Barrington TMC

VOLUME II

UNCLASSIFIED

TECHNICAL MANUAL

for

TRANSMITTING SET, RADIO, MODEL GPT-10K

(AN/FRT-39 and -39A)

THE TECHNICAL MATERIEL CORPORATION

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FOREWORD

The following table shows the equipment units or sections comprising Transmitting Set, Radio, Model GPT-10K (commercial designation) or Transmitting Set, Radio AN/FRT-39 and Transmitting Set, Radio AN/FRT-39A (military designations). The table shows that the essential differences between the earlier and later models of the GPT-10K are as follows:

Early Model (AN/FRT-39)	Late Model (AN/FRT-39A)
Sideband Level Monitor Model SLM-1	Sideband Level Monitor Model SLM-2
Transmitting Mode Selector Model SBE-2	Transmitting Mode Selector Model SBE-3
Monitor Control Panel Model MCP-1	Monitor Control Panel Model MCP-2
	Isolation Keyer Model AK-100

Each section of this volume describes, irrespective of model, all the exciter, test, or control units located on the auxiliary frame chassis. Volume I of the manual similarly describes all equipments located on the main frame chassis.

TABLE OF EQUIPMENT UNITS OR SECTIONS OF TRANSMITTING SET RADIO AN/FRT-39 AND AN/FRT-39A (GPT-10K)

AN/FRT-39 (TMC vs Military Designations)	AN/FRT-39A (TMC vs Military Designations)	COLLOQUIAL NAME
Transmitting Set, Radio, Model GPT-10K vs Transmitting Set, Radio AN/FRT-39	Transmitting Set, Radio, Model GPT-10K vs Transmitting Set, Radio AN/FRT-39A	GPT-10K
AUXILIARY FRAME CHASSIS		
Sideband Level Monitor Model SLM-1	Sideband Level Monitor Model SLM-2	SLM
Frequency Spectrum Analyzer Model FSA vs Spectrum Analyzer Group AN/URM-116	Frequency Spectrum Analyzer Model FSA vs Spectrum Analyzer Group AN/URM-116	FSA
a. Analyzer Model SA-1 vs Analyzer Spectrum TS-1236/URM-116	a. Analyzer Model SA-1 vs Analyzer Spectrum TS-1236/URM-116	a. SA
b. Power Supply Model PS-12 vs Power Supply PP-2206/URM-116	b. Power Supply Model PS-12 vs Power Supply PP-2206/URM-116	b. PS-12
Transmitting Mode Selector Model SBE-2 vs Modulator-Power Supply Group AN/URA-23	Transmitting Mode Selector Model SBE-3 vs Modulator Power Supply Group AN/URA-28	SBE
a. Exciter Unit Model A-1516 vs Oscillator, Radio Frequency 0-503/URA-23	a. Exciter Unit Model AO-101 vs Oscillator, Radio Frequency 0-672/URA-28	a. SBE
b. Power Supply Model A-1397 vs Power Supply PP-1769/URA-23	b. Power Supply Model A-1397 vs Power Supply PP-1769/URA-23	b. SBE
Monitor Control Panel Model MCP-1 vs Control Panel SB-971/FRT-39	Monitor Control Panel Model MCP-2 vs Control Panel SB-971A/FRT-39	MCP
————	Isolation Keyer Model AK-100	ISK
Variable Frequency Oscillator Model VOX-2 vs Oscillator, Radio Frequency 0-330/FR	Variable Frequency Oscillator, Model VOX-2 vs Oscillator, Radio Frequency 0-330/FR	VOX
Frequency Shift Exciter Model XFK vs Control, Electrical Frequency C-2749/URT	Frequency Shift Exciter Model XFK vs Control, Electrical Frequency C-2749/URT	XFK
Two Tone Generator Model TTG vs Generator, Signal 0-579/URT	Two Tone Generator Model TTG vs Generator, Signal 0-579/URT	TTG
Auxiliary Power Panel Model APP-1	Auxiliary Power Panel Model APP-1	APP

TABLE OF EQUIPMENT UNITS OR SECTIONS OF TRANSMITTING SET RADIO AN/FRT-39 AND AN/FRT-39A (GPT-10K) (Cont.)

AN/FRT-39 (TMC vs Military Designations)	AN/FRT-39A (TMC vs Military Designations)	COLLOQUIAL NAME
	MAIN FRAME CHASSIS	
RF Amplifier Model vs Amplifier, Radio Frequency AM-2103/URT	RF Amplifier Model vs Amplifier, Radio Frequency AM-2103/URT	IPA
a. RF Amplifier Model RFB-1	a. RF Amplifier Model RFB-1	a. IPA
b. Power Supply Model AX-104	b. Power Supply Model AX-104	b. AX-104
Power Amplifier Section Model T1-102	Power Amplifier Section Model T1-102	PA
Main Power Supply Section	Main Power Supply Section	Main power supply
a. High Voltage Coil and Blower Compartment	a. High Voltage Coil and Blower Compartment	a. Coil/blower units or compartment
b. High Voltage Resistor/ Capacitor Compartment	b. High Voltage Resistor/ Capacitor Compartment	b. Resistor/ capacitor units or compartment
c. Main Transformer Compartment	c. Main Transformer Compartment	c. Main transformer
High Voltage Rectifier Section Model AX-103	High Voltage Rectifier Section Model AX-103	AX-103
Relay Panel Assembly Model T1-106	Relay Panel Assembly Model T1-106	Relay control panel
Indicator Control Panel	Indicator Control Panel	Indicator control panel
PA TUNE/PA LOAD Panel Assembly	PA TUNE/PA LOAD Panel Assembly	PA tuning/loading panel or units
Main Power Panel Assembly	Main Power Panel Assembly	Main power control panel
Meter Panel Assembly	Meter Panel Assembly	Meter panel

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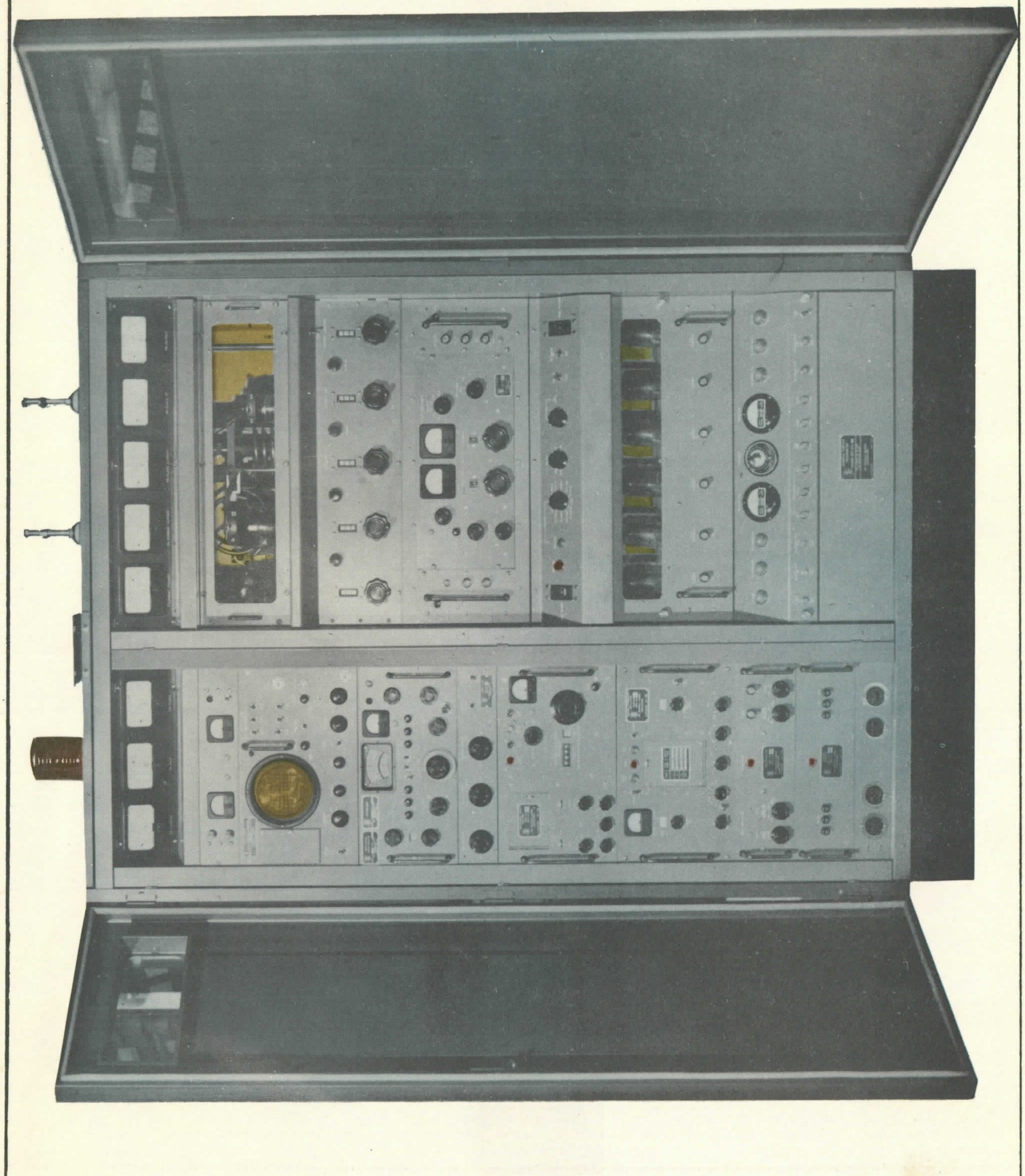


Figure 1-1-a Front View, Model GPT-10K

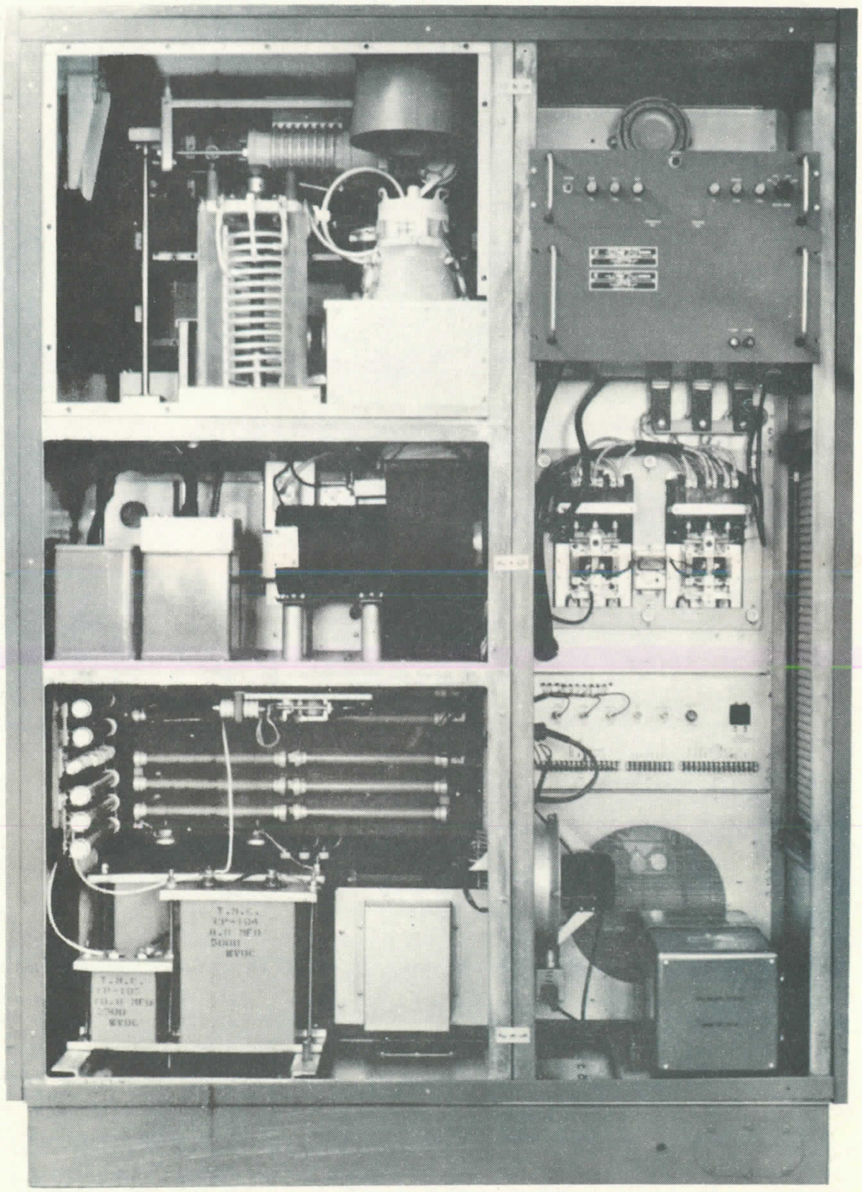


Figure 1-1-b Rear View, Transmitting Set, Radio, Model GPT-10K

SECTION 1
GENERAL DESCRIPTION

1-1. INTRODUCTION.

Figures 1-1-a and 1-1-b show Technical Materiel Corporation's Transmitting Set, Radio, Model GPT-10K (Transmitting Set, Radio AN/FRT-39). The GPT-10K is described in the present three-volume manual as follows:

Volume	Description
I	Units located on the main frame chassis; however, brief functional descriptions are given of units on the auxiliary frame chassis when necessary to clarify the functions of the main frame chassis units.
II	Units located on the auxiliary frame chassis.
III	Parts lists of all units.

This arrangement was adopted for two principal reasons:

a. To simplify the instructions in Volume I. For example: the more important GPT-10K controls are all located on the main frame chassis while the more numerous controls on the auxiliary frame chassis concern exciter and/or test equipments only. Consequently, tuning and loading GPT-10K is simplified when exciter and test equipment are initially set for a given mode of transmission following which concentrated effort may be given to problems of GPT-10K performance.

b. The test and exciter units on the auxiliary frame chassis constitute general purpose equipment and have many uses beyond their specific uses with GPT-10K operation. Placement of extended descriptions in Volume II permits complete descriptions of the test and exciter units without complicating the instructions in Volume I.

For convenience, the following tabulation of the organization of the manual is abstracted from paragraph 1-2 of Volume I of the manual.

Volume I consists of the following:

a. Section 1, GENERAL DESCRIPTION: Covers all GPT-10K units in order to present an overall picture of their inter-relationship, with emphasis on the units on the main frame chassis (right-hand section facing GPT-10K).

b. Section 2, INSTALLATION: Covers all GPT-10K units to facilitate a complete installation of a GPT-10K.

c. Section 3, OPERATOR'S SECTION: Consists of detailed step-by-step procedures for tuning and loading GPT-10K at rated output and low distortion under each of its various emissions. The procedures deal principally with the units on the main frame chassis but present short exciter and test equipment directions necessary to accomplish the tune up. Detailed operating procedures of the units on the auxiliary frame chassis are given in Section 3 of Volume II of the manual.

d. Section 4, PRINCIPLES OF OPERATION: Deals only with equipment located on the main frame chassis.

e. Section 5, TROUBLE-SHOOTING: Deals only with equipment located on the main frame chassis.

f. Section 6, MAINTENANCE: Deals only with equipment located on the main frame chassis.

g. Section 7, PRINCIPAL SCHEMATICS, WIRING DIAGRAMS, AND INTERCONNECTING DIAGRAMS: Covers all GPT-10K units.

Volume II consists of the following:

a. Section 1, GENERAL DESCRIPTION: Covers general field of utility of all test and exciter units on the auxiliary frame chassis (left-hand section facing GPT-10K) in greater detail than in Volume I.

b. Section 2, INSTALLATION: Covers all test and exciter units on the auxiliary frame chassis.

c. Section 3, OPERATOR'S SECTION: Consists of detailed step-by-step procedures to operate all units on the auxiliary frame chassis, particularly coordinating their activities with those of the main GPT-10K units on the main frame chassis. Detailed operating procedures of the units on the main frame chassis are given in Section 3 of Volume I of the manual.

d. Section 4, PRINCIPLES OF OPERATION: Deals only with equipment located on the auxiliary frame chassis.

e. Section 5, TROUBLE-SHOOTING: Deals only with equipment located on the auxiliary frame chassis.

f. Section 6, MAINTENANCE: Deals only with equipment located on the auxiliary frame chassis.

g. Section 7, PRINCIPAL SCHEMATICS, WIRING DIAGRAMS, AND INTERCONNECTING DIAGRAMS: Covers both the equipment located on the auxiliary frame chassis and the equipment located on the main frame chassis.

Volume III covers parts lists for all units and tabulates units used in various assemblies of GPT-10K.

1-2. FUNCTIONAL DESCRIPTION.

a. GENERAL. The panel views of the units on the auxiliary frame chassis are illustrated on the left-hand section of figures 1-1-a and 1-2 in this volume of the manual.

b. METER PANEL. (See figures 1-1-a and 1-2, top panel.) - The three meters monitor DC voltages on the PA tube and consequently concern operation of a main frame chassis unit. Normal PA SCREEN DC voltage is either 600 or 1200, depending on the position of the TUNE-OPERATE switch; normal PA BIAS DC voltage is -300; normal PA PLATE DC voltage is +7500. For greater detail, see figure 4-13 of Volume I of the manual.

c. MONITOR CONTROL PANEL MODELS MCP-1 and MCP-2. (See figures 1-1-a and 1-2, fifth panel.) - This panel is a switching panel. MCP-1 contains three selector switches and two toggle switches; MCP-2 is the same as MCP-1 except for an additional selector switch. The panel switches channel various outputs of units on the main frame and auxiliary frame chassis to test and exciter units on the auxiliary frame chassis.

The following is a brief functional description of the MCP-1: The SBE VMO INPUT selector switch channels one of three variable medium-frequency (2 to 4 mc) oscillator sources, an EXT source, the VOX (an RF oscillator), or the XFK (a frequency shift exciter) to the SBE VMO INPUT circuit. This is in place of the crystal oscillator supply of Transmitting Mode Selector Model SBE-2 and SBE-3. The VOX RF OUTPUT selector switch channels the oscillator output to the SBE, the ANALYZER, the XFK (a frequency shift keyer), or to an EXT circuit. The ANALYZER MONITOR channels a TEST source of voltage, the SBE RF output, the DRIVER RF output, or the FINAL RF output to Analyzer Model SA-1. CHANNEL 1 may be supplied with tones or audio from LINE 1 INPUT and CHANNEL 2 may also be supplied with tones or audio from LINE 2 INPUT.

The functional description of the MCP-1 is applicable to the MCP-2. In addition, the MODE selector switch channels keying intelligence via an isolation keyer to either the SBE or XFK. In positions 1 and 2, the SBE operates on SSB and CW intelligence respectively. Only the CW intelligence is routed through the isolation keyer. In positions 3, 4, and 5, the XFK operates on CW, RTTY, or FAX intelligence, respectively. In the first two cases, the keying intelligence is routed through the isolation keyer.

General descriptive characteristics of MCP-1 and MCP-2 are presented in tables 1-1 and 1-6-d.

d. SIDEBAND LEVEL MONITOR MODELS SLM-1 AND SLM-2. (See figures 1-1-a and 1-2, second panel.) - This panel assembly provides two meters that indicate sideband levels in the LSB-USB filter outputs of the SBE unit. In the SLM-2 unit, these outputs operate as 250-kc oscillator sidebands and actuate the SLM's VTVM meters; in the SLM-1 unit, these outputs operate as 17-kc oscillator sidebands and actuate the SLM's VTVM meters. Besides the meters, the front panel contains LSB-USB calibrating potentiometers, main power ON-OFF switch, MAIN POWER indicator lamp, and two fuses. On the rear of the front panel are LSB, USB, and AC INPUT POWER jacks.

General descriptive characteristics of the SLM-1 and SLM-2 are presented in tables 1-1, 1-2, 1-3, 1-4-a, 1-5, and 1-6.

e. FREQUENCY SPECTRUM ANALYZER (FSA). (See figures 1-1-a and 1-2, third panel.) - The FSA is an automatic scanning superheterodyne receiver which permits analysis and identification of one or many RF signals at one time. Each signal within the band being scanned is displayed on a cathode-ray tube as one of a series of inverted V's or "pips." The pip amplitude and position along the calibrated horizontal axis are indicative of signal level and frequency, respectively. A CW signal produces a single pip. Modulated signals (AM, FM, or pulsed) cause a series of pips which indicate sideband distribution and levels.

The variable sweep widths (0 to 100 kc, 0 to 2 kc) and preset widths (150∼, 500∼, 2KC, 10KC, and 30 KC) for any point in the RF spectrum up to several hundred megacycles; in conjunction with the automatic scanning feature, the variable sweep widths make the FSA an ideal tool for research, design, or test applications. It is particularly useful in the operation and testing of the GPT-10K. For example, the FSA quickly evaluates modulation products, sideband levels, noise, residual carrier, spurious oscillation, etc. The wider bands are for search and preliminary analysis; the narrower bands are for detailed analysis. The 150-, 500-, and 2000-cps sweep widths are AFC stabilized.

The FSA is unique in that it offers all the advantages of automatically scanning spectrum presentations, yet enables examination of signals so closely adjacent in frequency that their corresponding deflections normally tend to merge together or even completely mask one another, even with static-wave analyzers. This instrument can, at reduced sweep widths and slow sweep rates, resolve equal amplitude signals down to 10-cps separation. Signals with an amplitude ratio of 50 db separated by 60 cps are clearly separated. (See figure 1-3.)

General descriptive characteristics of the FSA are presented in tables 1-1, 1-2, 1-3, 1-4-b, 1-5, and 1-6-b.

f. TRANSMITTING MODE SELECTOR MODELS SBE-2 AND SBE-3. (See figures 1-1-a and 1-2, fourth panel.) - The SBE-2 and SBE-3 are filter-type, single- or double-sideband exciters designed for radio telephone, telegraph, and frequency-shift operation. They are continuously tunable from 2 to 32 mc.

The SBE is primarily intended for use as an exciter in sideband (single, double, independent) transmission with various degrees of carrier insertion, as desired. It is excellently suited to serve as an exciter for any well designed, linear, RF amplifier that requires up to 1-watt (SBE-3) or 3-watts (SBE-2) PEP excitation through 72-ohm input impedance.

A voice-operated control circuit is provided to ensure that transmission will occur only when the operator is speaking directly into the microphone. A squelch circuit is used to prevent the audio from local receivers from operating the voice-operated control circuit. Both are front panel controls and may be easily adjusted for best performance over a wide range of operating conditions. Manual push-to-talk control may be used instead of voice-operated control, if desired.

The following modes of operation may be selected and used with continuously adjustable amounts of carrier insertion:

(1) Carrier Amplitude Modulation (AM)

(2) Single Sideband (SSB)

(3) Double Sideband (DSB)

(4) Independent Sideband (ISB)
(Separate intelligence on each sideband.)

(5) Frequency Shift Keying (FSK)

(6) CW Telegraphy (CW)

The power supply for the SBE-2 is the same as for the SBE-3. Front panel views show three fuses and one indicator. The power supply fuses unregulated B+ (125, 180, and 250 volts), regulated B+ (150 volts), and filament (6.3 AC). The power supply is shown in figures 1-1-a and 1-2, next to last panel.

General descriptive characteristics of the SBE-2 and SBE-3 are presented in tables 1-1, 1-2, 1-3, 1-4-c, 1-4-d, 1-5, and 1-6-c.

g. VARIABLE FREQUENCY OSCILLATOR MODEL VOX-2. (See figures 1-1-a and 1-2, sixth panel.) - The VOX is a precision, direct-reading, variable-frequency device which is designed to provide high-frequency and medium-frequency oscillator injection with extremely high stability.

The VOX provides the following:

(1) High-frequency output voltage, continuously variable over the range of 2 to 64 mc.

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

(3) Crystal-controlled BFO voltage over the range of 300 to 1000 kc (frequency dependent upon crystals used) for dual-conversion superheterodynes such as the Hammarlund 600 series.

(4) 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 GPT-10K SBEs.

The VOX incorporates a highly stable variable-frequency oscillator, (1) 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, (2) above.

Additional crystal oscillators provide crystal-controlled beat frequency oscillator voltage, (3) above, and a 3.2- to 3.9-mc crystal-controlled RF output, (4) above, for dual conversion receivers.

General descriptive characteristics of the VOX are presented in tables 1-1, 1-2, 1-3, 1-4-e, 1-5, and 1-6-e.

h. FREQUENCY SHIFT EXCITER MODEL XFK. (See figures 1-1-a and 1-2, seventh panel.) - The XFK is a single-unit, frequency-shift exciter designed for fixed station use. The XFK is a high-stability RF oscillator which provides a means of shifting an RF carrier in accordance with the variations of an audio pulse signal. It provides frequency shift telegraph signals in two bands, 1 to 2.5 mc and 2.5 to 6.9 mc.

The XFK replaces the crystal oscillator in a GPT-10K and provides "mark" and "space" carrier shift transmission of teleprinter, telegraph, and facsimile (or telephoto) intelligence. Carrier shift up to 1000 cycles is available; either linear with applied voltage or independent of applied voltage-amplitude variations.

Carrier shift has become the most accepted means of transmitting the above mentioned types of intelligence. The GPT-10K frequency is changed from a low "space" frequency to a higher "mark" frequency in accordance with the input intelligence. At the receiver, the GPT-10K's RF frequency-shift telegraph signals are detected, and a suitable converter changes them to audio or pulse signals. These signals are replicas of the input intelligence at the transmitting terminal (discounting distortion in the overall transmission path) and are fed to audio-frequency receiving equipment at the receiving terminal. For receiving, a Dual Diversity Receiver (such as TMC Model DDR-2) is recommended in conjunction with a Frequency Shift Converter (such as TMC Model CFA).

General descriptive characteristics of the XFK are presented in tables 1-1, 1-2, 1-3, and 1-4-f, 1-5, and 1-6-f.

i. TWO TONE GENERATOR MODEL TTG. (See figures 1-1-a and 1-2, eighth panel.) - The TTG was especially designed for operation with the GPT-10K but is readily usable with other transmitting equipment. The unit is a primary source of two groups of test tones. The TTG provides two audio tones, 935 cps and 2805 cps, and two RF output frequencies, 1999 kc and 2001 kc.

The audio oscillator has especially low distortion to ensure an accurate check of distortion in the standard two-tone GPT-10K test. Crystal control of the RF oscillators provides stable and dependable frequency output, useful for checking proper operation of the SA.

General descriptive characteristics of the TTG are presented in tables 1-1, 1-2, 1-3, and 1-4-g, 1-5, and 1-6-g.

j. ISOLATION KEYER MODEL AK-100. (See figure 1-1-b, panel above FSA power supply panel.) This panel contains six fuses (three of which are spare), an indicator lamp, a power on-off switch, two screw-driver potentiometer controls, and a four-position keying mode selector switch. The latter enables the keyer to perform on keying signals as follows:

Position	Keying Mode
1	50V
2	100V
3	60MA
4	20MA

Incoming keying signals (CW or RTTY) are electronically handled by the keyer and passed along to the SBE (CW) or to the XFK (CW, RTTY).

General descriptive characteristics of the ISK are presented in tables 1-1, 1-3, 1-4-i, 1-5, and 1-6-h.

k. AUXILIARY POWER PANEL MODEL APP-1. (See figures 1-1-a and 1-2, bottom panel.) - The APP contains four Power Supply Model PS-12 plugs for EXTERNAL 115-VOLT, 60-cycle supply. A fifth plug is located on the rear of the panel. These five plugs are unwired. This supply panel is not used since 115-volt power is derived from 230-volt power via a regulating transformer. In an emergency, however, the units on the auxiliary frame chassis may be supplied with 115-volt external power. Under this arrangement, the stability of the SA, in particular, will be relatively poor. For reliability of power supply to GPT-10K, do not interconnect the five plugs (normally unwired) to the GPT-10K's 115-volt regulating transformer output which should be reserved solely for power supply to the units on the auxiliary frame chassis.

TABLE 1-1. EQUIPMENT SUPPLIED AND PHYSICAL CHARACTERISTICS

UNIT	DESIGNATION COMMERCIAL	DESIGNATION MILITARY	QUANTITY PER GPT-10K	*APPROXIMATE INSTALLATION DIMENSIONS LENGTH	HEIGHT	DEPTH	*VOLUME	*WEIGHT
SIDEBAND LEVEL MONITOR	SLM-1	None	1	19	3-1/2	8	0.3	8-1/2
	SLM-2	None	1	19	3-1/2	8	0.3	8-1/2
FREQUENCY SPECTRUM ANALYZER	FSA	AN/URM-116	–	–	–	–	–	–
Analyzer	SA-1	TS-1236/URM-116	1	19	10-1/2	21-7/8	–	31
Analyzer Cabinet	–	–	1	22	12-9/16	21-3/8	–	27
Power Supply	PS-12	PP-2206/URM-116	1	19	8-23/32	14-5/8	–	28
Power Supply Cabinet	–	–	1	16-1/4	8-3/4	14-1/8	–	12
Constant Voltage Transformer	T3003-1	–	1	4-1/2	7-1/2	8-3/8	–	18
Power Interconnecting Cable	W 3046	–	1	5-ft long with two connectors AN-3106-28-25 and AN-3106B-28-P				
Signal Input Cable	W 3001	RG-8/U	2	3-ft long ea with one connector UG-21B/U and 1 tinned end				
Spare Fuses	AGC, 2A, 250V	–	3	–	–	–	–	–
Alignment Tool	E1010	–	1	–	–	–	–	–
TRANSMITTING MODE SELECTOR	SBE-3	AN/URA-28	–	–	–	–	–	–
RF Oscillator	AO-101	0-672/URA-28	1	19	8-3/4	15	1.5	41
Power Supply	A-1397	PP-1769/URA-23	1	19	5-1/4	15	0.9	38
Power Interconnecting Cable	CA-346	–	1	Approximately 7-ft long with two connectors AN-3057-12P and AN-3057-12S				5
Signal Interconnecting Cable	P/O CA-427	–	1	Approximately 12-ft long; 14 wires E/W tinned ends; 5 coaxials E/W connectors				
AC Cable (Power Supply)	CA-103.72	–	–	Approximately 6-ft long; interconnects 115-volt source to power supply.				
TRANSMITTING MODE SELECTOR	SBE-2	AN/URA-23	–	–	–	–	–	–
RF Oscillator	A-1516	0-503A/URA-23	1	19	8-3/4	15	1.5	41
Power Supply	A-1397	PP-1769/URA-23	1	19	5-1/4	15	0.9	38
Power Interconnecting Cable	CA-346	–	1	Approximately 7-ft long with two connectors AN-3057-12P and AN-3057-12S				5
Signal Interconnecting Cable	P/O CA-427	–	1	Approximately 12-ft long; 14 wires E/W tinned ends; 5 coaxials E/W connectors				
AC Cable (Power Supply)	CA-103.72	–	–	Approximately 6-ft long; interconnects 115-volt source to power supply.				
MONITOR CONTROL PANEL	MCP-1	SB-971/URT-39	1	19	3-1/2	5-3/4		4
	MCP-2	SB-971A/URT-39	–	19	3-1/2	5-3/4		4
VARIABLE FREQUENCY OSCILLATOR	VOX-2	0-330/FR	1	19	10-1/2	16	1.8	70
Auxiliary Service Cables	CA-108, CA-109, CA-110		3	6 ft ea	–	–	–	1-1/2
Coaxial Connector	–	UG-260/U	10	–	–	–	–	
Tube Puller	GP-104	–	1	–	–	–	–	
FREQUENCY SHIFT EXCITER	XFK	C-2749/URT	1	19	10-1/2	16	1.8	48
Cable Assembly	CA-103	–	1	6 ft	–	–	–	1/2
TWO TONE GENERATOR	TTG	0-579/URT	1	19	5-1/4	13	0.8	19
AUXILIARY POWER PANEL	APP-1	–	1	19	3-1/2	–	–	2-1/2
ISOLATION KEYER (Rear Chassis)	ISK	–	1	19	5-1/4	15	0.9	28

* Unless otherwise stated, dimensions are in inches, volume in cubic feet, weight in pounds.

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED

PART I. AS COMPONENTS OF GPT-10K

UNIT	COMPONENT REQUIRED QUANTITY	NAME	NAVY TYPE DESIGNATION	REQUIRED USE	REQUIRED CHARACTERISTICS
SBE-2, SBE-3	10	Crystals	CR-27/U	Frequency source	2-4 mc
	1	Microphone	-	Speech input	Audio
	2	Audio Line Channels	-	Speech input	Audio
XFK	3	Crystals	CR-27/U	Frequency Source	2-4 mc

PART II. AS INDEPENDENT UNITS (end items). (Additional items to those shown in Part I.)

UNIT	QUANTITY	ITEM	REQUIRED CHARACTERISTICS
FSA	1	Power Supply Line	115-volt, 1-phase, 60 cps
SBE-2, SBE-3	1	Power Supply Line	115- or 230-volt, 1-phase, 50 and 60 cps
VOX-2	1	Power Supply Line	115- or 230-volt, 1-phase, 50 and 60 cps
XFK	1	Power Supply Line	115- or 230-volt, 1-phase, 50 and 60 cps
TTG	1	Power Supply Line	115- or 230-volt, 1-phase, 50 and 60 cps

TABLE 1-3. SHIPPING DATA

PART I. AS COMPONENTS OF GPT-10K TRANSMITTER.

Refer to table 1-3 in Volume I.

PART II. AS INDEPENDENT UNITS (end items).

UNIT	*DIMENSIONS			*VOLUME	*WEIGHT	
	LENGTH	WIDTH	HEIGHT		WOODEN BOX	NET
SLM-1, SLM-2	22-1/2	15	10	1.9	44	20
FSA	(As packaged by TMC.)					
SA-1	29	23-1/2	19	7.5	81	36
PS-12	23-3/4	16-1/2	13-1/2	3.1	55	39
SBE-2	-	-	-	-	-	-
A-1516	27	22-1/4	13-3/4	4.8	87	41
A-1397	24-3/4	10	15-1/4	2.2	62	38
SBE-3	-	-	-	-	-	-
AO-101	27	22-1/4	13-3/4	4.8	87	41
A-1397	24-3/4	10	15-1/4	2.2	62	38
VOX-2	24-1/2	14	23-1/2	4.4	116	67
XFK	24-1/2	14	23-1/2	4.4	91	47
TTG	23-3/4	21-3/4	9-1/2	2.8	50	19
MCP-1	-	-	-	-	-	-
MCP-2	-	-	-	-	-	-
ISK	-	-	-	-	-	-

* Unless otherwise stated, dimensions are in inches, volume in cubic feet, weight in pounds.

TABLE 1-4-a. ELECTRICAL CHARACTERISTICS OF THE SLM

ITEM	CHARACTERISTIC
SLM-2	
Input circuit:	1000-ohm potentiometer to ground; swinger to control grid 2 of 1/2 6U8A vacuum tube.
Output circuit:	0-200 microammeter
Sensitivity:	Full scale with 0.008-volt (peak) input
Input frequency:	250 ±7.5 kc sidebands
Stages:	Two amplifiers and one rectifier (each sideband)
SLM-1	
Input circuit:	0.1-mf blocking capacitor between input jack and control grid 2 of 1/2 6U8A vacuum tube.
Output circuit:	0-200 microammeter
Sensitivity:	Full scale with 0.008-volt (peak) input
Input frequency:	17 ±3 kc sidebands
Stages:	Two amplifiers and one rectifier (each sideband)

TABLE 1-4-b. ELECTRICAL CHARACTERISTICS OF THE FSA

ITEM	CHARACTERISTIC		
Sweep widths:	SWEEP WIDTH SELECTOR SWITCH	AFC SWITCH	SWEEP WIDTH
	VAR	OFF	0 to 100 kc, continuously variable
	VAR	ON	0 to 2 kc, continuously variable
	30KC	*OFF	30KC Preset with automatically optimum IF bandwidth
	10KC	*OFF	10KC
	2KC	ON	2KC
	500~	ON	500~
	150~	ON	150~
Input center frequency:	500 KC		
Bandpass region (after input mixer):	450-550 KC		
Bandpass region amplitude characteristic, 450-550 KC:	Uniform within 5% or 1/2 db.		
Image rejection:	Better than (130 to 1) at input center frequency.		
Input impedance:	50 ohms at each of two input terminals.		
Input attenuator:	0- to 65-db attenuation of the input signal in 5-db steps. Accuracy 2% to 30 MC.		

TABLE 1-4-b. ELECTRICAL CHARACTERISTICS OF THE FSA (Cont.)

ITEM	CHARACTERISTIC
Amplitude scales:	Linear and 2 decade log, selectable by front panel switch. A front panel 20-db attenuator may be used to extend calibrated range to 60 db.
Direct sensitivity:	Maximum rms voltage (at signal input terminal) in center frequency band (450-550 KC) required for full scale linear deflection: 30 uv.
Conversion sensitivity:	Maximum rms signal required at signal input terminal for full scale log deflection when 0.1 volt rms from an external signal generator is injected into VFO input terminal: 3 mv. (The signal generator frequency should be adjusted to heterodyne the signal down to the input frequence band of the FSA.)
Input mixer range:	The SA input aperiodic mixer is suitable for signals up to approximately 1000 mc.
Scan rates:	0.1 cps to 30 cps continuously variable. On preset sweep widths of 150 cps, 500 cps, 2 kc - 0.1-cps scan rate. On preset sweep widths of 10 KC and 30 KC - 1-cps scan rate.
Resolution:	Continuously adjustable with IF BANDWIDTH control except on preset sweep widths. Range from approximately 3 KC down to less than 10 cps. (Resolution is defined as the frequency separation between two equal adjacent signals such that the intersection between their respective pip indications is 30% below the apex amplitude.) The SA is capable of 10-cps resolution or better at slow scan rates and reduced sweep widths. (See figure 1-3.)
Dynamic amplitude range:	Two Tone Test: All in-band residual (odd order) inter-modulation products better than 60 db below level of two equal reference signals deflected 20 db above full scale log provided that: a. Reference signals are separated so that their intersection is at least 60 db down. b. All front panel gain settings are maximum. c. IF BANDWIDTH control is adjusted for broadest position consistent with visual separation of signals. On preset sweep widths of 150 ~ , 500 ~ , 2KC, 10KC, and 30KC the 60-db dynamic range is provided automatically. d. Signal generator amplitude of at least 300 mv rms.
Auxiliary outputs:	Vertical amplitude and horizontal frequency output terminals provided. Connector provided for operation with chart recorder.
Indicator:	5-inch diameter flat face crt (5ADP7) with edge lit reticule and scale illumination, and a standard oscilloscope camera mounting bezel.
Power consumption:	Approximately 180 watts.
Power source:	95- to 125-volt 60 cps. Line regulator supplied. Special regulators available for 220-volt or 50-cps operation.

* The AFC switch may be turned on in the 30-kc and 10-kc ranges for use as a center frequency control.

TABLE 1-4-c. ELECTRICAL CHARACTERISTICS OF THE SBE-3

ITEM	CHARACTERISTIC
Frequency range:	2 to 32 mc continuous, bandswitched.
Operating modes:	*Single sideband *Double sideband *Independent sideband (separate intelligence) amplitude modulation, CW or MCW, FSK
Frequency control:	Temperature-controlled crystals or external VFO.
Frequency determining elements:	Contained in two temperature-controlled high mass aluminum ovens designed for high thermal inertia.
Crystal oven temperatures:	75°C for 250-kc oscillator, and 70°C for medium-frequency and high-frequency oscillator.
Stability:	1 PPM for 24-hour period.
MF injection requirements, crystal or VMO:	Crystal positions: 10 crystals, each with independent trimmer. Selection by front panel switch. Crystals CR-27/U to be inserted in Holders HC-6/U. VMO input frequency: 2 to 4.0 mc to serve for entire SBE output range of 2 to 32 mc. VMO input impedance: 72 ohms nominal. VMO input voltage: Approximately 1.5 V RMS.
Tuning controls:	Directly calibrated in frequency.
Output power:	Continuously adjustable from zero to a maximum of 1 watt PEP.
Output impedance:	72 ohms nominal.
Carrier suppression:	At least 55 db down from PEP level.
Carrier insertion:	Continuously adjustable.
Connections:	VFO input -BNC RF output -BNC Monitor -BNC Audio control -Terminal Barrier Mike input -3 pin MIKE jack
Spurious output:	At least 60 db below PEP output.
Distortion products:	At full PEP output, third order distortion products are at least 45 db below either tone of a standard two tone test.
Harmonic radiation:	Second harmonic at least 40 db below PEP output. All other harmonics at least 50 db below PEP output.
Rejection of unused sideband:	500-cps tone 60 db below transmitted PEP.

TABLE 1-4-c. ELECTRICAL CHARACTERISTICS OF THE SBE-3 (Cont.)

ITEM	CHARACTERISTIC
Audio input:	Two independent 600-ohm channels, balanced or unbalanced, -20-db level for full RF output. 500 k for high impedance crystal or dynamic mike, -50 db for full RF output.
Audio response per sideband:	Within 3 db from 350 to 7500 cps.
VOX operation:	Voice control with anti-trip features, adjustable gain, and squelch controls.
Metering:	Peak reading VTVM indicates: a. Audio level in USB or LSB channel. b. Mid frequency level for tuning purposes. c. SBE RF output (percent of maximum power).
* May be used with any degree of carrier insertion.	

TABLE 1-4-d. ELECTRICAL CHARACTERISTICS OF THE SBE-2

ITEM	CHARACTERISTIC
Frequency range:	2 to 32 mc continuous, bandswitched.
Operating modes:	*Single sideband *Double sideband *Independent sideband (separate intelligence) amplitude modulation, CW or MCW, FSK
Frequency control:	Temperature-controlled crystals or external VFO.
Frequency determining elements:	Contained in two temperature-controlled high mass aluminum ovens designed for high thermal inertia.
Crystal oven temperatures:	75°C for 17-and 287-kc oscillators, and 70°C for medium-frequency and high-frequency oscillator.
Stability:	1 PPM for 24-hour period.
MF injection requirements, crystal or VMO:	Crystal positions: 10 crystals, each with independent trimmer. Selection by front panel switch. Crystals CR-27/U to be inserted in Holders HC-6/U. VMO input frequency: 2 to 4.0 mc to serve for entire SBE output range of 2 to 32 mc. VMO input impedance: 72 ohms nominal. VMO input voltage: Approximately 1.5 V RMS.

TABLE 1-4-d. ELECTRICAL CHARACTERISTICS OF THE SBE-2 (Cont.)

ITEM	CHARACTERISTIC
Tuning controls:	Directly calibrated in frequency.
Output Power:	Continuously adjustable from zero to a maximum of 3 watt PEP.
Output impedance:	72 ohms nominal.
Carrier suppression:	At least 55 db down from PEP level.
Carrier insertion:	Continuously adjustable.
Connections:	VFO input -BNC RF output -BNC Monitor -BNC Audio control -Terminal Barrier Mike input -3 pin MIKE jack
Spurious output:	At least 60 db below PEP output.
Distortion products:	At full PEP output, third order distortion products are at least 45 db below either tone of a standard two tone test.
Harmonic radiation:	Second harmonic at least 40 db below PEP output. All other harmonics at least 50 db below PEP output.
Rejection of unused sideband:	500 cps tone 60 db below transmitted PEP.
Audio input:	Two independent 600-ohm channels, balanced or unbalanced, -20-db level for full RF output. 500 k for high impedance crystal or dynamic mike, -50 db for full RF output.
Audio response per sideband:	Within 3 db from 350 to 3000 cps.
VOX operation:	Voice control with anti-trip features, adjustable gain, and squelch controls.
Metering:	Peak reading VTVM indicates: a. Audio level in USB or LSB channel. b. Mid frequency level for tuning purposes. c. SBE RF output (percent of maximum power).
* May be used with any degree of carrier insertion.	

TABLE 1-4-e. ELECTRICAL CHARACTERISTICS OF THE VOX

ITEM	CHARACTERISTIC
HF OSCILLATOR	
Frequency range:	2 to 64 mc continuous.
Output impedance:	75 ohms coaxial.
Output level:	2 watts throughout basic range of 2 to 4 mc and 0.5 watts, 4 to 64 mc, adjustable.
Output connections:	Three BNF 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 megacycle 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 megacycle.
Resetability:	20 cycles per megacycle to a calibrated frequency.
Line voltage change effects:	10 cycles for ±10% change in line voltage.
Humidity effects:	No appreciable change for 50- to 95-percent humidity.
High-frequency oscillator calibration:	Against 100-kc crystal oscillator at 50-kc points.
BEAT FREQUENCY OSCILLATOR	
Frequency range:	300 to 1000 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:	110 and 220 volts, 50 and 60 cps. Approximately 100-watt average or 250-watt peak, depending upon cycling of oven heating elements.

TABLE 1-4-f. ELECTRICAL CHARACTERISTICS OF THE XFK

ITEM	CHARACTERISTIC
Output frequency range:	1 to 2.5 mc on band 1; 2.5 to 6.9 mc on band 2.
Frequency shift:	Linear to 1000 cycles.
Output power:	Adjustable to 3 watts.
Output impedance:	50 to 70 ohms.
Keying sources:	a. Contact closing to ground. b. Polar or neutral positive. c. Linear input 30,000 ohms impedance.
Keying speed:	1000 wpm maximum.
Keying input impedance:	Polar or neutral operation 1000,000 ohms may be bridged by external 1800-ohm loop resistance. Contact closing to ground must be open circuit.
RF source:	Internal crystal oscillator or external oscillator.
Input impedance for external RF source:	70 ohms, 6 to 8 volts rms.
Frequency control:	High-frequency crystal oscillator 0.8 to 6.7 mc. High stability 200-kc oscillator.
Crystal holders:	FT-243 three positions and HC-6/U three positions.
Oven temperature:	70°C held constant within ±0.1°C.
Keying bias:	Not greater than 10% at 1000 wpm.
Overall stability:	a. 10 cps for ambient temperature change of 0°C to 50°C. b. 10 cps for line voltage change of 10%. c. No drift for input signal variations of +25 volts to +150 volts (mark frequency).
Crystal frequency:	Assigned transmitter frequency minus 200 kc transmitter multiplication.
Metering:	PA plate current (tuning).
Monitoring:	100 mv across 70-ohm coaxial connector.
Primary power:	110 and 220 volts, 50 and 60 cps. Both ovens off - 100 watts; each oven - 40 watts.

TABLE 1-4-g. ELECTRICAL CHARACTERISTICS OF THE TTG

ITEM	CHARACTERISTIC
AUDIO FREQUENCY OSCILLATOR	
Output frequencies:	935 cps. - 2805 cps.
Harmonic distortion:	More than 65 db down.
Intermodulation distortion:	More than 55 db down.
Output impedance:	600 ohms unbalanced.
Output level:	0 to 0.5 volt continuously variable.
Output connection:	Terminal strip.
RADIO FREQUENCY OSCILLATOR	
Output frequencies:	1999-kc crystal controlled 2001-kc crystal controlled
Distortion:	More than 60 db down.
Output impedance:	70 ohms unbalanced.
Output level:	1.0 volt
Output connector:	BNC
Primary power:	115 and 230 volts, 50 and 60 cps, approximately 35 watts.

TABLE 1-4-h. ELECTRICAL CHARACTERISTICS OF THE ISK

ITEM	CHARACTERISTIC
Keying sources:	a. Teletype b. CW
Keying modes:	a. 50 volts (neutral pulse) b. 100 volts (neutral pulse) c. 60 mils (neutral pulse) d. 20 mils (polar pulse)
Keyline input impedance (refer to item 2 above):	a. 50 k b. 100 k c. 100 ohms d. 300 ohms
Output keying voltage (refer to item 1 above):	a. 0- to 30-volt pulse (terminated into XFK) b. Dry keying (ground on, ground off)
Keying speed:	120 wpm max
Operating controls:	a. Threshold adjust b. Voltage adjust
Primary power:	110 and 220 volts, 50 and 60 cps, 20 watts

TABLE 1-5. ELECTRON TUBE COMPLEMENT

1 SBE-2	2 SBE-3	3 P.S. for Items 1, 2	4 VOX	5 XFK	6 TTG	7 SLM	8 FSA	9 PS-12	10 ISK	Tube
2	2									6CL6
1	1									6146
		1								5R4
				1	1	1				6X4
1	2	1	1			SLM1=1 SLM2=1	1			OA2 OB2
										872A
4	4		1							6AB4
2	2						4			6U8
3	1				2		1		1	12AT7
3	5		3	3	4		4		1	12AU7
3	3						1			6AH6
1	1									6AL5
			1							5V4G
			1							6BE6
			6							6AQ5
			1							6AB4
				1						6J6
				2			1			6BE6
				1						2E26
				1						5U4G
				2						OB2
						2				6U8A
							1			12BE26
							2			6BH6
							1			12AL5
							2			6AU6
							1			5ADP7
							1	1		5651
								1		5Y3GT
								1		6AS7G
								1		6AS7G

TABLE 1-6-a. FRONT PANEL CONTROLS OF THE SLM

CONTROL	FUNCTION
	SLM-2
LSB LEVEL VTVM:	Indicates lower sideband level of associated SBE's 250-kc LSB filter (LSB's 250-kc balanced modulator circuit).
USB LEVEL VTVM:	Indicates upper sideband level of associated SBE's 250-kc USB filter (USB's 250-kc balanced modulator circuit).
MAIN POWER indicator lamp:	Indicates main power ON or OFF.
ON-OFF toggle switch:	Energizes or deenergizes SLM (60-cycle power supply).
CALIBRATE potentiometers:	Adjusts LSB and USB VTVMs to read correctly on a suitable calibrated input to SLM.
Two fuses:	One in main power supply circuit and the other in B+ power supply circuit.
	SLM-1
LSB LEVEL VTVM:	Indicates lower sideband level of associated SBE's 17-kc LSB filter (LSB's 17-kc balanced modulator circuit).
USB LEVEL VTVM:	Indicates upper sideband level of associated SBE's 17-kc USB filter (USB's 17-kc balanced modulator circuit).
MAIN POWER indicator lamp:	Indicates main power ON or OFF.
ON-OFF toggle switch:	Energizes or deenergizes SLM (60-cycle power supply).
CALIBRATE potentiometers:	Adjusts LSB and USB VTVMs to read correctly on a suitable calibrated input to SLM.
Two fuses:	One in main power supply circuit and the other in B+ power supply circuit.

TABLE 1-6-b. FRONT PANEL CONTROLS OF THE FSA

CONTROL	FUNCTION
INPUT ATTENUATOR:	Provides attenuation in the SIGNAL INPUT circuit.
GAIN:	Adjusts amplitude of the indication on the crt screen.
AMPLITUDE SCALE:	Selects linear or logarithmic amplitude presentations on
IF ATTEN:	Allows 20 DB of attenuation to be inserted in the IF amplifier.
CAL OSC LEVEL:	Varies the output amplitude of the 500-kc crystal oscillator, which is internally connected to the signal input receptacle. This signal may be used to locate the center frequency of the FSA.
CENTER FREQ:	Sets or maintains the frequency modulated local oscillator at its specified mean frequency.
AFC OFF:	Turns on the AFC circuit.
ILLUMINATION:	Turns on the power. Continued clockwise rotation of this control increases the edge illumination of the crt screen.
BRILLIANCE:	Adjusts the intensity of the screen presentation.
FOCUS:	Adjusts the sharpness of the screen presentation.
SWEEP WIDTH SELECTOR:	Provides a choice of five preset sweep widths of 150∿, 500∿ , 2KC, 10KC, and 30KC, and a sixth position marked VAR. In the VAR position, the sweep width may be set to any value from 0 to 100 kc, the IF bandwidth may be set for any desired resolution within the capability of the instrument, and the sweep rate may be set to any value from 0.1 cps to 30 cps. The video filter switch is also operative in this position.
FAST SWEEP:	This momentary contact pushbutton sweep speeds up the sweep rate from 0.1 cps to 1 cps, on the 150∿ , 500∿ , and 2kc preset sweep ranges.
H POS:	Adjusts the position of the baseline trace along the horizontal axis.
V POS:	Adjusts the position of the baseline trace along the vertical axis.
SWEEP WIDTH:	Adjusts the scanning width of the instrument. When it is turned completely clockwise, the maximum spectrum width for which the instrument is designed, that is, 100 kc when AFC is off or 2 kc when AFC is on, can be seen on the screen. As the control is backed off in a counterclockwise direction, the bandwidth viewed becomes narrower.
IF BANDWIDTH:	Narrows the IF bandwidth. Resolution sharpens as both the frequency-scanning rate and IF bandwidth are decreased. On the preset sweep ranges, the IF bandwidth is automatically set for optimum resolution.

TABLE 1-6-b. FRONT PANEL CONTROLS OF THE FSA (Cont.)

CONTROL	FUNCTION
VIDEO FILTER:	Provides 2° of video filtering to suppress such unwanted effects as noise, spurious beating between closely adjacent signals, hum, etc.
SWEEP RATE:	Provides continuously adjustable scanning rates between 0.1 cps and 30 cps. The control is operative only in the VAR position of the SWEEP WIDTH SELECTOR.

TERMS AND DEFINITIONS APPLICABLE TO FSA:

a. Sweep width is the band, measured in cycles, kilocycles, or megacycles, which can be observed by FSA reception. It corresponds to the range of oscillator sweep in the FSA unit.

b. Frequency sweep axis is the line along which the signal deflections are produced and which can be calibrated in frequency according to a given frequency scale.

c. Center frequency is the frequency of the signal received on that part of the frequency sweep axis corresponding to zero sweep voltage applied to the reactance modulator.

d. Resolution of a given signal is the frequency difference measured along the sweep width scale between the points where its deflection is 30% down from the peak value. This characteristic corresponds to "selectivity" in ordinary receivers. The smaller this frequency difference is, the better the resolution.

e. Sweep rate is the number of times per second the electron beam sweeps across the cathode-ray tube.

f. Deflection amplitude is the visual equivalent of signal input voltage. It is the height of a given signal deflection measured from the baseline to the top of the deflection.

g. Screen scale is the scale adjacent to the baseline which is calibrated in frequency units above and below center frequency for a maximum sweep width setting.

h. VFO is the associated external oscillator or signal generator which is used with the FSA to heterodyne with the test signal to produce the required input frequency of the FSA.

NOTE

The heterodyne product should be the difference between the two frequencies used. If the sum frequency is used, spurious screen indications may result from heterodyne products of the test signals and the external signal generator output (including its harmonics).

TABLE 1-6-c. FRONT PANEL CONTROLS OF THE SBE-2 AND SBE-3

CONTROL	FUNCTION
POWER ON-OFF (S103)	ON - Applies line voltage to SBE. OFF - Turns off entire SBE.
EXCITER ON-STANDBY (S105)	ON - Activates SBE without need for VOX or push-to-talk input and without operating GPT-10K. STANDBY - Allows VOX or push-to-talk to activate the SBE and the GPT-10K which the SBE serves.
XMTR ON-OFF (S104)	ON - Activates GPT-10K. Eliminates need for VOX or push-to-talk, through S105 (above), by completing the ground circuit of the XMTR final plates relay. OFF - GPT-10K operated by VOX or push-to-talk circuit when EXCITER switch is in STANDBY position.
LSB	Switch selects audio input source for lower sideband channel. GAIN - Adjusts level of LSB audio input.
USB	Switch selects audio input source for upper sideband channel. GAIN - Adjusts level of USB audio input.
VOX GAIN	Voice operated GPT-10K circuit gain control.
SQUELCH GAIN	Used in conjunction with VOX GAIN. (Refer to paragraph 4-4f of Volume II of the manual.)
MF XTAL SW	Selects either external oscillator (VMO) or proper crystal for mid-frequency oscillator.
BAND MCS	Indicates injection frequency range of high-frequency modulator in 2-mc increments. It is controlled by the knob beneath the dial.
CARRIER INSERT	Controls level of carrier insertion.
OUTPUT TUNING	Selects output frequency band and adjusts setting of main tuning dial centrally located above knob.
MF TUNING	Selects setting of mid-frequency as indicated in lower section of main tuning dial.
OUTPUT	Adjusts exciter output power level.
METER SW	Selects point in system to be measured by built-in VTVM circuit. CAL position is used to zero meter.
CAL	Meter adjustment located directly beneath meter. Use screwdriver to zero meter when METER SW is in CAL position.
EXCITER lamp	Glows during operation when EXCITER switch is in ON position or EXCITER is activated by VOX or push-to-talk.
OVEN lamp	Glows during operation when thermostats demand oven heating (automatic).

TABLE 1-6-c. FRONT PANEL CONTROLS OF THE SBE-2 AND SBE-3 (Cont.)

CONTROL	FUNCTION
MIKE	Input jack to audio pre-amp for all high-impedance (500 k) microphones.
	POWER SUPPLY
Lamp	Glows during operation. Indicates MAIN fuse intact and power is applied. — 110 volts — 220 volts B+ FUSE — 0.25 amp — 0.25 amp MAIN FUSE — 3.0 amp — 1.5 amp OVEN FUSE — 2.0 amp — 1.0 amp These fuses protect their respective circuits.

TABLE 1-6-d. FRONT PANEL CONTROLS OF MCP-1 AND MCP-2

CONTROL	FUNCTION
	MCP-1
SBE VMO INPUT:	Channels three external 2- to 4-mc master oscillator supplies to the medium-frequency oscillator stage of the SBE. In the OFF position, the SBE supplies its own medium-frequency RF.
VOX RF OUTPUT:	Feeds VOX RF output to XFK or SBE (2- to 4-mc range) or to FSA and external vox output jack (J3005) (2- to 32-mc range).
ANALYZER MONITOR:	Channels four sources of RF signal to FSA, three for monitoring purposes and one for testing FSA's distortion.
CHANNEL 1:	Place TTG's tones or telephone/telegraph line No. 1 signals in audio channel 1 of SBE.
CHANNEL 2:	Places TTG's tones or telephone/telegraph line No. 2 signals in audio channel 2 of SBE.
	MCP-2
SBE VMO INPUT:	Channels three external 2- to 4-mc master oscillator supplies to the medium-frequency oscillator stage of the SBE. In the OFF position, the SBE supplies its own medium-frequency RF.
VOX RF OUTPUT:	Feeds VOX RF output to XFK or SBE (2- to 4-mc range) or to FSA and external vox output jack (J3005) (2- to 32-mc range).
ANALYZER MONITOR:	Channels four sources of RF signal to FSA, three for monitoring purposes and one for testing FSA's distortion.
CHANNEL 1:	Places TTG's tones or telephone/telegraph line No. 1 signals in audio channel 1 of SBE.
CHANNEL 2:	Places TTG's tones of telephone/telegraph line No. 2 signals in audio channel 2 of SBE.
MODE SELECTOR:	Channels SSB, CW signals to SBE; CW, RTTY signals to XFK; FAX signals to FAX.

TABLE 1-6-e. FRONT PANEL CONTROLS OF THE VOX

CONTROL	FUNCTION
POWER toggle switch (compartment behind door):	Applies line voltage to, or disconnects line voltage from, power supply circuit.
HFO toggle switch (compartment behind door):	Applies DC plate voltage to HFO vacuum tubes.
IFO toggle switch (compartment behind door):	Applies DC plate voltage to IFO vacuum tube.
BFO toggle switch (compartment behind door):	Applies DC screen voltage to BFO vacuum tube.
BEAT ON-OFF toggle switch (compartment behind door):	Applies 100-kc oscillator to one of MIXER (V103) vacuum tube grids. Other grid receives output of VMO (cathode V302).
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.
TUNING selector switch:	Tunes HFO output circuit. Used to maximize meter reading with METER selector switch in HFO position.
OUTPUT potentiometer:	Controls level of output of HFO circuit.
BAND-MCS selector switch:	Controls tuning elements in HFO circuit.
XTAL FREQ padding capacitor:	Enables small changes in crystal frequency. Used only when VOX uses a crystal for RF output.
CALIBRATE potentiometer:	A control to calibrate VMO with 100-kc oscillator at check points.
MASTER OSCILLATOR FREQUENCY knob:	Controls output frequency of VMO.
XTAL selector switch:	Determines whether VOX's output is produced by crystals in positions 1, 2, 3, or by its VMO.
MASTER OSCILLATOR FREQUENCY dial:	Registers output frequency of VOX.
Meter:	Registers level of VOX's RF outputs in line with position of METER selector switch located in compartment behind door.
ZERO BEAT indicator:	Indicates beat tones when calibrating VMO with 100-kc oscillator at check points.
OUTER OVEN indicator:	Lights when outer oven is receiving heat.
INNER OVEN indicator:	Lights when inner oven is receiving heat.
MAIN POWER indicator:	Lights when VOX is receiving 60-cycle power.
BFO ADJ potentiometer (chassis mounted at top):	Controls BFO output level.
BFO XTAL SW (chassis mounted at rear):	Determines which of two crystals shall be used for BFO beats.

TABLE 1–6–f. FRONT PANEL CONTROLS OF THE XFK

CONTROL	FUNCTION
POWER ON-OFF toggle switch:	Energizes or deenergizes XFK's power supply circuit. With switch in ON position, POWER indicator should light.
PLATE ON-OFF toggle switch:	Energizes or deenergizes XFK's vacuum tubes with DC plate voltage.
200 KC OVEN indicator:	When lighted indicates oven is receiving power; when off, the oven is not receiving power.
XTAL OVEN indicator:	When lighted indicates oven is receiving power; when off, the oven is not receiving power.
PA PLATE CURRENT meter:	Measures PA plate DC supply.
OUTPUT TUNING MC knob:	Varies capacitors in XFK's output network. Dip in PA PLATE CURRENT meter indicates optimum tuning.
FREQUENCY SHIFT CPS potentiometer:	Provides a means to vary DC voltages to the XFK's reactance tube in order to obtain a given shift. For a shift of ±425 cycles, set dial to 850. With a multiplier of unity, the actual frequency shift is ±425 cps. When a GPT-10K has a multiplier of two and its desired output is a frequency shift of ±425 cps, set the dial as before to 850 but place the XFK's multiplier to 2. Under this condition, the XFK's frequency shift is $\pm\frac{425}{2}$ cps but the GPT-10K's frequency shift is ±425 cps.
BAND CHANGE selector switch:	Switches XFK's tuning networks associated with mixer and PA tubes from band 1 (1 to 2.5 mc) to 2 (2.5 to 6.9 mc).
FREQUENCY selector switch:	Varies trimmer capacitors in input and output tuning networks in mixer and PA tube circuits.
XTAL selector switch:	Selects whether XFK's output is produced by MF crystals (located in XFK) or by an EXT MF supply.
POWER potentiometer:	Controls XFK's output power.
TEST selector switch (old model):	In the older model provides input voltages to XFK's keyer vacuum tube as MARK, SPACE, or operating LINE signals.
MODE selector switch (new model):	In the newer model provides input voltages to XFK's keyer vacuum tube as FAX, MARK, SPACE, LINE, and CW.

TABLE 1-6-g. FRONT PANEL CONTROLS OF THE TTG

CONTROL	FUNCTION
POWER	ON-OFF switch.
AUDIO TONE SELECTOR:	Channels 935 cps (tone 1), 2802 cps (tone 2), and 935 and 2802 cps (tones 1 and 2) into output circuit.
RF TONE SELECTOR:	Channels 1999 kc (tone 1), 2001 kc (tone 2), 43 and 1999 and 2001 kc (tones 1 and 2) into output circuit.
AUDIO OUTPUT:	Volume control potentiometer.
AUDIO FREQ. ADJUST:	Screwdriver adjustments of tones.

TABLE 1-6-h. FRONT PANEL CONTROLS OF THE ISK

CONTROL	FUNCTION
KEYING MODE:	Position switch 1 through 4.
MAIN:	POWER ON-OFF switch.
Six fuses:	One fuse (1A) within the input power transformer primary circuit; another two fuses in series with the B+ bus lines; the remaining three fuses are spares.
THRESHOLD potentiometer:	Adjusts ON-OFF time of keyer oscillator to correspond to space-mark times of incoming signals.
VOLT potentiometer:	Adjust the + volt output of the ISK on E-4001.
MAIN POWER indicator lamp:	Indicates main power ON or OFF.

BASIC TRANSMITTER COMPONENTS
GPT-10K

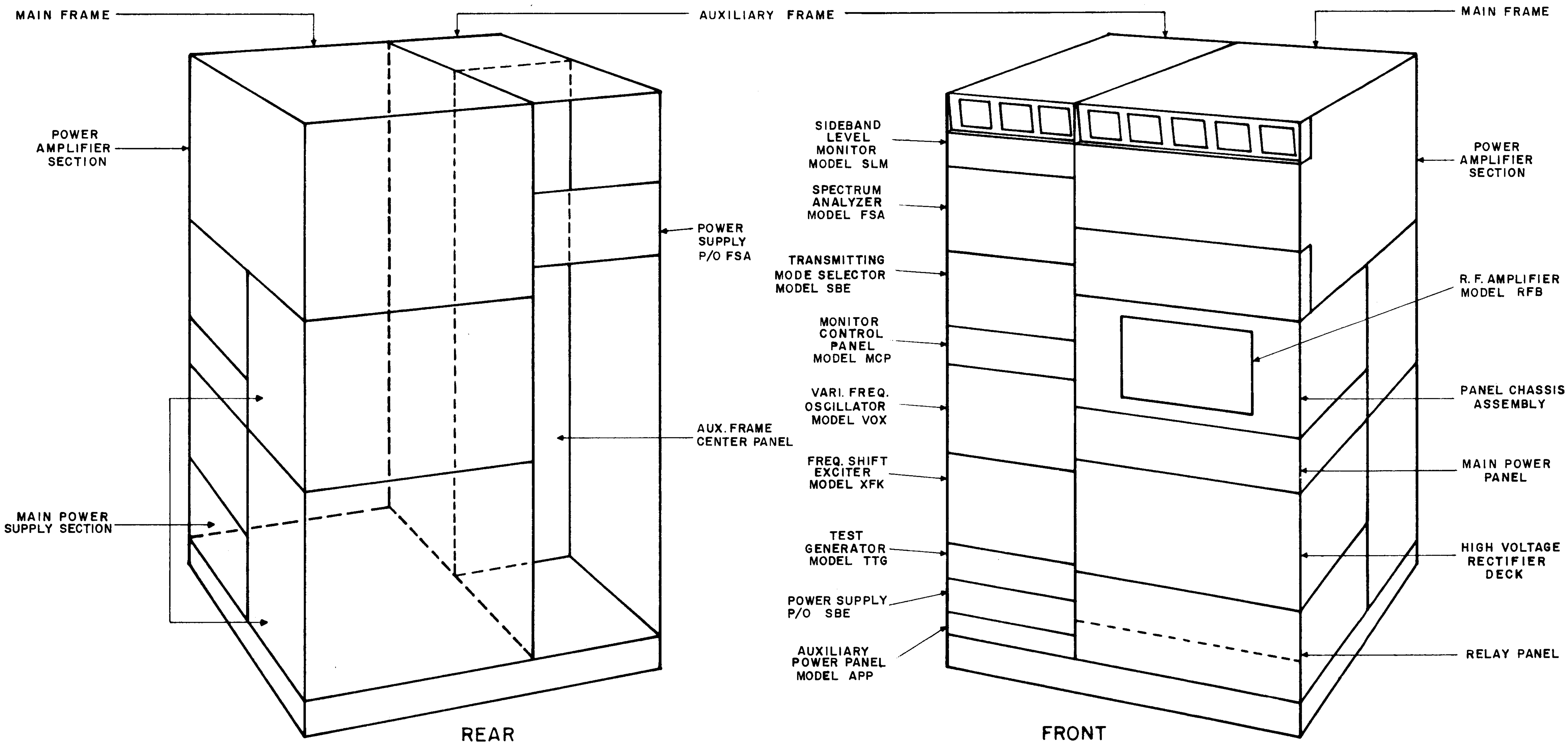
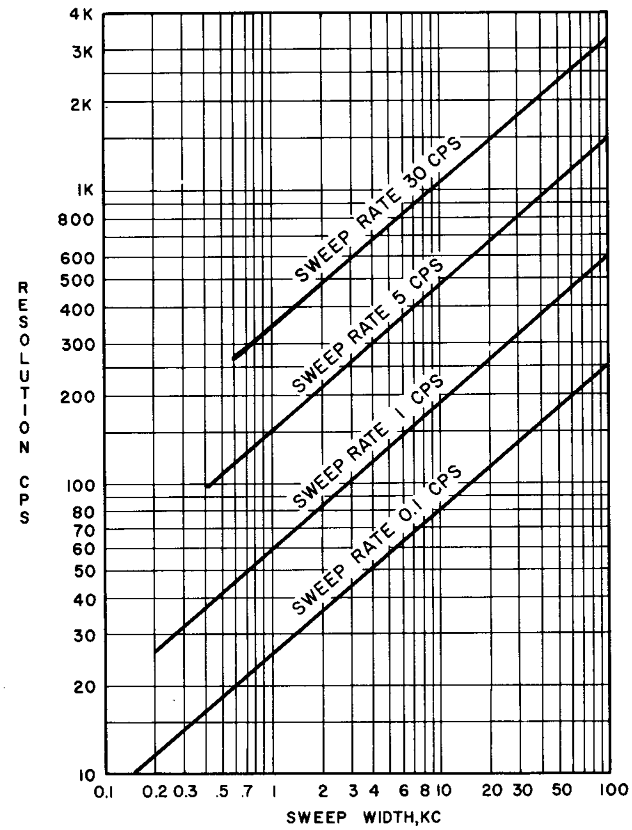


Figure 1-2. Isometric Diagram, GPT-10K



Left: Resolution (in cps) vs sweep width (in kc).

Below: Minimum frequency separation f required to measure amplitude ratios E_2/E_1. Figures in parenthesis represent preset sweep widths. The curves represent the electrical resolution of the SA. The dashed portion represents electrical resolution beyond optical resolution. To obtain the results shown in this portion of the curve, an expanded scale oscilloscope must be used.

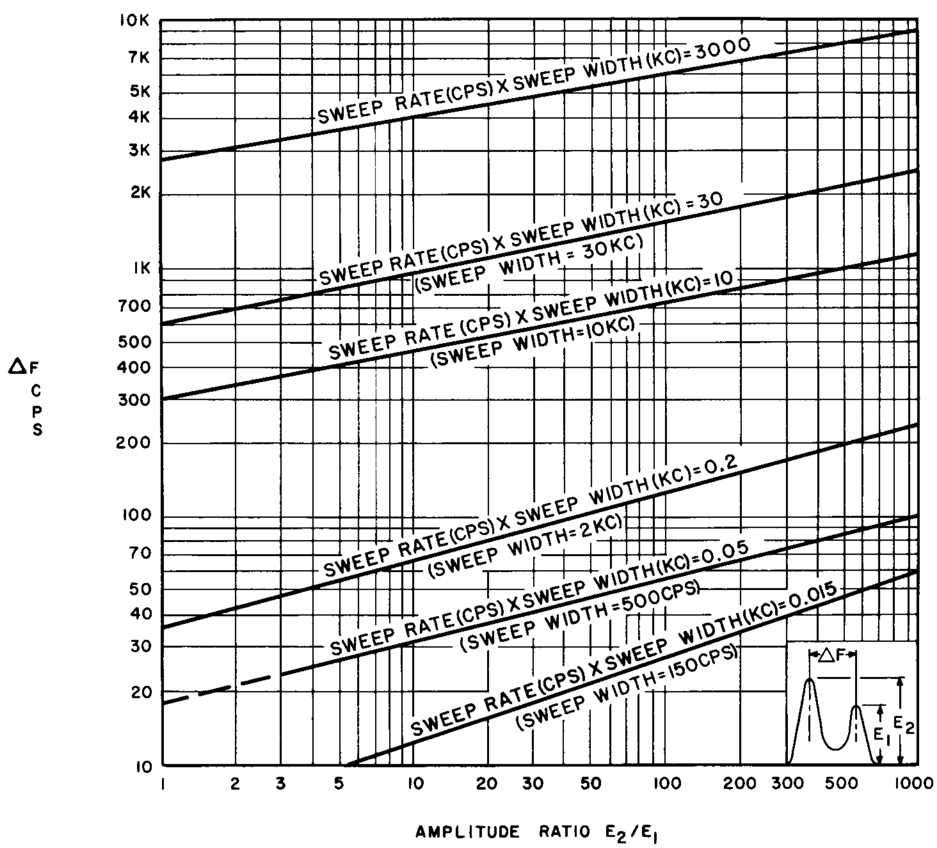


Figure 1-3. Resolution Characteristics of SA

SECTION 2
INSTALLATION

2-1. GENERAL.

The installation details given in Section 2 of Volume I of the manual apply in the case where the units on the auxiliary frame chassis form an integral part of a GPT-10K shipment. In this case TMC's production-line checkout verifies satisfactory operation; consequently, installation of these units as stated below is relatively simple.

General installation details apply to the case where the units on the auxiliary frame chassis are moved about as general-purpose test and/or exciter units and where the simpler information contained in Section 2 of Volume I of the manual is inadequate.

The following general procedure outlines the steps taken by TMC in packaging their test and exciter units:

a. Place the unit in a cardboard carton, cover with paper to avoid scratches, and wedge with heavy cardboard corrugated fillers. Include desiccant, accessories, and spare parts if practicable. Seal carton.

b. Place carton (item a) in moisture-proof barrier bag and seal.

c. Place barrier bag (item b) in waterproof outer carton and seal.

d. Place outer carton (item c) in strong wooden packing box and wedge to tightness.

e. Encircle packing box with two steel straps. Top side of packing box is identified by seals on straps. When seals are removed, this side may be readily pried open.

2-2. FREQUENCY SPECTRUM ANALYZER (FSA).

a. INITIAL INSPECTION. - This unit 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 and crystals installed. Check that all such components are properly seated in their sockets.

b. INTERCONNECTING PROCEDURE. - When the FSA forms "part" of the GPT-10K assembly, the interconnecting procedure is as follows:

(1) Connect single-conductor coaxial cable designated 1 into VFO IN jack. (Refer to paragraph 2-7 Volume II of the manual.)

(2) Connect single-conductor coaxial cable designated 2 into SIGNAL IN jack. (Refer to paragraph 2-7 Volume II of the manual.)

(3) Connect 14-conductor cable between PS-12 and SA.

(4) Connect PS-12 cord between 115-volt regulated 50- and 60-cycle PS-12 accessory multiple and PS-12 115-volt input.

When the FSA forms part of the GPT-10K assembly, Constant Voltage Transformer No. T3003-1 is not supplied because its function is performed by the GPT-10K's Sola Constant Current Transformer CAT. No. 22-374.

When the FSA is an "end item", the equipment supplied and the interconnecting instructions are as follows:

Description	Quantity
Analyzer Model SA-1	1
Power Supply Model PS-12	1
Constant Voltage Transformer No. T3003-1	1
Interconnecting Power Cable No. W 3046	1
Signal Input Cable No. W 3001	2
Spare Fuses, AGC, 2A, 250V	3
Alignment Tool No. E1010	1

The SA is normally operated from a 115-volt, 60-cycle, single-phase, power source. The power transformer connections are factory wired for 115-volt operation. With T3003-1, the equipment will operate properly over a line voltage variation of 95 to 130 volts. The T3003-1 must be used with the equipment to ensure proper operation. The regulator is of the saturable-reactor type and is designed for a 60-cycle power source. It should not be used on a 50-cycle line.

The 50-cycle operation requires the use of either a saturable-reactor type regulator specifically designed for this frequency or a line stabilizer which is not frequency sensitive. It should be capable of a 150-volt-ampere output.

(1) Connect the FSA and its PS-12 together with the 14-conductor cable furnished.

(2) Connect the connector (female) on the cable from T3003-1 to the receptacle (male) on the cable from the PS-12 Chassis.

(3) Connect the AC line cord from T3003-1 to the power source.

(4) Rotate the ILLUMINATION control clockwise to turn on the equipment. In about a minute the baseline trace should appear on the crt screen.

(5) Adjust the BRILLIANCE control until the trace is just discernible. Allow at least a 30-minute warmup before proceeding with further adjustments and checks.

(6) Connect the external signal to be analyzed to the SIGNAL INPUT connector, using one of the RF cables supplied. Connect the external heterodyning signal generator to the VFO INPUT connector with the other RF cable.

NOTE

If the signal generator frequency is not varied during examination of the test signal, the connecting cable need not match the 50-ohm input impedance of the FSA. This also applies when flatness of response is not critical. Otherwise, the generator cable impedance must be 50 ohms and nonterminated, or a suitable pad may be used to prevent reflections and the resultant nonuniform response due to mismatch.

The test signal may be coupled to the free end of the input cable, either capacitively or inductively as may be required (a small loop may be attached to the end of the cable). If the test signal has a DC component and the FSA is to be connected directly to the signal source, a suitable blocking capacitor should be used at the free end of the cable.

c. INSTALLATION ADJUSTMENTS AND CHECKS. - When the FSA is a part of a GPT-10K, installation adjustments and checks are unnecessary since they were made during checkout of the GPT-10K. When the FSA is an end item, the installation adjustments and checks are as follows:

(1) Set the front panel controls as follows:

INPUT ATTENUATOR	All switches up
GAIN	Fully counterclockwise
CAL OSC LEVEL	OFF
CENTER FREQ	Center
AFC	OFF
AMPLITUDE SCALE	LIN
FOCUS	For a sharp trace
BRILLIANCE	As desired
SWEEP WIDTH SELECTOR	VAR
IF ATTEN	O DB
VIDEO FILTER	OFF
SWEEP RATE	Fully clockwise
IF BANDWIDTH	Fully clockwise
SWEEP WIDTH	Fully clockwise
V POS	So that baseline trace coincides with frequency scale.
H POS	To center the baseline approximately on the crt screen.

(2) Rotate the CAL OSC LEVEL control fully clockwise. Advance the GAIN control until a pip is displayed at approximately full screen deflection.

(3) Rotate the SWEEP WIDTH control counterclockwise until the pip opens up into a horizontal line. Adjust the CENTER FREQ control for maximum height of the trace. Set the SWEEP WIDTH control fully clockwise. A pip should appear near the center frequency calibration. Adjust the H POS control until the pip coincides with the center frequency calibration.

(4) Rotate the SWEEP RATE control through its range. At its clockwise extreme (30 cps), the trace will appear as a line. At its counterclockwise extreme (0.1 cps), a spot should move from right to left on the crt screen with a 10-second period.

(5) Rotate the SWEEP RATE control fully clockwise. Adjust the SWEEP WIDTH control until the pip base covers approximately one-third of the screen. Turn the IF BANDWIDTH control counterclockwise; the pip width should decrease. At the same time, there may be a change in pip height. It will also be noticed that "ringing" will appear on the trailing edge of the pip. Optimum resolution occurs when the first ringing notch beyond the apex of the pip digs into the baseline. Besides indicating the procedure to obtain maximum resolution, this test checks the variable response of the IF bandwidth.

(6) Turn on the AFC by clockwise rotation of the control. This automatically provides a maximum scanning width of approximately ±1 kc with the necessary center frequency stability. Counterclockwise rotation of the SWEEP WIDTH control reduces the scanning width from ±1 kc to nominally zero. The AFC control is used as the CENTER FREQ control. As it is rotated in a clockwise direction, the display may shift to the left, then to the right. Normally, the best centering action is had with the AFC control in approximately a "2 o'clock" position. The CENTER FREQ control is used as a vernier. The maximum sweep is conveniently checked by feeding a 1-kc audio signal to the EXT MOD jack. This will generate sidebands which may be set on the end frequency calibrations of the crt screen by means of the SWEEP WIDTH control. Use only sufficient audio amplitude to produce visible and usable sidebands, since excessive amplitude may prevent the crystal oscillator from functioning. It should be noted that there may be an extraneous pip or pips present on the right side of the screen (but outside the calibrations) when the AFC is on. The SWEEP RATE control should be set for a rate of approximately 5 cps or lower and the IF BANDWIDTH control set appropriately.

NOTE

Tests 7, 8, and 9 provide screen calibrations.

(7) Set the controls as outlined for CENTER FREQ test. Carefully adjust the GAIN control for full-scale deflection of the pip. Set AMPLITUDE SCALE to LOG. The pip should read 0 db (center of screen). The LOG calibration appears at the left edge of the screen. Dots are engraved at 5-db intervals on the screen. Set IF ATTEN to 20 DB. The pip should now reach the -20-db calibration.

(8) Increase the GAIN and CAL OSC LEVEL controls until full-scale deflection is obtained. Operate the INPUT ATTENUATOR switches so as to insert attenuations up to 40 db in 5-db steps. At each setting, the pip height should coincide with the corresponding screen calibration within ±1 db.

(9) Set the IF ATTEN to 0 DB and continue to insert attenuation as before until the pip is at the -20-db calibration. At this point the signal has been reduced 60 db from its original level, which is 20 db over full scale. With all switches down (65 db), the pip should go below the -20-db calibration point.

(10) Set the INPUT ATTENUATOR to zero (all switches up) and adjust the GAIN control for full-scale deflection. Set the VIDEO FILTER to the HI position. This reduces the video bandwidth to about 400 cps. Any noise on the screen should be filtered, and signal pips integrate and shift slightly. The SWEEP RATE should be reduced to prevent excessive distortion of the pip shape. Set the VIDEO FILTER to the LO position. The video bandwidth is now about 40 cps and a much greater filtering effect should be observed. This position of the VIDEO FILTER should only be used with sweep rates of 1 cps or less.

NOTE

Tests 11, 12, and 13 indicate the use of SWEEP WIDTH SELECTOR in searching for and displaying signals on the crt screen in several scales.

(11) With a full-scale optimally-resolved pip (LIN amplitude scale) displayed in the center of the screen (see item 5), set the SWEEP WIDTH SELECTOR to 30 KC. The pip should appear at or near the center of the screen. The amplitude should be essentially unchanged. The sweep width is now ±15 kc, and the sweep rate is 1 cps. The SWEEP WIDTH, SWEEP RATE, IF BANDWIDTH, and VIDEO FILTER controls are not effective on this and other preset sweep width ranges.

(12) Set the SWEEP WIDTH SELECTOR to 10KC. The pip should appear with essentially the same amplitude near the center of the screen. In this position, the sweep width is ±5 kc.

(13) Set the SWEEP WIDTH SELECTOR to 2KC. The AFC circuit is automatically switched on for this and the 500-cycle and 150-cycle sweep widths, and the sweep rate is 0.1 cps. The amplitude of the pip should be essentially constant on all ranges.

(14) To facilitate locating a signal on the preset sweep widths of 150 , 500 , and 2KC, employing a 0.1-cps sweep rate, a FAST SWEEP button has been provided on the front panel. Depressing this button speeds up the sweep rate to 1 cps, and it immediately returns to 0.1 cps when the button is released. The pip shape is distorted when the FAST SWEEP is used, but this does not impair its usefulness for locating signals on narrow sweep widths, or for repeated examination of a portion of the sweep width without requiring a 10-second wait between scans.

(15) An external audio signal may be connected to the EXT MOD connector to aid in setting up any desired sweep width. This signal amplitude modulates the CAL OSC LEVEL. For example, a 10-kc audio signal will produce sidebands at ±10 KC relative to the center-frequency pip. When the SWEEP WIDTH control is adjusted so that these sidebands appear at the left and right extremities of the calibrated screen, the sweep width is +10 kc or 20 kc overall. Excessive audio amplitude should be avoided, since it may prevent the crystal oscillator from functioning.

(16) The H OUTPUT and V OUTPUT connectors on the rear apron of the chassis provide voltages proportional to the horizontal and vertical position of the crt spot. They are intended for operation of a slave oscilloscope or other external indicator.

d. OUTLINE DIMENSIONAL DRAWINGS. - Figures 2-1, 2-2, and 2-3 show diagrams for the SA, PS-12, and T3003-1, respectively; figures 2-4, 2-5, and 2-6 show cabinet-mounted diagrams for SA equipped with the PS-12, SA, and PS-12, respectively.

2-3. TRANSMITTING MODE SELECTOR MODELS SBE-2 AND SBE-3.

a. INITIAL INSPECTION. - Physically there is little or no difference between the SBE-2 and SBE-3; consequently, except as noted, the following installation procedures apply to both models. As in other cases, both units have been tested and calibrated before shipment. Consequently, only minor preparations are required to put the units 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.

b. 115-VS 230-VOLT POWER SUPPLY CONNECTIONS. - SBE's power supply is designed for 115- and 230-volt, 50- and 60-cps, single-phase power; it is factory wired for 115 volts. If 230-volt operation is required (sometimes when SBE is used as an end item), minor wiring changes to SBE's power supply and crystal oven are necessary. These are shown in figure 2-7.

c. INTERCONNECTING PROCEDURE. - When the SBE forms "part" of the GPT-10K assembly, the interconnecting procedure is as follows:

(1) As shown by wiring diagram (refer to paragraph 2-7 in Volume II of the manual), signal conductors, forming part of signal-supply cable CA-427, interconnect the SBE to a terminal board and to coaxial connectors of RF circuits. This group of conductors consists of 5 single-conductor coaxial cables (with each end equipped with coaxial connectors) and 14 single-conductor wires (with each end equipped with terminal lugs). Connect as shown in paragraph 2-7.

(2) Connect 14-conductor power supply cable CA-346 between SBE's connector J109 and the SBE's power supply connector J402.

(3) Connect power supply cord between 115-volt regulated 50- and 60-cycle power supply accessory multiple and power supply 115-volt input.

When the SBE is an "end item", the equipment supplied and the interconnecting instructions are as follows:

Description	Quantity
Transmitting Mode Selector Model SBE-2	1
a. Exciter Unit Model A-1516	--
b. Power Supply Model A-1397	--
Transmitting Mode Selector Model SBE-3	1
a. Exciter Unit Model AO-101	--
b. Power Supply Model A-1397	--
Power Interconnecting Cable CA-346	1
Signal Interconnecting Cable P/O CA-427 (when and as ordered by customer to fulfill specific requirements)	--
AC Cable (Power Supply) CA-103.72	1
Terminal Strip TM-105-14AL	1
Microphone Connector PL-132-3	1
Connectors UG-260/U	2

(1) Mount the SBE and its power supply in a standard 19-inch relay rack or other housing as desired. Figure 2-8 is an outline dimensional drawing of the SBE and its power supply.

(2) Connect cable CA-346 (supplied) from J402 of the power supply to J109 of the SBE.

(3) Set the three toggle switches in the center of the front panel to the following positions: XMTR ON-OFF to OFF, EXCITER ON-STANDBY to STANDBY, POWER ON-OFF to OFF.

(4) Connect Cable CA-103.72 (supplied) from J401 of the power supply to an AC source.

(5) Connect RF OUT (J102) of the SBE to the input of the associated GTP-10K. Use one of the two (supplied) Connectors UG-260/U.

(6) If an external VMO is to be used, connect it to VMO in (J104) on the rear of the SBE and use the MF XTAL SW in the VMO position. Use one of the two (supplied) Connectors UG-260/U.

(7) For local voice operation, connect high impedance (1/2 megohm) crystal or dynamic microphone to the MIKE jack on the front panel of the SBE.

d. INITIAL ADJUSTMENTS AND INSTALLATION OF MF CRYSTALS. - Proceed as follows:

(1) Set POWER ON-OFF switch to ON. Allow 1-hour warm-up period.

(2) Turn METER SW to CAL and zero meter by screwdriver adjustment through opening located directly beneath the meter.

(3) The equipment is now ready to be tuned. Refer to Section 3 of Volume II of the manual.

Refer to paragraph 4-2 of Volume II of the manual for proper crystal selection for desired output frequency. To insert crystals, open oven top by turning snap screws 1/2 turn counterclockwise. Remove cover and celotex insulation and install crystals. Sockets 1, 2, 3, etc., correspond to positions of front panel switch MF XTAL SW. The crystal trimmers are factory adjusted for average crystals, but for more accurate frequency adjustment, beat crystals against any accurate frequency standard. An adjustment tool is provided for trimmer adjustments.

2-4. VARIABLE FREQUENCY OSCILLATOR MODEL VOX-2.

a. INITIAL INSPECTION. - This unit 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.

b. 115-VS 230-VOLT POWER SUPPLY CONNECTIONS. - VOX's power supply is designed for 115- and 230-volt, 50- and 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 2-9.

c. INTERCONNECTING PROCEDURE. - When the VOX forms "part" of the GPT-10K assembly, the interconnecting procedure is as follows:

(1) As shown by wiring diagram, (refer to paragraph 2-7 in Volume II of the manual), a single-conductor coaxial signal conductor interconnects the VOX's RF HFO output to the swinger of selector switch VOX RF OUT on the MCP.

(2) Figure 2-10 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).

(3) Connect power supply cord between 115-volt regulated 50- and 60-cycle power supply accessory multiple and power supply 115-volt input.

When the VOX is an "end item", the equipment supplied and the interconnecting instructions are as follows:

Description	Quantity
Variable Frequency Oscillator Model VOX-2	1
Power Supply-Multiplier Auxiliary	1
Interconnect Cable, 12 contact, CA-109	
Power Supply-Master Oscillator	1
Auxiliary Interconnect Cable, 6-contact, CA-110	
RF Cable, Power Supply-Multiplier	1
Auxiliary Interconnect, single contact, CA-108	
TUBE PULLER GR-104	9

(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 2-11 is an outline dimensional drawing of the VOX.

As an end item, nine coaxial connectors furnished 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 7-5 in Volume I and figure 7-5 in Volume II.

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	300-1000 kc	BFO	Power Supply
Y102	XY 102	CR-25/U	300-1000 kc	BFO	Power Supply
Y201	XY 201	CR-18/U	3.2-3.9 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.

d. 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:

(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 will result 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 stable 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.

2-5. FREQUENCY SHIFT EXCITER MODEL XFK.

a. INITIAL INSPECTION. - This unit 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.

b. 115- VS 230-VOLT POWER SUPPLY CONNECTIONS. - XFK's power supply is designed for 115- and 230-volt, 50- and 60-cps, single-phase power; it is factory wired for 115 volts. If 230-volt operation is required (sometimes when XFK is used as an end item), minor wiring changes to XFK's power supply and ovens are necessary. These are shown in figure 2-12.

c. INTERCONNECTING PROCEDURE. - When the XFK forms "part" of the GPT-10K assembly, the interconnecting procedure is as follows:

(1) As shown by wiring diagram (refer to paragraph 2-7 in Volume II of the manual), two single-conductor coaxial signal conductors interconnect the XFK's RF output/input to selector switch contacts on the MCP as follows: XFK's output to XFK contact of SBE VMO IN selector switch, and XFK's input to XFK contact of VOX RF OUT selector switch. These RF cable interconnections form part of a larger cable (CA-427).

(2) As shown by wiring diagram (refer to paragraph 2-7 in Volume II of the manual), six conductors (numbers 24, 25, 26, 27, 28, and 49) interconnect the XFK to a terminal board via part of cable C-427. Each terminal of these six conductors is provided with a terminal lug to facilitate the interconnection.

(3) Connect power supply cord between 115-volt regulated 50- and 60-power supply accessory multiple and power supply 115-volt input.

When the XFK is an "end item", the equipment supplied and the interconnecting instructions are as follows:

Description	Quantity
Frequency Shift Exciter Model XFK	1
Cable Assembly CA-103	1
Terminal Bar for 8 connections	1
Terminal Strip TM-105-AL	
Plugs (coaxial) UG-176/U	2
Plugs PL-259	2

(Equipment required but not supplied consists of the following: two coaxial cables, each utilizing one Plug UG-176/U on one terminal and one Plug PL-259 on the other terminal; and eight conductors interconnecting the XFK's eight-conductor terminal bar to the customer's supplied Terminal Strip TM-105-AL.

The XFK may be mounted in a standard 19-inch relay rack or other housing as desired. Figure 2-13 is an outline dimensional drawing of the XFK.

The input keying line may be a twisted pair of a standard telephone-type line. The line should be connected between terminals marked VOLT and GND at the rear of the chassis and should be connected so that a positive voltage appears at VOLT on "mark" condition. The input impedance of the keying line is 100,000 ohms. However, the line should be terminated in as low an impedance into which the keying source may operate. For this reason a 2000-ohm, 10-watt resistor is supplied with each XFK attached to the appropriate terminals.

A twisted pair may be brought into the terminals marked CONT. and GND. This line may be used to key the XFK merely by shorting it ("mark" condition.) In order for the regular keying line to function properly, care must be taken to see that this line is kept open when not in case.

The facsimile line should be connected to FAX and GND terminals on the terminal board. When using a facsimile demodulator, such as TMC's Model XFD, +105 volts is supplied from the XFK and should be wired along with a ground to the appropriate terminals on the XFD.

The OUTPUT jack should be connected by a suitable length of 72-ohm cable to the frequency shift input terminal on the associated GPT-10K.

Should it be desired that an external oscillator be used to replace the crystal oscillator within the unit, a coaxial cable of 72 ohms with the required signal level and frequency should be connected to the jack labeled EXT INPUT on the rear chassis panel.

A jack labeled MONITOR is also available at the rear of the chassis and taps off a very small portion of the output of the XFK. This may be connected through a 72-ohm coaxial cable to any suitable monitoring system available at the GPT-10K.

d. CRYSTAL SELECTION. - Before operating the equipment it is necessary to select the proper crystal for the desired output frequency. This may be done by the following formula:

$$fx = \frac{fo}{n} - 200 \text{ kc}$$ (Since XFK uses upper sideband in RF/200-KC oscillator Mixer's Output).

Where fx = crystal frequency in mc

fx = output frequency of GPT-10K in mc

n = GPT-10K multiplication ratio

The crystal used should preferably be the new hermetically sealed JAN unit CR-27/U (Military Specification MIL-C-3098). The crystal should be inserted in one of the appropriate crystal sockets inside the oven. The oven may be reached merely by opening the small thumb adjustment on the door located on the front panel. Writing space for the crystal frequency and output frequency of the XFK is available on the front of the oven door to aid in selection of the crystal channel.

e. MULTIPLICATION PRESET. - The proper GPT-10K multiplication ratio should be set at the rear of the chassis by means of the plug corresponding to the crystal position used on the front panel. Should the jack for any ratio be in use by another position, the plug may merely be inserted into the jack which is in parallel with the plug inserted into this particular ratio. (See figure 2-14.) For further details, refer to paragraphs 3-6 and 4-6 of the manual.

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

Designation	Socket Installed	Type	Freq. Char.	Function	Chassis
No. 1	XY1 and XY2	CR-27/U	800 to 6700 kc	Oscillator	Inner Oven
No. 2	XY3 and XY4	CR-27/U	800 to 6700 kc	Oscillator	Inner Oven
No. 3	XY5 and XY6	CR-27/U	800 to 6700 kc	Oscillator	Inner Oven

f. KEY-FAX SWITCH. - This switch, located on the rear chassis panel on the older model must be set in KEY position to work on either voltage or contact keying. In this position, the multiplier preset plugs must be properly inserted as explained in the preceding paragraph in order that the unit may "shift." In FAX position, a facsimile signal may be applied as explained more fully in paragraphs 3-6 and 4-6 of the manual.

On the new model, the MODE switch is a five-position selector switch on the front panel and performs the same overall functions as the three-position selector TEST switch and two-position KEY-FAX switch on the old model.

2-6. ISOLATION KEYER MODEL AK-100.

a. INITIAL INSPECTION. - This unit 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.

b. LOCATION. - This unit is mounted on the rear chassis just above the power supply of the FSA.

c. 115- VS 230-VOLT POWER SUPPLY CONNECTIONS. - ISK's power supply is designed for 115- and 230-volt, 50- and 60-cps, single-phase power; it is factory wired for 115 volts. If 230-volt operation is required, reconnect in series the ISK's power supply transformer primary windings.

d. INTERCONNECTING PROCEDURE. - Figure 2-15 is a simplified diagram showing interconnections between terminal boards E301 of the MCP-2 and E4001 of the ISK and the auxiliary frame chassis.

2-7. WIRING DIAGRAM OF AUXILIARY FRAME CHASSIS.

Figure 2-16 shows wiring details of test and exciter units on the auxiliary frame chassis when the chassis contains an MCP-1 but not an ISK. Figure 2-17 shows wiring details of test and exciter units when the chassis contains an MCP-2 and an ISK.

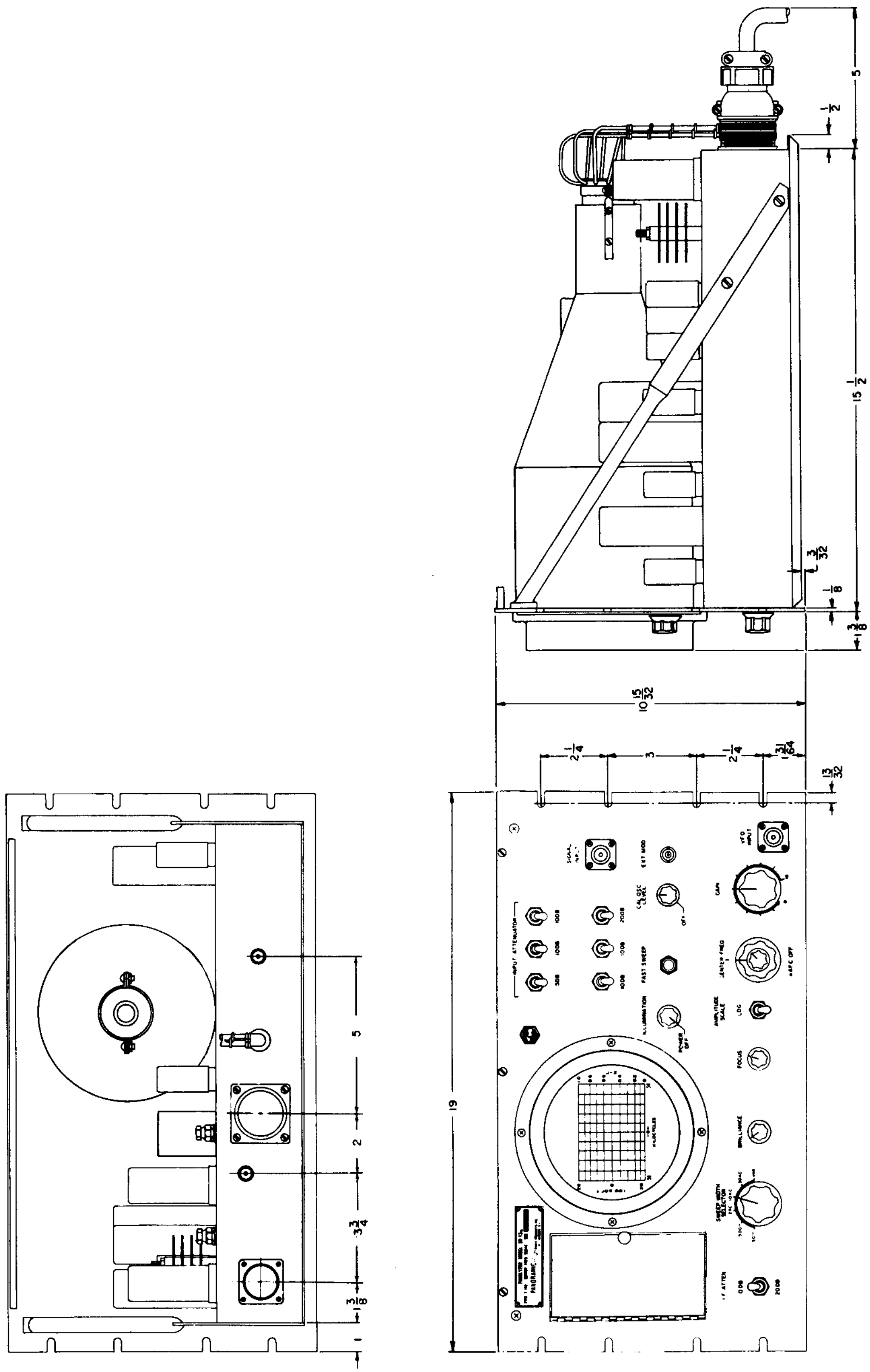


Figure 2-1. Outline Dimensional Drawing, SA, Rack Mount Style

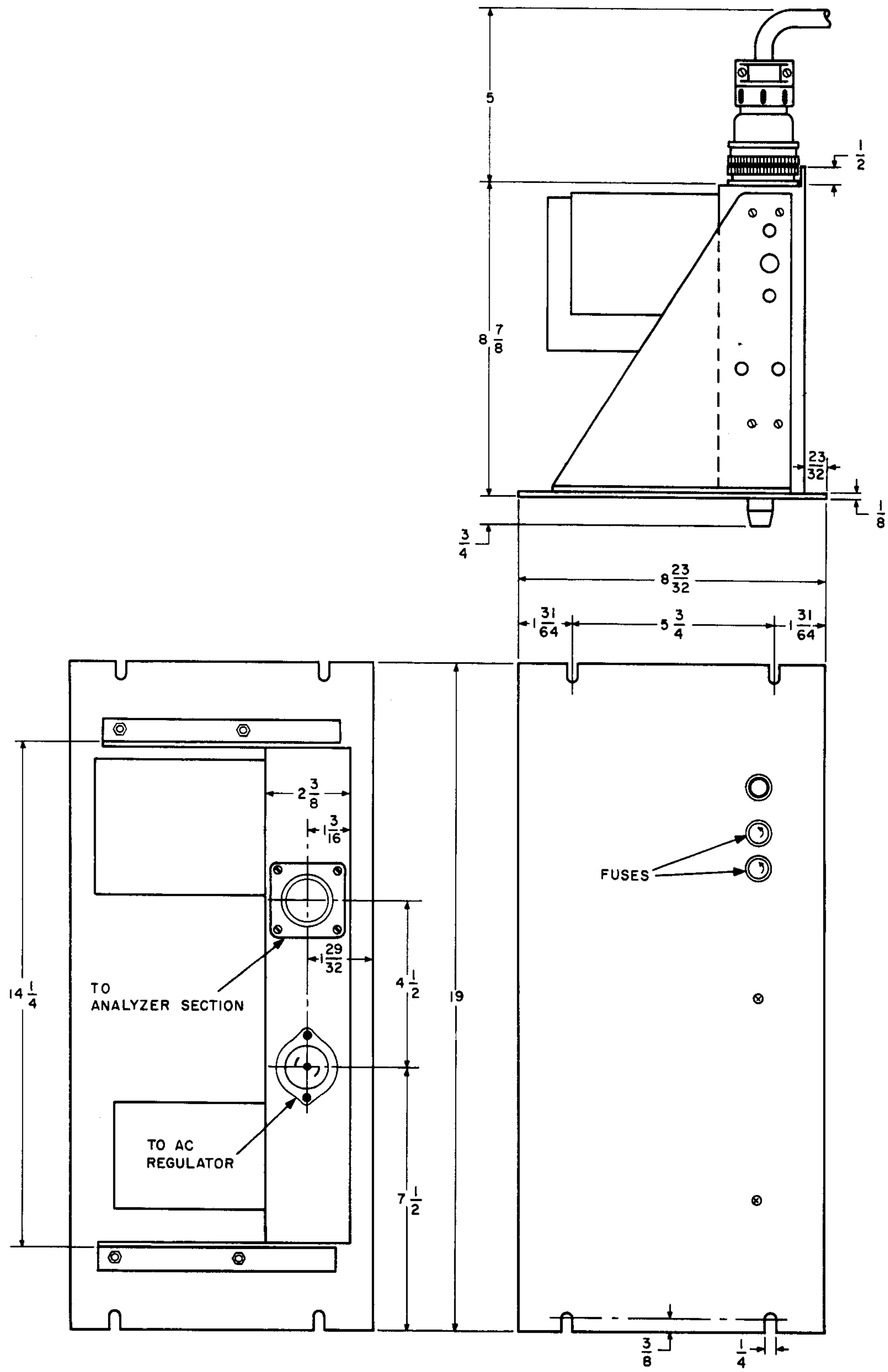


Figure 2-2. Outline Dimensional Drawing, PS-12, Rack Mount Style

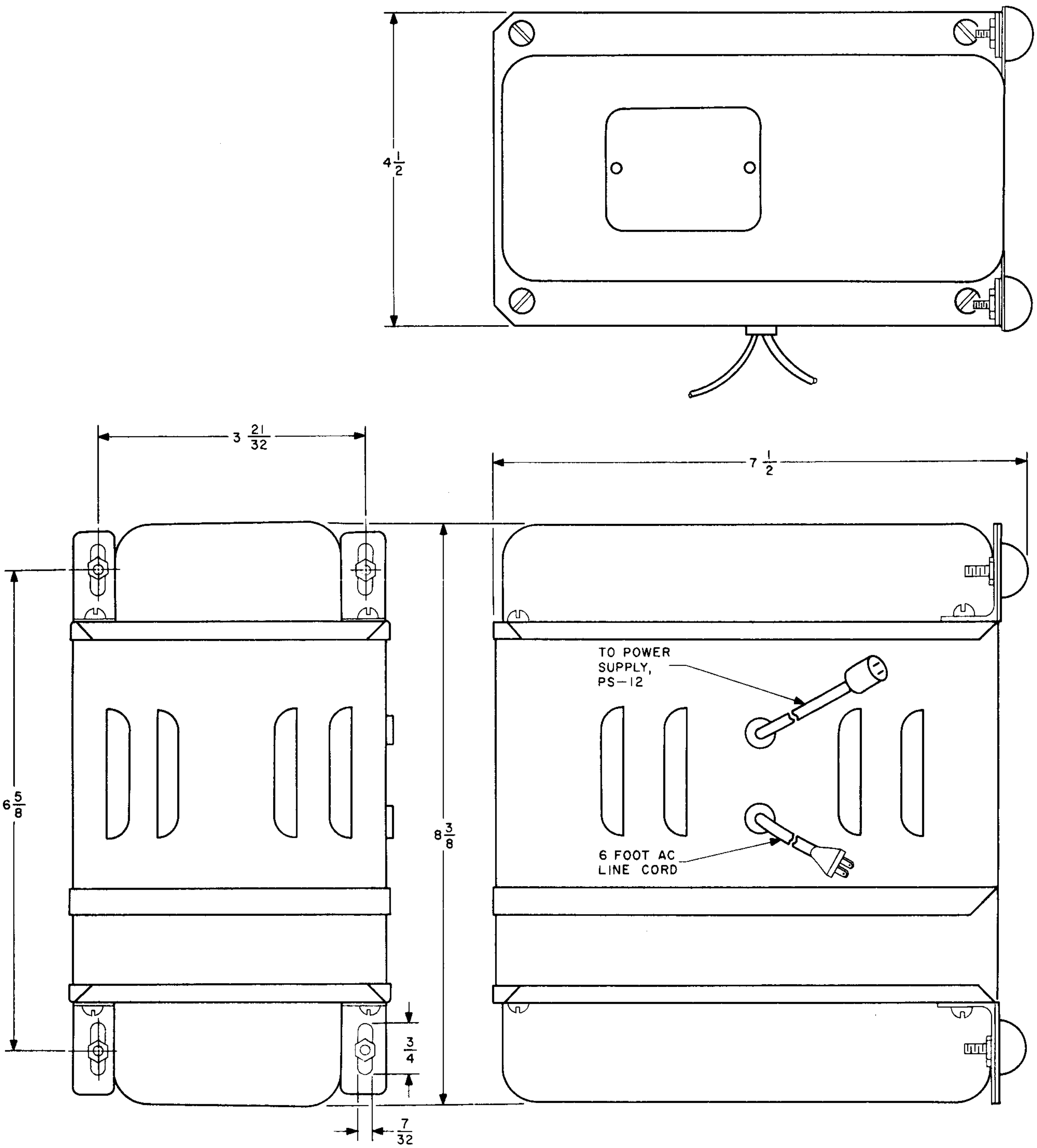


Figure 2-3. Outline Dimensional Drawing, T3003-1, Part of FSA

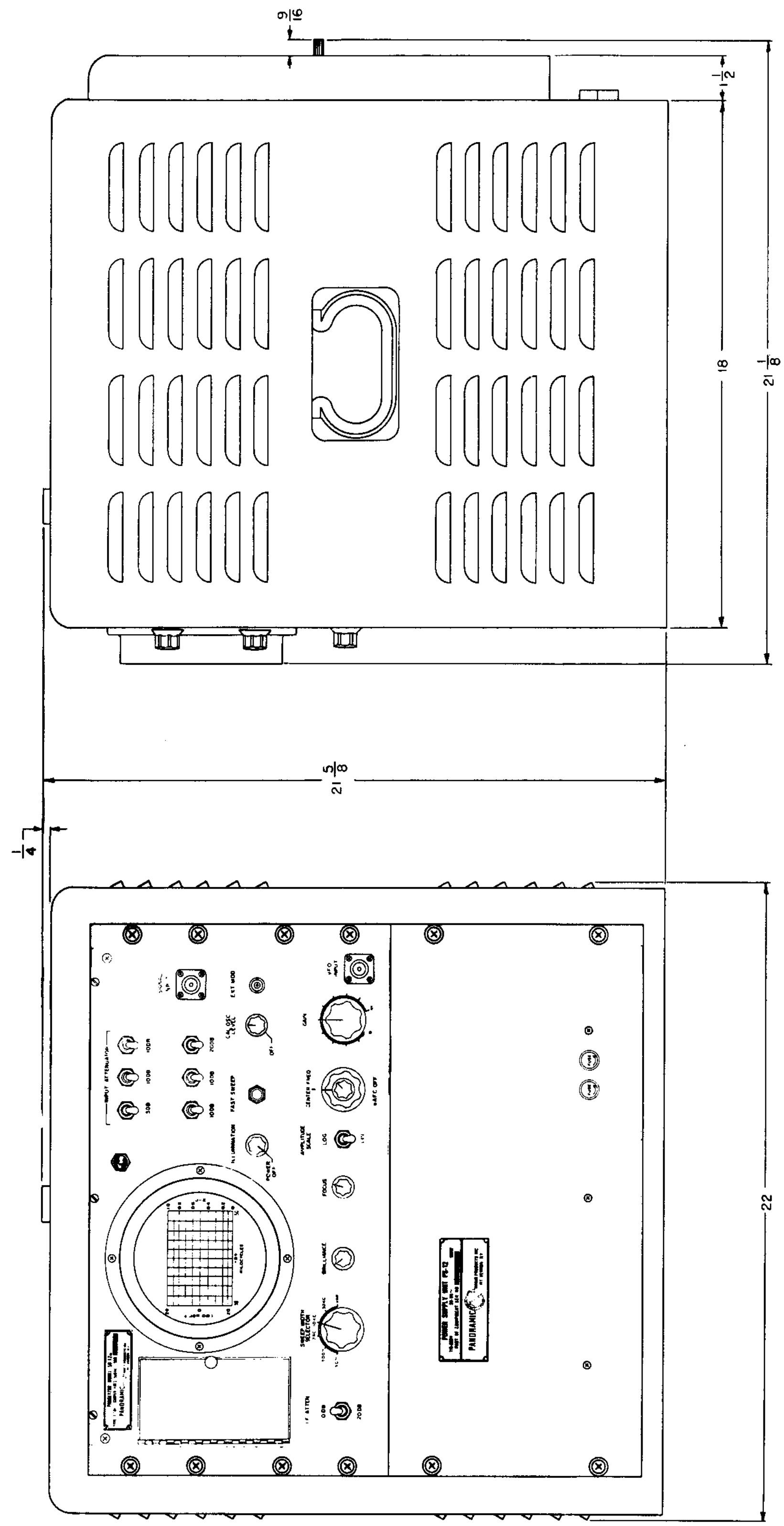


Figure 2-4. Outline Dimensional Drawing, SA and PS-12 in Cabinet

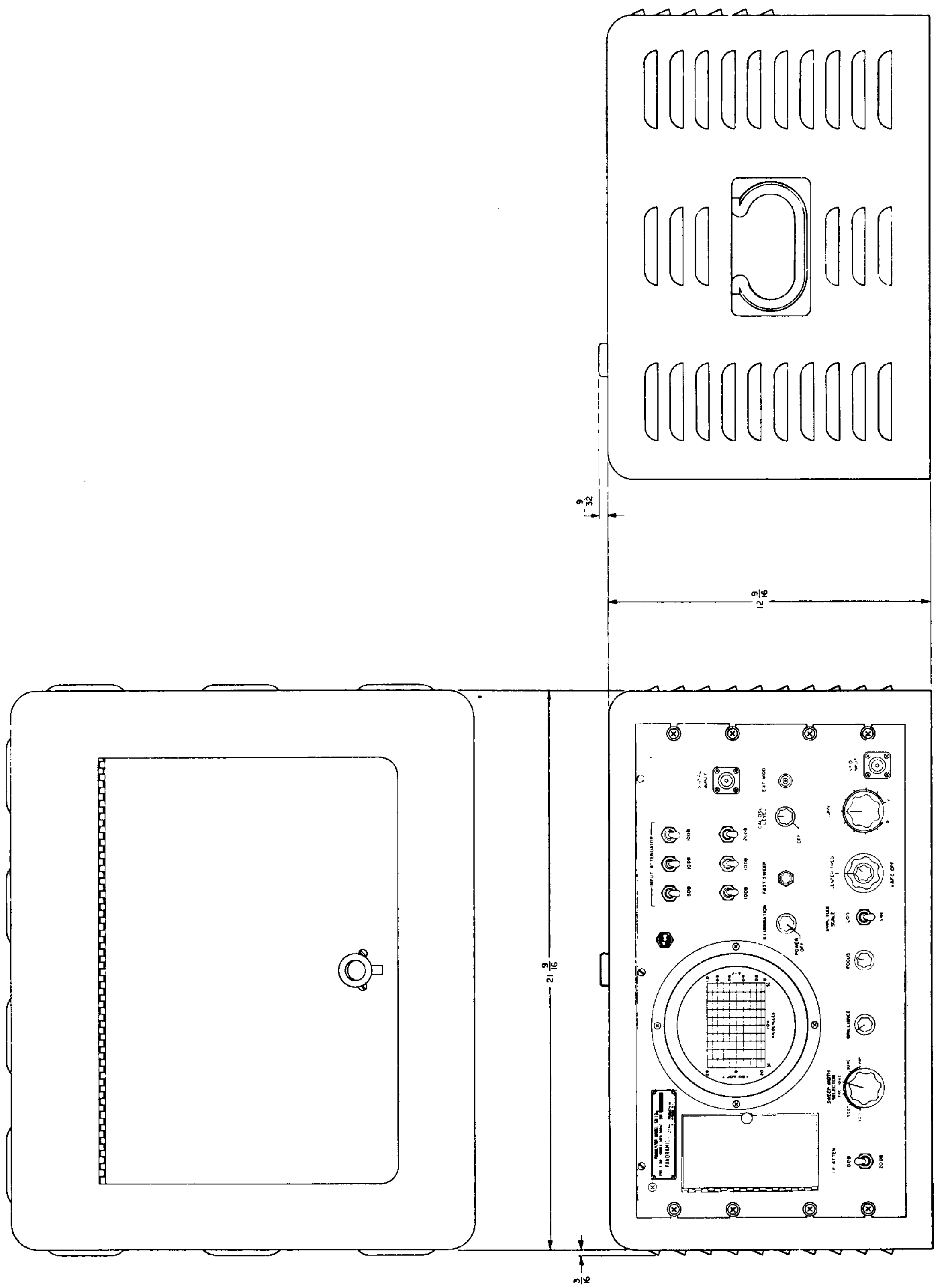


Figure 2-5. Outline Dimensional Drawing, SA in Cabinet

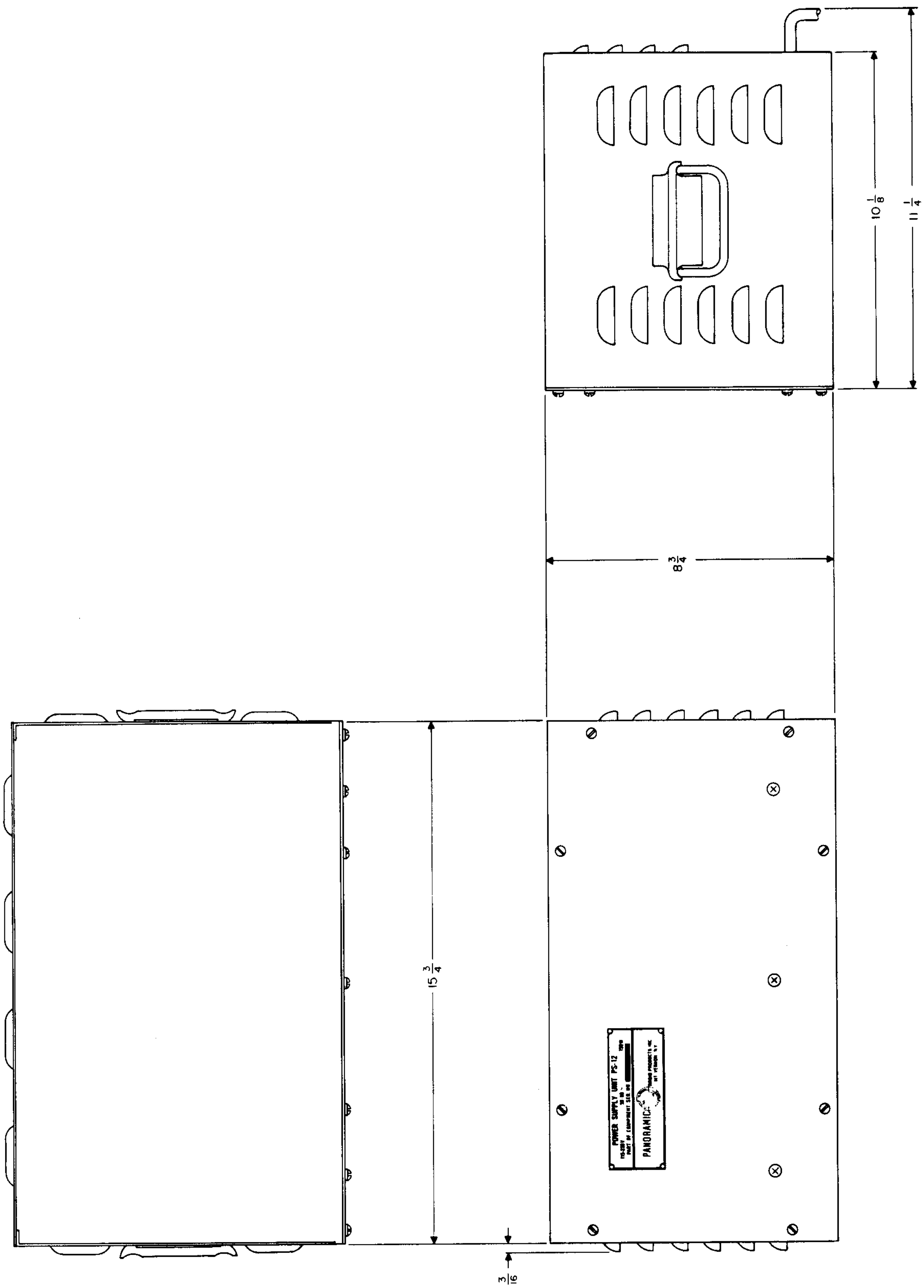


Figure 2-6. Outline Dimensional Drawing, PS-12 in Cabinet

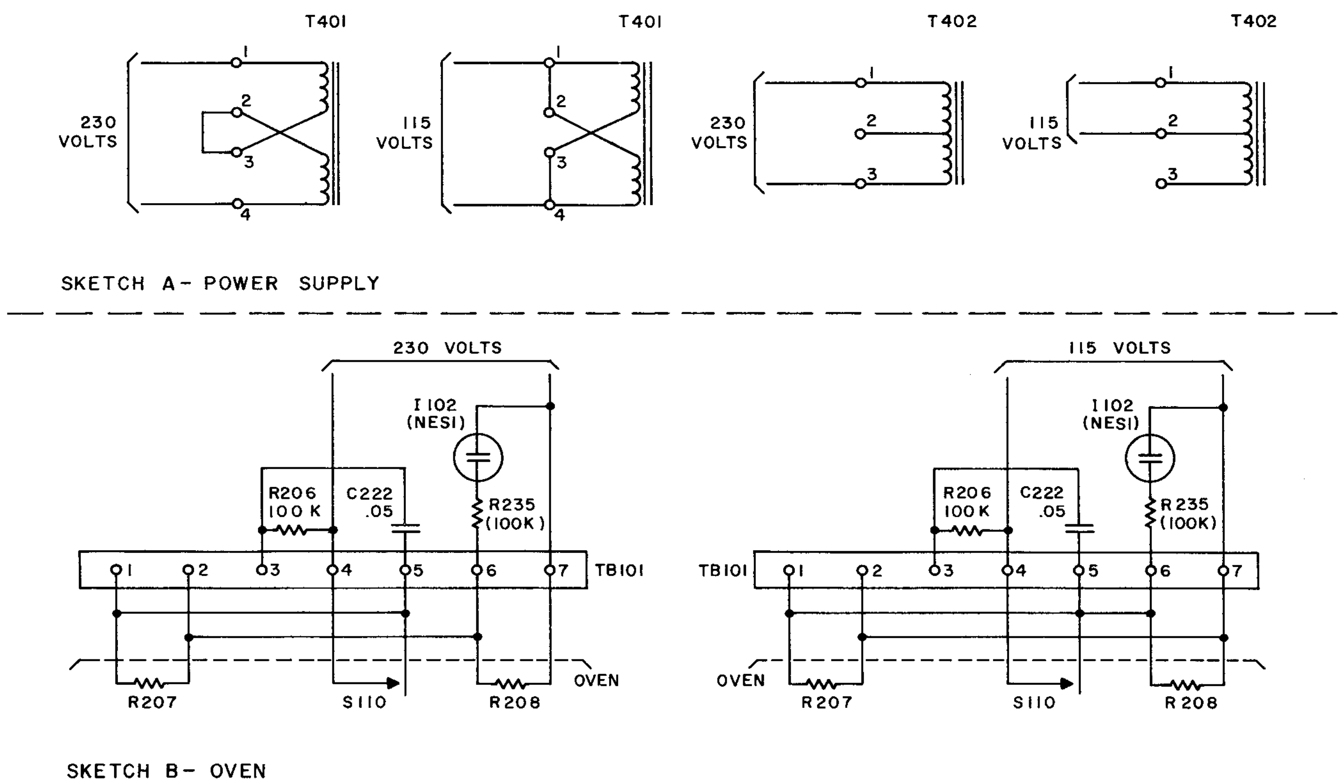


Figure 2-7. Installation Diagram Showing 115- vs 230-Volt Power Supply Connections, SBE-2 and SBE-3

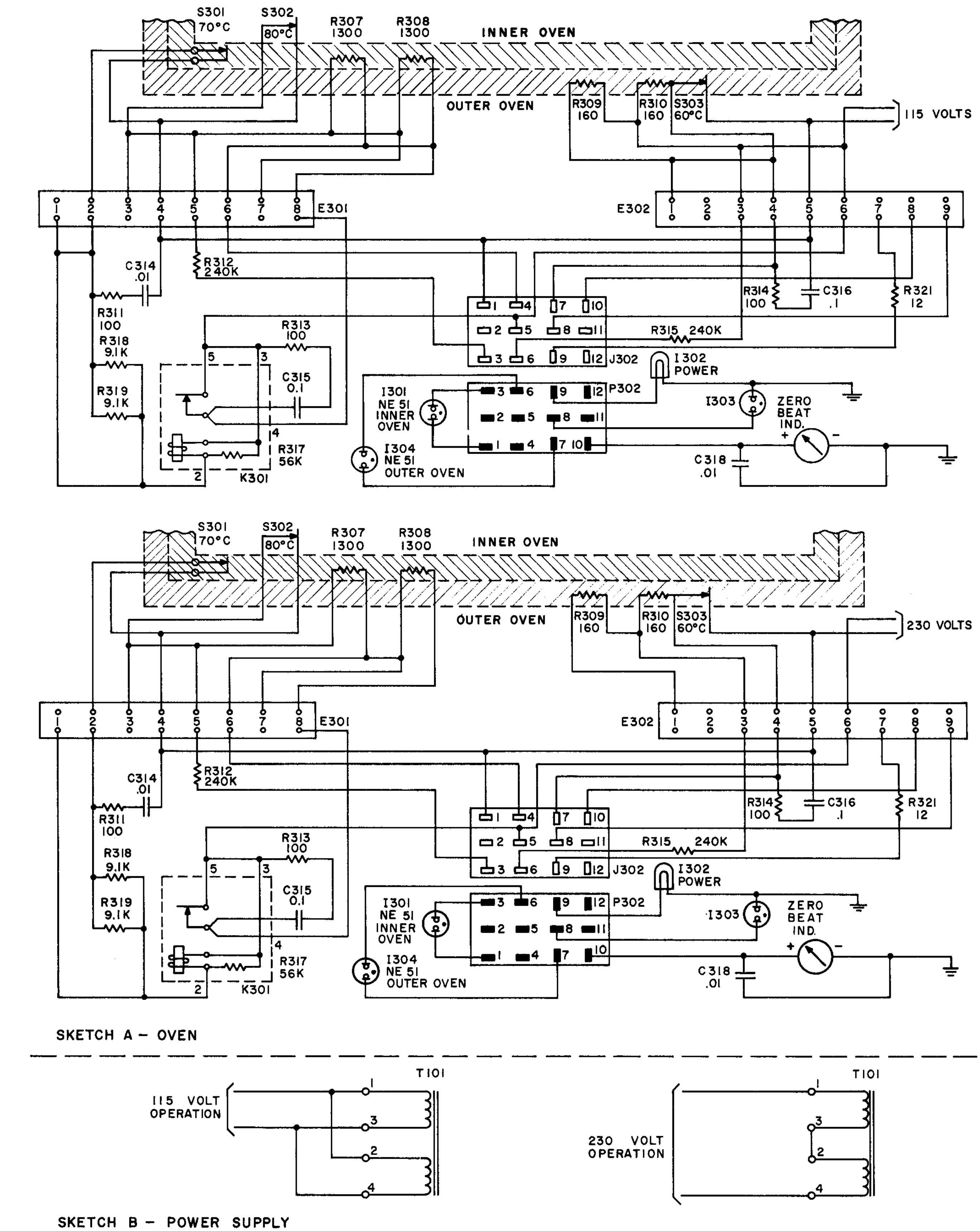
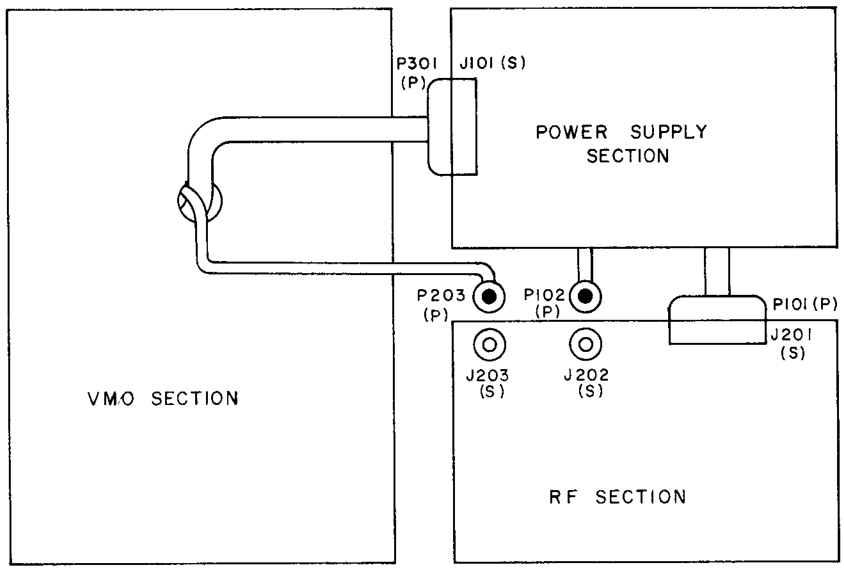
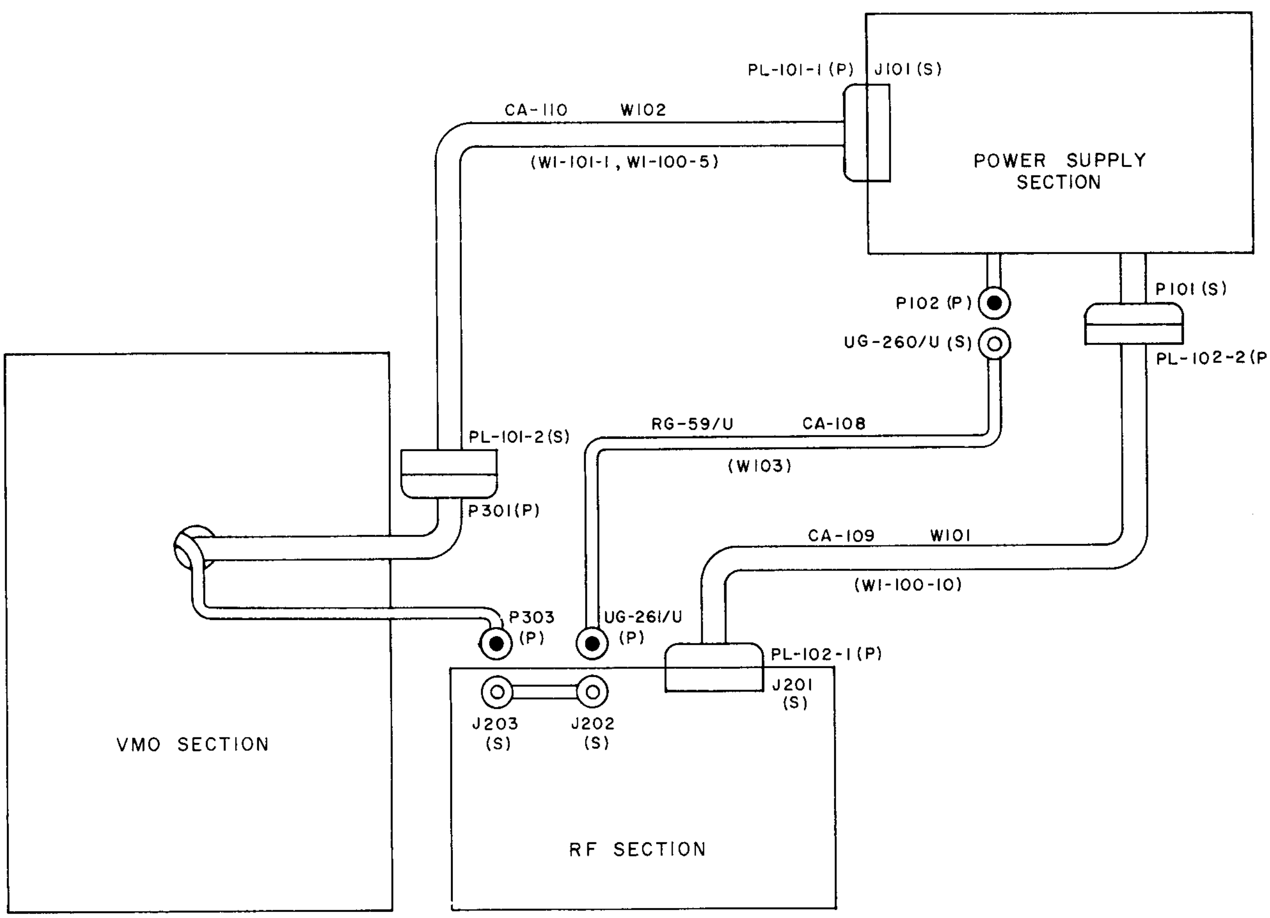


Figure 2-9. Installation Diagram Showing 115- vs 230-Volt Power Supply Connections, VOX



SKETCH A – CABLES UNDER NORMAL CONDITIONS



SKETCH B – CABLES UNDER SERVICING CONDITIONS

Figure 2-10. Installation Diagram Showing Cabling Under Operating and Servicing Conditions, VOX

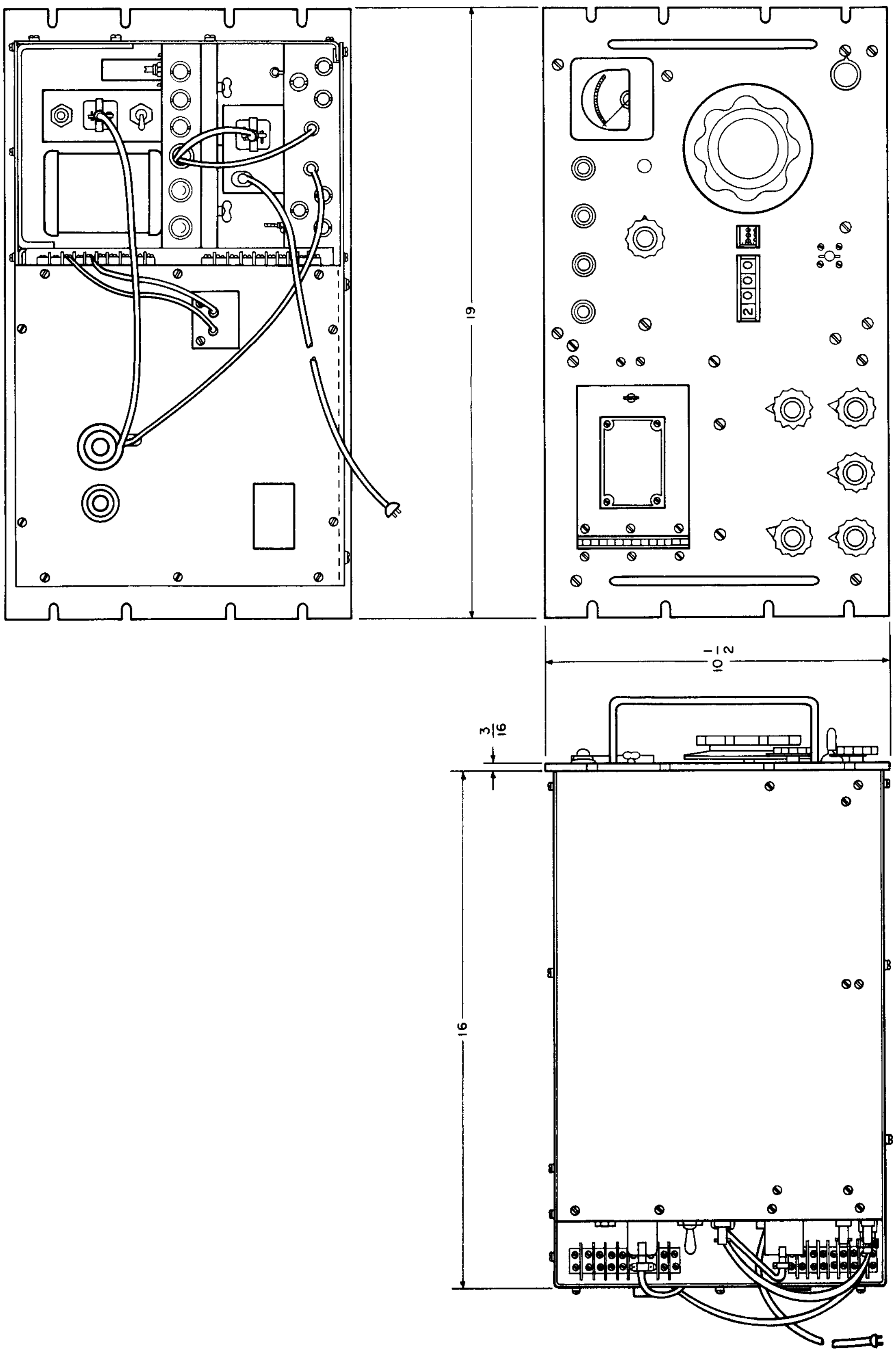
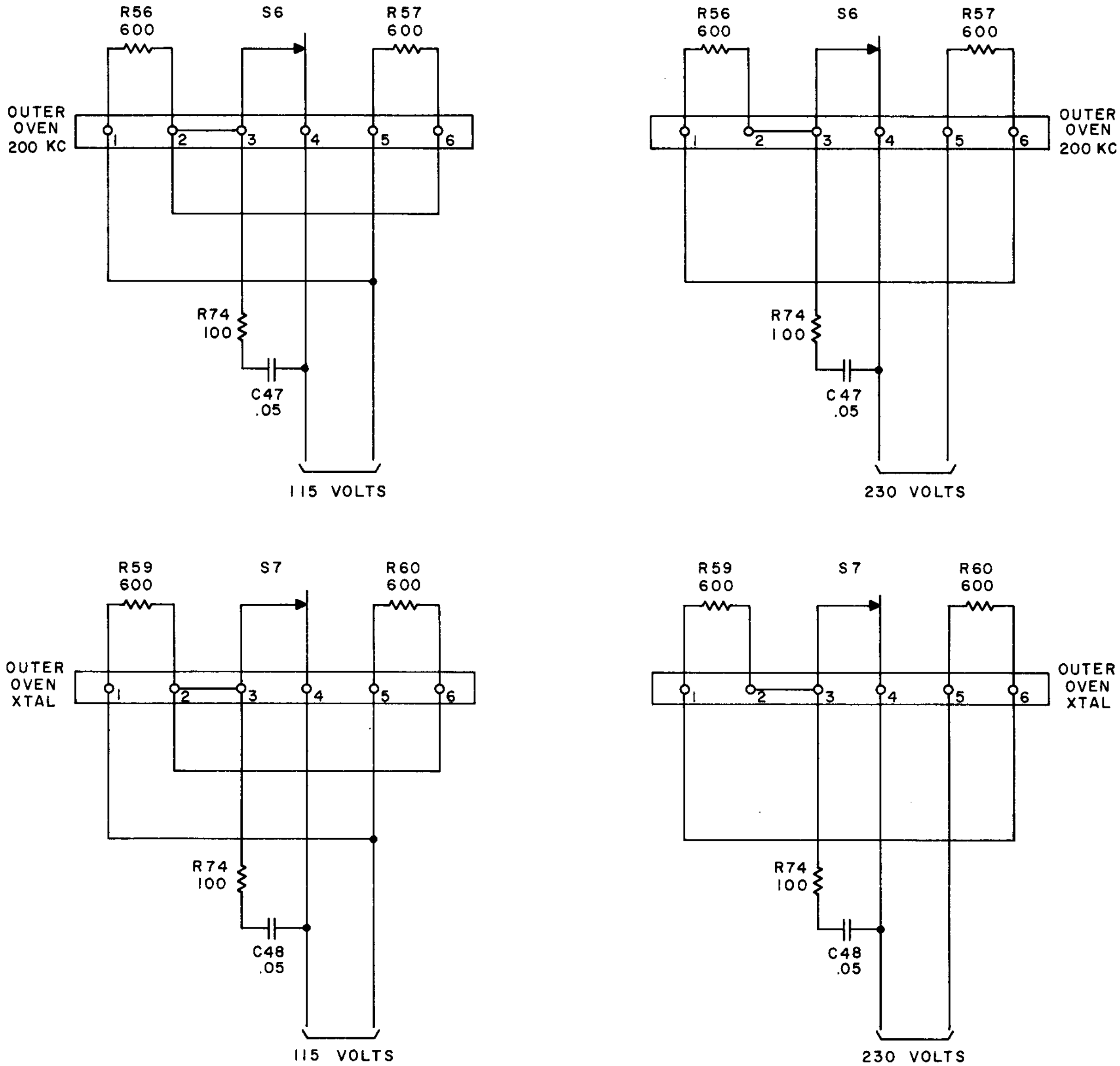
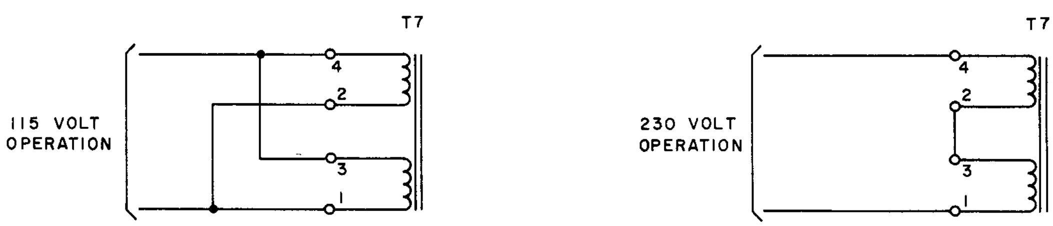


Figure 2-11. Outline Dimensional Drawing, VOX



SKETCH A – OVENS



SKETCH B– POWER SUPPLY

Figure 2-12. Installation Diagram Showing 115- vs 230-Volt Power Supply Connections, XFK

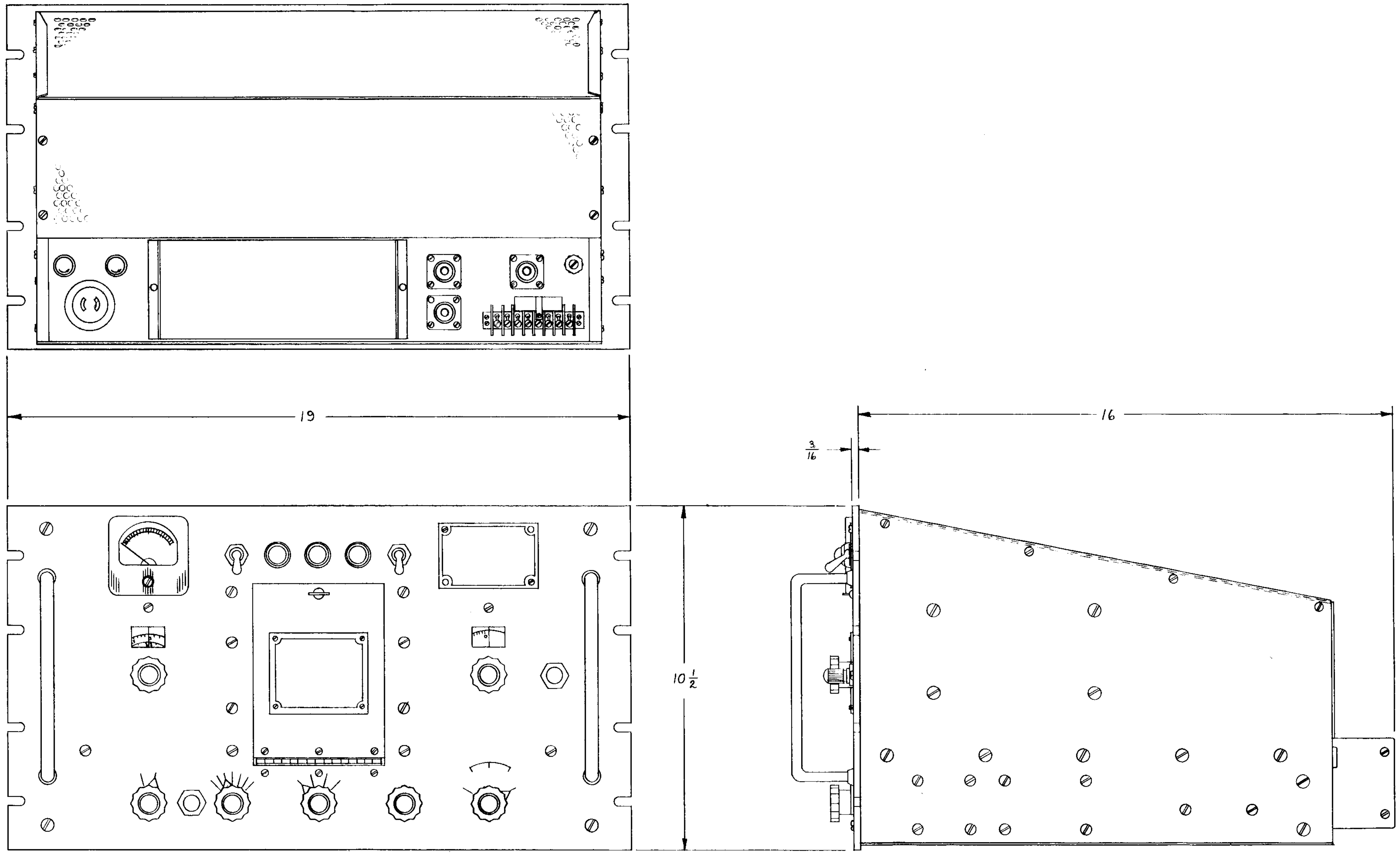
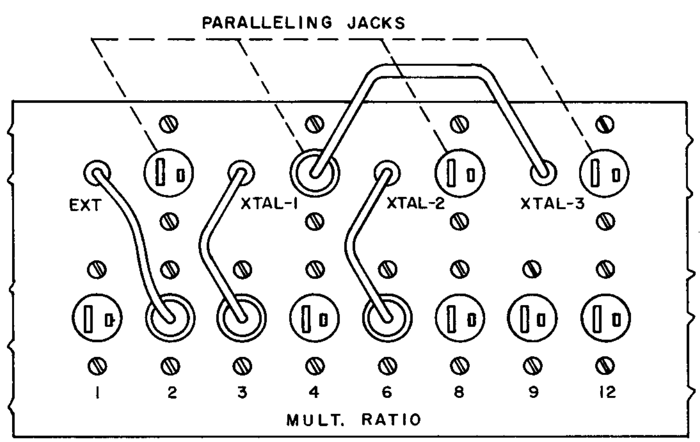


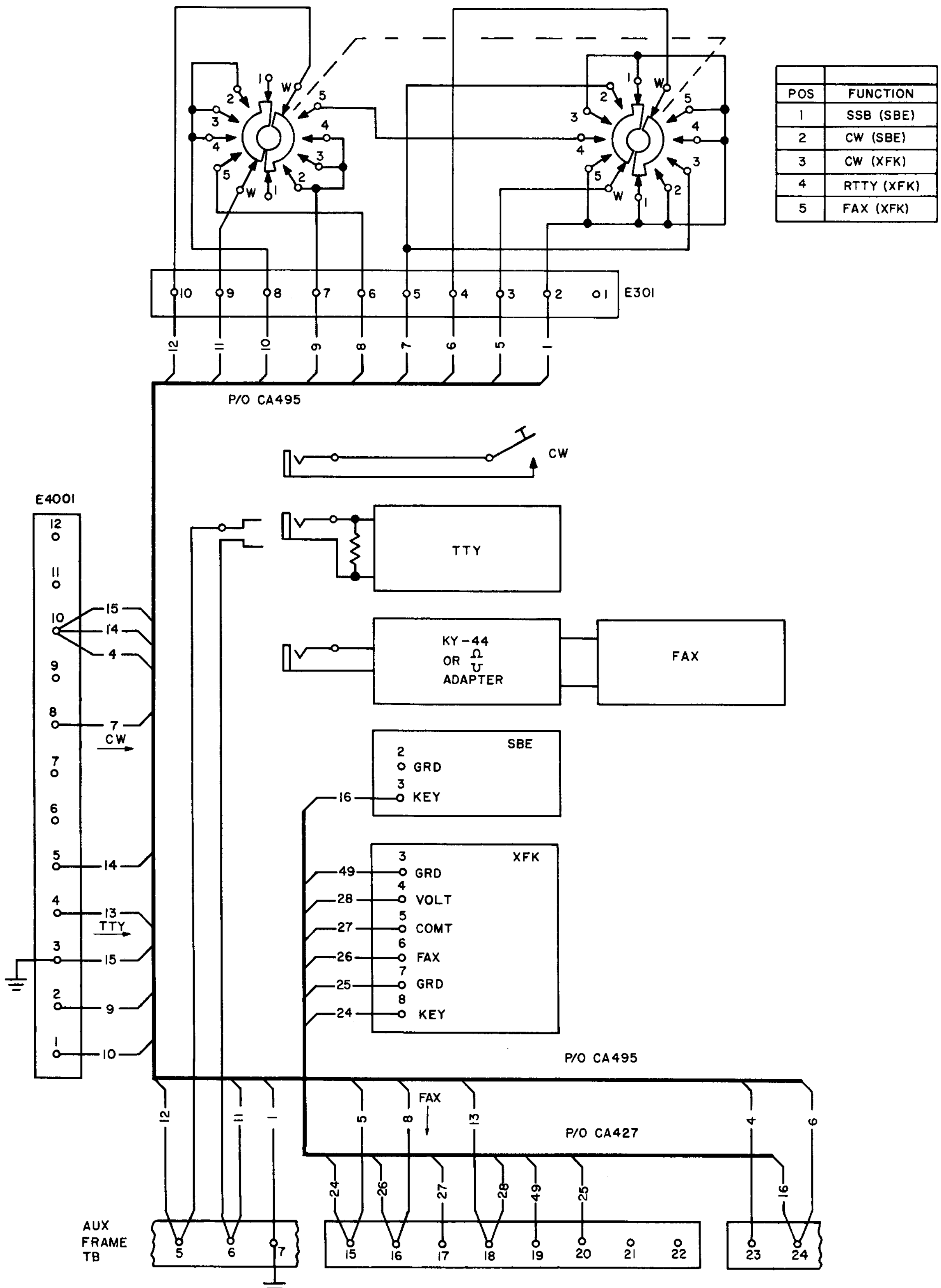
Figure 2-13. Outline Dimensional Drawing, XFK



A TYPICAL PATCHING ARRANGEMENT

XTAL SELECTOR POSITION	XMTR MULTI-RATIO	XMTR. OUTPUT FREQ. SHIFT (DIAL SET) CPS	XFK FREQ. SHIFT
EXT	2	850	425
XTAL-1	3	850	283
XTAL-2	6	850	142
XTAL-3	3	850	283

Figure 2-14. Diagram Illustrating Multiplication Preset, XFK



POS	FUNCTION
1	SSB (SBE)
2	CW (SBE)
3	CW (XFK)
4	RTTY (XFK)
5	FAX (XFK)

Figure 2-15. Diagram Illustrating Interconnections between E301 of MCP-2 and E4001 of ISK and Auxiliary Frame Chassis

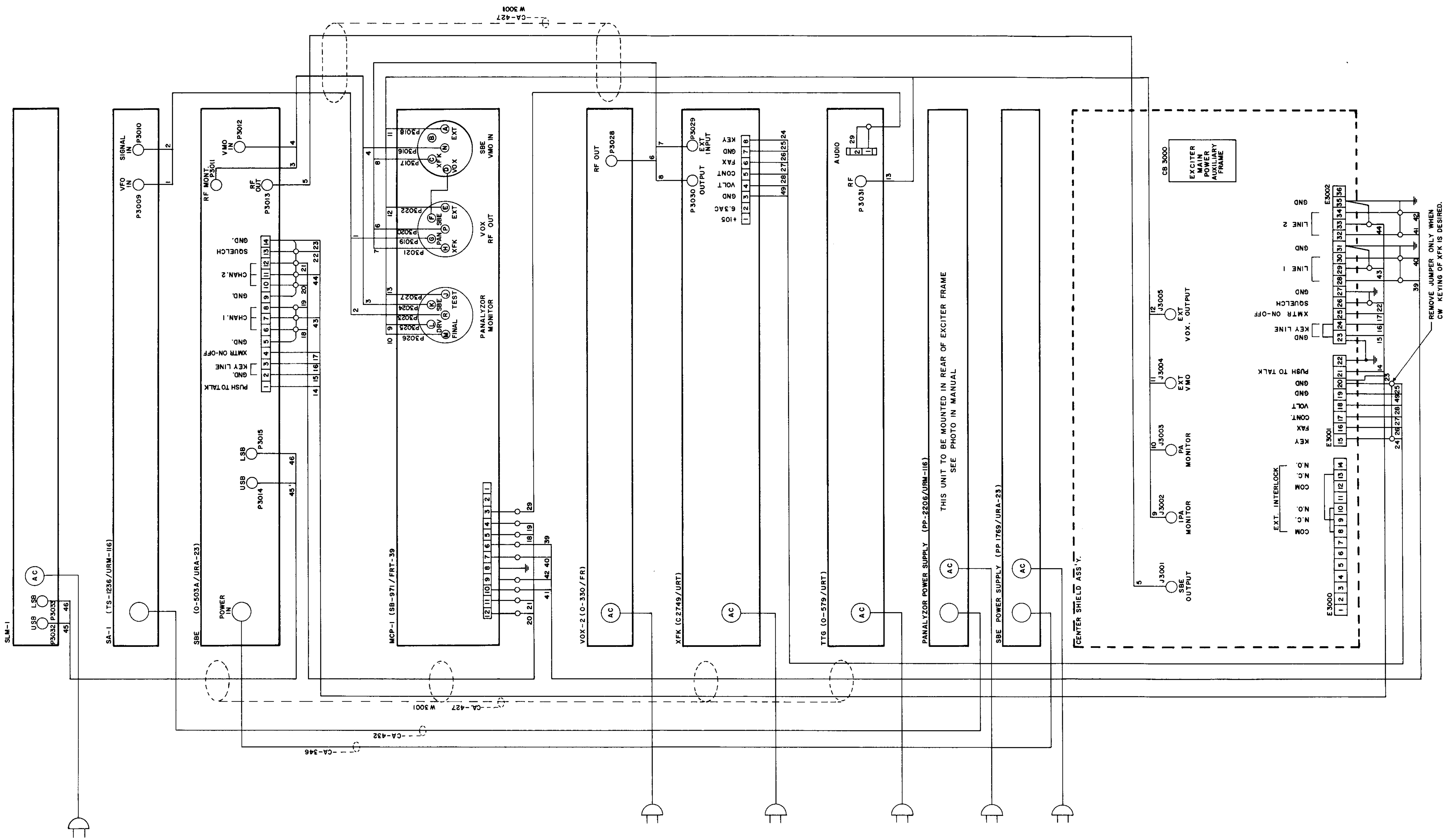


Figure 2-16. Wiring Diagram, GPT-10K Containing MCP-1

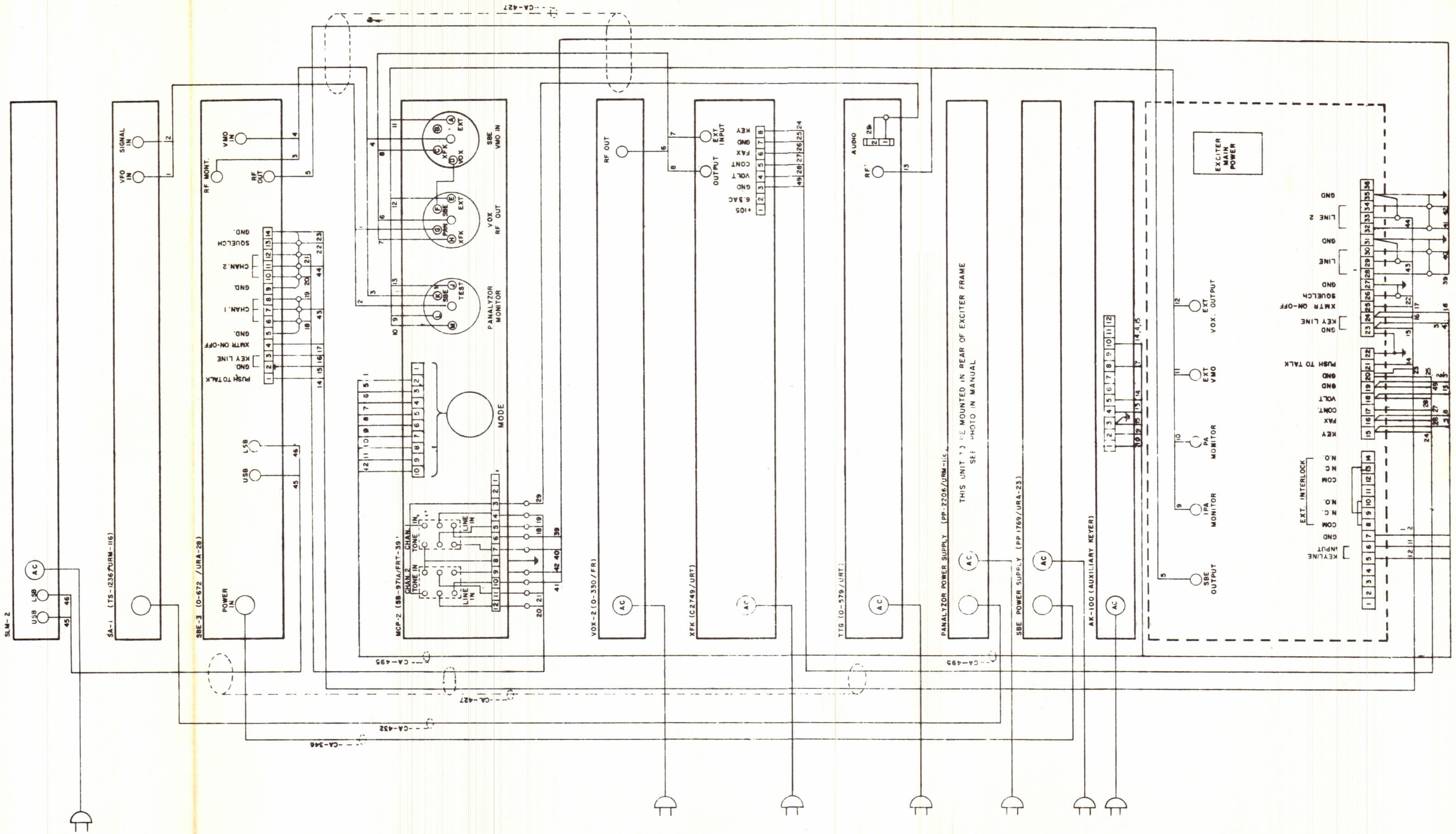


Figure 2-17. Wiring Diagram, GPT-10K Containing MCP-2

SECTION 3
OPERATOR'S SECTION

3-1. GENERAL.

This section consists of detailed step-by-step procedures to operate all units on the auxiliary frame chassis (left-hand section facing GPT-10K). The procedures given in Section 3, Volume I of the manual for operating the units on the auxiliary frame chassis as adjuncts of the units on the main frame chassis (right-hand section facing GTP-10K) are derived from these more detailed procedures but are considerably abridged to simplify the task of tuning and loading a GPT-10K by a skilled operator. The detailed procedures given below serve two general purposes: to provide less skilled operators with the additional information necessary to enable them to operate efficiently, and to provide complete operating instructions for general purpose use of the units on the auxiliary frame chassis.

The operating procedures presented below for the seven principal units on the auxiliary frame chassis make frequency reference to table 3-1, and figure 3-1. Close coordination between the operating procedures and these references will facilitate an understanding of the procedures. This presentation is consistent with the operating procedures in Section 3, Volume I of the manual for the main frame chassis units, and results in a uniform operating procedure for all units comprising the GPT-10K.

3-2. SIDEBAND LEVEL MONITOR MODELS SLM-1 AND SLM-2.

a. GENERAL INSTRUCTIONS APPLICABLE TO SLM-2. - The SLM-2 consists essentially of two 250-kc amplifiers; the output of each contains a VTVM. These meters monitor the sideband levels of an associated SBE-3's 250-kc balanced modulator. Good operating practice is to keep the indicated levels below 0 db, and preferably around -10 db. These levels are of course a function of SBE-3's audio inputs; these levels too should be limited to 0 db and should preferably be kept around -10 db.

While the SBE-3's output meter may be used to limit the SBE-3's audio input properly, and consequently its 250-kc balanced modulator's upper/lower sideband levels, the SLM's meters provide a convenient means of continuously monitoring the sideband levels while permitting SBE-3's output meter to monitor other quantities essential to the good operation of a GPT-10K.

b. GENERAL INSTRUCTIONS APPLICABLE TO SLM-1. - The SLM-1 consists essentially of two 17-kc amplifiers; the output of each contains a VTVM. These meters monitor the sideband levels of an associated SBE-2's 17-kc balanced modulator. Good operating practice is to keep the indicated levels below 0 db, and preferably around -10 db. These levels are of course a function of SBE-2's audio inputs; these levels too should be limited to 0 db and should preferably be kept around -10 db.

While the SBE-2's output meter may be used to limit the SBE-2's audio input properly, and consequently its 17-kc balanced modulator's upper/lower sideband levels, the SLM's meters provide a convenient means of continuously monitoring the sideband levels while permitting SBE-2's output meter to monitor other quantities essential to the good operation of a GPT-10K.

c. CALIBRATION APPLICABLE TO SLM-2. - The SLM-2's CALIBRATE potentiometers, USB and LSB, should be set so that SLM-2's VTVMs track the associated SBE-3's output meter. On this basis, SLM's VTVMs read SBE-3's audio input levels rather than the SBE-3's 250-kc balanced modulator sideband levels. The difference is of no practical importance.

d. CALIBRATION APPLICABLE TO SLM-1. - The SLM-1's CALIBRATE potentiometers, USB and LSB, should be set so that SLM-1's VTVMs track the associated SBE-2's output meter. On this basis, SLM's VTVMs read SBE-2's audio input levels rather than the SBE-2's 17-kc balanced modulator sideband levels. The difference is of no practical importance.

e. OPERATION APPLICABLE TO SLM-2. - Since the SLM-2 is a VTVM, operation is automatic provided the input circuits are connected to a 250-kc signal source and the meter is powered.

f. OPERATION APPLICABLE TO SLM-1. - Since the SLM-1 is a VTVM, operation is automatic provided the input circuits are connected to a 17-kc signal source and the meter is powered.

3-3. FREQUENCY SPECTRUM ANALYZER (FSA).

a. GENERAL INSTRUCTIONS. - Turn on the power with ILLUMINATION control 66 and allow a 1-hour warm-up period before operating adjustments are made. When the baseline appears (usually within 30 seconds), set up the controls as described below.

The operating instructions below cover three general cases: general or search operation, narrow band or detailed analysis, and general procedure for distortion measurements. A brief discussion relative to the interpretation of the FSA's signals follows these instructions.

b. GENERAL OR SEARCH OPERATION.

For all test signal frequencies up to 1,070 kc, use a signal generator frequency 500 kc above the test signal frequency. For test signal frequencies between 1070 kc and 1770 kc, a signal generator frequency above the test signal frequency is preferable but not essential. This will avoid the presence of image frequencies and spurious signals resulting from harmonics of the signal generator. For frequencies above 1770 kc, no advantage will be gained by having the signal generator frequency above that of the test signal.

Step	Panel Serial Designation	Operation	Check or Purpose (Refer to table 1-6-b)
1	74	Set CENTER FREQ on vertical marker.	Center frequency
2	83	Turn SWEEP WIDTH maximum clockwise.	Sweep width
3	82	Turn IF BANDWIDTH maximum clockwise.	IF bandwidth
4	77	Set BRILLIANCE for desired trace brightness.	Brilliance
5	78	Turn SWEEP WIDTH SELECTOR to VAR.	Sweep width selector
6	76	Set FOCUS for sharpest trace.	Focus
7	75	Set AMPLITUDE SCALE to LIN.	Amplitude scale
8	73	Set GAIN half to full.	Gain
9	80	Turn SWEEP RATE maximum clockwise.	Sweep rate
10	81	Set VIDEO VILTER to OFF position.	Video filter
11	85	Set POS for centered position of center-frequency pip.	Horizontal position
12	84	Set POS for baseline coincident with bottom screen calibration.	Vertical position
13	74	Set AFC to OFF position.	AFC OFF
14	67	Set INPUT ATTENUATOR to zero (all switches up).	AFC OFF input attenuator

NOTE

Refer to steps 2 and 3 above. When SWEEP WIDTH and IF BANDWIDTH controls 83 and 82, respectively, are concurrently set close to their maximum counterclockwise position, the centered signal will appear as an elevated baseline or pip with hum superimposed. This is normal.

NOTE

Although the frequency of the external heterodyning oscillator (signal generator), which is connected to the VFO INPUT RF connector 72, may be either above or below the test-signal frequency by a frequency equal to the input center frequency of the equipment (500 kc), use the following rules in choosing this frequency. If possible, do not use a frequency within the input bandpass range of the FSA; that is, 450 to 550 kc.

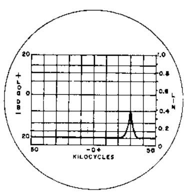
The signal generator frequency can be recognized as being below the test signal frequency if the pip moves from left (-) to right (+) as the generator frequency is increased. When the generator frequency is above the test signal frequency, a pip will move from right (+) to left (-) as the generator frequency is increased. When the frequency of the external oscillator is above the test signals, the plus and minus signs on the screen apply; that is, signals on the (+) side are higher in frequency than the center signal while those on the (-) side are lower. If the oscillator frequency is below the test signals, the signs are reversed. Note that when signals whose frequencies are within the bandpass region, that is, 450 to 550 kc are fed directly into the input, the screen signs are reversed.

NOTE

Slowly search the spectrum with the external oscillator until the signal appears at the center of the screen. To locate the signal, it may be found convenient to operate the FSA at maximum gain and the signal generator for high output. Once the signal is located, GAIN control 73 may be backed off counterclockwise and the generator output lowered to obtain a signal which falls below full scale. INPUT ATTENUATOR control 67 may also be used to reduce signal level.

NOTE

Frequencies of signals appearing on the screen may be quickly determined by adding or subtracting the screen calibration for a given signal to the frequency to which the signal generator is adjusted and then subtracting or adding the input-center frequency.



Conditions: 100-kc scanning width. Heterodyne oscillator frequency 2450 kc. Oscillator frequency set above test signal (pip moves to left as oscillator frequency is raised).

Signal Frequency = (2450 - 500) +30 = 1980 kc

NOTE

The relative amplitudes of presented signals are proportional to the relative heights of the corresponding deflections, within the limits specified for flatness of response. The use of a preamplifier may effect this flatness. To observe signals of comparable amplitude (10:1 or less), AMPLITUDE SCALE switch 75 should be set to LIN. On the other hand, examination of signals widely divergent in amplitude will require the LOG setting of this switch. This allows simultaneous reading of amplitudes having a 40-db range.

c. NARROW BAND OR DETAILED ANALYSIS. - For narrow band analysis, it is necessary to use a stable hum-free VFO. Three operating procedures are outlined below:

(1) SWEEP WIDTH SELECTOR control 78 on VAR and (as indicated below) other controls changed from those specified in preceding paragraph 3-3b.

(2) SWEEP WIDTH SELECTOR control on VAR, AFC control 74 on ON, and (as indicated below) other controls changed from those specified in preceding paragraph 3-3b.

(3) SWEEP WIDTH SELECTOR control in preset position (150~ or 500~, or 2KC, 10KC, or 30KC). When signals or a carrier and its sidebands are so closely spaced in frequency that, at full-sweep width, their corresponding deflections tend to merge into each other or mask one another, it may be possible to separate or resolve them by sharpening the IF bandwidth and concurrently reducing the scanning width, or by reducing the scanning rate, or by doing both of the foregoing.

In case (1) above, to increase the resolution capabilities beyond those obtainable by the methods outlined in preceding paragraph 3-3b, diminish the scanning width, narrow the IF bandwidth, and increase the scanning time as follows:

(a) Keep IF BANDWIDTH control 82 at maximum clockwise (broad).

(b) With the external oscillator, tune in the particular band of signals to the center of the screen.

(c) Spread the band of signals across the screen by turning SWEEP WIDTH knob 83 counterclockwise. Note that, at reduced scanning width, each frequency calibration mark represents a frequency separation equal to one-tenth of the reduced sweep width. Keep the band centered with CENTER FREQ control.

(d) Turn IF BANDWIDTH control counterclockwise until individual signals are most clearly resolved.

NOTE

Rotation of IF BANDWIDTH control may result in increased or decreased pip height. Pip amplitude may be returned to suitable level with GAIN control 73. Turning IF BANDWIDTH control counterclockwise after optimum resolution is reached will decrease the resolving power and result in greatly reduced sensitivity.

If the resolution adjustment results in practically complete separation of signal pips, maximum resolution can be recognized by the presence of "ringing" on one side of the pip. "Ringing" can be seen more easily with VIDEO FILTER control 81 in the OFF position. Illustrations a to f of figure 3-2 indicate progressive variations in pip width effected by counterclockwise rotation of IF BANDWIDTH control. In illustrations a and b, IF width is broad for the particular scanning velocity. Illustration c shows beginning of "ringing." Extent of "ringing" in illustration d shows optimum resolution. As the IF section is made narrower, excessive "ringing" widens pip and amplitude decreases as shown in illustrations e and f. Further counterclockwise rotation of IF BANDWIDTH control causes a reduction in amplitude and a tendency of remerging of the pips.

(e) To better separate the signals, the SWEEP WIDTH and IF BANDWIDTH controls, respectively, can be further backed off counterclockwise and the SWEEP RATE control set to a lower rate. Refer to following paragraph for use of AFC control. If it is mandatory to observe a given bandwidth at one time and the signals contained therein are so closely spaced that they cannot be completely resolved, maximum resolution is recognized by the appearance of the clearest picture. Further counterclockwise rotation of IF BANDWIDTH control will result in lessened resolution and a "bobbing" presentation.

In case (2) above, to increase the resolution capabilities beyond those specified in preceding case (1), the 0.1-cps scanning rate and AFC control can be used. Turning AFC control on provides a suitably small scanning width (±1 kc) as well as the necessary frequency stability. The following procedure should be used over and above that described in preceding paragraph 3-3b. AFC control 74 may also be used with faster rates, up to approximately 5 cps.

(a) With IF BANDWIDTH control fully clockwise and SWEEP WIDTH control set completely clockwise, tune in the signals to the center of the screen with the external oscillator.

(b) Turn AFC control on. If necessary, adjust the external oscillator for a centered presentation. The AFC control may be used as an aid in centering the presentation. The CENTER FREQ control may be used as a vernier on the AFC control.

(c) Set SWEEP RATE control 80 to a suitable rate, less than 5 cps, depending upon the desired degree of frequency separation and the nature of the signals. AFC control should not be used at sweep rates greater than 5. Note that, with AFC control on and SWEEP WIDTH control at maximum clockwise, each frequency calibration mark on the screen represents 200 cps. Further reduction of sweep width can be had by counterclockwise rotation of SWEEP WIDTH control.

(d) Turn IF BANDWIDTH control counterclockwise until optimum resolution is obtained. See paragraph 3-3c(3)(d) above.

(e) Use VIDEO FILTER control as required to reduce objectionable beating between closely adjacent signals, hum, etc. The HI position provides a moderate amount of filtering. The LO position provides heavy filtering suitable for use with very low sweep rates. Note that the use of VIDEO FILTER control 81 results in integration of the signal pips as well as slight shifting of the pips.

In case (3) above, in many cases, it will be most convenient to use SWEEP WIDTH SELECTOR control to set up operating conditions for narrow band analysis. In this mode of operation, the sweep width, sweep rate, IF bandwidth, and video filtering are automatically set for optimum presentation.

d. OPERATION PROCEDURE FOR DISTORTION MEASUREMENTS. - In measuring third-order distortion in a single sideband (SSB) transmitter or exciter, the transmitter is usually modulated by two audio tones of equal amplitude, with a difference frequency of the order of 1-kc. The RF output consists of two signals separated by the audio difference frequency. The presence of third-order distortion in the transmitter is indicated by the appearance of spurious signals higher and lower in frequency than the two RF carriers by an amount equal to the difference frequency.

In GPT-10K operation, which is based on the VMO being 500-kc above the FSA center frequency, the TTG tones of 935 and 2805 cps appear in the FSA's spectrum as frequencies of f_c-935 and f_c-2805 (where f_c is the carrier frequency). Third order distortion appears as a frequency f_c+935 and fifth-order distortion as a frequency f_c+2805.

The FSA has very low internal third-order distortion (at least 60 db down from the level of the two test signals). In order to obtain this order of performance, the following procedure should be followed:

(1) Set the amplitude of the external signal generator voltage to approximately 0.3 volts rms. Greater amplitudes (up to approximately 1 volt) may be used without degradation of performance.

(2) Follow the regular operating procedure to display the two RF signals on the screen. Use a sweep width at least three times the separation between the two signals.

(3) Set AMPLITUDE SCALE switch 75 to LOG. Set IF ATTEN switch 79 to 20 DB. Set GAIN control 73 to maximum (fully clockwise) and adjust the INPUT ATTENUATOR 67 to obtain full scale deflection. GAIN control may be reduced slightly for the final adjustment.

(4) Set IF ATTEN switch to 0 DB. The FSA display now shows signals from -20 db to -60 db relative to the two input signals. The amplitude of third-order distortion pips may be read from the LOG scale calibration on the screen, adding 20 db to account for the fact that the signals are deflected 20 db over full scale.

e. BRIEF DISCUSSION ON INTERPRETATION OF ANALYZERS SIGNALS. (See figure 3-3.) - With a little experience, the operator will be able to recognize the visual character of various types of signals.

(1) A constant carrier appears as a deflection of fixed height (sketches a and b of figure 3-3).

(2) An amplitude-modulated carrier appears as a deflection of variable height. Nonconstant tone modulation of low frequency produces a series of convolutions varying in height, their number being determined by the modulation frequency. The nature of the presentation depends upon the scanning width (sketches c and d of figure 3-3).

As the modulation frequency increases, the convolutions move toward the two sides of the deflection, sidebands tending to become visible. When the modulation frequency is increased, it becomes possible to separate the sidebands by reducing the sweep width of the FSA. IF BANDWIDTH control 82 will enable further spearation. The higher the frequency of modulation, the farther away these sidebands will move from the center deflection representing the carrier. One should remember that due to possible nonlinear amplification of the FSA or nonuniform generator output, or both, over a wide band, the sidebands may appear unequal in height even though they are of equal strength. Their relative heights may vary as the generator is tuned and as the deflection moves from one end of the screen to the other.

(3) Single sideband modulation appears as two carriers of slightly different frequency. (Refer to item 7 below.)

(4) A carrier frequency modulated at low rate appears as a carrier which wobbles sideways.

(5) A CW signal appears and disappears in step with the keying of the GPT-10K. During the moments when the signal is off, the frequency sweep axis is closed at the base of the signal. In very rapidly keyed signals the deflection and the baseline are seen simultaneously.

(6) An MCW signal appears like a CW signal of periodic varying height. If the modulation rate is high, sidebands will appear as explained above.

(7) Signal Interference (sketches g and h of figure 3-3.) Two signals which are so close in frequency as to cause aural interference (beats) may appear on the screen as a single deflection varying in height as with a modulated signal. As the frequency separation is increased, the deflection appears as if modulated on one side only. Further increase of frequency will cause a "break" in the apex of the deflection. By reducing the sweep width of the FSA, the respective deflection will gradually separate. Further separation is effected with IF BANDWIDTH control by setting SWEEP RATE control 80 to a lower rate and by using AFC control 74.

(8) Transient disturbances (generally examined) are of two types: periodic and aperiodic transients. Periodic transients, such as produced by motors, vibrators, buzzers, etc., appear as signals moving along the frequency sweep baseline in one direction or another. Thus, an engine which is accelerating will produce a set of deflections which may move first in one direction, slow down, step, and then move in an opposite direction. This is caused by the fact that the FSA is sweeping at a fixed rate whereas the transient occurs at a variable rate. The images stand still on the screen when there is synchronism between the two. If the transient disturbance is synchronized with the 60-cycle line, the "noise" appears as a fixed signal which, however, does not move on the screen when the generator is tuned but only varies in height. Such deflections may appear like amplitude-modulated signals or like steady carrier. Aperiodic transients such as "static" appear as irregular deflections and flash along the whole frequency sweep axis.

(9) Image signals will be distinguishable from normal signals by the fact that they move in an opposite direction with respect to normal signals on the screen of the FSA when the external oscillator is being tuned.

(10) Harmonics, produced in the converter by the beat of every strong signal with harmonics of the oscillator, will be distinguishable from other signals by the fact that they move on the screen more rapidly (with tuning) than the normal signals (twice as fast for second harmonic spurious signals). Generally, a reduction in the gain of the FSA and/or reduction in generator output will eliminate this type of spurious signal.

(11) Diathermy or other apparatus using an unfiltered or AC power supply will produce a periodic disturbance which will cause a deflection to appear on certain portions of the screen and disappear on other portions. This is due to the fact that such equipment emits a signal pulsating in synchronism with power line. On the other hand, the FSA is also sweeping the spectrum in synchronism with the line but at a lower frequency, and only when a certain phase relationship exists is it possible for the FSA to receive those periodic pulses.

In order to examine signals which are synchronized to the line frequehcy, adjust SWEEP RATE control 80 for the best presentation across the entire screen.

(12) Spurious signals. If the signal strength exceeds a certain value, the deflection caused by any signal breaks up into a series of parallel deflections somewhat similar to sidebands. Attenuation of signal input level will remedy this situation.

3-4. TRANSMITTING MODE SELECTOR MODELS SBE-2 AND SBE-3 AND THEIR POWER SUPPLY.

a. PRELIMINARY CONSIDERATIONS. - The panel views and the general operating procedures of the SBE-2 and SBE-3 are identical. Before attempting to operate the SBE, the following must be considered:

(1) Mode of transmission desired.

(2) Input circuit controls.

(3) Output frequency desired (crystal selection or use of VMO, bandwidth switch settings, etc.)

(4) 250-kc carrier insertion.

(5) Medium-frequency circuit controls.

(6) High-frequency circuit controls.

(7) Meter circuit and miscellaneous controls.

Mode of transmission breaks down into the following:

(1) Single sideband with any degree of carrier insertion.

(2) Double sideband with any degree of carrier insertion.

(3) Independent sideband with any degree of carrier insertion.

(4) Conventional AM operation.

(5) Frequency shift telegraphy.

(6) CW or MCW telegraphy.

Input circuit controls are as follows:

(1) LSB (channel, gain).

(2) USB (channel gain).

(3) MIKE.

LSB control places audio channel 1, 2, or MIKE in the lower sideband position; USB control places audio channel 1, 2, or MIKE in the upper sideband position. A microphone connection is made into MIKE connector.

Initially, output frequency requirements are concerned with the following front panel controls: MF XTAL SW (86), BAND MCS (105), and OUTPUT TUNING (bandswitch element 102). Subsequently, tuning concerns the following front panel controls: OUTPUT TUNING (tuning element 101), MF TUNING (99), OUTPUT (level control 97) and METER SW (94) and associated meter.

In this category of operations, the first consideration is whether the medium frequency (2 to 4 mc) is to be supplied by a VMO or a crystal. If by a VMO, the MF XTAL SW is placed in the VMO position; if by a crystal, MF XTAL SW is placed in the position that selects the proper crystal. More information on this phase of operation is given in the discussion below of medium-frequency circuit controls.

The output frequency (fo) desired requires the use of the proper medium frequency whether supplied by a VMO or a crystal. In the 2- to 4.25-mc range of the SBE-3, the lower sideband output of the medium frequency modulator reaches the antenna without further modulation. The VMO or crystal frequency (fx), therefore, is determined by the formula: fo = fx - 0.25. In the 2- to 4.27-mc range of the SBE-2, the formula for the VMO or crystal frequency becomes: fo = fx - 0.27. In the case of the SBE-3, if the output frequency (fo) is 2.00 mc, the crystal or VMO frequency (fx) is 2.25 mc. Note that for fo between 3.75 and 4.25, the VMO or crystal frequency ranges between 4.00 and 4.50 mc. To provide an fo between 3.75 and 4.25 mc with VMO and XTAL frequencies below 4.00 mc, the medium-frequency modulator is operated so as to pass its upper sideband to the antenna. The VMO or crystal frequency, therefore, is determined by the formula: fo = fx + 0.25. Under this arrangement, when fo is 3.75, fx becomes 3.50 mc; when fo is 4.00, fx becomes 3.75 mc; and when fo is 4.25, fx becomes 4.00 mc. It should be pointed out that the 2- to 4-mc range is below the normal operating range of the GPT-10K and that it is more practical to supply SSB signals in the 3.75- to 4.25-mc range, when required by other GPT-10K's, by using 4.0- to 4.5-mc crystals or a VMO that supplies these frequencies. More information on this phase of operation is given in the discussion below of medium-frequency circuit controls.

In the 4.25- to 32.25-mc range of the SBE-3, the output of the medium-frequency modulator is modulated by the high-frequency modulator whose lower sideband output, in turn, reaches the antenna. Consequently, the VMO or crystal frequency in this case is determined by the formulae:

fo = fhf - (fmf - 0.25); MF modulator passing lower sidebands

fo = fhf - (fmf + 0.25); MF modulator passing upper sidebands

The fhf (high frequency) crystals provide modulating frequencies of 8 to 34 mc in 2-mc steps; the fmf (medium frequency) crystals range between 2 and 4 mc. For example:

fo	fhf	fmf
4.25	8.00	4.00
8.00	10.00	2.25
15.00	18.00	3.25
21.50	24.00	2.75
27.25	30.00	3.00
32.25	34.00	2.50

In the 4.27- to 32.27-mc range of the SBE-2, similar formulas apply, giving the following tabular values:

fo	fhf	fmf
4.27	8.00	4.00
8.00	10.00	2.27
15.00	18.00	3.27
21.50	24.00	2.77
27.27	30.00	3.00
32.27	34.00	2.50

Referring to 250-kc carrier insertion, the degree of carrier insertion is controlled by the setting of front panel potentiometer designated CARRIER INSERT (104). The magnitude of carrier relative to sidebands may be readily determined in GPT-10K operation by the use of the FSA.

Referring to medium-frequency circuit controls, the following front panel controls are used to adjust the medium-frequency modulator: CARRIER INSERT, MF TUNING, and METER SW and its associated meter. In the case of the SBE-3, the medium-frequency modulator receives 250-kc sideband signals and VMO or MF XTAL frequencies; its output circuit is tuned to (passes) the lower sideband of the VMO or MF XTAL frequency. In the case of the SBE-2, the medium-frequency modulator receives 270-kc sideband signals and VMO or MF XTAL frequencies.

Referring to high-frequency circuit controls, the following front panel controls are used to adjust the high-frequency modulator together with the SBE's RF circuit's tuning elements: BAND MCS, OUTPUT TUNING (bandswitch, tuning elements), OUTPUT (level), METER SW and its associated meter. The high-frequency modulator receives the lower sideband output of the medium-frequency modulator in addition to the output of the high-frequency crystal oscillator; its output circuit and that of the SBE's RF circuit is tuned to (passes) the lower sideband of the high-frequency crystal oscillator's frequency.

Referring to meter circuit and miscellaneous controls, GPT-10K operation is with the front panel controls listed below as shown:

VOX GAIN (103):	full CCW
XMTR (88):	ON
EXCITER (89):	ON
POWER (90):	ON
SQUELCH GAIN (100):	full CCW

For further details, refer to Section 4 of Volume II of the manual.

b. SINGLE SIDEBAND WITH ANY DEGREE OF CARRIER INSERTION.

Step	Panel Serial Desig.	Operation	Purpose
Part I - Tune up on Carrier:			
1	88	XMTR toggle switch, ON.	Not effective on tune up on carrier. Refer to paragraph 4-4f of section 4, volume II of the manual.
2	89	EXCITER toggle switch, ON.	
3	103	VOX GAIN, full CCW.	
4	100	SQUELCH GAIN, full CCW	
5	106, 107	LSB OFF/GAIN, full CCW.	Not in circuit on tune up on carrier.
6	95, 96	USB OFF/GAIN, full CCW.	
7	90, 93	POWER toggle switch, ON.	Energizes unit. OVEN indicator 93 should light.
8	86	MF XTAL SW, use correct MF VMO/XTAL, frequency.	Paragraph 3-4a.
9	105	BAND MCS use correct MF frequency.	Paragraph 3-4a.
10	104	CARRIER INSERT, full CW.	Provides 100% carrier.
11	94	METER SW, MF position.	In preparation for step 13.
12	101, 102, 87	OUTPUT TUNING switch: knob 102 (coarse setting) for proper band, and disc 101 (vernier setting) for a frequency slightly below the desired output frequency on multi-scale dial 87.	In preparation for step 13.
13	99, 91, 104, 87	MF TUNING knob 99, tune MF. Peak SBE's meter 91 reading.	Decrease CARRIER INSERT (104) as necessary to avoid an off-scale reading. The reading on single-scale dial 87 should agree with the frequency of VMO on MF XTAL SW 86.
14	94	METER SW, RF position.	In preparation for step 15.
15	101, 91	OUTPUT TUNING disc 101, tune RF. Peak SBE's meter 91 reading.	Advance the OUTPUT TUNING vernier switch slightly to peak the reading on the SBE's meter.

Step	Panel Serial Desig.	Operation	Purpose
Part I - Tune up on Carrier (Cont.)			
15 (Cont.)			**NOTE** Several peaks, due to modulation products, are possible. The correct (lower sideband) peak is the first one encountered as the vernier switch is slightly advanced.
16	97, 104	Adjust OUTPUT knob 97 to control magnitude of the RF output.	Operation of OUTPUT knob 97 will control the magnitude of the RF output. The same is true by operating CARRIER INSERT switch (104).
17		The SBE is now tuned on carrier.	
Part II - Tune up on SSB with Any Degree of Carrier Insertion:			
18	106, 107	LSB OFF/GAIN, turn to CH 1, CH 2, or MIKE as required. Set GAIN to mid position.	To place audio channel in lower sideband.
19	95, 96	USB OFF/GAIN, turn to CH 1, CH 2 or MIKE as required. Set GAIN to mid position.	To place audio channel in upper sideband.
20	104	Set CARRIER INSERT to 0.	To suppress carrier 100%.
21	91, 94, 95, 96, 106, 107	Set METER SW 94 to USB and LSB and, in turn, USB 95 and LSB 107 each to CH 1 or CH 2 or as required. Advance or decrease GAIN control 96 or 106 as required until meter shows a maximum reading of 100 on audio peaks. (Lower peak values are frequently compatible with sufficient RF output as determined by the subsequent setting of OUTPUT control 97.)	**CAUTION** With METER SW 94 in USB, LSB, or RF position, meter peaks must never exceed 100 as inter-modulation distortion may become excessive beyond this point.
22	94	Set METER SW 94 to RF position.	Preparatory to step 23.
23	97, 104	Adjust OUTPUT control 97 for desired level simultaneously with adjusting CARRIER INSERT control 104 for desired degree of carrier insertion.	Steps 24 and 25 illustrate the procedure to inject a carrier 20 db down from full PEP.
24	91, 94, 97, 104	With METER SW 94 in RF position and CARRIER INSERT 104 in 0 position, set OUTPUT control 97 to give meter 91 reading of 90 with one of the audio channels in operation. Now advance CARRIER INSERT control 104 until meter 91 reading becomes 100.	Increasing a meter reading of 90 due to audio with no carrier, and to 100 with carrier (audio level unchanged) signifies a carrier level of 10% (-20 db) of the combined audio and carrier level.
NOTE As explained more fully in Section 5 of Volume II of the manual, the SBE's meter circuit, as is the case with most VTVM's, has a small amount of waveform error. For this reason, carrier and sideband additions may not be precisely linear.			
25	97	Decrease OUTPUT control 97 for desired PEP output. Do not change audio and carrier settings (96,104,and 106).	Decreases audio and carrier proportionately.

c. DOUBLE SIDEBAND WITH ANY DEGREE OF CARRIER INSERTION. - Part I, tune up on carrier, is the same as part I in paragraph 3-4b. After completing part I, proceed as follows: (For convenience, the following steps, 18 through 32, assume that channel 1 is used on both lower and upper sidebands with either 0- or 10-percent carrier insertion. In case channel 2 is used on both lower and upper sidebands with either 0- or 10-percent carrier insertion, substitutde CH 2 for CH 1 in the settings of USB 95 and LSB 107 controls.)

Step	Panel Serial Desig.	Operation	Purpose
Part II - Tune up on ISB with Any Degree of Carrier Insertion:			
NOTE Step numbering begins with 18 since this part II follows part I of paragraph 3-4b.			
18	106, 107	LSB OFF/GAIN, turn to CH 1 or CH 2 as required. Set GAIN to 1/4 scale.	To place desired audio channel in lower sideband.
19	104	CARRIER INSERT, set to 0.	To suppress carrier 100%.
20	95, 96	USB OFF/GAIN, set control 95 to OFF; set GAIN to 1/4 scale.	To cut off desired audio channel in upper sideband.
21	94	Set METER SW to LSB.	To measure desired audio channel level in lower sideband.
22	91, 106	Adjust LSB GAIN until the meter shows the following readings on audio peaks: Carrier Insertion Eventually Wanted — Audio Peaks 0 — 50 10% (-20 db) — 45	To obtain proper desired audio channel level in lower sideband with or without 10% carrier insertion.
23	107	Set control 107 to OFF.	To cut off desired audio channel in lower sideband.
24	95, 96	USB OFF/GAIN, turn to CH 1 or CH 2 as required. Set GAIN to 1/4 scale.	To place desired audio channel in upper sideband.
25	104	CARRIER INSERT, leave on 0.	To suppress carrier 100%.
26	94	Set METER SW to USB.	To measure desired audio channel level in upper sideband.
27	91, 96	Adjust USB GAIN until the meter shows the following readings on audio peaks: Carrier Insertion Eventually Wanted — Audio Peaks 0 — 50 10% (-20 db) — 45	To obtain proper desired audio channel level in upper sideband with of without 10% carrier insertion.
28	94	Set METER SW to RF.	To measure audio levels after RF modulation.
29	97, 91	Advance OUTPUT control 97 from 0 until meter 91 reads same as in step 27.	Check that LSB switch is OFF and USB switch is in desired channel.
30	95, 107	Set USB switch to OFF and LSB switch to its desired channel.	Check that METER SW is in RF position.
31	91, 106	Note reading on meter 91. Readjust LSB GAIN control 106 until meter 91 reads same as in step 22.	

d. INDEPENDENT SIDEBAND WITH ANY DEGREE OF CARRIER INSERTION. - Part I, tune up on carrier, is the same as part I in paragraph 3-4b. After completing part I, proceed as follows: (For convenience, the following steps, 18 through 32, assume that channel 1 is used on the lower sideband and channel 2 is used on the upper sideband with either 0- or 10-percent carrier insertion. In case channel 1 is used on the upper sideband and channel 2 is used on the lower sideband with either 0- or 10-percent carrier insertion, substitutde CH 2 or CH 1 and vice versa in the settings of USB 95 and LSB 107 controls.)

Step	Panel Serial Desig.	Operation	Purpose
Part II - Tune up on DSB with Any Degree of Carrier Insertion: (cont)			
32	91, 107, 95	Turn controls 107 and 95 to place CH 1 or CH 2 in both sidebands. Meter 91 should now read as follows on peaks: Carrier Insertion Finally Wanted — Audio Peaks 0 — 100 10% (-20 db) — 90	
33	**NOTE** As explained more fully in Section 5 of Volume II of the manual, the SBE's meter circuit, as is the case with most VTVM's, has a small mount of waveform error. For this reason, carrier and sideband additions may not be precisely linear.		
33	104	Set CARRIER INSERT to give desired amount of carrier insertion. For 0 insertion: turn control 104 to 0; peak readings on meter 91 should reach 100. For 10% (-20 db) insertion: advance control 104 until peak readings on meter 91 rise from 90 to 100.	

Step	Panel Serial Desig.	Operation	Purpose
Part II - Tune up on ISB with Any Degree of Carrier Insertion:			
NOTE Step numbering beings with 18 since this part II follows part I of paragraph 3-4b.			
18	106, 107	LSB OFF/GAIN, turn to CH 1 or CH 2 as required. Set GAIN to 1/4 scale.	To place desired audio channel in lower sideband.
19	104	CARRIER INSERT, set to 0.	To suppress carrier 100%.
20	95, 96	USB, OFF/GAIN, set control 95 to OFF; set GAIN to 1/4 scale.	To cut off desired audio channel in upper sideband.
21	94	Set METER SW to LSB.	To measure desired audio channel level in lower sideband.
22	91, 106	Adjust LSB GAIN until the meter shows the following readings on audio peaks: Carrier Insertion Eventually Wanted — Audio Peaks 0 — 50 10% (-20 db) — 45	To obtain proper desired audio channel level in lower sideband with or without 10% carrier insertion.
23	107	Set control 107 to OFF.	To cut off desired channel in lower sideband.
24	95, 96	USB OFF/GAIN, turn to CH 2 or CH 1 as required. Set GAIN 1/4 scale.	To place desired audio channel in upper sideband.
25	104	CARRIER INSERT, leave on 0.	To suppress carrier 100%.
26	94	Set METER SW to USB.	To measure desired audio channel level in upper sideband.

Step	Panel Serial Desig.	Operation	Purpose
Part II - Tune up on ISB with Any Degree of Carrier Insertion: (cont.)			
27	91, 96	Adjust USB GAIN until the meter shows the following readings on audio peaks: Carrier Insertion Eventually Wanted — Audio Peaks 0 — 50 10% (-20 db) — 45	To obtain proper desired audio channel level in upper sideband with or without 10% carrier insertion.
28	94	Set METER SW to RF.	To measure audio levels after RF modulation.
29	97, 91	Advance OUTPUT control 97 from 0 until meter 91 reads same as in step 27.	Check that ISB switch is OFF and USB switch is in desired channel.
30	95, 107	Set USB switch to OFF and LSB switch to its desired channel.	Check that METER SW is in RF position.
31	91, 106	Note reading on meter 91. Readjust LSB GAIN control 106 until meter 91 reads same as in step 22.	
32	91, 107, 95	Turn controls 107 and 95 to place CH 1 or CH 2 in both sidebands. Meter 91 should now read as follows on peaks. Carrier Insertion Finally Wanted — Audio Peaks 0 — 100 10% (-20 db) — 90	
NOTE As explained more fully in Section 5 of Volume II of the manual, the SBE's meter circuit, as is the case with most VTVM's, has a small amount of waveform error. For this reason, carrier and sideband additions may not be precisely linear.			
33	104	Set CARRIER INSERT to give desired amount of carrier insertion. For 0 insertion: turn control 104 to 0; peak readings on meter 91 should reach 100. For 10% (-20 db) insertion: advance control 104 until peak readings on meter 91 rise from 90 to 100.	

e. CONVENTIONAL AM OPERATION. - Part I, tune up on carrier, is the same as part I in paragraph 3-4b. Part II, conventional AM operation - 50-percent carrier insertion, is the same as part II in paragraph 3-4c except for the following modifications:

(1) Steps 22 and 27 should be modified as follows:

Carrier Insertion Eventually Wanted	Audio Peaks
50% (-6 db)	25

(2) Step 32 should be modified as follows:

Carrier Insertion Finally Wanted	Audio Peaks
50% (-6 db)	50

(3) Step 33 should be modified as follows: Set CARRIER INSERT to give desired amount of carrier insertion. For 50% (-6 db) insertion: advance control 104 until peak readings on meter 91 rise from 50 to 100.

f. FREQUENCY SHIFT TELEGRAPH OPERATION. - Part I, tune up on carrier, is the same as part I in paragraph 3-4b. In frequency shift telegraph operation, part II, only part of the SBE unit is used. In the case of the SBE-3, the medium-frequency modulator unit is supplied with a 250-kc carrier as well as the XFK's medium-frequency output signal (from the GPT-10K's XFK unit). In the case of the SBE-2 the medium-frequency modulator unit is supplied with a 270-kc carrier as well as the XFK's medium-frequency output signal (from the GPT-10K's XFK unit). In either case, this means that SBE's CARRIER INSERT potentiometer 104 should be in position 10, SBE's MF XTAL SW control 86 should be in position VMO, and XFK's medium-frequency output signal should reach SBE's modulator via selector switches on the MCP. Place SBE VMO INPUT selector switch 108 in position XFK and VOX RF OUTPUT meter selector switch 109 in position XFK (unless the XFK supplies its own medium frequency with a crystal of its own). Since SBE's medium-frequency modulator is supplied with a 250-kc (SBE-3) or a 270-kc (SBE-2) carrier as well as XFK's medium-frequency output signal of frequency fmf - (200 kc ±425 cps), the lower sideband of SBE's medium-frequency modulator has a pass-band frequency of fmf - (450 kc ±425 cps) for SBE-3 or fmf - (470 kc ±425 cps) for SBE-2. In SBE's medium-frequency output range, the lower sideband of the medium-frequency modulator reaches the antenna without further modulation. The relationship between fmf and antenna output frequency fo, for the case of the SBE-3, therefore, is determined by the formula fo = fmf-(0.45 mc ±425 cps) = fmf - 0.45 mc, approximately. This gives the following relationship between fo and fmf:

fo	fmf
2.00	2.45
2.50	2.95
3.00	3.45
3.55	4.00
4.00	4.45

For the case of the SBE-2, by similar reasoning, the relationship between fo and fmf is as follows:

fo	fmf
2.00	2.47
2.50	2.97
3.00	3.47
3.53	4.00
4.00	4.45

In the case of the SBE-3, note that for fo between 3.55 and 4.00, fmf ranges from 4.00 to 4.45. This means that if a suitable VMO is unavailable and the highest medium-frequency crystal available for use in the XFK unit is 4.00 mc, SBE's highest lower sideband medium-frequency output frequency is 3.55 mc. If SBE's high-frequency modulator is now used with 8-mc crystal injection, along with SBE's medium-frequency modulator's output, SBE's high-frequency modulator's lower sideband frequency becomes fo = 8.00 - fm + 0.45, which gives the following relationship between fo and fmf:

fo	fmf
4.00	4.45
4.45	4.00
5.00	3.45
5.50	2.95
6.45	2.00

Note, once more, that if a suitable VMO is unavailable and the highest medium-frequency crystal available for use in the XFK unit is 4.00, SBE's lowest high-frequency modulator output frequency is 4.45 mc. Consequently, for the SBE unit to cover the frequency range of 3.55 to 4.45 requires a medium-frequency crystal in the XFK unit, or a VMO, in the 4.00- to 4.45-mc range. As previously stated in paragraph 3-4a, it is more practical to supply FSK signals in the 3.55- to 4.45-mc range, when required by a GPT-10K, by using 4.0- to 4.45-mc crystals or a VMO that supplies these frequencies.

g. CW TELEGRAPH OPERATION. - Part I, tune up on carrier, is the same as part I in paragraph 3-4b. Part II, CW telegraph operation, is as follows:

(1) Remove jumper from pins 1 and 3. (E101 on rear of SBE).

(2) Attach key from pin 3 to ground.

(3) Set LSB and USB switches 107 and 95 to OFF position.

(4) Set CARRIER INSERT 104 to maximum clockwise position.

(5) Set METER SW 94 to RF position.

(6) Advance OUTPUT 97 control to drive GPT-10K with proper SBE output.

h. VOX AND SQUELCH CIRCUIT OPERATION. - The VOX and SQUELCH circuits may be used when GPT-10K's are actuated by speech into an associated microphone. In this case, he VOX circuit should be adjusted so that only the intermittent voice peaks actuate the VOX relay which turns on the GPT-10K. The time constant of the VOX circuit is such that the intermittent voice peaks will keep the GPT-10K turned on so long as there is reasonably strong speech coming into the MIKE. Otherwise, a GPT-10K is turned on manually or by keying. The SQUELCH circuit, on the other hand, should be adjusted so that extraneous sounds that reach the MIKE do not turn on the GPT-10K. Of course, if the extraneous sounds are loud enough, the action of the VOX circuit overpowers that of the SQUELCH circuit; consequently the GPT-10K will be turned on in this case. General field practice is such that the VOX and SQUELCH circuits are rarely used.

(1) VOX ADJUSTMENT. - The VOX circuit will function only in the SSB and DSB operation of the unit and not with conventional AM or SSB with carrier. Proceed as follows:

(a) Set EXCITER ON-STANDBY switch 89 to STANDBY position.

(b) Talking directly into the mike, adjust VOX GAIN control 103 until EXCITER lamp 92 remains on with normal speech level but extinguishes with no speech input. Further adjustment may be necessary to prevent background noises from actuating the exciter.

(2) SQUELCH GAIN ADJUSTMENT. - Proceed as follows:

(a) Make connection from the 600-ohm audio output terminals of the station receiver to terminal 13 and ground on terminal board E101 of the SBE.

(b) Advance SQUELCH GAIN control 100 until audio from the station receiver will no longer trip the VOX circuit.

i. ADJUSTMENT OF SBE AND AN ASSOCIATED GPT-10K. - Proceed as follows:

(1) Tune SBE on carrier of desired output frequency. Refer to preceding paragraph 3-4b.

(2) Tune GPT-10K on carrier output of SBE. Refer to Section III, Volume I of the manual.

(3) Place SBE in desired mode of transmission. Refer to preceding paragraphs 3-4c, 3-4d, 3-4e, 3-4f, and 3-4g.

(4) Adjust output of SBE for desired output level of GPT-10K as directed in Section III, Volume I of the manual.

(5) With SBE's METER SW in RF position, the meter reading on the SBE should never exceed 100.

(6) It is important that the GPT-10K be operated with ALDC on, especially on speech or multichannel carrier telegraph inputs.

3-5. MONITOR CONTROL PANEL MODEL MCP-1.

a. GENERAL CONSIDERATIONS. - The MCP is a switching assembly to facilitate interconnection of a number of GPT-10K's circuits for test or excitation purposes. Figure 4-28 of Volume II of the manual is a simplified schematic of the panel.

b. OPERATING INSTRUCTIONS.

Switch	Panel Designation	Operation	Result
112	CHANNEL 2	TONE INPUT	Connects TTG's audio tones to SBE's channel 2.
		LINE 2 INPUT	Connects audio signals on incoming line 2 to SBE's channel 2.
111	CHANNEL 1	TONE INPUT	Connects TTG's audio tones to SBE's channel 1.
		LINE 1 INPUT	Connects audio signals on incoming line 1 to SBE's channel 1.
110	ANALYZER MONITOR	TEST	Connects TTG's RF tones to FSA.
		SBE	Connects SBE's RF output to FSA.
		DRIVER	Connects IPA's RF output to FSA.
		FINAL	Connects PA's RF output to FSA.
109	VOX RF OUTPUT	EXT	Connects VOX's OUT SIGNAL to GPT-10K's jack J3005.
		SBE	Connects VOX's OUT SIGNAL to SBE via SBE VMO INPUT switch 108 position VOX.
		ANALYZER	Connects VOX's OUT SIGNAL to FSA.
		XFK	Connects VOX's OUT SIGNAL to XFK.
108	SBE VMO INPUT	EXT	Connects an external VMO to SBE via GPT-10K's jack J3004.
		OFF	Open connection.
		XFK	Connects XFK's RF frequency-shift signal to SBE.
		VOX	Connects VOX's RF signal to SBE (2- to 4-mc modulator)

3-6. VARIABLE FREQUENCY OSCILLATOR MODEL VOX-2.

a. GENERAL INSTRUCTIONS. For oscillator stabiliy, 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 2-4d of Volume II of the manual) were previously carried out.

b. 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. Located with the VOX's oven is a VMO and a 100-kc crystal-controlled calibrating oscillator. 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 22 harmonics of the 100-kc oscillator. At a VMO frequency of 2,214,286 cps, a check point also exists, namely, the seventh harmonic of the VMO and the 155th harmonic of the 100-kc oscillator. Again at a VMO frequency of 2,216,667 cps, another check point exists, namely, the sixth harmonic of the VMO and the 133rd harmonic of the 100-kc oscillator. Table 3-2 shows a number of check points in the 2.2- to 2.3-mc frequency range. The 100-kc check points automatically cover 50- and 25-kc check points. A 100-kc crystal will generate not only harmonics of the 100-kc fundamental but also harmonics of the 50- and 25-kc sub-tones. 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 check point calibrations, the operator should perform the following functions:

Step	Operation
1	Set POWER switch 116 to ON position. MAIN POWER indicator 120 should light.
2	Set the BEAT ON-OFF switch 113 to ON position.
3	Plug a headset into PHONES jack 115.
4	Turn BAND-MCS switch 131 to the desired band and XTAL switch 129 to VMO position. The operator should set MASTER OSCILLATOR FREQUENCY dial 126 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 resetability, 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 125, a zero-beat indication will be obtained in the headset and on ZERO BENT indicator 123. With a little experience, the operator will find 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 places BEAT ON-OFF switch 113 in OFF position. At the same time, METER switch 114 should be turned to HFO and HFO switch 117 turned to ON position.
6	The operator should now rotate TUNING knob 132 to a position roughly approximating the master oscillator frequency dial, at which point he will obtain a reading on the front panel milliammeter with OUTPUT control 128. TUNING knob 132 will have 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	Turn POWER switch 116 to ON position.
2	Turn HFO switch 117 to ON position.
3	Turn METER switch 114 to HFO position.
4	Turn XTAL switch 129 to proper position.
5	Turn BAND-MCS switch 131 to proper band.
6	"Trim" the crystal by tuning XTAL FREQ trimmer 130 until the exact frequency is set, and peak with TUNING knob 132 as described above.

c. OPERATING INSTRUCTIONS AFTER CALIBRATION.

Switch	Panel Designation	Operation	Result
116	POWER	ON	MAIN POWER indicator 120 lights.
117	HFO	ON	INNER OVEN/OUTER OVEN indicators indicate a long warm-up period. Refer to CAUTION below.
114	METER	HFO, IFO, BFO, VMO	
129	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.
131	BAND-MCS	Proper band	Selects proper multiplier for VOX's master oscillator.
126	MASTER OSCILLATOR FREQUENCY	Desired oscillator frequency	
128	OUTPUT	Desired level	
132	TUNING	Maximize meter reading	May require a decrease in OUTPUT potentiometer 128.

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.

d. APPLICATIONS.

(1) 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.

(2) FOR USE AS A MASTER OSCILLATOR IN TMC DUAL DIVERSITY RECEIVER MODEL DDR-2.

(a) 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 will serve to minimize the small amount of arithmetic involved.

(b) Diversity System Tuning.

1. Turn POWER switch 116 to ON position.

2. Turn BFO switch 119 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.)

3. Turn IFO switch 118 to ON position.

4. Plug a headset into PHONES jack 115.

5. Set MASTER OSCILLATOR FREQUENCY dial 127 to the desired frequency, in accordance with the following chart, and proceed with the calibration and peaking instructions as previously described.

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.

6. To complete the diversity system tuning, the operator must turn IFO 118 and HFO 117 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.

(3) 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 reference may, of course, be neglected, and both the plate switches controlling these sections may be turned to OFF position.

e. 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 check points. 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 check points 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.

3-7. FREQUENCY SHIFT EXCITER MODEL XFK.

a. GENERAL INSTRUCTIONS. - To obtain the best results with the XFK, the ovens should be allowed to run continuously. This means that the power switch on the front panel should always remain on.

b. TUNE UP PROCEDURE ON TELEGRAPH SIGNALS.

Step	Panel Serial Desig.	Operation	Purpose
1	135, 136, 137, 138	Set POWER ON-OFF switch 138 to ON position.	POWER indicator 136, XTAL OVEN indicator 137, and 200 KC OVEN indicator 136 should light. Allow at least a 6-hour warm-up time.
2	133, 134, 141	Set PLATE ON-OFF switch 134 to ON position and turn POWER control 141 to limit PA plate current to 50 ma.	Supplies B+ to mixer and PA stages.
3	142	Set XTAL selector switch 142 to the desired crystal.	Multiplication ratio should have been set as already discussed (in paragraph 2-5e of volume II).
4	144	Set BAND CHANGE switch 144 to the proper band for XFK's output frequency for the crystal selected.	
5	133, 145, 141	Set OUTPUT TUNING MC control 145 so that its dial shows the correct output frequency. PA PLATE CURRENT meter 133 reading should be set at 50 ma.	Only a slight readjustment of OUTPUT TUNING MC control 145 should now be required to cause PA PLATE CURRENT meter 133 current to dip. At the higher frequencies on band 2, the incorrect sideband may cause a smaller dip at 400 kc below the proper output frequency. This is of no practical consequence providing the operator reads the dial correctly.
6	141	Adjust POWER control 141 until the desired output power is reached being certain not to increase PA PLATE CURRENT 133 over 50 ma.	Desired output power is reached when XFK's drive is sufficient to operate the associated SBE and GPT-10K units properly.
7	139	Set FREQUENCY SHIFT CPS control 139 to the desired shift of the GPT-10K. No allowance for frequency multiplication need be made if the patch panel at the rear of the chassis has been properly connected.	Example 1: desired shift is 840 cps; GPT-10K's frequency multiplication is 1 and patch panel is so connected; set FREQUENCY SHIFT CPS control 139 to 840. Example 2: desired shift is 840 cps; GPT-10K's frequency multiplication is 2 and patch panel is so connected; set FREQUENCY SHIFT CPS control 139 at 840.
8	140	Turn TEST selector switch 140 to LINE. The XFK is now ready to operate on keyed or contact signals.	
9	143	Turn FREQUENCY control 143 to 0 and the unit will now be "on frequency" within ±50 cps plus the grinding error of the crystal used. If the frequency is monitored more accurately, the frequency may be changed by as much as ±600 cps with this control.	This control adjusts a small capacitor in parallel with the crystal so as to "pull" the crystal's frequency by as ±600 cps.

c. FACSIMILE OPERATION. - To convert the XFK from keyed signals to facsimile, it is only necessary to switch the KEY-FAX switch to FAX (early model). In the later model, place the MODE switch (control 140) in the FAX position. The XFK should be tuned exactly as in preceding paragraph. It must, however, be kept in mind that FREQUENCY SHIFT CPS dial 139 and the automatic multiplication ratio are now bypassed.

A signal at the FAX input of approximately ±4 volts then shifts the carrier ±500 cycles linear with applied voltage. TMC Model XFD converts an amplitude-modulated tone carrier to the DC modulation required to operate the XFK and has the required controls on its front panel. Complete instructions are supplied with TMC Model XFD for proper inter-connection and adjustment for use with the XFK.

3-8. TWO TONE GENERATOR MODEL TTG.

a. GENERAL INSTRUCTIONS. - This unit is a primary source of two groups of test tones, namely, two audio tones (935 and 2805 cps) and two radio tones (1999 and 2001 kc). The audio oscillators have especially low distortion to ensure an accurate check of distortion in the standard TTG GPT-10K test. Crystal control of the r-f oscillators provides stable and dependable frequency output useful for checking proper operation of the FSA. The audio and RF outputs are routed via the MCP to the associated SBE and FSA equipments.

b. AUDIO TONES OPERATING INSTRUCTIONS.

Step	Panel Serial Desig.	Operation	Purpose
1	146, 146	Set POWER switch 147 to ON position.	To power the TTG, MAIN POWER indicator should light.
2	146	Position AUDIO TONE SELECTOR control 149 so that the TTG supplies 935 cps (tone 1), 2805 cps (tone 2), or equal amounts of both tones.	Associated screwdriver adjust potentiometer enables output levels of these tones to be equal.
3	MCP unit	Channels audio tones as desired to the SBE.	Refer to paragraph 3-4 of Volume II of the manual.

c. RADIO TONES OPERATING INSTRUCTIONS.

Step	Panel Serial Desig.	Operation	Purpose
1	146, 147	Set POWER switch 147 to ON position.	To power the TTG, MAIN POWER indicator 146 should light.
2	148	Position RF TONE SELECTOR control 148 so that the TTG supplies 1999 kc (tone 1), 2001 kc (tone 2), or equal amounts of both tones.	
3	MCP unit	Channels audio tones as desired to the FSA.	Refer to paragraph 3-4 of Volume II of the manual.

3-9. ISOLATION KEYER MODEL AK-100.

a. GENERAL INSTRUCTIONS. - The ISK is factory adjusted so that continuous space-mark incoming signals will enable and disable the keyer's oscillator, thus making the outgoing signals a replica of the incoming ones. An oscilloscope on the keyer's output will show this condition is fulfilled by positioning the THRESHOLD potentiometer close to mid-range. If a keyer fails to drive its GPT-10K properly, the operator should adjust the THRESHOLD potentiometer over a small sector around its mid-range. If the keyer still fails to drive the GPT-10K properly. The operator should consult a more experienced technician.

b. OPERATING INSTRUCTIONS.

(1) Turn MAIN power switch to ON.

(2) Turn MODE switch to its proper position for type of incoming signals.

(3) Adjust VOLT ADJ potentiometer for proper output signal voltages.

(4) Adjust THRESHOLD potentiometer a little on either side of mid-range as required to obtain signals as explained above.

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
SIDEBAND LEVEL MONITOR MODELS SLM-1 AND SLM-2		
61	LSB LEVEL	Meter M401
62	USB LEVEL	Meter M400
63	MAIN POWER	Indicator I400
64	ON OFF	Toggle switch S400
FREQUENCY SPECTRUM ANALYZER MODEL FSA		
65	Oscilloscope	Crt V12
66	POWER, ILLUMINATION	Knob switch potentiometer S501 and R525
67	INPUT ATTENUATOR	Six toggle switches SW701 through SW706
68	SIGNAL INPUT	Coaxial jack J101
69	CAL OSC LEVEL	Potentiometer R726
70	EXT MOD	Coaxial jack J701
71	FAST SWEEP	Pushbutton switch SW403
72	VFO INPUT	Coaxial jack J102
73	GAIN	Potentiometer R108
74	AFC	Knob switch/potentiometer SW201/R207
75	AMPLITUDE SCALE	Toggle switch SW301
76	FOCUS	Potentiometer R520
77	BRILLIANCE	Potentiometer R522
78	SWEEP WIDTH SELECTOR	Knob (6-position) selector switch SW402
79	IF ATTEN	Toggle switch SW302
80	SWEEP RATE	Knob potentiometers R404 and R407
81	VIDEO FILTER	Toggle switch S502
82	IF BANDWIDTH	Knob potentiometers R305 and R309
83	SWEEP WIDTH	Knob potentiometers R424 and R218
84	V POS	Knob potentiometer R507
85	H POS	Knob potentiometer R427
TRANSMITTING MODE SELECTOR MODELS SBE-2 AND SBE-3		
86	MF XTAL SW	Knob (11-position) selector switch S107
87	2-position dial (No designation)	________________

TABLE 3-1. TABLE OF EQUIVALENT CONTROL DESIGNATIONS (Cont.)

SERIAL DESIGNATION (SEE FIGURE 3-1)	PANEL DESIGNATION (SEE FIGURE 3-1)	COMPONENT DESIGNATION ON OVERALL SCHEMATIC DIAGRAM
88	XMTR ON-OFF	Toggle switch S104
89	EXCITER ON-OFF	Toggle switch S105
90	POWER ON-OFF	Toggle switch S103
91	Output meter (No designation)	Meter M101
92	EXCITER	Indicator I101
93	OVEN	Indicator I102
94	METER SW	Knob (5-position) selector switch S109
95	USB (audio channels)	Knob (4-position) selector switch S101
96	USB GAIN	Knob potentiometer R168
97	OUTPUT	Knob potentiometer R205
98	MIKE	3-conductor jack J101
99	MF TUNING	Knob variable capacitor C167, A and B.
100	SQUELCH GAIN	Knob potentiometer R129
101	OUTPUT TUNING (disc)	Disc variable capacitor C181, A, B, and C.
102	OUTPUT TUNING (knob)	Knob (4-position) selector switch S106, A, B, C, and D.
103	VOX GAIN	Knob potentiometer R140
104	CARRIER INSERT	Knob potentiometer R263 (SBE-2) and R106 (SBE-3)
105	BAND MCS	Knob (18-position) selector switch S108, A and B.
106	LSB GAIN	Knob potentiometer R169
107	LSB (channels)	Knob (4-position) selector switch S102
MONITOR CONTROL PANEL MODEL MCP-1		
108	SBE VMO INPUT	Knob (4-position) selector switch S304
109	VOX RF OUTPUT	Knob (4-position) selector switch S303
110	ANALYZER MONITOR	Knob (4-position) selector switch S302
111	CHANNEL 1	Toggle switch S301
112	CHANNEL 2	Toggle switch S300

TABLE 3-1. TABLE OF EQUIVALENT CONTROL DESIGNATIONS (Cont.)

SERIAL DESIGNATION (SEE FIGURE 3-1)	PANEL DESIGNATION (SEE FIGURE 3-1)	COMPONENT DESIGNATION ON OVERALL SCHEMATIC DIAGRAM
VARIABLE FREQUENCY OSCILLATOR MODEL VOX-2		
113	BEAT	Toggle switch S104
114	METER	Knob (4-position) selector switch S107
115	PHONES	Telephone jack J105
116	POWER	Toggle switch S101
117	HFO	Toggle switch S103
118	IFO	Toggle switch S102
119	BFO	Toggle switch S106
120	MAIN POWER	Indicator I302
121	INNER OVEN	Indicator I301
122	OUTER OVEN	Indicator I304
123	ZERO BEAT	Indicator I303
124	Output meter (No designation)	Meter M301
125	CALIBRATE	Slug inductance L301
126	MASTER OSCILLATOR FREQUENCY (knob)	Knob variable capacitor C301 and C302
127	MASTER OSCILLATOR FREQUENCY (dial)	————————
128	OUTPUT	Knob potentiometer R215
129	XTAL	Knob (4-position) selector switch S201, A, B, C, and D.
130	XTAL	Knob variable capacitor C210
131	BAND-MCS	Knob (5-position) selector switch S202, A, B, C, and D.
132	TUNING	Knob (5-position) selector switch C225, A, B, C, and D.
FREQUENCY SHIFT EXCITER MODEL XFK		
133	PA PLATE CURRENT	Meter M1
134	PLATE ON-OFF	Toggle switch S4
135	200 KC OVEN	Indicator I2
136	POWER	Indicator I1
137	XTAL OVEN	Indicator I3
138	POWER ON-OFF	Toggle switch S8

TABLE 3–1. TABLE OF EQUIVALENT CONTROL DESIGNATIONS (Cont.)

SERIAL DESIGNATION (SEE FIGURE 3-1)	PANEL DESIGNATION (SEE FIGURE 3-1)	COMPONENT DESIGNATION ON OVERALL SCHEMATIC DIAGRAM
139	FREQUENCY SHIFT CPS	Knob potentiometer R8
140	TEST	Knob (3-position) selector switch, early model Knob (5-position) selector switch, S3, later model
141	POWER	Knob potentiometer R22
142	XTAL	Knob (4-position) selector switch S2
143	FREQUENCY	Knob variable capacitor C7
144	BAND CHANGE	Knob (2-position) selector switch S1, A, B, and S9
145	OUTPUT TUNING MC	Knob variable capacitor C18, A, B, and C
TWO TONE GENERATOR MODEL TTG		
146	MAIN POWER	Indicator I502
147	POWER ON-OFF	Knob (2-position) selector switch S500
148	RF TONE SELECTOR	Knob (4-position) selector switch S501
149	AUDIO TONE SELECTOR	Knob (4-position) selector switch S502
150	AUDIO OUTPUT	Knob potentiometer R524

TABLE 3–2. VOX'S CHECK-OUT POINTS; VMO VS 100-KC CALIBRATING OSCILLATOR (2.2- to 2.3-MC FREQUENCY RANGE)

VMO FREQUENCY	VMO HARMONIC	100-KC FUNDAMENTAL HARMONIC	50-KC HALF-TONE HARMONIC
2,200,000	5	110	220
2,205,000	10	—	441
2,210,000	10	221	442
2,212,500	4	—	177
2,220,000	5	111	222
2,225,000	4	89	178
2,228,571	7	156	312
2,230,000	10	223	446
2,233,333	3	67	134
2,240,000	5	112	224
2,245,000	10	—	449
2,250,000	4	89	178
2,255,000	10	—	451
2,260,000	5	113	226
2,266,667	3	68	136
2,271,428	7	159	318
2,275,000	4	91	182
2,280,000	5	114	228
2,283,333	6	137	274
2,285,714	7	160	320
2,290,000	10	229	458
2,295,000	10	—	459
2,300,000	1	23	46

Figure 3-1-A Main Frame Operating Controls

Figure 3-1-B Auxiliary Frame Operating Controls

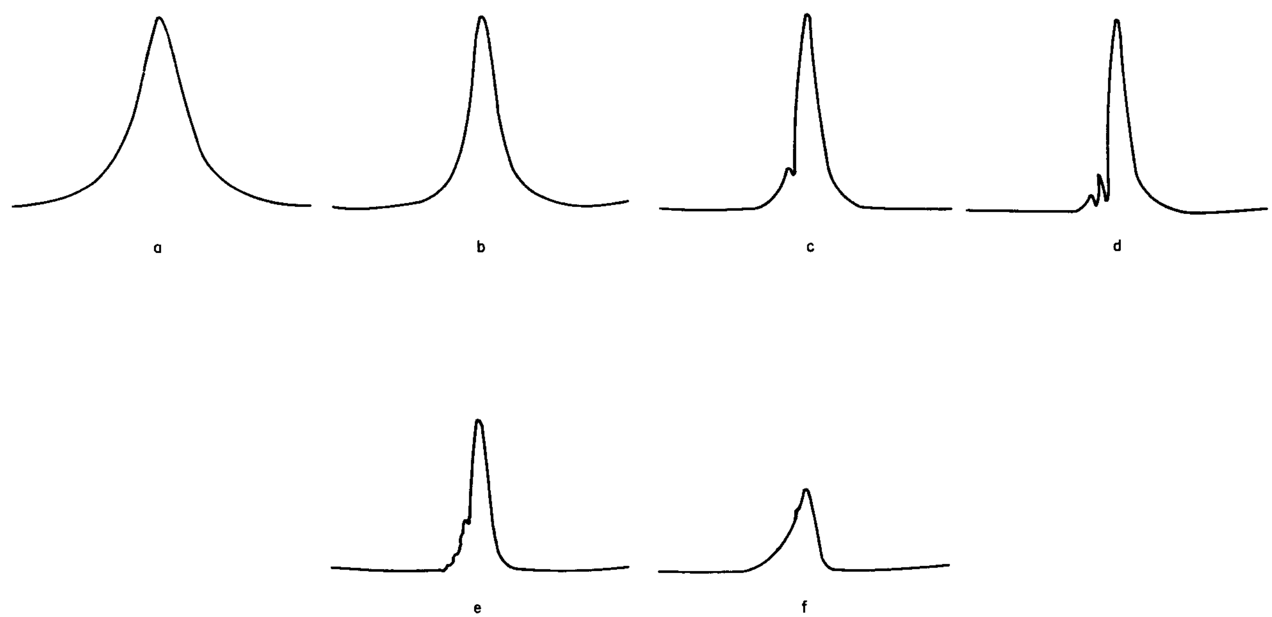


Figure 3-2. FSA Diagram Illustrating Ringing as an Indication of Optimum Resolution

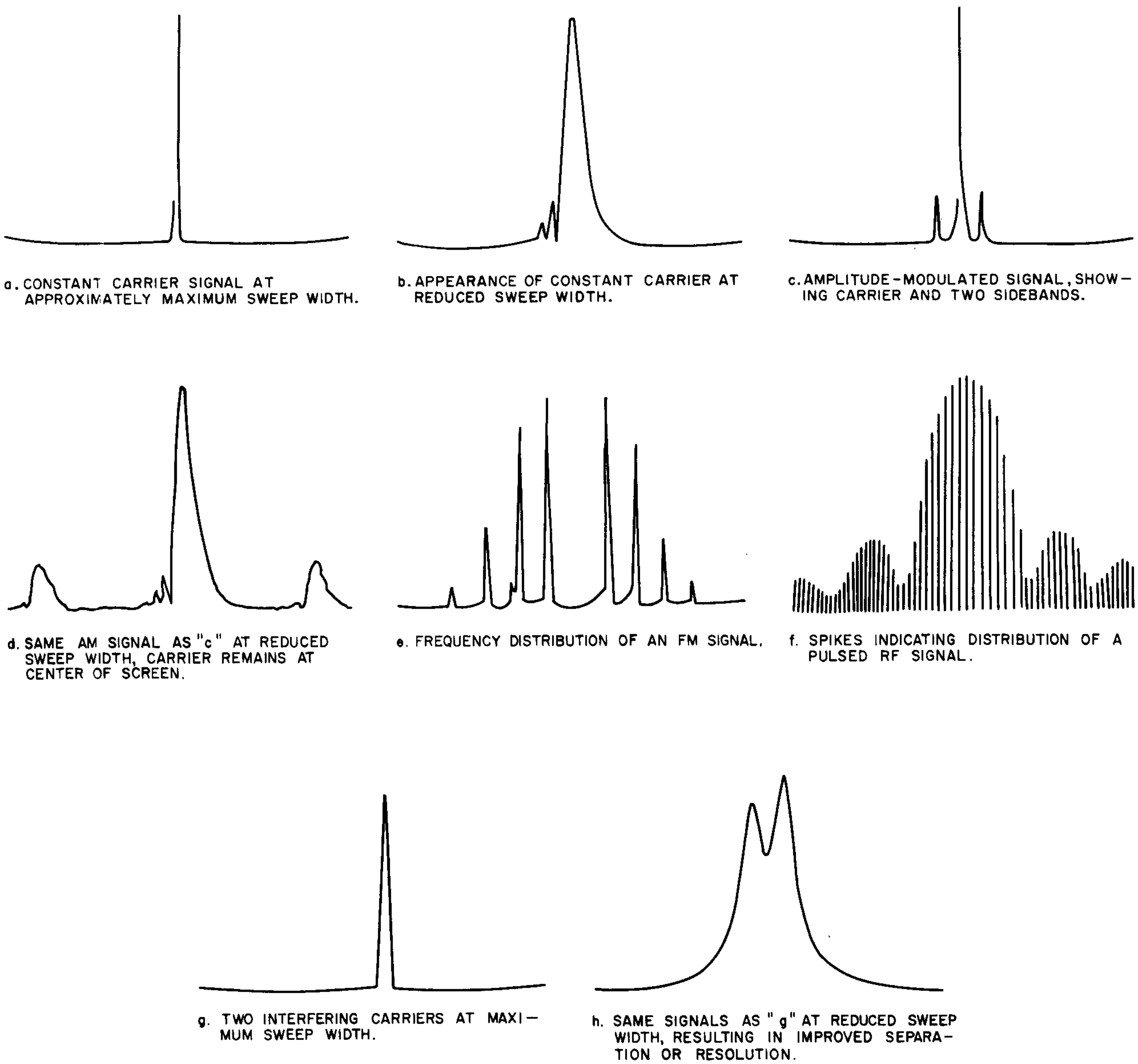


Figure 3-3. FSA Diagram Illustrating Appearance of Typical FSA Indications

SECTION 4
PRINCIPLES OF OPERATION

4–1. GENERAL.

This section describes the principles of operation of the exciter and test equipment located on the auxiliary frame chassis. (See figures 1-1-a and 1-1-b, left-hand section facing GPT-10K.)

4–2. SIDEBAND LEVEL MONITOR MODELS SLM–1 AND SLM–2.

a. INTRODUCTION. (See figure 4-1.) - As shown in figure 4-1, the SLMs consist of a lower sideband level VTVM circuit, an upper sideband level VTVM circuit, and a power supply circuit. Electrically, the SLM-2 monitors the sideband levels of an associated SBE-3's 250-kc balanced modulator, and the SLM-1 monitors the sideband levels of an associated SBE-2's 17-kc balanced modulator. In order to avoid appreciable distortion, the SLMs should not be operated to give peak meter deflections exceeding 100.

b. CIRCUIT DESCRIPTION. (See figure 4-2.) - Each SLM contains a pentode (first stage) and a triode (second stage). The SLM-2 is essentially an RF amplifier VTVM with its pentode's plate tuned to 250 kc. Its regulated power supply is 105 volts (OB2). The SLM-1 is essentially a low-frequency amplifier VTVM without plate tuning. Consequently, it has a relatively flat transmission characteristic. Its regulated power supply is 150 volts (OA2).

4–3. FREQUENCY SPECTRUM ANALYZER MODEL FSA.

a. INTRODUCTION. (See figure 4-3.) - As shown in figure 4-3, the FSA consists of the following seven principle sections:

(1) Input section

(2) Sweep generator section

(3) Mixer and sweep oscillator, reactance modulator, and AFC section

(4) 100-kc IF and video section

(5) Crt with H/V plate outputs section

(6) Crystal-controlled calibrating oscillator section

(7) PS-12 section

The input section is provided with three input circuits and a 450- to 550-kc output circuit. Since the output of the first mixer has a pass band of 450 to 550 kc, no VFO input frequency is required for incoming signals in the 450- to 550-kc range and a VFO input frequency 500-kc higher than the signal input frequency is required for incoming signals outside the 450- to 550-kc range. With a 0.1-volt rms VFO input level, a 3-ma SIGNAL INPUT level will produce full-scale log deflection on the following crt screen. This sensitivity is maintained throughout the radio communications spectrum to well above 30 mc. The mixer is usable, at reduced sensitivity, up to 1000 mc.

The sweep generator section is provided with two saw-tooth output circuits. The saw-tooth speeds are variable from 0.1 to 30 cps. One saw-tooth voltage wave provides the crt with horizontal sweep. The other saw-tooth voltage wave is fed to a reactance modulator whose operations are explained in the following paragraph.

On receiving the saw-tooth voltage wave, the reactance modulator in combination with network Z101 causes the local sweep oscillator (part of mixer-oscillator tube V3) frequency to vary in proportion to the progressively varying magnitude of the saw-tooth voltage. With the AFC feedback circuit OFF, the scanning width is ±50 kc from the 600-center frequency; with the AFC feedback circuit ON, ±1 kc. In the latter case, AFC provides the frequency stability necessary for the narrow bandwidth. The mixer section of V3 receives two signals: one, those in the 450- to 550-kc output circuit of first RF amplifier V2, and two, the scanning voltage (nominally 550 to 650 kc) of the local sweep oscillator; the scanning voltage progressively translates each voltage component in the 450- to 550-kc signal to a 100-kc difference frequency signal at the output of the mixer's 100-kc center frequency narrow band output filter.

The 100-kc IF and video section receives the 100-kc voltages from the output of the second mixer. These voltages, whose magnitudes vary from instant to instant depending upon the composition of the 450- to 550-kc IF amplifier's signal, are amplified in a narrow band four-stage amplifier, are detected, and are fed to the crt's vertical plates via a vertical amplifier.

Consequently, the crt displays the component signals in the 100-kc RF bandwidth under surveillance. If desired, narrower RF bandwidths may be displayed across the crt's screen. The pip amplitude and position along the calibrated horizontal axis are indicative of each component signal level and frequency, respectively. The saw-tooth voltage output of the sweep generator progressively shifts the crt's electron beam horizontally across the screen in order to enable the crt to display the successively demodulated 100-kc signals emerging from the second mixer. These signals represent magnitudes of the successive frequency components in the RF bandwidth being scanned.

If desired, the calibrating oscillator will provide the crt's screen with a 500-kc marker. When supplied with an audio signal (fed into EXT MOD jack) the modulated 500-kc signal provides frequency markers with known separations.

The PS-12 is a conventional electronically regulated type supplying +270 volts to the FSA.

b. INPUT SECTION. (See figure 4-4.) - The signal and/or calibrating oscillator input is through a 50-ohm step-type attenuator. Up to 65 db of loss can be inserted in the signal path in 5-db steps. The accuracy of the attenuator is 2 percent up to 30 mc. It is usable with reduced accuracy up to several hundred megacycles.

The input attenuator is followed by an aperiodic mixer V1 (12BE6) which is coupled to neutralized cascode RF amplifier V2 (12AT7). Gain control potentiometer R108 in the cathode circuit of V2 allows up to 20 db of attenuation. The output of the RF amplifier is coupled to second mixer V3 (6BE6). Coupling transformers T101 and T102 in the RF amplifier are designed to provide a flat bandpass from 450 to 550 kc with a sharp cutoff above 550 kc to reduce image response.

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

(1) INPUT ATTENUATOR SW701 through SW706. Toggle-switch control designated 67 on figure 3-1. This is a group of six toggle switches which provide attenuations of 5 DB, 10 DB, 10 DB, 10 DB, 10 DB, and 20 DB in the SIGNAL INPUT circuit. When the switches are in the down position, the indicated attenuation is inserted.

(2) GAIN R108. Potentiometer control designated 73 on figure 3-1. The amplitude of the indication on the crt screen is adjusted with this control. Maximum gain is obtained at maximum clockwise position. The GAIN control should be operated at the maximum setting consistent with low noise on the crt display to reduce internal distortion in the FSA input circuits.

(3) SIGNAL INPUT J101. Connector control designated 68 on figure 3-1. This coaxial jack receives RF signal to be analyzed.

NOTE

In GPT-10K operation, this front panel mounted jack is not used; a coaxial jack mounted on the rear chassis of the FSA is used in its place.

(4) VFO INPUT J102. Connector control designated 72 on figure 3-1. VFO is the associated external oscillator or signal generator which is used with the FSA to heterodyne with the test signal to produce the required frequency to operate the FSA.

NOTE

In GPT-10K operation, this front panel mounted jack is not used; a coaxial jack mounted on the rear chassis of the FSA is used in its place.

NOTE

The heterodyne product should be the difference between the two frequencies used. If the sum frequency is used, spurious screen indications may result from heterodyne products of the test signals and the external signal generator output (including its harmonics).

c. SWEEP GENERATOR SECTION. (See figure 4-5.) - The saw-tooth sweep voltage is derived from a feedback integrator circuit consisting of V13 (6AU6) and pins 1, 2, and 3 of V14 (12AU7). Capacitor C401 is charged with a constant current determined by the setting of SWEEP RATE potentiometers R404 and R407. The resulting saw-tooth voltage developed across C401 is available at the cathode of V14 (12AU7).

The setting of SWEEP RATE potentiometers R404 and R407 determines the charging current into C401. As C401 charges negatively, the grid of V13 starts to go negative and greatly amplified positive-going voltage appears at its plate. This is passed through cathode follower pins 1, 2, and 3 of V14 (12AU7) for purposes of impedance transformation. The output of the cathode follower causes the output side of C401 to go positive at a much greater rate than the input side goes negative. During any single sweep, the potential of the input side of C401 (and the grid of V13) remains very nearly zero. Thus, the charging current remains constant and a linear voltage sawtooth is generated.

When the saw-tooth voltage reaches a predetermined amplitude, blocking tube oscillator pins 6, 7, and 8 of V14 (12AU7) fire and cause discharge tube V15 (6BH6) to conduct heavily. This tube discharges C401 and the charging cycle repeats itself.

The sawtooth is coupled through LINE SIZE potentiometer control R421 to the grid of horizontal deflection amplifier V16 (12AU7) and to reactance tube V4 (6AH6) through SWEEP WIDTH LIMIT potentiometer control R423 and the sweep width divider network. The second half of V16 (12AU7) acts as a direct coupled phase inverter. The plates of V16 are direct coupled to the horizontal deflection plates of the crt. POS potentiometer control R427 is in the last stage. FOCUS and BRILLIANCE potentiometer controls R520 and R222, respectively, are in the high-voltage bleeder chain.

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

(1) SWEEP RATE R404 and R407. Potentiometer controls designated 80 on figure 3-1. The potentiometer controls provide continuously adjustable scanning rates between 0.1 and 30 cps. Counterclockwise rotation of the controls reduces the sweep rate. The controls are operative only in the VAR position of SWEEP WIDTH SELECTOR switch control 78.

(2) FAST SWEEP SW403. Switch control designated 71 on figure 3-1. This momentary contact pushbutton switch speeds up the sweep rate from 0.1 to 1 cps on the 150-cps, and 2-kc preset sweep range. This facilitates centering the display on the crt screen without the need to wait 10 seconds between sweeps. It also enables the operator to skip undesired portions of the frequency range being scanned.

(3) SWEEP WIDTH SELECTOR SW402-4B. Switch control designated 78 on figure 3-1. This switch control provides a choice of five preset widths of 150 , 500 , 2KC, 10KC, and 30KC, and a sixth position marked VAR. In the VAR position, the sweep width may be set to any value from 0 to 100 kc, the IF bandwidth may be set for any desired resolution within the capability of the instrument, and the sweep rate may be set to any value from 0.1 to 30 cps. The video filter switch is also operative in this position. In the preset positions, the IF bandwidth is automatically set for optimum resolution. On the three narrowest ranges, the AFC circuit is automatically turned on; on the 10- and 30-kc ranges it is disabled. On the three narrowest ranges, the sweep rate is 0.1 cps, and a low-pass video filter with a bandwidth of approximately 40 cps is switched on. The sweep rate on the 10- and 30-kc ranges is 1 cps, and the video filter bandwidth is approximately 400 cps. The sensitivity of the FSA is constant on all ranges within ±15 percent.

(4) SWEEP WIDTH R424 and R218. Potentiometer control designated 83 on figure 3-1. The scanning width of the instrument is adjusted with this potentiometer control. When it is turned completely clockwise, the maximum spectrum width for which the instrument is designed (that is, 100 kc when AFC is off, or 2 kc when AFC is on) can be seen on the screen. As the control is backed off in a counterclockwise direction, the bandwidth viewed becomes narrower. The part that can be seen, however, is expanded across the screen and, hence, is virtually magnified. The stability required for narrow sweep width and slow sweep rates is provided by turning on the AFC. The SWEEP WIDTH control, in conjunction with the IF BANDWIDTH control, is useful for separating two or more signal deflections which are so close as to merge into each other.

Chassis-mounted controls that apply to this section are as follows: (These are initially set by the manufacturer's personnel and should be changed only by qualified technical personnel.)

(1) LINE SIZE potentiometer R421

(2) 30-cycle adjust potentiometer R409

(3) 0.1-cycle adjust potentiometer R406

(4) HORIZ OUTPUT jack J401

(5) SWEEP WIDTH LIMIT potentiometer R423

d. MIXER AND SWEEP OSCILLATOR, REACTANCE MODULATOR, AND AFC SECTION. (See figure 4-6.) - The functions of a mixer and local oscillator are combined in V3 (6BE6). The center frequency of the oscillator is 600 kc. Reactance stage V4 (6AH6) sweeps the oscillator between 550 and 650 kc in accordance with a saw-tooth voltage applied to its grid. Variable resistor R203, CF PAD, varies the screen voltage on the reactance tube and hence tunes the center frequency of the oscillator.

The oscillator output is amplified by V5 (6BH6) and applied to a frequency discriminator V6 (12AL5). The center frequency of the discriminator is 600 kc. It effectively reduces the normal 100-kc sweep width of the local oscillator to 2 kc and stabilizes it against drift. The AFC circuit also reduces hum modulation of the local oscillator by a factor of 50.

Mixer V3 (receiving 450- to 550-kc IF amplifier V2 signals, and 550- to 650-kc local sweep oscillator V3 signals), equipped with 100-kc center frequency narrow band output filter Z103, delivers variable 100-kc signals to its following stage; these are the result of the scanning local oscillator's frequency-modulated voltages and the component signal voltages in the RF band under surveillance. In other words, the 100-kc component signal voltages from V3's 100-kc center frequency narrow band output filter Z103 represent, during the scanning cycle, the magnitude/frequency of the voltage components in the output of the 450- to 550-kc IF amplifier V2.

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

(1) CENTER FREQ/AFC OFF R207 and SW201. Potentiometer control designated 74 on figure 3-1. Center Frequency is the frequency of the signal received on that part of the frequency sweep axis corresponding to zero sweep voltage applied to the reactance modulator.

(2) SWEEP WIDTH SELECTOR SW402-2T, -1T, and -3T. Switch control designated 78 on figure 3-1. This switch control provides a choice of five preset sweep widths of 150 , 500 , 2KC, 10KC, and 30KC, and a sixth position marked VAR. In the VAR position, the sweep width may be set to any value from 0 to 100 kc, the IF bandwidth may be set for any desired resolution within the capability of the instrument, and the sweep rate may be set to any value from 0.1 to 30 cps. The video filter switch is also operative in this position. In the preset positions, the IF bandwidth is automatically set for optimum resolution. On the three narrowest ranges, the AFC circuit is automatically turned on; on the 10- and 30-kc ranges it is disabled. On the three narrowest ranges, the sweep rate is 0.1

cps, and a low-pass video filter with a bandwidth of approximately 40 cps is switched on. The sweep rate on the 10- and 30-kc ranges is 1 cps, and the video filter bandwidth is approximately 400 cps. The sensitivity of the FSA is constant on all ranges within ±15 percent.

(3) SWEEP WIDTH R424 and R218. Potentiometer control designated 83 on figure 3-1. The scanning width of the instrument is adjusted with this potentiometer control. When it is turned completely clockwise, the maximum spectrum width for which the instrument is designed (that is, 100 kc when AFC is off, or 2 kc when AFC is on) can be seen on the screen. As the control is backed off in a counterclockwise direction, the bandwidth viewed becomes narrower. The part that can be seen, however, is expanded across the screen and, hence, is virtually magnified. The stability required for narrow sweep width and slow sweep rates is provided by turning on the AFC. The SWEEP WIDTH control, in conjunction with the IF BANDWIDTH control, is useful for separating two or more signal deflections which are so close as to merge into each other.

Chassis-mounted controls that apply to this section are as follows: (These are initially set by the manufacturer's personnel and should be changed only by qualified technical personnel.)

(1) CF PAD potentiometer R203

(2) SWEEP WIDTH LIMIT/AFC potentiometer R216

(3) CENT FREQ potentiometer R206

(4) AFC TEST jack J201

e. 100-KC IF AND VIDEO SECTION. (See figure 4-7.) - The output of the second mixer is connected through 20-db attenuator SW302 to the 100-kc IF amplifier. This attenuator is used as a convenient means of setting the signal level at 20 db over full-scale log deflection. It is normally operated in the 0-db position.

First IF stage V7 (6U8), a neutralized amplifier, has a crystal filter in its cathode circuit. The filter is operated as a series resonant circuit which couples into the grid of the next stage (pentode section of V7). The grid return to ground is a parallel resonant circuit shunted by a resistance. As the shunting resistance is decreased (by operation of SWEEP WIDTH SELECTOR switch SW402-1B), the effective series resistance of the crystal filter is decreased and the crystal bandwidth narrows.

Second IF stage V8 (6U8), a neutralized amplifier, is similar to the first. Two shunting potentiometers, R305 and R309, designated IF BANDWIDTH form part of the IF selectivity circuits. SWEEP WIDTH SELECTOR switch SW402-3B, controls selectivity while switch SW402-2B controls gain.

Third IF stage V20 (6US), a neutralized amplifier, is similar to the first. SWEEP WIDTH SELECTOR switch SW402-5B shunts the grid return to ground in this stage.

Fourth IF stage V9 (6AU6), is a conventional IF amplifier. A DC feedback voltage from the following diode detector is applied to the grid of V9 to reduce its gain for strong signals when AMPLITUDE SCALE toggle switch SW301 is in LOG position.

The fourth IF stage is coupled to diode detector pins 6, 7, and 8 of V10 (12AU7). For LOG amplitude scale indications, the rectified pulses, which appear across the diode load, are fed back through the AMPLITUDE SCALE switch to the grid of the last IF stage. Chassis-mounted LOG SCALE ADJUST R325 and LOG ZERO ADJUST R321 controls determine the magnitude of the feedback voltage and the operating point of the IF stage which controls the logarithmic characteristic.

The output of the detector is direct coupled to the grid of the second half of V10 (12AU7) through a low-pass R-C filter. Two degrees of filtering and an OFF position are provided by the VIDEO FILTER switch S502.

The plate of the video amplifier is direct coupled to one vertical deflection plate of the crt and to the grid of phase inverter V11 (12AU7) whose output drives the other vertical deflection plate. The variable cathode bleeder resistor of the inverter controls the DC potential on its associated deflection plate and thus governs vertical position. The second section of V11 (12AU7) is a cathode follower which provides an auxiliary vertical output from J502 on the rear apron of the chassis for driving a slave oscilloscope or other external indicator.

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

(1) IF ATTEN SW302. Toggle-switch control designated 79 on figure 3-1. This toggle switch allows 20 db of attenuation to be inserted in the IF amplifier. When this is done, the input signal may be adjusted for full-scale LOG deflection. Placing the IF ATTEN switch in the 0 DB position permits the full 60-db dynamic range of the FSA to be used. Only the lower 40-db portion is displayed on the crt screen. This switch must always be in the 0 DB position when making measurements.

(2) IF BANDWIDTH R305 and R309. Potentiometer control designated 82 on figure 3-1. Resolution, or the ability to separate individual signals, is dependent upon two factors: the rate of frequency scan and the bandwidth of the IF section of the instrument. Optimum resolution requires a definite relationship between the two. Resolution sharpens as both the frequency scanning rate and IF bandwidth are decreased. The IF BANDWIDTH control is used to narrow the IF bandwidth. Counterclockwise rotation of this control narrows the width of the IF section. It should be noted that as this control is adjusted, there will be some

degree of change in the sensitivity of the equipment. The frequency scanning rate is diminished by increasing the scanning period or, conversely, by decreasing the spectrum width scanned within a given time. The AFC and SWEEP WIDTH controls provide the latter method. For a given setting of the SWEEP WIDTH control there is a complementary setting of the IF BANDWIDTH control to obtain optimum resolution. On the preset sweep ranges, the IF bandwidth is automatically set for optimum resolution.

(3) SWEEP WIDTH SELECTOR SW402-1B, -2B, -3B, -5B, -4T. Switch control designated 78 on figure 3-1. This control provides a choice of five preset sweep widths of 150 , 500 , 2KC, 10KC, and 30KC, and a sixth position marked VAR. In the VAR position, the sweep width may be set to any value from 0 to 100 kc, the IF bandwidth may be set for any desired resolution within the capability of the instrument, and the sweep rate may be set to any value from 0.1 to 30 cps. The video filter switch is also operative in this position. In the preset positions, the IF bandwidth is automatically set for optimum resolution. On the three narrowest ranges, the AFC circuit is automatically turned on; on the 10- and 30-kc ranges it is disabled. On the three narrowest ranges, the sweep rate is 0.1 cps, and a low-pass video filter with a bandwidth of approximately 40 cps is switched on. The sweep rate on the 10- and 30-kc ranges is 1 cps, and the video filter bandwidth is approximately 400 cps. The sensitivity of the FSA is constant on all ranges within ±15 percent.

(4) AMPLITUDE SCALE LOG-LIN SW301. Toggle-switch control designated 75 on figure 3-1. Selection of linear or logarithmic amplitude presentations is accomplished with this toggle switch. In the LOG position, signals having a 40-db (100:1) amplitude range may be viewed simultaneously on the screen. When using the LOG amplitude range, the calibration dots at the left edge of the calibrated screen are used. The calibration range is from -20 db to +20 db in 5-db steps. In the LIN position, signals having an amplitude ratio of 20 db (10:1) may be observed at one time. When using the LIN amplitude range, the horizontal lines on the calibrated screen are used. This linear scale is divided into 10 equal divisions. It should be noted that because of the time constant factor, the LOG feature does not function properly with narrow pulses.

(5) VIDEO FILTER HI-LO-OFF S502. Toggle-switch control designated 81 on figure 3-1. This toggle switch provides two degrees of video filtering to suppress such unwanted effects as noise, spurious beating between closely adjacent signals, hum, etc. In the upper (HI) position, the video bandwidth is moderately reduced. In the lower (LO) position of the VIDEO FILTER switch, the video bandwidth is greatly reduced. This position is suitable for use with very slow sweep rates and narrow sweep widths. On the 150-cps, 500-cps, and 2-kc preset sweep ranges, the LO filter is automatically switched on. On the 10- and 30-kc ranges, the HI filter is automatically switched on.

Chassis-mounted controls that apply to this section are as follows: (These are initially set by the manufacturer's personnel and should be changed only by qualified technical personnel.)

(1) BANDWIDTH LIMIT potentiometer R310

(2) LOG ZERO ADJ potentiometer R321

(3) LOG SCALE ADJ potentiometer R325

(4) Inductors L101A, L101B, and L101C

f. CRT WITH H/V PLATE OUTPUTS SECTION. (See figure 4-8.) - Cathode-ray tube V12 (5ADP7) has its horizontal and vertical plates driven as follows: horizontal, V16A and V16B; vertical, V10B and V11A. Cathode follower V11 provides monitoring the crt's vertical plates via VERT OUTPUT jack J502.

As shown in figure 4-8, the screens are calibrated by db (line) calibrations ranging from 0 to 40 db (left-hand scale) and by linear (dot) calibrations ranging from 1.0 to 0. A signal with 0 or reference db deflection will drop to 20 db with 20-db insertion in an attenuator. A signal with 1.0 deflection will drop to 0.1 deflection with a 20-db insertion in an attenuator.

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

(1) FOCUS R520. Potentiometer control designated 76 on figure 3-1. The sharpness of the screen presentation is adjusted with control R520.

(2) BRILLIANCE R522. Potentiometer control designated 77 on figure 3-1. The intensity of the screen presentation is adjusted with control R522.

(3) H POS R427. Potentiometer control designated 85 on figure 3-1. Control R427 is used to adjust the position of the baseline trace along the horizontal axis.

(4) V POS R507. Potentiometer control designated 84 on figure 3-1. Control R507 is used to adjust the position of the baseline trace along the vertical axis.

(5) ILLUMINATION, POWER ON-OFF SW501 and R525. Switch/potentiometer control designated 66 on figure 3-1. Control R525 is rotated in a clockwise direction to turn on the power. Continued clockwise rotation of this control increases the edge illumination of the crt screen.

Controls not mounted on the front panel that apply to this section are as follows: (These are initially set by the manufacturer's personnel and should be changed only by qualified technical personnel.)

(1) ASTIGMATISM potentiometer R516

(2) VERT OUTPUT jack J502

g. CRYSTAL-CONTROLLED CALIBRATING OSCILLATOR SECTION. (See figure 4-9.) - The triode section of V19 (6U8) is a Pierce crystal oscillator, operating at 500 kc. The pentode section of V19 couples the 500-kc signal to the signal input of the FSA through 1000-ohm isolating resistor R114. The output of V19 is varied by CAL OSC LEVEL control R726 which determines the plate voltage applied to V19.

An external audio signal may be applied via EXT MOD connector J701 to the grid of the oscillator section of V19. This amplitude modulates the 500-kc signal and provides frequency markers with a known separation.

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

(1) CAL OSC LEVEL R726. Potentiometer control designated 69 on figure 3-1. This potentiometer control varies the output amplitude of the 500-kc crystal oscillator which is internally connected to the signal input receptacle. The signal may be used to locate the center frequency of the FSA and may be modulated by an external audio oscillator to provide marker sidebands for setting up any desired sweep width. The 500-kc signal, in conjunction with the INPUT ATTENUATOR, may be used to check the accuracy of the LOG amplitude scale calibrations (which appear as dots at the left side of the calibrated screen). In its fully counterclockwise position, the CAL OSC LEVEL control reduces the oscillator output to zero.

(2) EXT MOD J701. Connector control designated 70 on figure 3-1. Provides the crt's screen with markers.

h. PS-12 SECTION. (See figure 4-10.) - The PS-12 is a conventional electronically regulated type supplying +270 volts to the FSA. The high voltage for the crt is obtained from a pair of high-voltage selenium rectifiers, CR601 and CR602. The bleeder current from the negative crt supply operates voltage reference tube V17 (5651) in the FSA, which supplies -87 volts to the sweep circuits. Voltage regulator tube V18 (OA2) supplies the RF amplifier and second mixer with +150 volts.

The heaters of V3, V4, V5, and V6, which are in the oscillator and AFC circuits, are operated from a DC supply obtained from the AC heater system via a selenium bridge rectifier CR-1.

4-4. TRANSMITTING MODE SELECTOR MODEL SBE-3 AND ITS POWER SUPPLY.

a. INTRODUCTION. (See figure 4-11.) - As shown in figure 4-11, the SBE-3, together with its power supply consists of the following seven principle sections:

(1) Audio input section

(2) 250-kc oscillator and balanced modulator section

(3) 2- to 4-mc MF section

(4) 2- to 32-mc HF section

(5) SQUELCH and VOX section

(6) M101 meter section

(7) Power supply section

The audio input section is provided with two "line" channels and one "microphone" channel which are equipped with functional switches S101, S102, and S106D to route incoming intelligence to audio amplifiers V122A and/or V123A. For example, the microphone input may be routed to V122A, V123A, or V122A and V123A; the same is true of signals received from LINE channel 1 or 2. If desired, signals received from LINE channel 1 and from LINE channel 2 may be simultaneously and independently routed to V122A and V123A, respectively. Likewise, microphone and LINE channel 1 signals may be simultaneously and independently routed to V122A and V123A, respectively. The functional switches provide flexibility in the routing of audio signals singly or independently in pairs to V122A and V123A. The audio input section is also provided with two meter amplifiers, V122B and V123B, and associated meter rectifiers CR111 and CR112. These circuits indicate the power level of incoming audio signals, which are important factors from the standpoint of avoiding the overloading of the following 250-kc balanced modulator section.

The 250-kc oscillator and balanced modulator section modulates the audio outputs from the audio input section, placing the intelligence in the 250-kc upper and/or lower sideband frequency regions (250 +7.5 kc). The output of LSB filter Z110 consists of a small amount of 250-kc carrier and signals in the 250 -7.5 kc frequency range; the output of USB filter Z111 consists of a small amount of 250-kc carrier and signals in the 250 +7.5 kc frequency range. The 250-kc notch filter Z112 removes the 250-kc carrier in these two sidebands. The output of 6AH6 amplifier V126 contains the LSB and USB signals, with as much 250-kc carrier reinsertion as desired by the setting of CARRIER INSERT potentiometer R263. The signal bandwidth at this point is 15 kc with LSB and USB operation, or 7.5 kc with either LSB or USB operation.

The 2- to 4-mc MF section provides the second stage of modulation. In this stage, the incoming 250-kc sidebands from 6AH6 amplifier V126 are heterodyned into the 2- to 4-mc frequency range. Crystals in the 2- to 4-mc range, associated with MF XTAL SW S107, may be used in the modulation process, or an external VMO may be used. The arrangement of V113, with input and output transformers T127 and T109, respectively, comprises a balanced modulator in which the 250-kc sidebands from V126 are mixed with the MF output of crystal oscillator V115 (with its crystal in S107) or with an external VMO.

The 2- to 32-mc HF section provides the third and final stage of modulation. In this stage, the incoming sidebands in the 2- to 4-mc range are heterodyned into the 2- to 32-mc frequency range. The arrangement of Z107, with input and output transformers T110 and T111 (part of Z107), respectively, comprises a balanced modulator in which the incoming sidebands in the 2- to 4-mc range from V114 are mixed with the HF output of the crystal oscillator consisting of V117 (with its crystal in S108) and amplifier V116. The 2- to 32-mc HF section also contains three stages of RF amplification V118, V119, and V120, together with RF amplifier tuning circuits, comprising components mounted on BANDSWITCH wafers S106A, S106B, and S106C.

The end result of the SQUELCH/VOX section, when not disabled by setting the XMTR ON-OFF and the EXCITER ON-STANDBY toggle switches to OFF and STANDBY positions, respectively, is as follows: Operation of plate relay K101 places a local ground in the SBE unit on the transmitters ON-OFF remote control circuit. In the case of the GPT-10K, there is no remote control ON-OFF circuit. In the case of other types of transmitters, however, when used with the SBE, provision is made for remote transmitter operation by the SBE unit.

Again, operation of plate relay K101 places plate voltage on the tubes comprising the SBE's HF section. Whether or not plate relay K101 operates depends as before on the audio signal level at any instant (a function of VOX GAIN potentiometer setting) and the sensitivity of the squelch circuit during idle periods of speech (a function of SQUELCH GAIN potentiometer setting.) GPT-10K's are usually operated with the XMTR ON-OFF and the EXCITER ON-STANDBY toggle switches both in ON position; in this case, the SQUELCH/VOX section is disabled (insofar as SBE and GPT-10K control by this section is concerned).

The M101 meter section provides means of indicating audio input power levels, the 2- to 4-mc MF power level, and the 2- to 32-mc HF power level. The five-position METER SW provides the following services:

(1) USB meter position indicates only the USB channel audio level.

(2) LSB meter position indicates only the LSB channel audio level.

(3) MF meter position indicates sum total of both sidebands and carrier when used. This meter position is used only to indicate proper tuning of the MF dial and, therefore, its absolute level has no real meaning.

(4) RF meter position indicates the sum total of both sidebands and carrier when used.

(5) CAL position zeroes the meter.

The power supply section provides 6.3-volt AC filament, +250-volt DC plate, +180-volt DC plate, +125-volt DC plate, and +150-volt DC regulated plate voltages.

HF frequency adjustments, tuning, and amplification are accomplished in the RF amplifier stages. The maximum output of the SBE is approximately one watt (PEP), which is considerably more than ample to drive a single sideband GPT-10K.

b. AUDIO INPUT SECTION. (See figure 4-12.) - Connections for two audio input channels (600-ohm balanced or unbalanced) are provided on terminal board E101. External LINE channel 1 connects to terminals 6, 7, and 8; external LINE channel 2 connects to terminals 10, 11, and 12. Terminals 7 and 11 may be grounded for systems balanced to ground. Terminals 8 and 12 may be grounded when used for systems unbalanced to ground. Approximately -20 db of 1000 cps is required at each channel input for full output of the SBE. When a high impedance mike is plugged into the front panel MIKE jack J101, a pre-amp stage (V101) raises the signal level to the level required for direct channel input. The outputs of V101, T101, and T102 are fed to S101 upper (USB) and S102 lower (LSB) sideband selector switches. The audio selected by these switches (CH 1, CH 2 or MIKE) then goes to R168 (USB GAIN) and R169 (LSB GAIN) controls. R168 and R169 center arms are connected to S106D for inverting upper and lower sideband inputs when the SBE is operating in the 3.75- to 4.25-mc range. Inversion takes place at this point to allow for a modulation inversion which occurs in a later circuit (Z107). (See figure 4-13.) The audio taken from S106D is amplified by audio amplifiers V122A and V123A. Audio is also taken from the center arms of R168 (USB GAIN) and R169 (LSB GAIN) to feed meter amplifiers V122B and V123B. Outputs of these amplifiers are connected to CR111 and CR112, respectively, where incoming peaks are rectified and coupled to V112/M101, a bridge-type VTVM. This circuit is a peak reading device rather than an RMS indicating meter circuit. For example, it would read 0.7 mv on a continuous sine wave of 1-mv peak or on a single short pulse of 1-mv peak.

Other inputs on terminal board E101 include the following:

(1) Terminal 1 and ground are intended for push-to-talk keying line when the VOX and SQUELCH circuits are not in use.

(2) Terminal 2 (ground) and terminal 3 (key) are CW keying terminals and are normally connected by a jumper when CW is not being used.

(3) Terminal 4 is grounded by K101 (SBE control relay) and can be used to energize an associated RF amplifier/transmitter.

(4) Terminal 13 is in the SQUELCH input which is normally obtained from the 600-ohm output of a receiver at the operating position.

(5) Terminals 5, 9, and 14 grounded.

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

(1) POWER ON-OFF S103. Toggle-switch control designated 90 on figure 3-1. ON, applies line voltage to power supply. OFF, turns SBE off entirely.

(2) LSB S102. Switch control designated 107 on figure 3-1. Selects audio input source for lower sideband channel.

(3) LSB GAIN R169. Potentiometer control designated 106 on figure 3-1. Adjusts level of LSB audio input.

(4) USB S101. Switch control designated 95 on figure 3-1. Selects audio input source for upper sideband channel.

(5) US

(5) USB GAIN R168. Potentiometer control designated 96 on figure 3-1. Adjusts level of USB audio input.

(6) OUTPUT TUNING KNOB S106. Part of switch control designated 102 on figure 3-1. Selects output frequency band. The associated outer disc designated 101 tunes the RF output circuits that are a part of the 2- to 32-mc HF section.

(7) MIKE J101. Connector control designated 98 on figure 3-1. Input jack to audio pre-amp for all high impedance microphones.

c. 250-KC OSCILLATOR AND BALANCED MODULATOR SECTION. (See figure 4-14.) - Audio amplifiers V122A and V123A operate as either lower or upper sideband amplifiers, respectively, as explained in the preceding paragraph. However, T104 and CR115 will be referred to as the LSB 250-kc balanced modulator, and T103 and CR116 as the USB 250-kc balanced modulator. This sideband relationship is always true when the OUTPUT TUNING knob control is placed in 2-4 mc. (See figure 4-13.)

T104 couples incoming audio (from S106D amplified by V122A) to CR115, a bridge-type diode modulator. Z103 and Z108 are in a very stable amplitude regulated 250-kc crystal oscillator circuit, the output of which is coupled to the center arms of R265 and R266. These resistors are used to equalize the injection voltage to CR115 and CR116. When this is achieved, the tuned outputs of T125 and T126 will consist of 250 kc-audio (LSB) and 250 kc+audio (USB), respectively. The 250-kc carrier is almost completely balanced out by the proper adjustment of R265 and R266. LSB filter T125 is designed to pass only frequencies from approximately 250 kc to 242.5 kc; thus, only the sideband below the suppressed 250-kc carrier is passed on to Z110. USB filter T126 performs in the same manner as T125, differing in that it passes frequencies between approximately 250 kc and 257.5 kc, or the upper sideband, on to Z111.

The 250-kc notch filter Z112 has considerable loss in the immediate region of 250 kc. This means that as the upper or lower or upper and lower sidebands pass through the filter, the 250-kc carrier residue from the 250-kc balanced modulators will be greatly attenuated. On the other hand, the 250-kc modulated audio signals will experience relatively small loss. The 250-kc amplifier V126 amplifies these signals; its output is fed to the following 2- to 4-mc MF section via modulator IF transformer T127.

Front panel control R263 (CARRIER INSERT), designated 104 on figure 3-1, selects any degree of carrier insertion from -55 db to full output of the SBE. It does so by taking the required amount of 250-kc output from 250-kc oscillator V105.

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

(1) CARRIER INSERT R263 which controls level of carrier insertion.

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

(1) SLM OUTPUT jacks J111 and J112

(2) 250-kc modulator balance potentiometers R265 and R266.

d. 2- TO 4-MC MF SECTION. (See figure 4-15.) - Sideband energy centering around 250 kc is coupled by T127 to pins 2 and 7 of push-pull amplifier V113. A 2- to 4-mc injection is obtained from V115 which, in turn, is fed by the crystal oscillator section or the VMO input from J104. This injection frequency is 250 kc higher than the lower sideband output of the medium frequency modulator. The mid-frequency dial (the single-scale dial of control designated 87 on figure 3-1) is calibrated to read directly in terms of the MF injection frequency; however, its associated circuit is actually tuned 250 kc below it by variable capacitors C167A and C167B (knob control 99 on figure 3-1). The grids of tubes V113A and V113B are supplied with 250-kc sideband voltages as well as MF injection voltages, and the lower sideband is passed by the tuned circuits of the modulator. The balancing out of the 2- to 4-mc injection supply is accomplished by MF balance control R130 which varies the gain of the A and B sections of V113; thus, the 2- to 4-mc injection cancels in the primary of T109. The medium-frequency modulator serves as the final modulation stage when output frequencies of less than 4.25 mc are required from the SBE. For output frequencies greater than 4.25 mc, its output is further raised in frequency by the high-frequency modulator.

Selection of the proper crystal for use with MF XTAL SW S107 (control designated 86 in figure 3-1) is as follows: Suppose the desired RF output of the SBE is 10.235 mc. BAND MCS switch S108 (control designated 105 in figure 3-1; a part of the 2- to 32-mc HF section, refer to paragraph 4-4e) shows a multiplying factor of 6 on its dial for an 8.25- to 10.25-mc range. The crystal to be selected by the position of MF XTAL SW S107 should have a frequency of 2 x 6 + 0.250 - 10.235 mc or 2.015 mc. The crystal sockets associated with MF XTAL SW S107 may hold up to 10 crystals, each corresponding to a particular RF output of the SBE.

When a VMO is used to supply 2- to 4-mc MF injection, the input is via VMO IN jack J104. In this case, MF XTAL SW S107 is placed in its VMO position.

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

(1) MF XTAL SW S107. Switch control designated 86 on figure 3-1. Selects either external oscillator (VMO) or proper crystal for mid-frequency oscillator.

(2) MF TUNING C167A and C167B. Variable capacitor control designated 99 on figure 3-1. Tunes MF (2- to 4-mc) modulator and is associated with the single-scale dial of control designated 87 in figure 3-1.

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

(1) 2- to 4-mc modulator balance potentiometer R130

(2) MF OUT jack J106

(3) VMO IN jack J104

e. 2- TO 32-MC HF SECTION. (See figure 4-16.) The function of high-frequency modulator Z107 is to provide final output frequencies from 4.25 mc to 32.25 mc by modulating the output of the medium-frequency amplifier with an injection frequency from the high-frequency oscillator. The medium-frequency amplifier output is received at terminal 2 of Z107, and the HFO output at jack J110. Final output frequencies between 2 and 32 mc are fed directly into the control grid of the first RF amplifier, V118. The high-frequency dial (the multi-scale dial of control designated 87 on figure 3-1) is calibrated to read directly in turns of the frequency to which RF amplifiers V118, V119, and V120 are tuned.

Injection frequencies from 8 to 34 mc in 2-mc steps are supplied by crystal-controlled high-frequency oscillator V117. The proper injection is selected by the use of BAND MCS switch S108A and S108B, a front panel control designated 105 on figure 3-1. The injection is always between 1.75 mc and 3.75 mc higher than the output of Z107 because one input of Z107 is supplied by the medium-frequency amplifier (whose output is the 0.25-mc lower sideband from its crystal; that is, 1.75 to 3.75 mc) and the other input is supplied by the HFO injection. The BAND MCS switch is used in the 0 position when SBE outputs below 4.25 mc are required. In this case, an 18-mc injection is applied to Z107 to prevent intermodulation distortion by keeping diodes CR107 and CR108 properly biased. The 18-mc injection and the sidebands produced in Z107 are not passed by the RF amplifiers which are tuned to 4.25 mc or less (approximately 14 mc away) in this instance.

The output of Z107 is also coupled to V118, the first RF amplifier.

The RF output taken from OUTPUT R205, a front panel control designated 97 on figure 3-1, is now at the output frequency of the SBE. The purpose of V118, V119, and V120 is to build up the generated signal to the rated 1-watt PEP output of the SBE. These stages are gang-tuned by C181A, C181B, C181C, and bandswitched by S106A, S106B, and S106C to cover the frequency range of 2 to 32 mc continuously. A fourth section of this switch, S106D, is used for inverting upper and lower sideband inputs when the SBE is operating in the 3.75- to 4.25-mc range as stated in paragraph 4-4b. A small portion of the output is applied to R210 and R211 where, through C176 and CR114, a small DC voltage is produced which is proportional to the output envelope peaks of the SBE. This voltage is indicated by the V112/M101 metering circuit. An output indication of 100 equals 1-watt PEP when METER SW S109 switch is in RF OUT position.

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

(1) BAND MCS S108A and S108B. Switch control designated 105 on figure 3-1. Determines injection frequency range of high-frequency modulator in 2-mc increments. Associated dial indicates frequency.

(2) OUTPUT TUNING disc C181A, C181B, and C181C. Variable capacitor control designated 101 on figure 3-1. Ganged variable capacitors tune output circuits that are part of the 2- to 32-mc HF section. The associated knob selects the output frequency band.

(3) OUTPUT TUNING knob S106A, S106B, S106C, and S106D. Switch control designated 102 on figure 3-1. Selects output frequency band. The associated disc tunes the RF output circuits and is associated with the multi-scale dial of control designated 87 in figure 3-1.

(4) OUTPUT R205. Potentiometer control designated 97 on figure 3-1. Adjusts SBE output power level.

The chassis-mounted control that applies to this section is 2- to 32-mc modulator balance potentiometer R150.

f. SQUELCH AND VOX SECTION. (See figure 4-17.) - The VOX circuit is operated by a portion of the 250-kc USB and/or LSB energizes taken from 250-kc amplifier V126 and coupled to pin 2 (control grid) of V110 SQUELCH and VOX amplifier. The gain of this amplifier is controlled by VOX GAIN R140. The output is coupled to pin 2 (plate) of V111 squelch and VOX rectifier. DC output is developed across R145/C282 and amplified by relay amplifier V127 which operates K101, the SBE actuating relay. The threshold of the signal level required to operate this circuit is controlled by VOX GAIN R140.

Some negative DC is also applied to the control grid of V127 by the squelch section of V111 rectifier, pins 1 through 7. The actuating signal for this part of the circuit is supplied by the squelch amplifier section of V110, pins 1, 8, and 9, the input for which is terminal 13, E101, through SQUELCH GAIN control R129.

The action of the squelch circuit is such that audio, originating from a receiver audio output terminal, causes the opposite action of the VOX circuit. The purpose of the squelch circuit is to prevent the audio from any nearby receiver from actuating the SBE. When VOX GAIN and SQUELCH GAIN are properly set, only the operator talking directly into the mike will actuate the SBE.

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

(1) EXCITER ON-STANDBY S105. Toggle-switch control designated 89 on figure 3-1. STANDBY allows VOX or push-to-talk input to activate the SBE and the GPT-10K which the SBE serves. ON activates SBE without need for VOX or push-to-talk input and without operating GPT-10K.

(2) XMTR ON-OFF S104. Toggle-switch control designated 88 on figure 3-1. ON activates GPT-10K. Eliminates need for VOX or push-to-talk, through S105 (above), by completing the ground circuit of the XMTR final plate relay. OFF GPT-10K operated by VOX or push-to-talk circuit when EXCITER switch is in STANDBY position.

(3) VOX GAIN R140. Potentiometer control designated 103 on figure 3-1. Voice-operated GPT-10K circuit gain control.

(4) SQUELCH GAIN R129. Potentiometer control designated 100 on figure 3-1. Used in conjunction with VOX GAIN. (Refer to paragraphs 3-4h and 3-4i of operator's section.)

(5) EXCITER I101. Indicator designated 92 on figure 3-1. Lights during operation when EXCITER switch is on or EXCITER is activated by VOX or push-to-talk.

g. M101 METER SECTION. (See figure 4-18.) - M101 is a peak reading VTVM and indicates audio level in USB and LSB channel, 2- to 4-mc MF level for tuning purposes, and 2- to 32-mc HF level, namely, SBE RF output.

With METER SW S109 in its CAL position, CAL potentiometer R135 zeroes the reading on meter M101.

With METER SW S109 in its LSB or USB positions, the reading on meter M101 reflects the output level of LSB or USB meter amplifiers V123B or V122B, respectively.

With METER SW S109 in its MF position, the reading on meter M101 reflects the output level of 2- to 4-mc MF amplifier V114.

With METER SW S109 in its RF position, the reading on meter M101 reflects the level at SBE's RF OUT jack J103.

h. POWER SUPPLY SECTION. (See figure 4-19.) - The power supply is a conventional electronic type supplying 6.3-volt AC filament supply and the following DC plate supplies: +125 volts unregulated, +180 volts unregulated, +150 volts regulated, and +125 volts unregulated.

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

(1) EXCITER I101. Indicator designated 92 on figure 3-1. Lights during operation. Indicates MAIN fuse is intact and power is applied.

(2) OVEN I102. Indicator designated 93 on figure 3-1. Lights during operation when thermostats demand oven heating (automatic).

(3) FUSES. B+, main, and oven.

4-5. TRANSMITTING MODE SELECTOR MODEL SBE-2 AND ITS POWER SUPPLY.

a. INTRODUCTION. (See figure 4-20.) - As shown in figure 4-20, the SBE-2 together with its power supply consists of the following seven principal sections:

(1) Audio input section

(2) 17- and 287-kc oscillators and balanced modulators section

(3) 2- to 4-mc MF section

(4) 2- to 32-mc section

(5) SQUELCH and VOX section

(6) M101 meter section

(7) Power supply section

While closely alike, the SBE-2 and SBE-3 have important differences aside from numerous circuit components. The principal differences are as follows:

SBE-2 (vs)	SBE-3
17-kc oscillator and balanced modulator plus 287-kc oscillator and balanced modulator	250-kc oscillator and balanced modulator
±3-kc sideband band width.	±7.5-kc sideband band width.
Output, 3-watt PEP	Output, 1-watt PEP

The audio input section is provided with two LINE channels and one MICROPHONE channel which are equipped with functional switches S101, S102 and S106D to route incoming intelligence to audio amplifiers V103 and/or V102. For example, the microphone input may be routed to V103, V102, or V103 and V102; the same is true of signals received from LINE channel 1 or 2. If desired, signals received from LINE channel 1 and from LINE channel 2 may be simultaneously and independently routed to V103 and V102, respectively. Likewise, microphone and LINE channel 1 signals may be simultaneously and independently routed to V103 and V102, respectively. The functional switches provide flexibility in the routing of audio signals singly or independently in pairs to V103 and V102. The audio input section is also provided with two meter amplifiers, V107 and V107B, and associated meter rectifiers CR104 and CR105. These circuits indicate the power level of incoming audio signals, which are important factors from the standpoint of avoiding the overloading of the following 17-kc balanced modulator section.

The 17-kc oscillator and balanced modulator section modulates the audio outputs from the audio input section, placing the intelligence in the 17-kc upper and/ or lower sideband frequency regions (17 ±3 kc). The output of LSB filter Z101 consists of a small amount of 17-kc carrier and signals in the 17 -3 kc frequency range; the output of USB filter Z102 consists of a small amount of 17-kc carrier and signals in the 17 +3 kc frequency range. The 17-kc notch filter Z106 removes the 17-kc carrier in these two sidebands. The output of 17-kc amplifier (V108, 12AT7) contains the LSB and USB signals with as much 17-kc carrier reinsertion as desired by the setting of R106, a front panel knob potentiometer control. The signal bandwidth at this point is 6 kc with LSB and USB operation, or 3 kc with either LSB or USB operation.

The 287-kc oscillator and balanced modulator section modulates the 17-kc sidebands (with or without carrier reinsertion), placing the intelligence in the 287-kc lower sideband in the frequency range of 270 ±3 kc. The principal components in this section comprise bridge-type modulator CR103 with input and output transformers T106 and T108, and, of course, the 17-kc sideband input and 287-kc modulator oscillator. The 270-kc output is amplified by a double-tuned (input, output) amplifier (V109B, 1/2 12AT7), and the amplifier feeds the following 2- to 4-mc section.

The 2- to 4-mc MF section provides the third stage of modulation. In this stage, the incoming 270-kc sidebands from 1/2 12AT7 amplifier V109B are heterodyned into the 2- to 4-mc frequency range. Crystals in the 2- to 4-mc range associated with MF XTAL SW S107 may be used in the modulation process, or an external VMO may be used. The arrangement of V113, with input and output transformers T107 and T109, respectively, comprises a balanced modulator in which the 270-kc sidebands from V109B are mixed with the MF output of crystal oscillator V115 (with its crystal in S107 or with an external VMO).

The 2- to 32-mc HF section provides the third and final stage of modulation. In this stage, the incoming sidebands in the 2- to 4-mc range are heterodyned into the 2- to 32-mc frequency range. The arrangement of Z107, with input and output transformers T110 and T111 (part of Z107), respectively, comprises a balanced modulator in which the incoming sidebands in the 2- to 4-mc range from V114 are mixed with the HF output of the crystal oscillator consisting of V117 (with its crystal in S108) and amplifier V116. The 2- to 32-mc HF section also contains three stages of RF amplification V118, V119, and V120, together with RF amplifier tuning circuits, comprising components mounted on BANDSWITCH wafers S106A, S106B, and S106C.

The end result of the SQUELCH/VOX section, when not disabled by setting the XMTR ON-OFF and the EXCITER ON-STANDBY toggle switches OFF and STANDBY positions, respectively, is as follows: Operation of plate relay K101 places a local ground in the SBE unit on the transmitters ON-OFF remote control circuit. In the case of the GPT-10K, there is no remote control ON-OFF circuit. In the case of other types of transmitters, however, when used with the SBE, provision is made for remote transmitter operation by the SBE unit.

Again, operation of plate relay K101 places plate voltage on the tubes comprising the SBE's HF section. Whether or not plate relay K101 operates depends as before on the audio signal level at any instant (a function of VOX GAIN potentiometer setting) and the sensitivity of the squelch circuit during idle periods of speech (a function of SQUELCH GAIN potentiometer setting). GPT-10K's are usually operated with the XMTR ON-OFF and the EXCITER ON-STANDBY toggle switches both in ON position; in this case, the SQUELCH/VOX section is disabled (insofar as SBE and GPT-10K control by this section is concerned).

The M101 meter section provides means of indicating audio input power levels, the 2- to 4-mc MF power level, and the 2- to 32-mc HF power level. The five-position METER SW provides the following services.

(1) USB meter position indicates only the USB channel audio level.

(2) LSB meter position indicates only the LSB channel audio level.

(3) MF meter position indicates sum total of both sidebands and carrier when used. This meter position is used only to indicate proper tuning of the MF dial and, therefore, its absolute level has no real meaning.

(4) RF meter position indicates the sum total of both sidebands and carrier, when used.

(5) CAL position zeroes the meter.

The power supply section provides 6.3-volt filament, +250-volt DC plate, +180-volt DC plate, +125-volt DC plate, and +150-volt DC regulated phase voltages.

HF frequency adjustments, tuning, and amplification are accomplished in the RF amplifier stages. The maximum output of the SBE is approximately 3 watts, (PEP), which is considerably more than ample to drive a single sideband GPT-10K.

b. AUDIO INPUT SECTION. (See figure 4-21.) - Connections for two audio input channels (600-ohm balanced or unbalanced) are provided on terminal board E101. External LINE channel 1 connects to terminals 6, 7, and 8; external LINE channel 2 connects to terminals 10, 11, and 12. Terminals 7 and 11 may be grounded for systems balanced to ground. Terminals 8 and 12 may be grounded when used for systems unbalanced to ground. Approximately -20 db of 1000 cps is required at each channel input for full output of the SBE. When a high impedance mike is plugged into front panel MIKE jack J101, a pre-amp stage (V101) raises the signal level to the level required for direct channel input. The outputs of V101, T101, and T102 are fed to S101 upper (USB) and S102 lower (LSB) sideband selector switches. The audio selected by these switches (CH1, CH2, or MIKE) then goes to R168 (USB GAIN) and R169 (LSB GAIN) controls. R168 and R169 center arms are connected to S106D for inverting upper and lower sideband inputs when the SBE is operating in the 3.73- to 4.27-mc range. Inversion takes place at this point to allow for a modulation inversion which occurs in a later circuit (Z107). (Similar to SBE-3 case illustrated in figure 4-13.) The audio taken from S106D is amplified by audio amplifiers V103 and V102. Audio is also taken from the center arms of R168 (USB GAIN) and R169 (LSB GAIN) to feed meter amplifiers V107A and V107B. Outputs of these amplifiers are connected to CR104 and CR105, respectively, where incoming peaks are rectified and coupled to V112/M101, a bridge-type VTVM. This circuit is a peak-reading device rather than an RMS indicating meter circuit. For example, it would read 0.7 mv on a continuous sine wave of 1-mv peak or on a single short pulse of 1-mv peak.

Other inputs on terminal board E101 include the following:

(1) Terminal 1 and ground are intended for push-to-talk keying line when the VOX and SQUELCH circuits are not in use.

(2) Terminal 2 (ground) and terminal 3 (key) are CW keying terminals and are normally connected by a jumper when CW is not being used.

(3) Terminal 4 is grounded by K101 (SBE control relay) and can be used to energize an associated RF amplifier/transmitter.

(4) Terminal 13 is in the SQUELCH input which is normally obtained from the 600-ohm output of a receiver at the operating position.

(5) Terminals 5, 9, and 14 grounded.

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

(1) POWER ON-OFF S103. Toggle-switch control designated 90 on figure 3-1. ON applies line voltage to power supply. OFF turns off entire SBE.

(2) LSB S102. Switch control designated 107 on figure 3-1. Selects audio input source for lower sideband channel.

(3) LSB GAIN R169. Potentiometer control designated 106 on figure 3-1. Adjusts level of LSB audio input.

(4) USB S101. Switch control designated 95 on figure 3-1. Selects audio input source for upper sideband channel.

(5) USB GAIN R168. Potentiometer control designated 96 on figure 3-1. Adjusts level of USB audio input.

(6) OUTPUT TUNING KNOB R106. Part of switch control designated 102 on figure 3-1. Selects output frequency band. The associated outer disc designated 101 tunes the RF output circuits that are a part of the 2- to 32-mc HF section.

(7) MIKE J101. Connector control designated 98 on figure 3-1. Input jack to audio preamp for all high impedance microphones.

c. 17-KC AND 287-KC OSCILLATORS AND BALANCED MODULATORS SECTION. (See figure 4-22.) - Audio amplifiers V103 and V102 operate as either lower or upper sideband amplifiers, respectively, as explained in the preceding paragraph. However, T104 and CR101 will be referred to as the LSB 17-kc balanced modulator, and T103 and CR102 as the USB 17-kc balanced modulator. This sideband relationship is always true when the OUTPUT TUNING knob control is placed in position 1. (See figure 4-13.)

T104 couples incoming audio (from S106D amplified by V103) to CR101, a bridge-type diode modulator. Z104 and Z105 are in a very stable amplitude regulated 17-kc crystal oscillator circuit, the output of which is coupled to the center arms of R110 and R112. These resistors are used to equalize the injection voltage to CR101 and CR102. When this is achieved, the tuned outputs of Z101 and Z102 will consist of 17 kc-audio (LSB) and 17 kc+audio (USB), respectively. The 17-kc carrier is almost completely balanced out by the proper adjustment of R110 and R112. LSB filter Z101 is designed to pass only frequencies from approximately 17 kc to 14 kc; thus, only the sideband below the suppressed 17-kc carrier is passed on to Z106. USB filter Z102 performs in the same manner as Z101, differing in that it passes frequencies between approximately 17 kc and 20 kc, or the upper sideband, on to Z106.

The 17-kc notch filter Z106 has considerable loss in the immediate region of 17 kc. This means that as the upper or lower or upper and lower sidebands pass through the filter, the 17-kc carrier residual from the 17-kc balanced modulators will be greatly attenuated. On the other hand, the 17-kc modulated audio signals will experience relatively small loss. The 17-kc amplifier V108 amplifies these signals; its output is fed to the following 287-mc section via modulator IF transformer T127.

Front panel control R106 (CARRIER INSERT), designated 104 on figure 3-1, selects any degree of carrier insertion from -55 db to full output of the SBE. It does so by taking the required amount of 17-kc output from 17-kc oscillator Z105.

T106 couples the 17-kc modulated audio signals to a bridge-type diode modulator which also receives 287-kc voltages from 287-kc oscillator Z103. The latter voltages are injected into the modulator at LF BAL resistor R113. The double-tuned 270-kc amplifier (V109B, 1/2 12AT7) passes the LOWER sideband (287 kc - 17 kc ± audio or 270 ± kc) frequencies. These are fed to the following 2- to 4-mc MF modulator section.

A function of a front panel control that applies to this section is CARRIER INSERT R106 which controls level of carrier insertion. Chassis-mounted controls that apply to this section are as follows:

(1) SLM OUTPUT jacks J111 and J112

(2) Modulator balance potentiometers R110, R112, and R113.

d. 2- TO 4-MC MF SECTION. (See figure 4-23.) - Sideband energy centering around 270 kc is coupled by T107 to pins 2 and 7 of push-pull amplifier V113. A 2- to 4-mc injection is obtained from V115 which, in turn, is fed by the crystal oscillator section or the VMO input from J104. This injection frequency is 270 kc higher than the lower sideband output of the medium-frequency modulator. The mid-frequency dial (the single-scale dial of control designated 87 on figure 3-1) is calibrated to read directly in terms of the MF injection frequency: however, its associated circuit is actually tuned 270 kc below it by variable capacitors C167A and C167B (knob control 99 on figure 3-1). The grids of tubes V113A and V113B are supplied with 270-kc sideband voltages as well as MF injection voltages; and the lower sideband is passed by the tuned circuits of the modulator. The balancing out of the 2- to 4-mc injection supply is accomplished by MF balance control R130 which varies the gain of the A and B sections of V113; thus, the 2- to 4-mc injection cancels in the primary of T109. The medium-frequency modulator serves as the final modulation stage when output frequencies of less than 4.27 mc are required from the SBE. For output frequencies greater than 4.27 mc, its output is further raised in frequency by the high-frequency modulator.

Selection of the proper crystal for use with MF XTAL SW S107 (control designated 86 in figure 3-1) is as follows: Suppose the desired RF output of the SBE is 10.235 mc. BAND MCS switch S108 (control designated 105 in figure 3-1; a part of the 2- to 32-mc HF section, refer to paragraph 4-5e) shows a multiplying factor of 6 on its dial for an 8.27- to 10.27-mc range. The crystal to be selected by the position of MF XTAL SW S107 should have a frequency of 2 x 6 + 0.270 - 10.235 mc or 2.035 mc. The crystal sockets associated with MF XTAL SW S107 may hold up to 10 crystals, each corresponding to a particular RF output of the SBE.

When a VMO is used to supply 2- to 4-mc MF injection, the input is via VMO IN jack J104. In this case, MF XTAL SW S107 is placed in its VMO position.

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

(1) MF XTAL SW S107. Switch control designated 86 on figure 3-1. Selects either external oscillator (VMO) or proper crystal for mid-frequency oscillator.

(2) MF TUNING C167A, and C167B. Variable capacitor control designated 99 on figure 3-1. Tunes MF (2- to 4-mc) modulator and is associated with the single-scale dial of control designated 87 in figure 3-1.

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

(1) 2- to 4-mc modulator balance potentiometer R130

(2) MF OUT jack J106

(3) VMO IN jack J104

e. 2- TO 32-MC HF SECTION. (See figure 4-24.) - The function of the high-frequency modulator Z107 is to provide final output frequencies from 4.27 mc to 32.27 mc by modulating the output of the medium-frequency amplifier with an injection frequency from the high-frequency oscillator. The medium-frequency amplifier output is received at the junction of CR107 and CR108 in Z107 and the HFO output at jack J110. Final output frequencies between 2 and 32 mc are fed directly into the control grid of the first RF amplifier, V118. The high-frequency dial (the multi-scale dial of control designated 87 on figure 3-1) is calibrated to read directly in terms of the frequency to which RF amplifiers V118, V119, and V120 are tuned.

Injection frequencies from 8 mc to 34 mc in 2-mc steps are supplied by crystal-controlled high-frequency oscillator V117. The proper injection is selected by the use of BAND MCS switch S108A and S108B, a front panel control designated 105 on figure 3-1. The injection is always between 1.73 mc and 3.73 mc higher than the output of Z107 because one input of Z107 is supplied by the medium-frequency amplifier (whose output is the 0.27-mc lower sideband from its crystal; that is, 1.73 to 3.73 mc) and the other input is supplied by the HFO injection. The BAND MCS switch is used in the 0 position when SBE outputs below 4.27 mc are required. In this case, an 18-mc injection is applied to Z107 to prevent intermodulation distortion by keeping diodes CR107 and CR108 properly biased. The 18-mc injection and the sidebands produced in Z107 are not passed by the RF amplifiers which are tuned to 4.27 mc or less (approximately 14 mc away) in this instance.

The output of Z107 is also coupled to V118, the first RF amplifier.

The RF output taken from OUTPUT R205, a front panel control designated 97 on figure 3-1, is now at the output frequency of the SBE. The purpose of V118, V119, and V120 is to build up the generated signal to the rated 3-watt PEP output of the SBE. These stages are gang-tuned by C181A, C181B, C181C, and band-switched by S106A, S106B, and S106C to cover the frequency range of 2 to 32 mc continuously. A fourth section of this switch, S106D, is used for inverting upper and lower sideband inputs when the SBE is operating in the 3.73- to 4.27-mc range as stated in paragraph 4-5b. A small portion of the output is applied to R210 and R211 where, through C176 and CR114, a small DC voltage is produced which is proportional to the output envelope peaks of the SBE. This voltage is indicated by the V112/M101 metering circuit. An output indication of 100 equals 3-watt PEP when METER SW S109 switch is in RF OUT position.

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

(1) BAND MCS S108A and S108B. Switch control designated 105 on figure 3-1. Determines injection frequency range of high-frequency modulator in 2-mc increments. Associated dial indicates frequency.

(2) OUTPUT TUNING disc C181A, C181B, and C181C. Variable capacitor control designated 101 on figure 3-1. Ganged variable capacitors tune RF output circuits that are a part of the 2- to 32-mc HF section. The associated knob selects the output frequency band.

(3) OUTPUT-TUNING knob S106A, S106B, S106C, and S106D. Switch control designated 102 on figure 3-1. Selects output frequency band. The associated disc tunes the RF output circuits and is associated with the multi-scale dial of control designated 87 on figure 3-1.

(4) OUTPUT R205. Potentiometer control designated 97 on figure 3-1. Adjusts SBE output power level.

The chassis-mounted control that applies to this section is 2 to 32 mc modulator balance potentiometer R750.

f. SQUELCH AND VOX SECTION. (See figure 4-25.) - The VOX circuit is operated by a portion of the 17-kc USB and/or LSB energies taken from 17-kc amplifier V108 and coupled to pin 2 (control grid) of V110 SQUELCH and VOX amplifier. The gain of this amplifier is controlled by VOX GAIN R140. The output is coupled to pin 2 (plate) of V111 squelch and VOX rectifier. DC output is developed across R145/C282 and amplified by relay amplifier V109 which operates K101, the SBE actuating relay. The threshold of the signal level required to operate this circuit is controlled by VOX GAIN R140.

Some negative DC is also applied to the control grid of V109 by the squelch section of V111 rectifier, pins 1 through 7. The actuating signal for this part of the circuit is supplied by the squelch amplifier section of V110, pins 1, 8, and 9, the input for which is terminal 13, E101, through SQUELCH GAIN control R129. The section of the squelch circuit is such that audio, originating from a receiver audio output terminal, causes the opposite action of the VOX circuit. The purpose of the squelch circuit is to prevent the audio from any nearby receiver from actuating the SBE. When VOX GAIN and SQUELCH GAIN are properly set, only the operator talking directly into the mike will actuate the SBE.

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

(1) EXCITER ON-STANDBY S105. Toggle-switch control designated 89 on figure 3-1. STANDBY allows VOX or push-to-talk input to activate the SBE and the GPT-10K which the SBE serves. ON activates SBE without need for VOX or push-to-talk input and without operating GPT-10K.

(2) XMTR ON-OFF S104. Toggle-switch control designated 88 on figure 3-1. ON activates GPT-10K. Eliminates need for VOX or push-to-talk, through S105 (above), by completing the ground circuit of the XMTR final plate relay. OFF GPT-10K operated by VOX or push-to-talk circuit when EXCITER switch is in STANDBY position.

(3) VOX GAIN R140. Potentiometer control designated 103 on figure 3-1. Voice-operated GPT-10K circuit gain control.

(4) SQUELCH GAIN R129. Potentiometer control designated 100 on figure 3-1. Used in conjunction with VOX GAIN. (Refer to paragraphs 3-4h and 3-4i of operator's section.)

(5) EXCITER I101. Indicator designated 92 on figure 3-1. Lights during operation when EXCITER switch is on or EXCITER is activated by VOX or push-to-talk.

g. M101 METER SECTION. (See figure 4-26.) - M101 is a peak reading VTVM and indicates audio level in USB and LSB channel, 2- to 4-mc MF level for tuning purposes, and 2- to 32-mc HF level, namely, SBE RF output.

With METER SW S109 in its CAL position, CAL potentiometer R135 zeroes the reading on meter M101.

With METER SW S109 in its LSB or USB positions, the reading on meter M101 reflects the output level of LSB or USB meter amplifiers V123B or V122B, respectively.

With METER SW S109 in its MF position, the reading on meter M101 reflects the output level of 2- to 4-mc MF amplifier V114.

With METER SW S109 in its RF position, the reading on meter M101 reflects the level at SBE's RF OUT jack J103.

h. POWER SUPPLY SECTION. (See figure 4-27.) - The power supply is a conventional electronic type supplying 6.3-volt AC filament supply and the following DC plate supplies: +125 volts unregulated, +180 volts unregulated, +150 volts regulated and +125 volts unregulated.

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

(1) EXCITER I101. Indicator designated 92 on figure 3-1. Lights during operation. Indicates MAIN fuse is intact and power is applied.

(2) OVEN I102. Indicator designated 93 on figure 3-1. Lights during operation when thermostats demand oven heating (automatic).

(3) FUSES. B+, main, and oven.

4-6. MONITOR CONTROL PANEL MODELS MCP-1 AND MCP-2. (See figure 4-28.)

a. SWITCH S300 - CHANNEL 2. - Depending upon the position of S300, incoming TTG audio tone signals or audio signals on telephone/telegraph line 2 reach SBE channel 2.

b. SWITCH S301 - CHANNEL 1. - Depending upon the position of S301, incoming TTG audio tone signals or audio signals on telephone/telegraph line 1 reach SBE channel 1.

c. SWITCH S302 - ANALYZER MONITOR. - FSA is wired for four RF signal sources, namely, TG, output of SBE, output of IPA (DRIVER), and output of PA.

d. SWITCH S303 - VOX RF OUTPUT. - VOX's output may be fed to four inputs, namely, external injection jack J15 of XFK, VFO INPUT jack J102 of FSA, VMO in jack J104 of SBE, and EXTERNAL VOX OUTPUT jack J3005 located on the center shield panel assembly which is mounted on the auxiliary frame chassis. For XFK and SBE service, the HFO output of VOX is restricted to the 2- to 4-mc band; for FSA and external RF supply service, the HFO output of VOX may be anywhere within the 2- to 32-mc band.

e. SWITCH S304 - SBE VMO INPUT. - The SBE is wired for three external 2- to 4-mc signal sources, namely, VOX, XFK, and a VMO connected to EXTERNAL VMO jack J3004 located on the center shield panel assembly which is mounted on the auxiliary frame chassis.

f. SWTICH S305 - MODE. - MCP-2 is like MCP-1 except for the addition of the MODE switch. As shown by the wiring diagram, figure 2-15, signals of various types are routed via the MODE switch as follows:

(1) SSB signals are directed to the SBE.

(2) CW signals are directed either to the SBE or XFK.

(3) RTTY signals are directed to the XFK.

(4) FAX signals are directed to the XFK.

In cases (2) and (3), the telegraph signals are routed through an isolation keyer interposed between the CW and RTTY keying equipments (refer to paragraph 4-10).

4-7. VARIABLE FREQUENCY OSCILLATOR MODEL VOX-2.

a. INTRODUCTION. (See figure 4-29.) - As shown in figure 4-29, 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 190 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; 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 4-30.) 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.

b. VMO SECTION. (See figure 4-31.) - 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 C311 (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 4-30 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 2-9, Volume II of the manual, shows the 115-volt and 230-volt circuits for controlling the VMO's oven temperature.

BAND-MCS Selector Switch (Figure 3-1, designation 131)	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

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

(1) MASTER OSCILLATOR FREQUENCY knob C301 and C302. Variable capacitor control designated 126 on figure 3-1. Varies the output frequency of the master oscillator within its operating range of 2 to 4 mc. The associated dial, designated 127 on figure 3-1, indicates the oscillator's output frequency. It is important to observe the requirement that, at all times, the operating range of 2000 to 4000 kc is not exceeded. The dial can be turned beyond these limits but, if the departures are appreciable, variable capacitors C301 and C302 may not reset properly with dial indications and the oscillator may require partial disassembly in order to effect proper readjustment. Due to frequency multipliers in the VOX's RF section, the VOX's outputs are as follows:

(2) Small cover plate at left of meter C303. Screwdriver control undesignated on figure 3-1. See (3) below.

(3) CALIBRATE L301. Slug inductance control designated 125 on figure 3-1. These two controls, (2) and (3), 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.

(4) ZERO BEAT I303. Indicator designated 123 on figure 3-1. During calibration of master oscillator vs 100-kc standard oscillator, the indicator becomes unlighted when a harmonic of the 100-kc oscillator matches a harmonic of the 2- to 4-mc master oscillator.

(5) INNER OVER I301. Indicator designated 121 on figure 3-1. See (6) below.

(6) OUTER OVEN I304. Indicator designated 122 on figure 3-1. These indicators, (5) and (6), are lighted 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.

(7) MAIN POWER I302. Indicator designated 120 on figure 3-1. Indicates filaments of tubes V103, V104, and V105 contained in power supply chassis are receiving 6.3-volt filament supply.

(8) Meter M301. Meter designated 124 on the figure 3-1. In conjunction with METER selector switch designated 114 in figure 3-1 indicates output level of HFO, IFO, BFO, or VMO.

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

c. RF SECTION.

(1) HFO CHAIN. (See figure 4-32.) - The output of cathode follower V302, located in the VMO section (figure 4-31), 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,
f

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:

(a) XTAL S201. Switch control designated 129 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.

(b) XTAL FREQ C210. Variable capacitor control designated 130 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.

(c) OUTPUT R215. Potentiometer control designated 128 on figure 3-1. Controls RF output level of VOX.

(d) BAND-MCS S202. Switch control designated 131 on figure 3-1. Controls RF multiplying factor of VOX's 2- to 4-mc oscillator, namely, 1 for 2-4mc 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.

(e) TUNING C225. Switch control designated 132 on figure 3-1. Tunes HFO output circuits; should be used in conjunction with meter designated 124 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.

(2) IFO CIRCUIT. (See figure 4-33.) - 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 bandpass 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.

d. POWER SUPPLY CHASSIS.

(1) CALIBRATING CHAIN. (See figure 4-34.) - Contained within the oven enclosure of the VMO section (figure 4-31) 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 113 on figure 3-1. ZERO BEAT indicator I303 on the front panel (control designated 123 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.

(2) BFO CIRCUIT. (See figure 4-35.) - 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. 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 preceding paragraph 4-7c(1).

(3) POWER SUPPLY. (See figure 4-36.) - 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.

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

(a) POWER S101. Toggle-switch control designated 116 on figure 3-1. Turns power on the VOX.

(b) PHONES J105. Jack designated 115 on figure 3-1. Audible monitor of "zero beat" between VOX's 100-kc and master frequency oscillators.

(c) BEAT S104. Toggle-switch control designated 113 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.

(d) HFO. Toggle-switch control designated 117 on figure 3-1. Connects B+ to HFO tubes V202 through V207.

(e) IFO. Toggle-switch control designated 118 on figure 3-1. Connects B+ to IFO tube V201.

(f) BFO S106. Toggle-switch control designated 119 on figure 3-1. Connects B+ to BFO tube V105.

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

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

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

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

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

4-8. FREQUENCY SHIFT EXCITER MODEL XFK.

a. INTRODUCTION. (See figure 4-37.) - As shown in figure 4-37, the XFK is an eight-stage electronic device with two ovens; it consists of a keyer, multiplier preset, crystal oven with three crystals, RF crystal oscillator and buffer, oven with reactance tube and 200-kc oscillator, mixer, power amplifier, and power supply. In radio teletype (RATT) operation, the teletype input signal will cause keyer tube V7 to key reactance tube V2 which, in turn, shifts the frequency of 200-kc oscillator V1 between "marks" and "spaces." The 200-kc frequency shift signal is fed to a mixer along with the RF crystal oscillator's output and the resulting RF output frequency shift signal is fed to a GPT-10K which amplifies and/or modifies it for transmission over the air.

For radio teletype operation, a sequence of two frequencies is transmitted, corresponding to "mark" (closed key) and "space" (open key) conditions of the teletypewriter. The assigned frequency of the radio transmitter is the mean of the mark and space frequencies. The mark frequency is higher than the assigned frequency, and the space frequency is lower. The difference between the mark and space frequencies is termed "shift." Usually the XFK will be used to produce a total shift of 850 cycles. The mark frequency will be 425 cycles higher than the assigned frequency, and the space frequency will be 425 cycles lower than the assigned frequency.

b. KEYER TUBE V7. (See figure 4-38.) - Teletypewriter or hand keying signals enter the XFK via terminals 4 or 5, respectively. For either type of keying it is necessary that the same voltage be consistently impressed upon the reactance tube for any given shift. Since this voltage must be polar and perfectly balanced, keyer tube V7 generates the actual internal keying voltage for either type of external keying. This is accomplished in the following manner: When using teletypewriter or voltage keying, "space" voltage (either 0 or negative voltage) is applied to the grid of section 1 of V7 (pin 2). This section will then be "cutoff" due to the cathode bias applied through voltage divider R33 and R34. As a result, a high positive voltage is impressed on the grid of section 2 of V7 (pin 7) which causes the second section to draw current and to act as a low resistance across R36. R37, R37, R38, and R39, in series, act as a voltage divider from +105 to -105 volts to apply a small positive voltage to R40 and R41. When "mark" voltage (+25 to +150 volts) is applied to the grid of section 1, the tube will conduct and its plate voltage will drop. Since the grid of section 2 is tied directly to the plate of section 1, section 2 will be "cutoff." R36, R37, R38, and R39, in series, again act as a voltage divider to apply a small negative voltage to R40 and R41.

R38, a chassis-mounted screwdriver control, is an adjustment to balance the positive and negative voltage; R40, another chassis-mounted screwdriver control, regulates the amplitude of positive or negative voltage fed to the reactance tube.

When using hand or contact keying, the operation of the second section is identical, but the grid is directly controlled by grounding for the "mark" condition.

For test purposes, provision is made via TEST selector switch S3, a front panel control, to set SPACE by grounding the grid of section 1 or MARK by putting +105 volts on the same grid.

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

MODE S3, (late model). Switch control designated 160 on figure 3-1. Provides the XFK (late model) with SPACE or MARK pulses for test purposes, or with LINE teletype signals for operation. Provides for FAX or CW operation. In the early model of the XFK, this switch consisted of a front panel switch designated TEST and a rear chassis switch designated FAX-CW.

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

(1) Shift-balance screwdriver potentiometer R38

(2) Shift-amplitude screwdriver potentiometer R40

c. MULTIPLIER PRESET STAGE. (See figure 4-39.) - The multiplier preset plugs and jacks (sketch 2) provide a series of voltage dividers which may be inserted between the keyer and the reactance tube (sketch 1). There is a separate jack for each multiplication ratio commonly used between the output frequency of the XFK and the output frequency of the associated GPT-10K, namely, 1, 2, 3, 4, 6, 8, 9, and 12. Each divider consists of two resistors, one reducing the output from the keyer tube to the reactance tube by exactly the multiplication ratio, the other resistor shunting the original tap from R40 so as to maintain a constant input resistance of 10,000 ohms. For each position of the crystal selector switch there is a small cable which may be plugged into any multiplier ratio desired (sketch 3). Should it be required that two or more crystals require identical multiplication ratios, a jack is provided in parallel with each cable. If the desired shift at the output of the GPT-10K is now directly set on the dial (figure 3-1, control designated 139), the proper shift of the XFK will be set automatically. Figure 4-40 is a brief circuit analysis of the conditions of two of the cases illustrated in figure 4-39.

A function of a front panel control that applies to this section is FREQUENCY SHIFT CPS R8. (Potentiometer control designated 139 on figure 3-1.) This knob should be set for the desired shift at the output of the GPT-10K. The multiplier preset associated with potentiometer R8 reduces the potential at R8 to compensate for any frequency multiplication in the GPT-10K receiving XFK's signals. For example, assume the desired shift at the output of the GPT-10K is 850 cps and that the GPT-10K has a frequency multiplication of 3. Set control 139 to 850 and patch the XTAL 1 plug to MULT RATIO 3 jack. (See figure 4-40, sketch 3.) In this example, XTAL 1 is the selected crystal for the GPT-10K. This means control knob designated 142 on figure 3-1 should be set to XTAL 1.

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

(1) Multiplier preset cables. (See discussion earlier in this paragraph.)

(2) FAX-KEY switch S5. Toggle switch mounted on rear of chassis (early model XFK only).

d. RF CRYSTALS AND OVENS. (See figure 4-41.) - Sections 1, 2, and 3 of the XTAL selector switch (a front panel control designated 142 on figure 3-1) selects RF crystal 1, 2, 3 or an external RF injection circuit for the XFK's RF output. Sections 4 and 5 of the XTAL selector switch connect to the multiplier preset circuits.

Two separate ovens are used in the XFK. One is used for the 200-kc reactance oscillator while the other is used for the RF crystals. The ovens are very similar, the main difference being the cover of the crystal oven which is hinged and which may be opened from the front panel. Figure 4-41 shows the general features of this oven. Two cartridge type heaters are used in each oven, sunk into a well at the bottom of a thick aluminum casting. The thermostat is sunk in the same well as one of the heaters ensuring close thermal coupling. The thermostat is a bimetallic strip with high sensitivity and extremely long life. Replacement of either heaters or thermostats is a very simple operation. The thermostat is set at 70°C to allow for a 15°C rise within the equipment above a 55°C ambient. Heater operation may be observed by means of neon lamps in parallel with either set of heaters.

Functions of a front panel control that applies to this section are XTAL. Switch control designated 142 on figure 3-1. This switch selects the proper RF crystal for the GPT-10K associated with the XFK. The crystal, in turn, should be associated with the proper multiplication ratio for the GPT-10K. This ratio is set at the rear of the XFK unit as discussed in paragraph 4-8c.

A chassis-mounted control that applies to this section is EXT INPUT jack J15, a coaxial jack mounted on rear of chassis.

e. CRYSTAL OSCILLATOR AND BUFFER V6. (See figure 4-42.) - Section 1 of V6 pins 1, 2, and 3 is used as a modified Pierce crystal-controlled oscillator while section 2 (pins 6, 7, and 8) is used as a cathode follower buffer. Since the output frequency of the XFK is determined by the sum frequency of the 200-kc oscillator and the RF crystal oscillator, the crystals are controlled in an oven and the plate voltage of the crystal oscillator section is stabilized. Crystals may be easily exchanged, as the oven is easily accessible through a small door in the front panel. XTAL selector switch, designated 142 on figure 3-1, allows selection of any one of three crystals or an external signal. The crystals may be either type FT243 or the new CR-27/U, as sockets are provided for either type. The larger sockets house FT243 crystals, and the smaller sockets house CR-27/U crystals. The crystal selector switch also selects the multiplication ratio which is set at the rear of the unit as discussed in paragraph 4-8c.

f. REACTANCE TUBE V2 and 200-KC OSCILLATOR TUBE V1. (See figure 4-43.) - V1 is a push-pull modified Colpitts oscillator operating at 200 kc. The major part of its tank circuit is located within a temperature stabilized oven with a fast heating characteristic; this portion of the tank circuit is temperature compensated and utilizes only components having very uniform retrace characteristics. In addition, the plate voltage is regulated and the oscillator is compensated external to the oven for changes in ambient temperature. External to the oven are two air-spaced, ceramic-supported trimmers C7 and C8 used, respectively, as fine and coarse frequency adjustments. C7 is designated control 143 on figure 3-1; C8 is chassis-mounted (on rear) and designated COARSE FREQ ADJ.

Reactance tube V2 receives the intelligence signal at the grid of section 1 (pins 1, 2, and 3); section 2 (pins 6, 7, and 8) is an inverter. The two sections vary the reactance across the 200-kc push-pull oscillator tank and, therefore, shift the frequency of the oscillator in accordance with the incoming intelligence. The magnitude of the reactance variation, and consequently the oscillator frequency change, depends on the magnitude and polarity of the incoming signal on pin 2 of tube V2. Over a narrow frequency range (200-kc ± 500 cps), this frequency change will be linear with respect to applied voltage, positive or negative. This system provides the advantage of having the reactance tube currents contribute a negligible amount to the center frequency of the 200-kc oscillator. C2 adjusts the phase shift of section 1 so that for a given positive or negative signal voltage the amount of shift will be equal. C2 is chassis-mounted (on top) and designated C2.

A function of a front panel control that applies to this section is FREQUENCY C7. Variable capacitor control designated 143 on figure 3-1. Adjusts frequency of 200-kc oscillator.

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

(1) COARSE FREQ ADJ. C8. Mounted on rear chassis. Adjusts frequency of 200-kc oscillator.

(2) C2. Mounted on top chassis. Adjusts the phase shift of the reactance tube so that for a given positive or negative signal the amount of shift will be equal.

g. MIXER TUBES V3 AND V4. (See figure 4-44.) - V3 and V4 together operate as a balanced mixer to add the RF crystal frequency and the 200-kc shift frequency from the reactance tube oscillator. Since the crystal frequency is fed in phase to both grids of V3 and V4, it is cancelled in the secondaries of transformers T3 and T4 on bands 1 and 2, respectively. To obtain exact cancellation in the secondaries, balancing adjustments R13 and R84 which vary the relative gains of V3 and V4 are provided.

The input from the crystal oscillator is tuned by C18A and the output, or sum frequency, is tuned by C18B. Band switching is used to cover two frequency ranges, 0.8 to 2.3 mc and 2.3 to 6.7 mc for the crystal frequencies and 1 to 2.5 mc and 2.5 to 6.9 mc for the output frequencies. These are bands 1 and 2, respectively. Capacitors C19 and C30 are trimmers. These are factory set but are accessible on the top chassis for readjustment when necessary.

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

(1) BAND CHANGE S1. Switch control designated 144 on figure 3-1. Selects tuning circuits for MIXER and PA stages for band 1 (0.8 to 2.3 mc) or band 2 (2.3 to 6.7 mc).

(2) OUTPUT TUNING MC C18. Variable capacitor control designated 145 on figure 3-1. Tunes MIXER and PA stages to peak RF for any given setting of POWER potentiometer R22, designated control 141 on figure 3-1.

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

(1) Screwdriver adjusted potentiometer R13 designated MIXER BALANCE on top chassis.

(2) Screwdriver adjusted potentiometer R84 accessible from bottom chassis.

(3) Trimmer capacitors C19 and C30 accessible on top chassis.

h. POWER AMPLIFIER TUBE V5. (See figure 4-45.) - V5 is a 2E26 class B tuned radio frequency power amplifier fed from the output of mixers V3 and V4. Fixed bias is used and power output is controlled by adjusting bias voltage by means of POWER potentiometer R22, designated control 141 on figure 3-1. Plate current is metered and tuning is indicated by a 50-ma meter M1. A small portion of the output voltage is fed back to the grid in proper phase and amplitude to neutralize the amplifier should the load be removed. Its amplitude is adjusted by means of C27. The output is tuned by C18C which is ganged along with C18B and C18A.

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

(1) POWER R22. Potentiometer control designated 141 on figure 3-1. Controls the output of the XFK.

(2) BAND CHANGE S1. Potentiometer control designated 144 on figure 3-1. Selects tuning circuits for MIXER and PA stages for band 1 (0.8 to 2.3 mc) or band 2 (2.3 to 6.7 mc).

(3) OUTPUT TUNING MC C18. Variable capacitor control designated 145 on figure 3-1. Tunes MIXER and PA stages to peak RF for any given setting of POWER potentiometer R22, designated control 141 on figure 3-1.

(4) PA PLATE CURRENT M1. Meter designated 133 on figure 3-1. Indicates tuning of XFK.

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

(1) Neutralizing capacitor C27, factory set, accessible on top chassis

(2) Trimmer capacitors C43, C24, C46, and C28 accessible on top chassis

i. POWER SUPPLY. (See figure 4-46.) - The power supply is a conventional full-wave rectifier supply with capacitor input. The unregulated output voltage is approximately 300 volts. R71 and V10 (OB2) supply +105 volts regulated to the 200-kc oscillator and reactance tube, crystal oscillator, keyer and for external use with a facsimile demodulator. A -105-volt supply (regulated) is obtained through a 6 X 4 half-wave rectifier, an RC filter, and an OB2 regulator tube. This voltage is used in the keying circuit and also to provide bias for the power amplifier.

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

(1) POWER ON-OFF S8. Toggle switch control designated 138 on figure 3-1. Powers the XFK.

(2) XTAL OVEN I3. Indicator designated 137 on figure 3-1. Lights when XTAL OVEN is lighted.

(3) POWER I1. Indicator designated 136 on figure 3-1. Lights when vacuum tube filaments receive 6.3 volts.

(4) 200 KC OVEN I2. Indicator designated 135 on figure 3-1. Lights when 200-kc oven is lighted.

(5) PLATE ON-OFF S4. Toggle-switch control designated 134 on figure 3-1. Energizes and deenergizes 300-volt B+ supply.

(6) POWER R22. Potentiometer control designated 141 on figure 3-1. Controls the output of the XFK.

4-9. TWO TONE GENERATOR MODEL TTG.

a. INTRODUCTION. (See figure 4-47.) - As shown in figure 4-47, the TTG consists of three sections; audio, radio, and rectifier. The audio section is composed of a 935- and 2805-cycle oscillator; each oscillator is followed by an amplifier and bandpass filter; a selector switch determines the output frequencies and a potentiometer determines the output level. The radio section is composed of a 1999- and 2001-kc oscillator; each oscillator is followed by an amplifier; a selector switch determines the radio frequency output and a variable capacitor determines the output level. A 6 X 4 tube is used in a full-wave rectifier circuit to supply 235 volts to all tubes.

b. AUDIO SECTION. (See figure 4-48.) - Each 12AT7 tube is used in a very low distortion Wein bridge-type oscillator. A Z500 and Z501 are frequency-determining elements. R501 and R513 are regeneration controls to provide adjustment of oscillation for optimem operation. I500 and I501 are thermal resistors that limit current variations to provide stability. Each oscillator is transformer coupled to its following amplifier stage, a second 12AT7 tube, comprising a push-pull class A circuit. The output of each amplifier is matched to 600 ohms through transformers T503 and T504. Potentiometers R516 and R517 provide a means of equalizing the 935-1 and 2805-tone levels. Bandpass filters Z502 and Z503 provide large attenuation for unwanted products in the tone output. Combined tone level may be adjusted by AUDIO OUTPUT potentiometer R524, a front panel control designated 150 on figure 3-1. AUDIO TONE SELECTOR switch S502, a front panel control designated 149 on figure 3-1, determines the audio output frequencies as follows:

Position	Function	Result
1	OFF	NO tones
2	TONE 1	935-cycle tone output
3	TONE 2	2805-cycle tone output
4	TWO TONE	935- and 2805-cycle tone outputs

c. RADIO SECTION. (See figure 4-49.) - The first section of each 12AU7 tube is a crystal-controlled RF oscillator which makes use of a Pierce oscillator circuit. The output of each oscillator is capacitance coupled to the following amplifier stage. Variable capacitors C520 and C521 adjust the level of the RF signals. Each amplifier is plate tuned to obtain the desired output level. RF TONE SELECTOR switch S501, a front panel control designated 148 on figure 3-1, determines the radio output frequencies as follows:

Position	Function	Result
1	OFF	No RF output
2	TONE 1	1999-kc output
3	TONE 2	2001-kc output
4	TWO TONES	1999- and 2001-kc outputs

d. RECTIFIER SECTION. (See figure 4-50.) - The 6X4 rectifier supplies B+ 235 volts to the various tubes. POWER ON-OFF switch S500, a front panel control designated 147 on figure 3-1, turns 115-volt (or 230-volt) power on and off on the TTG. When power is on, MAIN POWER indicator control 146 is lighted.

4-10. ISOLATION KEYER MODEL AK-100.
(See figure 4-51).

The ISK is an electronic keyer that functionally replaces the well-known relay keyer in RATT lines at transmitter sites. In figure 4-51, terminal E4001, pins 1 and 2, receive teletype mark-space signals or CW dot-dash signals. The path of the signals from their source to E4001 is shown in figure 2-17 (section 2, volume II).

Assume a specific case where 60 marks and 60 spaces per second (corresponding to 60-dot cycles or 240 words per minute) are being received at E4001; the square shape voltage wave having a 50-volt amplitude. In this case, KEYING MODE switch S4001 is turned to position 1 and the 50 volts dissipates itself across voltage divider R4006 and R4004.

V5001B is an oscillator (15 to 18 kc) which is excited or cut off according to the "blocking action" of V5001A. On reception of "marks," V4001A disables V4001B, stopping oscillation; on reception of "spaces," V4001A is cut off allowing V4001B to oscillate freely.

Action at V4002A and V4002B is as follows: On reception of "marks," the negative bias at V4002A is removed and V4002B conducts; on reception of "spaces," the negative bias appears at V4002A and V4002B is cut off.

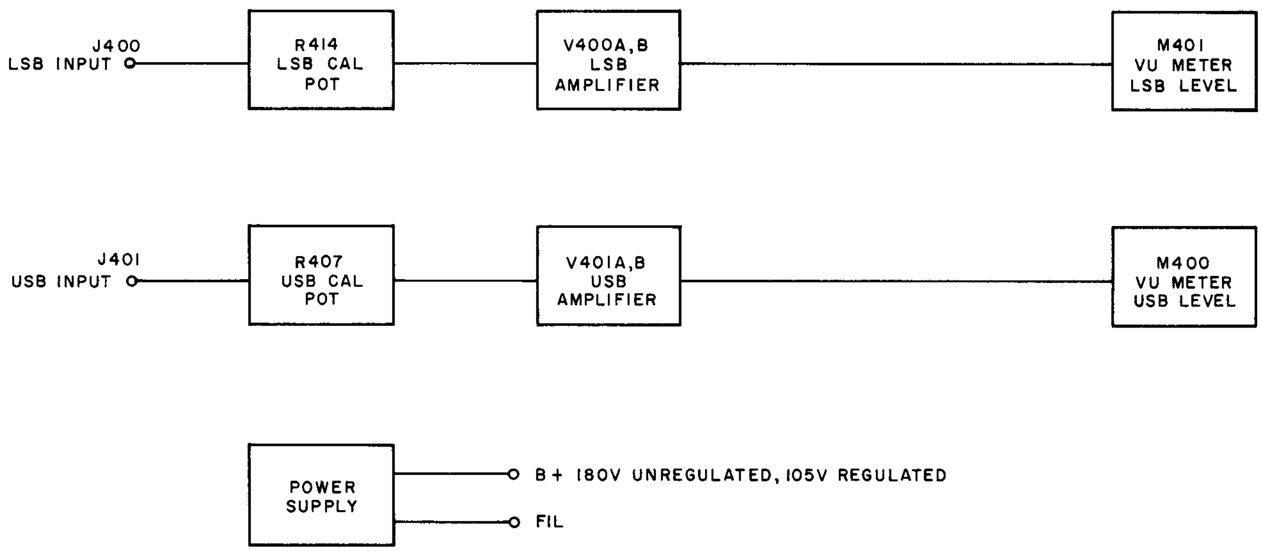
The output of the ISK on RATT operation is at E4001, pins 4 and 5. R4014 provides voltage at these pins during "marks" and no voltage during "spaces." The output of the ISK on CW operation is at E4001, pins 8 and 10. Relay K4001 connects pins 8 and 10 on "marks" and disconnects pins 8 and 10 on "spaces."

Keying mode switch S4001 enables the ISK to function properly on four types of key-line reception:

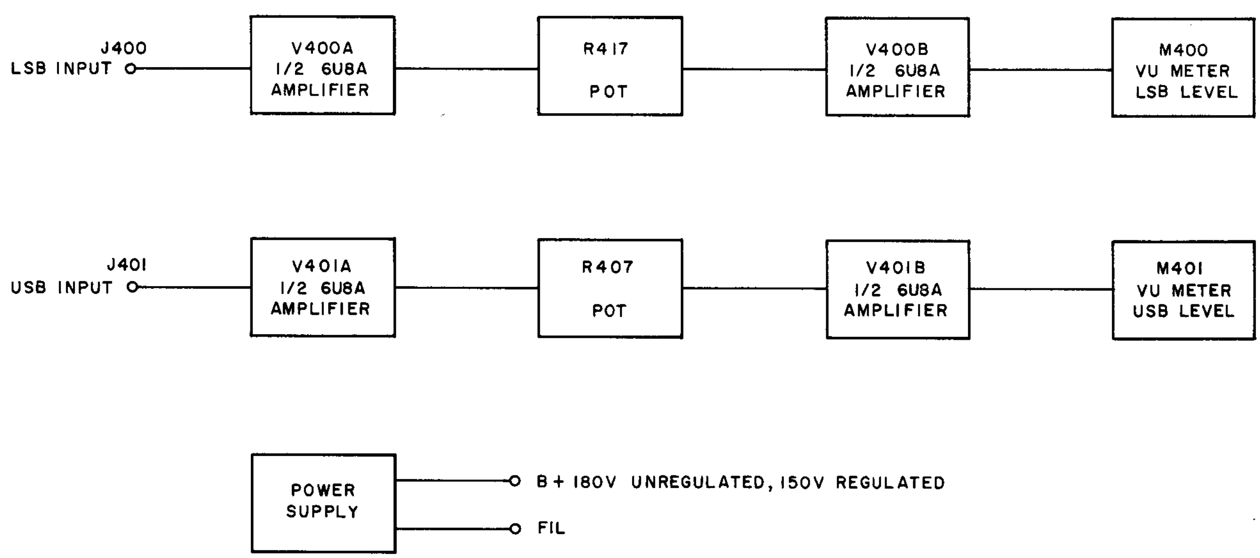
Position	Keying Mode
1	50 volts
2	100 volts
3	60 ma (neutral)
4	20 ma (polar)

Threshold adjust potentiometer R4011 should be set to trigger oscillator V4001B on and off coincidentally with incoming "space" and "mark" signals, respectively. As pointed out in Section 6, comparison of incoming and outgoing waveforms, at E4001, pins 1 and 2 versus 4 and 5 or 8 and 10, on an oscilloscope is a convenient and practical marker to determine the optimum setting of R4011.

Voltage adjust potentiometer R4014 should be set to furnish the proper magnitudes of "space" and "mark" signals.

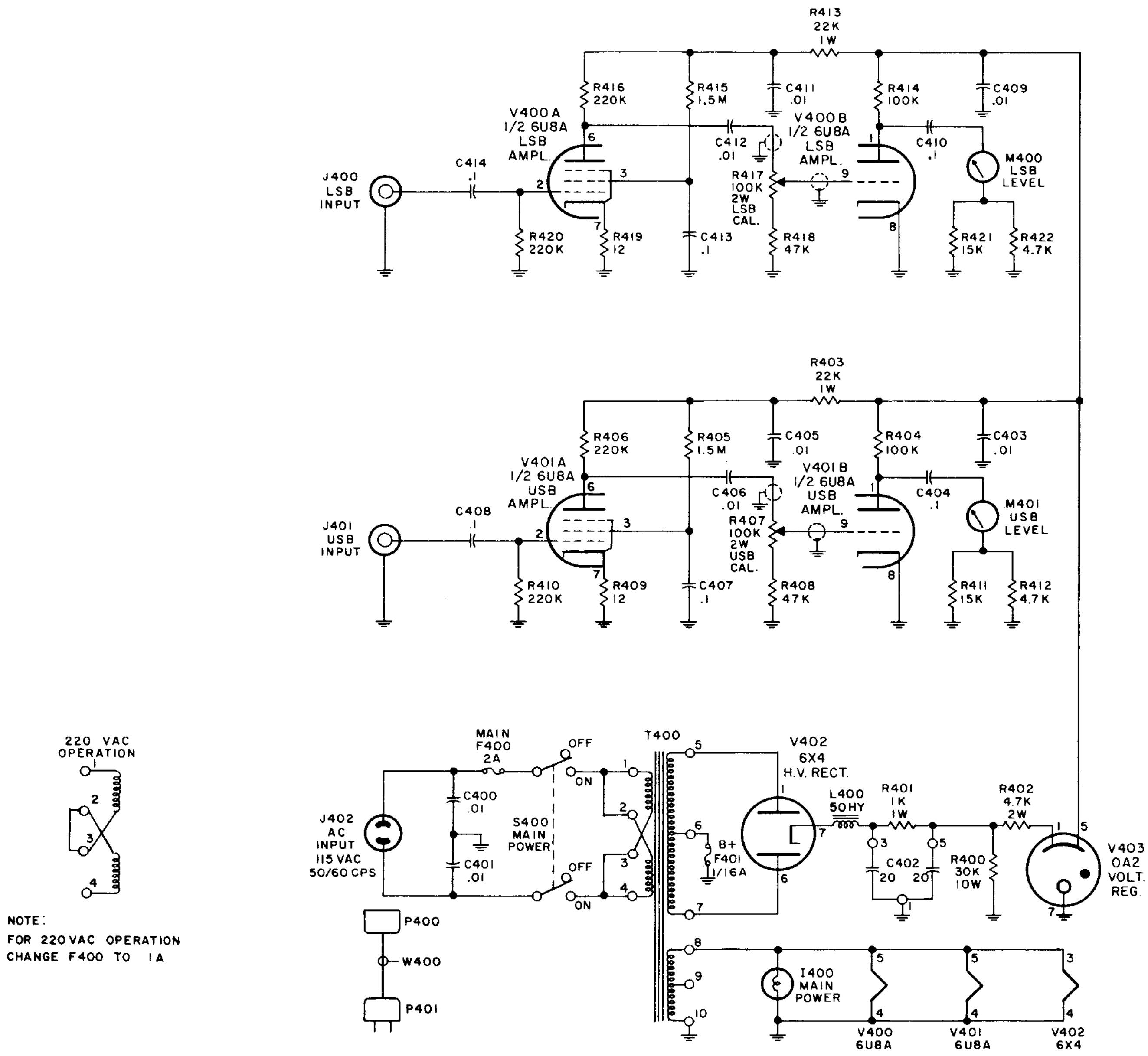


SKETCH 1 BLOCK DIAGRAM, SIDEBAND LEVEL MONITOR MODEL SLM-2



SKETCH 2 BLOCK DIAGRAM, SIDEBAND LEVEL MONITOR MODEL SLM-1

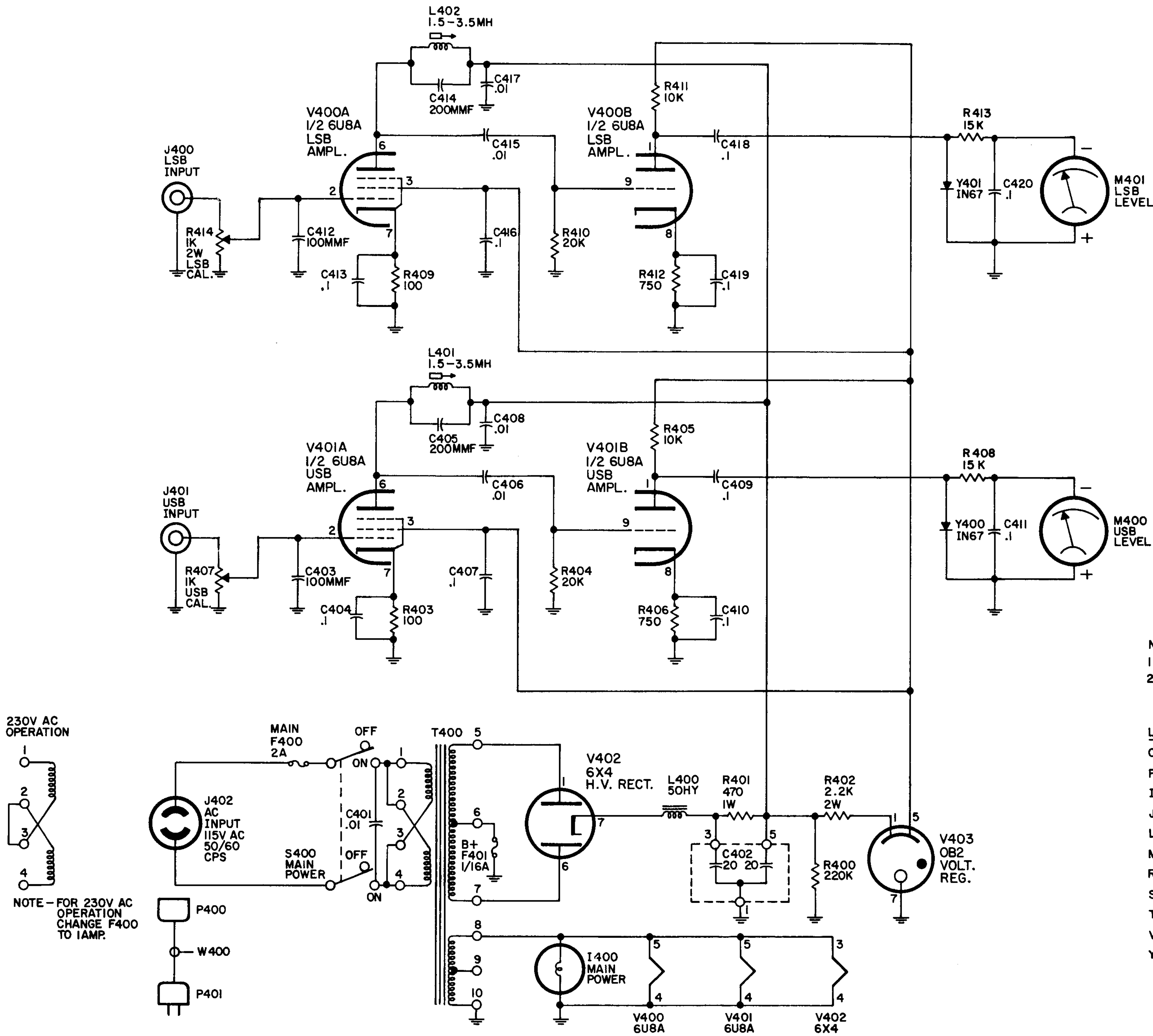
Figure 4-1. Block Diagram, SLM-1 and SLM-2



NOTES:
1. ALL CAPACITORS ARE IN MFDS.
2. ALL RESISTORS ARE 1/2 WATT, UNLESS OTHEWISE SPECIFIED.

LAST SYMBOLS-
C414
F401
I400
J402
L400
M401
P401
R422
S400
T400
V403
W400

Figure 4-2. Schematic Diagram, SLM-1 and SLM-2 (Sheet 1 of 2)



NOTES— UNLESS OTHERWISE SPECIFIED
1. ALL CAPACITORS ARE IN MFD.
2. ALL RESISTORS ARE 1/2 WATT.

LAST SYMBOLS	MISSING SYMBOLS
C420	C400
F401	
I400	
J402	
L402	
M401	
R414	
S400	
T400	
V403	
Y401	

Figure 4-2. Schematic Diagram, SLM-1 and SLM-2 (Sheet 2 of 2)

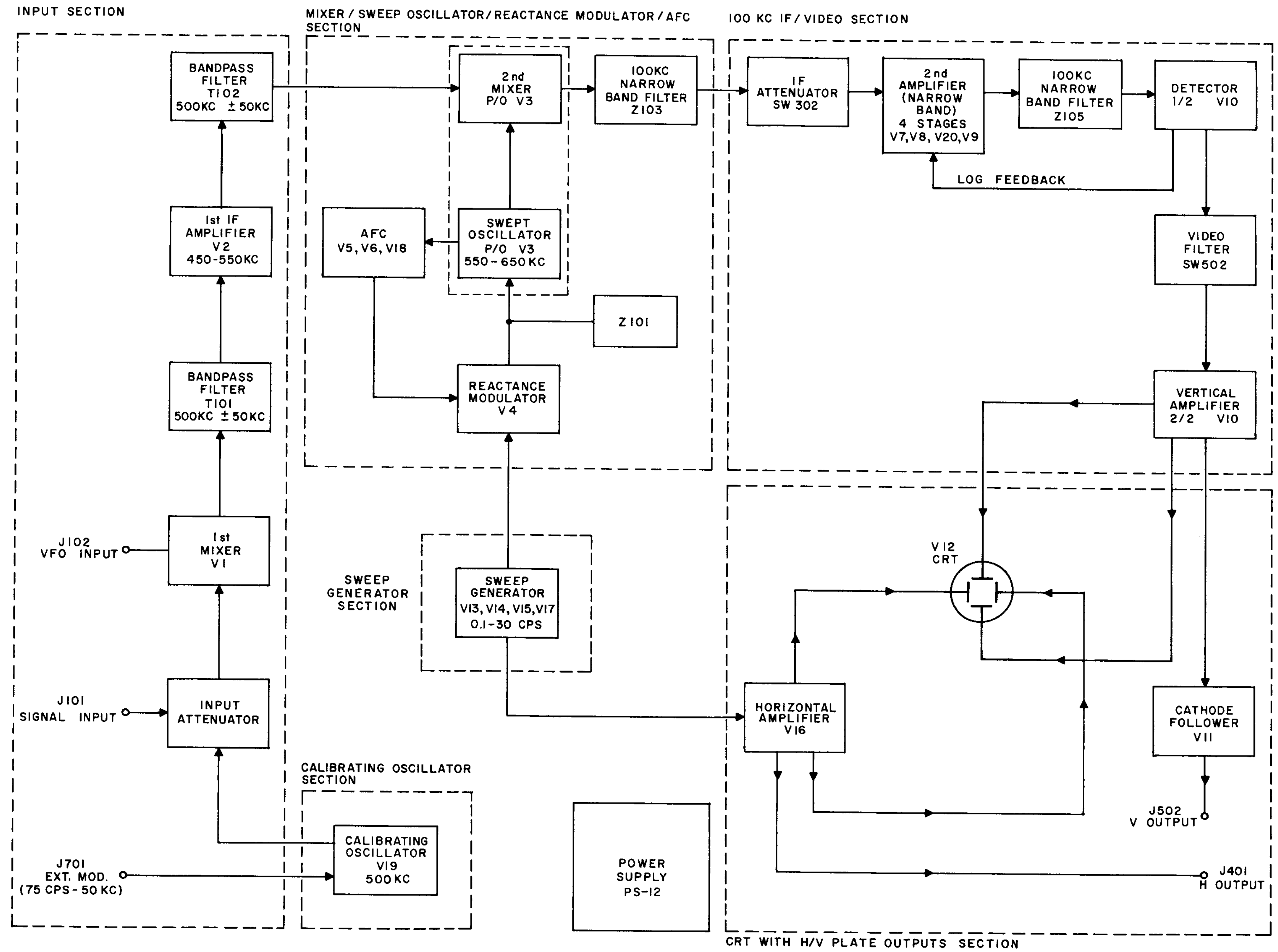


Figure 4-3. Block Diagram, FSA

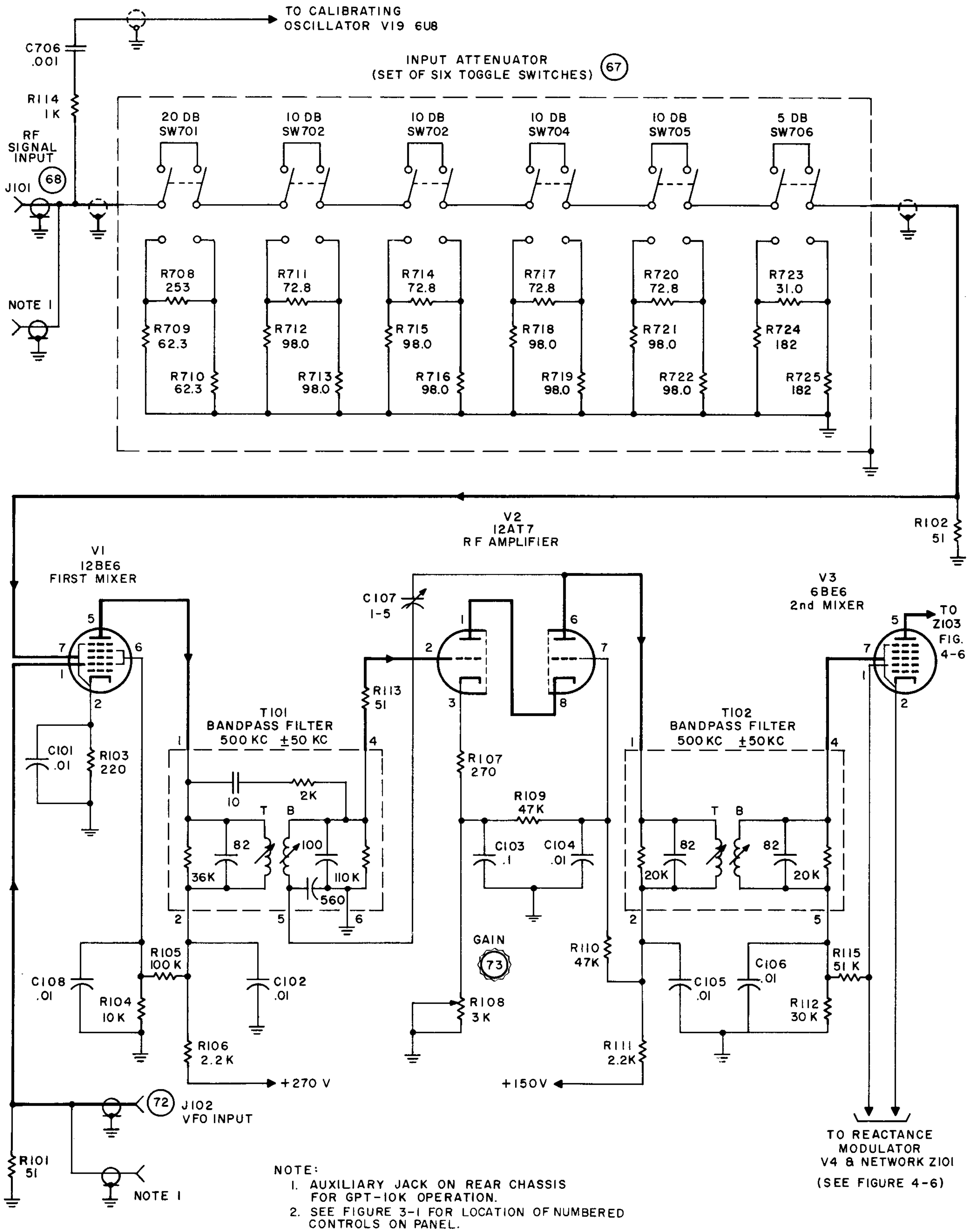


Figure 4-4. Schematic Diagram, FSA, Input Section

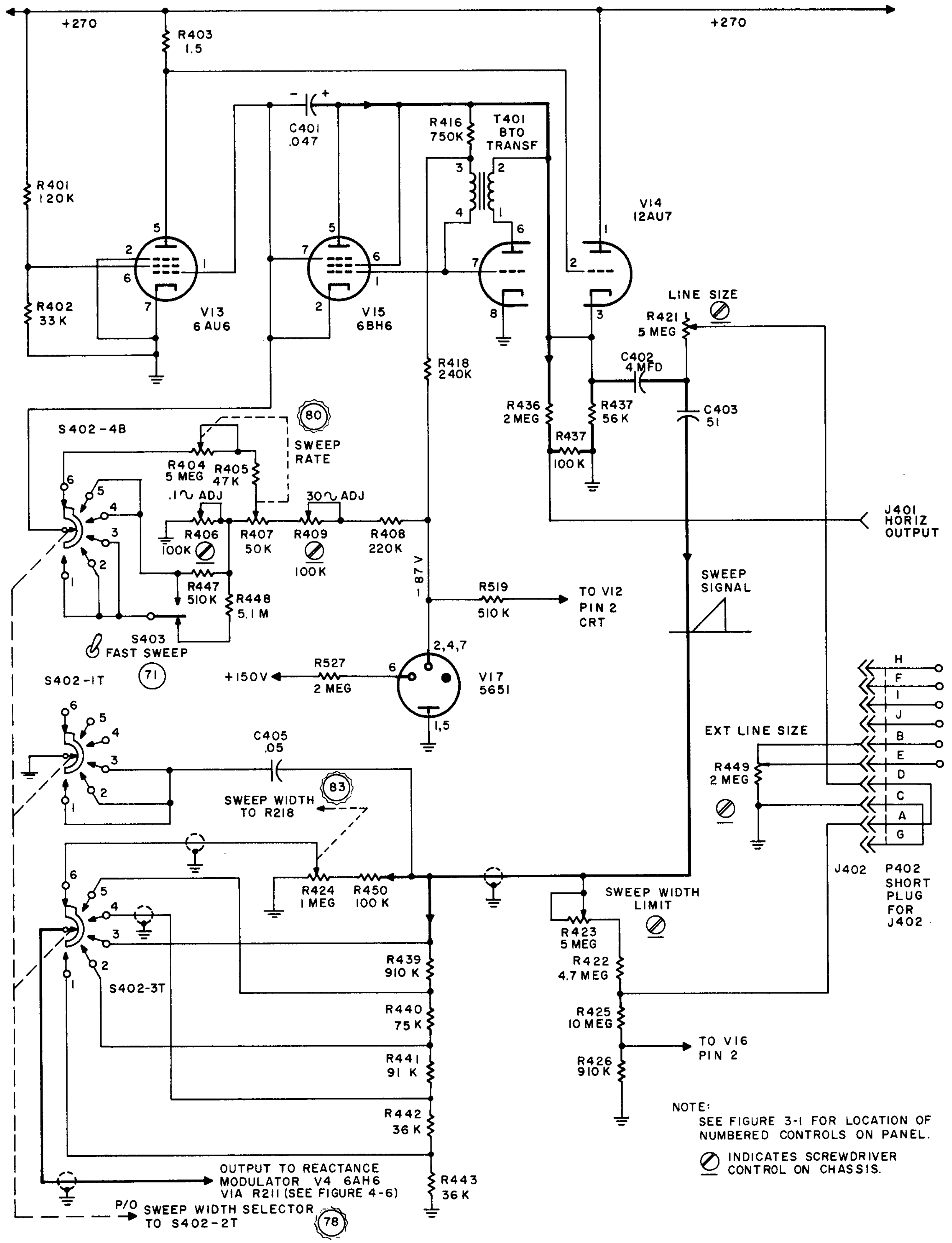


Figure 4-5. Schematic Diagram, FSA, Sweep Generator Section

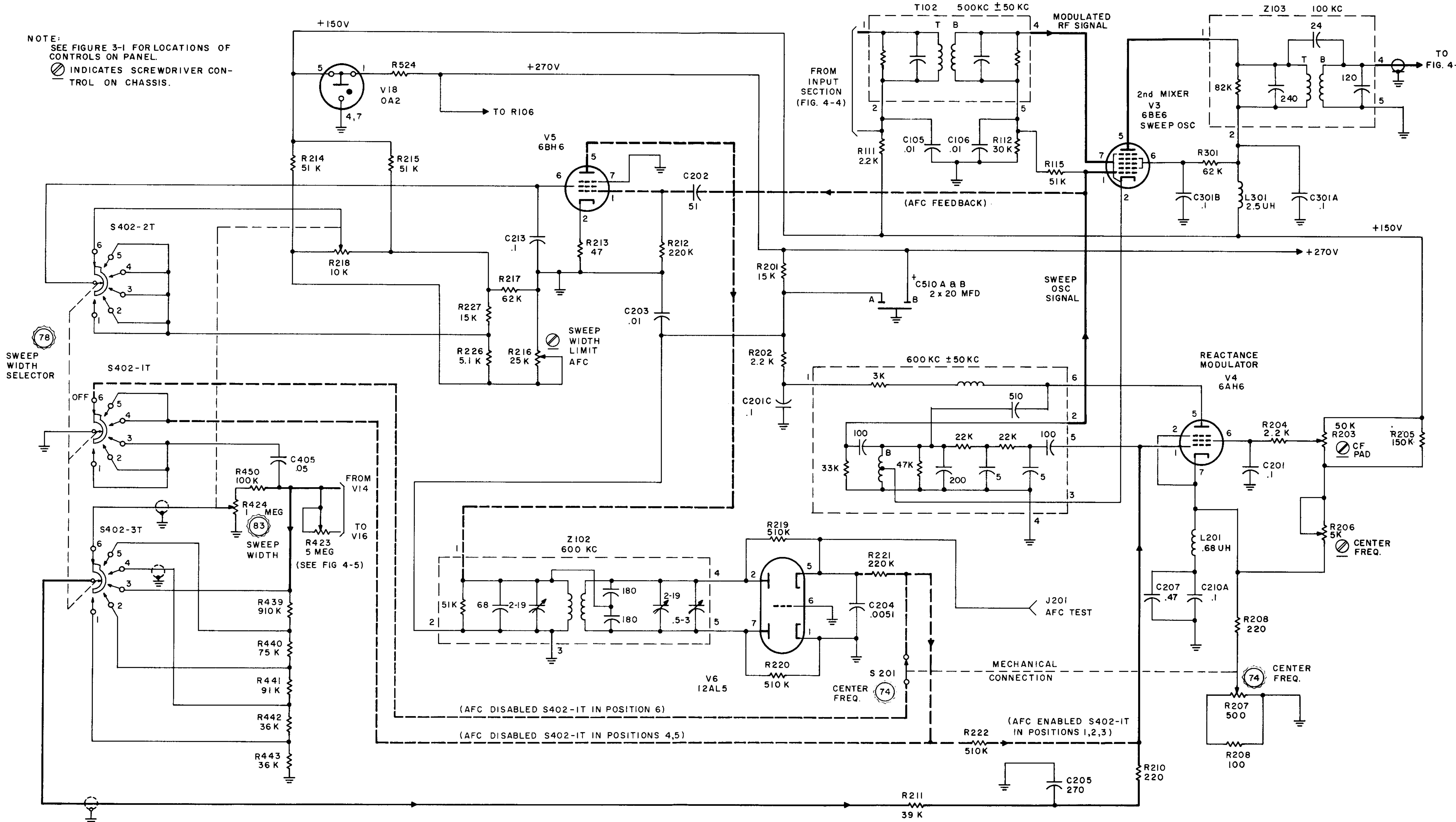


Figure 4-6. Schematic Diagram, FSA, Mixer, Sweep Oscillator, Reactance Modulator, and AFC

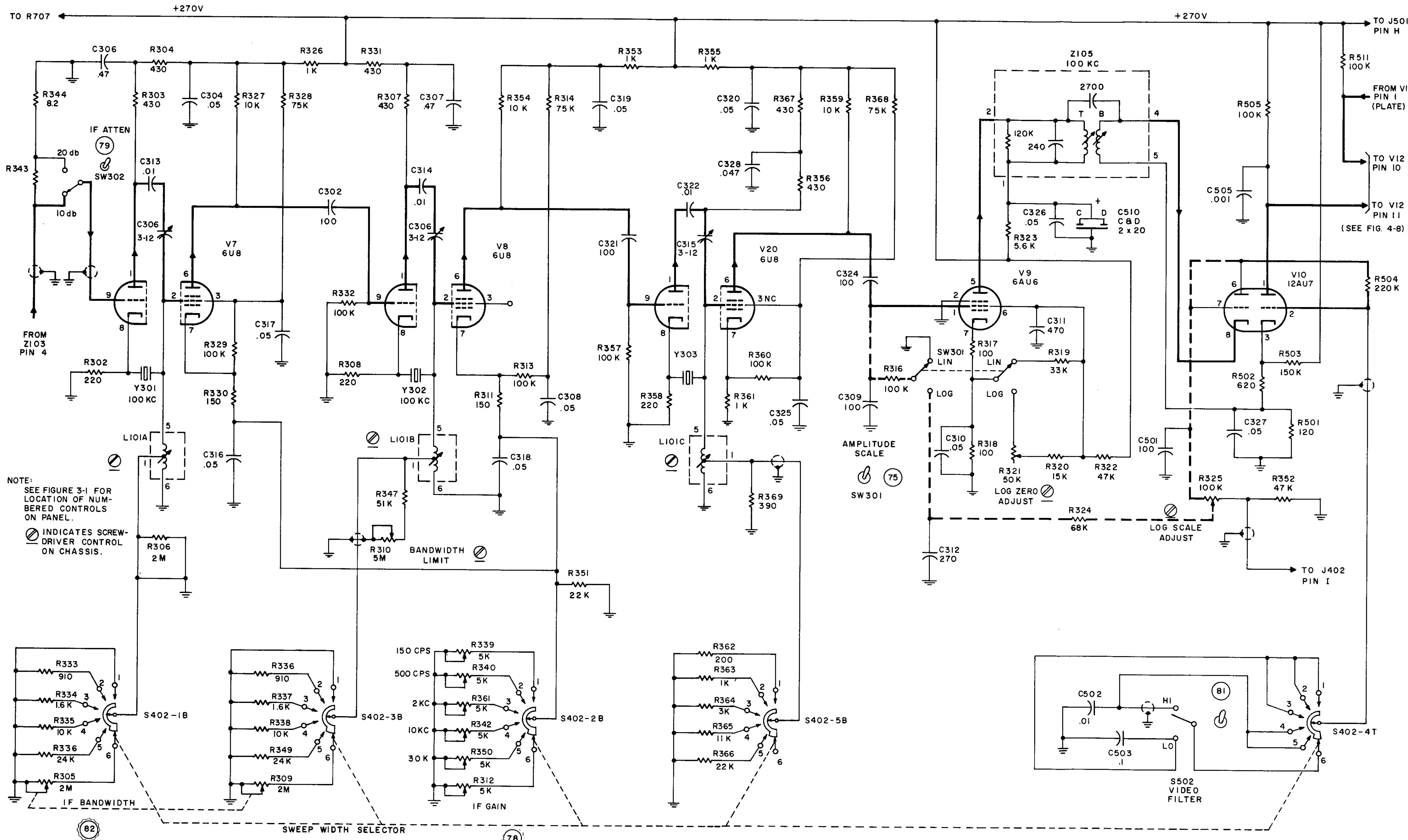


Figure 4-7. Schematic Diagram, FSA, 100-kc IF and Video Section

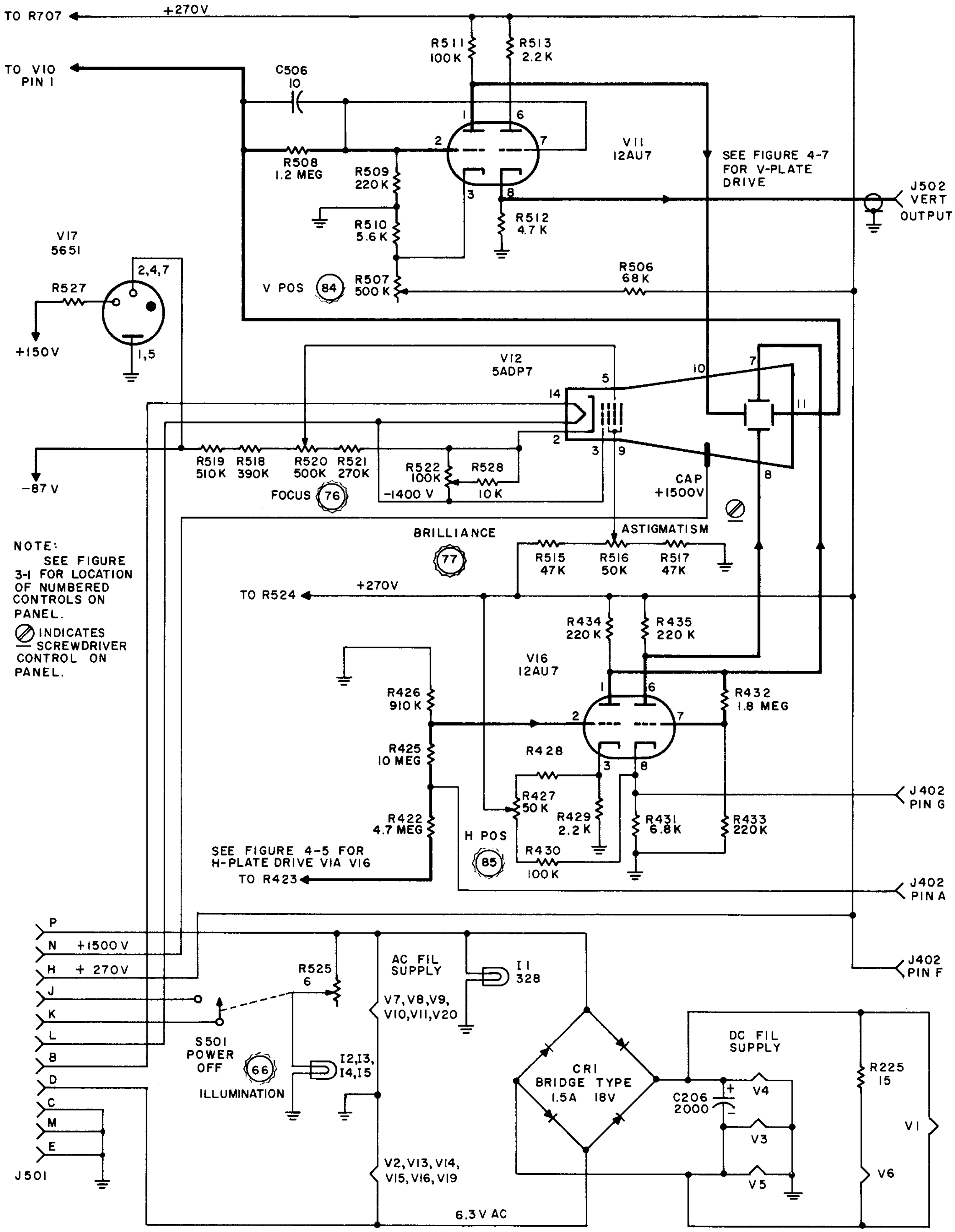


Figure 4-8. Schematic Diagram, FSA, Crt with H/V Plate Outputs Section

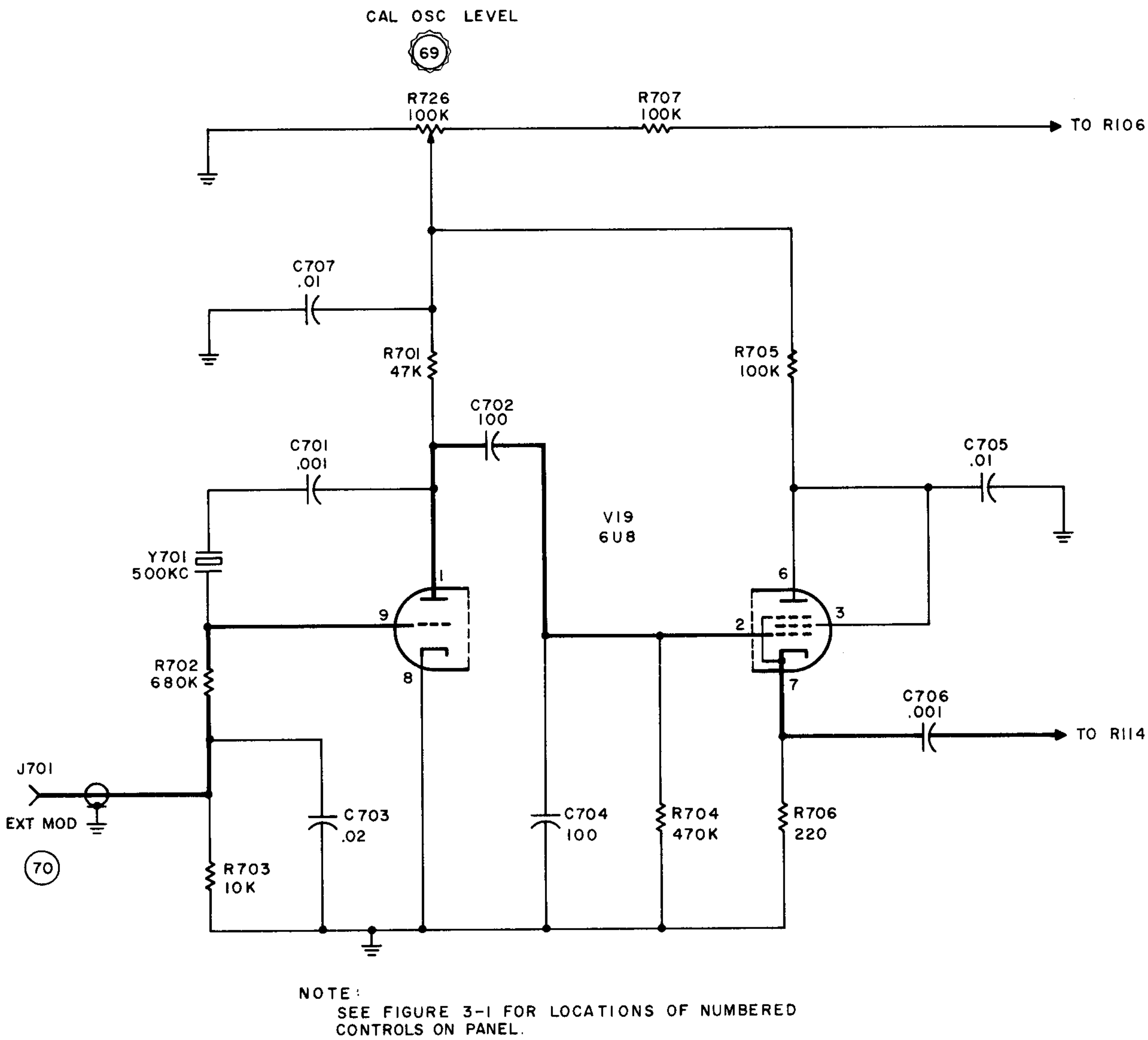


Figure 4-9. Schematic Diagram, FSA, Crystal-Controlled Calibrating Oscillator Section

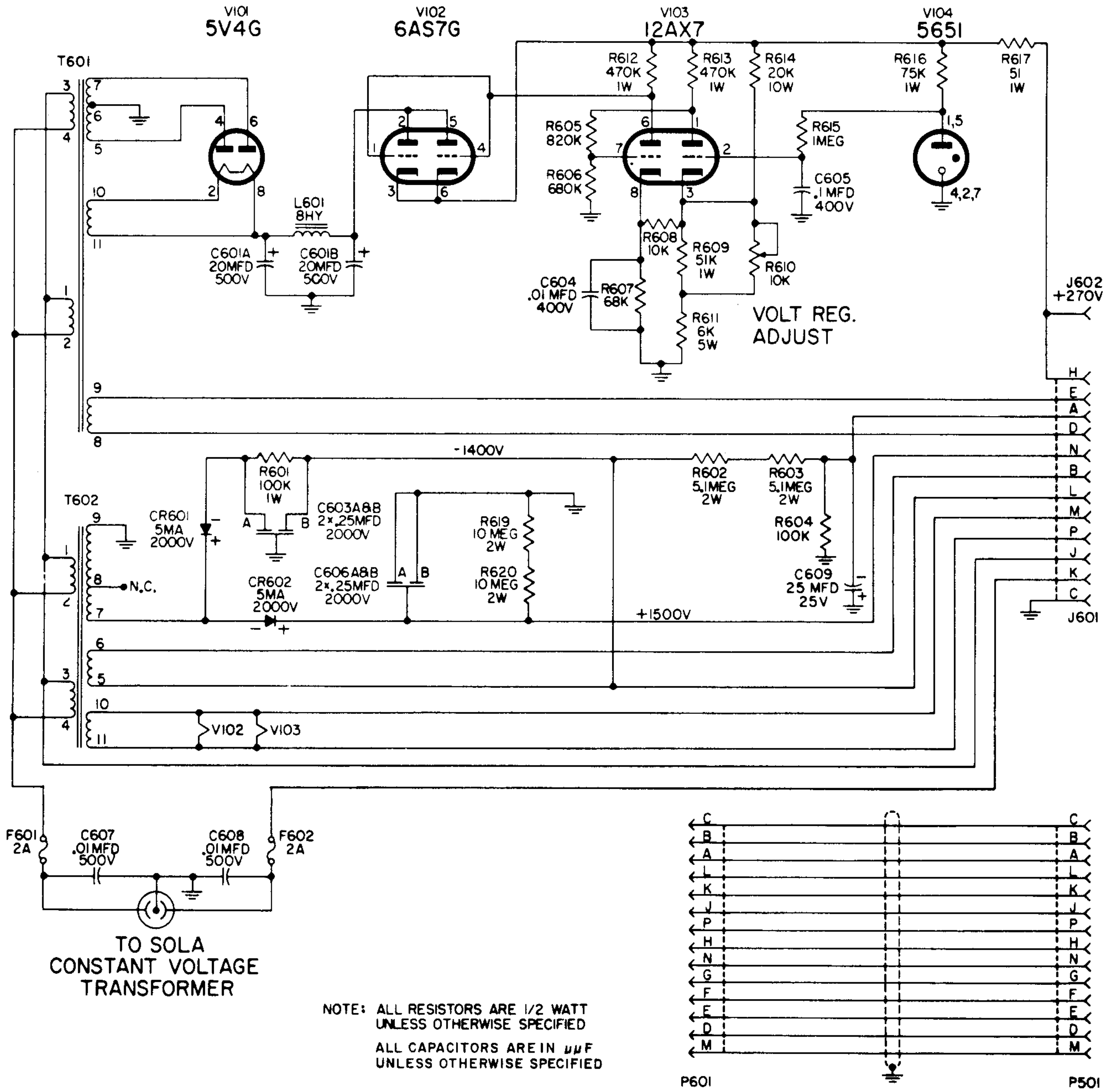


Figure 4-10. Schematic Diagram, FSA, PS-12 Section

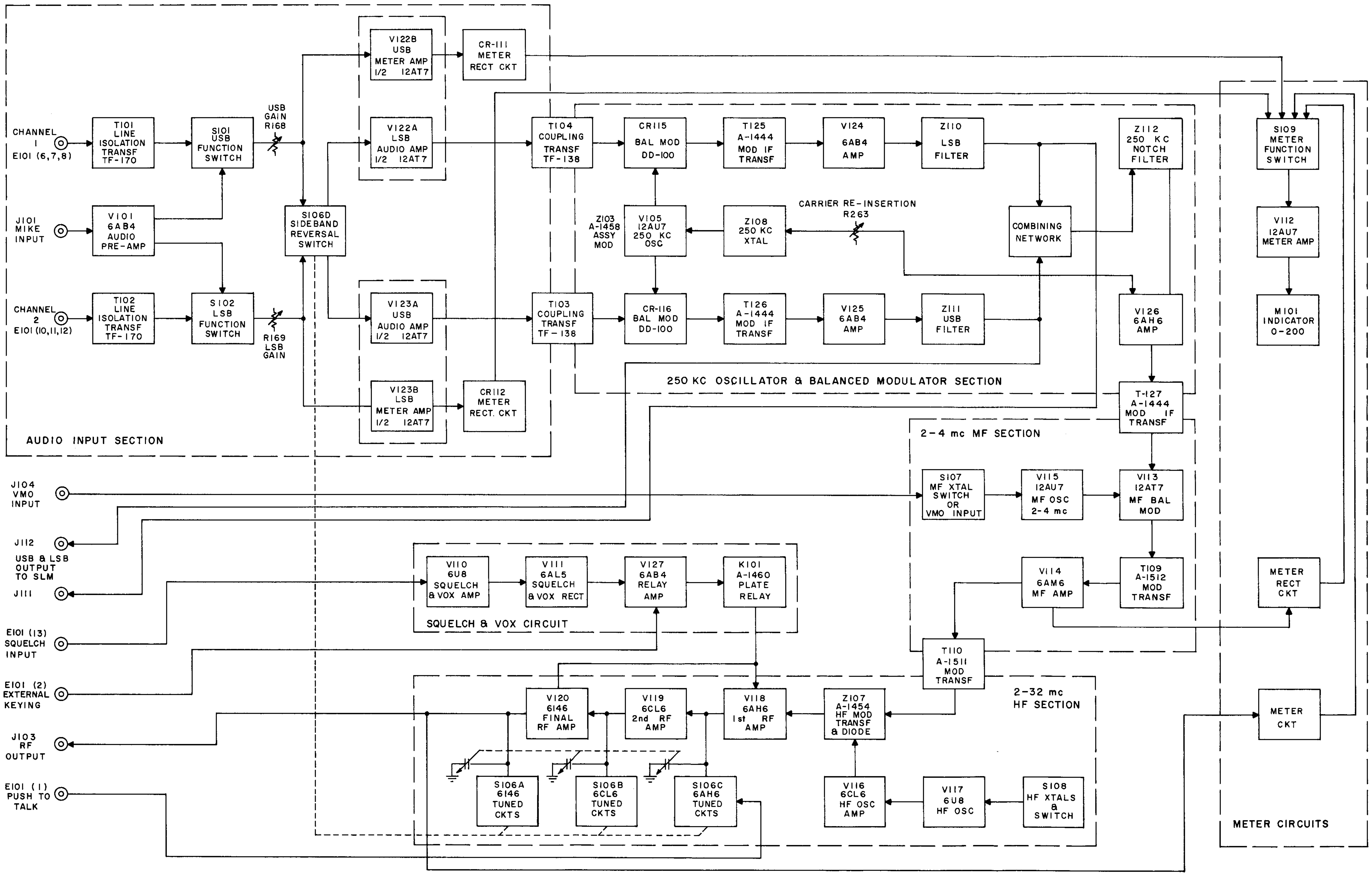


Figure 4-11. Block Diagram, SBE-3 and Its Power Supply

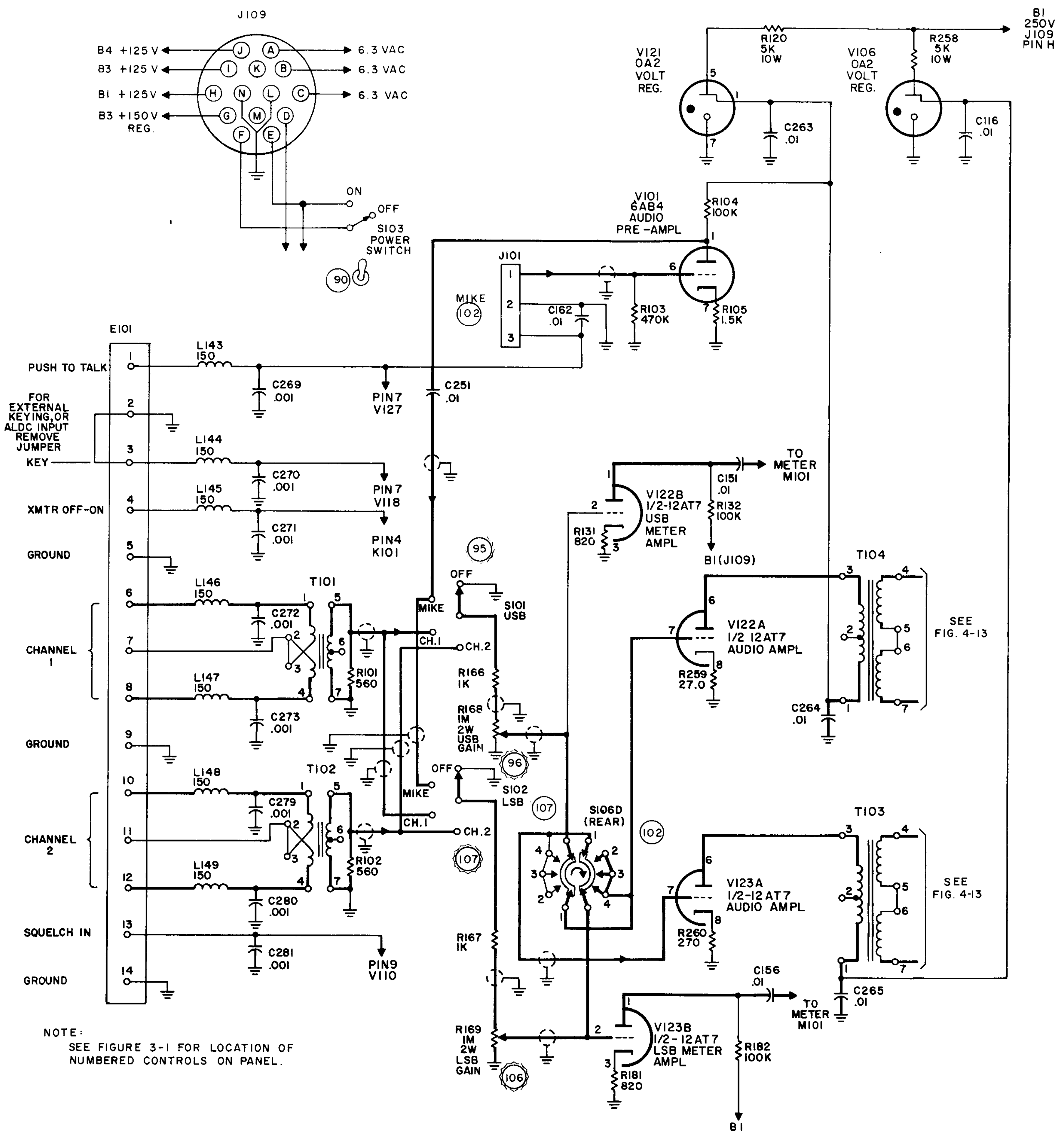
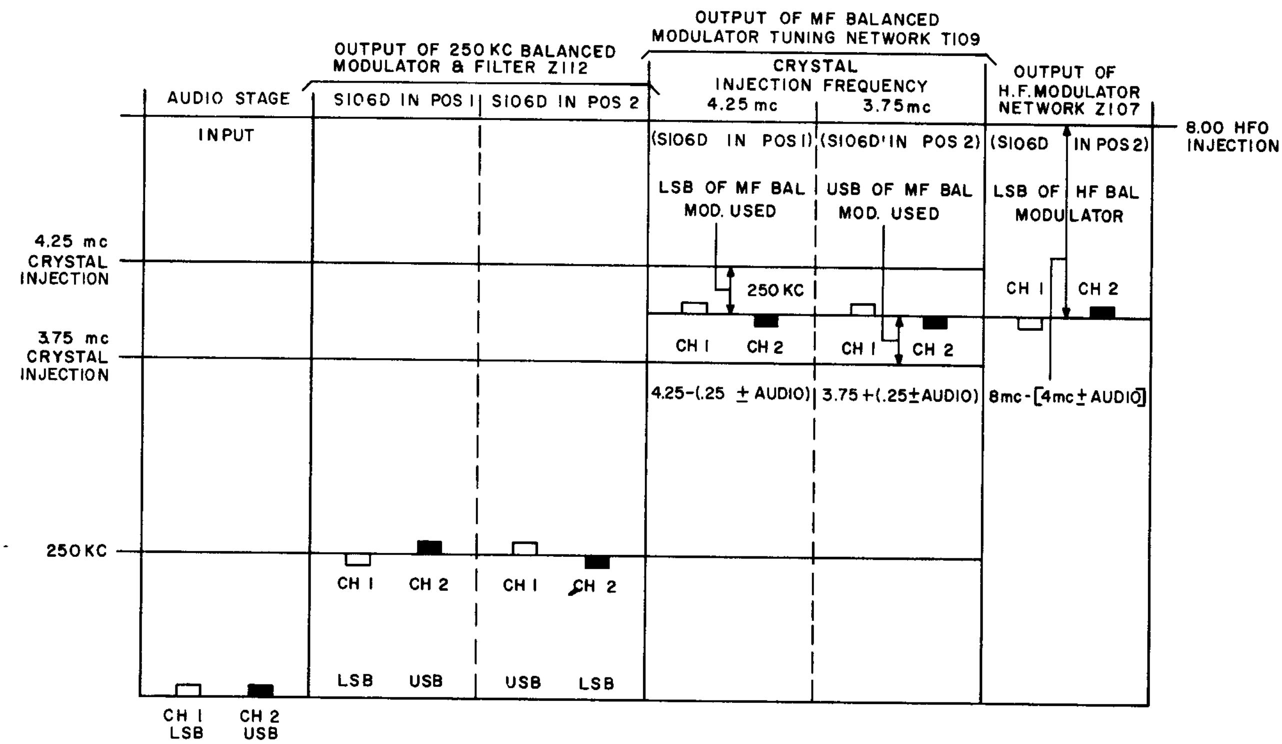


Figure 4-12. Schematic Diagram, SBE-3, Audio Input Section



NOTE:

THE 4.25 mc INJECTION GIVES NORMAL OUTPUTS OF CHANNEL 1 LSB OF 4 mc AND CHANNEL 2 USB OF 4 mc

THE 3.75 mc INJECTION GIVES INVERTED OUTPUTS OF CHANNEL 1 USB OF 4 mc AND CHANNEL 2 LSB OF 4 mc

Figure 4-13. Diagram Illustrating Modulation Inversion in SBE-3

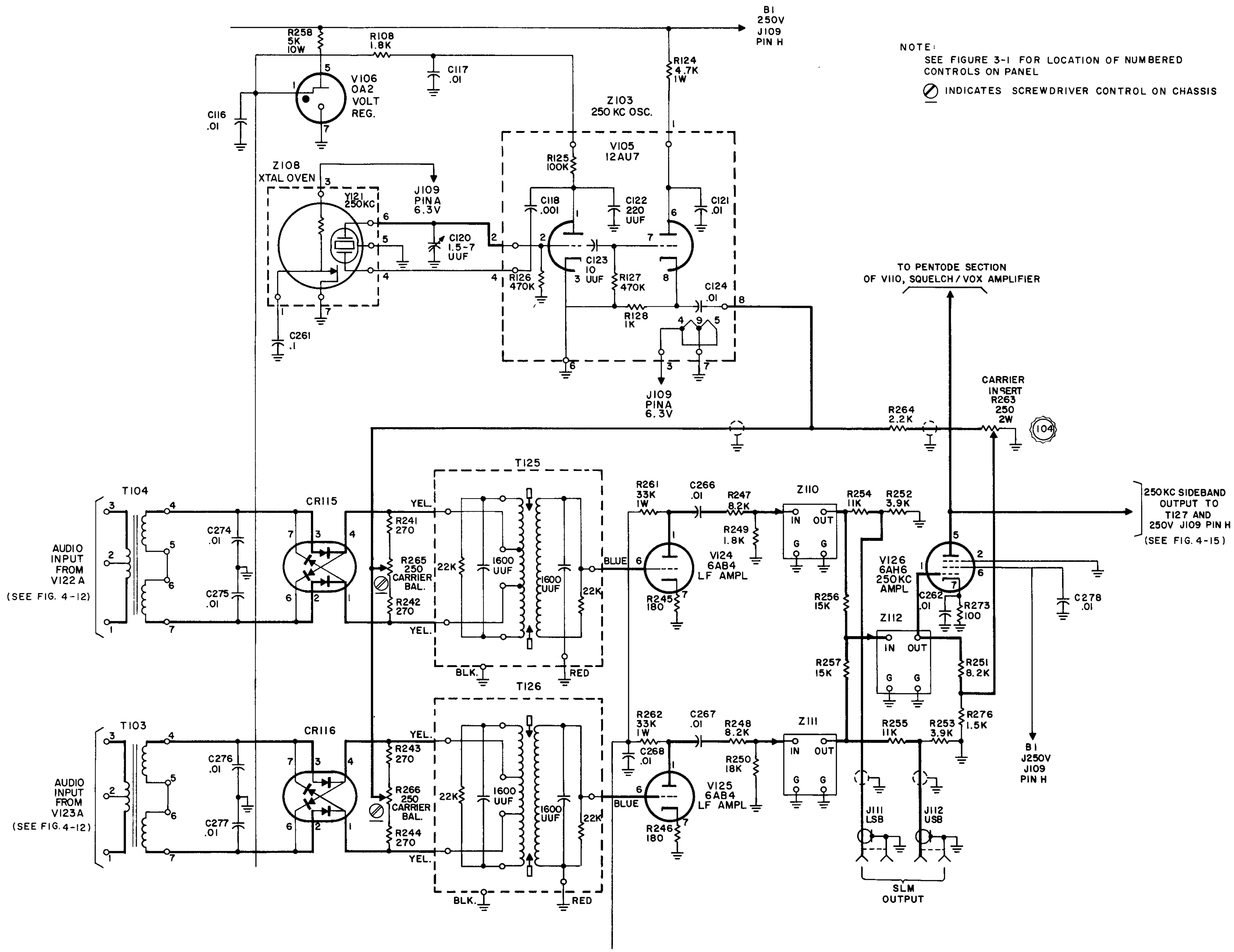


Figure 4-14. Schematic Diagram, SBE-3, 250-kc Oscillator and Balanced Modulator Section

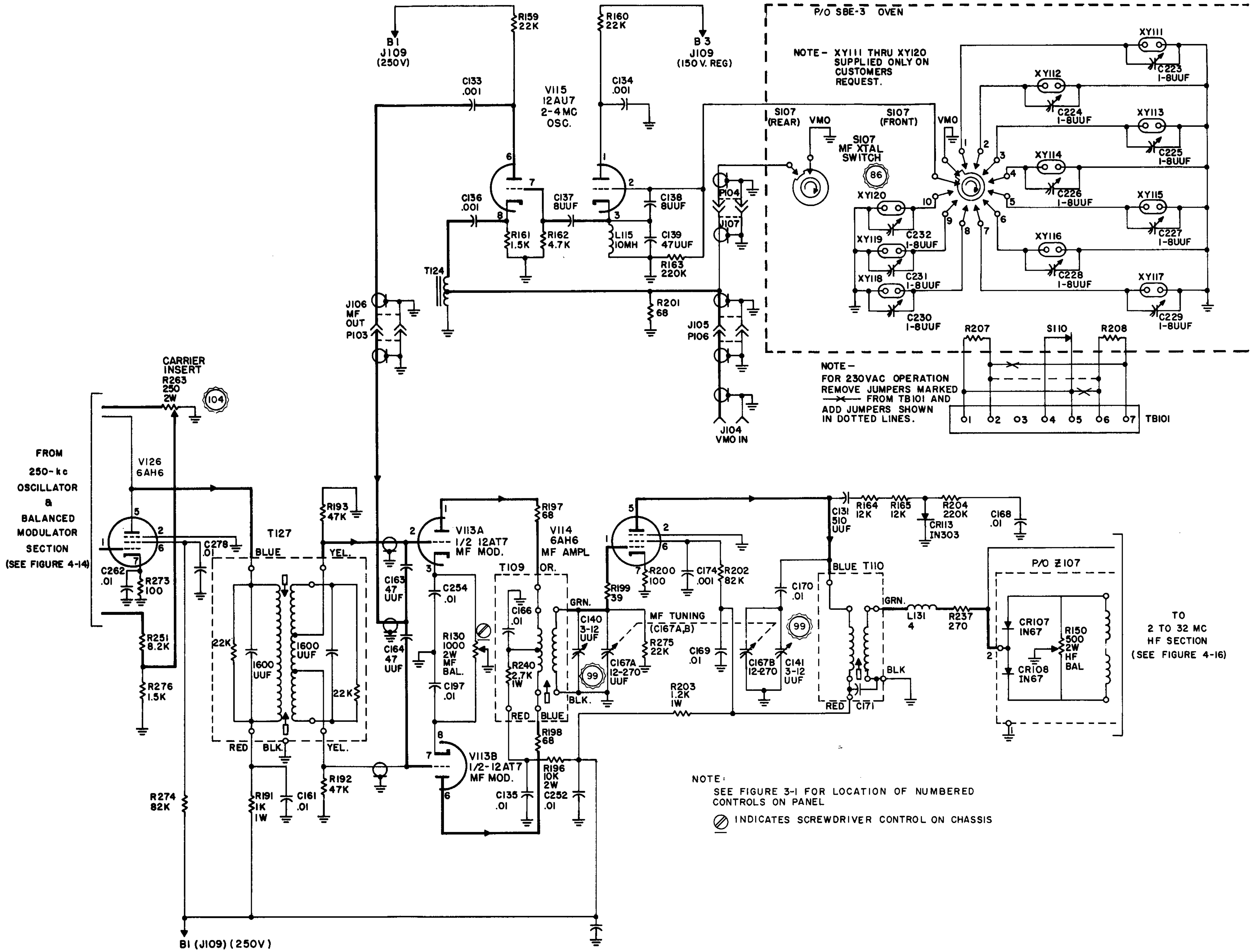
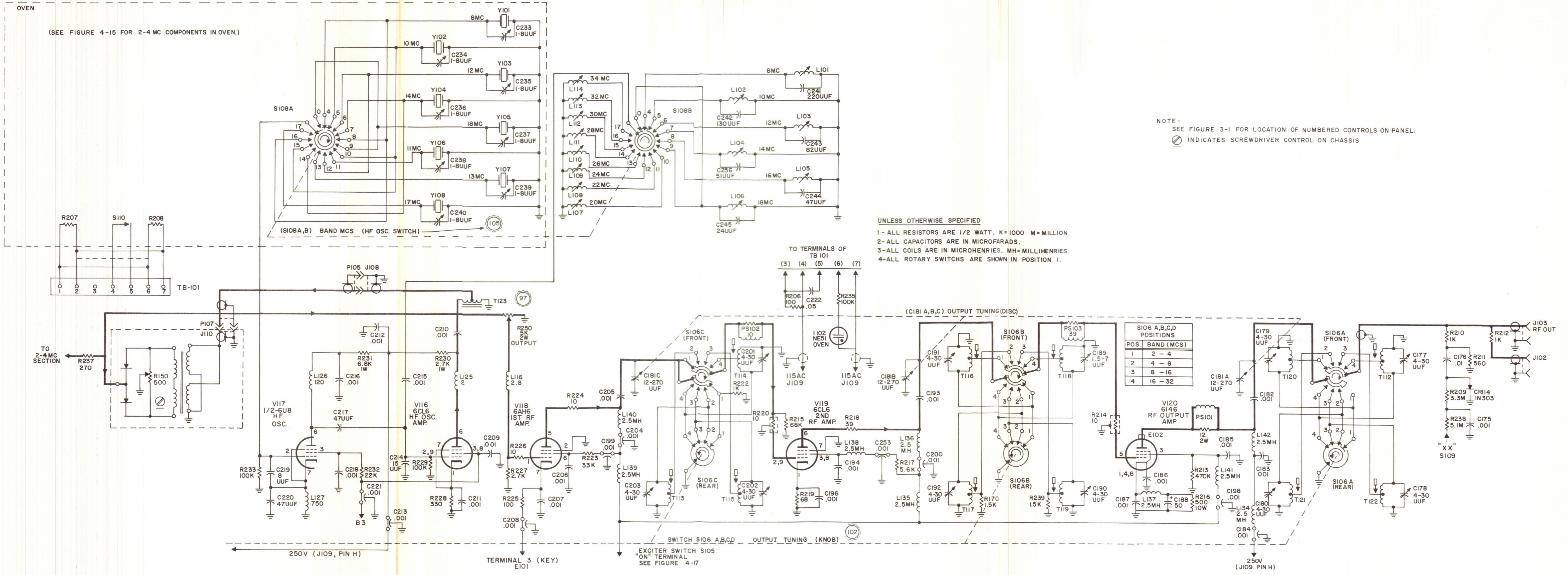


Figure 4-15. Schematic Diagram, SBE-3, 2- to 4-mc MF Section



POS.	BAND (MCS)
1	2 – 4
2	4 – 8
3	8 – 16
4	16 – 32

NOTE:
SEE FIGURE 3-1 FOR LOCATION OF NUMBERED CONTROLS ON PANEL.
⊘ INDICATES SCREWDRIVER CONTROL ON CHASSIS

UNLESS OTHERWISE SPECIFIED

1- ALL RESISTORS ARE 1/2 WATT. K=1000 M=MILLION
2- ALL CAPACITORS ARE IN MICROFARADS.
3- ALL COILS ARE IN MICROHENRIES. MH=MILLIHENRIES
4- ALL ROTARY SWITCHES ARE SHOWN IN POSITION 1.

Figure 4-16. Schematic Diagram, SBE-3, 2- to 32-mc HF Section

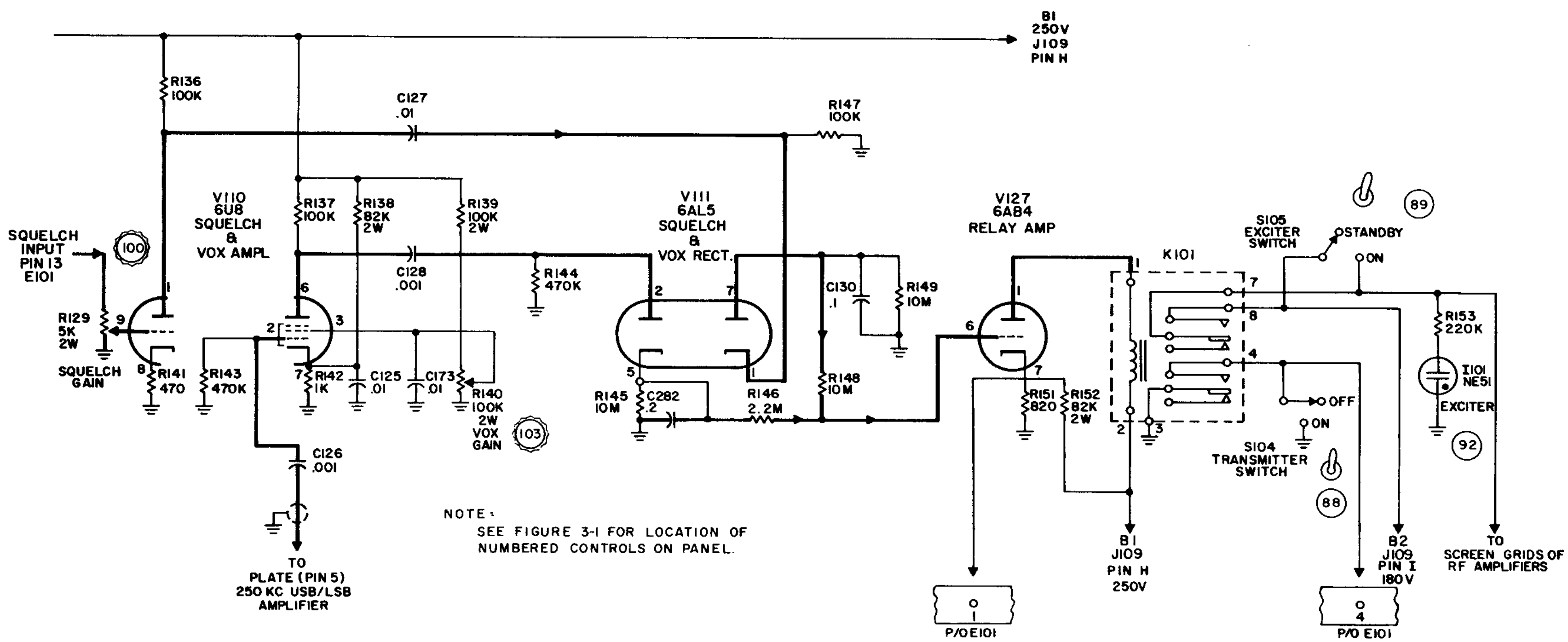


Figure 4-17. Schematic Diagram, SBE-3, SQUELCH and VOX Section

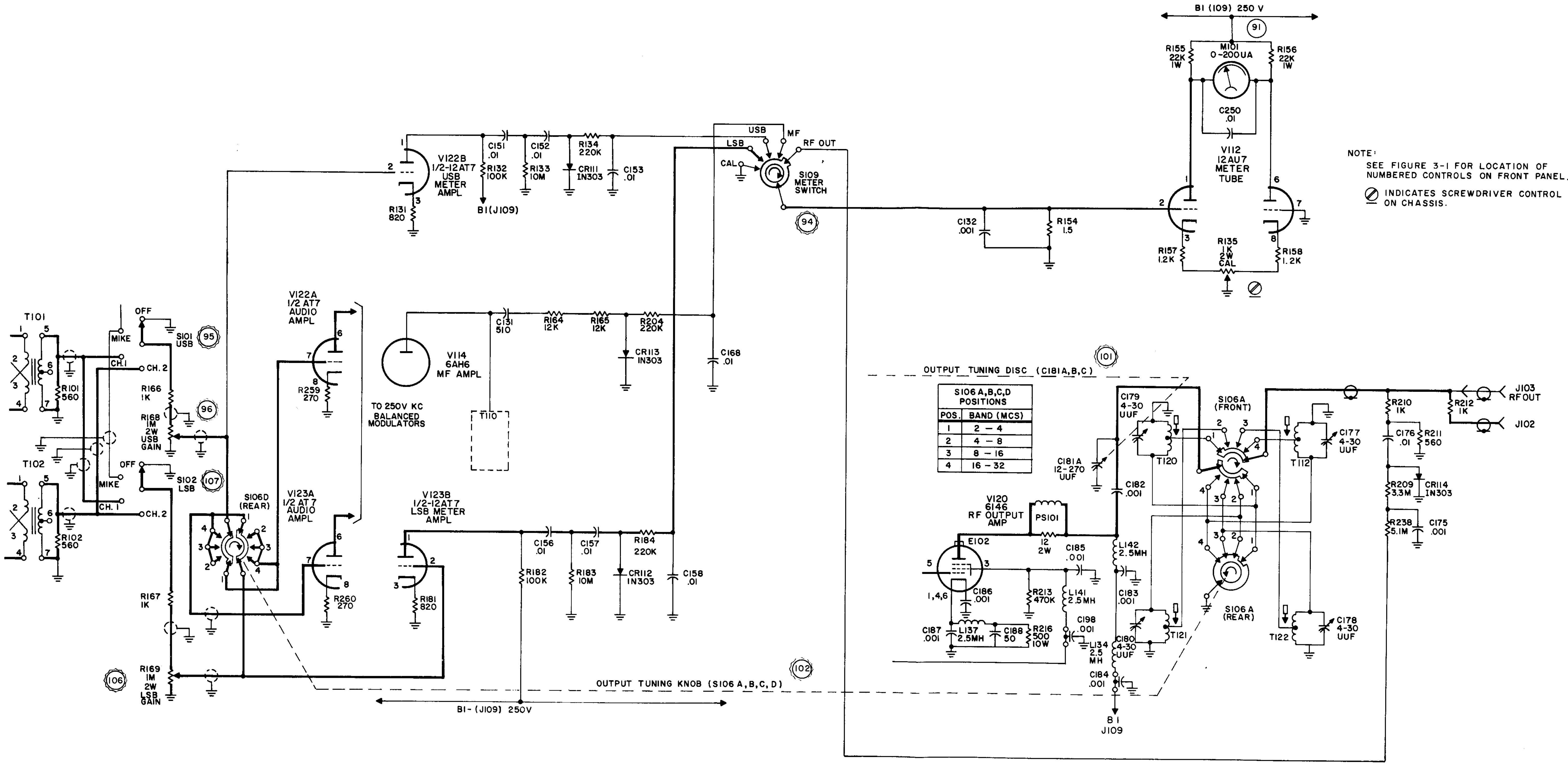


Figure 4-18. Schematic Diagram, SBE-3, M101 Meter Circuits

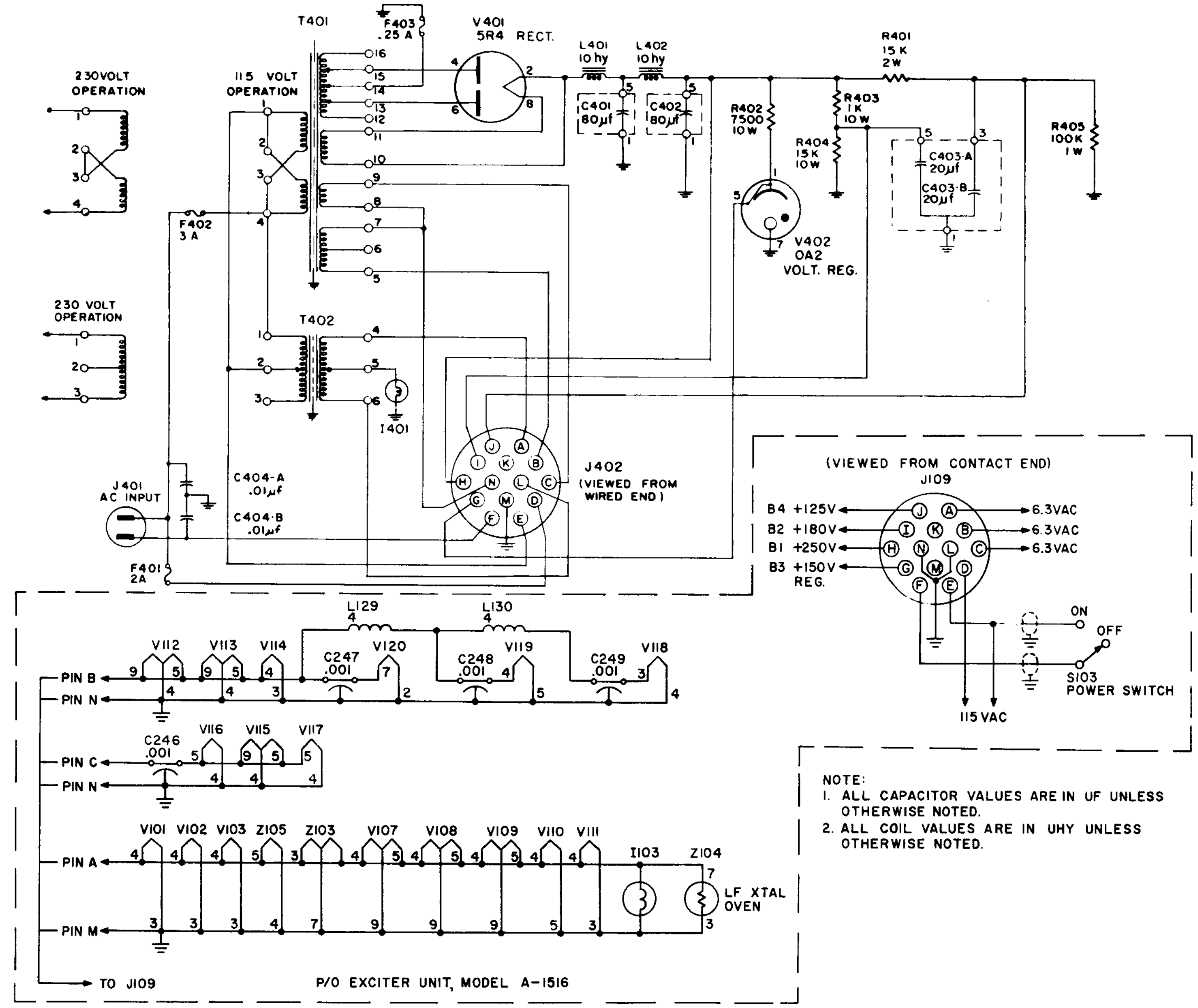


Figure 4-19. Schematic Diagram, SBE-3, Power Supply Section

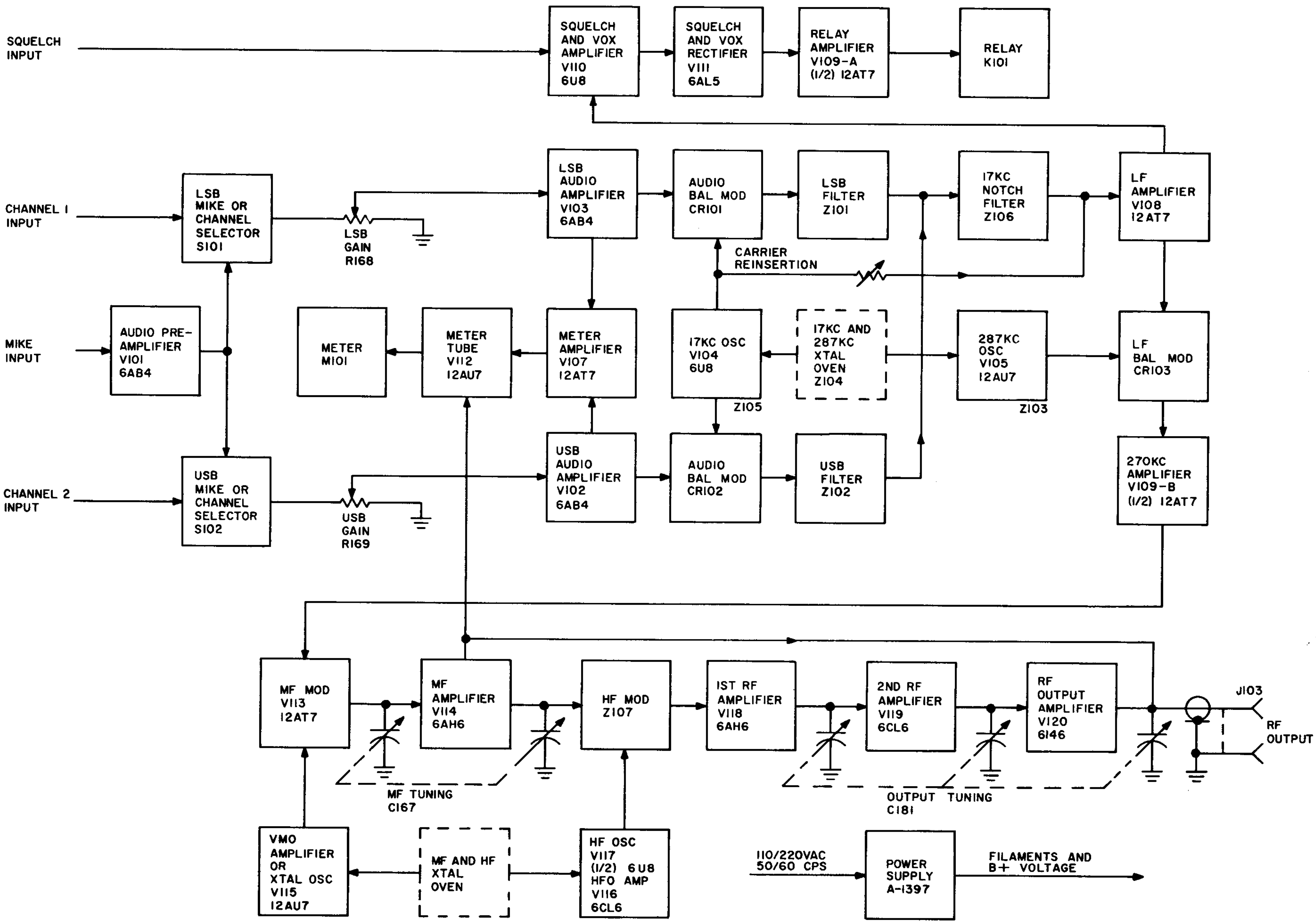


Figure 4-20. Block Diagram, SBE-2 and Its Power Supply

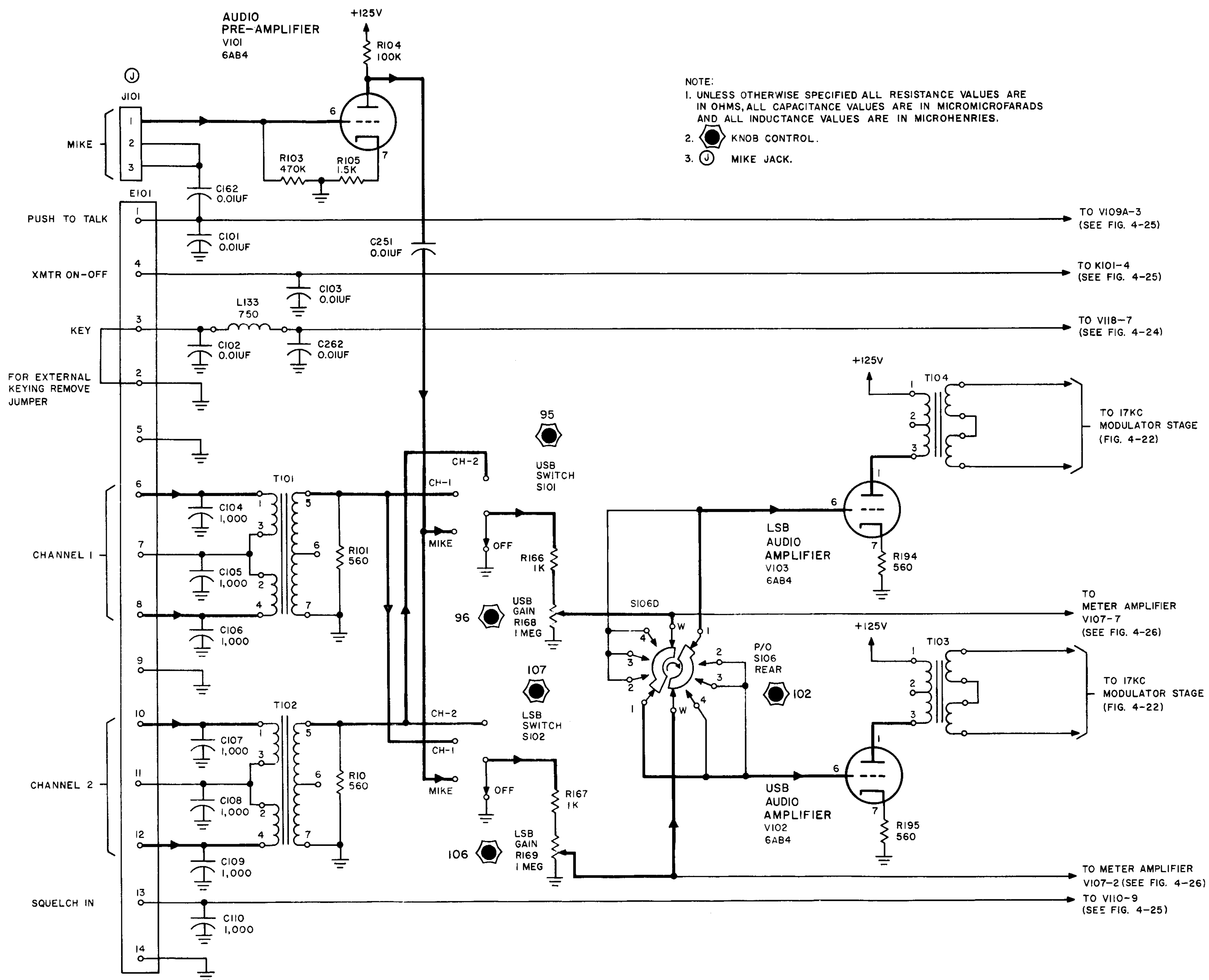


Figure 4-21. Schematic Diagram SBE-2, Audio Input Section

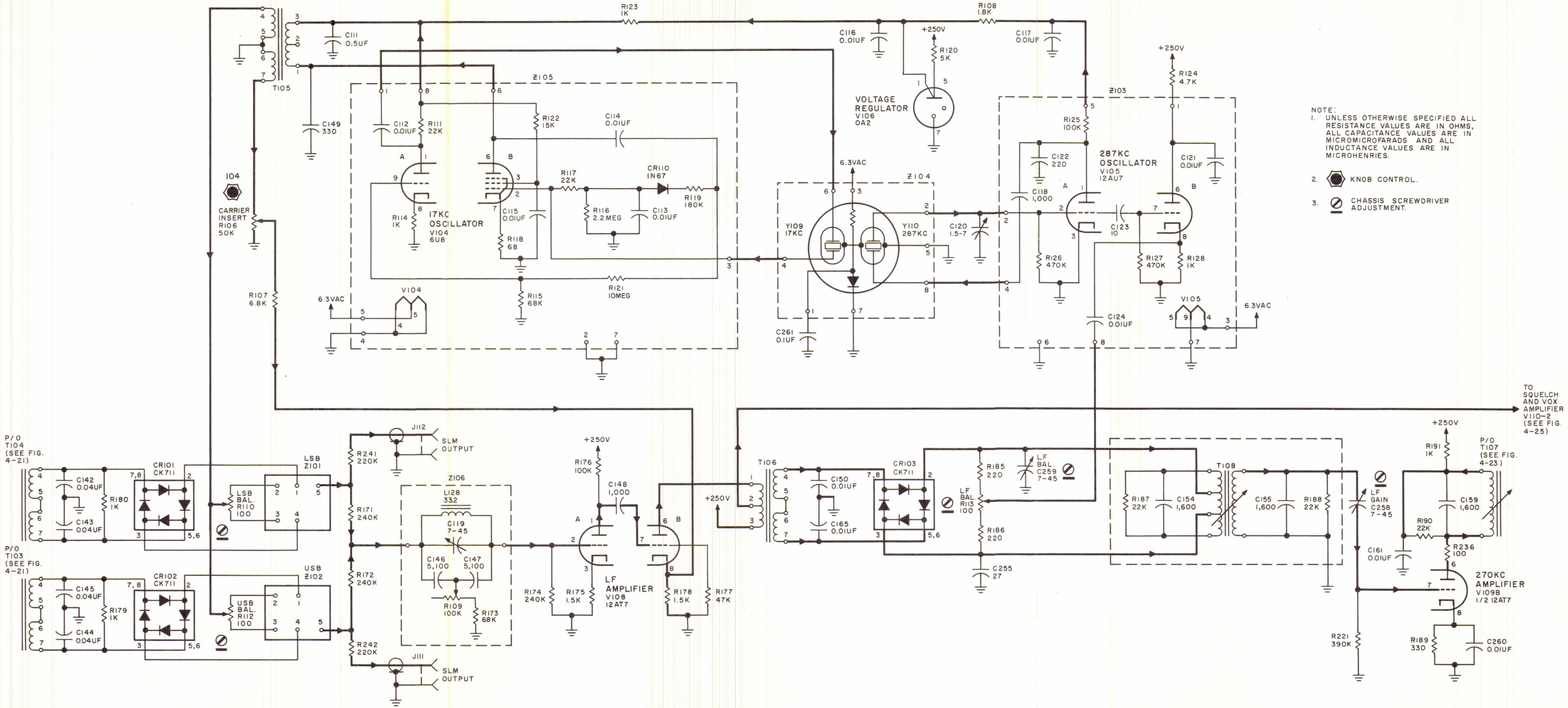


Figure 4-22. Schematic Diagram, SBE-2, 17-kc and 287-kc Oscillator and Balanced Modulators Section

NOTE:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES.
2. FOR 230V OPERATION REMOVE LEADS MARKED -x-x-x-, AND ADD LEADS MARKED - - - -.
3. KNOB CONTROL.
4. CHASSIS SCREWDRIVER ADJUSTMENT.

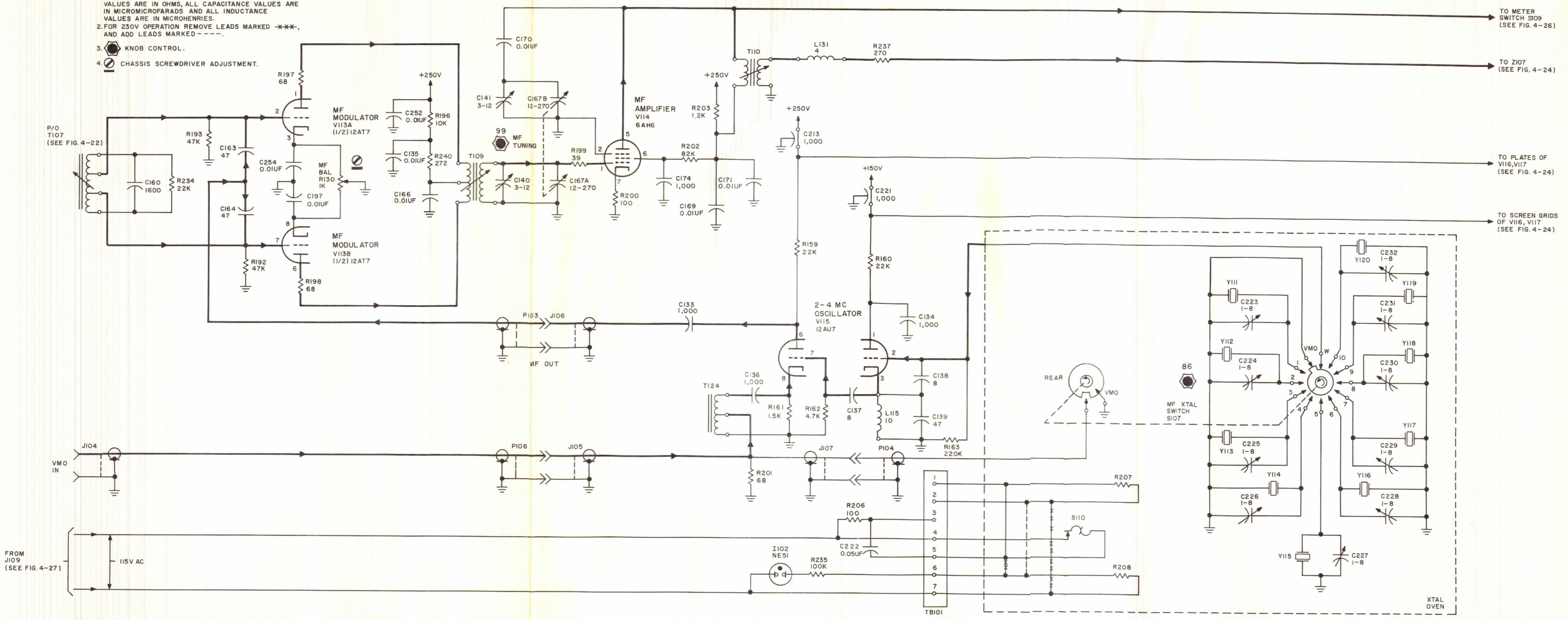
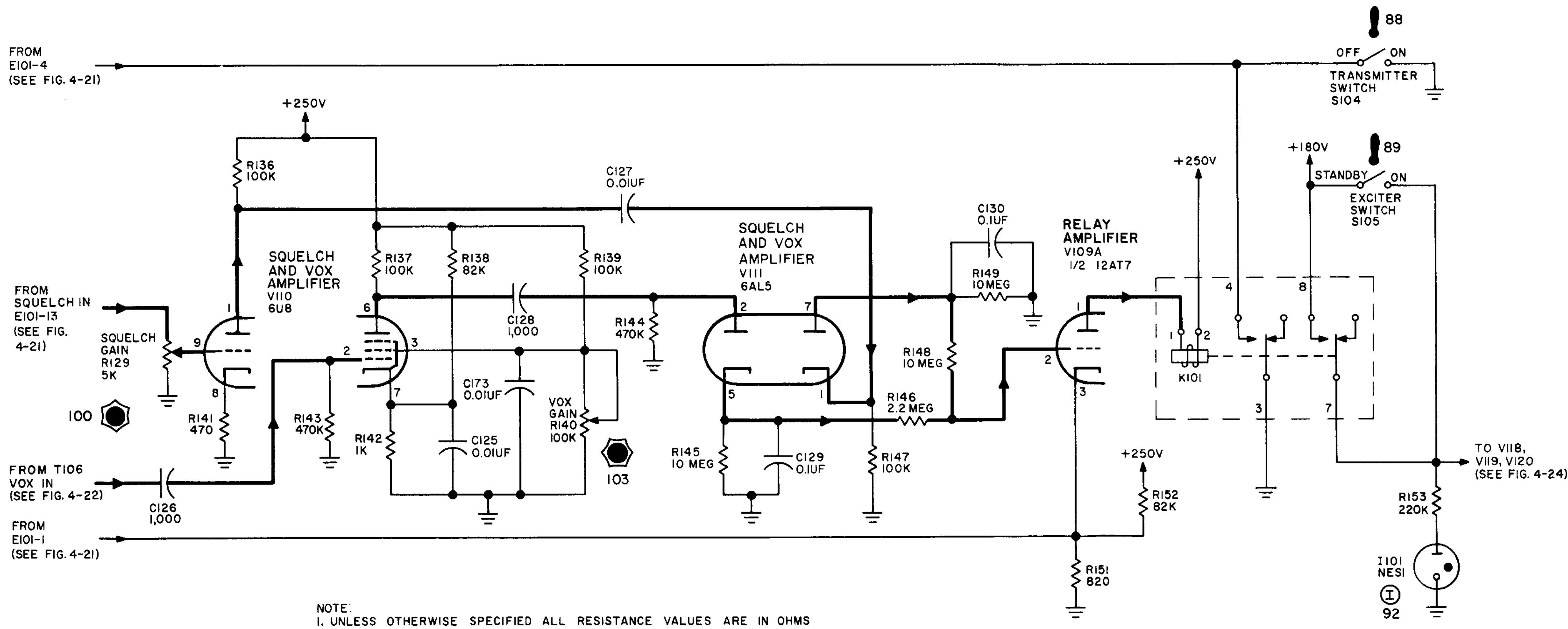


Figure 4-23. Schematic Diagram, SBE-2, 2- to 4-mc MF Section

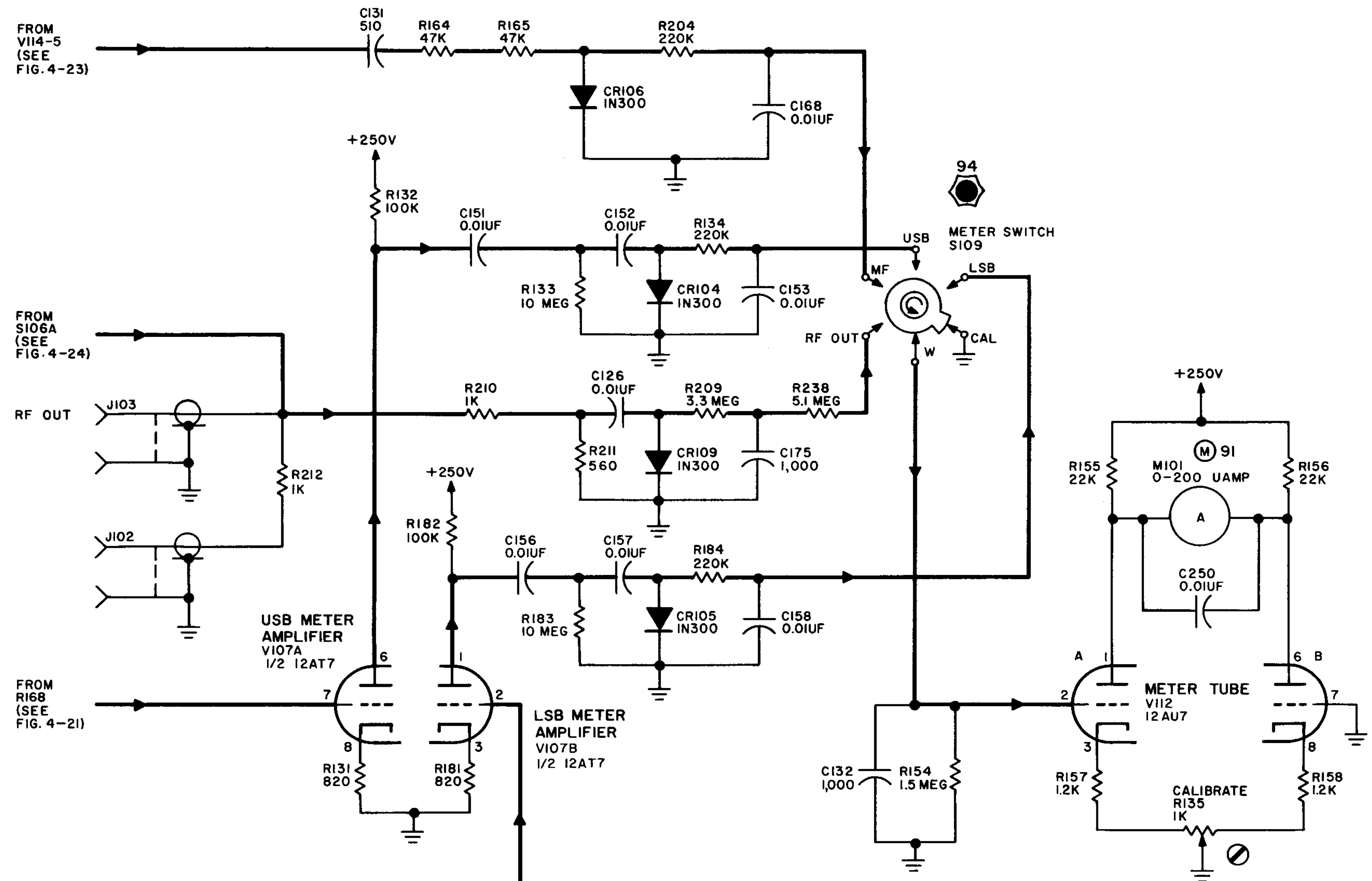
S106 A,B,C,D POSITIONS	
POS	BAND (MCS)
1	2–4
2	4–8
3	8–16
4	16–32

Figure 4-24. Schematic Diagram, SBE-2, 2- to 32-mc HF Section



NOTE:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS AND ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS.
2. KNOB CONTROL.
3. TOGGLE SWITCH.
4. (I) NEON INDICATOR.

Figure 4-25. Schematic Diagram, SBE-2, SQUELCH and VOX Section



NOTE:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS.
2. KNOB CONTROL.
3. FRONT PANEL SCREWDRIVER ADJUSTMENT.
4. (M) METER.

Figure 4-26. Schematic Diagram, SBE-2, M101 Meter Section

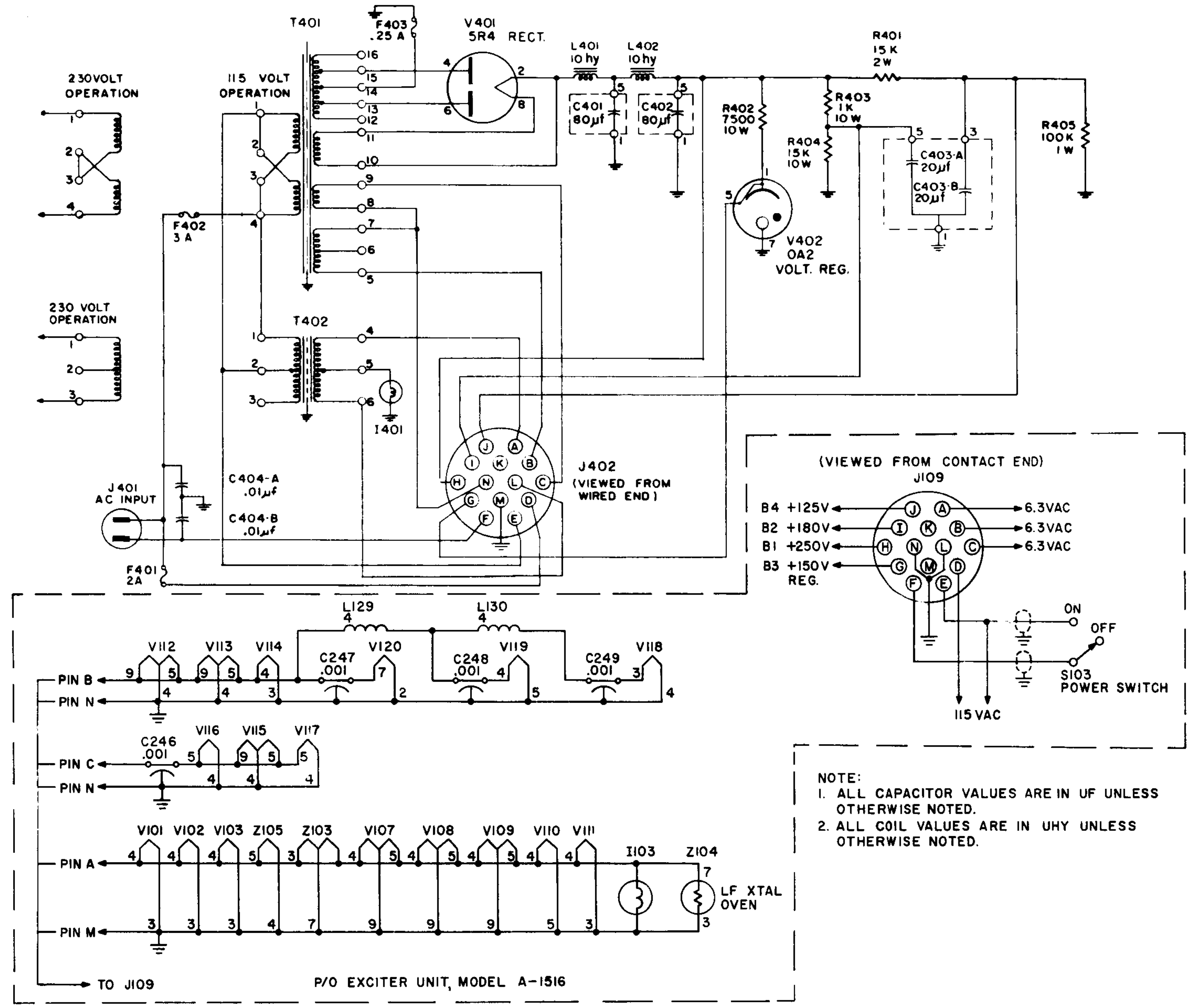


Figure 4-27. Schematic Diagram, SBE-2, Power Supply Section

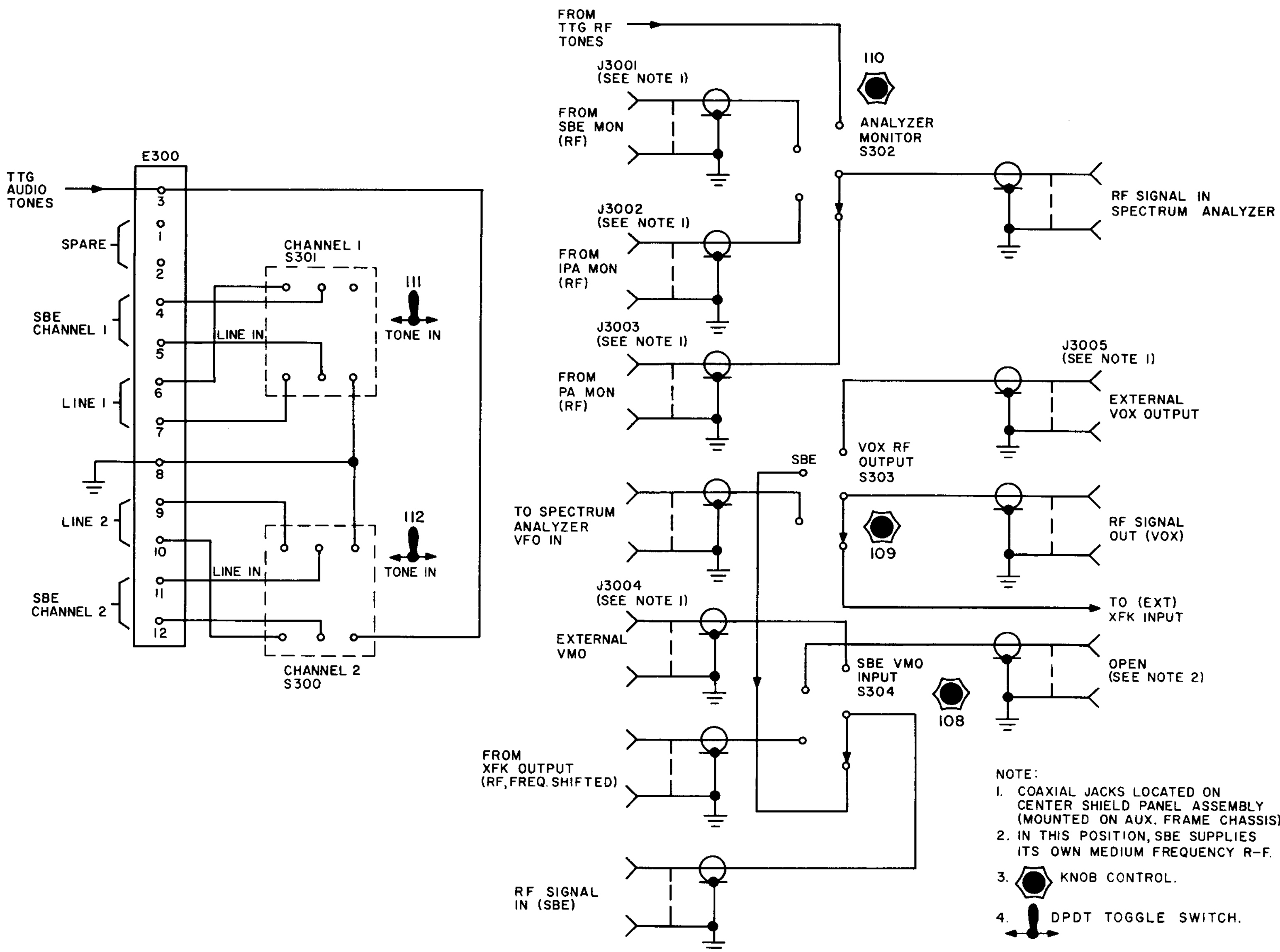
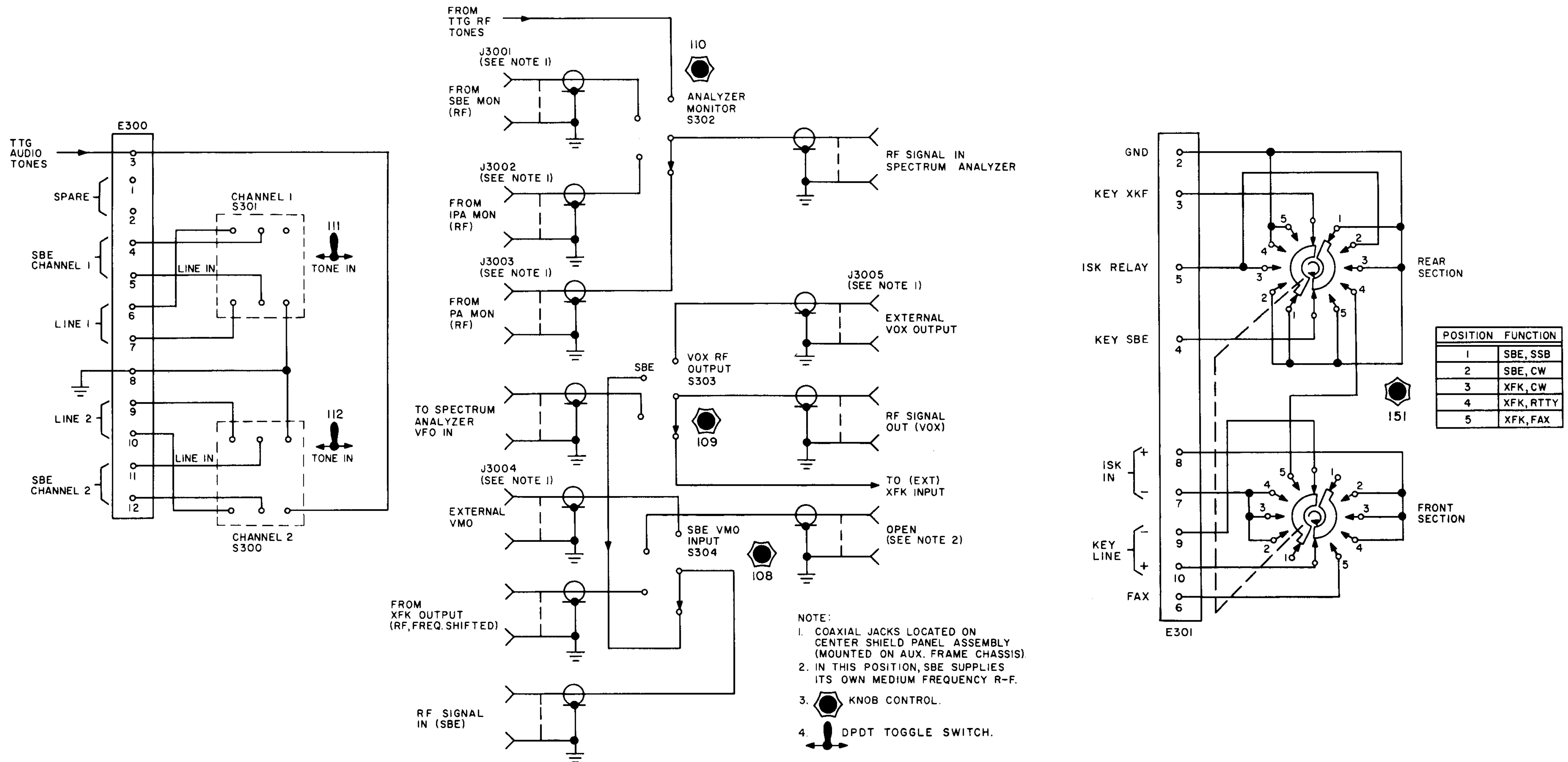


Figure 4-28. Schematic Diagram, MCP (Sheet 1 of 2)



POSITION	FUNCTION
1	SBE, SSB
2	SBE, CW
3	XFK, CW
4	XFK, RTTY
5	XFK, FAX

Figure 4-28. Schematic Diagram, MCP (Sheet 2 of 2)

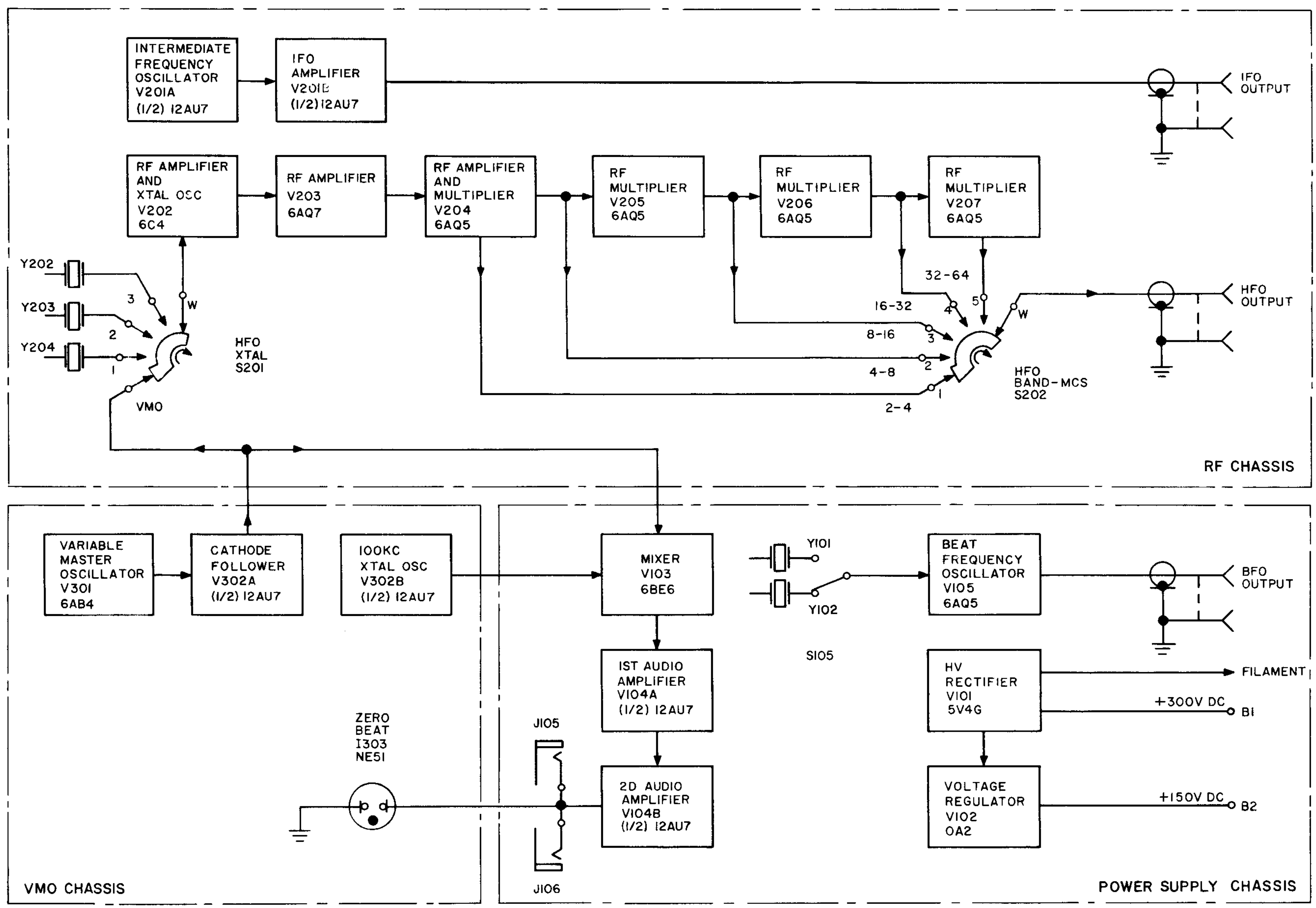


Figure 4-29. Block Diagram, VOX

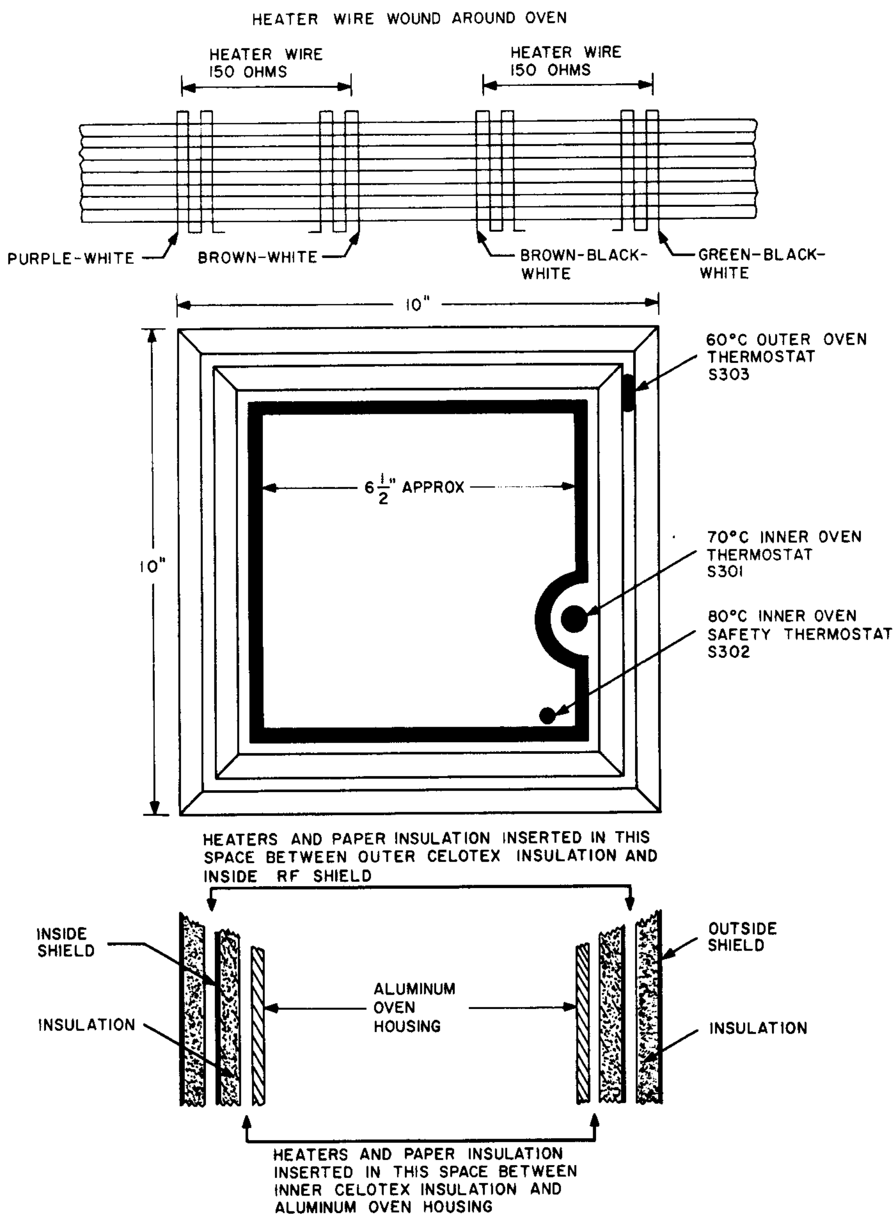


Figure 4-30. Diagram Illustrating Oven, VOX

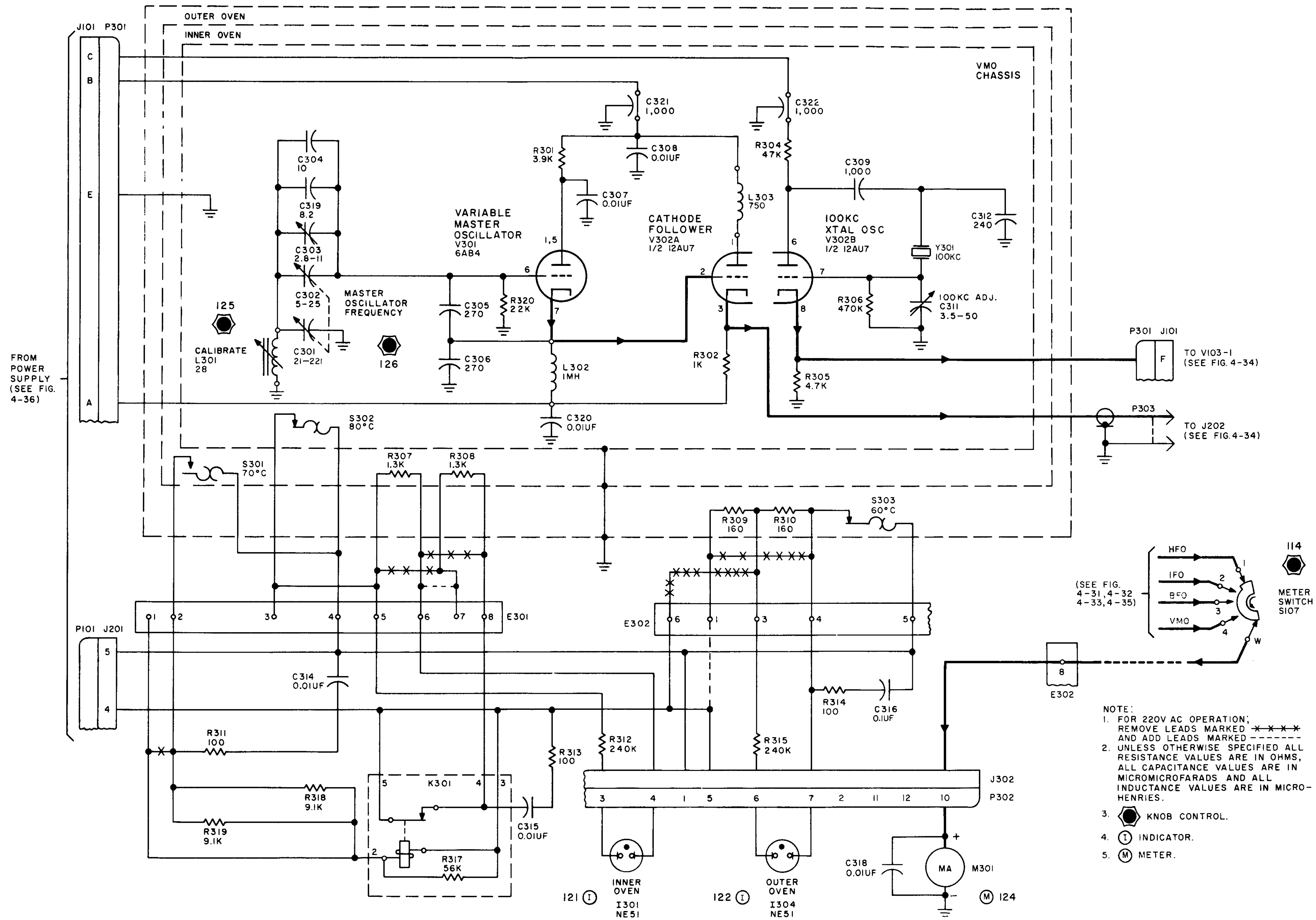
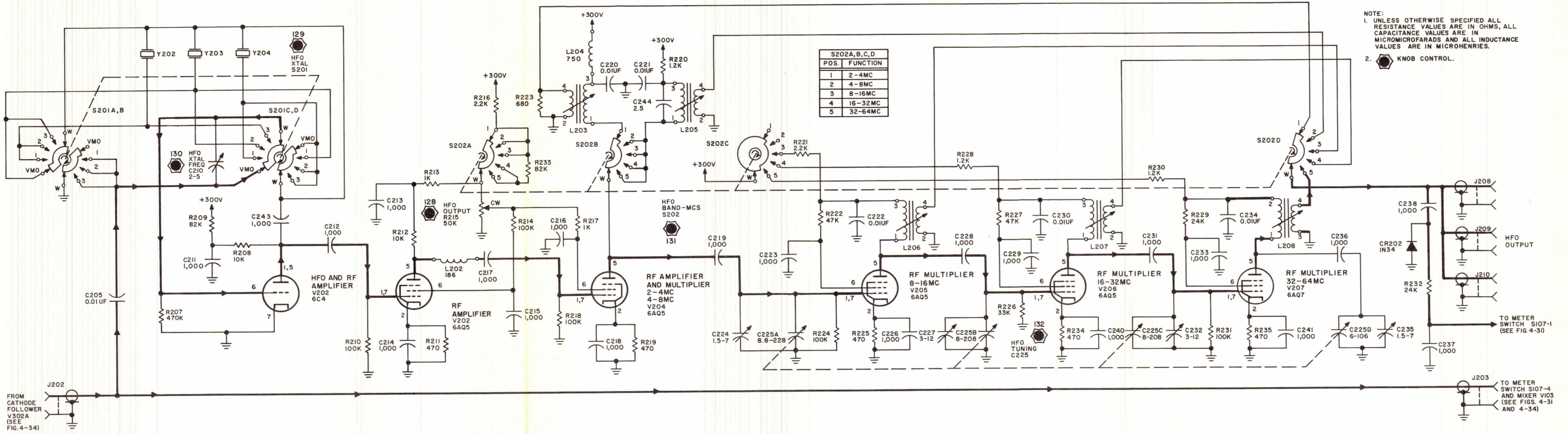


Figure 4-31. Schematic Diagram, VOX, VMO Section



S202A,B,C,D	
POS.	FUNCTION
1	2-4MC
2	4-8MC
3	8-16MC
4	16-32MC
5	32-64MC

NOTE:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES.
2. ⬢ KNOB CONTROL.

Figure 4-32. Schematic Diagram, VOX, HFO Chain

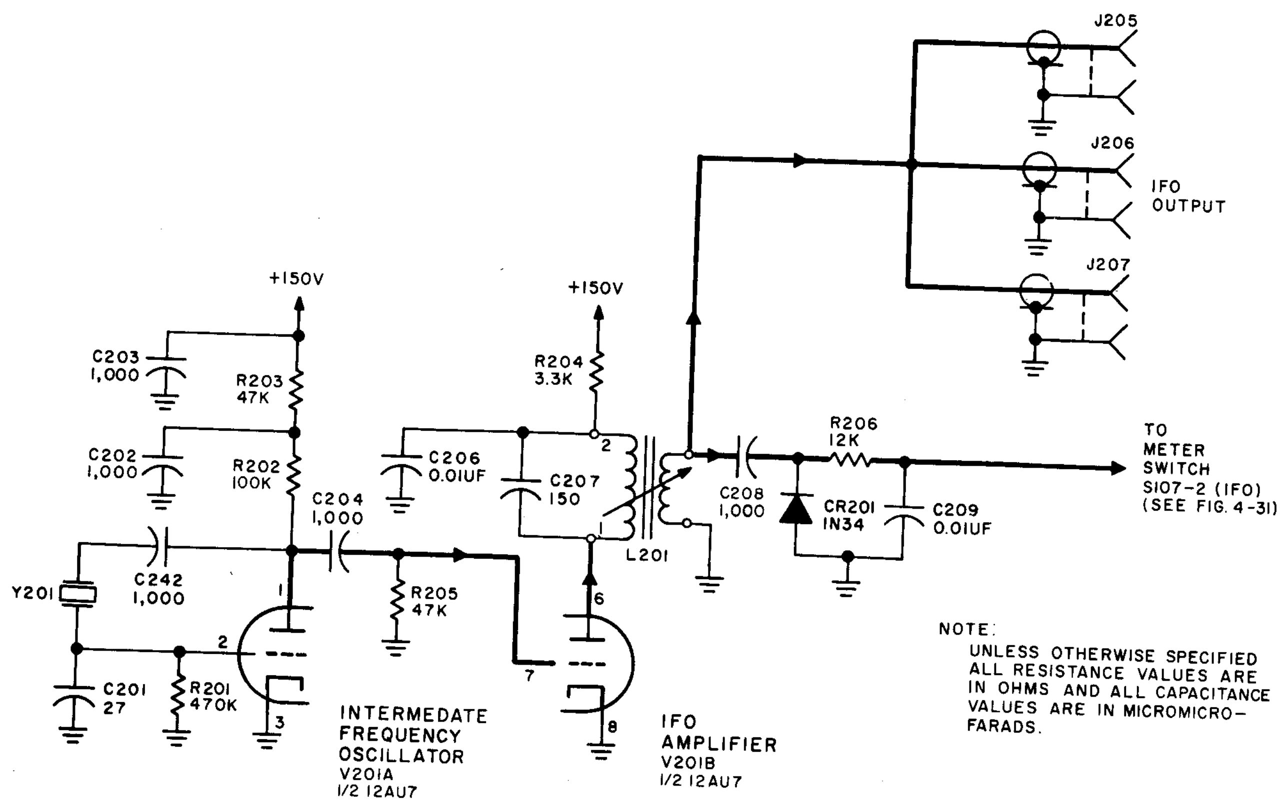


Figure 4-33. Schematic Diagram, VOX, IFO Circuit

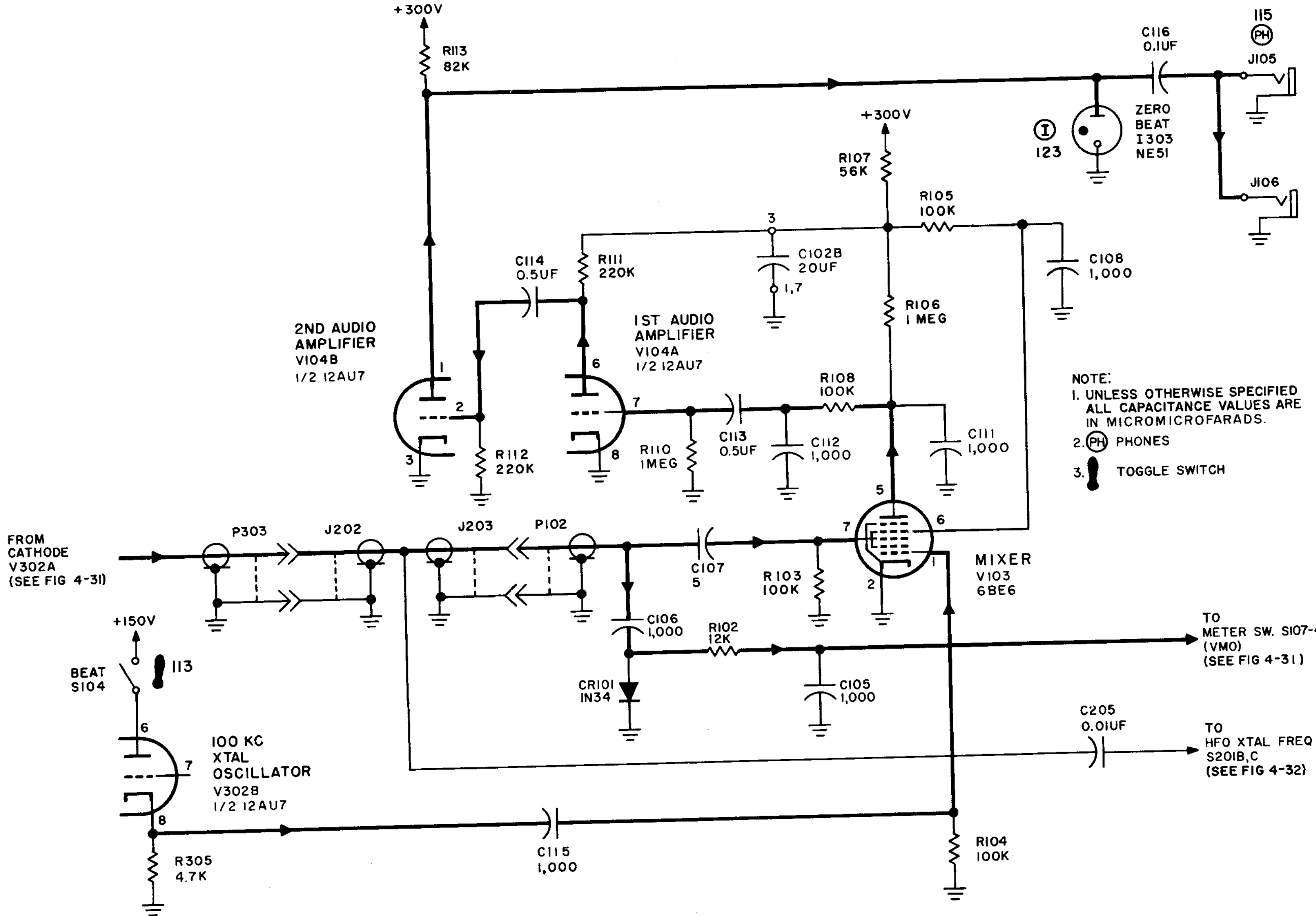


Figure 4-34. Schematic Diagram, VOX, Calibrating Chain

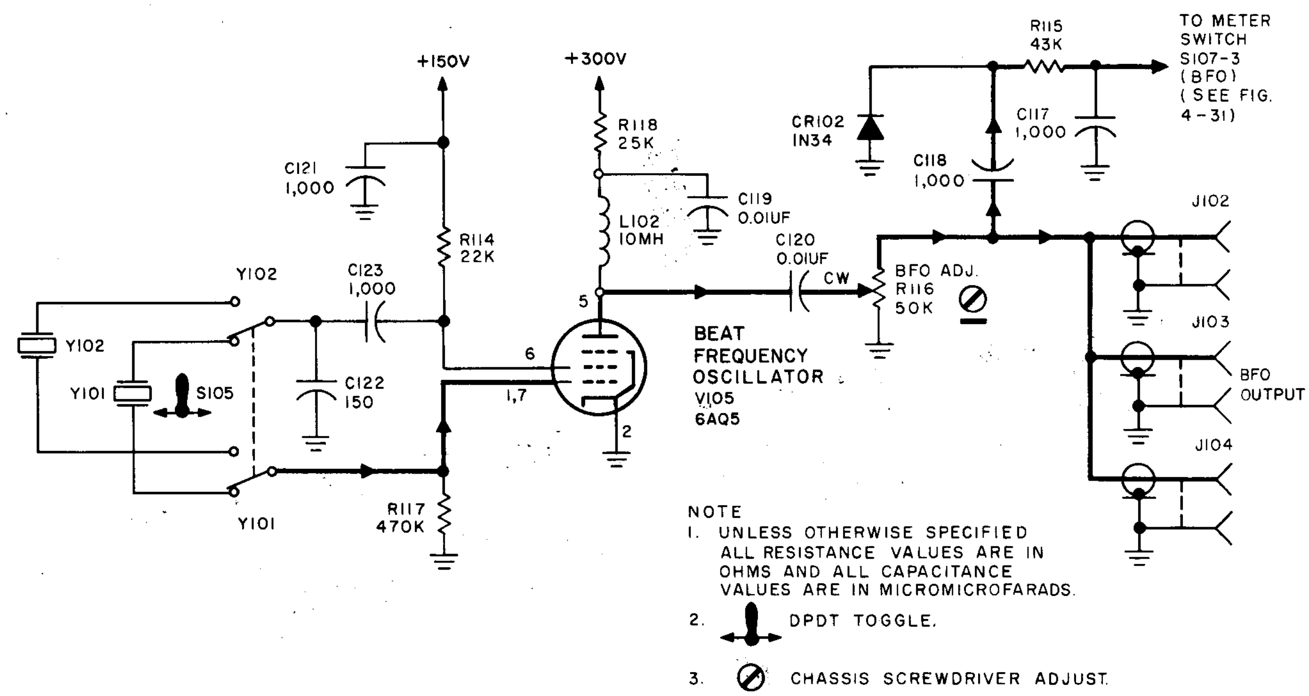


Figure 4-35. Schematic Diagram, VOX, BFO Circuit

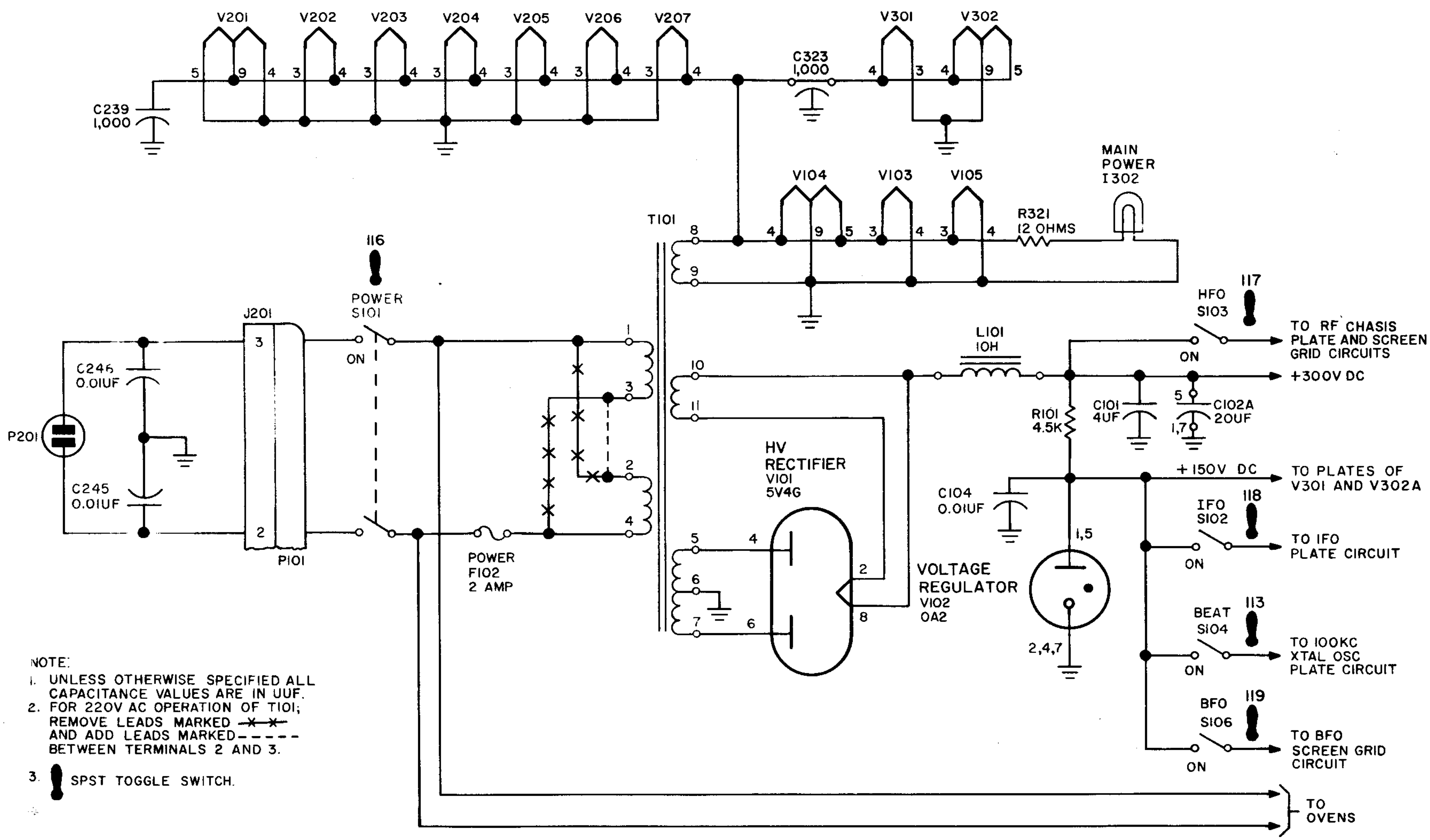


Figure 4-36. Schematic Diagram, VOX, Power Supply

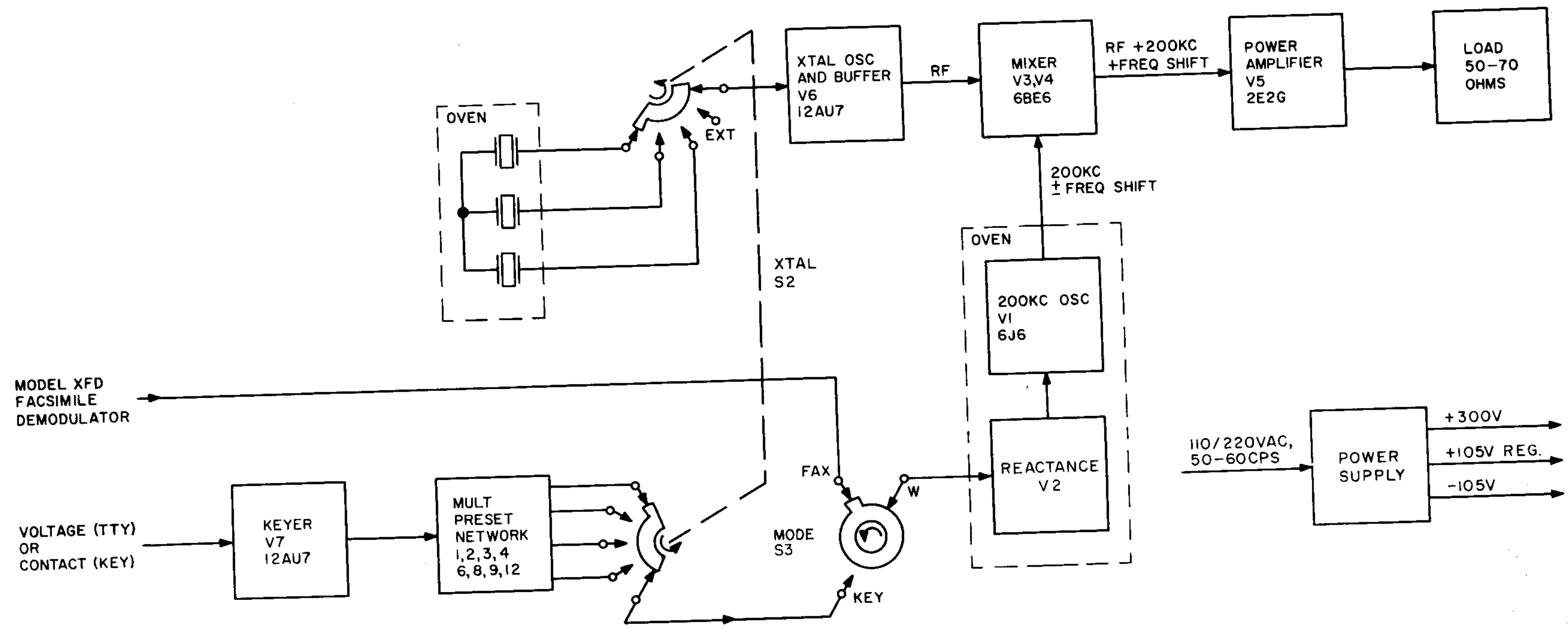


Figure 4-37. Block Diagram, XFK

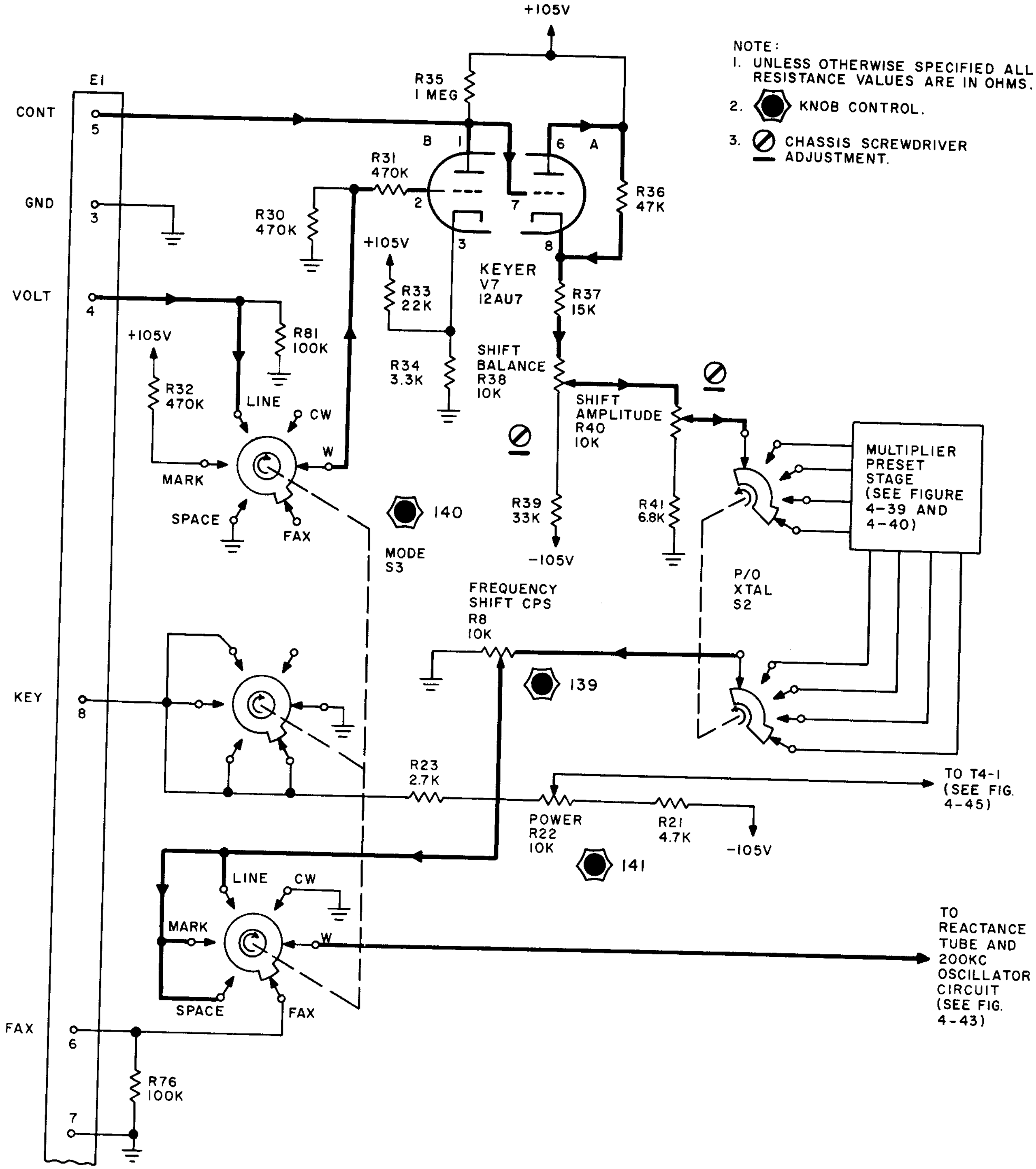
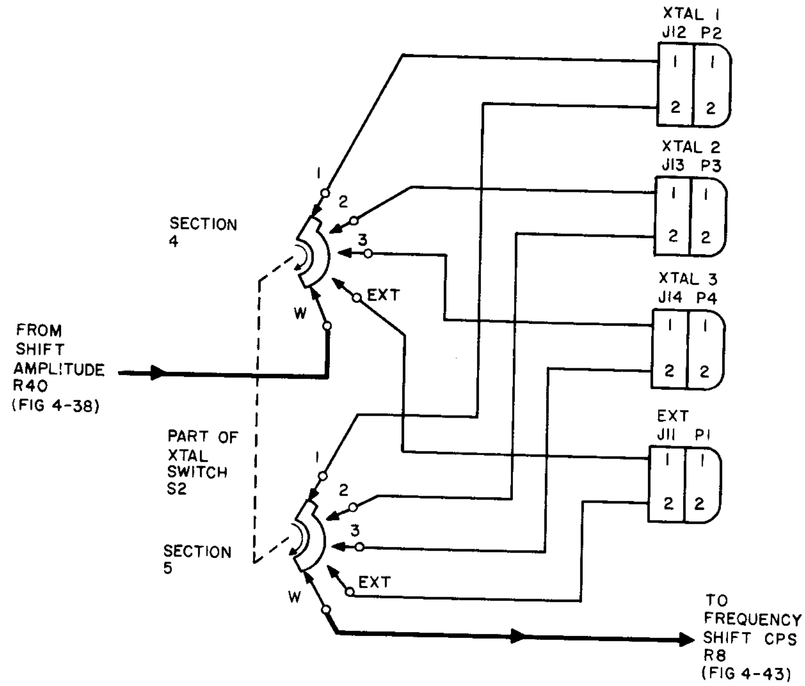
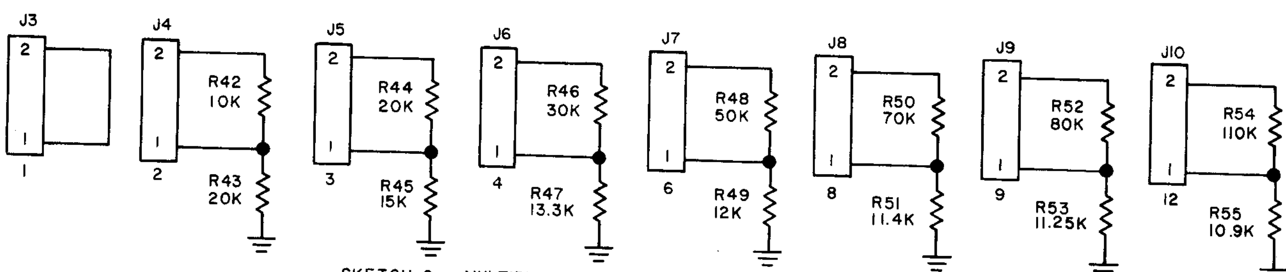


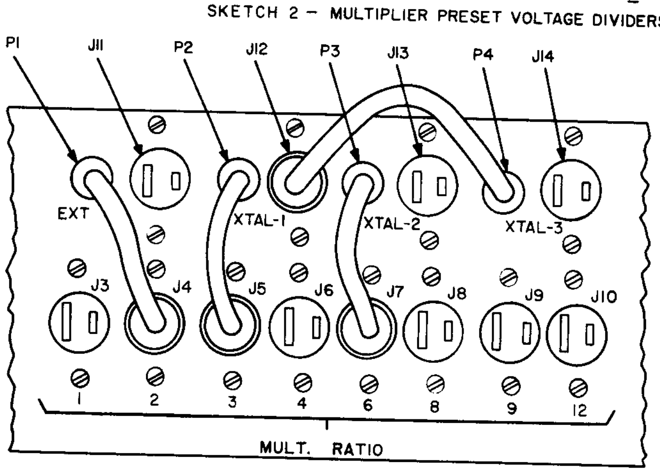
Figure 4-38. Schematic Diagram, XFK, Keyer Tube V7



SKETCH 1 – INTERCONNECTIONS BETWEEN KEYER V7 AND MULTIPLIER PRESET SECTIONS 4 AND 5



SKETCH 2 – MULTIPLIER PRESET VOLTAGE DIVIDERS



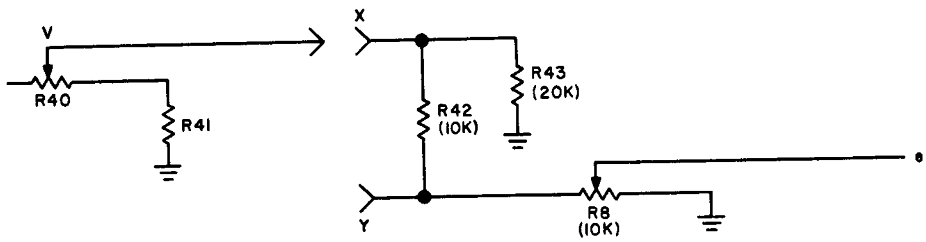
A TYPICAL PATCHING ARRANGEMENT

XTAL SELECTOR POSITION	XMTR. MULT. RATIO	XMTR. OUTPUT FREQ. SHIFT (DIAL SET.) CPS	XFK FREQ. SHIFT
EXT	2	850	425
XTAL-1	3	850	283
XTAL-2	6	850	142
XTAL-3	3	850	283

SKETCH 3 – ILLUSTRATING A SPECIFIC PATCHING ARRANGEMENT TO OBTAIN FREQUENCY SHIFTS SHOWN UNDER CONDITIONS STATED IN TABLE

Figure 4-39. Schematic Diagram, XFK, Multiplier Preset Stage

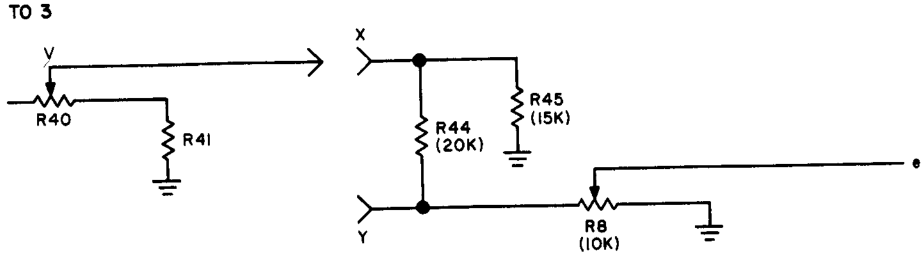
CASE 1-EXT TO 2



1. IMPEDANCE TO GROUND AT R40
   "Y" WIRING : 10K.
   "X" WIRING : (R42+R8)(20K) PARALLELED BY R43 (20K): 10K.
   HENCE POTENTIAL AT R40 (V) IS UNCHANGED BY OPTIONS X,Y.

2. VALUE OF e
   "Y" WIRING : POTENTIAL AT POINT Y IS V; e = P/O(V).
   "X WIRING : POTENTIAL AT POINT Y IS V/2; e = P/O (V/2).

CASE 2-XTAL 1 TO 3



1. IMPEDANCE TO GROUND AT R40
   "Y" WIRING: 10K.
   "X" WIRING:(R44 + R8)(30K) PARALLELED BY R45 (15K) ; 10K.
   HENCE POTENTIAL AT R40 (V) IS UNCHANGED BY OPTIONS X, Y.

2. VALUE OF e
   "Y" WIRING: POTENTIAL AT POINT Y IS Y; e = P/O(V).
   "X" WIRING: POTENTIAL AT POINT Y IS V/3; e = P/O (V/3).

Figure 4-40. Circuit Diagram Illustrating Proper Setting of Shift, XFK

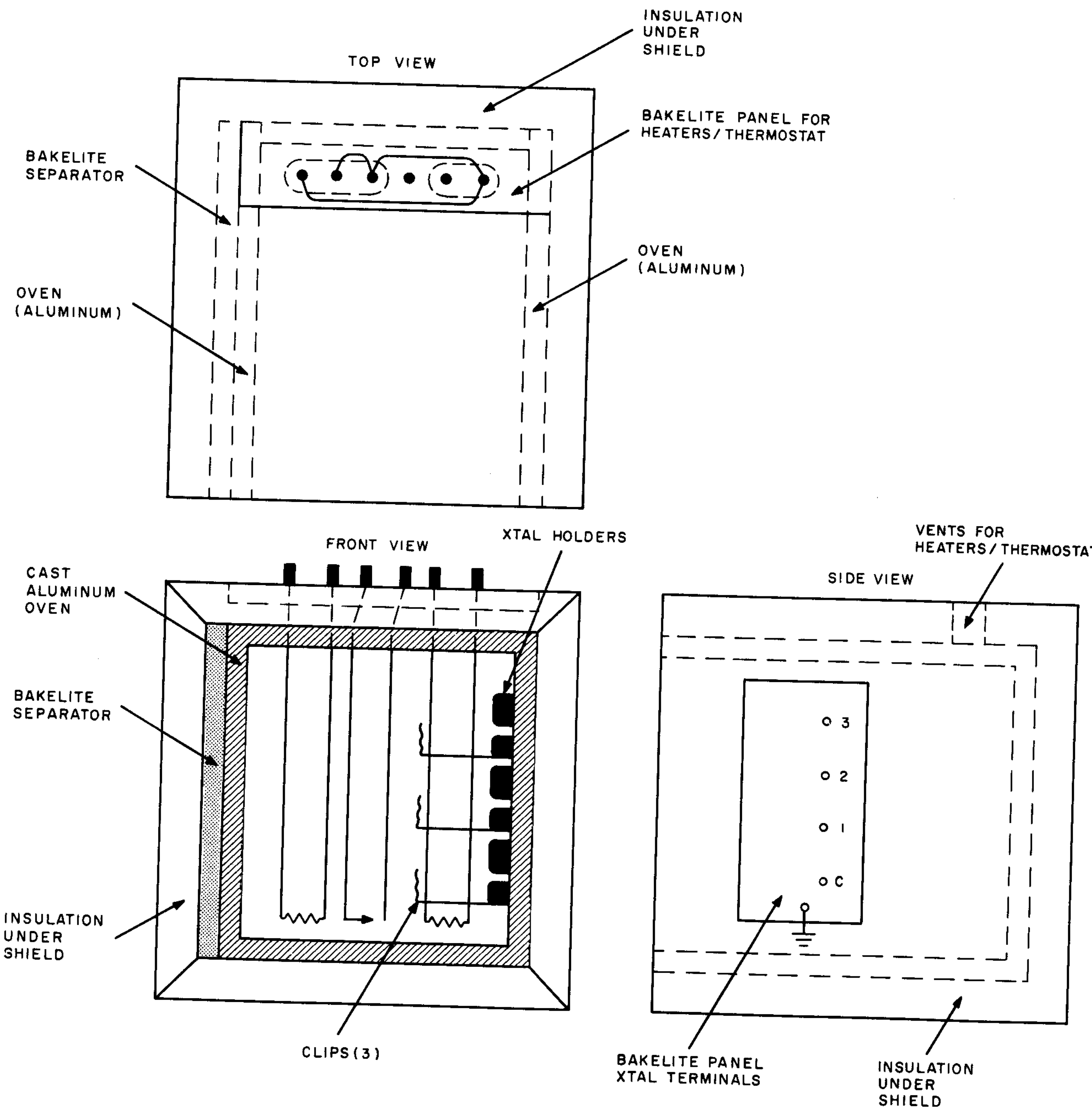


Figure 4-41. Diagram Illustrating Ovens, XFK

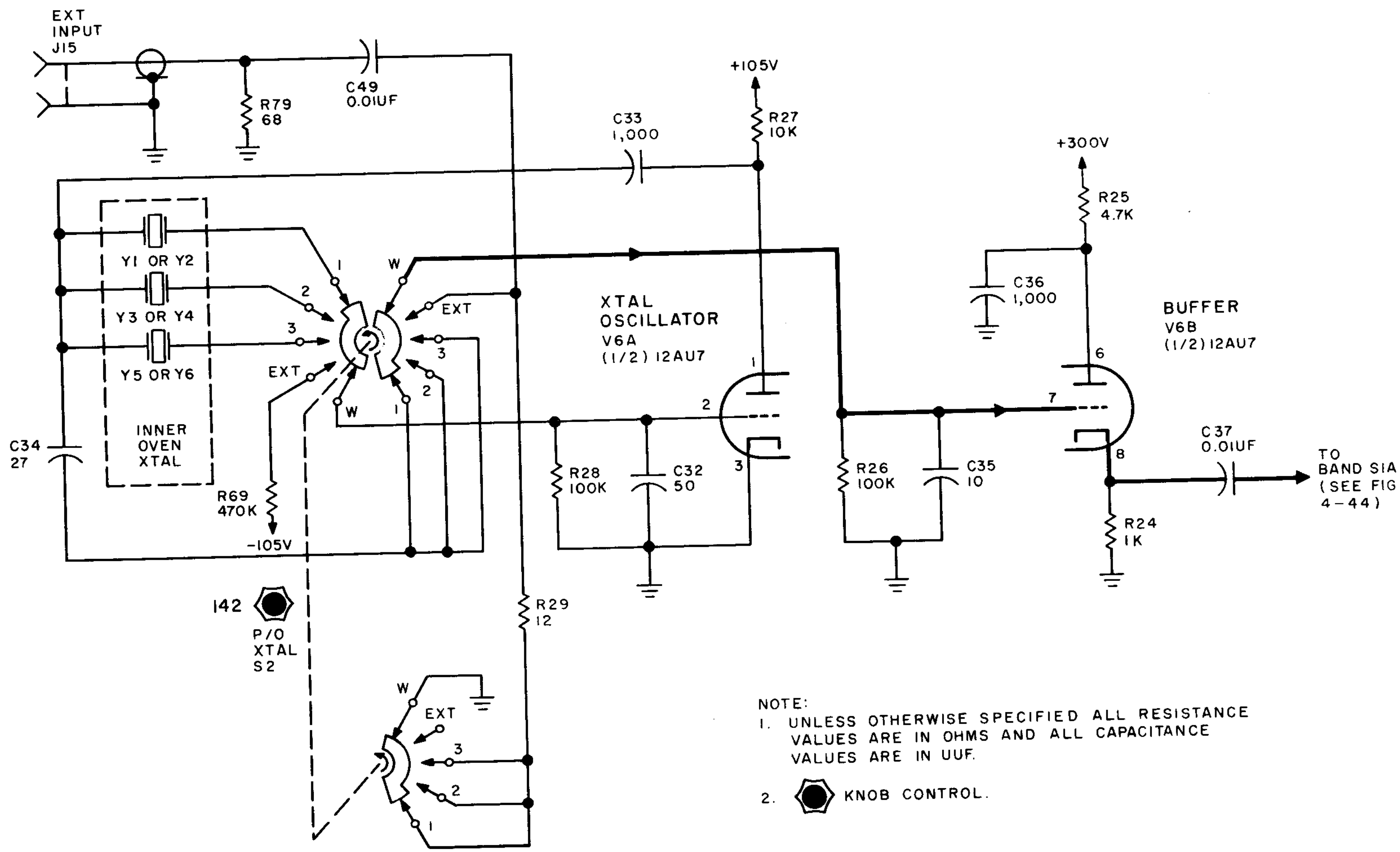


Figure 4-42. Schematic Diagram, XFK, Crystal Oscillator and Buffer V6

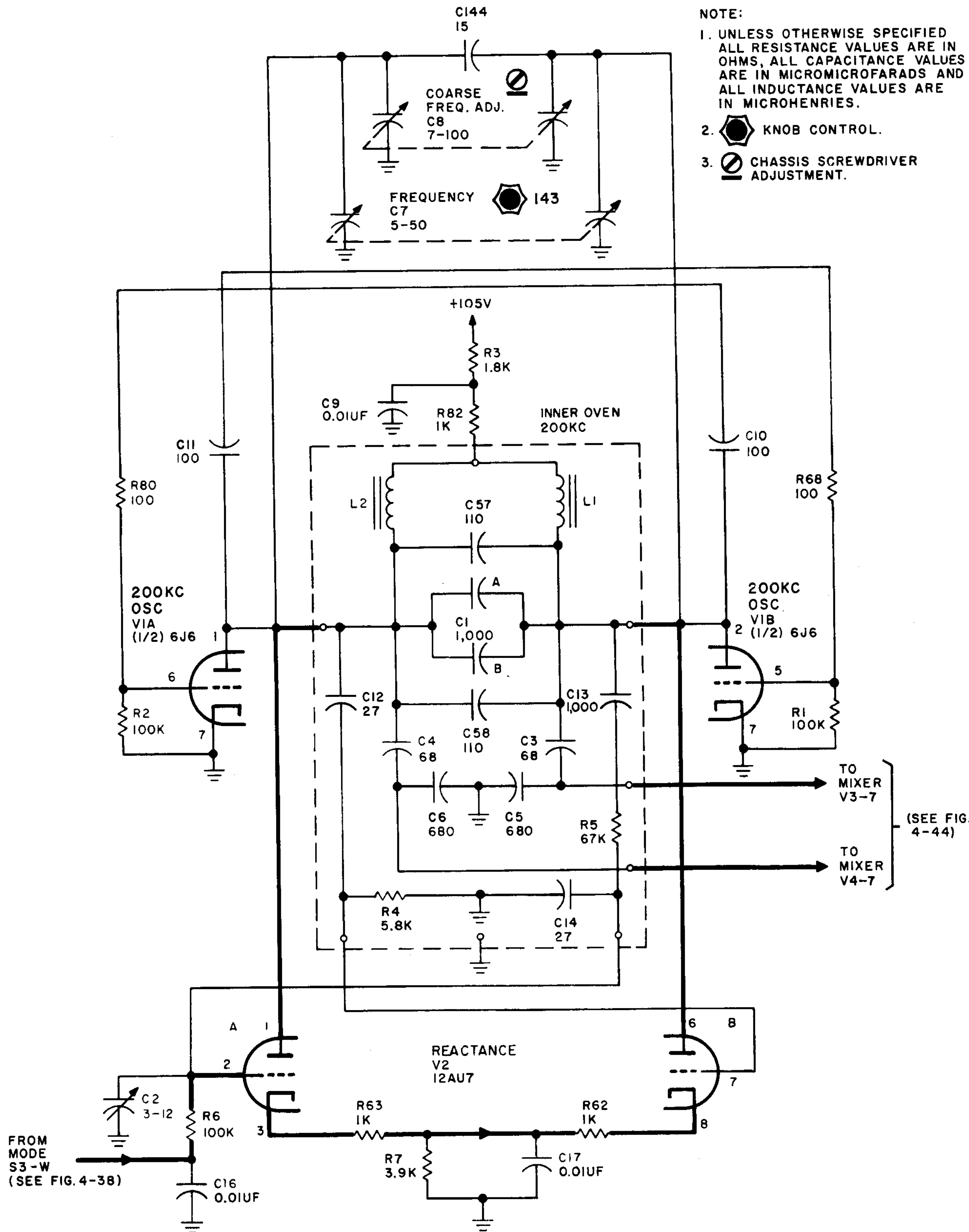


Figure 4-43. Schematic Diagram, XFK, Reactance Tube V2 and 200-kc Oscillator Tube V1

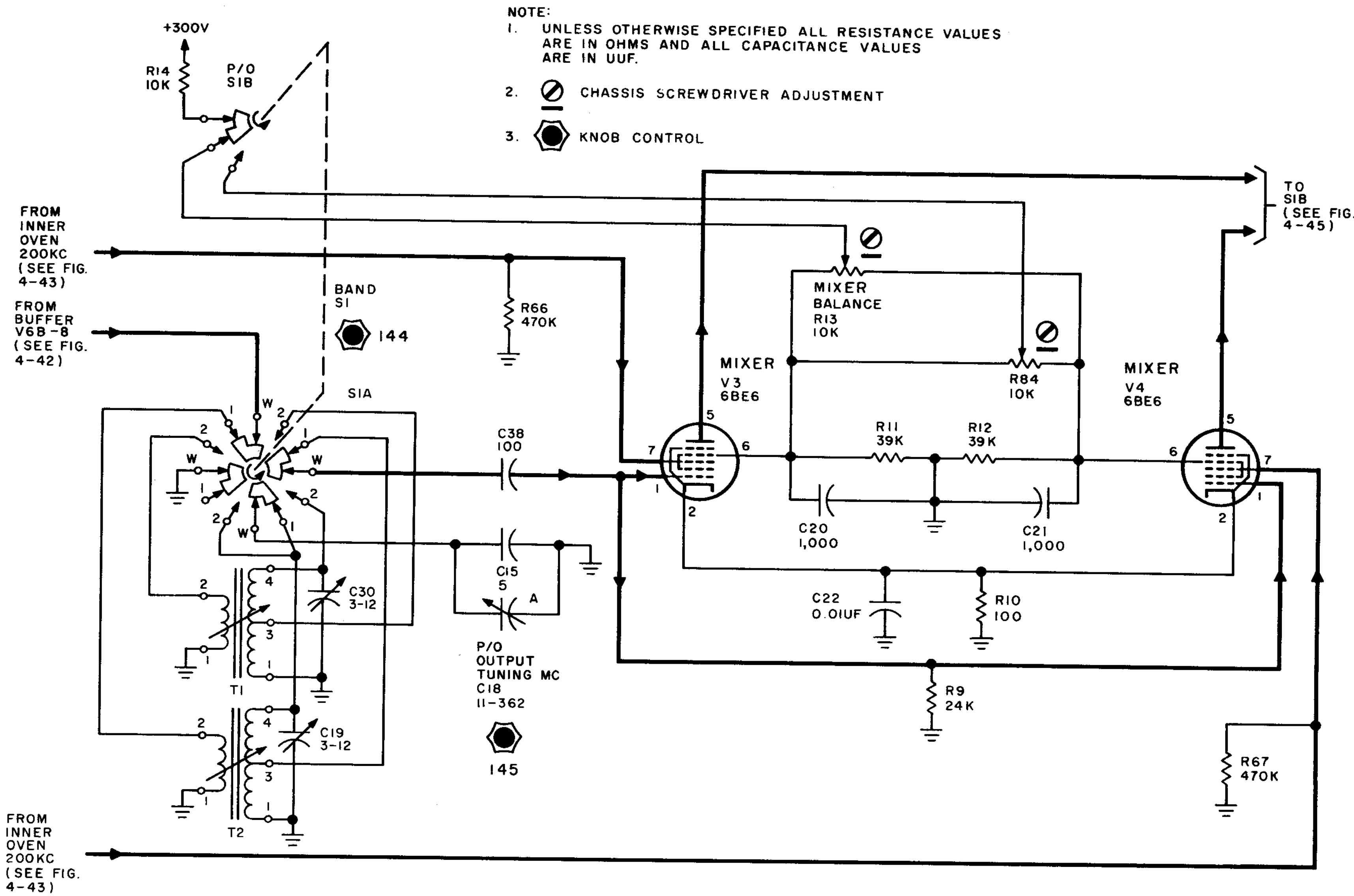


Figure 4-44. Schematic Diagram, XFK, Mixer Tubes V3 and V4

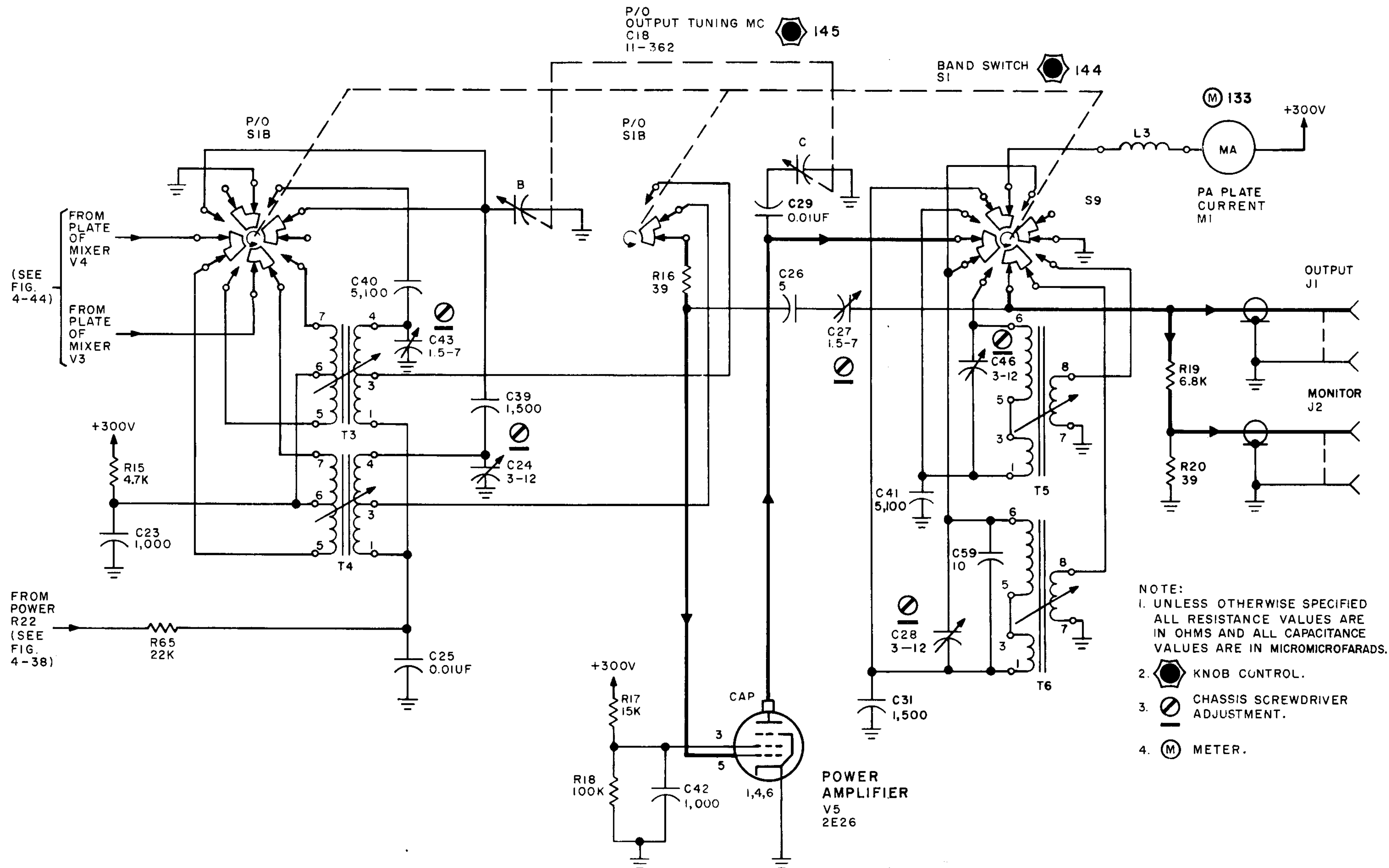
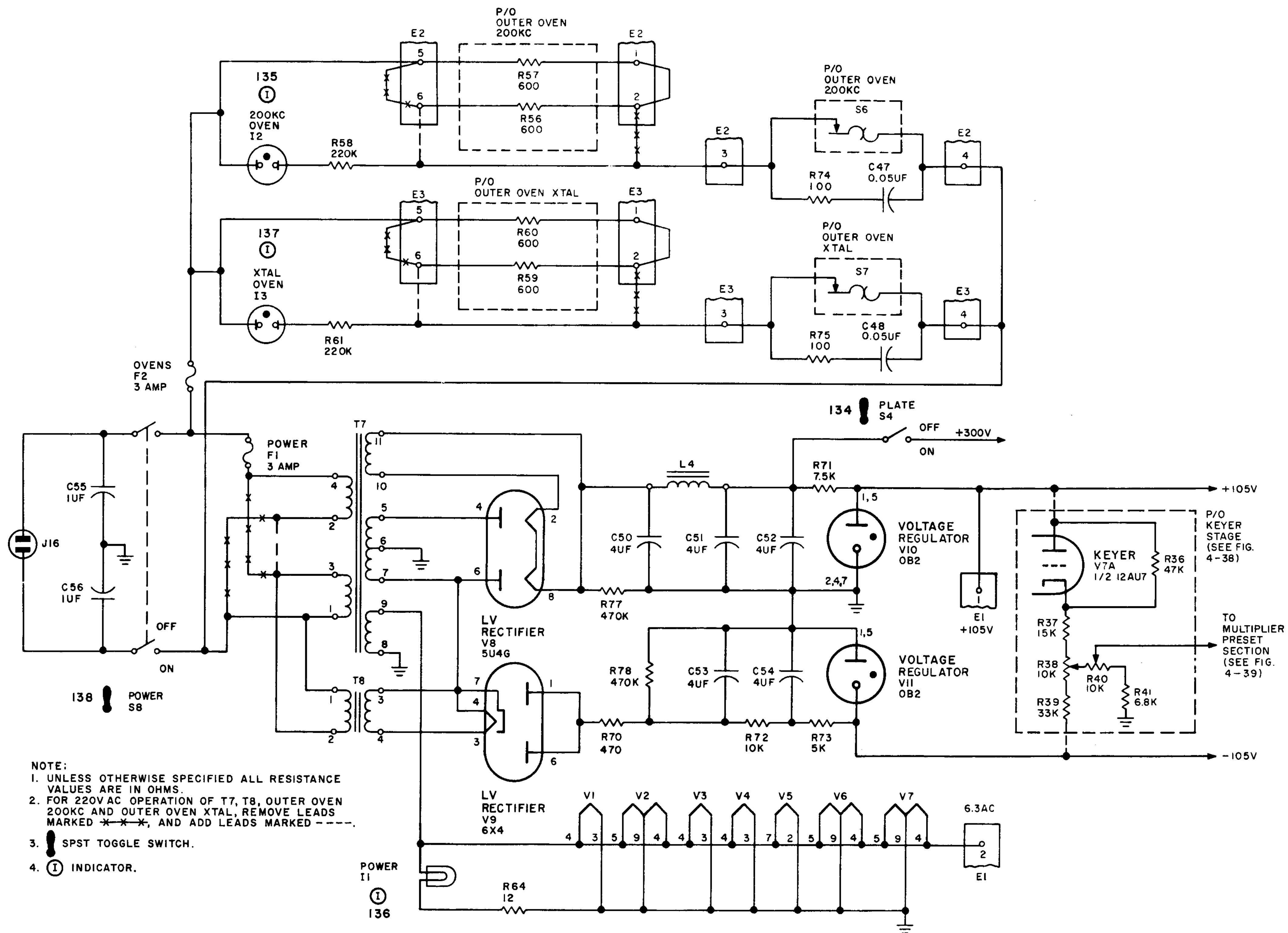


Figure 4-45. Schematic Diagram, XFK, Power Amplifier Tube V5



NOTE:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS.
2. FOR 220V AC OPERATION OF T7, T8, OUTER OVEN 200KC AND OUTER OVEN XTAL, REMOVE LEADS MARKED -x-x-x, AND ADD LEADS MARKED - - - -.
3. SPST TOGGLE SWITCH.
4. (I) INDICATOR.

Figure 4-46. Schematic Diagram, XFK, Power Supply

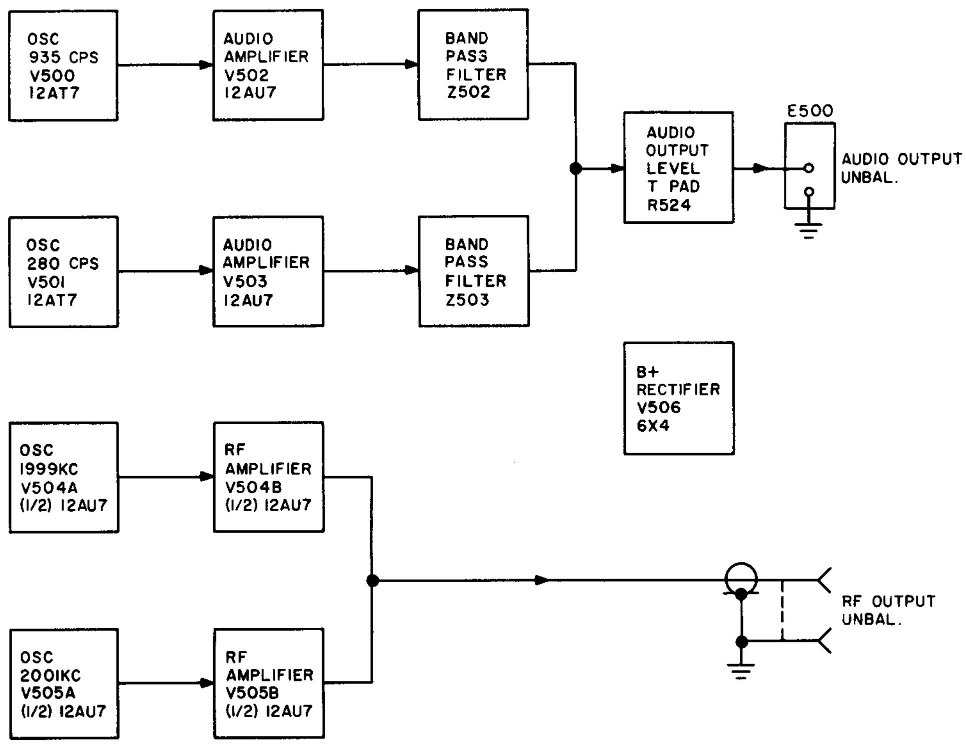
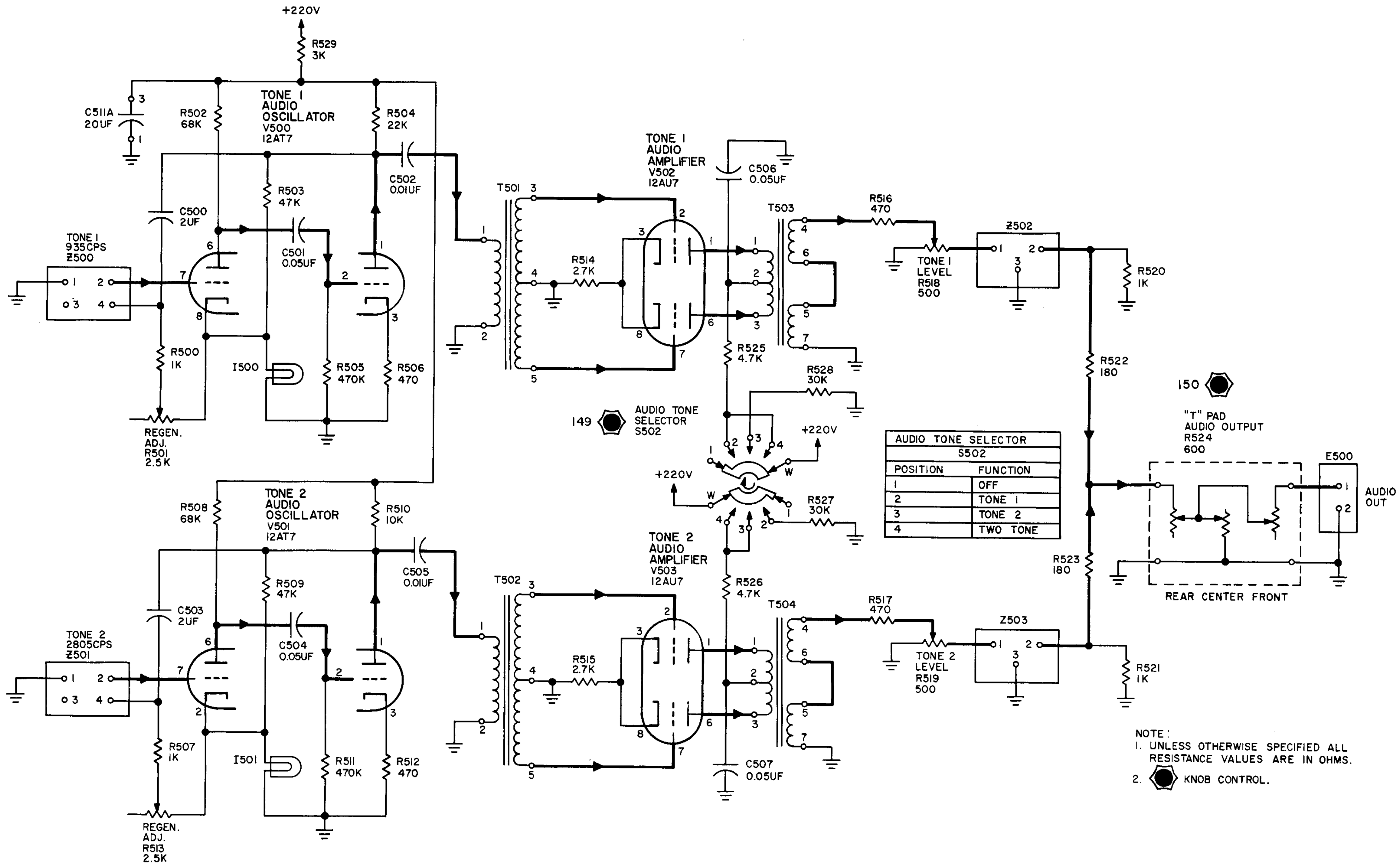


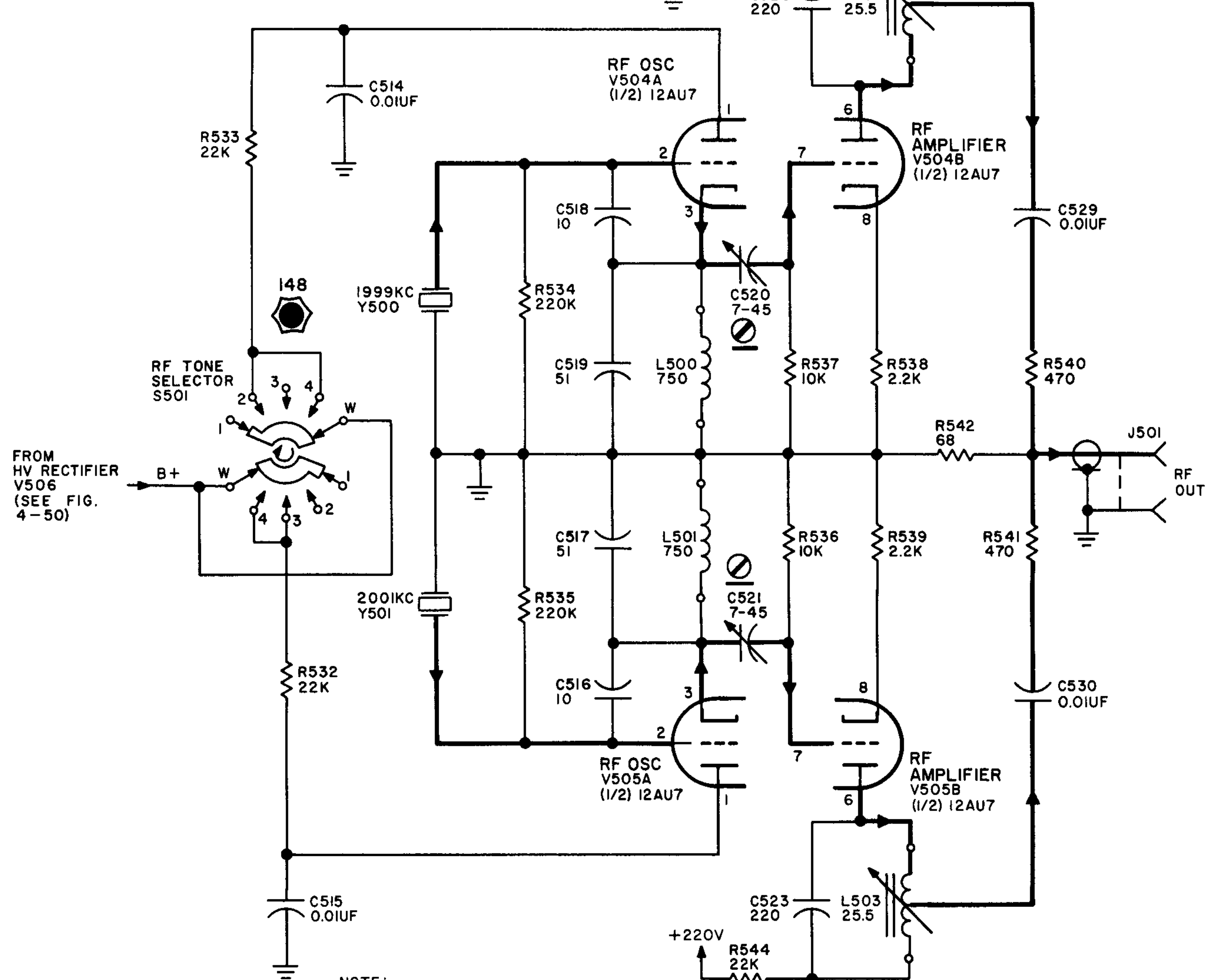
Figure 4-47. Block Diagram, TTG



AUDIO TONE SELECTOR S502	
POSITION	FUNCTION
1	OFF
2	TONE 1
3	TONE 2
4	TWO TONE

Figure 4-48. Schematic Diagram, TTG, Audio Section

RF TONE SELECTOR	
S501	
POSITION	FUNCTION
1	OFF
2	TONE 1
3	TONE 2
4	TWO TONE



NOTE:
1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES.
2. ⊘ CHASSIS SCREWDRIVER ADJUSTMENT.
3. ⬢ KNOB CONTROL.

Figure 4-49. Schematic Diagram, TTG, Radio Section

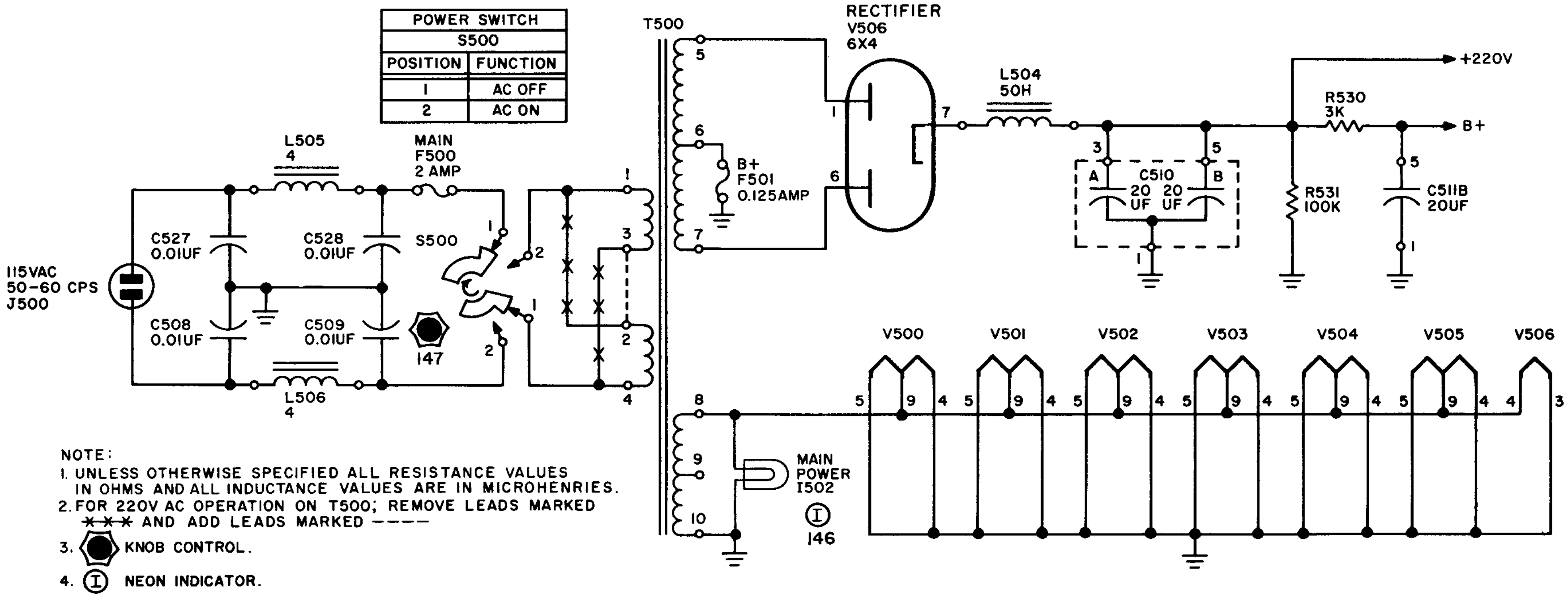


Figure 4-50. Schematic Diagram, TTG, Rectifier Section

S4001

POS.	KEYING MODE
1	50V
2	100V
3	60MA
4	20MA

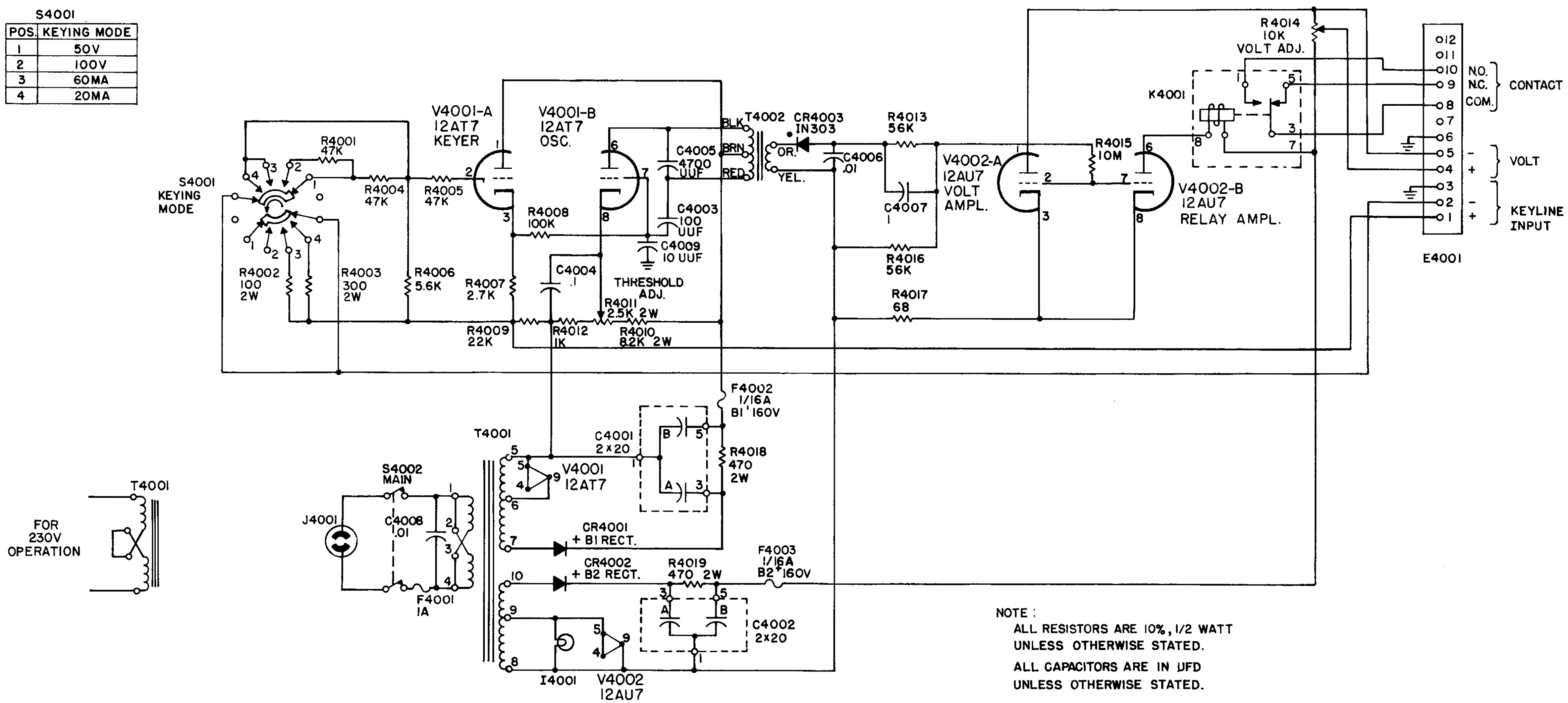


Figure 4-51. Schematic Diagram, ISK

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 call outs 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 occuring 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. Schematic diagrams of all equipments will be found in Section 7, Volumes I and II of the manual.

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 wave forms, 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. SIDEBAND LEVEL MONITOR MODEL SLM-1.

a. VOLTAGE AND RESISTANCE DIAGRAM. - Figure 5-1 shows voltage and resistance to chassis measurements at vacuum tube pins and other selected points in the SLM-1 unit.

b. LOCATION DATA. - Figure 5-2 is a photograph with callouts of the major electronic equipment elements of the SLM-1.

c. TROUBLE-SHOOTING CHART BASED ON OPERATING PROCEDURE. - See figure 7-1 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 SLM-1.

(1) POWER SUPPLY. - The power supply should always be checked in cases of trouble. If the tube filaments and MAIN POWER indicator lamp I400 fail to go on, the probable cause may be: MAIN fuse F400; no input power; or the primary and secondary filament winding of transformer T400. In this event turn off the equipment, remove the power cord, and check continuity of power supply transformer T400. Also check B+ fuse F401, HV rectifier tube V402, filter network (L400, C402, and R401), and/or voltage regulator tube V403. See the SLM-1 voltage and resistance diagram, figure 5-1, and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

(2) USB SECTION. - The USB section can be checked by observing USB LEVEL output meter M400 readings under various magnitudes of 17-kc inputs at jack J401. If the USB LEVEL meter fails to indicate a reading, check tube V401 and tube pin voltages. See the SLM-1 voltage and resistance diagram, figure 5-1, and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

(3) LSB SECTION. - The LSB section can be checked by observing LSB LEVEL output meter M401 readings under various magnitudes of 17-kc inputs at jack J400. If the LSB LEVEL meter fails to indicate a reading, check tube V400 and tube pin voltages. See the SLM-1 voltage and resistance diagram, figure 5-1, and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

5-4. SIDEBAND LEVEL MONITOR MODEL SLM-2.

a. VOLTAGE AND RESISTANCE DIAGRAM. - Figure 5-3 shows voltage and resistance-to-chassis measurements at vacuum tube pins and other selected points in the SLM-2 unit.

b. LOCATION DATA. - Figure 5-4 is a photograph with callouts of the major electronic equipment elements of the SLM-2.

c. TROUBLE-SHOOTING CHART BASED ON OPERATING PROCEDURES. - See figure 7-1 for interpretation of control designations. Refer to table 5-2.

d. TROUBLE-SHOOTING PROCEDURES BASED ON CIRCUIT SECTIONALIZATION. - The following paragraphs present selected specification performance data of the SLM-2. The trouble-shooting procedures based on circuit sectionalization for Sideband Level Monitor Model SLM-2 with a few exceptions, as indicated in the following paragraphs.

(1) POWER SUPPLY. - See 5-3d(1) and figure 5-3 instead of figure 5-1.

(2) USB SECTION. - See 5-3d(2) and figure 5-3 instead of figure 5-1.

(3) LSB SECTION. - See 5-3d(3) and figure 5-3 instead of figure 5-1.

5-5. FREQUENCY SPECTRUM ANALYZER (FSA).

a. VOLTAGE AND RESISTANCE DIAGRAM. - The voltage and resistance diagram, figure 5-5, was made with the SA section and power supply interconnected for normal operation. All readings were taken between points specified and chassis ground, using an RCA VTVM Model WV-77A. The following control positions were used:

IF ATTEN	O DB
SWEEP WIDTH SELECTOR	VAR
BRILLIANCE	Bright trace
FOCUS	Sharp trace
AMPLITUDE SCALE	LIN
CENTER FREQ.	Marker
AFC	OFF
GAIN	10 (max)
CAL OSC LEVEL	OFF
INPUT ATTENUATOR	All up
H POS	Normal operation
V POS	Normal operation
SWEEP WIDTH	Maximum (clockwise)
IF BANDWIDTH	Maximum (clockwise)
VIDEO FILTER	OFF
SWEEP RATE	Maximum (clockwise)

b. LOCATION DATA. - Figure 5-6 is a photograph with callouts of the major electronic equipment elements of the FSA.

5-6. TRANSMITTING MODE SELECTOR MODEL SBE-3.

a. VOLTAGE AND RESISTANCE DIAGRAM. - Figure 5-7 shows voltage and resistance-to-chassis measurements at vacuum tube pins and other selected points in the SBE and its power supply.

b. LOCATION DATA. - Figure 5-8 is a photograph with callouts of the major electronic equipment elements of the SBE-3.

c. TROUBLE-SHOOTING CHART BASED ON OPERATING PROCEDURES. - See figure 7-3 for interpretation of control designations. Refer to table 5-3.

d. TROUBLE-SHOOTING PROCEDURES BASED ON CIRCUIT SECTIONALIZATION. - The following paragraphs present selected specification performance data of the SBE-3.

(1) POWER SUPPLY. - The SBE-3 power supply has triple fuse protection: oven heater, power supply primary, and high voltage. (Since a partial short across the B+ line may not blow the line fuse, this separate high-voltage fuse has been incorporated in this unit.) If no meter readings can be obtained or the EXCITER lamp fails to go on when the EXCITER ON-STANDBY switch is in ON position, check fuse F402 (MAIN fuse). If after 1-hour warm-up period, the OVEN lamp fails to go on alternately every 4 or 5 minutes, check fuse F401 (OVEN fuse). See the SBE-3 voltage and resistance diagram, (figure 5-7) and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

(2) 250-KC OSCILLATOR. - Use a reliable VTVM with an RF probe to check for a reading of 1.0 to 1.5 volts (250 kc) from the center arm of R263 to ground. If this requirement is not fulfilled, check the 250-kc oscillator section (Z103). See the SBE-3 voltage and resistance diagram, figure 5-7, and check the tube pin sockets voltages with a reliable 20,000 ohms-per-volt meter.

(3) MID-FREQUENCY OSCILLATOR. - Connect a VMO or signal generator (2 to 4 mc, 1.0 to 2.5 volts, see below) to VMO input. Place the 2- and 4-mc crystals in positions 1 and 2, respectively, in the MF XTAL OVEN. Connect an RF voltmeter to the junction of C163 and C164. Check the following voltages:

MF STAL SW	Volts (approximately)
Position 1 (2 MC)	2.5
Position 2 (4 MC)	1.2
VMO (2 MC)	2.5
VMO (4 MC)	1.4

If these voltages are not obtained, check for faulty components in the mid-frequency section. See the SBE-3 voltage and resistance diagram, figure 5-7, and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

(4) HIGH-FREQUENCY OSCILLATOR. - Connect an RF voltmeter to the top of R205 (output control); turn off mid-frequency oscillator by turning MF XTAL SW a vacant position. Voltage should vary from 2 to 5 volts as BAND MCS switch is rotated from 1 to 14. In the event that the high-frequency oscillator appears to be faulty, see the SBE-3 voltage and resistance diagram, figure 5-7, and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

(5) VOX SECTION. - The VOX circuit will function only in the SSB or DSB operation of the unit and not with conventional AM or SSB with full carrier. The VOX GAIN and SQUELCH GAIN controls (R140 and R129, respectively) are set properly only when the operator talking directly into the mike will energize the EXCITER; outputs from nearby receivers or background noise should not energize the exciter. If the VOX circuit is not working properly, see the SBE-3 voltage and resistance diagram, figure 5-7, and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

(6) USB AND LSB SECTIONS. - Turn TTG on to SBE-3 and note correlation of TTG with SBE LSB and USB levels on meter. Both sideband outputs can be adjusted through the LSB GAIN or USB GAIN controls and the gain indicated on the output meter. If either sideband (USB or LSB) cannot be peaked, this would be an indication of trouble. In this event, see the SBE-3 voltage and resistance diagram, figure 5-7, and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

5-7. TRANSMITTING MODE SELECTOR MODEL SBE-2.

a. VOLTAGE AND RESISTANCE DIAGRAM. - Figure 5-9 shows voltage and resistance-to-chassis measurements at vacuum tube pins and other selected points in the SBE and its power supply.

b. LOCATION DATA. - Figure 5-10 is a photograph with callouts of the major electronic equipment elements of the SBE-2.

c. TROUBLE-SHOOTING CHART BASED ON OPERATING PROCEDURES. - See figure 7-3 for interpretation of control designations. Refer to table 5-4.

d. TROUBLE-SHOOTING PROCEDURES BASED ON CIRCUIT SECTIONALIZATION. - The following paragraphs present selected specification performance data of SBE-2.

(1) POWER SUPPLY. - The SBE-2 power supply has triple fuse protection: oven heater, power supply primary, and high voltage. (Since a partial short across the B+ line may not blow the line fuse, this separate high-voltage fuse has been incorporated in this unit.) If no meter readings can be obtained or the EXCITER lamp fails to go on when the EXCITER ON-STANDBY switch is placed in ON position, check fuse F402 (MAIN fuse). If after 1-hour warm-up period, the OVEN lamp fails to go on alternately every 4 or 5 minutes, check fuse F401 (OVEN fuse). See the SBE-2 voltage and resistance diagram, figure 5-9, and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

(2) 17-KC OSCILLATOR. - A reading of 1.0 to 1.5 volts (17 kc) should be indicated between the center arm of R110 or R112 and ground. This reading should be made with a reliable AC VTVM. If a widely different reading is obtained, check for faults in the 17-kc oscillator section. See the SBE-2 voltage and resistance diagram, figure 5-9, and check the tube pin socket voltages (V104) with a reliable 20,000 ohms-per-volt meter.

(3) 287-KC OSCILLATOR. - Use a reliable VTVM with an RF probe to check for a reading of 1.0 to 1.5 volts (287 kc) from the center arm of R113 to ground. If a widely different reading is obtained, check for faults in the 287-kc oscillator section. See the SBE-2 voltage and resistance diagram, figure 5-9, and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

(4) MID-FREQUENCY OSCILLATOR. - Connect a VMO or signal generator (2 to 4 mc, 1.0 to 2.5 volts, see below) to VMO input. Place 2- and 4-mc crystals in positions 1 and 2, respectively, in the MV XTAL OVEN. Connect an RF voltmeter to the junction of C163 and C164. Check the following voltages:

MG XTAL SW	Volts (approximately)
Position 1 (2 MC)	2.5
Position 2 (4 MC)	1.2
VMO (2 MC)	2.0
VMO (4 MC)	1.0

If these voltages are not obtained, check for faulty components in the mid-frequency section. See the SBE-2 voltage and resistance diagram, figure 5-9, and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

(5) HIGH-FREQUENCY OSCILLATOR. - Connect an RF voltmeter to top of R205 (output control); turn off mid-frequency oscillator by turning MF XTAL SW to a vacant position. Voltage should vary from 2 to 5 volts as BAND MCS switch is rotated from 1 to 14. In the event the high frequency oscillator appears to be faulty, see the SBE-2 voltage and resistance diagram, figure 5-9, and check the tube pin socket voltages with a reliable 20,000 ohms-per-volt meter.

(6) VOX SECTION. - The VOX circuit will function only in the SSB or DSB operation of the unit and not with conventional AM or SSB with full carrier. The VOX section contains a VOX and SQUELCH amplifier V110, VOX and SQUELCH rectifier V111, a RELAY amplifier V109, and relay K101. Amplifier V110 detects and amplifies a portion of the 17-kc LSB and USB signal; the signal is rectified through V111, generating a DC signal. It is then amplified in V109, energizing relay K101. When relay K101 is energized, it automatically provides a ground circuit for the GPT-10K (with EXCITER switch S105 in STANDBY position) when the operator talks directly into the mike. The VOX gain and SQUELCH gain controls (R140 and R129, respectively) are set properly only when the operator talking directly into the mike will energize the EXCITER; outputs from nearby receivers or background noise should not energize the exciter.

(7) USB and ISB SECTIONS. - Turn TTG on to SBE-2 and note correlation of TTG with SBE LSB and USB levels on meter. Both sideband outputs can be adjusted through the LSB GAIN or USB GAIN control and the gain indicated on the output meter. If trouble is indicated, see the SBE-2 voltage and resistance diagram, figure 5-9.

5-8. VARIABLE FREQUENCY OSCILLATOR MODEL VOX-2.

a. GENERAL. - As pointed out in paragraph 4-7, the VOX consists of the power supply (section 1), the RF chassis (section 2), and the VMO (section 3). The voltage and resistance diagrams, figure 5-11-a, through 5-11-c make use of this division of equipment.

b. VOLTAGE AND RESISTANCE DIAGRAMS. - Figures 5-11-a and 5-11-b show voltage and resistance-to-chassis and voltage-to-chassis measurements at vacuum tube pins and other selected points in the VOX under the conditions stated.

c. LOCATION DATA. - Figures 5-12-a through 5-12-c are photographs with callouts of the major electronic equipment elements of the VOX.

d. TROUBLE-SHOOTING CHART BASED ON OPERATING PROCEDURES. - See figure 7-5 for interpretation of control designations. Refer to table 5-5.

e. 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 will greatly hamper 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 4-30 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 will continue 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 S01 in the rear of the unit and replace S301 if the thermometer reads well over 70°C.

To check the VMO output, simply turn METER switch 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 band switch, 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.

5-9. FREQUENCY SHIFT EXCITER MODEL XFK.

a. VOLTAGE AND RESISTANCE DIAGRAM. - Figure 5-13 shows voltage and resistance-to-chassis measurements at vacuum tube pins and other selected points in the XFK under the conditions stated.

b. LOCATION DATA. - Figures 5-14-a through 5-14-c are photographs with callouts of the major electronic equipment elements of the XFK.

c. TROUBLE-SHOOTING CHART BASED ON OPERATING PROCEDURES. - See figure 7-6 for interpretation of control designations. Refer to table 5-6.

d. TROUBLE-SHOOTING PROCEDURES BASED ON CIRCUIT SECTIONALIZATION. - Careful observation of the performance of the XFK on the various frequencies while operating various controls may sectionalize the faults to a particular stage or circuit. The XFK may be divided into four main operating sections:

(1) 200-kc oscillator and reactance tube circuitry

(2) Keyer circuit including automatic multiplication section

(3) Radio frequency section

(4) Power supply

Which section is in trouble will be apparent from the symptoms.

A major fault in the power supply will be indicated on the PA PLATE CURRENT meter. If there is no plate current when PLATE ON-OFF switch S4 is set to ON position, the power supply is malfunctioning. Should the PA PLATE CURRENT meter read over 50 ma and cannot be controlled, check the PA neutralization.

Correct performance of the keyer circuit may be determined by measuring the DC voltage at the grid of V2, pin #2. With 1000 cycles shift applied, the voltage should be approximately +4 volts with MODE switch S3 in the SPACE position, and -4 volts when the MODE switch is in the MARK position.

Proper performance of the 200-kc oscillator and reactance tube may be easily determined by use of a frequency meter. The frequency should be close to 200-kc and shift approximately ±500 cps. If so, the 200-kc oscillator and reactance tube are operating properly. If there is no output from the XFK, the malfunction may be traced to the RF section.

With any XTAL within the operating range of the XFK, there should be 10 volts of RF at the grid of cathode follower stage (buffer) V6. If the unit has checked satisfactorily to this point, the trouble is in the RF section.

5-10. TWO TONE GENERATOR MODEL TTG.

a. VOLTAGE AND RESISTANCE DIAGRAM. - Figure 5-15 shows voltage and resistance-to-chassis measurements at vacuum tube pins and other selected points in the TTG under the conditions stated.

b. LOCATION DATA. - Figures 5-16-b through 5-16-b are photographs with callouts of the major electronic equipment elements of the TTG.

c. TROUBLE-SHOOTING CHART BASED ON OPERATING PROCEDURES. - See figure 7-7 for interpretation of control designations. Refer to table 5-7.

d. TROUBLE-SHOOTING PROCEDURES BASED ON CIRCUIT SECTIONALIZATION. - The following outline presents selected specification performance data of TTG stages. The TTG can be easily separated into three segments, audio (935 and 2805), radio (1.999 and 2.001 kc), and power supply, greatly facilitating trouble-shooting procedures based on circuit sectionalization. The following paragraphs isolate a malfunction to a particular segment of TTG.

(1) POWER SUPPLY. - If the MAIN POWER indicator and the tube filaments fail to go on with the POWER ON-OFF switch set to ON position, check fuse F500. If there is no B+ power throughout the chassis, check B+ fuse F501, high-voltage rectifier V506, power supply filter network, and the position of the AUDIO TONE SELECTOR and RF TONE SELECTOR switches. Inspect the power supply for any signs of discoloration due to arcing and loose connections. Any one of the above symptoms mentioned could cause the TTG to be inoperative. (See the TG voltage and resistance diagram, figure 5-15.) Check the tube pin socket voltage with a reliable 20,000 ohms-per-volt meter.

(2) AUDIO TONE SECTION. - The audio tone output is controlled through the AUDIO TONE SELECTOR switch. This switch controls the B+ to either tone 1 or tone 2 oscillators individually or simultaneously. If there is no output from the audio tone section, a quick check would be to turn the RF TONE SELECTOR to either TONE 1 or TONE 2 position. If there is an RF output from the TTG, the fault is within the audio tone section. Should there be no output from the RF tone section too, the B+ fuse is defective. Tubes V500 and V502 are the tone 1 audio oscillator and audio amplifier, respectively. If either tube is defective, this can cause no audio tone 1 output; V501 and V503 control the output for audio tone 2 output. If either tube is defective, this can cause no audio tone 2 output. The above mentioned tubes can be checked through voltage and resistance measurements. (See the TTG voltage and resistance diagram, figure 5-9.) Check each tube pin socket voltage with a reliable 20,000 ohms-per-volt meter.

(3) RF TONE SECTION. - The RF tone output is controlled through the RF TONE SELECTOR switch. This switch controls the B+ to either tone 1 or tone 2 oscillators individually or simultaneously. In the event there is no output from the RF TONE SELECTOR, a quick check would be to set the AUDIO TONE SELECTOR to either TONE 1 or TONE 2 position. If there is an audio OUTPUT from the TTG, the fault is within the RF tone SECTION. Should there be no output from audio tone section too, the B+ fuse is defective. Tube V504 is the tone 1 RF oscillator and RF amplifier, respectively. If this tube is defective, this can cause no RF tone 1 output. Tube V505 is the tone 2 RF oscillator and RF amplifier, respectively. If this tube is defective, this can cause no RF tone 2 output. Tubes V504 and V505 can be checked through voltage and resistance measurements. (See the TTG voltage and resistance diagram, figure 5-9.) Check each tube pin socket voltage with a reliable 20,000 ohms-per-volt meter.

5-11. ISOLATION KEYER MODEL AK-100.

a. VOLTAGE AND RESISTANCE DIAGRAM. - Figure 5-17 shows voltage and resistance-to-chassis measurements at vacuum tube pins and other selected points in the ISK under the conditions stated.

b. LOCATION DATA. - Figures 5-18-b through 5-18-b are photographs with callouts of the major electronic equipment elements of the ISK.

c. TROUBLE-SHOOTING CHART BASED ON OPERATING PROCEDURES. - See figure 7-8 for interpretation of control designations. Refer to table 5-8.

TABLE 5-1. TROUBLE-SHOOTING CHART, SIDEBAND LEVEL MONITOR MODEL SLM-1

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
1	Set ON-OFF switch S400 to ON position.	MAIN POWER (red) indicator I400 and tube filaments will go on.	Set ON-OFF switch S400 to OFF position. Check MAIN fuse F400 and the power cord. Check incoming power.
2	a. Adjust LSB CALIBRATE potentiometer R417 for zero reading on the LSB LEVEL meter M401.	LSB LEVEL meter M401 adjusts to zero.	In the event both meters fail to adjust to zero, connect a VTVM and check the B+ voltage at tube V403, pin 5. If there is no voltage at tube V403 check B+ at fuse F401 and tube V403. If only one meter fails to adjust, visually check all connections to the meter.
	b. Adjust USB CALIBRATE potentiometer R417 for zero reading on USB LEVEL meter M400.	USB LEVEL meter M400 adjusts to zero.	
	c. Connect jack J400 LSB INPUT to LSB output jack J111 on the SBE-2, if available, or connect a signal generator at 17-kc and approximately 0.01-volt amplitude.	LSB LEVEL meter should monitor the incoming signal at full scale meter reading.	In the event there is no indication on the LSB LEVEL meter with an incoming signal at J400 LSB INPUT, remove V400 and check.
	d. Connect jack J401 USB INPUT to USB output jack J112 on SBE-2, if available or connect a signal generator at 17-kc and approximately 0.01-volt amplitude.	USB LEVEL meter should monitor the incoming signal at full scale meter reading.	In the event there is no indication on the USB LEVEL meter with an incoming signal at J401 USB INPUT, remove V401 and check.

TABLE 5-2. TROUBLE-SHOOTING CHART, SIDEBAND LEVEL MONITOR MODEL SLM-2

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
1	Close ON-OFF switch S400 to ON position.	MAIN POWER (red) indicator I400 and tube filaments will go on.	Set ON-OFF switch S400 to OFF position. Check MAIN fuse F400 and the power cord. Check incoming power.
2	a. Connect jack J400 LSB INPUT to LSB output jack J111 on the SBE-3, if available, or connect a signal generator at 250-kc and approximately 0.01-volt amplitude.	LSB LEVEL meter M401 should read.	If LSB LEVEL meter M401 fails to indicate, check all meter wire connections, check continuity of meter, and check tube V400.
	b. Adjust indicator L402 slowly to peak M401 reading. c. Adjust LSB CALIBRATE potentiometer R414 to zero meter on no 250-kc input.	LSB level meter M401 should read maximum.	In the event the LSB LEVEL meter fails to indicate a maximum reading, inspect peaking coil L402 for continuity, discoloration, broken connections, and check tube pin voltages. (See figure 5-3.)
3	a. Connect jack J401 USB INPUT to USB output jack J112 on the SBE-3, if available, or connect a signal generator at 250-kc and approximately 0.01-volt amplitude.	USB LEVEL meter M400 should read.	If USB LEVEL meter M400 fails to indicate, check all meter wire connections, check continuity of meter, and check tube V401.
	b. Adjust indicator L401 slowly clockwise. c. Adjust USB CALIBRATE potentiometer R407 to zero meter on no 250-kc input.	USB LEVEL meter M400 should read maximum.	In the event the USB LEVEL meter fails to indicate a maximum reading, inspect peaking coil L401 for continuity, discoloration and broken connections, and check tube pin voltages. (See figure 5-3.) If there is no needle deflection in either meter, repeat steps 2 and 3. Check B+ fuse F401. Check power supply tubes V401 and V403.

TABLE 5-3. TROUBLE-SHOOTING CHART, TRANSMITTING MODE SELECTOR MODEL SBE-3

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
1	Set POWER ON-OFF switch S103 to ON position.	Power supply (red) indicator I103, OVEN indicator lamp I102, dial lamps, and tube filaments should all go on.	Set POWER switch S103 to OFF position. Check fuses F401 and F402, and the power cord. Check incoming power.
2	Set EXCITER ON-STANDBY switch S105 to ON position.	EXCITER indicator lamp I101 should go on.	Set POWER switch S103 to OFF position. Check fuse F403 and wire connections.
3	Set XMTR ON-OFF switch S104 to ON position.	Activates GPT-10K eliminates need for VOX, or push-to-talk through EXCITER switch S105.	Check the ground circuit of the GPT-10K for final-plate relay.
4	a. SET XMTR ON-OFF switch S104 to OFF position. b. Set EXCITER ON-STANDBY switch S105 to STANDBY position. c. Connect a mike to MIKE input jack J101. Start talking directly into the mike and at the same time slightly rotate VOX GAIN control R140. d. At conclusion of step 4, return XMTR ON-OFF and EXCITER ON-STANDBY switches to their ON position.	GPT-10K can be operated by VOX or push-to-talk circuits, when EXCITER switch S105 is in STANDBY position. EXCITER indicator lamp I101 remains on with normal speech level and goes off with no speech input.	Visually check all wire connections to the XMTR and EXCITER switches, or fault may be in the VOX section. In the event that the EXCITER indicator lamp will not go on, set EXCITER ON-STANDBY switch S105 to ON position. This tests the EXCITER lamp, otherwise the fault may be within the VOX section. Should the EXCITER pilot indicator lamp blink erratically with no direct speech input, SQUELCH GAIN control R129 is not adjusted properly; refer to the VOX section.
5	MF TUNING a. Turn METER SW S109 to CAL position and zero meter. b. Turn METER SW to MF position. c. Turn MF XTAL SW to VMO or XTAL. d. Set MF dial to frequency of VMO or XTAL by use of MF TUNING control. e. Turn USB, LSB, and XMTR switches to their OFF positions. f. Turn CARRIER INSERT control fully clockwise. g. Adjust MF TUNING control slightly.	Meter reads zero for step a. In step b as the MF TUNING control is rotated, the meter deflection needle should read maximum.	In the event the meter will not calibrate to zero or the meter will not indicate a reading with the METER SW in MF position, proceed as follows: Check V112 and R135. Visually check all meter and various control and switch wire connections. If these are normal, the probable cause is within the MF section.

TABLE 5-3. TROUBLE-SHOOTING CHART, TRANSMITTING MODE SELECTOR MODEL SBE-3 (Cont.)

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
6	RF TUNING a. Do not alter previous settings of MF TUNING control. b. Turn BAND MCS switch to frequency range desired. c. Turn OUTPUT TUNING band switch to frequency range desired. d. Turn METER SW to RF position. e. Using OUTPUT TUNING control, set OUTPUT TUNING dial to output frequency. f. Advance OUTPUT control for any indication on the meter. g. Adjust OUTPUT TUNING control slightly.	Maximum meter needle deflection.	In the event of a malfunction, visually check all control wire connections. If these are normal, the probable cause is within the RF section.
7	DOUBLE SIDEBAND (Without Carrier) a. Turn USB switch to desired channel. b. Turn CARRIER INSERT to zero. c. Turn LSB switch to OFF. d. Turn METER SW to USB. e. Advance USB GAIN until meter reads 50. f. Turn USB switch to OFF. g. Turn LSB switch to desired channel. h. Turn METER SW to LSB. i. Advance LSB GAIN until meter reads 50. j. Turn METER SW to RF. k. Advance OUTPUT control until meter reads 50. l. Turn LSB switch to OFF. m. Turn USB switch to position selected in step a. n. Adjust USB GAIN to obtain a meter reading of 50. o. Turn LSB switch to desired channel as selected in step g.	Combined gain settings of USB and LSB GAIN controls should read approximately 100 on the meter. **NOTE** The meter circuit within the SBE, as is the case with most VTVM's, has a small amount of waveform error, For this reason, when each sideband is set up independent of the other and when each is added on the meter, the sum of 50 percent and 50 percent may be slightly less than 100 percent. This is due to the presence of a modulated envelope which is generated when two or more frequencies are present in the output at the same time.	In the event the combined meter reading of the USB and LSB differs considerably from 100, alternately switch the USB and LSB ON-OFF switches and readjust each channel for a meter reading of 50. If either channel cannot peak to a meter reading of 50, the malfunction may be in either or both the LSB or USB audio sections.

TABLE 5-4. TROUBLE-SHOOTING CHART, TRANSMITTING MODE SELECTOR MODEL SBE-2

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
1	Set POWER ON-OFF switch S103 to ON position.	Power supply red indicator I103; OVEN indicator lamp I102 dial lamps, and tube filaments should all go on.	Set POWER switch S103 to OFF position. Check fuse F401 and F402, and the power cord. Check incoming power.
2	Set EXCITER ON-STANDBY switch S105 to ON position.	EXCITER indicator lamp I101 should go on.	Set POWER switch S103 to OFF position. Check fuse F403 and wire connections.
3	Set XMTR ON-OFF switch S104 to ON position.	Activates GPT-10K, eliminates need for VOX, or push-to-talk through EXCITER switch S105.	Check the ground circuit of the GPT-10K final-plate relay.
4	a. Set XMTR ON-OFF switch S104 to OFF position. b. Set EXCITER ON-STANDBY switch S103 to STANDBY position. c. Connect a mike to MIKE input jack J101. Start talking directly into the mike and at the same time slightly rotate VOX GAIN control R140. d. At conclusion of step 4, return XMTR ON-OFF and ON-STANDBY switches to their ON positions.	GPT-10K can be operated by VOX or push-to-talk circuits when EXCITER switch S105 is in the STANDBY position. EXCITER indicator lamp I101 remains on with normal speech level and goes off with no speech input.	Visually check all wire connections to the XMTR and EXCITER switches or fault may be in the VOX section. In the event that the EXCITER indicator lamp will not go on, set EXCITER ON-STANDBY switch S105 to ON position. This tests the EXCITER lamp, otherwise the fault may be within the VOX section. Should the EXCITER pilot indicator lamp blink erratically with no direct speech input, SQUELCH GAIN control R129 is not adjusted properly; refer to the VOX section.
5	MF TUNING a. Turn METER SW S109 to CAL position, and zero meter. b. Turn METER SW to MF position. c. Turn MF XTAL SW to VMO or XTAL. d. Set MF dial to frequency of VMO or XTAL by use of MF TUNING control. e. Turn USB, LSB, and XMTR switches to their OFF positions. f. Turn CARRIER INSERT control fully clockwise. g. Adjust MF TUNING control slightly.	Meter reads zero for step a. In step b as the MF TUNING control is rotated, the meter deflection needle should read maximum.	In the event the meter will not calibrate to zero or the meter will not indicate a reading with the METER SW in MF position, proceed as follows: Check V112 and R135. Visually check all meter and various control and switch wire connections. If these are normal, the probable cause is within the MF section.

TABLE 5-4. TROUBLE-SHOOTING CHART, TRANSMITTING MODE SELECTOR MODEL SBE-2 (Cont.)

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
6	RF TUNING a. Do not alter previous settings of MF TUNING control. b. Turn BAND MCS switch to frequency range desired. c. Turn OUTPUT TUNING band switch to frequency range desired. d. Turn METER SW to RF position. e. Using OUTPUT TUNING control, set OUTPUT TUNING dial to output frequency. f. Advance OUTPUT control for any indication on the meter. g. Adjust OUTPUT TUNING control slightly.	Maximum meter needle deflection.	In the event of a malfunction, visually check all control wire connections. If these are normal, the probable cause is within the RF section.
7	DOUBLE SIDEBAND (Without Carrier) a. Turn USB switch to desired channel. b. Turn CARRIER INSERT to zero. c. Turn LSB switch to OFF. d. Turn METER SW to USB. e. Advance USB GAIN until meter reads 50. f. Turn USB switch to OFF. g. Turn LSB switch to desired channel. h. Turn METER SW to LSB. i. Advance LSB GAIN until meter reads 50. j. Turn METER SW to RF. k. Advance OUTPUT control until meter reads 50. l. Turn LSB switch to OFF. m. Turn USB switch to position selected in step a. n. Adjust USB GAIN to obtain a meter reading of 50. o. Turn LSB switch to desired channel as selected in step g.	Combined gain settings of USB and LSB GAIN controls should read approximately 100 on the meter. **NOTE** The meter circuit within the SBE, as is the case with most VTVM's has a small amount of waveform error. For this reason, when each sideband is set up independent of the other and when they are added on the meter, the sum of 50 percent and 50 percent may be slightly less than 100 percent. This is due to the presence of a modulated envelope which is generated when two or more frequencies are present in the output at the same time.	In the event the combined meter reading of the USB and LSB differs considerably from 100, alternately switch the USB and LSB ON-OFF switches and readjust each channel for a meter reading of 50. If either channel cannot peak to a meter reading of 50, the malfunction may be in either or both the LSB, or USB audio sections.

TABLE 5-5. TROUBLE-SHOOTING CHART, VARIABLE FREQUENCY OSCILLATOR VOX-2

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 will observe the OUTER OVEN pilot indicator will alternately go 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 will open 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 ON-OFF switches to their ON positions.	Applies power to each section.	In the event of no output from any section, turn power OFF, and check all connections and continuity of the meter.
	Turn METER selector switch S107 concurrently to each of the above positions.	Monitors the output of each section.	No output from the HFO section, check continuity of switch S103, plug P101 (pin 11), and jack 201 (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.	Applies power to the 100-kc calibration oscillator. ZERO BEAT pilot indicator will go on any 100- or 50-kc checkpoint.	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.
	Plug headset into PHONES jack J105.	Monitors ZERO BEAT aurally.	If the ZERO BEAT pilot indicator does not go on and the beat frequency cannot be heard aurally, the fault is in BEAT ON-OFF switch S104 or in the BFO circuit.

TABLE 5-5. TROUBLE-SHOOTING CHART, VARIABLE FREQUENCY OSCILLATOR VOX-2 (Cont.)

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
4	Rotate the XTAL selector switch S201 to VMO position. Concurrently rotate METER selector switch S101 to VMO position.	Connects the VOX's VMO output to the HFO input. Notice the deflection of the output meter M301 (milliammeter) on the front panel; it should indicate approximately 0.9 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 the METER selector switch is positioned at HFO.	Needle deflection of 0.5 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 head set. Rotate tuning control in one direction only. Vary the calibrate control.	A zero beat will be detected in the head set and ZERO BEAT indicator I303 will go on at each 100-kc checkpoint.	If there is no zero beat on the ZERO BEAT pilot indicator or aural indication on the head set, 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 0.75 ma.	Should there be no needle deflection, visually check all the connection 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 will be 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.		

TABLE 5-6. TROUBLE-SHOOTING CHART, FREQUENCY SHIFT EXCITER MODEL XFK

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
1	Set POWER ON-OFF switch S8 to ON position.	POWER (red) indicator, the 200 KC OVEN indicator lamp D2, and XTAL OVEN indicator lamp I3 should all go on.	Turn POWER ON-OFF switch S8 to OFF position. Check continuity of fuses F1 and F2, and the power cord. Check the incoming power.
		After a sufficient time elapse, the operator will see the XTAL OVEN and 200 KC OVEN pilot indicators alternately go on. **NOTE** Each oven in independent of the other; the alternate illumination of each pilot indicator has no direct relationship to the other. This will merely indicate visually to the operator that the ovens are operating properly.	In the event the XTAL OVEN pilot indicator remains on the 70°C(S7) thermostat is sticking. Should the 200 KC OVEN pilot indicator remain on the 70°C(S6) thermostat is sticking. If either the XTAL OVEN or 200 KC OVEN pilot indicator will not go on, check each indicator lamp and lamp connections.
2	Set PLATE ON-OFF switch S4 to ON position. Next, position MODE switch S3 to FAX position. Rotate POWER control R22 clockwise and observe PA PLATE CURRENT meter.	PA PLATE CURRENT meter M1 needle should deflect to the right and read approximately 50 ma.	If there is no output indicated on the meter, rotate MODE switch S3 to the M (MARK) S (SPACE) or L (LINE) position. Check the position of POWER control R22. If there is still no output indicated on PA PLATE CURRENT meter, output control may be defective. Check continuity and connection of PA PLATE CURRENT meter and control. Should the needle deflect over 50 ma and cannot be controlled, check neutralization of PA tube to "kill" oscillation; the fault may also be in the power supply circuitry.
3	a. Preset the multiplication ratio at the rear of the chassis at unity. b. Set XTAL selector switch S2 to desired crystal. c. Set BAND CHANGE switch S1 to proper band.	PA PLATE CURRENT meter needle will dip at the proper output frequency desired.	In the event of a malfunction, check the plug connection in the patch panel at the rear of the chassis. Check the setting of XTAL selector switch S2 and make sure that the crystal is inserted. Check BAND CHANGE switch S1 setting and wire connections.

TABLE 5-6. TROUBLE-SHOOTING CHART, FREQUENCY SHIFT EXCITER MODEL XFK (Cont.)

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
3 (Cont.)	d. Rotate OUTPUT TUNING MC dial to correct output frequency.		Check tubes V1 and V2. If these are normal, the fault remains in the RF section.
4	Turn FREQUENCY SHIFT CPS control to the desired frequency.	Frequency indicated on the frequency meter should be close to the setting of the FREQUENCY SHIFT CPS control.	If the previous operational tests performed in steps 1 through 3 are normal, the trouble may be traced to the RF section.

TABLE 5-7. TROUBLE-SHOOTING CHART, TWO TONE GENERATOR MODEL TTG

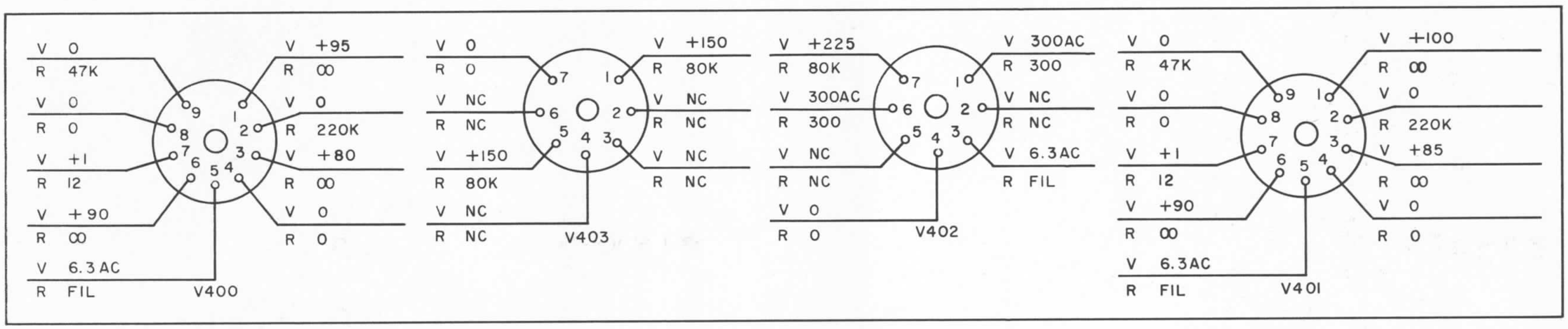
STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
1	Set POWER ON-OFF switch S500 to ON position.	MAIN POWER (red) indicator I502 will go on.	In the event MAIN POWER (red) indicator I502 does not go on, inspect the tube filaments and observe if they are on. If the tube filaments are on, turn POWER ON-OFF switch to OFF position and check MAIN POWER indicator lamp and lamp socket connections. In the event the tube filaments are not on, fuse F500 may be faulty. If all of the above conditions are normal, fault is within the power supply section.
2	a. Turn AUDIO OUTPUT control R524 maximum counterclockwise. b. Turn AUDIO TONE SELECTOR S502 to OFF position. c. Turn RF TONE SELECTOR S501 to TONE 2 position. d. Set POWER ON-OFF switch S500 to ON position. e. Connect RF output jack J501 to an input on the FSA.	Observe the FSA; a 2-kc difference between peaks will be indicated.	If there are no peaks displayed on the FSA, turn RF TONE SELECTOR switch S501 to either TONE 1 or TONE 2 position while observing the FSA. Should no signal appear on the FSA in either TONE 1 or TONE 2 position, set POWER ON-OFF to OFF position and check B+ fuse (F501) and high-voltage rectifier tube V506. Visually check all the connectors on the RF TONE SELECTOR switch. In the event only one peak is displayed on the FSA, turn the RF TONE SELECTOR switch to TONE 1 and TONE 2 positions respectively. If the peak disappears from the FSA, in the TONE 2 position, check tube V505. Should these remain normal, the malfunctioning is within the RF section.

TABLE 5-7. TROUBLE-SHOOTING CHART, TWO TONE GENERATOR MODEL TTG (Cont.)

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
3	a. Turn the AUDIO OUTPUT control R524 sufficiently to module the sideband exciter. b. Turn AUDIO TONE SELECTOR to TONE 2 position. c. Turn RF TONE SELECTOR to OFF position. d. Set POWER ON-OFF switch to ON position. e. Connect AUDIO OUTPUT to the input of the sideband exciter. f. Connect the output from the sideband exciter to the FSA input jack.	Two-tone test for distortion. The peak signals should be positioned to the right portion of the FSA.	If there are no peaks displayed on the FSA, turn AUDIO TONE SELECTOR switch to either TONE 1 or TONE 2 position while observing the FSA. Should no signal appear on the FSA, in either TONE 1 or TONE 2 position, set POWER ON-OFF to OFF position and check B+ fuse (F501) and high-voltage rectifier tube V506. Visually check all wire connections on the AUDIO TONE SELECTOR. In the event only one peak is displayed on the FSA, turn AUDIO TONE SELECTOR switch to TONE 1 and TONE 2 positions, respectively. If the peak disappears from the FSA, in TONE 1 position, check tubes V500 and V502. If the peak disappears from the FSA in the TONE 2 position, check tubes V501 and V503. Should these remain normal, the malfunction is within the AUDIO OSCILLATOR section.

TABLE 5-8. TROUBLE-SHOOTING CHART, ISOLATION KEYER MODEL AK-100

STEP	CONTROL OPERATED	NORMAL INDICATION	REMEDY
1	Set MAIN POWER switch S4002 to ON position.	MAIN POWER (red) indicator I4001 and the tube filaments will go on.	If the tube filaments are on and the MAIN POWER indicator is not, the indicator lamp or lamp socket is defective. If the lamp filaments are not on, check fuse F4001. Make continuity check on transformer T4001 primary and secondary.
2	With KEYING MODE switch S4001 placed in any one of four positions, connect a VTVM between pins 9 and 10 at terminal board E4001.	VTVM should indicate continuity.	If the VTVM meter does not indicate continuity, check all wire connections in relay K4001. Check relay coil continuity. Check fuses F4002 and F4003. Rotate the THRESHOLD ADJ. slightly clockwise with the VTVM. Still connect to pins 9 and 10 at terminal board E4001 for continuity on VTVM. Check tubes V4001 and V4002.



CONDITIONS:

RESISTANCE MEASUREMENTS;
1. ALL CONNECTIONS DISCONNECTED.
2. USB (R407) FULLY CCW.
3. LSB (R414) FULLY CCW.
4. MAIN POWER SWITCH (S400) OFF.
5. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS.

VOLTAGE MEASUREMENTS;
1. POWER PLUG CONNECTED.
2. MAIN POWER SWITCH (S400) ON.
3. USB (R407) FULLY CCW.
4. LSB (R414) FULLY CCW.

Figure 5-1. Voltage and Resistance Diagram, SLM-1

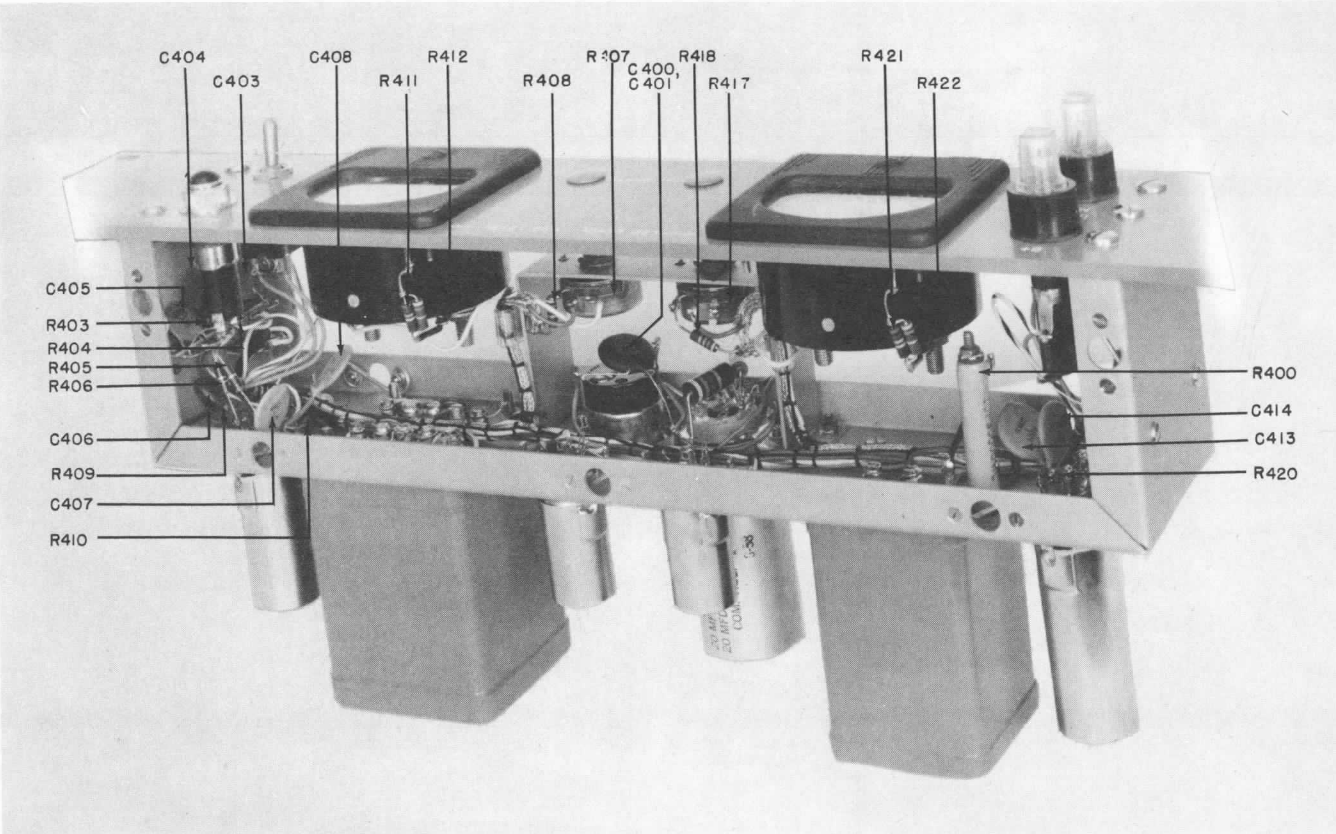


Figure 5-2-a. Location Diagram of Major Electronic Equipment Components, SLM-1, Top View

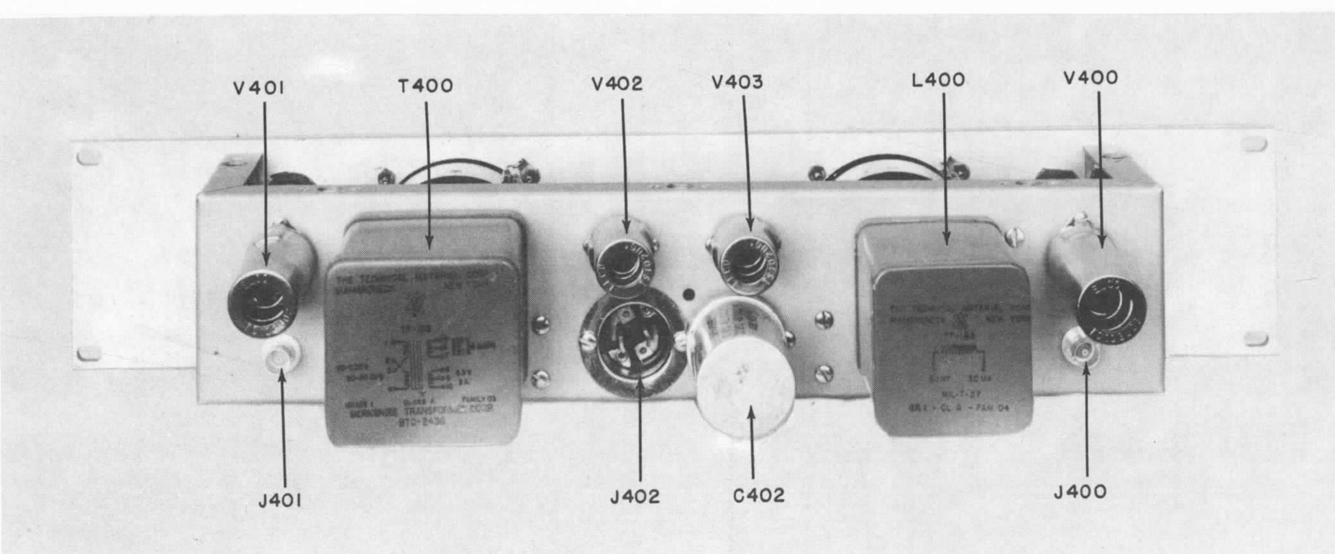
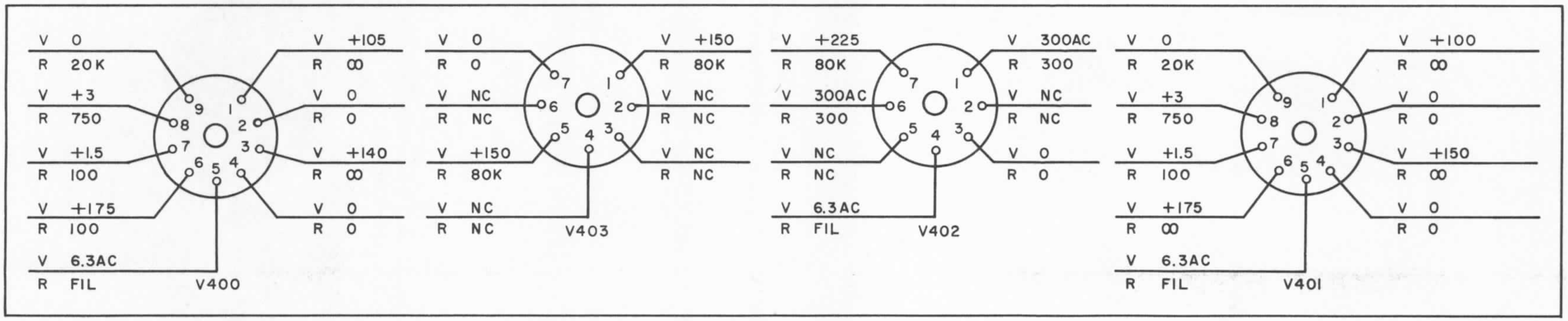


Figure 5-2-b. Location Diagram of Major Electronic Equipment Components, SLM-1, Rear View



CONDITIONS:

RESISTANCE MEASUREMENTS;
1. ALL CONNECTIONS DISCONNECTED.
2. USB(R407) FULLY CCW.
3. LSB(R414) FULLY CCW.
4. MAIN POWER SWITCH (S400) OFF.
5. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS.

VOLTAGE MEASUREMENTS;
1. POWER PLUG CONNECTED.
2. MAIN POWER SWITCH (S400) ON.
3. USB (R407) FULLY CCW.
4. LSB (R414) FULLY CCW.

Figure 5-3. Voltage and Resistance Diagram, SLM-2

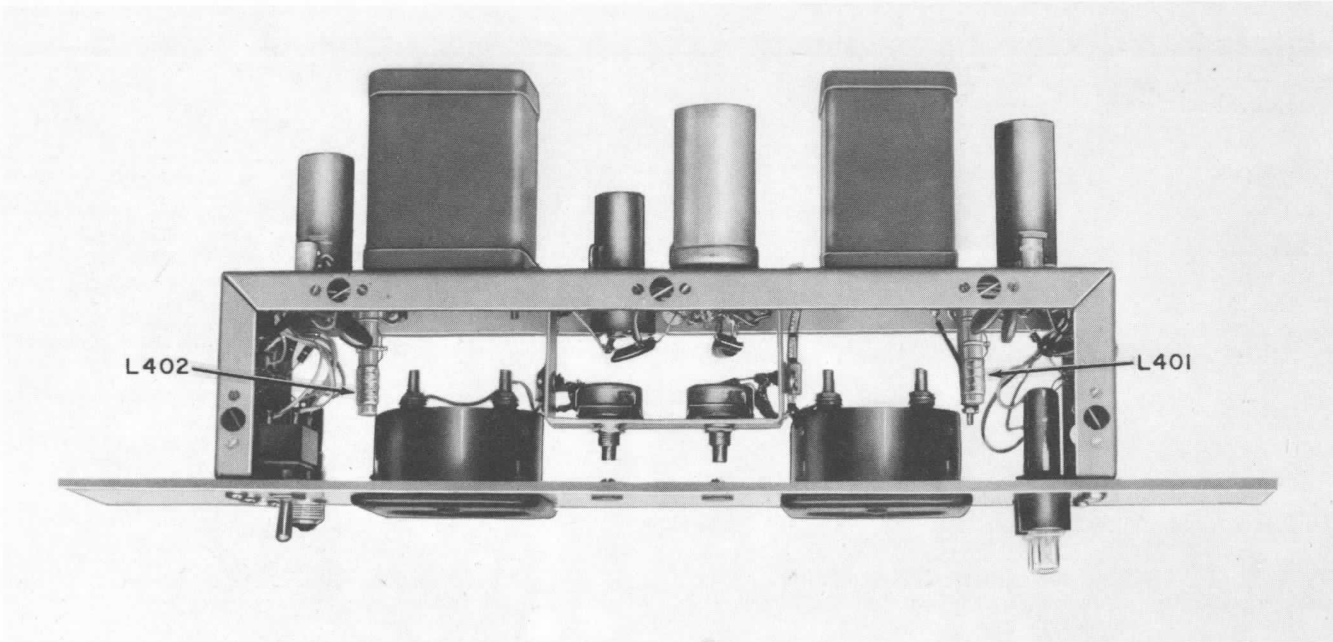


Figure 5-4-a. Location Diagram of Major Electronic Equipment Components, SLM-2, Top View

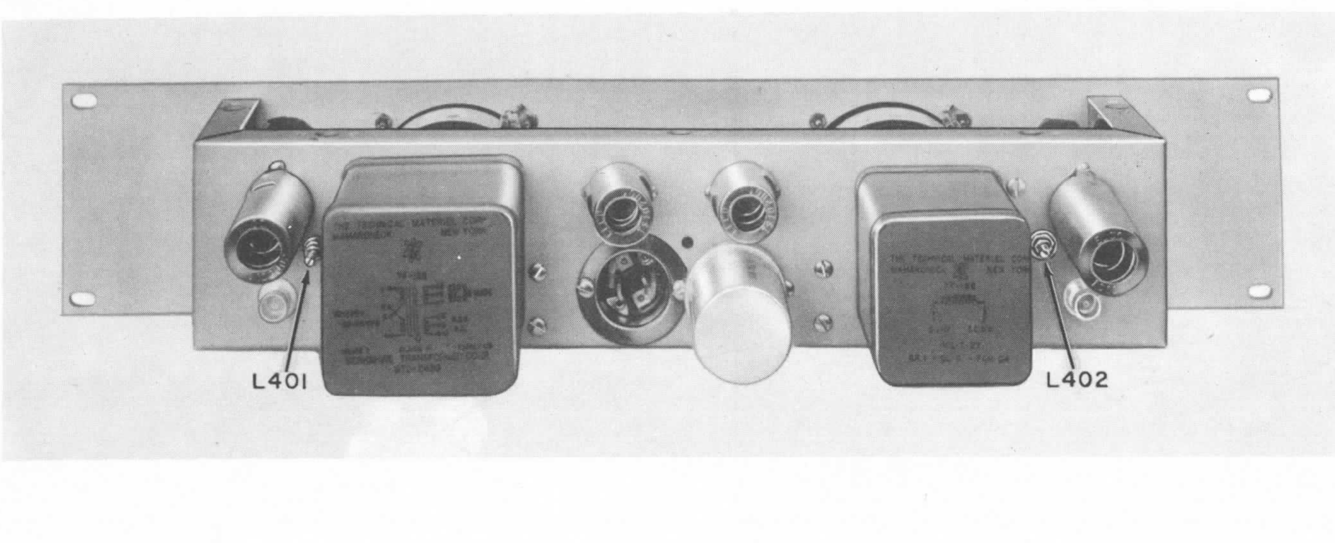


Figure 5-4-b. Location Diagram of Major Electronic Equipment Components, SLM-2, Rear View

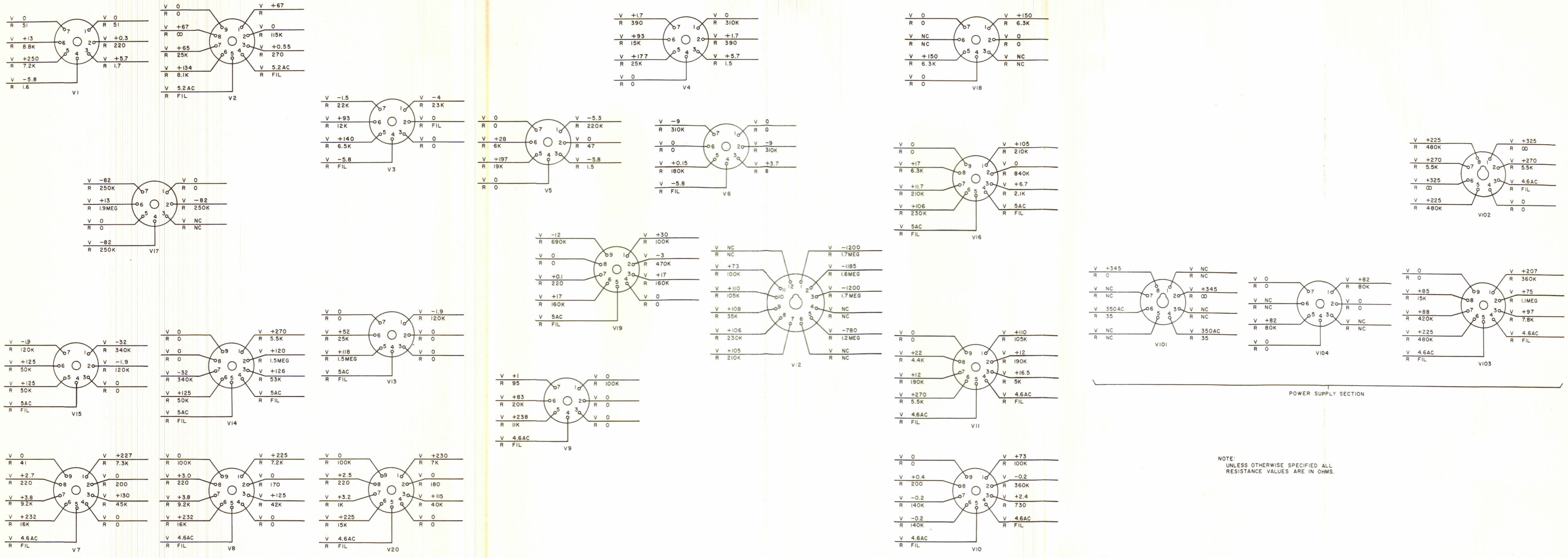


Figure 5-5. Voltage and Resistance Diagram, FSA

Figure 5-6-a. Location Diagram of Major Electronic Equipment Components, FSA, Top View

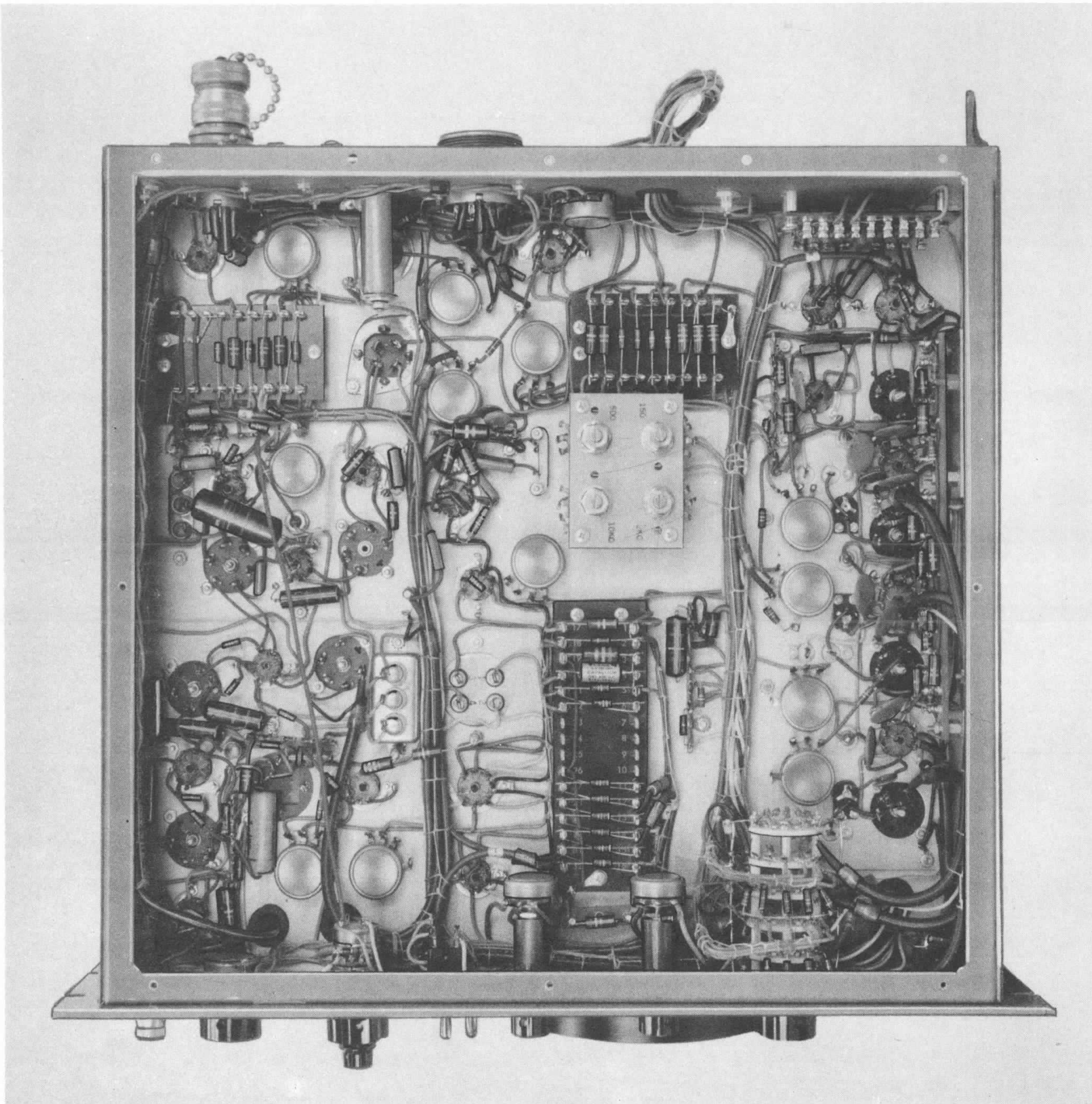


Figure 5-6-b. Location Diagram of Major Electronic Equipment Components, FSA, Bottom View

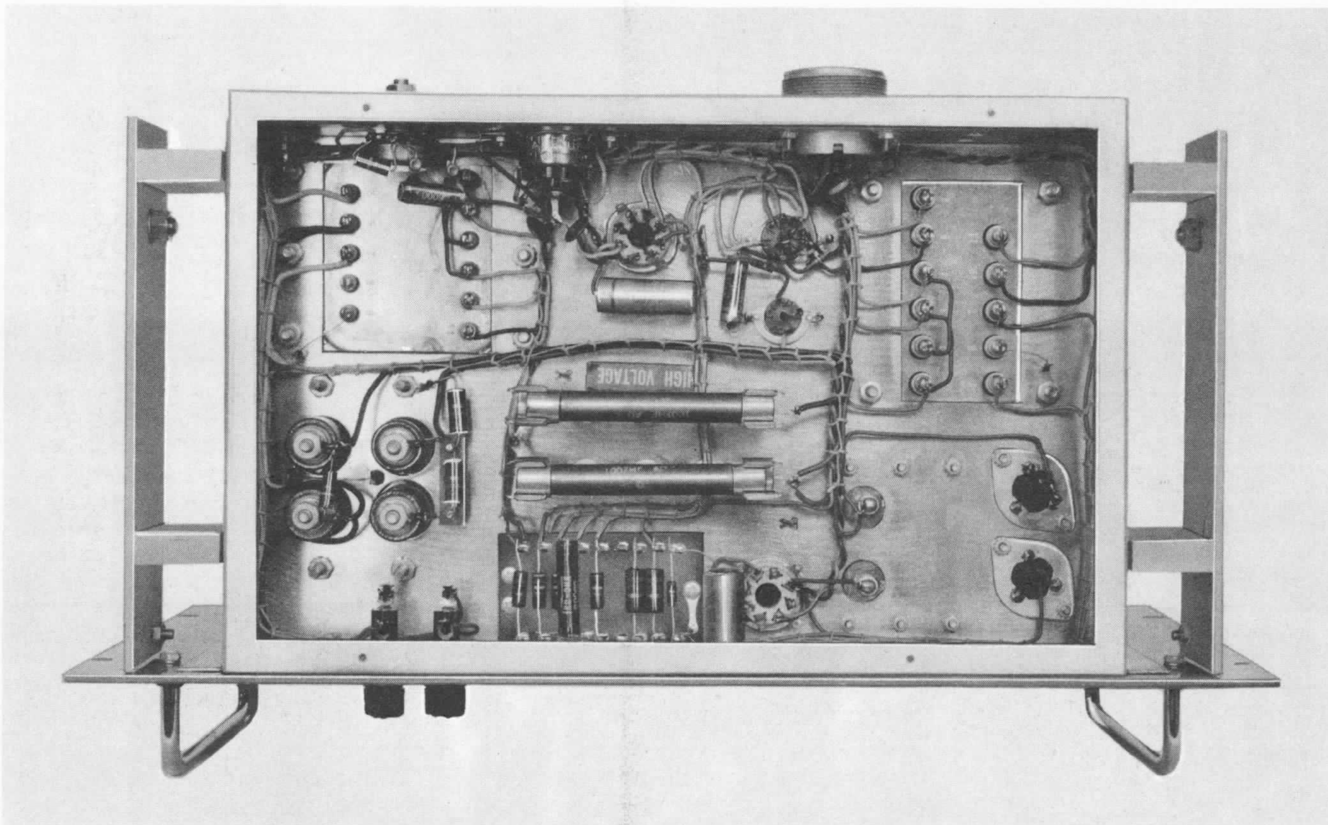
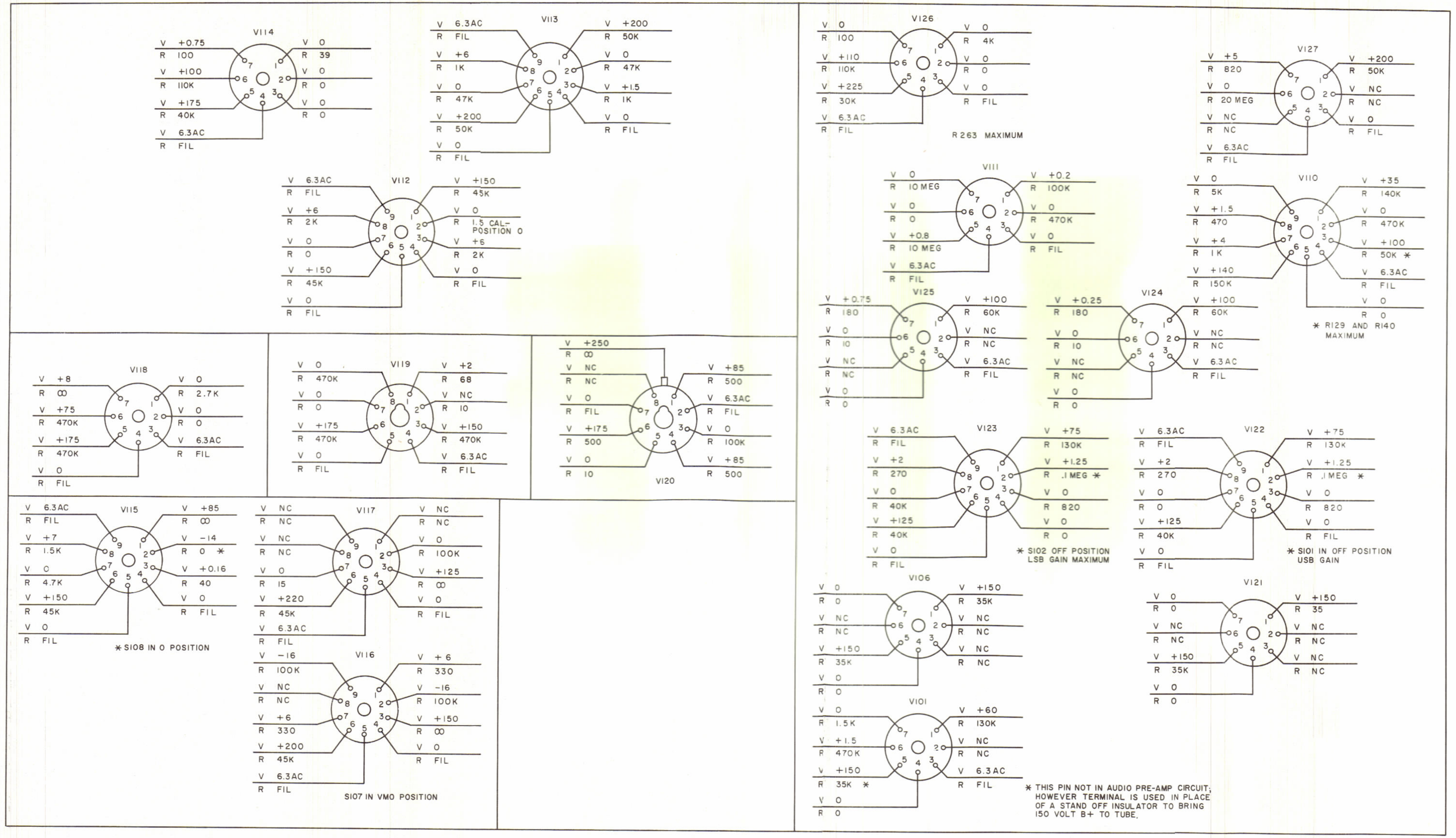
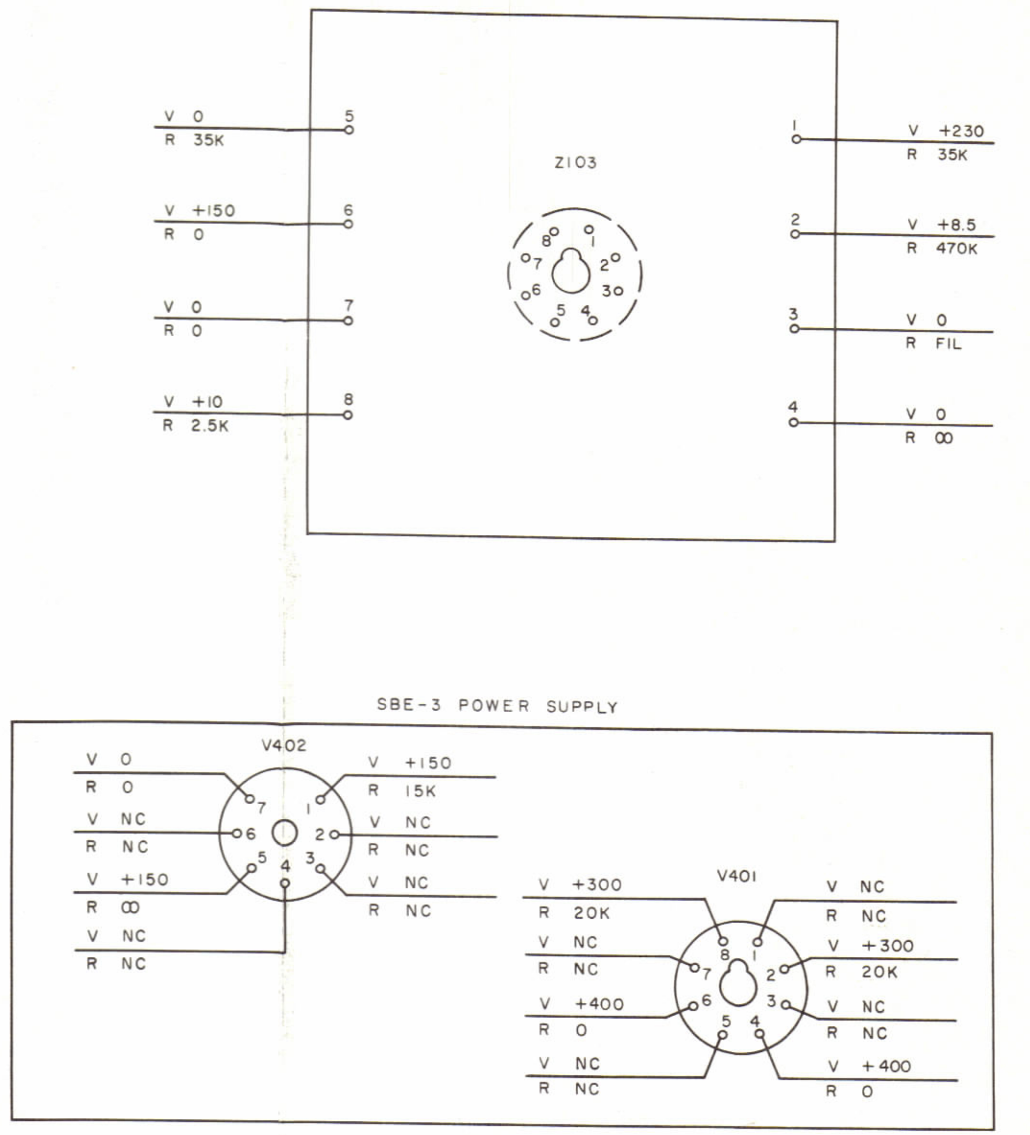


Figure 5-6-c. Location Diagram of Major Electronic Equipment Components, PS-12, Bottom View

Figure 5-6-d. Location Diagram of Major Electronic Components, PS-12, Rear View





CONDITIONS

VOLTAGE MEASUREMENTS:

1. OUTPUT TUNED TO 8.0MCS.
2. BANDSWITCH 4 - 8 MCS.
3. METER SWITCH IN RF POSITION.
4. OUTPUT CONTROL SET TO 100% ON METER.
5. RF OUTPUT TERMINATED WITH 70 OHM NON-INDUCTIVE LOAD.
6. MF XTAL SWITCH IN VMO POSITION.
7. LSB AND USB GAIN CONTROL MIN.
8. MIKE/CHANNEL SELECTOR "OFF."
9. MAIN POWER "ON."
10. EXCITER "ON."
11. XMTR "OFF."
12. V105 DATA TAKEN AT OCTAL SOCKET.

RESISTANCE MEASUREMENTS:

1. ALL POWER OFF.
2. POWER PLUGS DISCONNECTED.
3. ALL MEASUREMENTS TAKEN WITH RESPECT TO GROUND USING A HEWLETT-PACKARD MODEL 410B VTVM OR EQUIVILENT.
4. ALL FRONT PANEL SWITCHES AND CONTROLS IN MAX CW POSITION.
5. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS.

Figure 5-7. Voltage and Resistance Diagram, SBE-3

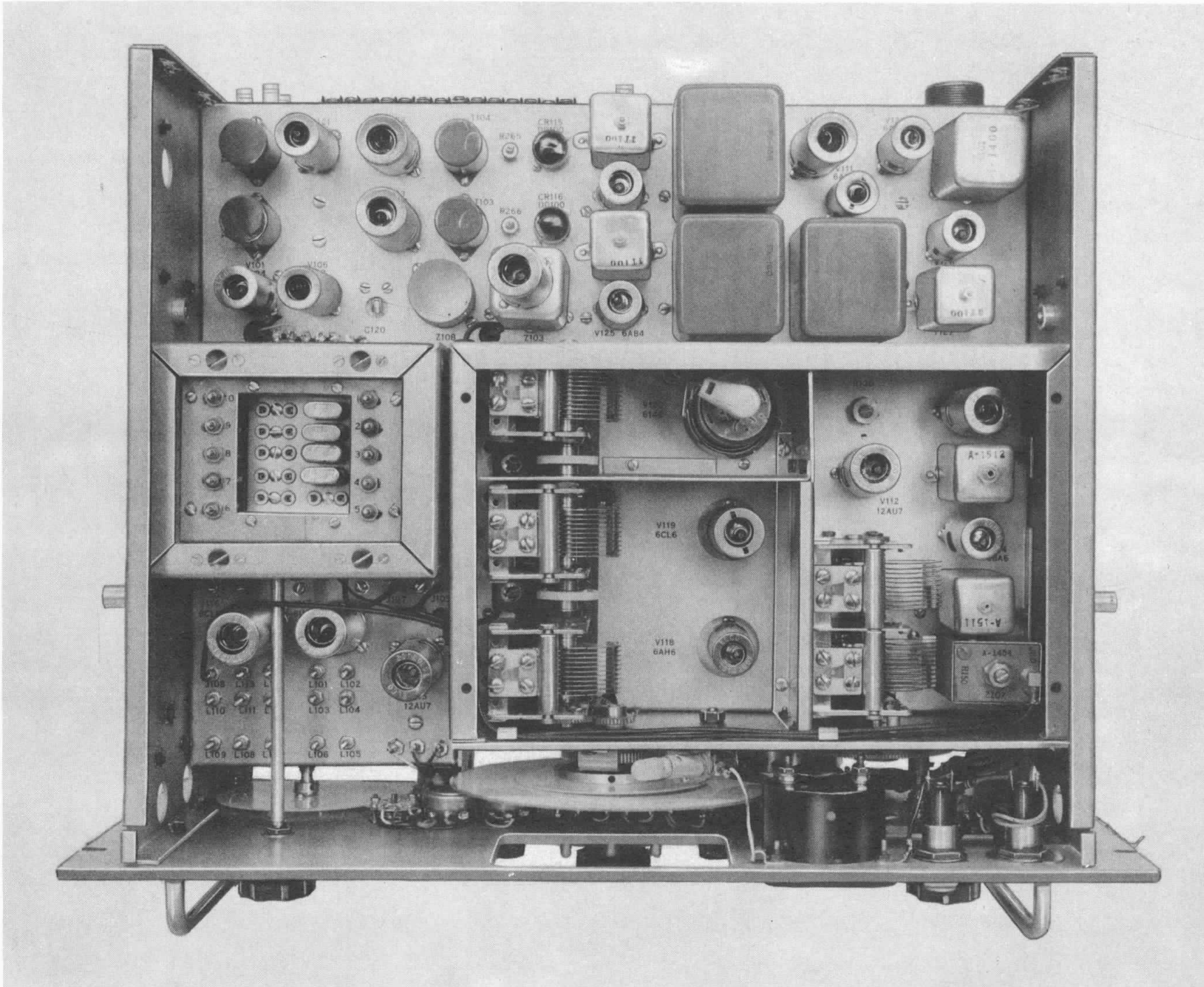
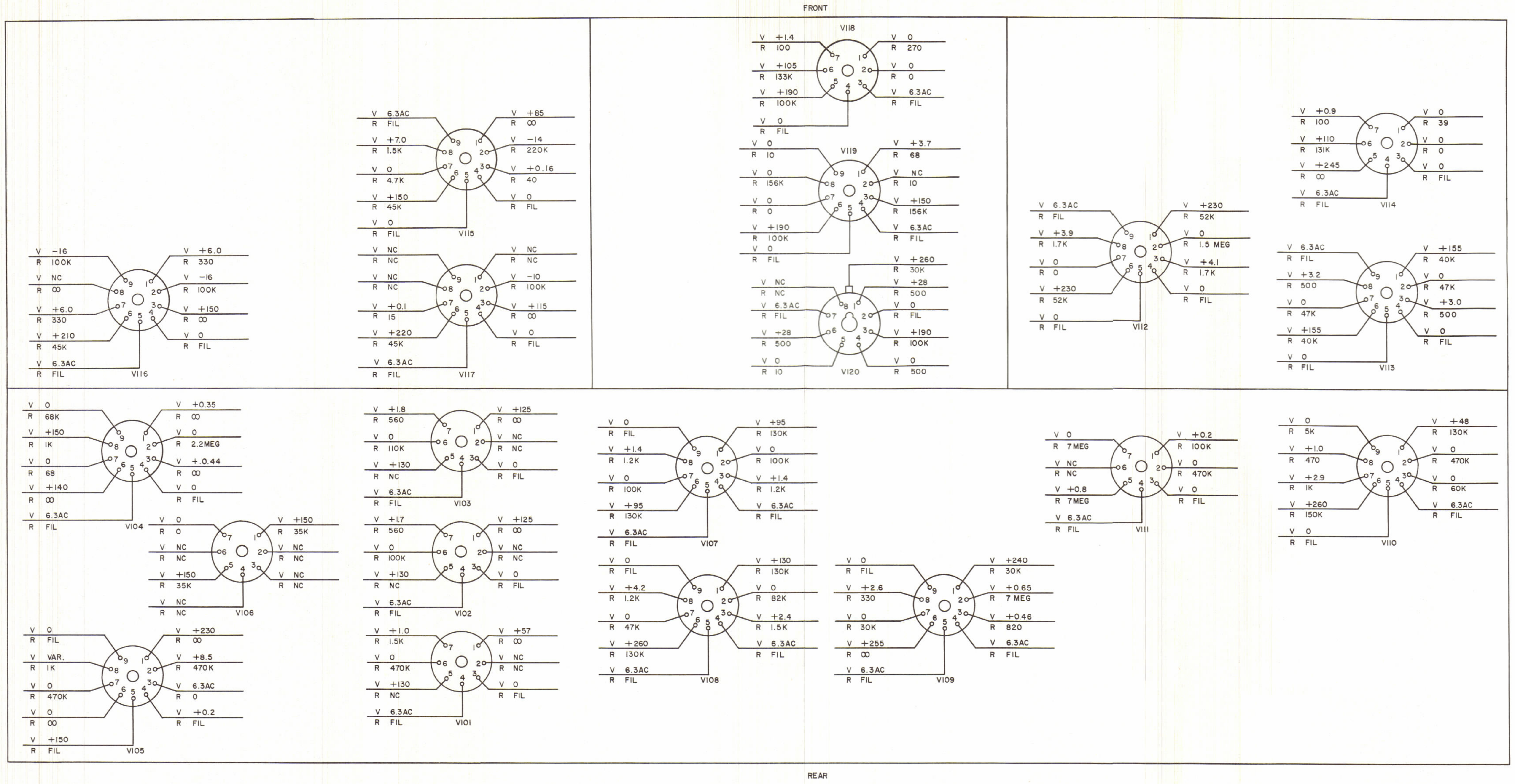
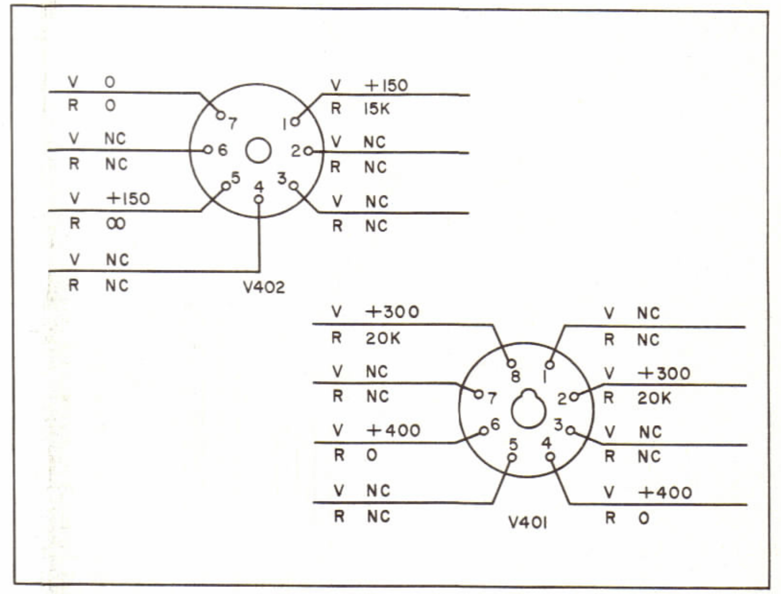


Figure 5-8-a. Location Diagram of Major Electronic Equipment Components, SBE-3, Top View

Figure 5-8-b. Location Diagram of Major Electronic Equipment Components, SBE-3, Bottom View





SBE—2 POWER SUPPLY

CONDITIONS:

VOLTAGE MEASUREMENTS:

1. H.F. OSCILLATOR SWITCH 4.27—6.27 MCS.
2. OUTPUT TUNED TO 8.0 MCS.
3. BAND SWITCH 4—8 MCS.
4. METER SWITCH IN RF POSITION.
5. OUTPUT CONTROL SET TO 100% ON METER.
6. RF OUTPUT TERMINATED WITH 70 OHM NONINDUCTIVE LOAD.
7. M.F. XTAL SWITCH IN VMO POSITION.
8. LSB AND USB GAIN CONTROLS MIN.
9. MIKE/CHANNEL SELECTOR "OFF".
10. MAIN POWER "ON".
11. EXCITER "ON".
12. XMTR "OFF".
13. V104 AND V105 DATA TAKEN AT OCTAL SOCKET.

RESISTANCE MEASUREMENTS:

1. ALL POWER "OFF"
2. POWER PLUGS DISCONNECTED.
3. ALL MEASUREMENTS TAKEN WITH RESPECT TO GROUND USING A HEWLETT-PACKARD MODEL 410B VTVM OR EQUIVALENT.
4. ALL FRONT PANEL SWITCHES AND CONTROLS IN MAXIMUM CW POSITION.
5. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS.

Figure 5-9. Voltage and Resistance Diagram, SBE-2

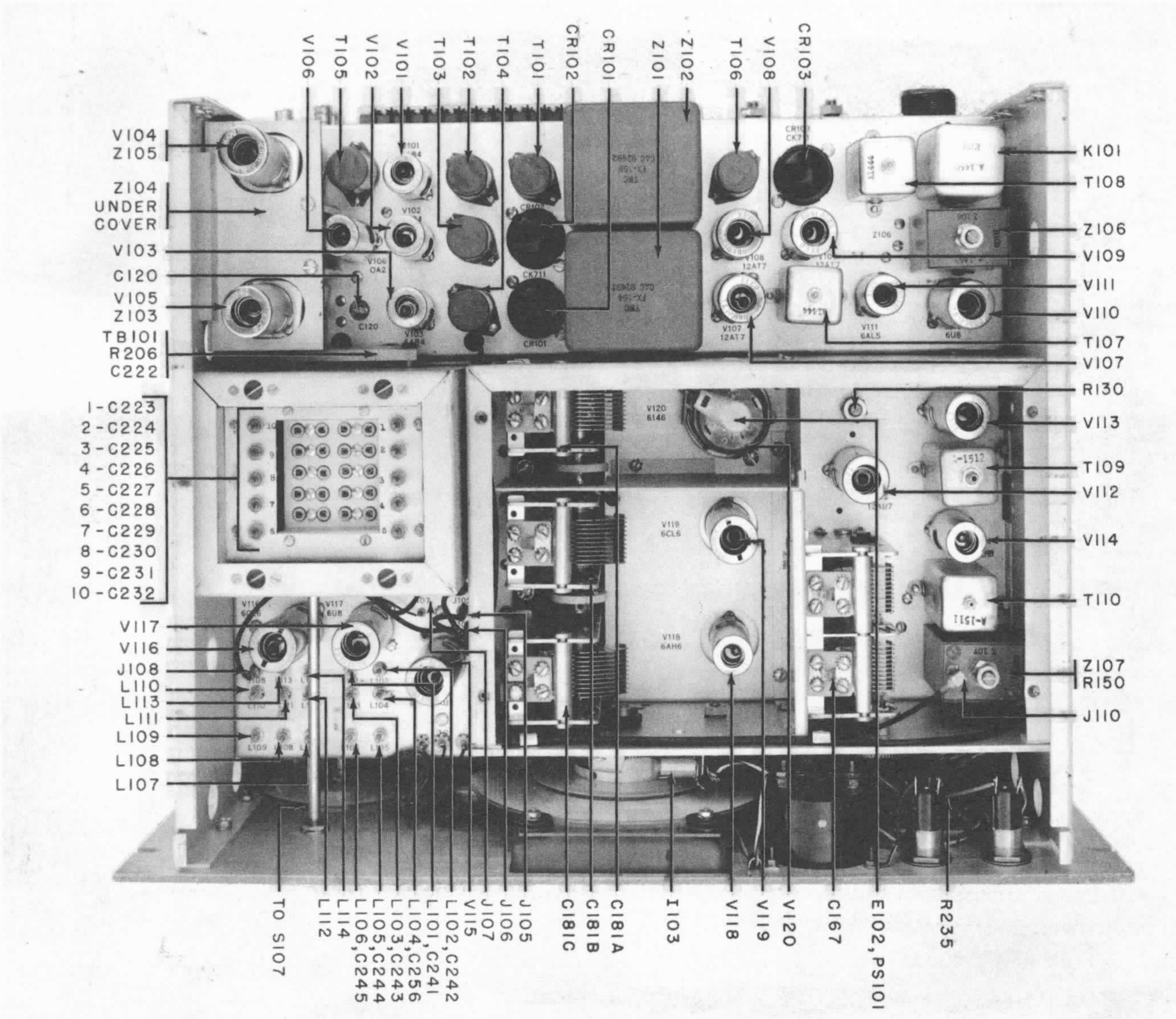


Figure 5-10-a. Location Diagram of Major Electronic Equipment Components, SBE-2, Top View

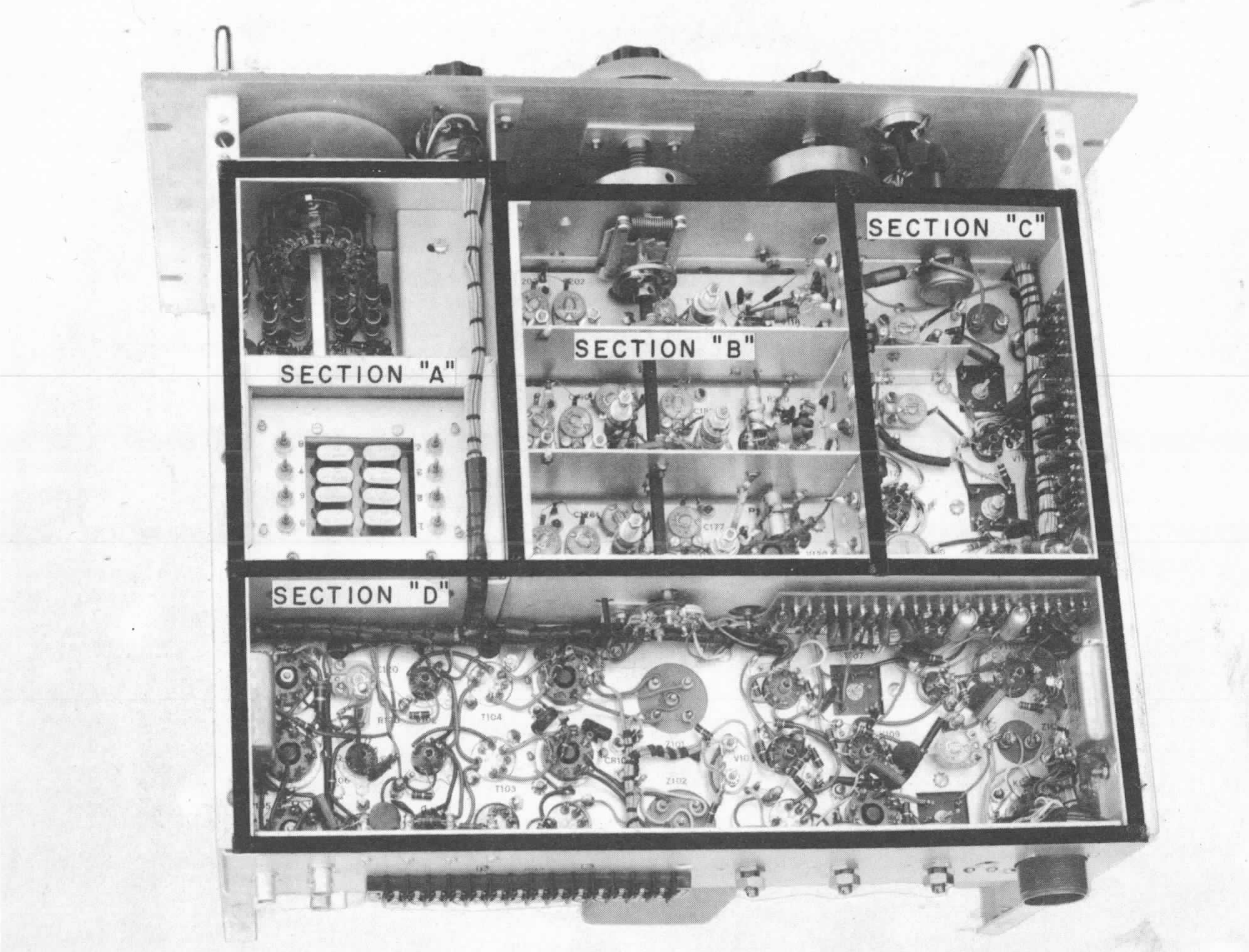


Figure 5-10-b. Location Diagram of Major Electronic Equipment Components, SBE-2, Bottom View

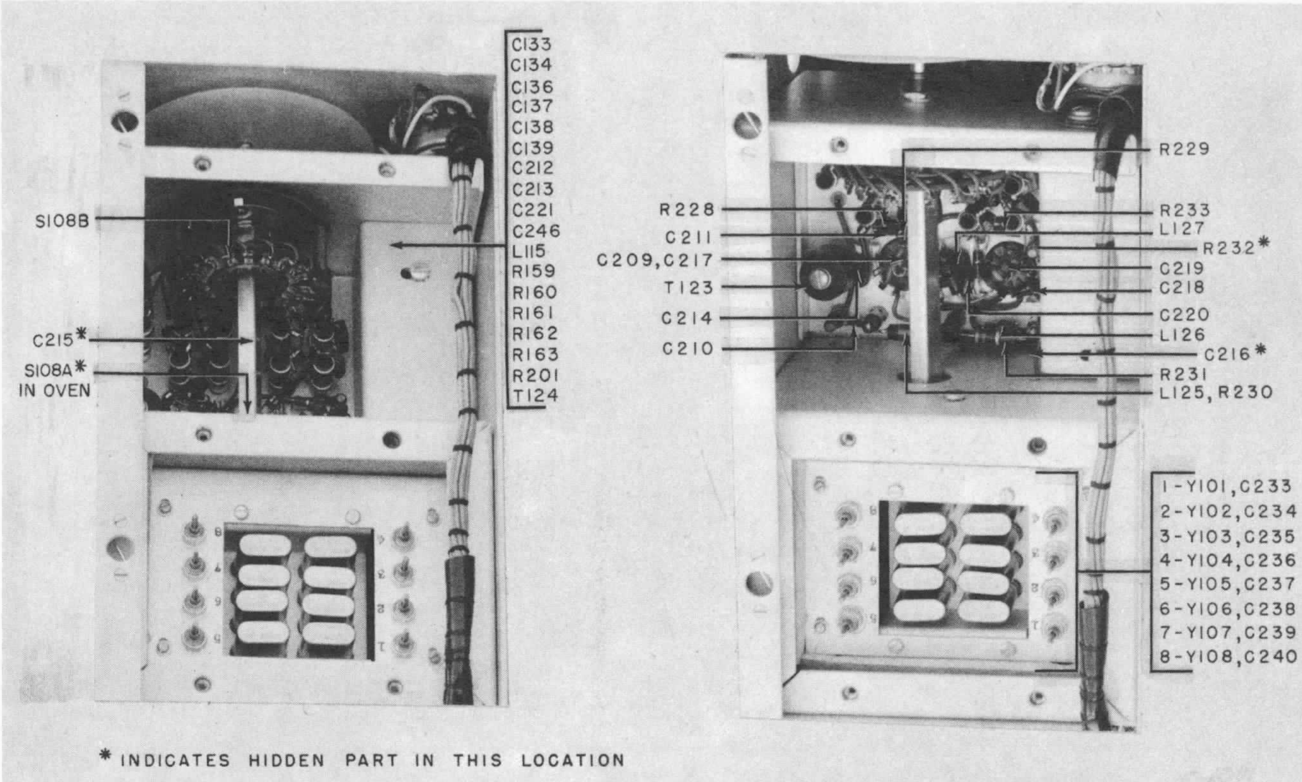


Figure 5-10-c. Location Diagram of Major Electronic Equipment Components, SBE-2, Section A

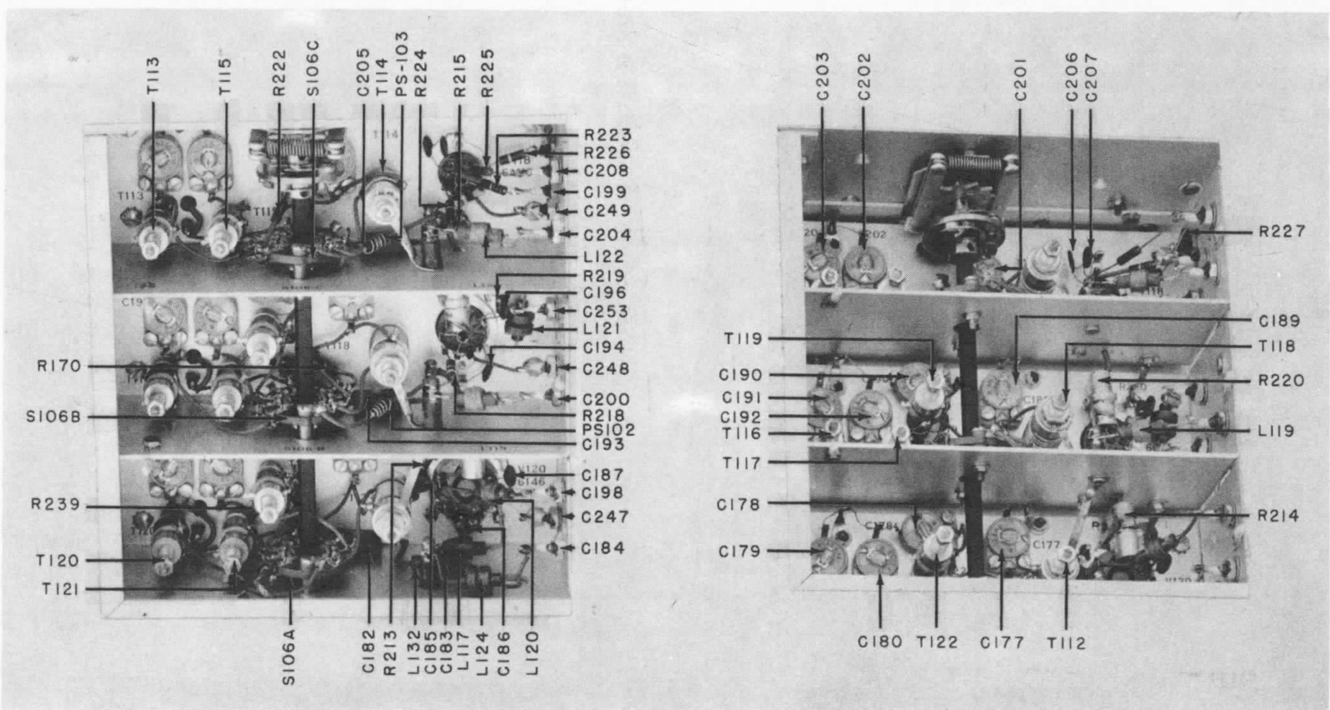


Figure 5-10-d. Location Diagram of Major Electronic Equipment Components, SBE-2, Section B

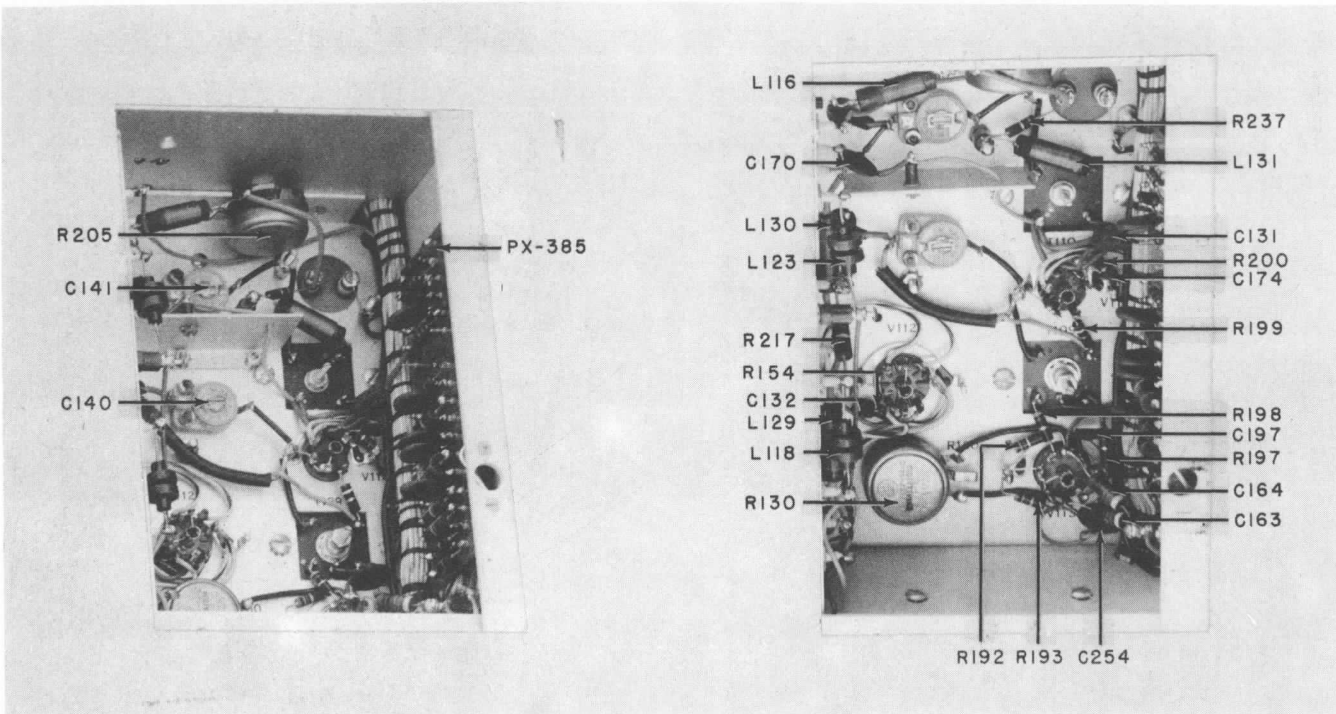


Figure 5-10-e. Location Diagram of Major Electronic Equipment Components, SBE-2, Section C

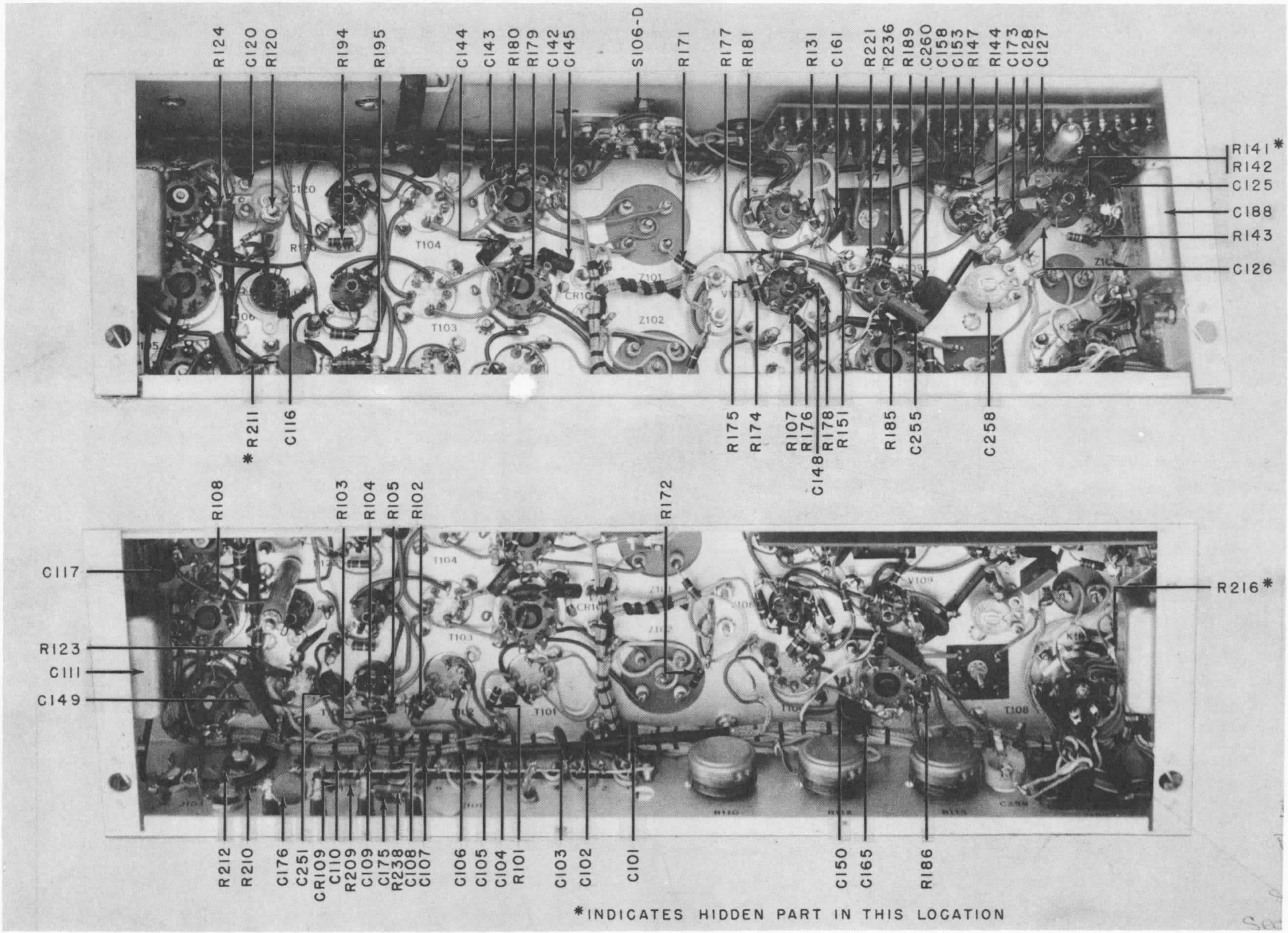
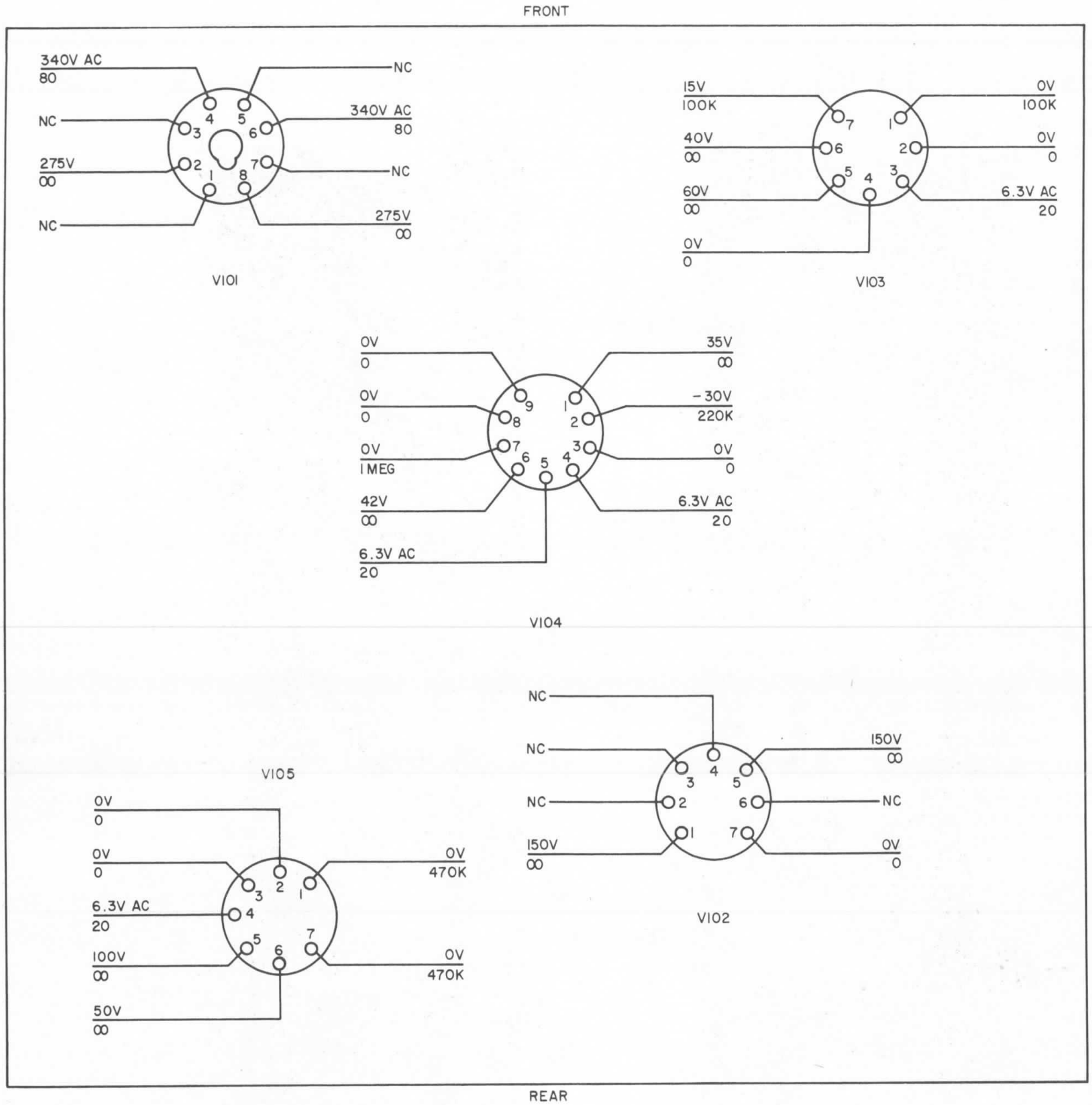


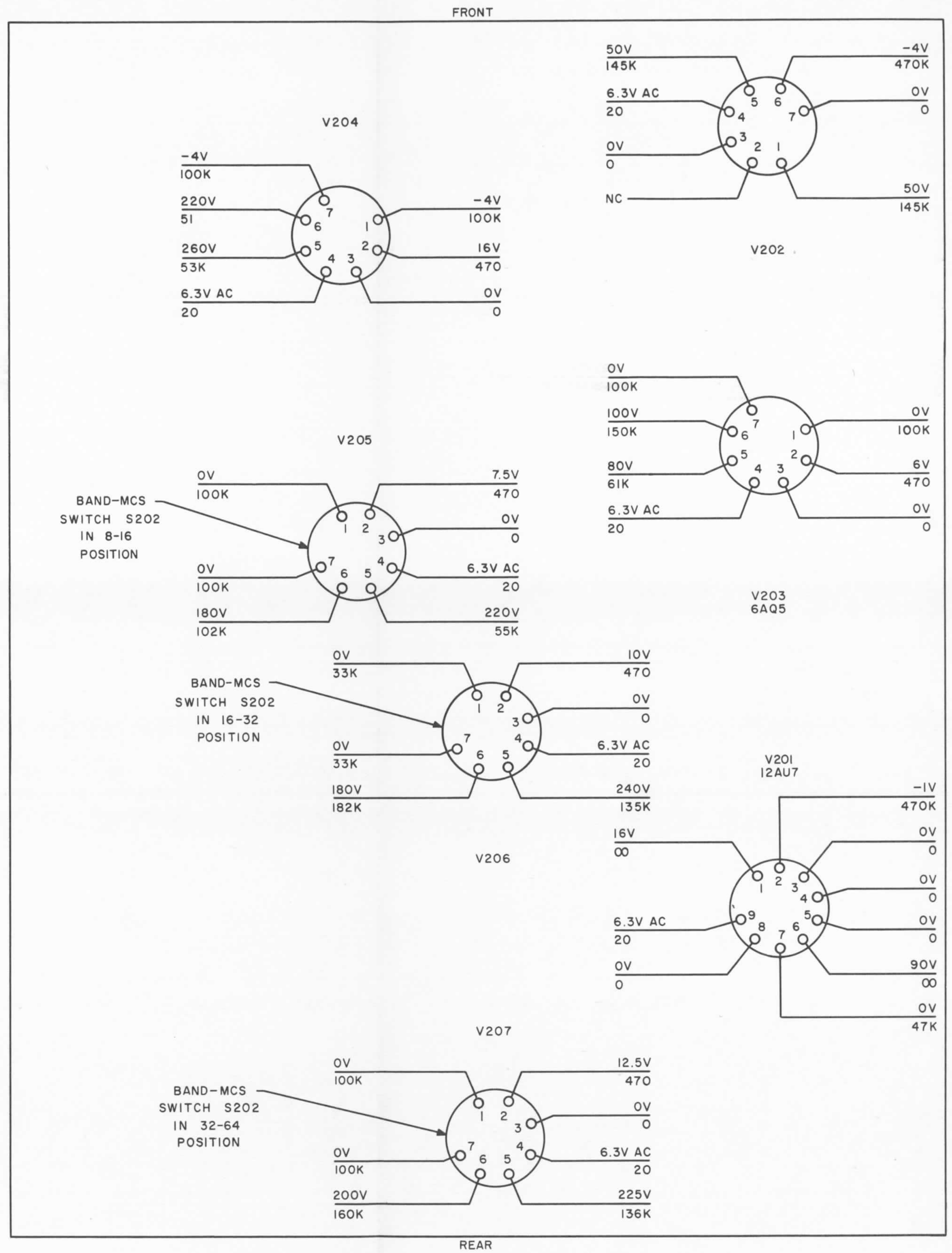
Figure 5-10-f. Location Diagram of Major Electronic Equipment Components, SBE-2, Section D



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 MAXIUM CLOCKWISE; XTAL SWITCH TO VMO.
3. VOLTAGES ARE DC UNLESS OTHERWISE INDICATED.
4. VOLTAGE READING ABOVE LINE, RESSISTANCE READING BELOW LINE.
5. ∞ INDICATES INFINITY

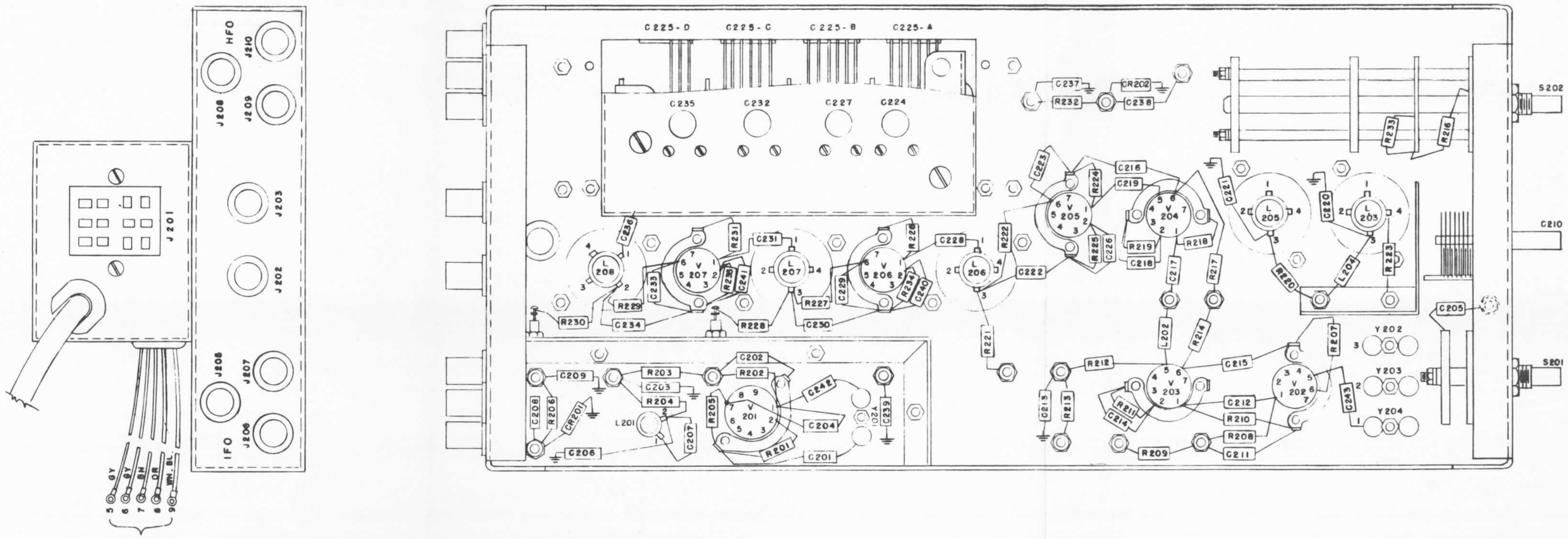
Figure 5-11-a. Voltage and Resistance Diagram, VOX, Power Supply Chassis



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.

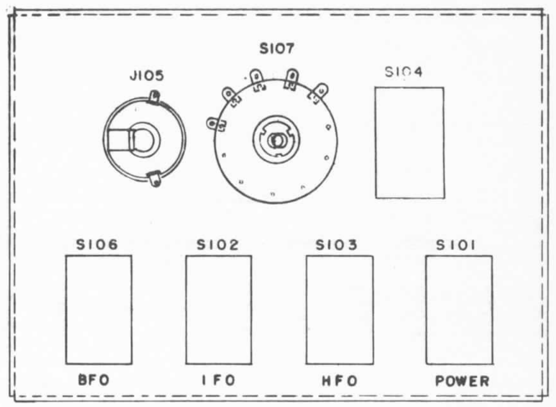
Figure 5-11-b. Voltage and Resistance Diagram, VOX, RF Chassis



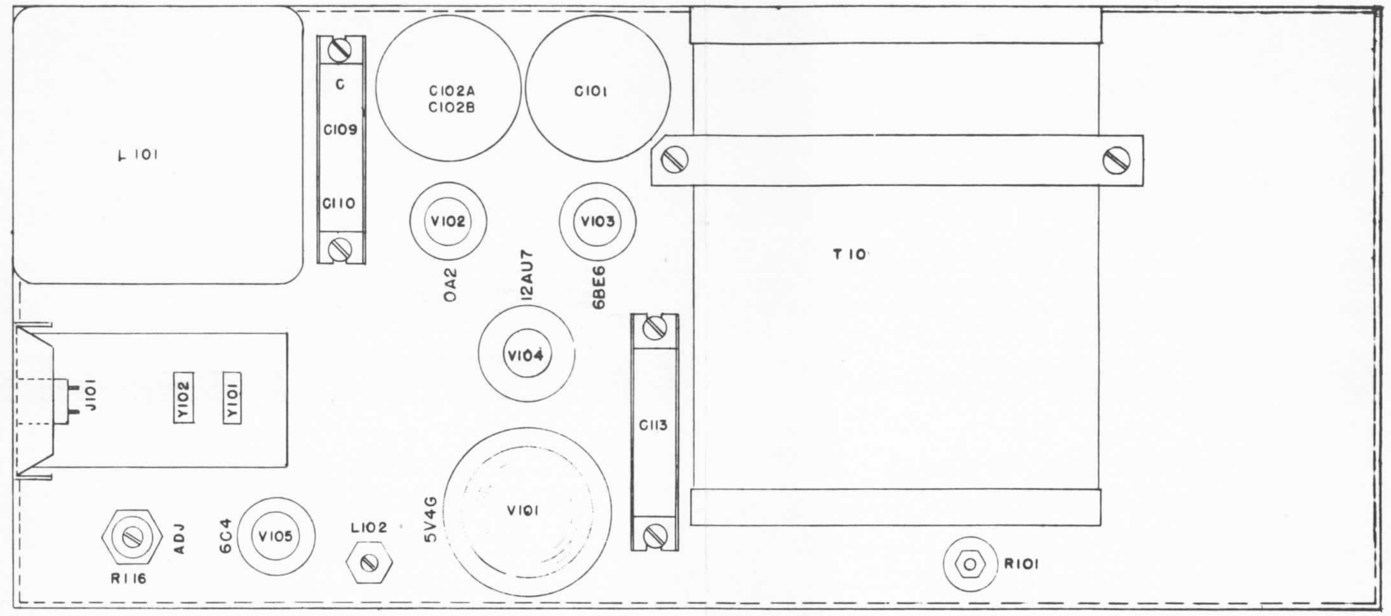
TO E 302

NOTE
RF JACKS COLORED AS FOLLOWS
J206 = BLUE/GREEN
J207 = BLUE/YELLOW
J209 = RED/GREEN
J210 = RED/YELLOW

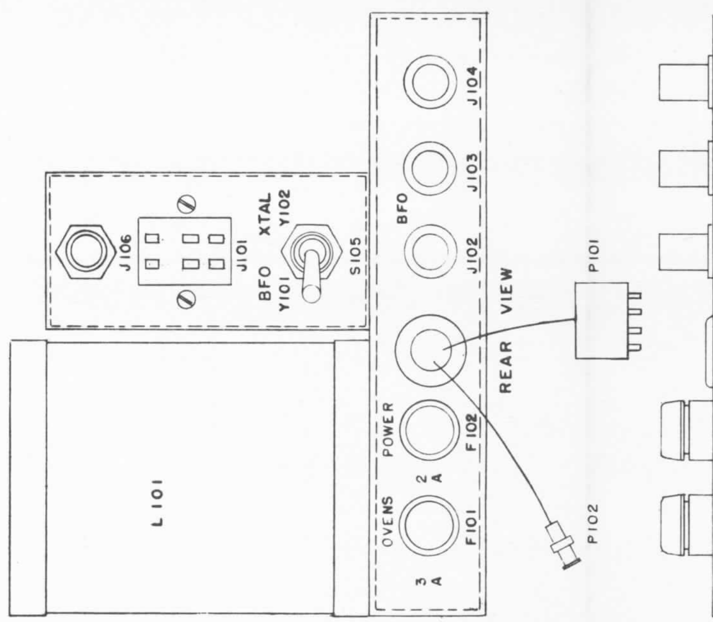
Figure 5-12-a. Layout Diagram, VOX, RF Chassis

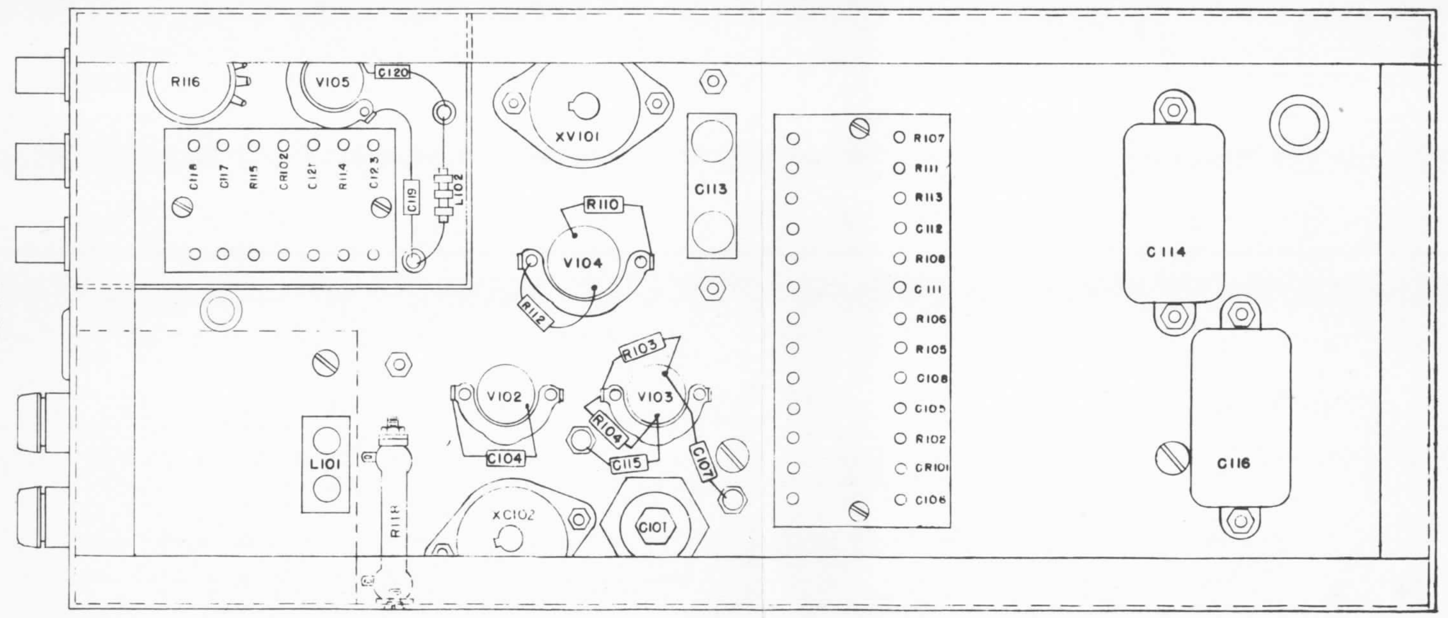


SUB-CONTROL PANEL
REAR VIEW



TOP VIEW



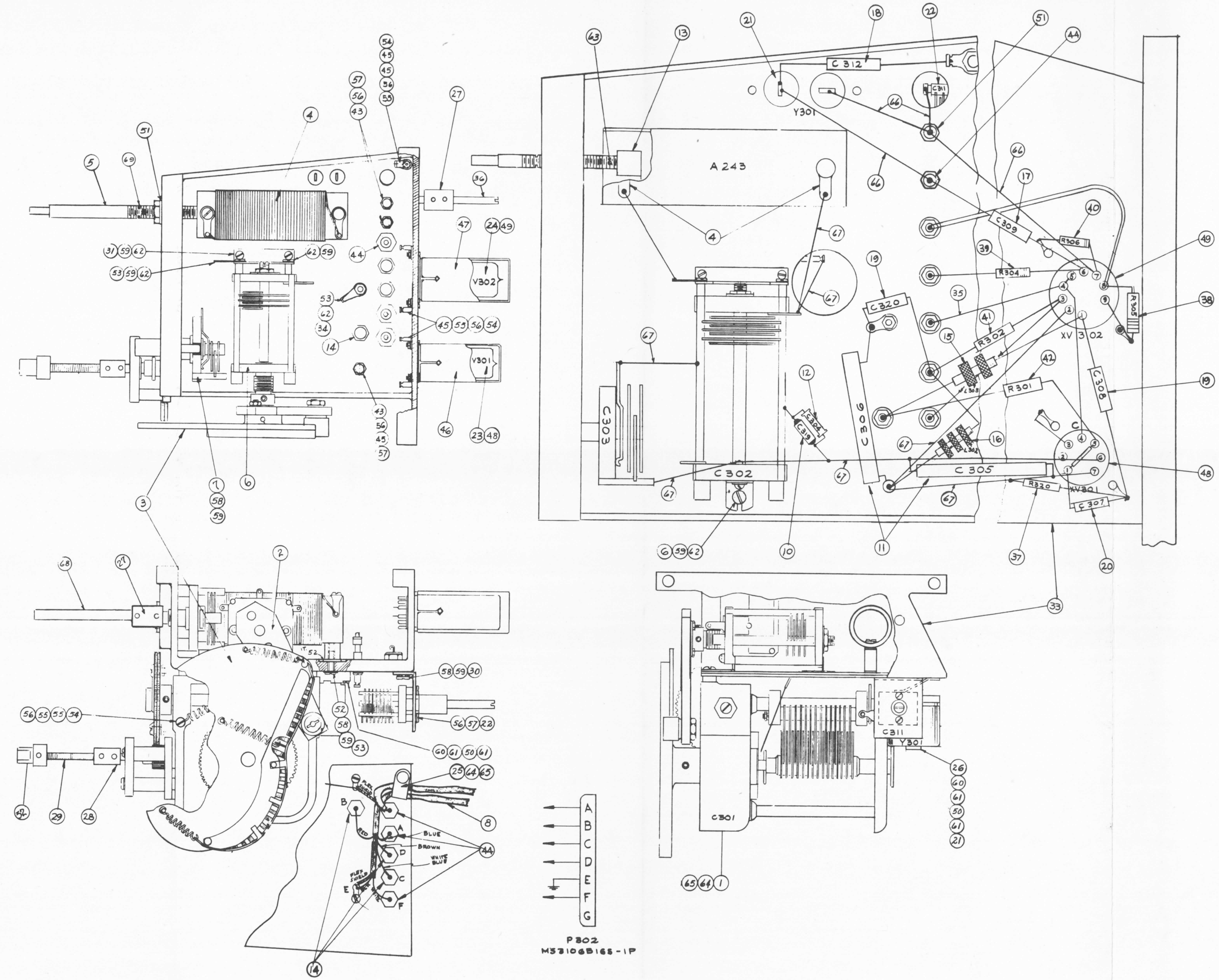


BOTTOM VIEW

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

SUPERCEDES
CMS 070-C

Figure 5-12-b. Layout Diagram,
VOX, Power Supply Chassis



REQ.	ITEM	PART NO.	DESCRIPTION	SYMBOL
X	70	BS-100	SOLDER, SOFT	
1	69	SP-138	SPRING, CLIP	
1	68	PX-239	OSC. COND. EXT. SHAFT	
X	67	WL-100-4	WIRE, BUSS (SIZE 16)	
X	66	WL-100-5	WIRE, BUSS (SIZE 18)	
4	65	LWE08MRN	LOCKWASHER, EXT	
4	64	SCBS0832BN8	SCREW, MACHINE	
1	63	PN-109-2	PIN, ROLL	
4	62	SCBS0632BN4	SCREW, MACHINE	
4	61	WA-109-18	WASHER, FIBER	
2	60	SCBS0440BN10	SCREW, MACHINE	
8	59	LWE06MRN	LOCKWASHER, EXT.	
5	58	SCBS0632BN6	SCREW, MACHINE	
6	57	SCBS0440BN4	SCREW, MACHINE	
12	56	LWE04MRN	LOCKWASHER, EXT	
7	55	NTH0440BN6	NUT, HEX.	
5	54	SCBS0440BN6	SCREW, MACHINE	
3	53	TE-104-2	TERMINAL, LOCKING	
2	52	WA-12C	WASHER, FIBRE	
1	51	LWI37MRN	LOCKWASHER, INT.	
1	50	TS-105-1	SOCKET, CRYSTAL	XY301
1	49	TS-103P01	SOCKET, TUBE	XV302
1	48	TS-102P01	SOCKET, TUBE	XV301
1	47	TS103U02	SHIELD, TUBE	
1	46	TS102U02	SHIELD, TUBE	
7	45	TE-149-.120	LUG, SOLDER	
3	44	TE-114-2	TERMINAL, FEED-THRU, INSULATED	
3	43	TE-102-2	TERMINAL, TURRET	
1	42	RC30GF392K	RESISTOR, FIXED COMPOSITION	R301
1	41	RC30GF102K		R302
1	40	RC20GF474K		R-306
1	39	RC20GF473K		R-304
1	38	RC20GF472K		R-305
1	37	RC20GF223K	RESISTOR, FIXED COMPOSITION	R-320
1	36	PX-259	SHAFT, OSC. COND. EXT.	
X	35	WL-100-7	WIRE, BUSS (SIZE 22)	
1	34	NTH0632BN8	NUT, HEX	
1	33	PM-501	CHASSIS, OSC. MACHING (LD-	
1	32	PM-319	COUPLING, MAIN SHAFT	
1	31	MS-1582	BRACKET, CONDENSER	
1	30	MS-309	BRACKET, OSC. CONDENSER	
1	29	MC-123	COUPLING, FLEXIBLE SHAFT	
1	28	MC-107	COUPLING	
2	27	MC-102	COUPLING, SWITCH SHAFT	
1	26	CU-106	CLAMP, CRYSTAL	
1	25	CU-102-5	CLAMP, "G" TYPE	
1	24	12AU7	TUBE, ELECTRON	V302
1	23	6AB4	TUBE, ELECTRON	V301
1	22	CT-103	CAPACITOR, VARIABLE	C311
1	21	CR-100-1	CRYSTAL UNIT	Y301
1	20	CM35B103J	CAPACITOR, FIXED, MICA	C307
2	19	CM35B103K	CAPACITOR, FIXED, MICA	C308 C320
1	18	CM20C241J	CAPACITOR, FIXED, MICA	C312
1	17	CM20B102J	CAPACITOR, FIXED, MICA	C309
1	16	CL-101-2	CHOKE, R.F.	L302
1	15	CL-100-5	CHOKE, R.F.	L303
3	14	CK-70A102M	CAPACITOR, FEED-THRU, CERAMIC	C321 322-323
1	13	CI-117	TUNING SLUG P/oL301	
1	12	CC107RG100C	CAPACITOR, FIXED, CERAMIC	C306
2	11	CM20OF270F	CAPACITOR, FIXED, CERAMIC	C305 C304
	10	CC-102-5	CAPACITOR, FIXED, MICA	C319
	9	CA-282	CABLE, R.F.	P301
	8	CA-281	CABLE, MO. POWER	P302
1	7	CB-121	CAPACITOR, VARIABLE	C303
1	6	CB-105	CAPACITOR, VARIABLE	C302
	5	A-1578	TUNING SLUG ASS'Y.	P/o L301
	4	A-243	COIL ASS'Y.	L301
	3	A-584	CAM, SUB-ASS'Y	
	2	A-583	CAM FOLLOWER ARM SUB ASS'Y	
	1	A-1000	SUB-ASSEMBLY CAP, VAR. AIR	C301

A-1742

Figure 5-12-c. Layout Diagram, VOX, VMO Chassis

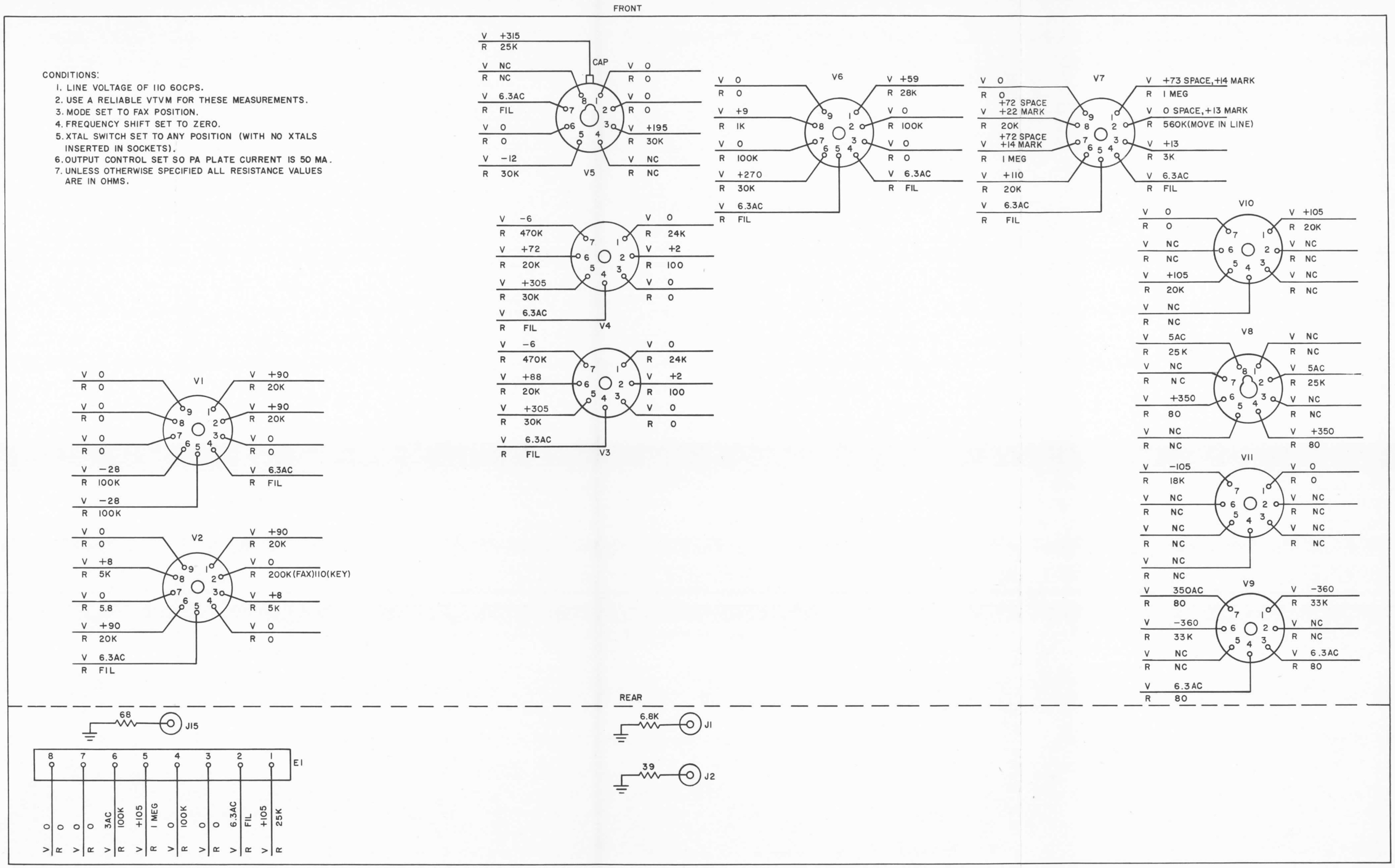


Figure 5-13. Voltage and Resistance Diagram, XFK

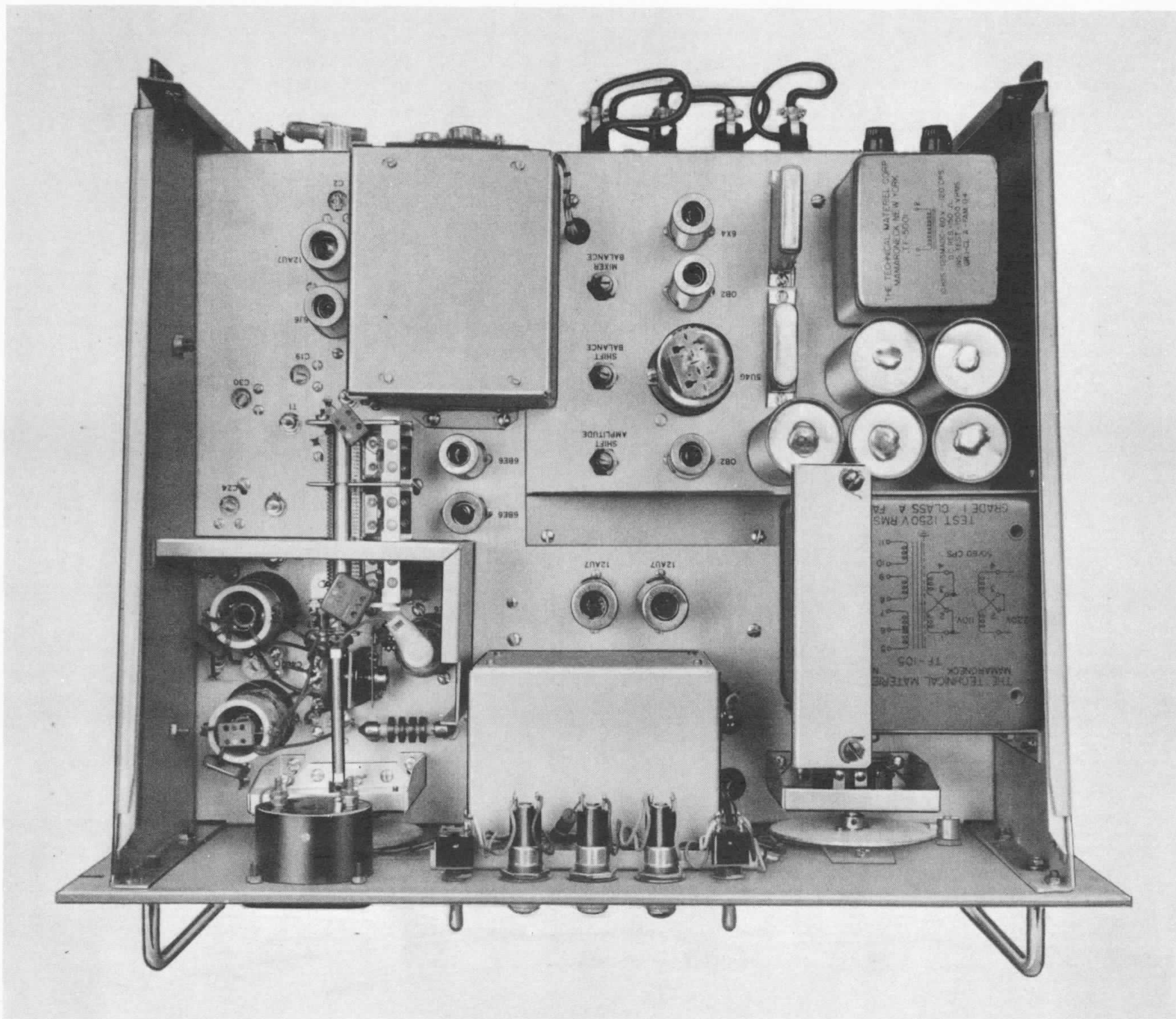


Figure 5-14-a. Location Diagram of Major Electronic Equipment Components, XFK, Top View

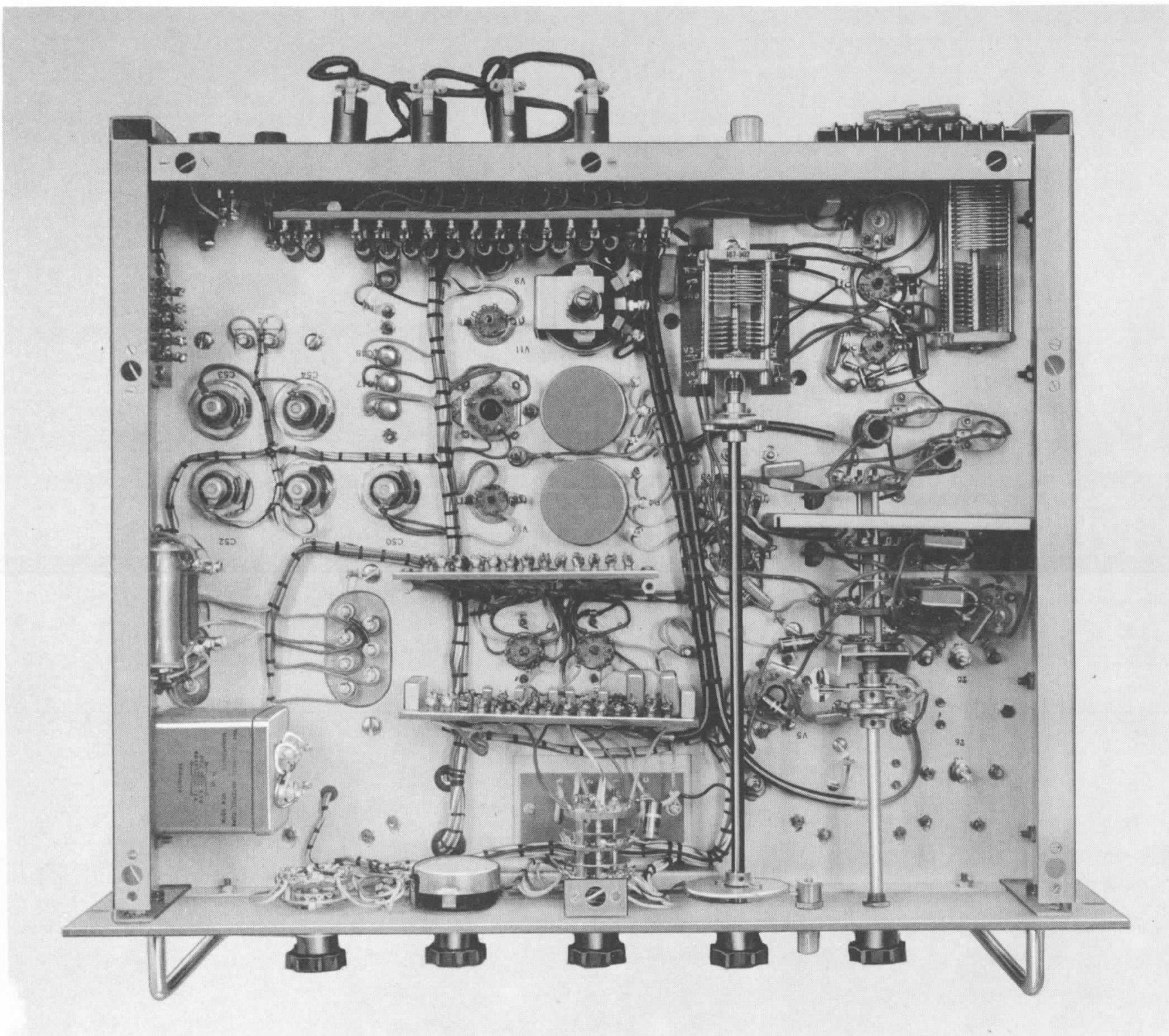


Figure 5-14-b. Location Diagram of Major Electronic Equipment Components, XFK, Bottom View

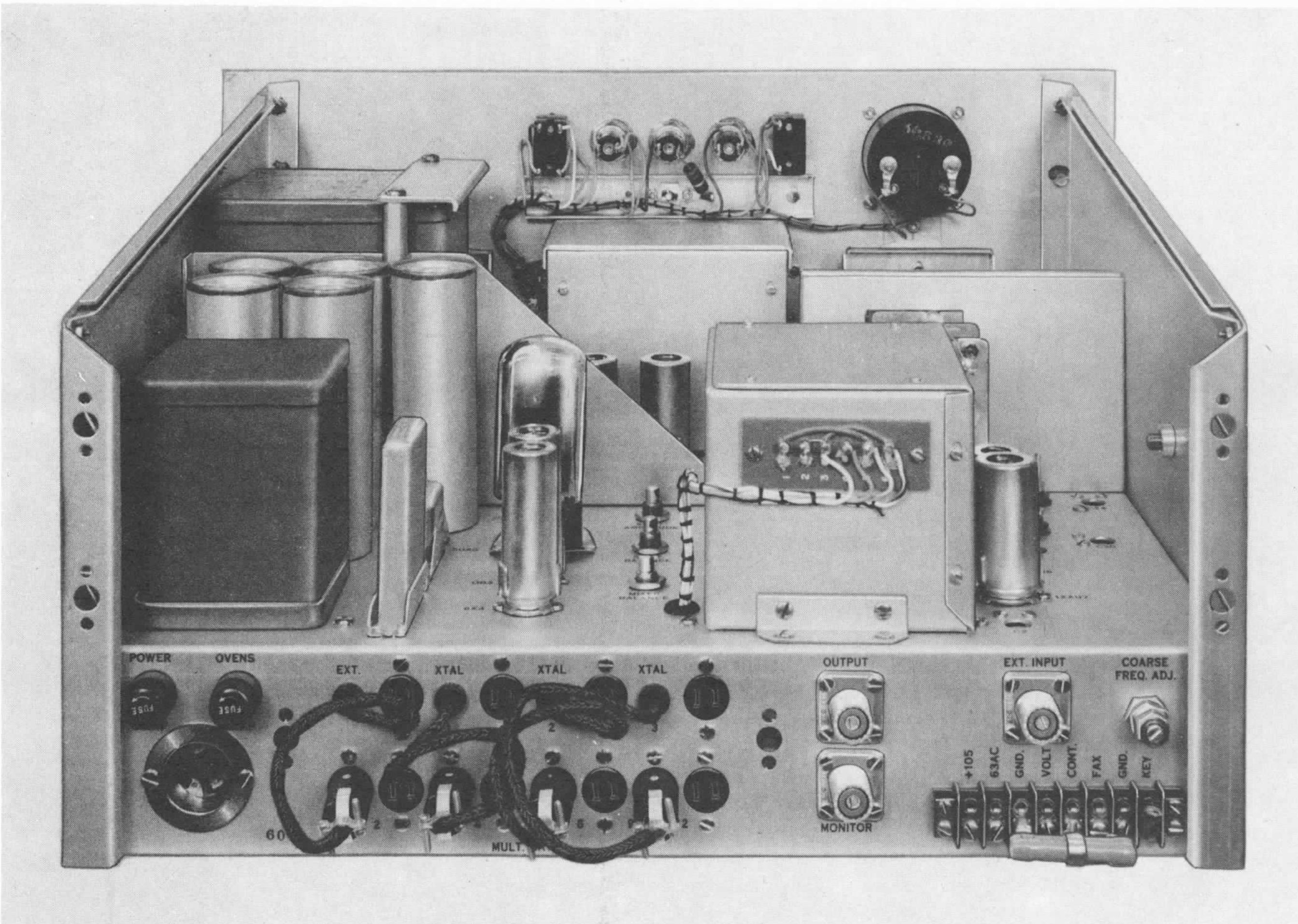
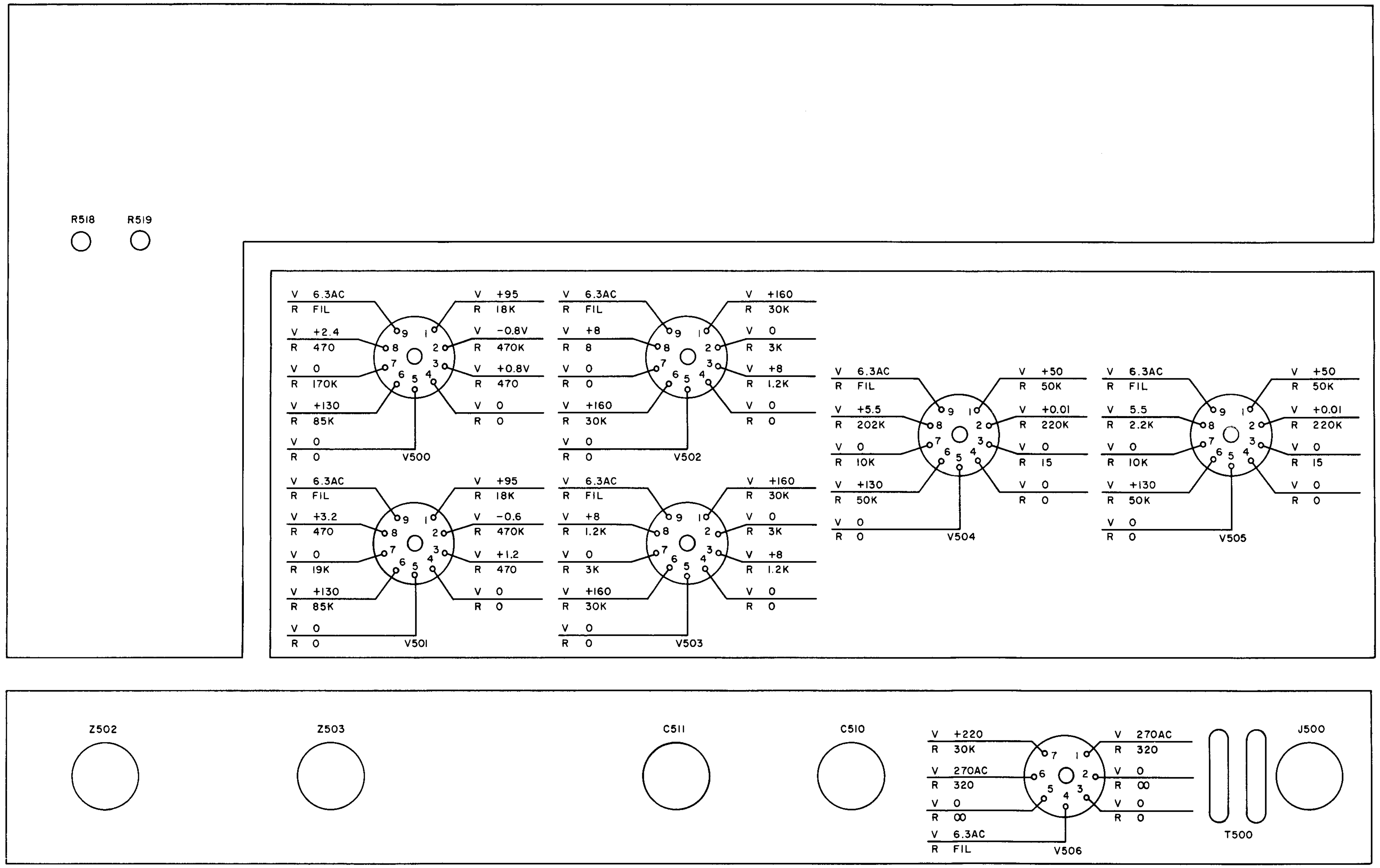


Figure 5-14-c. Location Diagram of Major Electronic Equipment Components, XFK, Rear View



NOTE:
UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS.

Figure 5-15. Voltage and Resistance Diagram, TTG

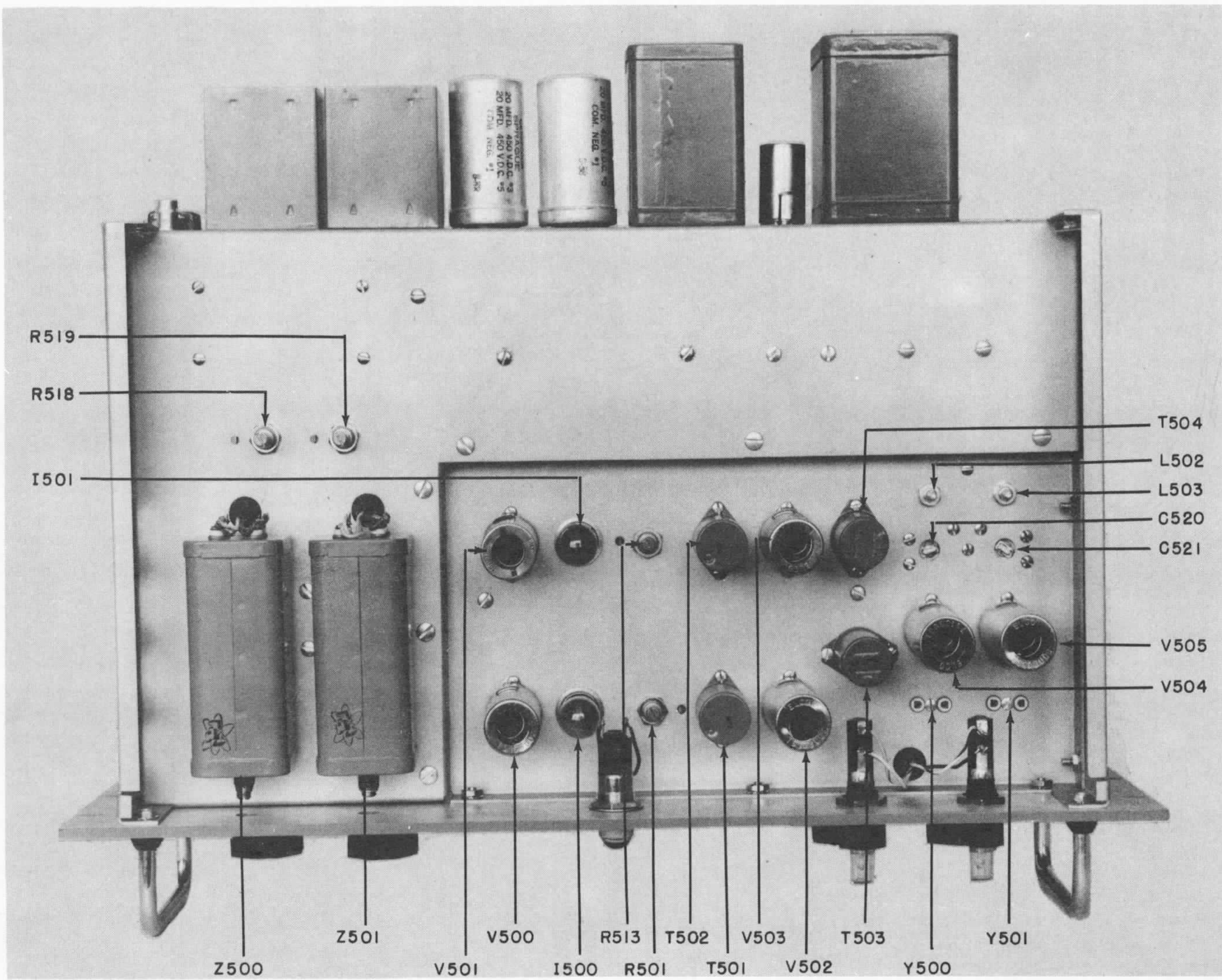


Figure 5-16-a. Location Diagram of Major Electronic Equipment Components, TTG, Top View

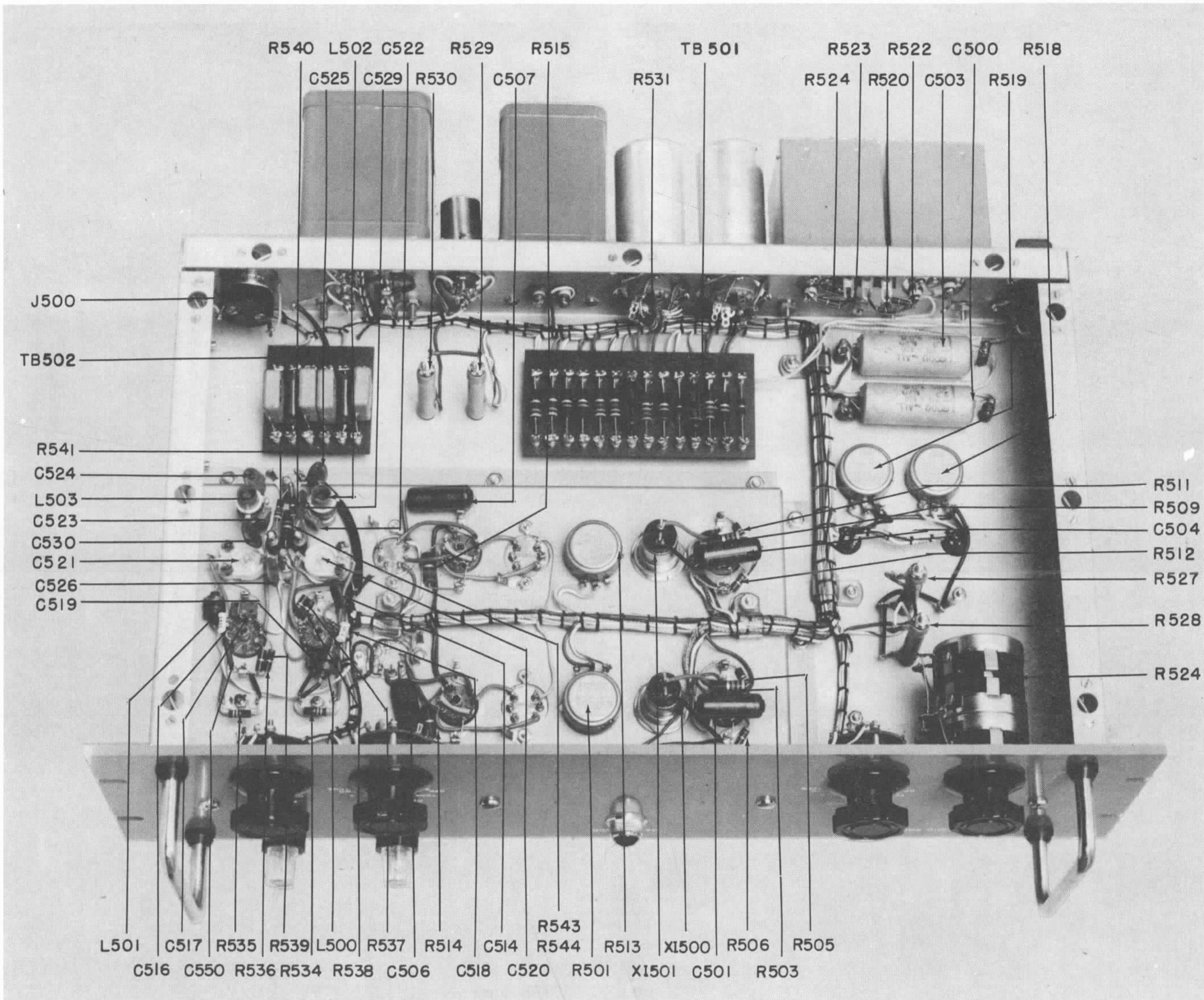
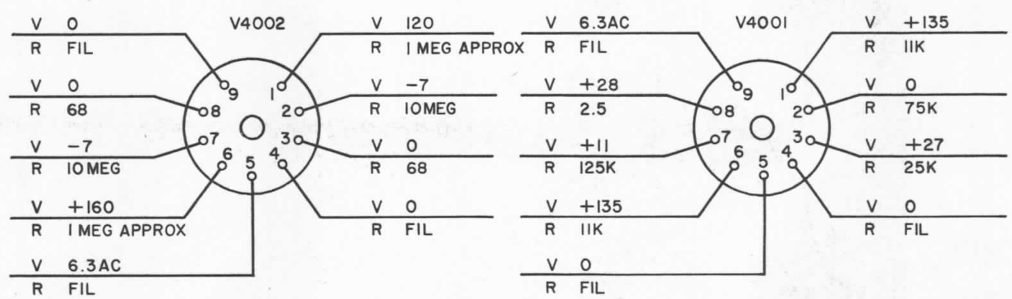


Figure 5-16-b. Location Diagram of Major Electronics Equipment Components, Bottom View



CONDITIONS:
VOLTAGE MEASUREMENTS
1. POWER SWITCH (S4002) ON.
2. MODE SWITCH (S4001) TO 50V.
RESISTANCE MEASUREMENTS
1. POWER SWITCH (S4002) OFF.
2. MODE SWITCH (S4001) TO 50V.

NOTE:
1. THE ISOLATION KEYER POWER SUPPLY CIRCUITS ARE NOT GROUNDED TO THE CHASSIS. READINGS FOR V4001 WERE TAKEN WITH THE VTVM COMMON LEAD CONNECTED TO C4001 PIN #1. READINGS FOR V4002 WERE TAKEN WITH THE VTVM COMMON LEAD TO C4002 PIN #1.

Figure 5-17. Voltage and Resistance Diagram, ISK

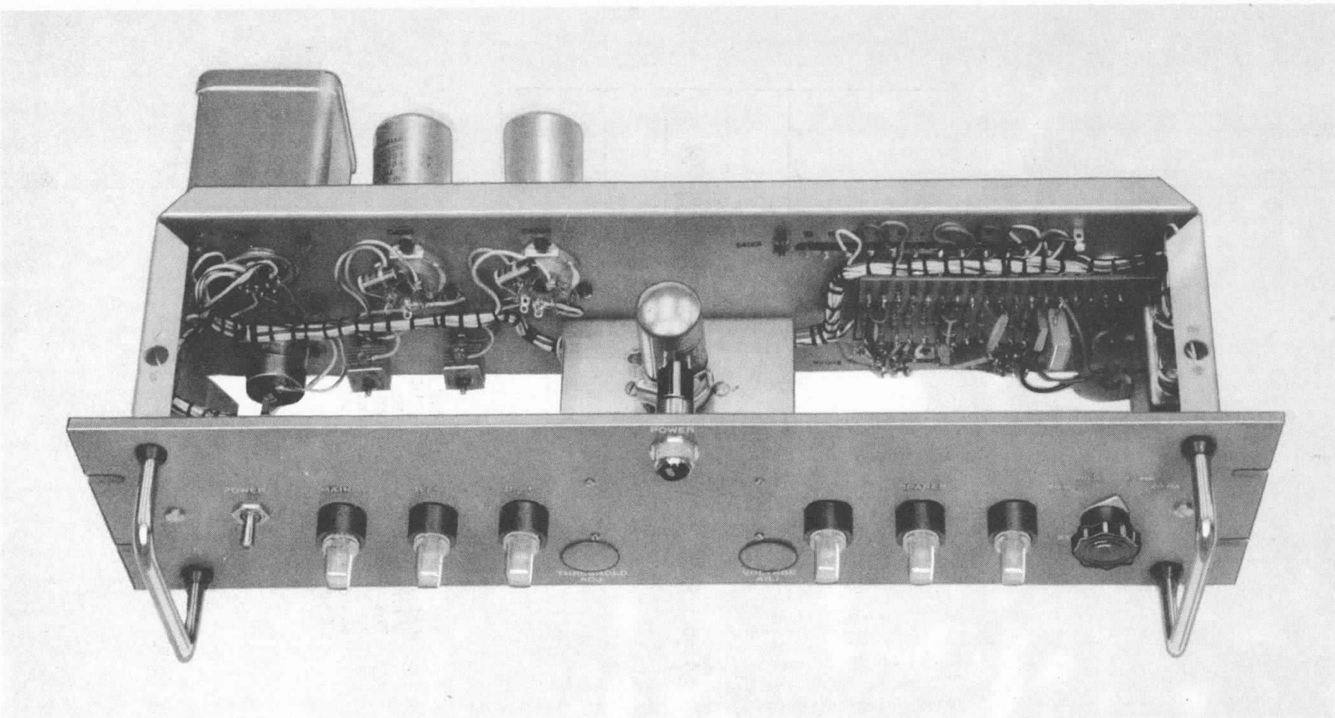


Figure 5-18-a. Location Diagram of Major Electronic Equipment Components, ISK, Top View

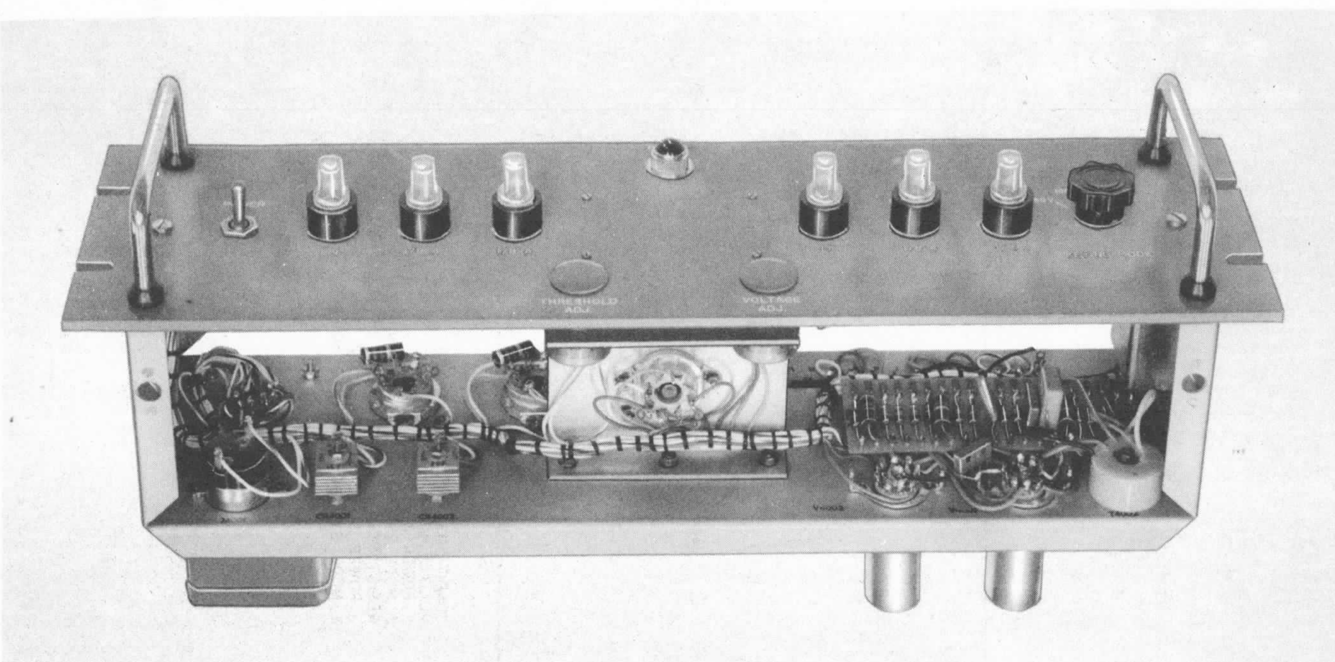


Figure 5-18-b. Location Diagram of Major Electronic Equipment Components, ISK, Bottom View

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).

6-2. SIDEBAND LEVEL MONITOR MODELS SLM-1 AND SLM-2.

a. GENERAL. From a maintenance standpoint, there is no essential difference between the SLM-1 and SLM-2. The following statements apply to both, unless otherwise stated.

b. OPERATOR'S MAINTENANCE. - The operator should:

(1) Check the condition of the two panel fuses as well as that of the four tubes contained within the sets.

(2) Note the condition of the main power ON-OFF switch and observe whether the MAIN POWER indicator lights properly.

(3) Make minor adjustments of the CALIBRATE potentiometers to make the SLM meter readings correspond to the associated SBE's audio meter reading.

CAUTION

Never replace a fuse with one of higher rating. If a fuse burns out immediately after replacement, DO NOT replace it a second time until the cause has been corrected.

c. PREVENTIVE MAINTENANCE.

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

(2) At periodic intervals (at least every six months) the equipment should be removed from the rack for cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring, or grease; 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 (CCl_4) may be used if great care is excercised because it is a toxic substance. Do not inhale its fumes. Avoid contact with skin.

(3) While unit is out of the rack and covers are removed, it is advisable to check the tubes, all of which are accessible from the top of the chassis.

WARNING

Tubes should be removed and checked one at a time to eliminate the danger of replacing a tube in the wrong socket. Do not fail to replace the shields.

d. CORRECTIVE MAINTENANCE. - The corrective maintenance procedure presented below is essentially Technical Materiel Corporation's factory alignment procedure:

(1) SIDEBAND LEVEL MONITOR SLM-1.

(a) Turn main power ON-OFF switch (S400) to ON position; allow the SLM-1 a 1-hour warm-up period.

(b) Connect an RF generator to USB input jack J401.

(c) Connect a VTVM across USB input jack J401. (Use a Davan voltmeter or an equivalent with a high input impedance.)

(d) Turn RF generator ON-OFF switch to ON position. Adjust RF generator output for 17 kc at 0.004 volt maximum on the VTVM.

(e) Adjust SLM-1 CALIBRATE potentiometer (R407) for 0 DB deflection on the USB meter.

(f) For LSB calibration, the RF generator output is connected to LSB input jack J400; LSB CALIBRATE potentiometer (R417) is adjusted. Repeat stages (b) through (e).

(2) SIDEBAND LEVEL MONITOR SLM-2.

(a) Turn main power ON-OFF switch (S400) to ON position; allow the SLM-2 a 1-hour warm-up period.

(b) Connect an RF generator output to USB input jack J401.

(c) Connect a VTVM across USB input jack J401. (Use a Davan voltmeter or equivalent with a high input impedance.)

(d) Turn RF generator ON-OFF switch to ON position. Adjust RF generator output for 250 kc at 0.01 volt maximum on the VTVM.

(e) Adjust SLM-2 CALIBRATE potentiometer (R407) to approximately half rotation (CW). This will increase the sensitivity of the USB meter.

(f) Tune peaking coil L401 for maximum needle deflection on the USB meter.

(g) Adjust SLM-2 CALIBRATE potentiometer (R407) to its maximum rotation (CW). The USB meter deflection needle should "peg" the meter scale.

(h) Readjust SLM-2 CALIBRATE potentiometer (R407) to minimum rotation (CCW). The USB meter deflection needle should read zero.

(i) Adjust R407 for 0 DB indications on the USB meter.

(j) For LSB calibration, the RF generator output is connected to LSB input jack J400; LSB CAL potentiometer (R414) and peaking coil L402 are adjusted. Repeat steps (b) through (i).

6-3. FREQUENCY SPECTRUM ANALYZER (FSA).

a. GENERAL. - The FSA has been designed to provide long term trouble free operation. It is recommended that any maintenance to the equipment be done by a competent maintenance technician. Recalibration, realignment, and readjustment require a high degree of specialization in servicing auxiliary test equipment. This fact becomes evident by the detailed data given in the following paragraph, 6-3d. The required specialized test equipment and personnel trained in its use are available in the Testing Department of Technical Material Corporation. If trouble develops which cannot be corrected by following the procedures outlined in the following paragraphs, it is recommended that the instrument be returned to Technical Materiel Corporation for servicing. To expedite the return of the serviced equipment to you, it is recommended that the equipment be shipped to us by Air Freight and that we be authorized to return it the same way.

b. OPERATOR'S MAINTENANCE. - The operator should make minor adjustments of tuning controls to obtain accurate, discernible, and satisfactory crt patterns; should note general condition of panel switches; should observe whether panel indicator lamps light properly; and should check the condition of the power supply fuses as well as that of all 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.

The following tabulation indicates general areas to be checked when tubes age or are changed. It is not intended to imply that any or all of the adjustments will have to be made. The location of all tubes in the analyzer is indicated in the tube location diagram of figure 5-5.

Tube	Areas to Be Checked and/or Adjustments to Be Made
V1	Select replacement tube. Replacement should provide a jack-to-jack sensitivity ratio of not greater than 2:1. IF gain ccontrols.
V2	None.
V3	CF PAD, sweep width limit controls. Refer to paragraph 6-3d.
V4	Z101, CF PAD, sweep width limit control. Refer to paragraph 6-3d.
V5	None.
V6	None.
V7	IF gain controls. Refer to paragraph 6-3d.
V8	IF gain controls. Refer to paragraph 6-3d.
V9	Log scale, log zero controls. Refer to paragraph 6-3d.
V10	Log scale, log zero controls. Refer to paragraph 6-3d.
V11	None.
V12	Line size, log zero, log scale and sweep width limit controls. Refer to paragraph 6-3d.
V13	None.
V14	None.
V15	Select replacement tube. Replacement should be selected for best linearity.
V16	None.
V17	None.

Tube	Areas to Be Checked and/or Adjustments to Be Made
V18	None.
V19	None.
V20	IF gain controls. Refer to paragraph 6-3d.
V101	None.
V102	None.
V103.	None.
V104	Voltage regulator adjust.

c. PREVENTIVE MAINTENANCE.

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

(2) 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 (CCl_4) may be used if great care is exercised because it is a toxic substance. Do not inhale its fumes. Avoid contact with skin.

(3) While unit is out of the rack and covers are removed, it is advisable to check the tubes, all of which are accessible from the top of the chassis.

WARNING

Tubes should be removed and checked one at a time to eliminate the danger of replacing a tube in the wrong socket. Do not fail to replace tube shields.

d. CORRECTIVE MAINTENANCE.

(1) GENERAL. - Corrective maintenance on the FSA is limited to a complete factory alignment procedure and to the adjustment of controls (located on top of the chassis) which seldom require adjustment.

(2) COMPLETE FACTORY ALIGNMENT - The following is a complete factory alignment procedure. It should be used only after touch-up alignment techniques have been tried and have failed to yield satisfactory results.

(a) GENERAL.

1. Transformers T101, T102, Z101, Z102, Z103, and Z105 are tuned by means of movable iron cores. Windings at the top of the coil are tuned with a hollow iron core which may be turned with the pin end of the alignment tool furnished.

The bottom windings may be tuned from either the top or the botton of the transformer. In either case, the screwdriver tip of the aligning tool is used. When the bottom core is approached from the top, the tool is inserted through the hollow top core and finally engaged in a slot in the top of the lower core. Allow the FSA and necessary signal generator to warm up for at least one-half hour before alignment is attempted.

2. Set the front panel controls as follows:

IF ATTEN	- 0 DB
SWEEP WIDTH SELECTOR	- VAR
BRILLIANCE	- Bright trace
FOCUS	- Sharp trace
AMPLITUDE SCALE	- LIN
CENTER FREQ	- To marker
GAIN	- 10 (maximum)
AFC	- OFF
CAL OSC LEVEL	- OFF
INPUT ATTENUATOR	- All up
H POS	- For normal operation
V POS	- For normal operation
SWEEP WIDTH	- Maximum (clockwise)
IF BANDWIDTH	- Maximum (clockwise)
VIDEO FILTER	- OFF
SWEEP RATE	- Maximum (clockwise)

(b) IF AMPLIFIER ALIGNMENT.

1. The frequencies involved in IF alignment are:

Type	Input Center Freq.	IF
SA	500 kc	100 kc

2. Connect an 0.01-uf capacitor in series with the output of the signal generator and proceed as follows:

(c) FM OSCILLATOR ALIGNMENT. - The following adjustments are a series of approximations, which are narrowed down until the desired results are obtained.

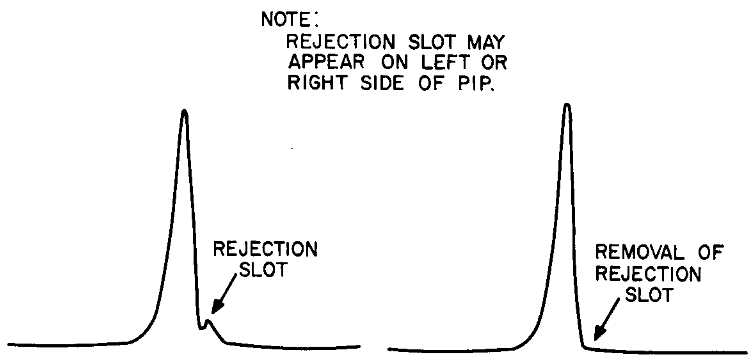
1. Set the sweep width limit control fully clockwise.

2. Adjust the CF PAD for +85 volts, measured between the arm of the CF PAD and ground.

3. Set front panel CAL OSC LEVEL control fully clockwise.

Step	Sig. Gen. Output	Sweep Width Control at	Signal Fed to	Procedure
1	100 kc (40,000 uv)	Minimum	Pin 1 V9 (6AU6)	Tune top and bottom cores of Z105 for maximum baseline rise. When either core is tuned for maximum deflection, no further tuning is required because windings are in parallel.
2	Same as above.	Same as above.	Pin 7 V3 (6BE6)	Tune top and bottom cores of Z103 for maximum baseline rise possible with each.
3	500 kc (700 uv)	Maximum	Pin 7 V3 (6BE6)	Adjust the CENTER FREQ control and, if necessary, the CF PAD control to center the pip on the screen. Gradually reduce the sweep width, at the same time continuously readjusting the CENTER FREQ control to keep the pip on the screen until the base of the pip occupies approximately 25 percent of the frequency scale.
4	500 kc	Adjust continuously as required to keep the entire pip within screen limits.	Same as above.	Mark the position of crystals in their sockets. Holder capacity varies with position; therefore, it will be important when replacing the crystals to preserve their orientation with respect to the socket. Remove crystals Y301 and Y302.
5				A neutralizing capacitor is mounted near each crystal on the underside of the IF strip. These capacitors are to be tuned with the screwdriver end of the aligning tool furnished. Each capacitor tunes the crystal nearest to it.

Step	Sig. Gen. Output	Sweep Width Control at	Signal Fed to	Procedure
6				Set the BANDWIDTH LIMIT control to the center of its rotational range. At this point pip should approximate the shape as shown below:



A. ILLUSTRATION OF REJECTION SLOT

B. ILLUSTRATION OF COMPLETE REJECTION SLOT REMOVAL

Step	Sig. Gen. Output	Sweep Width Control at	Signal Fed to	Procedure
7				Gradually rotate the trimmer screw of the capacitor nearest Y303 in a counterclockwise direction, and note the change in pip shape. The rejection slot should sharpen and disappear on one side of the pip and approach from the other side.
8				Reverse the rotation and choose a point where best pip symmetry is obtained and a rejection slot is not present. (Approximately halfway between the two positions at which the slot enters the pip from either side.) (See illustration B above.)
9				Tune coil L101C for a minimum height and a broadest pip. Note that as the core is moved from one end of its range to the other, the pip will broaden and decrease in amplitude until a condition of minimum height and broadest pip is reached. Continued rotation will cause the pip to sharpen and increase in

Step	Sig. Gen. Output	Sweep Width Control at	Signal Fed to	Procedure
9 (Cont.)				amplitude. (As the pip decreases in amplitude, it may be necessary to increase the amplitude of the input signal to maintain a readable deflection on the screen.)
10				Check for forrect rejection slot removal by adjusting sweep width until pip base occupies approximately 25 percent of the screen baseline. Set the piput amplitude for a full-scale deflection. Increase input amplitude by 10 times. Set AMPLITUDE SCALE selector to LOG. If the pip is not full scale, set the LOG SCALE ADJ control for a full-scale pip. Pip should remain approximately symmetrical and no rejection slot should appear. If it does appear, readjust trimmer slightly to remove it and retune as in step 9. Reduce the input amplitude 10 times and set the AMPLITUDE SCALE selector to LIN.
11				Remove crystal Y303.
12				Insert crystal Y302 in its socket. Repeat the procedure given in steps 5 through 10 using the capacitor nearest crystal Y302 and coil L101B.
13				Remove crystal Y302.
14				Insert crystal Y301 in its socket. Repeat the procedure given in steps 5 through 10, using the capacitor nearest crystal Y301 and coil L101A.
15				Replace crystals Y302 and Y303 in the same orientation they have prior to removal. Repeat step 10 with all crystals installed but omit reference to step 9. If trimmer adjustment is required, make small gradual changes in the trimmer settings.

Step	Sig. Gen. Output	Sweep Width Control at	Signal Fed to	Procedure
15 (Cont.)				If there is no change when adjusting one of the trimmers, restore it to its original setting and adjust one of the other trimmers.
16				Adjust BANDWIDTH LIMIT control for the broadest (without double peak) symmetrical peak possible without more than 20 percent drop in amplitude as the SWEEP WIDTH control is changed from a maximum counterclockwise position to a maximum clockwise position.

4. Adjust GAIN control for a full-scale pip.

5. Connect an accurate 50 kc signal source to front panel EXT MOD connector. Adjust the output amplitude for usable sidebands (approximately 1/4 scale).

6. Adjust the core of Z101 to center the oscillator (center) pip on the screen.

7. Adjust the sweep width limit control to place the ±50-kc sideband pips directly under the ±50 vertical screen calibrations. If necessary, make slight centering readjustments with the CF PAD.

8. Check linearity by noting the location of the center pip relative to the vertical CF screen calibration. Linearity is within specifications if, with the ±50-kc pips directly under the ±50 vertical screen calibrations, the center pip is within ±1/4 of a division of the CF screen calibration.

9. If linearity is not within specifications, rotate the CF PAD slightly in a clockwise direction and recenter the display with Z101. Recheck linearity as in steps 7 and 8.

10. Repeat steps 7, 8, and 9 until the sweep width and linearity are correct.

(d) RF ALIGNMENT. - The RF transformers used in this equipment have sliders. This makes it possible to adjust the spacing between the primary and secondary so as to obtain the proper frequency separation between the peak frequencies. If the frequency separation is correct, then it is only necessary to trim the cores of two RF transformers until the desired flatness is obtained. If the frequency separation is not correct, the full alignment procedure must be used. The sliders have been waxed down to prevent movement. If it is necessary to change the position of the sliders, the waxing must be removed. Upon completion of the alignment procedure, rewax the coils to prevent movement.

This alignment requires a "cut and try" procedure. The frequency response of the section is determined by feeding in constant amplitude signals at various frequencies over the RF band of the equipment. First align interstage transformer T102 as follows:

1. Make the spacing between the primary and secondary winding approximately 1/4-inch.

2. Using a 0.01 uf coupling capacitor, feed a 500-kc signal to pin 6 of V2. Tune the secondary (bottom core) of T102 for a peak deflection at the center of the screen.

3. Apply a 515-kc signal to pin 2 of V2. Tune the primary (top core) for a peak deflection.

4. Shift the signal generator frequency to 485 kc. Tune the secondary (bottom core) of T102 for a peak deflection.

5. Vary the signal generator frequency between the high- and low-frequency peaks as read on the screen of the equipment. The peaks should appear at approximately 515 kc and 485 kc. If the frequency separation is greater than specified, increase the coil spacing. If the frequency separation is less than specified, decrease the coil spacing.

6. Repeat steps 3, 4, and 5 until peak deflections and the proper frequency separation are obtained.

Then align input transformer T101 as follows:

1. Make the spacing between the primary and secondary windings approximately 1/16-inch.

2. Connect the signal generator to pin 5 of V1 and set the frequency to 500 kc. Tune the secondary (bottom core) of T101 for a peak deflection at the center of the screen.

3. Apply a 550-kc signal to the SIGNAL INPUT connector through the input cable. Tune the primary (top core) of T101 for maximum pip amplitude.

4. Set the signal generator to 450 kc. Tune the secondary (bottom core) of T101 for maximum pip amplitude.

5. Vary the signal generator frequency between 450 kc and 550 kc, noting the frequency separation between the high- and low-frequency peaks as read on the screen. The peaks should appear at 450 kc and 550 kc. If the frequency separation is greater than specified, increase the coil spacing.

If the frequency separation is less than specified, decrease the coil spacing.

6. Repeat steps 3, 4, and 5 until peak deflections and the proper frequency separation are obtained.

Adjust the cores of RF transformer T102 for proper flatness as follows:

Step	Sig. Gen. Output	Signal Fed to	Transformer Tuned	Procedure
1	450 kc then 550 kc	SIGNAL INPUT Connector	T102	If the 450-kc pip is taller than the 550-kc pip, adjust for equal amplitude by trimming the bottom core clockwise and the top core counterclockwise. On the other hand, if the 550-kc pip is the taller of the two, trim the bottom core counterclockwise and the top cora clockwise.
2	450 kc 500 kc 550 kc	SIGNAL INPUT Connector	T102	If the 450-kc and 550-kc pips are taller than the 500-kc pip, trim the top and bottom cores clockwise. If they are lower, trim both cores counterclockwise.
3				Repeat 1 and 2 until response flatness is within ± 5 percent.

(e) DISCRIMINATOR ALIGNMENT.

1. Before adjusting the discriminator, the CF PAD must be adjusted according to the procedure given in paragraph 6-3d(3)(j).

2. Center the pip on the screen with the SWEEP WIDTH SELECTOR in the 10KC position. Switch it to the 2KC position. The pip should appear near the center of the screen. If it does, switch successively to the 500∿ and 150∿ ranges and repeat the check. If the pip is off screen or cannot be centered on one or more of these ranges, it will be necessary to adjust the DISC ZERO located on top of Z102, using the insulated tool supplied with the FSA.

Starting on the narrowest sweep range for which a pip can be seen, carefully adjust DISC ZERO to center the pip. This procedure may be expedited by depressing the FAST SWEEP pushbutton, but the final check must be done at a 0.1-cps sweep rate.

Following this adjustment, proceed to the next narrower sweep width and repeat. The final adjustment should be on the 150-cps sweep width. When this has been adjusted, the pip will be approximately centered on all sweep ranges.

NOTE

The DISC ZERO adjustment is very critical, particularly on the narrowest sweep width. It will usually be necessary to move the adjustment through the correct point several times before the final setting is obtained.

(3) SEMI-ADJUSTABLE CONTROLS. - These controls are in circuits which seldom require adjustment. They are located on top of the chassis.

(a) LINE SIZE. - This control is adjusted for correct baseline length of approximately 1/4-inch on either side of the frequency scale limits.

(b) SWEEP WIDTH LIMIT. - This control is adjusted to provide correct sweep widths in the VAR, 30KC, and 10KC positions of the SWEEP WIDTH SELECTOR.

1. Turn SWEEP WIDTH SELECTOR to VAR.

2. Turn CAL OSC LEVEL control fully clockwise.

3. Adjust the GAIN and CENTER FREQ controls to give an approximately full-scale signal centered on the calibrated screen.

4. Connect a 50-kc signal souce to the EXT MOD connector. Adjust the amplitude of the 50-kc signal source to give roughly 1/4-scale sideband pips.

5. Adjust the sweep width limit control to place the sideband pips approximately 1/8 inch inside the left and right extremes of the frequency scale.

6. Turn SWEEP WIDTH SELECTOR to 30KC.

7. Shift the signal source to 15 kc and check location of sideband pips relative to the right and left extremes of the frequency scale.

8. Turn SWEEP WIDTH SELECTOR to 10KC.

9. Shift signal source to 5 kc and check location of sideband pips relative to the right and left extremes of the frequency scale.

10. In the VAR, 30KC, and 10KC positions of the SWEEP WIDTH SELECTOR, the pips should fall within ±1/2 division of the left and right extremes of the frequency scale. If they do not, adjust the sweep width limit control slightly to move the pips in the required direction. Repeat steps 6 through 9 above until the sideband pips fall within ±1/2 division of the left and right extremes of the frequency scale in the VAR, 30KC, and 10KC positions of the SWEEP WIDTH SELECTOR.

(c) SWEEP WIDTH LIMIT AFC. - When the sweep width has been adjusted in accordance with the paragraphs above, turn the SWEEP WIDTH SELECTOR to 2KC and modulate the CAL OSC LEVEL with a 1-kc signal. Adjust the sweep width limit AFC control to place the sidebands on the left and right extremes of the frequency scale. This also calibrates the 500-cycle and 150-cycle sweep ranges.

(d) ASTIGMATISM. - This control is adjusted together with the FOCUS control to produce a sharp circular spot on the crt.

(e) IF GAIN. - This control is effective in the VAR position of the SWEEP WIDTH SELECTOR. It adjusts the gain of the IF amplifier for the specified sensitivity.

1. Set the front panel controls as follows:

IF ATTEN	- 20 DB
SWEEP WIDTH SELECTOR	- VAR
AMPLITUDE SCALE	- LIN
CENTER FREQ	- Marker
AFC	- OFF
GAIN	- 10 (maximum)
CAL OSC LEVEL	- OFF
INPUT ATTENUATOR	- All up
H POS	- Normal operation
V POS	- Normal operation
SWEEP WIDTH	- Maximum (clockwise)
IF BANDWIDTH	- Maximum (clockwise)
VIDEO FILTER	- OFF
SWEEP RATE	- Maximum (clockwise)

2. Connect a 500-kc signal source to the front panel SIGNAL INPUT connector. Set the amplitude of the signal source to 150 uv.

3. Adjust the IF gain control for a full-scale pip on the screen.

(f) 30 KC. - This control adjusts the IF gain in the 30KC position of the SWEEP WIDTH SELECTOR. It is set for the same overall gain obtained in paragraph 6-3d(3)(e).

(g) 10KC, 2KC, 500∿ AND 150∿. - These IF gain controls are located under the chassis and may be reached through holes in the bottom plate of the SA. They are adjusted in a manner similar to the adjustment of the 30KC IF gain control.

(h) LOG SCALE ADJUST AND LOG ZERO ADJUST. - These controls may require adjust if IF tube V9 (6AU6), detector V10 (12AU7), or crt V12 (5ADP7) is replaced.

1. Set the baseline trace accurately on the calibrated line with the V POS control.

2. Set the INPUT ATTENUATOR to 20 DB and AMPLITUDE SCALE to LIN. Adjust the CAL OSC LEVEL control to obtain a full-scale deflection on the crt.

3. Set AMPLITUDE SCALE to LOG and the INPUT ATTENUATOR to 0 DB and adjust log scale adjust until the pip reaches the +20-db screen calibration.

4. Set the INPUT ATTENUATOR to 20 DB and adjust log zero adjust until the pip reaches the dot engraved next to the 0-db calibration of the screen.

5. Set the INPUT ATTENUATOR to 0 DB and readjust log scale adjust if necessary.

6. Since the log scale adjust and log zero adjust controls interact to some extent, it may be necessary to repeat the foregoing procedure several times to obtain proper calibration of the LOG scale.

7. Check the intermediate points of the LOG calibration using the INPUT ATTENUATOR. If the error at any point exceeds ±1 DB, it may be possible to readjust the log scale calibration controls so that the error remains within these limits over the entire 40-db range. If this cannot be done, it is suggested that different tubes be tried in the V9 and V10 circuits. If this does not achieve proper calibration, the screen must be recalibrated.

(i) 0.1-CYCLE ADJUST AND 30-CYCLE ADJUST SWEEP RATE ADJUSTMENT.

1. Set the SWEEP WIDTH SELECTOR to 2KC. Adjust 0.1-cycle adjust control until the period of the horizontal spot motion is 0.1 cps.

2. Set the SWEEP WIDTH SELECTOR to VAR and the SWEEP RATE control fully clockwise. Modulate the calibrating oscillator with a 60-cps signal and turn the SWEEP WIDTH control fully counterclockwise. Adjust CENTER FREQ control until the baseline rises and a sine wave display can be seen on the crt. Adjust 30-cycle adjust control until two cycles of the sine wave appear on the screen.

3. Repeat the procedure given in 1 above. There is some interaction between the 0.1-cycle adjust and 30-cycle, adjust controls, and it may be necessary to repeat the entire procedure several times.

(j) CF PAD. - Set the CENTER FREQ control to its center position. With the SWEEP WIDTH SELECTOR at VAR, set the SWEEP RATE and IF BANDWIDTH controls fully clockwise and the SWEEP WIDTH control fully counterclockwise. Adjust the CF PAD until the baseline rises to a maximum reading (the CAL OSC LEVEL and GAIN controls should be set for an on-screen deflection near full scale). Return SWEEP WIDTH to its maximum clockwise position. Adjust H POS to make the pip coincide with the center frequency scale calibration.

(k) VOLTAGE REGULATOR ADJUST. - This control (located on the power supply chassis) is adjusted to give +270 volts DC at the pin jack on the rear apron of the power supply chassis.

6-4. TRANSMITTING MODE SELECTOR MODELS SBE-2 AND SBE-3 AND THEIR POWER SUPPLIES.

a. GENERAL. - The SBEs have been designed to provide long term trouble free operation under continuous duty conditions. It is recommended that any necessary maintenance be done by a competent maintenance technician familiar with sideband techniques. Otherwise, advantage may be taken of the required specialized test equipment and personnel trained in its use in the Testing Department of Technical Materiel Corporation. If trouble develops which cannot be corrected by following the procedures outlined in the following paragraphs, it is recommended that the instrument be returned to Technical Materiel Corporation for servicing. To expedite the return of the serviced equipment to you, it is recommended that the equipment be shipped to us by Air Freight and that we be authorized to return it the same way.

b. OPERATOR'S MAINTENANCE. - The operator should make minor adjustments of tuning controls to verify proper tuning, note general condition of panel switches, observe whether panel indicator lamps light properly, and check the condition of the three panel fuses as well as that of all tubes. All fuses and a power indicator lamp are located on the front panel of the power supply. The locations of all tubes in the SBE-3 are indicated by the tube location diagram action of figure 5-7; and the locations of all tubes in the SBE-2 are indicated on figure 5-9.

The SBE has triple fuse protection, oven heater, power supply primary, and high voltage (since a partial short across the B+ line may not blow the line fuse, this separate high-voltage fuse has been incorporated in the unit).

If no meter readings can be obtained or the EXCITER lamp (control 92 on figure 3-1) fails to light when the POWER ON-OFF switch (control 90 on figure 3-1) is in the ON position, check F403 (B+ fuse). If dial lights and tube filaments fail to go on when POWER ON-OFF switch is in the ON position, check F402 (MAIN fuse). If after 1-hour warm-up period, the OVEN lamp (control 93 on figure 3-1) fails to cycle every 4 or 5 minutes, check F401 (OVEN fuse).

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 trouble has been located and corrected.

c. PREVENTIVE MAINTENANCE.

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

(2) At periodic intervals (at least every six months) the equipment should be removed from the rack for cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring, or grease; 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 (CCl_4) may be used if great care is exercised because it is a toxic substance. Do not inhale its fumes. Avoid contact with skin.

(3) While unit is out of the rack and covers are removed, it is advisable to check the tubes, all of which are accessible from the top of the chassis.

WARNING

Tubes should be removed and checked one at a time to eliminate the danger of replacing a tube in the wrong socket. Do not fail to replace tube shields.

(4) Should the gear train (directly behind the front panel) show signs of becoming dry, apply one drop of any high-quality light machine lubricant to each gear. Recommended time interval is once a year.

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

d. CORRECTIVE MAINTENANCE. - The corrective maintenance procedure presented below is essentially Technical Materiel Corporation's factory alignment procedure.

(1) ALIGNMENT OF TRANSMITTING MODE SELECTOR MODEL SBE-3. - Adjustment of the SBE-3 resolves itself into the following eight general operations and requires the following test equipment:

(a) An RF frequency meter accurate to one part per million.

(b) An RF generator accurate to one part per million.

(c) A sensitive RF VTVM (such as a Ballantine).

(d) A sensitive communications receiver (AM).

1. 250-KC OSCILLATOR. - With a frequency counter (Hewlett-Packard model 524C or 524D), check the 250-kc output at pin 8 of Z103. This oscillator is factory adjusted and should not require attention in the field. If adjustment is proven necessary, this may be accomplished via C120, located under the chassis deck behind the crystal oven. The 250-kc output voltage at pin 8 of Z103 should equal approximately 1 volt.

2. TRANSFORMERS T125 AND T126. - For simplicity, the procedure for T125 only is given. Connect a sensitive VTVM at the junction of C266 and R247. Unbalance carrier balance resistor R265 to feed 250 kc to T125. Adjust top and bottom slugs of T125 to obtain maximum VTVM reading.

3. CARRIER BALANCE RESISTORS R265 AND R266. - For simplicity, the procedure for R265 only is given. After completing item 2 above, adjust R265 to obtain minimum VTVM reading.

4. TRANSFORMER T127. - Connect a sensitive VTVM at grid 2 or 7 of V113. Turn CARRIER INSERT resistor R263 for appreciable 250-kc carrier reinsertion. Adjust top and bottom slugs of T127 to obtain maximum VTVM readings.

5. MF MODULATOR. - Insert 2-mc supply at junction of C163 and C164. A 2-mc crystal associated with V115 or a 2-mc VMO injection will suffice. Connect a sensitive VTVM at terminal 2 of Z107. Keep CARRIER INSERT resistor R263 for appreciable 250-kc carrier reinsertion. Turn MF TUNING knob for a dial reading of 2 mc. At this setting the MF modulator circuit is tuned to the lower sideband of 2 mc or 1.75 mc. Align T109 and T110 for peak reading on VTVM.

Insert 4-mc supply at junction of C163 and C164. A 4-mc crystal associated with V115 or a 4-mc VMO injection will suffice. Keep VTVM at terminal 2 of Z107 and CARRIER INSERT resistor R263 for appreciable 250-kc carrier reinsertion. Turn MF TUNING knob for a dial reading of 4 mc. At this setting the MF modulator circuit is tuned to the lower sideband of 4 mc or 3.75 mc. Align C140 and C141 for peak reading on VTVM.

Repeat the 2- and 4-mc procedures outlined above until the MF modulator circuit is tuned at both 1.75 and 3.75 mc corresponding to MF TUNING knob settings of 2 and 4 mc, respectively.

6. MF BALANCE RESISTOR R130. - Set CARRIER INSERT resistor R263 for zero 250-kc carrier reinsertion. Insert 2.25-mc supply at junction of C163 and C164. A 2.25-mc crystal associated with V115 or a 2.25-mc VMO rejection will suffice. Keep VTVM at terminal 2 of Z107. Turn MF TUNING knob for a dial reading of 2.5 mc. At this setting, the MF modulator circuit is tuned to 2.25 mc which corresponds to the 2.25-mc injection. adjust R130 for minimum VTVM reading.

7. HF BALANCE RESISTOR R150. - Supply voltage D terminal 2 of Z107 from J110. Plug VTVM's coaxial connector into V110. Adjust R150 for minimum deflection of VTVM. Repeat with 32-mc supply. Set R150 for minimum deflection of VTVM at the two extreme injection frequencies.

8. RF OUTPUT CIRCUIT ADJUSTMENT. - Maximum sensitivity of the RF output circuit is obtained by conventional adjustments of slug inductors and trimmer capacitors. Band switching establishes four sets of tuning devices associated with each of three RF linear amplifiers. A continuously variable set of ganged OUTPUT TUNING capacitors C181A, C181B, and C181C work in conjunction with the above mentioned tuning devices.

(2) ALIGNMENT OF TRANSMITTING MODE SELECTOR MODEL SBE-2. Adjustment of the SBE-2 resolves itself into the following eight general operations and requires the following test equipments:

(a) An RF frequency meter accurate to one part per million (such as a Hewlett-Packard model 524C or 524D).

(b) An RF generator accurate to one part per million.

(c) A sensitive RF VTVM (such as a Ballantine).

(d) A sensitive communications receiver (AM).

1. 17-KC OSCILLATOR. - A reading of 1.0 to 1.5 volts should be found between the center arm of R110 or R112 and ground. This reading should be made with a reliable AC VTVM. If it is not correct, check for faults in the 17-kc oscilllator section (Z105).

2. 287-KC OSCILLATOR. - Use a reliable VTVM with an RF probe to check for a reading of 1.0 to 1.5 volts from the center arm of R113 to ground. If the reading is not correct, check for faults in the 287-kc oscillator section (Z103).

3. MID-FREQUENCY OSCILLATOR. - Connect VMO or signal generator (2 to 4 mc up to 2.5 volts, see below) to VMO input. Place 2-mc and 4-mc crystals in positions 1 and 2, respectively, in the MF crystal oven. Connect RF voltmeter to

the junction of C163 and C164. Measure for the following voltages:

MF XTAL SW	Volts (Approximate)
Position 1 (2 mc)	2.5
Position 2 (4 mc)	1.2
VMO (2 mc)	2.0
VMO (4 mc)	1.0

If these voltages are not obtained, check for faulty components in the mid frequency section.

4. HIGH-FREQUENCY OSCILLATOR. - Connect RF voltmeter to top of R205 (output control), and turn off medium-frequency oscillator by turning MF XTAL SW to a vacant position. Voltage should vary from 2 to 5 volts as BAND MCS switch is rotated from 0 to 14.

5. 17-KC CARRIER BALANCE RESISTORS R110 AND R112. - For simplicity, the procedure for R110 only is given. Connect a sensitive AC VTVM on R171's terminal remote from Z106. Adjust R110 for a minimum reading of the VTVM, with 17-kc oscillator providing normal 17-kc injection.

6. TRANSFORMER T108. - Reduce CARRIER INSERT resistor R106 to zero (knob fully counterclockwise). Connect a 270-kc voltage across terminals 1 and 3 of T106. Adjust top and bottom slugs of T108 for maximum reading on a sensitive VTVM connected between grid 7 of V109B and ground.

7. TRANSFORMER T107 AND LONG-FREQUENCY BALANCE RESISTOR R113. - Connect sensitive RF VTVM at grid 2 of V113. Feed the 270-kc modulator circuit with a small amount of 17-kc carrier reinsertion and full output of the 287-kc oscillator. If an FSA is used as the RF VTVM, T107 may be tuned for maximum 270-kc response and then R113 set to minimize this response. The following alternate method, which requires a 270-kc signal generator and somewhat longer operations, may be used if desired:

For low-frequency balance resistor R113, reduce CARRIER INSERT resistor R106 to zero (knob fully counterlockwise). Remove Z103 (287-kc oscillator assembly) and energize lead from pin 8 to R113 with 1 to 1.5 volts of 270 kc. Adjust R113 for minimum reading on a sensitive VTVM connected between grid 7 of V109B and ground. Low-frequency balance capacitor C259 should also be adjusted simultaneously to minimize the VTVM's reading.

For transformer T107, disconnect P103 and J104 so that no 2- to 4-mc voltage reaches V113. Connect a sensitive VTVM between grid 2 of V113 and ground. Supply T107 with 270 kc. Adjust T107's bottom and top slugs for maximum reading on the VTVM.

8. MF MODULATOR. - Insert 2-mc supply at junction of C163, and C164. A 2-mc crystal associated with V115 or a 2-mc VMO injection will suffice. Connect a sensitive VTVM at terminal 2 of Z107. Provide T107 with normal 270-kc voltages due to 17-kc reinsertion (50-percent setting of CARRIER INSERTION resistor R106) and normal output of 287-kc oscillator. Trun MF TUNING knob for a dial reading of 2 mc. At this setting, the MF modulator circuit is tuned to the lower sideband of 2 mc or 1.73 mc. Align T109 and T110 for peak reading on VTVM.

Insert 4-mc supply at junction of C163 and C164. A 4-mc crystal associated with V115 or a 4-mc VMO injection will suffice. Keep VTVM at terminal 2 of Z107 and CARRIER INSERT resistor R106 as stated above. Turn MF TUNING knob for a dial reading of 4 mc. At this setting, the MF modulator circuit is tuned to the lower sideband of 4 mc or 3.73 mc. Align C140 and C141 for peak reading on VTVM.

Repeat the 2- and 4-mc procedures outlined above until the MF modulator circuit is tuned to both 1.73 and 3.73 mc corresponding to MF TUNING knob settings of 2 and 4 mc, respectively.

9. MF BALANCE RESISTOR R130. - Remove V109B in order that T107 will not receive any 270-kc supply. Insert 2.27-mc supply at junction of C163 and C164. A 2.27-mc crystal associated with V115 or a 2.27-mc VMO injection will suffice. Keep VTVM at terminal 2 of Z107. Turn MF TUNING knob for a dial reading of 2.54 mc. At this setting, the MF modulator circuit is tuned to 2.27 mc which corresponds to the 2.27-mc injection. Adjust R130 for VTVM reading.

10. RF BALANCE RESISTOR R150. - Supply terminal 2 of Z107 with 2 mc and disconnect P107 from J110. Plug VTVM's coaxial connector into J110. Adjust R150 for minimum deflection of VTVM. Repeat with 32-mc supply. Set R150 for minimum deflection at the two extreme injection frequencies.

11. RF OUTPUT CIRCUIT ADJUSTMENT. - Maximum sensitivity of the RF output circuit is obtained by conventional adjustments of slug inductors and trimmer capacitors. Band switching establishes four sets of tuning devices associated with each of three RF linear amplifiers. A continuously variable set of gauged OUTPUT TUNING capacitors C181A, C181B, C181C work in conjunction with the above mentioned tuning devices.

6-5. MONITOR CONTROL PANEL MODELS MCP-1 AND MCP-2.

a. GENERAL. - From a maintenance standpoint, there is no essential difference between the MCP-1 and MCP-2. The following statements apply to both, except as otherwise stated.

b. OPERATOR'S AND PREVENTIVE MAINTENANCE. - Operator's maintenance resolves itself into checking that the switches make the proper and satisfactory interconnections between associated equipments as they are rotated from position to position.

c. CORRECTIVE MAINTENANCE. (See figures 6-1 and 6-2.) - When contact trouble develops or lubrication is desirable, the coaxial rotary switch may be disassembled as follows:

(1) Disconnect the four coaxial connectors on the back of the switch.

(2) Remove the knob on the front of the switch.

(3) Unscrew three machine screws on the front of the switch to free switch from panel.

(4) Unscrew three machine screws on the back of the switch to free switch from its cover. The switch contacts are now accessible and may be conditioned as required by crocus cloth and/or lubricant.

(5) Details of the MODE switch are shown in figure 6-2 and maintenance procedures are similar to those given above for the coaxial rotary switch.

6-6. VARIABLE FREQUENCY OSCILLATOR MODEL VOX-2.

a. GENERAL. - The VOX has been designed to provide long term trouble free operation under continuous dirty 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; but in the event that maintenance to the oven section of the unit is required, the unit should be returned to the factory for repairs. For maintenance to 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:

(1) Part No. CA108, W101	Power Supply-Multiplier Interconnect; Twelve Contact.
(2) Part No. CA109, W102	Power Supply-Master Oscillator Interconnect; Six Contact.
(3) Part No. CA110, W103	R.F.Cable; Power Supply-Multiplier Interconnect; Single Contact.

Figure 6-3 shows the three service cables connected properly for maintenance operation, allowing the ovens to function as usual during the maintenance period.

b. 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.

(1) 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 120 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.

(2) REPLACEMENT OF TUBES. - The location of all tubes in the VOX is indicated in the tube location diagram, figures 5-11a through 5-11c. The tubes may be checked visually to see if they are on or warm. 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.

c. PREVENTIVE MAINTENANCE.

(1) 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.

(2) 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 (CCl_4) may be used if great care is exercised because it is a toxic substance. Do not inhale its fumes. Avoid contact with skin.

(3) 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.

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

d. CORRECTIVE MAINTENANCE.

(1) GENERAL. - During its initial calibration, the VOX is set so that relatively little rotation of the CALIBRATE (control designated 125 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 check point on the dial, then the ends of the dial should be reset by the procedure outlined below, paragraphs 6-6d(3).

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, paragraph 6-6d(2).

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.

(2) 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:

(a) 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.

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

(c) 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 will be seen on the "S" meter.

(d) 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.

(3) 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 2-4d (of this volume) designated "Initial Adjustments." These are repeated below for convenience.

(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 will result 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 stabled 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.

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

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

2. 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.

3. 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.

4. 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 will then be correct and the CALIBRATE knob will be closest to its correct mean position.

5. 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.

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

(a) BFO CIRCUIT LOCATED ON POWER SUPPLY CHASSIS.

1. Connect all cables.

2. Insert a 455-kc crystal in each BFO crystal socket.

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

4. Turn on POWER switch (S101).

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

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

(b) CALIBRATE CIRCUIT LOCATED ON POWER SUPPLY CHASSIS.

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

2. Set BEAT 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 6-6a(2) and 6-6d(3) for corrective procedure. (The power supply does not contain any adjustments to compensate for an erroneous zero beat.)

(c) 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.

(d) HFO CIRCUIT LOCATED ON RF CHASSIS. - The RF chassis consists principally of RF multipliers extending from 2 to 64 mc. It's 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.

6-7. FREQUENCY SHIFT EXCITER MODEL XFK.

a. GENERAL. - The XFK has been designed to provide long term trouble free operation under continuous duty conditions. It is recommended that any necessary maintenance be done by a competent maintenance technician familiar with a sideband techniques.

b. OPERATOR'S MAINTENANCE. - The operator should make minor adjustments of tuning controls to verify the XFK's output frequency and level is proper, 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 all 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.

(1) 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.

Power fuse failure in the XFK is normally indicated by failure of the red pilot lamp (designated POWER, control 136 on figure 3-1) to go on when the POWER switch (control designated 138 on figure 3-1) is set to ON. In addition to the pilot lamp not going on, the vacuum tubes in the XFK do not go on. In this case, the 3-ampere power fuse on the rear panel should be checked and replaced if defective.

Oven fuse failure in the XFK is normally indicated by failure of two clear pilot lamps (designated XTAL OVEN and 200 KC OVEN, controls 137 and 135, respectively, on figure 3-1) to go on, at least intermittently, when the POWER switch is set to ON. In addition to the pilot lamps not going on, the ovens of the XFK are cold. In this case, the 3-ampere oven fuse on the rear panel should be checked and replaced if defective.

(2) REPLACEMENT OF TUBES. - The location of all tubes in the XFK is indicated in the tube location diagram, figure 5-14. The tubes may be checked visually to see if they are on or warm. When necessary, the tubes should be carefully removed and tested, and when replaced, care should be taken to install tube shields.

c. PREVENTIVE MAINTENANCE.

(1) 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.

(2) 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 other parts with any good dry cleaning fluid.

WARNING

Carbon tetrachloride (CCl_4) may be used if great care is exercised because it is a toxic substance. Do not inhale its fumes. Avoid contact with skin.

(3) 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 six months.

(4) No special tube selection is necessary in the event of tube replacement. However, for optimum results, the section on corrective maintenance should be carefully read to determine the extent of adjustment necessary in replacing any particular tube. These adjustments, necessary for changing only four tubes, are unwarranted unless performed by competent technical personnel using accurate equipment.

(5) When replacing the XFK in the rack, ensure that all terminal board screws at the rear of the equipment are tight.

d. CORRECTIVE MAINTENANCE.

NOTE

Only competent technical personnel using proper equipment should attempt to tamper with any adjustments and only if there is specific reason to suspect that the adjustment is the cause of the difficulty. If unit is to be worked on, it should be removed from its rack and placed on a convenient work bench. The dust covers should be removed. All controls and adjustments should now be readily accessible.

The least likely source of trouble should be the misalignment of the RF section. Should this be suspected, due to either reduced power output or the output frequency dial showing a marked deviation from the indicated frequency calibration, the following procedure is recommended:

(1) IF ALIGNMENT OF BAND 2.

(a) Connect a 50- to 70-ohm load to the OUTPUT jack. Meter either current through the load with an RF thermocouple or connect an RF voltmeter across the load.

(b) Set BAND CHANGE switch to band 2. Rotate main tuning capacitor (OUTPUT TUNING MC knob) to full-mesh position (lowest frequency). Note that the hairline on the dial matches the indicator line. If this is not so, leave the capacitor in the full-mesh position. Loosen the set screws fastening the flexible coupling to the capacitor and rotate the dial until the hairline on the dial matches the indicator line.

(c) Set ceramic trimmers C30, C43, and C46 on top of chassis to minimum capacity.

(d) The following indicated frequencies should either be supplied by means of crystals or an external source. To simplify procedure it will be assumed that crystals will be used. If an external source is used, connect the signal source to the EXT jack on the rear of the chassis and turn the XTAL selector switch (front panel control 142 on figure 3-1) to EXT.

(e) Insert 2.6-mc crystal in socket No. 1; 6.3-mc crystal in socket No. 2.

(f) Turn XTAL selector switch to crystal 1. Turn OUTPUT TUNING MC dial to 2.8 mc. Place RF voltmeter on pin 1 of V4; tune transformer T1 for maximum voltage by adjusting its slug (accessible on top chassis). Place RF voltmeter at pin 5 of V5; tune transformer T3 for maximum voltage by adjusting its slug (accessible on top chassis). Select first peak going in from minimum inductance. Tune transformer T5 for maximum output indication in load adjusting its slug (accessible on top chassis). Remove RF voltmeter and retrim transformers T1, T3, and T5 for maximum output in load.

(g) Turn XTAL selector switch to crystal 2. Turn OUTPUT TUNING MC dial to 6.5 mc. Tune capacitors C30, C43, and C46 for maximum output indication in load.

(h) Remove vacuum tube V1, 200-kc oscillator tube. Tune main tuning capacitor (OUTPUT TUNING MC knob) for maximum output indication in load. This will occur at the crystal frequency. Trim mixer balance potentiometer R84 (on bottom chassis) for minimum indication in load.

(i) Remove load. Remove crystal or external excitation. Set plate current to 50 ma by turning POWER knob (front panel control designated 141 on figure 3-1). Rotate OUTPUT TUNING MC knob over entire upper range of band and note spurious excitation, if any. Parasitics may be evidenced by dip in plate current of final amplifier when rotating OUTPUT TUNING MC knob. If parasitics are evidenced, neutralize same by tuning capacitor C27.

(j) Replace vacuum tube V1 and repeat steps (f) and (g).

(k) Check tuning dial for proper sideband selection. If the above procedure has been performed properly, there will be no indication above 6.5 mc and the lower sideband will appear at 6.1 mc.

(2) RF ALIGNMENT OF BAND 1.

(a) Set BAND CHANGE switch to band 1. Insert 1.0-mc crystal in socket No. 1 and 2.1-mc crystal in socket No. 2.

(b) Set ceramic trimmers C19, C24, and C28 on top of chassis to minimum capacity.

(c) Turn XTAL selector switch to crystal 1. Turn OUTPUT TUNING MC dial to 1.2 mc. Place RF voltmeter to pin 1 of V4. Tune transformer T2 for maximum voltage by adjusting its slug (accessible on top chassis). Place RF voltmeter to pin 5 of V5. Tune transformer T4 for maximum voltage by adjusting its slug (accessible on top chassis). Select first peak going in from minimum inductance. Tune transformer T6 for maximum output indication in load by adjusting its slug (accessible on top chassis). Remove RF voltmeter and retrim transformers T2, T4, and T6 for maximum output indication in load.

(d) Turn XTAL selector switch to crystal 2. Turn OUTPUT TUNING MC dial to 2.3 mc. Tune capacitors C19, C23, and C28 for maximum output indication in load.

(e) Repeat steps (c) and (d).

(f) Check OUTPUT TUNING MC dial for proper sideband selection. If the above procedure has been performed properly, there will be no indication above 2.3 mc, and the lower side band will appear at 1.9 mc.

(3) ADJUSTMENT OF REACTANCE TUBE AND 200-KC OSCILLATOR. - The proper alignment of this section of the XFK requires accurate frequency measurements. This is readily possible in cases where primary standards, such as a Hewlett-Packard Electronic Counter Model 524C, are available. Otherwise, it is recommended that the equipment and method outlined in figure 6-4 be adopted for best accuracy and ease of measurement. The following procedure applies to the older XFK equipments; the same procedure applies to the newer units when allowance is made for the KEY-FAX switch being incorporated into the TEST switch (from panel control designated 140 on figure 3-1).

(a) Set up equipment as shown in figure 6-4.

(b) Observe that the pointer on the FREQUENCY knob (front panel control designated 143 on figure 3-1) reads -600 cycles when the fine frequency adjust trimmer capacitor C7 is approximately 7 degrees from being fully meshed. Capacitor C7 should then move toward decreasing capacity as the knob is turned toward the +600-cycle position.

(c) Set KEY-FAX switch on rear chassis to FAX Return FREQUENCY knob to 0 cycles. By means of the coarse frequency adjust screwdriver capacitor control on the rear of the chassis, "zero beat" 200kc oscillator with 200kc crystal in mixer.

(d) Connect a small variable voltage source (6 volts) to the FAX terminals on terminal board at rear of chassis. This source should be capable of alternately impressing equal positive and negative voltages at the FAX terminal.

(e) Set C2 on top of chassis at one-half its capacity. With zero voltage at FAX input terminal, "zero beat" 200-kc oscillator with mixer crystal. Apply sufficient positive voltage to cause a 500-cycle shift (approximately 4 volts). Reverse polarity, maintaining same amplitude. Note shift. If second shift is over 500 cycles, slightly increase capacity of C2. Again, "zero beat" 200-kc oscillator with mixer crystal with no DC (FAX) input voltage; then repeat above procedure until both shifts are equal.

(4) ADJUSTMENT OF KEYER CIRCUIT.

(a) Set KEY-FAX switch on rear chassis to KEY. With power OFF, set ohmmeter to center arm of shift potentiometer R8 (designated FREQUENCY SHIFT CPS, front panel control 139 on figure 3-1). When dial reads 50 cycles, resistance to ground on ohmmeter should be 400 ohms.

(b) Set XTAL selector switch (front panel control designated 142 on figure 3-1) to crystal 1, and plug in to multiplication ratio 1 on rear of chassis.

(c) Again, "zero beat" 200-kc oscillator in XFK (refer to paragraph 6-7d(3) above). Set FREQUENCY SHIFT CPS dial to 500 cycles. Vary TEST switch (front panel control designated 140 on figure 3-1) from MARK to SPACE and note frequency shift (use test setup of preceding item (refer to paragraph 6-7d(3) above). Adjust shift balance screwdriver potentiometer R38 (chassis mounted) until shifts are equal. Adjust shift amplitude screwdriver potentiometer R40 (chassis mounted) until shift on either side is 250 cycles. Recheck shift balance. The total shift is now 500 cycles, 250 cycles on either side of carrier.

(5) REPLACEMENT OF HEATERS AND THERMOSTAT IN 200-KC OVEN ASSEMBLY. (See figures 6-5 and 4-34.)

(a) Loosen four screws that hold the XFK top access cover; remove top access panel.

(b) Loosen and remove two screws that hold the heater terminal board strip (with heating thermostat attached). This allows access to both heaters and thermostat switch for necessary inspection and repairs.

(c) The heater and the thermostat can easily be replaced by simply unsoldering the leads connected to the heater terminal board strip.

(d) For inspection and repair of any one 200-kc oscillator oven stabilized component, the entire 200-kc oven assembly must be removed.

(e) Loosen and remove four screws that hold the 200-kc oscillator oven outer shell to the XFK chassis.

(f) From the underside of the XFK chassis four port holes can be observed. They allow access to four machine metal screws that hold the oven casting to the XFK chassis.

(g) Insert a screwdriver through each port hole. While supporting the oven casting with one hand, loosen and remove each screw. This will expose the inner component terminal board for the necessary inspection and repairs.

6-8. TWO TONE GENERATOR MODEL TTG.

a. GENERAL. - The TTG has been designed to provide term trouble free operation under continuous duty conditions. It is recommended that any necessary maintenance be done by a competent maintenance technician familiar with sideband techniques.

b. OPERATOR'S AND PREVENTIVE MAINTENANCE.

CAUTION

No attempt should be made to change the frequency of audio tones. These are adjusted to their proper frequencies in conjunction with the bandpass filters. If attempts are made to change frequency, the unit may not function properly, as indicated by an increase in distortion and unbalanced or no output.

In order to prevent failure of the equipment due to corrosion, dust, and other destructive ambient conditions, thoroughly inspect the inside of the chassis for signs of dirt, dampness, molding, charring or corrosion. This should be done periodically depending upon the severity of the conditions. Correct any defect with a cleaning agent of proven quality.

c. CORRECTIVE MAINTENANCE.

(1) AUDIO ADJUSTMENTS. - If increased distortion should indicate a need for realignment, the unit may be readjusted according to the procedure outlined below. Equipment required includes an AC VTVM and a sonic analyzer (such as Panoramic LP-1a).

NOTE

If a sonic analyzer is not available, the regeneration control setting likely to produce the least distortion is the minimum rotation of the control at which the oscillator will "start" immediately when that tone is switched on.

NOTE

The setting of the regeneration controls is important to achieve minimum distortion. When a control is not advanced far enough, the oscillator will not "start" immediately when that tone is switched on. When the control is advanced too far, the distortion will increase rapidly. There is a point, however, where the oscillator will start immediately, and where distortion is a minimum. This is the correct adjustment.

(a) Connect the AC VTVM and sonic analyzer to output terminal strip, E500; set R524 and R518 to maximum, S502 to TONE 1 position, and adjust the regeneration control, R501, until an indication is observed on the VTVM.

(b) Adjust control on Z500 for peak indication on VTVM.

(c) Observe analyzer and adjust R501 for minimum second harmonic distortion without affecting oscillator "starting."

(d) Recheck Z500 for peak on VTVM.

(e) Adjust tone 1 level control, R518, for 1.0 volt AC on VTVM.

(f) Tighten lock on R501 and R518.

(g) Set R519 to maximum, S502 to TONE 2 position, and adjust regeneration control, R513, until an indication is observed on VTVM.

(h) Adjust control on Z501 for peak indication on VTVM.

(i) Observe analyzer and adjust R513 for minimum second harmonic distortion without affecting oscillator "starting."

(j) Recheck R501 for peak on VTVM.

(k) Adjust tone 2 level control, R519, for 1.0 volt AC on VTVM.

(l) Tighten lock on R513 and R519.

NOTE

It is extremely unlikely that I500 or I501 will need replacement. If, however, either one has to be replaced, several lamps may have to be tried to find one which will cause the oscillator to perform properly.

(2) RF ADJUSTMENTS. - Equipment required is an RF VTVM.

(a) Connect RF VTVM to J501. Set RF TONE SELECTOR switch to TONE 1 position. Set C520 to maximum capacity.

(b) Adjust L502 for maximum reading on RF VTVM. Tighten lock nut on slug.

(c) Set C520 for 1.0 volt RF on RF VTVM.

(d) Set RF TONE SELECTOR switch to TONE 2 position. Set C521 to maximum capacity.

(e) Adjust L503 for maximum reading on RF VTVM. Tighten lock nut on slug.

(f) Set C521 for 1.0 volt RF on RF VTVM.

6-9. ISOLATION KEYER MODEL AK-100.

a. GENERAL. - The ISK has been designed to provide long term trouble free operation under continuous duty conditions. It is recommended that any necessary maintenance be done by a competent maintenance technician familiar with sideband techniques.

b. OPERATOR'S AND PREVENTIVE MAINTENANCE.

CAUTION

The THRESHOLD or VOLTAGE adjustment should not be changed by the operator unless absolutely necessary. These adjustments have been set for a proper output from the ISK. The THRESHOLD adjustment controls the cathode bias of oscillator tube V4001-B. The VOLTAGE adjustment controls the output signal amplitude of the ISK.

c. CORRECTIVE MAINTENANCE. - If there is inefficient signal amplitude output or improper signal output waveship, the ISK may be adjusted in accordance with the procedure outlined below. Equipment required includes a square-wave generator, two oscilloscopes, a 6-volt DC battery, and a 10-k resistor.

(1) Connect the output of the square-wave generator to terminal board E4001, pins 1 and 2, on the ISK.

(2) Connect one of the oscilloscopes to pins 3 and 4 on terminal board E4001.

(3) Connect the 10-k resistor between the input terminals on the remaining oscilloscope.

(4) Connect the 6-volt DC battery negative terminal to the ground side of the 10-kc resistor and the positive terminal on the 6-volt battery to terminal board E4001, pin 8.

(5) Connect a lead from E4001, pin 10, and the remaining side of the 10-k resistor.

(6) Set KEYING MODE switch S4001 to position 1. Place POWER switch S4002 to ON position.

(7) Adjust the square-wave generator output for 50-volt keying at 50 cps.

(8) Set VOLTAGE ADJ. R4014 fully counterclockwise; adjust THRESHOLD ADJ. R4011 approximately to mid position of its full range. An integrated waveform will appear on the oscillator connected to E4001, pins 3 and 4, approximately 50-volt amplitude. A square wave will appear on the other oscilloscope connected to E4001, pins 8 and 10, approximately 50-volt amplitude.

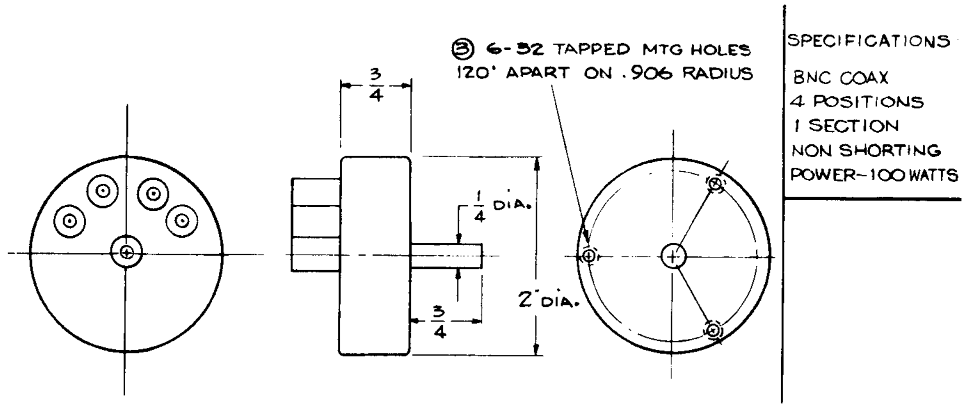
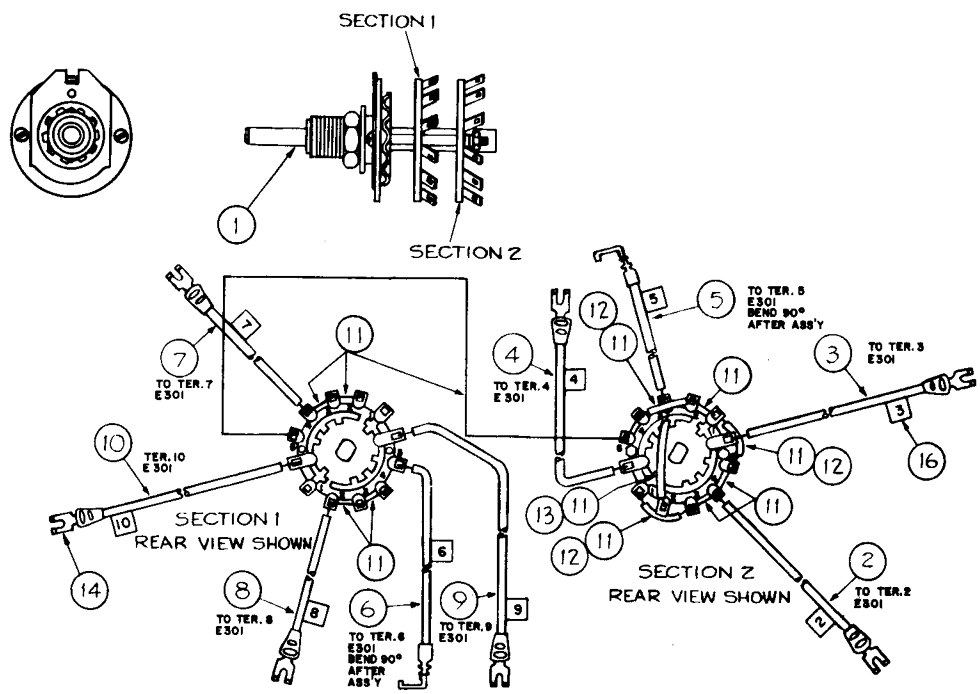


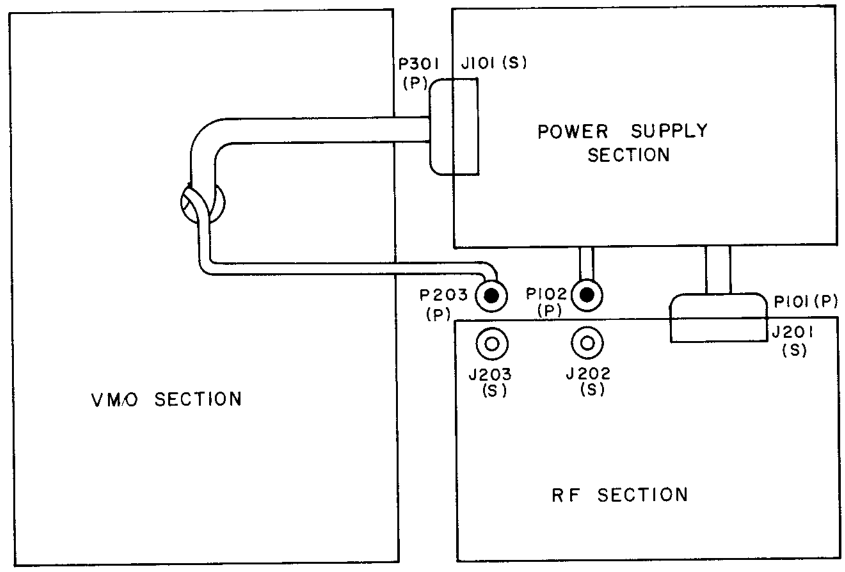
Figure 6-1. Maintenance Diagram Showing Details of Coaxial Rotary Switch, MCP



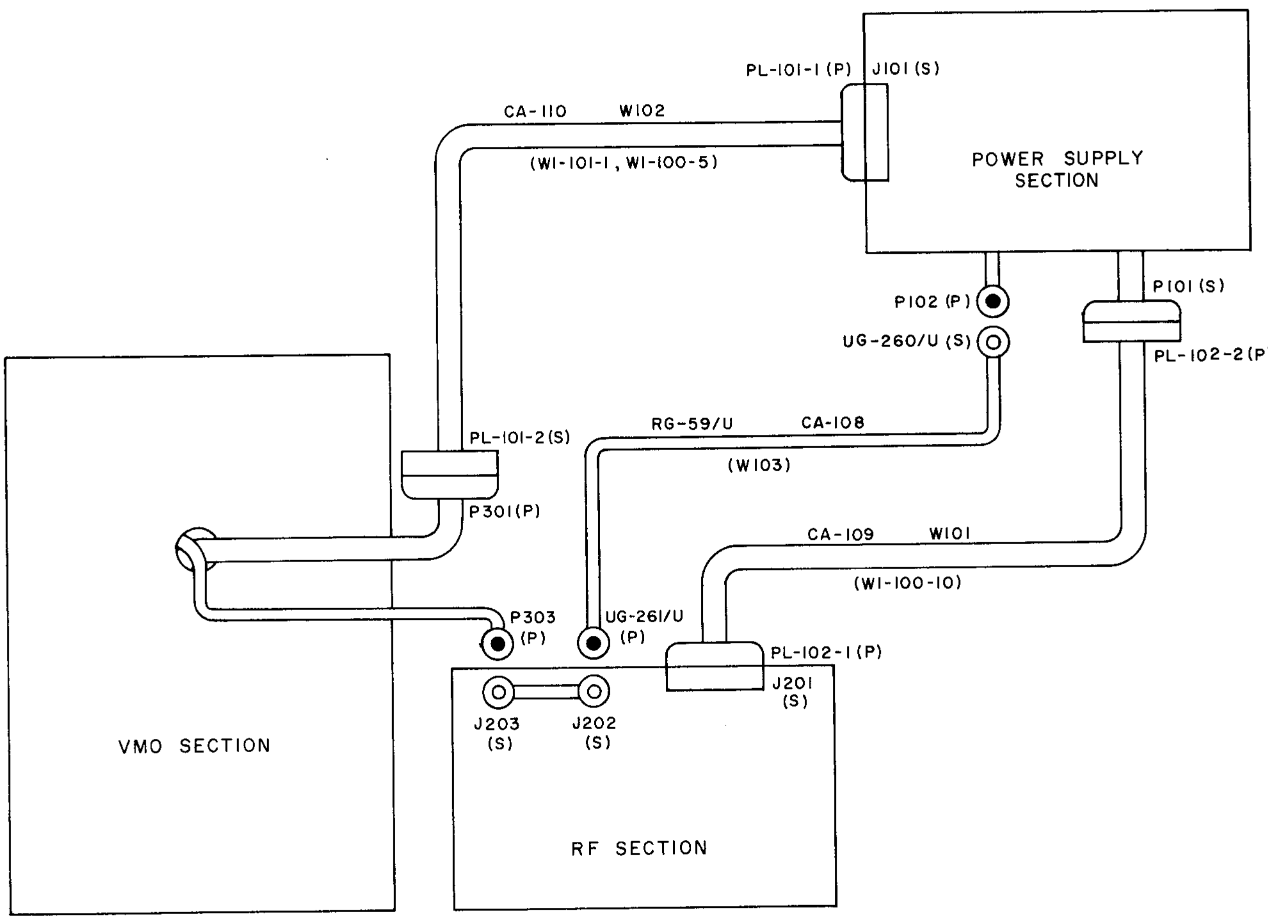
NOTE ~ SWITCH SHOWN IN POSITION 1.

REQ.	ITEM	PART NO.	DESCRIPTION	SYMBOL
X	16	LA 101	WIRE, MARKER (NO's 2 THRU 10)	
X	15	BS 100	SOLDER, SOFT	
9	14	TE-120-2	LUG, SPADE	
X	13	PX100-3-.022	INSULATION, SLEEVING	Orange
X	12	PX-100-1-.022	INSULATION, SLEEVING	Black
X	11	WL 100-8	WIRE, BUSS	
3¼"	10	MWC22(7)U8	CABLE, INSULATED	Grey
6"	9	7		Violet
3½"	8	6		Blue
3"	7	5		Green
3⅝"	6	4		Yellow
2⅜"	5	3		Orange
4⅜"	4	2		Red
2½"	3	1		Brown
3¼"	2	MWC22(7)U0	CABLE, INSULATED	Black
	1	SW 265	SWITCH, ROTARY, 5 POSITION	

Figure 6-2. Maintenance Diagram Showing Details of Mode Switch, MCP

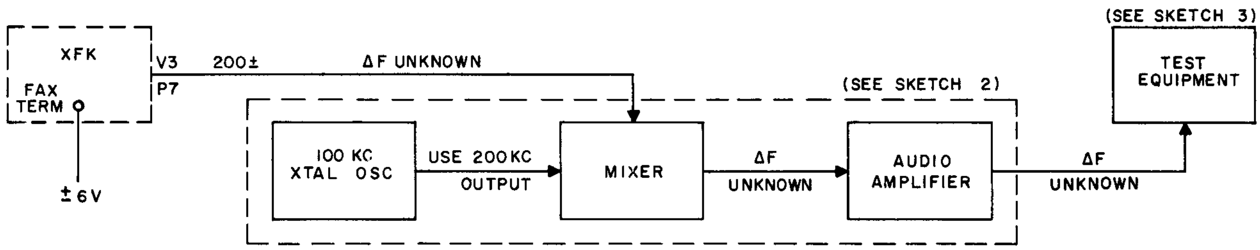


SKETCH A – CABLES UNDER NORMAL CONDITIONS

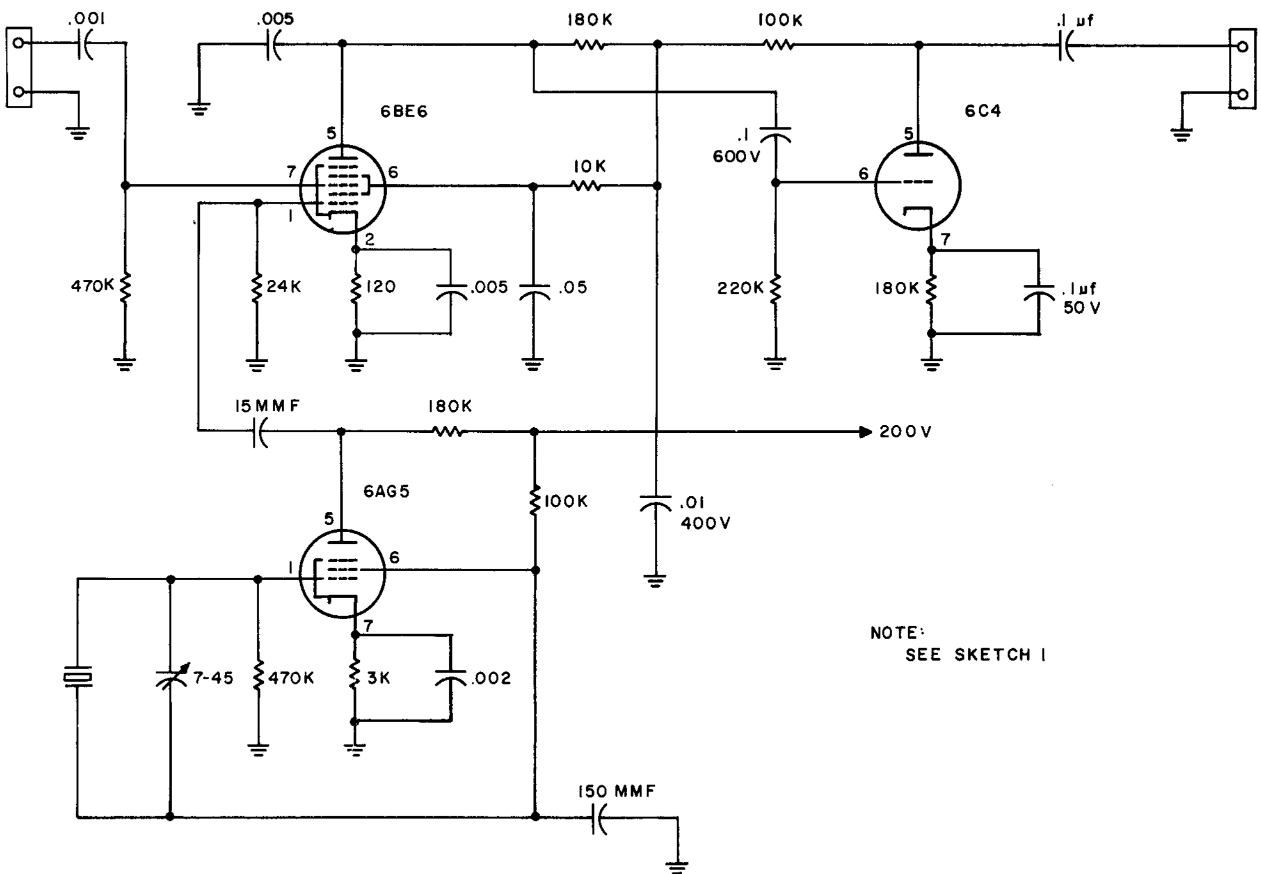


SKETCH B – CABLES UNDER SERVICING CONDITIONS

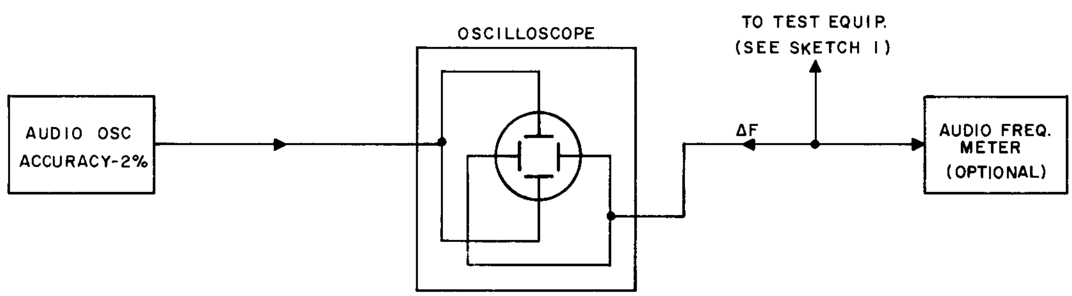
Figure 6-3. Maintenance Diagram Showing Servicing Cable Arrangement, VOX



SKETCH 1 BLOCK DIAGRAM



SKETCH 2 SCHEMATIC DIAGRAM OF MIXER AND 200KC XTAL OSC.



SKETCH 3 DETAIL OF TEST EQUIPMENT

Figure 6-4. Maintenance Diagram Showing Procedure of Adjusting Reactance Tube and 200-kc Oscillator, XFK

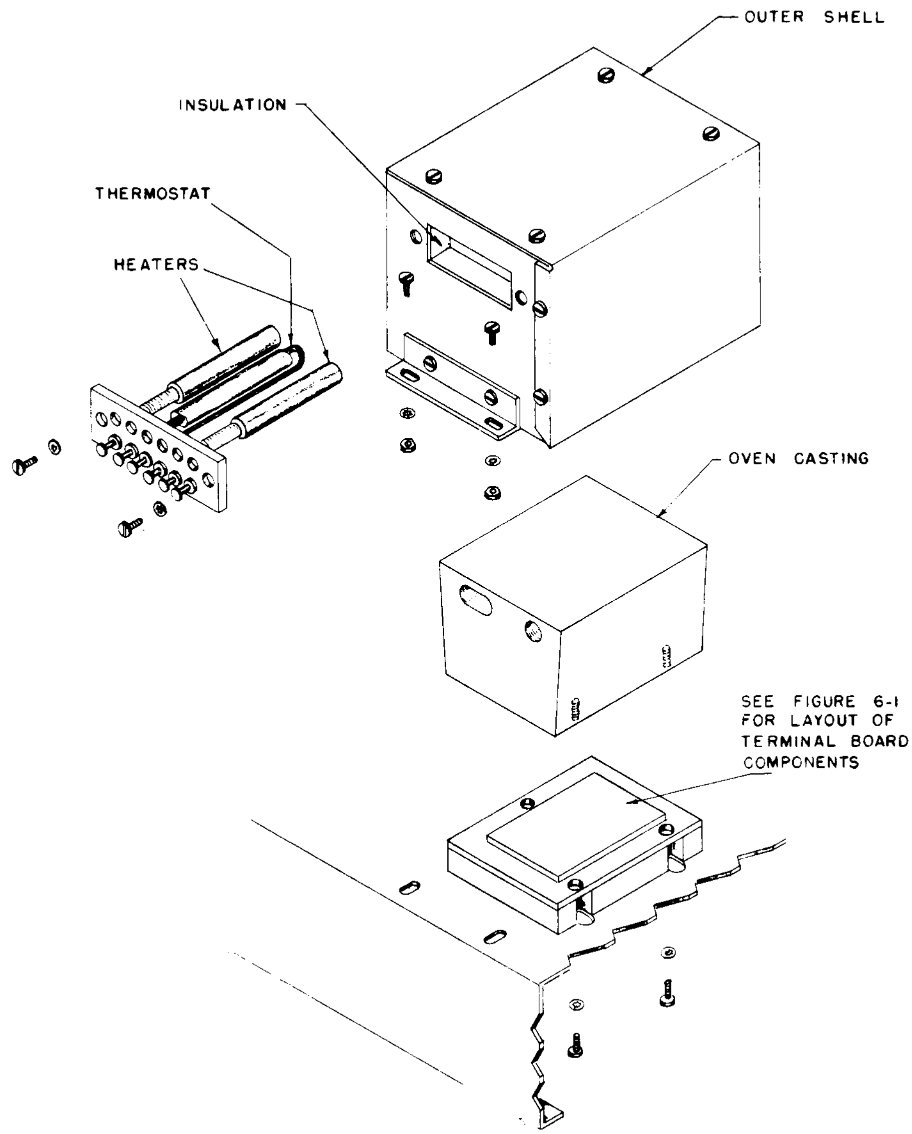
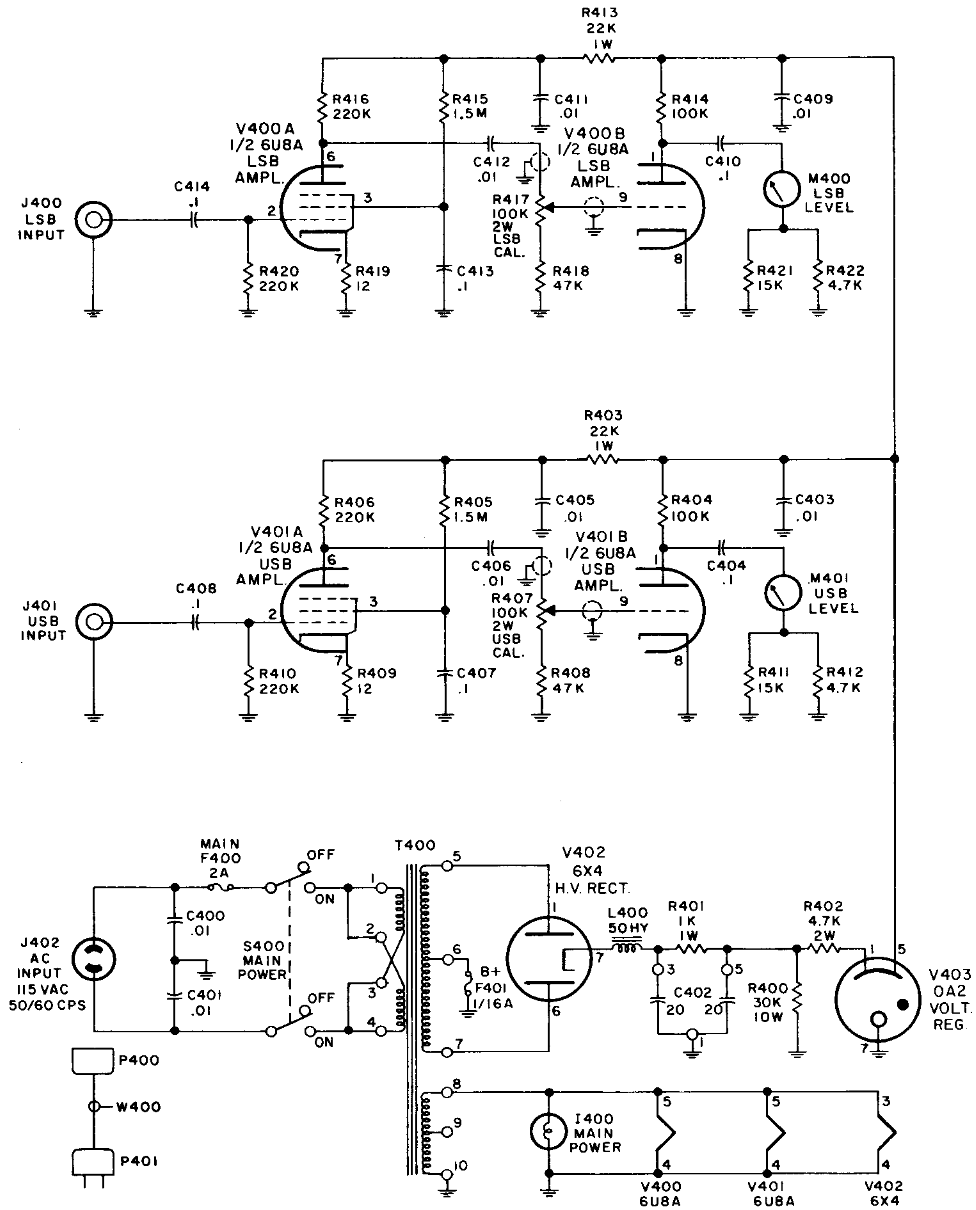
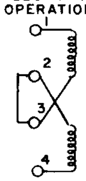


Figure 6-5. Maintenance Diagram Showing 200-kc Oven Assembly, XFK

SECTION 7
PRINCIPAL SCHEMATICS, WIRING DIAGRAMS, AND INTERCONNECTING DIAGRAMS



220 VAC
OPERATION

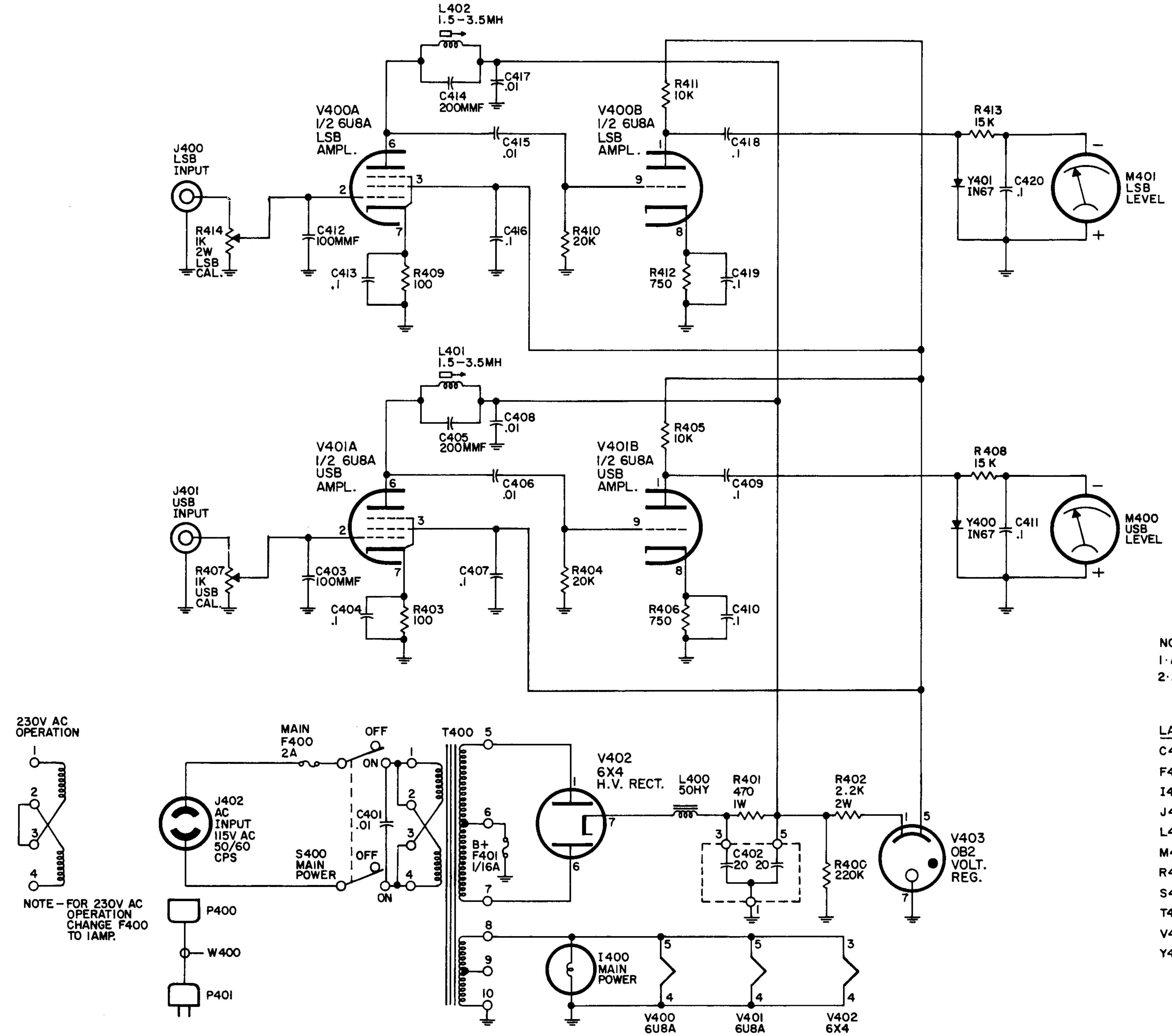


NOTE:
FOR 220 VAC OPERATION
CHANGE F400 TO 1A

NOTES:
1. ALL CAPACITORS ARE IN MFDS.
2. ALL RESISTORS ARE 1/2 WATT, UNLESS OTHEWISE SPECIFIED.

LAST SYMBOLS-
C414
F401
I400
J402
L400
M401
P401
R422
S400
T400
V403
W400

Figure 7-1. Schematic Diagram, SLM-1 (Sheet 1 of 2)



NOTES— UNLESS OTHERWISE SPECIFIED
1. ALL CAPACITORS ARE IN MFD.
2. ALL RESISTORS ARE 1/2 WATT.

LAST SYMBOLS	MISSING SYMBOLS
C420	C400
F401	
I400	
J402	
L402	
M401	
R414	
S400	
T400	
V403	
Y401	

Figure 7-1. Schematic Diagram
SLM-1 (Sheet 2 of 2)

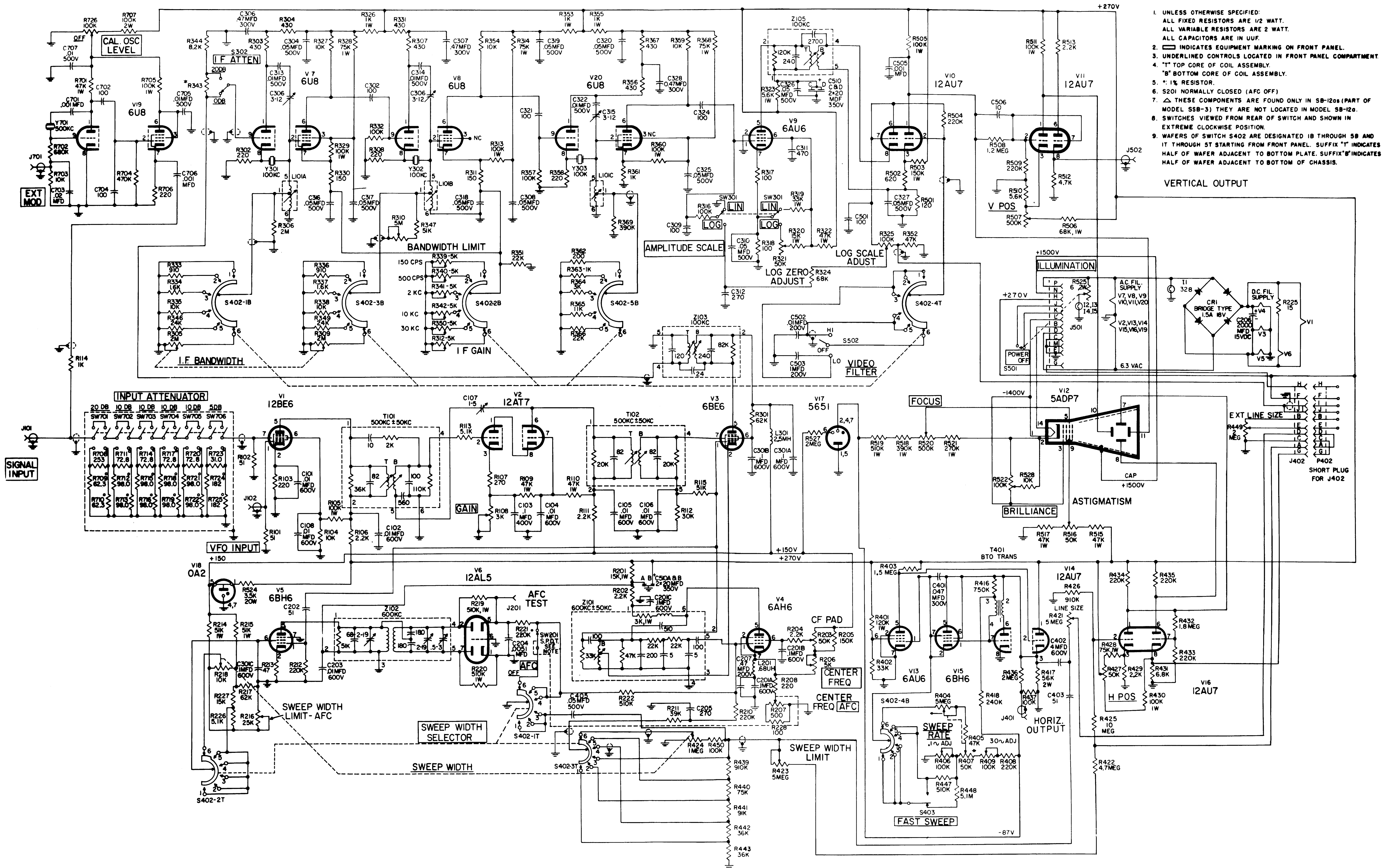


Figure 7-2. Schematic Diagram, FSA and PS-12 (Sheet 1 of 2)

1. UNLESS OTHERWISE SPECIFIED:
   ALL FIXED RESISTORS ARE 1/2 WATT.
   ALL VARIABLE RESISTORS ARE 2 WATT.
   ALL CAPACITORS ARE IN UUF.
2. ▭ INDICATES EQUIPMENT MARKING ON FRONT PANEL.
3. UNDERLINED CONTROLS LOCATED IN FRONT PANEL COMPARTMENT.
4. "T" TOP CORE OF COIL ASSEMBLY.
   "B" BOTTOM CORE OF COIL ASSEMBLY.
5. *: 1% RESISTOR.
6. S201 NORMALLY CLOSED (AFC OFF)
7. △ THESE COMPONENTS ARE FOUND ONLY IN SB-12oa (PART OF MODEL SSB-3) THEY ARE NOT LOCATED IN MODEL SB-12a.
8. SWITCHES VIEWED FROM REAR OF SWITCH AND SHOWN IN EXTREME CLOCKWISE POSITION.
9. WAFERS OF SWITCH S402 ARE DESIGNATED 1B THROUGH 5B AND 1T THROUGH 5T STARTING FROM FRONT PANEL. SUFFIX "T" INDICATES HALF OF WAFER ADJACENT TO BOTTOM PLATE. SUFFIX "B" INDICATES HALF OF WAFER ADJACENT TO BOTTOM OF CHASSIS.

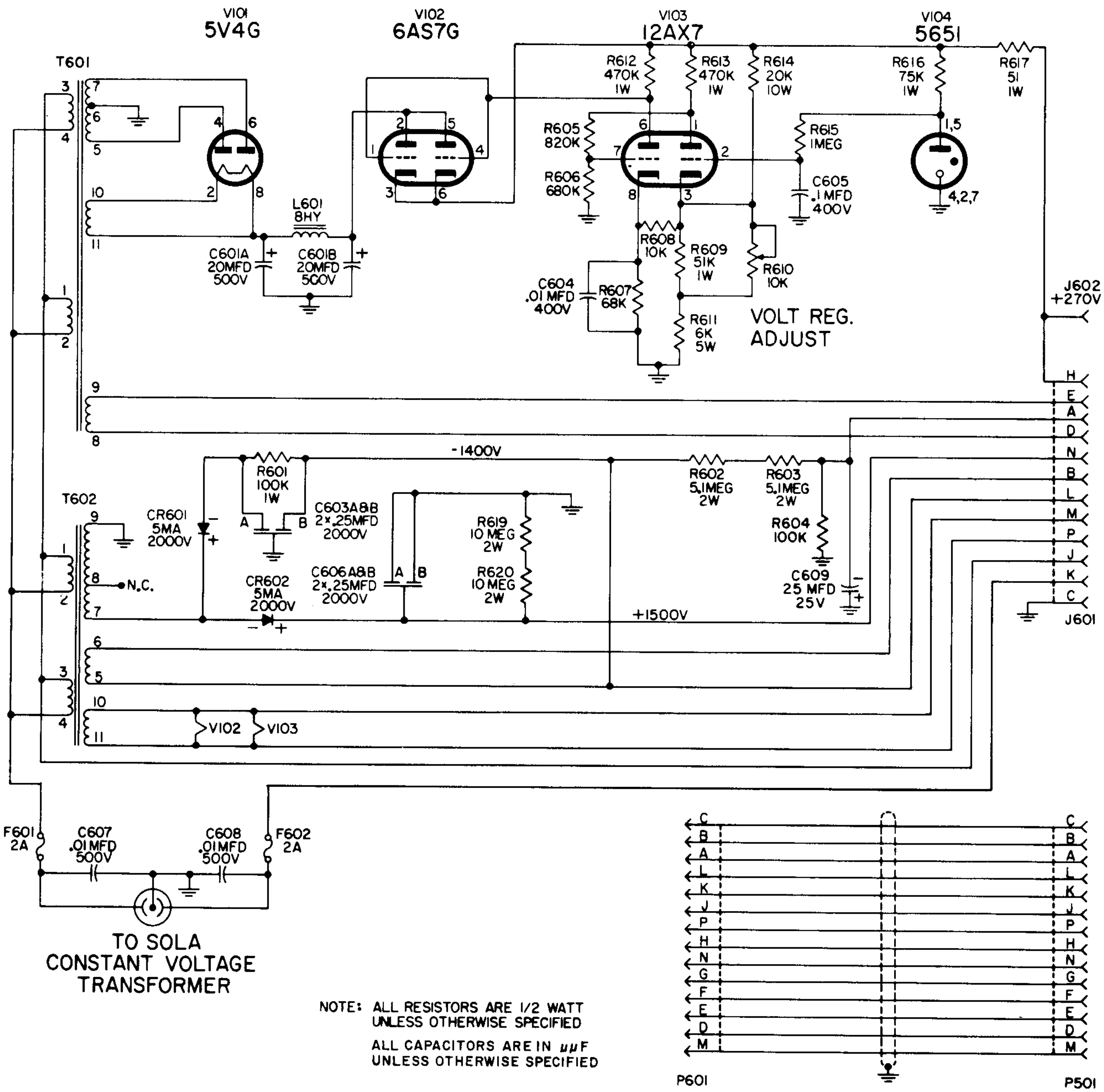
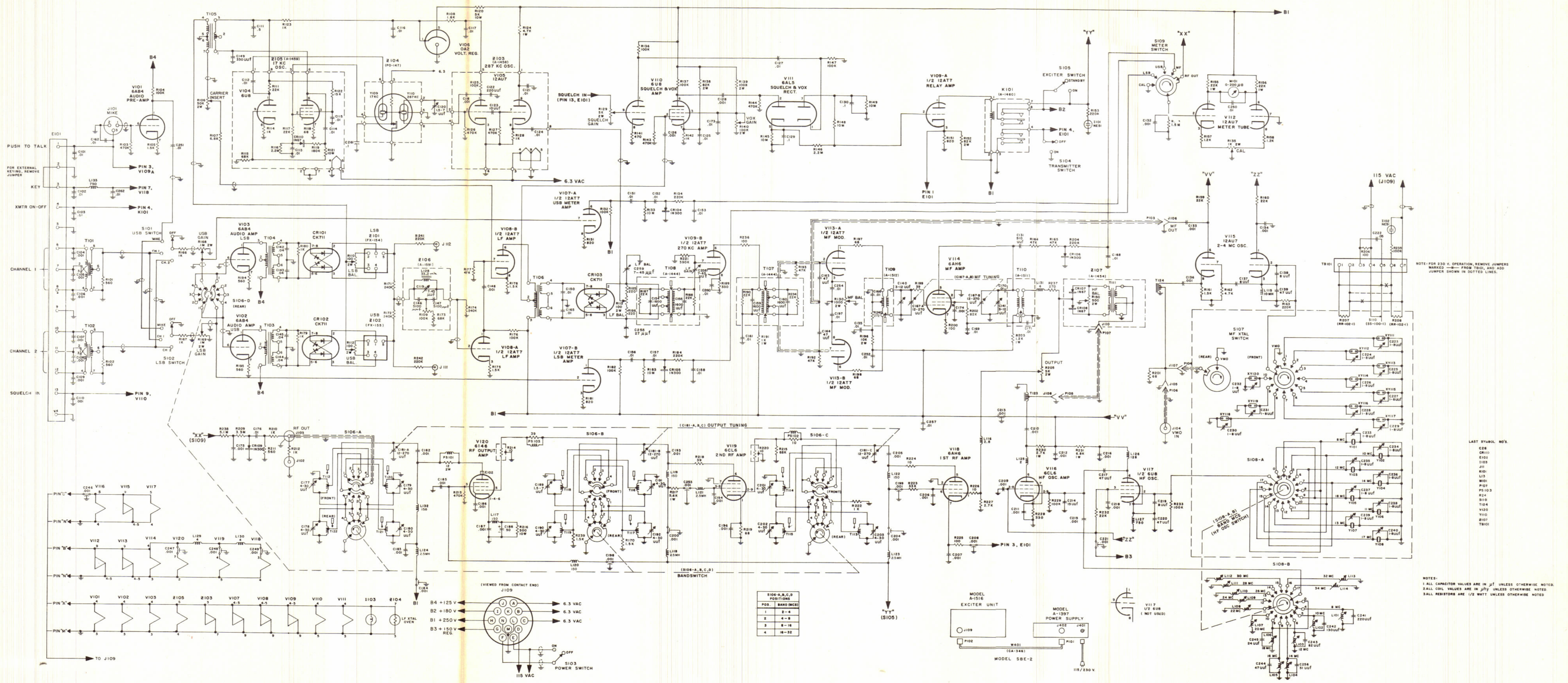


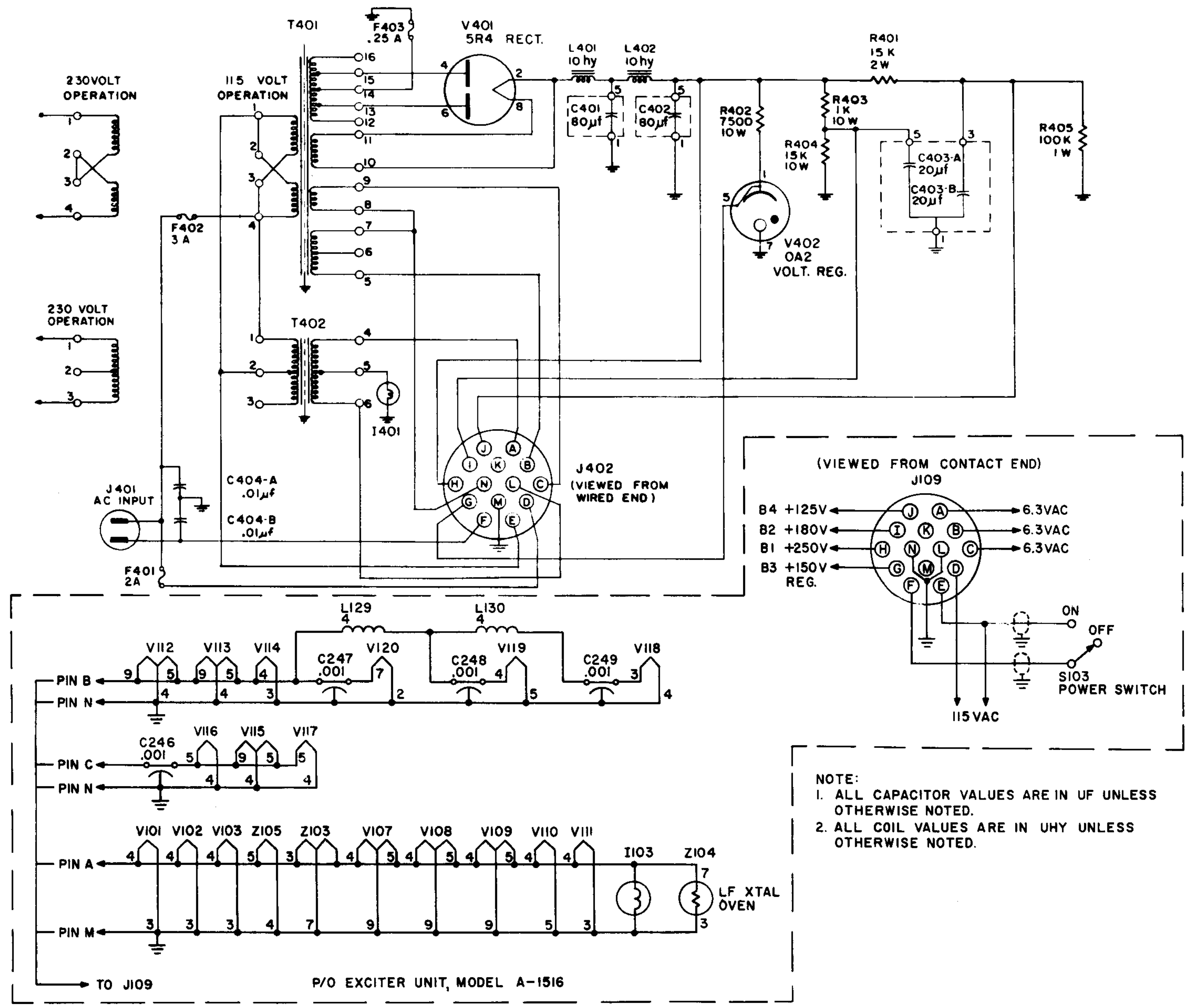
Figure 7-2. Schematic Diagram, FSA and PS-12 (Sheet 2 of 2)

Figure 7-3. Schematic Diagram, SBE-3, SBE-2, and Power Supplies (Sheet 1 of 3)



S106-A,B,C,D POSITIONS	
POS.	BAND (MCS)
1	2 – 4
2	4 – 8
3	8 – 16
4	16 – 32

Figure 7-3. Schematic Diagram, SBE-3, SBE-2 and Power Supplies (Sheet 2 of 3)



NOTE:
1. ALL CAPACITOR VALUES ARE IN UF UNLESS OTHERWISE NOTED.
2. ALL COIL VALUES ARE IN UHY UNLESS OTHERWISE NOTED.

Figure 7-3. Schematic Diagram, SBE-3, SBE-2, and Power Supplies (Sheet 3 of 3)

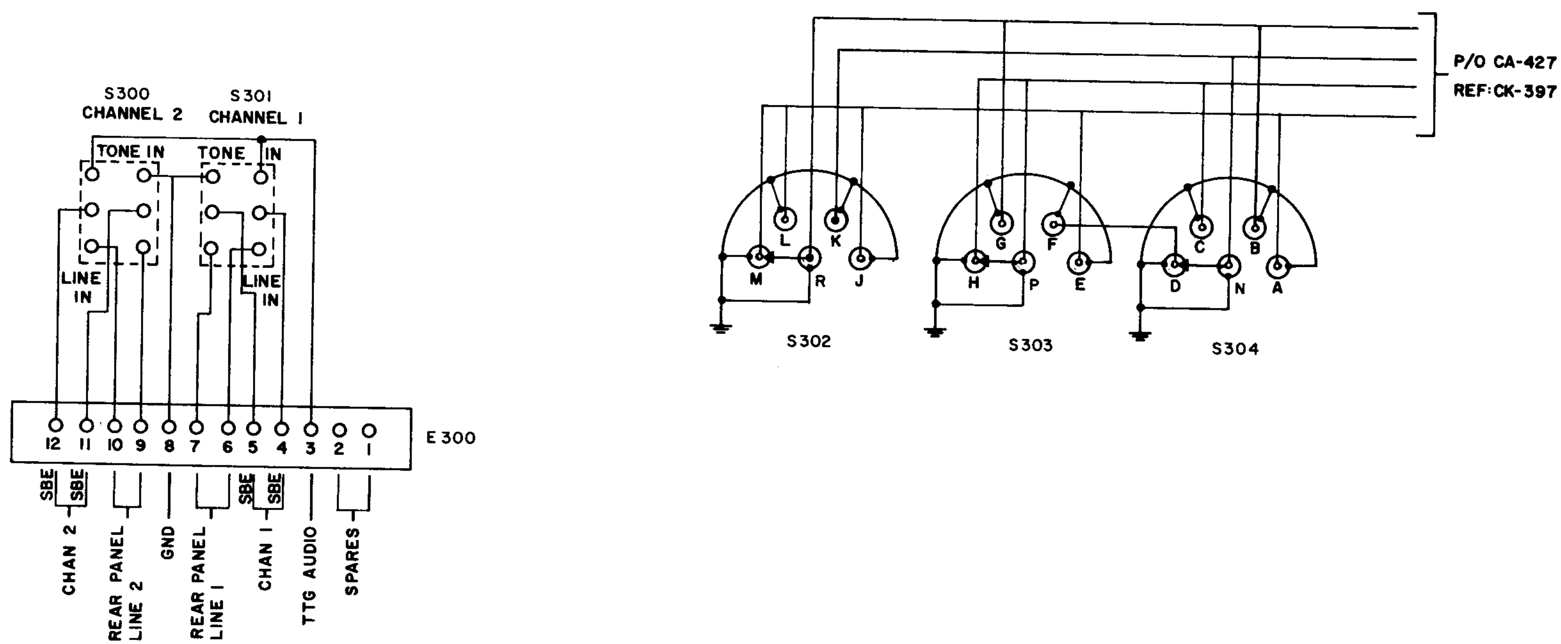
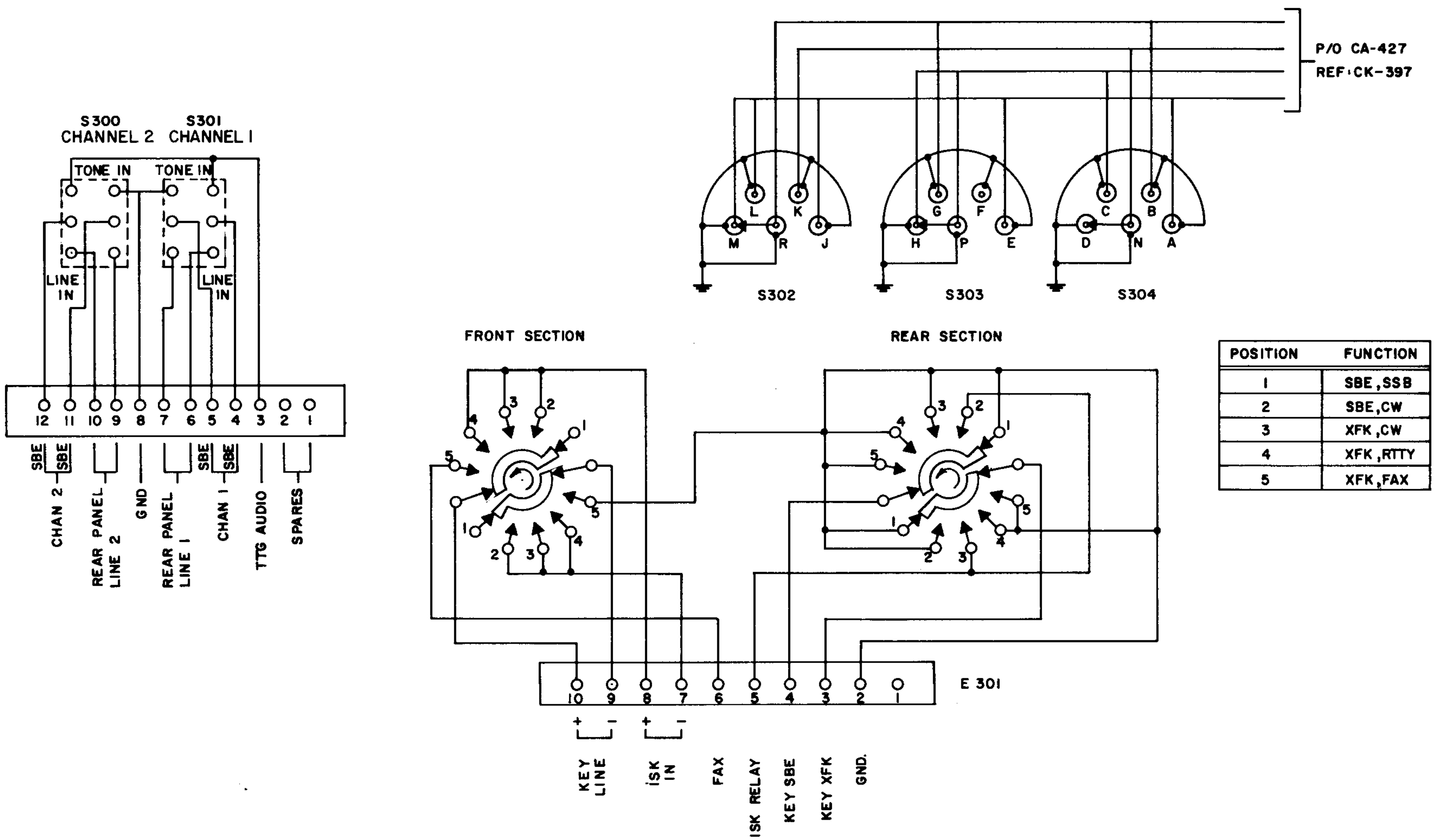
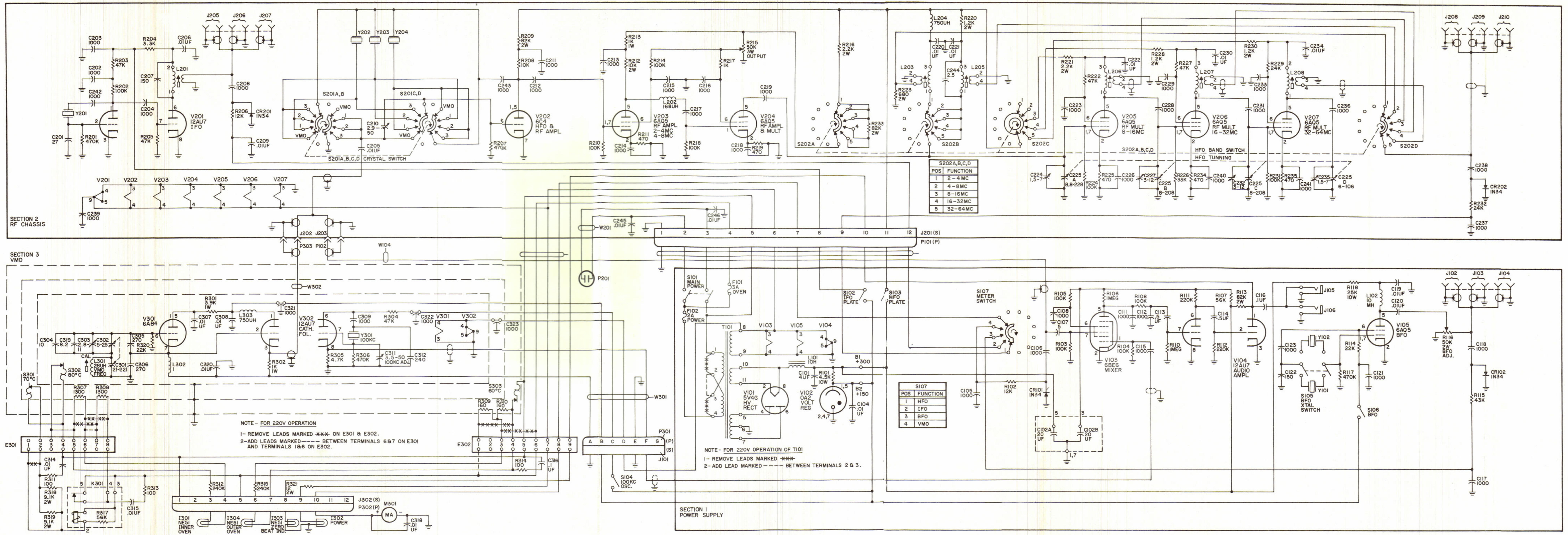


Figure 7-4. Schematic Diagram, MCP-1 and MCP-2 (Sheet 1 of 2)



POSITION	FUNCTION
1	SBE, SSB
2	SBE, CW
3	XFK, CW
4	XFK, RTTY
5	XFK, FAX

Figure 7-4. Schematic Diagram, MCP-1 and MCP-2 (Sheet 2 of 2)



100 SERIES	
LAST SYMBOLS	MISSING SYMBOLS
C123	C103, C109, C110
CR102	
F102	
J106	
L102	
P108	
R118	R109
S107	
T101	
V105, W104	
Y102	

200 SERIES	
LAST SYMBOLS	MISSING SYMBOLS
C246	
CR202	
J210	J204
L208, P201	
R235	
S202	
V207, W201	
Y204	

300 SERIES	
LAST SYMBOLS	MISSING SYMBOLS
C323	C310, C313, C317
E302	
I304	
J302	J301
K301	
L303	
M301	
P303	
R321	R303, R316
S303	
V302, W302	
Y301	

NOTES—UNLESS OTHERWISE SPECIFIED

1- ALL CAPACITORS ARE IN MICRO-MICROFARADS

2- ALL RESISTORS ARE 1/2 WATT

3- ALL SWITCHES ARE SHOWN IN POSITION 1

4- ALL COILS ARE IN MILLIHENRIES

5- ALL CRYSTALS ARE SUPPLIED ONLY UPON CUSTOMERS REQUEST

SERVICING INTERCONNECT CABLES

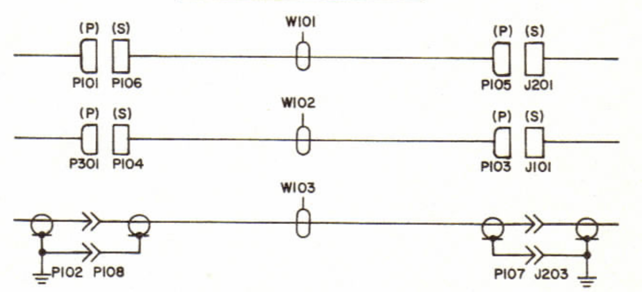
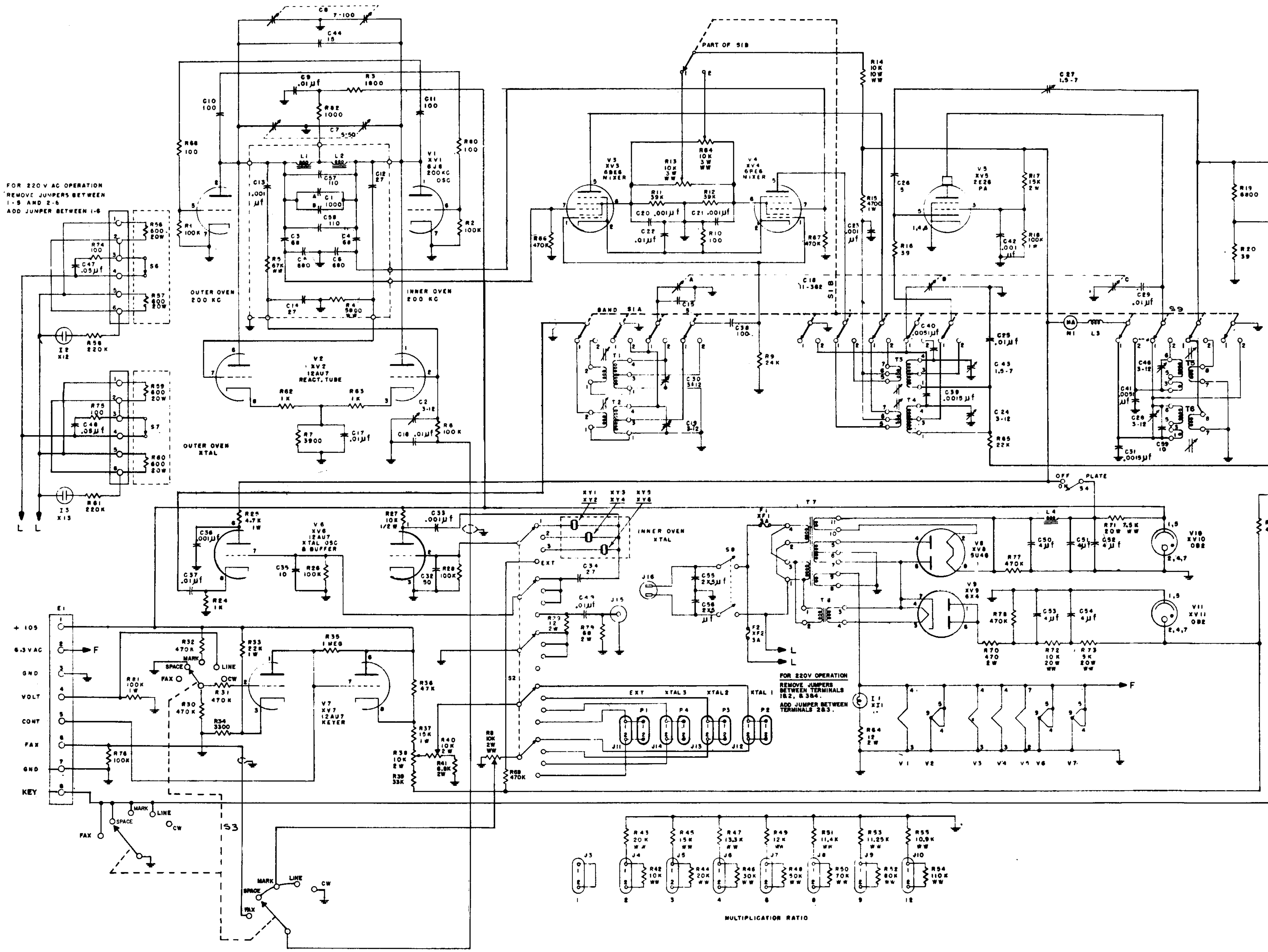


Figure 7-5. Schematic Diagram, VOX

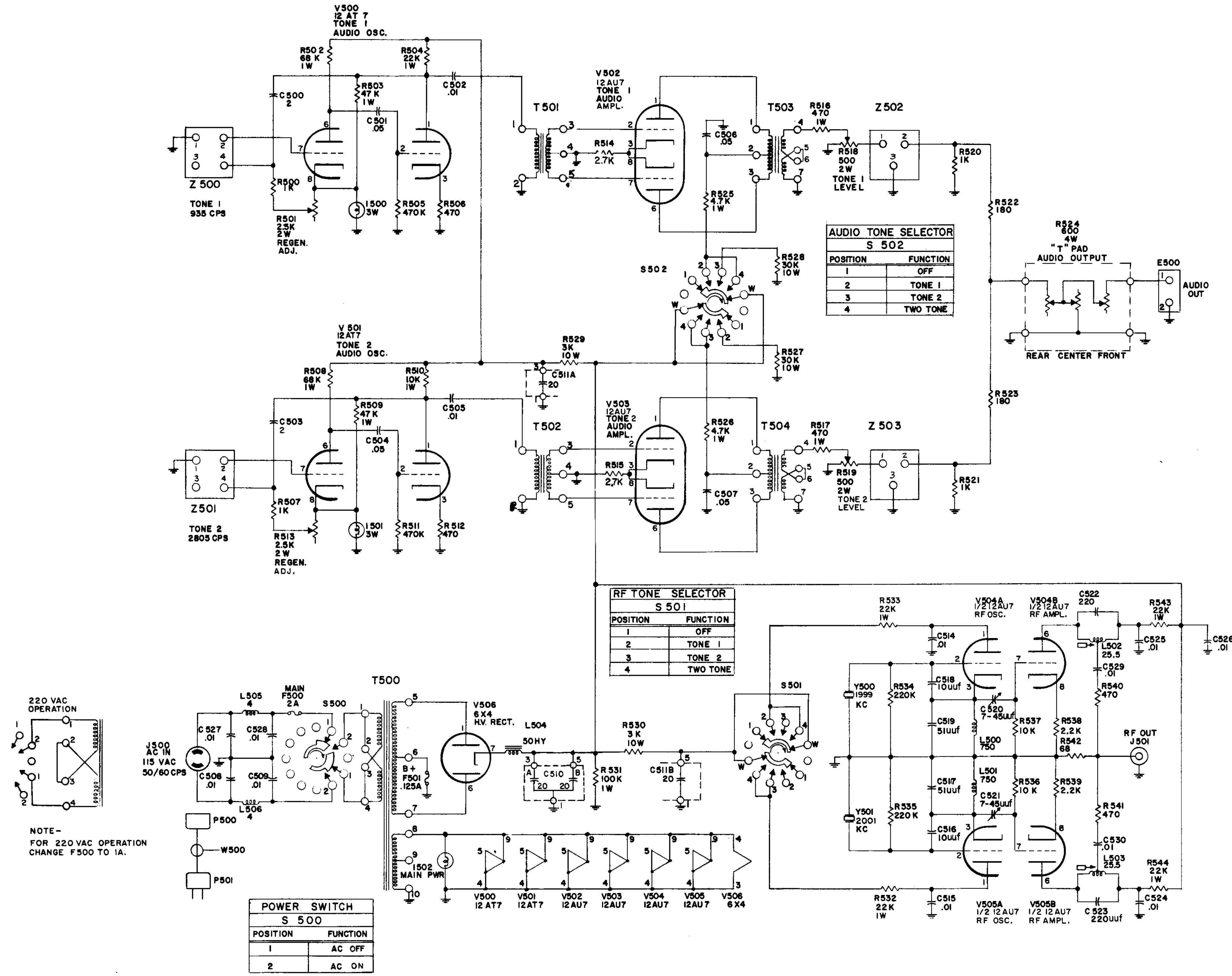


CAPACITANCE VALUES ARE GIVEN IN μμf UNLESS OTHERWISE NOTED.

RESISTANCE VALUES ARE GIVEN IN OHMS. K-1,000 M-1,000,000

RESISTORS ARE 1/2 W UNLESS OTHERWISE NOTED.

Figure 7-6. Schematic Diagram, XFK



AUDIO TONE SELECTOR	
S 502	
POSITION	FUNCTION
1	OFF
2	TONE 1
3	TONE 2
4	TWO TONE

RF TONE SELECTOR	
S 501	
POSITION	FUNCTION
1	OFF
2	TONE 1
3	TONE 2
4	TWO TONE

POWER SWITCH	
S 500	
POSITION	FUNCTION
1	AC OFF
2	AC ON

NOTES:

1. ALL CAPACITORS ARE IN MICROFARADS, UNLESS OTHERWISE SPECIFIED.
2. ALL RESISTORS ARE 1/2 WATT, " " "
3. ALL COILS ARE IN MICROHENRIES " " "
4. ALL SWITCHES SHOWN IN POSITION # 1

LAST SYMBOLS

C 530
E 500
F 501
I 502
J 501
L 506
P 501
R 544
S 502
T 504
V 506
W 500
Y 501
Z 503

MISSING SYMBOLS

C512, C513

Figure 7-7. Schematic Diagram, TTG

S4001

POS.	KEYING MODE
1	50V
2	100V
3	60MA
4	20MA

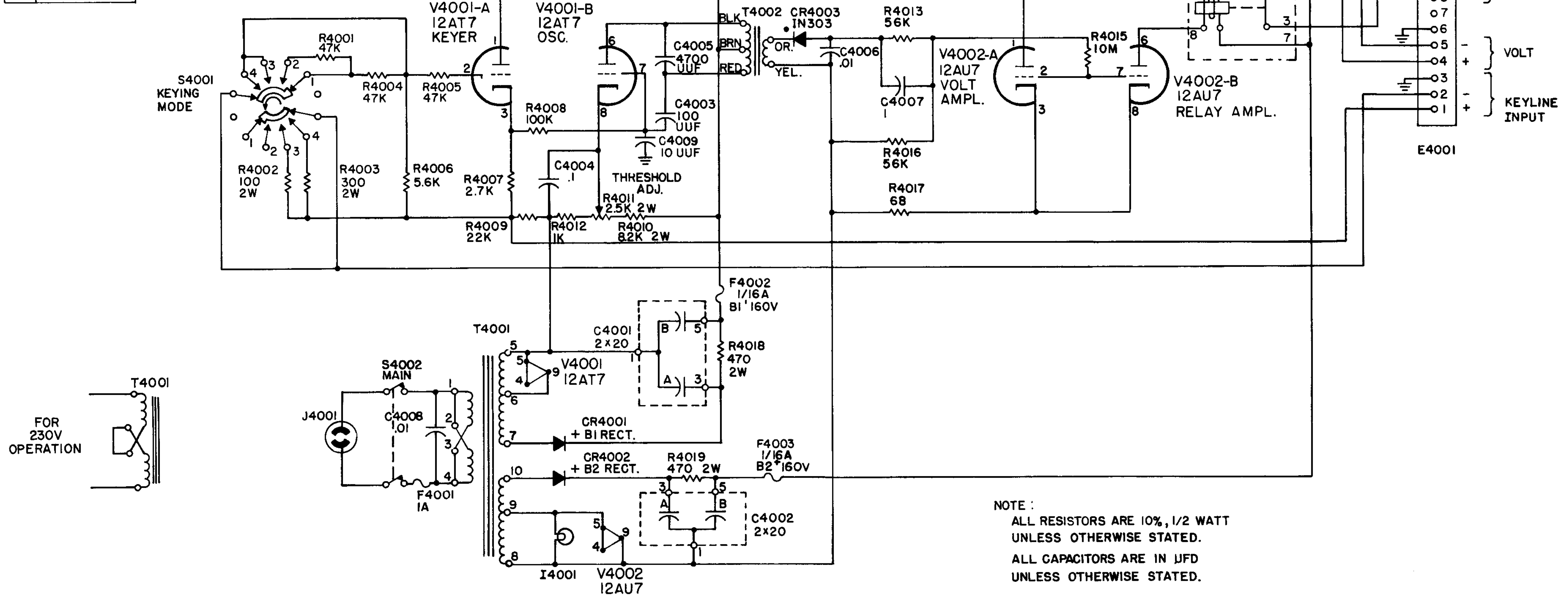


Figure 7-8. Schematic Diagram, ISK

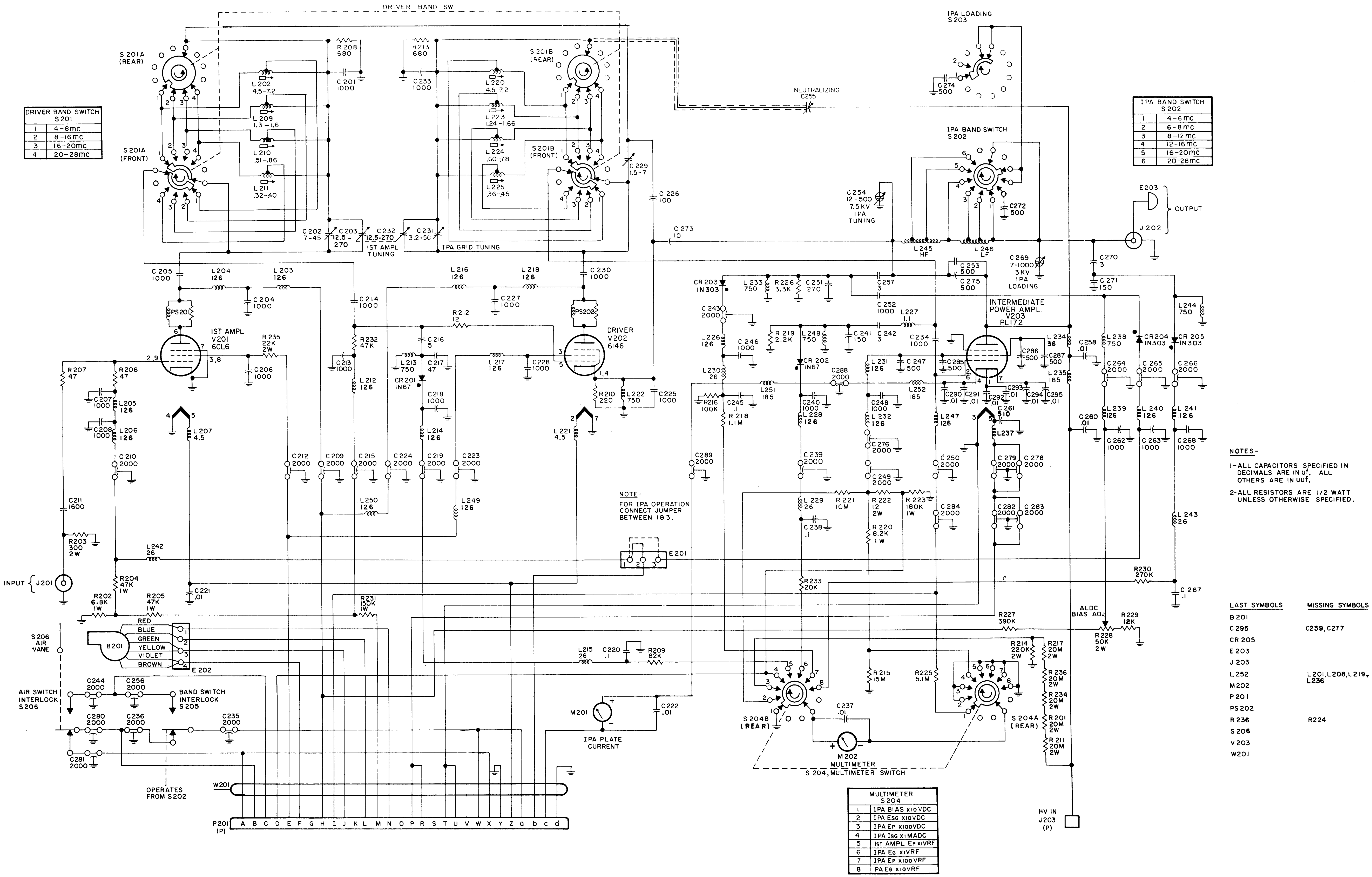
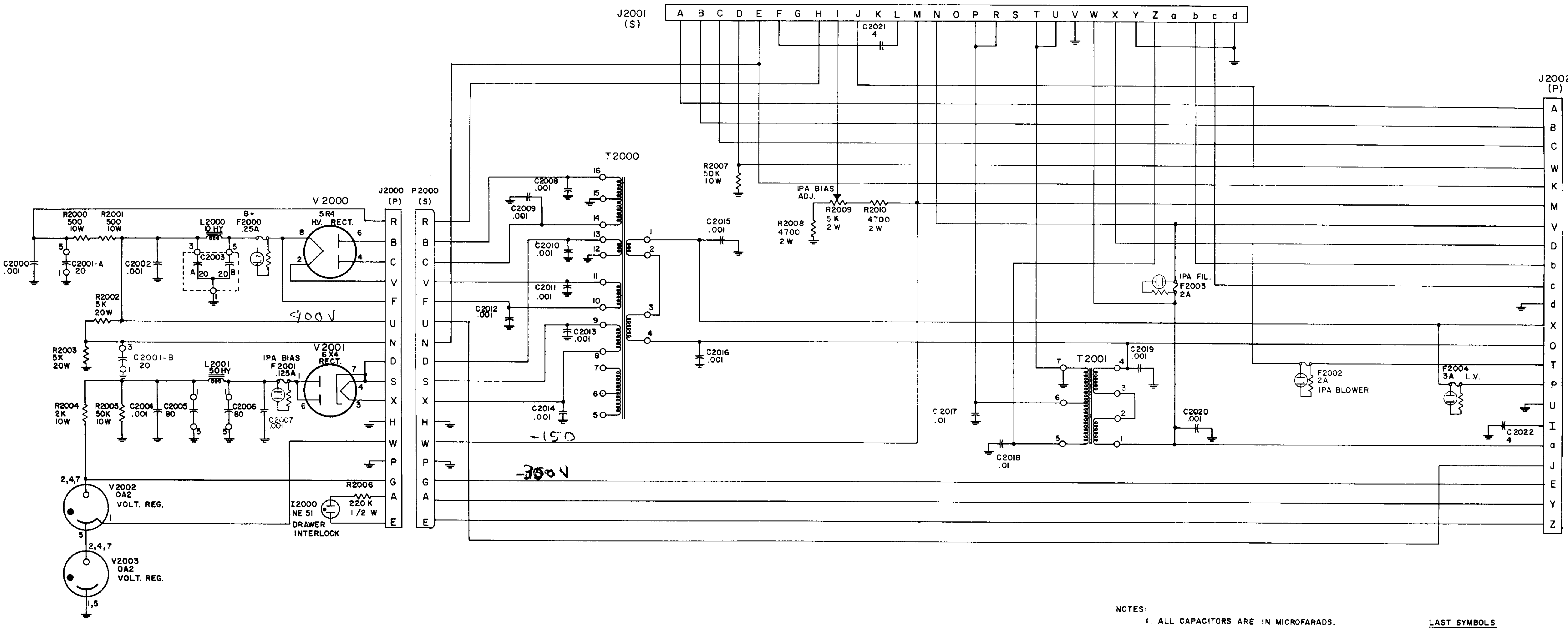


Figure 7-9. Schematic Diagram, IPA and Power Supply (Sheet 1 of 2)

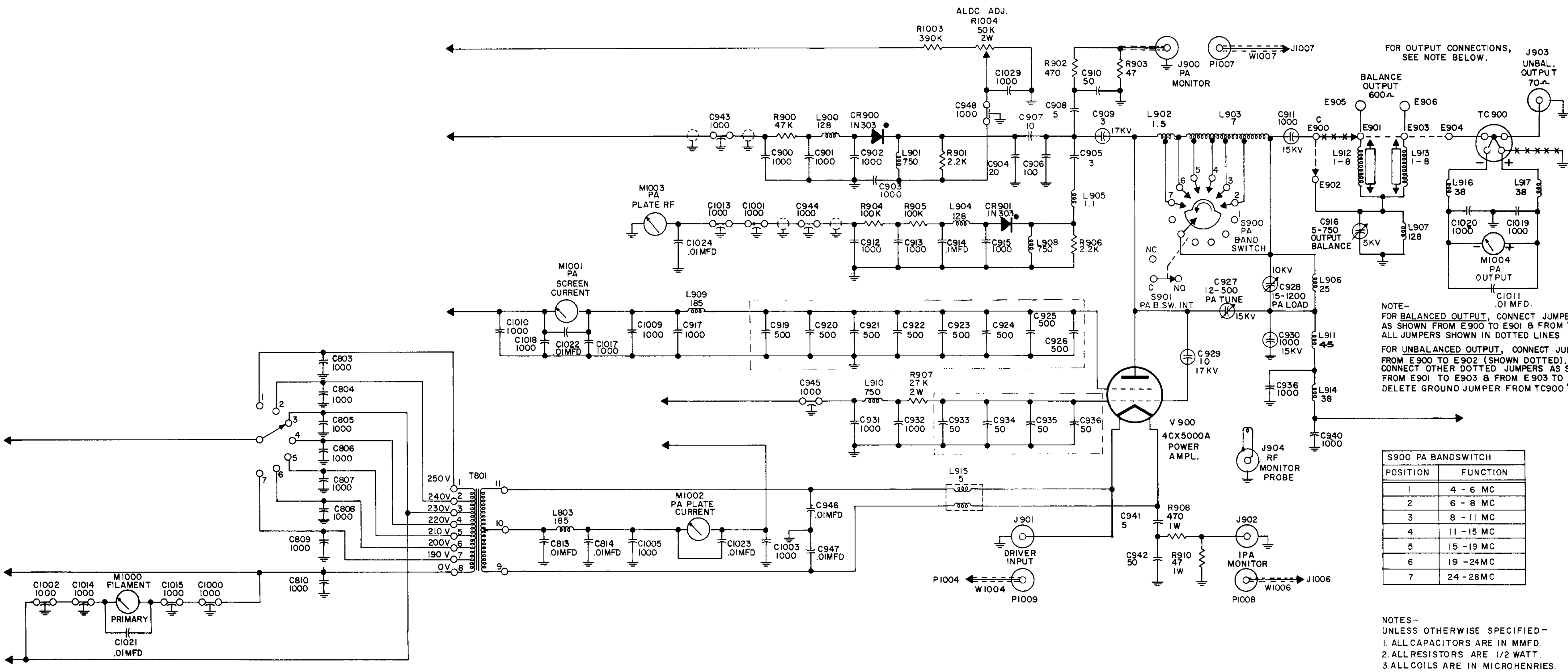


NOTES:
1. ALL CAPACITORS ARE IN MICROFARADS.
2. FUSES-
RESISTOR P/O FUSE SOCKET
INDICATOR P/O FUSE SOCKET CAP

LAST SYMBOLS

C2022
F2004
I 2000
J2002
L2001
P2000
R2010
T2001
V2003

Figure 7-9. Schematic Diagram, IPA and Power Supply (Sheet 2 of 2)



NOTE–
FOR BALANCED OUTPUT, CONNECT JUMPER MARKED –x–x–x→ AS SHOWN FROM E900 TO E901 & FROM TC900 "+" TO GROUND. ALL JUMPERS SHOWN IN DOTTED LINES WILL BE LEFT OUT.

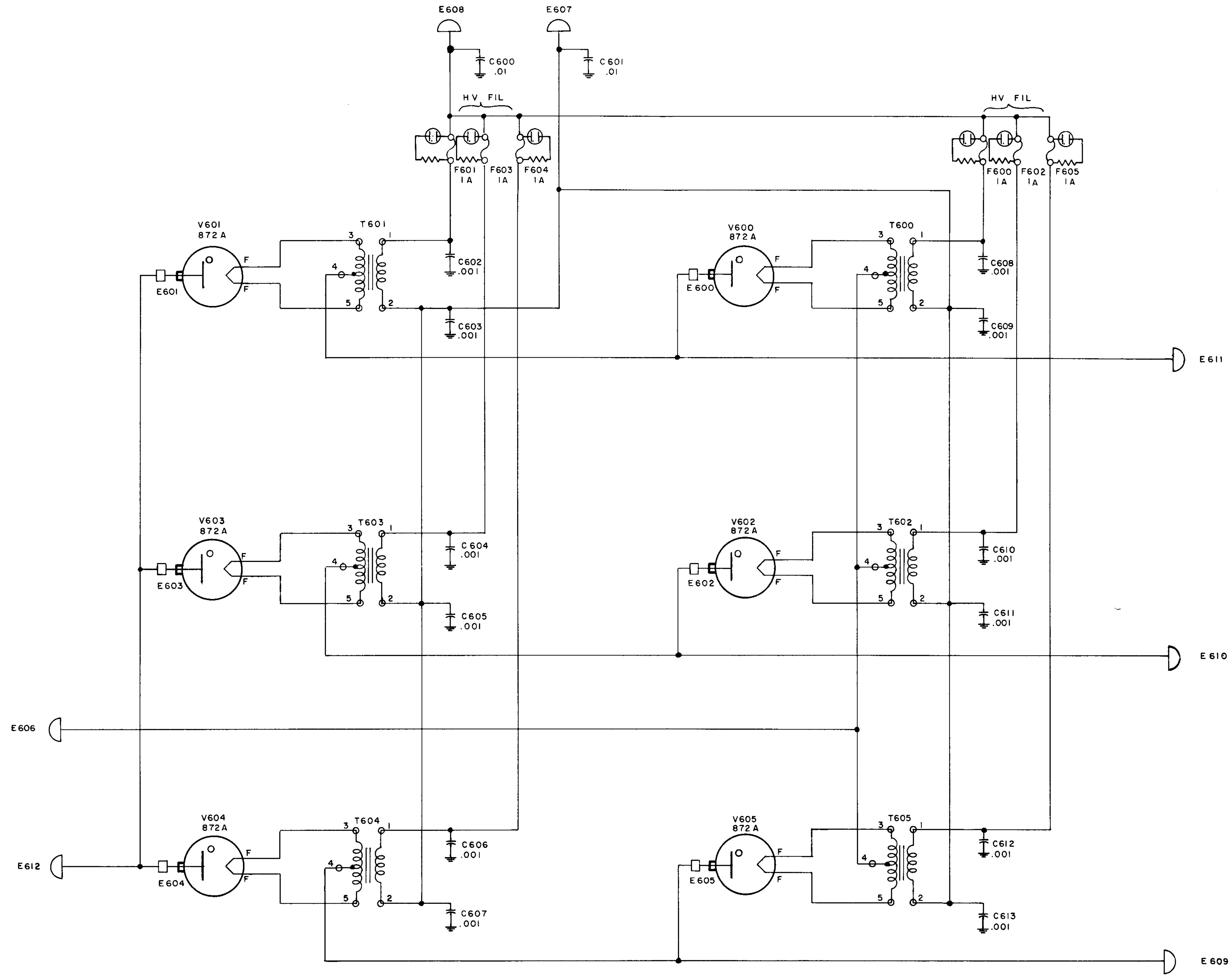
FOR UNBALANCED OUTPUT, CONNECT JUMPER MARKED –x–x–x→ FROM E900 TO E902 (SHOWN DOTTED). CONNECT OTHER DOTTED JUMPERS AS SHOWN. FROM E901 TO E903 & FROM E903 TO E904. DELETE GROUND JUMPER FROM TC900 "+" TO GROUND.

S900 PA BANDSWITCH	
POSITION	FUNCTION
1	4 - 6 MC
2	6 - 8 MC
3	8 - 11 MC
4	11 - 15 MC
5	15 - 19 MC
6	19 - 24MC
7	24 - 28MC

NOTES–
UNLESS OTHERWISE SPECIFIED–
1. ALL CAPACITORS ARE IN MMFD.
2. ALL RESISTORS ARE 1/2 WATT.
3. ALL COILS ARE IN MICROHENRIES.
4. S900 SHOWN IN POSITION 1.
5. S901 IS P/O INTERLOCK SYSTEM. SEE MASTER SCHEM.(CK-403) FOR CONNECTIONS.
6. THE 800 & 1000 SYMBOL SERIES SHOWN ARE NOT P/O P.A.

LAST SYMBOLS	MISSING SYMBOLS
C948	C937, 938, 918
CR901	
E906	
J904	
L917	
R910	R909
S901	
TC900	
V900	

Figure 7-10. Schematic Diagram, PA Section



NOTE-
ALL CAPACITORS ARE IN uf.
E606 H V OUTPUT
E607, E608 } 230V AC INPUT
E609, E610, E611 } INPUT FROM HV TRANSFORMER
E612 B MINUS
FUSES-
INDICATOR, P/O FUSE SOCKET CAP
RESISTOR, P/O FUSE SOCKET.

LAST SYMBOLS

C - 613
E - 612
F - 605
T - 605
V - 605

Figure 7-11. Schematic Diagram, High-Voltage Rectifier Section

Figure 7-12. Schematic Diagram, GPT-10K (Sheet 1 of 2)

Figure 7-12. Schematic Diagram, GPT-10K (Sheet 2 of 2)