

HEWLETT-PACKARD
CORPORATION

122A

OSCILLOSCOPE

OPERATING AND SERVICING MANUAL



OPERATING AND SERVICING MANUAL

FOR

MODEL 122A/AR OSCILLOSCOPE SERIAL 101 AND ABOVE



SPECIFICATIONS

SWEEP

Sweep Range:	15 Calibrated sweeps, accurate to within $\pm 5\%$, in a 1, 2, 5, 10, ... sequence, 5 $\mu\text{sec}/\text{cm}$ to 200 millisecc/cm. Vernier permits continuous adjustment of sweep time between calibrated steps and extends the 200 millisecc/cm step to at least 0.5 sec/cm.
Sweep Expand:	X5 sweep expansion may be used on all ranges and expands fastest sweep to 1 $\mu\text{sec}/\text{cm}$. Expansion is about the center of the CRT and expanded sweep accuracy is $\pm 10\%$.
Synchronization:	Automatic from 50 cps to 250 kc; internally from vertical deflection signals causing 1/2 cm or more vertical deflection; from external signals 2.5 volts peak-to-peak or greater, and from line voltage.
Trigger Point:	Control overrides automatic and permits the trigger point to be set between -10 and +10 volts. Turning fully counterclockwise into AUTO restores automatic operation.

VERTICAL AMPLIFIERS

Bandwidth:	DC coupled: dc to 200 kc. AC coupled: 2 cps to 200 kc. Bandwidth is independent of calibrated sensitivity setting.
Sensitivity:	10 millivolts/cm to 100 volts/cm. 4 calibrated steps accurate within $\pm 5\%$, 10 mv/cm, 100 mv/cm, 1 v/cm and 10 v/cm. Vernier permits continuous adjustment of sensitivity between steps and extends 10 v/cm step to at least 100 v/cm.
Internal Calibrator:	Calibrating signal automatically connected to vertical amplifier for standardizing of gain, accuracy $\pm 2\%$.
Input Impedance:	1 megohm, approximately 50 μf shunt capacitance.
Phase Shift:	Vertical and horizontal amplifiers have same phase characteristics within $\pm 2^\circ$ to 100 kc when verniers are fully cw.
Balanced Input:	On 10 mv/cm range on both amplifiers. Input impedance, 2 megohms shunted by approximately 25 μf . Common mode rejection is at least 40 db. Common mode signal must not exceed ± 3 volts peak.
Difference Input:	Both input signals may be switched to one channel to give differential input on all vertical sensitivity ranges. The sensitivity switches may be set separately to allow mixing signals of different levels. Common mode rejection is at least 40 db with both switches on most sensitive range, 30 db on other ranges.
Vertical Presentation:	Switch selects: A ONLY, B ONLY, B-A, ALTERNATE or CHOPPED.

SPECIFICATIONS (CONT'D.)HORIZONTAL AMPLIFIER

Bandwidth:	DC coupled: dc to 200 kc. AC coupled: 2 cps to 200 kc. Bandwidth is independent of calibrated sensitivity setting.
Sensitivity:	0.1 volt/cm to 100 volts/cm. 3 calibrated steps, accurate within $\pm 5\%$, .1 v/cm, 1 v/cm, and 10 v/cm. Vernier permits continuous adjustment of sensitivity between steps and extends 10 v/cm step to at least 100 v/cm.
Input Impedance:	1 megohm, nominal, shunted by approximately 100 μ f.
Phase Shift:	Horizontal and vertical amplifiers have same phase characteristics within $\pm 2^\circ$ to 100 kc.

GENERAL


Cathode Ray Tube:	5AQP1 mono-accelerator normally supplied; 2500 volt accelerating potential. P7 and P11 phosphors are also available. P2 is available if desired for special applications.
CRT Bezel:	Light proof bezel provides firm mount for oscilloscope camera and is removed easily for quick change of filter.
CRT Plates:	Direct connection to deflection plates via terminals on rear. Sensitivity approximately 20 v/cm.
Intensity Modulated:	Terminals on rear. +20 v to blank trace of normal intensity.
Filter Supplied:	Color of filter compatible with CRT phosphor supplied: Green with P1 and P2 Amber with P7 Blue with P11.
Illuminated Graticule:	Edge lighted with controlled illumination, 10 cm x 10 cm, marked in cm squares. Major horizontal and vertical axes have 2 mm subdivisions.
Dimensions:	Cabinet Mount: 9-3/4 in. wide, 15 in. high, 21-1/4 in. deep. Rack Mount: 19 in. wide, 7 in. high, 21-1/4 in. deep. 19-1/2 in. deep behind panel.
Weight:	Cabinet Mount: Net 35 lbs., shipping 51 lbs. Rack Mount: Net 33 lbs., shipping 48 lbs.
Power:	115/230 volts $\pm 10\%$, 50-1000 cps; approximately 150 watts.
Accessories Available:	AC-83A Viewing Hood, face-fitting molded rubber.

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CATHODE RAY TUBE WARRANTY

The cathode ray tube supplied in your Hewlett-Packard Oscilloscope and replacement cathode ray tubes purchased from , are guaranteed against electrical failure for one year from the date of sale by the Hewlett-Packard Company. Broken tubes or tubes with burned phosphor are not included in this guarantee.

Your local Hewlett-Packard representative maintains a stock of replacement tubes and will be glad to process your warranty claim for you. Please consult him.

Whenever a tube is returned for a warranty claim, the reverse side of this sheet must be filled out in full and returned with the tube. Follow shipping instructions carefully to insure safe arrival, since no credit can be allowed on broken tubes.

SHIPPING INSTRUCTIONS

- 1) Carefully wrap the tube in 1/4" thick cotton batting or other soft padding material.
- 2) Wrap the above in heavy kraft paper.
- 3) Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.
- 4) Surround the tube with at least four inches of packed excelsior or similar shock absorbing material. Be certain that the packing is tight all around the tube.
- 5) Tubes returned from outside the continental United States should be packed in a wooden box.
- 6) Ship prepaid preferably by AIR FREIGHT or RAILWAY EXPRESS. We do not recommend parcel post or air parcel post shipment.

CRT WARRANTY CLAIM

FROM:

DATE: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

Person to contact for further information:

NAME: _____

TITLE: _____

COMPANY: _____

ADDRESS: _____

To process your claim quickly please enter the information indicated below:

1) ϕ INSTRUMENT MODEL _____ SERIAL _____

2) TUBE TYPE _____ SERIAL _____

3) ORIGINAL TUBE _____ REPLACEMENT TUBE _____

4) YOUR PURCHASE ORDER NO. _____

5) DATE PURCHASED _____

6) PURCHASED FROM _____

7) COMPLAINT: (Please describe nature of trouble) _____

8) OPERATING CONDITIONS: (Please describe conditions prior to and at time of failure) _____

SIGNATURE _____

SECTION 1

GENERAL INFORMATION

1-1 GENERAL DESCRIPTION

The Model 122A is a dc to 200 kc dual-trace cathode-ray oscilloscope. It has accurately calibrated input sensitivity and sweep-speed ranges. This oscilloscope features dc-coupled differential amplifiers and dual-trace operation.

Differential amplifiers are useful since they reject the common-mode (in-phase) part of the input while amplifying the differential (out-of-phase) part. For instance, they will reject hum pick-up while amplifying the desired signal. In addition, using differential amplifiers has other advantages. Normally dc amplifiers are difficult to keep stable. Changes such as aging and changes of potentials cause this drift. However, these changes are of the common-mode type and are rejected by differential amplifiers. Thus differential amplifiers are also used to stabilize dc amplifiers.

Dual-trace operation is obtained with an electronic switch. This permits observation of two signals at the same time. The two signals may be viewed either alternately during consecutive sweeps or chopped on each sweep. Chopped operation involves switching rapidly between the two signals so that both appear to be traced simultaneously. The most useful type of presentation in each case will depend upon the frequencies involved. Generally, chopped operation is used with low frequency signals. These signals may also be viewed separately or with their difference (B-A) displayed on the screen.

1-2 DAMAGE IN TRANSIT

Refer to the warranty page in this manual if any damage is apparent upon receipt.

1-3 POWER LINE VOLTAGES

This instrument is designed to operate from a nominal 115 or 230 volt source. The instrument will operate satisfactorily over a $\pm 10\%$ variation from the nominal value, i.e. 103-127 volts. Operation at 130/260 volts will damage the instrument. If abnormally high line voltage is suspected monitor the line voltage to be certain it does not exceed 127 volts.

1-4 CONVERSION FOR 230 VOLT OPERATION

The instrument can be converted from 115 v to 230 v operation by reconnecting the power transformer dual primary windings as follows: Remove the instrument from the cabinet by removing the two large screws from the rear of the cabinet. Push the instrument from the cabinet by pushing on the rear of the chassis.

Locate the power supply terminal strip situated next to the power transformer. The two outer terminals on each side are jumpered together connecting the windings in parallel. Remove these jumpers. Connect an insulated jumper between the second and fourth terminals, connecting the windings in series. Refer to the Low Voltage Power Supply Schematic for details. Replace the 2.0 amp slow-blow fuse with a 1.0 amp slow-blow fuse.

1-5 ACCESSORIES AVAILABLE

An AC-83 Viewing Hood is available at extra cost. This is a face-fitting moulded rubber hood used to shade the face of the cathode-ray tube under high ambient light conditions. It will permit the use of lower beam intensity setting.

— NOTE —
INSTRUCTIONS ARE GIVEN FOR CHANNEL A ONLY,
BUT ARE IDENTICAL TO THOSE USED FOR CHANNEL B.
LOCATION OF THE CONTROLS IS DIFFERENT
ON RACK-MOUNTED MODELS, BUT FUNCTIONS OF
THE CONTROLS ARE IDENTICAL.

TO OBTAIN A PATTERN EASILY SET THE CONTROLS EXACTLY AS
SHOWN AND PERFORM THE NUMBERED STEPS IN SEQUENCE.
USE SAME PROCEDURE WHENEVER DIFFICULTY IS ENCOUNTERED IN OBTAIN-
ING A PATTERN. THIS WILL ELIMINATE FAULTS DUE TO MISALIGNMENT OF THE
CONTROLS AND WILL ISOLATE ANY TROUBLES TO MAJOR SECTIONS.

- 1 ROTATE INTENSITY CONTROL CLOCKWISE TO
9 O'CLOCK TO TURN ON.
- 2 ADJUST VERTICAL POSITION, HORIZONTAL POSITION,
INTENSITY, AND FOCUS CONTROLS TO OBTAIN A
CENTERED, CLEAR PATTERN.
- 3 SET TRIGGER LEVEL TO AUTO

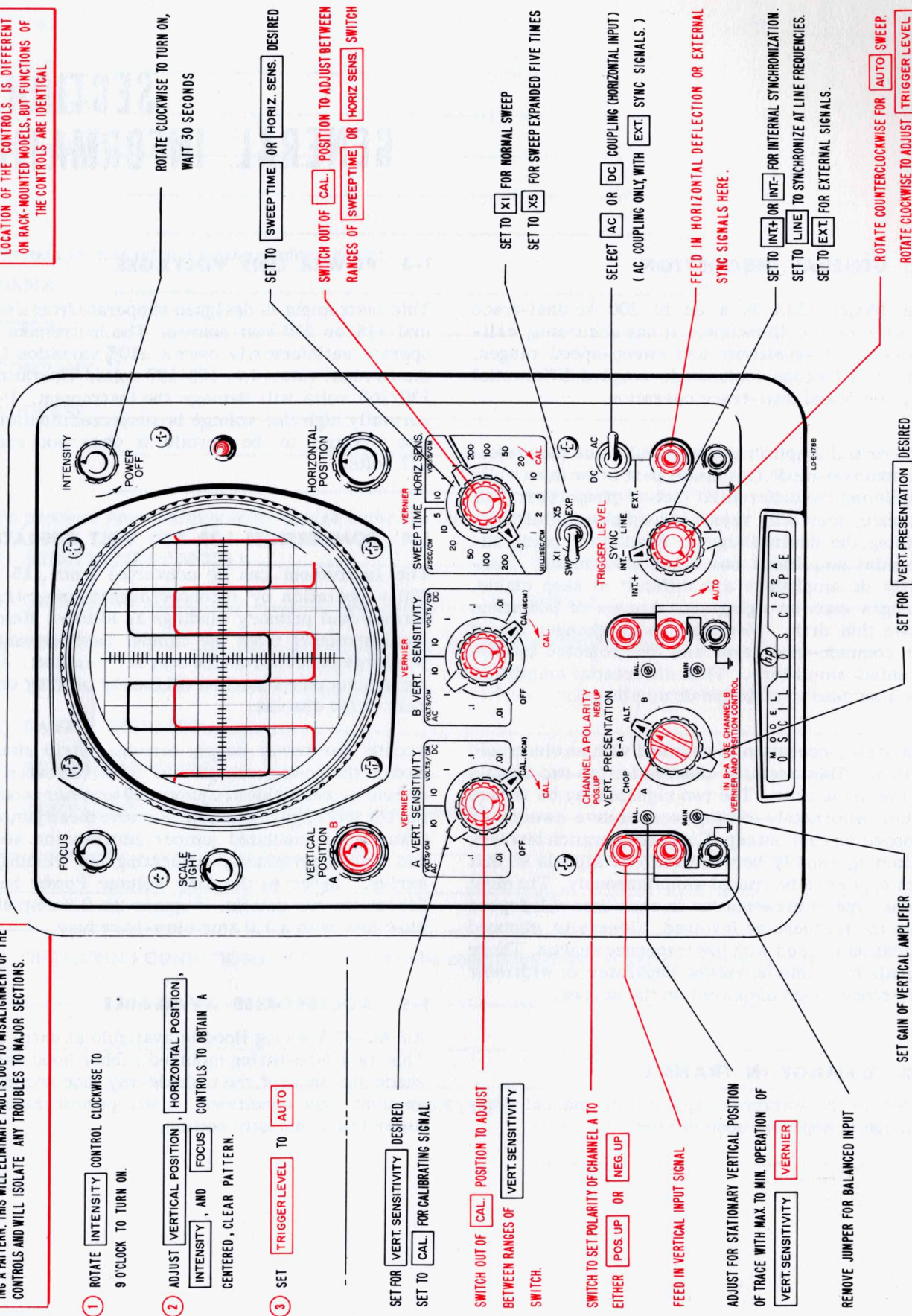


Figure 2-1. Front Panel Control Diagram

SECTION II

OPERATING INSTRUCTIONS

2-1 CONTROLS AND TERMINALS

Figure 2-1 briefly shows how to operate the instrument. Additional detailed information is given below:

2-2 VERTICAL AMPLIFIER INPUT CONSIDERATIONS

Do not exceed the common-signal voltage limit under any conditions. This limit is ± 3 volts on the input grid. Note that this is the sum of all voltages (dc plus peak ac).

When the attenuators are used the voltage to the input terminals may be increased by the amount of the attenuation as follows:

TABLE 2-1

Attenuator Setting	Common-Signal Limit
0.01 VOLTS/CM	± 3 volts
0.1	30
1.0	300
10	500

NOTE Maximum peak input voltage limit is 600 volts (dc plus peak ac). The following are recommended ways of connecting the oscilloscope. Refer to Figures 2-1 to 2-4 for further details concerning connections.

A. Unbalanced Input (see Figure 2-2)

Maximum voltage limit as in table 2-1.

B. Differential (B-A) Input (see Figure 2-3)

Maximum voltage limit from each line to ground as in table 2-1. Common-signal rejection is at least 40 db with both switches set on 10 MILLI-VOLTS/CM. Rejection is at least 30 db on other ranges.

C. Other Types of Input

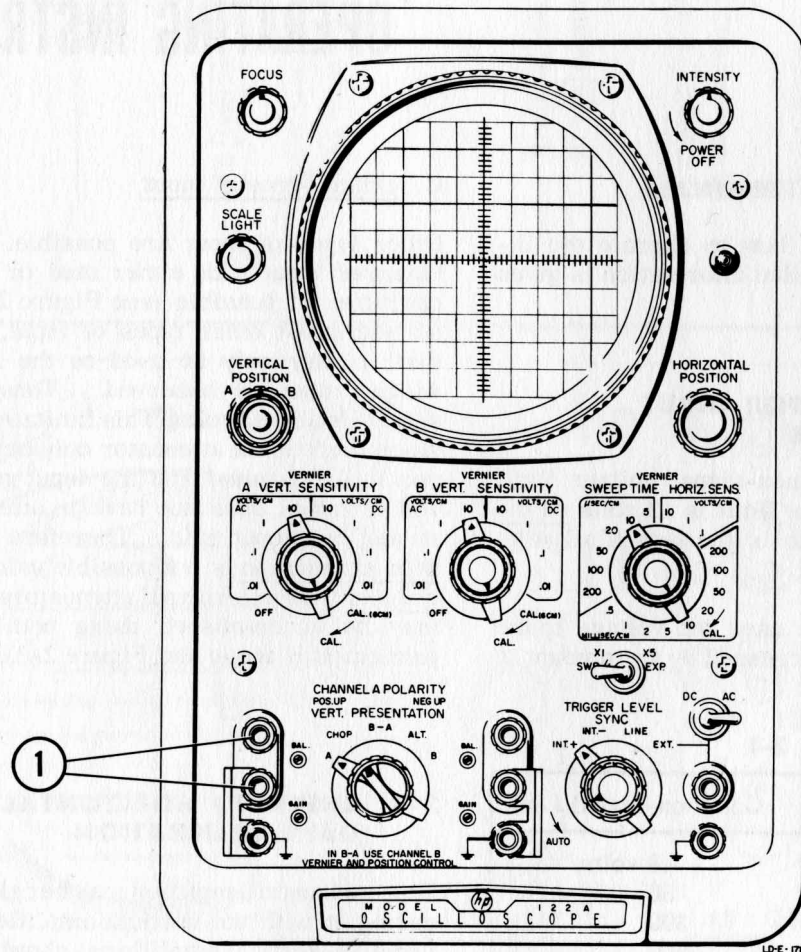
Other types of input are possible. For example, balanced input with either dual or single channel operation is possible (see Figure 2-4). However, as with most other types of input, the limitation that it may only be used on the .01 VOLTS/CM ranges must be observed. Thus the common-signal limit is ± 3 volts. This limitation is necessary since there is an attenuator only between the upper red input terminal and the input grid. The lower red terminal does not have an attenuator between it and its input grid. Therefore balanced input with attenuation is not possible using only a single channel without external attenuators. However, this may be accomplished using both channels (see paragraph B above and Figure 2-3).

2-3 CHECKING HORIZONTAL AMPLIFIER GAIN CALIBRATION

The horizontal amplifier may be calibrated by comparing it with the vertical amplifier. First, calibrate the vertical amplifier as shown in Figure 2-10. Set both VERT. and HORIZ. SENSITIVITY switches to 0.1 VOLTS/CM with VERNIER's in Cal. Feed an external 1 volt signal into the vertical and horizontal input terminals. Adjust the input amplitude for a 10 cm high pattern. Set Horiz. Gain Adj., R114, for exactly 10 cm of horizontal deflection.

2-4 OPERATING DRAWINGS

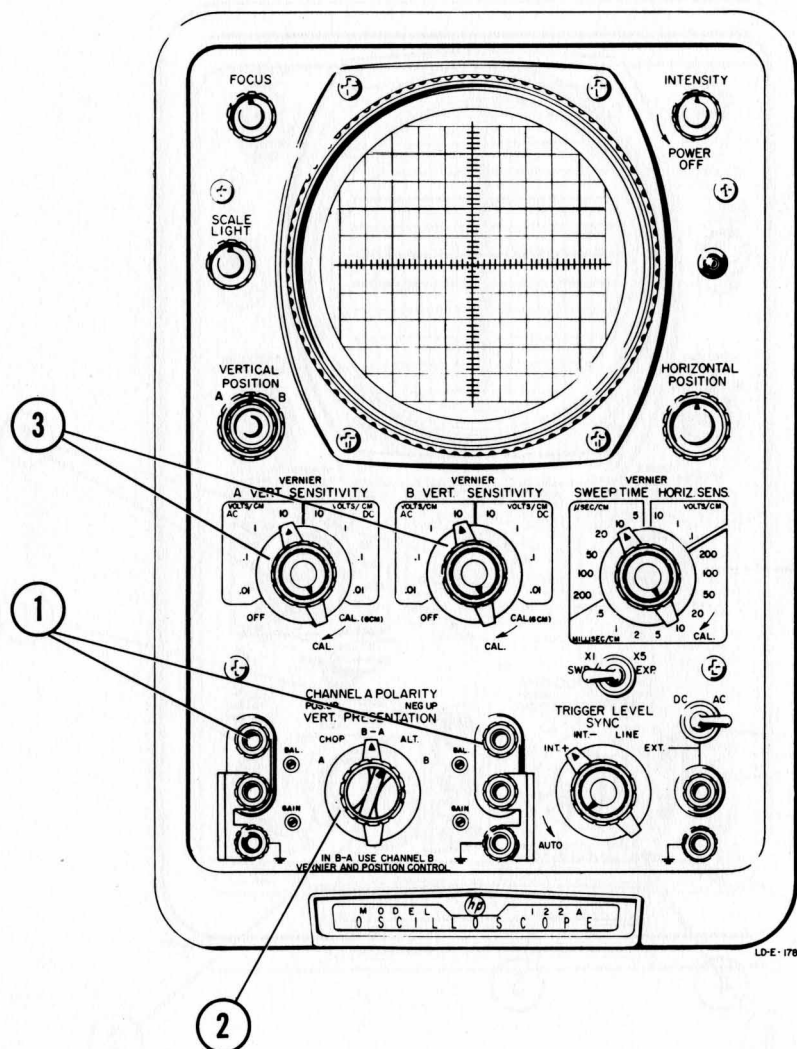
Basic operating procedures are shown in the illustrations that follow. Directions are given for the cabinet model but are the same for the rack mount model. The location of the controls on the front panel is different in the rack mount model but the functions of the controls are the same.

UNBALANCED INPUT

1. Connect input to red terminals with ground to lower terminal.

Follow same procedure for other channel.

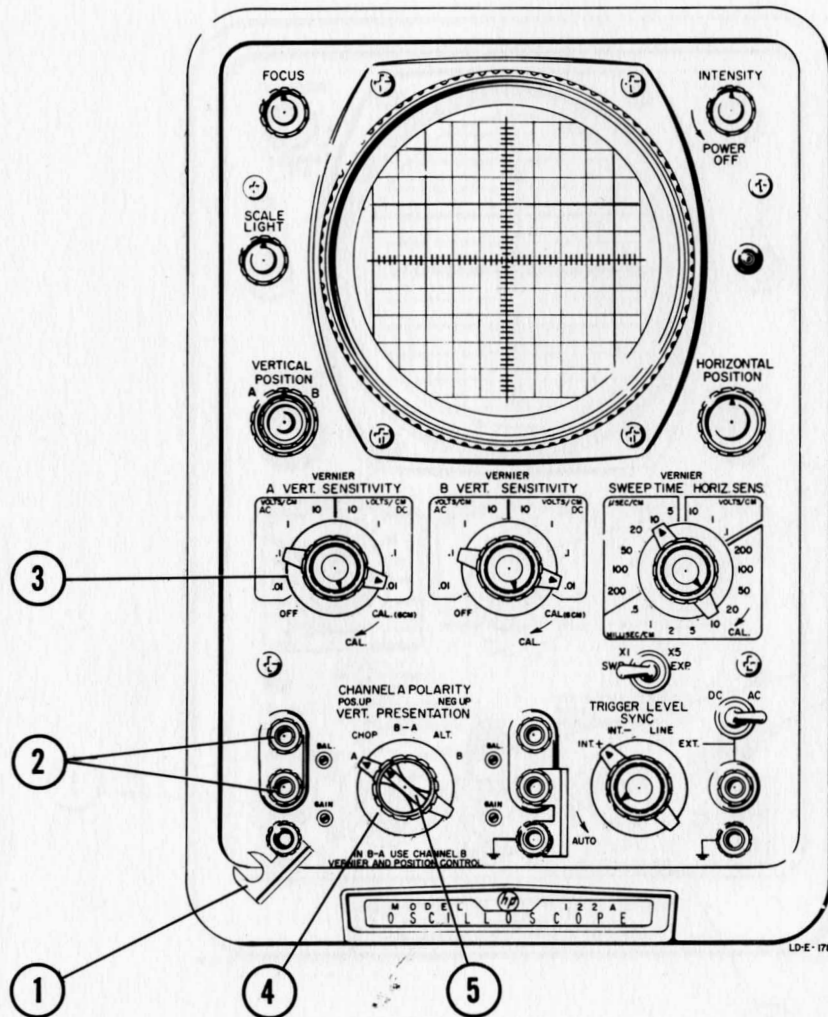
Figure 2-2

BALANCED INPUT

1. Connect one lead to top terminal of one channel and other lead to other channel.
2. Set VERT. PRESENTATION to B-A.
3. Set both VERT. SENSITIVITY switches to (same) sensitivity desired (AC or DC range).

Figure 2-3

BALANCED INPUT **.01 VOLTS/CM SENSITIVITY ONLY**



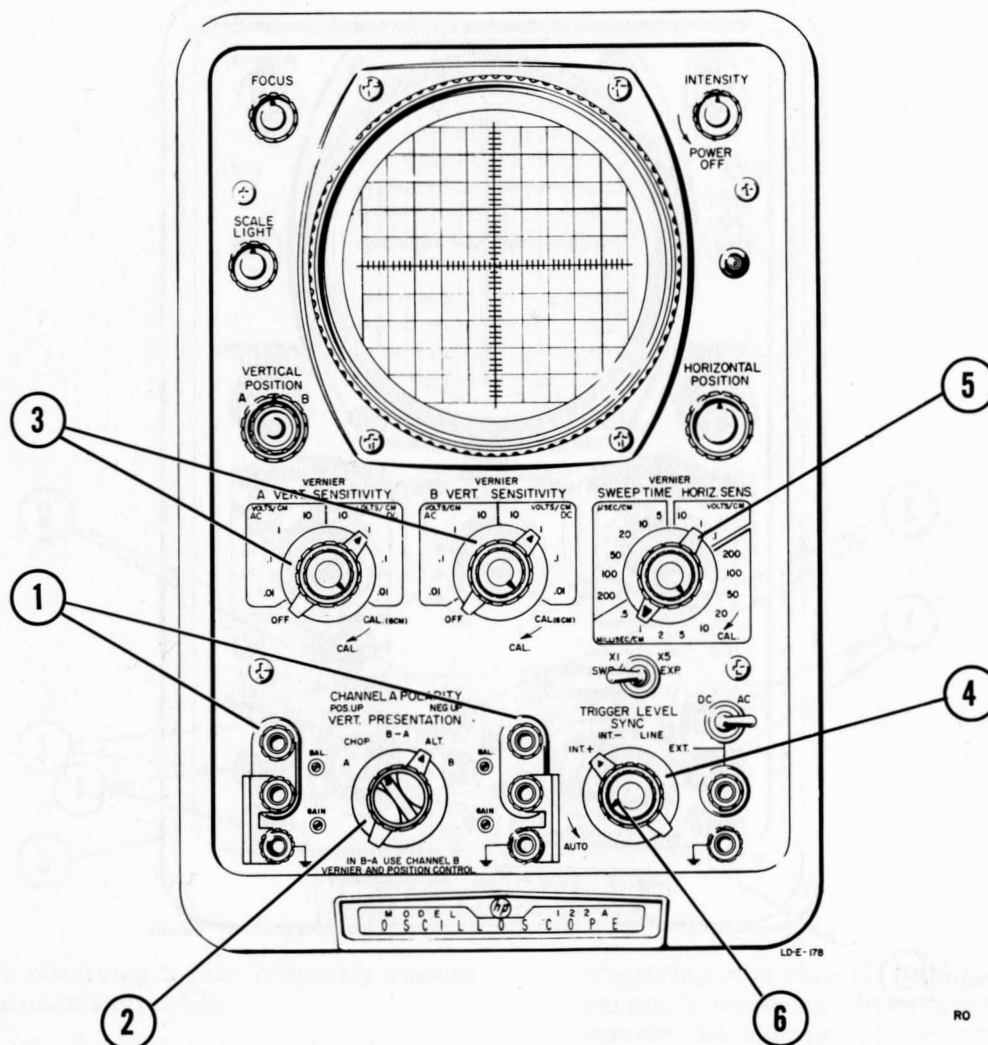
Balanced input may be used only on the .01 VOLTS/CM ranges (AC or DC) because only the upper red terminal has an attenuator in series between it and the amplifier input grid.

To connect proceed as follows:

1. Disconnect ground strap.
2. Connect input to red terminals.
3. Set VERT. SENSITIVITY switch to .01 VOLTS/CM (AC or DC).
4. Set VERT. PRESENTATION to A.
5. Set CHANNEL A POLARITY to polarity desired. Channel B may be connected similarly. Both channels may be connected and observed with either CHOP. or ALT. presentation.

Figure 2-4

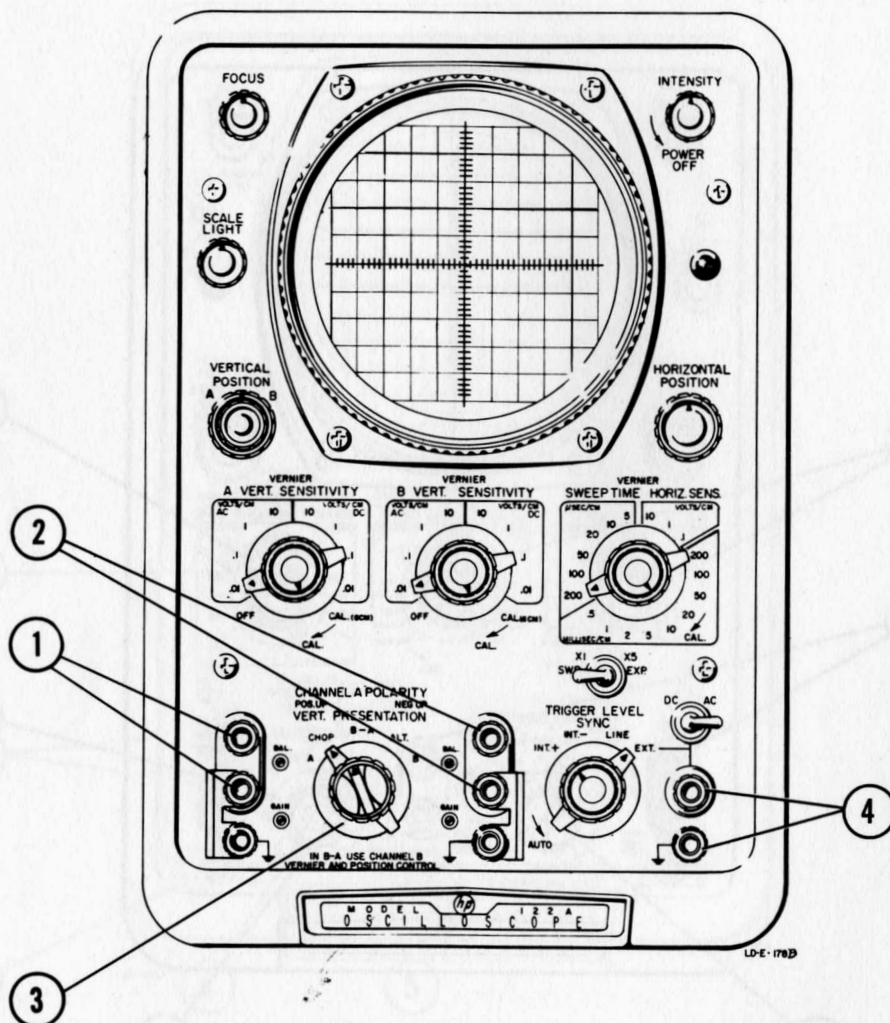
INTERNAL SWEEP — INTERNAL SYNCHRONIZATION



1. Feed vertical input signal(s) into vertical input terminal(s).
2. Set VERT. PRESENTATION switch to desired presentation.
3. Adjust VERT. SENSITIVITY switch(es) for desired sensitivity. (Note that there are both AC and DC coupled ranges.)
4. Set SYNC switch to T(+ or -), depending upon slope of trigger point desired.
5. Set SWEEP TIME - HOR. SENS. switch for desired sweep speed.
6. If AUTOMATIC sweep is not desired, rotate TRIGGER LEVEL control to select level of trigger point.

Figure 2-5

CHOPPED OPERATION



Useful for observing low frequency signals (less than approximately 2 kc). Synchronize sweep externally to avoid "jitter".

1. Connect signal (1) to two red terminals of channel A.

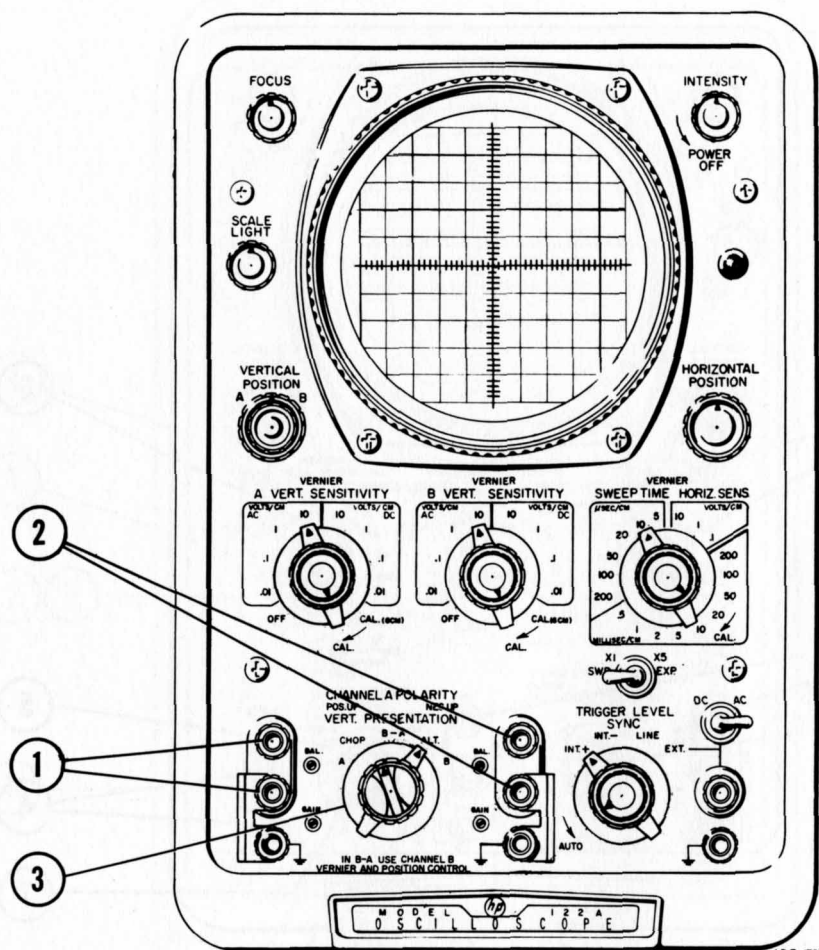
2. Connect signal (2) to the two red terminals of channel B.

3. Set VERT. PRESENTATION to CHOP.

4. Connect external sync signal.

Figure 2-6

ALTERNATE SWEEP OPERATION



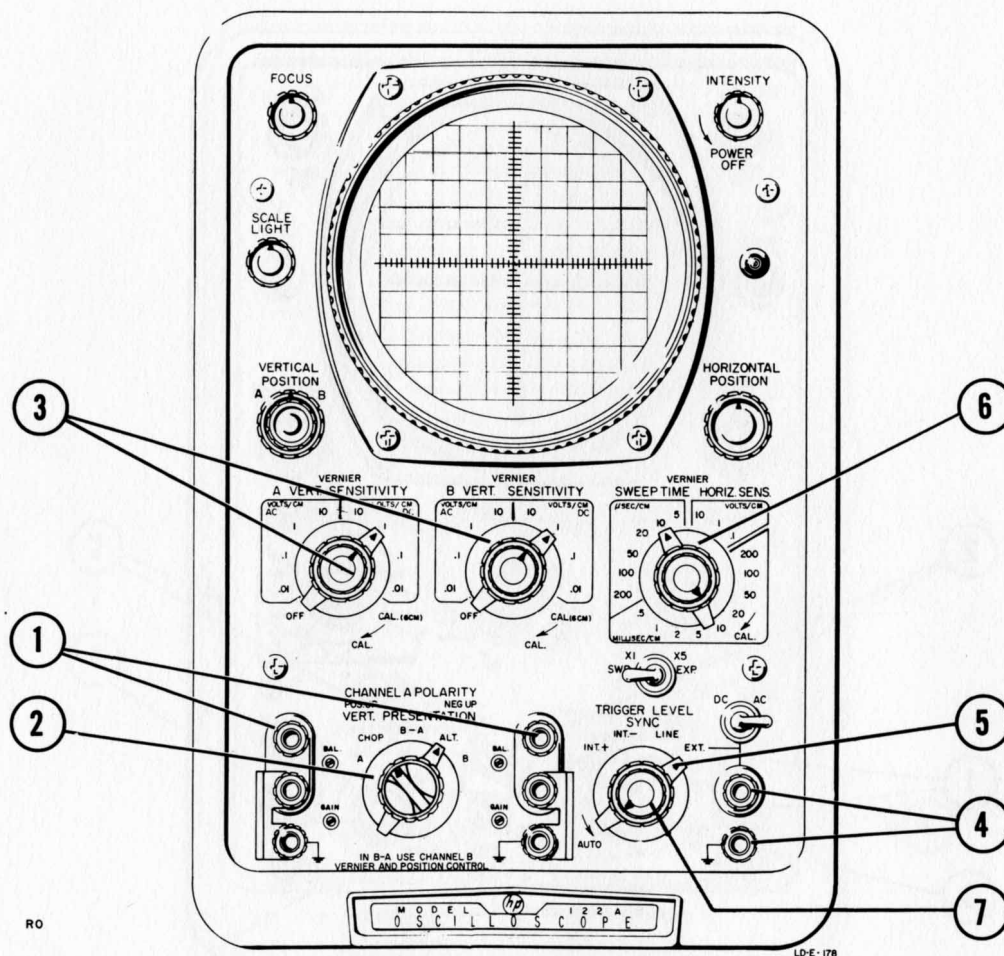
Useful for observing higher frequency signals (above approximately 2 kc).

1. Connect signal to two red terminals of channel A.
2. Connect signal to two red terminals of channel B.
3. Set VERT. PRESENTATION to ALT. Use this method of presentation for fast sweep speeds. Since each is individually triggered, this presentation can be used with internal

triggering even when the two signals are not related in frequency. When operating in this manner the intensity of the traces will be reduced if the traces are separated on the screen. This may be eliminated by adjusting the VERTICAL POSITION controls so that the traces overlap. Usually operation will involve signals related in frequency. Also, if it is desired to maintain phase information between the two signals being viewed, it is necessary to use external triggering. If this is the case, use external triggering. It is then possible to separate the traces without intensity reduction.

Figure 2-7

INTERNAL SWEEP — EXTERNAL SYNCHRONIZATION



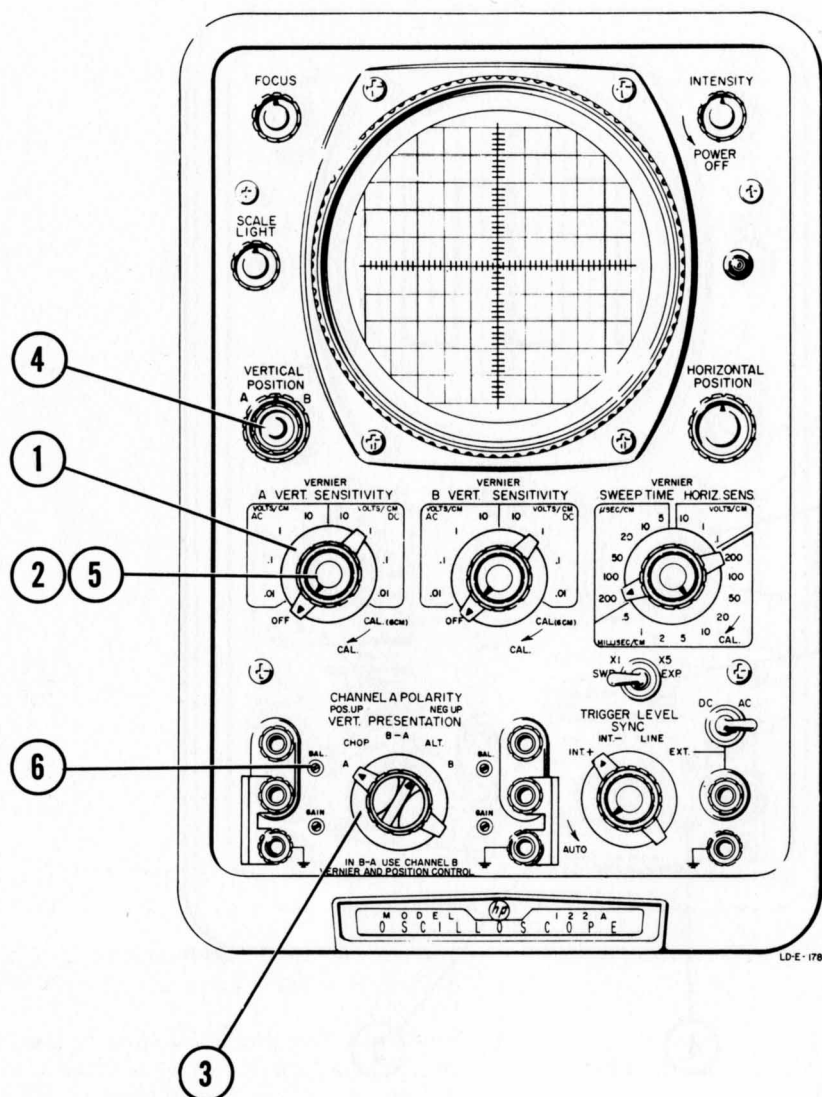
1. Feed vertical input signal(s) into vertical input terminal(s).
2. Set VERT. PRESENTATION switch to desired presentation.
3. Adjust VERT. SENSITIVITY switch(es) for desired sensitivity. (Note that there are both AC and DC coupled ranges.) Use DC coupling below 2 cps or to preserve dc level. AC couple above 2 cps or to eliminate dc component in input. AC coupling may introduce excessive tilt in low-frequency square waves.

The sum of the dc and peak ac applied to the INPUT terminals must not exceed 600 volts.

4. Feed synchronizing signal (2-1/2 v p-p or more) into external synchronizing terminals which are ac coupled. AC - DC switch has no effect.
5. Set SYNC switch to EXT.
6. Adjust SWEEP TIME - HOR. SENS. switch for desired sweep speed.
7. If AUTOMATIC sweep is not desired, rotate TRIGGER LEVEL control to select level of trigger point.

Figure 2-8

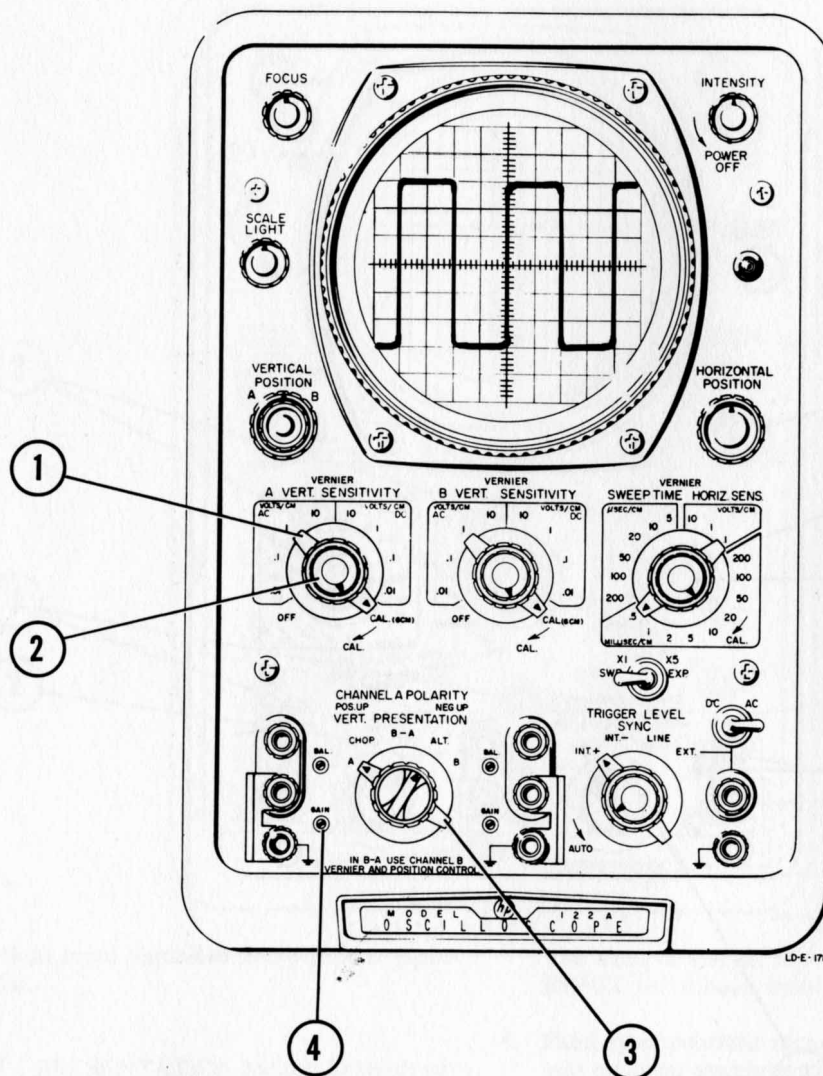
VERTICAL BALANCE ADJUSTMENT



1. Set both VERT. SENSITIVITY switches to OFF.
2. Turn both VERT. SENSITIVITY VERNIERS fully counter-clockwise.
3. Set VERT. PRESENTATION switch to A.
4. Center trace with VERT. POS. control.
5. Turn VERNIER fully clockwise.
6. Adjust BAL control to center trace or spot. Repeat procedure for Channel B.

Figure 2-9

VERTICAL SENSITIVITY CALIBRATION



1. Set A VERT. SENSITIVITY switch to CAL. position.
4. Adjust GAIN control to give a pattern height of 6 cm. Repeat this procedure for Channel B.

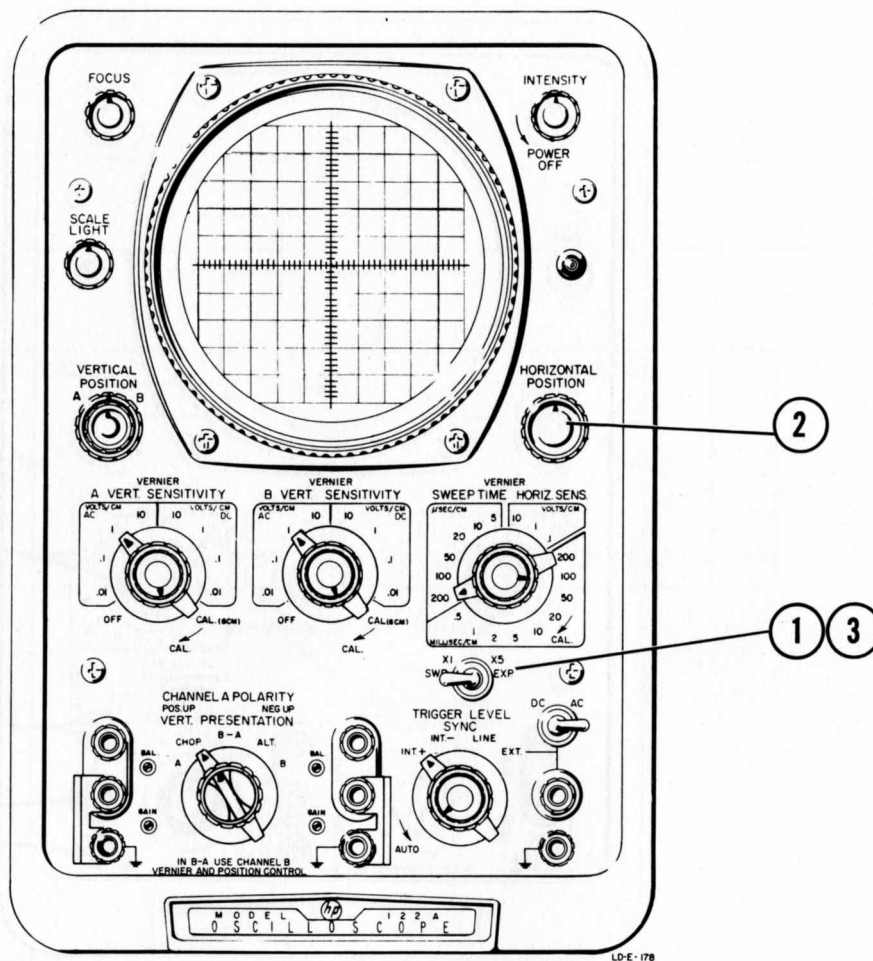
2. Set VERNIER to CAL. position.

3. Set VERT. PRESENTATION switch to A.

The vertical amplifier is now calibrated so that the engraved markings on the VERT. SENSITIVITY controls are accurate within $\pm 5\%$ whenever the VERNIERS are in CAL.

Figure 2-10

INTERNAL SWEEP MAGNIFICATION



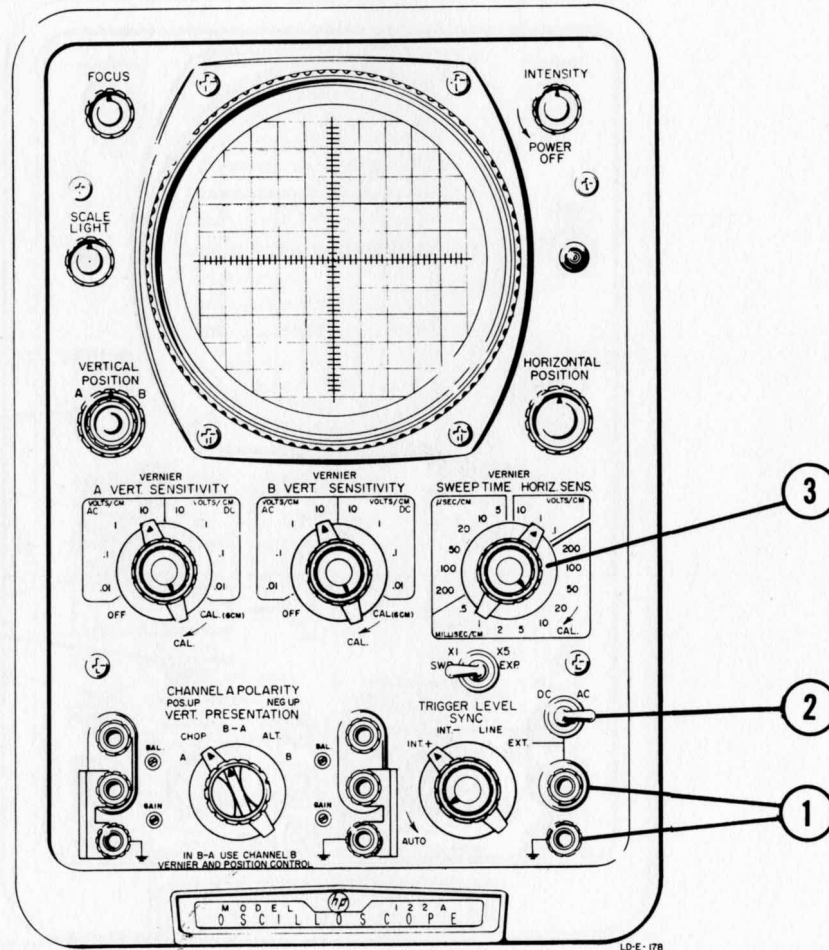
1. Make sure SWP. EXP. switch in in X1 position.

3. Set SWP. EXP. switch to X5.

2. After obtaining pattern, center the two centimeters of pattern to be magnified on center vertical axis with HORIZ. POS. control.

Any two cm portion of pattern may be selected to be viewed magnified five times by adjustment of HORIZ. POS. control.

Figure 2-11

EXTERNAL HORIZONTAL INPUT

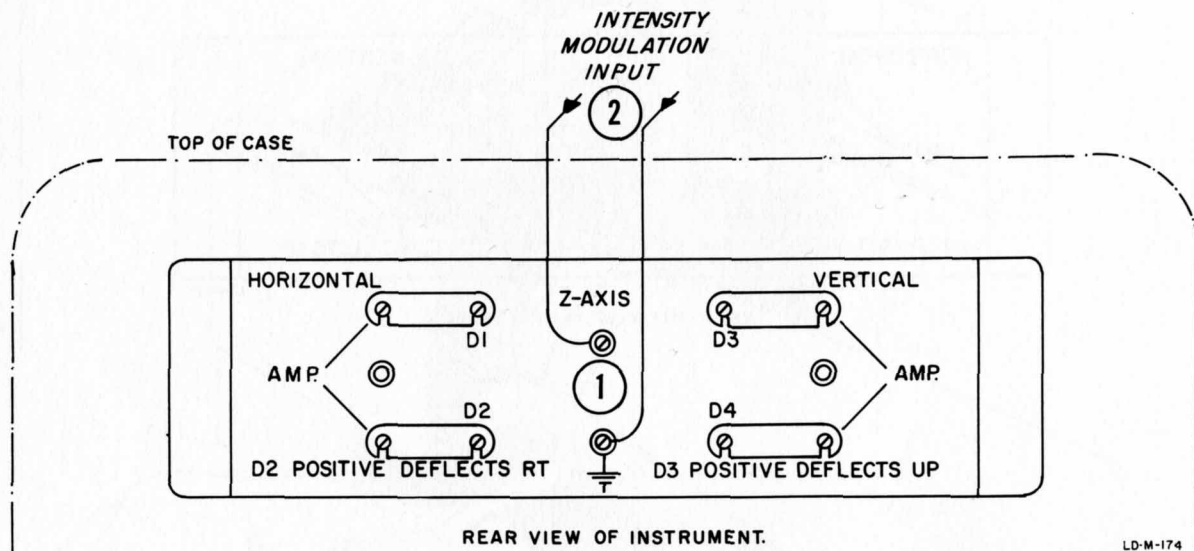
1. Feed horizontal signal to horizontal input terminals.
2. Set AC-DC switch for type of input coupling desired.

3. Set SWEEP TIME - HORIZ. SENS. switch for desired sensitivity.

This type of input will be found useful for viewing Lissajous patterns, etc.

Figure 2-12

INTENSITY MODULATION OPERATION



CAUTION - The deflection plates of the oscilloscope operate at a dc potential above ground. TURN THE INSTRUMENT OFF BEFORE REMOVING THE COVER PLATE FROM THE DEFLECTION PLATE TERMINALS, TO AVOID COMING IN CONTACT WITH HIGH VOLTAGES.

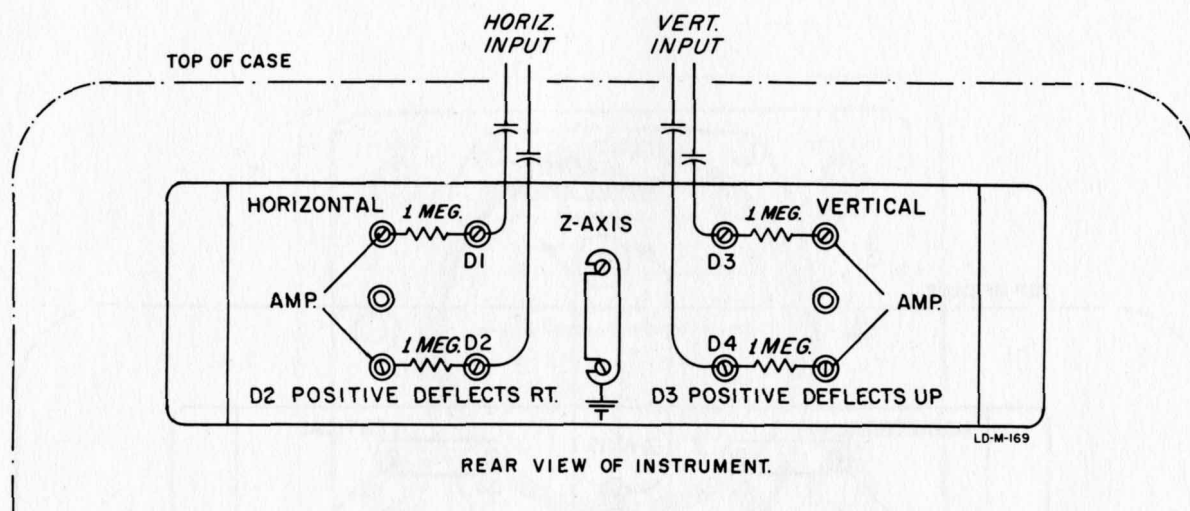
To intensity modulate with an external signal:

1. Remove the vertical jumper marked Z-axis.

2. Connect the external intensity modulation signal to these terminals (a negative signal will brighten the trace).

Figure 2-13

CONNECTION TO DEFLECTION PLATES



CAUTION - Deflection plates of cathode-ray tube operate at high dc potentials. **TURN 122A OFF BEFORE REMOVING COVER PLATE FROM DEFLECTION PLATE TERMINALS.**

To connect an external signal to the deflection plates:

A. AC COUPLED

1. Remove the jumpers going to terminals D1 and D2 for horizontal input and/or D3 and D4 for vertical input.
2. Connect 1 megohm 1/2 watt resistors in place of the jumpers removed in step 1.
3. Connect the vertical input blocking capacitors to terminals D3 and D4 and the horizontal input blocking capacitors to D1 and D2.

The POSITION controls on the 122A will still control the pattern and good focus will be maintained.

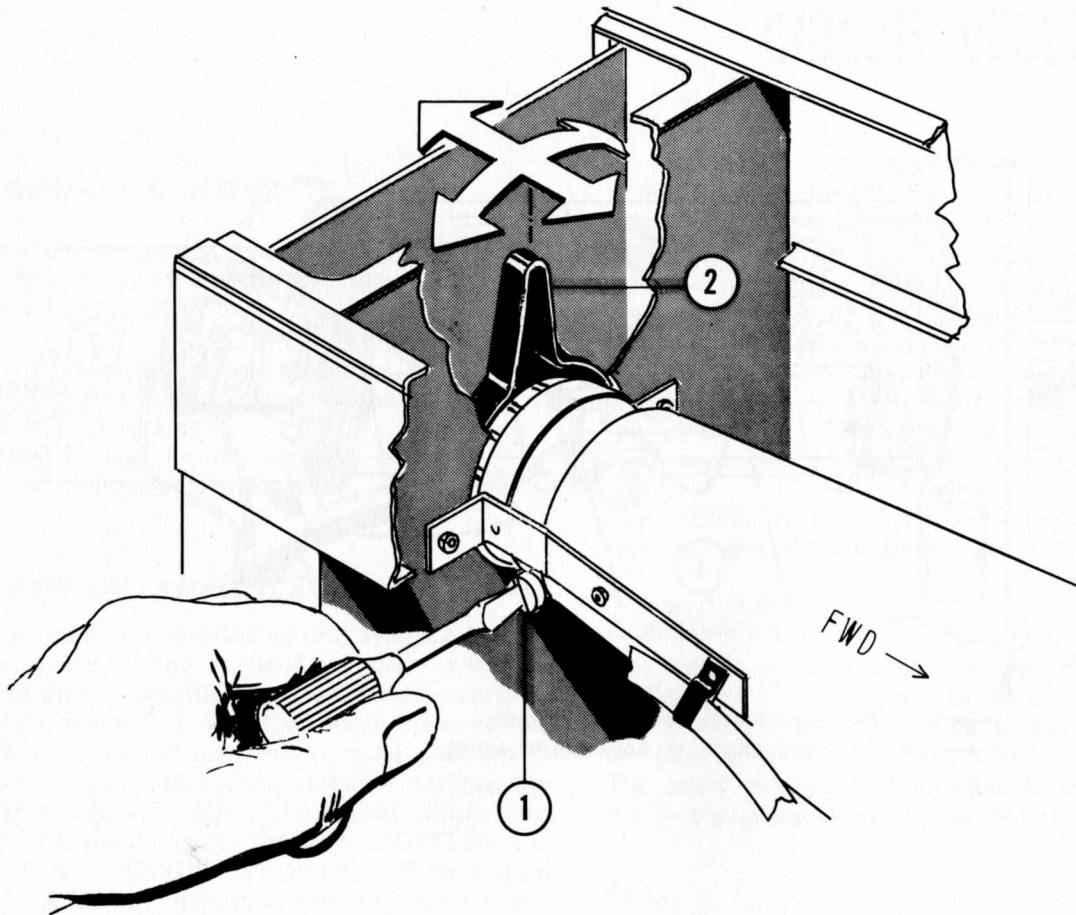
B. DIRECT COUPLED

1. Remove the jumpers going to terminals D1 and D2 for horizontal input and/or D3 and D4 for vertical input.
2. Connect leads from the vertical input directly to D3 and D4 and the lead from the horizontal input directly to D1 and D2.

POSITION controls will no longer control pattern. Position voltages must be furnished by the signal source. Best picture focus is obtained when plates are at +275V with respect to 122A chassis.

Figure 2-14

ALIGNING SCOPE TRACE WITH GRATICULE



To align oscilloscope trace with graticule, remove oscilloscope from cabinet; then

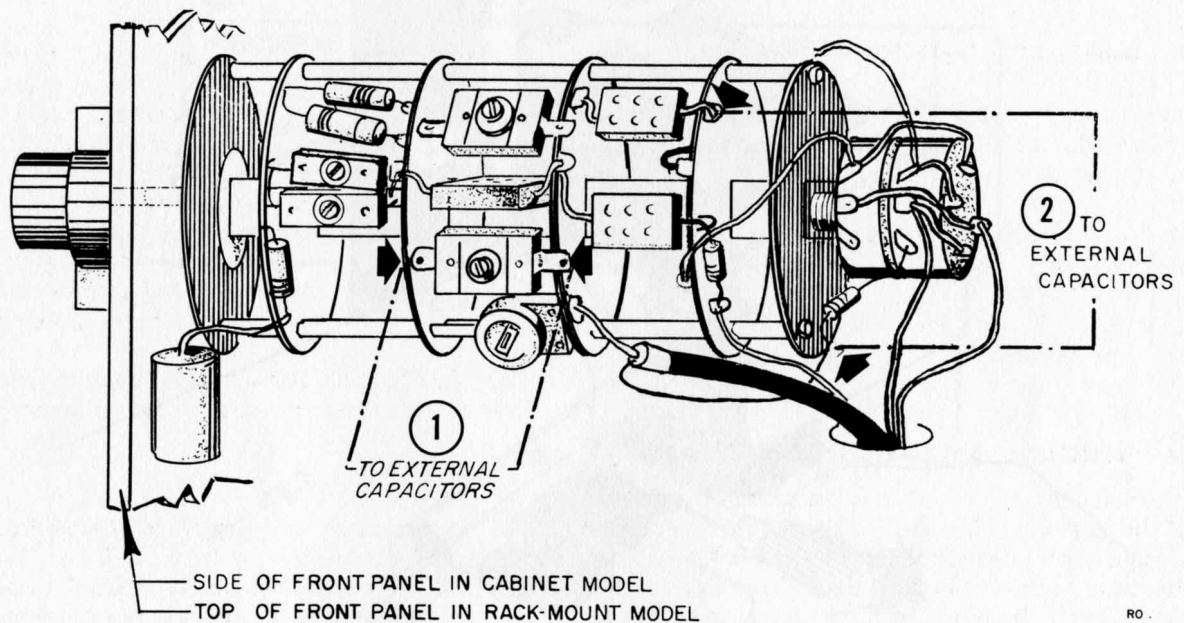
1. Loosen locking clamp with screwdriver.
2. Adjust fiber lever to adjust position of cathode-ray tube in both radial and longitudinal direc-

tions. **CAUTION HIGH VOLTAGE. TAKE CARE NOT TO TOUCH TERMINALS WHICH HAVE A HIGH POTENTIAL ON THEM.**

When the cathode-ray tube is in desired position tighten locking clamp and replace instrument in cabinet.

Figure 2-15

CONNECTING EXTERNAL CAPACITORS TO EXTEND SWEEP TIME



The slowest calibrated sweep provided on the instrument is 1/5 second/cm. This can be extended with the SWEEP TIME VERNIER to at least 1/2 second/cm or 5 seconds for the full 10 cm sweep. If you wish a slower sweep the range can be extended indefinitely by connecting a pair of external capacitors to the sweep circuits.

To extend the sweep time, remove chassis from cabinet.

1. Connect external capacitor across capacitor shown on SWEEP TIME/CM switch.
2. Connect external capacitor from point shown to ground.

Values of both capacitors are the same and will be determined by the sweep speed desired. Note that the only ranges that these capacitors will affect are the 50, 100 and 200 MICROSECONDS/CM ranges. The extension of the sweep time is in proportion to the amount of capacity added to the circuit. Using 2 μ fd capacitors will increase the calibration of the above ranges to approximately .5, 1, and 2 seconds/cm respectively.

The capacitor mentioned in step 1 of this figure must be a high-quality type such as mylar. No loss of sweep linearity occurs if a capacitor with these specifications is used. The second capacitor is connected to the hold-off circuits and does not require special characteristics.

Figure 2-16

SECTION III

CIRCUIT DESCRIPTION

3-1 GENERAL CONTENT

This section contains a description of the operation of the Model 122A Oscilloscope. The material in this section is as follows:

- 3-2 Vertical Amplification Channels
- 3-3 Horizontal Amplification Channel
- 3-4 Sweep Generator
- 3-5 High Voltage Power Supply
- 3-6 Low Voltage Power Supply

3-2 VERTICAL AMPLIFICATION CHANNELS

Both channels are similar so only one description will be given. The vertical amplifier receives the input signal, amplifies it, and drives the vertical deflection plates. It provides attenuation of the input signal, determines the vertical position of the spot on the screen, and supplies a signal for internal synchronization. The signal comes into the input terminals and is fed to the AC-DC section of the VERT. SENSITIVITY switch. If the switch is on an AC range the signal goes through a capacitor. If the switch is on a DC range the signal goes directly to the attenuator. The attenuator has three frequency-compensated attenuators, a straight-through range, an OFF range where the input grid is shorted, and a CAL. range. In the CAL. position the calibrator output is connected to the vertical amplifier input and plate voltage is connected to the calibrator. The calibrator is a neon-lamp relaxation oscillator.

Vertical Amplifiers

The vertical amplifiers consist of two identical channels of amplification, a switching amplifier, a switching multivibrator, and a trigger amplifier.

Each vertical amplifier is composed of three dc-coupled differential amplifiers in cascade. The input amplifier in each channel has the BAL. control between its cathodes. The VERT. SENSITIVITY

VERNIER and the GAIN control are between the plates of the input amplifier. The second amplifier and output amplifier in each channel have plate-to-grid neutralization. The VERTICAL POSITION control is between the cathodes of the second amplifiers. The output amplifiers are controlled by the switching amplifiers since the cathode current for the output amplifiers is furnished by the switching amplifiers. The switching amplifiers in turn are controlled by the switching multivibrator.

The VERT. PRESENTATION switch selects the type of vertical amplifier operation as follows:

A or B

The locked state is used when the VERT. PRESENTATION switch is set to A, B or B-A. Note that the multivibrator can be locked in either of two possible states (Channel A on or Channel B on). The other channel in each case is biased off. In the B-A position Channel B is locked on.

ALT.

The bi-stable state is used when the VERT. PRESENTATION switch is set to ALT. Bi-stable means stable in either of two positions. For example, when operating in the ALT. position, Channel A is off and Channel B is on until a trigger pulse is received from the sweep. Then Channel A is turned on and Channel B is turned off. This action is repetitive and occurs at the end of each sweep.

CHOP

In the CHOP. position the multivibrator is astable. The circuit is a free-running multivibrator running at an approximately 40 kc rate. Thus, in the CHOP. position, the trace is switched back and forth between the two channels at a 40 kc rate.

B-A

In the B-A position the signal from Channel B input is fed directly into the channel B amplifier. The

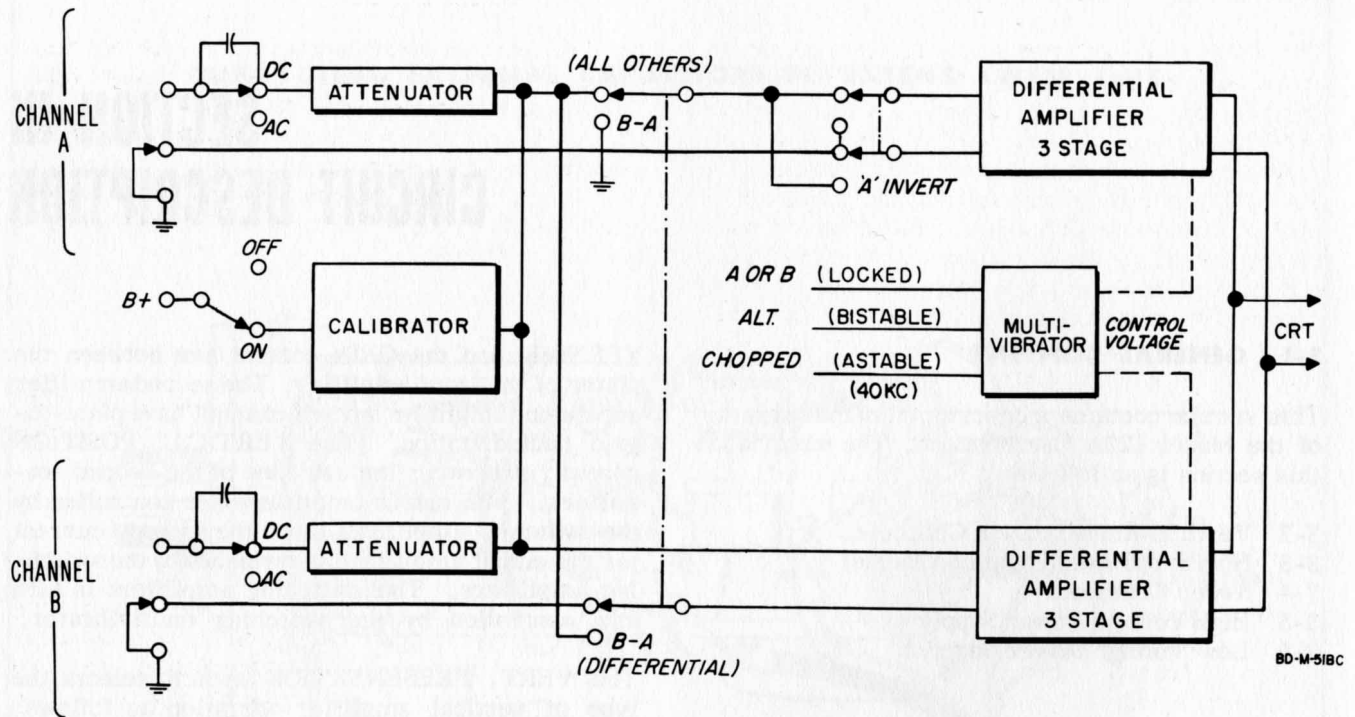


Figure 3-1. Model 122A Block Diagram

signal from Channel A input is fed into the opposite side of the Channel B differential amplifier. The output of the Channel B amplifier is then the difference between the Channel B and Channel A signal. This is the only signal shown on the screen.

3-3 HORIZONTAL AMPLIFICATION CHANNELS

The horizontal amplifier receives an input signal either from the horizontal input terminals or from the internal sweep generator, amplifies the signal, and drives the horizontal deflection plates. The horizontal amplification channel also provides attenuation of the input signal, magnification of the internal sweep, and determines the horizontal position of the trace on the screen.

The signal comes into the input terminals and is fed to the AC-DC switch. If this switch is in the AC position the signal goes through a capacitor. If this switch is in the DC position the signal goes straight through. The horizontal input signal then goes through the horizontal sensitivity section of the SWEEP TIME - HORIZ. SENS. switch. This

switch has a three-position frequency compensated attenuator.

A signal is fed into the horizontal amplifier. This signal may be either the horizontal input signal or a sawtooth signal from the sweep generator. The position of the SWEEP TIME-HORIZ. SENS. switch will determine which signal is fed into the amplifier. The amplifier consists of two differential amplifiers in cascade. Plate-to-grid neutralization is used in both stages. The input differential amplifier, V101A, is driven single-ended. The grid of the undriven tube, V101B, goes to the HORIZ. POS. potentiometer. Two potentiometers, HORIZ. SENS. VERNIER and Horiz. Gain, in the cathode circuit of V101 provide gain adjustment. These potentiometers are in the circuit only when the SWEEP TIME - HORIZ. SENS. switch is in the HORIZ. SENS. ranges. In the SWEEP TIME ranges the SWEEP EXPAND switch is used. Either the X1 or the X5 resistor legs may be switched between the cathodes of V101. A Horiz. Bal. potentiometer and a Phase. Adj. condenser are connected between the plates of V101. Tube V101 feeds another differential amplifier, V102. The output of V102 goes to the horizontal deflection plates.

3-4 SWEEP GENERATOR

The sweep generator consists of a trigger generator and a sawtooth generator. The trigger generator receives the synchronizing signal, selected by the SYNC selector, and generates a pulse which initiates the action of the sawtooth generator. The sawtooth generator then goes through one complete cycle. It automatically shuts itself off by means of feedback upon completion of one cycle. The sweep circuit will operate again when another pulse is received from the trigger generator, but only after a hold-off time during which all of the circuits have had time to return to their quiescent voltages. This delay is necessary so that successive waveforms will start from the same voltage each time.

Trigger Generator

The trigger generator consists of a synchronizing circuit and a trigger generator, V201. The synchronizing circuit receives a signal either from the vertical amplifier for internal synchronization (+ or -), from an internal 6.3 volt source for line frequency synchronization, or from the horizontal input terminals for external synchronization. The trigger generator converts the signal into a fast, constant-amplitude pulse for operation of the start-stop trigger, V202.

The trigger generator, V201, is a Schmitt Trigger with narrow hysteresis limits. A negative signal starts the action by causing the trigger generator to change state. This action generates a square wave output. This square wave output is differentiated by L201 into a series of positive and negative pulses. These pulses are fed to the start-stop trigger.

Sawtooth Generator

The sawtooth generator consists of a start-stop trigger, an integrator switch, an integrator, and a hold-off cathode follower. The pulse from the trigger generator controls the start-stop trigger which, in turn, controls the integrator switch. The integrator switch controls the action of the integrator. The integrator generates a linear, rising, voltage. This action plus the switching action of the integrator switch generates a sawtooth voltage. This sawtooth voltage is fed to the horizontal amplifier and to the hold-off cathode follower. The output of the hold-off cathode follower is fed to the grid of the start-stop trigger. This voltage keeps the start-stop trigger from triggering until all the circuits have had time to recover to their original quiescent voltage.

Gate Cathode-Follower

Another function of the sweep generator is to furnish a positive pulse to unblank the cathode-ray tube. This pulse is obtained from the start-stop trigger. Normally the voltage applied to the grid of the cathode-ray tube cuts off the beam. During the time of the sweep operation a positive pulse is applied which overrides the negative voltage and unblanks the picture.

3-5 HIGH VOLTAGE POWER SUPPLY

The High Voltage Power Supply consists of a Hartley Oscillator feeding two separate secondary windings and rectifiers.

Hartley Oscillator

The Hartley Oscillator consists of a pentode, V302, and a tapped winding on the high-voltage transformer. This circuit oscillates at approximately 100 kc. The high-voltage transformer has two separate secondaries and feeds two separate rectifier tubes. Output of one rectifier, V304, is connected to the grid of the cathode-ray tube. The INTENSITY control in the output divider of this supply determines the voltage on the CRT control grid and thus the brilliance of the pattern. The unblanking pulse is also direct-coupled to this supply and hence to the grid of the cathode-ray tube. Output from the other rectifier is connected to the cathode of the cathode-ray tube. Voltage is taken from this supply and fed into the input of a two stage dc-coupled amplifier. The output of this amplifier is fed back to the screen of the Hartley Oscillator in the proper phase to oppose any change in the dc output of the cathode supply.

The Intensity-Modulation terminals are ac coupled to the cathode of the cathode-ray tube. A negative voltage input will brighten the trace while a positive voltage of approximately twenty volts will blank the tube from normal intensity.

3-6 LOW VOLTAGE POWER SUPPLY

The Low Voltage Power Supply consists of three regulated supplies, one positive and one negative and a dc filament supply.

Positive Voltage Supply

The Positive Voltage supply furnishes + 380 volts and +100 volts. It consists of a transformer, four

silicon rectifiers, a pentode amplifier and a triode regulator in the usual regulated power supply configuration, and a triode cathode-follower. Full output of the supply is +380 volts. The output cathode-follower drops this down to furnish +100 volts. Neon tube, V315, protects V307B from excessive cathode-to-grid voltage during warm-up.

Negative Voltage Supply

The Negative Voltage Supply furnishes -150 volts and -30 volts. It consists of a transformer, two silicon rectifiers, and a regulator-amplifier-reference tube combination in the usual regulated power supply configuration. The -30 volt output is

used as a filament reference voltage and fed to the center tap of the Hum Balance potentiometer.

Regulated Filament Supply

This supply furnishes regulated +24 volts to the heaters of the four input tubes of the vertical amplifier. These tubes, V1, 2, and V4, 5 are connected in series-parallel. By supplying this filament voltage from a regulated source vertical trace drift is greatly reduced.

The supply consists of a transformer, a silicon rectifier, and two pnp transistors. Transistor Q301 is the series element. Transistor Q302 is an emitter follower controlling Q301. Reference voltage is obtained from the -150 volt supply.

SECTION IV MAINTENANCE

4-1 INTRODUCTION

This section contains instructions for testing, adjusting, and trouble-shooting the Model 122A Oscilloscope.

The Front Panel Operational Check, paragraph 4-2, is a fast method of checking the operation of the instrument. The Trouble-Shooting Procedure, paragraph 4-5, is a rapid means of isolating a section of the instrument that is not functioning. The Condensed Test and Adjustment Procedure, paragraph 4-6, is a fast method of checking the basic adjustments of the instrument. The Complete Test Procedure, paragraph 4-7, is an expansion of the condensed test and adjustment procedure.

Paragraphs 4-3 and 4-4 contain information on removing the cabinet and replacing tubes.

Schematic Diagrams and the Table of Replaceable Parts are located at the end of this section.

Standard, readily available components are used for manufacture of hp instruments whenever possible. Special components are available directly from the hp factory. Perhaps the most convenient source for spare or replacement parts is your local hp representative who maintains a parts stock for your convenience. When ordering parts, please specify instrument model and serial number plus the component description and stock number appearing in the Table of Replaceable Parts.

Your local hp representative also maintains complete facilities and specially trained personnel to assist you with any engineering, application, test, or repair problems you may have with hp instruments.

SPECIFICATIONS FOR THE hp 122A OSCILLOSCOPE ARE GIVEN IN THE FRONT OF THIS MANUAL. THE SERVICE PROCEDURES THAT FOLLOW CONTAIN EXTRA DATA TO HELP YOU

ANALYZE A PARTICULAR INSTRUMENT. THIS EXTRA DATA CANNOT BE CONSIDERED AS SPECIFICATIONS.

In general, the Model 122A can be divided into sections with the parts for any particular section located behind the front panel controls for that section. The power supplies are in the rear and on the top chassis brace. The material that follows is divided into sections according to circuit functions. Each section has a complete set of adjustment instructions.

The following test equipment is used for testing and adjusting the Model 122A Oscilloscope during manufacture. Equivalent test equipment may be used for testing purposes.

- 1) "Reference Oscillator" with frequency range of 400 cps to 500 kilocycles, and adjustable output 5 millivolts to 20 volts, such as hp Model 200CD Wide Range Oscillator.
- 2) "Reference VTVM" with 1% accuracy, 400 cps to 500 kilocycles frequency range, and 50 millivolts to 60 volts voltage range, such as the hp Model 400H Vacuum Tube Voltmeter.
- 3) "Marker Generator" with frequency range of 200 kilocycles to 1 cycle per second in decade steps and an accuracy of $\pm 0.3\%$, such as the Tektronix 180 Time Mark Generator.
- 4) "Calibration Generator" furnishing 100 v dc and 100 v ac at 400 or 1000 cps, all voltages with an accuracy of $\pm 0.25\%$. In addition the "Calibration Generator" must have an attenuator which will reduce the voltage to 20 millivolts in a 1-2-5 times attenuation with an accuracy of $\pm 0.25\%$. The hp Specification 23678 Voltmeter Calibration Generator will meet these specifications.
- 5) "Adjustable Attenuator" having adjustable db steps from 1 to 110 db. Use an hp Model 350A Attenuator or equivalent.

6) "Square Wave Generator" capable of furnishing square waves or pulses, audio frequencies, such as the Φ Models 211A and 212A.

4-2 FRONT PANEL OPERATIONAL CHECK

Perform the following procedure whenever there is any question about the proper functioning of the instrument. This will enable you to determine if the malfunction is in this instrument or associated equipment. Always perform this Operation Check before attempting instrument adjustment or repair.

For a Proof-of-Performance Check complete the steps as given and compare the results with the specifications. All tests are made with the instrument in the cabinet and the instrument warmed up for at least fifteen minutes.

A. ADJUST DC BALANCE AND VERTICAL CALIBRATION

1) Check the vertical dc balance as shown in Figure 2-9.

2) Check the vertical sensitivity calibration as shown in Figure 2-10. If these controls do not function properly, refer to VERTICAL AMPLIFIER section of the maintenance procedure before proceeding further.

B. VERTICAL AMPLIFIER SENSITIVITY

1) Set VERTICAL PRESENTATION to A
A VERT. SENSITIVITY to .01 VOLTS/CM (DC)
A VERT. SENSITIVITY VERNIER to CAL.
TRIGGER LEVEL maximum counterclockwise but not in AUTO.

2) Connect a 0.1 volt ac signal from the "Calibration Generator" to input terminal A. The vertical trace should be 10 cm $\pm 5\%$ (9.5 - 10.5 cm). If not, refer to VERTICAL AMPLIFIER section of maintenance procedure.

3) Check dc response by switching a 0.1 volt dc voltage from the "calibration generator" off and on. As the voltage is switched off and on the CRT spot should shift 10 cm $\pm 5\%$ (9.5 - 10.5 cm). Adjust VERTICAL POSITION as necessary.

4) Check the accuracy of the remaining VOLTS/CM positions. Table 4-1 lists the selector positions and gives peak-to-peak and rms voltages which should produce the deflection listed.

5) Repeat steps 3 and 4 using the A VERT. SENSITIVITY AC ranges.

6) Repeat above procedure for channel B.

C. VERTICAL AMPLIFIER BANDWIDTH

1) Set VERTICAL PRESENTATION to A
A VERT. SENSITIVITY to .01 VOLTS/CM
TRIGGER LEVEL to AUTO.

2) Connect the "reference oscillator" to input terminal A, and monitor the input voltage with the "reference vtvm".

3) Set "reference oscillator" to 2 kilocycles and adjust for 10 cm of deflection. Note reading on "reference vtvm".

4) Set "reference oscillator" to 200 kilocycles. Set output to previous reading on "reference vtvm". The deflection should be at least 7.07 cm (3 db down point). If not, refer to VERTICAL AMPLIFIER section of maintenance procedure.

TABLE 4-1. VERTICAL DEFLECTION SENSITIVITY

Sensitivity Volts/cm	Deflection cm $\pm 5\%$	Voltage Required	
		Peak/Peak	rms
.01	5	0.05	0.01767
.1	5	0.5	0.1767
1	5	5.0	1.767
10	5	50.0	17.67

5) Repeat above procedure for channel B.

D. VERTICAL AMPLIFIER COMMON - SIGNAL REJECTION

1) Set A VERT. SENSITIVITY to .01 VOLTS/CM
A VERT. SENSITIVITY VERNIER to CAL.
SWEEP TIME to 0.5 MILLISECONDS/CM
VERT. PRESENTATION to A
TRIGGER LEVEL to AUTO.
SYNC to INT

2) Connect the "reference oscillator" to the channel A input terminal through an "adjustable attenuator" terminated with 600 ohms.

3) With "reference oscillator" set to 1 kc and maximum output, switch in attenuation until 1 cm of deflection is displayed.

4) Change input so that the same signal is fed into both red input terminals. Remove ground strap and connect ground side of "reference oscillator" to black terminal.

5) Switch "adjustable attenuator" until a deflection of 1 cm is again obtained. The external attenuation change is the common-signal rejection and should be at least 40 db.

6) Repeat above procedure for channel B.

E. VERTICAL AMPLIFIER COMMON-SIGNAL REJECTION (B-A)

1) A VERT. SENSITIVITY to 10 VOLTS/CM
B VERT. SENSITIVITY to 10 VOLTS/CM
B VERT. SENSITIVITY VERNIER to CAL.
SWEEP TIME to 0.5 MILLISECONDS/CM
VERT. PRESENTATION to B

2) Connect the "reference oscillator" to both the channel A and channel B input terminals.

3) Set "reference oscillator" to 2 kc and adjust output for 5 cm of deflection.

4) Switch VERT. PRESENTATION to B-A. Deflection should be less than 0.1 cm.

5) Set A & B VERT. SENSITIVITY to 1 V. Deflection should be less than 1.0 cm.

6) Switch A VERT. SENSITIVITY and B VERT. SENSITIVITY to 0.1 VOLTS/CM. There should be less than 10 cm of deflection.

7) Switch VERT. PRESENTATION to B.

8) Set the "reference oscillator" to 200 kc, and adjust for 5 cm of deflection.

9) Repeat steps 4, 5 and 6. Limits are the same as before.

If the instrument fails to meet any of these limits consult the appropriate part of the VERTICAL AMPLIFIER section of the maintenance procedure.

F. DUAL TRACE PRESENTATION

1) Set TRIGGER LEVEL to AUTO.
SYNC to INT
VERT. PRESENTATION to CHOP
SWEEP TIME to 50 MILLISECONDS/CM
A VERT. SENSITIVITY to OFF
B VERT. SENSITIVITY to OFF

2) Adjust remaining oscilloscope controls to display the chopped trace.

3) The A VERT. POS control should move one chopped trace and B VERT. POS control should move the other.

4) Set VERT. PRESENTATION to ALT. The channel A and channel B traces should be displayed alternately.

G. HORIZONTAL AMPLIFIER SENSITIVITY

1) Set HORIZ SENS to .1 VOLTS/CM
HORIZ SENS VERNIER to CAL
VERT PRESENTATION to A
DC-AC (horizontal input coupling) to DC

2) Connect the "calibration generator", set for 1.0 volts 400~PTP to the horizontal input terminals. Adjust the position controls to center the horizontal trace. The trace should be 10 ±5% long (9.5 - 10.5 cm). If not, refer to the HORIZONTAL AMPLIFIER section of the maintenance procedure.

3) Check the dc response by switching a 0.1 volt dc voltage from the "calibration generator" off and on. As the voltage is switched off and on, the CRT "spot" should shift 10 cm ±5%. Adjust A VERT. POS. as necessary.

4) Check the accuracy of the remaining VOLTS/CM positions as given in the following table:

Sensitivity Volts/cm	Voltage for 10 (5%) cm Deflection	
	Peak/Peak	RMS
.1	1.0	0.3535
1	10.0	3.535
10	100.0	35.35

H. HORIZONTAL AMPLIFIER BANDWIDTH

- 1) Set HORIZ SENS to .1 VOLTS/CM
TRIGGER LEVEL to AUTO
- 2) Connect the "reference oscillator" to the oscilloscope horizontal input terminals. Monitor the sine wave amplitude with the "reference vtm".
- 3) Adjust the remaining oscilloscope controls to display the horizontal trace.
- 4) Set the "reference oscillator" to 2 kilocycles and adjust for 10 cm of deflection. Note reading on "reference vtm".
- 5) Set "reference oscillator" to 200 kilocycles. Set output to previous reading on "reference vtm". The deflection should now be at least 7.07 cm (3 db down point). If not, refer to the HORIZONTAL AMPLIFIER section of the maintenance procedure.

I. SWEEP GENERATOR TRIGGERING

- 1) Set SYNC to INT
TRIGGER LEVEL to AUTO
A VERT SENSITIVITY to 0.1 VOLTS/CM
A VERT SENSITIVITY VERNIER to CAL
VERT PRESENTATION to A
- 2) Connect the "reference oscillator", set for approximately 0.5 v rms, 400 cps, to the oscilloscope vertical input.
- 3) Adjust remaining oscilloscope controls to display a few cycles of signal.
- 4) Decrease the input from the "reference oscillator" until the pattern goes out of synchronization. The pattern should be 0.5 cm high or less.
- 5) Connect "reference oscillator" to the external synchronization terminals and the oscilloscope

vertical input. Monitor the sine wave amplitude with the "reference vtm".

- 6) Set SYNC switch to EXT.

7) Decrease the amplitude of the "reference oscillator" until the pattern goes out of synchronization. The reading on the "reference vtm" should be 0.885 volts or less.

If the oscilloscope fails to meet either check, refer to the TRIGGER GENERATOR section of the maintenance procedure.

J. INTERNAL SWEEP TIME

- 1) Set SWEEP TIME to 1 MILLISECONDS/CM
SWEEP TIME VERNIER to CAL
SYNC to INT
TRIGGER LEVEL to AUTO
SWEEP EXPAND to X1
- 2) Connect the output of the "marker generator" to the oscilloscope vertical input. Set "marker generator" for 1/1,000 sec of a 1 millisecond period. Adjust remaining oscilloscope controls to display the signal with a vertically centered peak-to-peak deflection of 4 to 6 centimeters. This signal should produce 10 cycles in $10 \pm 5\%$ (9.5 - 10.5) cm of horizontal deflection.
- 3) Each step of the SWEEP TIME/CM selector is checked using the method outlined in the previous step. Table 4-2 provides complete information on selector position, frequency or period of the timing signal and cycles of the signal produced in 9.5-10.5 cm of horizontal deflection. If your oscilloscope does not meet these checks, refer to the TRIGGER GENERATOR section of the maintenance procedure.

K. EXPANDED SWEEP CALIBRATION

- 1) Set SWEEP TIME to 1 MILLISECONDS/CM
SWEEP TIME VERNIER to CAL.
SYNC. to INT.
TRIGGER LEVEL to AUTO.
SWEEP EXPAND to X1
- 2) Connect the output of the "marker generator" to the oscilloscope vertical input. Set "marker generator" for 1,000/sec. or a 1 millisecond period. Adjust remaining oscilloscope controls to display the signal with a vertically centered peak-to-peak deflection of 4 to 6 centimeter. This signal should produce 10 cycles in $10 (\pm 5\%)$ centimeters of horizontal deflection.

TABLE 4-2. SWEEP TIME ACCURACY

SWEEP TIME/CM Position	Timing Signal		Cycles Produced in 9.5 to 10.5 cm
	Frequency	Period	
*200 MILLISECONDS	1 cycle	1 second	2
100 MILLISECONDS	10 cycles	100 milliseconds	10
50 MILLISECONDS	10 cycles	100 milliseconds	5
20 MILLISECONDS	10 cycles	100 milliseconds	2
10 MILLISECONDS	100 cycles	10 milliseconds	10
5 MILLISECONDS	100 cycles	10 milliseconds	5
2 MILLISECONDS	100 cycles	10 milliseconds	2
1. MILLISECONDS	1,000 cycles	1 millisecond	10
.5 MILLISECONDS	1,000 cycles	1 millisecond	5
200 MICROSECONDS	1,000 cycles	1 millisecond	2
100 MICROSECONDS	10 kilocycles	100 microseconds	10
50 MICROSECONDS	10 kilocycles	100 microseconds	5
20 MICROSECONDS	10 kilocycles	100 microseconds	2
10 MICROSECONDS	100 kilocycles	10 microseconds	10
5 MICROSECONDS	100 kilocycles	10 microseconds	5

* Use DC input coupling to avoid degrading input signal.

3) Set SWEEP EXPAND switch to X5. Two complete cycles should now appear in 10 ($\pm 5\%$) centimeters of horizontal deflection.

adequate safety precautions, especially when working around the cathode-ray tube terminals and the power supplies.

4-3 REMOVING THE CABINET

Disconnect power cord and remove two large screws on the rear of cabinet. Do not remove any front panel screws. Slide oscilloscope forward out of cabinet.

CAUTION

If the instrument is operated with the cabinet removed, dangerous voltages are exposed. Take

4-4 TUBE REPLACEMENT

In many cases instrument malfunction can be corrected by replacing a weak or defective tube. Before changing the setting of any internal adjustment, check the tubes. Adjustments that are made in an attempt to compensate for a defective tube will often complicate the repair problem.

It is good practice to check tubes by substitution rather than by use of a "tube checker". The

results obtained from the "tube checker" can be misleading. Before removing a tube, mark it so that if the tube is good it can be returned to the same socket. Replace only tubes proved to be weak or defective.

Any tube with corresponding standard EIA (JEDEC) characteristics can be used as a replacement. The following table lists the tests and adjustments which should be performed after the tubes are replaced.

TABLE 4-3. TUBE & TRANSISTOR REPLACEMENT CHART

CIRCUIT REFERENCE	TUBE OR TRANSISTOR TYPE AND FUNCTION	TESTS AND/OR ADJUSTMENTS
Q301	CTP1113 Regulator	Check + 24 volt power supply output.
Q302	2N383 Amplifier	Same as Q301.
V1	12AU7 Vert. Input Amp.	Check Vertical Balance and Gain.
V2	12AU7 Vert. Amp.	Same as V1.
V3	6DJ8/ECC88 Output Amp.	Check Vertical Gain and Balance.
V4	12AU7 Vert. Input Amp.	Same as V1.
V5	12AU7 Vert. Amp.	Same as V1.
V6	6DJ8/ECC88 Output Amp.	Same as V3.
V7	6DJ8/ECC88 Switching Amp.	None.
V8	12AU7 Switching Multivibrator	None.
V9	6AU6 Switching Amplifier	None.
V101	6DJ8/ECC88 Horiz. Amp.	Entire Horiz. Amp. test procedure except Attenuator Compensation.
V102	12AT7 Output Amplifier	Same as V101.
V201	6AN8 Trigger Generator	Check Trigger Generator.
V202	6U8 Start-Stop Trigger	Check Sweep Stability Control Adj.
V203	12AU7 Gate and Hold-off Cathode-Follower.	None.
V204	12AU7 Integrator Switch	Hum Balance.
V205	6U8 Sawtooth Integrator	None.
V301	12AU7 Amplifier	Check H. V. Power Supply Output.
V302	6AQ5 Oscillator	Same as V301.
V303 & V304	5642 H. V. Rectifier	Same as V301.
V305	5AQP- Cathode-Ray Tube	See adjustments under TURN ON and check Vert. and Horiz. Gain.
V306	12B4A Regulator	Check +380 volt power supply output.
V307	6U8 Amp.- Output Cathode-Follower	Check +380 and +100 v output voltages.
V308	12B4A Regulator	Check -150 volt output voltage.
V309	6AU6 Amplifier	Same as V308.
V310	5651 Reference	Same as V308.

4-5 TROUBLE-SHOOTING PROCEDURE

The Model 122A Oscilloscope is composed of several basic sections or circuits. Repair and test time can be minimized by following a procedure that will isolate the section needing repair. It is important to isolate the problem before changing any internal adjustments. In the majority of cases, only a tube change will be required.

A. CHECK AC POWER CIRCUIT

All ac power circuits are normal if any tube filaments will light with the instrument turned on and connected to a suitable power source.

If the tubes will not light:

- 1) Check the power line fuse mounted on the rear of the chassis. The cause of a blown line fuse can usually be found in the low voltage power supply. Check silicon rectifiers, filter capacitors, etc.

B. CHECK DC LOW VOLTAGE CIRCUITS

Check dc voltages as described under paragraph 4-9 POWER SUPPLIES. If you replace any tubes refer to Table 4-3 TUBE REPLACEMENT CHART and Table 4-4 CONDENSED TEST AND ADJUSTMENT PROCEDURE.

C. CHECK HIGH VOLTAGE CIRCUITS

If you are able to get a small, round, and sharply focused spot with good brilliance by adjusting the controls, the high voltage power supply can be assumed to be working.

If a spot or trace is not present, short circuit the horizontal deflection plates of the CRT with an insulated clip lead. **DANGER HIGH VOLTAGE! TURN INSTRUMENT OFF BEFORE MAKING THIS CONNECTION.** Terminals for these plates will be found in the rear access hatch. With a second clip lead short circuit the vertical deflection plates.

This should produce a spot near the center of the CRT screen at some setting of the INTENSITY control. If not, check the voltage on the cathode-ray tube cathode.

The voltage on the cathode and grid of the CRT can be most easily measured at the rectifier tubes on the high voltage transformer assembly on the top brace of the instrument (shield will have to be removed on the cabinet model only). Use a vacuum tube voltmeter with a high voltage probe, such as the Model 410B VTVM with Model 459A Voltage Multiplier Probe, for this measurement. Measure this voltage on the rectifier terminal with the orange wire. This voltage should be approximately -2250 volts. If the voltage is of this value, both the Hartley Oscillator and the secondary connected to the cathode of the CRT can be assumed to be functioning properly.

Measure the CRT grid voltage by measuring the voltage on the green wire going to the other rectifier. This voltage should be -2260 to -2325 volts. If this voltage is within these limits, both the Hartley Oscillator and the secondary connected to the grid are functioning properly.

If either of the above voltages are correct the Hartley Oscillator may be assumed to be functioning properly. If neither voltage is present, look for the trouble in the Hartley Oscillator. If only one voltage is correct, both the Hartley Oscillator and that secondary are functioning properly. Look for trouble in the secondary supply with the incorrect voltage.

If you replace any tubes refer to Table 4-3 TUBE REPLACEMENT CHART and Table 4-4 CONDENSED TEST AND ADJUSTMENT PROCEDURE.

D. CHECK HORIZONTAL AND VERTICAL AMPLIFIERS

The Horizontal and Vertical Amplifiers are functioning properly when a spot on the face of the CRT can be moved easily and smoothly by the horizontal and vertical position controls.

If a spot is not visible on the screen:

- 1) Short the horizontal deflection plates together with an insulated clip lead. **DANGER HIGH VOLTAGE! TURN THE INSTRUMENT OFF BEFORE MAKING THIS CONNECTION.** Terminals for these plates are accessible through the rear access

hatch. If the "short" produces a spot that can be moved by VERT POS control and deflected by a vertical input, the vertical amplifier is functioning properly.

2) Short the vertical deflection plates together. If this produces a spot that can be moved by HORIZ POS control and deflected by a horizontal input, the horizontal amplifier is functioning properly.

The amplifiers in the instrument are direct coupled and balanced, and corresponding voltages in each side of the circuit must remain balanced to keep the spot on the screen. The settings of gain, balance and position controls can introduce unbalanced voltages and should be considered when checking an amplifier.

To check an inoperative amplifier, short circuit corresponding points in each stage, starting at the CRT, until a point is reached where the spot does not return to the screen. For example, in the Horizontal Amplifier, if the spot is on the screen when the deflection plates are connected together, remove the jumper from between the deflection plates and connect it between the plate (pin 6) of V102B and the plate (pin 1 of V102A). Work toward the input, shorting grid-to-grid, and plate-to-plate until a point is reached where the spot does not appear. The trouble will be between the last point where the spot appeared and the point where the spot no longer appears.

E. CHECK SWEEP GENERATORS

- 1) Set A VERT SENSITIVITY to OFF
 B VERT SENSITIVITY to OFF
 VERT. PRESENTATION to A
 SWEEP EXPAND to X1
 SYNC to INT
 TRIGGER LEVEL to AUTO

2) A repetitive sweep should be obtained in each position of the SWEEP TIME/CM selector. If the generator is inoperative, try the following steps in the order listed.

NOTE

Turn the power off before removing or installing the tubes discussed in this procedure. All voltages are measured between ground and the indicated point with an Φ Model 410B High Impedance Vacuum Tube Voltmeter.

3) Check tubes V201 through V205, one at a time by substitution. Always replace the original tube if proper operation is not restored.

4) Check the setting of Stability Adjustment, R228, by rotating the control through the entire adjustment range.

a. If the generator operates at some setting, complete adjustment step 10, described in Table 4-4.

b. If adjustment does not restore operation, set R228 near the mechanical center of the adjustment range.

5) Check the setting of Trigger Sensitivity R247. Rotate the control through the entire adjustment range.

a. If the generator operates at some setting, complete adjustment step 9, described in Table 4-4.

b. If adjustment does not restore operation, set R247 near the mechanical center of the adjustment range.

4-6 CONDENSED TEST AND ADJUSTMENT PROCEDURE

All the basic test and adjustments are covered

in the following Table 4-4. This procedure is for instruments that are functioning. If the instrument is not operating refer to paragraph 4-5.

TEST	EQUIPMENT REQUIRED	PROCEDURE	ADJUST	NOTES
1. Low Voltage Power Supply	Dc vtvm with 1% accuracy.	Measure all low voltage power supply outputs, should be within the following limits: -150±2 volts +100±3 volts +380±10 volts + 24 ±1 volt	Do not adjust if within limits. Adjust R344 for -150 volts.	Check sweep calibration if -150v (R268) is adjusted.
2. Vertical Amplifier Balance	None	A. VERT. SENSITIVITY to .01, VERNIER fully ccw. B VERT. SENSITIVITY to OFF HORIZ. SENS. to 10 VOLTS/CM	Adjust spot to center of screen with A VERTICAL POSITION control.	Repeat as required. Repeat for channel B.
		Rotate VERNIER fully cw	Center spot with channel A BAL.	
3. Vertical Amplifier Gain	400 cycle Voltage Calibration Generator	A VERT. SENSITIVITY to .01, VERNIER to CAL VERT. PRESENTATION to A Connect 100 mv p-p from Calibration Generator to (A) vertical amplifier.	Adjust channel A Gain (R27) for 10 cm deflection.	
		B VERT. SENSITIVITY to .01, VERNIER to CAL VERT. PRESENTATION to B Connect 100 mv p-p from Calibration Generator to (B) vertical amplifier.	Adjust channel B Gain (R47) for 10 cm deflection.	
4. Calibrator	None	A VERT. SENSITIVITY in CAL B VERT. SENSITIVITY in CAL and both VERNIER's in CAL.	Adjust Calibrator Set (R356) for 6.0 cm deflection.	
5. Horizontal Balance	None	HORIZ SENS to 10 VOLTS/CM, VERNIER to CAL., A VERT. SENSITIVITY to OFF, VERT. PRESENTATION to A.	Center spot with A (outer) VERT. POS. knob.	Repeat as required.
		Turn VERNIER fully ccw.	Center spot with Horiz. Bal. (R110).	
6. Horizontal Amplifier Gain	400 cycle Voltage Calibration Generator	HORIZ SENS to .1 VOLTS/CM, VERNIER to CAL., A VERT. SENS. to OFF, VERT. PRESENTATION to A.	Set Horiz. Gain (R114) for 10 cm horiz. deflection.	
		Connect 1.0 v p-p from Calibration Generator to horizontal input.		
7. Horizontal Amplifier Sweep Gain	Time Marker Generator	SWEEP TIME to 5 MILLISECONDS/CM, SWEEP EXPAND to X1. Apply 5 millisecond markers to vertical input.	Adjust trigger level for stable pattern. Adjust R107 for marker coincidence with 1 cm graticule marks.	
		Change time markers to 1 MILLISECONDS/CM and set SWEEP EXPAND to X5.	Adjust R108 for marker coincidence with 1 cm graticule marks.	
8. Horizontal Amplifier Compensation	Oscilloscope with low capacity probe	SWEEP TIME 10 μsec/cm., SWEEP EXPAND to X1 Connect probe to pin 1 or 6 of V102. Adjust sweep start to center of screen.	Adjust C105 to compensate flyback.	
		SWEEP EXPAND to X5. Adjust Sweep-Start to center of screen.	Adjust C106 to compensate flyback.	
9. Trigger Sensitivity	Oscilloscope with 10:1 probe 50 cps to 250 kc oscillator AC VTVM	SYNC to EXT., TRIGGER LEVEL to AUTO. DC couple a 250 kc sine wave of .5 v rms into the EXT. SYNC. input. Couple probe loosely to body of R204 (a 3.6K resistor pin 6 V201)	Set trigger sensitivity control (R247) just clockwise of the point where stable triggers are obtained.	Check for stable triggers from 50 cps to 250 kc with 0.5 v rms.
10. Sweep Stability	DC VTVM	Disconnect all ext. inputs. Connect VTVM (-100 v scale) to pin 8 of V203, VERT. SENS. to OFF SWEEP TIME to .5 MILLISECONDS/CM, SYNC INT. TRIGGER LEVEL fully ccw but not in AUTO.	Slowly adjust SWEEP STABILITY (R228) until sweep begins. Repeat and note voltage just prior to sweep start. Set R228 for 2.0 volts more positive.	
11. Sweep	250 cps oscillator	SWEEP TIME to .250 MICROSECONDS/CM	Adjust channel A Gain (R27) for 10 cm deflection.	

4-7 COMPLETE ADJUSTMENT PROCEDURE

Usually a particular oscilloscope will not need complete testing and calibration. Only one or two tests will be needed and they can be done without completing the entire test procedure.

The following procedures are listed in a recommended sequence for a complete test and calibration operation. In general, tubes are the main cause of trouble and new ones should be tried before making adjustments or component replacements. See paragraph 4-4.

SPECIFICATIONS FOR THE Φ MODEL 122A OSCILLOSCOPE ARE GIVEN IN THE FRONT OF THIS MANUAL. THE FOLLOWING TEST PROCEDURE CONTAINS EXTRA CHECKS TO HELP YOU ANALYZE A PARTICULAR INSTRUMENT. THESE EXTRA CHECKS AND THE DATA THEY CONTAIN CANNOT BE CONSIDERED AS SPECIFICATIONS.

For location of the controls mentioned in the following procedure, see Figures 4-1, 4-2 and the Voltage and Resistance Diagram at the end of this section. A fifteen minute warm-up and power supply output voltage measurements are always recommended before making any other test or adjustment.

4-8 TURN ON PROCEDURE

Perform this procedure only after repair work has been done on the instrument. The purpose of this procedure is to check that none of the power supplies have been shorted and to serve as a partial check upon the correctness of the repairs that have been made.

1) Measure resistances from the power supplies to ground. When measured with an Φ Model 410B Voltmeter, they should be within 50% of the following:

+ 380 volt supply	50K ohms
+ 100	50K
-150	12K
+ 24	5.5K (Remove V1, 2, 4, and 5 to check)

2) Measure resistances to ground into the vertical and horizontal input terminals for all dc switch positions. As measured with an Φ Model 410B Voltmeter these resistances should read:

VERT SENSITIVITY = 1 Megohm
 OFF = ∞
 CAL = ∞
 HORIZ SENSITIVITY = 1 Megohm

3) Turn instrument on and measure the output voltage of the internal power supplies (see paragraph 4-9 POWER SUPPLIES). When turning the oscilloscope on for the first time after repair in any power supply circuit, turn the INTENSITY control fully counterclockwise before applying power. Failure to follow this precaution may cause permanent cathode-ray tube damage. If you are able to get a small, round, and sharply focused spot with good brilliance by adjusting the controls, the high voltage power supply can be assumed to be operating properly.

4) If necessary, the high voltage can be measured and adjusted as in paragraph 4-8. If R308, High Voltage Adjustment, is changed, adjust FOCUS and Astigmatism (R316) controls at low intensity to obtain a small, round, and sharply focused spot. If the high voltage is changed, recalibrate the Vertical and Horizontal Amplifier Gain.

5) If the cathode-ray tube physical position has been changed, check trace alignment with bezel. Turn TRIGGER LEVEL control fully counterclockwise to AUTO. Set SWEEP TIME switch to 50 MICROSECONDS/CM. The CRT trace should be parallel with the graticule lines. The CRT face should be placed just behind the filter in the bezel. If CRT face and filter touch, a visible interference pattern will result.

4-9 POWER SUPPLIES

The power supplies in the oscilloscope are extremely stable and will require infrequent adjustment. The output voltages should be measured with a recently calibrated 1% voltmeter, such as an Φ Model 405A or 412A, at regular intervals but unnecessary adjustments should be avoided.

CAUTION

When first turning the oscilloscope on turn the INTENSITY control fully counterclockwise before applying power. Failure to follow this precaution can cause permanent cathode-ray tube damage.

1) Turn instrument on and allow at least 15 minutes for warm-up.

2) Turn the sweep generator off by turning the SWEEP TIME - HORIZ SENS switch to 10 VOLTS/CM.

3) Measure power supply output voltages with line voltage set to 115 v. The points at which the various voltages appear can be identified by the wire color code given in Table 4-5. The voltages will normally be within the limits given. Potentiometer Low Voltage Set, R344, can be adjusted, if necessary, to set the -150 volt supply within the limits in Table 4-5. If the voltages are within limits and pass steps 4 and 5 that follow, do not adjust in an attempt to refine the existing control settings.

If adjustment of the -150 volt supply is necessary, check all Sweep Generator and Calibrator adjustments.

TABLE 4-5. REGULATED POWER SUPPLY TOLERANCES

NOMINAL VOLTAGE	NORMAL RIPPLE	COLOR CODE	VOLTAGE TOLERANCE*
-150	3 mv	Violet	± 2 volts
+380	40	Red	± 10
+100	4	Yellow	± 3
+24	40	White**	± 1

* With line voltage set to 115 v.

** In vertical amplifiers.

4) You may wish to check regulation of each power supply voltage as the power line voltage is varied between 103 and 127 volts. All regulated voltages should remain within $\pm 1\%$ over this line voltage range.

5) Measure the ripple voltage on the various supplies. They should approximate the values given in Table 4-5 with the line voltage at 115 volts.

6) Measure cathode-ray tube cathode voltage as instructed in paragraph 4-5C. If necessary R308, H. V. Adjustment, can be adjusted to set this voltage to -2250 volts. If this adjustment is changed, recalibrate the horizontal and vertical amplifier gain.

7) Adjust FOCUS control for best focus and set ASTIGMATISM control, R316, for a small, round,

spot. Set pointer on INTENSITY knob to 9 o'clock and adjust Intensity Limit control, R322, so that the CRT spot is just extinguished. These adjustments are usually required only if the setting of the high voltage control, R308, has been changed.

4-10 TRIGGER GENERATOR

The Trigger Generator must be working to adjust the Vertical and Horizontal Amplifiers. Also, these amplifiers must be adjusted before the Sawtooth Generator can be adjusted. Check the Trigger Generator as follows:

- 1) Check power supply according to paragraph 4-9.
- 2) Adjust Stability Control, R228.

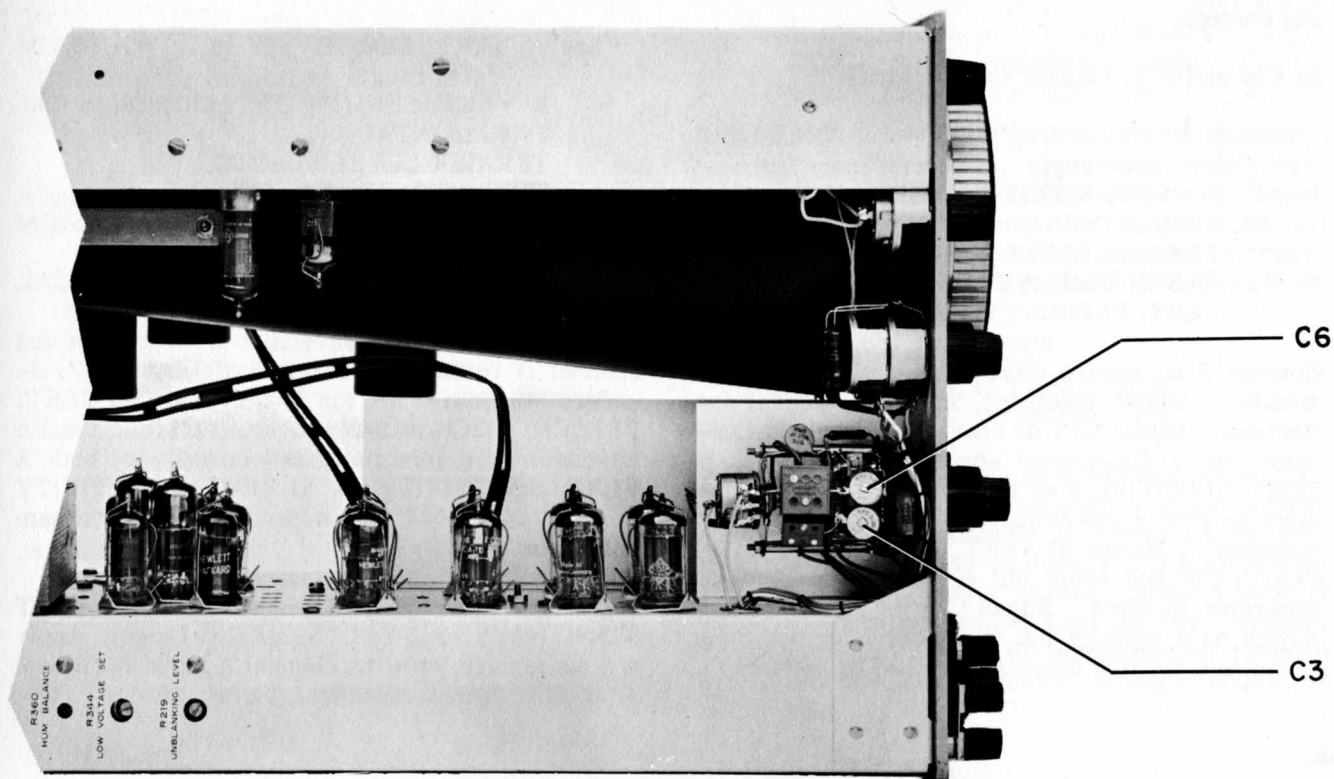
Set A VERT SENSITIVITY to OFF
 B VERT SENSITIVITY to OFF
 SWEEP TIME to .5 MILLISECONDS/CM
 SYNC to INT
 TRIGGER LEVEL fully counterclockwise but not in AUTO.
 VERT PRESENTATION to A or B

Connect an Φ 410B (-100 v dc range) to pin 8 of V203. Slowly rotate Stability Control, R228, counterclockwise until the sweep starts free-running. Then back control off until it just stops. Take a voltage reading which should be about -78 volts. Set R228 to 2.0 volts more positive than the last reading. This is the proper setting for the stability control.

- 3) External Trigger Sensitivity

Set SYNC switch to EXT
 TRIGGER LEVEL to AUTO
 Horizontal AC-DC switch to DC
 VERT PRESENTATION control to A or B
 Trigger Sensitivity Control, R247, fully counterclockwise.

Connect a 250 kc sine wave of 0.7 v rms to the SYNC (right-hand) terminals. With an oscilloscope observe the square wave by clipping the oscilloscope probe over the body of R204 (V201A plate resistor). Increase Trigger Sensitivity control R247, until stable triggers are obtained. Check trigger sensitivity from 50 cps to 250 kc. Stable triggering should be obtained with less than 0.7 v rms over this range. Remove the test set-up and check the rate when the TRIGGER LEVEL control is in AUTO position--should be about 120 ± 50 cps.



MP-S-408

Figure 4-1. Left-Side Adjustment Location Diagram

4-11 VERTICAL AMPLIFIER

1) Balance Channel A

Set VERT. PRESENTATION to A
 A VERT. SENSITIVITY to .01 VOLTS/CM
 HORIZ. SENSITIVITY to 10 VOLTS/CM

Turn A VERT. SENSITIVITY VERNIER fully counterclockwise and adjust spot to center with A VERT. POS. control. Turn A SENSITIVITY VERNIER control fully clockwise and readjust spot to center with BAL control. Repeat this sequence until there is no movement of spot as VERNIER is rotated. Set A VERT. POS. control to the center. Spot should now be on screen.

2) Balance Channel B

Set VERT. PRESENTATION to B
 B VERT. SENSITIVITY to 10 VOLTS/CM
 HORIZ. SENS. to 10 VOLTS/CM

Using B VERT. SENSITIVITY VERNIER and B VERT. POS. control repeat procedure of step 1.

3) Adjust Channel A Gain

Set VERT. PRESENTATION to A
 A VERT. SENSITIVITY to .01 VOLTS/CM
 A VERT. SENSITIVITY VERNIER to CAL

Feed into channel A input terminals a 100 millivolt peak-to-peak signal from a Voltmeter Calibration Generator (Specification 23678). Set GAIN of channel A to give exactly 10 cm of deflection. Check this setting at 127 and 103 volts line input. Setting of GAIN control should be same with all voltages. If not, check power supplies and vertical amplifier tubes.

4) Adjust Channel B Gain

Set VERT. PRESENTATION to B
 B VERT. SENSITIVITY VERNIER to CAL

Repeat procedure of step 3 with channel B input and controls.

5) Channel B Attenuator Compensation

Set B VERT. SENSITIVITY to .1 VOLTS/CM (DC range)
 B VERT. SENSITIVITY VERNIER to CAL SYNC to INT +
 TRIGGER LEVEL to AUTO.
 SWEEP TIME to 200 μ SEC/CM
 VERT. PRESENTATION to B

Connect 5 kc square wave to channel B input terminals. Adjust level for an 8 cm vertical deflection. Adjust C13 on channel B vertical attenuator for a flat-topped square wave. Switch B VERT. SENSITIVITY to 1 VOLTS/CM and increase input to give 8 cm deflection. Adjust C16 for flat response. Switch B VERT. SENSITIVITY to 10 VOLTS/CM and apply full output of square wave generator to input. Adjust C18 for flat response. Switch back through the four attenuator positions and check for 10:1 divisions (should be within 1%).

6) Channel A Attenuator Compensation

Set A VERT. SENSITIVITY to .1 VOLTS/CM (DC range)
 A VERT. SENSITIVITY VERNIER to CAL SYNC to INT +
 TRIGGER LEVEL to AUTO.
 SWEEP TIME to 200 μ SEC/CM
 B VERT. SENSITIVITY to .1 VOLTS/CM (DC range)
 B VERT. SENSITIVITY VERNIER to CAL

Apply a 200 kc sine wave to both channel A and channel B vertical input terminals from a "reference oscillator" set for 20-25 volts. Set VERT. PRESENTATION to B-A and adjust C3 on channel A attenuator for minimum deflection. Set both A VERT. SENSITIVITY and B VERT. SENSITIVITY to 10 VOLTS/CM and adjust C8 for minimum deflection.

Set VERT. PRESENTATION to A and A VERT SENSITIVITY to .1 VOLTS/CM (DC range). Apply a 5 kc square wave to channel A input and adjust

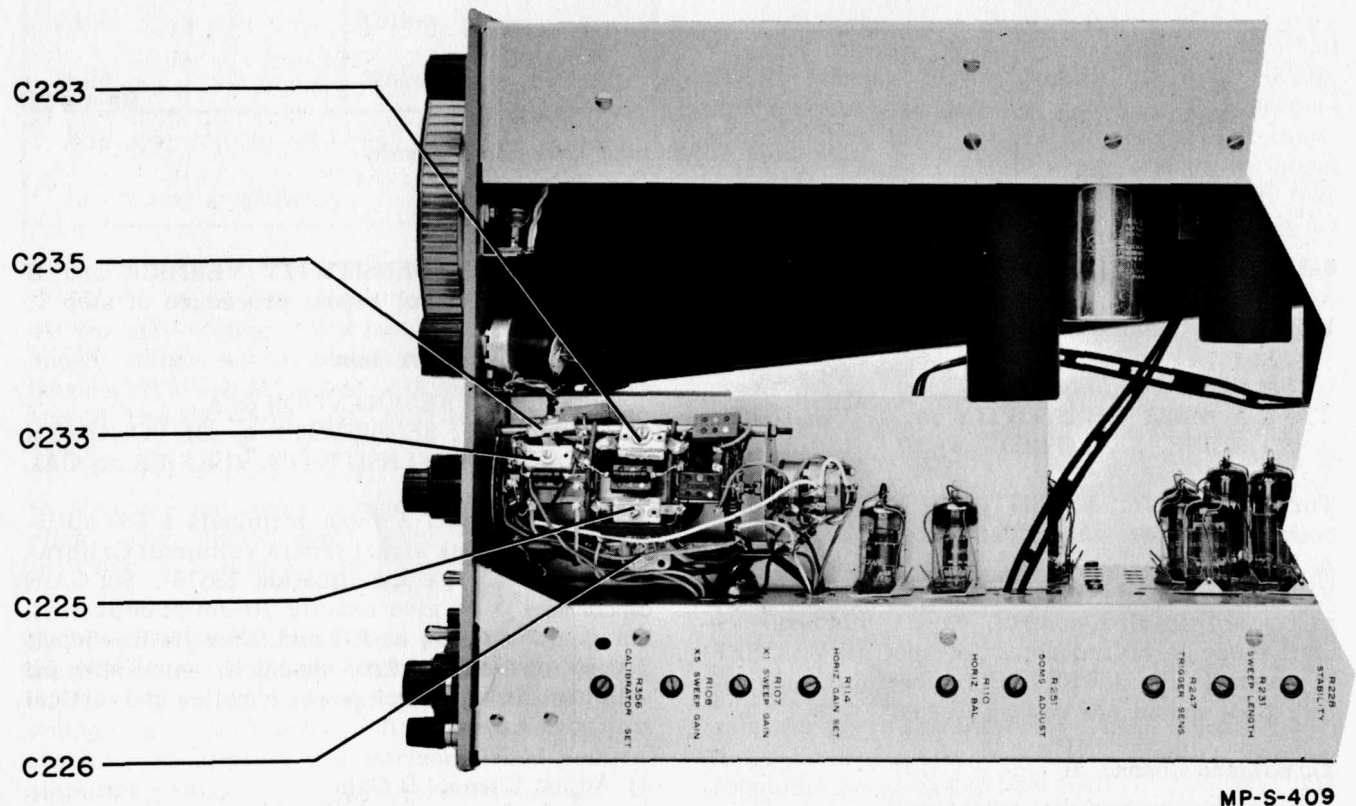


Figure 4-2. Right-Side Adjustment Location Diagram

level for 8 cm deflection. Adjust C22 on VERT PRESENTATION switch for flat response.

7) Calibrator Amplitude

NOTE

Channel A gain should be adjusted before doing this step.

Set A VERT SENSITIVITY to CAL
 A VERT SENSITIVITY VERNIER to CAL
 B VERT SENSITIVITY to CAL
 B VERT SENSITIVITY VERNIER to CAL
 VERT PRESENTATION to A
 TRIGGER LEVEL to AUTO

Adjust Calibrator Set, R365, for exactly 6 cm of vertical deflection.

4-12 HORIZONTAL AMPLIFIER ADJUSTMENTS

1) Balance

Set HORIZ SENS switch to 10 VOLTS/CM
 HORIZ SENS VERNIER to CAL
 B VERT SENSITIVITY to OFF
 VERT PRESENTATION to B

Adjust spot to center of screen with HORIZ POS control. Turn HORIZ SENS VERNIER fully counter clockwise and readjust position of spot with Horizontal Balance Adjustment, R110. Turn HORIZ SENS VERNIER to CAL and center spot with HORIZ POS control. Repeat until there is no movement of spot when HORIZ SENS VERNIER is rotated. Set HORIZ POS control to center. The spot should now be on screen.

2) Adjust GAIN

Set HORIZ. SENS. control to .1 VOLTS/CM
 HORIZ. SENS. VERNIER to CAL

Apply 1.0 v peak-to-peak from a Voltmeter Calibration Generator (@Specification 23678) to the horizontal input terminals. Set Horiz. Gain Adjustment, R114, for exactly 10 cm of deflection.

Check this setting at high and low line voltages. Setting of GAIN control should be same at all voltages. If not, check power supplies and horizontal amplifier tubes.

3) Square Wave Response

Set HORIZ. SENS. to .1 VOLTS/CM
 HORIZ. SENS. VERNIER to CAL
 VERT. PRESENTATION to B

Connect "square wave generator" to channel B vertical input terminals. Apply 50 kc square wave to horizontal input terminals and use same signal to trigger Sawtooth Generator. Adjust C107 for minimum capacity. Adjust C110 for optimum square wave. A maximum of 2% overshoot is permitted.

4) Attenuator Compensation

Set HORIZ. SENS. to 1 VOLTS/CM
 HORIZ. SENS. VERNIER to CAL

Apply 5 kc square wave to horizontal input terminals and also use same signal to trigger a Sawtooth Generator connected to vertical input terminals. Adjust C233 on SWEEP TIME switch for flat response. Switch HORIZ. SENS. switch to 10 VOLTS/CM and adjust C233 for flat response. Now switch back through the three attenuator ranges and check for 10:1 division. Division should be within 1%.

5) Phase Adjustment

Set HORIZ. SENS. to .1 VOLTS/CM
 HORIZ. SENS. VERNIER to CAL
 A VERT. SENSITIVITY to .1 VOLTS/CM
 A VERT. SENSITIVITY VERNIER to CAL
 B VERT. SENSITIVITY to .1 VOLTS/CM
 B VERT. SENSITIVITY VERNIER to CAL
 VERT. PRESENTATION to A

Apply 100 kc sine wave to both channel A and channel B input terminals, and to the horizontal input terminals. Adjust amplitude to give about 6 cm of deflection along both axes. Switch VERT. PRESENTATION to B and adjust C107 for closure of pattern. Switch VERT. PRESENTATION to A and adjust C44 for closure of pattern. Check phase adjustment on .1 VOLTS/CM and 1 VOLT/CM ranges also.

4-13 SWEEP GENERATOR

The Vertical and Horizontal amplifiers must be adjusted before Sweep Generator Adjustment can be completed.

1) X1 Calibration

Set SWEEP TIME switch to 5 MILLISECONDS/CM
 SWEEP EXPAND switch to X1

Apply 100 cps from a Time Marker Generator to Vertical Input terminals. Adjust TRIGGER LEVEL control and choose either INT+ or - for best pattern. Adjust X1 Sweep Gain Adjustment, R107, so that the markers coincide with every other major division on the graticule.

2) X5 Calibration

Set SWEEP EXPAND switch X5

Apply 1 kc from "Marker Generator" to Vertical input terminals. Adjust TRIGGER LEVEL control for best pattern. Adjust X5 Sweep Gain Adjustment R108, so that the markers coincide with each major division on the graticule.

3) Sweep Attenuator Compensation

Set SWEEP TIME switch to 10 MICROSECONDS/CM
SWEEP EXPAND switch to X1

Set C226 (see Figure 4-2) to mid-value. Attach 50:1 probe to the calibrator output of an additional, monitor, oscilloscope. Compensate the probe. Attach this probe to pin 2 of V101A to view sawtooth at input to Horizontal Amplifier. Apply 100 kc marker pips from a "Marker Generator" to the Vertical input terminals. Adjust C214 (see Figure 4-4 in this section) to compensate fly-back of sawtooth. The flyback should not overshoot or undershoot the steady-state voltage.

4) X1 - X5 Compensation

Set SWEEP EXPAND switch to X1

Connect 50:1 probe to output of Horizontal Amplifier, pin 1 or 6 of V102. Position start of sweep to center of screen with HORIZ. POS. control. Adjust C105 (see Figure 4-3) for compensation of fly-back of sawtooth. Switch SWEEP EXPAND switch to X5 and adjust C106 (see Figure 4-3) for proper compensation. Remove probe.

5) Calibrate 50 millisecond Adjustment Control

Set SWEEP TIME to 50 MILLISECONDS/CM

Apply 10 cps time markers to Vertical input terminals. Adjust 50 ms Calibrate adjustment, R251, for marker coincidence with every other major division on the graticule.

6) Calibrate 0.5 millisecond Adjustment Control

Set SWEEP SPEED to .5 MILLISECONDS/CM

Apply 1 kc time markers to the Vertical input terminals. Adjust C223 (see Figure 4-2) for marker coincidence with every other major marker on the graticule.

7) Calibrate 50 MICROSECONDS/CM Adjustment Control

Set SWEEP SPEED control to 50 MICROSECONDS/CM

Apply 10 kc time markers to the Vertical input terminals. Adjust C225 (see Figure 4-2) for marker coincidence with every other major division on the graticule.

8) Calibrate 5 MICROSECONDS/CM Adjustment Control

Set SWEEP SPEED switch to 5 MICROSECONDS/CM

Apply 100 kc from "Marker Generator" to the Vertical input terminals. Adjust C226 (see Figure 4-2) for marker coincidence with every other major division on the graticule.

9) Hum

Set SWEEP TIME switch to .5 MILLISECOND/CM

SYNC to INT

TRIGGER LEVEL control to AUTO

SWEEP EXPAND switch to X1

Apply 1 kc sine wave from "reference oscillator" to the Vertical input terminals. Turn the SWEEP TIME VERNIER down approximately 3:1 and tune to observe hum modulation on the sweep. Switch SWEEP EXPAND switch to X5. Adjust Hum Balance control, R360, for minimum hum.

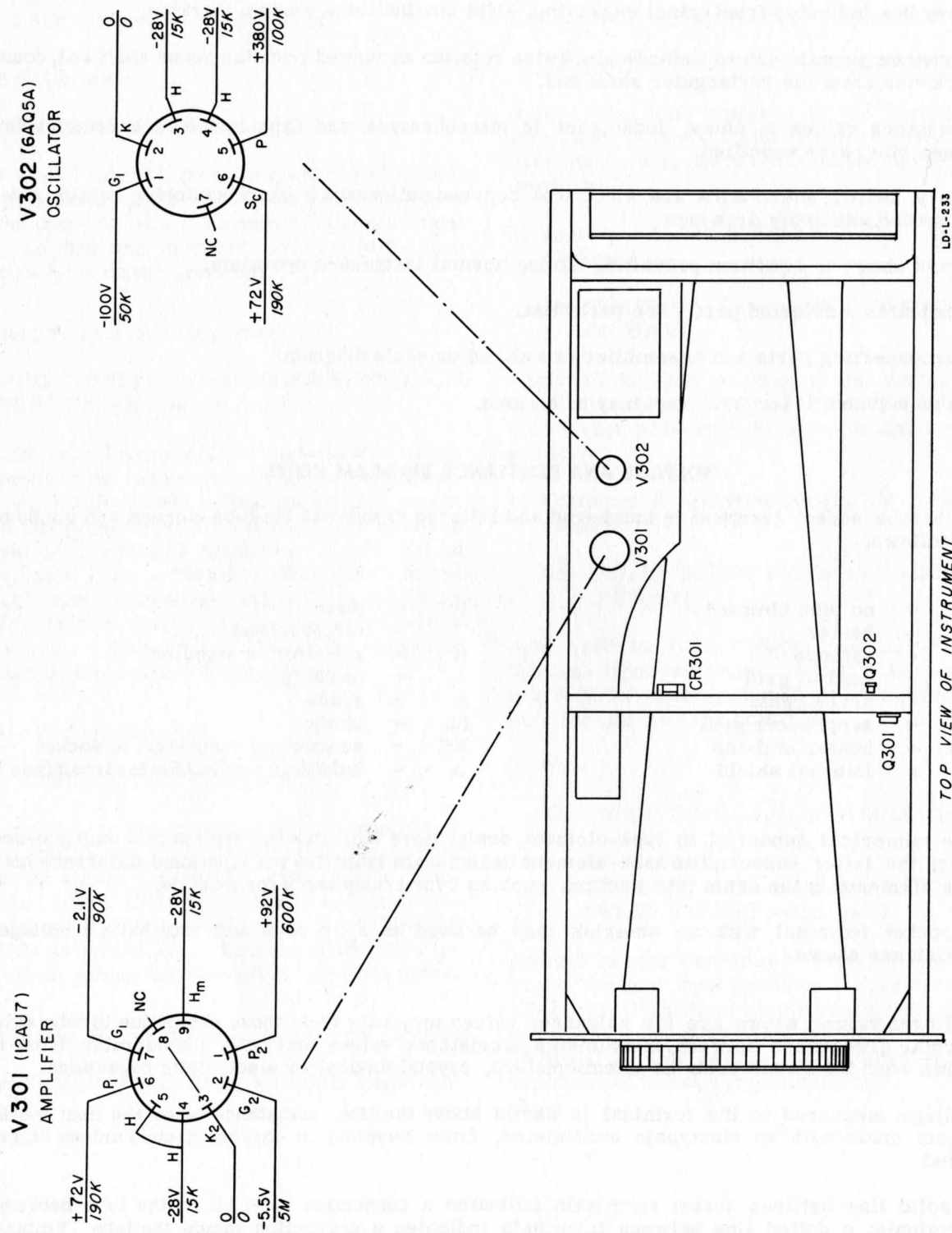


Figure 4-3. Top View Adjustment Location and Voltage Resistance Diagram

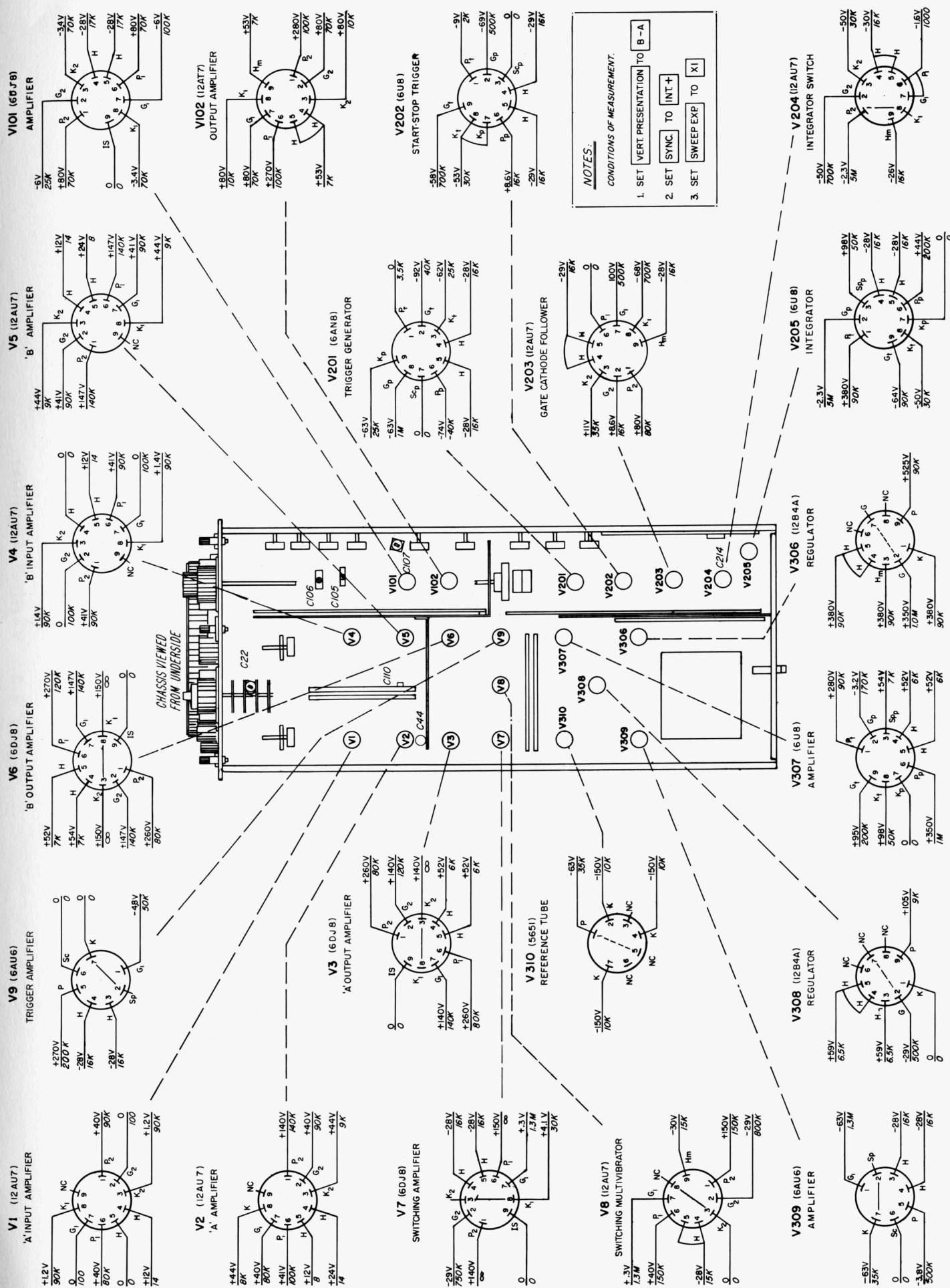
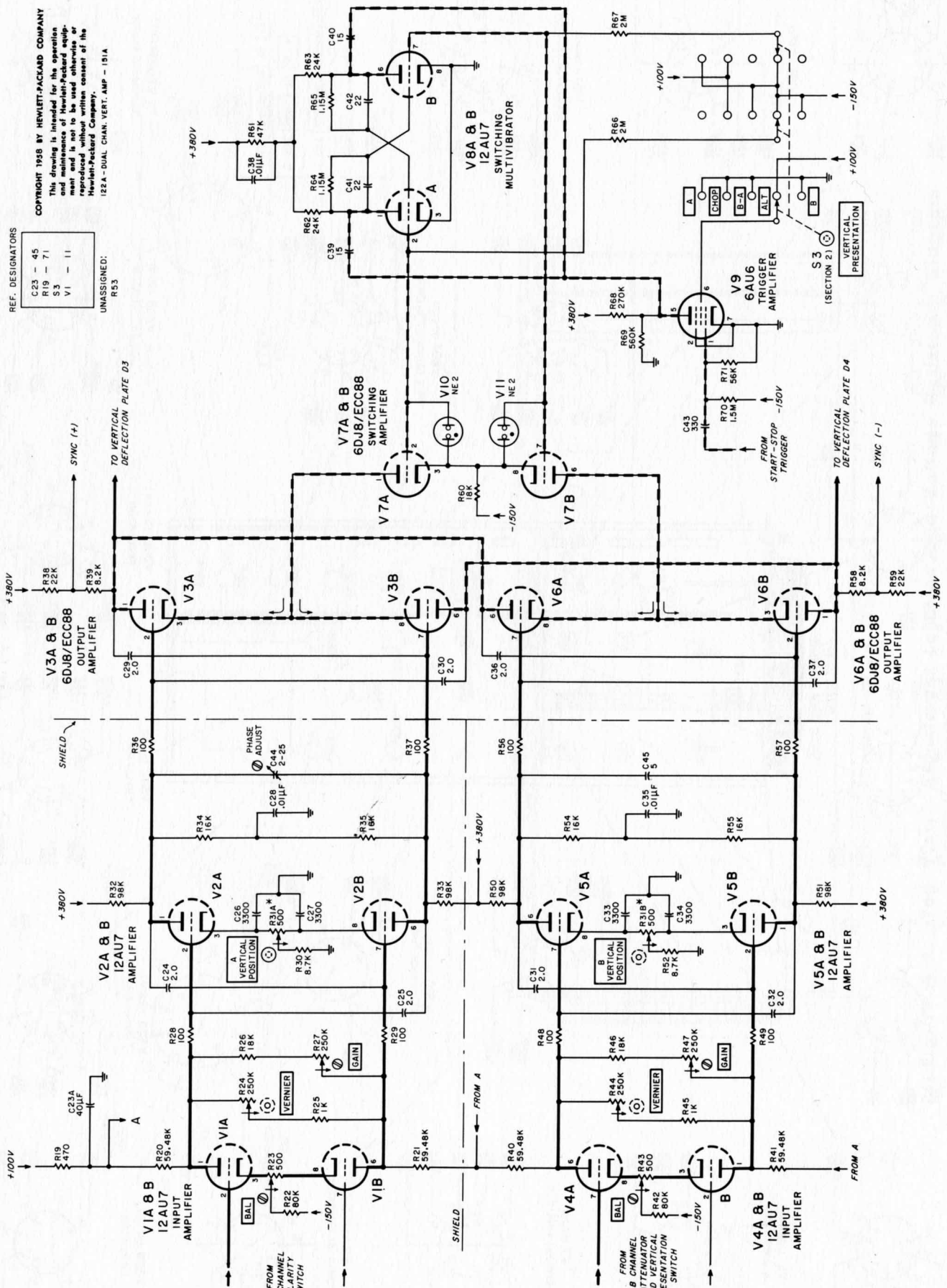


Figure 4-4. Bottom View Adjustment Location and Voltage Resistance Diagram



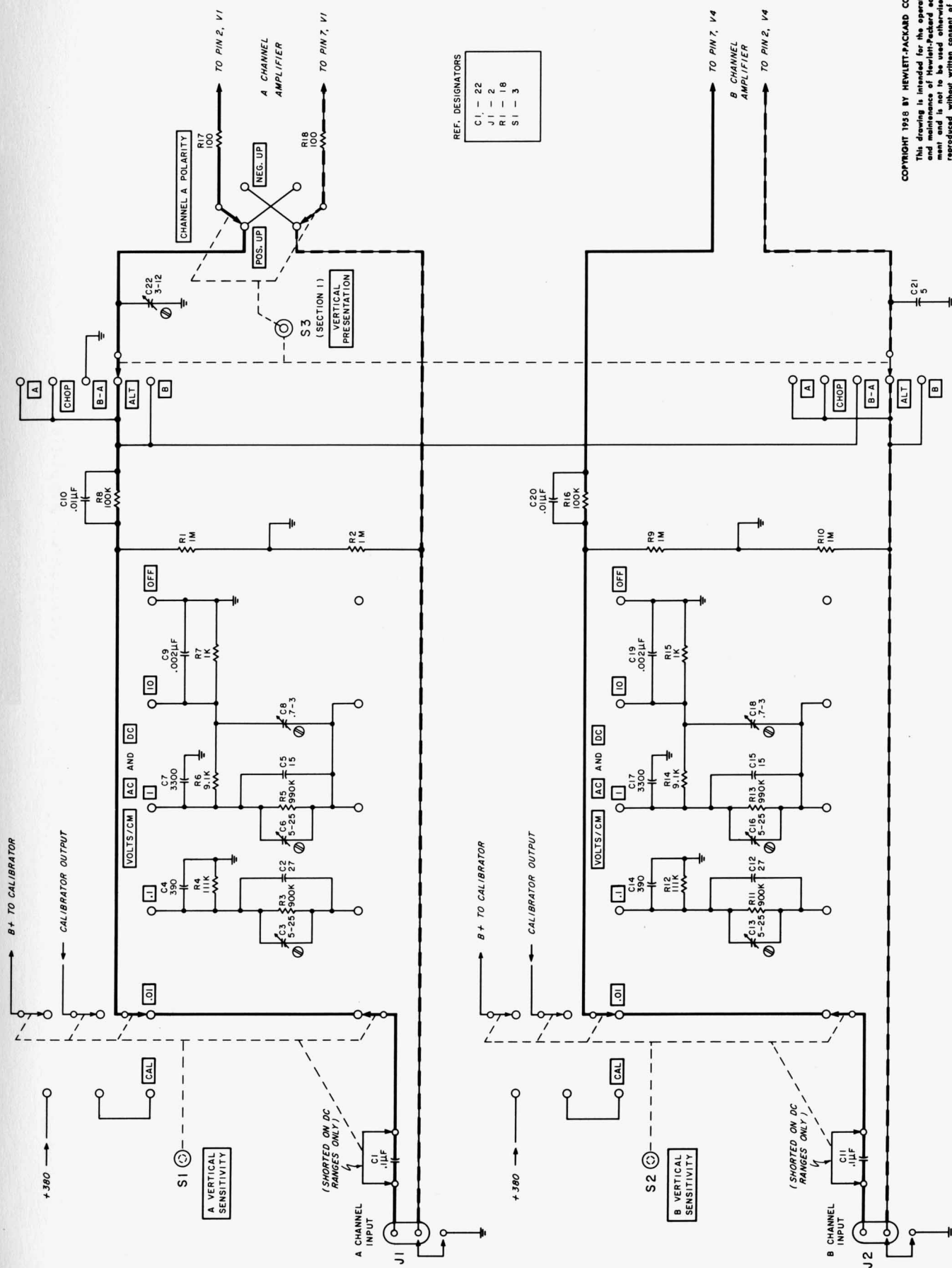


Figure 4-6. Vertical Amplifier Switch Detail

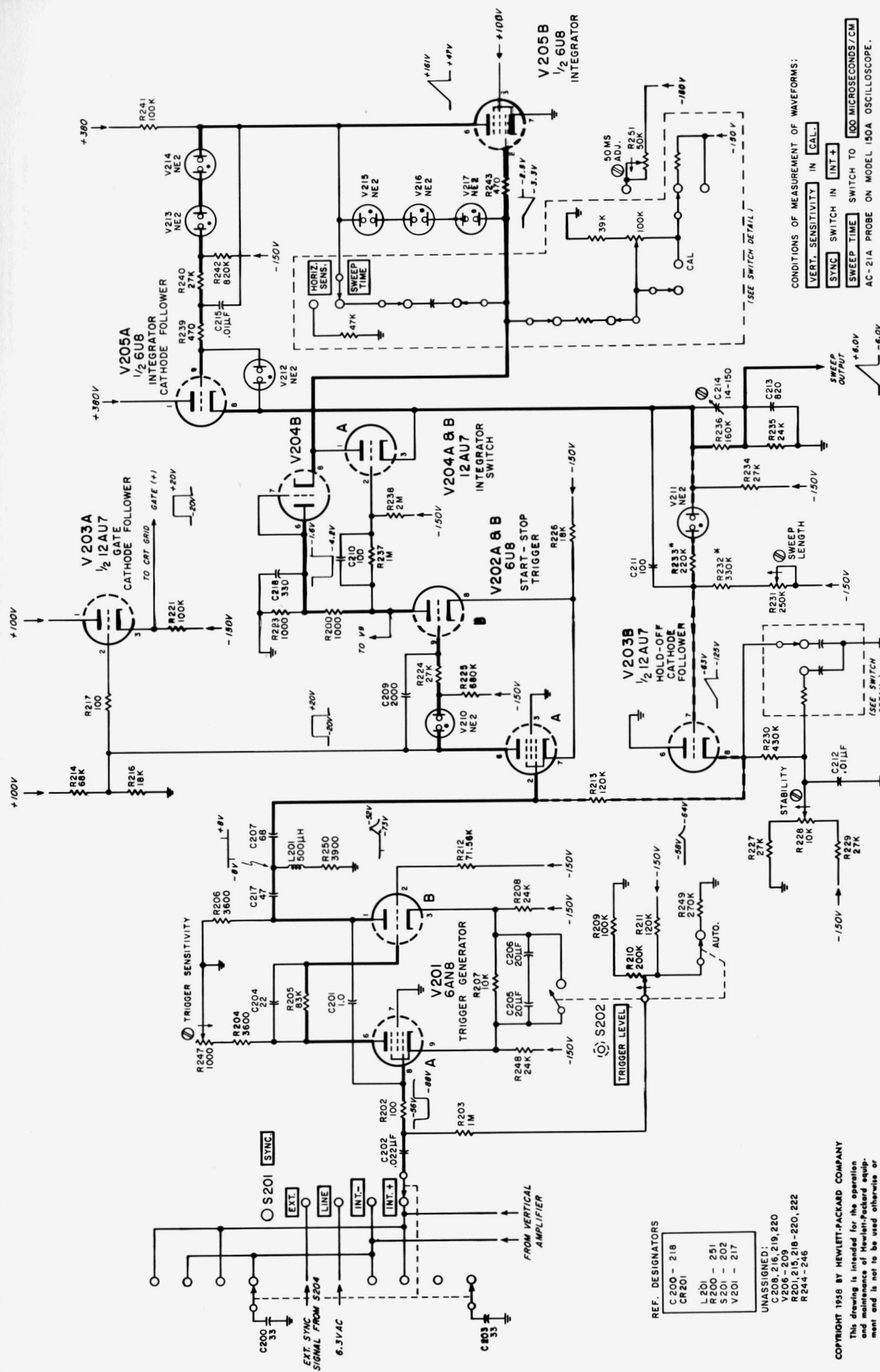


Figure 4-8. Sweep Generator

This drawing is intended for the operation
 and maintenance of Hewlett-Packard equip-
 ment and is not to be used otherwise or
 reproduced without written consent of the
 Hewlett-Packard Company.
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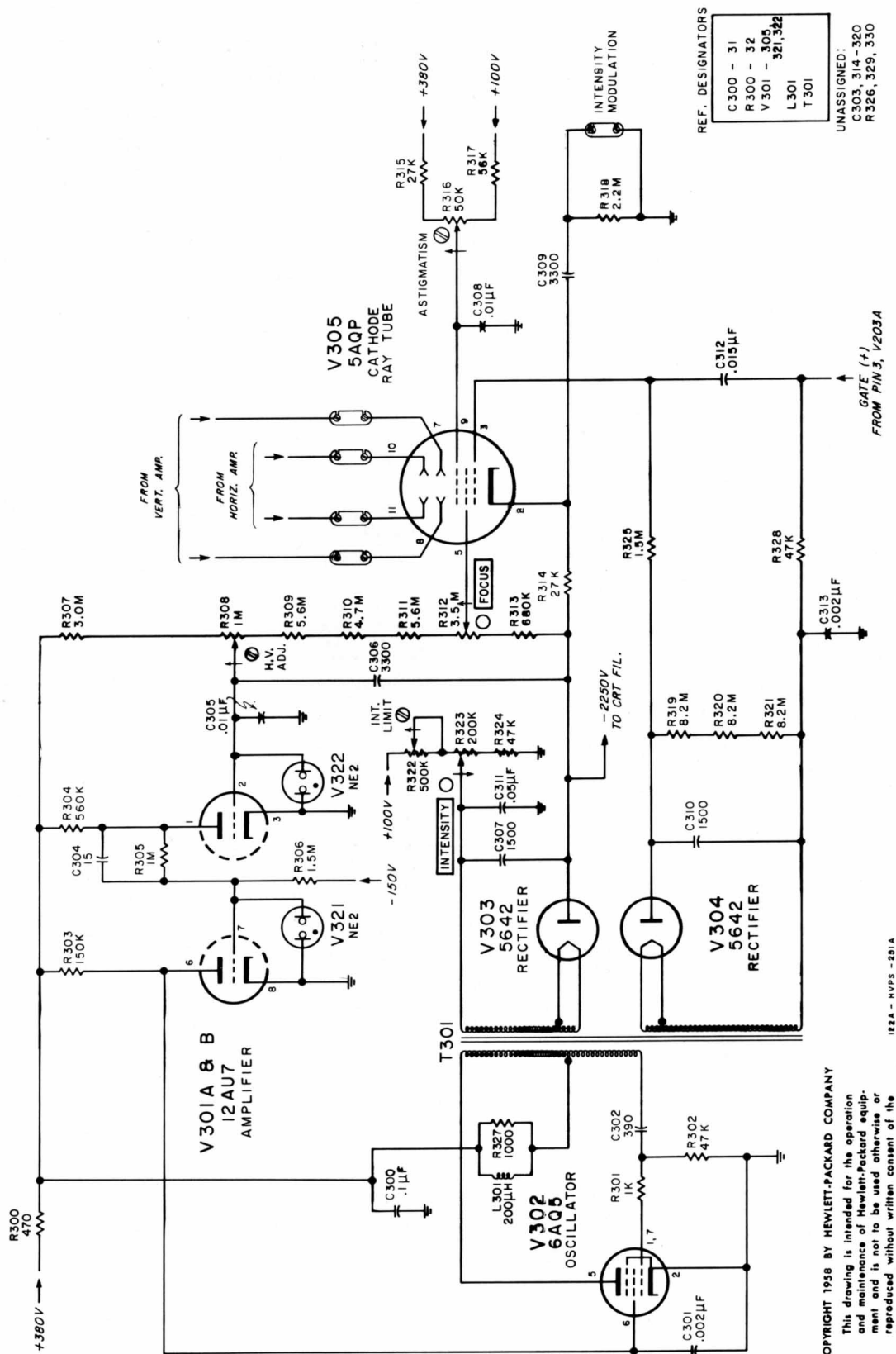


Figure 4-10. High Voltage Power Supply

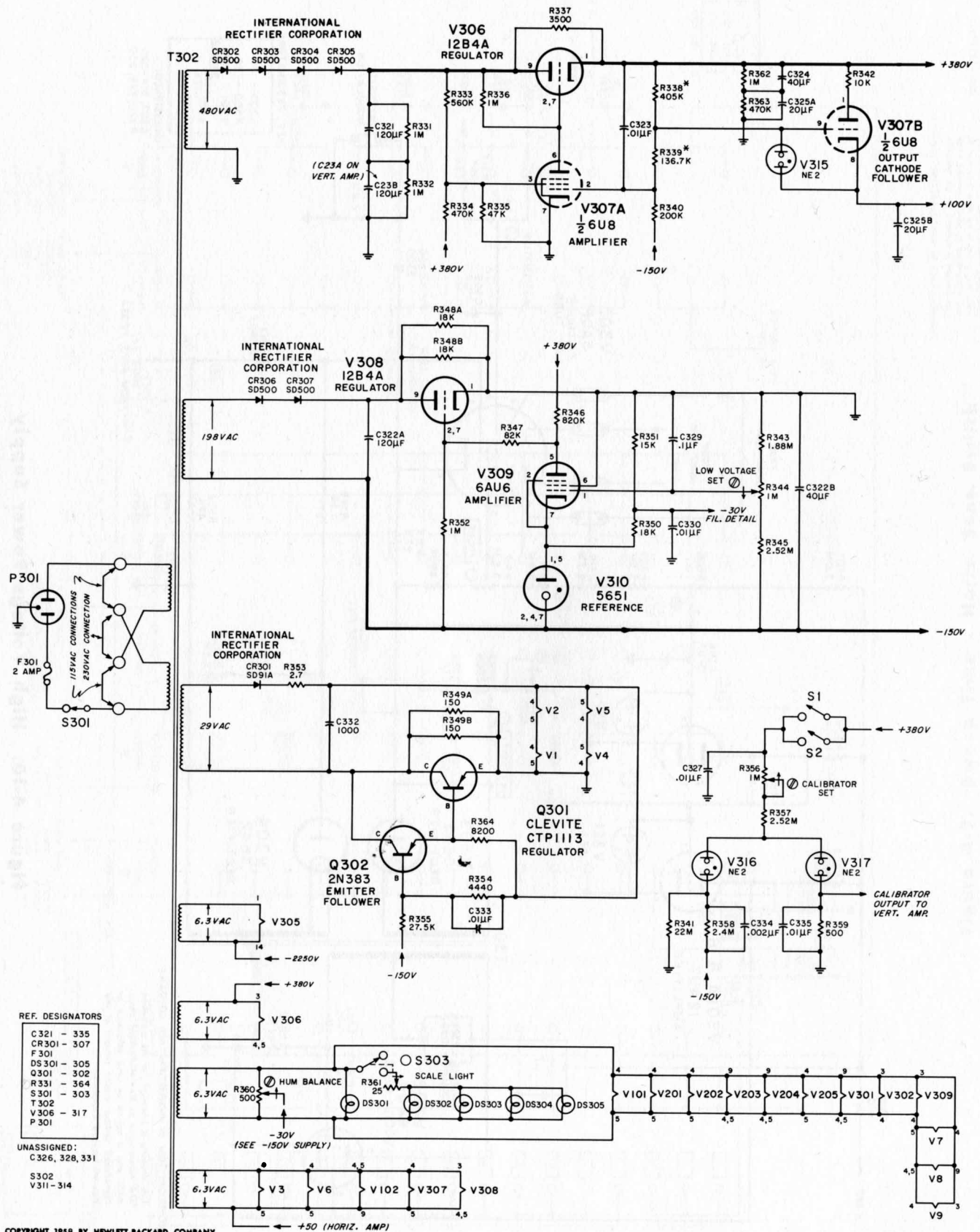



Figure 4-11. Low Voltage and Filament Supplies



CATHODE RAY TUBE WARRANTY

The cathode ray tube supplied in your Hewlett-Packard Oscilloscope and replacement cathode ray tubes purchased from , are guaranteed against electrical failure for one year from the date of sale by the Hewlett-Packard Company. Broken tubes or tubes with burned phosphor are not included in this guarantee.

Your local Hewlett-Packard representative maintains a stock of replacement tubes and will be glad to process your warranty claim for you. Please consult him.

Whenever a tube is returned for a warranty claim, the reverse side of this sheet must be filled out in full and returned with the tube. Follow shipping instructions carefully to insure safe arrival, since no credit can be allowed on broken tubes.

SHIPPING INSTRUCTIONS

- 1) Carefully wrap the tube in 1/4" thick cotton batting or other soft padding material.
- 2) Wrap the above in heavy kraft paper.
- 3) Pack in a rigid container which is at least 4 inches larger than the tube in each dimension.
- 4) Surround the tube with at least four inches of packed excelsior or similar shock absorbing material. Be certain that the packing is tight all around the tube.
- 5) Tubes returned from outside the continental United States should be packed in a wooden box.
- 6) Ship prepaid preferably by AIR FREIGHT or RAILWAY EXPRESS. We do not recommend parcel post or air parcel post shipment.

CRT WARRANTY CLAIM

FROM:

DATE: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

Person to contact for further information:


NAME: _____

TITLE: _____

COMPANY: _____

ADDRESS: _____

To process your claim quickly please enter the information indicated below:

1)  INSTRUMENT MODEL _____ SERIAL _____

2) TUBE TYPE _____ SERIAL _____

3) ORIGINAL TUBE _____ REPLACEMENT TUBE _____

4) YOUR PURCHASE ORDER NO. _____

5) DATE PURCHASED _____

6) PURCHASED FROM _____

7) COMPLAINT: (Please describe nature of trouble) _____

8) OPERATING CONDITIONS: (Please describe conditions prior to and at time of failure) _____

SIGNATURE _____


SECTION V

TABLE OF REPLACEABLE PARTS

NOTE

Readily available standard-components have been used in this instrument, whenever possible. However, special components may be obtained from your local Hewlett-Packard representative or from the factory.

When ordering parts always include:

1.  Stock Number.
2. Complete description of part including circuit reference.
3. Model number and serial number of instrument.
4. If part is not listed give complete description, function, and location of part.

If there are any corrections for the Table of Replaceable Parts they will be listed on an Instruction Manual Change sheet at the front of this manual.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	Ⓢ STOCK NO.	#			
C1	Capacitor: fixed, mylar, 0.1 μ f \pm 20%, 600 vdcw Texas Capacitor Co.	16-110	2			
C2	Capacitor: fixed, mica, 27 μ f \pm 5%, 300 vdcw Z*	14-78	2			
C3	Capacitor: variable, ceramic, 5 - 25 μ f L*	13-28	5			
C4	Capacitor: fixed, mica, 390 μ f \pm 10%, 500 vdcw V*	14-65	2			
C5	Capacitor: fixed, mica, 15 μ f \pm 10%, 500 vdcw V*	14-15	4			
C6	Same as C3					
C7	Capacitor: fixed, mica, 3300 μ f \pm 10%, 500 vdcw V*	14-64	6			
C8	Capacitor: variable, polystyrene, 0.7 - 3 μ f, 350 vdcw L*	13-37	2			
C9	Capacitor: fixed, ceramic, .002 μ f \pm 20%, 1000 vdcw L*	15-80	5			
C10	Capacitor: fixed, ceramic, .01 μ f \pm 20%, 250 vdcw CW*	15-135	2			
C11	Same as C1					
C12	Same as C2					
C13	Same as C3					
C14	Same as C4					
C15	Same as C5					
C16	Same as C3					
C17	Same as C7					
C18	Same as C8					

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	Φ STOCK NO.	#			
C19	Same as C9					
C20	Same as C10					
C21	Capacitor: fixed, mica, 5 μ f $\pm 20\%$, 500 vdcw	V* 14-68	2			
C22	Capacitor: variable, ceramic, 3 - 12 μ f	L* 13-29	1			
C23A	Capacitor: fixed, electrolytic, 2 sections, 120 μ f, 40 μ f, 450 vdcw	CC* 18-51HP	2			
C24, 25	Capacitor: fixed, titanium dioxide, 2.0 μ f $\pm 5\%$, 500 vdcw	DD* 15-118	3			
C26, 27	Same as C7					
C28	Capacitor: fixed, ceramic, .01 μ f, tol. -0% +100%, 1000 vdcw	CC* 15-43	13			
C29, 30	Capacitor: fixed, titanium dioxide, 1.5 μ f $\pm 20\%$, 500 vdcw	DD* 15-38	4			
C31, 32	Same as C24					
C33, 34	Same as C7					
C35	Same as C28					
C36, 37	Same as C29					
C38	Same as C28					
C39, 40	Same as C5					
C41, 42	Capacitor: fixed, mica, 22 μ f $\pm 5\%$, 500 vdcw	J* 15-116	2			
C43	Capacitor: fixed, mica, 330 μ f $\pm 10\%$, 500 vdcw	Z* 14-79	2			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	STOCK NO.	#			
C44	Capacitor: variable, mica, 2 - 25 μf , 175 vdcw	QQ*	13-34	4		
C45	Same as C21					
C46 thru C100	These circuit references not assigned					
C101	Capacitor: fixed, paper, 0.1 μf $\pm 10\%$, 600 vdcw	CC*	16-1	2		
C102	Capacitor: fixed, titanium dioxide, 2.2 μf $\pm 10\%$, 500 vdcw	DD*	15-52	3		
C103	Same as C28					
C104	Same as C102					
C105	Same as C44					
C106	Capacitor: variable, mica, 50 - 380 μf , 175 vdcw	QQ*	13-5	2		
C107	Same as C3					
C108, 109	Same as C102					
C110	Same as C106					
C111	Capacitor: fixed, mica, 680 μf $\pm 10\%$, 500 vdcw	Z*	14-21	1		
C112	Same as C28					
C113 thru C199	These circuit references not assigned					
C200	Capacitor: fixed, mica, 33 μf $\pm 5\%$, 300 vdcw	Z*	15-136	2		
C201	Capacitor: fixed, titanium dioxide, 1.0 μf $\pm 10\%$, 500 vdcw	DD*	15-102	1		

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	STOCK NO.	#			
C202	Capacitor: fixed, paper, 220 μf $\pm 10\%$, 600 vdcw CC*	16-12	1			
C203	Same as C200					
C204	Capacitor: fixed, mica, 22 μf $\pm 5\%$, 500 vdcw V*	14-69	1			
C205, 206	Capacitor: fixed, electrolytic, 20 μf , 25 vdcw CC*	18-66	2			
C207	Capacitor: fixed, mica, 68 μf $\pm 10\%$, 500 vdcw V*	14-60	1			
C208	This circuit reference not assigned					
C209	Capacitor: fixed, ceramic, 2000 μf $\pm 20\%$, 1000 vdcw Radio Materials Corp.	15-80	1			
C210	Capacitor: fixed, mica, 100 μf $\pm 10\%$, 500 vdcw V*	14-73	1			
C211	Capacitor: fixed, mica, 100 μf $\pm 10\%$, 500 vdcw V*	14-100	1			
C212	Same as C28					
C213	Capacitor: fixed, mica, 820 μf $\pm 10\%$, 500 vdcw V*	14-28	2			
C214	Capacitor: variable, mica, 14 - 150 μf , 175 vdcw QQ*	13-33	1			
C215	Same as C28					
C216	This circuit reference not assigned					
C217	Capacitor: fixed, mica, 47 μf $\pm 10\%$, 500 vdcw V*	14-67	1			
C218	Same as C43					
C219, 220	These circuit references not assigned					

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.


TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	STOCK NO.	#			
C221	Capacitor: fixed, mylar, 0.2 μ f \pm 5%, 200 vdcw CW*	16-121	1			
C222	Capacitor: fixed, mylar, .02 μ f \pm 5%, 200 vdcw CW*	16-120	1			
C223	Capacitor: variable, mica, 170 - 790 μ f, 175 vdcw QQ*	13-32	1			
C224	Capacitor: fixed, mylar, .0018 μ f \pm 5%, 200 vdcw CW*	16-119	1			
C225	Same as C213					
C226	Capacitor: variable, ceramic, 7 - 45 μ f, 500 vdcw L*	13-1	1			
C227	Capacitor: fixed, paper, .22 μ f \pm 10%, 400 vdcw CC*	16-48	1			
C228	Capacitor: fixed, paper, .022 μ f \pm 10%, 600 vdcw CC*	16-12	1			
C229	Capacitor: fixed, paper, 2200 μ f \pm 10%, 600 vdcw CC*	16-22	1			
C230	Capacitor: fixed, mica, 220 μ f \pm 10%, 500 vdcw V*	14-66	1			
C231	Capacitor: fixed, mica, 150 μ f \pm 10%, 500 vdcw V*	14-150	1			
C232	Capacitor: fixed, mica, 1500 μ f \pm 20%, 500 vdcw Z*	14-1500	1			
C233	Same as C44					
C234	Capacitor: fixed, mica, 470 μ f \pm 10%, 500 vdcw V*	14-62	1			
C235	Same as C44					
C236	Capacitor: fixed, silver mica, 30 μ f \pm 5%, 500 vdcw Z*	15-146	1			
C237	Capacitor: fixed, silver mica, 150 μ f \pm 5%, 500 vdcw A*	15-31	1			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	 STOCK NO.	#			
C238 thru C299	These circuit references not assigned					
C300	Same as C101					
C301	Same as C9					
C302	Capacitor: fixed, mica, 390 $\mu\text{f} \pm 5\%$, 500 vdcw	Z* 14-43	1			
C303	This circuit reference not assigned					
C304	Same as C5					
C305	Capacitor: fixed, tubular, .01 $\mu\text{f} \pm 20\%$, 400 vdcw	CC* 16-109	1			
C306	Capacitor: fixed, paper, 3300 $\mu\text{f} \pm 20\%$, 6000 vdcw	CC* 16-94	2			
C307	Capacitor: fixed, paper, 1500 $\mu\text{f} \pm 20\%$, 5000 vdcw	CC* 16-125	2			
C308	Same as C28					
C309	Same as C306					
C310	Same as C307					
C311	Capacitor: fixed, paper, .051 $\mu\text{f} \pm 10\%$, 200 vdcw	Z* 16-84	1			
C312	Capacitor: fixed, paper, .015 $\mu\text{f} \pm 10\%$, 3000 vdcw	CC* 16-126	1			
C313	Same as C9					
C314 thru C320	These circuit references not assigned					

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	Ⓢ STOCK NO.	#			
C321	Capacitor: fixed, electrolytic, 120 μ f, 350 vdcw CC*	18-62HP	1			
C322A	Same as C23A					
C323	Same as C28					
C324	Capacitor: fixed, electrolytic, 40 μ f, 450 vdcw CC*	18-40HP	1			
C325 A, B	Capacitor: fixed, electrolytic, 2 sections, 20 μ f/sect., 450 vdcw CC*	18-22HP	1			
C326	This circuit reference not assigned					
C327	Same as C28					
C328	This circuit reference not assigned					
C329	Capacitor: fixed, paper, 0.1 μ f \pm 10%, 400 vdcw CC*	16-35	1			
C330	Same as C28					
C331	This circuit reference not assigned					
C332	Capacitor: fixed, electrolytic, 1000 μ f, 50 vdcw CC*	18-77HP	1			
C333	Same as C28					
C334	Same as C9					
C335	Same as C28					
CR301	Rectifier, silicon: 100V, P.I.V. AA*	212-134	1			
CR302 thru CR307	Rectifier, silicon: SD500 Audio Devices	212-147	5			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	STOCK NO.	#			
DS301	Lamp, incandescent: 6 - 8V, 2 pin base, GE#12 N*	211-78	1			
DS302 thru DS305	Lamp, incandescent: 6 - 8V, .15 amp, #47 N*	211-47	4			
F301	Fuse, cartridge: 2 amp, "slow-blow" or 1 a (230 v only) E*	211-16	1			
J1	Consists of: Connector Assembly: binding post and ground link HP*	G-76K	1			
	Binding post insulator: double, black HP*	AC-54A	4			
	Binding post: insulated, black HP*	AC-10C	3			
	Binding post: insulated, red HP*	AC-10D	5			
J2	Consists of: Connector Assembly: binding post and ground link HP*	G-76J	1			
	Binding post insulator: double, black HP*	AC-54A				
	Binding post: insulated, black HP*	AC-10C				
	Binding post: insulated, red HP*	AC-10D				
J3 thru J100	These circuit references not assigned					
J101	Consists of: Binding post insulator: single, black HP*	AC-54D	1			
	Binding post: insulated, black HP*	AC-10C				
	Binding post: insulated, red HP*	AC-10D				
L201	Coil, R.F.: 500 μ h CG*	48-37	1			
L202 thru L300	These circuit references not assigned					
L301	Coil, R.F.: 200 μ h CG*	48-34	1			
P301	Power Cord Elec. Cords Co.	812-56	1			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	STOCK NO.	#			
Q301	Transistor: germanium CTP-1113 Clevite	213-2	1			
Q302	Transistor: germanium TS-600C CB*	213-1	1			
R1	Resistor: fixed, deposited carbon, 1 megohm $\pm 1\%$, 1/2 W NN*	33-1M	2			
R2	Resistor: fixed, composition, 1 megohm $\pm 5\%$, 1/2 W B*	23-1M-5	3			
R3	Resistor: fixed, deposited carbon, 900,000 ohms $\pm 1\%$, 1/2 W NN*	33-900K	2			
R4	Resistor: fixed, deposited carbon, 111,000 ohms $\pm 1\%$, 1/2 W NN*	33-111K	2			
R5	Resistor: fixed, deposited carbon, 990,000 ohms $\pm 1\%$, 1/2 W NN*	33-990K	2			
R6	Resistor: fixed, deposited carbon, 9100 ohms $\pm 1\%$, 1/2 W NN*	33-9.1K	2			
R7	Resistor: fixed, deposited carbon, 1000 ohms $\pm 1\%$, 1/2 W NN*	33-1K	2			
R8	Resistor: fixed, composition, 100,000 ohms $\pm 10\%$, 1/2 W B*	23-100K	4			
R9	Same as R1					
R10	Same as R2					
R11	Same as R3					
R12	Same as R4					
R13	Same as R5					
R14	Same as R6					
R15	Same as R7					
R16	Same as R8					

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	Ⓢ STOCK NO.	#			
R17, 18	Resistor: fixed, composition, 100 ohms $\pm 10\%$, 1/2 W B*	23-100	15			
R19	Resistor: fixed, composition, 470 ohms $\pm 10\%$, 1/2 W B*	23-470	3			
R20, 21	Resistor: fixed, deposited carbon, 59,480 ohms $\pm 1\%$, 1/2 W NN*	33-59.48K	4			
R22	Resistor: fixed, deposited carbon, 80,000 ohms $\pm 1\%$, 1 W NN*	31-80K	2			
R23	Resistor: variable, composition, linear taper, 500 ohms $\pm 10\%$ I*	210-25	2			
R24	Resistor: variable, composition, 250,000 ohms $\pm 20\%$, .25 W BO*	210-239	2			
R25	Resistor: fixed, composition, 1000 ohms $\pm 10\%$, 1/2 W B*	23-1K	6			
R26	Resistor: fixed, composition, 18,000 ohms $\pm 10\%$, 1/2 W B*	23-18K	4			
R27	Resistor: variable, composition, 250,000 ohms $\pm 20\%$, 1/4 W BO*	210-228	2			
R28, 29	Same as R17					
R30	Resistor: fixed, deposited carbon, 8700 ohms $\pm 1\%$, 1 W NN*	31-8.7K	2			
R31A,B	Resistor: variable, wirewound, dual concentric, 500 ohms each $\pm 10\%$, 2 W BO*	210-129	1			
R32, 33	Resistor: fixed, deposited carbon, 98,000 ohms $\pm 1\%$, 1 W NN*	31-98K	4			
R34, 35	Resistor: fixed, composition, 16,000 ohms $\pm 5\%$, 1/2 W B*	23-16K-5	4			
R36, 37	Same as R17					
R38	Resistor: fixed, composition, 22,000 ohms $\pm 5\%$, 2 W B*	25-22K-5	2			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.


TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	Ⓢ STOCK NO.	#			
R39	Resistor: fixed, composition, 8200 ohms $\pm 10\%$, 1 W	24-8.2K	2			
R40, 41	Same as R20					
R42	Same as R22					
R43	Same as R23					
R44	Same as R24					
R45	Same as R25					
R46	Same as R26					
R47	Same as R27					
R48, 49	Same as R17					
R50, 51	Same as R32					
R52	Same as R30					
R53	This circuit reference not assigned					
R54, 55	Same as R34					
R56, 57	Same as R17					
R58	Same as R39					
R59	Same as R38					
R60	Resistor: fixed, composition, 18,000 ohms $\pm 10\%$, 2 W	25-18K	3			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	 STOCK NO.	#			
R61	Resistor: fixed, composition, 47,000 ohms $\pm 10\%$, 2 W B*	25-47K	1			
R62, 63	Resistor: fixed, composition, 24,000 ohms $\pm 5\%$, 1 W B*	24-24K-5	4			
R64, 65	Resistor: fixed, deposited carbon, 1.15 megohms $\pm 1\%$, 1/2 W NN*	33-1.15M	2			
R66, 67	Resistor: fixed, deposited carbon, 2 megohms $\pm 1\%$, 1/2 W NN*	33-2M	3			
R68	Resistor: fixed, composition, 270,000 ohms $\pm 10\%$, 1/2 W B*	23-270K	2			
R69	Resistor: fixed, composition, 560,000 ohms $\pm 10\%$, 1/2 W B*	23-560K	1			
R70	Resistor: fixed, composition, 1.5 megohms $\pm 10\%$, 1/2 W B*	23-1.5M	3			
R71	Resistor: fixed, composition, 56,000 ohms $\pm 10\%$, 1/2 W B*	23-56K	1			
R72 thru R100	These circuit references not assigned					
R101	Resistor: variable, composition, linear taper, 500,000 ohms G*	210-20	2			
R102	Resistor: fixed, composition, 120,000 ohms $\pm 10\%$, 1/2 W B*	23-120K	1			
R103	Resistor: fixed, composition, 1 megohm $\pm 10\%$, 1/2 W B*	23-1M	9			
R104	Same as R8					
R105	Same as R17					
R106	Resistor: fixed, composition, 22,000 ohms $\pm 10\%$, 1/2 W B*	23-22K	3			
R107	Resistor: variable, linear taper, 50,000 ohms $\pm 20\%$, 1/3 W BO*	210-245	4			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	STOCK NO.	#			
R108	Resistor: variable, linear taper, 5000 ohms $\pm 20\%$, 1/2 W BO*	210-246	1			
R109	Resistor: fixed, composition, 2700 ohms $\pm 10\%$, 1/2 W B*	23-2.7K	1			
R110	Resistor: variable, linear taper, 2500 ohms, tol. 20%, 1/2 W BO*	210-243	2			
R111	Resistor: fixed, composition, 12,000 ohms $\pm 10\%$, 1/2 W B*	23-12K	2			
R112	Resistor: fixed, composition, 100,000 ohms $\pm 10\%$, 1 W B*	24-100K	3			
R113	Resistor: variable, composition, 2 sections, 50,000 ohms $\pm 20\%$; rear section: 100,000 ohms $\pm 20\%$ (part of S103) BO*	210-226	2			
R114	Same as R110					
R115	Same as R112					
R116	Same as R111					
R117, 118	Same as R17					
R119	Resistor: fixed, composition, 30,000 ohms $\pm 5\%$, 2 W B*	25-30K-5	2			
R120	Resistor: fixed, composition, 6800 ohms $\pm 10\%$, 1/2 W B*	23-6800	2			
R121	Resistor: fixed, composition, 6800 ohms $\pm 10\%$, 2 W B*	25-6800	1			
R122	Resistor: fixed, composition, 1800 ohms $\pm 10\%$, 1/2 W B*	23-1800	1			
R123	Same as R120					
R124	Same as R119					

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	Ⓢ STOCK NO.	#			
R125 thru R199	These circuit references not assigned					
R200	Same as R25					
R201	Same as R103					
R202	Same as R17					
R203	Same as R103					
R204	This circuit reference not assigned					
R205	Resistor: fixed, deposited carbon, 83,000 ohms $\pm 1\%$, 1/2 W NN*	33-83K	1			
R206	This circuit reference not assigned					
R207	Resistor: fixed, composition, 10,000 ohms $\pm 10\%$, 1/2 W B*	23-10K	1			
R208	Same as R62					
R209	Same as R8					
R210	Resistor: variable, linear taper, 200,000 ohms, tol. 20%, .25 W (not separately replaceable) (part of S202) BO*	210-241	1			
R211	Resistor: fixed, composition, 120,000 ohms $\pm 5\%$, 1/2 W B*	23-120K-5	2			
R212	Resistor: fixed, deposited carbon, 71,560 ohms $\pm 1\%$, 1/2 W NN*	33-71.56K	1			
R213	Same as R211					
R214	Resistor: fixed, composition, 68,000 ohms $\pm 10\%$, 1/2 W B*	23-68K	1			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	Ⓢ STOCK NO.	#			
R215	This circuit reference not assigned					
R216	Same as R26					
R217	Same as R17					
R218	This circuit reference not assigned					
R219, 220	These circuit references not assigned					
R221	Same as R112					
R222	Resistor: fixed, composition, 47,000 ohms $\pm 10\%$, 1/2 W	B* 23-47K	5			
R223	Same as R25					
R224	Resistor: fixed, composition, 27,000 ohms $\pm 10\%$, 1/2 W	B* 23-27K	6			
R225	Resistor: fixed, composition, 680,000 ohms $\pm 10\%$, 1/2 W	B* 23-680K	2			
R226	Same as R60					
R227	Same as R224					
R228	Resistor: variable, linear taper, 10,000 ohms, tol. 30%, 1/3 W	BO* 210-240	1			
R229	Same as R224					
R230	Resistor: fixed, composition, 430,000 ohms $\pm 5\%$, 1/2 W	B* 23/430K-5	1			
R231	Resistor: variable, linear taper, 250,000 ohms, tol. 20%, 1/4 W	BO* 210-244	1			
R232	Resistor: fixed, composition, 330,000 ohms $\pm 10\%$, 1/2 W Electrical value adjusted at factory	B* 23-330K	1			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	STOCK NO.	#			
R233	Resistor: fixed, composition, 220,000 ohms $\pm 10\%$, 1/2 W Electrical value adjusted at factory B*	23-220K	1			
R234	Resistor: fixed, glass body, 27,000 ohms $\pm 10\%$, 4 W AB*	334-27K	1			
R235	Resistor: fixed, composition, 24,000 ohms $\pm 5\%$, 1/2 W B*	23-24K-5	1			
R236	Resistor: fixed, composition, 160,000 ohms $\pm 5\%$, 1/2 W B*	23-160K-5	1			
R237	Same as R2					
R238	Resistor: fixed, composition, 2 megohms $\pm 5\%$, 1/2 W B*	23-2M-5	1			
R239	Same as R19					
R240	Same as R224					
R241	Resistor: fixed, composition, 100,000 ohms $\pm 10\%$, 2 W B*	25-100K	1			
R242	Resistor: fixed, composition, 820,000 ohms $\pm 10\%$, 1/2 W B*	23-820K	2			
R243	Same as R19					
R244 thru R246	These circuit references not assigned					
R247	Resistor: variable, linear taper, 1000 ohms, tol 20%, 1/2 W BO*	210-247	1			
R248	Same as R62					
R249	Resistor: fixed, composition, 270,000 ohms $\pm 5\%$, 1/2 W B*	23-270K-5	1			
R250	Resistor: fixed, composition, 3900 ohms $\pm 10\%$, 1/2 W B*	23-3.9K	1			
R251	Same as R107					

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	STOCK NO.	#			
R252	Same as R106					
R253	Resistor: fixed, composition, 47,000 ohms $\pm 10\%$, 1 W B*	24-47K	1			
R254 A,B	Resistor: fixed, deposited carbon, 3 megohms $\pm 1\%$, 1 W NN*	31-3M	1			
R255, 256	Resistor: fixed, deposited carbon, 3 megohms $\pm 1\%$, 1/2 W NN*	33-3M	2			
R257	Same as R113					
R258	Resistor: fixed, composition, 39,000 ohms $\pm 10\%$, 1/2 W B*	23-39K	1			
R259	Same as R68					
R260	Resistor: fixed, deposited carbon, 20,000 ohms $\pm 1\%$, 1/2 W NN*	33-20K	1			
R261	Same as R66					
R262	Resistor: fixed, deposited carbon, 200,000 ohms $\pm 1\%$, 1/2 W NN*	33-200K	1			
R263	Resistor: fixed, deposited carbon, 1.8 megohms $\pm 1\%$, 1/2 W NN*	33-1.8M	1			
R264 thru R299	These circuit references not assigned					
R300	Resistor: fixed, composition, 1000 ohms $\pm 10\%$, 1 W B*	24-1K	1			
R301	Same as R25					
R302	Same as R222					
R303	Resistor: fixed, composition, 150,000 ohms $\pm 10\%$, 2 W B*	25-150K	1			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.


TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	Ⓢ STOCK NO.	#			
R304	Resistor: fixed, composition, 560,000 ohms $\pm 10\%$, 1 W B*	24-560K	2			
R305	Same as R103					
R306	Same as R70					
R307	Resistor: fixed, composition, 3 megohms $\pm 5\%$, 1/2 W B*	23-3M-5	1			
R308	Resistor: variable, linear taper, 1 megohm, tol. 30%, .25 W BO*	210-242	3			
R309	Resistor: fixed, composition, 4.7 megohms $\pm 10\%$, 2 W B*	25-4.7M	1			
R310, 311	Resistor: fixed, composition, 5.6 megohms $\pm 10\%$, 2 W B*	25-5.6M	2			
R312	Resistor: variable, composition, linear taper, 3.5 megohms $\pm 30\%$, 1/2 W I*	210-150	1			
R313	Same as R225					
R314, 315	Same as R224					
R316	Same as R107					
R317	Resistor: fixed, composition, 56,000 ohms $\pm 10\%$, 1 W B*	24-56K	1			
R318	Resistor: fixed, composition, 2.2 megohms $\pm 10\%$, 1/2 W B*	23-2.2M	1			
R319 thru R321	Resistor: fixed, composition, 8.2 megohms $\pm 10\%$, 2 W B*	25-8.2M	3			
R322	Same as R101					
R323	Resistor: variable, composition, 200,000 ohms $\pm 20\%$, 1/4 W BO* (not separately replaceable) (part of S301)	210-224	1			
R324	Same as R222					

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	 STOCK NO.	#			
R325	Same as R70					
R326	This circuit reference not assigned					
R327	Same as R25					
R328	Same as R222					
R329, 330	These circuit references not assigned					
R331, 332	Same as R103					
R333	Same as R304					
R334	Resistor: fixed, composition, 470,000 ohms $\pm 10\%$, 1 W B*	24-470K	1			
R335	Same as R222					
R336	Same as R103					
R337	Resistor: fixed, wirewound, 3500 ohms $\pm 10\%$, 10 W R*	26-102	1			
R338	Resistor: fixed, deposited carbon, 405,000 ohms $\pm 1\%$, 1/2 W Electrical value adjusted at factory NN*	33-405K	1			
R339	Resistor: fixed, deposited carbon, 136,700 ohms $\pm 1\%$, 1/2 W Electrical value adjusted at factory NN*	33-136.7K	1			
R340	Resistor: fixed, deposited carbon, 200,000 ohms $\pm 1\%$, 1/2 W NN*	33-200K	1			
R341	Resistor: fixed, composition, 22 megohms $\pm 10\%$, 1/2 W B*	23-22M	1			
R342	Resistor: fixed, composition, 10,000 ohms $\pm 10\%$, 2 W B*	25-10K	1			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	STOCK NO.	#			
R343	Resistor: fixed, deposited carbon, 1.88 megohms $\pm 1\%$, 1/2 W NN*	33-1.88M	1			
R344	Same as R308					
R345	Resistor: fixed, deposited carbon, 2.52 megohms $\pm 1\%$, 1/2 W NN*	33-2.52M	2			
R346	Same as R242					
R347	Resistor: fixed, composition, 82,000 ohms $\pm 10\%$, 1/2 W B*	23-82K	1			
R348	Same as R60					
R349	Resistor: fixed, composition, 150 ohms $\pm 10\%$, 2 W B*	25-150	1			
R350	Same as R26					
R351	Resistor: fixed, composition, 15,000 ohms $\pm 10\%$, 1/2 W B*	23-15K	1			
R352	Same as R103					
R353	Resistor: fixed, composition, 2.7 ohms $\pm 10\%$, 1 W B*	24-2.7	1			
R354	Resistor: fixed, deposited carbon, 4440 ohms $\pm 1\%$, 1/2 W NN*	33-4.44K	1			
R355	Resistor: fixed, deposited carbon, 27,500 ohms $\pm 1\%$, 1 W NN*	31-27.5K	1			
R356	Same as R308					
R357	Same as R345					
R358	Resistor: fixed, composition, 2.4 megohms $\pm 5\%$, 1/2 W B*	23-2.4M-5	1			
R359	Resistor: fixed, deposited carbon, 500 ohms $\pm 1\%$, 1/2 W NN*	33-500	1			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	hp STOCK NO.	#			
R360	Resistor: variable, linear taper, 500 ohms $\pm 30\%$, 3/10 W BO*	210-115	1			
R361	Resistor: variable, wirewound, 25 ohms $\pm 10\%$, 2 W (includes S301) BO*	210-188	1			
R362	Same as R103					
R363	Resistor: fixed, composition, 470,000 ohms $\pm 10\%$, 1/2 W B*	23-470K	1			
S1, 2	Vertical Attenuator Switch Assembly: complete less components HP* W*	122A-19D 310-251	2			
S3	Presentation-Polarity Switch Assembly: complete less components HP* W*	122A-19B 310-250	1			
S4 thru S100	These circuit references not assigned					
S101	Switch, toggle: SPST D*	310-11	1			
S102	Switch, toggle: SPDT D*	310-12	1			
S103	Part of S204					
S104 thru S200	These circuit references not assigned					
S201	Sync-Trigger Level Switch Assembly HP*	122A-19C	1			
S202	Switch, trigger-level (part of R210 and S201)					
S203	This circuit reference not assigned					
S204	Sweep Time-Horizontal Sensitivity Switch Assembly: includes S103 HP*	122A-19A	1			
S205 thru S300	These circuit references not assigned					
S301	Part of R361					
S302	This circuit reference not assigned					

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	Ⓜ STOCK NO.	#			
S303	Switch, rotary W*	310-231	1			
T301	T ransformer, power HP*	910-177	1			
T302	Transformer, HV HP*	120A -11A-1	1			
V1, 2	Tube, electron: 12AU7 ZZ*	212-12AU7	8			
V3	Tube, electron: 6DJ8/ECC88 ZZ*	212-6DJ8	4			
V4, 5	Same as V1					
V6, 7	Same as V3					
V8	Same as V1					
V9	Tube, electron: 6AU6 ZZ*	212-6AU6	2			
V10, 11	Lamp, glow, 1/25 W N*	211-43	8			
V12 thru V100	These circuit references not assigned					
V101	Same as V3					
V102	Tube, electron: 12AT7 ZZ*	212-12AT7	1			
V103 thru V200	These circuit references not assigned					
V201	Tube, electron: 6AN8 ZZ*	212-6AN8	1			
V202	Tube, electron: 6U8 ZZ*	212-6U8	3			
V203, 204	Same as V1					
V205	Same as V202					
V206 thru V209	These circuit references not assigned					
V210	Neon, lamp, aged and selected, blue code HP*	G-84B	6			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.


TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	hp STOCK NO.	#			
V211 thru V213	Same as V10					
V214	Neon, lamp, aged and selected, green code	HP* G-84D	1			
V215 thru V217	Same as V210					
V219 thru V300	These circuit references not assigned					
V301	Same as V1					
V302	Tube, electron: 6AQ5	ZZ* 212-6AQ5	1			
V303, 304	Tube, electron: 5642	ZZ* 212-5642	2			
V305	Tube, cathode ray: 5AQP flat-faced, 5"	212-5AQP 1, 2, 7, 11	1			
V306	Tube, electron: 12B4A	ZZ* 212-12B4A	2			
V307	Same as V202					
V308	Same as V306					
V309	Same as V9					
V310	Tube, electron: 5651	ZZ* 212-5651	1			
V311 thru V314	These circuit references not assigned					
V315	Same as V10					
V316, 317	Same as V215					
V318 thru V320	These circuit references not assigned					
V321, 322	Same as V10					

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	 STOCK NO.	#			
	<u>MISCELLANEOUS</u>					
	Fuseholder T*	140-16	1			
	Jewel AD*	145-23A	1			
	Pilot Light Assembly AD*	145-25	1			
	Knob: HORIZ. POS., FOCUS, SCALE LIGHT, INTENSITY (rack model only) HP*	G-74D	4			
	FOCUS, INTENSITY, SCALE LIGHT (cabinet model only) HP*		3			
	Knob: CHAN. A POLARITY HP*	G-74E	1			
	Knob: HORIZ. POS. (Cabinet model only) HP*	G-74G	1			
	Knob: A+B VERT. SENS., SWEEP TIME-HORIZ. SENS., VERT. PRESENTATION, SYNC HP*	G-74Q	5			
	Knob: TRIGGER LEVEL, A+B VERT. SENS., SWEEP TIME-HORIZ SENS. HP*	G-74AU	4			
	Knob: B VERT. POS. HP*	G-74AW	1			
	Knob: A VERT. POS. HP*	G-74BE	1			

* See "List of Manufacturers Code Letters For Replaceable Parts Table".

Total quantity used in the instrument.

LIST OF CODE LETTERS USED IN TABLE OF REPLACEABLE PARTS TO DESIGNATE THE MANUFACTURERS

<u>CODE LETTER</u>	<u>MANUFACTURER</u>	<u>ADDRESS</u>	<u>CODE LETTER</u>	<u>MANUFACTURER</u>	<u>ADDRESS</u>
A	Aerovox Corp.	New Bedford, Mass.	AK	Hammerlund Mfg. Co., Inc.	New York 1, N. Y.
B	Allen-Bradley Co.	Milwaukee 4, Wis.	AL	Industrial Condenser Corp.	Chicago 18, Ill.
C	Amperite Co.	New York, N. Y.	AM	Insuline Corp. of America	Manchester, N. H.
D	Arrow, Hart & Hegeman	Hartford, Conn.	AN	Jennings Radio Mfg. Corp.	San Jose, Calif.
E	Bussman Manufacturing Co.	St. Louis, Mo.	AO	E. F. Johnson Co.	Waseca, Minn.
F	Carborundum Co.	Niagara Falls, N. Y.	AP	Lenz Electric Mfg. Co.	Chicago 47, Ill.
G	Centralab	Milwaukee 1, Wis.	AQ	Micro-Switch	Freeport, Ill.
H	Cinch-Jones Mfg. Co.	Chicago 24, Ill.	AR	Mechanical Industries Prod. Co.	Akron 8, Ohio
HP	Hewlett-Packard Co.	Palo Alto, Calif.	AS	Model Eng. & Mfg., Inc.	Huntington, Ind.
I	Clarostat Mfg. Co.	Dover, N. H.	AT	The Muter Co.	Chicago 5, Ill.
J	Cornell Dubilier Elec. Co.	South Plainfield, N. J.	AU	Ohmite Mfg. Co.	Skokie, Ill.
K	Hi-Q Division of Aerovox	Olean, N. Y.	AV	Resistance Products Co.	Harrisburg, Pa.
L	Erie Resistor Corp.	Erie 6, Pa.	AW	Radio Condenser Co.	Camden 3, N. J.
M	Fed. Telephone & Radio Corp.	Clifton, N. J.	AX	Shallcross Manufacturing Co.	Collingdale, Pa.
N	General Electric Co.	Schenectady 5, N. Y.	AY	Solar Manufacturing Co.	Los Angeles 58, Calif.
O	General Electric Supply Corp.	San Francisco, Calif.	AZ	Sealectro Corp.	New Rochelle, N. Y.
P	Girard-Hopkins	Oakland, Calif.	BA	Spencer Thermostat	Attleboro, Mass.
Q	Industrial Products Co.	Danbury, Conn.	BC	Stevens Manufacturing Co.	Mansfield, Ohio
R	International Resistance Co.	Philadelphia 8, Pa.	BD	Torrington Manufacturing Co.	Van Nuys, Calif.
S	Lectrohm Inc.	Chicago 20, Ill.	BE	Vector Electronic Co.	Los Angeles 65, Calif.
T	Littlefuse Inc.	Des Plaines, Ill.	BF	Weston Electrical Inst. Corp.	Newark 5, N. J.
U	Maguire Industries Inc.	Greenwich, Conn.	BG	Advance Electric & Relay Co.	Burbank, Calif.
V	Micamold Radio Corp.	Brooklyn 37, N. Y.	BH	E. I. DuPont	San Francisco, Calif.
W	Oak Manufacturing Co.	Chicago 10, Ill.	BI	Electronics Tube Corp.	Philadelphia 18, Pa.
X	P. R. Mallory Co., Inc.	Indianapolis, Ind.	BJ	Aircraft Radio Corp.	Boonton, N. J.
Y	Radio Corp. of America	Harrison, N. J.	BK	Allied Control Co., Inc.	New York 21, N. Y.
Z	Sangamo Electric Co.	Marion, Ill.	BL	Augat Brothers, Inc.	Attleboro, Mass.
AA	Sarkes Tarzian	Bloomington, Ind.	BM	Carter Radio Division	Chicago, Ill.
BB	Signal Indicator Co.	Brooklyn 37, N. Y.	BN	CBS Hytron Radio & Electric	Danvers, Mass.
CC	Sprague Electric Co.	North Adams, Mass.	BO	Chicago Telephone Supply	Elkhart, Ind.
DD	Stackpole Carbon Co.	St. Marys, Pa.	BP	Henry L. Crowley Co., Inc.	West Orange, N. J.
EE	Sylvania Electric Products Co.	Warren, Pa.	BQ	Curtiss-Wright Corp.	Carlstadt, N. J.
FF	Western Electric Co.	New York 5, N. Y.	BR	Allen B. DuMont Labs	Clifton, N. J.
GG	Wilkor Products, Inc.	Cleveland, Ohio	BS	Excel Transformer Co.	Oakland, Calif.
HH	Amphenol	Chicago 50, Ill.	BT	General Radio Co.	Cambridge 39, Mass.
II	Dial Light Co. of America	Brooklyn 37, N. Y.	BU	Hughes Aircraft Co.	Culver City, Calif.
JJ	Leecraft Manufacturing Co.	New York, N. Y.	BV	International Rectifier Corp.	El Segundo, Calif.
KK	Switchcraft, Inc.	Chicago 22, Ill.	BW	James Knights Co.	Sandwich, Ill.
LL	Gremar Manufacturing Co.	Wakefield, Mass.	BX	Mueller Electric Co.	Cleveland, Ohio
MM	Carad Corp.	Redwood City, Calif.	BY	Precision Thermometer & Inst. Co.	Philadelphia 30, Pa.
NN	Electra Manufacturing Co.	Kansas City, Mo.	BZ	Radio Essentials Inc.	Mt. Vernon, N. Y.
OO	Acro Manufacturing Co.	Columbus 16, Ohio	CA	Raytheon Manufacturing Co.	Newton, Mass.
PP	Alliance Manufacturing Co.	Alliance, Ohio	CB	Tung-Sol Lamp Works, Inc.	Newark 4, N. J.
QQ	Arco Electronics, Inc.	New York 13, N. Y.	CD	Varian Associates	Palo Alto, Calif.
RR	Astron Corp.	East Newark, N. J.	CE	Victory Engineering Corp.	Union, N. J.
SS	Axel Brothers Inc.	Long Island City, N. Y.	CF	Weckesser Co.	Chicago 30, Ill.
TT	Belden Manufacturing Co.	Chicago 44, Ill.	CG	Wilco Corporation	Indianapolis, Ind.
UU	Bird Electronics Corp.	Cleveland 14, Ohio	CH	Winchester Electronics, Inc.	Santa Monica, Calif.
VV	Barber Colman Co.	Rockford, Ill.	CI	Malco Tool & Die	Los Angeles 42, Calif.
WW	Bud Radio Inc.	Cleveland 3, Ohio	CJ	Oxford Electric Corp.	Chicago 15, Ill.
XX	Allen D. Cardwell Mfg. Co.	Plainville, Conn.	CK	Camloc-Fastener Corp.	Paramus, N. J.
YY	Cinema Engineering Co.	Burbank, Calif.	CL	George K. Garrett	Philadelphia 34, Pa.
ZZ	Any brand tube meeting RETMA standards.		CM	Union Switch & Signal	Swissvale, Pa.
AB	Corning Glass Works	Corning, N. Y.	CN	Radio Receptor	New York 11, N. Y.
AC	Dale Products, Inc.	Columbus, Neb.	CO	Automatic & Precision Mfg. Co.	Yonkers, N. Y.
AD	The Drake Mfg. Co.	Chicago 22, Ill.	CP	Bassick Co.	Bridgeport 2, Conn.
AE	Elco Corp.	Philadelphia 24, Pa.	CQ	Birnbach Radio Co.	New York 13, N. Y.
AF	Hugh H. Eby Co.	Philadelphia 44, Pa.	CR	Fischer Specialties	Cincinnati 6, Ohio
AG	Thomas A. Edison, Inc.	West Orange, N. J.	CS	Telefunken (c/o MVM, Inc.)	New York, N. Y.
AH	Fansteel Metallurgical Corp.	North Chicago, Ill.	CT	Potter-Brumfield Co.	Princeton, Ind.
AI	General Ceramics & Steatite Corp.	Keasbey, N. J.	CU	Cannon Electric Co.	Los Angeles, Calif.
AJ	The Gudeman Co.	Sunnyvale, Calif.	CV	Dynac, Inc.	Palo Alto, Calif.
			CW	Good-All Electric Mfg. Co.	Ogallala, Nebr.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Hewlett-Packard Company warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Klystron tubes as well as other electron tubes, fuses and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number and serial number. On receipt of this information, we will give you service data or shipping instructions.
2. On receipt of shipping instructions, forward the instrument prepaid, to the factory or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

All shipments of Hewlett-Packard instruments should be made via Truck or Railway Express. The instruments should be packed in a strong exterior container and surrounded by two or three inches of excelsior or similar shock-absorbing material.

DO NOT HESITATE TO CALL ON US

HEWLETT-PACKARD COMPANY

Laboratory Instruments for Speed and Accuracy

275 PAGE MILL ROAD

CABLE



PALO ALTO, CALIF. U.S.A.

"HEWPACK"

INSTRUCTION MANUAL CHANGES

MODEL 122A
OSCILLOSCOPE

ERRATA:

Section IV page 10, in Table 4-4, Test 5 column labeled ADJUST, first adjustment should be:

"Center spot with HORIZONTAL POS. control."

Section IV page 14, in Figure 4-2: interchange circuit designation of C233 and C235.

Section IV page 14, in paragraph 4-11, procedure 6 (Channel A Attenuator Adjustment), after adjustment of "C3 on channel A attenuator for minimum deflection" add: "Set both A and B VERT. SENSITIVITY switches to 1 VOLTS/CM and adjust C6 on channel A attenuator for minimum deflections."

Section IV page 15, in paragraph 4-12, procedure 3 (Horizontal Amplifier Adjustments), change to read: "Connect 'sawtooth generator' to channel B vertical input terminals."

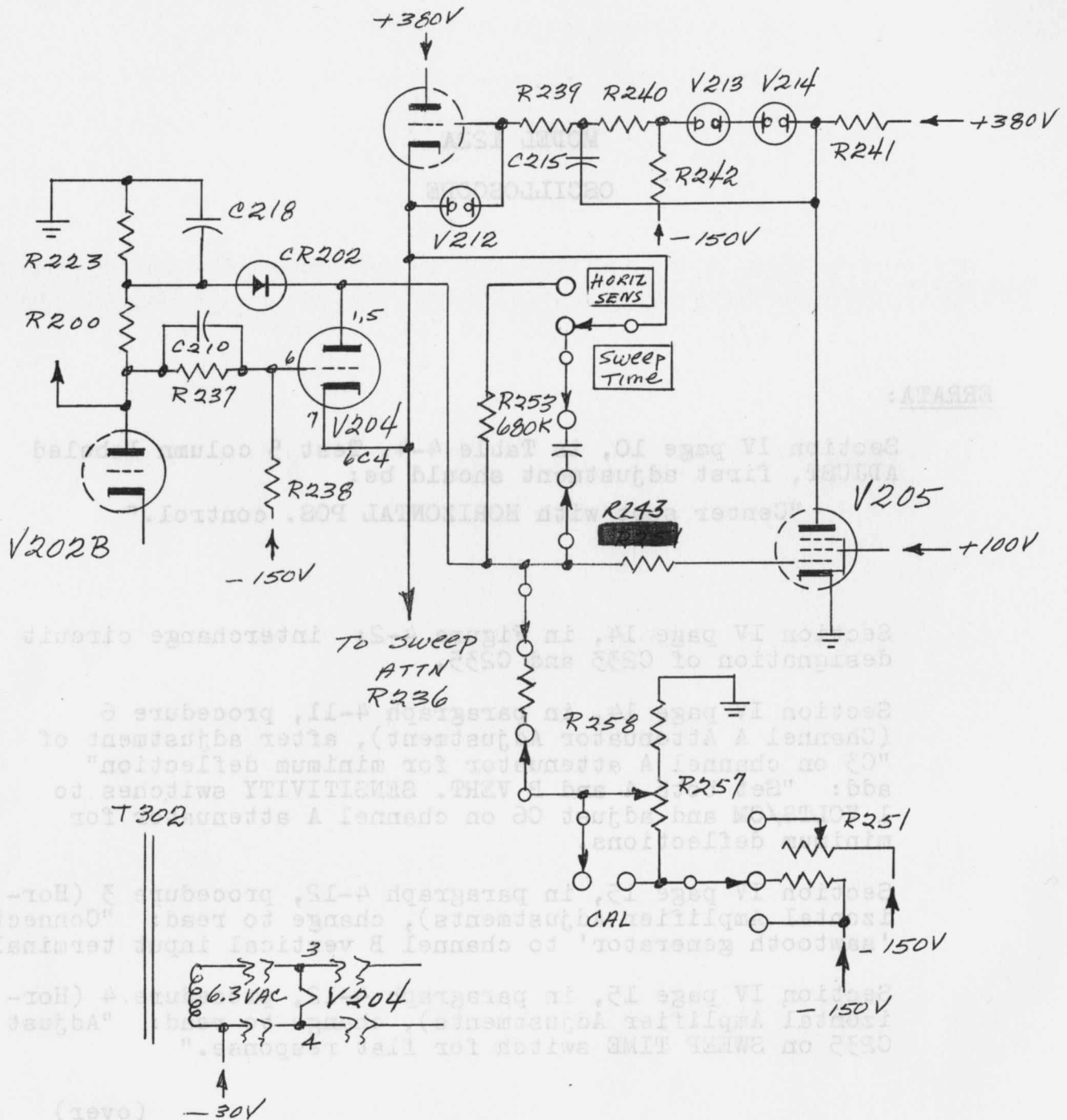
Section IV page 15, in paragraph 4-12, procedure 4 (Horizontal Amplifier Adjustments), change to read: "Adjust C235 on SWEEP TIME switch for flat response."

(over)

9/16 - 122A
122A - 5/28

HEWLETT - PACKARD CO.

Serial 651 and above:



3/16 - 122A
122A - 3/18

Serial 651 and above: (see partial schematic on page 2)

CR202: Add diode, breakdown; -hp- Stock No. G-29E-2, Mfr., HP
P301: Change to power cord; -hp- Stock No. 812-106, Mfr., HP
R121: Change to resistor, fixed, composition, 10,000 ohms
+10%, 2 W; -hp- Stock No. 25-10K, Mfr., B
R253: Change to resistor, fixed, composition, 680,000 ohms
+10%, ½ W; -hp- Stock No. 23-680K, Mfr., B
R360: Delete
V204: Change to tube, electron, 6C4; -hp- Stock No. 212-6C4,
Mfr., O
V215
thru
V217: Delete

Serial 651 and above: (see partial schematic on page 2)

- CR202: Add diode, breakdown; -hp- Stock No. G-29E-2, Mfr., HP
- P301: Change to power cord; -hp- Stock No. 812-106, Mfr., HP
- R121: Change to resistor, fixed, composition, 10,000 ohms
±10%, 2 W; -hp- Stock No. 25-10K, Mfr., B
- R253: Change to resistor, fixed, composition, 680,000 ohms
±10%, ½ W; -hp- Stock No. 23-680K, Mfr., B
- R360: Delete
- V204: Change to tube, electron, 6C4; -hp- Stock No. 212-6C4,
Mfr., O
- V215
thru
V217: Delete
- T301: Change to transformer, high voltage; -hp- Stock
No. 120A-11A-1, Mfr., HP
- T302: Change to transformer, power; -hp- Stock No. 910-177,
Mfr., HP

10-14-59

11/23 - 122A

