attempting to adjust the VOX's VMO, the full procedure outlined in the preceding paragraph must be followed. In addition, perform the adjustments given in paragraph 2-4 designated "Initial Adjustments." These are repeated below for convenience.

(1) The VOX is a high stability precision instrument and requires an initial warm-up period of at least 48 hours of continuous duty. Thereafter, the unit should never be turned off unless detailed repairs become necessary. Failure to comply with this procedure results in degradation of the instrument's accuracy.

(2) After the 48-hour warm-up period, the POWER switch (open front panel door) should be in ON position and the ovens should have reached a stabilized condition.

(3) Set the BEAT (ON-OFF) switch (open front panel door) to ON position.

(4) Plug a headset into the jack marked PHONES (open front panel door).

(5) Turn the BAND-MCS switch on front panel to 2-4 position.

(6) Turn the XTAL switch on front panel to VMO position.

(7) Turn the MASTER OSCILLATOR FREQUENCY dial to 2000 KCS 000 CPS position.

(8) Turn the CALIBRATE dial for zero beat on the phones and also on the ZERO BEAT indicator. The VMO's 2,000,000-cycle output now coincides in frequency with the 100-kc calibrating oscillator's 20th harmonic.

(9) Turn the MASTER OSCILLATOR FREQUENCY dial to its 4000 KCS 000 CPS position.

(10) Adjust the trimmer capacitor, behind circular disc (located on the front panel) between the CALIBRATE dial and the VOX's meter, to give zero beat on the phones and also on the ZERO BEAT indicator. The VMO's 4,000,000-cycle output now coincides in frequency with the 100-kc calibrating oscillator's 40th harmonic.

(11) Repeat steps (7) and (8) to compensate for the newly adjusted position of the trimmer capacitor.

(12) Repeat steps (9) and (10) to compensate for the newly adjusted position of the CALIBRATE dial.

(13) Readjust the trimmer capacitor to optimum zero beat condition at the two extremes of the 2- to 4-mc band.

Since other frequency bands are obtained by multiplication of the 2- to 4-mc band, the oscillator is adjusted throughout its entire frequency.

In making the adjustments given above, observe the following precautions:

(a) In setting the MASTER FREQUENCY OSCILLATOR dial to 2,000,000, note the direction of approach.

(b) In resetting the dial to 4,000,000, approach this point from the same direction used previously. If, for example, the first point was approached from 2,002,000, then the second point must be approached from 4,002,000.

(c) During the screwdriver adjustment of C303 for zero beat (through the capped hole adjacent to the CALIBRATE knob), monitor VOX's VMO on a convenient receiver to make certain that C303 is being varied in a manner which brings the VMO's frequency toward the 4-mc zero beat and not in the direction of a neighboring 50-kc checkpoint. It should never be necessary to vary the C303 control more than a few complete revolutions.

(d) Repeat the total procedure outlined above; that is, adjust the CALIBRATE knob to 2 mc and C303 to 4 mc, until it is possible to obtain a zero beat at both 2 and 4 mc without further adjustment being necessary. The ends are then correct and the CALIBRATE knob is closest to its correct mean position.

(e) Once this procedure has been completed, the button should be replaced and not disturbed again until a recalibration is deemed necessary. This operation is sometimes required after the first year of service and then seldom performed again, depending, once again, upon the type of service.

d. ALIGNMENTS. - The following alignment of the RF chassis and the power supply chassis is abstracted from TMC's test procedures on these assemblies:

(1) BFO CIRCUIT LOCATED ON POWER SUPPLY CHASSIS.

(a) Connect all cables.

(b) Insert a 455-kc crystal in each BFO crystal socket.

(c) Connect a 1000-ohm load resistor to BFO output connector jack (J102).

(d) Turn on POWER switch (S101).

(e) Turn METER switch (S107) to BFO position and set BFO switch (S106) to ON position.

(f) Rotate BFO adjust potentiometer (R116) to maximum CW for maximum output on meter (M301).

(2) CALIBRATE CIRCUIT LOCATED ON POWER SUPPLY CHASSIS.

(a) Turn METER switch (S107) to VMO; maximum output on meter is 10 volts full scale.

(b) Set BEAT (ON-OFF) switch (S104) to ON position. Tune the MASTER OSCILLATOR FREQUENCY control knob, the ZERO BEAT indicator (I303) should go on at each 100-kc checkpoint. Should the ZERO BEAT indicator not go on exactly at each 100-kc interval, refer to paragraphs 6-1 and 6-4 for corrective procedure. (The power supply does not contain any adjustments to compensate for an erroneous zero beat.)

(3) IFO CIRCUIT LOCATED ON RF CHASSIS. - Turn METER switch (S107) to IFO position, and set IFO plate switch (S102) to ON position. Maximum full-scale deflection is 10 volts. Peak the IFO output as indicated on the meter with C207 variable capacitor.

(4) HFO CIRCUIT LOCATED ON RF CHASSIS. - The RF chassis consists principally of RF multipliers extending from 2 to 64 mc. Its alignment is like any ordinary alignment of a tuned circuit; however, the common trimmer capacitor used on both the 2- to 4- and 4- to 8-mc bands involves a compromise setting to fulfill the requirements of both bands. The best alignment procedure will depend upon available test facilities and skills.

SECTION 7 PARTS LIST

INTRODUCTION

Reference designations have been assigned to identify all maintenance 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, amplifier, electron tubes, etc. The number differentiates between parts of the same generic group. Parts of the same first major unit are numbered from 1 to 199; parts of the second 201 to 299, etc. Two consecutive series of numbers have been assigned to major units in which there are more than 100 parts of the same generic group. Sockets associated with a particular plug-in device, such as

electron 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 F7 is designated XF7. The parts for each major unit are grouped together. Column 1 lists the reference series of each major unit, followed by the reference designations of the various parts in alphabetical and numerical order. Column 2 gives the name and describes the various parts. Major part assemblies are listed in their entirety; subparts of a major assembly are listed in alphabetical and numerical order with reference to its major assembly. Column 3 indicates how the part is used within a major component. Column 4 lists each Technical Materiel Corporation part number.

CONTENTS

Title	Page
Variable Frequency Oscillator VOX-5 (Symbol Series 100 through 300)	7-1

NOTE

The following information is added to page 7-4:

R119	RESISTOR, current regulating; ballast vacuum tube type; .43 to .49 amps; 10.1 to 15.1 volts; 9-pin base.	Resistor, Current Regulating	RR-109
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The following information is added to page 7-5:

XR119	Same as XV104.	Ballast Tube Socket	TS-103-P01
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**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C101 *	CAPACITOR, fixed: paper; 4 uf, $\pm 10\%$, 600 wvdc, oil-filled and impregnated, hermetically sealed metal case.	B+ R. F. Bypass, V101	CP40C2FF405K
C102 A, B	CAPACITOR, fixed: dry electrolytic dual unit, 20 uf ea. section, 450 wvdc.	B+ Filter, V103	CE52E200R
C103	NOT USED.		
C104	CAPACITOR, fixed: mica, .01 uf, $\pm 10\%$, char B, 300 wvdc.	REG. R. F. Bypass, V102	CM35B103K
C105	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc.	VMO Meter Bypass Cap., V103	CM20B102K
C106	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	VMO Meter, R. F. Coupling, Cap., V103	CM20B102K
C107	CAPACITOR, fixed: mica; 5 uuf, $\pm 20\%$, char B, 500 wvdc.	VMO Mixer Coupling Cap., V103	CM20B050M
C108	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	Mixer Screen Bypass Cap., V103	CM20B102K
C109	NOT USED.		
C110	NOT USED.		
C111	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	Mixer Plate Filter Cap., V103	CM20B102K
C112	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	Mixer Plate Filter Cap., V103	CM20B102K
C113	CAPACITOR, fixed: paper; .5 uf, $\pm 10\%$, 600 wvdc, oil-filled and impregnated, hermetically sealed metal case.	Mixer Output Coupling Cap., V104	CP69B1EF504K
C114	CAPACITOR, fixed: paper; .5 uf, $\pm 10\%$, 600 wvdc, oil-filled and impregnated, hermetically sealed metal case.	Audio Output Coupling, Cap., V104	CP53B1EF504K
C115	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	100 Kc Mixer Coupling, Cap., V103	CM20B102K
C116	CAPACITOR, fixed: paper; .1 uf, $\pm 10\%$, 600 wvdc, oil-filled and impregnated, hermetically sealed metal case.	Phones Coupling Cap., J105	CP53B1EF104K
C117	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	Bypass BFO Meter Decoupling, Cap. S107	CM20B102K

*C101 no longer exists in this equipment.

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C118	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	BFO Meter Coupling Cap., J104	CM20B102K
C119	CAPACITOR, fixed: mica; .01 uf, $\pm 10\%$, char B, 300 wvdc. (Same as C104)	BFO Plate Filter Cap., V105	CM35B103K
C120	CAPACITOR, fixed: mica; .01 uf, $\pm 10\%$, char B, 300 wvdc. (Same as C104)	BFO Tank Cap., V105	CM35B103K
C121	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char C, 500 wvdc. (Same as C105)	BFO Voltage Divider Cap., V105	CM20B102K
C122	CAPACITOR, fixed: mica; 150 uuf, $\pm 5\%$, char C, 500 wvdc.	BFO Xtal Load Cap., S105	CM20C151J
C123	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	BFO Xtal Coupling Cap., V105	CM20B102K
CR101	DIODE ASSEMBLY: rectifying; germanium.	VMO Output Rectifier V103	IN34
CR102	DIODE ASSEMBLY: rectifying; germanium. (Same as CR101)	BFO Output Rectifier J103	IN34
F101	FUSE, cartridge: 3.0 amp.	Oven Fuse	FU-100-3
F102	FUSE, cartridge: 2.0 amp.	Power Fuse	FU-100-2
J101	CONNECTOR, receptacle, female contact: polarized; six contact, chassis mounted.	Power Supply Oven Interconnect	MS3102A16S1S
J102	CONNECTOR, coaxial: female contact; BNC type, single hole mounted.	BFO Output	UG-625/U
J103	CONNECTOR, coaxial: female contact; BNC type, single hole mounted. (Same as J102)	BFO Output	UG-625/U
J104	CONNECTOR, coaxial: female contact; BNC type, single hole mounted. (Same as J102)	BFO Output	UG-625/U
J105	JACK, open circuit.	Phone Input	JJ-034
J106	JACK, open circuit. (Same as J105)	Phone Input	JJ-034
L101	REACTOR, filter: 10 henries, 125 ma DC, 1000 volts RMS test.	B+ Filter Choke V101	TF-5001
L102	INDUCTOR, fixed: 10 millihenries.	BFO Tank Coil, V105	CL-101-4

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
P101	CONNECTOR, plug, male contact: polarized; twelve contact, w/cable clamps.	PS-RF Interconnect	PL-102-1
P102	CONNECTOR, coaxial: male contact; BNC type for RG-58/U cable. (Part of W104)	Part of VMO Input Cable, W104	UG-88/U
P103	CONNECTOR, plug, male. (Part of W102)	p/o Service Cable W102	MS3106B16S1P
P104	CONNECTOR, plug, female. (Part of W102)	p/o Service Cable W102	MS3106B16S1S
P105	CONNECTOR, male contact: polarized; twelve contact, w/cable clamps. (Same as P101, Part of W101)	PS-RF Interconnect	PL-102-1
P106	CONNECTOR, plug: female; polarized; twelve contacts; w/cable clamp.	p/o Service Cable W101	PL-102-2
P107	CONNECTOR, plug: male; coaxial; BNC type for RG-59/U. (Part of W103)	p/o Service Cable W103	UG-260/U
P108	CONNECTOR, plug: female; coaxial; BNC type for RG-59/U. (Part of W103)	p/o Service Cable W103	UG-261/U
R101	RESISTOR, fixed: wire wound; 4500 ohms, $\pm 5\%$, 10 watts.	B+ Dropping Res., V102	RW-109-47
R102	RESISTOR, fixed: composition; 12,000 ohms, $\pm 5\%$, 1/2 watt.	Diode Load, Res., (CR101)	RC20GF123J
R103	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$, 1/2 watt.	Mixer Grid Lead Res., V103	RC20GF104K
R104	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R103)	Mixer Grid Leak Res., V103	RC20GF104K
R105	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R103)	Mixer Screen Dropping Res., V103	RC20GF104K
R106	RESISTOR, fixed: composition; 1 megohm, $\pm 10\%$, 1/2 watt.	Mixer Plate Load Res., V103	RC20GF105K
R107	RESISTOR, fixed: composition; 56,000 ohms, $\pm 10\%$, 1/2 watt.	Mixer Plate Filter Res., V103	RC20GF563K
R108	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R103)	Mixer Output Filter Res., V103	RC20GF104K
R109	NOT USED.		
R110	RESISTOR, fixed: composition; 1 megohm, $\pm 10\%$, 1/2 watt. (Same as R106)	Audio Grid Leak Res., V104	RC20GF105K

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
R111	RESISTOR, fixed: composition; 220,000 ohms, $\pm 10\%$, 1/2 watt.	Audio Plate Load Res., V104	RC20GF224K
R112	RESISTOR, fixed: composition; 220,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R111)	Grid Leak Res., V104	RC20GF224K
R113	RESISTOR, fixed: composition; 82,000 ohms, $\pm 10\%$, 2 watts.	Audio Cathode Res., V104	RC42GF823K
R114	RESISTOR, fixed: composition; 22,000 ohms, $\pm 10\%$, 1/2 watt.	Audio Plate Load Res., V105	RC20GF223K
R115	RESISTOR, fixed: composition; 43,000 ohms, $\pm 5\%$, 1/2 watt.	BFO Output Diode Load, Res., J103	RC20GF433J
R116	RESISTOR, variable: composition; potentiometer, 50,000 ohms, $\pm 20\%$, 2 watts.	BFO Output Control V105	RV4ATSA503B
R117	RESISTOR, fixed: composition; 470,000 ohms, $\pm 10\%$, 1/2 watt.	BFO Grid Leak Res., V105	RC20GF474K
R118	RESISTOR, fixed: wire wound; 25,000 ohms, $\pm 5\%$, 10 watts.	BFO Plate Filter Res., V105	RW-109-38
**			
S101	SWITCH, toggle: DPST; 3 amp, 250 volts, phenolic body.	Main Power	ST22K
S102	SWITCH, toggle: SPST; 3 amp, 250 volts, phenolic body.	IFO - Plate	ST12A
S103	SWITCH, toggle: SPST; 3 amp, 250 volts, phenolic body. (Same as S102)	HFO Plate	ST12A
S104	SWITCH, toggle: SPST; 3 amp, 250 volts, phenolic body. (Same as S102)	100 Kc Osc. On - Off	ST12A
S105	SWITCH, toggle: DPDT; 3 amp, 250 volts, phenolic body.	BFO - Crystal	ST22N
S106	SWITCH, toggle: SPST; 3 amp, 250 volts, phenolic body. (Same as S102)	BFO - Plate	ST12A
S107	SWITCH, rotary: non-shorting; single section, one pole, 4 position. Mycalex insulation contacts and wipers silver plated: 1/4 in. drive shaft, 5/8 in. lg.	Meter Switch	SW-105
T101	TRANSFORMER, power primary 110/120 volts, 50/60 cps; secondary #1 5 volts, 3 amps; secondary #2, 350 volts, 125 ma. center tapped; secondary #3, 6.3 volts, 4 amps.	Main Power	TF-229

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
V101	TUBE, electron: 5V4G; octal.	HV Rectifier	5V4G
V102	TUBE, electron: OA2; miniature 7 pin.	Voltage Regulator	OA2
V103	TUBE, electron: 6BE6; miniature 7 pin.	Mixer	6BE6
V104	TUBE, electron: 12AU7; miniature 9 pin.	Audio Amplifier	12AU7
V105	TUBE, electron: 6AQ5; miniature 7 pin.	BFO	6AQ5
W101	CABLE ASSEMBLY, twelve contact; male polarized one end, female polarized opposite end. (For servicing only) Consists of P105 and P106.	Power Supply-Multiplier Interconnect	CA-109
W102	CABLE ASSEMBLY, six contact; male polarized, one end, female polarized opposite end. (For servicing only) Consists of P103 and P104.	Power Supply - Master Oscillator Interconnect	CA-502
W103	CABLE R. F.: single contact; male connector one end, female opposite end. (For servicing only) Consists of P107 and P108.	Power Supply Multiplier Interconnect	CA-108
W104	CABLE ASSEMBLY: R. F., V103 to J202; consists of 17-1/2 in. of RG-58/U coaxial cable, 3 in. of flexible shield; one inner and outer ferrule; and one UG-88/U connector plug, P102.	Power Supply Mult. Interconnect	CA-204
XC102	SOCKET, tube: octal.	Socket for C102	TS101P01
XF101	HOLDER, fuse: extractor post type for single AGC type fuse.	F101 Socket	FH-100-2
XF102	HOLDER, fuse: extractor post type for single AGC type fuse. (Same as XF101)	F102 Socket	FH-100-2
**			
XV101	SOCKET, tube: octal. (Same as XC102)	Socket for V101	TS101P01
XV102	SOCKET, tube: 7 pin miniature.	Socket for V102	TS102P01
XV103	SOCKET, tube: 7 pin miniature. (Same as XV102)	Socket for V103	TS102P01
XV104	SOCKET, tube: 9 pin miniature.	Socket for V104	TS103P01
XV105	SOCKET, tube: 7 pin miniature. (Same as XV102)	Socket for V105	TS102P01
XY101	SOCKET, crystal: .487" spacing, for .050" pins.	Socket for Y101	TS-104-1

** See note on page 7-0.

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
XY102	SOCKET, crystal: .487" spacing, for .050" pins. (Same as XY101)	Socket for Y102	TS-104-1
Y101	CRYSTAL UNIT: quartz; 300 to 500 Kcs. (Supplied only on customer request)	BFO Crystal	CR-25/U
Y102	CRYSTAL UNIT: quartz; 300 to 500 Kcs. (Supplied only on customer request) (Same as Y101)	BFO Crystal	CR-25/U
C201	CAPACITOR, fixed: mica; 27 uuf, $\pm 5\%$, char C, 500 wvdc.	IFO Xtal Load, Cap., V201	CM20C270J
C202	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	IFO Plate Filter Cap., V201	CM20B102K
C203	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	IFO Plate Filter Cap., V201	CM20B102K
C204	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	IFO Grid Coupling Cap., V201	CM20B102K
C205	CAPACITOR, fixed: mica; .01 uf, $\pm 10\%$, char B, 300 wvdc.	VMO Coupling Cap., J203	CM35B103K
C206	CAPACITOR, fixed: mica; .01 uf, $\pm 10\%$, char B, 300 wvdc. (Same as C104)	IFO Amplifier Plate, Cap., V201	CM35B103K
C207	CAPACITOR, fixed: mica; 150 uuf, $\pm 5\%$, char C, 500 wvdc. (Same as C122)	IFO Amplifier Tank, Cap., V201	CM20C151J
C208	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	IFO Meter Coupling Cap., J206	CM20B102K
C209	CAPACITOR, fixed: mica; .01 uf, $\pm 10\%$, char B, 300 wvdc. (Same as C104)	IFO Meter Bypass Cap., J206	CM35B103K
C210	CAPACITOR, variable: air dielectric, one section 14 plates, 3.9-50 uuf, 500 wvdc.	HFO Xtal Trimmer V202	CT-100-1
C211	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc.	RF Ampl Plate Filter, Cap., V202	CM20B102K
C212	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	RF Ampl Grid Coupling, Cap., V202	CM20B102K

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C213	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	RF Ampl Plate Filter, Cap., V203	CM20B102K
C214	CAPACITOR, fixed, mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	RF Ampl Cathode Bypass, Cap., V203	CM20B102K
C215	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	RF Ampl Screen Bypass, Cap., V203	CM20B102K
C216	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	RF Ampl Screen Bypass, Cap., V204	CM20B102K
C217	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	RF Ampl Grid Coupling, Cap., V204	CM20B102K
C218	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	RF Ampl Cathode Bypass, Cap., V204	CM20B102K
C219	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	RF Mult Grid Coupling, Cap., V205	CM20B102K
C220	CAPACITOR, fixed: mica; .01 uf, $\pm 10\%$, char B, 300 wvdc. (Same as C104)	2-4 Mc Plate Filter Cap., S202B	CM35B103K
C221	CAPACITOR, fixed: mica; .01 uf, $\pm 10\%$, char B, 300 wvdc. (Same as C104)	4-8 Mc Plate Filter Cap., S202B	CM25B103K
C222	CAPACITOR, fixed: mica; .01 uf, $\pm 10\%$, char B, 300 wvdc. (Same as C104)	8-16 Mc Plate Filter Cap., V205	CM35B103K
C223	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	RF Mult Screen Bypass, Cap., V205	CM20B102K
C224	CAPACITOR, variable: ceramic; 1.5-7 uuf, char A, 500 wvdc.	4-8 Mc Trimmer	CV11A070
C225	CAPACITOR, variable: air dielectric; four sections Section A - 8.8 to 228 uuf Section B - 8 to 208 uuf Section C - 8 to 208 uuf Section D - 6 to 106 uuf	HFO Tuning Cap., V205	CB-100
C226	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	RF Mult Cathode Bypass, Cap., V205	CM20B102K

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C227	CAPACITOR, variable: ceramic; 3-12 mmfd, char A, 500 wvdc.	8-16 Mc Trimmer Cap., V205	CV11A120
C228	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	16-32 Mc Grid Coupling, Cap., V206	CM20B102K
C229	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	16-32 Mc Screen Bypass, Cap., V206	CM20B102K
C230	CAPACITOR, fixed: mica; .01 uf, $\pm 10\%$, char B, 300 wvdc. (Same as C104)	16-32 Mc Plate Filter	CM35B103K
C231	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	32-64 Mc Grid Coupling, Cap., V207	CM20B102K
C232	CAPACITOR, variable: ceramic; 3-12 mmfd, 500 wvdc. (Same as C227)	16-32 Mc Trimmer Cap., V206	CV11A120
C233	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	32-64 Mc Screen Bypass, Cap., V207	CM20B102K
C234	CAPACITOR, fixed: mica; .01 uf, $\pm 10\%$, char B, 300 wvdc. (Same as C104)	32-64 Mc Plate Filter, Cap., V207	CM35B103K
C235	CAPACITOR, variable: ceramic; 1.5-7 uuf, 500 wvdc. (Same as C224)	32-64 Mc Trimmer Cap., V207	CV11A070
C236	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	32-64 Mc Coupling Cap., V207	CM20B102K
C237	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	HFO Meter Filter Cap., J209	CM20B102K
C238	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	HFO Meter Coupling Cap., J209	CM20B102K
C239	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	RF Chassis Filament Bypass, Cap.	CM20B102K
C240	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	16-32 Cathode Bypass Cap., V206	CM20B102K
C241	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	32-64 Mc Cathode Bypass, Cap., V207	CM20B102K

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C242	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	IFO Xtal Coupling Cap., V201	CM20B102K
C243	CAPACITOR, fixed: mica; 1000 uuf, $\pm 10\%$, char B, 500 wvdc. (Same as C105)	HFO Xtal DC Blocking Cap., V202	CM20B102K
C244	CAPACITOR, fixed: ceramic; 2.5 uuf, $\pm 10\%$, 500 wvdc.	4-8 Mc Trimmer Cap., S202B	CC-101-1
C245	CAPACITOR, fixed: mica; .01 uf, $\pm 5\%$, char C, 300 wvdc.	RF Bypass, Cap., J201	CM35C103J
C246	CAPACITOR, fixed: mica; .01 uf, $\pm 5\%$, char C, 300 wvdc. (Same as C245)	RF Bypass, Cap., J201	CM35C103J
CR201	DIODE ASSEMBLY: rectifying; germanium (Same as CR101)	IFO Output Rectifier	IN34
CR202	DIODE ASSEMBLY: rectifying; germanium (Same as CR101)	HFO Output Rectifier	IN34
J201	CONNECTOR, female contact; polarized; twelve contact, chassis mounted.	Power Supply & RF Chassis	JJ-118-2
J202	CONNECTOR, coaxial: female contact; BNC type, single hole mounted. (Same as J102)	WMO Interconnect	UG-625/U
J203	CONNECTOR, coaxial: female contact; BNC type, single hole mounted. (Same as J102)	VMO Interconnect	UG-625/U
J204	NOT USED.		
J205	CONNECTOR, coaxial: female contact; BNC type, single hole mounted. (Same as J102)	IFO Output	UG-625/U
J206	CONNECTOR, coaxial: female contact; BNC type, single hole mounted. (Same as J102)	IFO Output	UG-625/U
J207	CONNECTOR, coaxial: female contact; BNC type, single hole mounted. (Same as J102)	IFO Output	UG-625/U
J208	CONNECTOR, coaxial: female contact; BNC type, single hole mounted. (Same as J102)	HFO Output	UG-625/U
J209	CONNECTOR, coaxial: female contact; BNC type, single hole mounted. (Same as J102)	HFO Output	UG-625/U

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
J210	CONNECTOR, coaxial: female contact; BNC type, single hole mounted. (Same as J102)	HFO Output	UG-625/U
L201	INDUCTOR, variable: slug tuned, 13.15 microhenries.	IFO Tank Coil, V201	A-242
L202	INDUCTOR, fixed: .168 millihenries.	RF Ampl Peaking Coil, V203	A-244
L203	INDUCTOR, variable: slug tuned, 35.25 microhenries.	Tank (2-4 Mc) Coil, S202B	A-245
L204	CHOKER, RF: 750 microhenries, $\pm 20\%$.	RF Choke, S202B	CL-100-5
L205	INDUCTOR, variable: slug tuned, 10.4 microhenries.	Tank (4-8 Mc) Coil, S202A	A-246
L206	INDUCTOR, variable: slug tuned, 2.47 microhenries.	Tank (8-16 Mc) Coil, V205	A-247
L207	INDUCTOR, variable: slug tuned, 0.67 microhenries.	Tank (16-32 Mc) Coil, V206	A-248
L208	INDUCTOR, variable: slug tuned, 0.2225 microhenries.	Tank (32-64 Mc) Coil	A-249
P201	CONNECTOR, Plug, p/o W201.	p/o AC Input Cable, W201	
R201	RESISTOR, fixed: composition; 470,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R117)	IFO Grid Leak Res., V201	RC20GF474K
R202	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R103)	IFO Plate Load Res., V201	RC20GF104K
R203	RESISTOR, fixed: composition; 47,000 ohms, $\pm 10\%$, 1/2 watt.	IFO Decoupling Res., V201	RC20GF473K
R204	RESISTOR, fixed: composition; 3300 ohms, $\pm 10\%$, 1/2 watt.	IFO Decoupling Res., V201	RC20GF332K
R205	RESISTOR, fixed: composition; 47,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R203)	IFO Ampl Grid Leak, Res., V201	RC20GF473K
R206	RESISTOR, fixed: composition; 12,000 ohms, $\pm 5\%$, 1/2 watt. (Same as R102)	IFO Output Diode Load, Res., V201	RC20GF123J
R207	RESISTOR, fixed: composition; 470,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R117)	HFO Grid Leak, V202	RC20GF474K
R208	RESISTOR, fixed: composition; 10,000 ohms, $\pm 10\%$, 1/2 watt.	HFO Plate Load Res., V202	RC20GF103K
R209	RESISTOR, fixed: composition; 82,000 ohms, $\pm 10\%$, 2 watts. (Same as R113)	HFO Decoupling Res., V202	RC42GF823K
R210	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R103)	RF Ampl Grid Leak Res., V203	RC20GF104K

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
R211	RESISTOR, fixed: composition; 470 ohms, $\pm 10\%$, 1/2 watt.	RF Ampl Cathode Res., V203	RC20GF471K
R212	RESISTOR, fixed: composition; 10,000 ohms, $\pm 10\%$, 2 watts.	RF Ampl Plate Load Res., V203	RC42GF103K
R213	RESISTOR, fixed: composition; 1000 ohms, $\pm 10\%$, 1 watt.	RF Ampl Decoupling Res., V203	RC30GF102K
R214	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R103)	RF Ampl Screen Dropping, Res., V203	RC20GF104K
R215	RESISTOR, variable: wire wound; 50,000 ohms, $\pm 10\%$, 3 watts.	HFO Output Control Res., V203	RA100ASRD-503A
R216	RESISTOR, fixed: composition; 2200 ohms, $\pm 10\%$, 2 watts.	Screen Dropping Res., S202A	RC42GF222K
R217	RESISTOR, fixed: composition; 1000 ohms, $\pm 10\%$, 1/2 watt.	Screen Dropping Res., V204	RC20GF102K
R218	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R103)	Mult. Grid Leak Res., V204	RC20GF104K
R219	RESISTOR, fixed: composition; 470 ohms, $\pm 10\%$, 1/2 watt. (Same as R211)	Mult. Cathode Bias Res., V204	RC20GF471K
R220	RESISTOR, fixed: composition; 1200 ohms, $\pm 10\%$, 2 watts.	Mult. Decoupling Res., S202B	RC42GF122K
R221	RESISTOR, fixed: composition; 2200 ohms, $\pm 10\%$, 2 watts. (Same as R216)	8-16 Mc Mult Decoupling, Res., V205	RC42GF222K
R222	RESISTOR, fixed: composition; 47,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R203)	8-16 Mc Mult Screen Dropping Res., V205	RC20GF473K
R223	RESISTOR, fixed: composition; 680 ohms, $\pm 10\%$, 2 watts.	Ampl Parasitic Suppressor, S202B	RC42GF681K
R224	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R103)	8-16 Mc Mult Grid Leak, Res., V205	RC20GF104K
R225	RESISTOR, fixed: composition; 470 ohms, $\pm 10\%$, 1/2 watt. (Same as R211)	8-16 Mc Mult Cathode Bias, Res., V205	RC20GF471K
R226	RESISTOR, fixed: composition; 33,000 ohms, $\pm 10\%$, 1/2 watt.	16-32 Mc Mult Grid Leak, Res., V206	RC20GF333K
R227	RESISTOR, fixed: composition; 47,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R203)	16-32 Mc Mult Screen Dropping, Res., V206	RC20GF473K
R228	RESISTOR, fixed: composition; 1200 ohms, $\pm 10\%$, 2 watts. (Same as R220)	16-32 Mc Mult Decoupling, Res., V206	RC42GF122K
R229	RESISTOR, fixed: composition; 24,000 ohms, $\pm 5\%$, 1/2 watt.	32-64 Mc Mult Screen Dropping, Res., V207	RC20GF243J

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
R230	RESISTOR, fixed: composition; 1200 ohms, $\pm 10\%$, 2 watts. (Same as R220)	32-64 Mc Mult Decoupling, Res., V207	RC42GF122K
R231	RESISTOR, fixed: composition; 100,000 ohms, $\pm 10\%$, 1/2 watt. (Same as R103)	32-64 Mc Mult Grid Leak, Res., V207	RC20GF104K
R232	RESISTOR, fixed: composition; 24,000 ohms, $\pm 5\%$, 1/2 watt. (Same as R229)	HFO Output Diode Load, Res., J209	RC20GF243J
R233	RESISTOR, fixed: composition; 82,000 ohms, $\pm 10\%$, 2 watts. (Same as R113)	Band Change Screen Dropping Res., S202A	RC42GF823K
R234	RESISTOR, fixed: composition; 470 ohms, $\pm 10\%$, 1/2 watt. (Same as R211)	16-32 Mc Mult Cathode Bias, Res., V206	RC20GF471K
R235	RESISTOR, fixed: composition; 470 ohms, $\pm 10\%$, 1/2 watt. (Same as R211)	32-64 Mc Mult Cathode Bias, Res., V207	RC20GF471K
S201 A, B, C, D	SWITCH, rotary: non-shorting; two section, two poles, four position.	Crystal Switch	SW-106
S202 A, B, C, D	SWITCH, rotary: four section, five position.	HFO Band Switch	SW-108
V201	TUBE, electron: 12AU7; miniature 9 pin. (Same as V104)	IFO Ampl	12AU7
V202	TUBE, electron: 6C4; miniature 7 pin.	HFO & RF Ampl	6C4
V203	TUBE, electron: 6AQ5; miniature 7 pin. (Same as V105)	RF Ampl	6AQ5
V204	TUBE, electron: 6AQ5; miniature 7 pin. (Same as V105)	RF Ampl-Mult: 2-4, 4-8 mc.	6AQ5
V205	TUBE, electron: 6AQ5; miniature 7 pin. (Same as V105)	8-16 Mc Multiplier	6AQ5
V206	TUBE, electron: 6AQ5; miniature 7 pin. (Same as V105)	16-32 Mc Multiplier	6AQ5
V207	TUBE, electron: 6AQ5; miniature 7 pin. (Same as V105)	32-64 Mc Multiplier	6AQ5
W201	CABLE, AC power: consists of 6 ft. of 16/30 and one molded plug, P201.	AC Input Cable	CA-102-2
XV201	SOCKET, tube: 9 pin miniature. (Same as XV104)	Socket for V201	TS103P01
XV202	SOCKET, tube: 7 pin miniature. (Same as XV102)	Socket for V202	TS102P01
XV203	SOCKET, tube: 7 pin miniature. (Same as XV102)	Socket for V203	TS102P01

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
XV204	SOCKET, tube: 7 pin miniature. (Same as XV102)	Socket for V204	TS102P01
XV205	SOCKET, tube: 7 pin miniature. (Same as XV102)	Socket for V205	TS102P01
XV206	SOCKET, tube: 7 pin miniature. (Same as XV102)	Socket for V206	TS102P01
XV207	SOCKET, tube: 7 pin miniature. (Same as XV102)	Socket for V207	TS102P01
XY201	SOCKET, crystal: .487" spacing for .050" pins. (Same as XY101)	Socket for Y201	TS-104-1
XY202	SOCKET, crystal: .487" spacing for .050" pins. (Same as XY101)	Socket for Y202	TS-104-1
XY203	SOCKET, crystal: .487" spacing for .050" pins. (Same as XY101)	Socket for Y203	TS-104-1
XY204	SOCKET, crystal: .487" spacing for .050" pins. (Same as XY101)	Socket for Y204	TS-104-1
Y201	CRYSTAL UNIT, quartz: 3.2 to 3.9 Mcs., (Supplied only on customer request)	IFO Crystal	CR-18/U
Y202	CRYSTAL UNIT, quartz: 2 to 64 Mcs., (Supplied only on customer request)	HFO Crystal	CR-18/U
Y203	CRYSTAL UNIT, quartz: 2 to 64 Mcs., (Supplied only on customer request)	HFO Crystal	CR-18/U
Y204	CRYSTAL UNIT, quartz: 2 to 64 Mcs., (Supplied only on customer request)	HFO Crystal	CR-18/U
C301	Not a replaceable part. Part of Z301.	VMO Tuning, Cap. V301	
C302	Not a replaceable part. Part of Z301.	VMO Correction, Cap. V301	
C303	Not a replaceable part. Part of Z301.	VMO Trimmer, Cap. V301	
C304	Not a replaceable part. Part of Z301.	VMO Padder, Cap. V301	
C305	Not a replaceable part. Part of Z301.	VMO Grid Coupling, Cap., V301	
C306	Not a replaceable part. Part of Z301.	VMO Cathode Coupling Cap., V301	
C307	Not a replaceable part. Part of Z301.	VMO Plate Bypass Cap., V301	
C308	Not a replaceable part. Part of Z301.	Cathode Follower Plate Bypass, Cap., V302	
C309	Not a replaceable part. Part of Z301.	100 Kc Plate Coupling Cap., V302	
C310	NOT USED.		

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C311	Not a replaceable part. Part of Z301.	100 Kc Adjust, V302	
C312	Not a replaceable part. Part of Z301.	100 Kc Output, V302	
C313	NOT USED.		
C314	CAPACITOR, fixed: mica; .01 uf, ±10%, char B, 300 wvdc. (Same as C104)	Inner Oven Thermostat Arc Suppressor, E301	CM35B103K
C315	CAPACITOR, fixed: mica; .01 uf, ±10%, char B, 300 wvdc. (Same as C104)	Relay Arc Suppressor K301	CM35B103K
C316	CAPACITOR, fixed: paper; .1 uf, ±40, -10%, 400 wvdc; plastic tubular case.	Outer Oven Thermostat Arc Suppressor, J302	CN-100-4
C317	NOT USED.		
C318	CAPACITOR, fixed: mica; .01 uf, ±10%, char B, 300 wvdc. (Same as C104)	Meter Bypass Cap., P302	CM35B103K
C319	Not a replaceable part. Part of Z301.	VMO Temperature Compensation, Cap., V301	
C320	Not a replaceable part. Part of Z301.	RF Bypass	
C321	Not a replaceable part. Part of Z301.	RF Bypass	
C322	Not a replaceable part. Part of Z301.	RF Bypass	
C323	Not a replaceable part. Part of Z301.	RF Bypass	
E301	BOARD, terminal: barrier type; eight 6-32 x 1/4" binding head machine screws.	Inner Oven Connections	TM-102-8
E302	BOARD, terminal: barrier type; nine 6-32 x 1/4" binding head machine screws.	Outer Oven	TM-102-9
I301	LAMP, neon: 110 volts, 1/25 watt, bayonet base.	Inner Oven Indicator	BI-100-51
I302	LAMP, incandescent: 6-8 volts, 250 ma DC, bayonet base.	Power Indicator	BI-101-44
I303	LAMP, neon: 105-125 volts, 1/25 watt, bayonet base. (Same as I301)	Zero Beat Indicator	BI-100-51
I304	LAMP, neon: 105-125 volts, 1/25 watt, bayonet base. (Same as I301)	Outer Oven Indicator	BI-100-51
J301	NOT USED.		

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
J302	CONNECTOR, female contact: polarized; twelve contact, chassis mounted. (Same as J201)	Internal VMO Connector	JJ-118-2
K301	RELAY, sensitive: 4500 ohms, DC res. (consists of R317)	Thermostat Control	A-123
L301	Not a replaceable part. Part of Z301.	VMO Tank, Coil V301	
L302	Not a replaceable part. Part of Z301.	VMO Cathode Choke, V301	
L303	Not a replaceable part. Part of Z301.	RF Choke, V301	
M301	METER, millimeter: 0-1, DC, 2-1/2" sq. case.	Test meter	MR-100-1
P301	CONNECTOR, plug: used on W301; not a replaceable part; part of Z301.	VMO Power Connector	MS3106B-16S1P
P302	CONNECTOR, male contact: polarized; twelve contact, w/cable clamps. (Same as P101)	VMO Connector	PL-102-1
P303	CONNECTOR, coaxial: used on W302; not a replaceable part; part of Z301.	p/o W302	UG-260/U
R301	Not a replaceable part. Part of Z301.	VMO Plate Filter, V301	
R302	Not a replaceable part. Part of Z301.	Cathode Follower Load	
R303	NOT USED.		
R304	Not a replaceable part. Part of Z301.	100 Kc Plate Filter	
R305	Not a replaceable part. Part of Z301.	100 Kc Cathode Load	
R306	Not a replaceable part. Part of Z301.	100 Kc Grid Leak	
R307	RESISTOR, fixed: wire wound; heater element, two section, 1300 ohms, each section insulated.	Inner Oven Heater Element, E301	RR-106
R308	RESISTOR, fixed: wire wound; heater element, two section, 1300 ohms, each section insulated. (Same as R307)	Inner Oven Heater Element, E301	RR-106
R309	RESISTOR, fixed: wire wound; heater element, 2 section, 160 ohms each section, insulated.	Outer Oven Heater Element, E302	RR-105
R310	RESISTOR, fixed: wire wound; heater element, 2 section, 160 ohms each section, insulated. (Same as R309)	Outer Oven Heater Element, E302	RR-105
R311	RESISTOR, fixed: composition; 100 ohms, -10%, 1/2 watt.	Inner Thermostat Arc Supp, E301	RC20GF101K
R312	RESISTOR, fixed: composition; 240,000 ohms, -5%, 1/2 watt.	Inner Oven Indicator Protector, E301	RC20GF244J

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
R313	RESISTOR, fixed: composition; 100 ohms, $\pm 10\%$, 1/2 watt. (Same as R311)	Relay Arc Supp, K301	RC20GF101K
R314	RESISTOR, fixed: composition; 100 ohms, $\pm 10\%$, 1/2 watt. (Same as R311)	Outer Oven Thermostat Arc Supp, E302	RC20GF101K
R315	RESISTOR, fixed: composition; 240,000 ohms, $\pm 5\%$, 1/2 watt. (Same as R312)	Outer Oven Indicator Protector, E302	RC20GF244J
R316	NOT USED.		
R317	RESISTOR, not a replaceable item, integral P/O A-123 Symbol K301	Relay Bleeder, Res., K301	P/O A-123
R318	RESISTOR, fixed: composition; 9100 ohms, $\pm 5\%$, 2 watts.	Voltage Dropping Res., E301	RC42GF912J
R319	RESISTOR, fixed: composition; 9100 ohms, $\pm 5\%$, 2 watt. (Same as R318)	Voltage Dropping Res., E301	RC42GF912J
R320	Not a replaceable part. Part of Z301.	VMO Grid Leak Res., V301	
R321	RESISTOR, fixed: composition; 12 ohms, $\pm 10\%$, 2 watts.	Power Indicator Series Dropping Res., E302	RC42GF120K
S301	SWITCH, thermostatic: bimetallic; operate at 70°C , $\pm 5^{\circ}\text{C}$.	Inner Oven Thermostat	A-1236
S302	SWITCH, thermostatic: bimetallic; operates 80°C , $\pm 2^{\circ}\text{C}$.	Inner Oven Safety Thermostat	SS-100-3
S303	SWITCH, thermostatic: bimetallic; operates 60°C , $\pm 2^{\circ}\text{C}$.	Outer Oven Thermostat	SS-100-1
V301	TUBE, electron: 6AB4; miniature 7 pin. (Part of Z301)	VMO	6AB4
V302	TUBE, electron: 12AU7; miniature 9 pin. (Part of Z301)	Cathode Follow & 100Kc Crystal Oscillator	12AU7
W301	CABLE ASSEMBLY, R.F.: VMO to J101; consists of various sizes, lengths, and color SR1R cable 20 in. of flexible shield; 16-1/2 in. of sleeving; and one connector; MS3106B16S-1P, P301. (Part of Z301)	VMO-PS Cable	CA-281
W302	CABLE ASSEMBLY, R.F.: VMO to J202; consists of 18 in. of RG-58/U; 3 in. of flexible shield; one inner and outer ferrule; and one connector, UG-260/U, P303. (Part of Z301)	VMO-Mult. Cable	CA-282
XI301	LIGHT, indicator: with clear white lens; for min. bayonet base T-3-1/4 bulb.	Socket for I301	TS-106-2
XI302	LIGHT, indicator: with red frosted lens, for min. bayonet base T-3-1/4 bulb.	Socket for I302	TS-106-1

**VARIABLE FREQUENCY OSCILLATOR VOX-5
(SYMBOL SERIES 100 THROUGH 300)**

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
XI303	LIGHT, indicator: with clear white lens, for min. bayonet base T-3-1/4 bulb. (Same as XI301)	Socket for I303	TS-106-2
XI304	LIGHT, indicator: with clear white lens, for min. bayonet base T-3-1/4 bulb. (Same as XI301)	Socket for I304	TS-106-2
XK301	SOCKET, tube: octal. (Same as XC102)	Socket for K301	TS101P01
XV301	Not a replaceable item. Part of Z301.	Socket for V301	
XV302	Not a replaceable item. Part of Z301.	Socket for V302	
XY301	Not a replaceable item. Part of Z301.	Socket for Y301	
Y301	Not a replaceable item. Part of Z301.	100 Kcs Osc	
Z301	OSCILLATOR ASSEMBLY, variable: consists of C301, 302, 303, 304, 305, 306, 307, 308, 309, 311, 312, 319, 320, 321, 322, 323; L301, 302, 303; P301, 303; R301, 302, 304, 305, 306, 320; V301, 302; W301, 302; XV301, XV302; XY301; Y301.	Master Oscillator	A0-100

SECTION 8
SCHEMATIC DIAGRAMS

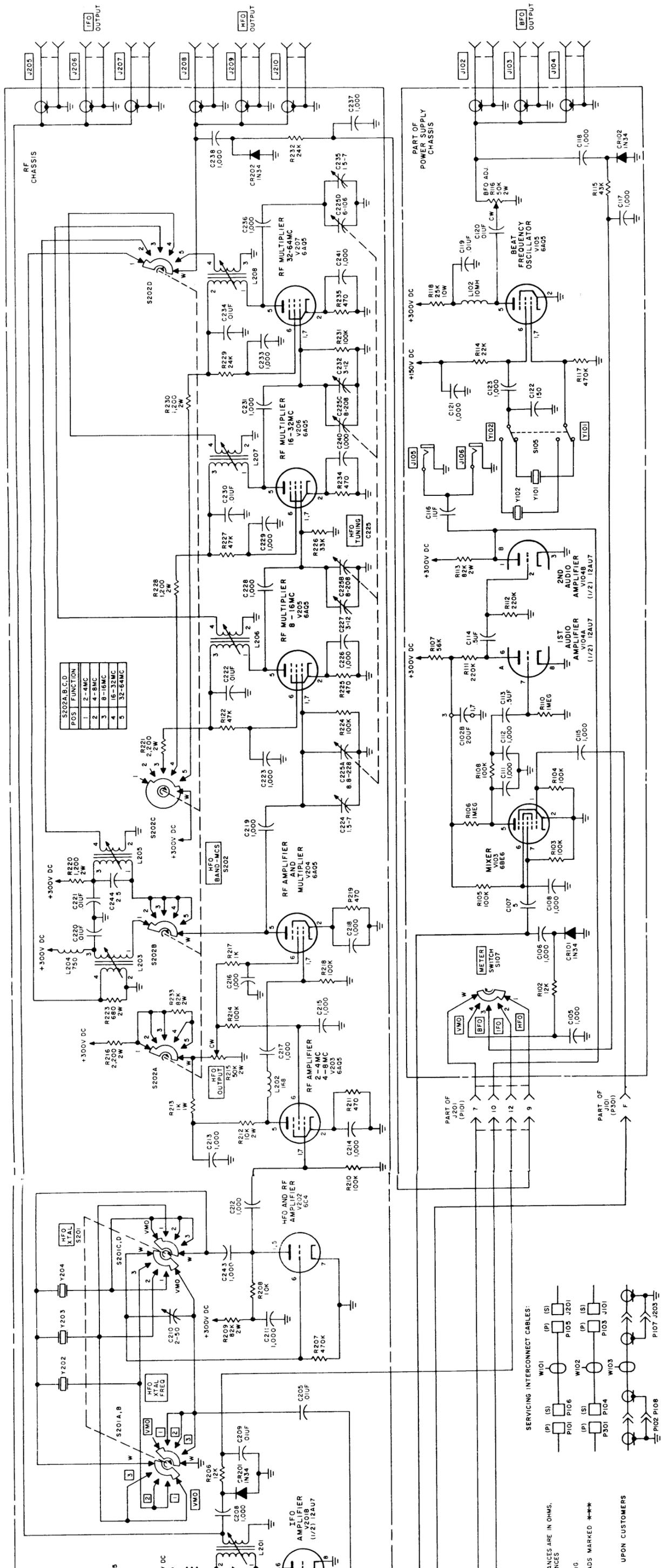
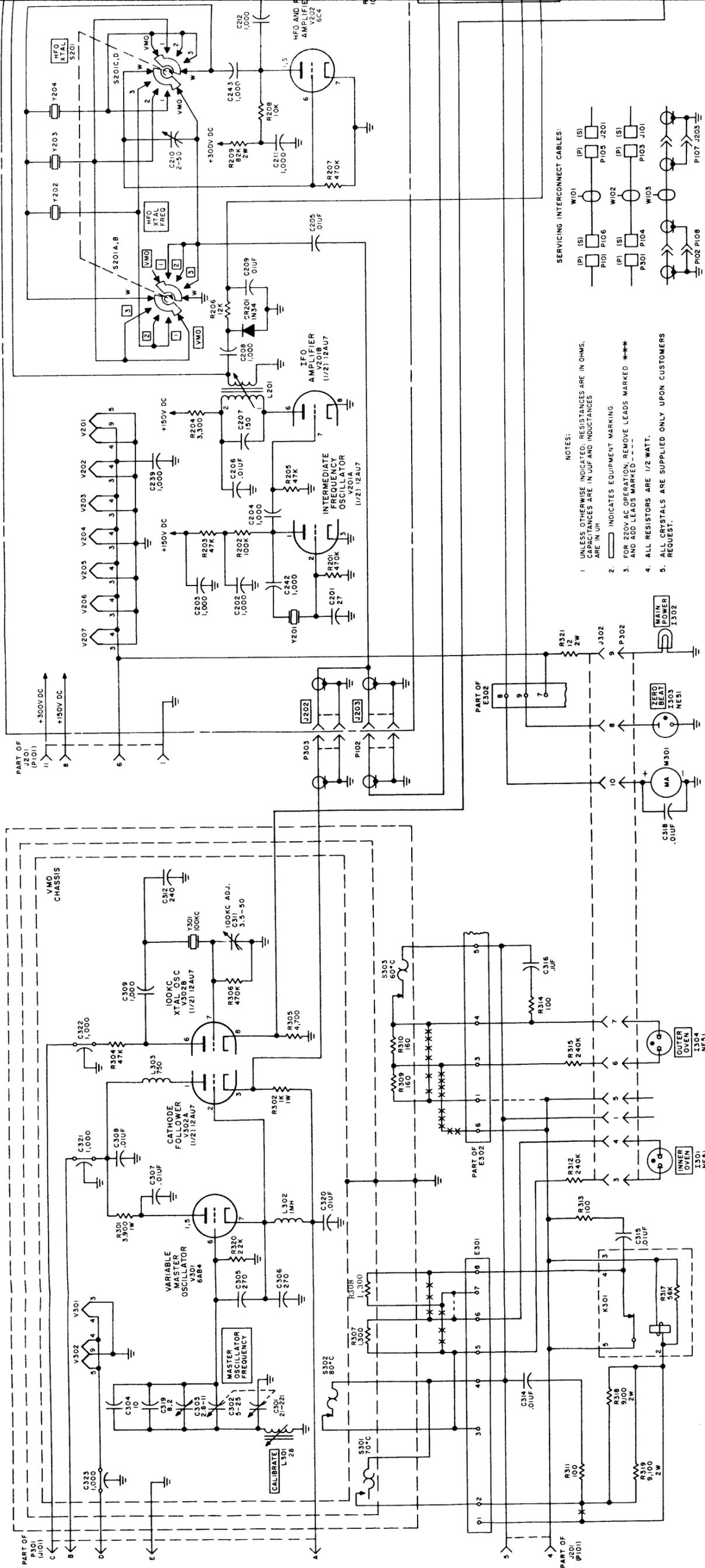
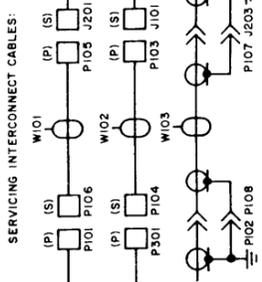
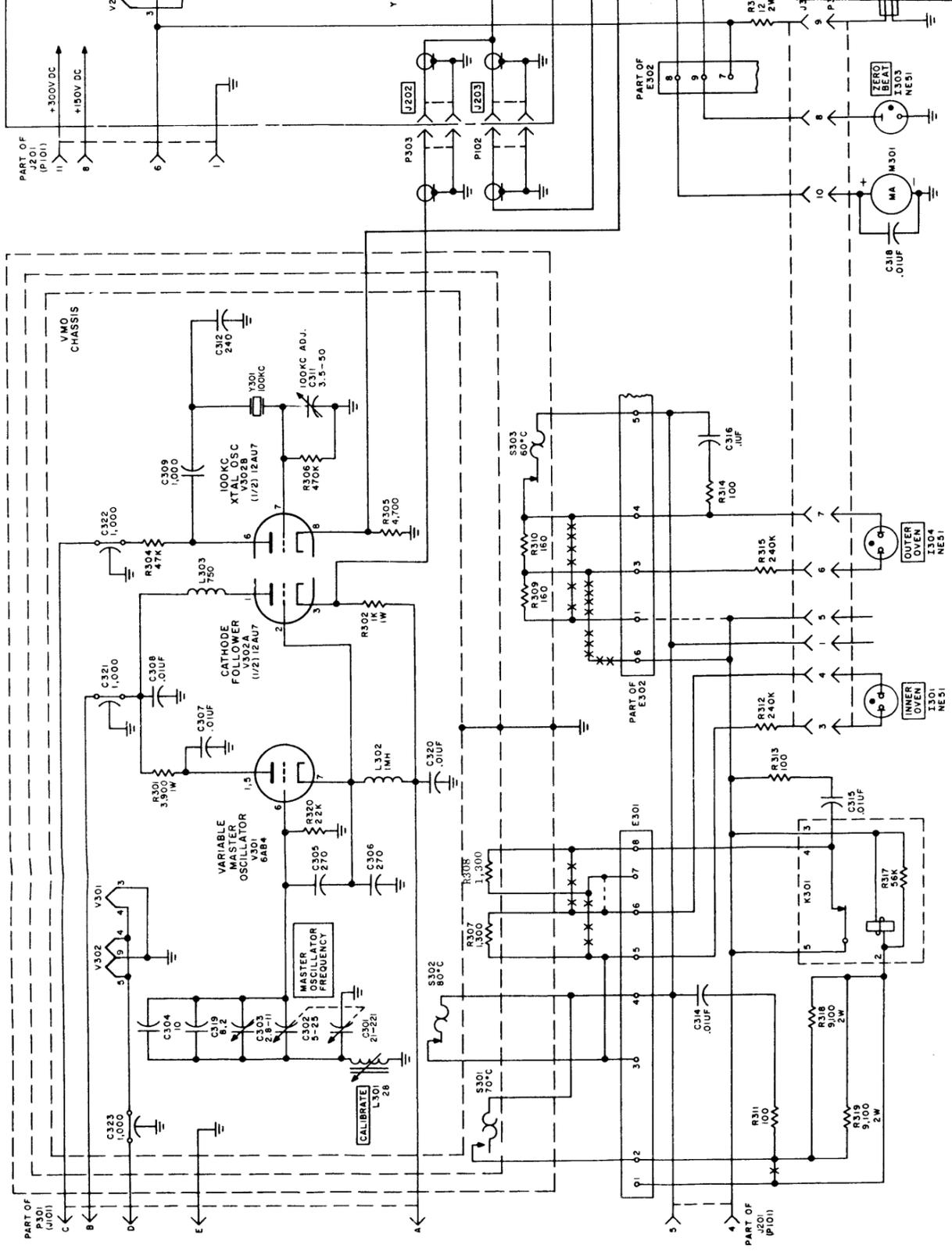


Figure 8-1. Schematic Diagram, VOX-5 (Sheet 1 of 2)



- NOTES:
1. UNLESS OTHERWISE INDICATED, RESISTANCES ARE IN OHMS, CAPACITANCES ARE IN UF AND INDUCTANCES ARE IN UH.
 2. INDICATES EQUIPMENT MARKING.
 3. FOR 220V AC OPERATION, REMOVE LEADS MARKED ***.
 4. ALL RESISTORS ARE 1/2 WATT.
 5. ALL CRYSTALS ARE SUPPLIED ONLY UPON CUSTOMERS REQUEST.





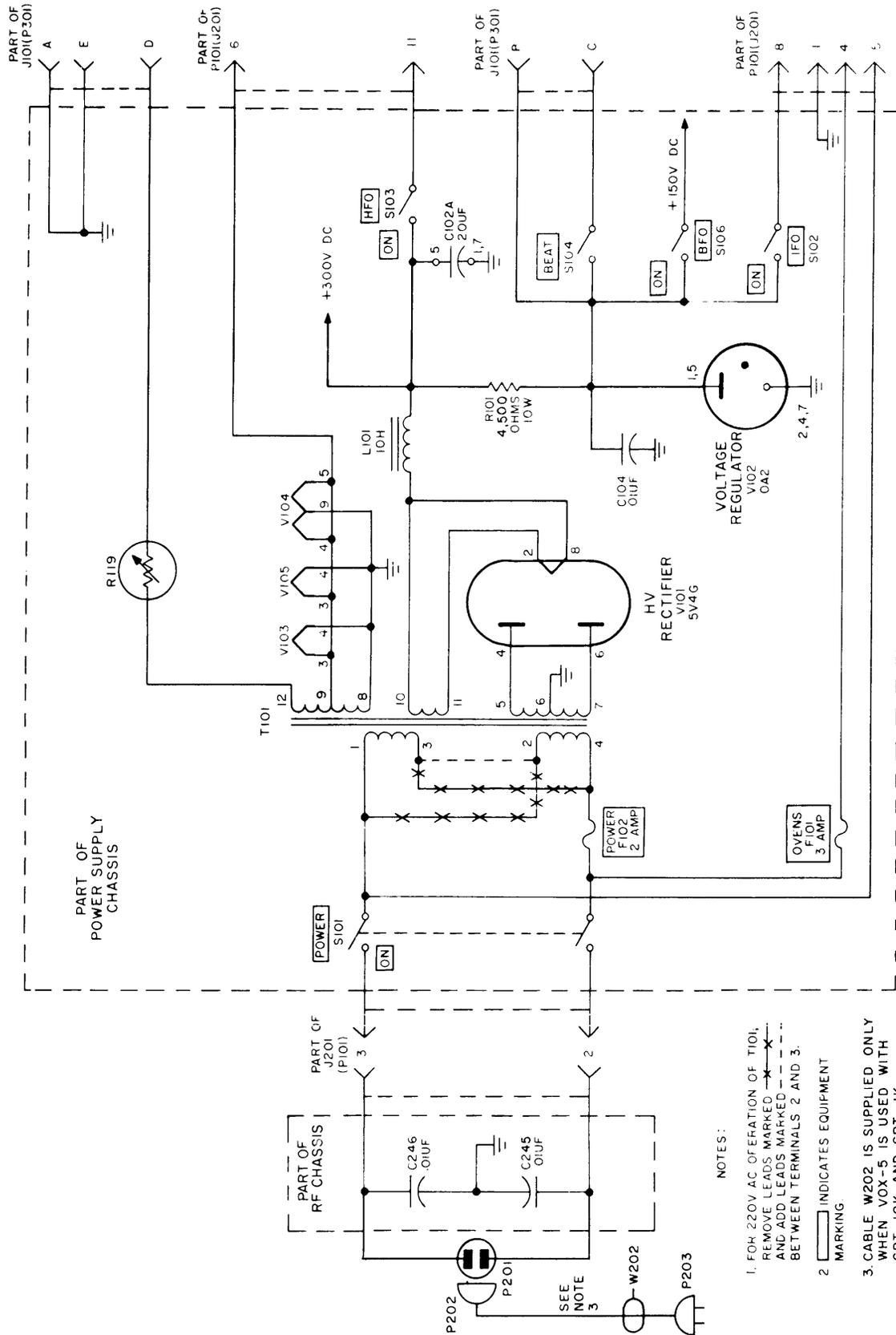


Figure 8-1. Schematic Diagram, VOX-5 (Sheet 2 of 2)