UNCLASSIFIED

TECHNICAL MANUAL

for

RF SPECTRUM ANALYZER

MODEL PTE-3
(AN/GRM-33A)

• WORLD WIDE SUPPLIERS • OF ELECTRONIC COMMUNICATIONS EQUIPMENT

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, ONTARIO

IN-240 Issue Date: 15 January 1962

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

Warranty

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

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

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

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

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

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

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

PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT

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

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

PROCEDURE FOR ORDERING REPLACEMENT PARTS

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

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

PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT

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

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

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

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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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PART I
PTE-3 SYSTEM

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

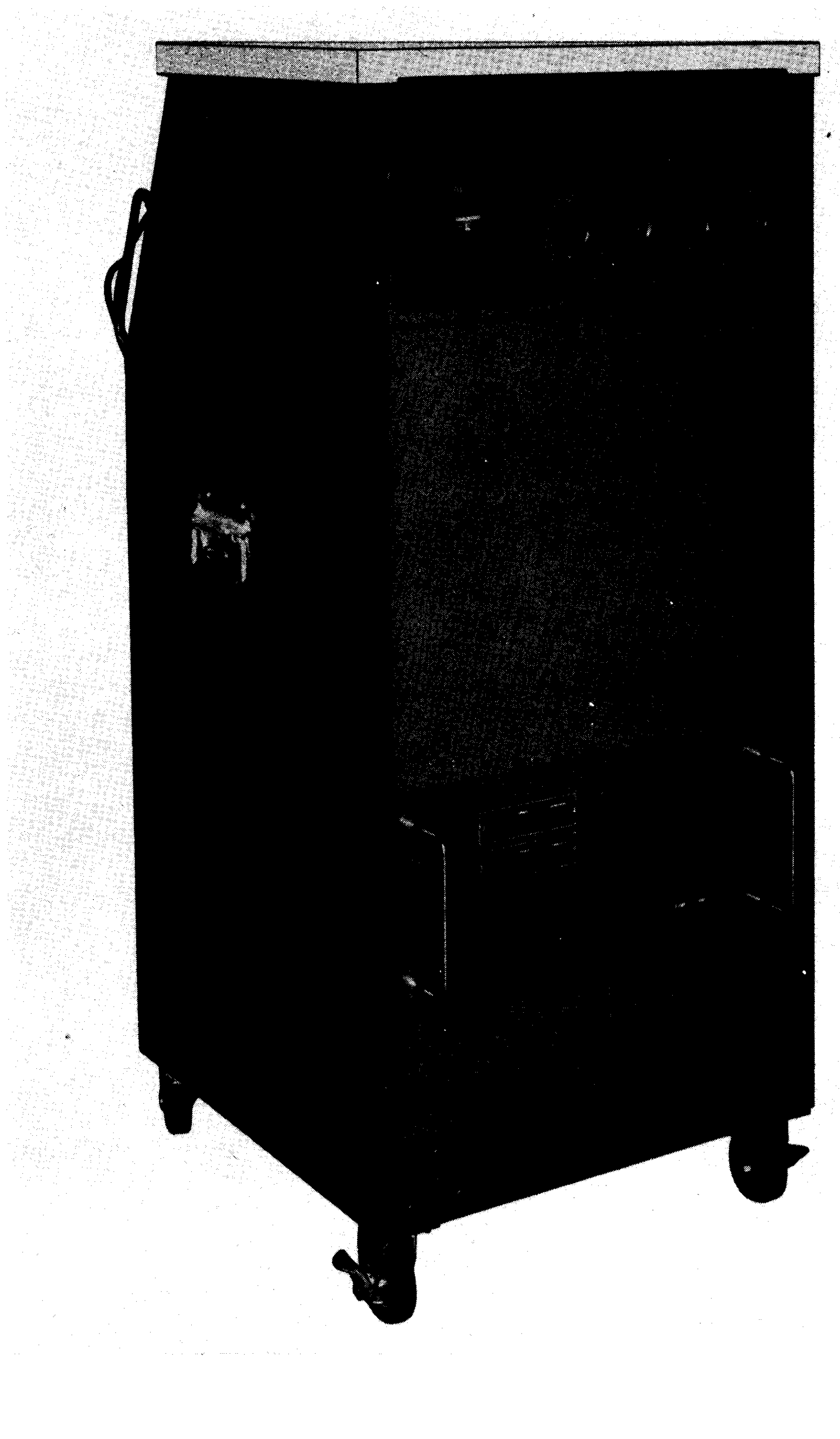


Figure I-1-1b. Rear Angle View, RF Spectrum Analyzer, PTE

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.

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.

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 (Appendix - 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.

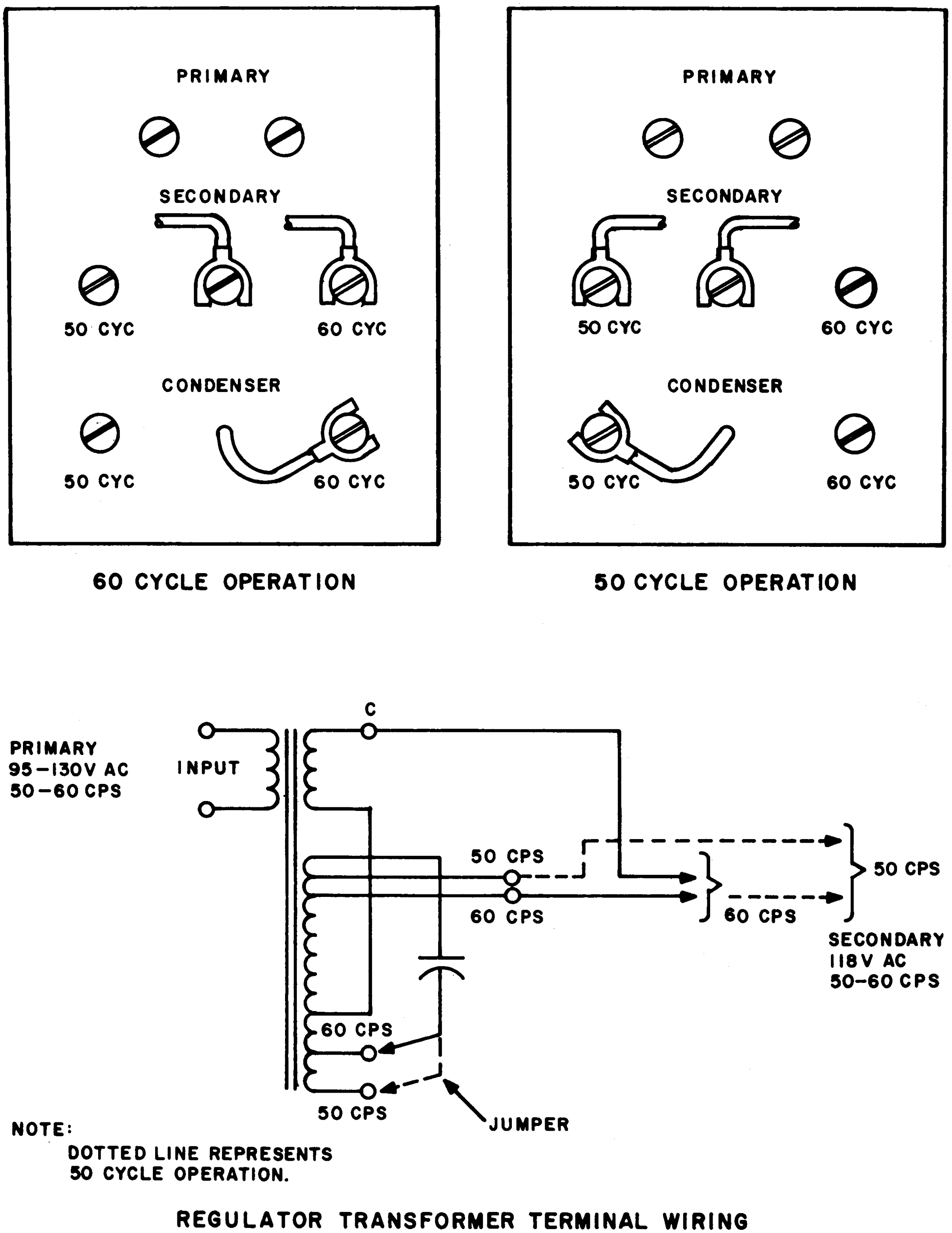


Figure I-2-1. PVR Regulator Wiring for 50 CPS vs. 60 CPS Line Voltage

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.

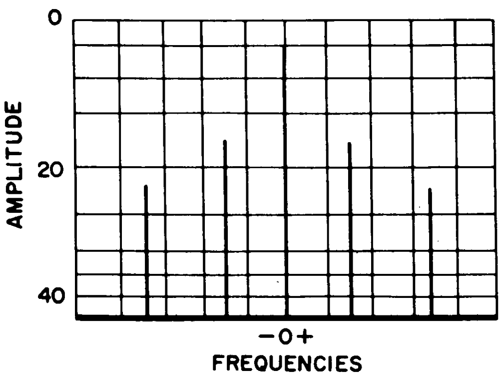


Figure I-3-1. Theoretical Appearance of Frequencies at 100% Resolution

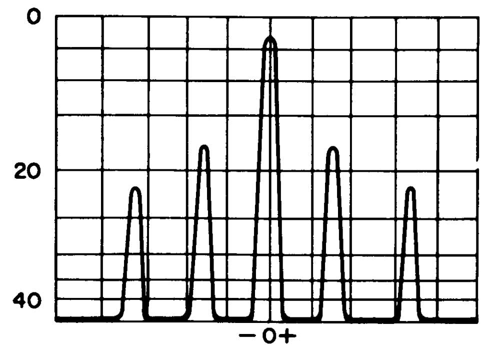


Figure I-3-2. Appearance of Frequencies at Less Than 100% Resolution on PTE Screen

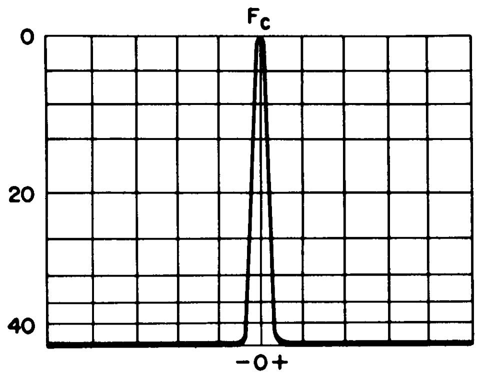


Figure I-3-3. Appearance of Carrier Alone

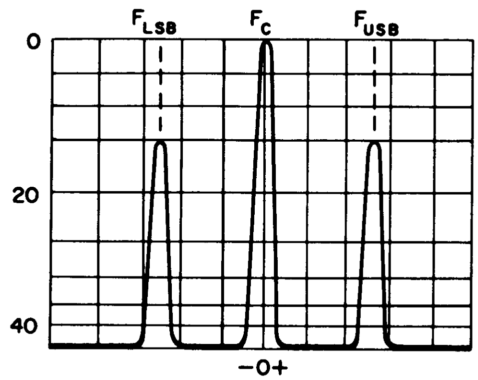


Figure I-3-4. Appearance of Carrier, USB and LSB for Carrier Modulated by One Tone

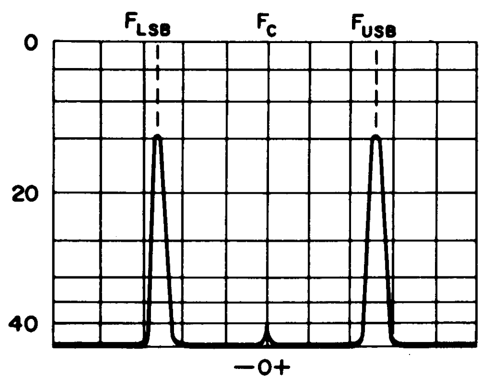


Figure I-3-5. Appearance of DSB with Suppressed Carrier Modulated by One Tone

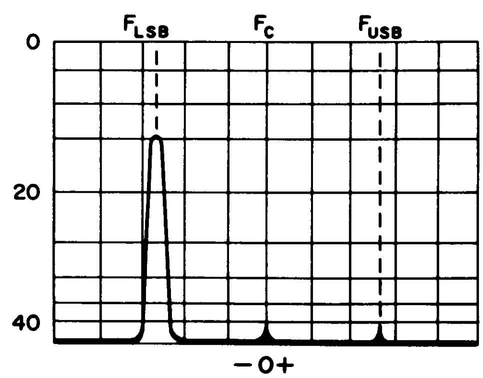


Figure I-3-6. Appearance of SSB with Suppressed USB and Suppressed Carrier Modulated by One Tone

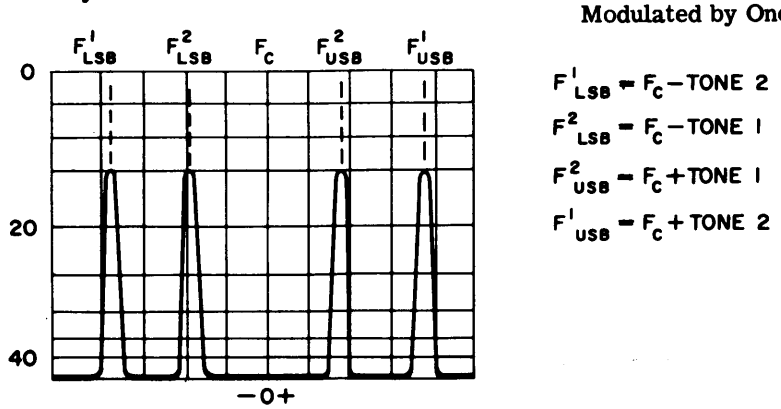


Figure I-3-7. Appearance of DSB with Suppressed Carrier Modulated by Two Tones

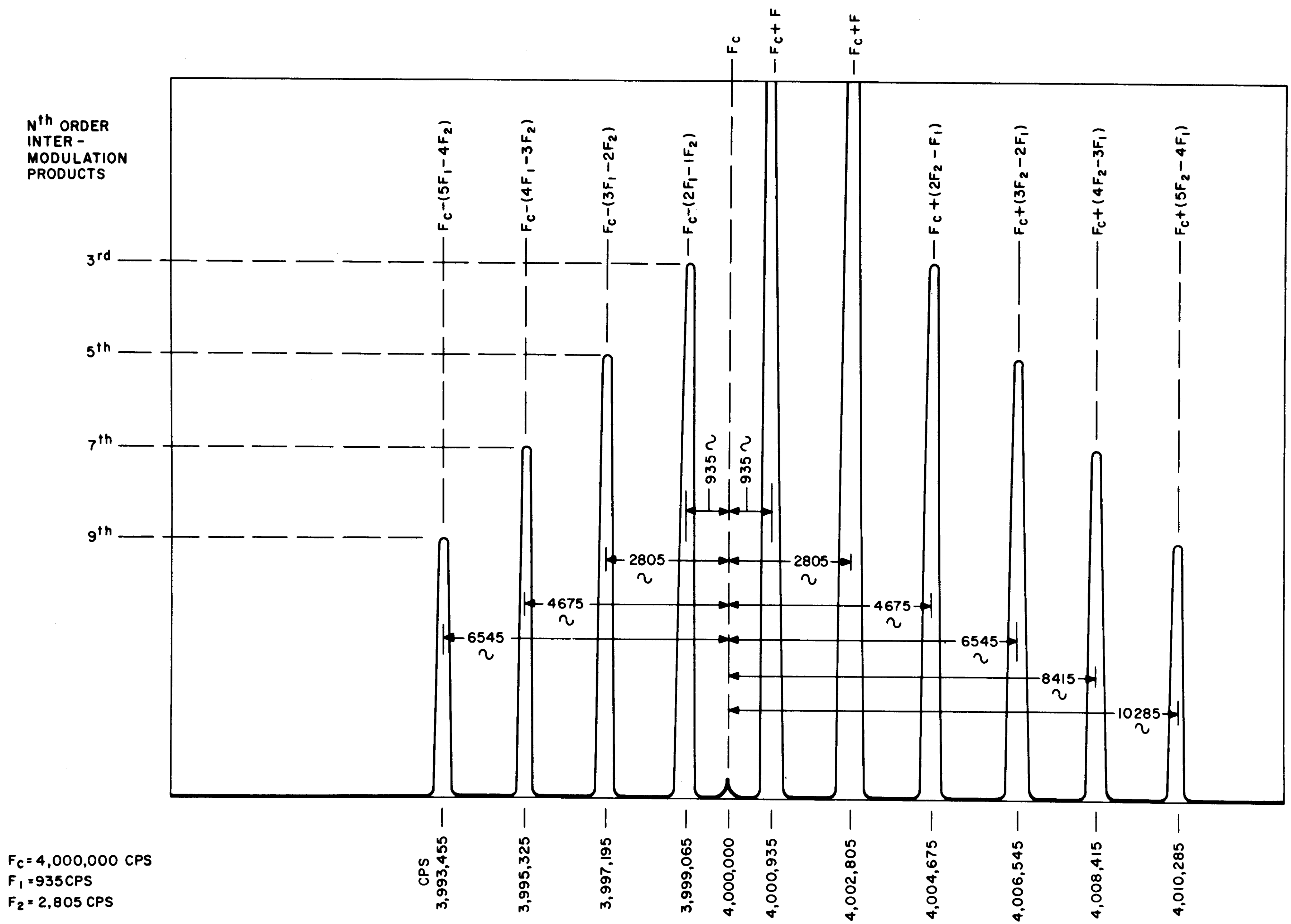


Figure I-3-8. Intermodulation Spectrum, Upper Sideband

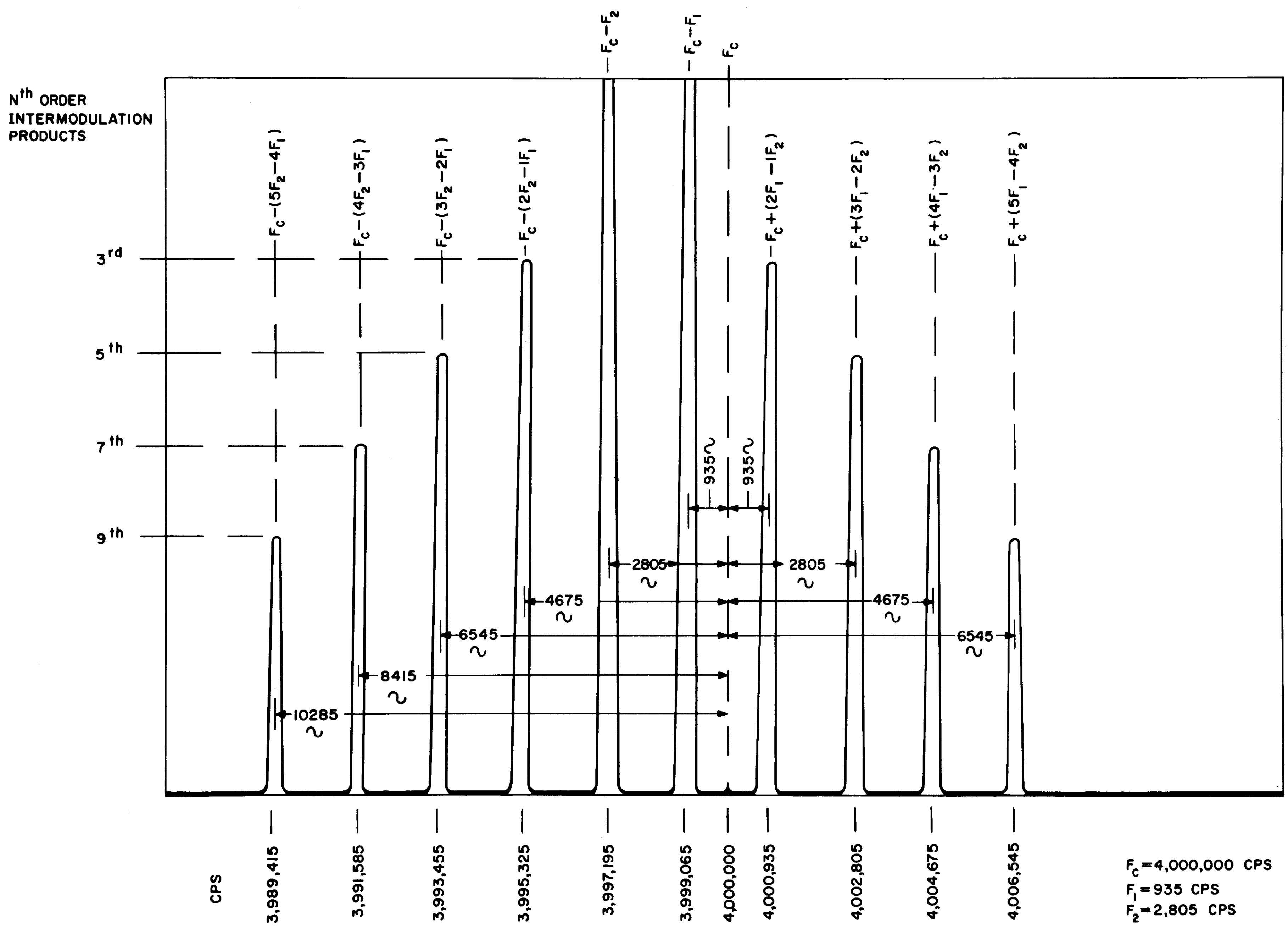


Figure I-3-9. Intermodulation Spectrum, Lower Sideband

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.

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

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	ILLUMINA-TION 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 SE-LECTOR	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.

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.

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.

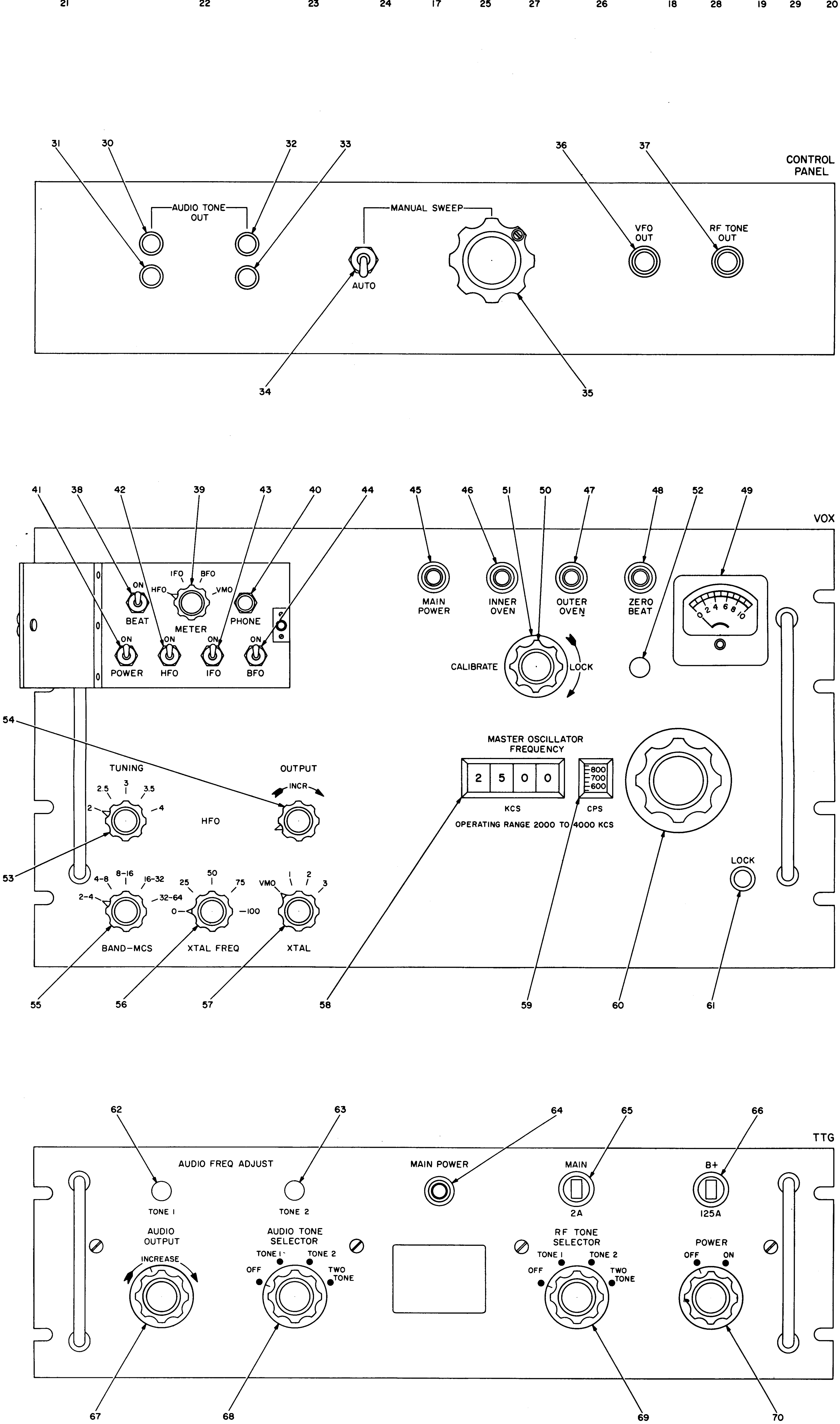
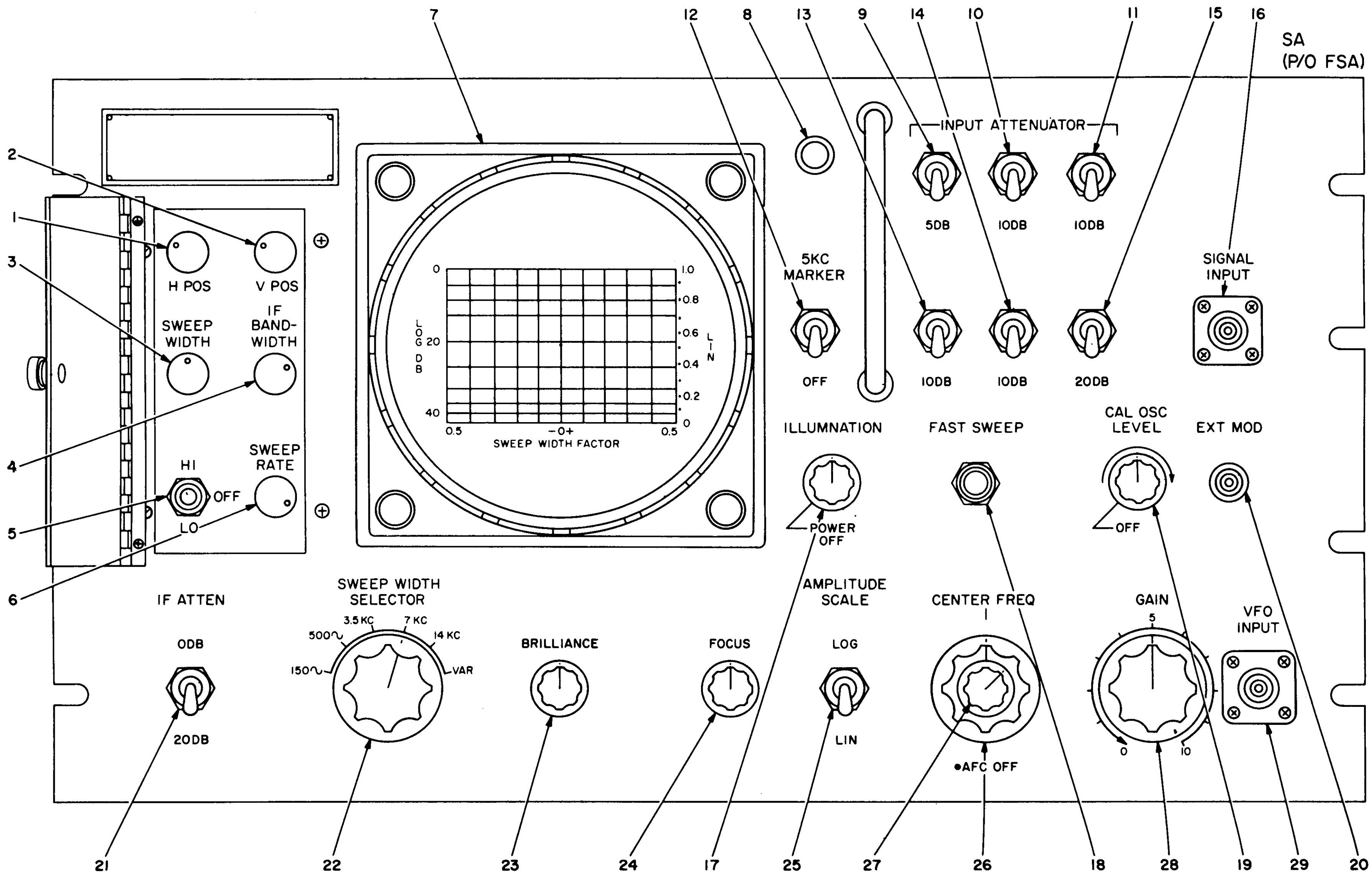


Figure I-3-10. Panel View of PTE, Showing Operating Controls


SA
(P/O FSA)
INPUT ATTENUATOR
5DB
10DB
10DB
10DB
10DB
20DB
SIGNAL INPUT
5KC MARKER
OFF
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
21
22
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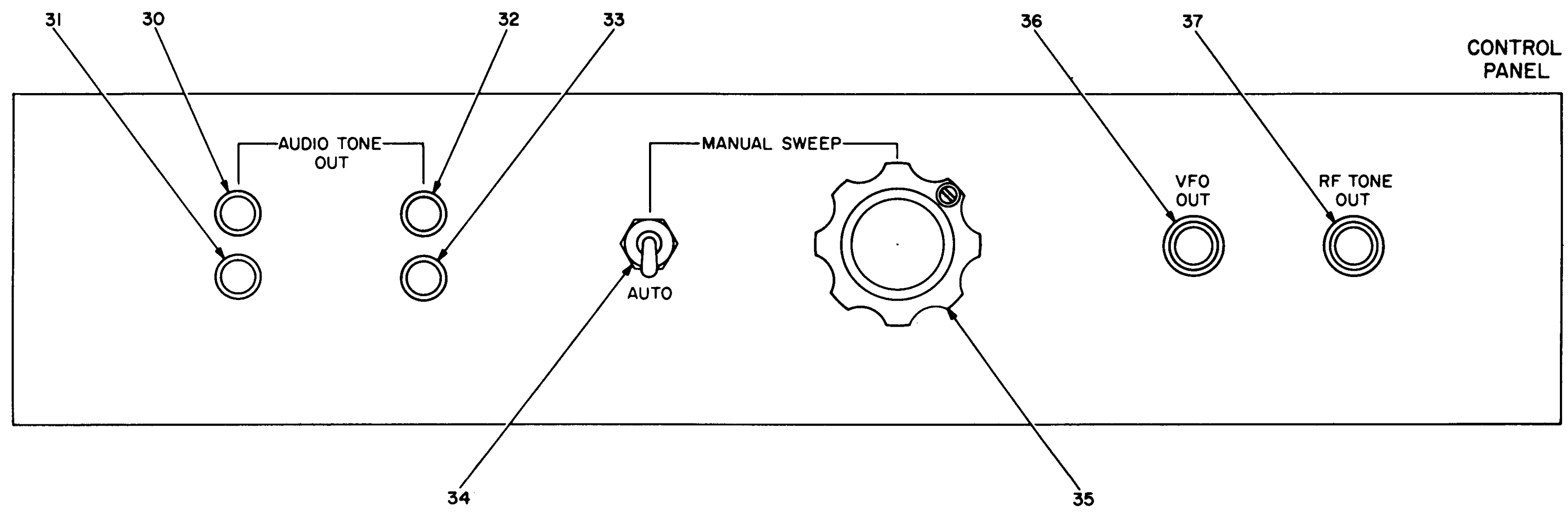
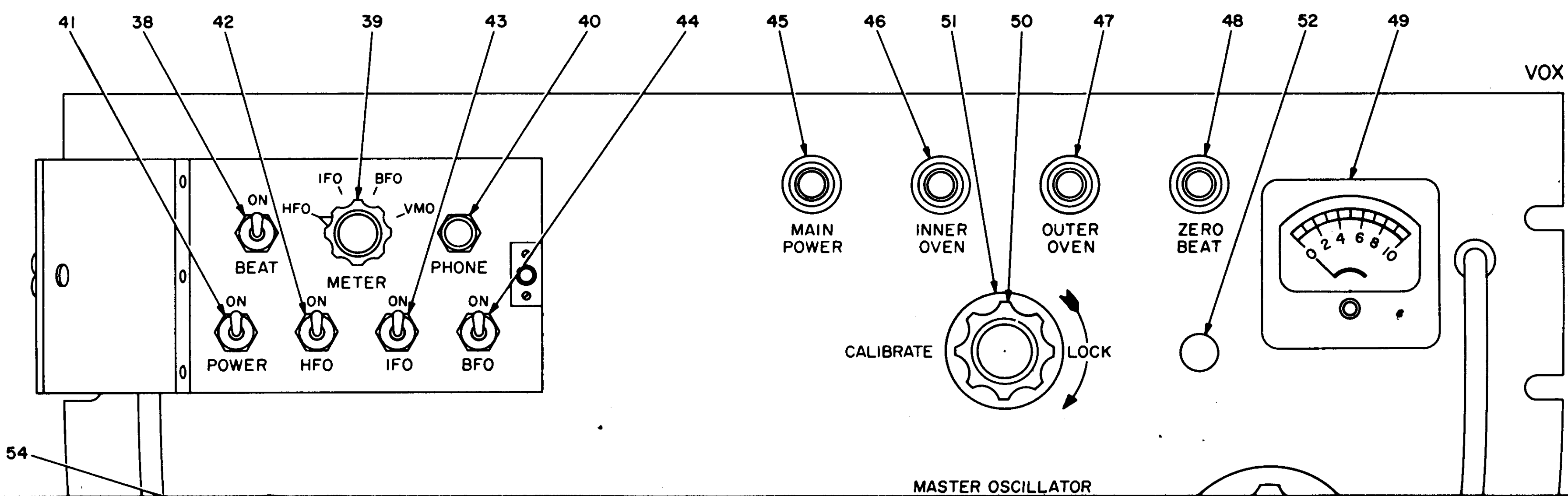
24
25
26
27
28
29


CONTROL PANEL
AUDIO TONE OUT
MANUAL SWEEP
AUTO
VFO OUT
RF TONE OUT
30
31
32
33
34
35
36
37


VOX
BEAT
METER
PHONE
POWER
HFO
IFO
BFO
VMO
ON
MAIN POWER
INNER OVEN
OUTER OVEN
ZERO BEAT
CALIBRATE
LOCK
MASTER OSCILLATOR
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
54

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.

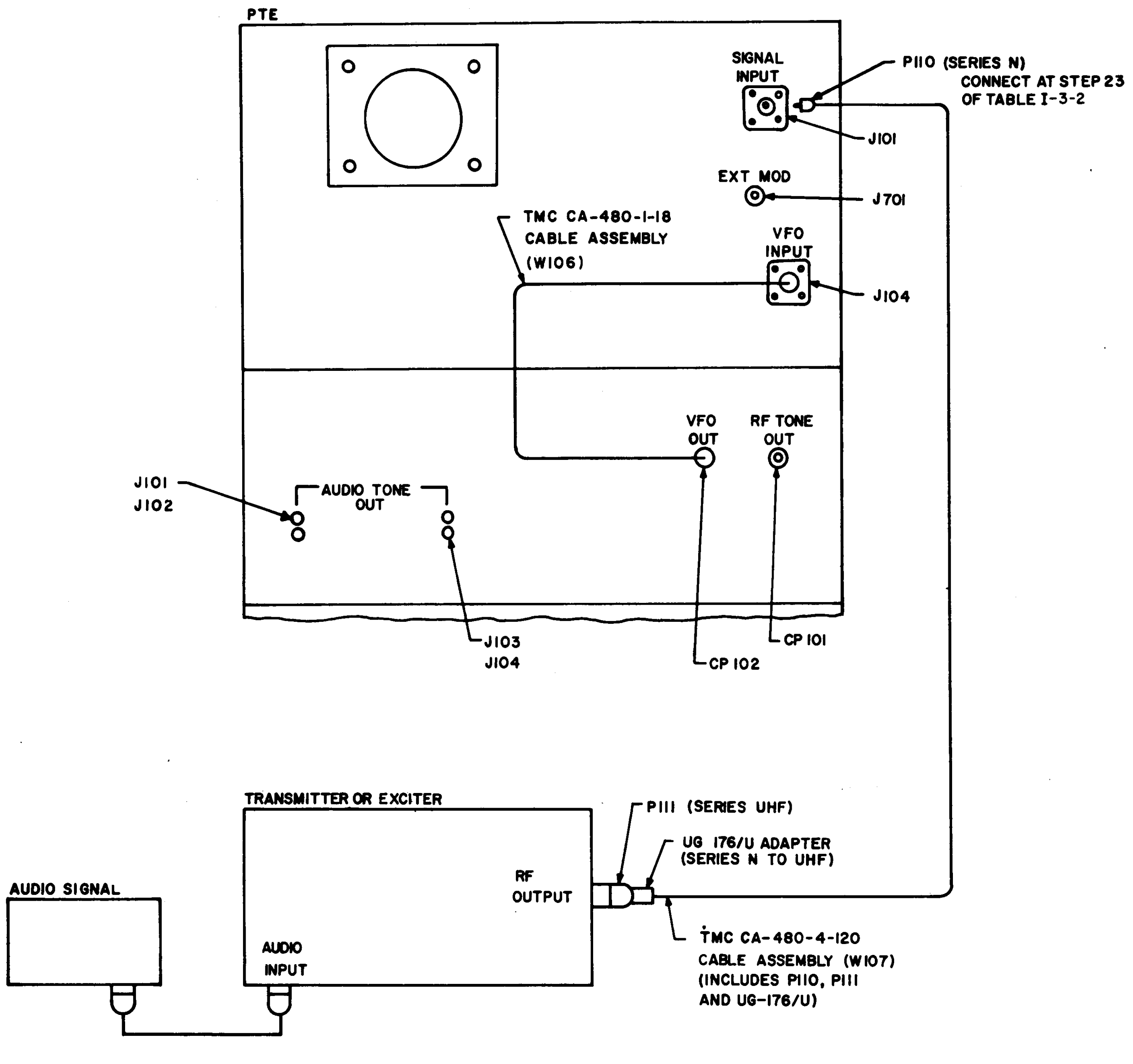


Figure I-3-11. Cable Connection Diagram for General Sideband Analysis

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.

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±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 (Cont)

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 interval pips 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. Measurements 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.

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 (C nt)

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 (Cont)

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.

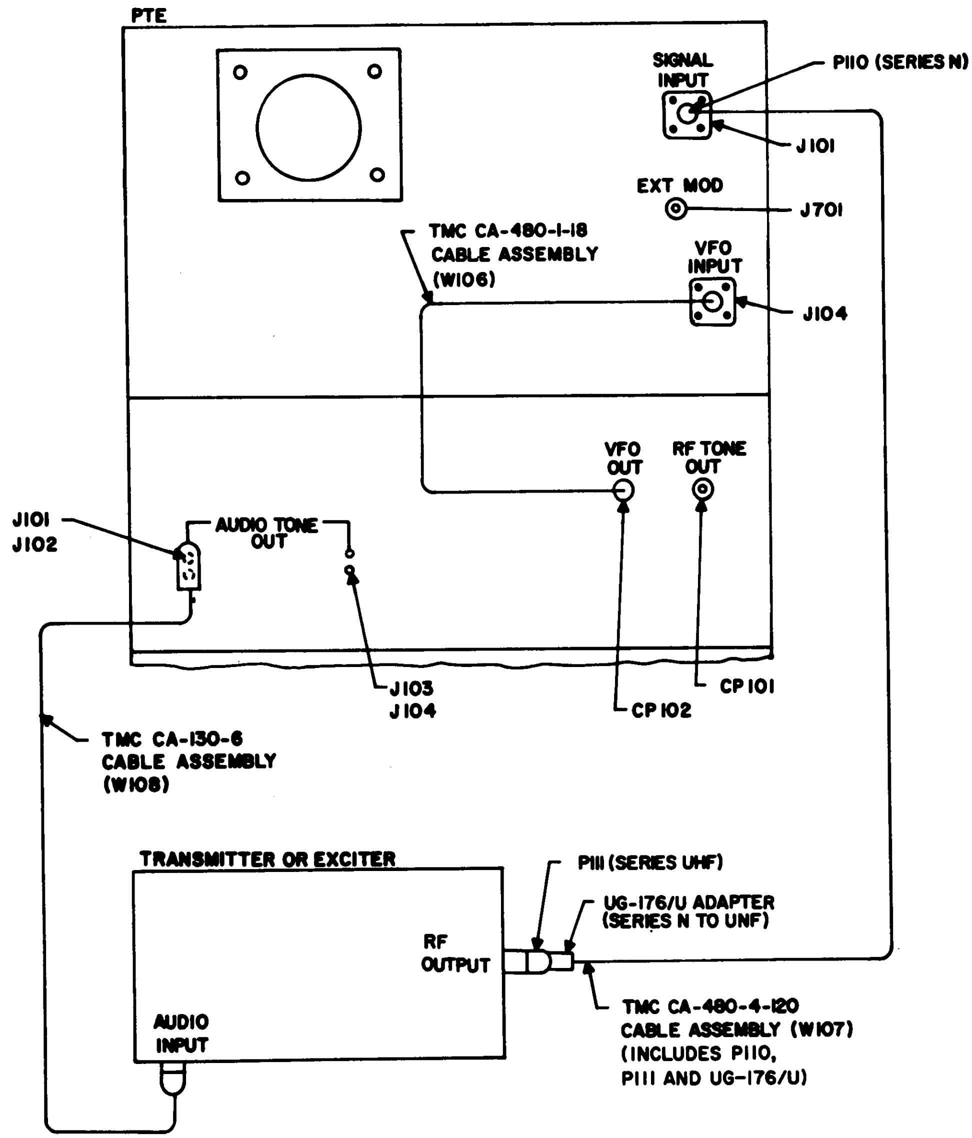


Figure I-3-12. Cable Connection Diagram for Odd-Order Distortion Measurements

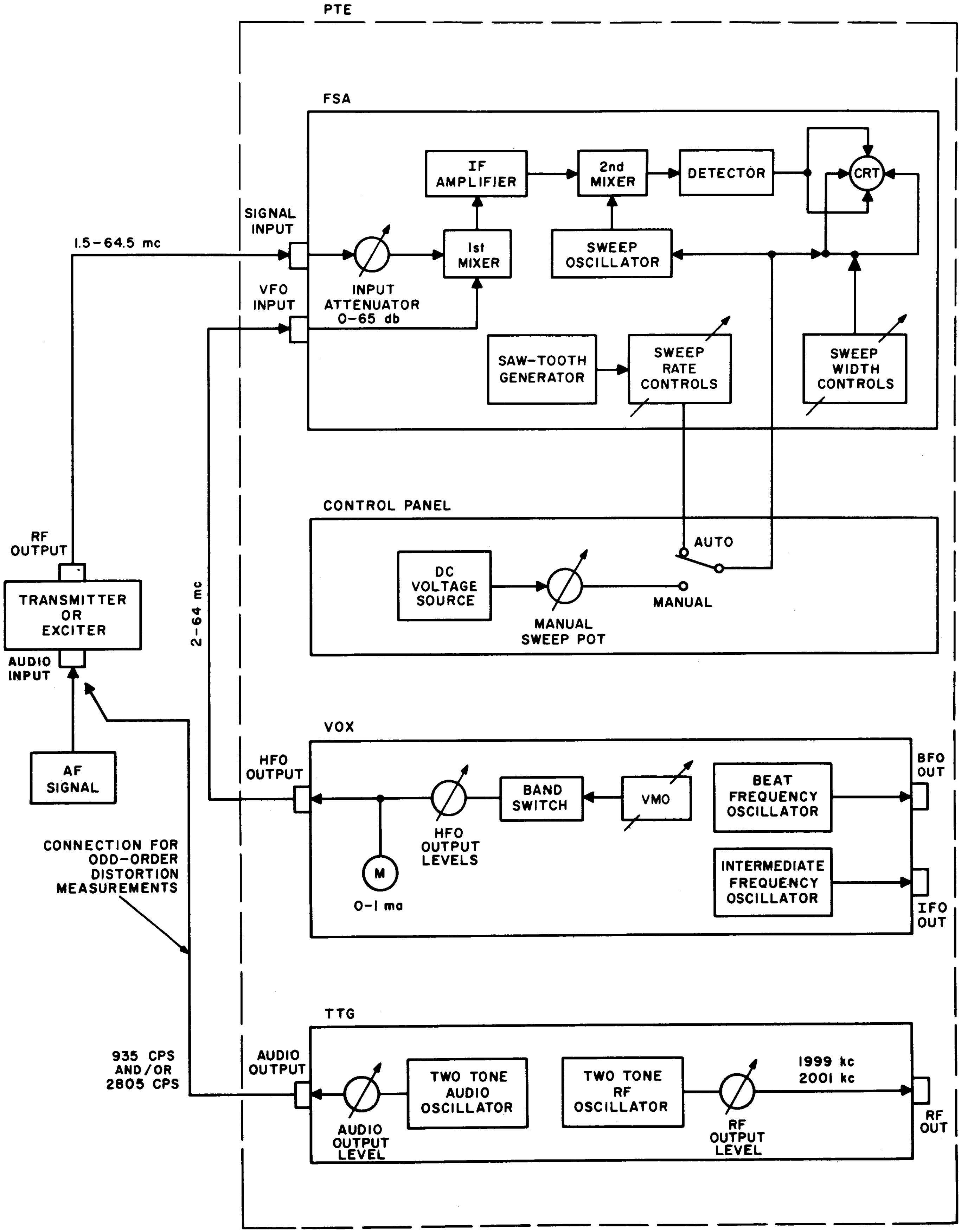


Figure I-4-1. Functional Block Diagram, RF Spectrum Analyzer, PTE

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.

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 (C nt)

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.

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

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.

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.

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.