NAVSHIPS 96031 UNCLASSIFIED

TECHNICAL MANUAL

for

RF SPECTRUM ANALYZER

AN/GRM-33A

INDUSTRIAL MANAGER, U.S.N.
POTOMAC RIVER NAVAL COMMAND
WASHINGTON, D.C. 20390

TABLE OF CONTENTS OF RF SPECTRUM ANALYZER MODEL PTE-3

FOREWORD

The RF Spectrum Analyzer, Model PTE-3 (sometimes called Portable Test Equipment or Single Sideband Analyzer) is largely made up of three basic TMC units:

FSA-2 Spectrum Analyzer
VOX-5 Variable Frequency Oscillator
TTG-2 Two-Tone Generator

These basic units are also included in different combinations in various TMC transmitter and receiving systems as well as in the PTE-3. To satisfy this condition most practically, individual manuals on each unit are written; then combined as required to cover any over-all transmitter, receiver, analyzer, etc. In this way the "building block" manuals may be assembled in many arrangements in order to fully describe a great many specific equipments. The PTE-3 manual is made up of individual manuals as described in Table of Contents of RF Spectrum Analyzer, Model PTE-3.

The following colloquial terms are sometimes used in this manual to simplify formal nomenclature terminology:

FORMAL		
MILITARY	TMC	COLLOQUIAL
Test Set, Radio AN/GRM-33A	RF Spectrum Analyzer, PTE-3	PTE
Spectrum Analyzer Group, AN/URM-116A	Spectrum Analyzer, FSA-2	FSA
Oscillator, Radio Frequency, 0-330( )/FR	Variable Frequency Oscillator, VOX-5	VOX
Generator, Signal, 0-579/URT	Two Tone Generator, TTG-2	TTG

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TECHNICAL MANUAL

for

RF SPECTRUM ANALYZER

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PART I

PTE-3 SYSTEM

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(GENERAL DESCRIPTION OF RF SPECTRUM ANALYZER, PTE)

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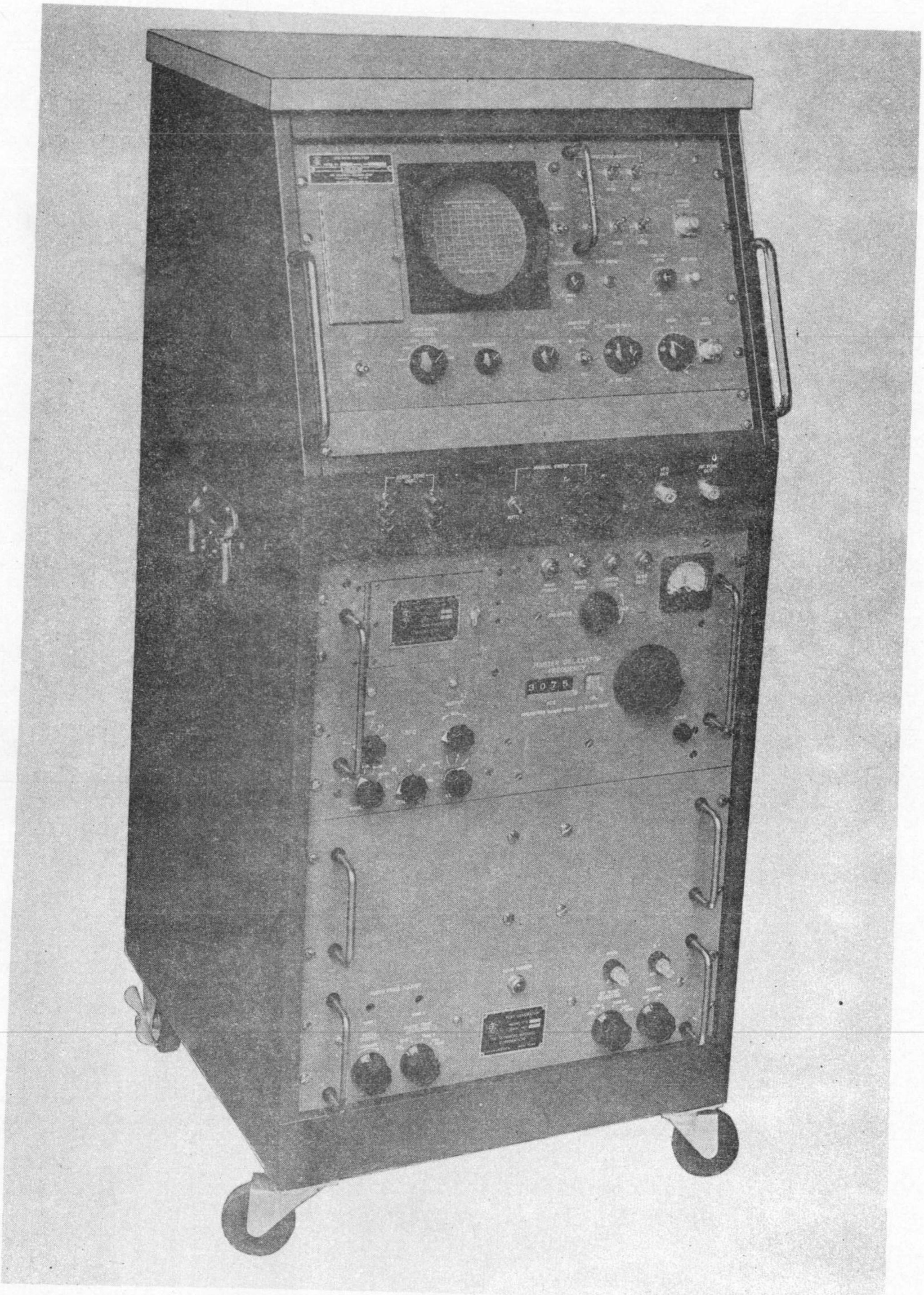

Figure I-1-1a. Front Angle View, RF Spectrum Analyzer, PTE

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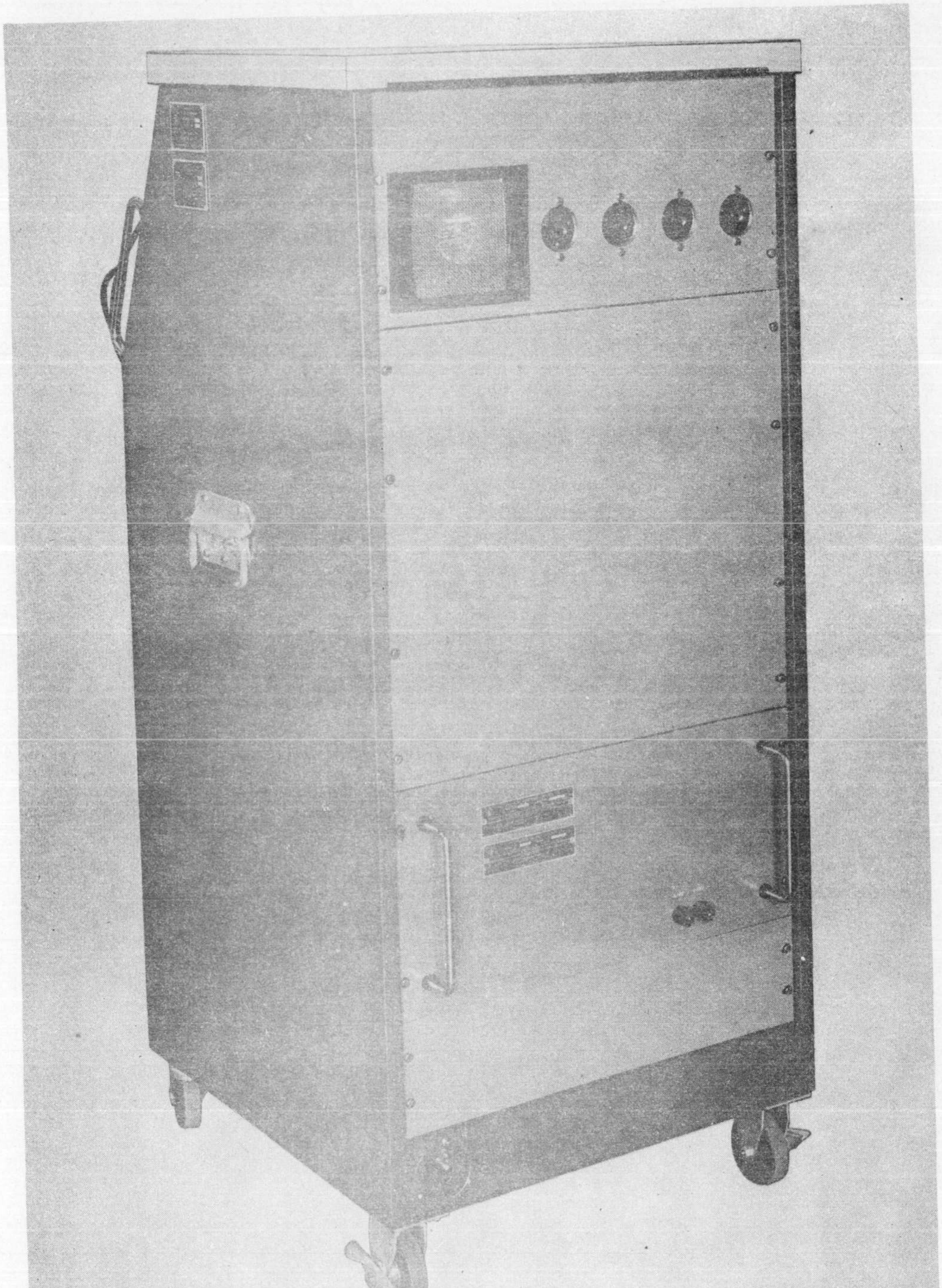

Figure I-1-1b. Rear Angle View, RF Spectrum Analyzer, PTE

SECTION 1
GENERAL DESCRIPTION

I-1-1. INTRODUCTION.

The PTE RF Spectrum Analyzer is a frequency meter originally designed for the specific purpose of tuning and aligning sideband transmitters and exciters. Carrier and sideband levels, intermodulation distortion products, hum and noise all appear together as clearly defined pips in a frequency spectrum display across a CRT screen.

By the nature of the capabilities, however, the PTE may be used to analyze any r-f signal within the rated frequency and power input ranges. In this way the PTE can serve as a general purpose frequency spectrum analyzer in development design phases or as tuning and monitoring equipment for an operating system.

This manual is written in terms of using PTE equipment to analyze, tune and monitor sideband transmitters and exciters. The same methods may be used for any equipment with an r-f output within the rated frequency and power input ranges.

I-1-2. FUNCTIONAL DESCRIPTION.

Figure I-1-1a is used for the brief functional description of the PTE. Functions of each removable drawer are described in the following paragraphs in the order as they appear reading from top to bottom.

The first removable drawer contains the SA unit (P/O FSA Spectrum Analyzer). This equipment is an automatic scanning superheterodyne receiver which permits analysis and identification of one or many radio frequency 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. Optimum tuning and a continuous monitoring of transmitter output is possible by connecting the FSA to sample the transmitter output. Carrier, sidebands, cross modulation products, spurious oscillations and all other spurious frequency components appear together on the display screen and may be magnified for closer inspection if required. Transmitter controls may then be varied to obtain the optimum relative levels for these components while observing results on the display screen.

The second removable drawer contains the VOX Variable Frequency Oscillator. This equipment supplies the variable frequency r-f signal with the necessary accuracy and stability required for the first mixer stage of the FSA.

The third removable drawer contains the Regulator Panel. Upon the back of the panel is mounted a constant voltage transformer which supplies a regulated voltage to the FSA Power Supply Unit and to the PTE blower.

The fourth removable drawer contains the TTG Two-Tone Generator. This equipment supplies two a-f and two r-f tones. The a-f tones are chosen to permit visual analysis of the 3rd, 5th, 7th and 9th order products. The r-f tones are generated for the purpose of checking the proper operation of the FSA.

Located between the first and second removable drawers is a control panel. This panel serves as a patch panel and also contains controls for a MANUAL SWEEP facility in conjunction with the operation of the FSA unit. By turning the MANUAL SWEEP crank, the trace may be slowed, accelerated, brought to a stop, or reversed. In this way a pip may be "held" so that adjustments may be made to reduce this distortion without waiting for the recycling of the display in some of the slower sweep rates necessary in narrow band analysis.

Mounted in the back of the PTE and located at the top, is a utility panel containing four extra line voltage outlets and a cooling exhaust blower.

Mounted in the back of the PTE and located at the bottom, is the power supply unit for the FSA.

In general, the sensitivity of the PTE enables a clear indication of equal amplitude signals down to 10 cps separation and signals with a 50db amplitude ratio down to 60 cps separation. See specific electrical characteristics listed in the FSA manual for separation vs. amplitude ratio chart.

An additional capability of the PTE is found in its individual units VOX and TTG. These units may be used by themselves without removing them from the PTE rack. Their many capabilities are described in their individual manuals.

I-1-3. PHYSICAL DESCRIPTION.

The PTE is shown in figures I-1-1a and I-1-1b. The rack is equipped with four heavy duty casters which permit the unit to be moved to the equipment being tested. The front of the FSA is sloped for convenient visibility from either a standing or sitting position. All controls and test connections are made on the front panels. Patch cords and cables are supplied for immediate operation. A storage bin at the top of the unit is accessible by lifting the hinged counter top.

The unit measures 23-1/2" wide, 24" deep, and 48" high. It weighs approximately 260 lbs. The unit is manufactured in accordance with JAN/MIL specifications wherever practicable. All parts and assemblies meet or exceed the highest quality standards.

I-1-4. REFERENCE DATA.

The PTE, crated for shipping, is divided into 5 crates with sizes and gross weights as follows:

size of crate (inches)	gross weight (lbs)
27-3/8 x 24-1/2 x 51-1/2	188
24-3/4 x 23 x 10-1/8	55
32-1/2 x 23-3/8 x 28-3/4	208
24-5/8 x 17-1/2 x 14-7/8	70
13-1/8 x 20-3/4 x 23-1/4	72
	593 lbs. total

Electrical Characteristics are given in Table I-1-1.

TABLE I-1-1. ELECTRICAL CHARACTERISTICS, PTE

SIGNAL INPUT frequency range:	- 1.5-64.5 mc, continuously adjustable - 450-550 kc, continuously adjustable
Sweep widths:	- Fixed: 150 CPS, 500 CPS, 3.5 KC, 7.0 KC and 14 KC - Continuously variable: 0-100 kc 0-2 kc
Input impedance:	- SIGNAL INPUT, 50 ohms
Input attenuator:	- 0-65db attenuation of the input signal in 5db steps. Accuracy ±2% up to 30 mc.
Sensitivity:	- (In 450-550 kc range) Maximum rms voltage at SIGNAL INPUT jack to produce full scale linear deflection = 200 mv. - (In 1.5 - 30.0 mc range) Approximate rms voltage at SIGNAL INPUT jack to produce full scale log deflection when VOX is supplying 2.6 volts (0.1 reading on VOX meter) = 5 mv. - (30.0 - 64.5 mc range) same as in 1.5 - 30.0 mc range with SIGNAL INPUT voltage slightly higher
SIGNAL INPUT, maximum input voltage without external pad:	- 3.0 volt rms
VFO INPUT, input voltage:	- 2.6 volts RMS (0.1 ma reading on VOX meter).
Amplitude scales:	- Linear and log, selectable by front panel switches. Linear shows 1:10 relative amplitudes; log, 40db relationships. Front panel switch extends 40db range to 60db.
Image rejection:	- Better than 130:1
Scan rates:	- On preset sweep widths of 150 CPS, 500 CPS, 3.5 KC - 0.1 cps. On preset sweep widths of 7 KC and 14 KC - 1.0 cps. On VAR sweep width - 0.1 cps to 30 cps, continuously variable.

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TABLE I-1-1. ELECTRICAL CHARACTERISTICS, PTE (C nt)

Scan rates: (cont)	On MANUAL SWEEP, sweep rate and direction manipulated by hand crank.
Resolution:	- On preset sweep widths, IF bandwidth is preset for optimum resolution. On VAR sweep width, IF BANDWIDTH control may be set for optimum resolution, down to 10 CPS separation of equal amplitude signals and 60 cps separation of 50db ratio signals. See resolution graph in FSA manual (Part II).
Dynamic amplitude range:	- On preset sweep widths, two equal signals deflected 20db above full scale log and separated so that their intersection is at least 60db down, will produce in-band intermodulation products better than 60db down provided that: 1. All front panel gain settings are maximum. 2. VFO source is at least 300 mv rms. On VAR sweep widths, the same applies, with the added provision that the IF BANDWIDTH control is adjusted for broadest position consistent with visual separation of signals.
Indicator:	- 5" diameter flat face cathode ray tube (5ADP) with edge lit reticule and scale illumination.
Power Consumption	- Approximately 315 watts average or 465 watts peak, depending on cycling of VOX-5 oven heating element.
Power Requirements:	- 115/230 volts, 50/60 CPS, single phase (The Model PTE-3 is supplied for 115 volt, 50 or 60 CPS operation. The unit will be supplied for 230-volt operation only at customer's specific request).
Outputs:	- Two-tone test signals to transmitter: 935 cps and 2,805 cps, 600-ohms unbalanced, 0 to 0.5 volts continuously variable. Harmonic distortion more than 65db down. - Two-tone test signals to FSA: 1,999 kc and 2,001 kc (crystal controlled): 50-ohms impedance. Harmonic distortion more than 60db down.
Auxiliary outputs:	- Type BNC vertical and horizontal deflection outputs for slave scope or monitoring on FSA. Beat frequency of crystal controlled 300 to 1000 kc and intermediate frequency of crystal controlled 3.2 to 3.9 mc, BNC fittings on VOX. AFC test, telephone type jack on FSA. Earphone jacks for zero beat on VOX.
Auxiliary inputs:	- EXT MOD (type BNC) for setting up markers on FSA screen in lieu of 5 kc oscillator.

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SECTION 2
INSTALLATION

I-2-1. INTRODUCTION.

Each PTE has been tested and calibrated before shipment. Upon shipment it is disassembled and packed into crates. It is only necessary to unpack and reassemble the equipment as outlined in the following paragraphs. Recalibration of the individual rack mounted units is not necessary.

I-2-2. INITIAL INSPECTION.

The complete PTE-3 will arrive in 5 crates, containing components as listed in Part V of this manual (Appendi-. - Rack & Accessories). Inspect each crate 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 plug-in components installed. Check that all such components are properly seated in their sockets. The following quartz crystals in the VOX unit are not furnished by TMC unless specifically ordered. These crystals are not required for the operation of the PTE system.

Xtal Designation	Socket Designation	Type	Within Frequency Range	Function
Y101	XY101	CR-25/U	300-1000kc	BFO
Y102	XY102	CR-25/U	300-1000kc	BFO
Y201	XY201	CR-18/U	2.9-3.2mc	IFO
Y202	XY202	CR-18/U	2-4mc	HFO
Y203	XY203	CR-18/U	2-4mc	HFO
Y204	XY204	CR-18/U	2-4mc	HFO

I-2-3. 50 CYCLE LINE VOLTAGE MODIFICATION.

The PTE is factory wired for 115VAC, 60 cycle, single phase line voltage. If the line voltage available is 115VAC 50 cycle, single phase, refer to figure I-2-1 for modification procedure.

A PTE capable of working from a 230VAC 50 or 60 cycle single phase line is available on special order.

I-2-4. ASSEMBLY OF PTE.

Install units in rack as shown in figure I-1-1. Make cable connections as described in Part V of this manual.

WARNING

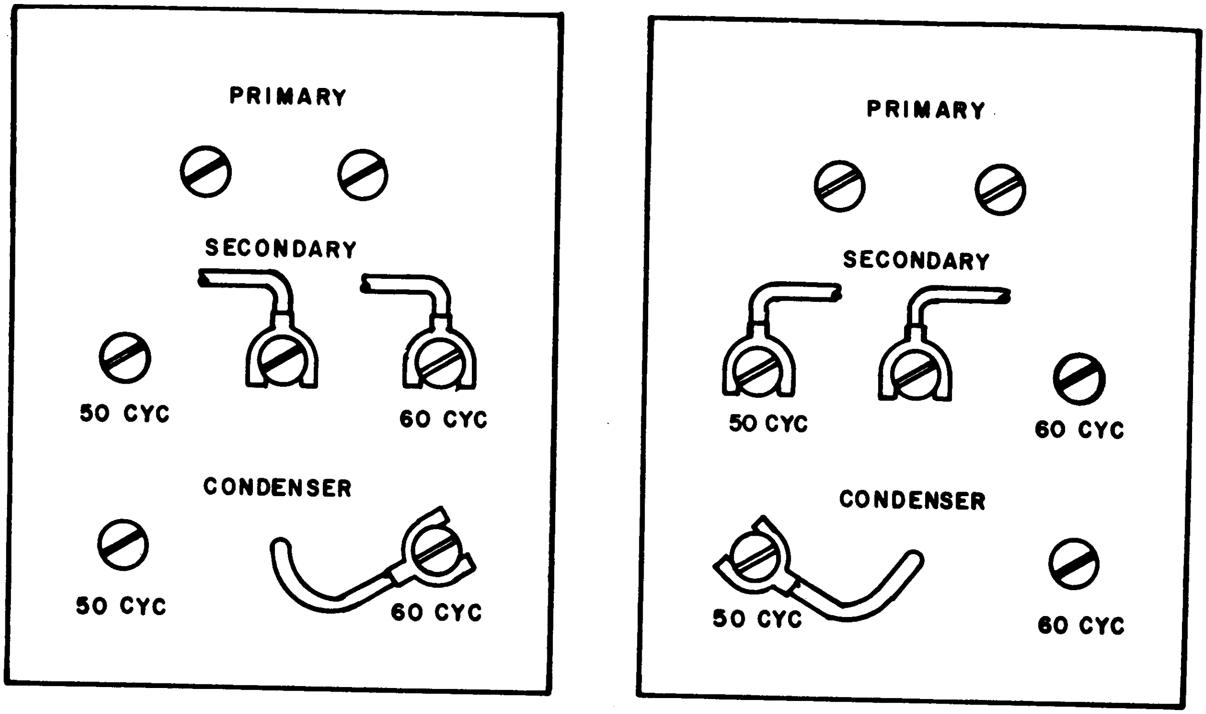
Be sure that PTE is not connected to line voltage during assembly and installation of cables. The FSA utilizes voltages dangerous to life and damaging to equipment.

Install back cover as shown in figure I-1-1b. Install power cable CA-575-1 at J109 receptacle at bottom of rack and connect to a 115VAC line voltage. PTE is not drawing current when the following power switches are in the OFF position.

Unit	Panel Designation
FSA	ILLUMINATION/POWER OFF
VOX	ON/POWER
TTG	POWER/OFF/ON

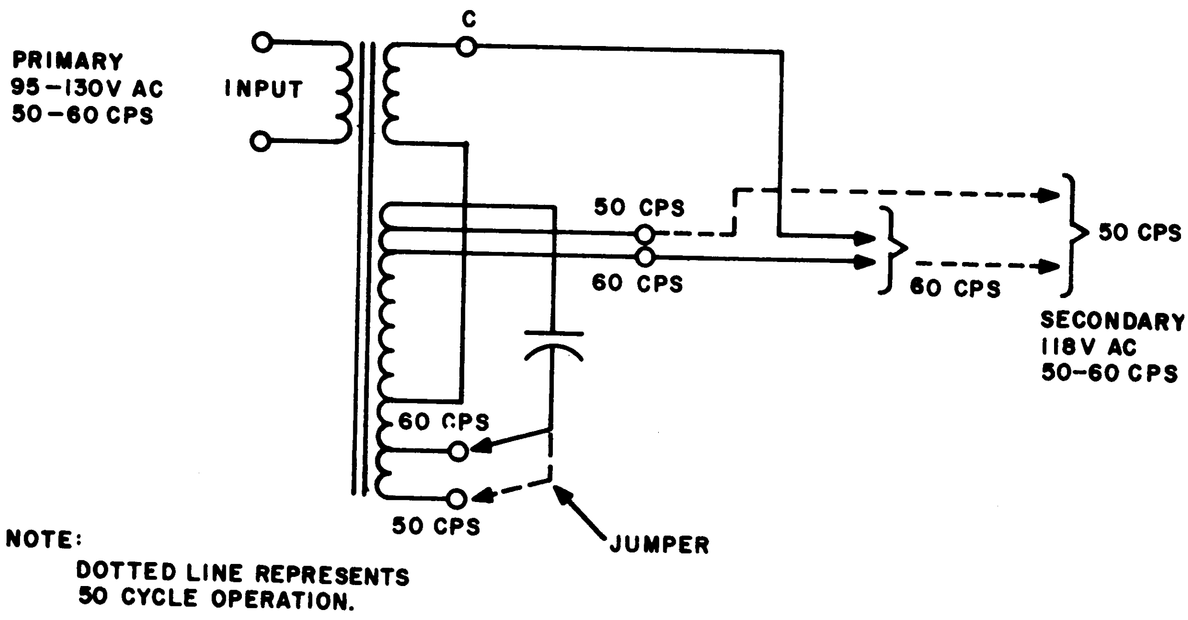
I-2-5. INITIAL ADJUSTMENTS.

Since the PTE has been tested and calibrated prior to its disassembly and shipping, there are no initial adjustments necessary before operation.



60 CYCLE OPERATION

50 CYCLE OPERATION



REGULATOR TRANSFORMER TERMINAL WIRING

Figure I-2-1. PVR Regulator Wiring for 50 CPS vs. 60 CPS Line Voltage

SECTION 3
OPERATOR'S SECTION

I-3-1. PRELIMINARY CONSIDERATIONS.

a. GENERAL. Do not proceed to operate the PTE until it is determined what mode of transmission is being measured and what type of analysis is required.

b. MODES OF TRANSMISSION. This section is written to apply for SSB, DSB and ISB modes with or without suppressed carrier. The same general operating procedures can be made to apply for MCW and AM modes, since the same frequency components are present. After becoming familiar with the general operating procedure and the functions of PTE panel controls, the operator may easily set up his own system for analyzing CW, FSK, FM, FAX, or any type of r-f signal in the 1.5-64.5 mc range.

c. TYPES OF ANALYSIS. Four types of sideband analysis are possible with the PTE; they are as follows:

(1) General analysis

(2) Narrow band analysis

(3) Odd-order distortion measurement

(4) Transmitter monitoring

General analysis procedures are for viewing a spectrum display of frequencies resulting from the combination of a carrier and one modulating audio frequency in a transmitter. It is advisable that the modulating frequency, in this case, be fixed rather than varying, in order to maintain a steady display on the PTE screen. Narrow band analysis affects a magnification of a portion of frequencies appearing in the spectrum display in general analysis. It is for the purpose of a closer inspection of portions of the entire spectrum and a separation of closely adjacent frequencies which tend to merge together in general analysis. Odd-order distortion measurements are for the purpose of measuring odd-order products generated in the transmitter by the introduction of two test audio tones into the transmitter input. Only the predominant distortion products, which are of an odd order and are close to the carrier frequency, are displayed on the PTE screen, since these are the ones that are of interest in sideband transmission. In transmitter monitoring operation, the PTE samples transmitter output and serves as a visual display of frequency components present around the carrier in actual transmitter operation. As the modulating frequency changes (as from voice transmission) the pips representing sidebands, distortion products, harmonics, and other spurious products above and below the carrier will shift along the baseline toward and away from the carrier pip.

During any type of analysis or monitoring, the transmitter controls can be adjusted for optimum transmission by observing the PTE screen and adjusting transmitter controls to minimize undesirable pip amplitudes.

d. BASIC THEORY FOR OPERATORS.

(1) Introduction. Before operating the PTE for the first time, the operator should review the basic theory involved in sideband transmission and the frequency components to be expected in the PTE display. For purposes of clarity, magnitudes of tones versus carrier magnitude are arbitrary in the following representations.

(2) Screen Display Representation. The PTE screen presents a graph of frequency within a determined bandwidth (along the horizontal axis) plotted against amplitude (along the vertical axis). If 100% resolution were possible, each frequency would appear as a vertical line as shown in figure I-3-1. Since 100% resolution is not possible, due to a finite sweep speed, the frequency indications generally appear as narrow inverted V's as shown in figure I-3-2. These V's can be further narrowed into almost a vertical line by sharpening the resolution controls on the PTE control panel when necessary. The procedure for sharpening resolution is included in table I-3-2.

(3) Carrier Frequency Appearance. The carrier frequency normally appears in the center of the screen as shown in figure I-3-3. When only the carrier is being transmitted, this will be the appearance on the PTE screen, plus some minor hum and spurious products (not shown) that may be present. Such products should appear at least 50db down on a correctly adjusted transmitter.

(4) DSB with Carrier. When the carrier is modulated with a single constant audio frequency (tone), an upper and lower sideband frequency will appear as shown in figure I-3-4. The upper sideband (USB) frequency will equal the carrier frequency plus the modulating frequency. The lower sideband (LSB) frequency will equal the carrier minus the modulating frequency. USB and LSB pips are mirror images of one another. Appearance of these frequencies for double sideband mode (DSB), as shown in figure I-3-4, will also occur in AM and MCW transmission, if the modulating frequency is a single constant audio tone. For 100% modulation, in AM and MCW, the maximum power in each sideband cannot exceed 25% of the carrier power. In sideband transmission modes, modulation percentage does not influence intelligibility of received signal, within good operating limits.

(5) DSB with Suppressed Carrier. In sideband modes, since the carrier conveys no information and serves only as a reference point, it may be suppressed. The power in each sideband is 50% of the total signal power. If the carrier appearing in figure I-3-4 is suppressed at the sideband transmitter, the result will be as shown in figure I-3-5.

(6) SSB with Suppressed Carrier. Since either LSB or USB frequencies contain all the intelligence to be transmitted, it is often elected to transmit only one of them in order to take up less space on the frequency spectrum. If the USB appearing in figure I-3-5 is suppressed at the sideband transmitter, the result will be as shown in figure I-3-6. Conversely, the LSB may be suppressed instead of the USB.

(7) Sideband Frequencies Produced by Two Audio Tones. Figure I-3-7 illustrates the appearance that results in the case of two modulating tones in DSB mode with suppressed carrier. As can be seen, the upper and lower sidebands now contain two frequency indications each. If tone 2 is a higher frequency than tone 1, reading left to right, the first pip indicates a frequency that is equal to the carrier minus tone 2, second pip is equal to carrier minus tone 1, third pip is equal to carrier plus tone 1, and fourth pip is equal to carrier plus tone 2.

(8) Distortion Frequencies caused by Intermodulation of two Audio Tones. To illustrate the appearance made by intermodulation products from a transmitter, figure I-3-8 is shown for display caused by the following transmitting conditions:

SSB mode
USB transmitted
LSB suppressed
4 Mc Carrier Suppressed (F_c)
Two modulating tones:
Modulating Frequency F_1 = 935 cps
Modulating Frequency F_2 = 2805 cps

Appearing on the screen are the two USB frequencies produced by the two modulating tones as described in paragraph (7) and the predominant intermodulation products adjacent to the carrier. Amplitudes of the intermodulation products will be considerably smaller than the two upper sideband frequency amplitudes. In a properly adjusted transmitter third order products should be at least 40 db down from the carrier amplitude. The relative amplitudes shown in figure I-3-8 are not intended to represent actual conditions but represent the fact that there is a general decline progressing from 3rd order to 9th order products. Figure I-3-8 is for the purpose of illustrating the horizontal locations of the products in relation to carrier and the two upper sideband frequencies.

Figure I-3-9 depicts spectrum display resulting from LSB transmission, with the USB suppressed and all other conditions the same as those for figure I-3-8.

(9) Hum. Hum generated in a transmitter appears on the PTE screen as pips at the frequency or multiples of the line frequency. In a 60 cps source, hum will appear at 60, 120 and 180 cps distances from the carrier frequency. Hum is difficult to observe due to its usually low amplitude. Hum generated in the PTE will appear not higher than 60db down from the carrier indication.

(10) Noise. Noise which may occur in the transmitter is usually in the form of periodic transients. The analyzer will show irregular and varying amplitude deflections flashing along the frequency sweep axis. External noise, such as produced by motors, vibration, buzzers etc., appears as fairly steady signals moving along the frequency sweep baseline in one direction or another. An engine accelerating will produce a set of deflections which may move first in one direction, slow down, stop and then move in an opposite direction. A few feet of wire connected to the SIGNAL INPUT and placed near a noise source such as an electric razor or automobile engine will serve to illustrate external noise.

I-3-2. GENERAL TESTING AND MONITORING OF SSB TRANSMITTERS.

a. GENERAL USE OF PTE. The PTE is useful for monitoring the SSB transmitter, or for use during tune-up. A continuous monitor of distortion products will ensure that the transmitter is functioning properly. When tuning a SSB transmitter, the meters of the transmitter will not necessarily indicate the optimum operating adjustments. Using the PTE, the operator may de-tune or de-load the transmitter controls to eliminate distortion products. This may mean increasing one order product to reduce a less desirable order product. Often a slight decrease in power or drive will decrease distortion to a large degree. Small power changes will not greatly influence communication reliability, but will result in a cleaner more effective transmitted signal. The PTE is also used for alignment and adjustment of SSB exciters.

b. SPECIFIC TRANSMITTER SYSTEMS. The operator should consult the equipment manufacturer's technical manual for points to check on a particular transmitter system. Tuneup of the PTE itself is described in this manual.

I-3-3. SPECIFIC OPERATIONAL PROCEDURE FOR SIDEBAND ANALYSIS.

a. INTRODUCTION. Tuning procedures for the three general types of sideband transmission analysis are given in tables I-3-2, I-3-3 and I-3-4 for general analysis, narrow band analysis and intermodulation distortion measurements, respectively. Table I-3-1 lists functions of each PTE panel control. Numbers in parentheses refer to control numbers shown in figure I-3-10. Refer to figure I-3-10 while using tables I-3-2, I-3-3 and I-3-4.

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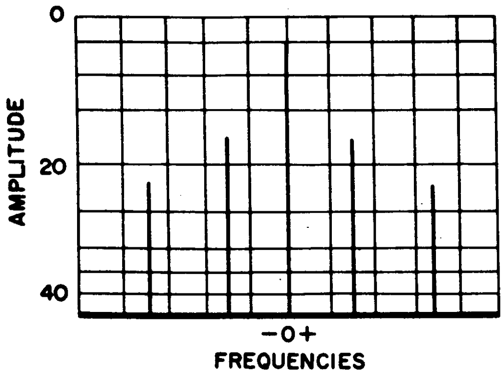

Figure I-3-1. Theoretical Appearance of Frequencies at 100% Resolution

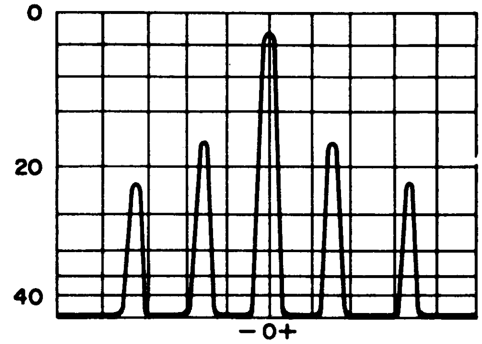

Figure I-3-2. Appearance of Frequencies at Less Than 100% Resolution on PTE Screen

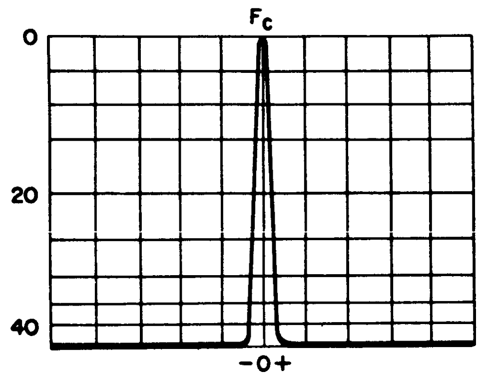

Figure I-3-3. Appearance of Carrier Alone

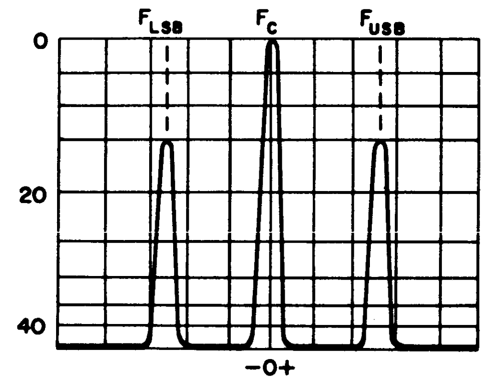

Figure I-3-4. Appearance of Carrier, USB and LSB for Carrier Modulated by One Tone

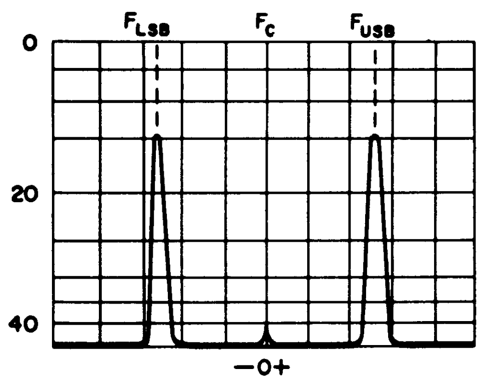

Figure I-3-5. Appearance of DSB with Suppressed Carrier Modulated by One Tone

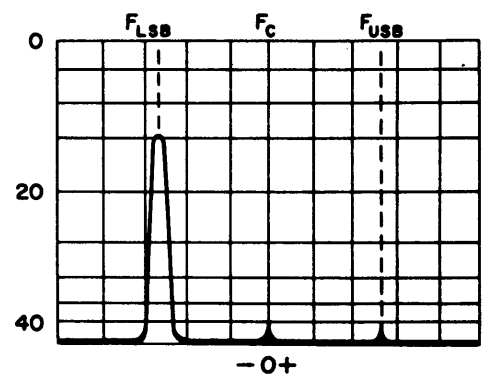

Figure I-3-6. Appearance of SSB with Suppressed USB and Suppressed Carrier Modulated by One Tone

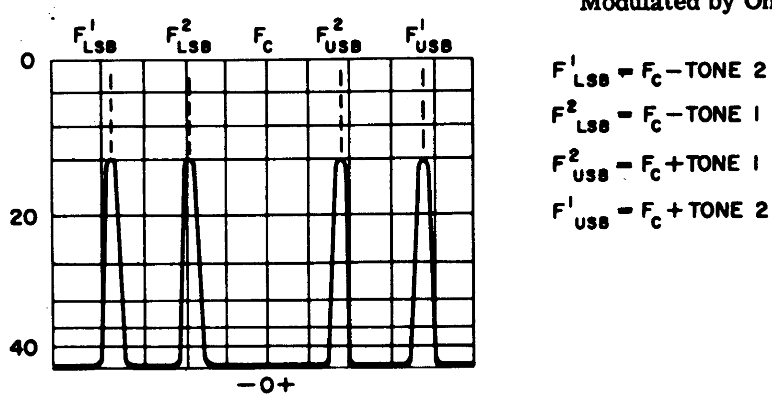

Figure I-3-7. Appearance of DSB with Suppressed Carrier Modulated by Two Tones

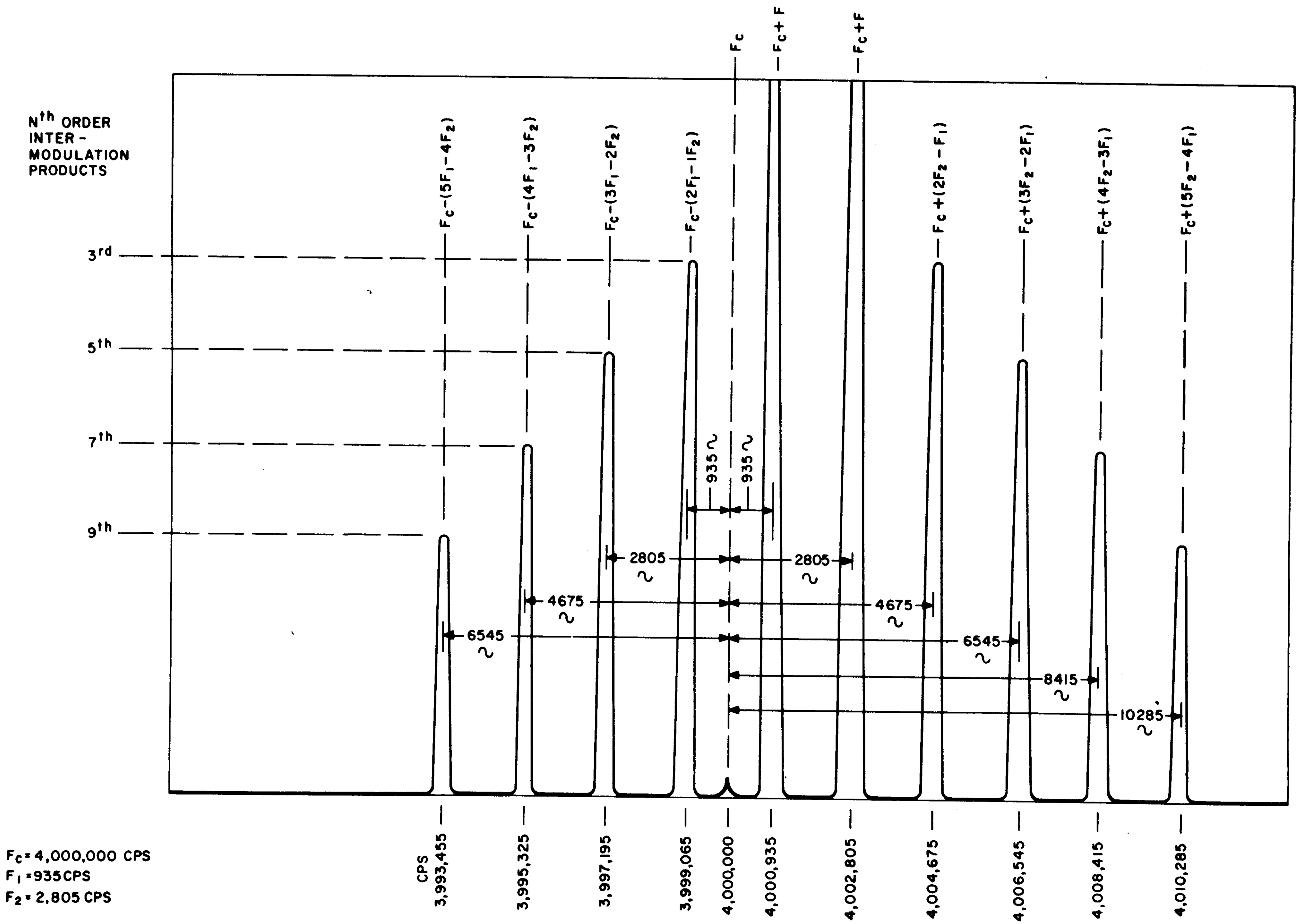

Figure I-3-8. Intermodulation Spectrum, Upper Sideband

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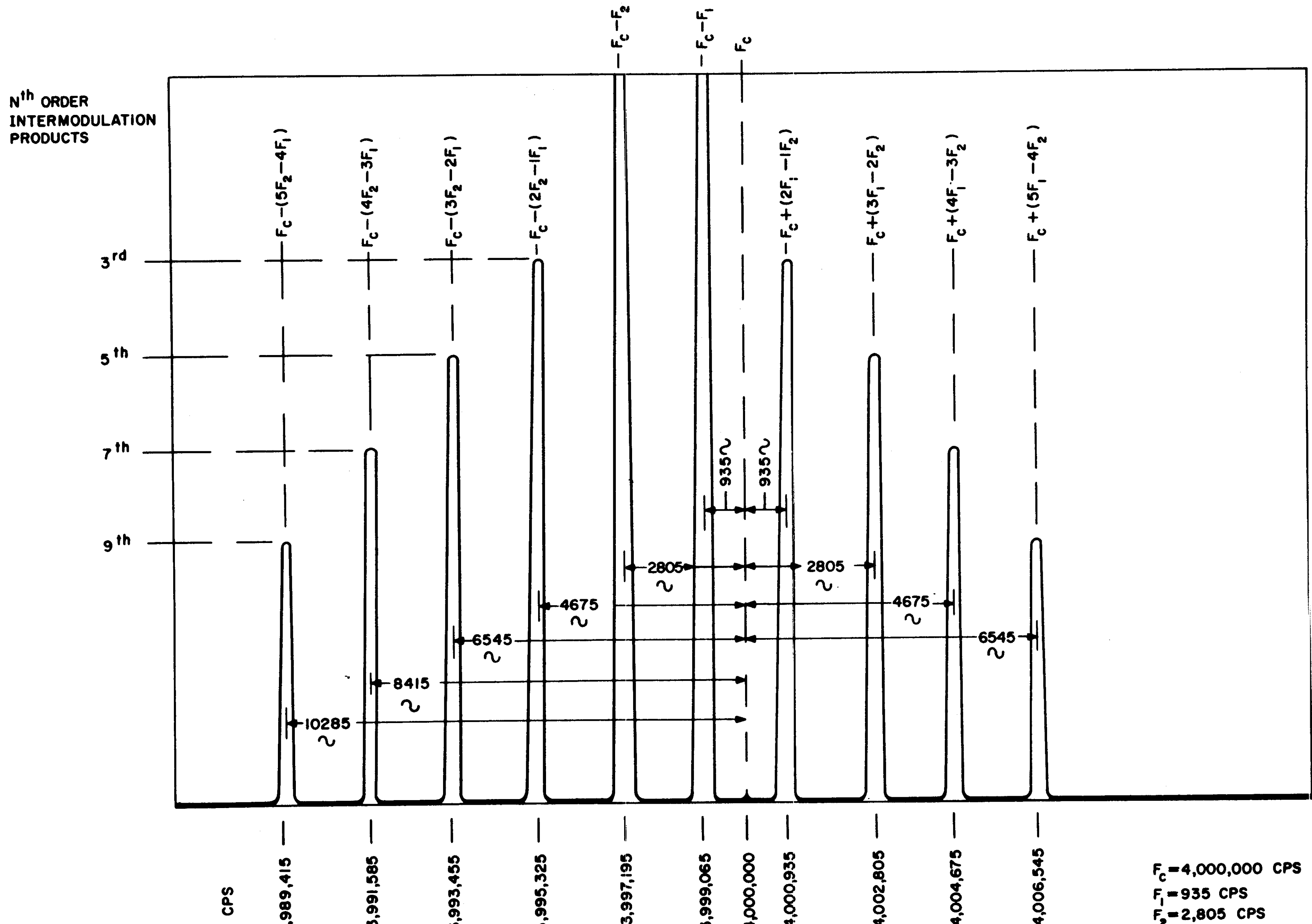

Figur I-3-9. Intermodulation Spectrum, Low r Sideband

TABLE I-3-1. PTE PANEL CONTROL FUNCTIONS

Figure I-3-10 Control Number	Panel Designation	Function
1	H POS	Adjusts the position of the baseline trace along the horizontal axis.
2	V POS	Adjusts the position of the baseline trace along the vertical axis.
3	SWEEP WIDTH	Adjusts width of band of frequencies to be scanned. When it is turned completely clockwise, the max. spectrum width for which the PTE is designed appears; i.e., 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 counter-clockwise 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 (27). SWEEP WIDTH control is operative only when SWEEP WIDTH SELECTOR is in VAR position.
4	IF BAND-WIDTH	Resolution, or the ability to separate individual signals, is dependent upon two factors: the rate of frequency scan and the bandwidth of the i-f section of the instrument. Optimum resolution requires a definite relationship between the two. Resolution sharpens as both SWEEP RATE (6) and IF BANDWIDTH (4) are decreased. The IF BANDWIDTH control is used to narrow the i-f bandwidth. Counterclockwise rotation narrows the width of the i-f 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 (27) and SWEEP WIDTH (3) 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. This control is operative only when SWEEP WIDTH SELECTOR (22) is in VAR position. On the preset sweep widths, the i-f bandwidth is automatically set for optimum resolution.
5	VIDEO FILTER, HI/OFF/LO	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 HI position, the video bandwidth is moderately reduced. In the LO position it is greatly reduced, and this position is suitable for use with very slow sweep rates and narrow sweep widths. On preset sweep widths, the LO filter is automatically switched on for 150 and 500 CPS; the HI filter is automatically switched on for 3.5, 7 and 14 KC widths.
6	SWEEP RATE	Provides continuously adjustable scanning rates between 0.1 CPS and 30 CPS. Counterclockwise rotation of this control reduces the sweep rate. This control is operative only when SWEEP WIDTH SELECTOR (22) is in VAR position.
7		Cathode Ray Tube with calibrations representing frequency and amplitude for measuring each frequency component in a swept band of frequencies.
8		Lamp indicates FSA is receiving power.
9, 10, 11, 13, 14 & 15	INPUT AT-TENUATOR	Group of six toggle switches which provide attenuations from 5 db up to 65 db for SIGNAL INPUT circuit. When switches are in the down position, the indicated attenuation is inserted.

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Figure I-3-10 Control Number	Panel Designation	Function
12	5 KC MARKER	This toggle switch is used to turn on a 5 KC oscillator. The 5 KC modulates the 500 KC oscillator test signal when CAL OSC LEVEL (19) is turned on. The resulting pips, at 5 KC intervals, appear on the CRT screen to a width of 50 KC on either side of the center 500 KC pip. This display facilitates setting up any desired sweep width when SWEEP WIDTH SELECTOR (22) is on VAR.
16	SIGNAL INPUT	Connection point for input of signal to be analyzed.
17	ILLUMINATION POWER OFF	This control is rotated in a clockwise direction to turn on the power supplied to the FSA. Continued clockwise rotation of this control increases the edge illumination of the CRT screen.
18	FAST SWEEP	Momentary-contact push-button speeds up the sweep rate from 0.1 to 1 CPS on the 150 and 500 CPS pre-set sweep widths. 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.
19	CAL OSC LEVEL	This control is rotated clockwise to turn on a 500 KC oscillator. Continued clockwise rotation increases 500 KC amplitude. The 500 KC signal may be used to locate the center frequency of the PTE, and may be modulated by an external audio oscillator connected at EXT MOD jack (20) or by the built-in 5 KC MARKER switch (12) to provide marker sidebands for setting up any desired sweep width. The 500 KC signal, in conjunction with the INPUT ATTENUATOR switches (9-11 & 13-15), may be used to check the accuracy of the LOG amplitude scale calibrations on the CRT screen (7).
20	EXT MOD	Connection point for input of a-f in lieu of using 5 KC MARKER oscillator.
21	IF ATTEN	Toggle switch in 20 DB position inserts 20 db of attenuation in the IF amplifier section. This enables adjustment of the input signal for full scale LOG deflection. Placing the switch in 0DB 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, in this latter case). This switch should always be in the 0DB position when making measurements requiring the full 60 db dynamic range of the instrument.
22	SWEEP WIDTH SELECTOR	This control provides a choice of five preset sweep widths of 150 CPS, 500 CPS, 3.5 KC, 7 KC and 14 KC, and a sixth position marked VAR(iable). In the VAR position, SWEEP WIDTH (3) may be set to any value from 0 to 100 KC, IF BANDWIDTH (4) may be set for optimum resolution, and SWEEP RATE (6) may be set to any value from 0.1 CPS to 30 CPS. The VIDEO FILTER switch (5) is also operative in this position. In the preset sweep width positions, the i-f bandwidth is automatically set for optimum resolution. In the 150 CPS and 500 CPS positions the AFC circuit is automatically turned on; in the 3.5 KC, 7 KC and 14 KC positions it is disabled. In the 150 CPS and 500 CPS positions the sweep rate is 0.1 CPS and a low pass video filter with a bandwidth of approximately 40 CPS is switched on. In the 3.5 KC, 7 KC, and 14 KC positions the sweep rate is 1 CPS, and the video filter bandwidth is approximately 400 CPS. The sensitivity of the FSA is constant on all settings, within ±15%.
23	BRILLIANCE	Adjusts the intensity of the screen presentation.

TABLE I-3-1. PTE PANEL CONTROL FUNCTIONS (C nt)

Figure I-3-10 Control Number	Panel Designation	Function
24	FOCUS	Adjusts the sharpness of the screen presentation.
25	AMPLITUDE SCALE	Selects linear (LIN) or logarithmic (LOG) amplitude presentations on the screen. In the LIN position, signals having an amplitude ratio of 20 db (10:1) may be observed at one time; in the LOG position, amplitude ratios of 40 db (100:1) may be observed. When using the LIN amplitude range, the calibration dots along the right edge of the grid are used. This linear scale is divided into 10 equal divisions. When using the LOG amplitude range, the horizontal lines on the grid are used. This log scale extends from 0 to 40 db in 5 db steps. It should be noted that, because of the time constant factor, the LOG feature does not function properly with narrow pulses.
26	AFC (OFF)	Clockwise rotation turns on the AFC (Automatic Frequency Control) circuit. It reduces the normal 100 KC maximum sweep width to 2 KC maximum, when the SWEEP WIDTH SELECTOR (22) is in VAR position. Further adjustment of the control adjusts the center frequency back to the center screen calibration to compensate for a shifting due to turning on the AFC. In this case, CENTER FREQUENCY (27) knob is used as a vernier to the AFC (26) knob. This frequency stabilized narrow scanning width, along with the proper corresponding sweep rate and IF bandwidth adjustments, provides the best resolution of which the instrument is capable. The AFC should be used only with sweep rates of 5 CPS or less. In 150 CPS and 500 CPS positions of SWEEP WIDTH SELECTOR, the AFC is automatically turned on.
27	CENTER FREQ	This control serves to set or maintain the frequency modulated local oscillator at its specified mean frequency. In this way, the pip on the screen corresponding to a signal at the input center frequency is centered on the screen's center calibration. When using AFC stabilized sweeps, this control acts as a vernier.
28	GAIN	Adjusts amplitude of the indication on the CRT screen. Maximum gain is obtained at maximum clockwise position. The GAIN control should be operated at a maximum setting consistent with low noise on the CRT display to reduce internal distortion in the FSA input circuits.
29	VFO INPUT	Connection point for input into FSA of a variable frequency from the VOX unit. This variable frequency is necessary when measuring a SIGNAL INPUT frequency outside of a 450-550 kc range.
30 thru 33	AUDIO TONE OUT	Two pairs of jacks for the connection of two double-pin audio cables. Audio cable connects TTG audio output test tone to audio input in transmitter being tested. TONE 1 (935 CPS) TONE 2 (2, 805 CPS) or TWO TONES are available at either pair of jacks.
34	MANUAL SWEEP/ AUTO	Toggle switch in up position turns on MANUAL SWEEP system which overrides automatic sweep rates generated in FSA and enables manual control of sweep rate by hand-crank (35). Switch in down position cuts out MANUAL SWEEP control and automatic sweep resumes.
35	MANUAL SWEEP	By turning MANUAL SWEEP hand-crank, horizontal speed and direction of the trace "spot" may be controlled by hand. Turning crank clockwise causes spot to proceed toward right; counterclockwise cranking causes spot to move left. Spot will remain stationary if crank is not moved. In this way a "pip" may be "held" so that adjustments may be made to reduce distortion without waiting for recycling of the display in some of the slower sweep rates.

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TABLE I-3-1. PTE PANEL CONTROL FUNCTIONS (C nt)

Figure I-3-10 Control Number	Panel Designation	Function
36	VFO OUT	Connection point for output of VOX variable frequency. 2-64 mc, continuously adjustable at VOX, is available at this connector.
37	RF TONE OUT	Connection point for output of TTG r-f output. TONE 1 (1999-kc), TONE 2 (2001-kc) or TWO TONES are available at this jack. These signals are used for checking the proper operation of the FSA Analyzer unit.
38	BEAT/ON	ON position of switch turns on 100-kc oscillator which is used to calibrate VOX variable frequency output to 50 kc integrals.
39	METER	Connects sample output of VOX to meter (49) for purposes of tuning VOX output.
40	PHONE	Not used in PTE system.
41	POWER/ON	ON position of switch supplies power to the VOX.
42	HFO-ON	ON position of switch turns on VOX amplifier section.
43	IFO/ON	Not used in PTE system.
44	BFO/ON	Not used in PTE system.
45	MAIN POWER	Lamp indicates VOX is receiving tube filament supply.
46, 47	INNER OVEN & OUTER OVEN	Lamps indicate cycling of inner and outer oven heating elements in VOX master oscillator temperature control oven.
48	ZERO BEAT	Lamp indicates calibration of VOX output frequency to a 50-kc integral.
49		Meter samples VOX output level. Used in conjunction with tuning VOX output section.
50	CALIBRATE	Control knob used in conjunction with ZERO BEAT lamp (48). Calibrates VOX output to a 50-kc integral.
51	LOCK	Locking ring locks movement of CALIBRATE knob (50).
52		Screwdriver adjustment of capacitor re-sets VOX calibration system, if necessary. (See VOX manual).
53	HFO TUNING	Tunes VOX output section.
54	HFO OUTPUT	Adjusts VOX output level.
55	BAND MCS	Selects VOX final output multiplication factor for frequency appearing on VOX counter (58) and (59). Factors are 1, 2, 4, 8 and 16.
56	HFO XTAL FREQ.	Not used in PTE system.
57	HFO XTAL	Not used in PTE system.

TABLE I-3-1. PTE PANEL CONTROL FUNCTIONS (C nt)

Figure I-3-10 Control Number	Panel Designation	Function
58, 59	MASTER OSCILLATOR FREQUENCY KCS & CPS	Counter indicates frequency of VOX master oscillator output before multiplication factor setting as indicated by BAND-MCS selector (55).
60	MASTER OSCILLATOR FREQUENCY	Tunes VOX master oscillator and moves counters (58) and (59). CAUTION: do not turn beyond 2000 to 4000 kc range.
61	LOCK	Locks movement of MASTER OSCILLATOR FREQUENCY tuning knob (60).
62, 63	AUDIO FREQ ADJUST, TONE 1 & TONE 2	Screwdriver adjustments for re-tuning TTG audio tone oscillators, if necessary.
64	MAIN POWER	Lamp indicates that TTG is receiving tube filament supply
65	MAIN 2A	Fuse for line voltage to TTG. Lighted cap indicates blown fuse.
66	B+ 125A	Fuse for TTG plate supply. Lighted cap indicates blown fuse.
67	AUDIO OUTPUT	Controls level of TTG audio output.
68	AUDIO TONE SELECTOR	Selects audio tones to be issued by TTG.
69	RF TONE SELECTOR	Selects r-f tones to be issued by TTG.
70	POWER OFF/ON	Switch turns on or off TTG line voltage.

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b. GENERAL SIDEBAND ANALYSIS

(1) Tune Up of PTE. Tune up PTE as outlined in table I-3-2.

Steps 1 and 2 are required for warm-up of the VOX. After using PTE, leave line voltage power cable connected and VOX POWER switch (41) in ON position. HFO switch (42) and BEAT switch (38) may be switched off (down), along with all other applicable controls on the PTE. This arrangement will continue to supply the VOX master oscillator temperature control oven with power in order to maintain the VOX rated frequency stability, eliminating the necessity for repeating steps 1 and 2 when the PTE is used again. A small amount of current is drawn for VOX tube filaments and oven heater elements and the indication will be a lighted MAIN POWER LAMP (45) and normally cycling INNER OVEN (46) and OUTER OVEN (47) lamps.

Steps 3 through 9 turn on the FSA Analyzer and make calibration checks and adjustments. These steps need not be repeated, while PTE is operating, to analyze each new signal.

Steps 10 through 23 tune the VOX to the appropriate frequency to be used to analyze a particular signal.

Steps 24 and 25 set the signal input to a proper level to prevent internal distortion originating in the FSA.

Steps 26 correlates carrier amplitude with calibration markings on the FSA screen.

The result obtained at step 27 is a display of a sweep of 14 kc, (7-kc on either side of the carrier) with a linear relationship of amplitudes capable of displaying a 10:1 ratio.

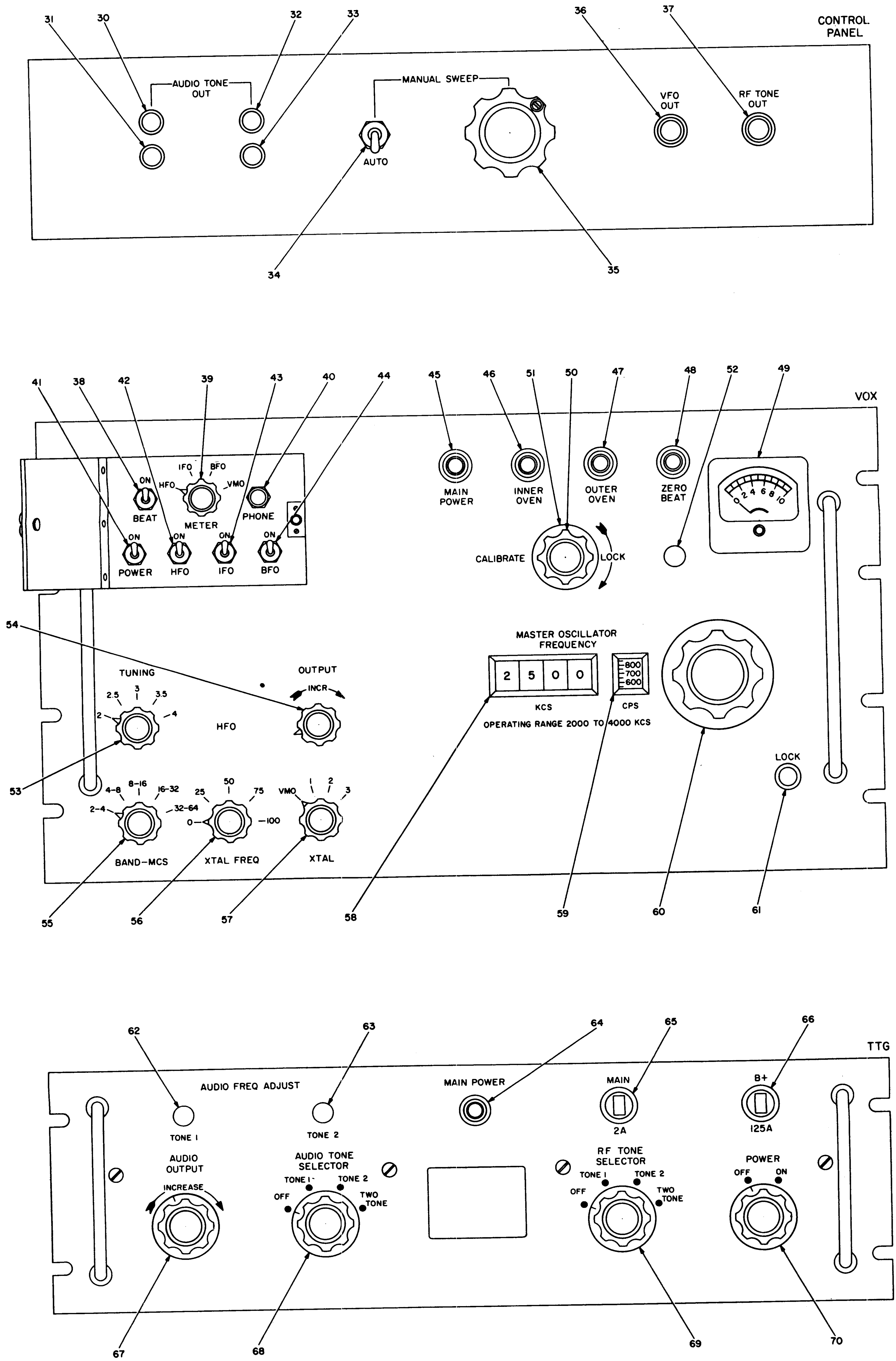

Figure I-3-10. Panel View of PTE, Showing Operating Controls

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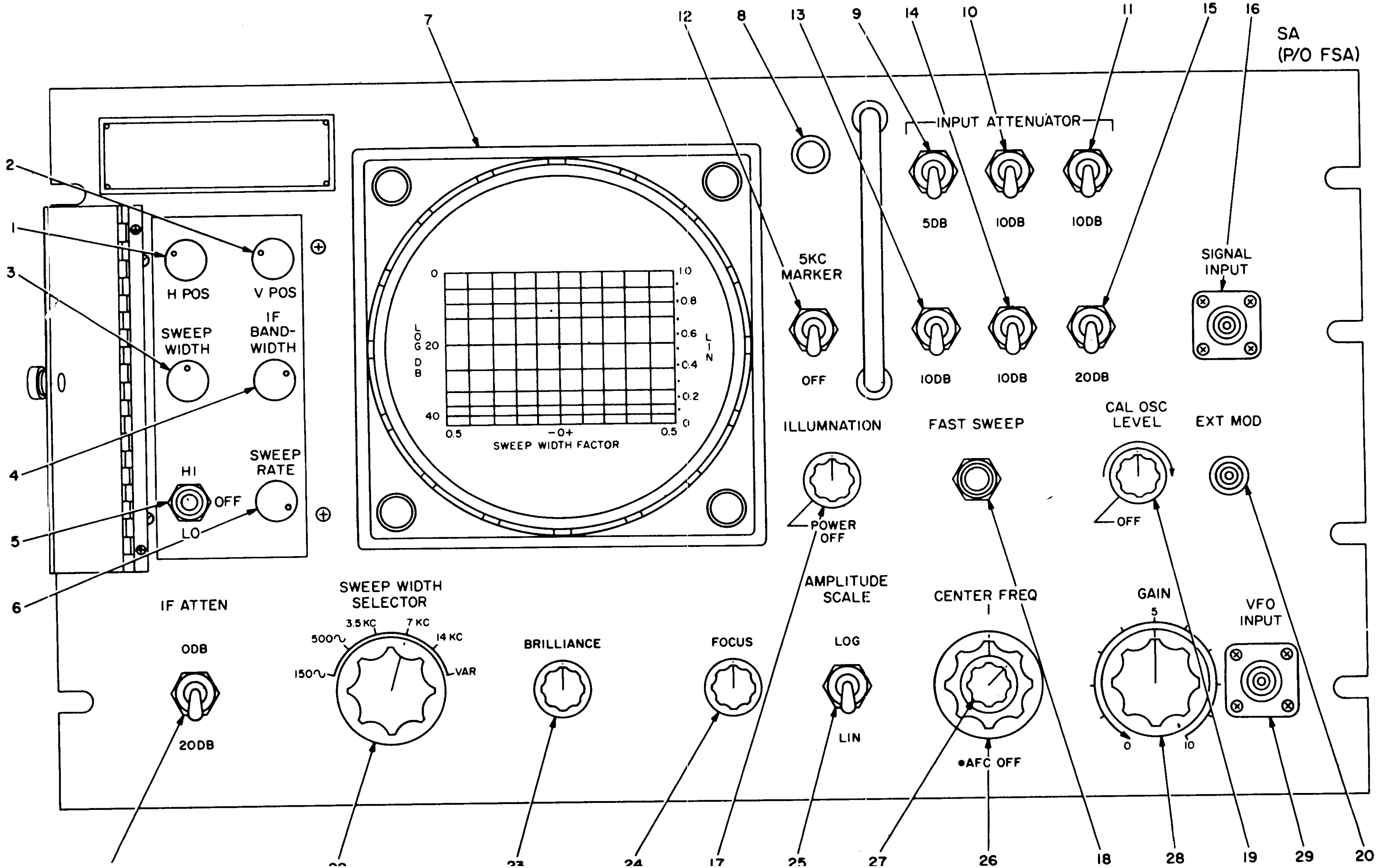

SA
(P/O FSA)
INPUT ATTENUATOR
5DB
10DB
10DB
10DB
10DB
20DB
5KC
MARKER
OFF
SIGNAL
INPUT
H POS
V POS
SWEEP
WIDTH
IF
BAND-
WIDTH
HI
OFF
LO
SWEEP
RATE
SWEEP WIDTH FACTOR
LOG DB
LIN
ILLUMNATION
POWER
OFF
FAST SWEEP
CAL OSC
LEVEL
OFF
EXT MOD
IF ATTEN
ODB
20DB
SWEEP WIDTH
SELECTOR
150∿
500∿
3.5 KC
7 KC
14 KC
VAR
BRILLIANCE
FOCUS
AMPLITUDE
SCALE
LOG
LIN
CENTER FREQ
•AFC OFF
GAIN
VFO
INPUT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
24
25
26
27
28
29

Position panel controls as listed below before proceeding with tune-up.

Fig. 1-3-10 Control No.	Panel Designation	Setting
3	SWEEP WIDTH	Max clockwise
4	IF BANDWIDTH	Max clockwise
5	VIDEO FILTER	OFF
6	SWEEP RATE	Max clockwise
9, 10, 11, 13, 14, 15	INPUT ATTENUATOR	All switches down (on)
12	5 KC MARKER	OFF
17	ILLUMINATION/ POWER	OFF
19	CAL OSC LEVEL	OFF
21	IF ATTEN	0DB
22	SWEEP WIDTH SELECTOR	VAR
25	AMPLITUDE SCALE	LIN
26	CENTER FREQ	Center on panel mark
27	AFC	OFF
28	GAIN	0
34	MANUAL SWEEP	AUTO
38	BEAT	Switch down (off)
39	METER	HFO
41	POWER	Switch down (off)
42	HFO	ON
43, 44	IFO, BFO	Both switches down (off)
51	LOCK	Fully counter-clockwise
54	OUTPUT	Fully counter-clockwise
57	XTAL	1
61	LOCK	Fully counter-clockwise
68	AUDIO TONE SELECTOR	OFF
69	RF TONE SELECTOR	OFF
70	POWER	OFF
Positions of all other controls are optional.		

Connect PTE with equipment being measured as shown in figure I-3-11. Output of exciter or transmitter may be measured at any intermediate section output or final output point provided that it falls within the 1.5-64.5 mc range. Refer to figure I-4-1. The 1st Mixer in the FSA-2 requires a SIGNAL INPUT/ VFO INPUT voltage ratio of approximately 5 mv/2.6 v for minimum distortion in its output. The INPUT ATTENUATOR switches are capable of decreasing the SIGNAL INPUT by an amount up to 65 db; any further decrease must be obtained by means of an external pad. Therefore it is generally advisable to set the transmitter or exciter at full output level, insert any necessary external decibel pad to bring the voltage down to below 3.0 volt and set all INPUT ATTENUATOR switches on PTE down. In this way the PTE circuitry is protected from excessive current and the transmitter or exciter output may be backed off to obtain the best distortion-free level for the transmitter or exciter. As the transmitter or exciter level is decreased, the INPUT ATTENUATOR switches may be decreased to maintain the FSA mixer ratio.

(2) Analysis Procedure. After PTE has been tuned to the test signal as described in table I-3-2, an analysis of the test signal may be made as described in the following paragraphs.

I. Reading the Carrier Frequency. Observe the display after making the adjustment described in step 27 of table I-3-2. If the carrier frequency issuing from the transmitter is exactly that determined in step 12, the carrier pip will coincide with the center vertical screen calibration. If the carrier pip is either to the left or right of the center calibration, the carrier frequency issuing from the transmitter is different from that determined (F_c) in step 12. To determine the actual frequency, use the following method. Refer to F_v, chosen in step 12 for VOX output. If F_v is 500 kc more that F_c the plus (+) and minus (-) signs on the screen apply, and the carrier issuing from the transmitter is either above or below F_c as indicated by the position of the carrier pip relative to the center calibration. If F_c, however, is 500 kc less that F_c, the plus (+) and minus (-) signs on the screen are reversed, and the relative position of the carrier pip and other pips should be calculated accordingly. When it has been established that the transmitter carrier is either above or below F_c, turn MASTER OSCILLATOR FREQUENCY knob (60) slowly until carrier pip on screen coincides with center calibration. Then note the new frequency reading on the counters (58) and (59). Multiply this frequency by the factor indicated by the setting of BAND-MCS switch (55) as listed below:

BAND-MCS switch setting	Multiplication Factor
2-4	1
4-8	2
8-16	4
16-32	8
32-64	16

The product is the carrier frequency issuing from the transmitter and the display is now centered on the screen so that relative frequencies of sideband and other component pips may be read.

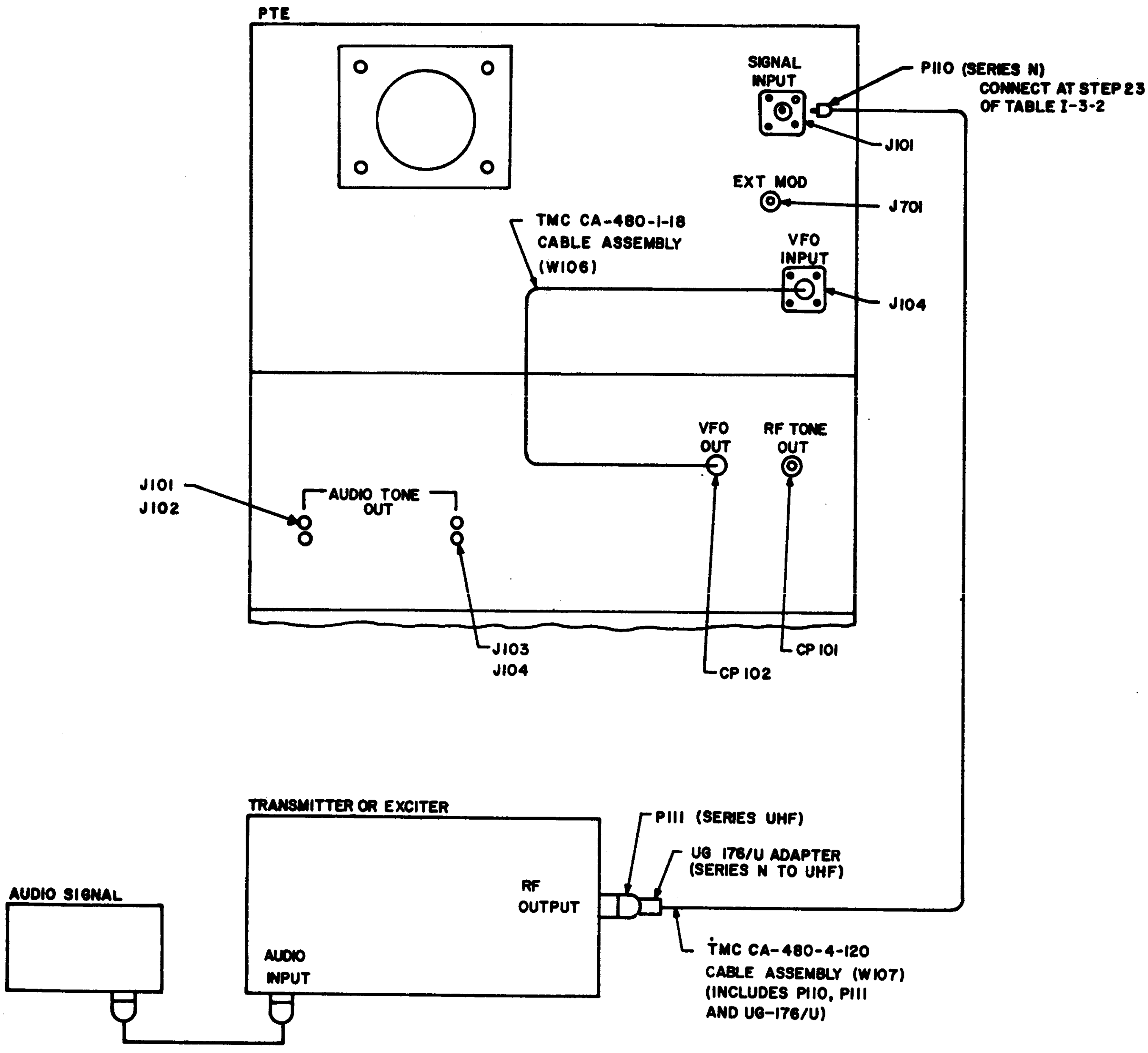

Figure I-3-11. Cable Connection Diagram for General Sideband Analysis

TABLE I-3-2. TUNE-UP OF PTE FOR GENERAL SIDEBAND ANALYSIS, WITH PRESET SWEEP WIDTHS

STEP	CONTROL NUMBER (FIG. I-3-10)	OPERATION	PURPOSE
1	41	Place POWER switch (41) in ON position. MAIN POWER lamp (45), INNER OVEN lamp (46) and OUTER OVEN lamp (47) will light.	Supplies power to VOX master oscillator oven heating elements.
2*	46,47	Wait for 48 hours or until INNER OVEN (46) and OUTER OVEN (47) lamps cycle normally. Normal cycling is indicated by a regular on-off time for the lamps as follows: lamp — on — off OUTER OVEN — 5 secs — 30 secs INNER OVEN — 90 secs — 90 secs	Normal cycling of lamps (46) and (47) indicate VOX master oscillator oven temperature stabilization. At this point, master oscillator frequency has reached its rated stability.
3	17 7 8	While waiting for oven temperature to stabilize, it is permissible to proceed with steps 3 through 9 at any time during this period. Turn ILLUMINATION knob (17) clockwise. Lamp (8) will light and calibration markings on screen (7) will glow. Adjust ILLUMINATION knob (17) to obtain desired brightness of screen calibration. Within about 30 seconds a baseline will appear on screen.	Supplies FSA Analyzer with filament and plate power. Further clockwise rotation of knob increases brightness of screen illumination lights.
4	23 24	Adjust BRILLIANCE knob (23) to obtain a minimum brightness of the baseline trace for suitable visibility. Allow at least 30 min. for warm-up. Then set the FOCUS knob (24) to obtain maximum sharpness of trace. Do not use the BRILLIANCE control (23) to compete with external lighting in the room but rather reduce the external light or shield the screen.	Clearest baseline trace is obtained.
5	1 2	If necessary, adjust V POS knob (2) to bring baseline trace to coincide with "0" of LIN scale of screen and H POS knob (1) to center baseline trace approximately on screen calibration. **NOTE** When making adjustments to line up display with screen calibrations, view screen with eye at a point about 15 inches away from screen and lined up with center of screen. This viewing point should be maintained for all subsequent observations for accurate measurements.	Lines up baseline trace with screen calibrations.
6	19 28	Turn CAL OSC LEVEL knob (19) fully clockwise. Small pip will appear at or near center of screen. Turn GAIN knob (28) clockwise until pip reaches 1.0 on LIN scale of screen (full scale deflection).	Generates 500 KC test signal.

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TABLE I-3-2. TUNE-UP OF PTE FOR GENERAL SIDEBAND ANALYSIS, WITH PRESET SWEEP WIDTHS (C nt)

STEP	CONTROL NUMBER (FIG. I-3-10)	OPERATION	PURPOSE
7	22 6 4 3 26 1	If pip coincides with vertical center calibration of screen, omit step 7. If pip does not coincide, make adjustments as follows: Rotate SWEEP WIDTH knob (3) fully counterclockwise. Pip will disappear. Adjust CENTER FREQ knob (26) to obtain maximum height of trace. Set SWEEP WIDTH knob (3) fully clockwise. The pip should reappear near the center calibration on the screen. Adjust the H POS knob (1) until pip coincides with center calibration.	Calibrates center frequency of sweep with center calibration on screen.
8	22 26	Set SWEEP WIDTH SELECTOR knob (22) to the 14 KC position. Recenter pip with CENTER FREQ knob (26).	Sets sweep width at 14 KC, sweep rate at 1 CPS and IF bandwidth for optimal resolution. Switches in 400 CPS video filter.
9	19	Turn CAL OSC LEVEL knob (19) to its fully counterclockwise position. Pip will disappear.	Turns off 500 KC test signal.
10	9,10,11, 13,14,15	Place all INPUT ATTENUATOR switches (9) through (11) and (13) through (15) in down (on) position.	Places 65 db attenuation in signal input section as a safety precaution to protect FSA from signal of unknown amplitude.
11	46 47 57	When INNER OVEN and OUTER OVEN lamps (46, 47) cycle normally as described in step 2, place XTAL knob (57) in VMO position.	Connects VOX variable master oscillator (VMO) output to VOX output amplifier chain.
12		Determine the carrier of the signal to be analyzed. This frequency will be referred to here as F_c. Proceed to tune the VOX to a frequency (F_v) as described below: if F_c = — VOX freq. (F_v) = 1,500-1,770kc — F_c+500 kc 1,770-63,500kc — $F_c \pm 500$ kc 63,500kc-64,500kc — F_c-500 kc Tuning procedure for VOX is described in steps 13 through 22.	
13	38 48	Place BEAT switch (38) to ON position. ZERO BEAT lamp (48) will light.	Feeds plate supply to 100-kc calibrating oscillator in VOX.
14	55	Turn BAND-MCS switch (55) to band in which F_v fails.	Selects multiplication factor for frequency appearing on MASTER OSCILLATOR FREQUENCY counters (58) and (59).

TABLE I-3-2. TUNE-UP OF PTE FOR GENERAL SIDEBAND ANALYSIS, WITH PRESET SWEEP WIDTHS (C nt)

STEP	CONTROL NUMBER (FIG. I-3-10)	OPERATION	PURPOSE
15	60 58 59	Turn MASTER OSCILLATOR FREQUENCY knob (60) to bring frequency reading on counters (58) and (59) which will equal 50 kc under Fmo as shown in table below. BAND-MCS switch setting — Fmo = 2-4 — $\frac{F_V}{1}$ 4-8 — $\frac{F_V}{2}$ 8-16 — $\frac{F_V}{4}$ 16-32 — $\frac{F_V}{8}$ 32-64 — $\frac{F_V}{16}$ **CAUTION** Do not turn knob (60) to bring figures on counter (58) to figure outside 2000 to 4000 range. A misalignment of a cam surface in the VOX may result, requiring TMC factory realignment.	Tunes VMO to Fmo minus 50-kc to prepare for calibration.
16	50 48 51	Adjust CALIBRATE knob (50) until ZERO BEAT lamp (48) produces a beat of about 1 or 2 CPS. Turn LOCK ring (51) clockwise until it tightens securely.	Calibrate counters (58) and (59) to VMO output at the nearest lower 50 kc integral to Fmo to within 1 or 2 CPS. Locks knob (50) against movement.
17	38 48	Place BEAT switch (38) in down (off) position. ZERO BEAT lamp (48) will go out.	Turns off 100 kc calibrating oscillator.
18	60 58 59	Turn MASTER OSCILLATOR FREQUENCY knob (60) clockwise to bring frequency reading on counters (58) and (59) to equal Fmo. Turn LOCK knob (61) clockwise until it tightens securely.	Tunes VMO output to Fmo. Locks knob (60) against movement.
19	53 58 59	Turn TUNING knob (53) to a position roughly approximating the figure appearing on MASTER OSCILLATOR FREQUENCY counters (58) and (59).	Coarse-tunes VOX output amplifier chain.
20	54 49	Turn OUTPUT knob (54) clockwise to obtain an approximate middle of dial reading on meter (49).	Increases VOX output level to obtain a good reading on output meter (49).
21	53 49	Adjust TUNING knob (53) to obtain maximum reading on meter (49).	Fine-tunes VOX output amplifier chain.
22	54 49	Turn OUTPUT knob (54) to bring "0.1" reading on meter (49).	Adjusts VOX output to appropriate level for use with FSA mixer.

TABLE I-3-2. TUNE-UP OF PTE FOR GENERAL SIDEBAND ANALYSIS, WITH PRESET SWEEP WIDTHS (C nt)

STEP	CONTROL NUMBER (FIG I-3-10)	OPERATION	PURPOSE
23	16	**Connect TMC #CA-480-4-120 Cable Assembly to SIGNAL INPUT jack (16) as shown in figure I-3-11.	Connects transmitter or exciter output signal to be analyzed to FSA Analyzer.
24	28	Set GAIN knob (28) to position "5".	Sets FSA GAIN potentiometer to mid-point.
25	9-11, 13-15 7	Position INPUT ATTENUATOR switches (9, 10, 11, 13, 14 and 15) to obtain best distortion free display on screen (7).	Adjusts signal level to create proper ratio with VOX input to produce minimum distortion in FSA mixer. This level is generally around 5 mv, with VOX meter reading "0.1".
26	28	Adjust GAIN knob (28) to bring top of carrier pip to coincide with "0.1" calibration on screen LIN scale.	Sets up carrier pip to represent 1.0 (unity) for measuring relative amplitudes of other frequency components in display.

*If it is intended to operate the PTE over a relatively long period of time (as in monitoring transmitters), wait for normal cycling. If however, a brief analysis is intended, a wait of 2 or 3 hours will give sufficient frequency stability or step 2 may be omitted altogether. A shifting VOX frequency will be indicated by a slow wandering of the entire display off center calibration of screen.

**It may be necessary to first tune the transmitter or exciter using a dummy load for accuracy.

II. Defining other frequency components. The SWEEP WIDTH SELECTOR knob (22) may now be used to either narrow or widen the sweep width. If the pips near the carrier are not sufficiently set apart from one another or tend to merge, the SWEEP WIDTH SELECTOR knob may be set to one of the narrower sweep widths to separate them. If 150 CPS does not accomplish this sufficiently or some intermediate sweep width is needed, narrow band analysis is in order (see par. I-3-3c).

NOTE

The 150 and 500 CPS positions on SWEEP WIDTH SELECTOR knob automatically switch in an AFC feedback circuit; 3.5 KC, 7 KC, and 14 KC positions switch out AFC feedback. As AFC is switched in or out, a shift of the display to the right or left may occur, due to a de-tuning effect. When this happens, bring the center frequency pip back to the center screen calibration by adjusting AFC knob (27) and CENTER FREQ knob (26). Use CENTER FREQ knob as a vernier adjustment for AFC knob. Do not re-center the display with any other controls, in this case.

If a wider spectrum than 14 kc is required, frequency components at points up to 50 kc above or below carrier may be observed by setting the SWEEP WIDTH SELECTOR knob on VAR and turning the SWEEP WIDTH knob (3) to its maximum clockwise position. Adjustments should be made to IF BANDWIDTH knob (4) and SWEEP RATE knob (6) for each setting of the SWEEP WIDTH knob (3) for maximum resolution. It should be kept in mind here that decreasing IF BANDWIDTH too far will decrease the sensitivity of the FSA. This will be indicated by a dropping of the carrier pip amplitude. In order to read the resulting pip frequencies in the VAR position of the SWEEP WIDTH SELECTOR, it will be necessary to establish the total sweep width that is being displayed. This is done by temporarily disconnecting the transmitter signal from the SIGNAL INPUT jack (16), turning the CAL OSC LEVEL knob (19) clockwise, and placing the 5 KC MARKER switch (12) in the up (on) position. A large 500-kc marker pip will appear in the center of the screen accompanied by smaller 5-kc int rvalpips on either side. The SWEEP WIDTH knob may then be adjusted slightly in order to bring the pips to coincide with the screen calibrations. Example: If a full 100 kc sweep width is required, adjust sweep width so that 10 pips appear on either side of the center calibration (2 pips to each of the five divisions).

III. Measuring Amplitudes. With the AMPLITUDE SCALE switch (25) set in LIN position the display of pip amplitudes are shown in a linear relationship and amplitude ratios as large as 20 db (10:1) may be observed. M asurem nts in this case, are made using the LIN scale (dots) on the right side of the screen. If it is required to inspect amplitude ratios of 40 db (100:1), place the AMPLITUDE SCALE switch in the LOG position and the IF ATTEN switch (21) in 20 DB position. Measurements are now made using the LOG scale (horizontal lines) on the left side of the screen. If a display of amplitude ratios up to 60 db is required, place the AMPLITUDE SCALE switch in the LOG position, and the IF ATTEN switch in 0 DB position. In this case the LOG scale is used, but only the lower 40 db section of the 60 db display will be visible on the screen.

c. NARROW BAND ANALYSIS.

(1) Introduction. Narrow band analysis is an effective magnification of any portion of the displayed frequency spectrum. If some relatively small, obscure or merged frequencies appear on the band display during a general analysis of the signal, these pips may be selected out of the band, spread apart and increased in amplitude, if necessary, to afford closer inspection. Narrow band analysis, as described here, is used to describe the procedure of examining a band of frequencies of 2-kc width maximum, continuously variable down to a nominal 0-kc, with the SWEEP WIDTH SELECTOR knob set at VAR position. Narrow band analysis may also be made with 150 CPS and 500 CPS preset sweep widths, if these particular widths are sufficient to reveal the necessary detail. In this case, steps 1 and 2 only are performed, since all subsequent control adjustments necessary to bring in maximum resolution are automatically made on the preset width positions of SWEEP WIDTH SELECTOR knob.

(2) Analysis Procedure. Perform narrow band analysis as described in table I-3-3. It is assumed that the PTE has been tuned up for general analysis as described in table I-3-2 and that a display of frequency components is visible. Table I-3-3 describes the adjustments for narrow band analysis from this point.

d. DISTORTION MEASUREMENTS.

(1) Introduction. The procedure described here will produce a display of odd-order distortion products present in a transmitter or exciter out to the ninth order and down to 60 db below the sideband amplitude. To define the distortion clearly on the screen, operate the transmitter or exciter on SSB (single sideband) mode with suppressed carrier. Either upper or lower sideband can be used.

(2) Tune-up of PTE. Table I-3-4 describes tune-up procedure of the PTE for measuring odd-order distortion out to the ninth order. Step 1 covers the procedure for tuning in a display for general analysis and need not be repeated if this has been done already. Step 8 may be omitted if it is desired to maintain the 40 db range in order to show amplitude changes in sideband vs. distortion pips resulting from adjustments in transmitter or exciter controls.

(3) Analysis. When step 8 of table I-3-4 has been accomplished, 3rd, 5th, 7th and 9th order distortion products will be displayed on the screen on either side of the two test tones. Refer to figures I-3-8 and I-3-9 for location and identification of pips for upper and lower sideband transmission. These displays are based on a 4-mc carrier.

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TABLE I-3-3. TUNE-UP OF PTE FOR NARROW BAND ANALYSIS

STEP	CONTROL NUMBER (FIG. I-3-10)	OPERATION	PURPOSE
1		Examine display on screen and determine section to be magnified. If section is far off the screen center portion, it may be necessary to move it to the center before magnifying it. This procedure is described in step 2. If section is in the screen center portion, it will not be necessary to move it and step 2 may be omitted. If step 2 is omitted, note amplitude of center frequency pip at this point for reference in measuring other frequencies.	
2	58 59 60 61	Turn LOCK knob (61) counterclockwise to unlock movement of MASTER OSCILLATOR FREQUENCY knob (60). Observe screen and slowly turn MASTER OSCILLATOR FREQUENCY knob (60) to bring section to be magnified to center of screen. Note new frequency reading appearing on counters 58 and 59. This reading, multiplied by a factor as indicated by the setting on BAND-MCS knob (55), is the new center frequency (F_c) at the center calibration of the shifted display and should be noted down for reference in measuring other frequencies. Turn LOCK knob (61) clockwise to re-lock knob (60).	Section to be magnified shifted to center of screen to prevent it from expanding out of screen scope.

TABLE I-3-3. TUNE-UP OF PTE FOR NARROW BAND ANALYSIS (Cont)

STEP	CONTROL NUMBER (FIG. I-3-10)	OPERATION	PURPOSE
3	22 27	Place SWEEP WIDTH SELECTOR knob (22) in VAR position. Turn AFC knob (27) slightly clockwise (on). (See NOTE in par. I-3-3b (2) II.)	Enables operator to adjust sweep width, sweep rate, and video filter. AFC feedback is turned on.
4	4	Set SWEEP WIDTH knob (3) fully clockwise. Set SWEEP RATE knob to point that causes beam to move across the screen at the rate of about 5 times per second. Turn IF BAND-WIDTH knob (4) counterclockwise to obtain optimally resolved pip.	Sets IF section for broadest band-pass width. Sets sweep width to 2-kc. Sets sweep rate at 5 CPS.
5	3	Vary SWEEP WIDTH knob (3) adjusting frequency pips for desired separation.	Width of frequencies swept is decreased and re-arranges to fill up screen width.
6	4 6 5 28	Turn IF BANDWIDTH knob (4) counterclockwise until individual signals are most clearly resolved. If signals cannot be resolved, a slower sweep rate may be required and SWEEP RATE knob (6) may be adjusted accordingly. Optimum resolution on a pip can be recognized by the nature of the ringing pulses that will appear on the trailing edge as described in the FSA manual. After resolution has been determined in this way, turn VIDEO FILTER switch (5) to HI or LO positions to get rid of the ringing which represents internally generated noise in the FSA. Sometimes improving resolution will cause pip amplitudes to drop slightly. In the event that they drop too much, they may be increased again to some convenient reference level by turning GAIN knob (28) clockwise without losing resolution.	Sets IF bandwidth and sweep rate to the best settings to correspond with sweep width setting for optimum resolution. Internally generated ringing is utilized to establish optimum resolution, and then switched out by means of the VIDEO FILTER switch.

TABLE I-3-4. TUNE-UP OF PTE FOR DISTORTION MEASUREMENTS

STEP	CONTROL NUMBER (FIG. I-3-10)	OPERATION	PURPOSE
1		Operate transmitter or exciter controls to produce mode of transmission which includes carrier. Tune up PTE per paragraph I-3-3b (General Sideband Analysis) including table I-3-2 complete.	Tunes PTE to specific carrier.
2	22 25 21 9-11 13-15 28	Operate transmitter or exciter controls to issue one sideband (either upper or lower) and suppressed carrier. Place SWEEP WIDTH SELECTOR knob (22) in 14 KC position. Set AMPLITUDE SCALE switch (25) in LOG position. Set IF ATTEN switch (21) in 20 DB position. Manipulate INPUT ATTENUATOR switches (9-11, 13-15) and GAIN knob (28) to bring sideband to full scale deflection (0 DB on screen).	To set PTE to present normal sideband level at 0 DB reference point at 14-kc sweep width.

TABLE I-3-4. TUNE-UP OF PTE FOR DISTORTION MEASUREMENTS (C nt)

STEP	CONTROL NUMBER (FIG. I-3-10)	OPERATION	PURPOSE
3	30 31	Position transmitter or exciter controls to disconnect audio frequency modulating carrier. Replace removed a-f with test audio tones from TTG unit by installing TMC cable #CA-130-6 between audio input and AUDIO TONE OUT jacks (30 and 31) as shown in figure I-3-12.	Substitutes two audio test tones (935 CPS and 2,805 CPS) at exciter audio input.
4	70 64	Turn POWER knob (70) to ON position. MAIN POWER lamp (64) will light. Allow 2 minutes for TTG to warm up.	Supplies voltage to TTG plate and filament circuits.
5	68 67 28	Place AUDIO TONE SELECTOR knob (68) in TWO TONE position. Turn AUDIO OUTPUT knob (67) clockwise. Two test tones will appear on screen. Adjust AUDIO OUTPUT knob (67) and GAIN knob (28) to bring test tones to full scale deflection (0 DB on screen) without distortion of pips.	Activates two audio oscillators (935 CPS and 2,805 CPS), and adjusts their output to produce test sideband frequencies (test tones) of the same level as normal operation of transmitter or exciter.
6	3 4 6 22	Set SWEEP WIDTH knob (3), IF BANDWIDTH knob (4), and SWEEP RATE knob (6) all at their maximum clockwise positions. Set SWEEP WIDTH SELECTOR knob (22) at VAR position.	Sets sweep width at 100-kc, IF bandwidth at maximum and sweep rate at maximum.
7	3 4 6	Turn SWEEP WIDTH knob (3) counterclockwise to bring sweep width on screen which includes 9th order pips. Then turn IF BANDWIDTH knob (4) and SWEEP RATE knob (6) both counterclockwise to a point that produces optimally resolved test tone pips at 0 DB deflection.	Sets sweep width to display 9th order products at the corresponding IF bandwidth and sweep rate to produce optimal resolution. Display now shows signals down to 40-db below test tones.
8	21	Place IF ATTEN switch (21) in 0 DB position. The display now shows the two test tones deflected over full scale and the distortion products in the lower 40-db portion of a 60-db range. The 40 DB mark on the screen now represents a point 60-db below the 2 test tones.	Produces display of signals 60-db down from 2 test tones.

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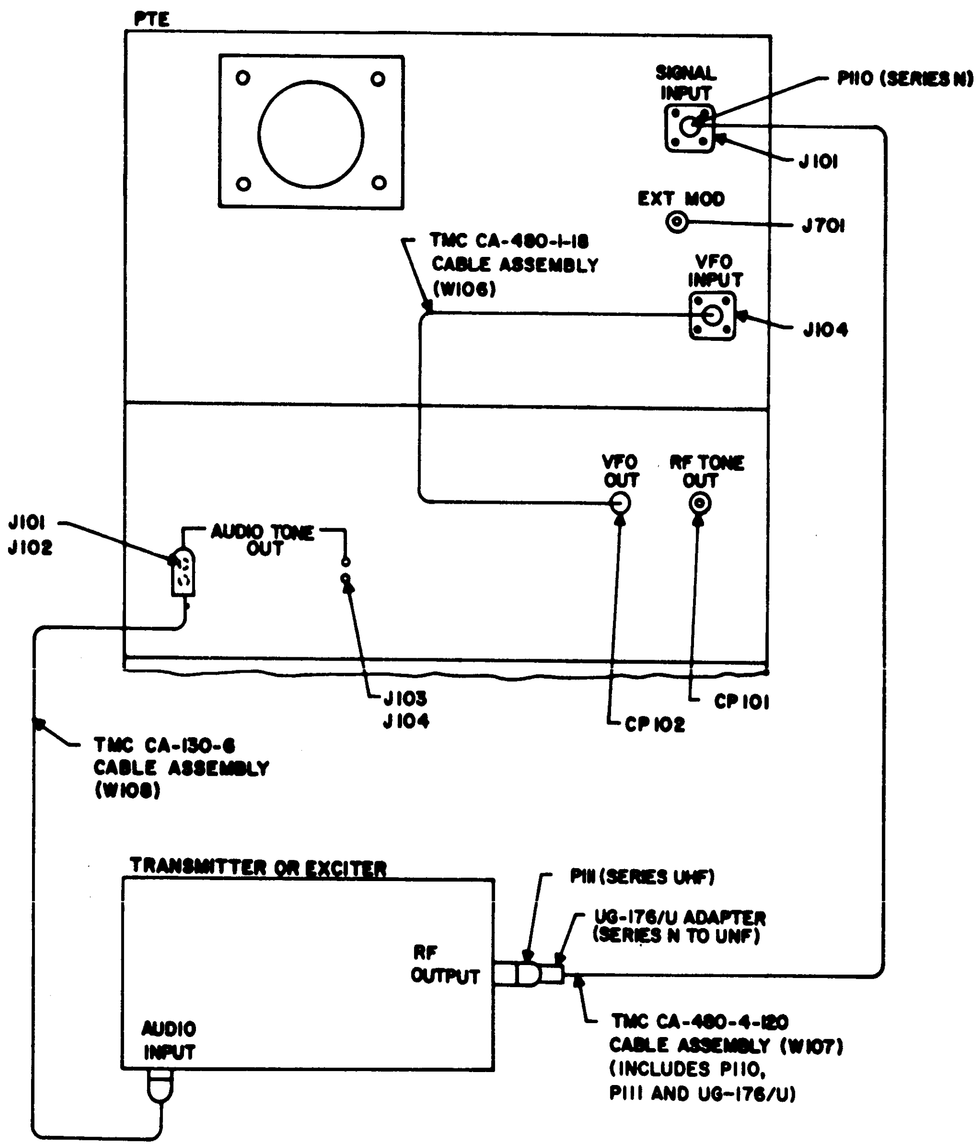

Figure I-3-12. Cable Connection Diagram for Odd-Order Distortion Measurements

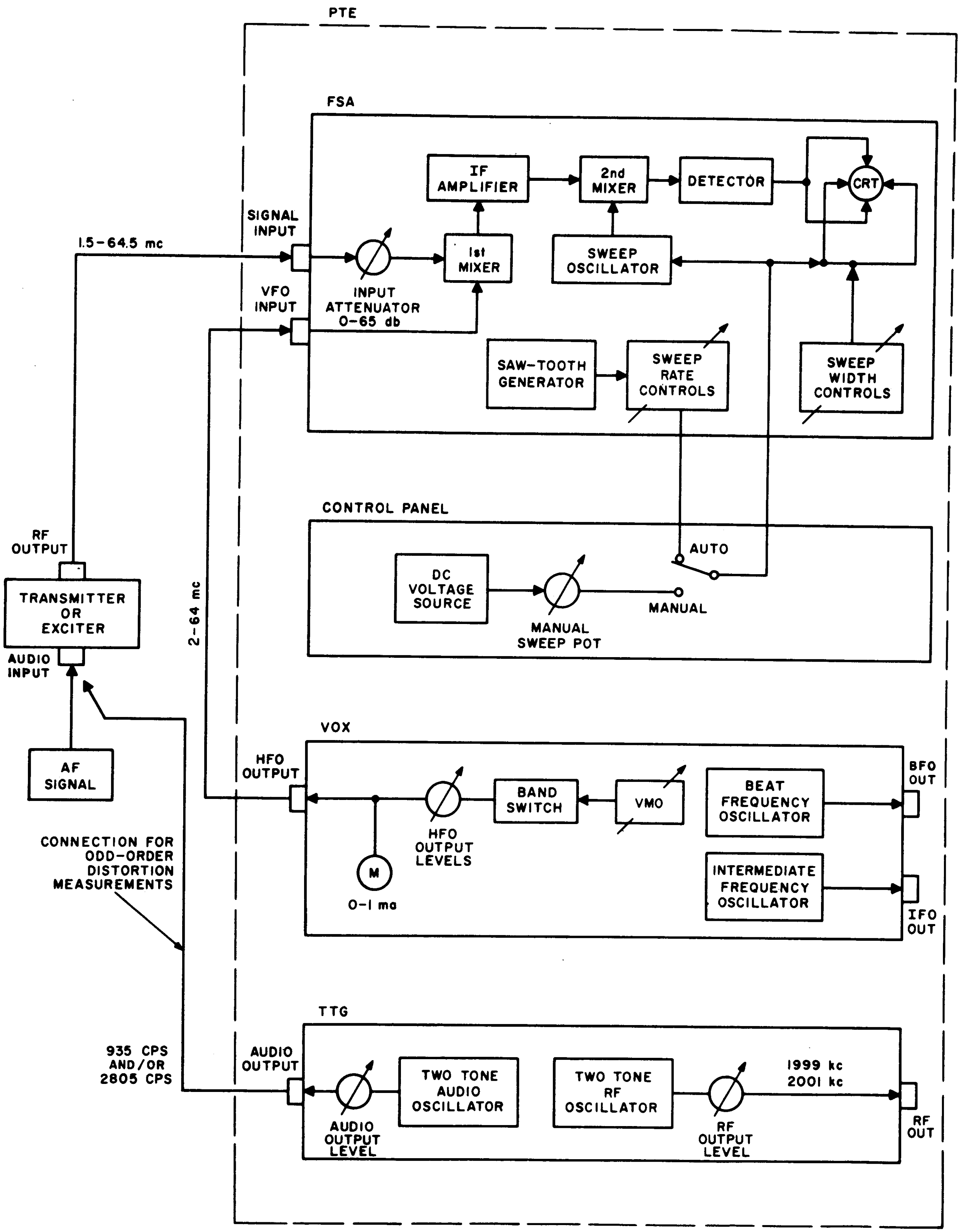

Figure I-4-1. Functional Block Diagram, RF Spectrum Analyzer, PTE

SECTION 4
PRINCIPLES OF OPERATION

I-4-1. INTRODUCTION.

Figure I-4-1 is a functional block diagram of the PTE, showing the main interrelationships of the FSA, VOX and TTG units. For a complete functional block diagram and schematic diagram of each unit, refer to the individual manual for the unit. A schematic diagram for RAK-7 rack wiring is shown in Part V. The basic TMC FSA unit has been modified for MANUAL SWEEP for use in the PTE. For wiring modification of the FSA unit, see Part V.

I-4-2. GENERAL AND NARROW BAND ANALYSIS.

A sample of the transmitter or exciter output is fed into the FSA SIGNAL INPUT jack. Since the center frequency of the FSA is 500 kc, a local oscillator (VOX) is required for heterodyning purposes. The frequency in the VOX output is set at the transmitter carrier frequency plus or minus 500 kc, creating a 500 kc difference center frequency in the FSA mixer output. Frequencies adjacent to the carrier are represented by corresponding frequencies in the 450-500 kc band. In the second mixer stage, the 450-500 kc frequencies are swept over a period of time (1 cycle) by a succession of frequencies starting at 550 kc and ending in 650 kc. This produces a difference frequency of 100 kc for each detected frequency in the 450-500 kc band with a voltage varying in accordance with the relative frequency strength. These voltages appear across the vertical deflection plates of the CRT and cause the electron beam to deflect accordingly for each frequency during the course of its sweep across the screen in one cycle. The rate of sweep (cycles per second) is set by sweep rate controls which synchronize the rate of the sweep oscillator to match the rate of the horizontal sweep of the electron beam. The horizontal sweep of the electron beam is generated by the sawtooth wave generator which applies a sawtooth wave voltage across the horizontal deflection plates.

In MANUAL SWEEP operation, the sawtooth generator and sweep rate controls are cut out and replaced by applying a varying d-c voltage directly across the CRT horizontal deflection plates, controlled by a hand-crank (MANUAL SWEEP pot) on the PTE control panel. It will be noticed that the sweep oscillator and horizontal beam motion are still synchronized in speed and direction by a single control source. Controls for sweep width (the band of frequencies appearing across the CRT screen) are independent of sweep rate controls. The basic FSA Spectrum Analyzer wiring is modified for MANUAL SWEEP when used in the PTE system.

The VOX Variable Frequency Oscillator is a TMC standard multiple duty oscillator with the necessary high stability and accuracy needed to produce clear stable signals on the FSA screen. It has, besides a bandswitched VMO (Variable Master Oscillator) output, a BFO (Beat Frequency Oscillator) output and an IFO (Intermediate Frequency Oscillator) output. These last two outputs, BFO and IFO, are not used in the PTE system, but may be used independently if desired. The VOX is capable of delivering up to 20 volts, but should be set at 0.1 ma maximum (".1" on VOX meter) when used in the PTE system with the FSA unit. Excess of 0.1 ma indicates a voltage at the FSA VFO INPUT which may produce distortion in the FSA mixer. The recommended SIGNAL INPUT voltage at the 1st mixer with this VOX setting is approximately 5 mv to produce a good distortion-free ratio. Although Part II of this manual, describing the FSA unit, states a voltage ratio for SIGNAL INPUT/VFO INPUT as 2mv/0.3V, the best performance when using the VOX is obtained with a ratio around 5mv/2.6V. 2.6V is produced at the VFO INPUT jack when the VOX meter reads "0.1" ma.

I-4-3. ODD-ORDER DISTORTION MEASUREMENTS.

In odd-order distortion measurements the transmitter and VOX signals are brought into the FSA in the same way as in general and narrow band analysis. In order to give a clear readable indication of the distortion producing qualities of the transmitter, however, the normal a-f signal is disconnected from the transmitter and replaced with the audio output from the TTG. The two audio tones, 935 CPS and 2805 CPS, have been selected to produce the most revealing distortion pattern of a transmitter or exciter. The predominant distortion products, which are of an odd order and adjacent to the carrier down to the ninth order, are displayed on the screen. The two r-f tones in the TTG are used in checking out the PTE as described in Section 5.

SECTION 5
TROUBLE SHOOTING

I-5-1. INTRODUCTION.

This section describes procedure of checking the PTE in order to determine which of the three major units (FSA, VOX and TTG) is at fault. When this is determined, the individual manual may be referred to for trouble shooting the unit.

Trouble shooting is the art of locating and diagnosing equipment troubles and maladjustments; the information necessary to remedy the equipment troubles is reserved for section 6 (Maintenance Section) of the individual manual for the faulty unit.

I-5-2. GENERAL TROUBLE SHOOTING TECHNIQUES.

Often it is unnecessary to follow a lengthy and orderly course of trouble shooting in order to localize and isolate the faulty part. When a piece of equipment has been working satisfactorily and suddenly fails, the cause of failure may be apparent either because of circumstances occurring at the time of failure or because of symptoms analogous to past failures.

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

A third short cut is to examine the equipment briefly 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 weaknesses or to some contributive cause beyond their control.

Sometimes excessive vibration will cause failure; for example with soldered joints or when components normally isolated from others are shaken together. Such failures are more difficult to locate.

I-5-3. TROUBLE SHOOTING THE PTE SYSTEM.

a. GENERAL NOTES. If trouble occurs during operation of the PTE, some general rules may be followed that will sometimes give a quick clue in determining which major unit (FSA, VOX or TTG) is at fault. Perform a general check along the lines listed in paragraphs under I-5-2. If the faulty unit is not revealed in this way, refer to paragraph I-5-3b which lists some generalizations as to causes of trouble during operation. If the faulty unit is still not evident, paragraph I-5-3c may be helpful. This last paragraph contains a procedure for checking out the entire PTE system. Or it may be elected to refer to Section 5 of the individual unit manuals and take voltage readings of each unit. Once the faulty unit has been determined, refer to the individual manual for narrowing down the trouble to the section and the defective component in the unit.

b. TROUBLE SHOOTING BASED ON OPERATIONAL PROCEDURE. In many cases the faulty unit may be evident from referring to the Purpose column in tables I-3-2, I-3-3 and I-3-4. If the various lights and indicators have responded correctly as described in the Operation column up to a certain step and do not respond in that step, the entry in the Purpose column of that step will usually give a clue.

A slow wandering of the entire display off the center of the screen indicates that the frequency issuing from either the measured signal or the VOX unit has not stabilized.

Inability to bring the carrier pip up to full scale deflection in step 26 of table I-3-2 indicates that either the signal from the transmitter is too small or the FSA RF or IF amplifier tubes may be weak. If increasing the input signal at the transmitter to bring the carrier pip to full scale causes distortion in the display, then the latter is the case.

c. CHECKOUT PROCEDURE FOR PTE. The following checkout procedure is essentially the factory test and calibrating procedure of the PTE before it is crated for shipping.

Referring to figure I-3-10 Control Panel, set controls as listed below:

Fig. I-3-10 Control No.	Panel Designation	Setting
3	SWEEP WIDTH	Fully CW
4	IF BANDWIDTH	Fully CW
5	VIDEO FILTER, HI/OFF/LO	OFF
6	SWEEP RATE	Fully CW
9-11, 13-15	INPUT ATTENUATOR	All switches up
12	5KC MARKER	OFF
17	ILLUMINATION, POWER OFF	POWER OFF
19	CAL OSC LEVEL	OFF
21	IF ATTEN, ODB/20DB	ODB

Fig. I-3-10 Control No.	Panel Designation	Setting
22	SWEEP WIDTH SELECTOR	VAR
25	AMPLITUDE SCALE	LIN
26	CENTER FREQUENCY	Center on panel mark
27	AFC	OFF
28	GAIN	Fully CCW
34	MANUAL SWEEP (AUTO)	AUTO
38	BEAT	Switch down (off)
39	METER	VMO
41	POWER, ON	Switch down (off)
42, 43, 44	HFO/IFO/BFO	All switches down (off)
54	OUTPUT (HFO)	Fully CCW
55	BAND-MCS	2-4
57	XTAL	VMO
68	AUDIO TONE SELECTOR	OFF
69	RF TONE SELECTOR	OFF
70	POWER, OFF/ON	OFF

The positions of all other controls are optional.

CAUTION

Do not turn knob (60) to bring figures on counter (58) to figure outside 2000 to 4000 range. A misalignment of a cam surface in the VOX may result requiring TMC factory re-alignment.

Connect Power Cable, TMC #CA-575-1 to line voltage supply. Connect one of the two Test Cables, TMC #CA-480-1-18.00 to VFO INPUT jack (29) and VFO OUT jack (36); connect the other to SIGNAL INPUT jack (16) and RF TONE OUT jack (37).

Proceed with checkout of PTE-3 as outlined in Table I-5-1. Control numbers in parentheses refer to Figure I-3-10.

TABLE I-5-1. CHECKOUT PROCEDURE, PTE

STEP	OPERATION	FUNCTION	NORMAL INDICATION
1	Place POWER switch (41) in ON position.	Supplies power to VOX tube filaments and oven heater elements.	MAIN POWER indicator light (45) ignites and remains lit. INNER OVEN and OUTER OVEN indicator lights (46) (47) ignite and remain lit almost constantly for about 48 hours, at which time they begin to cycle as follows: OUTER OVEN light goes on for about 5 seconds and off for about 30 seconds; INNER OVEN goes on for about 90 seconds and off for about 90 seconds.
2	Wait for INNER and OUTER OVEN lights (46) (47) to cycle as described in Step 1. While waiting, proceed with Steps 3 thru 45.	VOX oven temperature becomes stabilized, which, in turn, stabilizes master oscillator frequency components contained therein.	
3	Turn ILLUMINATION knob (17) clockwise.	Supplies all plate and filament power to FSA. Also turns on and controls brightness of illumination lights surrounding screen (7).	Indicator light (8) ignites. Illumination lights around screen (7) will brighten from CW turning of knob and dim from CCW turning. In about a minute a straight baseline trace will appear on screen (7).
4	Adjust BRILLIANCE knob (23) until trace is just discernible. Allow at least 30 minutes warm-up. Then	Focuses electron beam on screen.	Brightness of trace responds to movement of BRILLIANCE knob. Sharpness of trace responds to movement of FOCUS knob.

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TABLE I-5-1. CHECKOUT PROCEDURE, PTE (C nt)

STEP	OPERATION	FUNCTION	NORMAL INDICATION
4 (Cont.)	adjust FOCUS knob (24), for sharpest trace.		
5	Adjust V POS knob (2) so that baseline trace coincides with bottom edge of grid marked on screen (7).	Calibrates vertical beam movement to grid.	Baseline trace responds vertically to V POS knob movement.
6	Adjust H POS knob (1) to approximately center baseline on grid of screen (7).	Approximately centers sweep on grid.	Baseline trace responds horizontally to H POS knob movement.
7	Turn CAL OSC LEVEL knob (19) fully clockwise.	Connects a 500-kc test signal to FSA input. Clockwise rotation of knob increases 500-kc signal amplitude.	A small pip appears at or near center of screen and grows in height as knob is turned clockwise.
8	Turn GAIN knob (28) clockwise until pip reaches full scale deflection on screen (10 on LIN scale).	Further increases 500-kc input	Pip heightens with clockwise movement of GAIN knob.
9	Turn SWEEP WIDTH knob (3) completely counterclockwise or until pip widens into an elevated line.	Decreases sweep width in kc, thereby magnifying pip width.	Pip disappears. Trace may become elevated.
10	Adjust CENTER FREQ knob (26) for maximum height of trace.	Tunes V3 mixer in RF chain to 500-kc, passing through a greater amount of the test signal.	Trace height is raised by adjustment of CENTER FREQ knob.
11	Turn SWEEP WIDTH knob (3) to fully clockwise position.	Increases sweep width, thereby decreasing pip width. Also, as a result of tuning in Step 10, the 500-kc has been brought to the center of the sweep.	Pip reappears and now is at or near center of grid on screen (7).
12	Adjust H POS knob (1) until the pip coincides with the center frequency calibration on the screen.	Centers sweep on grid.	Adjustment of H POS knob brings pip to center calibration. About 1/4 inch of trace extends beyond grid markings on either side.
13	Place 5-KC MARKER switch (12) in up (on) position. Turn GAIN knob (28) clockwise to bring 5-kc pips up.	Activates built-in 5-kc oscillator which heterodynes with 500-kc signal to produce sum and difference frequencies at 5-kc intervals above and below 500-kc.	At least 14 5-kc marker pips appear across screen, 7 above and 7 below 500- kc pip in center.
14	Turn SWEEP WIDTH knob (3) in counterclockwise direction. Then return knob to max. clockwise position.	Counterclockwise movement of SWEEP WIDTH knob decreases sweep width.	5-kc pips move away from center as SWEEP WIDTH knob is turned counterclockwise.
15	Place 5-KC MARKER switch (12) in OFF position and adjust GAIN knob (28) to bring pip back to full scale deflection.	Turns 5-kc oscillator off.	5-kc pips disappear.

TABLE I-5-1. CHECKOUT PROCEDURE, PTE (Cont)

STEP	OPERATION	FUNCTION	NORMAL INDICATION
16	Turn SWEEP RATE knob (6) to fully counterclockwise position.	Changes sawtooth wave width from sweep generator, thereby changing sweep rate.	As SWEEP RATE knob is turned counterclockwise, electron beam slows down in its motion across the screen. At its CCW extreme position, spot moves from right to left at the rate of 0.1 CPS (or once within a 10 second period). Pip amplitude increases.
17	Turn SWEEP RATE knob (6) to fully clockwise position.	Changes sweep rate back to 30 cps.	Trace reappears as a solid line. Pip amplitude returns to full scale deflection.
18	Adjust SWEEP WIDTH knob (3) until the pip base covers approximately one-third of the screen.	Decreases sweep width from its maximum position.	Pip width is increased with decrease of sweep width. Pip height increases.
19	Turn IF BANDWIDTH knob (4) in counterclockwise direction until ringing appears on trailing edge (left side) of 500-kc pip. Adjust until first ringing notch beyond the apex of the pip dips into the baseline.	Decreases IF bandwidth to a point suitable for optimum resolution with a 30 cps sweep rate and the sweep width as set in step 18.	When IF BANDWIDTH knob (4) is turned counterclockwise, pip base width decreases. At the same time there may be a change in pip height.
20	Turn AFC knob (27) in a clockwise direction, slightly.	Turns on AFC feedback circuit from V3 mixer to V4 reactance modulator. Changes maximum sweep width adjustment from 100-kc to 2-kc.	500-kc pip distorts into an elevated line.
21	Turn SWEEP WIDTH knob (3) fully clockwise. Adjust SWEEP RATE knob (6) until spot moves across screen at the rate of approximately 5 times per second. Adjust IF BANDWIDTH knob (4) to obtain optimum resolution ringing.	Adjusts sweep width to 2-kc. Adjusts sweep rate and IF bandwidth for optimum resolution for 2-kc sweep width.	Pip may now appear shifted off center.
22	If 500-kc pip has shifted off center, turn AFC knob (27) to approximately center pip and use CENTER FREQ knob (26) as a vernier adjustment to center pip exactly.	Retunes V4 circuit which became detuned by switching in AFC feedback.	As AFC knob (27) is turned clockwise, the display may shift to the left, then to the right. Normally, with the AFC knob and CENTER FREQ knob (26) manipulated as described in Operation column, the pip should center.
23	Adjust GAIN knob (28) for full scale deflection of pip. Place AMPLITUDE SCALE switch (25) in LOG position.	Switches in a feedback circuit from V10 detector to V9 IF amplifier which has the effect of presenting pip amplitudes on the screen in a log relationship rather than linear.	Pip height reduces to "20 DB" on LOG scale on screen.

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TABLE I-5-1. CHECKOUT PROCEDURE, PTE (C nt)

STEP	OPERATION	FUNCTION	NORMAL INDICATION
24	Set IF ATTEN switch (21) in 20 DB position.	Inserts 20 db of attenuation in the IF amplifier input.	Pip height reduces to "40 DB" mark on LOG scale.
25	Turn GAIN knob (28) clockwise to bring pip back to full scale deflection.	Sets pip to full scale for comparisons to follow.	Another pip with ringing may appear at right edge of screen.
26	Operate INPUT ATTENUATOR switches (9, 10, 11, 13, 14 and 15) so as to insert attenuations up to 40 db in 5 db steps.	Inserts attenuations (which are additive) in the SIGNAL INPUT section. At final setting signal is reduced by 40 db from its level in step 25.	At each setting the pip height coincides with the corresponding screen calibration within ±1 db.
27	Set IF ATTEN switch (21) in ODB position.	Switches out 20 db attenuation in IF amplifier input.	Pip height increases to 20 DB mark on screen.
28	Continue to insert more attenuation with INPUT ATTENUATOR switches (9, 10, 11, 13, 14 and 15) until pip is brought down to 40 DB calibration on screen.	At this point, pip has been reduced by 60 db from its level in step 25, which would now appear 20 db over full scale if INPUT ATTENUATOR switches were returned to up positions.	Pip reads 40 DB on screen with all INPUT ATTENUATOR switches down except 5 DB switch (9).
29	Insert 5 db more attenuation by placing INPUT ATTENUATOR 5 DB switch (9) down.	Inserts a total of 65 db attenuation in signal level as set in step 25.	Pip is reduced below 40 DB calibration on screen.
30	Return all INPUT ATTENUATOR switches (9, 10, 11, 13, 14 and 15) in the up (off) position. Place IF ATTEN switch (21) in 20 DB position.	Switches out the 65 db attenuation. Returns controls to positions set in step 25.	Pip returns to full scale deflection.
31	Place VIDEO FILTER switch (5) in HI position.	Filters out frequencies above 400 CPS in V10 output.	Most noise indications on screen are eliminated.
32	Place VIDEO FILTER switch (5) in LO position. Decrease sweep rate with SWEEP RATE knob (6) to bring spot movement down to 1 CPS or less.	Filters out frequencies above 40 CPS in V10 output. Sweep rate is decreased for more effective results from 40 CPS BW filter.	A more effective elimination of noise is observed. Pip height is raised as sweep rate is decreased.
33	Place VIDEO FILTER switch (5) in OFF position. Set AFC knob (27) in OFF position. Set SWEEP WIDTH (3), IF BANDWIDTH (4) and SWEEP RATE (6) knobs in their fully clockwise positions. Place AMPLITUDE SCALE switch (25) in LIN position. Adjust	Switches out both 400 CPS and 40 CPS filters in V10 output. Switches out AFC and returns sweep width, IF bandwidth, and sweep rate to maximum settings. Returns amplitude representations to linear. Adjusts gain for reference point. Retunes V4 circuit	Pip appears at full scale deflection with solid line trace.

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TABLE I-5-1. CHECKOUT PROCEDURE, PTE (C nt)

STEP	OPERATION	FUNCTION	NORMAL INDICATION
33 (Cont.)	GAIN knob (28) to bring pip back to full scale deflection. Adjust CENTER FREQ knob (26) to bring pip back to center calibration.	which became detuned by turning off AFC.	
34	Set SWEEP WIDTH SELECTOR knob (22) in 14 KC position.	Sets sweep width at 14-kc and sweep rate at 1 cps. Sets IF bandwidth for optimal resolution. AFC remains off and 400 CPS video filter is in.	Pip appears at or near center of screen. Amplitude may reduce slightly. Beam takes about 1 second to cross screen. In steps 34 through 38, SWEEP WIDTH (3), IF BANDWIDTH (4), VIDEO FILTER (5), SWEEP RATE (6) and AFC (27) controls are all inoperative.
35	Set SWEEP WIDTH SELECTOR knob (22) in 7 KC position.	Sets sweep width at 7-kc and sweep rate at 1 cps. Sets IF bandwidth for optimal resolution. AFC remains off and 400 CPS video filter is in.	Same as step 34. Pip position and amplitude remain essentially unchanged from step 34.
36	Set SWEEP WIDTH SELECTOR knob (22) in 3.5 KC position.	Sets sweep width at 3.5 kc and sweep rate at 1 cps. Sets IF bandwidth for optimal resolution. AFC remains off and 400 CPS filter is in.	Same as step 35. Pip position and amplitude remain essentially unchanged from step 35.
37	Set SWEEP WIDTH SELECTOR knob (22) in 500~ position.	Sets sweep width at 500 cps and sweep rate at 0.1 cps. Sets IF bandwidth for optimal resolution. AFC is turned on and 400 CPS video filter is replaced by 40 CPS video filter.	Pip position may shift noticeably from that of step 36. Amplitude is essentially unchanged from step 36. Beam takes about 10 seconds to cross screen.
38	Recenter pip by using AFC knob (27) as a coarse adjustment and CENTER FREQ knob (26) as a vernier adjustment.	Retunes V4 circuit which became detuned when AFC feedback became switched in.	Pip is recentered.
39	Set SWEEP WIDTH SELECTOR knob (22) in 150~ position.	Sets sweep width at 150 cps and sweep rate at 0.1 cps. Sets IF bandwidth for optimal resolution. AFC remains on and 40 CPS video filter remains in.	Same as step 38. Pip position and amplitude remain essentially unchanged from step 38.
40	Place CENTER FREQ knob (26) on panel marker. Turn AFC knob (27) to OFF position. Set SWEEP WIDTH SELECTOR knob (22) to VAR position. Turn SWEEP WIDTH knob (3) fully counterclockwise. Adjust	Retunes V4 circuit which became detuned when AFC feedback became switched out.	Pip reappears at or near center of screen.

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TABLE I-5-1. CHECKOUT PROCEDURE, PTE (C nt)

STEP	OPERATION	FUNCTION	NORMAL INDICATION
40 (Cont.)	CENTER FREQ knob (26) to obtain maximum height of trace. Set SWEEP WIDTH knob (3) fully clockwise.		
41	Place POWER knob (70) in ON position. Wait 2 seconds for TTG to warm up.	Supplies voltages to TTG plate and filament circuits.	MAIN POWER lamp (64) lights.
42	Set RF TONE SELECTOR knob (69) in TWO TONE position.	Generates 1, 999-kc and 2001-kc test signals in TTG unit.	
43	Using patchcords supplied with PTE, connect VFO OUT jack,(36) to VFO INPUT jack (29) and RF TONE OUT jack (37) to SIGNAL INPUT jack (16).	Connects VOX output to FSA VFO input and TTG RF output to FSA SIGNAL INPUT.	
44	Place SWEEP WIDTH SELECTOR knob (22) in 14 KC position. Place CENTER FREQ knob (26) on panel mark and then adjust H POS knob (1) to bring 500 kc pip to center screen calibration. Turn CAL OSC LEVEL knob (19) to OFF position.	Sets sweep width at 14-kc and sweep rate at 1 cps. Sets IF bandwidth for optimal resolution. AFC is off and 400 CPS video filter is in. Turns off 500-kc oscillator.	Beam speeds up to 1 cps. Pip remains around full scale deflection mark and is centered by adjustment to H POS knob. Pip disappears when CAL OSC LEVEL knob is placed in OFF position.
45	Set GAIN knob (28) fully clockwise (maximum) and set AMPLITUDE SCALE switch (25) in LOG position. Set IF ATTEN switch (21) in ODB position.	Sets equipment for presentation of signals with a 60 db relationship (with only lower 40 db portion displayed).	No change from step 44.
46	If INNER and OUTER OVEN lamps (46 and 47) are cycling as described in step 1, set BEAT switch (38) to ON position.	Turns on 100-kc calibrating signal in VOX.	ZERO BEAT lamp (48) lights.
47	Turn MASTER OSCILLATOR FREQUENCY knob (60) to bring a reading of 2500 KCS, 000 CPS, on counters (58 and 59). Vary CALIBRATE knob (50) until ZERO BEAT light (48) flashes at the rate of about once or twice per second.	Sets VOX output frequency at 2500-kc within an error of one or two cycles.	Adjustment of CALIBRATE knob causes ZERO BEAT lamp to flash.
48	Set BEAT switch (38) to down position (off).	Turns off 100-kc calibrating signal.	ZERO BEAT lamp (48) goes out.
49	Set HFO switch (42) in ON position.	Turns on RF amplifier plate voltage in VOX.	

TABLE I-5-1. CHECKOUT PROCEDURE, PTE (C nt)

STEP	OPERATION	FUNCTION	NORMAL INDICATION
50	Set METER knob (39) in HFO position.	Connects meter (49) to sample output from RF amplifier.	
51	Watch meter (49). Turn OUTPUT knob (54) clockwise to bring a reading of approximately ".1" on meter dial.	Turns up VOX output level to approximately 0.1 ma to get good reading for next step. 1,999 kc, 2,001 kc combine to produce 499 kc and 501 kc signals on screen.	Two test tone pips now appear on screen, about 1 kc above and below center calibration.
52	Set TUNING knob (53) in 2.5 area to bring highest reading on meter (49).	Tunes VOX RF amplifier.	Pips may shift and become more defined.
53	Adjust OUTPUT knob (54) . to bring a reading of ".1" on meter (49) dial.	Sets VOX output at appropriate level for FSA mixer ratio.	
54	Set IF ATTEN switch (21) in 20 DB position. Then adjust INPUT ATTENUATOR switches (9-11, 13-15) to reduce pips down to ODB calibration on screen, using GAIN knob (28) for variations less than smallest INPUT ATTENUATOR switch position. Then set IF ATTEN switch (21) in ODB position.	Sets display to show lower 40 db portion of a 65 db presentation, with 2 test tones representing 0-db.	Odd-order distortion product pips appear on screen.
55	Check all odd-order distortion pips.	Checking to see if all odd-order distortion products fall below 60 db down from two test tones.	Maximum level of odd-order distortion pips do not exceed 40 DB mark on screen. (60-db below two test tone pips).
56	Set IF ATTEN switch (21) in 20DB position. Set MANUAL SWEEP switch (34) in up (manual) position.	Disconnects sweep generator from horizontal deflection plates and connects in MANUAL SWEEP control of plate voltage.	Horizontal movement of beam stops. Beam becomes stationary spot on screen. **CAUTION** Do not leave beam stationary for more than 60 seconds.
57	Crank MANUAL SWEEP knob (35) clockwise, then counterclockwise.	Changes voltage of horizontal deflection plates.	Clockwise movement of MANUAL SWEEP knob (35) causes spot on screen to move from left to right; counterclockwise movement causes spot to move from right to left. The same distortion products should be observed as in step 55. A slight adjustment of the GAIN knob (28) may be necessary to bring distortion pips to the same level as in step 55.
58	Return MANUAL SWEEP switch (34) to AUTO position.	Reconnects sweep generator to horizontal deflection plates.	Horizontal motion of beam resumes automatically.

SECTION 6
MAINTENANCE

I-6-1. INTRODUCTION.

Generalized phases of maintenance of the PTE are outlined below. Where this data is inadequate, refer to Parts II through IV as pertinent to specific equipment units.

I-6-2. GENERAL.

The PTE contains assemblies of many electrical and mechanical parts which may be maintained adequately by conventional preventive and corrective maintenance techniques as outlined in the following paragraphs. Long life and continual operation of moving parts require especially good maintenance. When a component fails in a highly precise frequency-sensitive assembly, it is generally more practical to replace the entire assembly than to attempt to repair it. Such assemblies may then be returned to the factory for repair and adjustment. The same is true of complicated mechanical assemblies. Installation of parts peculiar without suitable tools makes the replacement of the entire assembly more practical than disassembly, fabrication, and reassembly. Pieces of the PTE that fall into this category are the FSA CRT tube, large selector switches, VOX VMO (variable master oscillator) and oven assembly, VMO counters and VMO gears. Replacement of transistors in the FSA should be performed by technicians experienced in transistor installation.

I-6-3. OPERATOR'S MAINTENANCE.

Operator's maintenance consists in not only maintaining optimum equipment performance at all times but also keeping a detailed record of the equipment performance as well as a log of events and happenings, including climatic conditions, pertinent to equipment operation. Such records are useful in spotting gradual equipment degradation and when more general remedial measures are necessary.

I-6-4. PREVENTIVE MAINTENANCE.

a. GENERAL. Preventive maintenance is maintenance that detects and corrects trouble producing items before they become serious enough to affect equipment operation adversely. Some trouble producing items are dirt and grime, contact erosion, improper contact pressure, lack of proper lubrication, overheating, unstable power supplies, vacuum tubes with poor emission, loose parts (due to excessive vibration), etc.

It may appear contradictory to state that good preventive maintenance means that one should not constantly poke around and tinker with an equipment that is performing excellently. Overzealous maintenance can readily cause more, rather than less, potential trouble. Good preventive maintenance requires constant vigilance and good judgement of when, what, and how to apply remedial measures.

b. WEEKLY INSPECTION. While unit is in operation check the operator's performance record for irregularities and possible sources of future trouble. Observe all unit output amplitudes with meter and compare them with ratings stated in manuals. Observe indicator lights and rectifier tubes for abnormal color and signs of internal flashing.

c. MONTHLY INSPECTION. Inspect conditions of rotary switch contacts and recondition as necessary. Use crocus cloth and trichloroethylene or ethylenedichloride for cleaning. Inspect and rid the equipment of dust and dirt. Inspect the equipment for loose soldered connections or screws especially in those cases experiencing appreciable vibration in service. Note the condition of gear trains; those showing signs of becoming dry should be lubricated with a drop or two of any high quality, light machine lubricant. Check the condition of all tubes.

I-6-5. CORRECTIVE MAINTENANCE.

Corrective maintenance is an aftermath of trouble shooting as discussed in section 5, or preventive maintenance as discussed in the preceding paragraph. With the exception of those cases when components suddenly fail for no apparent good reason or under extenuating circumstances, an intelligent program of preventive maintenance should produce minimum equipment outage.

After a defective part has been localized and isolated by the trouble shooting techniques presented in various sections 5 of the manual, replacement generally presents no major problem particularly in the case of failure of non-complex electrical and mechanical components.

Refer to Appendix (Part V of this manual) for guide in reordering components used in the PTE.

INSTRUCTION MANUAL

for

PANORAMIC PANALYZOR
MODEL SB-12a

Applies to Serial No. 20S and above.

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CHAPTER I
INTRODUCTION

I-1. GENERAL

This Instruction Manual has been prepared to assist in the installation, operation and servicing of the Panoramic Panalyzor, Model SB-12a with serial numbers in the series 20S and above.

No attempt to operate the equipment should be made until the operator is thoroughly familiar with the information contained in CHAPTER III - OPERATING INSTRUCTIONS.

I-2. APPLICATIONS

The Model SB-12a is designed for research, design or production test applications such as:

- Single sideband studies.
- Hum level analysis.
- RF cross modulation analysis.
- Adjacent channel interference investigations.
- Band occupancy studies.
- Residual carrier and sideband level measurements.
- Spurious oscillation or modulation detection.
- FM deviation measurements.

I-3. EQUIPMENT SUPPLIED

Description	Quantity
Panalyzor, Model SB-12a, Type T-100	1
Power Supply, Model PS-12	1
Transformer, Constant Voltage, T3003A-1	1
Cable, Interconnecting, Power, #W3046	1
Cable, Signal Input, #W3001	2
Spare Fuse, 2 amp, 250 V, Type AGC	3
Tool, Alignment, #E1010	1

I-4. GENERAL DESCRIPTION

The Panalyzor, Model SB-12a, is an automatic scanning superheterodyne receiver which permits analysis and identification of one or many radio-frequency 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 Model SB-12a provides two modes of operation divided into seven ranges.

The variable sweep width mode of operation provides a 0 - 100 KC variable sweep width for search and preliminary analysis and a 0 - 2 KC variable sweep width with automatic frequency controlled sweep for detailed analysis.

The pre-set mode of operation provides pre-set, narrow band, sweep widths of 14 KC, 7 KC, 3.5 KC, 500 cps and 150 cps for slow speed, highly resolved analysis. The 2 KC, 500 cps and 150 cps sweep widths are AFC stabilized.

The Model SB-12a provides visual means of examining the effects of power supply fluctuations, thermal changes, humidity, component variations, shock, vibration and load changes upon frequency. Both magnitude and direction of frequency drift are indicated. Parasitic oscillations which normally may pass unnoticed can quickly be detected and identified. Spurious modulation by subsonics, hum and noise are readily spotted. In single sideband linearity tests, the Model SB-12a permits in-band intermodulation distortion readings to -60 db.

Because of its Panoramic presentation the instrument is invaluable for monitoring a frequency band for the appearance, disappearance and shift of signals. Highly useful graphic displays of such phenomena as Bessel function distributions of f-m signals, energy distribution of pulsed r-f signals with low p.r.f.'s, a-m sidebands, etc., can be obtained.

The SB-12a 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 Resolution and E_2/E_1 Graphs, Figures I-1 and I-2.)

I-5. ELECTRICAL CHARACTERISTICS

a. SWEEP WIDTHS:

	SWEEP WIDTH	MODE
	0-100 KC	Continuously variable
AFC Stabilized	0-2 KC	Continuously variable
AFC Stabilized	150 cps	Pre-set with automatically optimum I-F Bandwidth (Resolution).
AFC Stabilized	500 cps	Pre-set with automatically optimum I-F Bandwidth (Resolution).
	3.5 KC	Pre-set with automatically optimum I-F Bandwidth (Resolution).
	7 KC	Pre-set with automatically optimum I-F Bandwidth (Resolution).
	14 KC	Pre-set with automatically optimum I-F Bandwidth (Resolution).

(Other pre-set sweep widths available upon request.)

b. INPUT CENTER FREQUENCY:

500 KC

c. BANDPASS REGION (after input mixer):

450 - 550 KC

d. BANDPASS REGION AMPLITUDE CHARACTERISTIC: (450 - 550 KC)

Uniform within ±5% or ±1/2 db.

e. IMAGE REJECTION:

Better than 130 to 1 at input center frequency.

f. INPUT IMPEDANCE:

50 ohms at each of the two input terminals.

g. INPUT ATTENUATOR:

0 - 65 db attenuation of the input signal in 5 db steps.
Accuracy ±.05 db/db.

h. 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.

i. DIRECT SENSITIVITY:

Maximum rms voltage (at signal input terminal) in center frequency band (450 - 550 KC) required for full scale linear deflection: 200 uv.

j. CONVERSION SENSITIVITY:

Maximum rms signal required at signal input terminal for full scale log deflection when 0.1 volts rms from an external signal generator is injected into the VFO input terminal: 3 mv. (The signal generator frequency should be adjusted to heterodyne the signal down to the input center frequency band of the Panalyzor).

k. INPUT MIXER RANGE:

The SB-12a input aperiodic mixer is suitable for signals up to approximately 1000 mc.

l. SCAN RATES:

0.1 cps to 30 cps continuously variable. On pre-set sweep widths of 150 cps, 500 cps, - 0.1 cps scan rate. On pre-set sweep widths of 3.5 KC, 7 KC and 14 KC - 1 cps scan rate.

m. RESOLUTION:

Continuously adjustable with IF BANDWIDTH control except on pre-set 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.)

See Figure I-1, Resolution Graph. The Model SB-12a is capable of 10 cps resolution or better at slow scan rates and reduced sweep widths.

n. DYNAMIC AMPLITUDE RANGE:

Two Tone Test:

All in-band residual (odd order) intermodulation products better than 60 db below level of two equal reference signals deflected 20 db above full scale log provided that -

1. Reference signals are separated so that their intersection is at least 60 db down.
2. All front panel gain settings are maximum.
3. IF BANDWIDTH control is adjusted for broadest position consistent with visual separation of signals. On pre-set sweep widths of 150 cps, 500 cps, 3.5 KC, 7 KC and 14 KC the 60 db dynamic range is provided automatically.
4. Signal generator amplitude of at least 300 millivolts rms.

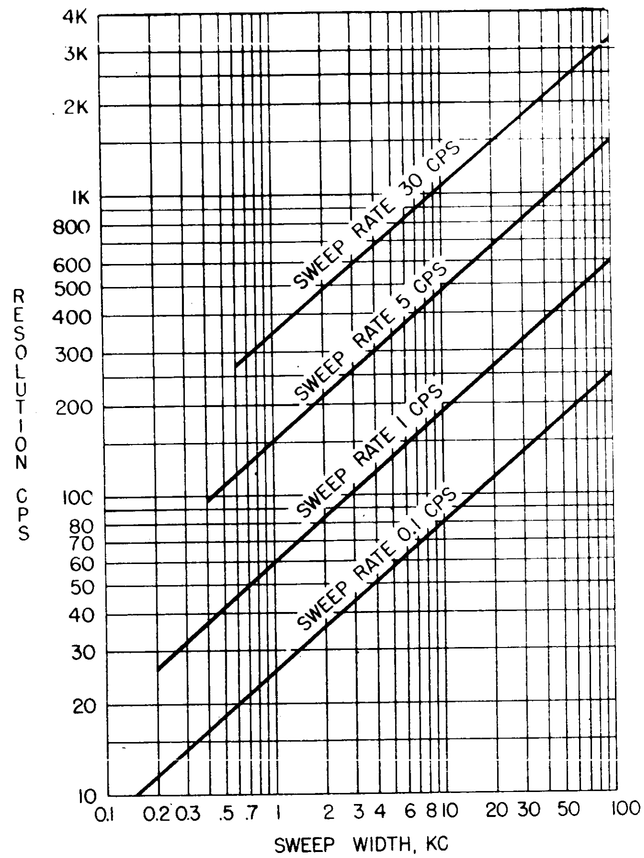

Figure I-1.
Left: Resolution (in cps) vs. Sweep Width (in KC).

Figure I-2.
Below: Minimum Frequency Separation Δf Required to Measure Amplitude Ratios E_2/E_1. Figures in parenthesis represent pre-set sweep widths. The curves represent the electrical resolution of the Model SB-12a. The dashed portion represents electrical resolution beyond optical resolution. To obtain the results shown in this portion of the curve, an expanded scale oscilloscope or Recorder, Model RC-3a, must be used.

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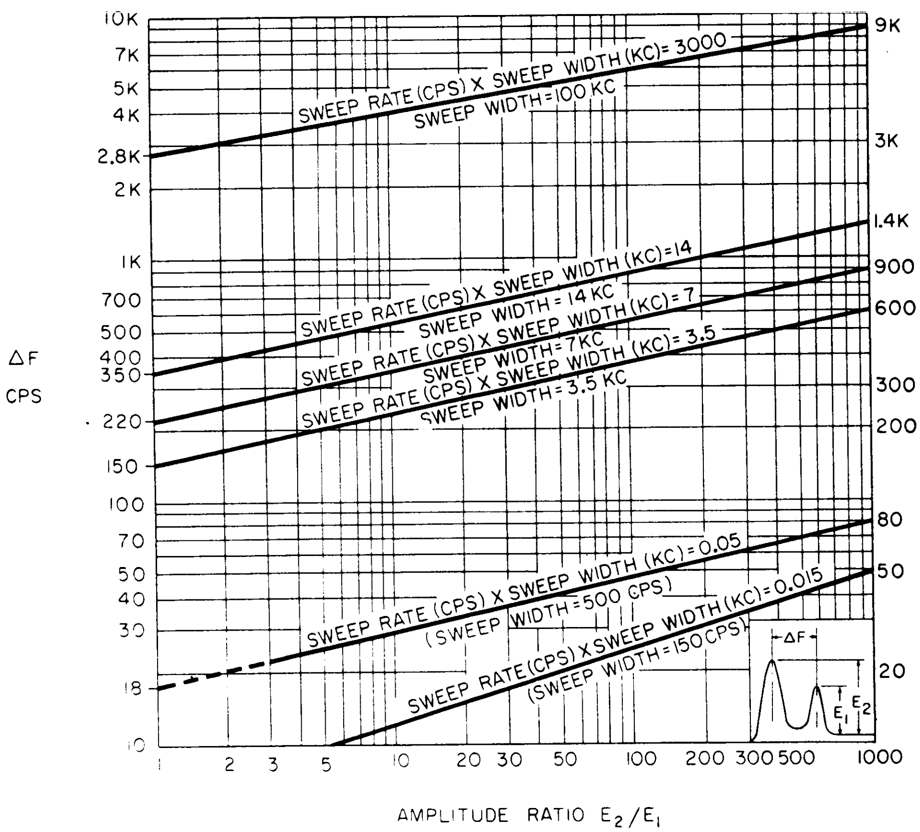

o. AUXILIARY OUTPUTS:

*Vertical amplitude and horizontal frequency output terminals provided. Connector provided for operation with chart recorder. Model RC-3b.

p. INDICATOR:

5" diameter flat face CRT (5ADP7) with edge lit reticule and scale illumination, and a standard oscilloscope camera mounting bezel.

q. POWER CONSUMPTION:

Approximately 180 watts.

r. POWER SOURCE:

95 - 125 volt 60 cps. Line regulator supplied. Special regulators available for 220 volts or 50 cps operation.

I-6. PHYSICAL CHARACTERISTICS

a. WEIGHTS

Description	Weight
Panalyzor, Model SB-12a, Type T-100	31 lbs.
Power Supply, Model PS-12	28 lbs.
Constant Voltage Transformer T3003A-1	18 lbs.
Analyzer Cabinet	27 lbs.
Power Supply Cabinet	12 lbs.
Cables	3 lbs.

b. DIMENSIONS

Description	Dimensions
Analyzer Cabinet	12-9/16 in. high 22 in. wide 21-3/8 in. deep*
Analyzer Front Panel (Standard Relay Rack)	10-1/2 in. high 19 in. wide
Power Supply Cabinet	8-3/4 in. high 16-1/4 in. wide 14-1/8 in. deep**
Transformer, Constant Voltage, #T3003A-1	8-1/16 in. high 7-1/4 in. wide 4-1/2 in. deep
Cable, Interconnecting, Power, 14 Wire #W3046 with 2 connectors: #MS3106B-28-2P and #MS3106B-28-2P	5 ft. long
Cable, Signal Input, #W3001, RG-8/U, with 1 connector, #UG-21B/U, and one tinned end	3 ft. long

* Includes a 1-1/8 in. knob projection and 3-1/2 in. power plug projection.

** Includes a 1/2 in. pilot light and 3-1/2 in. power plug projection.

I-7. TUBE AND TRANSISTOR COMPLEMENT

a. ANALYZER SECTION

Circuit Reference Symbol	Type	Function
V1	6J6	Input Mixer
V2	12AT7	RF Amplifier
V3	6BE6	2nd Mixer, Local Oscillator
V4	6AH6	Reactance Tube
V5	6BH6	AFC Amplifier
V6	12AL5	Discriminator
V7	6U8	IF Amplifier
V8	6U8	IF Amplifier
V9	6AU6	IF Amplifier
V10	12AU7	Detector: Video Amplifier
V11	12AU7	Amplifier: Cathode Follower
V12	5ADP7	CRT
V13	6AU6	Sweep Tube
V14	12AU7	Blocking Oscillator: Cathode Follower

continued

Circuit Reference Symbol	Type	Function
V15	6BH6	Sweep Discharge Tube
V16	12AU7	Horizontal Deflection Amplifier
V17	5651	Voltage Reference Tube
V18	OA2	Voltage Regulator Tube
V20	6U8	IF Amplifier
Q3	2N404	500 KC Oscillator
Q4	2N404	500 KC Oscillator
Q5	2N404	5 KC Oscillator
Q6	2N404	5 KC Oscillator

b. POWER SUPPLY

Circuit Reference Symbol	Type	Function
V101	5V4GA	Rectifier
V102	6AS7G	Series Regulator Tube
V103	12AX7	Amplifier
V104	5651	Voltage Reference Tube
CR601	International Rectifier V100HF	High Voltage Selenium Rectifier
CR602	International Rectifier V100HF	High Voltage Selenium Rectifier

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I-8. FRONT PANEL CONTROLS

a. INPUT ATTENUATOR

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.

b. GAIN

The amplitude of the indication of 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 Model SB-12a input circuits.

c. AMPLITUDE SCALE

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 0 db to -40 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.

d. IF ATTEN(uator)

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(uator) switch in the 0 db position permits the full 60 db dynamic range of the Model SB-12a to be used. Only the lower 40 db portion is displayed on the crt screen. This switch should always be in the 0 db position when making measurements requiring the full 60 db dynamic range of the instrument.

e. CAL(ibrating OSC(illator) LEVEL

This control 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 Panalyzor, and may be modulated by an external audio oscillator or by the built-in 5 KC marker 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(ibrating) OSC(illator) LEVEL control reduces the oscillator output to zero.

f. CENTER FREQ(uency)

This control serves to set or maintain the frequency-modulated local oscillator at its specified mean frequency. In this way, the deflection corresponding to a signal at the input center frequency is centered on the crt screen. When using AFC stabilized sweeps, this control acts as a vernier.

g. AFC (OFF)

Clockwise rotation of this control turns on the AFC circuit. It reduces the normal 100 KC maximum sweep width to 2 KC. This frequency stabilized narrow scanning rate provides the best resolution of which the instrument is capable. Further rotation of the control adjusts the center frequency. The AFC should only be used with sweep rates of 5 cps or less.

h. ILLUMINATION

This control 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.

i. BRILLIANCE

The intensity of the screen presentation is adjusted with this control.

j. FOCUS

The sharpness of the screen presentation is adjusted with this control.

k. SWEEP WIDTH SELECTOR

This control provides a choice of five pre-set widths of 150 cps, 500 cps, 3.5 KC, 7 KC, and 14 KC, and a sixth position marked VAR(iable). In the VAR(iable) position, the sweep width may be set to any value from 0 to 100 KC, the i-f 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.

In the pre-set positions, the i-f bandwidth is automatically set for optimum resolution. On the three narrowest ranges, the AFC circuit is automatically turned on; on the 3.5 KC, 7 KC and 14 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 3.5 KC, 7 KC and 14 KC ranges is 1 cps, and the video filter bandwidth is approximately 400 cps. The sensitivity of the Panalyzor is constant on all ranges, within ±15%.

l. FAST SWEEP

This momentary contact push button speeds up the sweep rate from 0.1 cps to 1 cps on the 150 cps and 500 cps pre-set sweep ranges. 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.

m. 5 KC MARKER

This toggle switch is used to turn on a transistorized 5 KC oscillator which is rich in harmonics. The 5 KC oscillator is connected to, and modulates, the 500 KC calibrating oscillator when the CAL OSC LEVEL control is operated. The sideband pips, at 5 KC intervals, are visable out to ±50 KC from the calibrating oscillator pip at 500 KC. This display facilitates setting up any desired sweep width in the VAR mode of operation.

The following controls are used relatively infrequently or are only needed when setting up the Panalyzor on the VAR(iable) position of the SWEEP WIDTH SELECTOR. They are located behind the door to the left of the crt.

n. HOR(izontal POS(ition

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This control is used to adjust the position of the baseline trace along the horizontal axis.

o. VERT(ical) POS(ition)

This control is used to adjust the position of the baseline trace along the vertical axis.

p. SWEEP WIDTH

The scanning width of the instrument is adjusted with this control. When it is turned completely clockwise, the maximum spectrum width for which the instrument is designed; i.e., 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.

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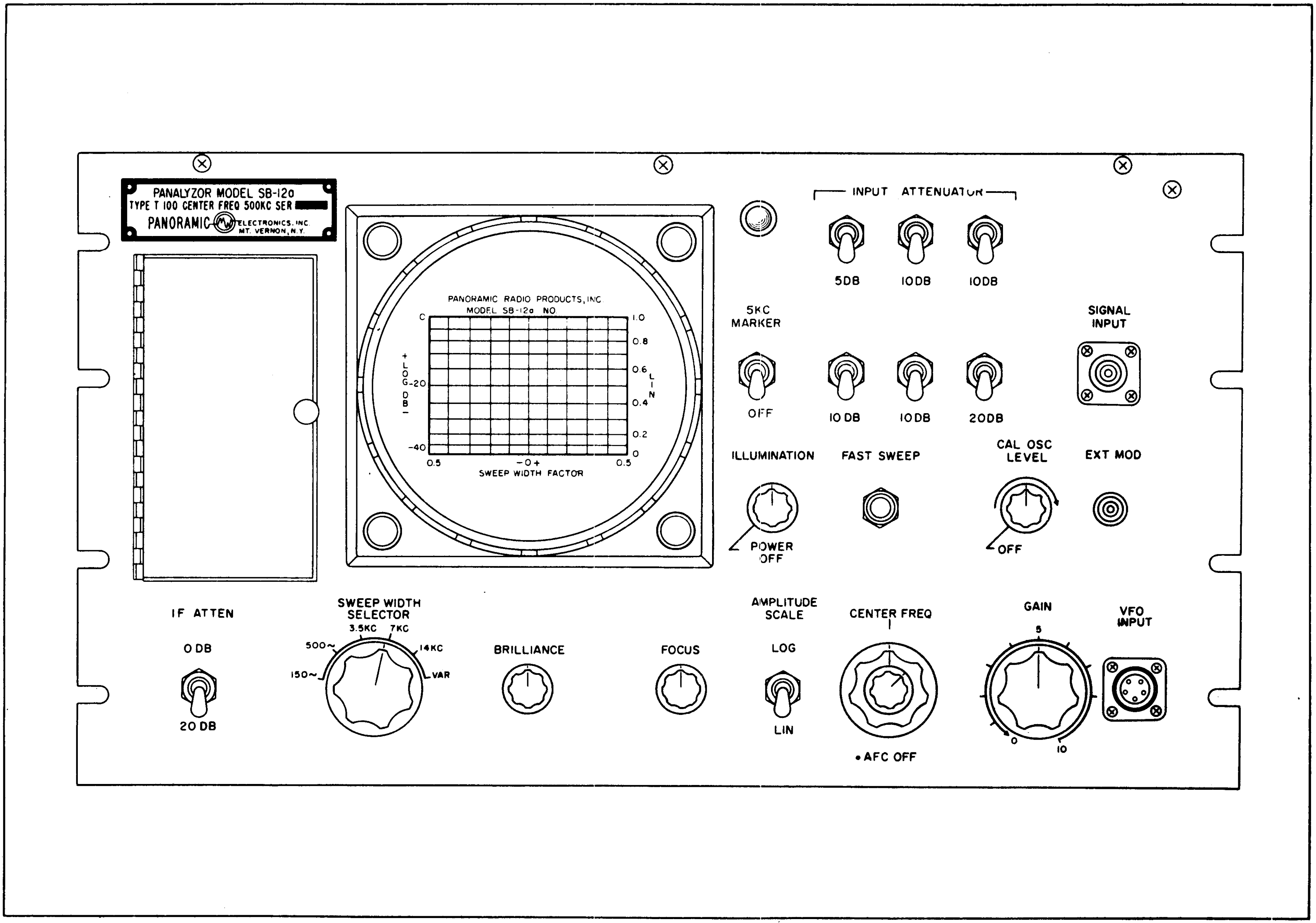

Figure I-3. Front Panel, Model SB-12a.

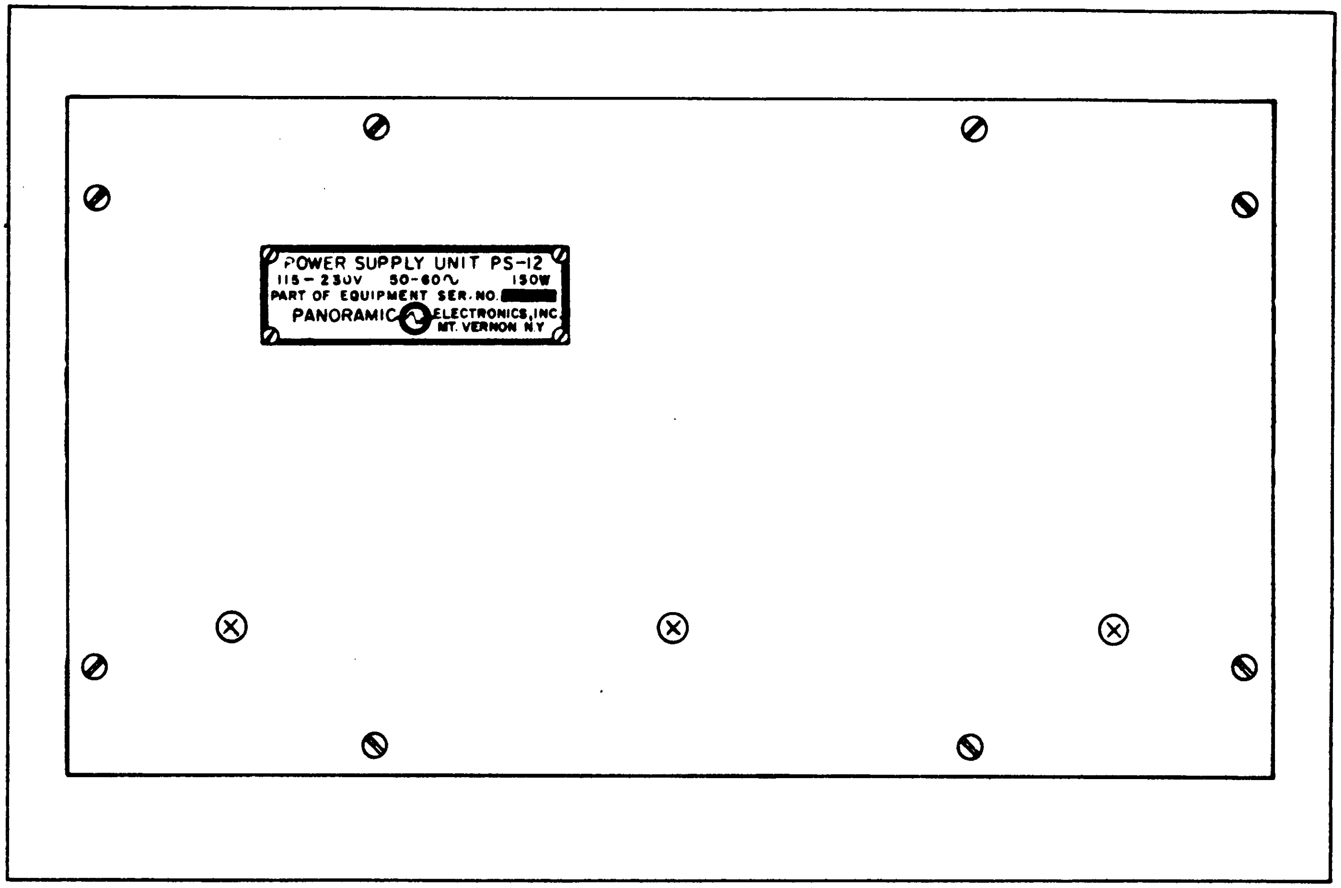

Figure I-4. Front Panel, Model PS-12 in Cabinet.

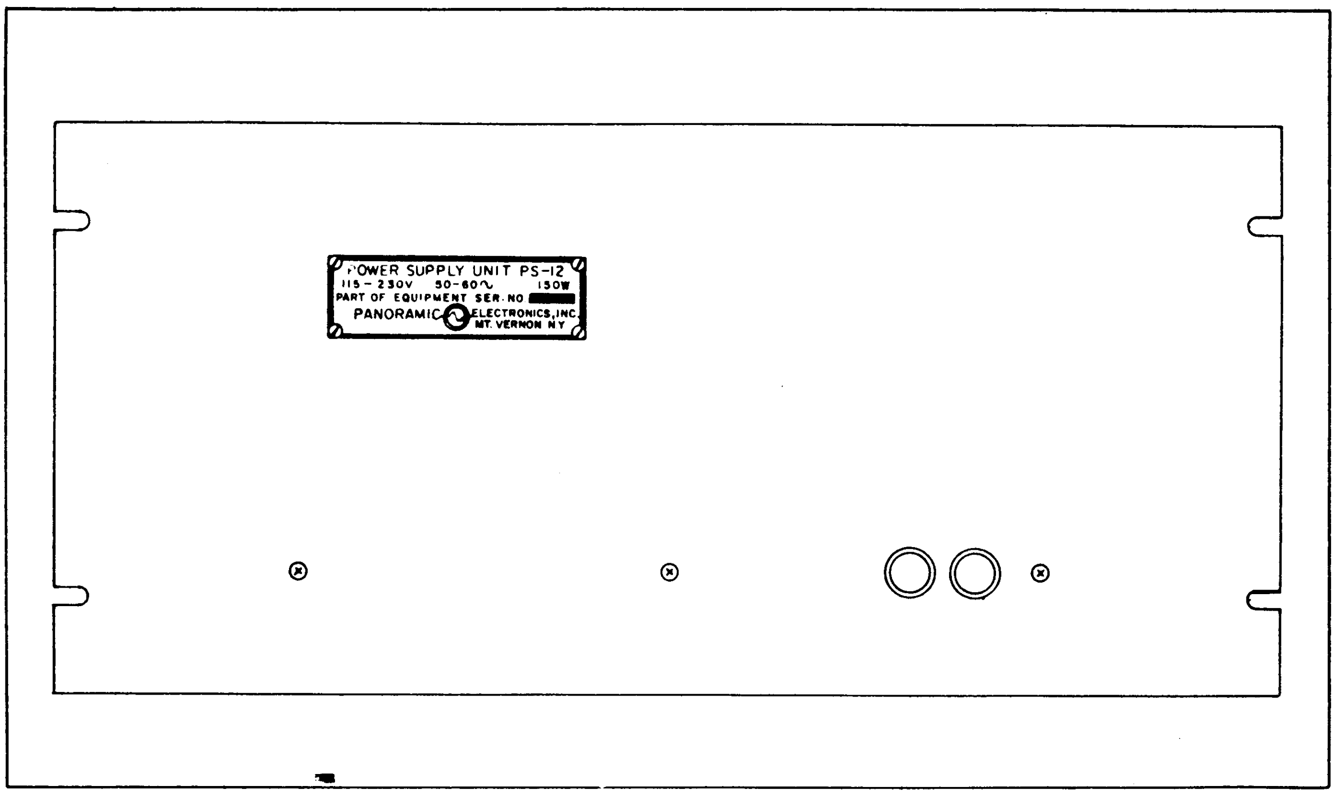

Figure I-5. Front Panel, Model PS-12, Rack Mount Style

q. IF BANDWIDTH

Resolution, or the ability to separate individual signals, is dependent upon two factors: the rate of frequency scan and the bandwidth of the i-f section of the instrument. Optimum resolution requires a definite relationship between the two. Resolution sharpens as both the frequency-scanning rate and i-f bandwidth are decreased.

The IF BANDWIDTH control is used to narrow the i-f bandwidth. Counterclockwise rotation of this control narrows the width of the i-f 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 pre-set sweep ranges the i-f bandwidth is automatically set for optimum resolution.

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r. VIDEO FILTER

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 pre-set sweep ranges, the LO filter is automatically switched on. On the 3.5 KC, 7 KC and 14 KC ranges, the HI filter is automatically switched on.

s. SWEEP RATE

This control provides continuously adjustable scanning rates between 0.1 cps and 30 cps. Counterclockwise rotation of this control reduces the sweep rate.

The control is operative only in the VAR position of the SWEEP WIDTH SELECTOR.

1-9. TERMS AND DEFINITIONS

a. Sweep Width is the band, measured in cycles, kilocycles or megacycles, which can be observed by Panoramic Reception. It corresponds to the range of oscillator sweep in the Panoramic equipment.

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 Panalyzor to heterodyne with the test signal to produce the required input frequency of the Panalyzor.

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).

CHAPTER II
INSTALLATION

II-1. INITIAL INSPECTION

This instrument has been tested and calibrated before shipment. Only minor preparations are required to put the instrument in operation.

If damage to the case is evident when delivery is made, have the person making the delivery describe the damage and sign the notation on all copies of the delivery receipt.

Most public carriers do not recognize claims for concealed damage if such damage is not reported within fifteen days after delivery. All shipping containers should be opened and the equipment inspected before 15 days elapse.

If damage is found, whether concealed or obvious when delivered, call or write the carrier and ask that an inspection be made by their agent.

Although the carrier is liable for any damage in the shipment, Panoramic Radio Products, Inc. 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.

II-2. INTERCONNECTING PROCEDURE

The Panoramic Panalyzor, Model SB-12a, Type T-100, 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 Constant-Voltage Transformer #T3003A-1, the equipment will operate properly over a line voltage variation of 95-130 volts.

NOTE

THE LINE VOLTAGE REGULATOR SUPPLIED MUST BE USED WITH THE EQUIPMENT TO INSURE 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. 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 180 VOLT-AMPERE OUTPUT.

Connect the Panalyzor and Power Supply together with the 14 wire power cable furnished. Connect the cable from the Constant-Voltage Transformer (female connector) to the receptacle on the Power Supply chassis. Connect the AC line cord from the Constant-Voltage Transformer to the a-c power source.

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

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

Connect the external signal to the SIGNAL INPUT connector, using one of the RF cables supplied. Connect the external 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 Panalyzor. This also applies when flatness of response is not critical. Otherwise, the generator cable impedance must be 50 ohms and non-terminated, or a suitable pad may be used to prevent reflections and the resultant non-uniform response due to mis-match.

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 Panalyzor is to be connected directly to the signal source, a suitable blocking capacitor should be used at the free end of the cable.

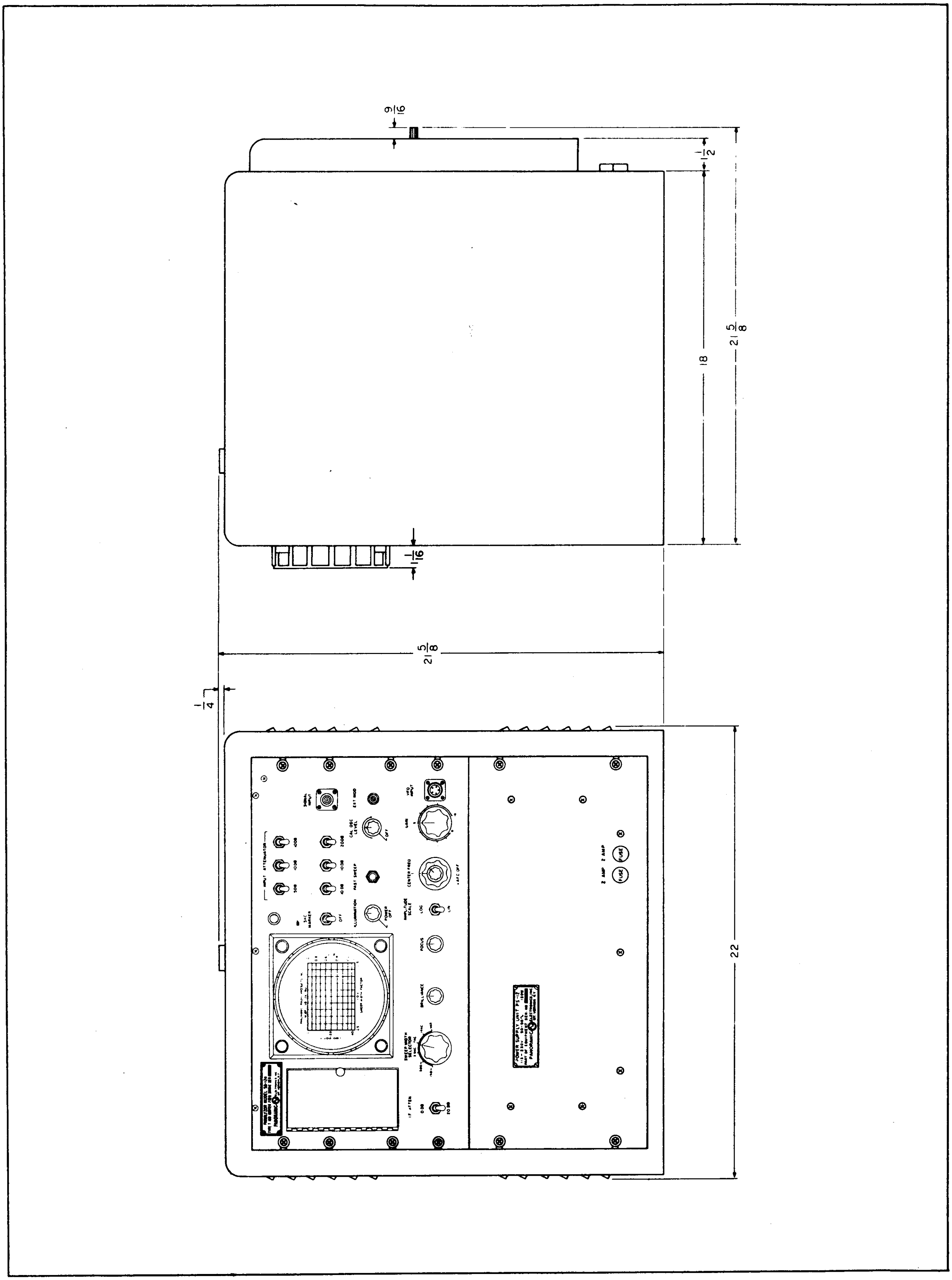

Figure II-1. Outline Dimensional Drawing, Models SB-12a and PS-12 in Common Cabinet.

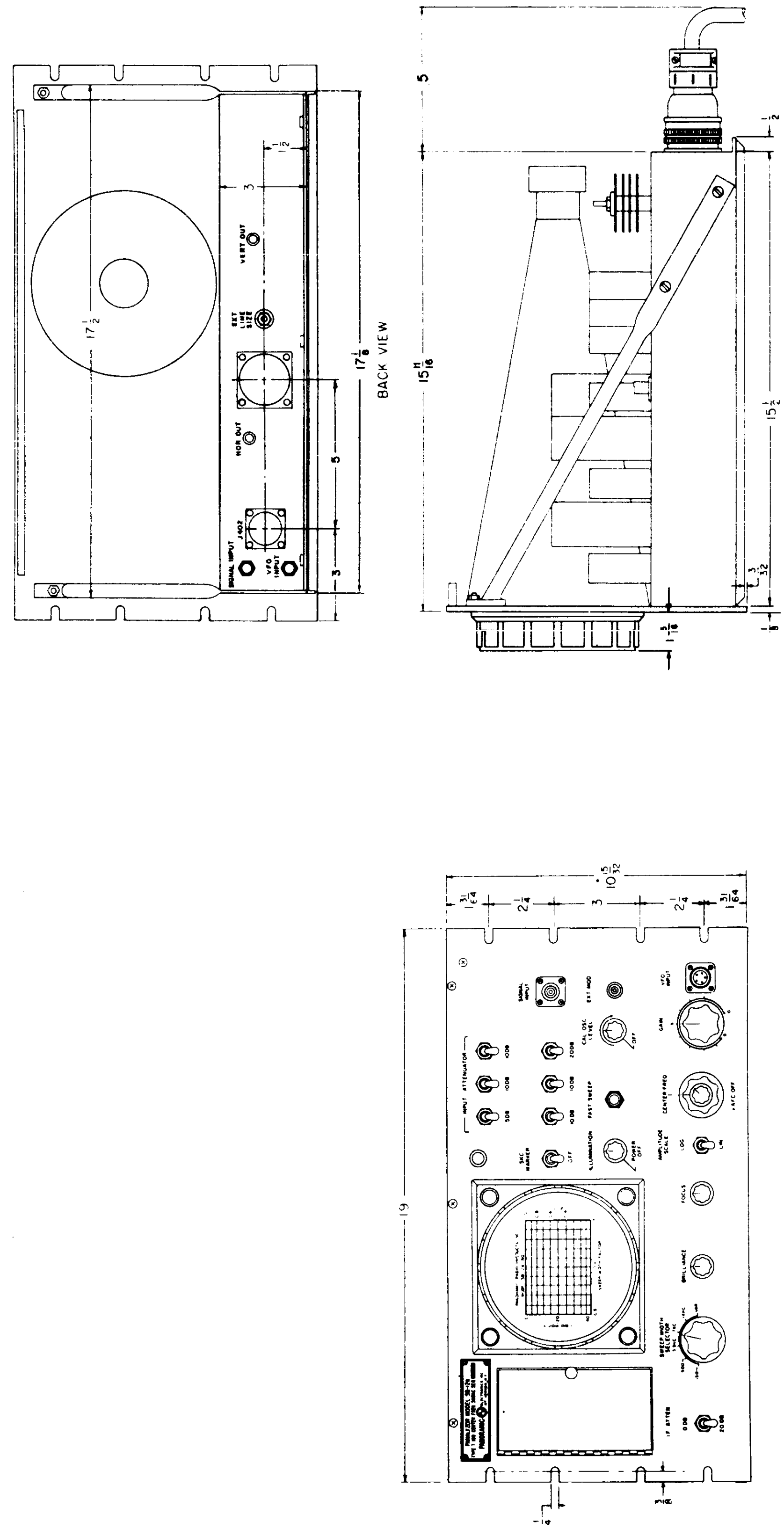

Figure II-2. Outline Dimensional Drawing, Model SB-12a, Rack Mount Style.

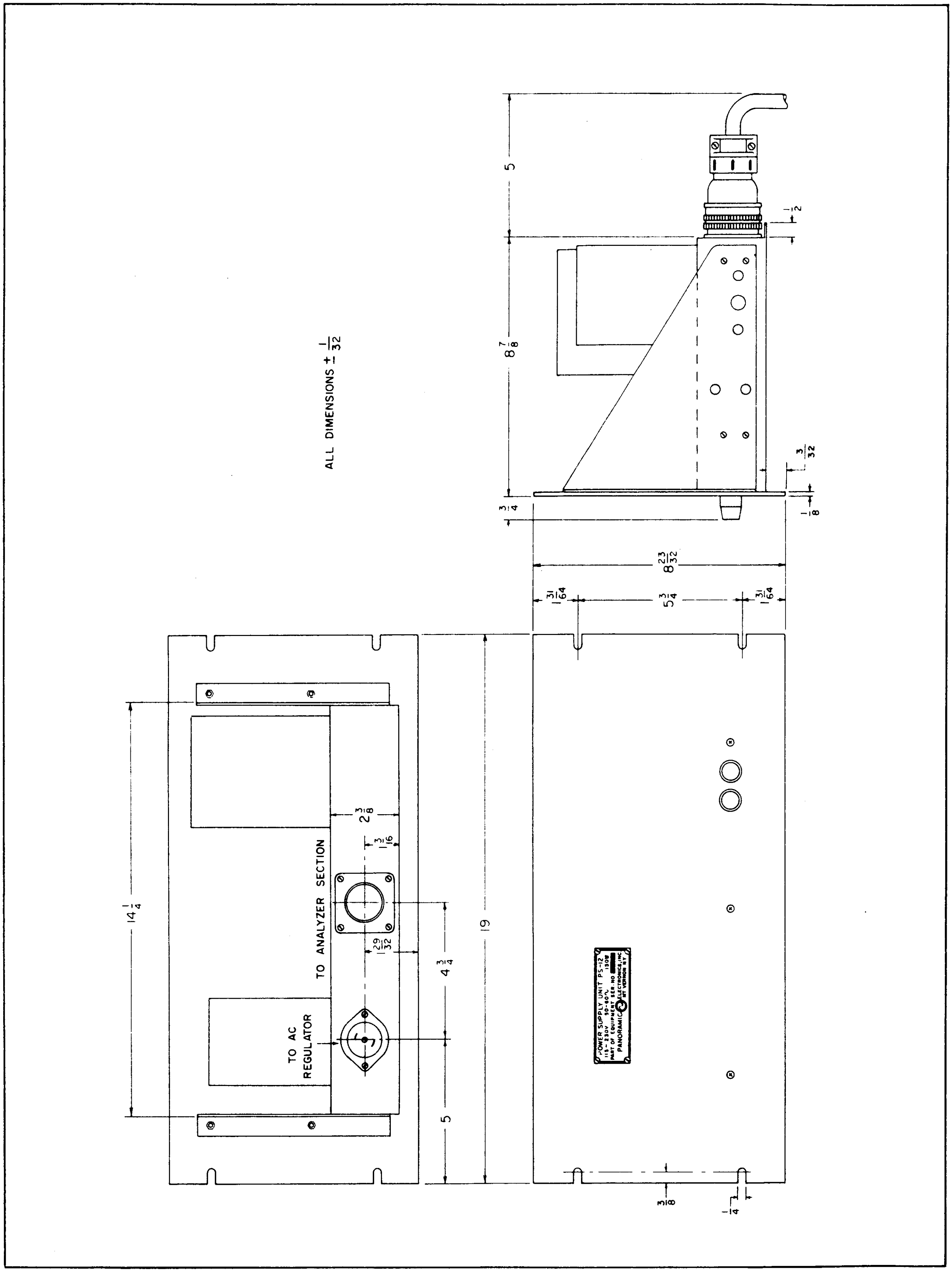

Figure II-3. Outline Dimensional Drawing, Model PS-12, Rack Mount Style.

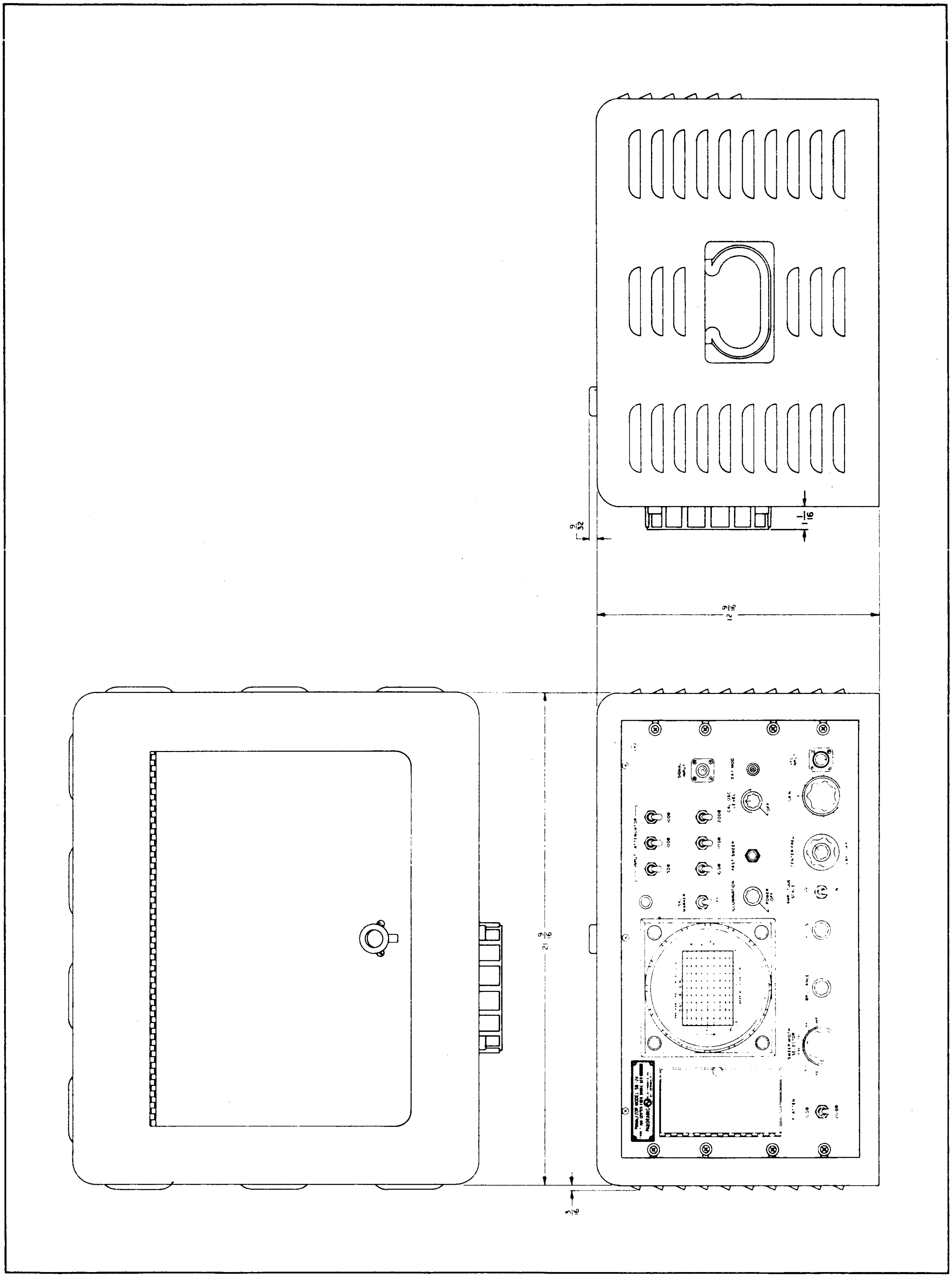

Figure II-4.   Outline Dimensional Drawing, Model SB-12a in Cabinet.

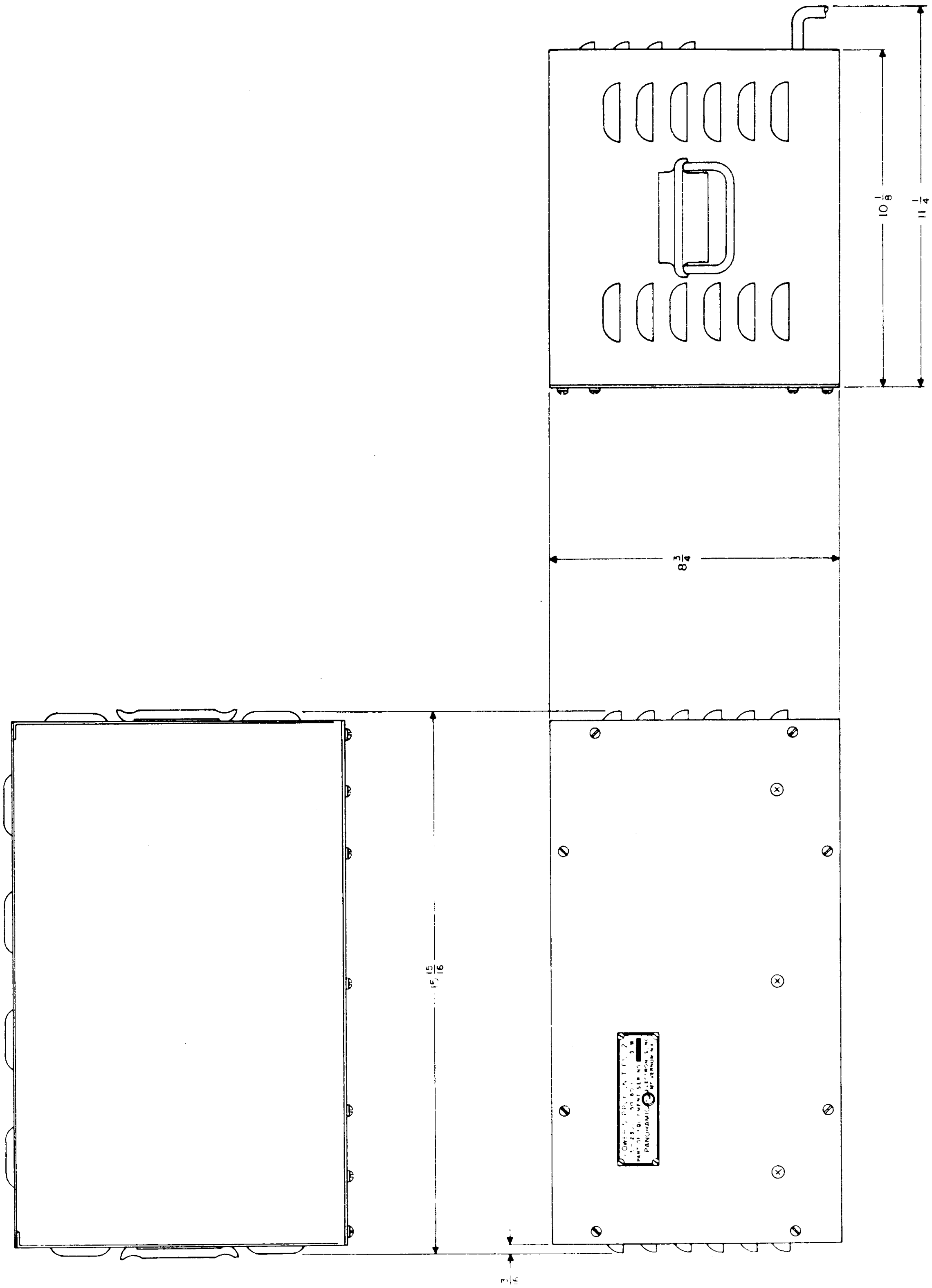

Figure II-5. Outline Dimensional Drawing, Model PS-12 in Cabinet.

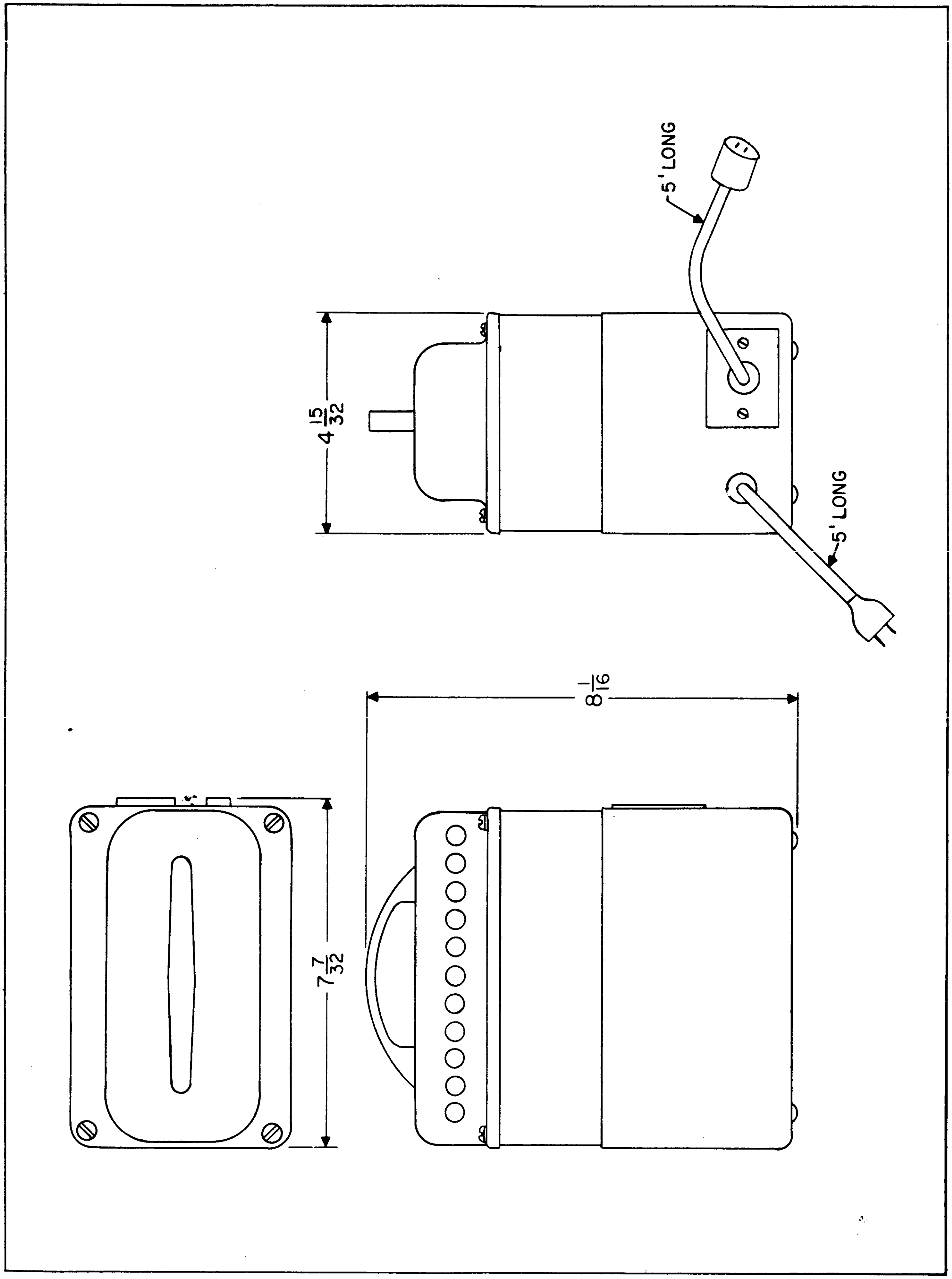

Figure II-6. Outline Dimensional Drawing, Constant-Voltage Transformer, T-3003A-1.

II-3. INSTALLATION ADJUSTMENTS AND CHECKS

a. Set the front panel controls as follows:

INPUT ATTENUATOR	All switches UP
GAIN	Fully counter-clockwise
CAL OSC LEVEL	OFF
CENTER FREQ	center
AFC	OFF
AMPLITUDE SCALE	LIN
FOCUS	For a sharp trace
BRILLIANCE	As desired
SWEEP WIDTH SELECTOR	VAR
5 KC MARKER	OFF
IF ATTEN	0 DB
VIDEO FILTER	OFF
SWEEP RATE	Fully clockwise
IF BANDWIDTH	Fully clockwise
SWEEP WIDTH	Fully clockwise
V POS	So that baseline trace coincides with the frequency scale.
H POS	To approximately center the baseline on the crt screen.

b. Turn the CAL OSC LEVEL control fully clockwise. Advance the GAIN control until a pip is displayed at approximately full screen deflection.

c. 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.

d. 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.

e. Turn 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 dips into the baseline.

f. 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 checked most conveniently 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 for approximately optimum resolution.

g. Set the controls as outlined for CENTER FREQ test. Carefully adjust the GAIN control for full scale deflection of the pip. Switch AMPLITUDE SCALE to LOG. The pip should read 20 db (center of screen). The LOG calibrations appear 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 40 db calibration.

h. Set the GAIN control fully clockwise and adjust the CAL OSC LEVEL control until full screen 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.

i. Set the INPUT ATTENUATOR to zero (all switches up) and adjust the GAIN control for full scale deflection. Switch 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 will be integrated and shifted slightly. The SWEEP RATE should be reduced to prevent excessive distortion of the pip shape. Switch 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 be used with sweep rates of the order of 1 cps or less.

j. With a full scale, optimally resolved, pip (LIN amplitude scale) displayed in the center of the screen, set the SWEEP WIDTH SELECTOR to 14 KC. The pip should appear at or near the center of the screen. The amplitude should be essentially unchanged. The sweep width is now ±7 KC, and the sweep rate is 1 cps. The SWEEP WIDTH, SWEEP RATE, IF BANDWIDTH, and VIDEO FILTER controls are not operative on this and the other pre-set sweep width ranges.

k. Set the SWEEP WIDTH SELECTOR to 7 KC. The pip should appear with essentially the same amplitude near the center of the screen. In this position, the sweep width is ±3.5 KC.

l. Set the SWEEP WIDTH SELECTOR to 3.5 KC. The pip should appear with essentially the same amplitude near the center of the screen. In this position the sweep width is ±1.75 KC.

m. Set the SWEEP WIDTH SELECTOR to 500 CPS. The AFC circuit is automatically switched on for this and the 150 cycle sweep width and the sweep rate is 0.1 cps. The amplitude of the pip should be essentially constant on both ranges.

n. To facilitate locating a signal on the ranges employing a 0.1 cps sweep rate, a FAST SWEEP button has been provided on the front panel. Pressing 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.

o. 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 calibrating oscillator.

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.

A built-in 5 KC oscillator is provided to modulate the calibrating oscillator, in lieu of an external audio signal. The 5 KC modulation is turned on by setting the 5 KC MARKER switch to the up position. Sidebands are produced at 5 KC intervals, of usable amplitude out to ±50 KC. The frequency accuracy of the 5 KC marker oscillator is ±2%.

p. 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.

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CHAPTER III
OPERATION

III-1. GENERAL OPERATION

a. Switch on the power by rotating the ILLUMINATION control fully clockwise. The crt scale illumination should go on immediately. Within 30 seconds a dot should appear on the screen and within a few seconds start to sweep across the screen. The scale illumination may be reduced to any desired level by counterclockwise rotation of the ILLUMINATION control.

If no indication appears on the screen, turn the BRILLIANCE control clockwise. The BRILLIANCE control should be set to a minimum point of suitable visibility and the FOCUS control for the finest clear line. A later adjustment of FOCUS and BRILLIANCE may be required, since the appropriate settings are partially dependent upon the signal density. Do not use the BRILLIANCE control to compete with external light falling on the crt screen but rather reduce the external light or shield the screen.

b. When viewing the crt screen, the eye of the observer should be along the axis of the crt at a distance of approximately 15 inches from the face. Since the screen calibrations have been made from this position, any other position will introduce parallax error. See Figure III-1. A convenient method of finding the correct position is to close one eye and obtain a reflection of the other eye at the exact center of the calibrated crt scale.

c. Set the front panel controls as follows:

CENTER FREQ.	on vertical marker (See Chapter II, Paragraph 2 e)
SWEEP WIDTH	maximum clockwise
IF BANDWIDTH.	maximum clockwise
BRILLIANCE.	for desired trace brightness
SWEEP WIDTH SELECTOR.	VAR
FOCUS.	sharpest trace
AMPLITUDE SCALE	LIN
GAIN	between half and maximum clockwise
SWEEP RATE.	maximum clockwise
VIDEO FILTER.	OFF
HORIZONTAL POSITION. . .	for centered position of center-frequency pip (See Paragraph II-3.c.)
VERTICAL POSITION.	for baseline coincident with bottom screen calibration
AFC	OFF
INPUT ATTENUATOR	all switches up
5 KC MARKER	OFF

d. When the SWEEP WIDTH and IF BANDWIDTH controls are concurrently set close to their maxi-

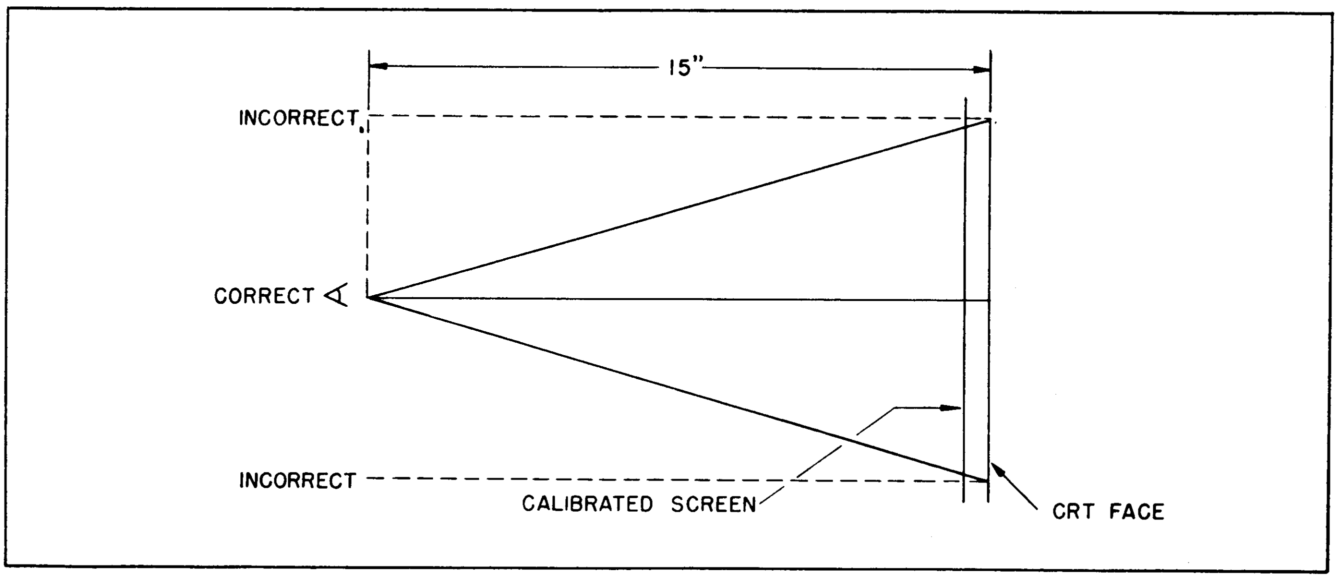

Figure III-1. Correct Viewing of CRT Screen.

mum counterclockwise position the centered signal will appear as an elevated baseline or pip with hum superimposed. This is normal.

Although the frequency of the external heterodyning oscillator or signal generator, which is connected to the VFO INPUT r-f connector, 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 Panalyzor; i.e, 450 KC to 550 KC.

Therefore, 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 1,070 KC and 1,770 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 1,770 KC no advantage will be gained by having the signal-generator frequency above that of the test signal.

NOTE

> 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; i.e., 450 KC to 550 KC are fed directly into the input, the screen signs are reversed.

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 analyzer at maximum gain and the signal generator for high output. Once the signal is located, the GAIN control may be backed off counterclockwise and the generator output lowered to obtain a signal which falls below full scale. The INPUT ATTENUATOR may also be used to reduce signal level.

e. 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. See NOTE in Paragraph 1.a. above.

Example: The Panalyzor is set for maximum scanning width. At maximum scanning width each frequency calibration mark for the T-100 is equivalent to a 10-KC separation. A pip appears at +30. The heterodyne oscillator is set to 2,450 KC.

The input center frequency of the Panalyzor is 500 KC. When the generator is raised, the signal moves right to left. Therefore, the screen calibration is added in this example since it is determined by following the procedure indicated in NOTE of Paragraph 2.a. above, that the oscillator was above the test signal. Therefore, the + sign applied.

Signal Freq. = Oscillator Freq. ± Screen Calib. ± Input Center Freq.

Signal Freq. = 2,450 KC + 30 KC -500 KC = 1,980 KC.

f. 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 affect this flatness.

To observe signals of comparable amplitude (10:1 or less) the AMPLITUDE SCALE switch should be set to LIN. On the other hand, examination of signals widely divergent in amplitude will require the LOG setting of this control. This will allow simultaneous reading of amplitudes having a 40 db range.

III-2. NARROW BAND ANALYSIS

a. At full sweep width, test signals having a small frequency difference tend to have their corresponding deflections merge into and mask each other. The ability of the equipment to separate individual signals depends upon two factors: the scanning velocity (product of sweep rate and sweep width) and the bandwidth of the intermediate-frequency section of the equipment. For any given scanning velocity, there is a complementary i-f bandwidth for optimum resolution. The scanning velocity is reduced by increasing the sweep period (reducing the sweep rate) and decreasing the spectrum width scanned within a given time (reducing the sweep width). Reducing the scanning velocity improves the resolution

(the ability of the equipment to separate closely-spaced frequency components.)

The IF BANDWIDTH control is used to adjust the intermediate-frequency section bandwidth. Counterclockwise rotation of this control narrows the width of the section. As this control is adjusted, there will be some degree of change in the sensitivity of the equipment. Narrowing the i-f bandwidth improves resolution until a point of optimum resolution is reached. Further narrowing of the i-f bandwidth decreases resolution beyond this point.

To increase the resolution capabilities by reducing sweep width, narrowing the i-f bandwidth, and increasing scanning time, the following procedures are used:

1. Set the IF BANDWIDTH control completely clockwise for widest i-f bandwidth.

2. Adjust the external oscillator frequency so that the desired band of signals is at the center of the screen.

3. Spread the band of signals across the screen by turning the SWEEP WIDTH control counterclockwise. (See b below for use of AFC.) Each frequency calibration mark on the screen represents a frequency separation equal to one-tenth of the reduced sweep width.

4. Turn the IF BANDWIDTH control counterclockwise until individual signals are most clearly resolved. If the signals cannot be resolved, a slower sweep rate will be required. Optimum resolution can be recognized by the nature of the ringing pulses that will appear on the trailing edge of the signal pip as optimum resolution is approached. See Figure III-2.

NOTE

Rotation of the IF BANDWIDTH control may result in increased or decreased pip height. Pip amplitude may be returned to suitable level with the GAIN control. Turning the 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 the video filter in the OFF position.

5. If the resolution adjustment results in practically complete separation of signal pips, maximum resolution can be recognized by the presence of ringing pulses on the trailing edge of the pips as shown in Figure III-2. Illustrations (a) to (f) of Figure III-2 indicate progressive variations in pip width caused by counterclockwise rotation of the IF BANDWIDTH control. In (a) and (b) i-f width is broad for the particular scanning

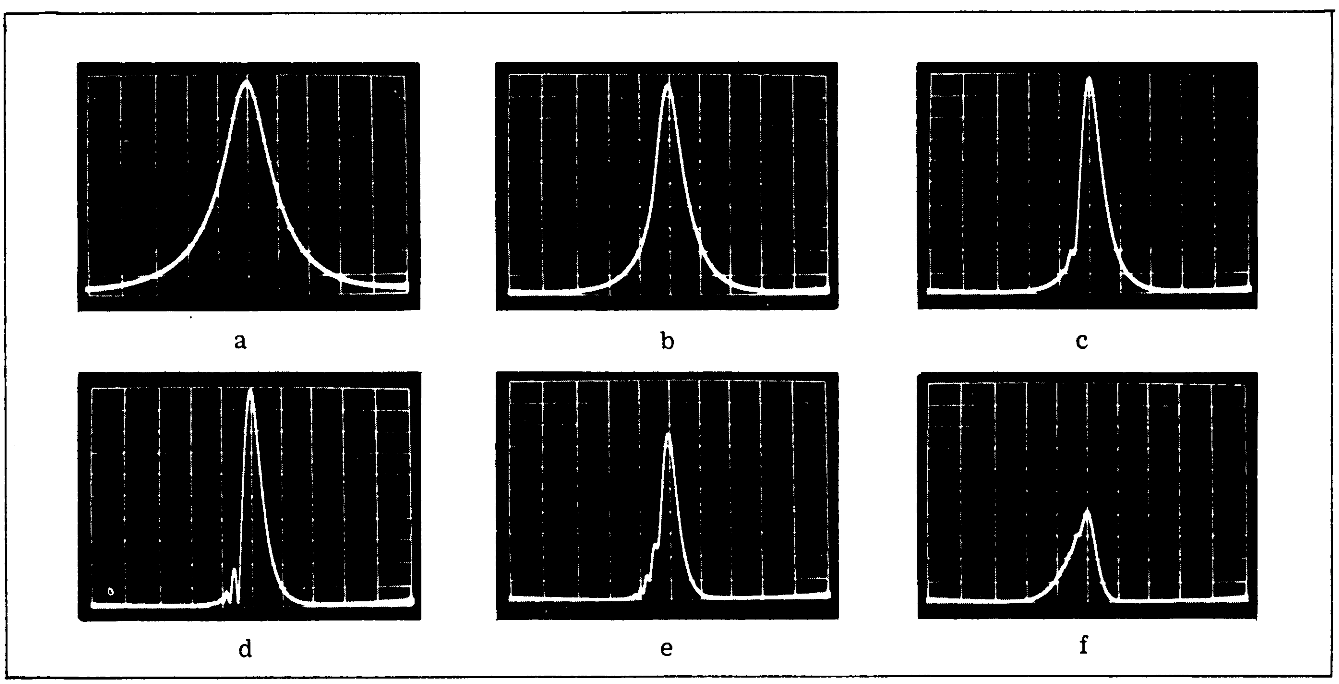

Figure III-2. Ringing as an Indication of Optimum Resolution.

velocity. (c) shows beginning of "ringing". Extent of "ringing" in (d) shows optimum resolution. As the i-f section is made narrower, excessive "ringing" widens pip and amplitude decreases as shown in (e) and (f).

Further counterclockwise rotation of the IF BANDWIDTH control causes a reduction in amplitude and a tendency of remerging of the pips.

6. To better separate the signals, the SWEEP WIDTH and IF BANDWIDTH controls can be further backed off counterclockwise and the SWEEP RATE set to a lower rate. (See b. below for use of AFC.)

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 the IF BANDWIDTH control will result in lessened resolution and a "bobbing" presentation.

7. If a signal of small amplitude is close in frequency to a signal of large amplitude, the pip representing the small amplitude signal will be influenced by the skirt of the large amplitude signal (the amplitude-versus-frequency response of the i-f section being bell-shaped). As the signals are separated in frequency, the error becomes less.

If adjacent signals have a large amplitude difference, IF BANDWIDTH control settings to depict the signals as definitely separated pips should be used. Waveforms (a) through (f) of Figure III-3 illustrate the progressive variation in pip separation of two signals as the IF BANDWIDTH control is rotated in a counterclockwise direction.

In (a) the i-f bandwidth is broad and there is no resolution of adjacent signals. In (b) and (c) the smaller adjacent pip begins to emerge as bandwidth is narrowed. In (d) definite separation of the pips is seen, however, due to beating of the two signals, the amplitude indication of the smaller pip is higher than its final value. In (e), the beginning of a ringing pip on the left side of the large pip shows i-f bandwidth approaching an optimum value. The extent of ringing in (f) shows that optimum i-f bandwidth has been reached. Highest accuracy of relative amplitude measurements results when adjacent signals are clearly resolved.

8. If it is mandatory to observe a given band width with the contained signals closely spaced, the best possible resolution is indicated by the clearest picture. A reasonably accurate measurement of relative amplitudes can be made by reading the center of the beats. This is illustrated in Figure III-4. The amplitude ratio in (a) is greater than the ratio (b), resulting in a different presentation.

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b. For best separation of signals the 0.1 cps scanning rate can be used. Turning AFC on provides a suitably small scanning width (±1 KC) as well as the necessary frequency stability. The following procedure should be used. AFC

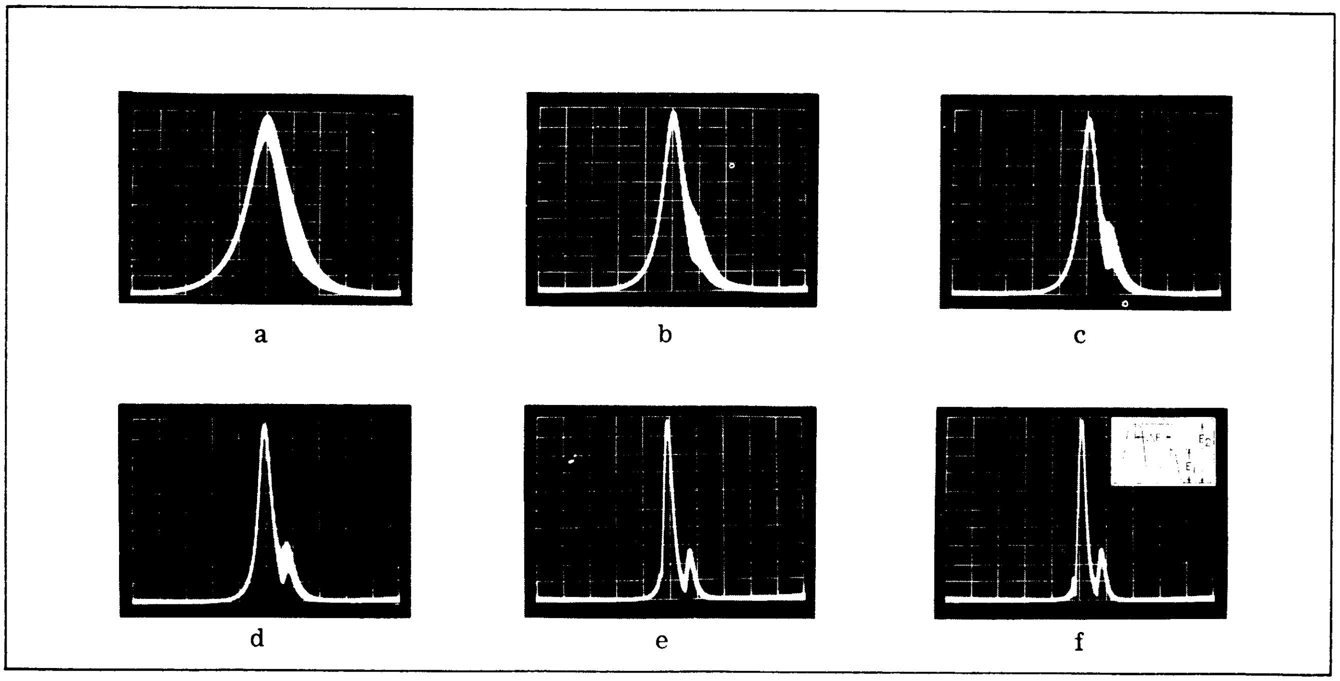
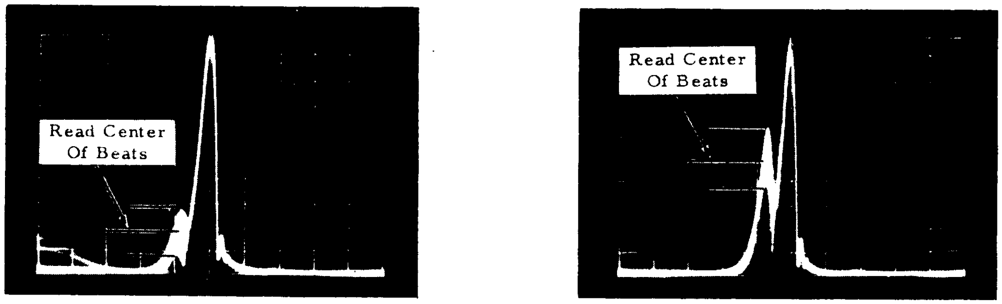


Figure III-3. Resolution of Signals of Unequal Amplitude.



a b

Figure III-4. Measurement of Closely Spaced Unequal Amplitude Signals.

may also be used with faster rates, up to approximately 5 cps.

1. With the IF BANDWIDTH control fully clockwise and SWEEP WIDTH set completely clockwise, tune the signals of interest to the center of the screen with the external oscillator.

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

3. Set the SWEEP RATE control to a suitable rate, less than 5 cps, depending upon the desired degree of frequency separation and the nature of the signals. AFC should not be used at sweep rates greater than 5 cps. Note that with AFC on and SWEEP WIDTH 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 the SWEEP WIDTH control.

4. Turn the IF BANDWIDTH control counterclockwise until optimum resolution is obtained. See a.4. above.

5. Use the VIDEO FILTER 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 the VIDEO FILTER results in integration of the signal pips as well as slight shifting of the pips.

c. In many cases, it will be most convenient to use the SWEEP WIDTH SELECTOR to set up operating conditions for narrow band analysis. In this mode of operation, the sweep width, sweep rate, i-f bandwidth, and video filtering are automatically set for optimum presentation.

III-3. OPERATING PROCEDURE FOR THIRD-ORDER 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 kilocycle. The r-f 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 r-f carriers by an amount equal to the difference frequency.

The Panalyzor, Model SB-12a, 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.

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

b. Follow the regular operating procedure to display the two r-f signals on the screen. Use a sweep width at least three times the separation between the two signals.

c. Set the AMPLITUDE SCALE switch to LOG. Set the IF ATTEN(uator) to 20 db. Set the GAIN to maximum (fully clockwise) and adjust the INPUT ATTENUATOR to obtain full scale deflection. The GAIN control may be reduced slightly for the final adjustment.

d. Set the IF ATTEN(uator) to 0 db. The Panalyzor 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.

III-4. OPERATION WITH MODEL RC-3 RECORDER

A connector, J402, located on the rear apron of the analyzer chassis, is provided for operation of the Panalyzor with the accessory chart recorder, Model RC-3b. When the Model RC-3b is not used, the jumper plug, P402, must be installed in J402.

See the Instruction Manual for the Model RC-3b for details of its operation with a Panoramic analyzer. The Model RC-3b Manual refers to a Model LP-1a as the companion analyzer. In all places where the Manual refers to "LP-1a", read "SB-12a". Where reference is made to test frequencies, scan widths and control settings, substitute appropriate values within the operating range of the Model SB-12a.

The Model SB-12a should be operated in the VAR mode. The SWEEP RATE control should be rotated to its maximum clockwise position. With the RECORDER OPERATION switch of the Model RC-3b in the STANDBY position, the SWEEP WIDTH control may be used to adjust the sweep width of the Model SB-12a to any desired value within its range. All normal operating controls are functional in this mode of operation.

It will be found that the IF BANDWIDTH control may be set further counterclockwise (narrower bandwidth) on the 1 minute and longer scans of the Model RC-3b than on the external sweep rates provided by the Model SB-12a. The proper setting must be determined by successive sweeps through a test signal such as the one from the 500 kc calibrating oscillator in the Model SB-12a.

Referring to the instructions on line size in the Model RC-3b Instruction Manual, the line size should be set so that it reaches the right edge of the "0" amplitude calibration at the right of the SB-12a, screen, and midway between the "2" and "0" of the "-20 db" amplitude calibration at the left edge of the screen.

When ordering the Model RC-3b separately from the Model SB-12a, the order should specify that it is to be used with the Model SB-12a, and the serial number of the Model SB-12a must be given.

III-5. INTERPRETATION OF SIGNALS

a. A constant carrier signal appears as deflection of fixed, height with the nature of presentation depending upon the sweep width as shown in Figure III-5 (a) and (b).

Deviations of the signal from true c-w will result in displays which will indicate the character of the signals as follows:

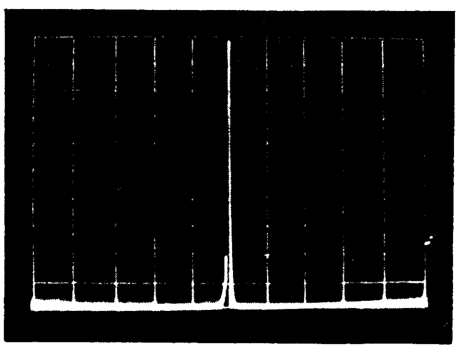
1. Oscillator Drift-deflection moves slowly across the screen.

2. Periodic Drift - deflection moves back and forth across the screen.

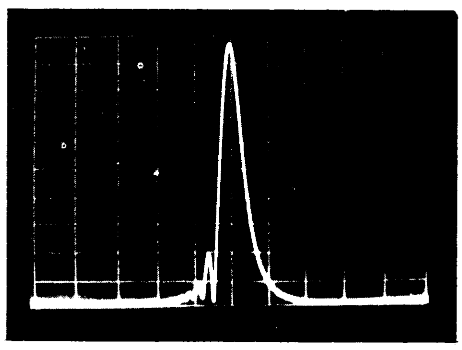
3. Squegging - interruption of an oscillator at a-f or r-f rate will result in a spectrum display resembling that of a pulse-modulated signal. Sideband components will be present in addition to the oscillating frequency.

b. An amplitude-modulated carrier appears as a deflection of variable height. Non-constant tone modulation of low frequency will produce a series of convolutions varying in height, their number being determined by the modulation frequency. The nature of the presentation will depend upon the sweep width (Figure II-5.a. and b.).

As the modulation frequency increases, the convolutions move toward the two sides of the de-



(a) Constant carrier signal at approximately maximum sweep width.



(b) Appearance of constant carrier at reduced sweep width.

Figure III-5. Screen Presentations of Constant Carrier Signal.

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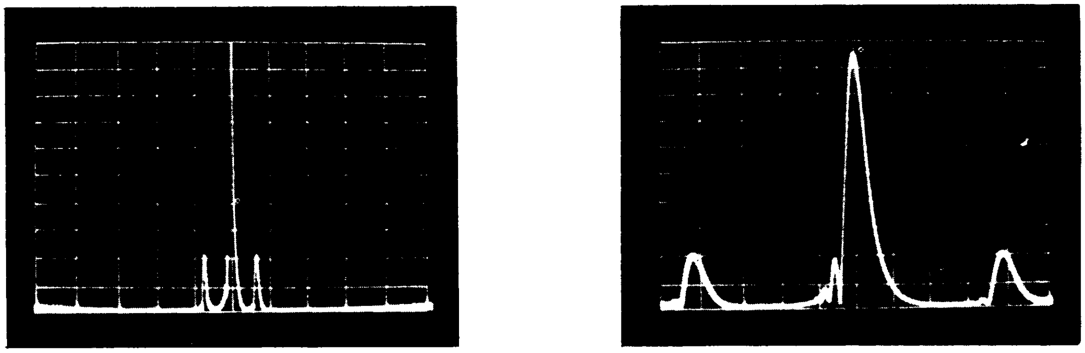


(a) A-m signal, showing carrier and two sidebands.

(b) Same a-m signal at reduced sweep width, carrier remains at center of screen.

Figure III-6. Screen Presentations of Amplitude-Modulated Signals.

flections, and the sidebands become visible. When the modulation frequency is increased, it becomes possible to separate the sidebands by reducing the sweep width of the analyzer. The IF BANDWIDTH control will enable further separation. The higher the frequency of modulation, the farther away those sidebands will move from the center deflections, which represent the carrier. The relative heights of the sidebands may vary as the external oscillator is tuned and as the deflection moves from one end of the screen to the other.

c. The appearance of single sideband signals depends upon the type of modulation employed. Tone-modulated single sideband signals appear as a carrier (for a single tone), or a series of carriers (for multi-tones) of slightly different frequency. Voice or music modulated single sideband signals appear as a "smear" of rapidly varying signals which occupy a finite band width. (See paragraph g., "Signal Interference", below.)

d. A carrier, frequency modulated at a low rate appears as a carrier which wobbles sideways.

e. A CW signal appears and disappears in step with the keying of the signal source. 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.

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

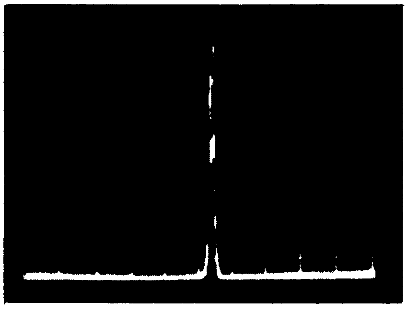
g. Signal Interference. Two c-w signals which are so close in frequency as to cause aural interference (beats) may appear on the screen as a single signal varying in height as with modulation. As the frequency separation is increased, the signal appears to be modulated on one side only. Further separation will cause a "break" in the apex of the deflection. By reducing the sweep width of the analyzer, the two signals will gradually separate. Further separation is effected with the IF BANDWIDTH control and by setting the SWEEP RATE to a lower rate (Figure III-7.a. and b).

h. Frequency modulated carriers appear as a series of vertical deflections (Figure III-8.a and b.)

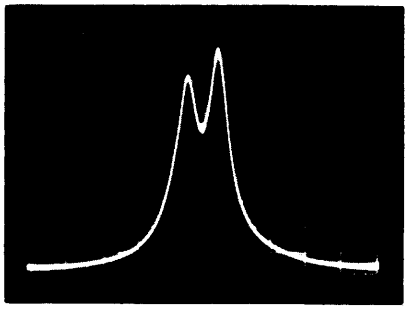
i. Radio interference signals of various types may appear on the screen of the spectrum analyzer. Such signals may have broad or narrow spectral distributions, and may occur at constant or at random repetition rates. Signals which occur at a variable repetition rate (such as those produced by accelerating motors, vibrators, buzzers, etc.) may move in one direction or the other along the frequency sweep baseline; this is caused by the fact that the analyzer is sweeping at a fixed rate, whereas the observed signal occurs at a variable rate. The images stand still on the screen when there is synchronism between the two. Signals produced by such sources as electrical arcing, switching transients, "static", and other short electrical impulses, have broad spectra which may cover the entire frequency sweep range of the analyzer.

j. Images. 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 Panalyzor when the external oscillator is being tuned.

k. Harmonics, produced in the converter by the beat of very strong signals with harmonics of the

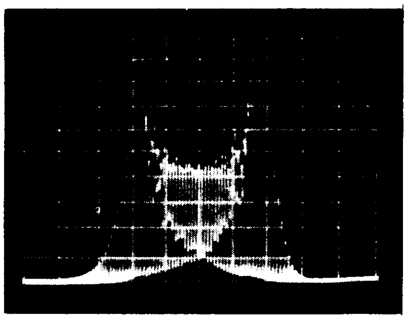


(a) Two interfering signals at maximum sweep width.

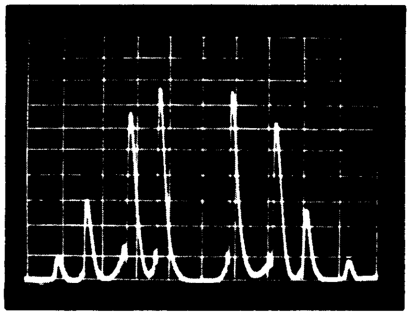


(b) Same signals at reduced sweep width, resulting in improved separation or resolution.

Figure III-7. Resolution of Interfering Signals.



(a) High level frequency-modulation with a low modulating frequency.



(b) Low level frequency-modulation with a high modulating frequency.

Figure III-8. Screen Presentations of Frequency-Modulated Signals.

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 Panalyzor and/or reduction in generator output will eliminate this type of spurious signal.

1. Spurious Signals. If the signal strength exceeds a certain value, the deflection caused by any signal may break up into a series of parallel deflections somewhat similar to sidebands. Attenuation of signal input level will remedy this.

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CHAPTER IV
THEORY OF OPERATION

IV-1. INTRODUCTION

As shown in Figure IV-1, the Model SB-12a consists of the following seven principal sections.

1. Input section.
2. Sweep generator section.
3. Mixer and sweep oscillator, reactance modulator, and AFC section.
4. 100 KC i-f and video section.
5. Crt with horizontal and vertical 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 external oscillator input frequency is required for incoming signals in the 450 - to 550-KC range. An external oscillator input frequency 500-KC higher or lower than the signal input frequency is required for incoming signals outside the 450 - to 550-KC range. With a 0.3-volt rms external oscillator input level, a 2-millivolt or smaller signal input level will produce full-scale log deflection on the 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 sawtooth output circuits. The sawtooth speeds are variable from 0.1 to 30 cps. One sawtooth voltage wave provides the crt with horizontal sweep. The other sawtooth voltage wave is fed to a reactance modulator whose operations are explained in the following paragraph.

On receiving the sawtooth 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 sawtooth 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 r-f 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 i-f 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 i-f amplifier's signal, are amplified in a narrow band four-stage amplifier, are detected, and are fed to the crt vertical plates via a vertical amplifier.

Consequently, the crt displays the component signals in the 100-KC r-f bandwidth under surveillance. If desired, narrower r-f bandwidths may be displayed across the crt screen. The pip amplitude and position along the calibrated horizontal axis are indicative of each component signal level and frequency, respectively. The sawtooth voltage output of the sweep generator progressively shifts the crt 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 r-f bandwidth being scanned.

If desired, the calibrating oscillator will provide the crt 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 built-in 5 KC oscillator, controlled from the front panel, performs the same function as an external modulating signal, for situations where 5 KC intervals are satisfactory. The PS-12 is a conventional electronically regulated type supplying +270 volts to the Model SB-12aS.

IV-2. CIRCUIT DESCRIPTION

a. Input Section. 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 ±.05 db/db up to 30 MC. It is usable with reduced accuracy up to several hundred megacycles.

The input attenuator is followed by an aperiodic

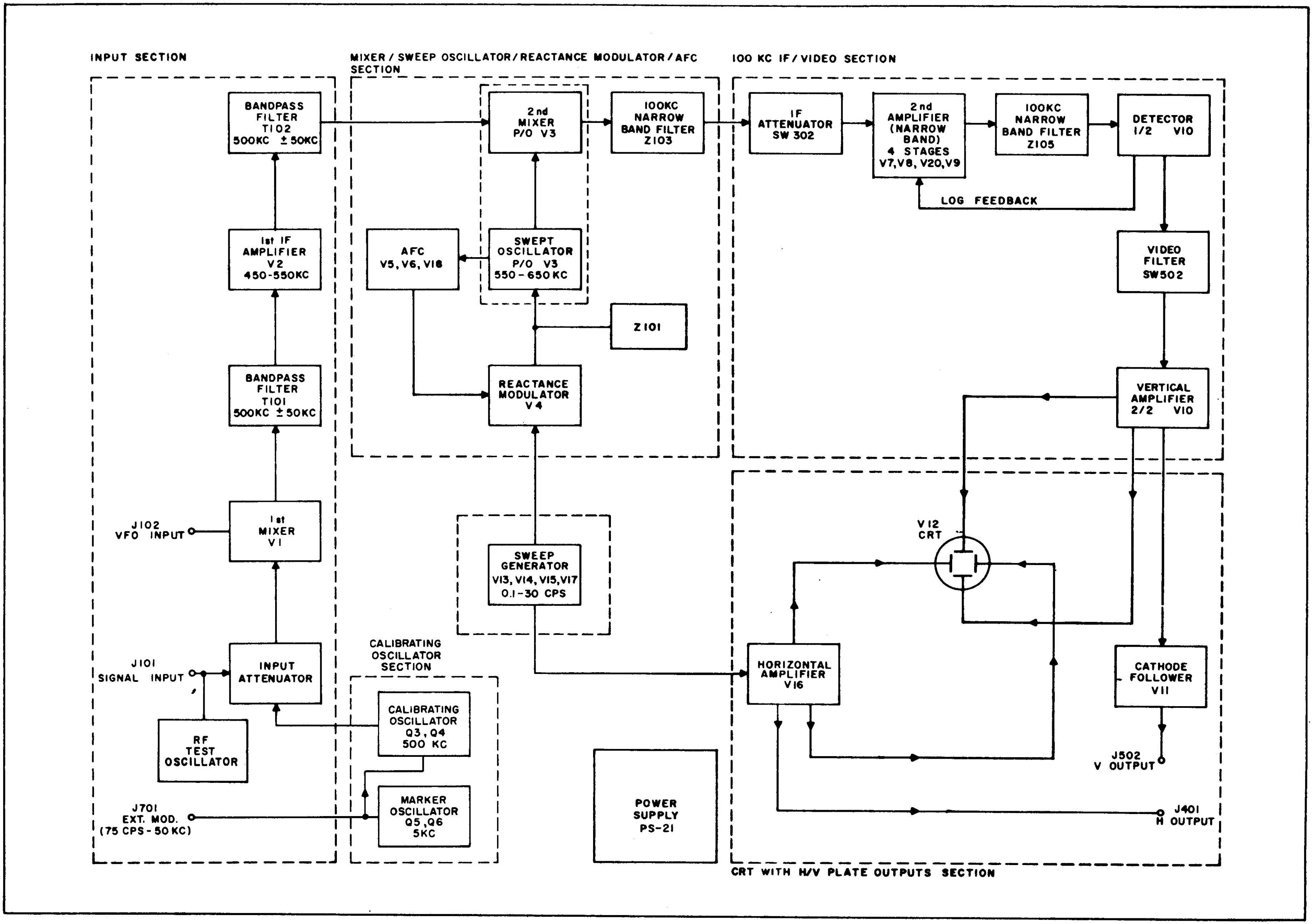

Figure IV-1. Block Diagram, Model SB-12aS.

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mixer V1 (6J6) which is coupled to neutralized cascode r-f amplifier V2 (12AT7). GAIN control potentiometer R108 in the cathode circuit of V2 allows up to 20 db of attenuation. The output of the r-f amplifier is coupled to second mixer V3 (6BE6). Coupling transformers T101 and T102 in the r-f 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 S701 through S706. 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. 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 Model SB-12a input circuits.

3. SIGNAL INPUT J101. This coaxial jack receives r-f signal to be analyzed. J103 on the rear chassis apron is in parallel with this jack.

4. VFO INPUT J104. VFO is the associated external oscillator or signal generator which is used to heterodyne with the test signal to produce the required frequency to operate the Model SB-12a.

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).

b. Sweep Generator Section. The sawtooth sweep voltage is derived from a feedback integrator circuit consisting of V13 (6AU6) and V14A (1/2 12AU7). Capacitor C401 is charged with a constant current determined by the setting of SWEEP RATE potentiometers R404 and R407. The resulting sawtooth 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 V14A (1/2 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 sawtooth voltage reaches a predetermined amplitude, blocking tube oscillator V14B (1/2 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. H 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. 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 the SWEEP WIDTH SELECTOR switch.

2. FAST SWEEP SW403. This momentary contact push-button switch speeds up the sweep rate from 0.1 to 1 cps on the 150-cps, and 500 cps preset sweep ranges. 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. This switch control provides a choice of five preset widths of 150 cps, 500 cps, 3.5 KC, 7 KC, and 14 KC, 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 i-f 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 i-f bandwidth

is automatically set for optimum resolution. On the two narrowest ranges, the AFC circuit is automatically turned on; on the 3.5 KC, 7 KC and 14-KC ranges it is disabled. On the two 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 3.5 KC, 7 KC and 14-KC ranges is 1 cps, and the video filter bandwidth is approximately 400 cps. The sensitivity of the Model SB-12a is constant on all ranges within ±15 per cent.

4. SWEEP WIDTH R424 and R218. 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 factory personnel and should be changed only by qualified technical personnel.)

(a). LINE SIZE potentiometer R421.

(b). 30-cycle adjust potentiometer R409.

(c). 0.1-cycle adjust potentiometer R406.

(d). HORIZ OUTPUT jack J401.

(e). SWEEP WIDTH LIMIT potentiometer R423.

c. Mixer and Sweep Oscillator, Reactance Modulator, and AFC Section. 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 sawtooth 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 i-f 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 r-f 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 i-f amplifier V2.

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

1. CENTER FREQ/AFC OFF, R207 and S201. 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, S402-2T, -1T, and -3T. This switch control provides a choice of five preset sweep widths of 150 cps, 500 cps, 3.5 KC, 7 KC, and 14 KC, 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 i-f 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 i-f bandwidth is automatically set for optimum resolution. On the two narrowest ranges, the AFC circuit is automatically turned on; on the 3.5 KC, 7 KC and 14 KC ranges it is disabled. On the two 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 3.5KC, 7 KC and 14 KC ranges is 1 cps, and the video filter bandwidth is approximately 400 cps. The sensitivity of the Model SB-12a is constant on all ranges within ±15 per cent.

3. SWEEP WIDTH R424 and R218. 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 factory personnel and should be changed only by qualified technical personnel.)

(a). CF PÀD potentiometer R203.

(b). SWEEP WIDTH LIMIT/AFC potentiometer R216.

(c). CENTER FREQ potentiometer R206.

(d). AFC TEST jack J201.

d. 100-KC I-f and Video Section. The output of the second mixer is connected through 20-db attenuator S302 to the 100-KC i-f 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.

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First i-f 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 S402-1B), the effective series resistance of the crystal filter is decreased and the crystal bandwidth narrows.

Second i-f stage V8 (6U8), a neutralized amplifier, is similar to the first. Two shunting potentiometers, R305 and R309, designated IF BANDWIDTH form part of the i-f selectivity circuits. SWEEP WIDTH SELECTOR switch S402-3B, controls selectivity while switch S402-2B controls gain.

Third i-f stage V20(6U8), a neutralized amplifier, is similar to the first. SWEEP WIDTH SELECTOR switch S402-5B shunts the grid return to ground in this stage.

Fourth i-f stage V9 (6AU6), is a conventional i-f amplifier. A d-c 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 S301 is in LOG position.

The fourth i-f 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 i-f 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 i-f 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 d-c 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 S302. This toggle switch allows 20 db of attenuation to be inserted in the i-f 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 Model SB-12a 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. Resolution, or the ability to separate individual signals, is dependent upon two factors: the rate of frequency scan and the bandwidth of the i-f section of the instrument. Optimum resolution requires a definite relationship between the two. Resolution sharpens as both the frequency scanning rate and i-f bandwidth are decreased. The IF BANDWIDTH control is used to narrow the i-f bandwidth. Counterclockwise rotation of this control narrows the width of the i-f 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 i-f bandwidth is automatically set for optimum resolution.

3. SWEEP WIDTH SELECTOR S402-1B, -2B, -3B, -5B, -4T. This control provides a choice of five preset sweep widths of 150 cps, 500 cps, 3.5 KC, 7 KC, and 14 KC, 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 i-f 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 i-f bandwidth is automatically set for optimum resolution. On the two narrowest ranges, the AFC circuit is automatically turned on; on the 3.5 KC, 7 KC and 14 KC ranges it is disabled. On the two 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 3.5 KC, 7 KC and 14 KC ranges is 1 cps, and the video filter bandwidth is approximately 400 cps. The sensitivity of the Model SB-12a is constant on all ranges within ±15 percent.

4. AMPLITUDE SCALE LOG-LIN S301. 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 lines on the calibrated screen are used. The calibration range is from 0 db to -40 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 calibration dots on the right edge of 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. 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 and 500 cps preset sweep ranges, the LO filter is automatically switched on. On the 3.5 KC, 7 KC and 14 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 factory personnel and should be changed only by qualified technical personnel.)

(a). BANDWIDTH LIMIT potentiometer R310.

(b). LOG ZERO ADJ potentiometer R321.

(c). LOG SCALE ADJ potentiometer R325.

(d). Inductors L101A, L101B, and L101C.

e. Crt with Hor/Vert Plate Outputs Section. 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 of the crt vertical plates via VERT OUTPUT jack J502.

The cathode-ray tube screen is 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. The sharpness of the screen presentation is adjusted with control R520.

2. BRILLIANCE R522. The intensity of the screen presentation is adjusted with control R522.

3. H POS R427. Control R427 is used to adjust the position of the baseline trace along the horizontal axis.

4. V POS R507. Control R507 is used to adjust the position of the baseline trace along the vertical axis.

5. ILLUMINATION, POWER ON-OFF S501 and R525. 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 factory personnel and should be changed only by qualified technical personnel.)

(a). ASTIGMATISM potentiometer R516.

(b). VERT OUTPUT jack J502.

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f. CRYSTAL-CONTROLLED CALIBRATING OSCILLATOR SECTION.

Transistor Q3 (2N404) is a 500 KC crystal oscillator. It drives an emitter-follower stage, Q4 (2N404) whose output is coupled through a 1000 ohm isolating resistor (R114) to the SIGNAL INPUT of the Model SB-12a. The output of the calibrating oscillator is varied by the CAL OSC LEVEL control R726 which determines the supply voltage delivered to the two transistors.

An external audio signal may be applied, via EXT MOD connector J701, to the emitter of the oscillator transistor Q3. The external audio signal amplitude modulates the 500 KC signal and provides frequency markers with a known separation.

The 5 KC marker oscillator consists of a bridged-T resistance-capacity oscillator with two transistors, Q5 and Q6 (2N404). The frequency of the oscillator is adjustable over a restricted range. It is factory adjusted to 5000 cps ±2%. The output of the oscillator is at a low impedance, and is capacitively coupled through C813 to the emitter of the 500 KC crystal oscillator transistor.

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

1. CAL OSC LEVEL R726. 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 Model SB-12a 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. In its fully counterclockwise position, the CAL OSC LEVEL control reduces the oscillator output to zero.

2. EXT MOD J701. Provides the crt screen with markers.

3. 5 KC MARKER S701. This two position switch connects the output of the 5 KC marker oscillator to the 500 KC calibrating oscillator when it is moved to the up position.

A control not mounted on the front panel that applies to this section is as follows: This control is initially set by factory personnel.

FREQ. ADJ. R807. This control is used to adjust the marker oscillator to 5 KC.

g. Power Supply, Model PS-12. The power supply is a conventional electronically regulated type supplying +270 volts to the analyzer.

The high voltage for the crt is obtained from a pair of high voltage selenium rectifiers, CR601, CR602. The bleeder current from the negative crt supply operates a voltage reference tube (V17, 5651) in the analyzer, which supplies -87 volts to the sweep circuits. A voltage regulator (V18 OA2) supplies the r-f 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 d-c supply obtained from the a-c heater system via a selenium bridge rectifier, CR-1.

CHAPTER V
SERVICE AND MAINTENANCE

V-1. GENERAL

This equipment has been thoroughly tested and aligned before shipment, and with normal usage should function as described in the previous chapters. However, as in all electronic devices, occasional failure of a tube or component may result in malfunctioning, necessitating maintenance action. This chapter is divided into eight sections to facilitate its use in the adjustment, alignment, maintenance, and repair of the equipment.

Section V-2 describes the procedure for inspecting and replacing components.

Section V-3 is a list of the test equipment recommended for use in servicing the equipment.

Section V-4 is a description of the screw driver-adjust controls found on the chassis of the equipment.

Section V-5 describes the touch-up alignment that may become necessary because of aging or failure of a tube or component in the circuit.

Section V-6 is a description of the complete alignment procedure. It is only under the most unusual circumstances that this procedure will have to be used in its entirety. Most of the alignment problems encountered in the field can be solved by using the applicable adjustment techniques mentioned in Section 4.

Section V-7 provides charts showing the tube layouts and the normal voltage and resistance measurements made on properly functioning instruments.

Section V-8 is a list of the replaceable parts used in the equipment.

If the equipment develops trouble which cannot be corrected by using the procedures outlined in this chapter, it is recommended that the instrument be returned to Panoramic Radio Products, Inc. for servicing. Before returning the instrument fill out and mail the Repair and Maintenance Form bound in the rear of this Manual. Upon receipt of the information thereon, the company's Service Department will supply the necessary servicing data or shipping instructions. After receiving shipping instructions, forward the instrument prepaid to the factory. If requested, an estimate of charges will be made before the repair is begun.

V-2. INSPECTION AND COMPONENT REPLACEMENT

a. INSPECTION.

All components of the equipment should be given a thorough inspection at regular intervals and whenever maintenance requires removal of an instrument from its cabinet. Moisture may cause deterioration of material and produce substandard operation. Dust and dirt materially affect both electrical and mechanical operation. Keep the various parts clean. Check accessible connections and tubes regularly to make sure that all contacts are clean and tight and that tubes and crystals are held securely in their sockets.

b. REPLACEMENT.

All tubes and crystals are accessible at the top of the chassis. The pilot lamp is located on the front-panel, and is removed by unscrewing. The fuses are located on the rear chassis apron of the Power Supply, Model PS-12. Spare fuses are mounted on the rear chassis apron of the Model SB-12a.

CAUTION

Never replace a fuse with one of a higher current rating. If a fuse burns out immediately after replacement, do NOT replace it a second time until the cause has been determined and trouble is corrected.

c. VACUUM TUBE REPLACEMENT.

Vacuum tubes should be checked on a reliable tube tester. An indication of "GOOD" on a tube tester does not mean that a tube will necessarily function properly in its circuit, but a "REPLACE", "BAD", or borderline indication does mean that better service will generally result if the tube is replaced. The average commercial tube tester should not be called upon to give more information than this. Many questions regarding the condition of a particular tube in a given circuit can best be answered by substituting a tube known to be free from defects in its place and comparing the performance of the equipment.

V-3. RECOMMENDED TEST EQUIPMENT

The following equipment should be available in order to properly service and align the Model SB-12a.

a. 2 Signal Generator, Hewlett-Packard Model 606A or equivalent (50 kc to 65 MC, 0.1 uv to 3 V).

b. 1 Signal Generator, Hewlett-Packard Model 200CD or equivalent. (5 cps to 600 KC, 0 to 5 V).

c. 1 Vacuum-tube Voltmeter, RCA Model WV-77C or equivalent.

V-4. SCREWDRIVER-ADJUST 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 one-quarter inch on either side of the frequency scale limits.

b. Sweepwidth Limit: This control is adjusted to provide correct sweep widths in the VAR, 14 KC, 7 KC and 3.5 KC positions of the SWEEP WIDTH SELECTOR.

1. Set the SWEEP WIDTH SELECTOR to VAR.

2. Set the 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 source 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 Sweepwidth Limit control to place the sideband pips approximately 1/8 inch inside the left and right extremes of the frequency scale.

6. Set the SWEEP WIDTH SELECTOR to 14 KC.

7. Shift the signal source to 7 KC and check location of sideband pips relative to the right and left extremes of the frequency scale.

8. Switch SWEEP WIDTH SELECTOR to 7 KC.

9. Shift signal source to 3.5 KC and check location of sideband pips relative to the right and left extremes of the frequency scale.

10. (Same as 8, at 3.5 KC).

11. (Same as 9, at 1.75 KC).

12. In the VAR, 14 KC, 7 KC and 3.5 KC 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 Sweepwidth 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, 14 KC, 7 KC and 3.5 KC positions of the SWEEP WIDTH SELECTOR.

c. Sweepwidth Limit AFC: When the sweep width has been adjusted in accordance with paragraph V-4. above, set the SWEEP WIDTH SELECTOR to 500 cps and modulate the CAL OSC with a 250 cps signal. Adjust the Sweepwidth Limit AFC control, to place the sidebands on the left and right extremes of the frequency scale. This also calibrates the 150 cycle sweep range.

d. Astigmatism: This control is adjusted, together with the FOCUS control, to produce a sharp circular spot over the full width of the crt.

e. 1. IF GAIN: This control is effective in the VAR position of the SWEEP WIDTH SELECTOR. It adjusts the gain of the i-f amplifier for the specified sensitivity.

(a) 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 ATTENUATORS	All up
5 KC MARKER	OFF
H POS	Normal Operation
V POS	Normal Operation
SWEEP WIDTH	Maximum (Clockwise)
IF BANDWIDTH	Maximum (Clockwise)
VIDEO FILTER	OFF
SWEEP RATE	Maximum (Clockwise)

(b) Connect a 3.0 MC signal source to the front panel SIGNAL INPUT connector. Set the amplitude of the signal source to 1 millivolt.

(c) Connect a 2.5 MC signal source to the front panel VFO INPUT connector. Set the amplitude of the signal source to 0.3 volts.

(d) Adjust the IF GAIN control for a full scale pip on the screen.

2. 14 KC: This control adjusts the i-f gain in the 14 KC position of the SWEEP WIDTH SELECTOR. It is set for the same overall gain obtained in paragraph e.1.

3. 7 KC, 3.5 KC, 500 cps and 150 cps: These i-f gain controls are adjusted in a manner similar to the adjustment of the 14 KC IF Gain control.

f. Log Scale Adj. and Log Zero Adj: These controls may require adjustment if the last i-f tube (V9, 6AU6), the detector (V10, 12AU7) or the 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 0 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 20 DB calibration of the screen.

5. Set the INPUT ATTENUATOR to 0 DB and re-adjust 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 crt scale.

7. Check the intermediate points of the LOG crt calibrations using the INPUT ATTENUATOR. If the error at any point exceeds ±1 DB, it may be possible to re-adjust 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 re-calibrated.

NOTE

This check should be performed with the IF ATTEN switch in the 20 DB position, to reduce noise on the baseline. Set the GAIN control fully clockwise and the CAL OSC LEVEL control set for a full scale (LOG) pip when all INPUT ATTENUATORs are up. The full 40 db calibrated screen may be checked using the INPUT ATTENUATORs above.

g. .1~ Adj and 30~ Adj Sweep Rate Adjustment

1. Set the SWEEP WIDTH SELECTOR to 500 cps. Adjust .1~ Adj 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 the 30~ Adj control until two cycles of the sine wave appear on the screen.

3. Repeat the procedure given in paragraph g.1. above. There is some interaction between the .1~ Adj and 30~ Adj controls, and it may be necessary to repeat the entire procedure several times.

h. 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 place the pip in coincide with the center frequency scale calibration.

i. 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.

V-5. TUBE REPLACEMENT AND TOUCH-UP ALIGNMENT

The Model SB-12a, has been factory aligned before shipment, and should not require re-alignment under normal conditions. However, it should be noted that the alignment has been made with the original set of tubes in operation; when tubes are replaced, touch-up alignment may become necessary because of non-uniformity in operating characteristics of vacuum tubes. Table V-1 lists the recommended adjustment procedures when the indicated tubes are replaced.

V-6. ALIGNMENT PROCEDURE

The following is a complete factory alignment procedure. It should be used only after touch-up

TABLE V-1. TOUCH-UP ALIGNMENT

TUBE	ADJUSTMENTS
V1	Selected replacement tube. Replacement should provide third order distortion of less than 60 db and direct sensitivity (at 500 KC), at least half as great as conversion sensitivity. IF Gain Controls.
V2	None
V3	CF PAD, Sweepwidth Limit Controls. See paragraphs V-4.b. and h.
V4	Z101, CF PAD, Sweepwidth Limit Control. See paragraphs V-4.b. and h. and V-6.c.
V5	None
V6	None
V7	IF Gain Controls. See paragraph V-4.e.
V8	IF Gain Controls. See paragraph V-4.e.
V9	Log Scale, Log Zero Controls. See paragraph V-4.f.
V10	Log Scale, Log Zero Controls. See paragraph V-4.f.

TUBE	ADJUSTMENTS
V11	None
V12	Line Size, Log Zero, Log Scale and Sweepwidth Limit Controls. See paragraph V-4.a, b and f.
V13	None
V14	None
V15	Selected replacement tube. Replacement should be selected for best linearity.
V16	None
V17	None
V18	None
V20	IF Gain Controls. See paragraph V-4.e.
V101	None
V102	None
V103	None
V104	Voltage Regulator Adjust

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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 aligning tool furnished.

The bottom windings may be tuned from either the top or the bottom 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 Panoramic equipment 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 ATTENUATORS . . . . . . All up
5 KC MARKER . . . . OFF
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)

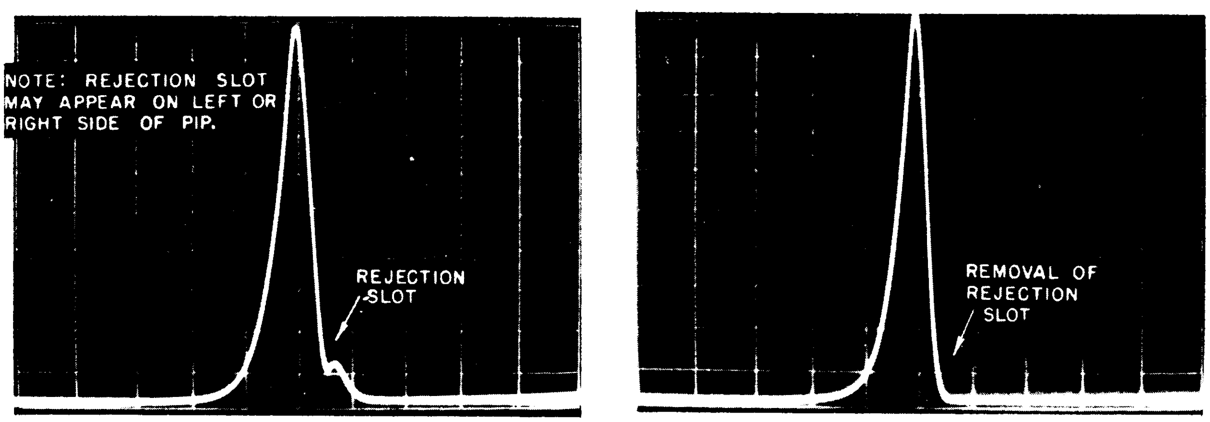
b. I-F AMPLIFIER ALIGNMENT

1. The frequencies involved in i-f alignment are:

TYPE	INPUT CENTER FREQ	IF
SB-12a	500 KC	100 KC

2. Connect a .01 mfd capacitor in series with the output of the signal generator and proceed as follows:

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 per cent 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 i-f



A. Illustration of Rejection Slot

B. Illustration of Complete Rejection Slot Removal

Figure V-1. Crystal Rejection Slot Removal

Step	Sig. Gen. Output	Sweep Width Control at	Signal Fed to	Procedure
				strip. These capacitors are to be tuned with the screwdriver end of the aligning tool furnished. Each capacitor tunes the crystal nearest it.
6	----	--------	----	Set the BANDWIDTH LIMIT control to the center of its rotational range. At this point pip should approximate the shape shown in Figure V-1A or V-1B.
7	----	--------	----	Gradually rotate the trimmer screw of the capacitor nearest Y303 in a counter-clockwise 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 Figure V-1B).
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 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 correct rejection slot removal by adjusting sweep width until pip base occupies approximately 25 per cent of the screen baseline. Set the input amplitude for a full-scale deflection. Increase input amplitude by ten 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.

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Step	Sig. Gen. Output	Sweep Width Control at	Signal Fed to	Procedure
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. 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 a 20 per cent drop in amplitude as the SWEEP WIDTH control is changed from a maximum counterclockwise position to a maximum clockwise position.

c. F-M OSCILLATOR ALIGNMENT

The following adjustments are a series of approximations, which are narrowed down until the desired results are obtained.

1. Set the Sweepwidth Limit control fully clockwise.

2. Adjust the CF PAD for +85 volts, measured between the arm of the CF PAD and ground.

3. Set the front panel CAL OSC LEVEL control fully clockwise.

4. Adjust the GAIN control for a full scale pip.

5. Connect an accurate 50 KC signal source to the 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 Sweepwidth Limit control to place the ±50 KC sideband pips directly under the ±50 vertical screen calibrations. If necessary make slight centering re-adjustments 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 re-center 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. R-F ALIGNMENT

The r-f 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 r-f 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, re-wax 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 r-f band of the equipment.

1. Adjustment of Neutralizing Capacitor C107.

(a) Temporarily clip a 51,000 ohm, 1/2 watt resistor between the junction of R109 and R107 and B+.

(b) Set the GAIN control almost completely counterclockwise (at the first scale division from the counterclockwise end).

(c) Connect a 500 KC signal source to the front panel SIGNAL INPUT connector. Adjust the amplitude of the input signal to give an approximately 1/4 scale pip. If necessary, adjust the GAIN control slightly to give the required pip height.

(d) Adjust C107 for a minimum pip deflection.

(e) Remove the 51,000 ohm resistor.

2. Alignment of Interstage Transformer T102

(a) Make the spacing between the primary and secondary winding approximately 1/4 inch.

(b) Using a .01 mfd 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.

(c) Apply a 515 KC signal to pin #2 of V2. Tune the primary (top core) for a peak deflection.

(d) Shift the signal generator frequency to 485 KC. Tune the secondary (bottom core) of T102 for a peak deflection.

(e) 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 at 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.

(f) Repeat steps (c), (d) and (e) until peak deflections and the proper frequency seperation are obtained.

3. Alignment of Input Transformer T101

(a) Make the spacing between the primary and secondary windings approximately 1/16".

(b) 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.

(c) 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.

(d) Set the signal generator to 450 KC. Tune the secondary (bottom core) of T101 for maximum pip amplitude.

(e) 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 at 550 KC.

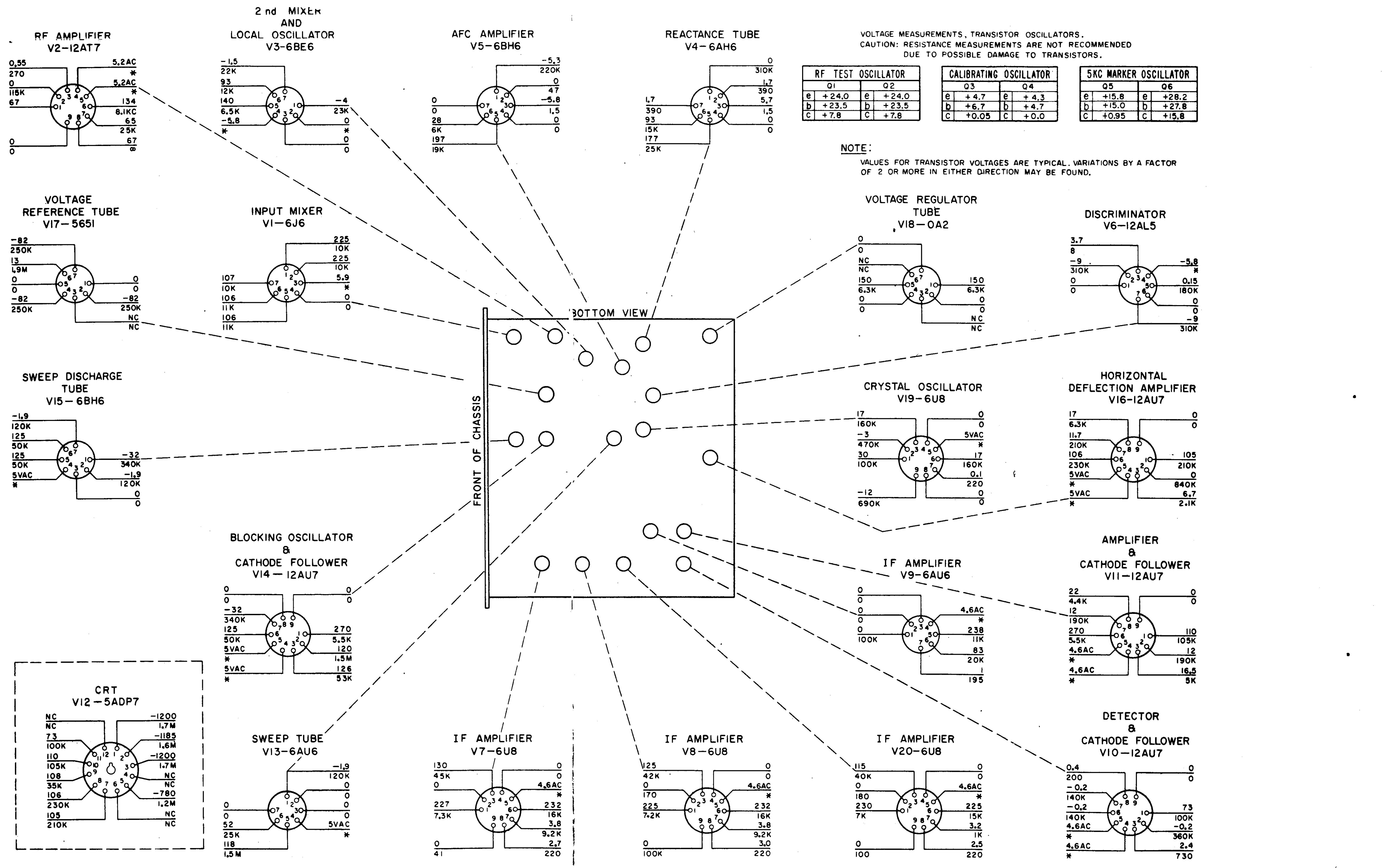
If the frequency separation is greater than specified, increase the coil spacing.

If the frequency separation is less than specified, decrease the coil spacing.

(f) Repeat steps (c), (d) and (e) until peak deflections and the proper frequency separation are obtained.

4. Adjust the cores of r-f 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.



RF TEST OSCILLATOR			
	Q1		Q2
e	+24.0	e	+24.0
b	+23.5	b	+23.5
c	+7.8	c	+7.8

CALIBRATING OSCILLATOR			
	Q3		Q4
e	+4.7	e	+4.3
b	+6.7	b	+4.7
c	+0.05	c	+0.0

5KC MARKER OSCILLATOR			
	Q5		Q6
e	+15.8	e	+28.2
b	+15.0	b	+27.8
c	+0.95	c	+15.8

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Figure V-2. Voltage and Resistance Chart, Model SB-12a

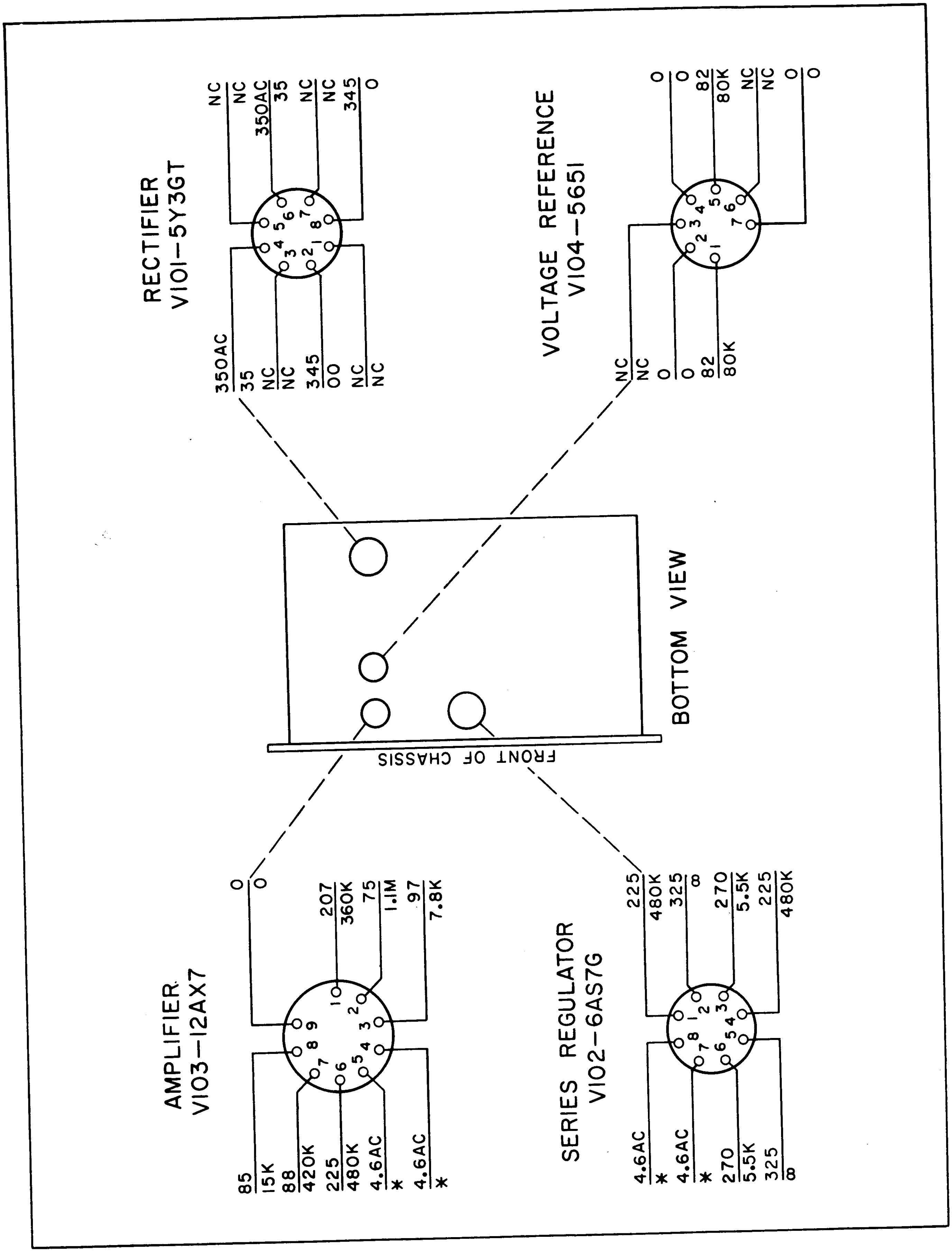

Figure V-3. Voltage and Resistance Chart, Model PS-12.

Step	Sig. Gen. Output	Signal Fed to	Transformer Tuned	Procedure
				On the other hand if the 550 KC pip is the taller of the two, trim the bottom core counterclockwise and the top core 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%.

e. Discriminator Alignment

1. Before adjusting the discriminator, the CF PAD must be adjusted according to the procedure given in paragraph V-4h.

2. Center the pip on the screen with the SWEEP WIDTH SELECTOR in the 3.5 KC position. Switch it to the 500~ position. The pip should appear near the center of the screen. If it does, switch to the 150~ position 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 Panalyzor.

(a) 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 pressing the FAST SWEEP button, but the final check must be done at a 0.1 cps sweep rate.

(b) Following this adjustment, proceed to the next narrower sweep width and repeat. The final adjustment should be on the 150~ 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.

V-7. VOLTAGE AND RESISTANCE MEASUREMENTS

The voltage and resistance measurements shown in Figures V-2 and V-3 should be used as an aid in locating and isolating causes of equipment malfunction.

All measurements were made with an RCA Vacuum Tube Voltmeter, Model WV-77B. The voltage and resistance readings on the charts are taken between the tube socket pin indicated and chassis ground. Resistance measurements were made with the power connecting cable and line cord disconnected and the ILLUMINATION control in the on position.

All measurements were made with the front panel controls in the following positions.

IF ATTEN . . . . 0 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
5 KC MARKER . . . . OFF
INPUT ATTENUATORS. . . . . 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)

Notes:
1. Voltage readings above line, resistance readings below line.
2. All voltages are DC unless otherwise specified.
3. All resistances are in ohms.
4. *indicates a very low resistance.
5. NC indicates on connection.

6. Q3 and Q4 measurements made with CAL OSC LEVEL control fully clockwise.
7. Q5 and Q6 measurements made with 5 KC MARKER ON.

V-8. LIST OF REPLACEABLE PARTS

NOTES:

a. In the case where an item appears more than once, the total quantity per section is listed only once in the "number in set" column. It is listed the first time the item appears in each section.

b. A list of the Manufacturers Code Letters used in this list is given on page 101.

c. In some cases values and ratings and source (manufacturer) shown are nominal and variations may be found. Satisfactory replacement may be made with either the listed component or an exact replacement for the part removed from the equipment.

When ordering parts from the factory, always include the following information:

1. Instrument Model Number.
2. Serial Number.
3. Circuit Reference Symbol.
4. Description of Part.

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List of Replaceable Parts for Models SB-12a and PS-21.

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C101		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105	14	
C102		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BA CD16XD-103Z	12	
C103		CAPACITOR: fixed, mylar, .1 uf, 200 V Pan Part CT2125-5	AL 338C104M	3	
C104		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BA CD16XD-103Z		
C105		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BA CD16XD-103Z		
C106		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BA CD16XD-103Z		
C107		CAPACITOR: variable, piston type trimmer, .6 uuf to 6 uuf, 1000 V Pan Part CV2051	AO VC-5	1	
C108		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500V Pan Part CC2123-1	AU 41C105		
C109*		CAPACITOR: fixed, tubular, .1 uf, 400 V Pan Part CT2011-10	AT 330401	1	

* Serial No's 20T and above only.

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C201 A,B,C		CAPACITOR: fixed, paper channel type, 3 x .1 uf, +20%, -10%, 600 V Pan Part CP69B5EF104V-5	AL Type 7710-BRN CP69B5EF104V	1	
C202		CAPACITOR: fixed, silvered mica, 51 uuf, ±5% Pan Part CM15C510J	AH CM15C510J	2	
C203		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BA CD16XD-103Z		
C204		CAPACITOR: fixed, silvered mica, 5100 uuf, ±5% Pan Part CM35C512J	AH CM35C512J	1	
C205		CAPACITOR: fixed, silvered mica, 270 uuf, ±5% Pan Part CM15C271J	AH CM15C271J	2	
C206		CAPACITOR: fixed, electro-lytic, twistlock, 2000 uf, 15 V Pan Part CE31X202E-1	AU Type DFP	1	
C207		CAPACITOR: fixed, paper, metal case, .47 uf, ±10%, 300 V Pan Part CT2060-1	AU 86P47493T15	4	
C301 A,B,C		CAPACITOR: fixed, paper, bath-tub, 3 x .1 uf, ±20%, 600 V Pan Part CP54B5FF104M-10	AT CP54B5FF104M	2	
C302		CAPACITOR: fixed, silvered mica, 100 uuf, ±5% Pan Part CM20C101J	AH CM20C101J	3	
C303		CAPACITOR: variable, ceramic trimmer, 3-12 uuf, NPO, 500 V Pan Part CV2111-13	AJ 557-3	3	
C304		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C305		CAPACITOR: fixed, paper, metal case, .47 uf, ±10%, 300 V Pan Part CT2060-1	AU 86P47493T15		
C306		CAPACITOR: variable, ceramic trimmer, 3-12 uuf, NPO, 500 V Pan Part CV2111-13	AJ 557-3		
C307		CAPACITOR: fixed, paper, metal case, .47 uf, ±10%, 300 V Pan Part CT2060-1	AU 86P47493T15		

List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C308		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C309		CAPACITOR: fixed, silver mica, 100 uuf, ±5% Pan Part CM15C101J	AH CM15C101J	2	
C310		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C311		CAPACITOR: fixed, silver mica, 470 uuf, ±5% Pan Part CM20C471J	AH CM20C471J	1	
C312		CAPACITOR: fixed, silver mica, 270 uuf, ±5% Pan Part CM15C271J	AH CM15C271J		
C313		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BA CD16XD-103Z		
C314		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BA CD16XD-103Z		
C315		CAPACITOR: variable, ceramic trimmer, 3-12 uuf, NPO, 500 V Pan Part CV2111-13	AJ 557-3		
C316		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C317		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C318		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C319		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C320		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C321		CAPACITOR: fixed, silver mica, 100 uuf, ±5% Pan Part CM20C101J	AH CM20C101J		

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List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C322		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC-2003-2	BA CD16XD-103Z		
C324		CAPACITOR: fixed, silver mica, 100 uuf, ±5% Pan Part CM20C101J	AH CM20C101J		
C325		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C326		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C327		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C328		CAPACITOR: fixed, paper, metal case, .47 uf, ±10%, 300 V Pan Part CT2060-1	AU 86P47493T15		
C401		CAPACITOR: fixed, paper, metal case, .047 uf, ±10%, 400 V Pan Part CT2077-1	AU 81P47394S1	1	
C402		CAPACITOR: fixed, paper, threaded neck mounting, 4 uf, 600 V Pan Part CP41B1FF405K-10	AT CP41B1FF405K	1	
C403		CAPACITOR: fixed, silver mica, 51 uuf, ±5% Pan Part CM15C510J	AH CM15C510J		
C405		CAPACITOR: fixed, ceramic disc, .05 uf, +80%, -20%, 500 V Pan Part CC2123-1	AU 41C105		
C407 A,B,C		CAPACITOR: fixed, paper, bath-tub, 3 x .1 uf, ±20%, 600 V Pan Part CP54B5FF104M-10	AT CP54B5FF104M		
C501		CAPACITOR: fixed, silver mica, 100 uuf, ±5% Pan Part CM15C101J	AH CM15-C101J		
C502		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC-2003-2	BA CD16XD-103Z		
C503		CAPACITOR: fixed, mylar .1 uf, 200 V Pan Part CT2125-5	AL 338C104M		

List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C505		CAPACITOR: fixed, silver mica, 1000 uuf, ±5% Pan Part CM20C102J	AH CM20-C102J	1	
C506		CAPACITOR: fixed, silver mica, 10 uuf, ±5% Pan Part CM20C100J	AH CM20C100J	1	
C510 A,B C,D		CAPACITOR: fixed, electrolytic, twistlock, 4x20 uf, 350 V Pan Part CE34X200P-1	AU Type DFP	1	
C601		CAPACITOR: fixed, electrolytic, twistlock, 20 uf, 500 V Pan Part CE31X200S-1	AU TVL-1943	1	
C602		CAPACITOR: fixed, electrolytic, twistlock, 30 uf, 500 V Pan Part CE31X300S-1	AU Type DFP	1	
C603 A,B		CAPACITOR: fixed, paper, rectangular, 2 x .25 uf, 2000 V Pan Part CP70D6XK254X-10	AT 7125-2x.25	2	
C604		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC2003-2	BA CD16XD-103Z		
C605		CAPACITOR: fixed, plastic molded, .1 uf, 400 V Pan Part CT-2011-10	AT 300401		
C606 A,B		CAPACITOR: fixed, paper, rectangular, 2 x .25 uf, 2000 V Pan Part CP70D6XK254X-10	AT 7125-2x.25		
C607		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC-2003-2	BA CD16XD-103Z		
C608		CAPACITOR: fixed, ceramic disc, .01 uf, 500 V Pan Part CC-2003-2	BA CD16XD-103Z		
C701		CAPACITOR: fixed, silver mica, 560 uuf, ±5% Pan Part CM15C561J	AH CM15C561J	1	
C702		CAPACITOR: fixed, silver mica, 910 uuf, ±5% Pan Part CM20C911J	AH CM20C911J		
C703		CAPACITOR: fixed, ceramic disc, .02 uf, ±20%, 500-600 V Pan Part CC-2055-1	AU 5GA-S2	2	

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List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
C704		CAPACITOR: fixed, silver mica, 470 uuf, ±5% Pan Part CM15C471J	AH CM15C471J	1	
C705		Not Used			
C706		CAPACITOR: fixed, ceramic disc, .02 uf, ±20%, 500 V Pan Part CC2055-1	AU 5GA-2		
C801		CAPACITOR: fixed, mica, 6,800 uuf, ±5% Pan Part CM35-682J	AH CM35-682J	1	
C803		CAPACITOR: fixed, mica, 10,000 uuf, ±5% Pan Part CM35-103J	AH CM35-103J	2	
C805		CAPACITOR: fixed, mica, 10,000 uuf, ±5% Pan Part CM35-103J	AH CM35-103J		
C807		CAPACITOR: fixed, electro-lytic, 10 uf, 12 VDC Pan Part CE71X100D-1	AU TE-1128	2	
C809		CAPACITOR: fixed, electro-lytic, 10 uf, 12 VDC Pan Part CE71X100D-1	AU TE-1128		
C811		CAPACITOR: fixed, mylar, .1 uf, 200 V Pan Part CT 2125-5	AL 338C104M		
C813		CAPACITOR: fixed, silver mica, 820 uuf, ±5% Pan Part CM20C821J	AH CM20C821J	1	
CR1		RECTIFIER: selenium, full wave, bridge type, 1.5 amp Pan Part CR2021	AS C11S1B1S1G	1	
CR601		RECTIFIER: selenium, half wave, cartridge type, 2000 V 5 ma Pan Part CR-2005	AM V100HF	2	
CR602		RECTIFIER: selenium, half wave, cartridge type, 2000 V 5 ma Pan Part CR-2005	AM V100HF		
F601		FUSE: instantaneous, glass cartridge, 2 amp, 250 V Pan Part F-1003	AD AGC2	2	

List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
F602		FUSE: instantaneous, glass cartridge, 2 amp, 250 V Pan Part F1003	AD AGC2		
I1		LAMP: miniature, T1-3/4, flanged, base, 6.3 V Pan Part B2106	BD 349	5	
I2		LAMP: miniature, T1-3/4, flanged, base Pan Part B2106	BD 349		
I3		LAMP: miniature, T1-3/4, flanged, base Pan Part B2106	BD 349		
I4		LAMP: miniature, T1-3/4, flanged, base Pan Part B2106	BD 349		
I5		LAMP: miniature, T1-3/4, flanged, base Pan Part B2106	BD 349		
J101		RECEPTACLE: N type, MIL type UG-58/U Pan Part J1061	AB 82-24	2	
J102		RECEPTACLE: N type, MIL type UG-58/U Pan Part J1061	AB 82-24		
J103		RECEPTACLE: bulkhead, BNC type, MIL type UG909A/U Pan Part J2037	AB 31-206	2	
J104		RECEPTACLE: bulkhead, BNC type, MIL type UG909A/U Pan Part J2037	AB 31-206		
J201		JACK: tip, black Pan Part J2001	BG 407	2	
J401		RECEPTACLE: bulkhead, BNC type, MIL type UG1094/U Pan Part J2031	AB 31-221	3	
J402		RECEPTACLE: 10 contact, female, solid shell, box mounting Pan Part J2023	AB MS3102A-18-1S	1	
J501		RECEPTACLE: 14 contact, male solid shell, box mounting Pan Part P2006	AB MS3102A-28-2P	1	

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Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
J502		RECEPTACLE: bulkhead, BNC type, MIL type UG1094/U Pan Part J2031	AB 31-221		
J601		RECEPTACLE: 14 contact, female, solid shell, box mounting Pan Part J2008	AB MS3102A-28-2S	1	
J602		JACK: tip, black Pan Part J2001	BG 407		
J603		RECEPTACLE: electrical, 3 wire, a-c power, flush mount, male, twistlock, polarized Pan Part J1002	BH 7486	1	
J701		RECEPTACLE: bulkhead, BNC type, MIL type UG-1094/U Pan Part J2031	AB 31-221		
L101A		COIL: crystal, loading, 100 KC Pan Part ZN-8223	AR ZN8223	3	
L101B		COIL: crystal, loading, 100 KC Pan Part ZN-8223	AR ZN8223		
L101C		COIL: crystal, loading, 100 KC Pan Part ZN-8223	AR ZN8223		
L201		CHOKE: insulated, .68 microhenry, ±10% Pan Part L2016	AN Type CLA	1	
L301		CHOKE: RF, 2.5 millihenry Pan Part L2019	AQ 6302	1	
L601		FILTER: reactor, 8 HY, 110 ma Pan Part L2-10789	AR L2-10789	1	
L701		CHOKE: r-f, fixed, 100 uh Pan Part L1112	BF CH-3-3	1	
L702*		CHOKE: r-f, fixed, 4.7 uf, ±10% Pan Part L2043	BC 213-11	1	
P402		PLUG: 10 contact, male, straight solid shell Pan Part P2036	AD MS3106A-18-1P	1	
Q3		TRANSISTOR: 2N404 Pan Part Q2N404-2	BE 2N404	4	
Q4		TRANSISTOR: 2N404 Pan Part Q2N404-2	BE 2N404		

* Serial No's 20T and above.

List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
Q5		TRANSISTOR: 2N404 Pan Part Q2N404-2	BE 2N404		
Q6		TRANSISTOR: 2N404 Pan Part Q2N404-2	BE 2N404		
R101		RESISTOR: fixed, composition, 51 ohms, ±5%, 1/2 W Pan Part RC20BX510J	AA EB5105	2	
R102		RESISTOR: fixed, composition, 51 ohms, ±5%, 1/2 W Pan Part RC20BX510J	AA EB5105		
R103		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AA EB1015	4	
R104		RESISTOR: fixed, composition, 10,000 ohms, ±5%, 2 W Pan Part RC42BX103J	AA HB1035	4	
R105		RESISTOR: fixed, composition, 1,000 ohms, ±5%, 1/2 W Pan Part RC20BX102J	AA EB1025	6	
R106		RESISTOR: fixed, composition, 4,300 ohms, ±5%, 1/2 W Pan Part RC20BX423J	AA EB4325	1	
R107		RESISTOR: fixed, composition, 270 ohms, ±5%, 1/2 W Pan Part RC20BX271J	AA EB2715	1	
R108		RESISTOR: variable, composition, 3,000 ohms, ±10%, 2 W linear Pan Part RV011	AA JU-3021	1	
R109		RESISTOR: fixed, composition, 47,000 ohms, ±5%, 1 W Pan Part RC32BX473J	AA GB4735	5	
R110		RESISTOR: fixed, composition, 47,000 ohms, ±5%, 1 W Pan Part RC32BX473J	AA GB4735		
R111		RESISTOR: fixed, composition, 2,200 ohms, ±5%, 1/2 W Pan Part RC20BX222J	AA EB2225	4	
R112		RESISTOR: fixed, composition, 30,000 ohms, ±5%, 1/2 W Pan Part RC20BX303J	AA EB3035	1	

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List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R113		RESISTOR: fixed, composition, 5,100 ohms, ±5%, 1/2 W Pan Part RC20BX512J	AA EB5125	2	
R114		RESISTOR: fixed, composition, 1,000 ohms, ±5%, 1/2 W Pan Part RC20BX102J	AA EB1025		
R115		RESISTOR: fixed, composition, 51,000 ohms, ±5%, 1/2 W Pan Part RC20BX513J	AA EB5135	5	
R116		RESISTOR: fixed, composition, 1,000 ohms, ±5%, 1/2 W Pan Part RC20BX102J	AA EB1025		
R201		RESISTOR: fixed, composition, 15,000 ohms, ±5%, 1 W Pan Part RC32BX153J	AA GB1535	2	
R202		RESISTOR: fixed, composition, 2,200 ohms, ±5%, 1/2 W Pan Part RC20BX222J	AA EB2225		
R203		RESISTOR: variable, composition, 50,000 ohms, ±10%, 2 W linear Pan Part RV014	AA JU-5031	4	
R204		RESISTOR: fixed, composition, 2,200 ohms, ±5%, 1/2 W Pan Part RC20BX222J	AA EB2225		
R205		RESISTOR: fixed, composition, 150,000 ohms, ±5%, 1/2 W Pan Part RC20BX154J	AA EB1545	1	
R206		RESISTOR: composition, variable, 5,000 ohms, ±20%, linear, concentric with R207 with SP-DT switch (SW201) Pan Part RVX905	AF Type C2-45-VF BS7723	1	
R207		RESISTOR: composition, variable, 500 ohms, ±20%, linear, concentric with R206 with SP-DT switch (SW201) Pan Part (See: R206)	AF Type C2-45VF BS7723		
R208		RESISTOR: fixed, composition, 220 ohms, ±5%, 1/2 W Pan Part RC20BX221J	AA EB2215	4	
R210		RESISTOR: fixed, composition, 220,000 ohms, ±5%, 1/2 W Pan Part RC20BX224J	AA EB2245	9	

List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R211		RESISTOR: fixed, composition, 39,000 ohms, ±5%, 1/2 W Pan Part RC20BX393J	AA EB3935	1	
R212		RESISTOR: fixed, composition, 220,000 ohms, ±5%, 1/2 W Pan Part RC20BX224J	AA EB2245		
R213		RESISTOR: fixed, composition, 47 ohms, ±5%, 1/2 W Pan Part RC20BX470J	AA EB4705	2	
R214		RESISTOR: fixed, composition, 51,000 ohms, ±5%, 1 W Pan Part RC32BX513J	AA GB5135	3	
R215		RESISTOR: fixed, composition, 51,000 ohms, ±5%, 1 W Pan Part RC32BX513J	AA GB5135		
R216		RESISTOR: variable, composition, 25,000 ohms, ±10%, 2 W linear Pan Part RV026	AA JU-2531	1	
R217		RESISTOR: fixed, composition, 62,000 ohms, ±5%, 1/2 W Pan Part RC20BX623J	AA EB6235	1	
R219		RESISTOR: fixed, composition, 510,000 ohms, ±5%, 1 W Pan Part RC32BX514J	AA GB5145	3	
R220		RESISTOR: fixed, composition, 510,000 ohms, ±5%, 1 W Pan Part RC32BX514J	AA GB5145		
R221		RESISTOR: fixed, composition, 220,000 ohms, ±5%, 1/2 W Pan Part RC20BX224J	AA EB2245		
R222		RESISTOR: fixed, composition, 510,000 ohms, ±5%, 1/2 W Pan Part RC20BX514J	AA EB5145	2	
R226		RESISTOR: fixed, composition, 5,100 ohms, ±5%, 1/2 W Pan Part RC20BX512J	AA EB5125		
R227		RESISTOR: fixed, composition, 15,000 ohms, ±5%, 1/2 W Pan Part RC20BX153J	AA EB1535	2	
R228		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AA EB1015		

List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R301		RESISTOR: fixed, composition, 6,200 ohms, ±5%, 1/2 W Pan Part RC20BX622J	AA EB6225	1	
R302		RESISTOR: fixed, composition, 220 ohms, ±5%, 1/2 W Pan Part RC20BX221J	AA EB2215		
R303		RESISTOR: fixed, composition, 430 ohms, ±5%, 1/2 W Pan Part RC20BX431J	AA EB4315	3	
R304		RESISTOR: fixed, composition, 10,000 ohms, ±5%, 1/2 W Pan Part RC42BX103J	AA HB1035		
R305 R309		RESISTOR: variable, composi- tion, dual 2 megohms, ±20%, 2 W cw taper (front section) 2 megohms, ±20%, 2 W cw taper (rear section) Pan Part RVT507	AA JJA-2052	1	
R306		RESISTOR: fixed, composition, 2 megohms, ±5%, 1/2 W Pan Part RC20BX205J	AA EB2055	3	
R307		RESISTOR: fixed, composition, 430 ohms, ±5%, 1/2 W Pan Part RC20BX431J	AA EB4315		
R308		RESISTOR: fixed, composition, 220 ohms, ±5%, 1/2 W Pan Part RC20BX221J	AA EB2215		
R310		RESISTOR: variable, composi- tion, 5 megohms, ±20%, 2 W linear Pan Part RV003	AA JU-5052	3	
R311		RESISTOR: fixed, composition, 150 ohms, ±5%, 1/2 W Pan Part RC20BX151J	AA EB1515	2	
R312		RESISTOR: variable, composi- tion, 5,000 ohms, ±10%, 2 W linear Pan Part RV012	AA JU-5021	1	
R313		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1 W Pan Part RC32BX104J	AA GB1045	7	
R314		RESISTOR: fixed, composition, 75,000 ohms, ±5%, 1 W Pan Part RC32BX753J	AA GB7535	5	

List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R316		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1/2 W Pan Part RC20BX104J	AA EB1045	6	
R317		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AA EB1015		
R318		RESISTOR: fixed, composition, 100 ohms, ±5%, 1/2 W Pan Part RC20BX101J	AA EB1015		
R319		RESISTOR: fixed, composition, 33,000 ohms, ±5%, 1 W Pan Part RC32BX333J	AA GB3335	1	
R320		RESISTOR: fixed, composition, 15,000 ohms, ±5%, 1 W Pan Part RC32BX153J	AA GB1535		
R321		RESISTOR: variable, composition, 50,000 ohms, ±10%, 2 W, linear Pan Part RV014	AA JU-5031		
R322		RESISTOR: fixed, composition, 47,000 ohms, ±5%, 1 W Pan Part RC32BX473J	AA GB4735		
R323		RESISTOR: fixed, composition, 5,600 ohms, ±5%, 1 W Pan Part RC32BX562J	AA GB5625	1	
R324		RESISTOR: fixed, composition, 68,000 ohms, ±5%, 1/2 W Pan Part RC20BX683J	AA EB6835	2	
R325		RESISTOR: variable, composition, 100,000 ohms, ±10%, 2 W linear Pan Part RV025	AA JU-1041	3	
R326		RESISTOR: fixed, composition, 1,000 ohms, ±5%, 1 W Pan Part RC32BX102J	AA GB1025	3	
R327		RESISTOR: fixed, composition, 10,000 ohms, ±5%, 1/2 W Pan Part RC20BX103J	AA EB1035	7	
R328		RESISTOR: fixed, composition, 75,000 ohms, ±5%, 1 W Pan Part RC32BX753J	AA GB7535		
R329		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1 W Pan Part RC32BX104J	AA GB1045		

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List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R330		RESISTOR: fixed, composition, 150 ohms, ±5%, 1/2 W Pan Part RC20BX151J	AA EB1515		
R331		RESISTOR: fixed, composition, 10,000 ohms, ±5%, 2 W Pan Part RC42BX103J	AA HB1035		
R332		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1/2 W Pan Part RC20BX104J	AA EB1045		
R333		RESISTOR: fixed, composition, 910 ohms, ±5%, 1/2 W Pan Part RC20BX911J	AA EB9115	2	
R334		RESISTOR: fixed, composition, 6,800 ohms, ±5%, 1/2 W Pan Part RC20BX682J	AA EB6825	6	
R335		RESISTOR: fixed, composition, 10,000 ohms, ±5%, 1/2 W Pan Part RC20BX103J	AA EB1035		
R336		RESISTOR: fixed, composition, 910 ohms, ±5%, 1/2 W Pan Part RC20BX911J	AA EB9115		
R337		RESISTOR: fixed, composition, 6,800 ohms, ±5%, 1/2 W Pan Part RC20BX682J	AA EB6825		
R338		RESISTOR: fixed, composition, 10,000 ohms, ±5%, 1/2 W Pan Part RC20BX103J	AA EB1035		
R339		RESISTOR: variable, composition, 5,000 ohms, ±10%, 1/2 W linear Pan Part RVA-M-1005	AA RV6LAYSA502A	5	
R340		RESISTOR: variable, composition, 5,000 ohms, ±10%, 1/2 W, linear Pan Part RVA-M-1005	AA RV6LAYSA502A		
R341		RESISTOR: variable, composition, 5,000 ohms, ±10%, 1/2 W linear Pan Part RVA-M-1005	AA RV6LAYSA502A		
R342		RESISTOR: variable, composition, 5,000 ohms, ±10%, 1/2 W linear Pan Part RVA-M-1005	AA RV6LAYSA502A		

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List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R343		RESISTOR: fixed, composition, 51,000 ohms,* ±5%, 1/2 W Pan Part RC20BX513J	AA EB5135		
R344		RESISTOR: fixed, composition, 8,200 ohms, ±5%, 1/2 W Pan Part RC20BX822J	AA EB8225	1	
R346		RESISTOR: fixed, composition, 24,000 ohms, ±5%, 1/2 W Pan Part RC20BX243J	AA EB2435	2	
R347		RESISTOR: fixed, composition, 51,000 ohms, ±5%, 1/2 W Pan Part RC20BX513J	AA EB5135		
R349		RESISTOR: fixed, composition, 24,000 ohms, ±5%, 1/2 W Pan Part RC20BX243J	AA EB2435		
R350		RESISTOR: variable, composition, 5,000 ohms, ±10%, 1/2 W, linear Pan Part RVA-M-1005	AA RV6LAYSA502A		
R351		RESISTOR: fixed, composition, 22,000 ohms, ±5%, 1/2 W Pan Part RC20BX223J	AA EB2235	2	
R352		RESISTOR: fixed, composition, 47,000 ohms, ±5%, 1/2 W Pan Part RC20BX473J	AA EB4735	2	
R353		RESISTOR: fixed, composition, 1,000 ohms, ±5%, 1 W Pan Part RC32BX102J	AA GB1025		
R354		RESISTOR: fixed, composition, 10,000 ohms, ±5%, 1/2 W Pan Part RC20BX103J	AA EB1035		
R355		RESISTOR: fixed, composition, 1,000 ohms, ±5%, 1 W Pan Part RC32BX102J	AA GB1025		
R356		RESISTOR: fixed, composition, 430 ohms, ±5%, 1/2 W Pan Part RC20BX431J	AA EB4315		
R357		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1/2 W Pan Part RC20BX104J	AA EB1045		

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* Selected at final assembly
See Schematic Diagram for actual value.

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R358		RESISTOR: fixed, composition, 220 ohms, ±5%, 1/2 W Pan Part RC20BX221J	AA EB2215		
R359		RESISTOR: fixed, composition, 10,000 ohms, ±5%, 1/2 W Pan Part RC20BX103J	AA EB1035		
R360		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1 W Pan Part RC32BX104J	AA GB1045		
R361		RESISTOR: fixed, composition, 1,000 ohms, ±5%, 1/2 W Pan Part RC20BX102J	AA EB1025		
R362		RESISTOR: fixed, composition, 200 ohms, ±5%, 1/2 W Pan Part RC20BX201J	AA EB2015	2	
R363		RESISTOR: fixed, composition, 1,000 ohms, ±5%, 1/2 W Pan Part RC20BX102J	AA EB1025		
R364		RESISTOR: fixed, composition, 5,600 ohms, ±5%, 1/2 W Pan Part RC20BX562J	AA EB5625	2	
R365		RESISTOR: fixed, composition, 6,800 ohms, ±5%, 1/2 W Pan Part RC20BX682J	AA EB6825		
R366		Not Used			
R367		RESISTOR: fixed, composition, 10,000 ohms, ±5%, 2 W Pan Part RC42BX103J	AA HB1035		
R368		RESISTOR: fixed, composition, 75,000 ohms, ±5%, 1 W Pan Part RC32BX753J	AA GB7535		
R369		RESISTOR: fixed, composition, 390,000 ohms, ±5%, 1/2 W Pan Part RC20BX394J	AA EB3945	1	
R401		RESISTOR: fixed, composition, 120,000 ohms, ±5%, 1 W Pan Part RC32BX124J	AA GB1245	1	
R402		RESISTOR: fixed, composition, 33,000 ohms, ±5%, 1/2 W Pan Part RC20BX333J	AA EB3335	3	
R403		RESISTOR: fixed, composition, 1.5 megohms, ±5%, 1/2 W Pan Part RC20BX155J	AA EB1555	1	

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List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R404 R407		RESISTOR: variable, composition, dual 50,000 ohms, ±10%, 2 W linear (front section) 5 megohms, ±20%, 2 W linear (rear section) Pan Part RVT506	AA JJU-5031/5052	1	
R405		RESISTOR: fixed, composition, 47,000 ohms, ±5%, 1/2 W Pan Part RC20BX473J	AA EB4735		
R406		RESISTOR: variable, composition, 100,000 ohms, ±10%, 2 W, linear Pan Part RV025	AA JU-1041		
R408		RESISTOR: fixed, composition, 220,000 ohms, ±5%, 1/2 W Pan Part RC20BX224J	AA EB2245		
R409		RESISTOR: variable, composition, 100,000 ohms, ±10%, 2 W, linear Pan Part RV025	AA JU-1041		
R416		RESISTOR: fixed, composition, 750,000 ohms, ±5%, 1/2 W Pan Part RC20BX754J	AA EB7545	1	
R417		RESISTOR: fixed, composition, 56,000 ohms, ±5%, 2 W Pan Part RC42BX563J	AA GB5635	1	
R418		RESISTOR: fixed, composition, 240,000 ohms, ±5%, 1/2 W Pan Part RC20BX244J	AA EB2445	1	
R421		RESISTOR: variable, composition, 5 megohms, ±20%, 2 W, linear Pan Part RV003	AA JU-5052		
R422		RESISTOR: fixed, composition, 5.6 megohms, ±5%, 1/2 W Pan Part RC20BX565J	AA EB5655	1	
R423		RESISTOR: variable, composition, 5 megohms, ±20%, 2 W, linear Pan Part RV003	AA JU-5052		
R424 R218		RESISTOR: variable, composition, dual 1 megohm, ±20%, 2 W linear (front section) 10,000 ohms, ±10%, 2 W linear (rear section) Pan Part RVT505	AA JJU-1052/1031	1	

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Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R425		RESISTOR: fixed, composition, 10 megohms, ±5%, 1/2 W Pan Part RC20BX106J	AA EB1065	1	
R426		RESISTOR: fixed, composition, 910,000 ohms, ±5%, 1/2 W Pan Part RC20BX914J	AA EB9145	1	
R427		RESISTOR: variable, composition, 50,000 ohms, ±10%, 2 W linear Pan Part RV014	AA JU-5031		
R428		RESISTOR: fixed, composition, 75,000 ohms, ±5%, 1 W Pan Part RC32BX753J	AA GB7535		
R429		RESISTOR: fixed, composition, 2,200 ohms, ±5%, 1/2 W Pan Part RC20BX222J	AA EB2225		
R430		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1 W Pan Part RC32BX104J	AA GB1045		
R431		RESISTOR: fixed, composition, 6,800 ohms, ±5%, 1/2 W Pan Part RC20BX682J	AA EB6825		
R432		RESISTOR: fixed, composition, 1.8 megohms, ±5%, 1/2 W Pan Part RC20BX185J	AA EB1855	1	
R433		RESISTOR: fixed, composition, 220,000 ohms, ±5%, 1/2 W Pan Part RC20BX224J	AA EB2245		
R434		RESISTOR: fixed, composition, 220,000 ohms, ±5%, 1/2 W Pan Part RC20BX224J	AA EB2245		
R435		RESISTOR: fixed, composition, 220,000 ohms, ±5%, 1/2 W Pan Part RC20BX224J	AA EB2245		
R436		RESISTOR: fixed, composition, 2 megohms, ±5%, 1/2 W Pan Part RC20BX205J	AA EB2055		
R437		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1/2 W Pan Part RC20BX104J	AA EB1045		
R439		RESISTOR: fixed, composition, 1.1 megohm, ±5%, 1/2 W Pan Part RC20BX115J	AA EB1155	1	

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List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R440		RESISTOR: fixed, composition, 51,000 ohms, ±5%, 1/2 W Pan Part RC20BX513J	AA EB5135		
R441		RESISTOR: fixed, composition, 51,000 ohms, ±5%, 1/2 W Pan Part RC20BX513J	AA EB5135		
R442		RESISTOR: fixed, composition, 15,000 ohms, ±5%, 1/2 W Pan Part RC20BX153J	AA EB1535		
R443		RESISTOR: fixed, composition, 12,000 ohms, ±5%, 1/2 W Pan Part RC20BX123J	AA EB1235	1	
R444		RESISTOR: fixed, composition, 22,000 ohms, ±5%, 1/2 W Pan Part RC20BX223J	AA EB2235		
R447		RESISTOR: fixed, composition, 510,000 ohms, ±5%, 1/2 W Pan Part RC20BX514J	AA EB5145		
R448		RESISTOR: fixed, composition, 5.1 megohms, ±5%, 1/2 W Pan Part RC20BX515J	AA EB5155	1	
R449		RESISTOR: variable, composition, 2 megohms, ±20%, 2 W linear Pan Part RV017	AA JU-2052	1	
R450		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1/2 W Pan Part RC20BX104J	AA EB1045		
R501		RESISTOR: fixed, composition, 120 ohms, ±5%, 1/2 W Pan Part RC20BX121J	AA EB1215	1	
R502		RESISTOR: fixed, composition, 620 ohms, ±5%, 1/2 W Pan Part RC20BX621J	AA EB6215	1	
R503		RESISTOR: fixed, composition, 150,000 ohms, ±5%, 1 W Pan Part RC32BX154J	AA GB1545	1	
R504		RESISTOR: fixed, composition, 220,000 ohms, ±5%, 1/2 W Pan Part RC20BX224J	AA EB2245		
R505		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1 W Pan Part RC32BX104J	AA GB1045		

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List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R506		RESISTOR: fixed, composition, 68,000 ohms, ±5%, 1 W Pan Part RC32BX683J	AA GB6835	1	
R507		RESISTOR: variable, composition, 500,000 ohms, ±10%, 2 W, linear Pan Part RV015	AA JU-5041	1	
R508		RESISTOR: fixed, composition, 1.2 megohms, ±5%, 1/2 W Pan Part RC20BX125J	AA EB1255	1	
R509		RESISTOR: fixed, composition, 220,000 ohms, ±5%, 1/2 W Pan Part RC20BX224J	AA EB2245		
R510		RESISTOR: fixed, composition, 5,600 ohms, ±5%, 1/2 W Pan Part RC20BX562J	AA EB5625	1	
R511		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1 W Pan Part RC32BX104J	AA GB1045		
R512		RESISTOR: fixed, composition, 4,700 ohms, ±5%, 1/2 W Pan Part RC20BX472J	AA EB4725	1	
R515		RESISTOR: fixed, composition, 47,000 ohms, ±5%, 1 W Pan Part RC32BX473J	AA GB4735		
R516		RESISTOR: variable, composition, 50,000 ohms, ±10%, 2 W, linear Pan Part RV014	AA JU-5031		
R517		RESISTOR: fixed, composition, 47,000 ohms, ±5%, 1 W Pan Part RC32BX473J	AA GB4735		
R518		RESISTOR: fixed, composition, 390,000 ohms, ±5%, 1 W Pan Part RC32BX394J	AA GB3945	1	
R519		RESISTOR: fixed, composition, 510,000 ohms, ±5%, 1 W Pan Part RC32BX514J	AA GB5145		
R520		RESISTOR; variable, composition, 500,000 ohms, ±10%, 2 W, linear Pan Part RVX903	AR RVX903	1	
R521		RESISTOR: fixed, composition, 270,000 ohms, ±5%, 1 W Pan Part RC32BX274J	AA GB2745	1	

List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In. Set	Qty. 3 Mo. Opn.
R522		RESISTOR: variable, composition, 100,000 ohms, ±10%, 2 W, linear Pan Part RVX902	AR RVX902	1	
R524		RESISTOR: fixed, wirewound, radial leads, 3,500 ohms, 20 W Pan Part RW20X352R-4	AX 20F3500WL	1	
R525		RESISTOR: variable, wirewound, with switch (SW501), 6 ohms Pan Part RVS700	AF Type GC-252	1	
R527		RESISTOR: fixed, composition, 2 megohms, ±5%, 1/2 W Pan Part RC20BX205J	AA EB2055		
R528		RESISTOR: fixed, composition, 10,000 ohms, ±5%, 1/2 W Pan Part RC20BX103J	AA EB1035		
R601		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1 W Pan Part RC32BX104J	AA GB1045		
R602		RESISTOR: fixed, composition, 10 megohms, ±5%, 2 W Pan Part RC42BX106J	AA HB1065	4	
R603		RESISTOR: fixed, composition, 10 megohms, ±5%, 2 W Pan Part RC42BX106J	AA HB1065		
R604		Not Used			
R605		RESISTOR: fixed, composition, 820,000 ohms, ±5%, 1/2 W Pan Part RC20BX824J	AA EB8245	1	
R606		RESISTOR: fixed, composition, 680,000 ohms, ±5%, 1/2 W Pan Part RC20BX684J	AA EB6845	1	
R607		RESISTOR: fixed, composition, 68,000 ohms, ±5%, 1/2 W Pan Part RC20BX683J	AA EB6835		
R608		RESISTOR: fixed, composition, 10,000 ohms, ±5%, 1/2 W Pan Part RC20BX103J	AA EB1035		
R609		RESISTOR: fixed, composition, 51,000 ohms, ±5%, 1 W Pan Part RC32BX513J	AA GB5135		
R610		RESISTOR: variable, composition, 10,000 ohms, ±10%, 2 W, linear Pan Part RV005	AA JU-1031	1	

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R611		RESISTOR: fixed, wire wound, radial leads, 6,000 ohms, 5 W Pan Part RW5X602R-6	AW Type FRL5	1	
R612		RESISTOR: fixed, composition, 470,000 ohms, ±5%, 1 W Pan Part RC32BX474J	AA GB4745	2	
R613		RESISTOR: fixed, composition, 470,000 ohms, ±5%, 1 W Pan Part RC32BX474J	AA GB4745		
R614		RESISTOR: fixed, wirewound, radial leads, 20,000 ohms, 10 W Pan Part RW10X203R-6	AW Type FRL10	1	
R615		RESISTOR: fixed, composition, 1 megohm, ±5%, 1/2 W Pan Part RC20BX105J	AA EB1055	1	
R616		RESISTOR: fixed, composition, 75,000 ohms, ±5%, 1 W Pan Part RC32BX753J	AA GB7535		
R617		RESISTOR: fixed, composition, 51 ohms, ±5%, 1 W Pan Part RC32BX510J	AA GB5105	1	
R619		RESISTOR: fixed, composition, 10 megohms, ±5%, 2 W Pan Part RC42BX106J	AA HB1065		
R620		RESISTOR: fixed, composition, 10 megohms, ±5%, 2 W Pan Part RC42BX106J	AA HB1065		
R701		RESISTOR: fixed, composition, 180,000 ohms, ±5%, 1/2 W Pan Part RC20BX184J	AA EB1845	2	
R702		RESISTOR: fixed, composition, 20,000 ohms, ±5%, 1/2 W Pan Part RC20BX203J	AA EB2035	1	
R703		RESISTOR: fixed, composition, 1,000 ohms, ±5%, 1/2 W Pan Part RC20BX102J	AA EB1025		
R704		RESISTOR: fixed, composition, 180,000 ohms, ±5%, 1/2 W Pan Part RC20BX184J	AA EB1845		
R705		RESISTOR: fixed, composition, 3,300 ohms, ±5%, 1/2 W Pan Part RC20BX332J	AA EB3325	1	

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Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R706		Not Used.			
R707		RESISTOR: fixed, composition, 82,000 ohms, ±5%, 2 W Pan Part RC42BX823J	AA HB8235	3	
R708		RESISTOR: fixed, deposited metal film, 253 ohms, ±1%, ½ W Pan Part RC20AZ2530F	AG Type NA-15	1	
R709		RESISTOR: fixed, deposited metal film, 62.3 ohms, ±1%, ½ W Pan Part RC20AZ62P3F	AG Type NA-15	2	
R710		RESISTOR: fixed, deposited metal film, 62.3 ohms, ±1%, ½ W Pan Part RC20AZ62P3F	AG Type NA-15		
R711		RESISTOR: fixed, deposited metal film, 72.8 ohms, ±1%, ½ W Pan Part RC20AZ72P8F	AG Type NA-15	4	
R712		RESISTOR: fixed, deposited metal film, 98 ohms, ±1%, ½ W Pan Part RC20AZ980F	AG Type NA-15	8	
R713		RESISTOR: fixed, deposited metal film, 98 ohms, ±1%, ½ W Pan Part RC20AZ980F	AG Type NA-15		
R714		RESISTOR: fixed, deposited metal film, 72.8 ohms, ±1%, ½ W Pan Part RC20AZ72P8F	AG Type NA-15		
R715		RESISTOR: fixed, deposited metal film, 98 ohms, ±1%, ½ W Pan Part RC20AZ980F	AG Type NA-15		
R716		RESISTOR: fixed, deposited metal film, 98 ohms, ±1%, ½ W Pan Part RC20AZ980F	AG Type NA-15		
R717		RESISTOR: fixed, deposited metal film, 72.8 ohms, ±1%, ½ W Pan Part RC20AZ72P8F	AG Type NA-15		
R718		RESISTOR: fixed, deposited metal film, 98 ohms, ±1%, ½ W Pan Part RC20AZ980F	AG Type NA-15		
R719		RESISTOR: fixed, deposited metal film, 98 ohms, ±1%, ½ W Pan Part RC20AZ980F	AG Type NA-15		
R720		RESISTOR: fixed, deposited metal film, 72.8 ohms, ±1%, ½ W Pan Part RC20AZ72P8F	AG Type NA-15		

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Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R721		RESISTOR: fixed, deposited metal film, 98 ohms, ±1%, $\frac{1}{2}$ W Pan Part RC20AZ980F	AG Type NA-15		
R722		RESISTOR: fixed, deposited metal film, 98 ohms, ±1%, $\frac{1}{2}$ W Pan Part RC20AZ980F	AG Type NA-15		
R723		RESISTOR: fixed, deposited metal film, 31 ohms, ±1%, $\frac{1}{2}$ W Pan Part RC20AZ310F	AG Type NA-15	1	
R724		RESISTOR: fixed, deposited metal film, 182 ohms, ±1%, $\frac{1}{2}$ W Pan Part RC20AZ1820F	AG Type NA-15	2	
R725		RESISTOR: fixed, deposited metal film, 182 ohms, ±1%, $\frac{1}{2}$ W Pan Part RC20AZ1820F	AG Type NA-15		
R726		RESISTOR: variable, composition, 100,000 ohms, ±10%, 2 W linear Pan Part RV025	AA JU-1041		
R741		RESISTOR: fixed, composition, 82,000 ohms, ±5%, 2 W Pan Part RC42BX823J	AC HB8235		
R743		RESISTOR: fixed, composition, 82,000 ohms, ±5%, 2 W Pan Part RC42BX823J	AC HB8235		
R801		RESISTOR: fixed, composition, 6,800 ohms, ±5%, 1/2 W Pan Part RC20BX682J	AA EB6825		
R803		RESISTOR: fixed, composition, 6,800 ohms, ±5%, 1/2 W Pan Part RC20BX682J	AA EB6825		
R805		RESISTOR: fixed, composition, 560 ohms, ±5%, 1/2 W Pan Part RC20BX561J	AA EB5615	1	
R807		RESISTOR: variable, miniature, 250 ohms, ±10%, 1/2 W Pan Part RVM400	AA RV6LAYSA251A	1	
R809		RESISTOR: fixed, composition, 33,000 ohms, ±5%, 1/2 W Pan Part RC20BX333J	AA EB3335		
R811		RESISTOR: fixed, composition, 33,000 ohms, ±5%, 1/2 W Pan Part RC20BX333J	AA EB3335		

List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
R813		RESISTOR: fixed, composition, 100,000 ohms, ±5%, 1/2 W Pan Part RC20BX104J	AA EB1045		
R815		RESISTOR: fixed, composition, 47 ohms, ±5%, 1/2 W Pan Part RC20BX470J	AA EB4705		
R817		RESISTOR: fixed, composition, 200 ohms, ±5%, 1/2 W Pan Part RC20BX201J	AA EB2015		
S201		See R206, R207		1	
S301		SWITCH: toggle, DP-DT, bat handle Pan Part S2023	AC 81027-CE	1	
S302		SWITCH: toggle, SP-DT, bat handle Pan Part S2043	AC 81021AV	1	
S402		SWITCH: miniature, rotary, 10/P2-6T, 5 section shorting contacts Pan Part S2-13124	AR S2-13124	1	
S403		SWITCH: SP-DT, Push button Pan Part S-2044	AV 203	1	
S501		See R525		1	
S502		SWITCH: toggle, DP-DT, center OFF, bat handle Pan Part S-2042	BB 8821K5	1	
S701M		SWITCH: toggle, SP-ST bat handle Pan Part S2022N	AC 81015AW		
S701		SWITCH: toggle, DP-DT bat handle Pan Part S2096	AC 83054	6	
S702		SWITCH: toggle, DP-DT bat handle Pan Part S2096	AC 83054		
S703		SWITCH: toggle, DP-DT bat handle Pan Part S2096	AC 83054		
S704		SWITCH: toggle, DP-DT bat handle Pan Part S2096	AC 83054		

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List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
S705		SWITCH: toggle, DP-DT bat handle Pan Part S2096	AC 83054		
S706		SWITCH: toggle, DP-DT bat handle Pan Part S2096	AC 83054		
T101		TRANSFORMER: RF 500 KC, ±50 KC Pan Part ZN8429	AR ZN8429	1	
T102		TRANSFORMER: RF 500 KC, ±50 KC Pan Part ZN8218	AR ZN8218	1	
T401		TRANSFORMER: pulse Pan Part T2-10790A	AR T2-10790A	1	
T601		TRANSFORMER: power, low voltage, Primary: 115/230V 50-60 cycles Secondary: 750VCT, 150 MADC 6.5 V, 4 A; 5 V, 2 A Pan Part T3-9877B	AR T3-9877B	1	
T602		TRANSFORMER: power, high voltage, Primary: 115V/230V, 50-60 cycles Secondary: 6.4 V, 0.6 A, 2.5 V, 1.75 A; 1200 V, 4 MA; 6.3 V, 6 A Pan Part T3-9875D	AR T3-9875D	1	
V1		ELECTRON TUBE: 6J6 Pan Part 6J6	AZ 6J6	1	
V2		ELECTRON TUBE: 12AT7 Pan Part 12AT7	AZ 12AT7	1	
V3		ELECTRON TUBE: 6BE6 Pan Part 6BE6	AZ 6BE6	1	
V4		ELECTRON TUBE: 6AH6 Pan Part 6AH6	AZ 6AH6	1	
V5		ELECTRON TUBE: 6BH6 Pan Part 6BH6	AZ 6BH6	2	
V6		ELECTRON TUBE: 12AL5 Pan Part 12AL5	AZ 12AL5	1	
V7		ELECTRON TUBE: 6U8A Pan Part 6U8A	AZ 6U8A	4	
V8		ELECTRON TUBE: 6U8A Pan Part 6U8A	AZ 6U8A		

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List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
V9		ELECTRON TUBE: 6AU6 Pan Part 6AU6	AZ 6AU6	2	
V10		ELECTRON TUBE: 12AU7 Pan Part 12AU7	AZ 12AU7	4	
V11		ELECTRON TUBE: 12AU7 Pan Part 12AU7	AZ 12AU7		
V12		ELECTRON TUBE: 5ADP7 Pan Part 5ADP7	AZ 5ADP7	1	
V13		ELECTRON TUBE: 6AU6 Pan Part 6AU6	AZ 6AU6		
V14		ELECTRON TUBE: 12AU7 Pan Part 12AU7	AZ 12AU7		
V15		ELECTRON TUBE: 6BH6 Pan Part 6BH6	AZ 6BH6		
V16		ELECTRON TUBE: 12AU7 Pan Part 12AU7	AZ 12AU7		
V17		ELECTRON TUBE: 5651 Pan Part 5651	AZ 5651	2	
V18		ELECTRON TUBE: OA2 Pan Part OA2	AZ OA2	1	
V19		Not Used			
V20		ELECTRON TUBE: 6U8A Pan Part 6U8A	AZ 6U8A		
V101		ELECTRON TUBE: 5V4GA Pan Part 5V4GA	AZ 5V4GA	1	
V102		ELECTRON TUBE: 6AS7G Pan Part 6AS7G	AZ 6AS7G	1	
V103		ELECTRON TUBE: 12AX7 Pan Part 12AX7	AZ 12AX7	1	
V104		ELECTRON TUBE: 5651 Pan Part 5651	AZ 5651		
Y301*		CRYSTAL: 100 KC Pan Part Y3001-2*	AR Y3001-2	2	
Y302*		CRYSTAL: 100 KC Pan Part Y3001-2*	AR Y3001-2		
Y303		CRYSTAL: 100 KC Pan Part Y3001-1	AR Y3001-1	1	

*Supplied as matched pair, Panoramic Part No. 2Y3001MR.

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List of Replaceable Parts for Models SB-12a and PS-21 (continued)

Circuit Ref. Symbol	Stock No.	Description	Mfr. & Mfrs. No.	Qty. In Set	Qty. 3 Mo. Opn.
Y701		CRYSTAL: 500 KC, ±.02% Pan Part Y-3006	AR Y3012	1	
Z101		COIL: oscillator, 600 KC Pan Part ZN-8219	AR ZN8219	1	
Z102		TRANSFORMER: RF, discrim-inator, 600 KC, ±50 KC Pan Part ZN-8220	AR ZN8220	1	
Z103		TRANSFORMER: RF, 100 KC Pan Part ZN-8372	AR ZN8372	1	
Z105		TRANSFORMER: RF, 100 KC Pan Part ZN-8222	AR ZN8222	1	
		FUSE: instantaneous, glass cartridge, 2 amp, 250 V Pan Part F-1003	AD AGC2	2	
		FUSE: instantaneous, glass cartridge, 2 amp, 250 V Pan Part F-1003	AD AGC2		
		HEX KEY: short arm #8 Allen, 5/64" Pan Part E-1009	AR E-1009	1	
		TOOL: alignment Pan Part E-1010	AR E-1010	1	
		TRANSFORMER: constant-voltage, 180 VA, 60 cps, single phase Pan Part T-3003-1	AR T-3003A-1	1	

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MANUFACTURERS CODE FOR LIST OF REPLACEABLE PARTS

AA	Allen Bradley Company
AB	Amphenol Electronics Corporation
AC	Arrow-Hart & Hegeman Electric Company
AD	Bussman Manufacturing Company
AE	Centralab Division of Globe-Union, Inc.
AF	Chicago Telephone Supply Company
AG	Continental Carbon, Inc.
AH	Electro Motive Manufacturing Company
AJ	Erie Resistor Corporation
AK	General Electric Company
AL	Gudeman Company
AM	International Rectifier Corporation
AN	International Resistance Company
AO	J. F. D. Electronics
AP	Kulka Electric Manufacturing Company, Inc.
AQ	J. W. Miller Company
AR	Panoramic Radio Products, Inc.
AS	Radio Receptor, Inc.
AT	Sangamo Electric Company
AU	Sprague Electric Company
AV	Switchcraft, Inc.
AW	Tru-Ohm Products Division, Model Engineering and Manufacturing, Inc.
AX	Ward-Leonard Electric Company
AY	Wright Electronics, Inc.
AZ	Any E. I. A. Manufacturer
BA	Solar Manufacturing Company
BB	Cutler-Hammer, Inc.
BC	Wilco Corporation
BD	Hudson Lamp Co.
BE	Texas Instruments, Inc.
BF	Teleradio Engineering Corp.
BG	Birnbach Radio Company, Inc.
BH	Harvey Hubbell, Inc.

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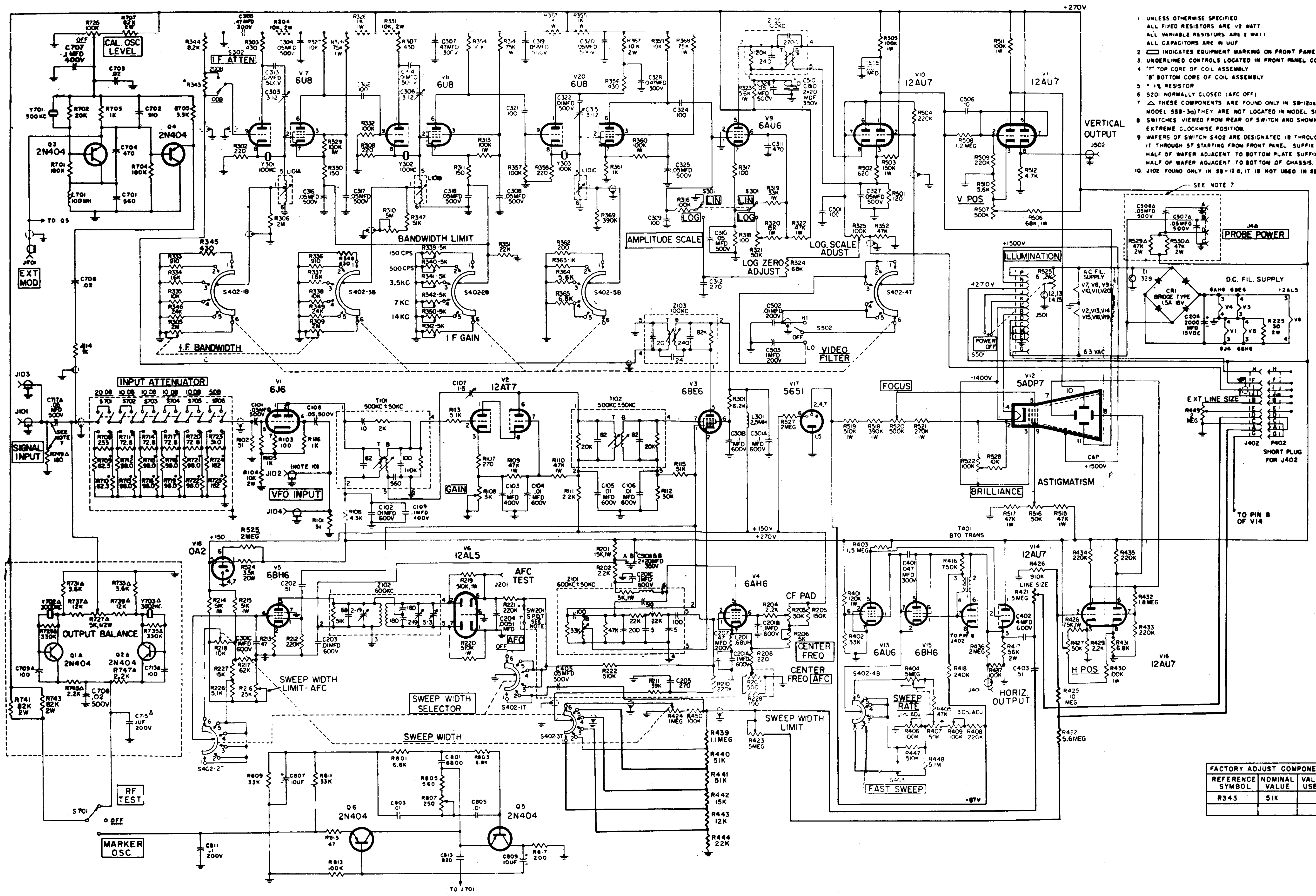

1. UNLESS OTHERWISE SPECIFIED
   ALL FIXED RESISTORS ARE 1/2 WATT.
   ALL VARIABLE RESISTORS ARE 2 WATT.
   ALL CAPACITORS ARE IN UUF.
2. ▭ INDICATES EQUIPMENT MARKING ON FRONT PANEL.
3. UNDERLINED CONTROLS LOCATED IN FRONT PANEL COMPARTMENT.
4. "T" TOP CORE OF COIL ASSEMBLY
   "B" BOTTOM CORE OF COIL ASSEMBLY
5. * 1% RESISTOR
6. S201 NORMALLY CLOSED (AFC OFF)
7. △ THESE COMPONENTS ARE FOUND ONLY IN SB-12as (PART OF MODEL SSB-3a) 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 "B" INDICATES HALF OF WAFER ADJACENT TO BOTTOM PLATE. SUFFIX "T" INDICATES HALF OF WAFER ADJACENT TO BOTTOM OF CHASSIS.
10. J102 FOUND ONLY IN SB-12a, IT IS NOT USED IN SB-12as

FACTORY ADJUST COMPONENTS		
REFERENCE SYMBOL	NOMINAL VALUE	VALUE USED
R343	51K	

P4-15020T

Schematic Diagram, Model SB-12a

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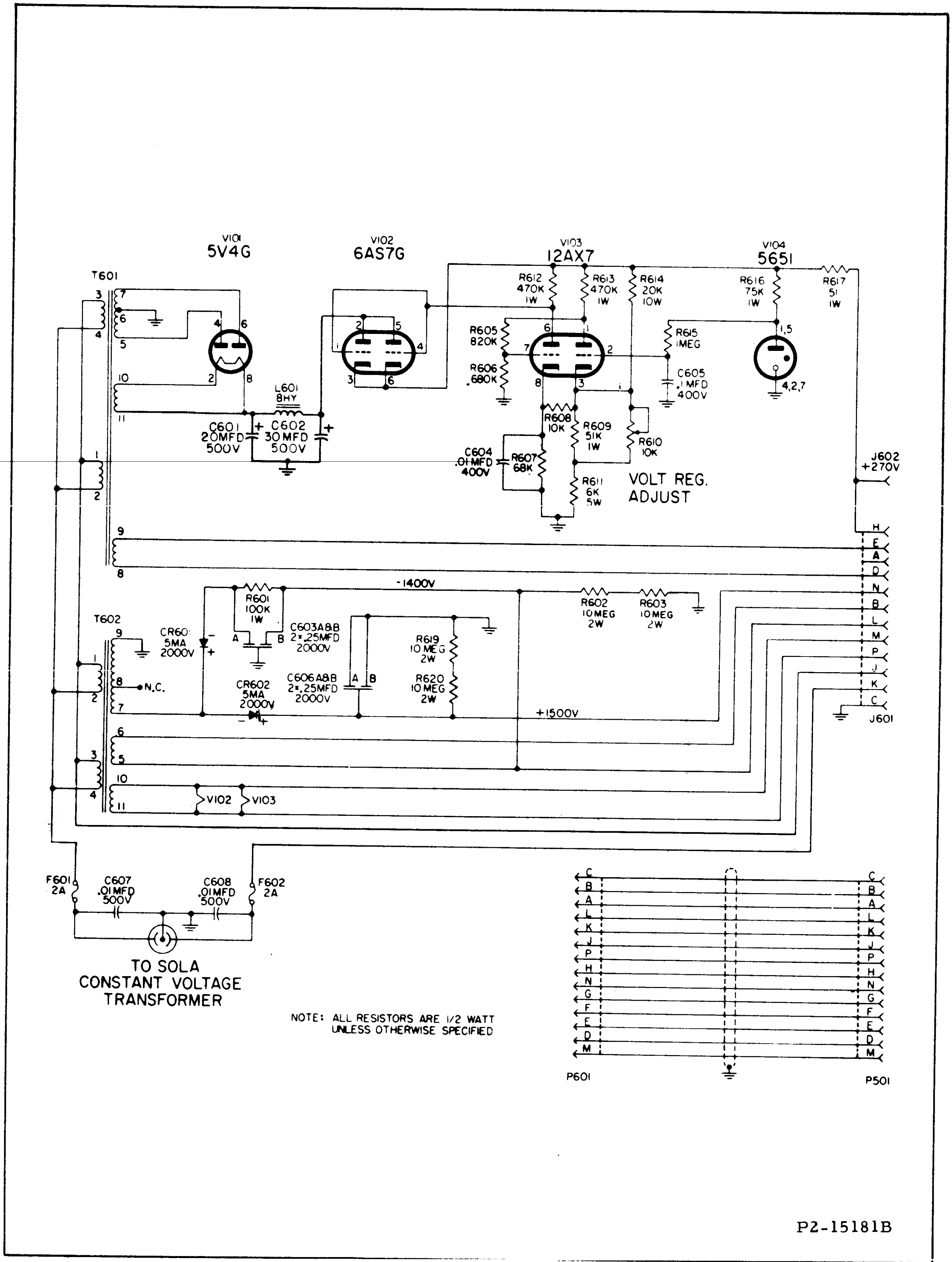

Schematic Diagram, Power Supply, Model PS-12

UNCLASSIFIED

TECHNICAL MANUAL

for

VARIABLE FREQUENCY OSCILLATOR, VOX-5

(OSCILLATOR, RADIO FREQUENCY 0-330( )/FR)

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CHANGE NO. 1 VOX-5

INSTRUCTION BOOK CHANGE NOTICE

Date 12/20/62

Manual affected: VARIABLE FREQUENCY OSCILLATOR VOX-5 IN -223

Page 2-1, paragraph 2-2.

Change first line to read "VOX's power supply and ovens ar designed for"

Page 2-1.

After paragraph 2-2 add the following:

NOTE

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When the VOX-5 is rewired for 230 volt operation, change POWER fuse F102 from 2 amperes to 1 ampere and and OVENS fuse F101 from 3 amperes to 1.5 amperes.

Page 2-1, Figure 2-1.

Change figure caption to read "Power Supply and Ovens Connections"

CHANGE NO. 1 VOX-5

INSTRUCTION BOOK CHANGE NOTICE

Date 12/20/62

Manual affected: **VARIABLE FREQUENCY OSCILLATOR VOX-5** IN -223

Page 2-1, Figure 2-1.

Delete the figure and substitute the following:

POWER SUPPLY

115 VOLT OPERATION — 230 VOLT OPERATION

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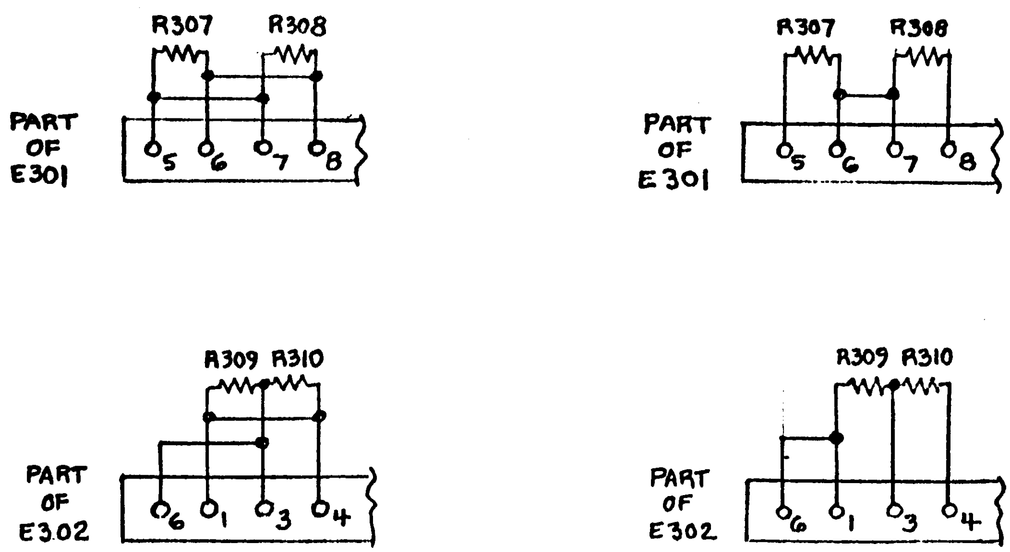
OVENS SUPPLY

115 VOLT OPERATION — 230 VOLT OPERATION



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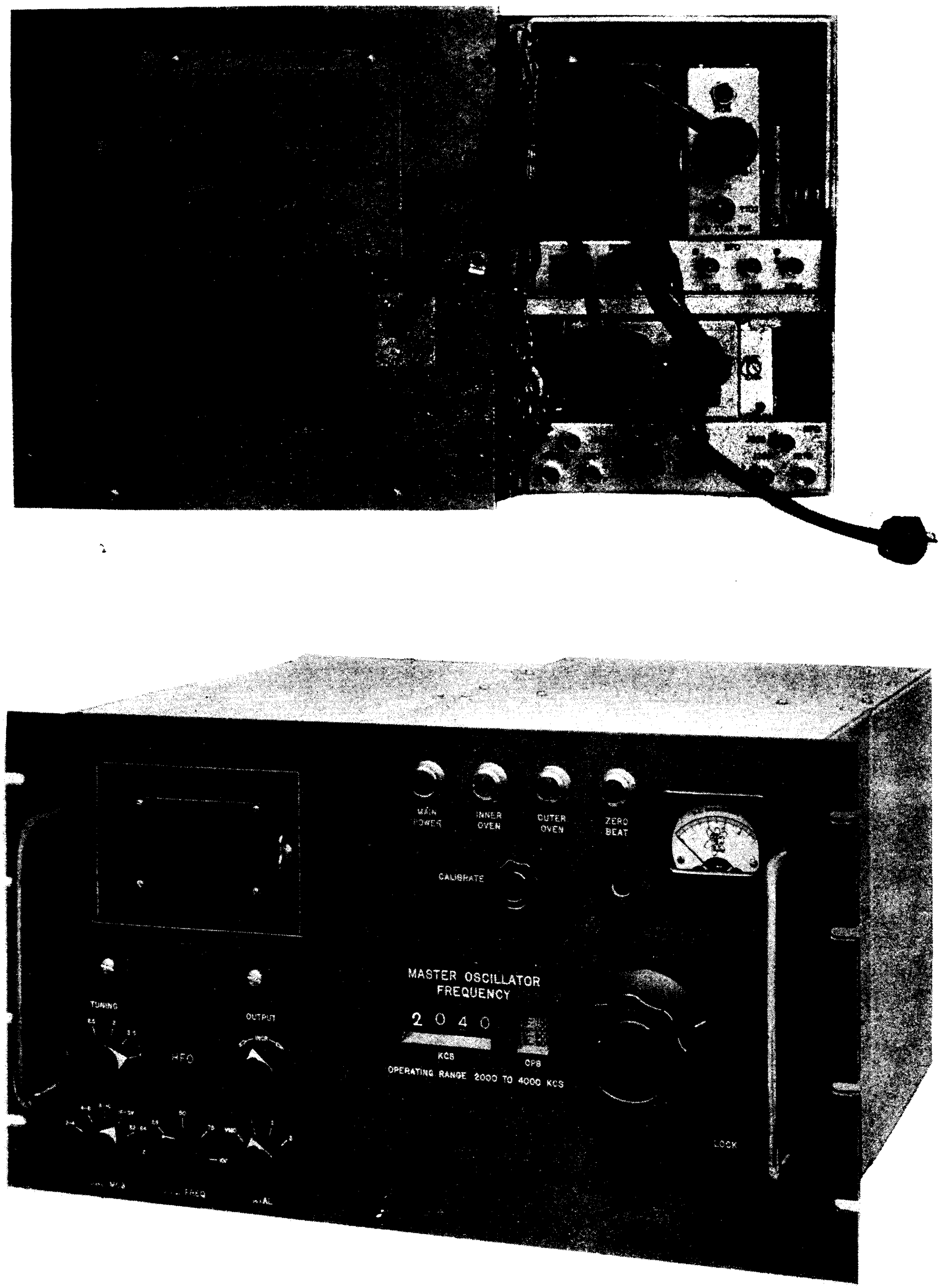

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Figure 1-1. Front and Rear Views, Variable Frequency Oscillator, VOX-5

SECTION 1
GENERAL DESCRIPTION

1-1. PURPOSE AND BASIC PRINCIPLES.

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

The VOX provides the following:

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

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

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

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

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

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

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

1-2. DESCRIPTION OF UNIT.

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

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

1-3. REFERENCE DATA.

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

TABLE 1-1. ELECTRICAL CHARACTERISTICS

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

TABLE 1-2. FRONT PANEL CONTROLS

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

TABLE 1-3. VACUUM TUBE COMPLEMENT

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

SECTION 2
INSTALLATION

2-1. INITIAL INSPECTION.

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

Inspect the case and its contents immediately for possible damage. Unpack the equipment carefully. Inspect all packing material for parts which may have been shipped as "loose items." Although the carrier is liable for any damage in the equipment, Technical Materiel Corporation will assist in describing and providing for repair or replacement of damaged items. The equipment is shipped with all tubes installed. Check that all such components are properly seated in their sockets.

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

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

2-3. INTERCONNECTING PROCEDURE.

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

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

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

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

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

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

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

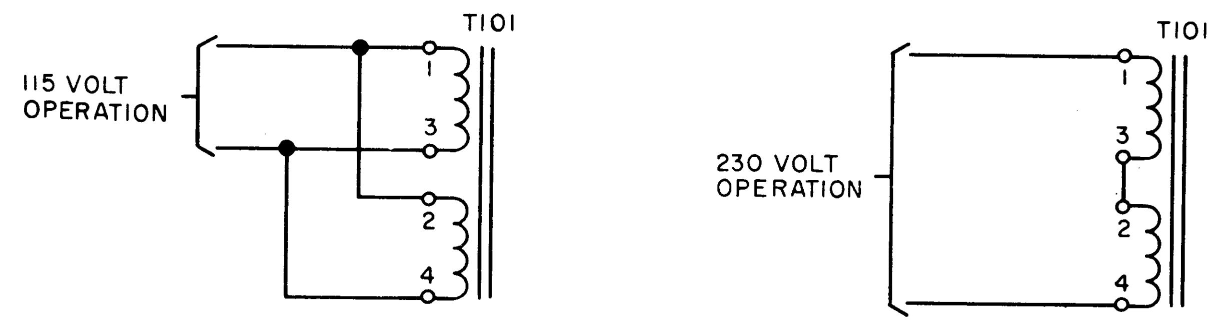

Figure 2-1. Installation Diagram Showing 115-vs 230-Volt Power Supply Connections

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

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

2-4. INITIAL ADJUSTMENTS.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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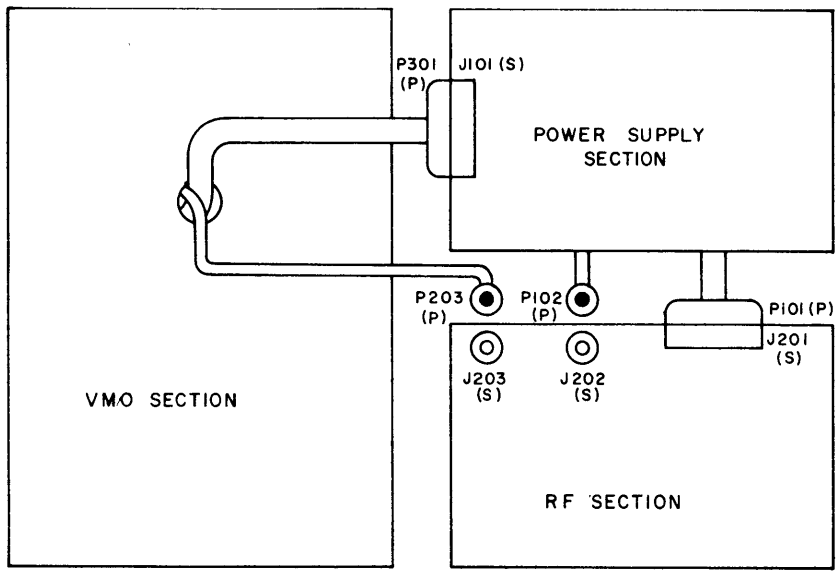
Do not operate the MASTER OSCILLATOR FREQUENCY dial 14 so that the stated frequency range of 200 to 4000 kc is exceeded, in order to prevent VMO cam displacement and possible VMO misalignment.



SKETCH A – CABLES UNDER NORMAL CONDITIONS

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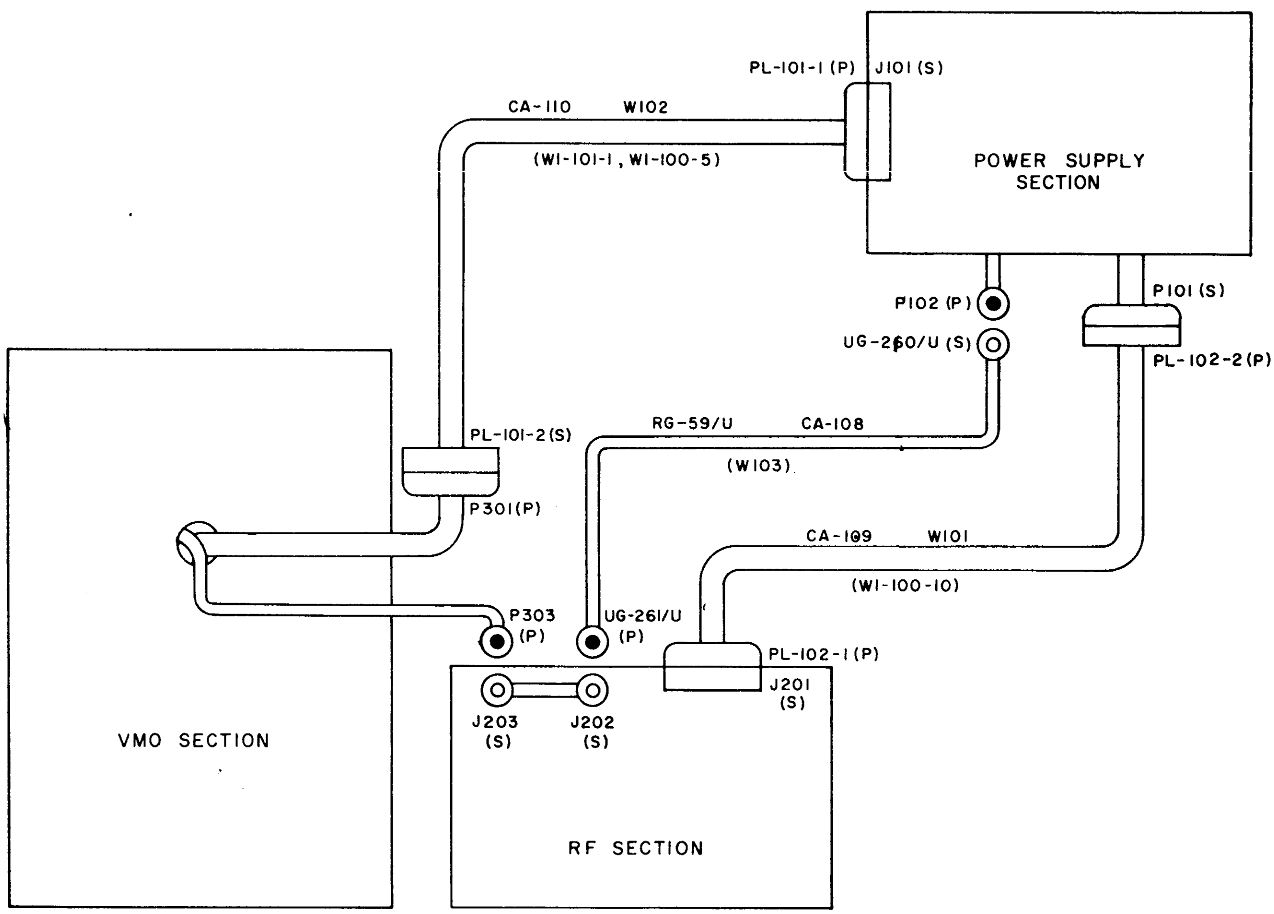

SKETCH B – CABLES UNDER SERVICING CONDITIONS

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

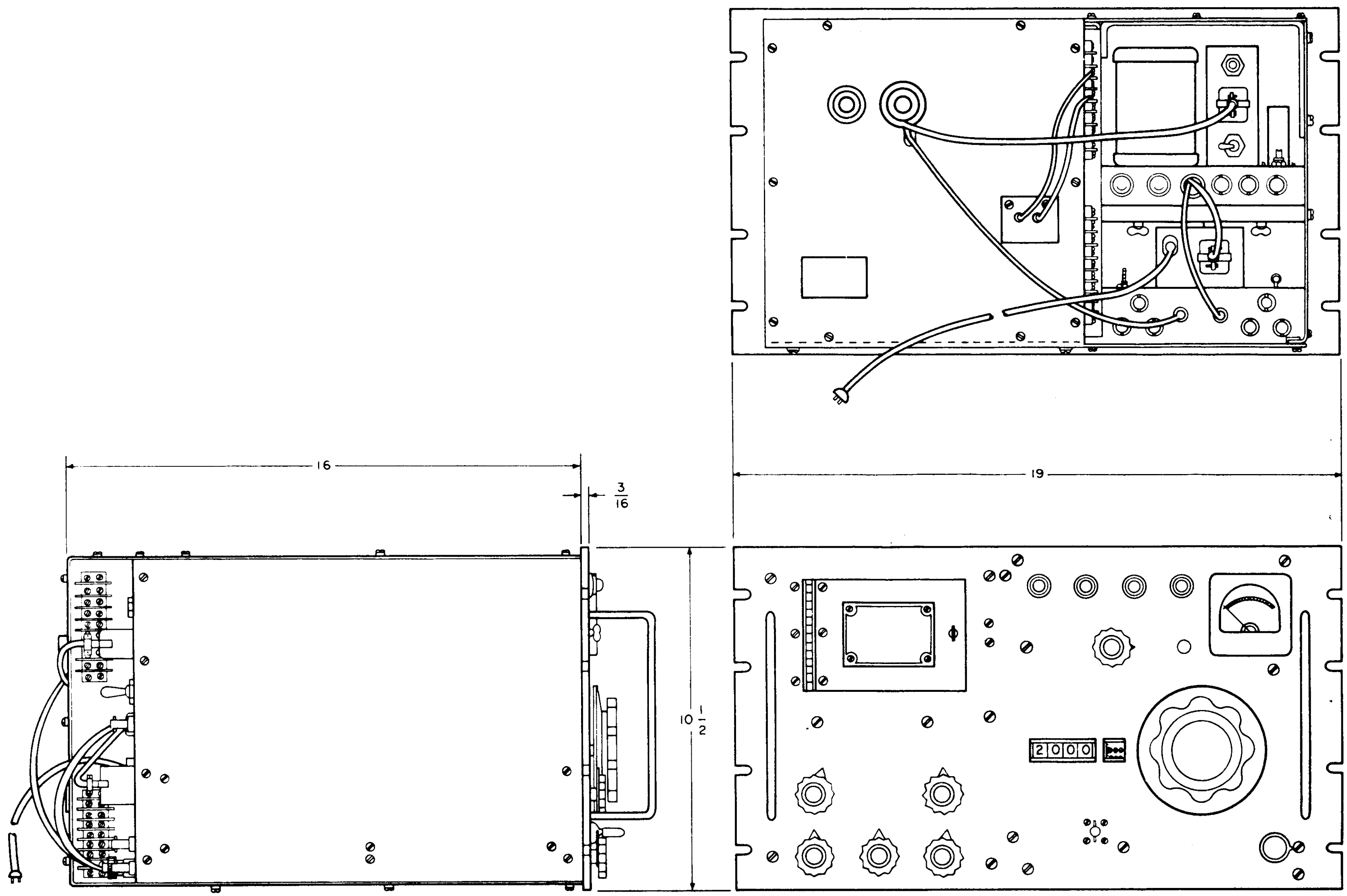

Figure 2-3. Outline Dimensional Drawing

SECTION 3
OPERATOR'S SECTION

3-1. GENERAL INSTRUCTIONS.

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

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

3-2. CALIBRATION.

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

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

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

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

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

3-3. OPERATING INSTRUCTIONS AFTER CALIBRATION.

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

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CAUTION

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

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

3-4. APPLICATIONS.

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

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

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

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

(a) Set power switch 4 to ON position.

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

(c) Set IFO switch 6 to ON position.

(d) Plug a headset into PHONES jack 3.

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

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

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

3-5. MAXIMUM CALIBRATION ACCURACY.

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

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

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

*Fr signifies receiver frequency.

TABLE 3-1. TABLE OF EQUIVALENT CONTROL DESIGNATIONS

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

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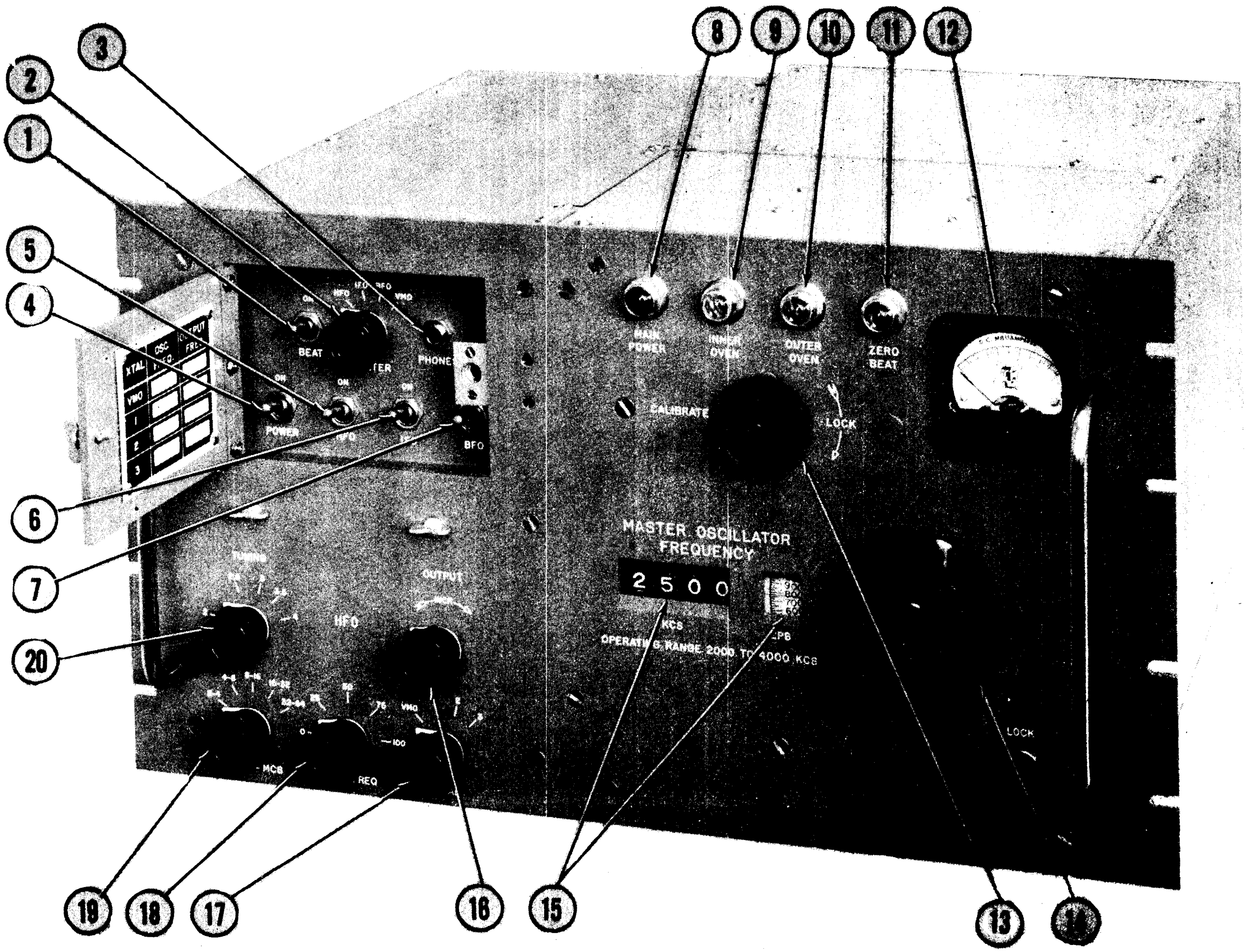

Figure 3-1. Operating Controls

SECTION 4
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

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

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

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

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

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

VMO tube V301 oscillates at frequencies between 2 and 4 mc and is tuned by capacitors C301, C302, and C303. R320 provides the necessary tube bias; L302 is an RF choke to ground; R301 and C307 provide the necessary decoupling action. Twin triode V302 performs the double function of a cathode follower (to impose less shunting effect on the preceding stage) and a crystal-controlled 100-kc oscillator. R302 is the unbypassed cathode resistor across which the output is taken. L303 and C308 provide filtering action to keep the RF out of the power supply by bypassing it through C308 and offering as high an impedance in L303 as practicable for the 300-volt B+ supply. The output from the second part of V302 is taken across R305. R306 supplies the necessary grid bias. Crystal Y301 resonates near 100 kc and may be "pulled" by means of adjuster-capacitor C3111 (a screwdriver control mounted on the rear of the oven chassis), which is not to be disturbed after its initial factory setting. R304 is the plate load and C309 is a coupling capacitor.

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

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

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

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

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

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

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

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

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

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

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

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

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

4-3. RF SECTION.

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

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

Tubes V204, V205, V206, and V207, used in conjunction with BAND-MCS switch S202, are voltage multipliers of the second harmonic of each preceding stage. 162

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4-4. POWER SUPPLY CHASSIS.

a. CALIBRATING CHAIN. (See figure 4-6.) - Contained within the oven enclosure of the VMO section (figure 4-3) is a highly stable 100-kc crystal oscillator against which the VMO is calibrated. When the 100-kc oscillator is turned on, both the 100-kc and the VMO oscillator voltages are fed to mixer V103. Here the difference frequency between one of the 100-kc oscillator's harmonics and the VMO's harmonics is passed by filter action of capacitors C111, C112, and resistor R108. This is a low-pass filter with a rising characteristic at very low frequencies. The audio signal is then amplified successively by the first and second halves of V104. Toggle switch S104 turns on or off the 100-kc oscillator's plate supply. This switch is designated 1 on figure 3-1. ZERO BEAT indicator I303 on the front panel (control designated 11 on figure 3-1) is connected into the plate circuit of the final amplifier so that the zero beat may be seen by the flashing of the neon lamp. Earphones may be plugged in at the output of the final amplifier at jack J105, in order to pick up the zero beat frequency audibly. The circuit, built around crystal CR101 containing C105, C106, and R102, is for metering the VMO output.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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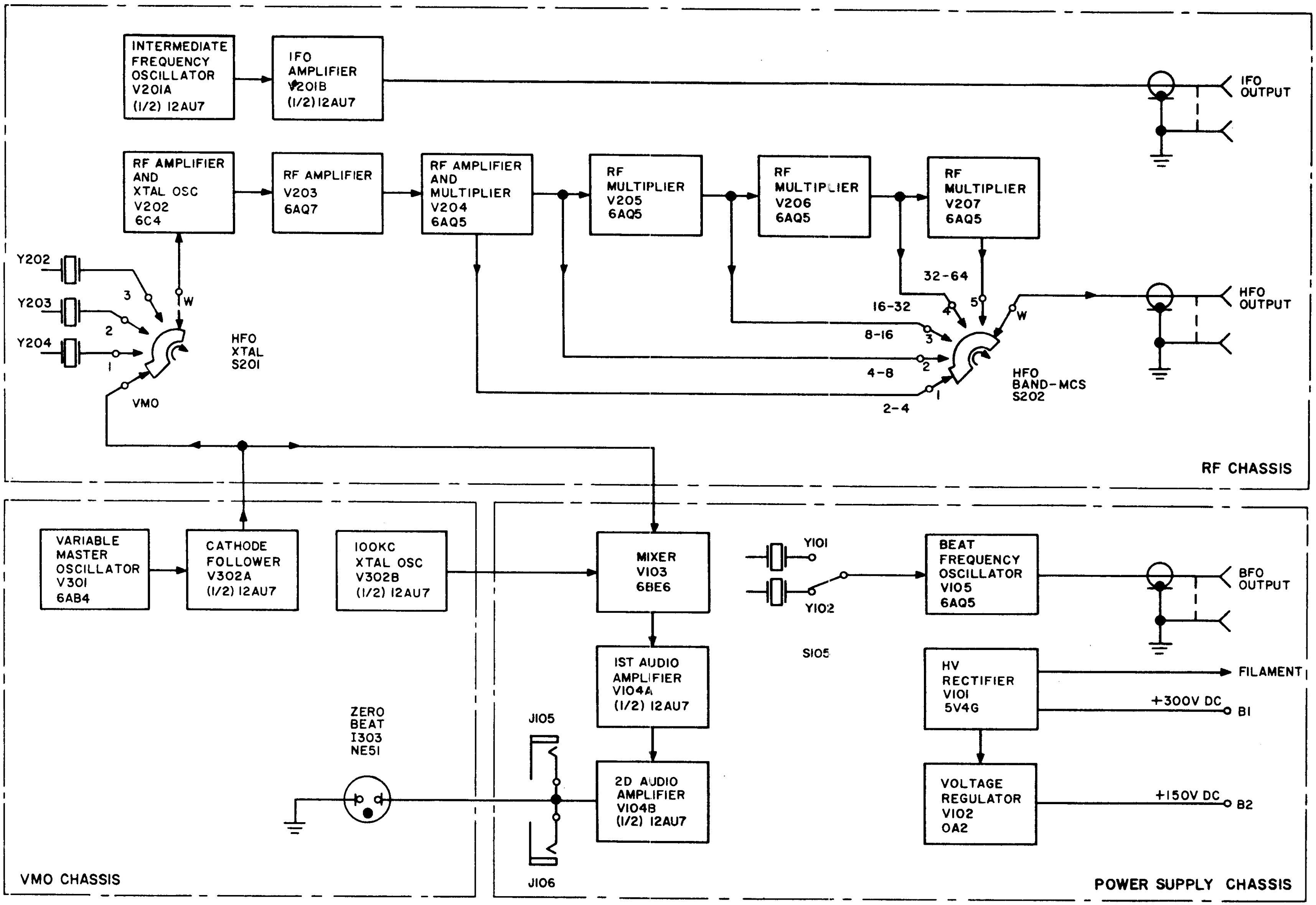
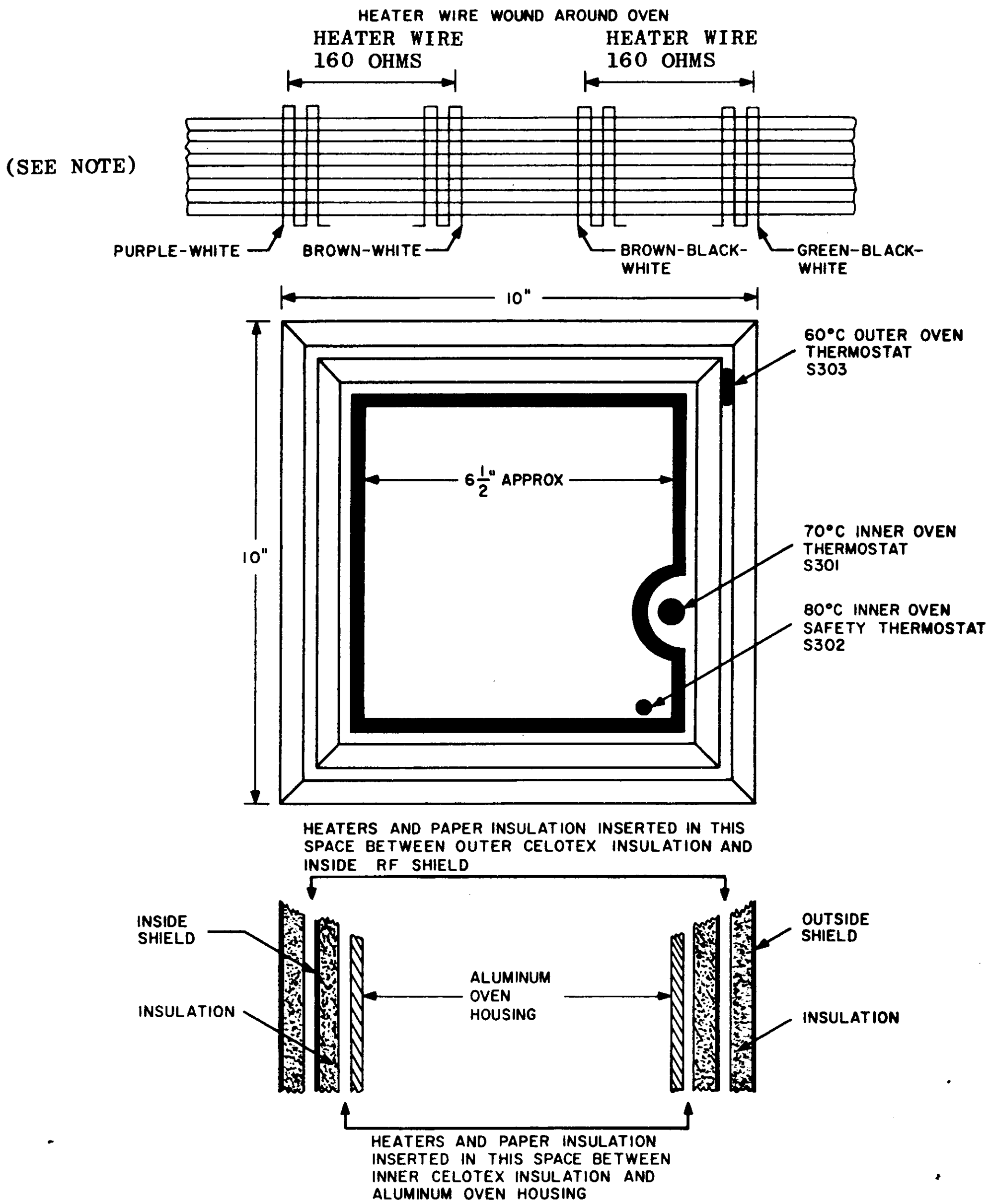


Figure 4-1. Block Diagram



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

Figure 4-2. Diagram Illustrating Oven

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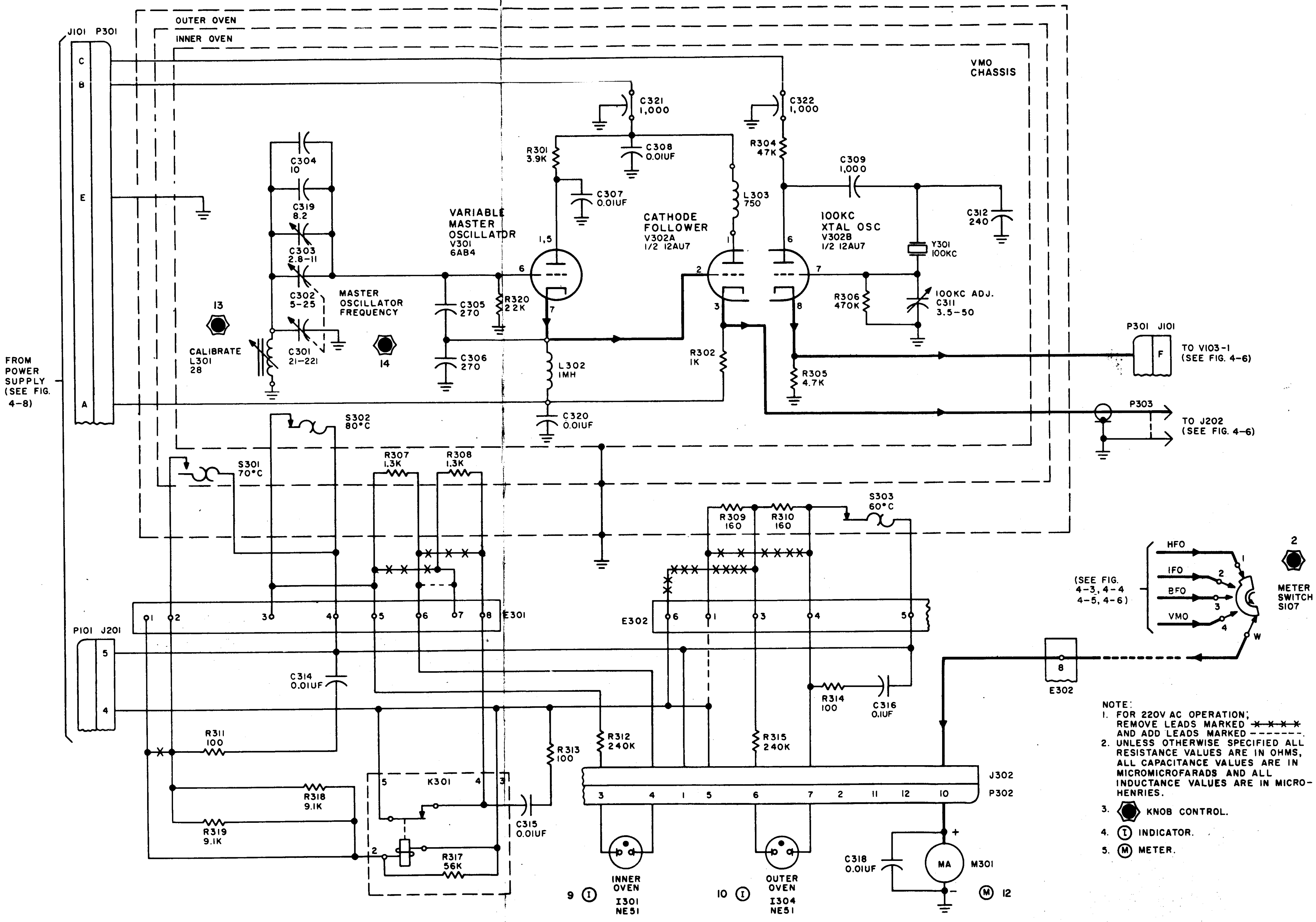
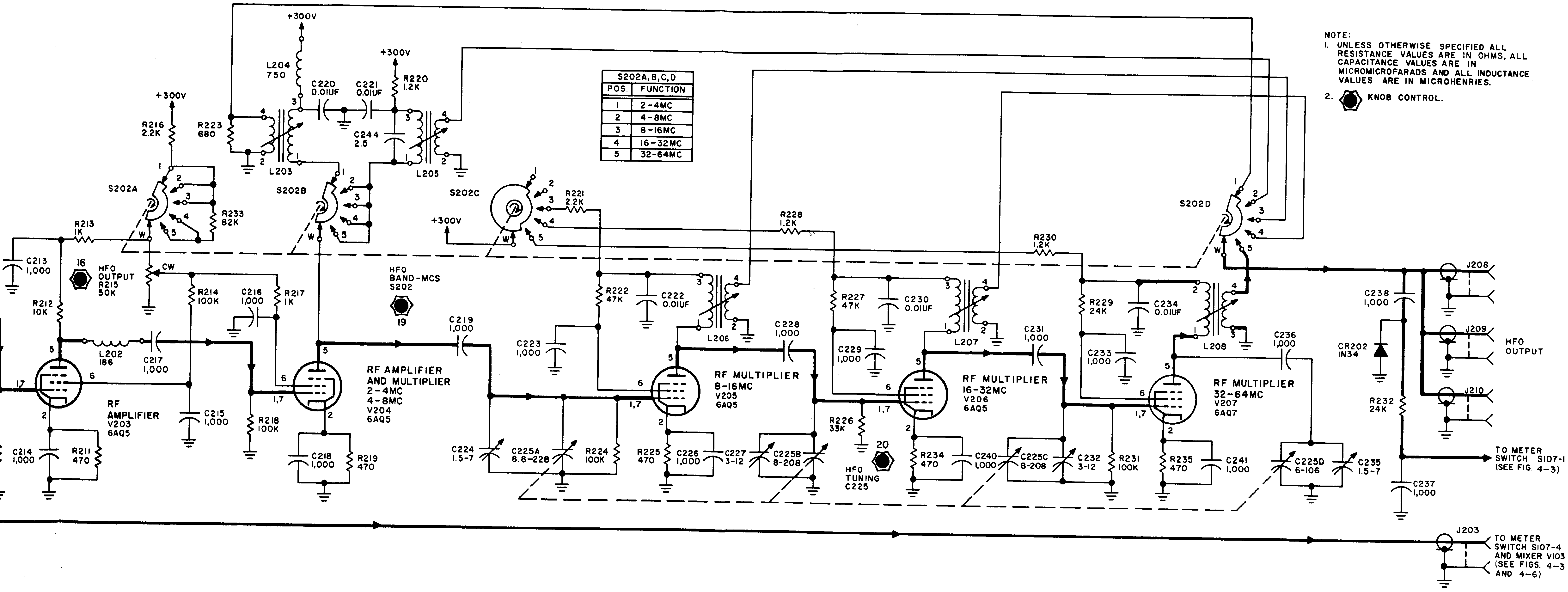


NOTE:
1. FOR 220V AC OPERATION; REMOVE LEADS MARKED -x-x-x-x AND ADD LEADS MARKED - - - - - - -.
2. UNLESS OTHERWISE SPECIFIED ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS AND ALL INDUCTANCE VALUES ARE IN MICRO-HENRIES.
3. KNOB CONTROL.
4. (I) INDICATOR.
5. (M) METER.

Figure 4-3. Schematic Diagram, VMO Section

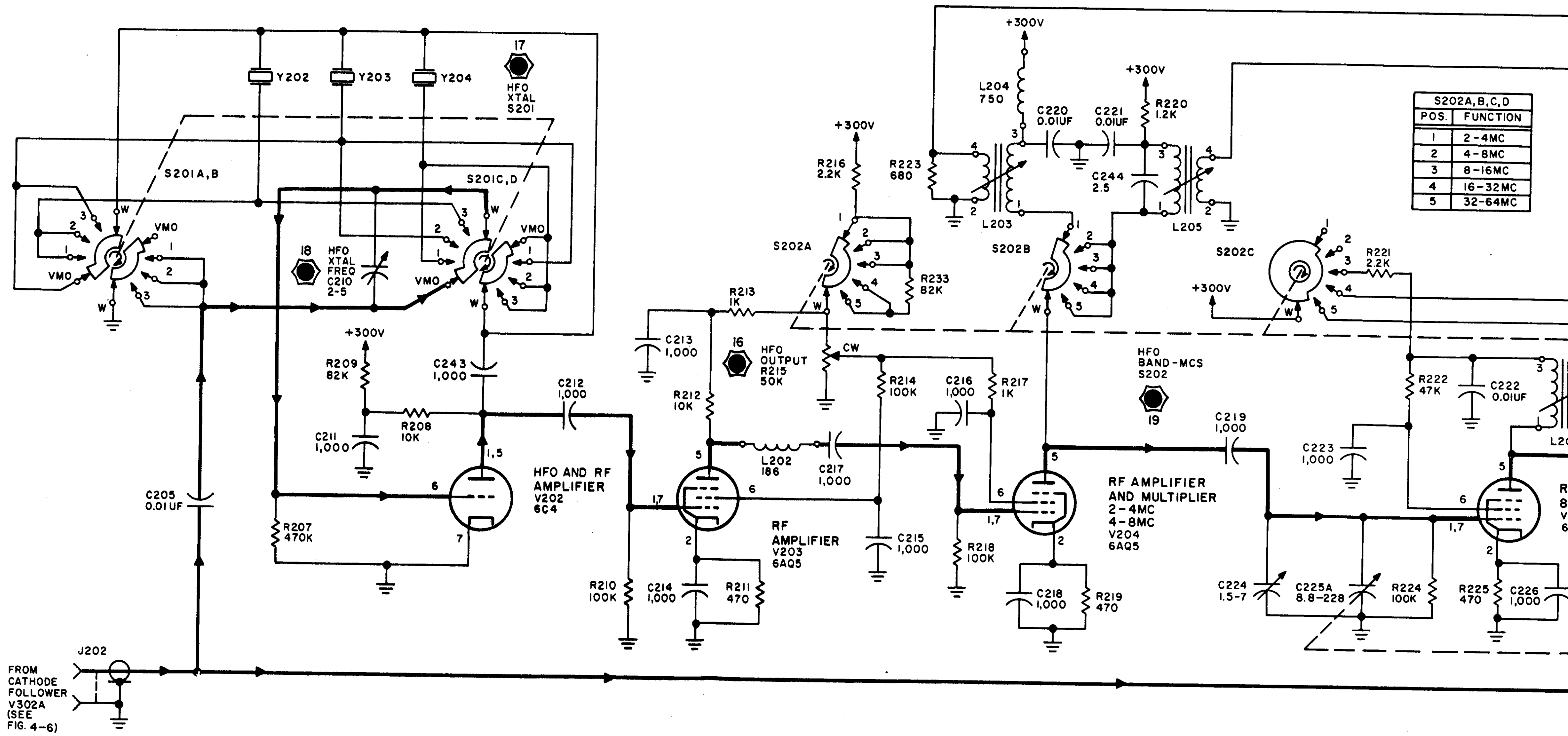
4-7-4-8

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.



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

Figure 4-4. Schematic Diagram, HFO Chain



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

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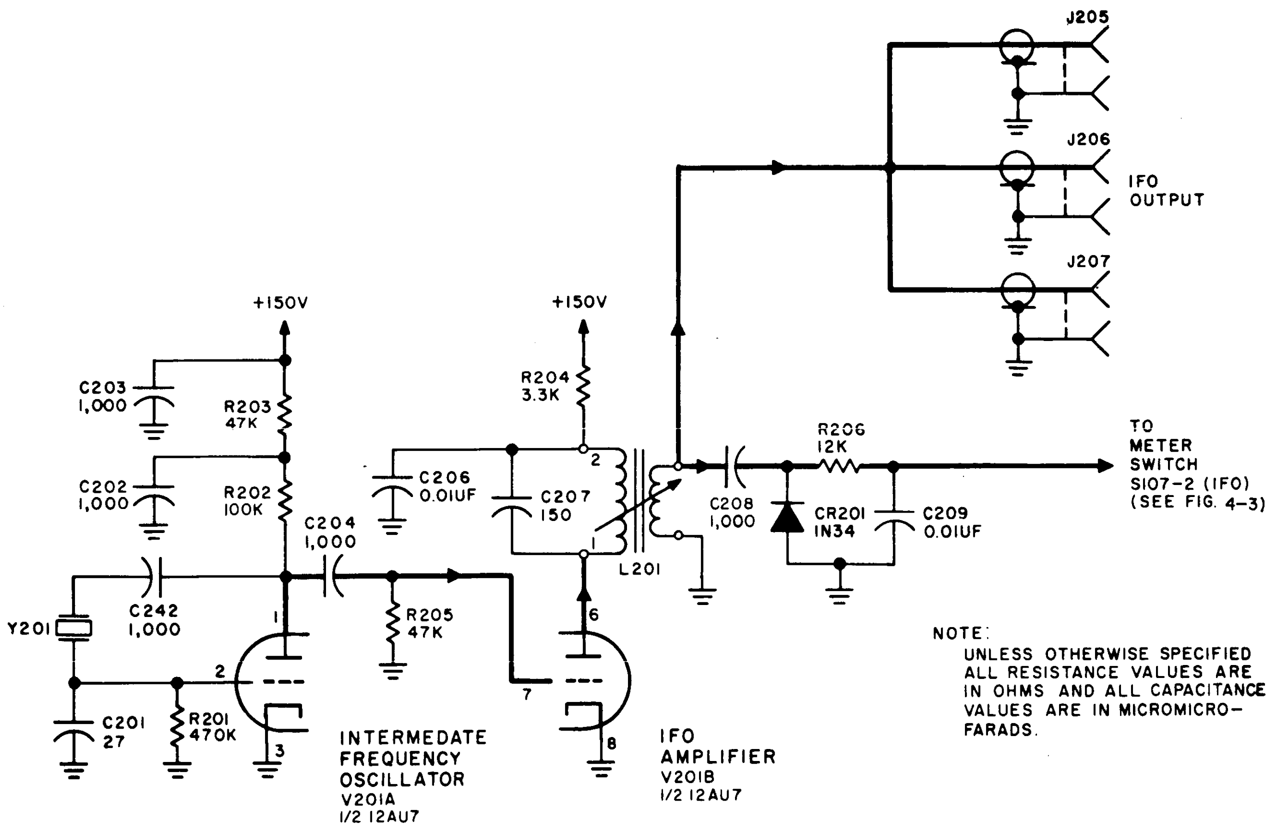

Figure 4-5. Schematic Diagram, IFO Chain

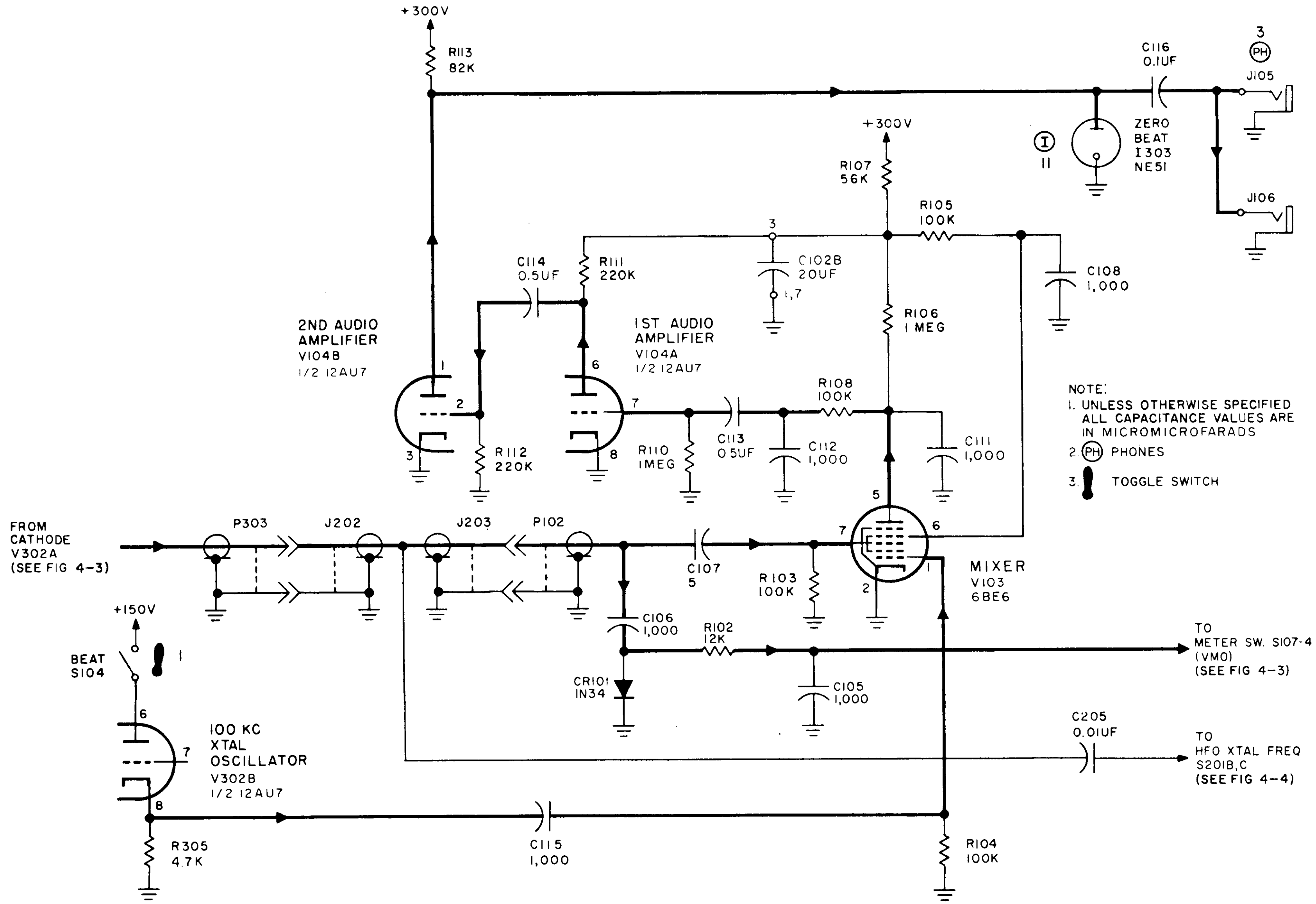

Figure 4-6. Schematic Diagram, Calibrating Chain

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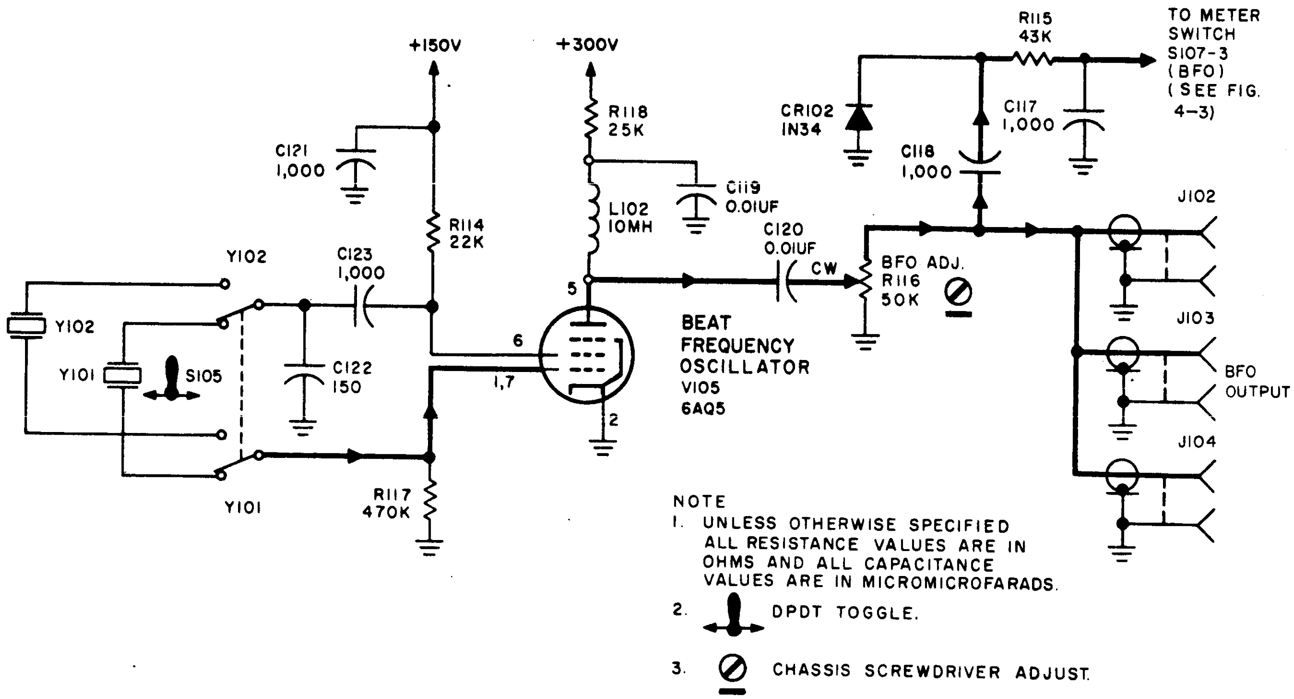

Figure 4-7. Schematic Diagram, BFO Circuit

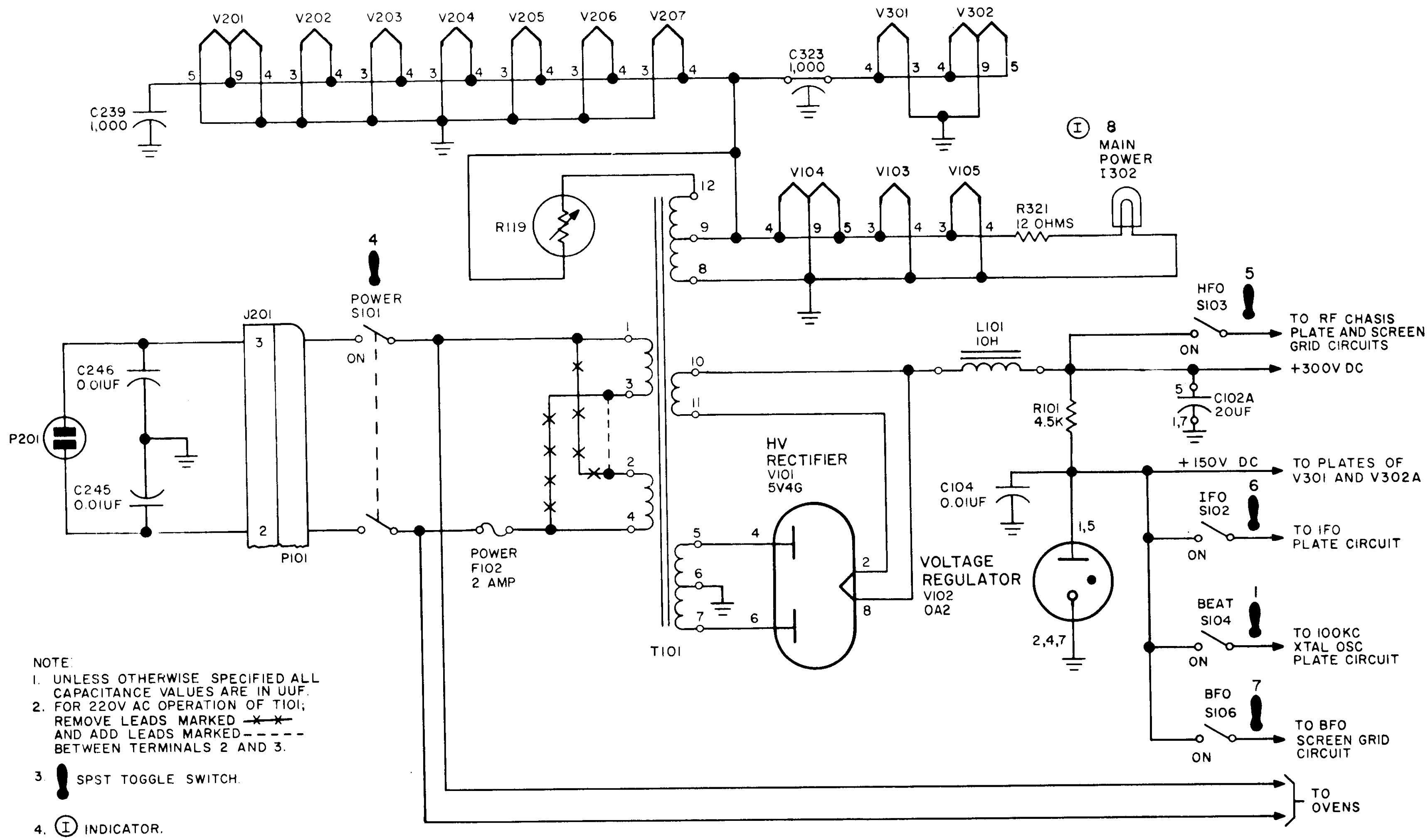

Figure 4-8. Schematic Diagram, Power Supply

SECTION 5
TROUBLE-SHOOTING

5-1. GENERAL.

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

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

a. Accurate schematic diagrams.

b. Tables of voltage and resistance; waveform data.

c. Location data (photographs with callouts of the major electronic equipment elements).

d. Trouble-shooting techniques.

e. Trouble-shooting charts based on operating procedures.

f. Trouble-shooting procedures based on circuit sectionalization.

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

5-2. TROUBLE-SHOOTING TECHNIQUES.

a. GENERAL CONSIDERATIONS. - When a piece of equipment has been working satisfactorily and suddenly fails, the cause of failure may be apparent either because of circumstances occurring at the time of failure or because of symptoms analogous to past failures. In this case, it is unnecessary to follow a lengthy and orderly course of trouble-shooting in order to localize and isolate the faulty part.

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

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

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

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

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

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

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

5-3. VARIABLE FREQUENCY OSCILLATOR VOX-5.

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

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

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

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

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

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

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

(a) Turn METER switch to HFO.

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

Then, notice the deflection in the needle of the milliammeter on the front panel. If, for example, the user wishes to operate on 20 mc, a null reading on the meter indicates a fault somewhere between the 16- to 32-mc stage (V206, L207, and C225) and/or each preceding stage to initial amplifier V202. Next, the operator should change his dial reading for the 8- to 16-mc band, switch to the 8- to 16-mc bandswitch, and notice any output on the milliammeter. The usual test procedure is recommended for checking the two amplifier output tubes, V203 and V204.

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

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

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

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

NOTE

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

HFO position - output meter reads 20 volts full scale.

IFO position - output meter reads 10 volts full scale.

BFO position - output meter reads 20 volts full scale.

VFO position - output meter reads 10 volts full scale.

TABLE 5-1. TROUBLE-SHOOTING CHART

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

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

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

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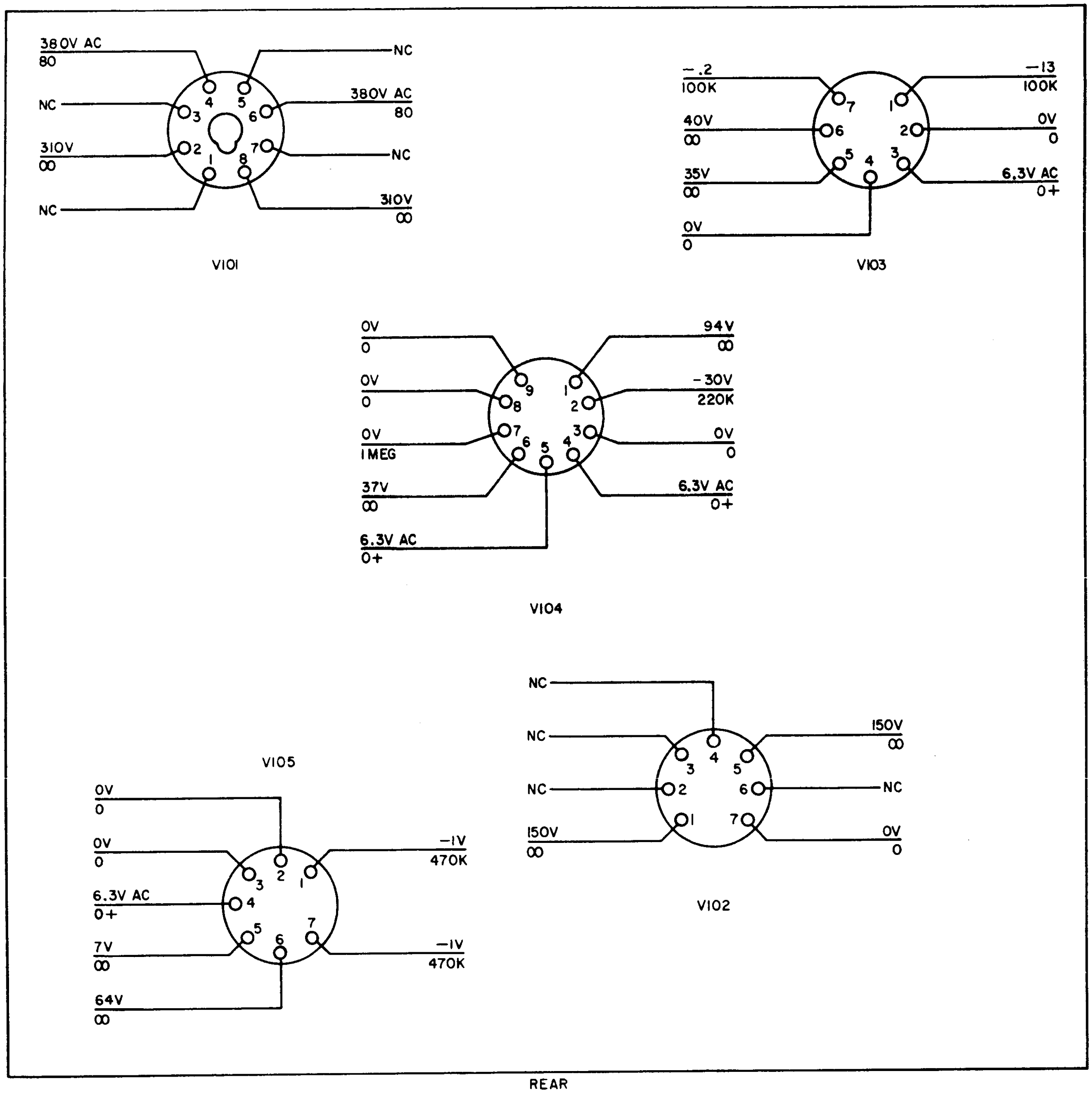
FRONT

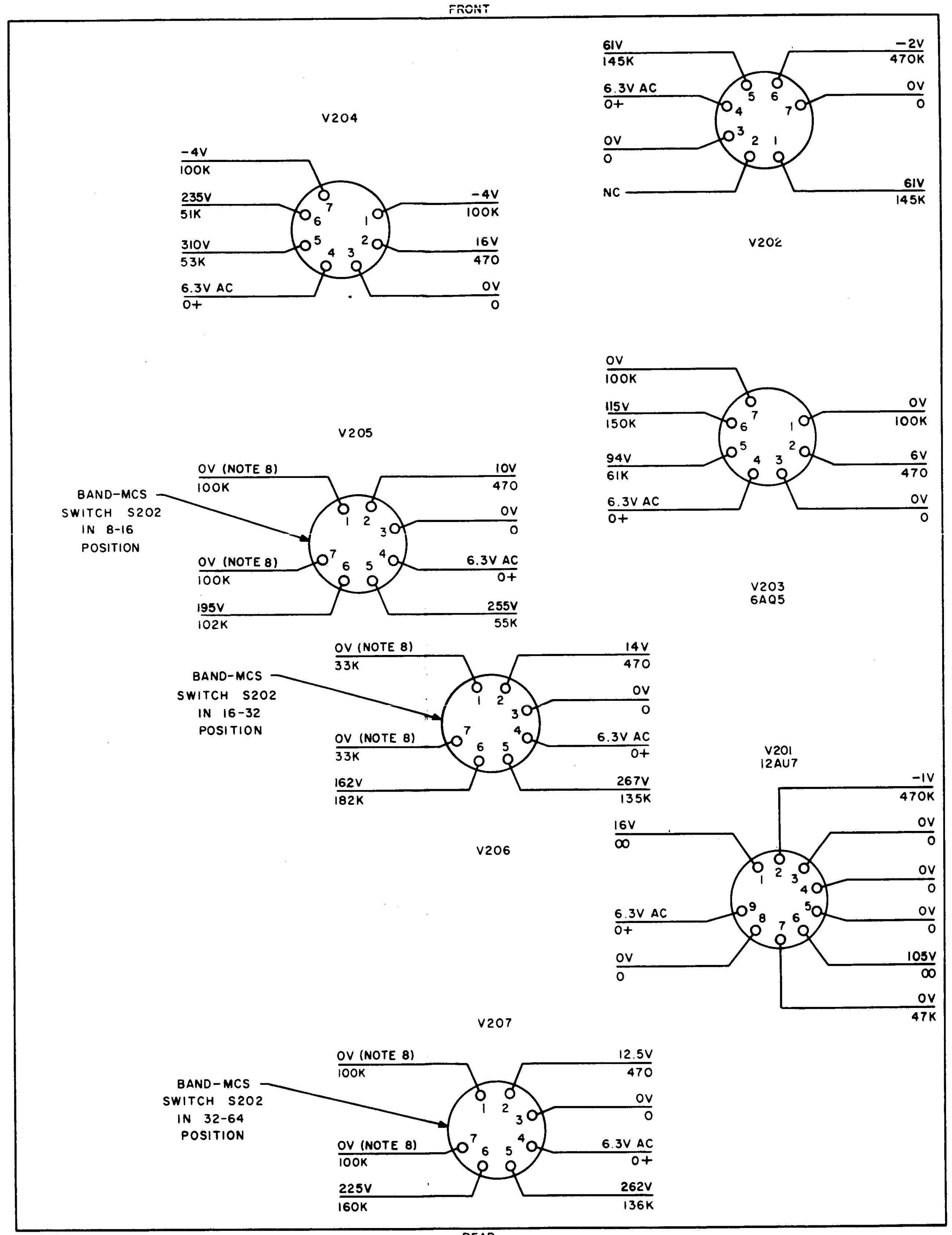


REAR

NOTE

1. UNLESS OTHERWISE SHOWN, RESISTANCES ARE IN OHMS. VOLTAGES AND RESISTANCES ARE MEASURED FROM TUBE SOCKET PINS TO GROUND WITH A 20,000 OHMS-PER-VOLT METER. FOR RESISTANCES ONLY, MEASUREMENTS ARE MADE WITH ALL THE INTER-CHASSIS CONNECTORS DISCONNECTED.
2. UNLESS OTHERWISE NOTED, ALL MEASUREMENTS ARE MADE WITH THE BAND-MCS SWITCH IN THE 2-4 POSITION; POWER, HFO, IFO, AND BEAT SWITCHES IN THE ON POSITION; TUNING CONTROL TO THE APPROXIMATE FREQUENCY OF THE VMO; OUTPUT CONTROL 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.

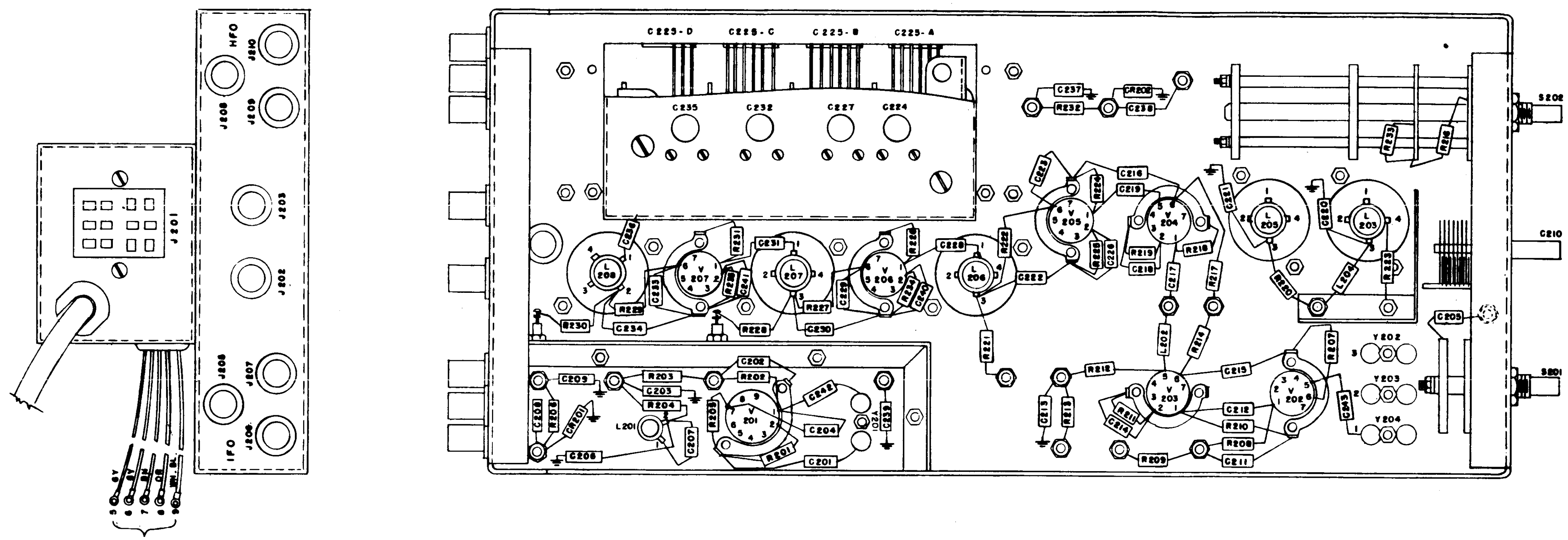
Figure 5-1. Voltage and Resistance Diagram, Power Supply Chassis



NOTE:

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

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



NOTE
RF JACKS COLORED AS FOLLOWS
J206 = BLUE/ GREEN
J207 = BLUE / YELLOW
J209 = RED / GREEN
J210 = RED / YELLOW

Figure 5-3. Layout Diagram,
RF Chassis

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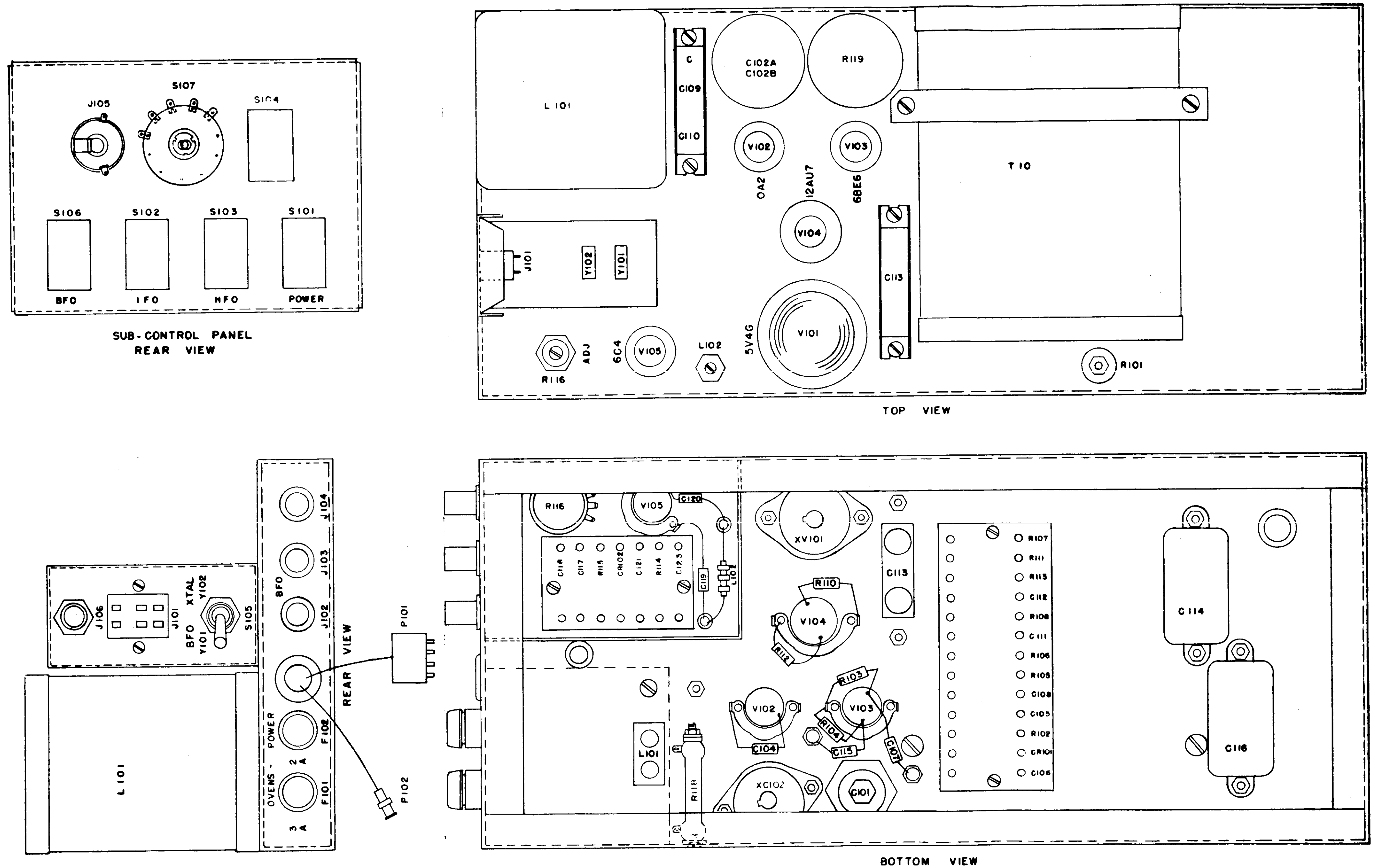

NOTE:
R.F. JACKS COLORED AS FOLLOWS:
J102 = BLACK / YELLOW.
J104 = BLACK / GREEN.

SUPERCEDES
CMS 070-C

Figure 5-4. Layout Diagram,
Power Supply Chassis

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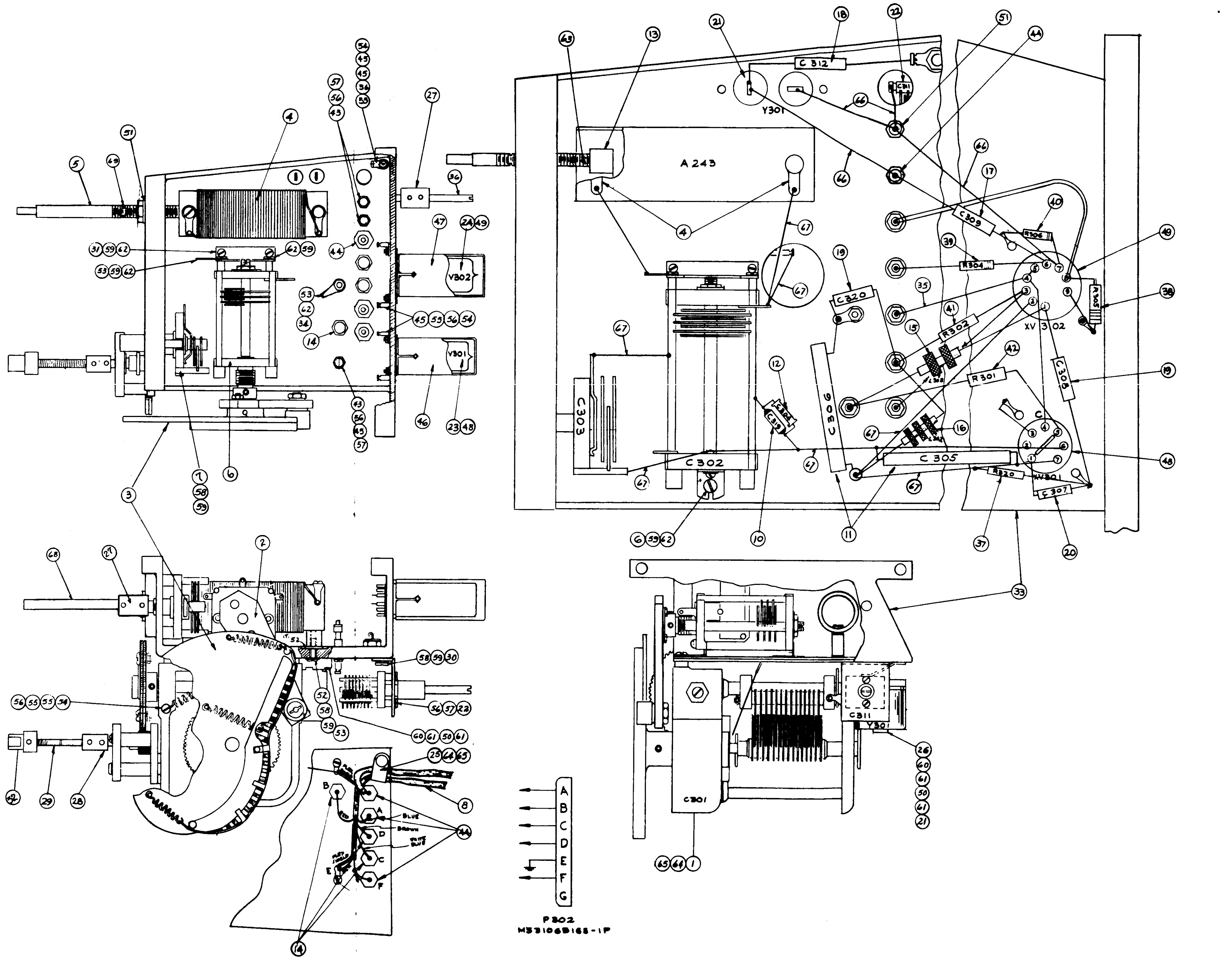

Figure 5-5. Layout Diagram, VMO Chassis

SECTION 6
MAINTENANCE

6-1. GENERAL.

Maintenance may be divided into three categories: operator's maintenance, preventive maintenance, and corrective maintenance. Corrective maintenance is sometimes considered as consisting of information useful in locating and diagnosing equipment troubles and maladjustments, existing and/or pending, and information necessary to remedy the equipment troubles and maladjustments. For the reasons stated in Section 5 of this manual, the remedial type of information is presented under corrective maintenance (Section 6) while the diagnosis type of information is presented under trouble-shooting (Section 5).

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

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

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

6-2. OPERATOR'S MAINTENANCE.

The operator should make minor adjustments of tuning controls to verify precise oscillator output frequency and level, note general condition of panel switches, observe whether panel indicator lamps light properly, and check the condition of the oven and power fuses as well as that of the tubes. Operators should not perform any emergency measures unless properly authorized to do so. If such authorization is given, it should be preceded by a short course of instruction.

a. REPLACEMENT OF FUSES.

CAUTION

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

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

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

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

6-3. PREVENTIVE MAINTENANCE.

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

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

WARNING

Carbon tetrachloride (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.

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

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

6-4. CORRECTIVE MAINTENANCE.

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

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

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

NOTE

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

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

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

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

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

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

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

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

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

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

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(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 stabled 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.

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

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

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

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

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

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

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

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

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

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

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

(1) BFO CIRCUIT LOCATED ON POWER SUPPLY CHASSIS.

(a) Connect all cables.

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

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

(d) Turn on POWER switch (S101).

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

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

(2) CALIBRATE CIRCUIT LOCATED ON POWER SUPPLY CHASSIS.

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

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

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

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

SECTION 7
PARTS LIST

INTRODUCTION

Reference designations have been assigned to identify all maintenance parts of the equipment. They are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams, and the parts list. The letters of a reference designation indicate the kind of part (generic group), such as resistor, amplifier, electron tubes, etc. The number differentiates between parts of the same generic group. Parts of the same first major unit are numbered from 1 to 199; parts of the second 201 to 299, etc. Two consecutive series of numbers have been assigned to major units in which there are more than 100 parts of the same generic group. Sockets associated with a particular plug-in device, such as electron tube or fuse, are identified by a reference designation which includes the reference designation of the plug-in device. For example, the socket for fuse F7 is designated XF7. The parts for each major unit are grouped together. Column 1 lists the reference series of each major unit, followed by the reference designations of the various parts in alphabetical and numerical order. Column 2 gives the name and describes the various parts. Major part assemblies are listed in their entirety; subparts of a major assembly are listed in alphabetical and numerical order with reference to its major assembly. Column 3 indicates how the part is used within a major component. Column 4 lists each Technical Materiel Corporation part number.

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NOTE

The following information is added to page 7-4:

R119	RESISTOR, current regulating; ballast vacuum tube type; .43 to .49 amps; 10.1 to 15.1 volts; 9-pin base.	Resistor, Current Regulating	RR-109

The following information is added to page 7-5:

XR119	Same as XV104.	Ballast Tube Socket	TS-103-P01

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

*C101 no longer exists in this equipment.

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

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

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

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

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

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** See note on page 7-0.

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

** See note on page 7-0.

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

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

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

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

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

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

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

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

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

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

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

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

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

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C311	Not a replaceable part. Part of Z301.	100 Kc Adjust, V302	
C312	Not a replaceable part. Part of Z301.	100 Kc Output, V302	
C313	NOT USED.		
C314	CAPACITOR, fixed: mica; .01 uf, ±10%, char B, 300 wvdc. (Same as C104)	Inner Oven Thermostat Arc Suppressor, E301	CM35B103K
C315	CAPACITOR, fixed: mica; .01 uf, ±10%, char B, 300 wvdc. (Same as C104)	Relay Arc Suppressor K301	CM35B103K
C316	CAPACITOR, fixed: paper; .1 uf, ±40, -10%, 400 wvdc; plastic tubular case.	Outer Oven Thermostat Arc Suppressor, J302	CN-109-4
C317	NOT USED.		
C318	CAPACITOR, fixed: mica; .01 uf, ±10%, char B, 300 wvdc. (Same as C104)	Meter Bypass Cap., P302	CM35B103K
C319	Not a replaceable part. Part of Z301.	VMO Temperature Compensation, Cap., V301	
C320	Not a replaceable part. Part of Z301.	RF Bypass	
C321	Not a replaceable part. Part of Z301.	RF Bypass	
C322	Not a replaceable part. Part of Z301.	RF Bypass	
C323	Not a replaceable part. Part of Z301.	RF Bypass	
E301	BOARD, terminal: barrier type; eight 6-32 x 1/4" binding head machine screws.	Inner Oven Connections	TM-102-8
E302	BOARD, terminal: barrier type; nine 6-32 x 1/4" binding head machine screws.	Outer Oven	TM-102-9
I301	LAMP, neon: 110 volts, 1/25 watt, bayonet base.	Inner Oven Indicator	BI-100-51
I302	LAMP, incandescent: 6-8 volts, 250 ma DC, bayonet base.	Power Indicator	BI-101-44
I303	LAMP, neon: 105-125 volts, 1/25 watt, bayonet base. (Same as I301)	Zero Beat Indicator	BI-100-51
I304	LAMP, neon: 105-125 volts, 1/25 watt, bayonet base. (Same as I301)	Outer Oven Indicator	BI-100-51
J301	NOT USED.		

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

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

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

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

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SECTION 8
SCHEMATIC DIAGRAMS

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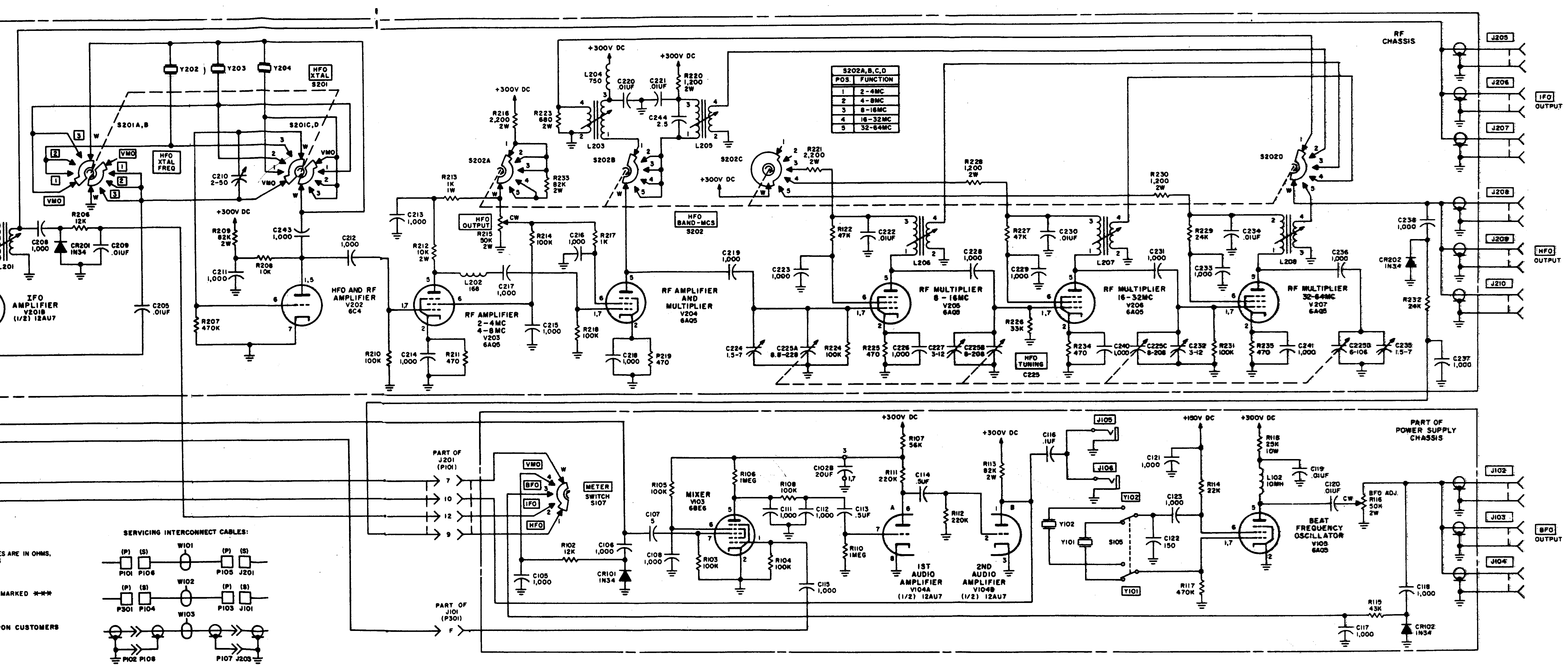

Figure 8-1. Schematic Diagram, VOX-5 (Sheet 1 of 2)

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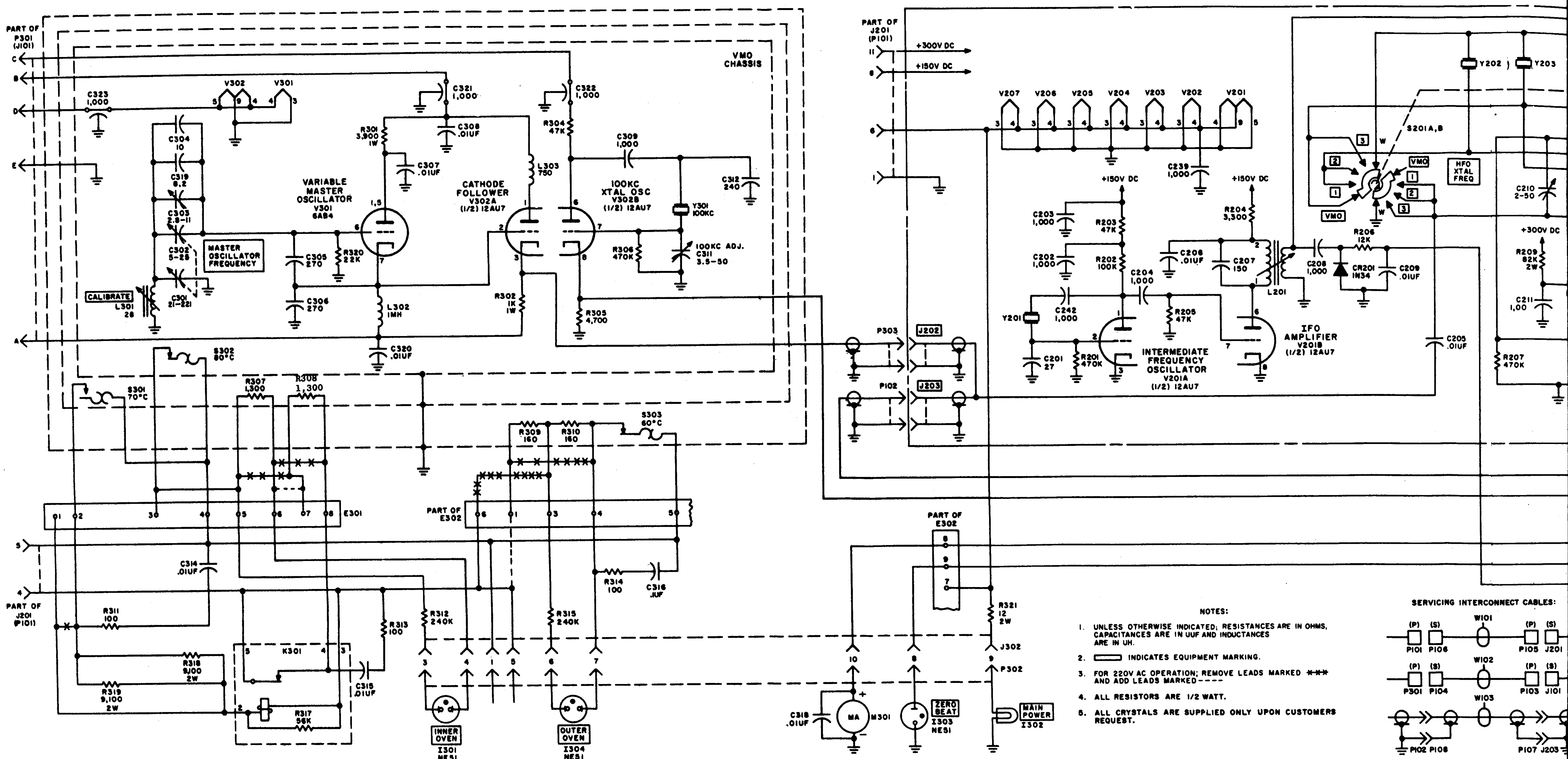

NOTES:

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

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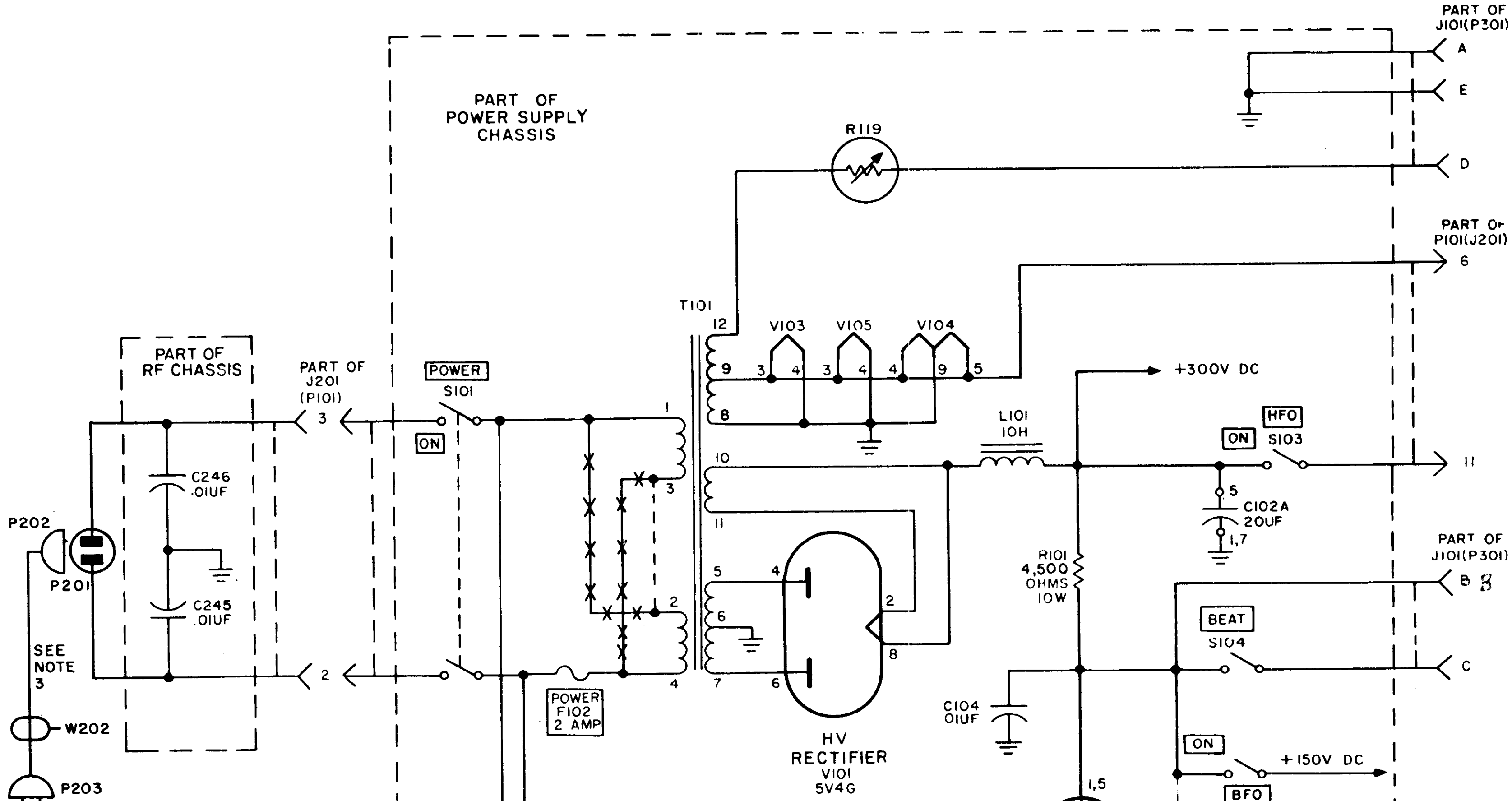


NOTES:

1. FOR 220V AC OPERATION OF T101; REMOVE LEADS MARKED —✕—✕— AND ADD LEADS MARKED - - - - - BETWEEN TERMINALS 2 AND 3.
2. ▭ INDICATES EQUIPMENT MARKING.
3. CABLE W202 IS SUPPLIED ONLY WHEN VOX-5 IS USED WITH GPT-10K AND SPT-1K.

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

NAVSHIPS 93707 UNCLASSIFIED

TECHNICAL MANUAL

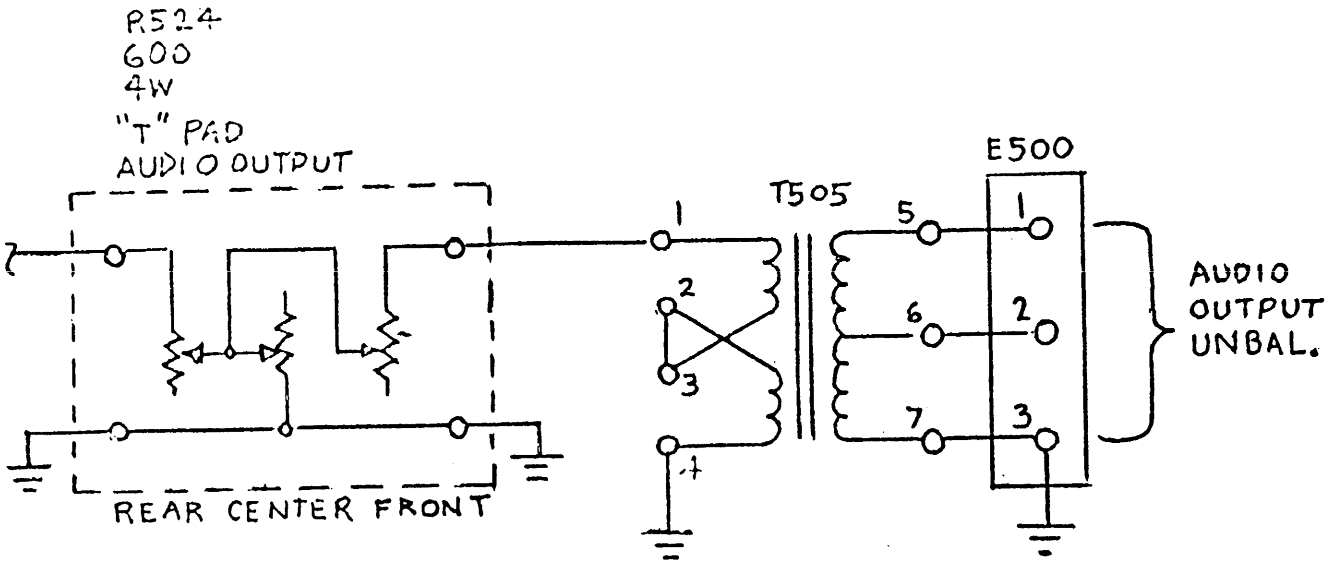
for

TWO TONE GENERATOR
MODEL TTG-1
(GENERATOR, SIGNAL, O-579/URT)

2/5

DEPARTMENT OF THE NAVY
BUREAU OF SHIPS

IN-207 *Issue Date:* 1 OCTOBER 1959



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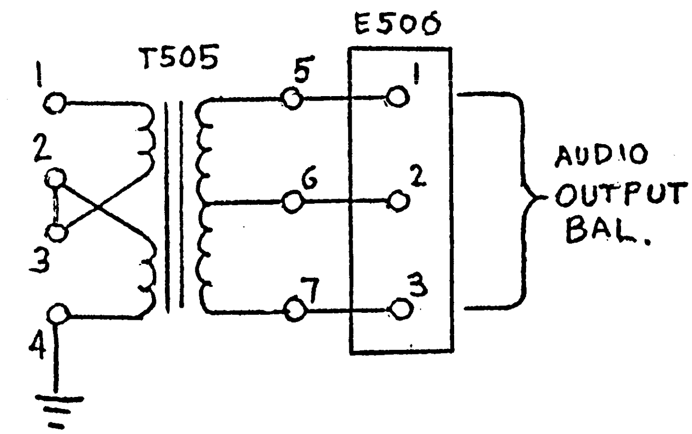

FIGURE I - AUDIO OUTPUT SCHEMATIC
FOR TTG-2

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LIST OF ILLUSTRATIONS

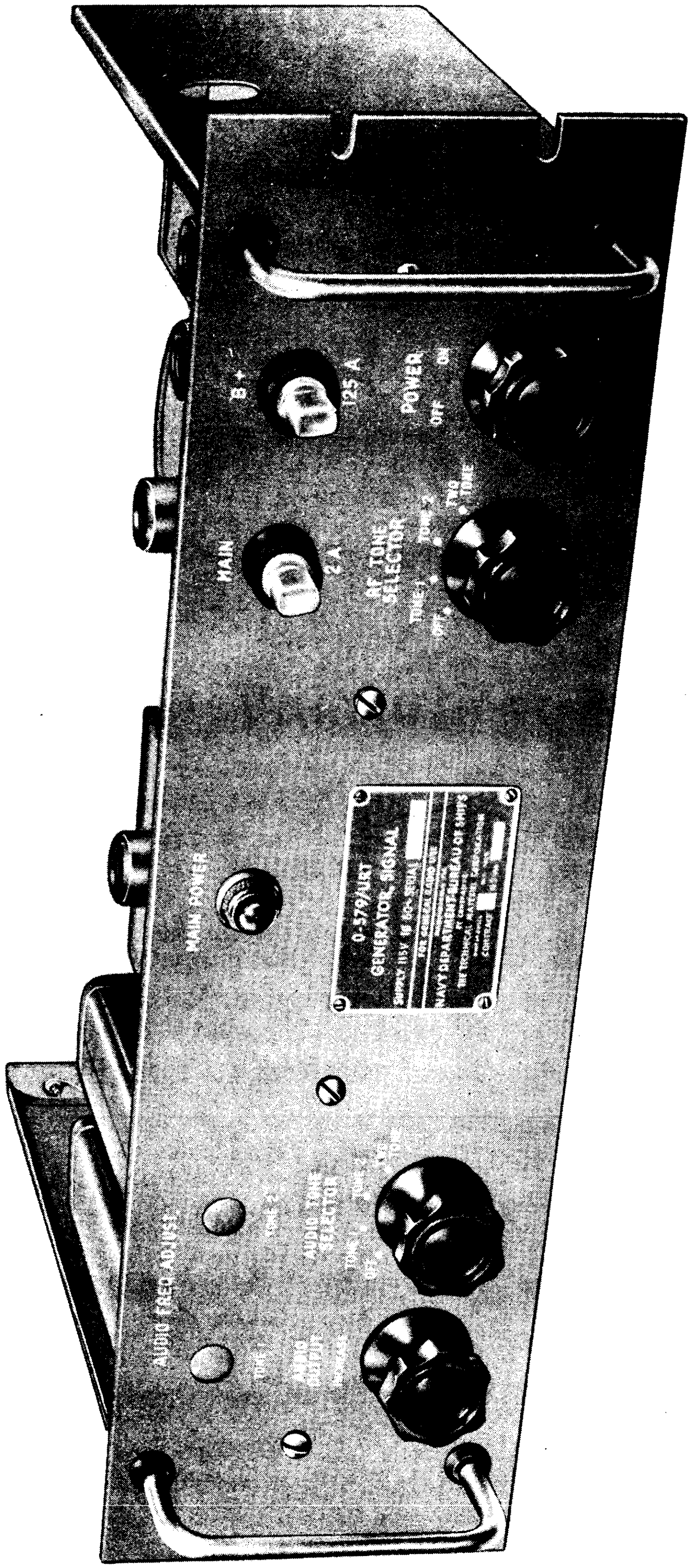

Figure 1-1. Front Vi w Model TTG

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SECTION I
GENERAL DESCRIPTION

1-1. PURPOSE AND BASIC PRINCIPLES

1-1. 1. The TMC Test Generator, Model TTG (0-579/URT), was especially designed for operation with the TMC Model GPT 10K Transmitter (AN/FRT-39), 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.

1-1. 2. The unit features selection of any combination of the four extremely low distortion and stable output frequencies. The audio oscillator has especially low distortion to ensure an accurate check of distortion in the standard two-tone test. Crystal control of the RF oscillators provides stable and dependable frequency output useful for checking proper operation of the spectrum analyzer and the variable oscillator of the transmitting equipment.

1-2. DESCRIPTION OF UNIT

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

1-2. 2. All operational controls are located on the front panel. These controls are clearly marked according to function.

1-2. 3. Input and output connections are made on the rear apron.

1-3. TECHNICAL SPECIFICATIONS

<u>AUDIO FREQUENCY OSCILLATOR</u>

OUTPUT FREQUENCIES:
935 cps and 2805 cps

HARMONIC DISTORTION:
65 db down

INTERMODULATION DISTORTION:
55 db down

OUTPUT IMPEDANCE:
600 ohms unbalanced

OUTPUT LEVEL:
0 to 0. 5 volts continuously variable

OUTPUT CONNECTION:
Terminal strip

<u>RADIO FREQUENCY OSCILLATOR</u>

OUTPUT FREQUENCIES:
1999 kc crystal controlled
2001 kc crystal controlled

DISTORTION:
60 db down

OUTPUT IMPEDANCE:
70 ohms unbalanced

OUTPUT LEVEL:
1. 0 volt

OUTPUT CONNECTOR:
BNC type

CONTROLS:
POWER ON/OFF switch
AF TONE SELECTOR
RF TONE SELECTOR
AUDIO OUTPUT CONTROL

PRIMARY POWER:
115/230 volts, 50/60 cps approximately 35 watts

SIZE:
19 inches wide x 5-1/4 inches high x 13-1/2 inches deep

WEIGHT:
14. 5 pounds

TUBE COMPLEMENT:
2 ea. 12AT7
4 ea. 12AU7
1 ea. 6X4

The equipment is manufactured in accordance with JAN/MIL specifications wherever practicable. All parts and assemblies meet or exceed the highest quality standards.

SECTION II
THEORY OF OPERATION

2-1. GENERAL DESCRIPTION OF CIRCUITS

2-1.1. The Model TTG consists of two pairs of oscillators, two similar audio oscillators and two similar RF oscillators. The only difference between the oscillators of each pair is operating frequency. Each generated audio tone is amplified and filtered to assure low distortion. The two audio tones can be used separately or may be combined, and are available at the terminal strip E500. R524 provides a continuously variable output level. The RF signals are generated and amplified in circuits suitable to the frequency of operation. Crystal control of the oscillators assures dependable, stable signal. The individual or combined RF signals are available at the connector, J501. The selectors, S501 and S502 provide a selection of any desired combination of the RF and audio signals.

2-2. CIRCUIT ANALYSIS

2-2.1. The following will describe only one of the audio and RF sections respectively. The other corresponding sections are identical in operation. A check of the block diagram will show which circuits are similar in operation.

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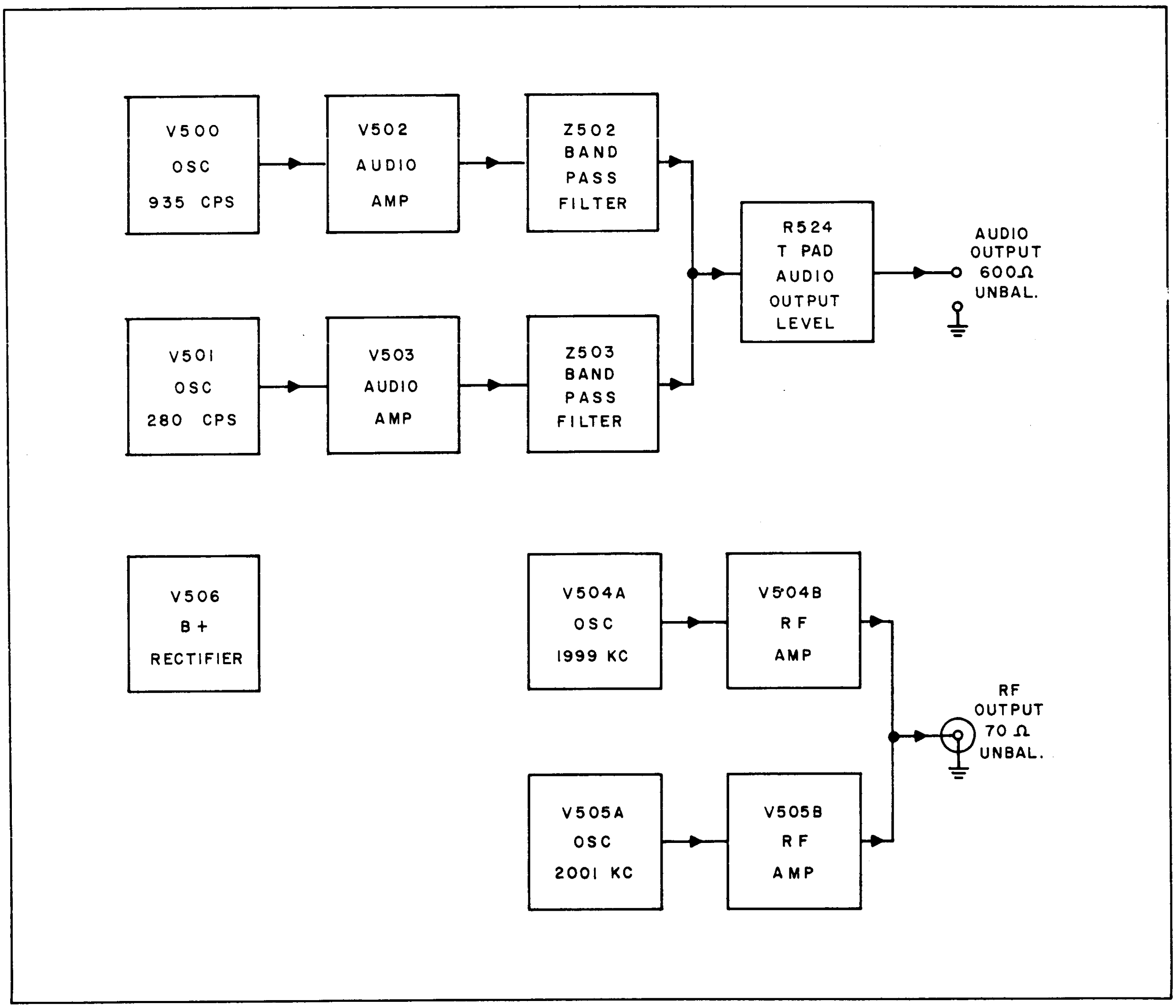

Figure 2-1. Block Diagram Model TTG

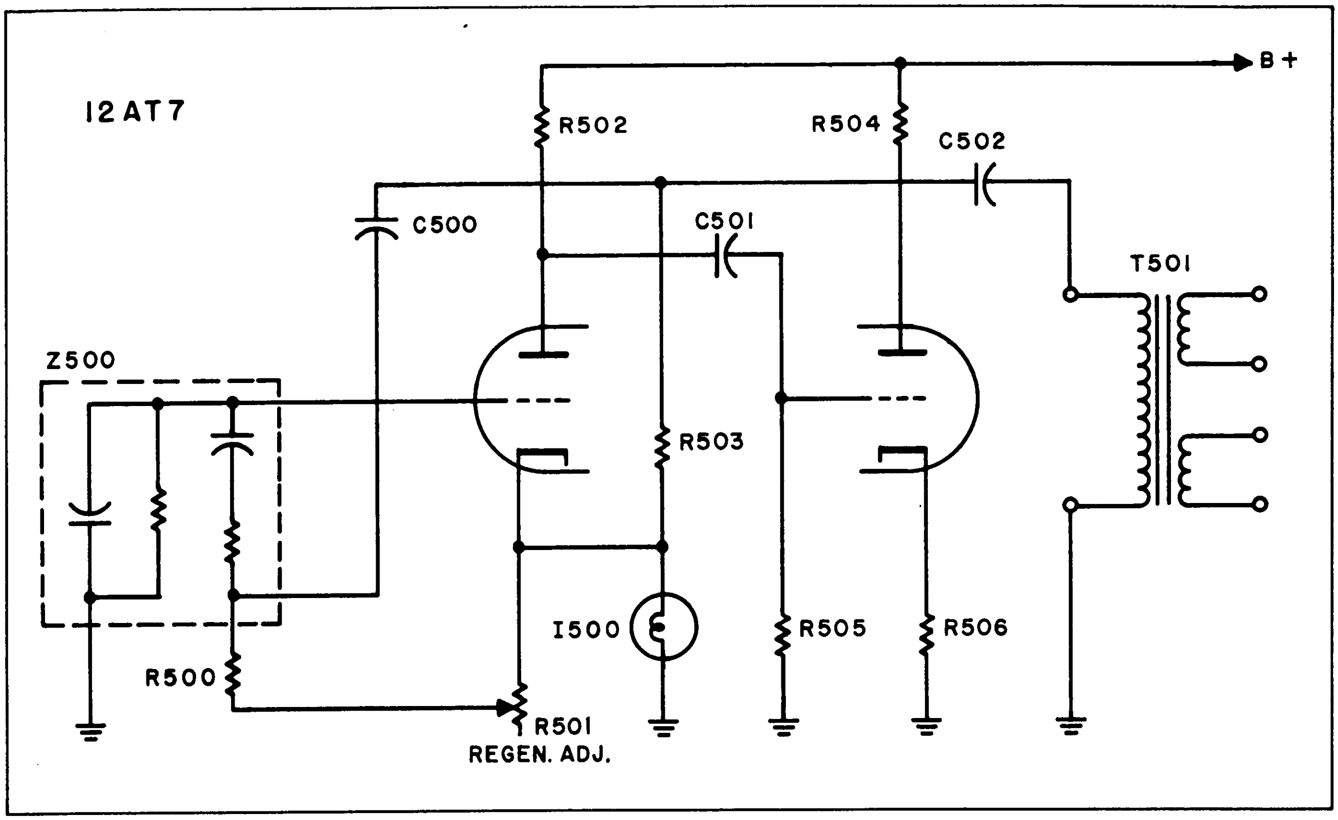

Figure 2-2. Simplified Schematic Audio Oscillator

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2-2. 2. The Audio Oscillator (V500). A 12AT7 is used in a very low distortion Wein bridge type oscillator. Z500, a sealed unit, is the frequency determining element. R501, regeneration control, provides adjustment of oscillation for optimum operation. A thermal resistor in the form of a lamp, I500, limits current variations to prevent changes in oscillator output level. The output of the oscillator is fed to the audio amplifier through a transformer, T501.

2-2.3. The Audio Amplifier V502. The audio tone from T501 is amplified by a 12AU7 in a push-pull class A circuit. The output of the amplifier is matched to 600 ohms through the transformer, T501.

2-2. 4. The Output Network. The output from the transformer is bandpass filtered by Z502 to remove any remaining distortion products. The individual tone level may be varied, for balance with the other tone, by R518. Combined tone level may be adjusted by R524, a front panel control.

2-2.5. The RF Oscillator (V504A). The crystal-controlled RF signal oscillator makes use of the first half of V504 in a modified Pierce oscillator circuit. The output of the oscillator is coupled to the grid of the amplifier through C520. C520, a variable capacitor, adjusts the level of the particular RF signal.

2-2. 6. The RF Amplifier (V504B). The second half of the 12AU7 is used as a tuned-output amplifier in order to bring the output to the required level.

2-2.7. The Rectifier (V506). A 6X4 is used in a full-wave rectifier circuit which supplies operating voltages to all stages of the TTG Test Generator.

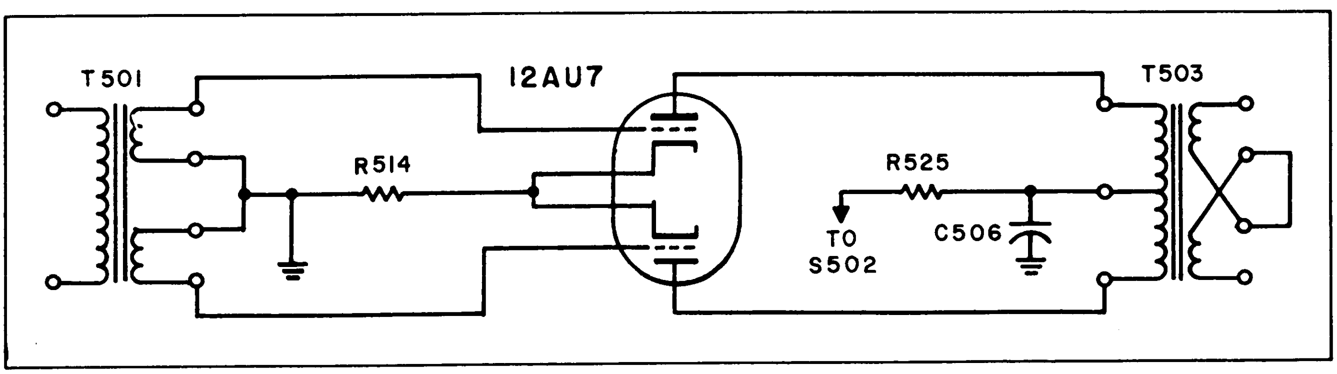

Figure 2-3. Simplified Schematic Audio Amplifier

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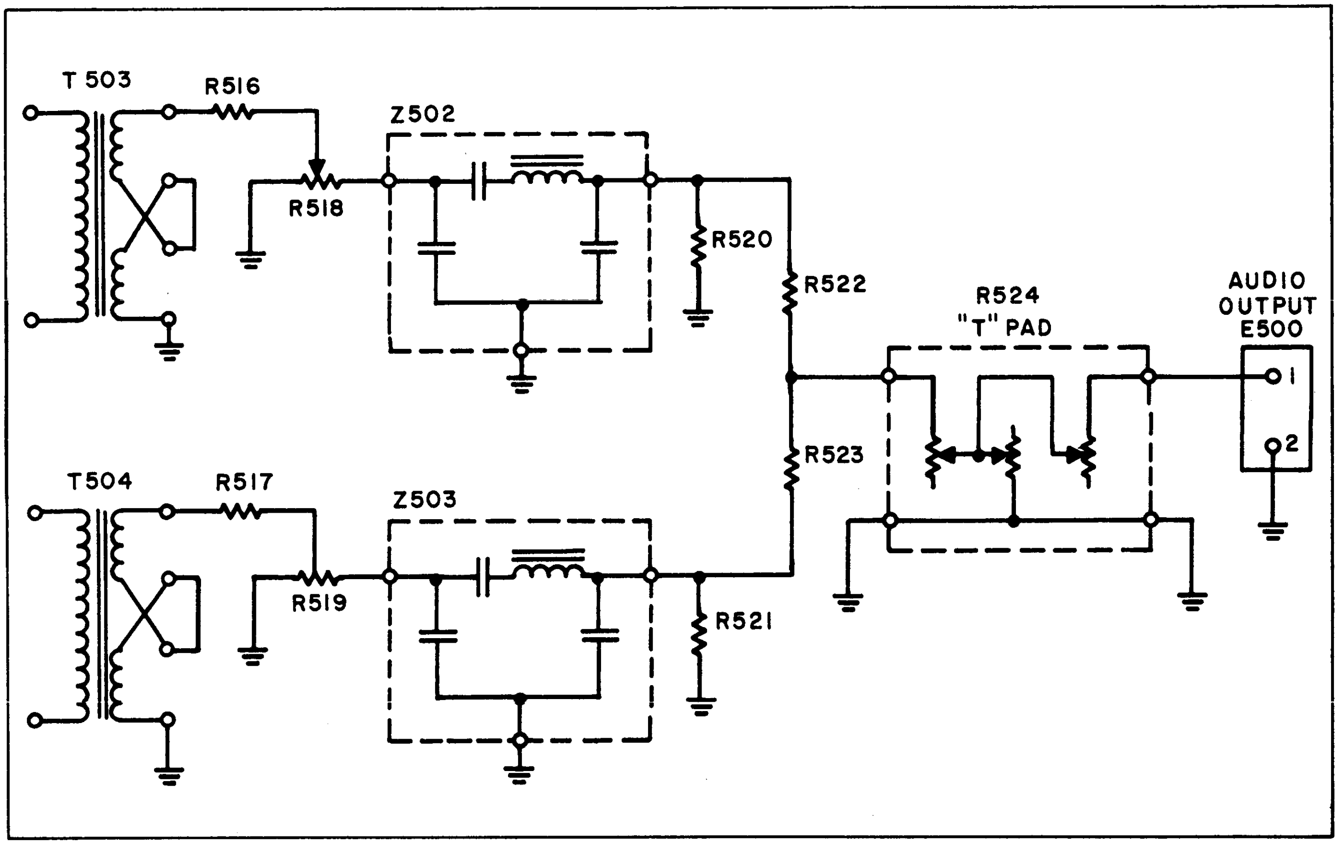

Figure 2-4. Simplified Schematic Output Network

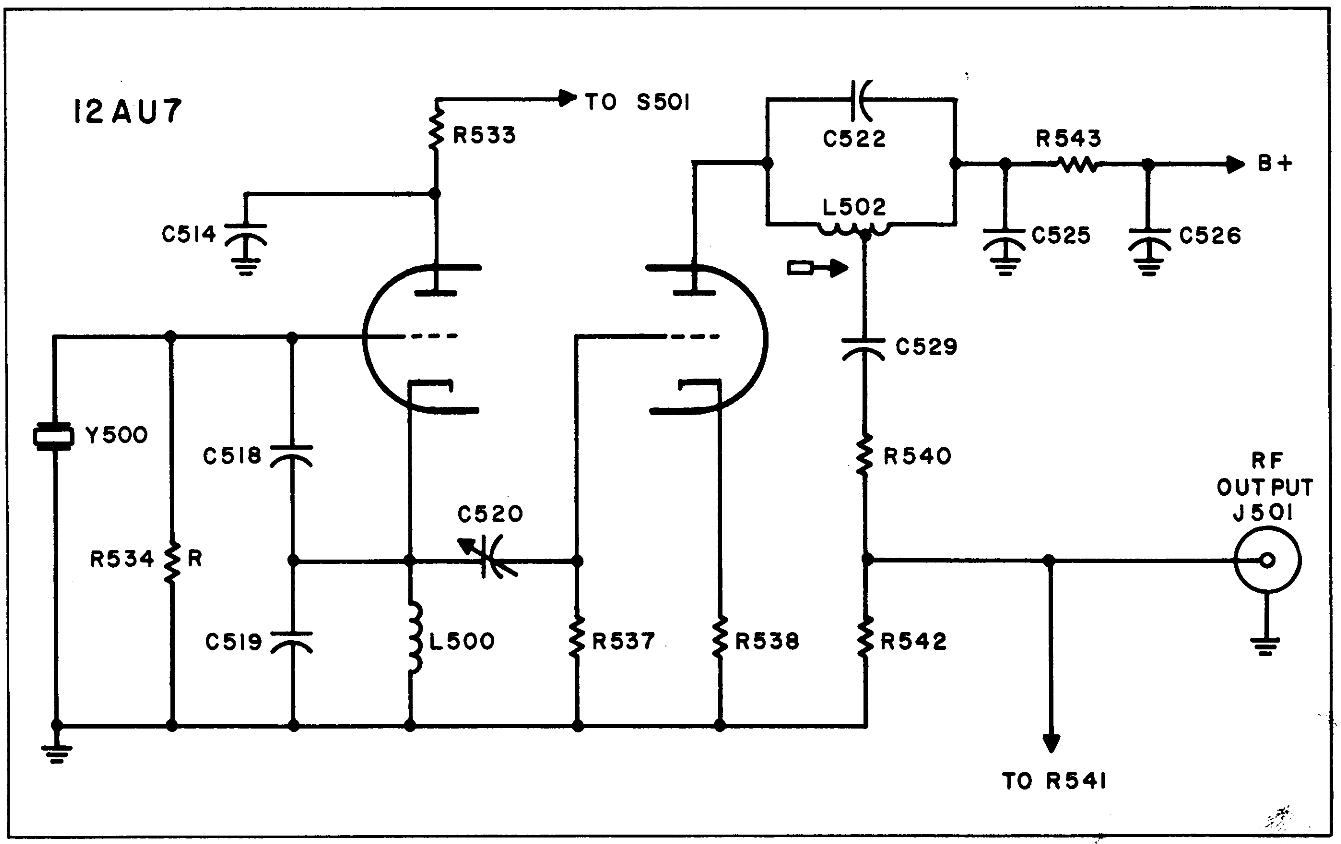

Figure 2-5. Simplified Schematic RF Oscillator and Amplifier

SECTION III
INSTALLATION AND OPERATION

3-1. INSTALLATION

3-1.1. The TMC Model TTG, Test Generator, has been designed for ease of installation and minimum effort in operation.

3-1.2. The unit is packed in an individual shipping container, and should be carefully unpacked. Packing material should be examined for loose items before discarding. A close visual inspection should be made to determine any physical damage due to rough handling during shipment. If damage is found, notify carrier immediately.

3-1.3. The unit is designed for operation from 115/230 volt, 50/60 cycle source. Unless specifically ordered for 230 volt, 50/60 cycle source, the unit is shipped wired for 115 volt AC operation. A simple wiring change in the tapped primary circuit of the power transformer, T500, is necessary to change the Model TTG to 230 volt AC operation. See Figure Schematic diagram. Remove jumpers connecting terminals 1 and 2, 3 and 4 of T500. Connect a jumper between terminal 2 and 3. Note that the other leads on terminal 1 and 4 are not disturbed.

3-1.4. Three external electrical connections are made to the unit. Connect the power cord from J500 to a power source of proper voltage and frequency. The 600 ohm unbalanced audio output may be obtained at E500 terminal strip on the rear apron. Connect a BNC type connector to jack, J501, for the RF output.

3-2. OPERATION

3-2.1. The Model TTG may be used in a variety of ways to test a transmitting system. Figures 3-1, 3-2, and 3-3 show typical installations of the Model TTG with TMC Models VOX, Variable Master Oscillator, and FSA, Frequency Shift Analyzer. Figures 3-4 and 3-5 show typical installations of the TTG with commonly available test equipment.

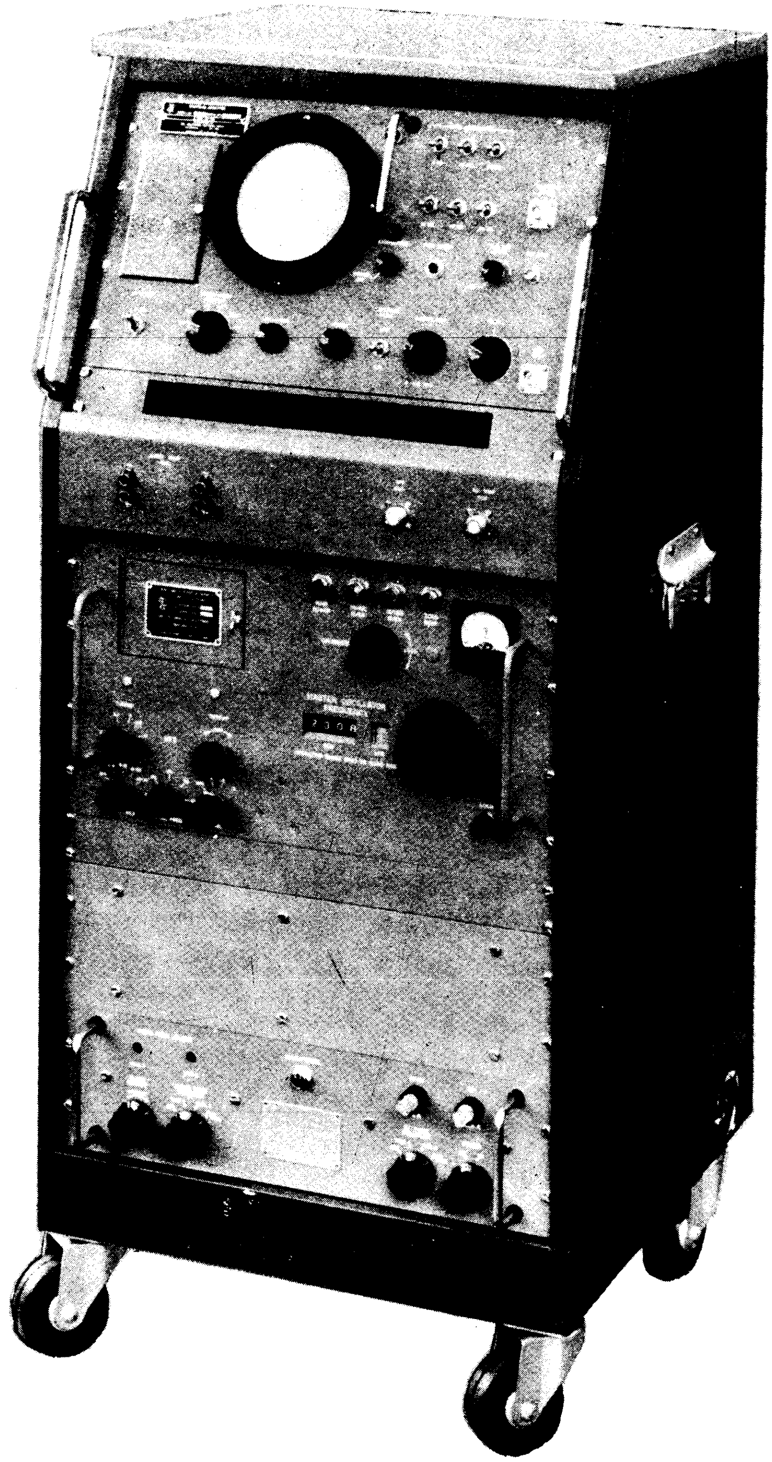

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Figure 3-1. Model PTE Single Sideband Analyzer

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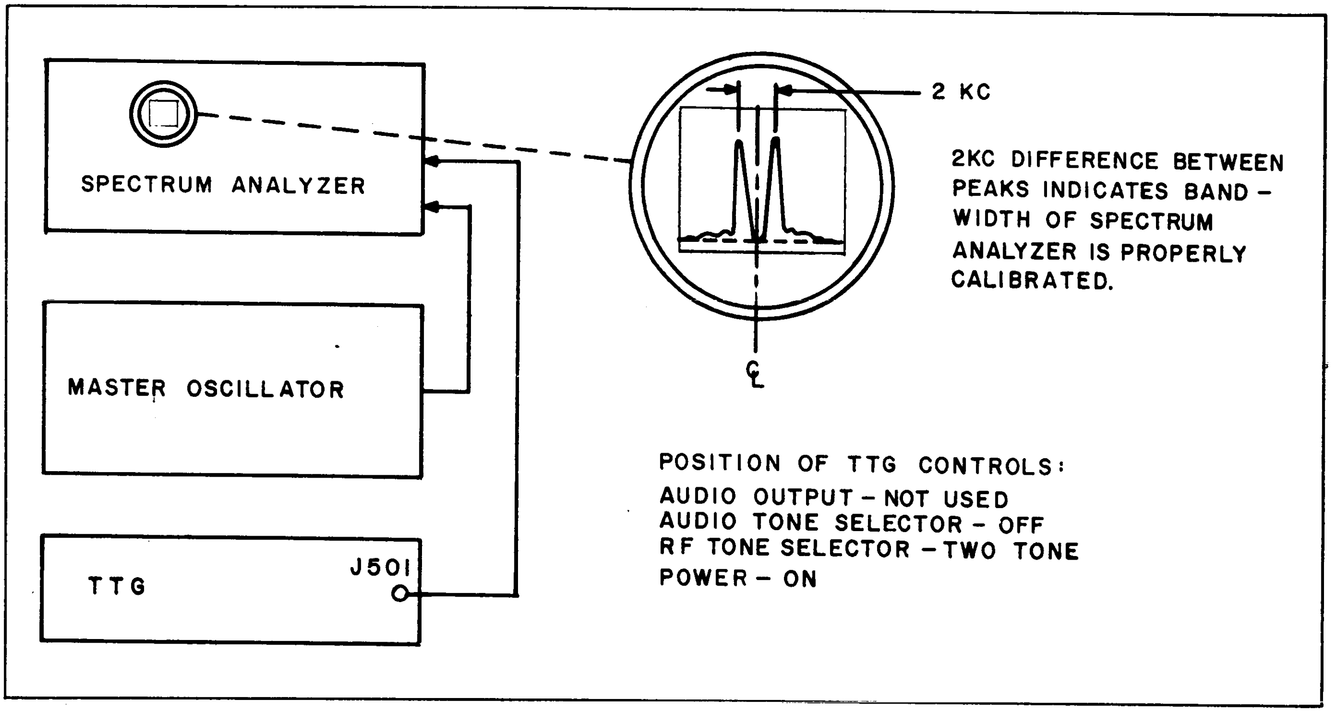

Figure 3-2. Spectrum Analyzer Center Frequency Check

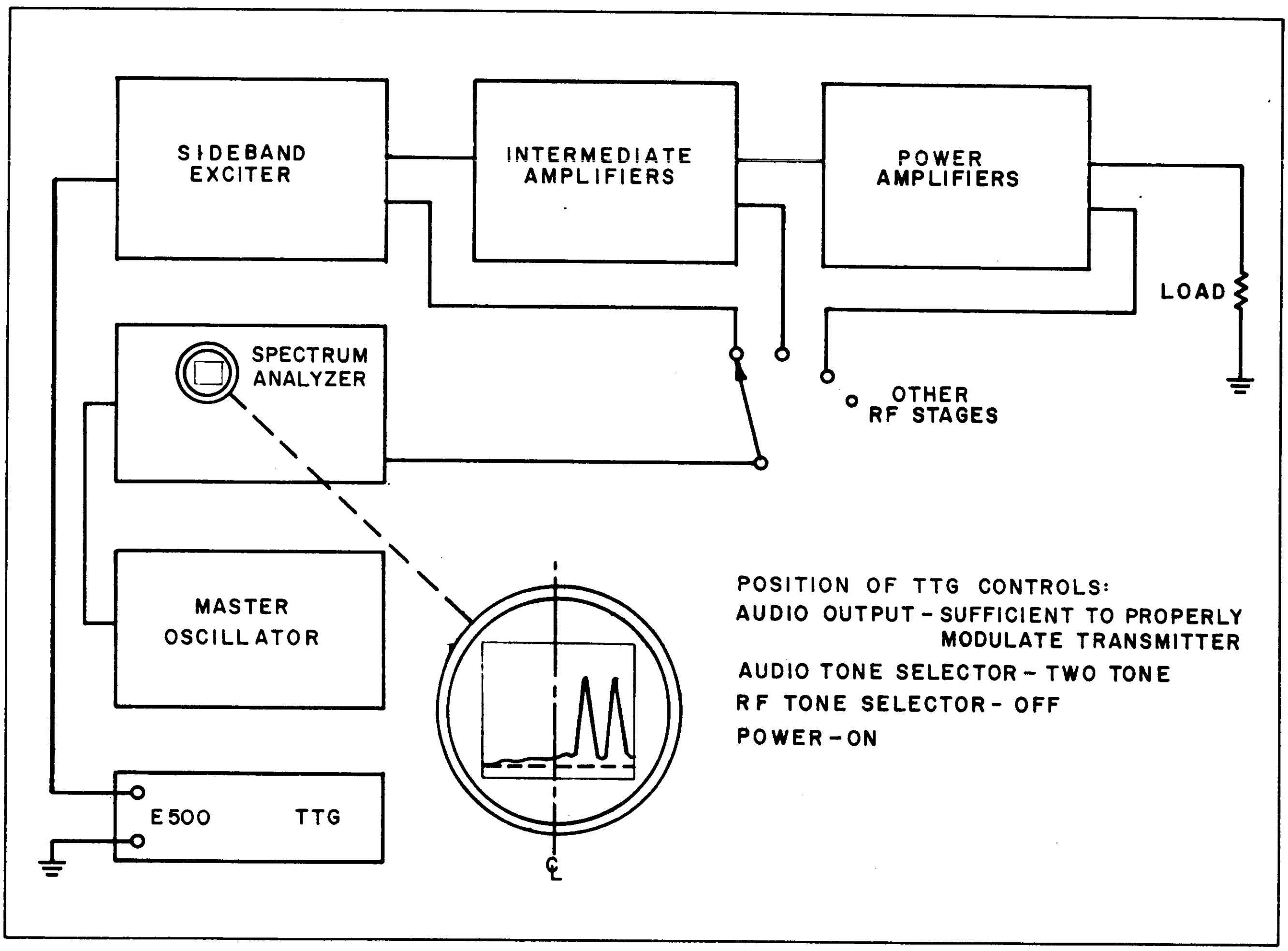

Figure 3-3. Two-Tone Test for Distortion

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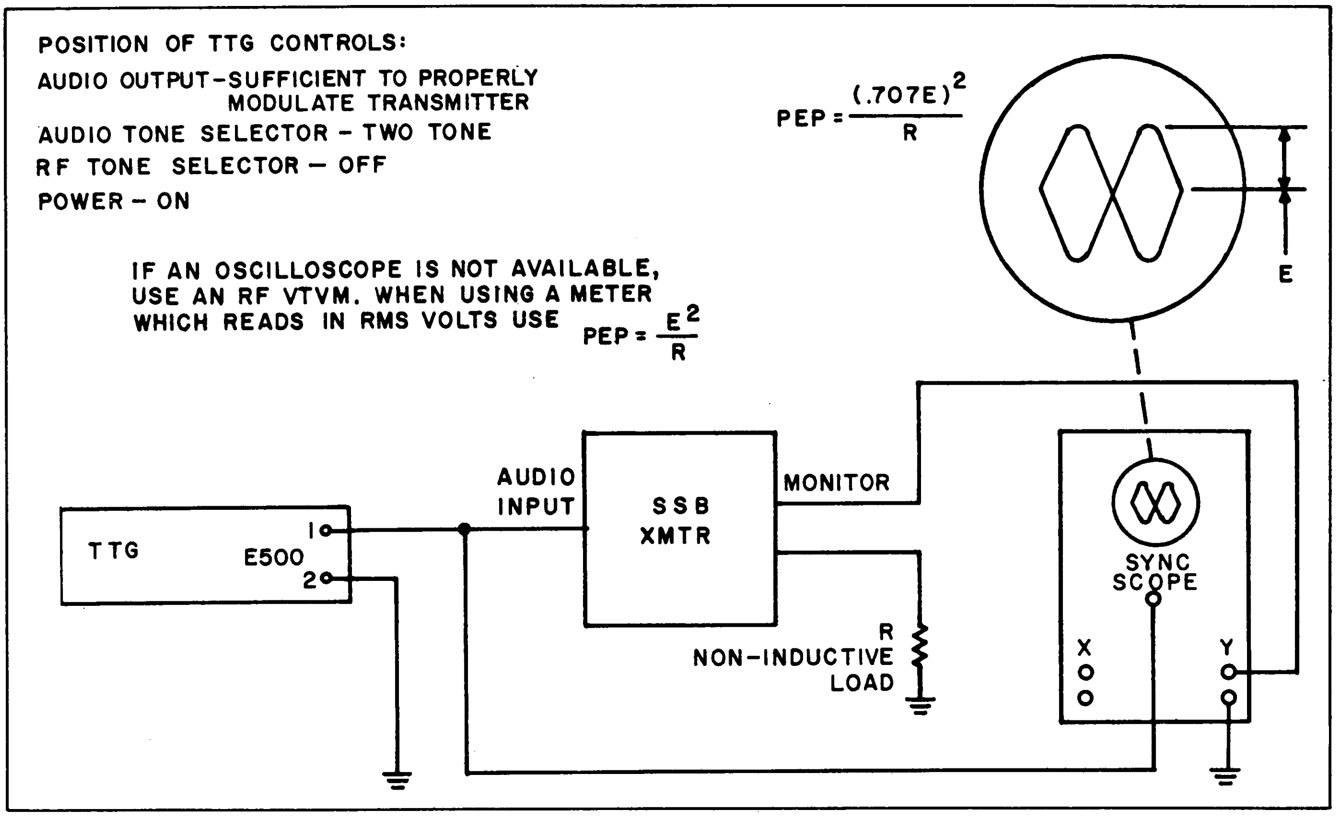

Figure 3-4. Two-Tone Measurement of Peak Envelope Power

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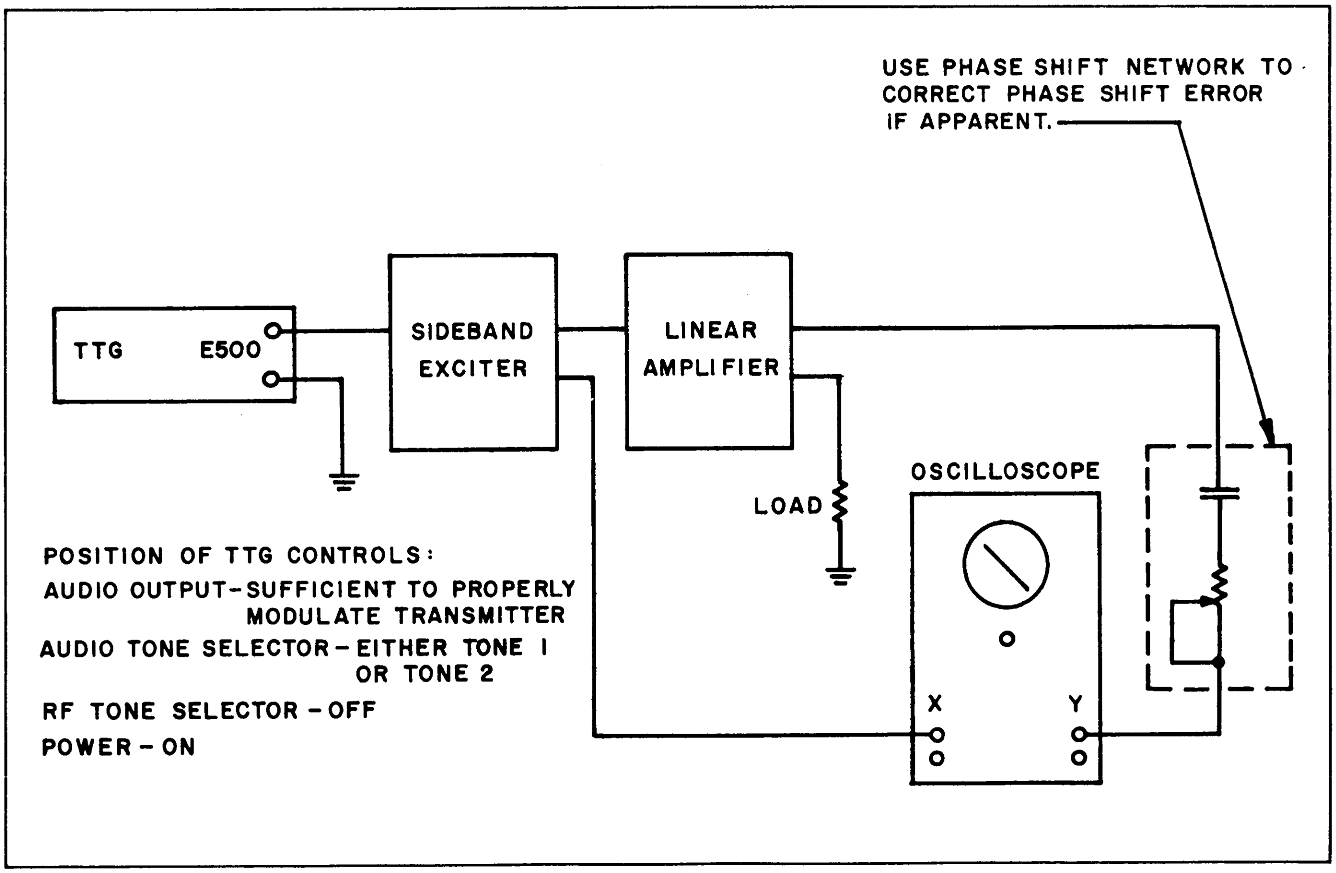

Figure 3-5. Linearity Test

SECTION IV
MAINTENANCE

4-1. GENERAL

4-1.1. The Model TTG has been designed for long term trouble free duty. Little attention beyond normal maintenance is required. Any maintenance to the equipment should be performed by a competent technician.

4-2. OPERATOR'S AND PREVENTIVE MAINTENANCE

4-2.1. The operator is cautioned that no attempt should be made to change the frequency of the audio tones. These are adjusted to their proper frequencies, in conjunction with the band-pass 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.

4-2.2. 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.

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4-3. ADJUSTMENTS, AUDIO

4-3.1. If increased distortion should indicate a need for realignment, the unit may be readjusted according to the procedure outlined below.

EQUIPMENT REQUIRED:
- AC VTVM
- Sonic analyzer (such as Panoramic LP-la)*

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.

* 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.

1. 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.
2. Adjust control on Z500 for peak indication on VTVM.
3. Observe analyzer and adjust R501 for minimum second harmonic distortion without affecting oscillator "starting."
4. Recheck Z500 for peak on VTVM.
5. Adjust Tone 1 level control, R518, for 1.0 V AC on VTVM.
6. Tighten lock on R501 and R518.
7. Set R519 to maximum, S502 to TONE 2 position, and adjust regeneration control, R513, until an indication is observed on VTVM.
8. Adjust control on Z501 for peak indication on VTVM.
9. Observe analyzer and adjust R513 for minimum second harmonic distortion without affecting oscillator "starting."
10. Recheck R501 for peak on VTVM.
11. Adjust Tone 2 level control, R519, for 1.0 V AC on VTVM.
12. 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.

4-4. ADJUSTMENTS, RF

EQUIPMENT REQUIRED:

RF VTVM

1. Connect RF VTVM to J501. Set RF TONE SELECTOR switch to TONE 1 position. Set C520 to maximum capacity.
2. Adjust L502 for maximum reading on RF VTVM. Tighten lock nut on slug.
3. Set C520 for 1.0 V RF on RF VTVM.
4. Set RF TONE SELECTOR switch to TONE 2 position. Set C521 to maximum capacity.
5. Adjust L503 for maximum reading on RF VTVM. Tighten lock nut on slug.
6. Set C521 for 1.0 V RF on RF VTVM.

PIN NO.	1	2	3	4	5	6	7	8	9
V500 12AT7	95	-0.8	0.8	0	0	130	0	2.4	6.3AC
V501 12AT7	95	-0.6	1.2	0	0	130	0	3.2	6.3AC
V502 12AU7	160	0	8	0	0	160	0	8	6.3AC
V503 12AU7	160	0	8	0	0	160	0	8	6.3AC
V504 12AU7	50	0.01	0	0	0	130	0	5.5	6.3AC
V505 12AU7	50	0.01	0	0	0	130	0	5.5	6.3AC
V506 6X4	270AC	0	0	6.3AC	0	270AC	220	—	—

CONDITIONS

AUDIO OUTPUT - FULLY COUNTER-CLOCKWISE
AUDIO TONE SELECTOR - TWO TONE
RF TONE SELECTOR - TWO TONE
POWER - ON

ALL READINGS TO GROUND WITH VTVM

VOLTAGES GIVEN ARE TYPICAL AND MAY VARY AS MUCH AS 20% FROM UNIT TO UNIT.

VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 4-1. Voltage Chart

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PIN NO.	1	2	3	4	5	6	7	8	9
V500 12AT7	18K	470K	470	0	0	85K	170K	470	0^+
V501 12AT7	18K	470K	470	0	0	85K	19K	470	0^+
V502 12AU7	30K	3K	1.2K	0	0	30K	3K	1.2K	0^+
V503 12AU7	30K	3K	1.2K	0	0	30K	3K	1.2K	0^+
V504 12AU7	50K	220K	15	0	0	50K	10K	2.2K	0^+
V505 12AU7	50K	220K	15	0	0	50K	10K	2.2K	0^+
V506 6X4	320	INF	0	0^+	INF	320	30K	—	—

CONDITIONS

AUDIO OUTPUT - FULLY COUNTER-CLOCKWISE
AUDIO TONE SELECTOR - TWO TONE
RF TONE SELECTOR - TWO TONE
POWER - ON

ALL READINGS TO GROUND

Figure 4-2. Resistance Chart

SECTION V
ELECTRICAL PARTS LIST

SYM.	DESCRIPTION	FUNCTION	TMC PART NO.
C500	CAPACITOR, fixed: plastic; 2 ufd, ±5%, 200 wvdc.	Coupling	CN108C2004J
C501	CAPACITOR, fixed: paper; .05 ufd, +40%, -20%, 400 wvdc.	Coupling	CN-100-3
C502	CAPACITOR, fixed: paper; .01 ufd, +40% -20%, 400 wvdc.	Blocking	CN-100-1
C503	CAPACITOR, fixed: plastic; 2 ufd, ±5%, 200 wvdc. (Same as C500)	Coupling	CN108C2004J
C504	CAPACITOR, fixed: Paper; .05 ufd, +40% -20%, 400 wvdc. (Same as C501)	Coupling	CN-100-3
C505	CAPACITOR, fixed: paper; .01 ufd, +40% -20%, 400 wvdc. (Same as C502)	Blocking	CN-100-1
C506	CAPACITOR, fixed: paper; .05 ufd, +40% -20%, 400 wvdc. (Same as C501)	Bypass	CN-100-3
C507	CAPACITOR, fixed: paper; .05 ufd, +40% -20%, 400 wvdc. (Same as C501)	Bypass	CN-100-3
C508	CAPACITOR, fixed: mica; .01 ufd, ±10%, char. D, 300 wvdc.	Bypass	CM35D103K
C509	CAPACITOR, fixed: mica; .01 ufd, ±10%, char. D, 300 wvdc. (Same as C508)	Bypass	CM35D103K
C510	CAPACITOR, fixed: dry electrolytic; polarized; dual unit; 20 ufd each section, 450 wvdc, char. E.	Filter	CE52E200R
C511	CAPACITOR, fixed: dry electrolytic; polarized; dual unit; 20 ufd each section, 450 wvdc, char. E. (same as C510)	Filter	CE52E200R
C512	NOT USED		
C513	NOT USED		
C514	CAPACITOR, fixed: ceramic; .01 ufd, +80% -20%, 500 wvdc.	Bypass	CC-100-16
C515	CAPACITOR, fixed: ceramic; .01 ufd, +80% -20%, 500 wvdc. (same as C514)	Bypass	CC-100-16
C516	CAPACITOR, fixed: ceramic; 10 uufd, ±.25 uufd, 500 wvdc, char. RH.	Excitation Control Cap.	CC20RH100G
C517	CAPACITOR, fixed: mica; 51 uufd, ±5%, 500 wvdc, char. C.	Excitation Cap.	CM150510J
C518	CAPACITOR, fixed: ceramic; 10 uufd, ±.25 uufd, 500 wvdc, char. RH. (Same as C516)	Excitation Control Cap.	CC20RH100G

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SYM	DESCRIPTION	FUNCTION	TMC PART NO.
C519	CAPACITOR, fixed: mica; 51 uufd, ±5%, 500 wvdc, char. C. (Same as C517)	Excitation Cap.	CM15C510J
C520	CAPACITOR, variable: ceramic; 7-45 uufd, 500 wvdc, char. C.	Coupling	CV11C450
C521	CAPACITOR, variable: ceramic; 7-45 uufd, 500 wvdc, char. C. (Same as C520)	Coupling	CV11C450
C522	CAPACITOR, fixed: mica; 220 uufd, ±5%, 500 wvdc, char. C.	Tank Cap.	CM15C221J
C523	CAPACITOR, fixed: mica; 220 uufd, ±5%, 500 wvdc, char. C. (Same as C522)	Tank Cap.	CM15C221J
C524	CAPACITOR, fixed: ceramic; .01 ufd, +80% -20%; 500 wvdc. (Same as C514)	Bypass	CC-100-16
C525	CAPACITOR, fixed: ceramic; .01 ufd, +80% -20%, 500 wvdc. (Same as C514)	Bypass	CC-100-16
C526	CAPACITOR, fixed: ceramic; .01 ufd, +80% -20%, 500 wvdc. (Same as C514)	Bypass	CC-100-16
C527	CAPACITOR, fixed: mica; .01 ufd, ±10%, char. D, 300 wvdc. (Same as C508)	Bypass	CM35D103K
C528	CAPACITOR, fixed: mica; .01 ufd, ±10%, char. D, 300 wvdc. (Same as C508)	Bypass	CM35D103K
C529	CAPACITOR, fixed: ceramic; .01 ufd, +80% -20%, 500 wvdc. (Same as C514)	Blocking	CC-100-16
C530	CAPACITOR, fixed: ceramic; .01 ufd, +80% -20%, 500 wvdc. (Same as C514)	Blocking	CC-100-16
E500	TERMINAL STRIP, barrier type: 2 terminals; 4 6-32 x 1/4 inch screws; bakelite base.	Audio Output	TM-102-2
F500	FUSE, cartridge: 2 amp.	Main Power Fuse	FU-100-2
F501	FUSE, cartridge: 1/8 amp; 250 v, straight through element.	B+ Fuse	FU-100-.125
I500	LAMP, incandescent: double contact bayonet base; 120 volts, 3 watts; S-6 clear bulb.	Osc. Lamp Stabilization	BI-102-3
I501	LAMP, incandescent: double contact bayonet base; 120 volts, 3 watts; S-6 clear bulb. (Same as I500)	Osc. Lamp Stabilization	BI-102-3
I502	LAMP, incandescent: bayonet base; 6-8 volts, 150 ma; T-3-1/4 clear bulb.	Main Power Indicator	BI-101-47

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
J500	CONNECTOR, receptacle: male; two contacts, 10 amps at 250 v., 15 amps at 125 v., twist lock type.	Power Input	JJ-100
J501	CONNECTOR, receptacle: receptacle: female	RF Out	UG-604/U
L500	CHOKE, R.F.: 750 microhenries, ±20%, 100 ma, max. current; DC res. approx. 17 ohms; bakelite body.	Choke, RF	CL-100-5
L501	CHOKE, R.F.: 750 microhenries, ±20%, 100 ma, max. current; DC res. approx. 17 ohms; bakelite body. (same as L500)	Choke, RF	CL-100-5
L502	TRANSFORMER, R.F.: 2-4.3 mc; slug tuned.	RF Transformer	A-1451-2
L503	TRANSFORMER, R.F.: 2-4.3 mc; slug tuned. (Same as L502)	RF Transformer	A-1451-2
L504	REACTOR, filter: 50 henries.; 30 ma. D.C.; DC res. approx. 800 ohms; insulated for 1500 v.	Filter	TF-166
L505	COIL, R.F.: 4 microhenries, 1700 ma. max. current, mica body.	Line Filter	CL-105-2
L506	COIL, R.F.: 4 microhenries, 1700 ma. 1700 ma. max. current, mica body. (Same as L505)	Line Filter	CL-105-2
R500	RESISTOR, fixed: composition; 100 ohms, ±10%, 1/2 watt.	Dropping	RC20GF102K
R501	RESISTOR, variable: composition; 2500 ohms, ±10%, 2 watts, linear taper.	Regen. Adj.	RV4ATXA252A
R502	RESISTOR, fixed: composition; 68,000 ohms, ±10%, 1 watt.	Plate Load	RC30GF683K
R503	RESISTOR, fixed: composition; 47,000 ohms, ±10%, 1 watt.	Dropping	RC30GF473K
R504	RESISTOR, fixed: composition; 22,000 ohms, ±10%, 1 watt.	Plate Load	RC30GF223K
R505	RESISTOR, fixed: composition; 470,000 ohms, ±10%, 1/2 w.	Grid Return	RC20GF474K
R506	RESISTOR, fixed: composition; 470 ohms, ±10%, 1/2 watt.	Cathode	RC20GF471K
R507	RESISTOR, fixed: composition; 100 ohms, ±10%, 1/2 watt. (Same as R500)	Dropping	RC20GF102K
R508	RESISTOR, fixed: composition; 68,000 ohms, ±10%, 1 watt. (Same as R502)	Plate Load	RC30GF683K
R509	RESISTOR, fixed: composition; 47,000 ohms, ±10%, 1 watt. (Same as R503)	Dropping	RC30GF473K

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SYM	DESCRIPTION	FUNCTION	TMC PART NO.
R510	RESISTOR, fixed: composition; 10,000 ohms, ±10%, 1 watt.	Plate Load	RC30GF103K
R511	RESISTOR, fixed: composition; 470,000 ohms, ±10%, 1/2 w. (Same as R505)	Grid Return	RC20GF474K
R512	RESISTOR, fixed: composition; 470 ohms, ±10%, 1/2 watt. (Same as R506)	Cathode	RC20GF471K
R513	RESISTOR, variable: composition; 2500 ohms, ±10%, 2 watts, linear taper. (Same as R501)	Regen. Adj.	RV4ATXA252A
R514	RESISTOR, fixed: composition; 2700 ohms, ±10%, 1/2 watt.	Cathode	RC20GF272K
R515	RESISTOR, fixed: composition; 2700 ohms, ±10%, 1/2 watt. (Same as R514)	Cathode	RC20GF272K
R516	RESISTOR, fixed: composition; 470 ohms, ±10%, 1 watt.	Dropping	RC30GF471K
R517	RESISTOR, fixed: composition; 470 ohms, ±10%, 1 watt. (Same as R516)	Dropping	RC30GF471K
R518	RESISTOR, variable: composition; 500 ohms, ±10%, 2 watts, linear taper.	1 Tone Level	RV4ATXA501A
R519	RESISTOR, variable: composition; 500 ohms, ±10%, 2 watts, linear taper. (Same as R518)	2 Tone Level	RV4ATXA501A
R520	RESISTOR, fixed: composition; 1000 ohms, ±10%, 1/2 watt. (Same as R500)	Imp. Matching	RC20GF102K
R521	RESISTOR, fixed: composition; 1000 ohms, ±10%, 1/2 watt. (Same as R500)	Imp. Matching	RC20GF102K
R522	RESISTOR, fixed: composition; 180 ohms, ±10%, 1/2 watt.	Dropping	RC20GF181K
R523	RESISTOR, fixed: composition; 180 ohms, ±10%, 1/2 watt. (Same as R523)	Dropping	RC20GF181K
R524	RESISTOR, variable: wire wound; 600 ohms, "T" attenuator, 7/8 in. long flatted 1/4 in. dia. shaft.	Level Adj.	RR-108-9-R-C
R525	RESISTOR, fixed: composition; 4700 ohms, ±10%, 1 watt.	Dropping	RC30GF472K
R526	RESISTOR, fixed: composition; 4700 ohms, ±10%, 1 watt. (Same as R525)	Dropping	RC30GF472K

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SYM	DESCRIPTION	FUNCTION	TMC PART NO.
R527	RESISTOR, fixed: wire wound; 4700 ohms, ±10%, 1 watt.	Dropping	RW-109-39
R528	RESISTOR, fixed: wire wound; 4700 ohms, ±10%, 1 watt. (Same as R527)	Dropping	RW-109-39
R529	RESISTOR, fixed: wire wound; 3000 ohms, ±5%, 10 watts.	Dropping	RW-109-30
R530	RESISTOR, fixed: wire wound; 3000 ohms, ±5%, 10 watts. (Same as R529)	Dropping	RW-109-30
R531	RESISTOR, fixed: composition; 100,000 ohms, ±10%, 1 watt.	Bleeder	RC30GF104K
R532	RESISTOR, fixed: composition; 22,000 ohms, ±10%, 1 watt.	Plate Load	RC30GF223K
R533	RESISTOR, fixed: composition; 22,000 ohms, ±10%, 1 watt. (Same as R532)	Plate Load	RC30GF223K
R534	RESISTOR, fixed: composition; 220,000 ohms, ±10%, 1/2 watt.	Grid Return	RC20GF224K
R535	RESISTOR, fixed: composition; 220,000 ohms, ±10%, 1/2 watt. (Same as R534)	Grid Return	RC20GF224K
R536	RESISTOR, fixed: composition; 10,000 ohms, ±10%, 1/2 watt.	Grid Return	RC20GF103K
R537	RESISTOR, fixed: composition; 10,000 ohms, ±10%, 1/2 watt. (Same as R536)	Grid Return	RC20GF103K
R538	RESISTOR, fixed: composition; 2200 ohms, ±10%, 1/2 watt.	Cathode	RC20GF222K
R539	RESISTOR, fixed: composition; 2200 ohms, ±10%, 1/2 watt. (Same as R538)	Cathode	RC20GF222K
R540	RESISTOR, fixed: composition; 470 ohms, ±10%, 1/2 watt. (Same as R506)	Dropping	RC20GF471K
R541	RESISTOR, fixed: composition; 470 ohms, ±10%, 1/2 watt. (Same as R506)	Dropping	RC20GF471K
R542	RESISTOR, fixed: composition; 68 ohms, ±10%, 1/2 watt.	Dropping	RC20GF680K
R543	RESISTOR, fixed: composition; 22,000 ohms, ±10%, 1 watt. (Same as R504)	Plate Load	RC30GF223K
R544	RESISTOR, fixed: composition; 22,000 ohms, ±10%, 1 watt. (Same as R504)	Plate Load	RC30GF223K

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SYM	DESCRIPTION	FUNCTION	TMC PART NO.
S500	SWITCH, rotary: shorting; 1 section, 2 positions, bakelite insulation; silver plated brass contacts.	Main Power	SW-253
S501	SWITCH, rotary: 4 positions; 2 poles, 1 section, non-shorting contacts.	RF Tone Selector	SW-120
S502	SWITCH, rotary: 4 positions; 2 poles, 1 section, non-shorting contacts. (Same as S501)	Audio Tone Selector	SW-120
T500	TRANSFORMER, power: primary - 110/220 v, 50/60 cps, single phase: section 1 -250-0-250 v RMS, 35 ma dc: section 2-6.3 v. C.T.	Power Transformer	TF-126
T501	TRANSFORMER, audio: primary - impedance 15000 ohms; secondary impedance 9500 ohms split; unbalanced DC in primary 4 ma; hermetically sealed steel case.	Push-Pull Inter-stage Transformer	TF-206
T502	TRANSFORMER, audio: primary - impedance 15000 ohms; secondary impedance 95000 ohms split; unbalanced DC in primary 4 ma; hermetically sealed steel case.	Push-Pull Inter-stage Transformer	TF-206
T503	TRANSFORMER, audio: primary - 20,000 ohms CT: sec. - 150, 600 ohms, 4 ma dc in primary; ±2 db; 200 to 10000 cps.	Audio Transformer	TF-138
T504	TRANSFORMER, audio: primary - 20,000 ohms CT: sec. - 150, 600 ohms, 4 ma dc in primary ±2 db; to 10000 cps. (Same as T503)	Audio Transformer	TF-138
V500	TUBE, electron: duo-triode, 9 pin miniature.	1 Audio Osc. Tone	12AT7
V501	TUBE, electron: duo-triode, 9 pin miniature. (Same as V500)	2 Audio Osc. Tone	12AT7
V502	TUBE, electron: medium-mu duo-triode, 9 pin miniature.	1 Audio Amp. Tone	12AU7
V503	TUBE, electron: medium-mu duo-triode, 9 pin miniature. (Same as V502)	2 Audio Amp. Tone	12AU7
V504	TUBE, electron: medium-mu duo-triode, 9 pin miniature. (Same as V502)	V504A - RF Osc. V504B - RF Ampl.	12AU7
V505	TUBE, electron: medium-mu duo-triode, 9 pin miniature. (Same as V502)	V505A - RF Osc. V505B - RF Ampl.	12AU7
V506	TUBE, electron: full wave rectifier, 7 pin miniature.	HV Rectifier	6X4
XF500	HOLDER, fuse: bayonet type; 100/250 volts, neon lamp, clear knob; accomodates 1/4 x 1-1/4 in. fuse.	Holder for F500	FH-104-3

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
XF501	HOLDER, fuse: bayonet type; 100/250 volts, neon lamp, clear knob; accomodates 1/4 x 1-1/4 inch fuse. (Same as XF500)	Holder for F501	FH-104-3
XI500	SOCKET, lamp; double contact, solder lug type; 1 inch x 1-3/16 inch o/a.	Socket for I500	TS-108-2
X1501	SOCKET, lamp: double contact, solder lug type; 1 inch x 1-3/16 inch o/a. (Same as XI500)	Socket for I501	TS-108-2
XI502	SOCKET, lamp: w/red frosted lens, for miniature bayonet base, T-3-1/4 bulb.	Socket for I502	TS-106-1
XV500	SOCKET, tube: miniature 9 pin.	Socket for V500	TS-103-P01
SV501	SOCKET, tube: miniature 9 pin. (Same as XV500)	Socket for V501	TS-103-P01
XV502	SOCKET, tube: miniature 9 pin. (Same as XV500)	Socket for V502	TS-103-P01
XV503	SOCKET, tube: miniature 9 pin. (Same as XV500)	Socket for V503	TS-103-P01
XV504	SOCKET, tube: miniature 9 pin. (Same as XV500)	Socket for V504	TS-103-P01
XV505	SOCKET, tube: miniature 9 pin. (Same as XV500)	Socket for V505	TS-103-P01
XV506	SOCKET, tube: miniature 7 pin.	Socket for V506	TS-102-P01
XY500	SOCKET, crystal: .486 in. spacing for .050 inch pin dia.	Socket for Y500	TS-104-1
XY501	SOCKET, crystal: .486 in. spacing for .050 inch pin dia. (Same as XY500)	Socket for Y501	TS-104-1
Y500	CRYSTAL UNIT, quartz: 1.999 mc; pin type connectors; ±005% tolerance.	Crystal Osc	CR-18/U-1.999P
Y501	CRYSTAL UNIT, quartz: 2.001 mc; pin type connectors; ±.005% tolerance.	Crystal Osc.	CR-18/U-2.001P
Z500	NETWORK, frequency determining; 935 cps.	p/o Audio Osc.	NF-104-935
Z501	NETWORK, frequency determining: 2805 cps.	p/o Audio Osc.	NF-104-2805
Z502	FILTER, bandpass: 935 cps; 600 ohm input and output impedance; hermetically sealed rectangular steel case.	Bandpass Filter	FX-156
Z503	FILTER, bandpass: 2805 cps: 600 ohm input and output impedance; hermetically sealed rectangular steel case.	Bandpass Filter	FX-157

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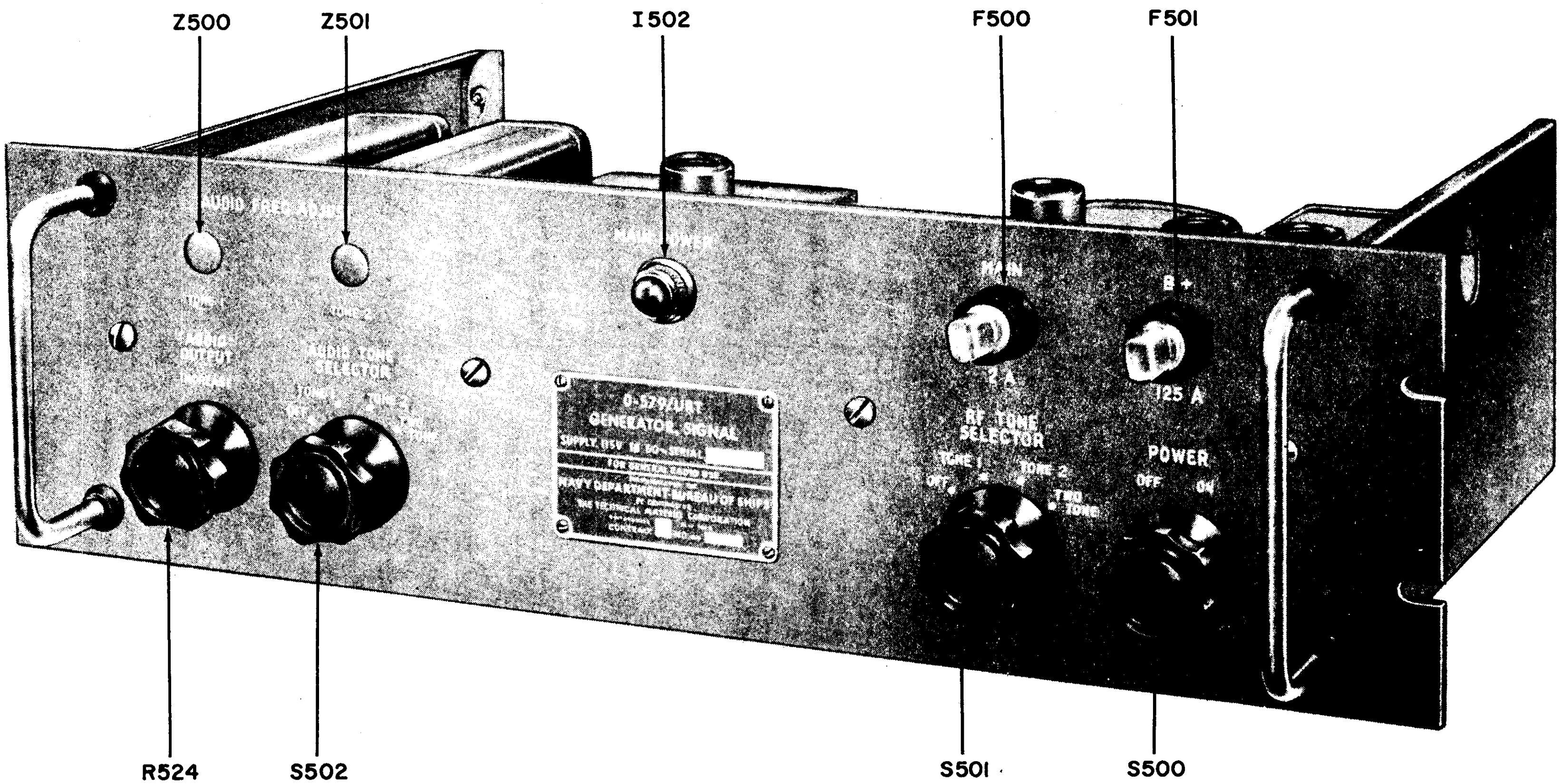

PH-791

Figure 5-1. Front View, Model TTG

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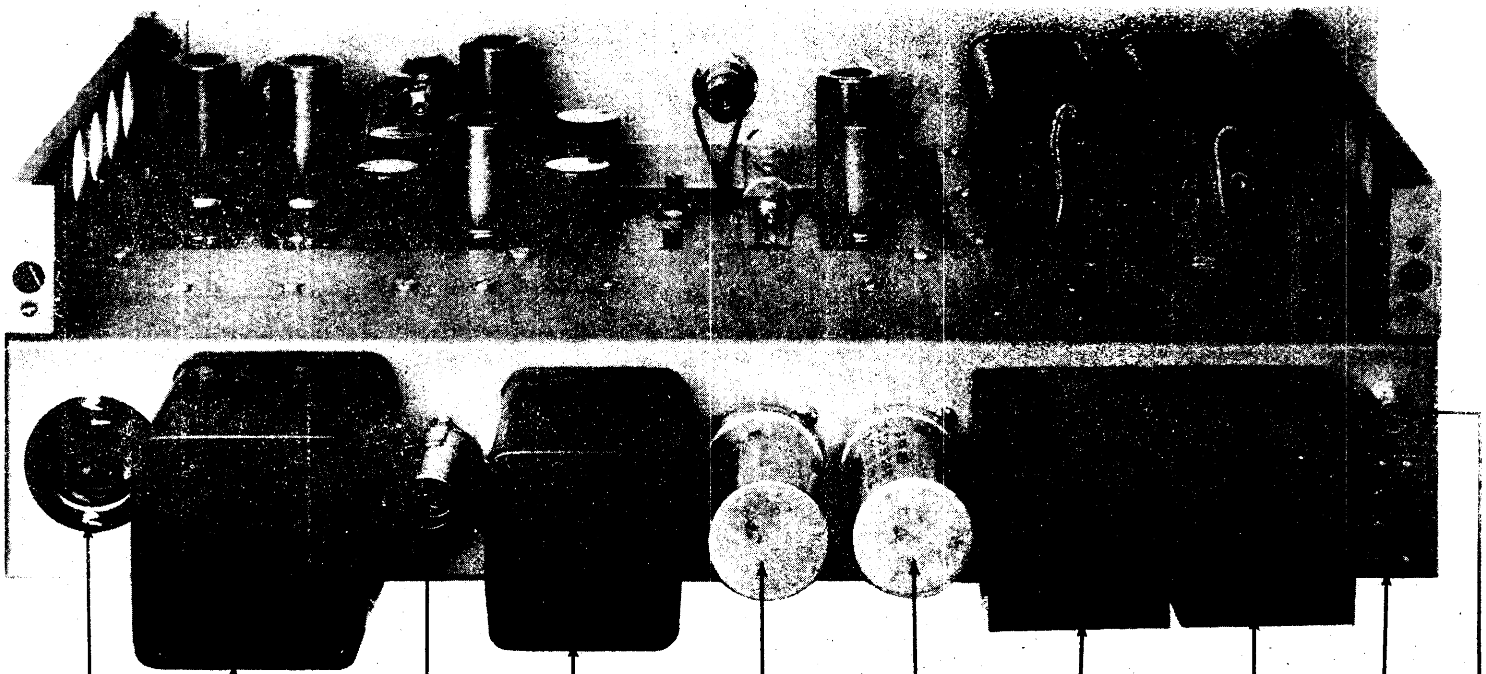

PH-792

Figure 5-2. R ar View, Mod 1 TTG

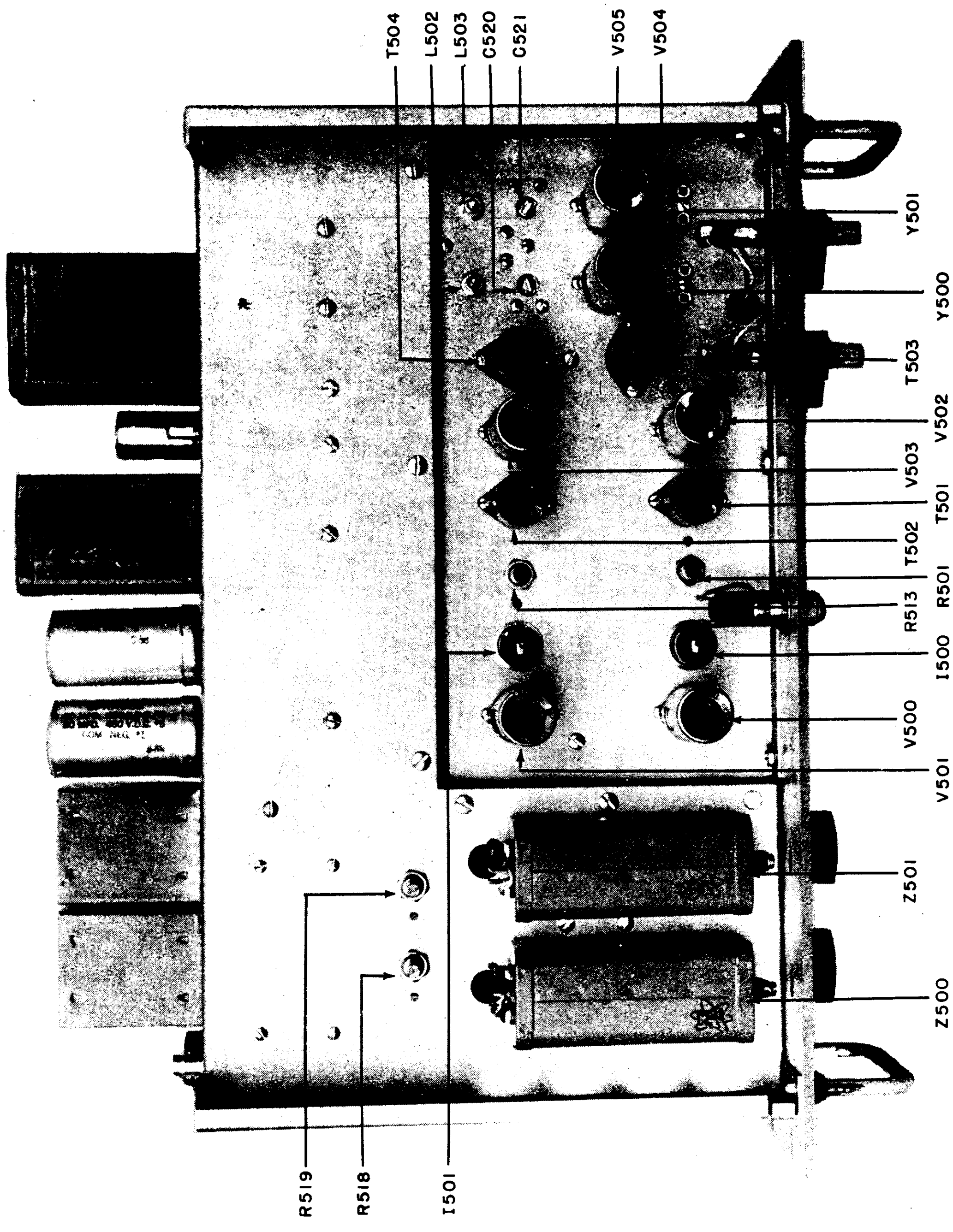

Figure 5-3. Top View, Model TTG

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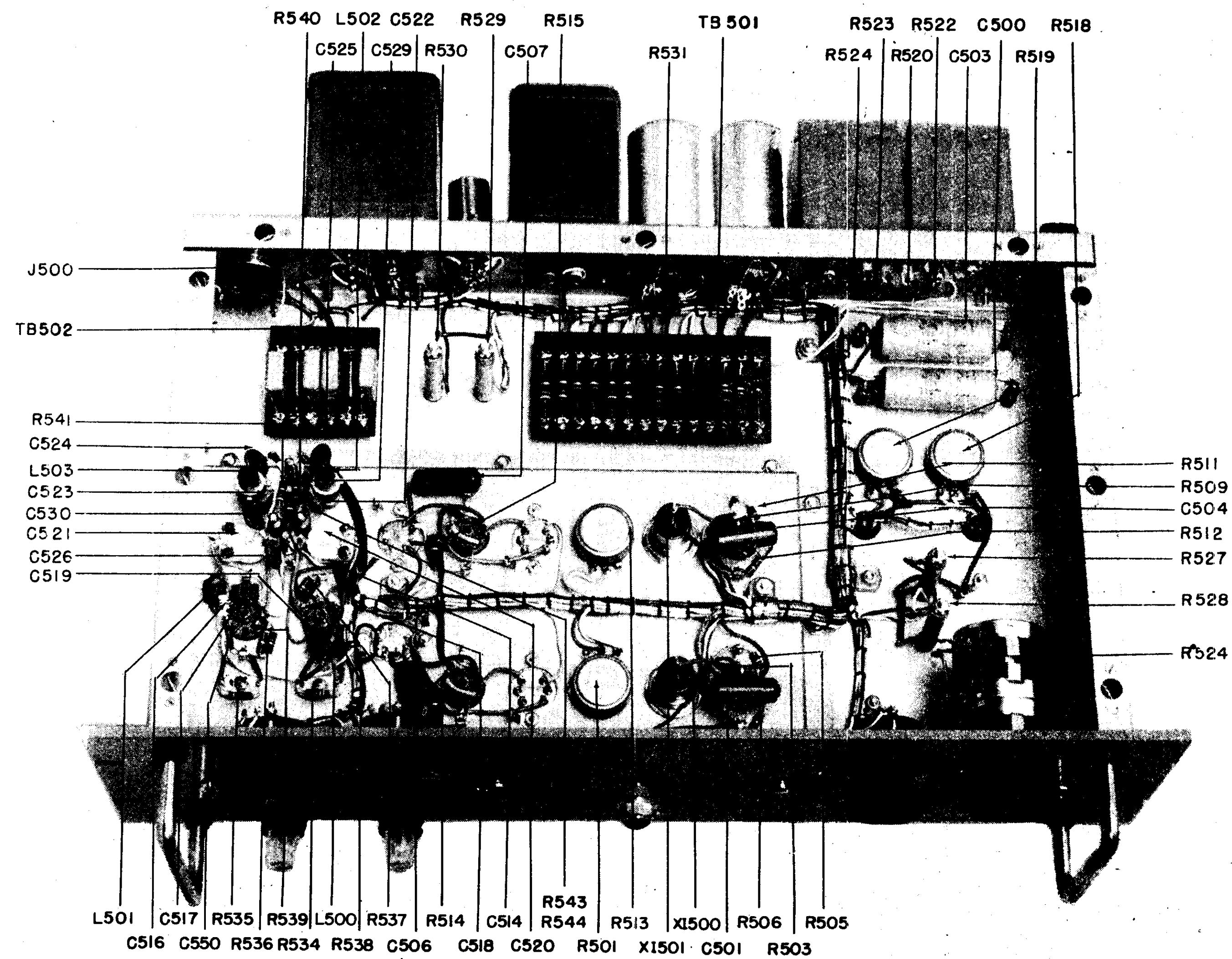
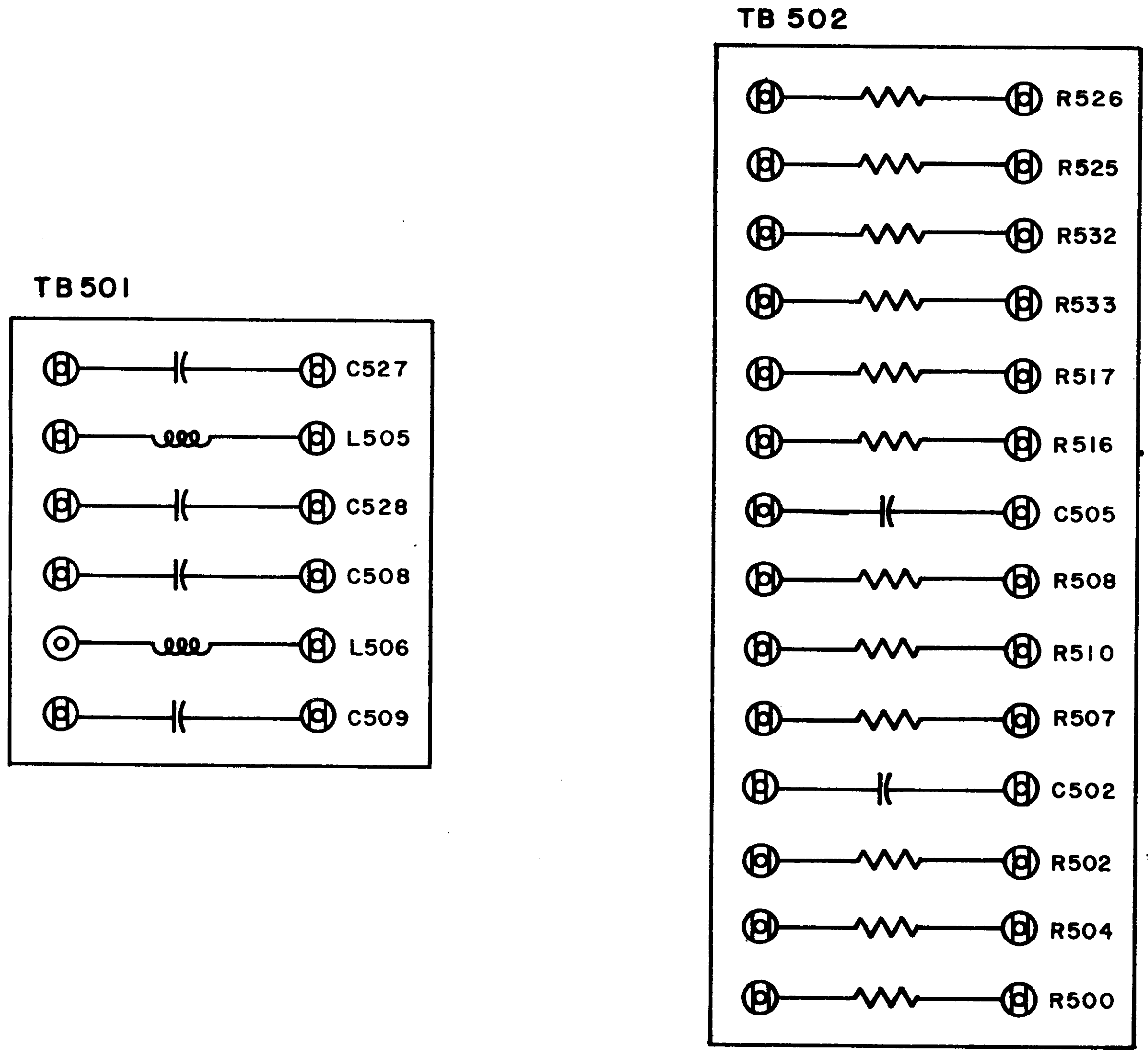
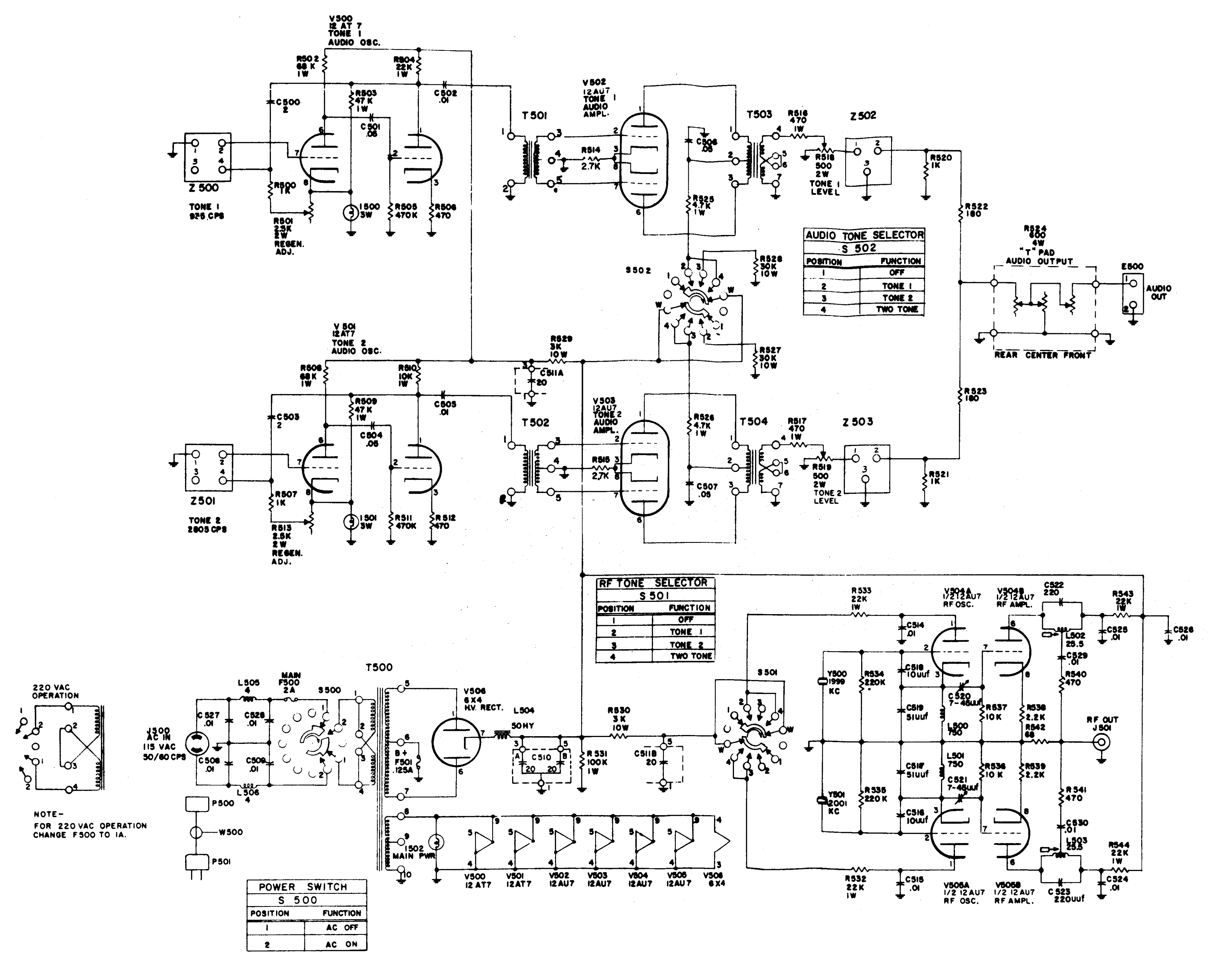


PH-794

Figure 5-4. Bottom Vi w, Model TTG



Figur 5-5. Terminal Board Layout Model TTG



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	MISSING SYMBOLS
C 530	C512, C513
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	

CK-394

Figure 5-6. Schematic Diagram, Test Generator

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UNCLASSIFIED

TECHNICAL MANUAL

for

RF SPECTRUM ANALYZER

AN/GRM-33A

PART V

APPENDIX

RACK & ACCESSORIES

TABLE OF CONTENTS

(APPENDIX-RACK & ACCESSORIES, PTE-3)

LIST OF ILLUSTRATIONS

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LIST OF TABLES

APPENDIX
RACK AND ACCESSORIES

V-1. INTRODUCTION.

This part of the manual describes the rack and all accessory items included in the make-up of a complete PTE-3, not covered by Parts I, II, III and IV. In addition, it is intended that this appendix and its revisions will serve to illustrate such items as minor wiring and component rating variations occurring within a production run of a model. Unless otherwise noted, the following data applies to PTE-3, serial #136 and up.

V-2. PARTS BREAKDOWN.

The parts breakdown of the PTE-3 by major assemblies is described in TABLE A, which lists all parts (except fastening hardware) that go into the assembly of a PTE-3. Further breakdown of electrical parts are as follows

RAK-7B	See TABLE B of Part V
FSA-2	See Part II and TABLE A of Part V
VOX-5	See Part III and TABLE A of Part V
PVR-2	See TABLE C of Part V
TTG-2	See Part IV and TABLE A of Part V
CA-575-1	See TABLE A of Part V

Parts arriving in the shipment of the PTE-3 are described in TABLE D. When re-ordering any major units listed in TABLE A, reference to the proper parts list, as shown above, will describe all the electrical parts plus special cables and modifications peculiar to the PTE-3 that will be included in the shipment. In each case, when ordering, it should be specified that the part is to be for a PTE-3.

V-3. PTE-3 EQUIPMENT RACK.

a. GENERAL DESCRIPTION. Figure V-3 is a dimensional outline drawing of the RAK-7B equipment rack. The two back casters are rigid and the two in front are swivel-type. All units going into the rack are panel supported and do not employ chassis slides. The rack is constructed with mounting flanges on both its front and back surfaces, so that modular units may be mounted on both of these surfaces. The front side is reserved for units with operating controls. In the back, the utility panel with blower and extra outlets is included as part of the RAK-7B rack assembly and is removable. Blank panels are included in the RAK-7B rack assembly to fill in unused areas at the mounting flanges.

b. INTERCONNECTING WIRING. Figure V-2 is a schematic diagram of interconnecting wiring in the PTE-3 rack resulting from the assembly and connection of all units. Indications at each cable show TMC part number, symbol number and major assembly of which the cable is a part. Figure V-2 and the schematic wiring diagrams from Parts II, III and IV, as indicated on figure V-2, make up the complete wiring schematic for the PTE-3. Figure V-1 shows a rear view of the PTE-3 assembled except for the installation of the PS-2 unit and a blank panel.

V-4. CABLE HOOK-UP.

To assemble PTE-3 cabling, make connections per figure V-2 using figure V-1 as a guide in locating items. RAK-7B is shipped with most of its cabl s and harnesses installed. It is generally only necessary to connect the loose ends of the cables to the proper equipment and install CA-432-2 cable between the SA-2 and PS-2 units. Cables CA-480-1-18.00, CA-480-4-120.00 and CA-130-6 are patch cords to be used at the front panel controls. Their use is d - scribed in Section 3 of Part I. Extra 3-prong female a-c power plug (TMC #PL-134-NG) mates with J109 for completing CA-575-1 power cable; the two extra 3-prong male a-c power plugs (TMC #PL-172) mate with J105 through J108 for a-c pow r extensions if required.

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TABLE A—LIST OF PARTS

R F SPECTRUM ANALYZER MODEL PTE-3

QTY/UNIT	TMC PART NO.	TITLE	DESCRIPTION
1	RAK-7B	EQUIPMENT RACK	Consists of rack structure and electrical components listed in RAK-7B parts list (Table B).
1	FSA-2	FREQUENCY SPECTRUM ANALYZER	Consists of Model SA-2 Analyzer (modified for manual sweep) Model PS-2 Power Supply and CA-432-2 special cable, 53 inches long. CA-432-2 consists of wiring per figure V-2, MS3016B28-2S (P501) and MS3106B28-2P(P601).
1	VOX-5	VARIABLE FREQUENCY OSCILLATOR	Consists of VOX-5 unit including CA-569-2 cable (W201) and CA-435-3 special cable (W202). CA-569-2 consists of 6 inches (retracted) of coiled a-c cable and #PL-171 plug, 2-prong, male, twist lock (P201). CA-435-3 consists of 7 inches (retracted) of coiled a-c cable, #PL-100 plug, 2-prong, female twist-lock (P202) and #PL-171 plug (P203).
1	PVR-2	VOLTAGE REGULATOR PANEL	Consists of panel and electrical parts as listed in PVR-2 parts list (Table C).
1	TTG-2	TWO TONE GENERATOR	Consists of TTG-2 unit including CA-435-1 cable (W500). CA-435-1 consists of 1 foot (retracted) of coiled a-c cable, #PL-171 plug (P501) and #PL-100 plug (P500).
2	CA-575-1	POWER CABLE	Consists of 1 foot (retracted) of coiled a-c cable and #PL-171 plug.

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TABLE B

EQUIPMENT RACK MODEL RAK-7B, ELECTRICAL

PARTS LIST (SERIES 100)

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
B101	FAN, axial: mounted in venturi block, without grille, 100 CFM free delivery, 115V, 50/60 CPS.	Cooling exhaust	BL-106-2
CP101	ADAPTER, connector: RF, coaxial, series N, bulkhead mounting.	RF TONE OUT	UG-30D/U
CP102	ADAPTER, connector: same as CP101.	VFO OUT	UG-30D/U
J101	JACK, telephone: 3-conductor, for 1/4 in. dia. plug.	AUDIO TONE OUT, red lead	JJ-116-2

TABLE B—EQUIPMENT RACK MODEL RAK-7B, ELECTRICAL PARTS LIST (SERIES 100) (C nt)

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SYM	DESCRIPTION	FUNCTION	TMC PART NO.
J102	JACK, telephone: same as J101.	AUDIO TONE OUT, black lead	JJ-116-2
J103	JACK, telephone: same as J101.	AUDIO TONE OUT, red lead	JJ-116-2
J104	JACK, telephone: same as J101.	AUDIO TONE OUT, black lead	JJ-116-2
J105	CONNECTOR, receptacle: AC, 3 prong, female.	Auxiliary outlet	JJ-173
J106	CONNECTOR, receptacle: AC, 3 prong, female.	Auxiliary outlet	JJ-173
J107	CONNECTOR, receptacle: AC, 3 prong, female.	Auxiliary outlet	JJ-173
J108	CONNECTOR, receptacle: AC, 3 prong, female.	Auxiliary outlet	JJ-173
J109	CONNECTOR, receptacle: AC, 3 prong, male.	Main AC power input	PL-133-NG
J110	CONNECTOR, receptacle: AC, 2 prong, female, twist lock.	Outlet, AC power strip	JJ-170
J111	CONNECTOR, receptacle: same as J110.	Outlet, AC power strip	JJ-170
J112	CONNECTOR, receptacle: same as J110.	Outlet, AC power strip	JJ-170
J113	CONNECTOR, receptacle: same as J110.	Outlet, AC power strip	JJ-170
P101	CONNECTOR, plug: RF, coaxial, series N (P/O W101).	Mates with CP101	UG-603/U
P102	CONNECTOR, plug: RF coaxial, series BNC (P/O W101).	Mates with J501 on TTG-2 unit	UG-260/U
P103	CONNECTOR, plug: same as P101 (P/O W102).	Mates with CP102	UG-603/U
P104	CONNECTOR, plug: same as P102 (P/O W102).	Mates with J208 on VOX-5 unit	UG-260/U
P105	CONNECTOR, plug: AC, 2 prong, male, twist lock (P/O W104).	Mates with J110	PL-171

TABLE B—EQUIPMENT RACK MODEL RAK-7B,
ELECTRICAL PARTS LIST (SERIES 100) (C nt)

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
P106	CONNECTOR, plug: same as P101 (P/O W105).	See W105	UG-603/U
P107	CONNECTOR, plug: same as P104 (P/O W105).	See W105	UG-603/U
P108	CONNECTOR, plug: same as P101 (P/O W106).	See W106	UG-603/U
P109	CONNECTOR, plug: same as P101 (P/O W106).	See W106	UG-603/U
P110	CONNECTOR, plug: same as P101 (P/O W107).	Mates with J101 on SA-2 unit	UG-603/U
P111	CONNECTOR, plug: RF, coaxial, series UHF, male (P/O W107).	Mates with transmitter or exciter	PL-259A-TEF
—	ADAPTER, RF coaxial: series N to series UHF (P/O W107).	Used with P111	UG-176/U
P112	CONNECTOR, plug: telephone, audio, twin prong, male (P/O W108).	See W108	PL-194
P113	CONNECTOR, plug: same as P112 (P/O W108).	See W108	PL-194
P114	NOT USED.		
P115	NOT USED.		
P116	NOT USED.		
P117	CONNECTOR, plug: same as P105 (P/O W104).	Mates with P3 on PVR-2	PL-171
P118	CONNECTOR, plug: Mil type MS3106B18-1P, male (P/O W110).	Mates with J402 on SA-2	MS3106B18-1P
—	CONNECTOR, plug: AC power, 3 prong, female.	Extra plug to mate with J109.	PL-134-NG
—	CONNECTOR, plug: AC power, 3 prong, male, with removable ground connections.	Extra plug to mate with J105, 6, 7, or 8.	PL-172

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TABLE B—EQUIPMENT RACK MODEL RAK-7B, ELECTRICAL PARTS LIST (SERIES 100) (C nt)

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
—	CONNECTOR, plug: AC power, 3 prong, male, with removable ground connection.	Extra plug to mate with J105, 6, 7 or 8.	PL-172
R101	RESISTOR, variable: 500K, 2w, linear taper.	MANUAL SWEEP horizontal sweep control.	RV4ATRD504A
R102	RESISTOR, fixed: composition, 1.5 MEG ±10%, 1/2 watt.	Voltage drop, MANUAL SWEEP.	RC20GF155K
R103	RESISTOR, fixed, composition, 270K ±10%, 1/2 watt.	Voltage drop, MANUAL SWEEP.	RC20GF274K
S101	SWITCH, toggle: DPDT, on-none-on.	MANUAL/AUTO sweep selector.	ST-22N
W101	CABLE, R. F.: consists of RG-59/U coaxial cable, P101 and P102, 42 inches. long.	J501 on TTG-2 to CP101.	CA-480-2-42
W102	CABLE, R. F.: consists of RG-59/U coaxial cable, P103 and P104, 42 inches long.	J208 on VOX-5 to CP102.	CA-480-2-42
W103	NOT USED.		
W104	CABLE, AC power: consists of coiled a-c cable and P105.	J110 to J105	CA-575-4
W105*	CABLE, RF: consists of RG-59/U coaxial cable, P106 and P107, 18 inches long.	Patch cord from CP101 to J101 on SA-2.	CA-480-1-18
W106*	CABLE, RF: consists of RG-59/U coaxial cable, P108 and P109, 18 inches long.	Patch cord from CP102 to J104 on SA-2.	CA-480-1-18
W107	CABLE, RF: consists of RG-59/U coaxial cable, P110 and P111, UG-176/U adapter, 10 feet long.	Patch cord from transmitter or exciter output to J101 or SA-2.	CA-480-4-120
W108	CABLE, audio: consists of tinned copper 2-conductor stranded wire, shielded, P112 and P113, 10 feet long.	Patch cord from AUDIO TONE OUT (J101 and 2 or J103 and 4) to exciter audio input.	CA-130-6

*W105 and W106 are interchangeable.

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TABLE B—EQUIPMENT RACK MODEL RAK-7B, ELECTRICAL PARTS LIST (SERIES 100) (Cont)

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
W109	CABLE, AC power: consists of a-c cable and P117.	B101 to P3 on PVR-2	CA-569-2
W110	CABLE, harness: includes P102 and P118.	MANUAL SWEEP circuit and AUDIO TONE OUT connection from SA-2 and TTG-2 to control panel.	CA-611
—	JUMPER, grounding.	J109 to rack structure	CA-409-43-4.00

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TABLE C

50/60 CYCLE REGULATOR MODEL PVR-2, ELECTRICAL PARTS LIST (SYMBOL SERIES 1)

SYM	DESCRIPTION	FUNCTION	TMC PART NO.
P1	CONNECTOR, plug: AC power, 2-prong, female.	Mates with AC power input receptacle on PS-2	PL-176
P2	CONNECTOR, plug: AC power, 2-prong, male, twist lock.	Mates with J112 on RAK-7B	PL-171
P3	CONNECTOR, plug: AC power, 2-prong, female, twist lock.	Mates with P117 on RAK-7B	PL-100
T1	TRANSFORMER, voltage regulator, primary 95-130VAC 50/60 CPS, secondary 118 VAC regulated to ±1%.	Voltage Regulator	TF-209
W1	CABLE, AC power: consists of AC cable and P1.	Regulated Voltage from T1 to PS-2	CA-555-2
W2	CABLE, AC power: consists of AC cable and P2.	95-130VAC to T1	CA-575-3
W3	CABLE, AC power: consists of AC cable and P3.	Regulated Voltage from T1 to B101 on RAK-7B	CA-605-2

TABLE D

SHIPPING LIST, PTE-3

CRATE NO.	QTY	TMC PART NO.	DESCRIPTION
1	1	RAK-7B	EQUIPMENT RACK
	2	CA-575-1	POWER CABLE
	1	CA-432-2	INTERCONNECTING CABLE
	2	CA-480-1-18.00	PATCH CORD
	1	CA-480-4-120.00	PATCH CORD
	1	CA-130-6	PATCH CORD
	2	PL-172	PLUG
	1	PL-134-NG	PLUG
	2	IN-240	TECHNICAL MANUAL, PTE-3
	1	—	TEST DATA, PTE-3 (against serial number shipped)
2	1	TTG-2	TWO-TONE GENERATOR
3	1	SA-2 (P/O FSA-2)	SPECTRUM ANALYZER
	1	VOX-5	VARIABLE FREQUENCY OSCILLATOR
4	1	PS-2 (P/O FSA-2)	POWER SUPPLY
5	1	PVR-2	VOLTAGE REGULATOR

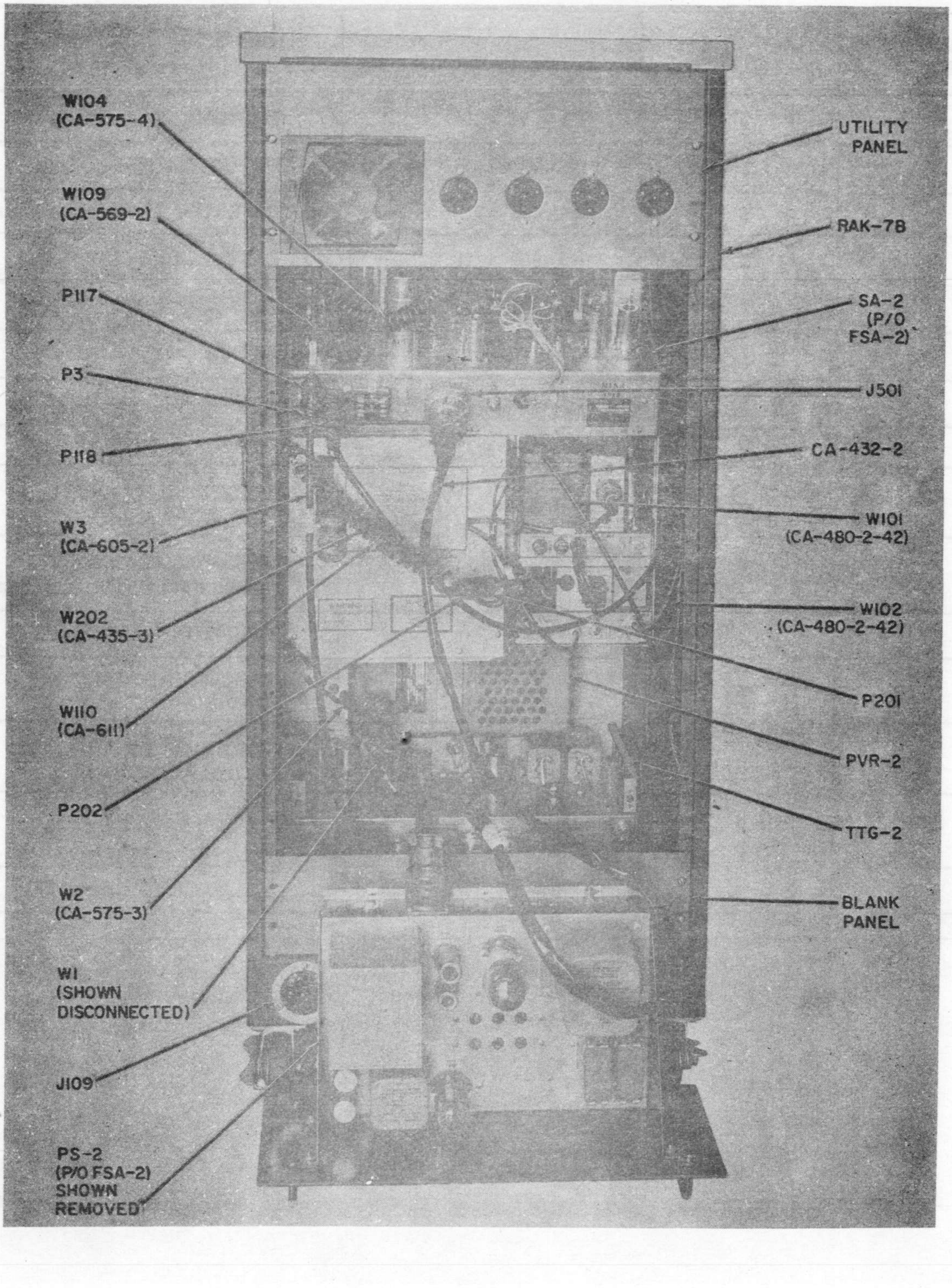

Figure V-1. Cable Location Diagram

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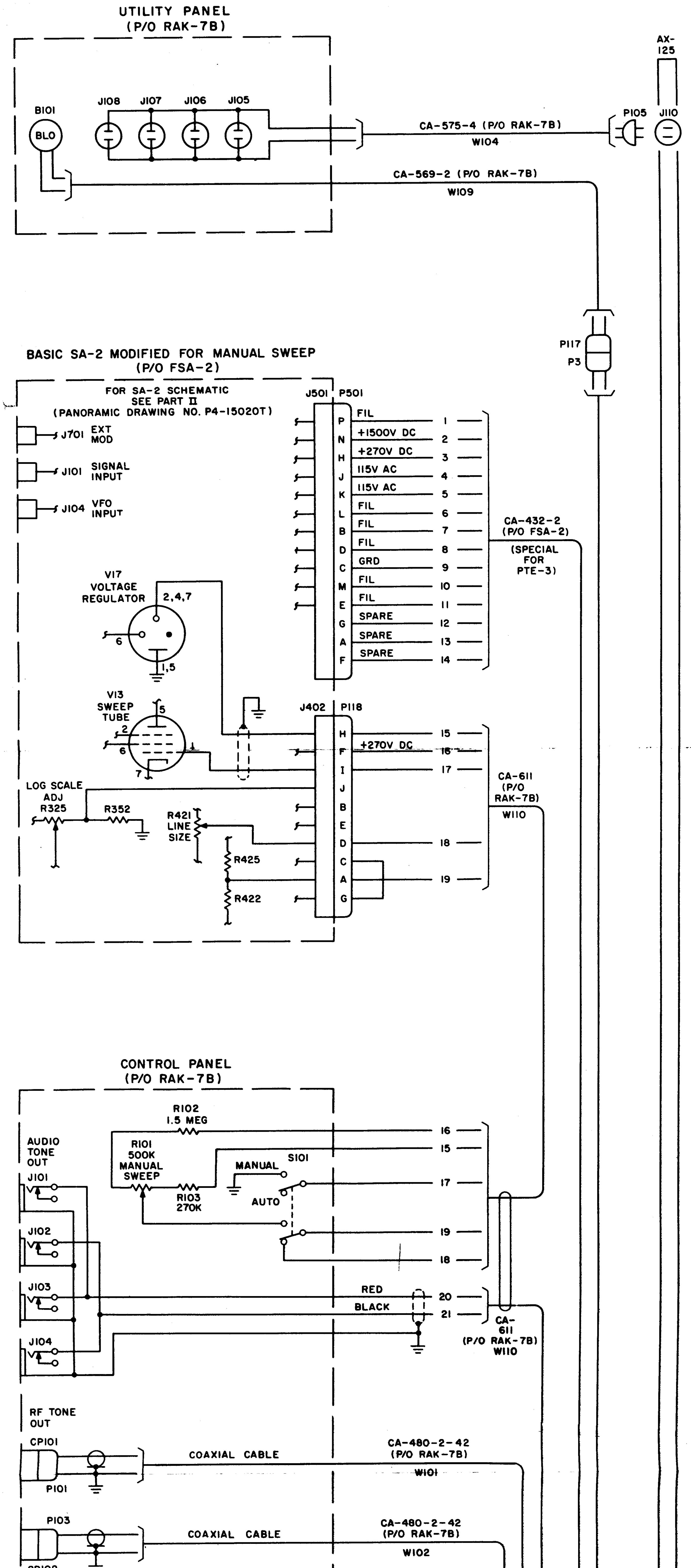
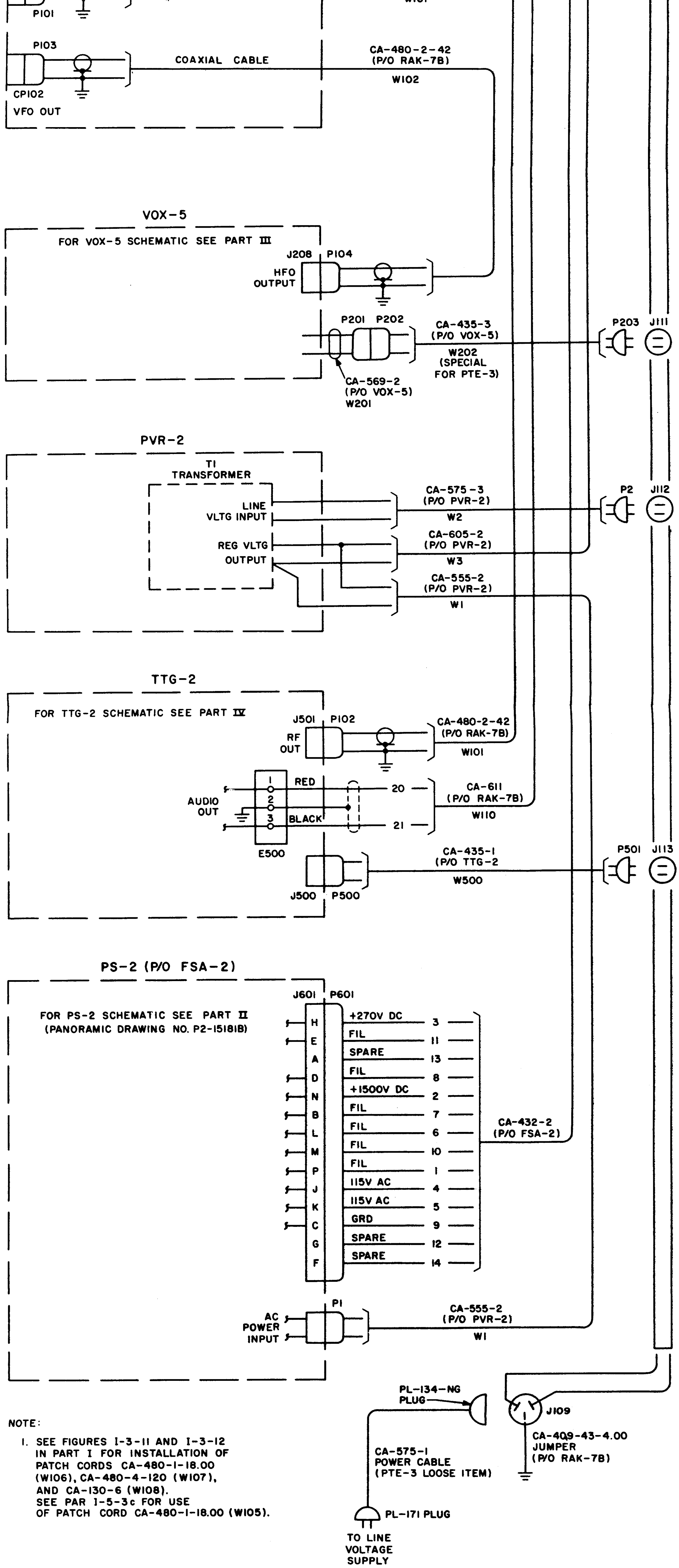

UTILITY PANEL
(P/O RAK-7B)
B101
BLO
J108
J107
J106
J105
CA-575-4 (P/O RAK-7B)
W104
P105
J110
AX-
125
CA-569-2 (P/O RAK-7B)
W109
P117
P3
BASIC SA-2 MODIFIED FOR MANUAL SWEEP
(P/O FSA-2)
FOR SA-2 SCHEMATIC
SEE PART II
(PANORAMIC DRAWING NO. P4-15020T)
J701 EXT MOD
J101 SIGNAL INPUT
J104 VFO INPUT
J501
P501
FIL
+1500V DC
+270V DC
115V AC
115V AC
FIL
FIL
FIL
GRD
FIL
FIL
SPARE
SPARE
SPARE
CA-432-2
(P/O FSA-2)
(SPECIAL FOR PTE-3)
V17
VOLTAGE
REGULATOR
2,4,7
1,5
V13
SWEEP
TUBE
J402
P118
+270V DC
CA-611
(P/O RAK-7B)
W110
LOG SCALE
ADJ
R325
R352
R421
LINE
SIZE
R425
R422
CONTROL PANEL
(P/O RAK-7B)
R102
1.5 MEG
AUDIO
TONE
OUT
J101
R101
500K
MANUAL
SWEEP
MANUAL
S101
R103
270K
AUTO
J102
J103
J104
RED
BLACK
CA-
611
(P/O RAK-7B)
W110
RF TONE
OUT
CP101
P101
COAXIAL CABLE
CA-480-2-42
(P/O RAK-7B)
W101
P103
COAXIAL CABLE
CA-480-2-42
(P/O RAK-7B)
W102



NOTE:

1. SEE FIGURES I-3-11 AND I-3-12 IN PART I FOR INSTALLATION OF PATCH CORDS CA-480-1-18.00 (W106), CA-480-4-120 (W107), AND CA-130-6 (W108). SEE PAR 1-5-3c FOR USE OF PATCH CORD CA-480-1-18.00 (W105).

Figure V-2. Interconnecting Wiring Schematic, PTE-3 Rack

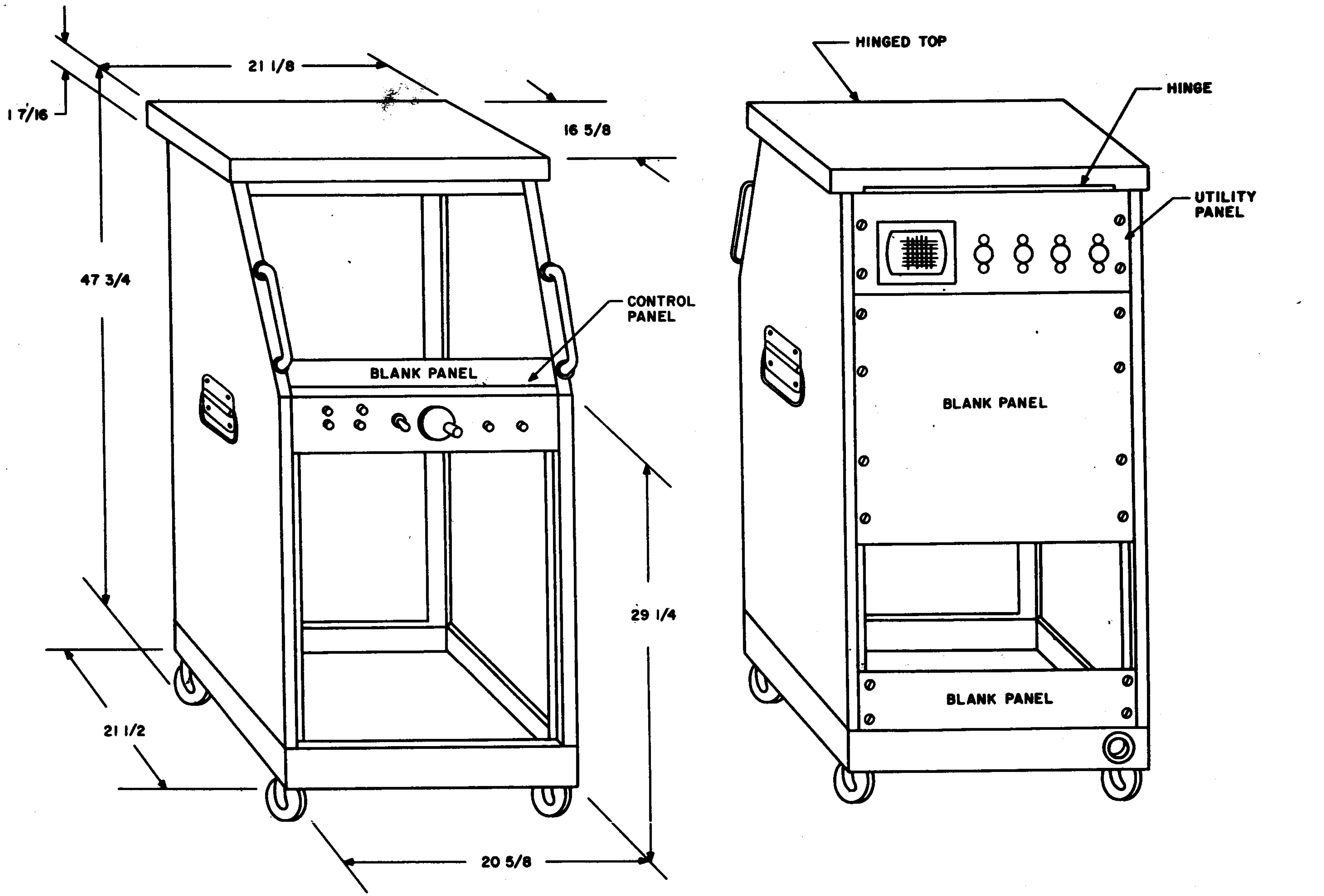


Figure V-3. Dimensional Outline of RAK-7B Rack