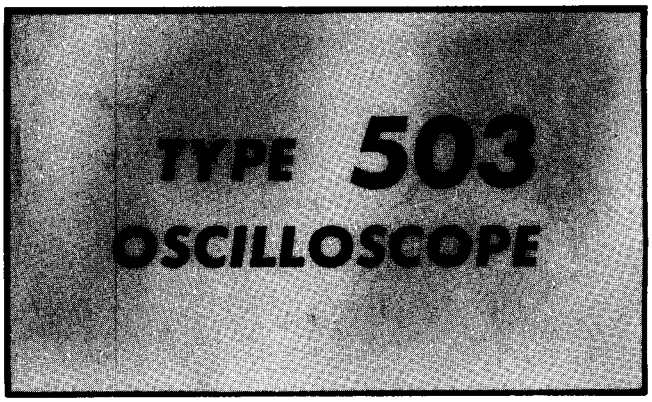
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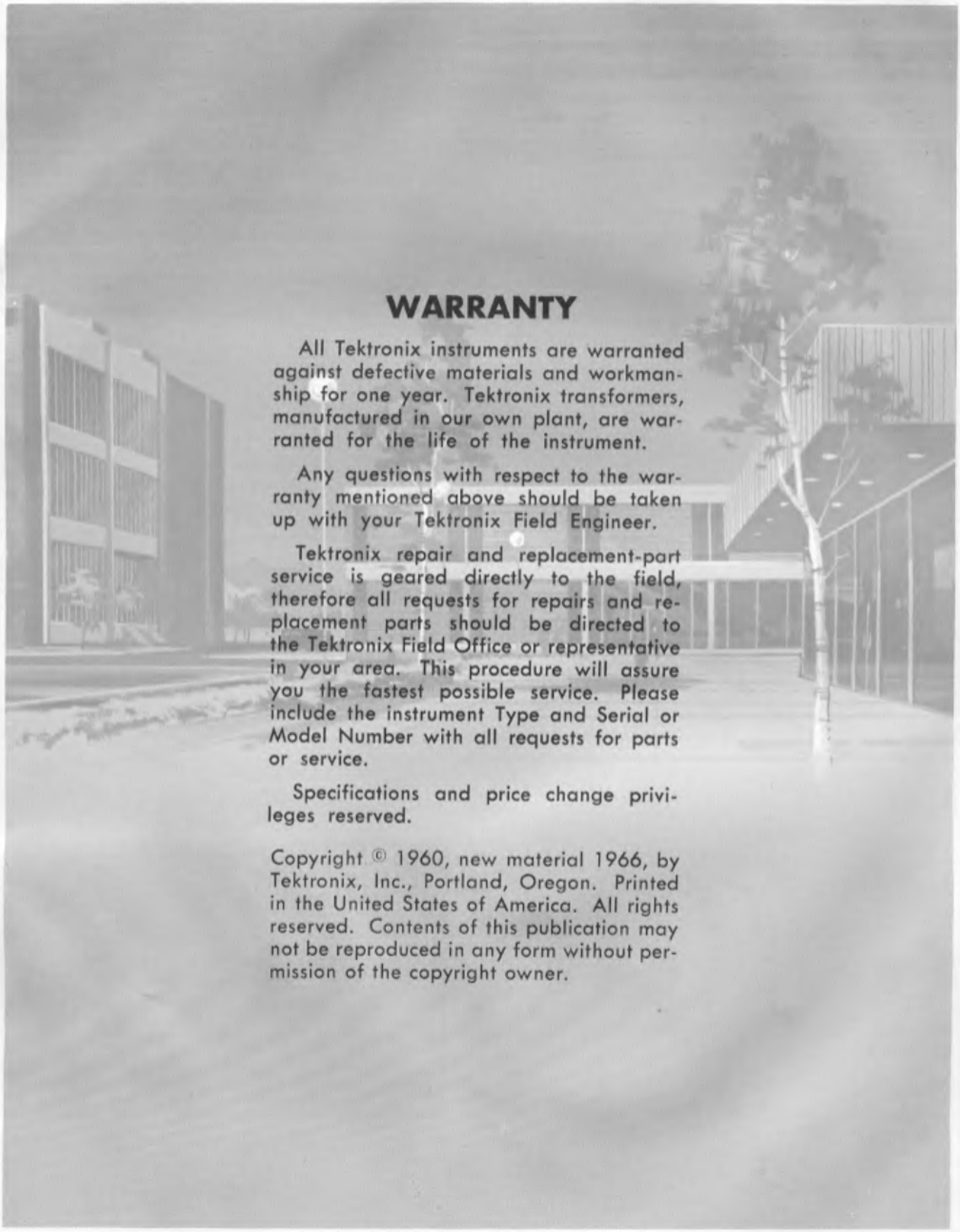
Serial Number _____



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070-0218-01

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WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial or Model Number with all requests for parts or service.

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Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

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Fig. 1-1. Type 503 Oscilloscope.

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SECTION 1

CHARACTERISTICS

Introduction

The Tektronix Type 503 Oscilloscope is a low-frequency, high-sensitivity laboratory instrument providing accurate measurements in the range from DC to 450 kHz. Identical vertical and horizontal amplifiers may be used for accurate curve plotting in the X-Y mode of operation. Both amplifiers may be operated with single-ended inputs for conventional operation, or with differential inputs for cancellation of common-mode signals. Sweep rates to 1 microsecond per centimeter, combined with sweep magnification factors to 50, provide effective calibrated sweep rates to 0.1 microsecond per centimeter.

VERTICAL AND HORIZONTAL AMPLIFIERS

Characteristic	Performance Requirement		Supplemental Information
Bandwidth			
DC Coupled	DC to 450 kHz		
AC Coupled LF Response	≤10 Hz		LF −3 dB ≤ 1 Hz with 10:1 probe
Rounding, ringing, overshoot and tilt	±2%		
Deflection Factor	±3%, 1 mV to 20 V/CM		Steps in 1, 2, 5 sequence
Variable	Ratio ≥2.5:1		
Common Mode Rejection			
Sensitivity (V/CM)	Rejection Ratio	Common-mode Signal	
1 mV to .2 V	100:1 min	4 V(P to P) max	DC input coupling with ≤50 kHz sine wave (With AC coupling, 1 kHz to 50 kHz)
.5 V to 2 V	30:1 min	40 V(P to P) max	
5 V to 20 V	30:1 min	400 V(P to P) max	
Phasing	≤1° (1 mV/CM to .2 V/CM) to 450 kHz		With equal X and Y sensitivities, Variable Control in CALIBRATED position, like polarities, and DC input coupling
	≤2° (0.5 V/CM to 20 V/CM) to 50 kHz		
Maximum Input Voltage	350 V (DC + peak AC)		
Input R and C	Approximately 1 megohm ±1.5% Paralleled by 47 pF ±2%		
Warm-up Time	Meets required accuracies after 20 minutes		

SWEEP GENERATOR

Time Base		
Calibrated Sweep	Accuracy within ±3%, 1 μs to 5 s/cm	Steps in 1, 2, 5 sequence
Magnifier	Accuracy within ±5% when magnified sweep rate does not exceed .1 μs/cm	×2, ×5, ×10, ×20, and ×50 magnifications available
Variable Range	Ratio ≥2.5:1	

TRIGGERING

Trigger Sensitivity		
Internal AC	0.5 cm 50 Hz to 50 kHz, increasing to 2 cm at 450 kHz	
DC	0.5 cm to 50 kHz, increasing to 2 cm at 450 kHz	
AUTO	0.8 cm 50 Hz to 50 kHz, increasing to 2.5 cm at 450 kHz	Approximately 50 Hz with no signal
External AC	0.5 V 50 Hz to 450 kHz	
DC	0.5 V to 450 kHz	
AUTO	0.5 V 50 Hz to 450 kHz	Approximately 50 Hz with no signal
Trigger Level Range	±9 V	

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CALIBRATOR

Characteristic	Performance Requirement	Supplemental Information
Amplitude		
500 mV	Accuracy within ±3%	
5 mV	Accuracy within ±3%	
Repetition Rate	350 Hz ±50%	
Duty Cycle	30 to 70%	

CRT DISPLAY

Tube Type	T-5030-2	
Z-axis	Intensity modulation with 10-volt signal, frequency from approximately 1 kHz to 450 kHz	With normal viewing intensity

POWER SOURCE

AC Voltage Range		
50-60 Hz	105-125 V or 210-250 V	
400 Hz	112-132 V or 224-264 V	
800 Hz	120-140 V or 240-280 V	
Maximum Power Input	120 W	≈100 W (115 V at 60 Hz)

MECHANICAL

Characteristic	Information
Construction	Aluminum alloy chassis and cabinet
Finish	Anodized panel, blue vinyl-finish cabinet
Dimensions	21¼" long, 9¾" wide, 13½" high

ACCESSORIES

A list of accessories that may be used with this Oscilloscope may be found at the rear of this instruction manual on the last fold-out page of the Mechancial Parts List Illustrations.

SECTION 2

OPERATING INSTRUCTIONS

General

To use the Type 503 effectively, the operation and capabilities of the instrument must be known. This section describes the operation of the front-panel and rear-panel controls and connectors, gives first time and general operating information and lists some basic applications for this instrument.

Power Requirements

The Type 503 line transformer primary can be wired for either 117-volt or 234-volt operation, at a line frequency of 50 to 60 Hz. At this line frequency, regulation of the power supply will be obtained at line voltages between 105 volts and 125 volts when the line transformer is wired for 117-volt operation, and between 210 volts and 250 volts when the line transformer is wired for 234-volt operation. Fig. 2-3 shows the transformer connections required for each range of operation.

The Type 503 can be operated at any AC line frequency from 50 Hz to 800 Hz, although higher line voltages may be required at the higher line frequencies. See Fig. 2-1.

Fuse Requirements

A 1.25-ampere slow-blowing type fuse is used with 117-volt operation; for 234-volt operation, a 0.7-ampere slow-blowing type fuse is used.

CONTROLS AND CONNECTORS

The front panel of the Type 503 is shown in Fig. 2-2. Functions of all front panel controls and connectors are described in Table 2-1.

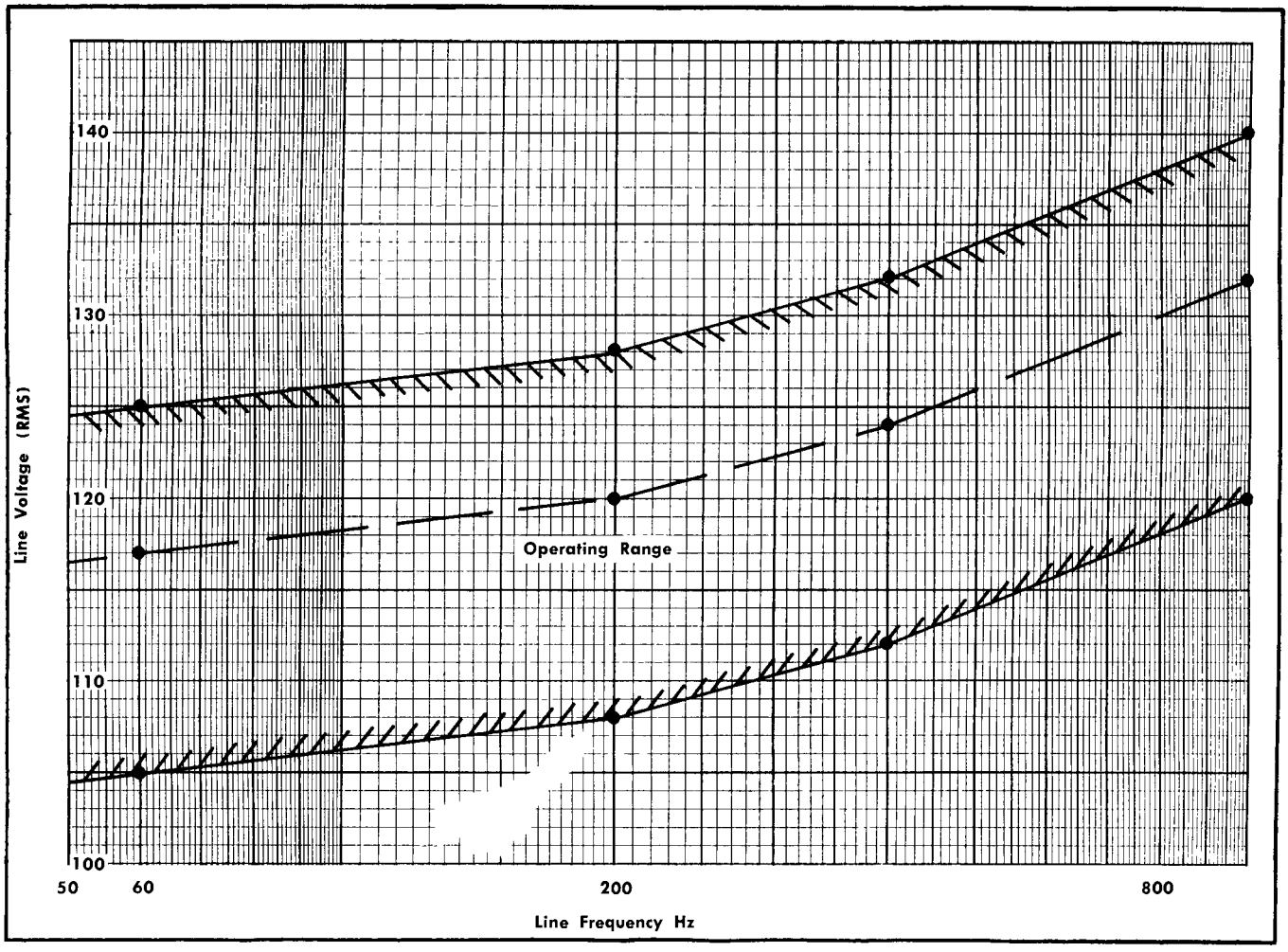


Fig. 2-1. Line voltage requirements at various line frequencies.

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TABLE 2-1

SLOPE	Determines whether triggering occurs on rising portion (+ slope) or falling portion (— slope) of triggering waveform.
COUPLING	Selects whether triggering will occur at a specific DC level or at an AC level.
SOURCE	Selects the source of the triggering signal.
EXTERNAL TRIG. IN	Input connector for external triggering signals.
LEVEL	Selects the voltage point on the triggering waveform at which the horizontal sweep is triggered. This control also selects automatic triggering (AUTO. position) or allows the sweep to free run (FREE RUN position.)
SWEEP TIME/CM	Selects the desired horizontal sweep rate from a choice of 21 calibrated steps.
SWEEP TIME/CM VARIABLE (red)	Provides a continuous range of sweep rates between the fixed steps selected by the SWEEP TIME/CM switch. (The sweep rates are calibrated only when the VARIABLE control is set fully clockwise to the CALIBRATED position.)
SWEEP STABILITY ADJUST	Provides for a stable presentation when the LEVEL control is in the AUTO. position.
FOCUS	Focuses the trace or spot on the screen.
ASTIGMATISM	Controls roundness of the spot on the screen. (This control is located inside on instruments with serial numbers 000270 and above).
INTENSITY	Controls the brightness of the trace or spot on the screen.
POWER AND SCALE ILLUM.	Turns instrument power on and off, and controls graticule illumination.
CAL. OUT connectors	Provide amplitude-calibrated square waves of 5 and 500 millivolts for use in calibrating gain of amplifiers.
HORIZONTAL DISPLAY	Selects conventional (horizontal sweep) or X-Y mode of operation. Also provides magnification of sweep rate selected by SWEEP TIME/CM control.
	VERTICAL CHANNEL
POSITION	Controls vertical positioning of the display on the screen.
SENSITIVITY	Selects the sensitivity of the Vertical Amplifier from 14 calibrated steps.
SENSITIVITY VARIABLE (red)	Provides a continuous range of sensitivity values between the fixed calibrated steps selected by SENSITIVITY control. (Normally, sensitivity is calibrated only when VARIABLE control is in CALIBRATED position.)
DC BAL.	Provides for vertical stability of no-signal trace for all positions of the SENSITIVITY control.
+INPUT and —INPUT connectors	Input connectors for signal to be displayed vertically. (Signals connected to the —INPUT connector will be displayed inverted.)
+INPUT and —INPUT switches	Select desired coupling for incoming signal.
	HORIZONTAL CHANNEL
DC BAL.	Provides for horizontal stability of no-signal trace for all positions of SENSITIVITY control.
SENSITIVITY	Selects the sensitivity of the Horizontal Amplifier from 14 calibrated steps.
SENSITIVITY VARIABLE (red)	Provides a continuous range of sensitivity values between the fixed calibrated steps selected by the SENSITIVITY control. (Normally, sensitivity is calibrated only when VARIABLE control is in CALIBRATED position.)
POSITION	Controls horizontal positioning of the display on the screen.
+INPUT and —INPUT connectors	Input connectors for signal to be displayed horizontally. (Signals connected to the —INPUT connector will be displayed inverted.)
+INPUT and —INPUT switches	Select desired coupling for incoming signal.

PRELIMINARY INSTRUCTIONS

To set up the Type 503 Oscilloscope for operation, proceed as follows:

1. Connect the oscilloscope to a suitable source of power and turn the POWER switch clockwise from the POWER OFF position. Set the INTENSITY control fully counterclockwise. Let the instrument warm up for about 15 minutes.

2. Set the HORIZONTAL DISPLAY switch to the HORIZ. AMPLIFIER position.

3. Set all of the INPUT switches to the GND position.

4. Set the two SENSITIVITY switches to the .2 VOLTS/CM position and the SENSITIVITY VARIABLE controls to the CALIBRATED position (fully clockwise until they snap into position).

5. Set both POSITION controls to midrange and advance the INTENSITY control to produce a spot on the screen. The INTENSITY control should be set to produce an easily seen, but not bright, spot. Too bright a spot may damage the phosphor on the face of the CRT. The intensity should never be turned up to the point where a halo forms around the spot.

6. Adjust the FOCUS control to produce the smallest, roundest spot possible. Note the position of the spot on the CRT.

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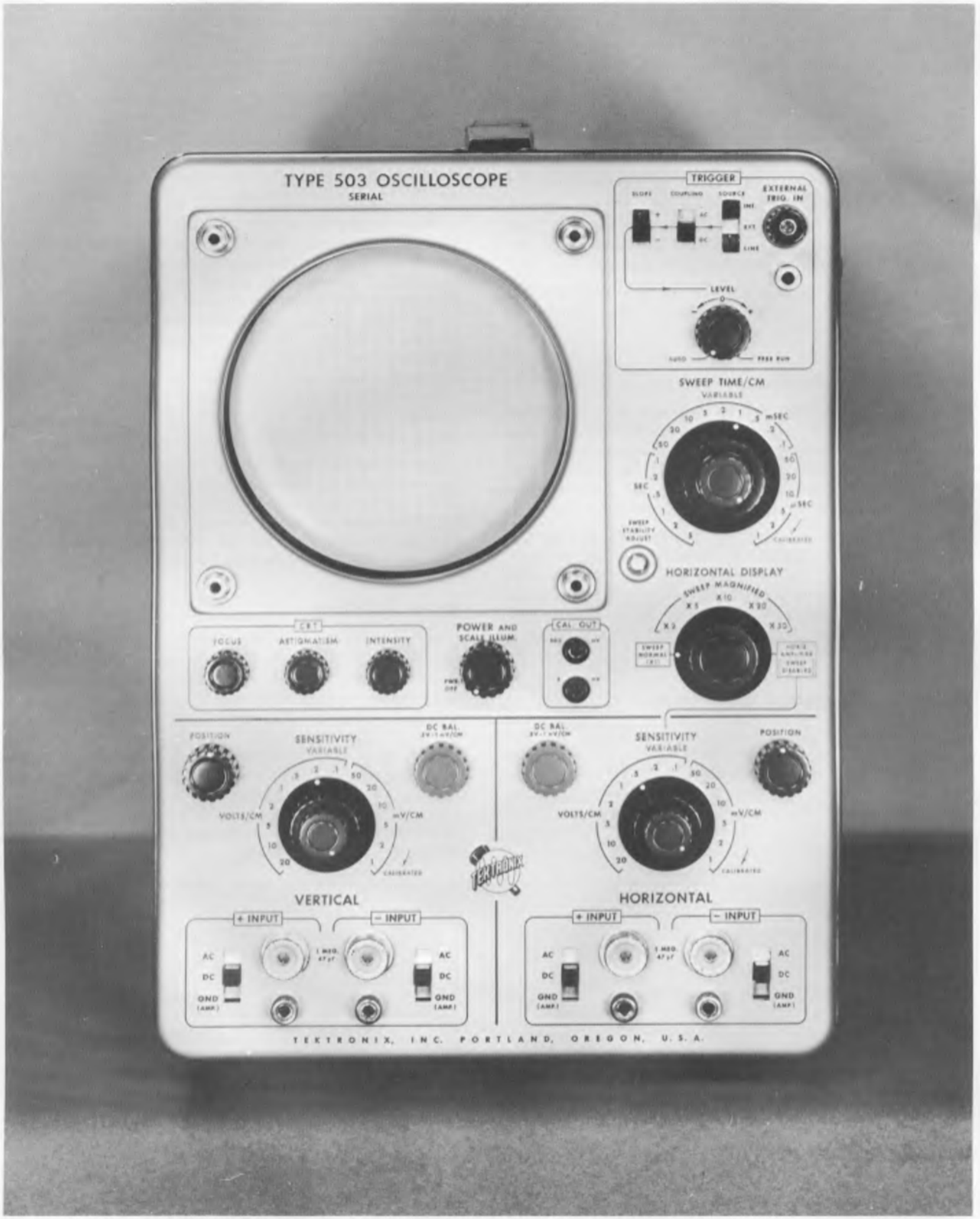


Fig. 2-2. Type 503 Oscilloscope front panel.

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7. Set the VERTICAL SENSITIVITY control to the 1 mV/CM position. Make sure that the SENSITIVITY VARIABLE control has remained in the CALIBRATED position.

8. With the VERTICAL DC BAL. control, move the spot back to where it was in step 6.

9. Set the HORIZONTAL SENSITIVITY control to the 1 mV/CM position. Make sure that the SENSITIVITY VARIABLE control has remained in the CALIBRATED position.

10. With the HORIZONTAL DC BAL. control, move the spot back to where it was in step 6.

11. Adjust both DC BAL. controls so that the spot does not move as the SENSITIVITY controls are moved from the .2 VOLTS/CM position to the 1 mV/CM position.

The amplifiers in the oscilloscope are now balanced and the oscilloscope is ready for operation as described in the remainder of this section.

Graticule Illumination

Graticule illumination can be adjusted to the ambient lighting conditions by means of the POWER AND SCALE ILLUM. control. Turning the control counterclockwise (but not to the PWR. OFF position) increases the graticule illumination. It is possible to extinguish the graticule illumination completely by turning the control fully clockwise.

The graticule of the Type 503 Oscilloscope can be illuminated so that it appears to have either red or white graticule markings. The markings can be changed from white to red or red to white simply by removing the graticule cover and rotating the graticule. As a general rule, white graticule lines are superior to red for photographic purposes.

INPUT SELECTION

Two INPUT connectors and associated INPUT switches are provided in each channel. When a single input signal is used, it may be applied through either the +INPUT or —INPUT connector. If the signal is connected to the +INPUT connector, the +INPUT switch should be placed in either the AC or DC position, depending upon the type of coupling desired. The —INPUT switch should be placed in the GND position. If the signal is connected to the —INPUT connector, the —INPUT switch should be placed in either the AC or DC position, and +INPUT switch should be placed in the GND position. It should be noted that when a signal is applied to the —INPUT connector of either channel, the display on the oscilloscope screen will be opposite in polarity to a normal presentation. Conventionally, a normal display places the more positive portions of a waveform in the vertical channel toward the top of the screen, and the more positive portions of a waveform in the horizontal channel toward the right-hand side of the screen.

When a display is desired which shows the difference between two signals, the signals are connected to the two INPUT connectors of the appropriate channel. In this case, both INPUT switches are placed in either the AC or DC position, depending on the type of input coupling desired. In this mode of operation, (called the "differential" mode), the two signals are added algebraically, and the difference is displayed as a single trace on the screen. It permits elimination of signals which are common to both inputs, and observation of a waveform which is peculiar to one of the signals. Figs. 2-4 and 2-5 show the effects of signal application to one or both INPUT connectors of the vertical channel.

The differential mode of operation also makes possible the observation of current changes in a circuit. The changes in the voltage drop across a given resistor are proportional to the changes in current through it, so a differential display of the voltages at the two ends of a resistor will show the changes in current through the resistor.

Input Coupling

Input signals to both the vertical and horizontal channels can be either AC or DC coupled by placing the corresponding INPUT switches in the appropriate positions. DC coupling applies both the AC and DC components of the input signal to the amplifier circuits. This permits measurement of the DC voltage level as well as the amplitude of the AC component. However, it is sometimes neither necessary nor desirable to display the DC component, and in such cases, AC coupling should be used. With AC coupling, a capacitor is placed in series with the INPUT connector to block the DC component while allowing the AC component to be displayed.

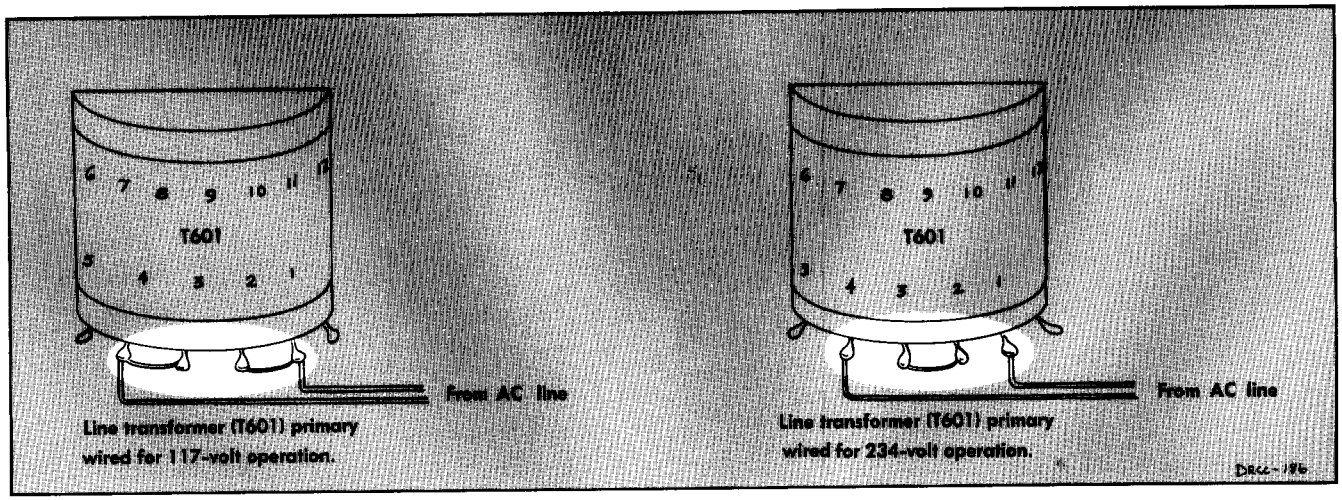


Fig. 2-3. Line transformer wired for 117- and234-volt operation.

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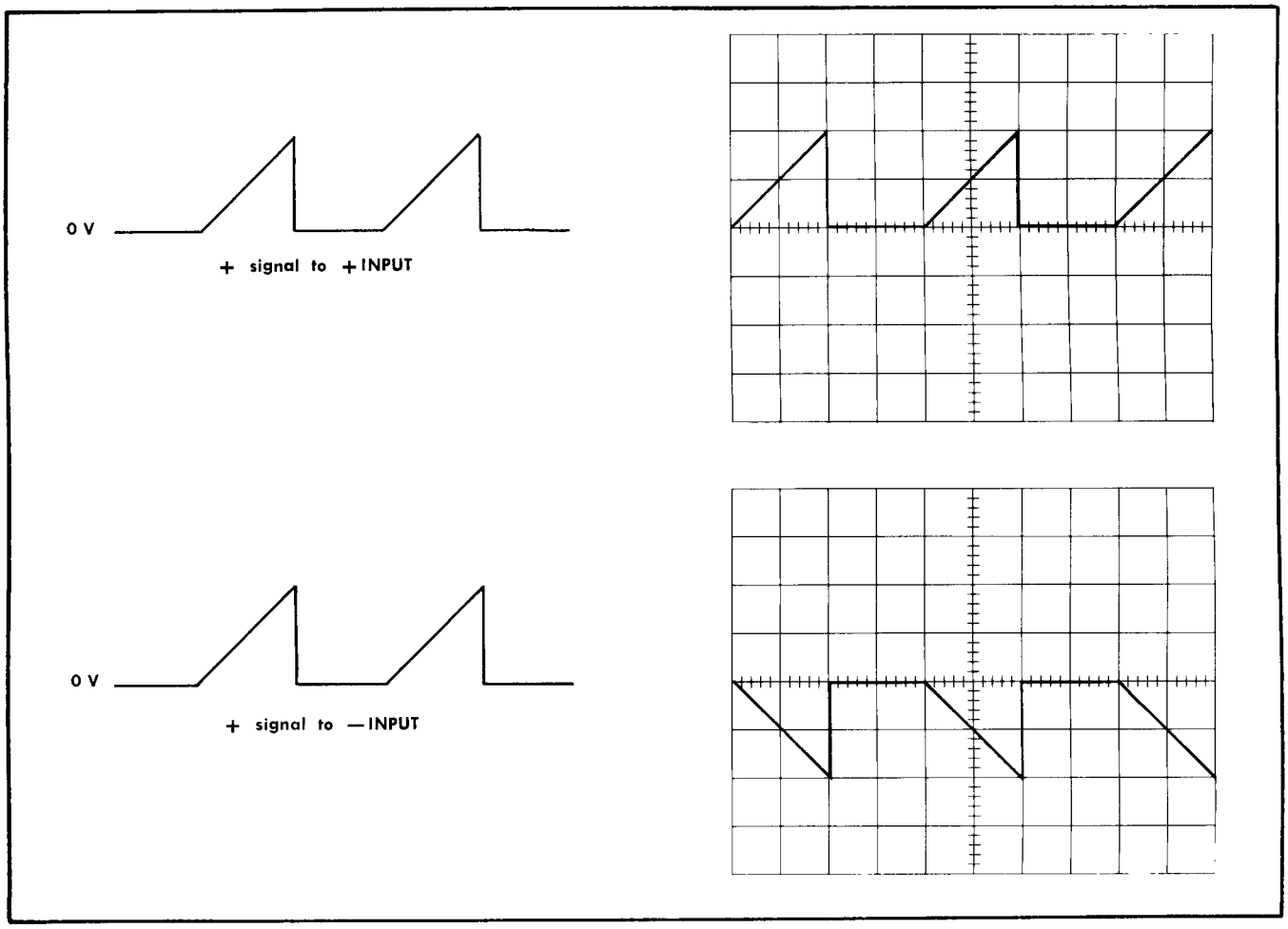


Fig. 2-4. Inputs to the vertical amplifier. Waveforms applied to the +INPUT connector are displayed in the upright position, while waveforms applied to the —INPUT connector are inverted.

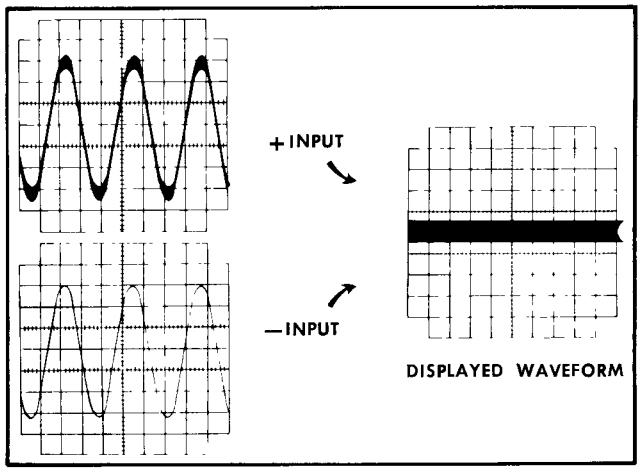


Fig. 2-5. Rejection of a common mode signal by the differential amplifier. The waveform applied to —INPUT connector is inverted and algebraically added to the waveform applied to +INPUT connector. The resultant waveform is displayed on the screen of the CRT.

CONVENTIONAL OSCILLOSCOPE OPERATION

Placing the HORIZONTAL DISPLAY switch in the SWEEP NORMAL position prepares the Type 503 for conventional oscilloscope operation. In this mode of operation, an internally generated horizontal sweep is applied through the horizontal amplifier to the horizontal deflection plates of the CRT, and the input signal is applied through the vertical amplifier to the vertical deflection plates.

The Type 503 allows selection, with the SWEEP TIME/CM control, of any one of 21 calibrated sweep rates, ranging in steps from 1 microsecond to 5 seconds per centimeter. The SWEEP TIME/CM VARIABLE control allows a continuous range of sweep rates between the steps selected by the SWEEP TIME/CM control; however, all sweep rates obtained with the SWEEP TIME/CM VARIABLE control in any position except fully clockwise are uncalibrated.

Sweep Triggering

In order to obtain a stable display, the horizontal sweep must start at the same time relative to recurring cycles of the input waveform. The sweep, therefore, must be triggered by the input waveform itself or by some waveform

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which bears a fixed time relationship to the input waveform. The following instructions show how to select and use the proper triggering signal for various applications of the oscilloscope.

Selecting the Trigger Source

For most applications the sweep can be triggered by the input waveform. The only requirement is that the input signal be large enough to provide at least 0.5 centimeter of deflection on the screen at the sensitivity level for which the VERTICAL SENSITIVITY control is set. To obtain triggering of the sweep from the input waveform, set the SOURCE switch to the INT. position.

Sometimes it is advantageous to trigger the sweep with some external signal. This is especially true when the input waveform is of such small magnitude that it cannot provide stable triggering of the sweep by itself. External triggering is also useful where waveforms are to be sampled from several different places within a device. By using external triggering, it is not necessary to reset the triggering controls each time a new waveform is shown. In order to obtain a stable display, it is necessary that the external waveform bear a fixed time relationship to the input waveform. To use an external waveform for triggering the horizontal sweep, connect the signal to the EXTERNAL TRIG. IN connector and set the SOURCE switch to the EXT. position.

When observing a waveform which bears a fixed time relationship to the line frequency, the sweep may be triggered from the line-frequency waveform. To do this, set the SOURCE switch in the LINE position.

Selecting the Trigger Coupling

For most recurrent waveforms, AC coupling of the triggering signal (COUPLING switch in the AC position) will provide satisfactory triggering of the sweep. DC coupling of the triggering signal (COUPLING switch in the DC position) is particularly useful in triggering from random pulse trains or very low frequency waveforms. With DC coupling the sweep is triggered when the waveform reaches a preset level (established by the Trigger LEVEL control). With AC coupling the sweep is triggered when the signal reaches a given amplitude from its average level.

Selecting the Trigger Slope

When the SLOPE switch is in the + position, the sweep is triggered on a positive-going slope of the triggering signal. When the SLOPE switch is in the — position, the sweep is triggered on a negative-going slope of the triggering signal. In most cases, selection of the triggering slope is not critical since triggering on either slope will provide a display which is suitable.

Selecting the Trigger Level

The LEVEL control determines the point, (AC or DC, depending upon the setting of the COUPLING switch) on the triggering signal at which the sweep is triggered. With the SLOPE switch in the + position, adjustment of the LEVEL control makes it possible to trigger the sweep consistently at virtually any point on the positive-going slope of the triggering signal. Likewise, with the SLOPE switch in the — position, adjustment of the LEVEL control makes it possible to trigger the sweep consistently at virtually any point on the negative-going slope of the triggering signal. Fig. 2-6 shows the effects of the LEVEL control and the SLOPE switch.

At the extreme clockwise and counterclockwise ends of its range, the LEVEL switch activates, respectively, the FREE RUN and AUTO. switches. The effects of these switches are discussed in the following paragraphs.

Automatic Mode of Operation

Setting the LEVEL control fully counterclockwise to the AUTO. position sets the Type 503 Oscilloscope up for an automatic mode of triggering which is suitable for most applications. In this mode, the triggering signal is AC coupled, and the triggering level is automatically set such that any external triggering signal of one volt or more, or internal triggering signal which will produce 1 centimeter or more of deflection on the CRT screen, will trigger the sweep. In the absence of such a triggering signal, the sweep will continue to be triggered automatically at about a 50-Hz rate to produce a base line which indicates that the instrument is adjusted to display any signal which might be connected to the vertical channel.

Free-Running Mode of Operation

Setting the LEVEL control fully clockwise to the FREE RUN position produces a free-running sweep, independent of any synchronizing signal. The frequency of the free-running sweep is dependent upon the setting of the SWEEP TIME/CM control. This free-running trace is useful as a base line from which to make DC measurements when the input signal is DC coupled.

Magnification of the Sweep

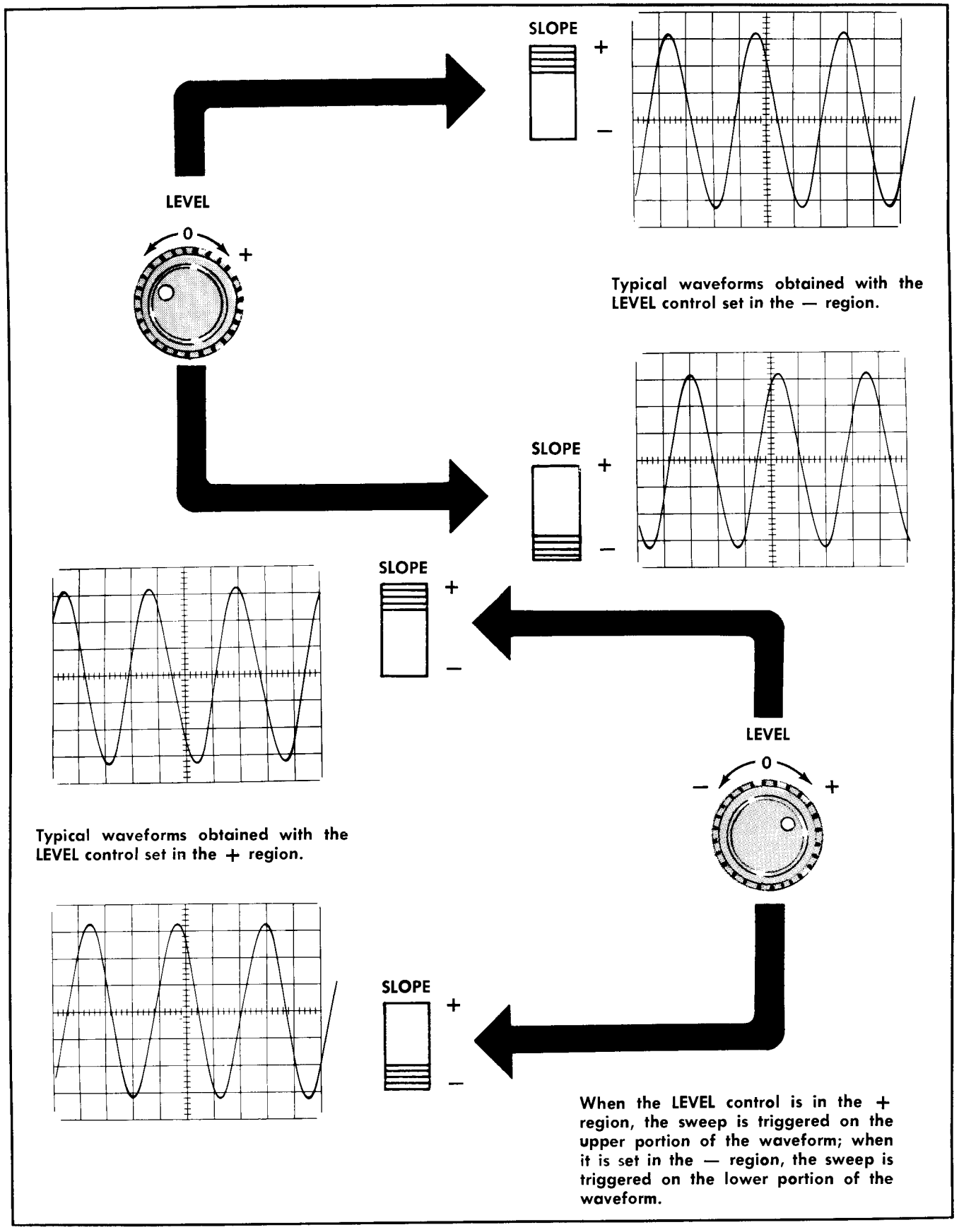
Any part of the trace may be expanded horizontally by as much as 50 times through the use of the SWEEP MAGNIFIED portion of the HORIZONTAL DISPLAY switch. To expand a given portion of the sweep, first set that portion to the center of the graticule by means of the HORIZONTAL POSITION control. Then set the HORIZONTAL DISPLAY switch to the desired degree of magnification.

In magnified sweep operation, the sweep rate is increased by a factor indicated by the HORIZONTAL DISPLAY switch. For example, if the SWEEP TIME/CM switch is set to 5 μSEC and the HORIZONTAL DISPLAY switch is set to ×10, the true sweep rate is 0.5 microsecond per centimeter.

NOTE

Magnified sweep rates to 0.1 microsecond/cm are accurate to within 5%. Combinations of the SWEEP TIME/CM and HORIZONTAL DISPLAY switches can produce sweep rates in excess of 0.1 microsecond/cm; at these faster sweep rates, calibration tolerance may exceed 5%.

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Typical waveforms obtained with the LEVEL control set in the — region.

Typical waveforms obtained with the LEVEL control set in the + region.

When the LEVEL control is in the + region, the sweep is triggered on the upper portion of the waveform; when it is set in the — region, the sweep is triggered on the lower portion of the waveform.

Fig. 2-6. Effects of the LEVEL control and SLOPE switch.

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X-Y MODE OF OPERATION

Placing the HORIZONTAL DISPLAY switch in the HORIZ. AMPLIFIER position sets the Type 503 Oscilloscope up for X-Y operation. In this mode of operation, input signals may be applied to both the horizontal and vertical amplifiers, and the display is a graph of the waveform on one channel versus the waveform on the other channel. The horizontal sweep is disabled. Examples of the use of the X-Y mode of operation are the plotting of hysteresis loops, of voltage across a semiconductor versus current through it, and of force or pressure versus deformation or strain in a material. Use can be made of the differential input feature on one or both channels.

APPLICATIONS

The following paragraphs describe procedures for making measurements of voltage, elapsed-time, and phase-shift with the Type 503 Oscilloscope. No attempt has been made to describe any but the most basic techniques. Familiarity with the instrument will enable the operator to apply the essence of these techniques to a wide variety of applications.

Voltage Measurements

To measure the AC component of a signal, proceed as follows:

1. Display the waveform over as large a portion of the screen as possible by adjusting the appropriate SENSITIVITY control.

2. With the aid of the graticule, measure the distance (in centimeters) between the two points on the waveform between which the voltage measurement is desired. This will be a vertical measurement where the waveform to be measured is applied to the vertical channel, a horizontal measurement where the waveform to be measured is applied to the horizontal channel. Make sure that the appropriate VARIABLE control is in the CALIBRATED position. On small voltage measurements, the width of the trace can make up an appreciable part of the entire measurement. For this reason, it is important to take all readings in a given measurement from the same side of the trace.

3. Multiply the distance between the two points by the setting of appropriate SENSITIVITY control and by the attenuation factor, if any, of the probe. This is the voltage between the two points on the waveform.

To measure the DC level at some point on a signal, proceed as follows:

1. Set the INPUT switch for the channel in use to the GND position.

2. If the horizontal sweep is being used, rotate the LEVEL control fully clockwise to the FREE RUN position to produce a free-running trace. If the oscilloscope is being used in the X-Y mode of operation, the signal on the other channel will produce a trace.

3. With the appropriate POSITION control, position the trace so that it lies along one of the lines of the graticule. This line will be used as a ground reference; its position in any given case will depend upon the polarity and amplitude of the input signal to be measured. Do not adjust this POSITION control after the reference line has been established.

4. Set the INPUT switch mentioned in step 1 to the DC position. If the horizontal sweep is being used, adjust the LEVEL control for a stable display.

5. Measure the distance, in centimeters, from the ground reference line established in step 3 to the point at which the DC voltage level reading is desired.

6. Multiply this distance by the setting of the appropriate SENSITIVITY control and the attenuation factor, if any, of the probe. This is the DC level of the point measured.

Time and Frequency Measurements

To measure the time interval between two points on a waveform, proceed as follows:

1. Set the oscilloscope up for conventional operation with the signal applied to either of the vertical INPUT connectors.

2. With the aid of the graticule, measure the horizontal distance, in centimeters, between the two points whose interval you wish to find. Make sure that the SWEEP TIME/CM VARIABLE control is in the CALIBRATED position.

NOTE

When making time measurements from the graticule, the area between the 1-cm and 9-cm graticule lines provides the most accurate time measurement in the specified area (see Fig. 2-7). Therefore, the first and last centimeters of the display should not be used for making accurate time measurements. Position the display area to be timed so the timing area starts at the first centimeter graticule line. Set the SWEEP TIME/CM switch so the end of the display timing area falls between the first and ninth cm graticule lines.

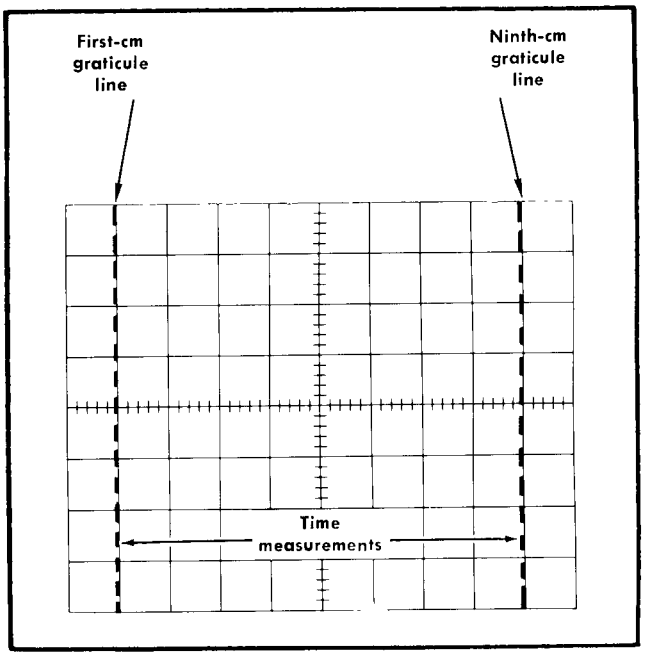


Fig. 2-7. Area of graticule used for obtaining accurate time measurements.

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3. Multiply the disance measured by the setting of the SWEEP TIME/CM control and divide by the setting of the HORIZONTAL DISPLAY switch (×1, ×2, ×5, etc.). This is the time interval between the two points measured.

NOTE

Errors caused by a lack of resolution can be reduced by expanding the displayed waveform for a 1-cycle presentation between the first and ninth graticule lines.

To determine the frequency of a recurrent waveform, simply take the reciprocal of the time interval between corresponding points on two consecutive cycles of the waveform.

Phase-Shift Measurements

To measure the phase shift produced in a given signal by some device, proceed as follows:

1. Set up the oscilloscope for conventional externally triggered operation with the signal at the input to the phase-shifting device applied to either of the vertical INPUT connectors.

2. Horizontally position the display so that an easily identifiable point of a cycle corresponds to one of the vertical graticule lines.

3. Without making any adjustments to the oscilloscope, move the signal probe from the input to the output of the device under test. If there is phase shift in the device, the displayed waveform will be shifted horizontally.

4. Measure the amount of horizontal shift of the display in centimeters.

5. Measure the distance in centimeters between corresponding points on two consecutive cycles of the waveform.

6. Divide the measurement obtained in step 4 by the measurement obtained in step 5 and multiply the result by 360°. This is the phase shift produced in the signal by the device under test.

A second method for comparing the phase relationship of two signals of the same frequency makes use of the X-Y mode of operation (HORIZONTAL DISPLAY switch set to HORIZ. AMPLIFIER, SWEEP DISABLED). This method is suitable only when comparing two sine waves.

1. Applying the sine waves to the two +INPUT connectors. The display will be an ellipse. (Actually, the display will appear as a diagonal straight line if the two sine waves are inphase or exactly 180° out of phase, or it will appear as a circle if the two sine waves are exactly 90° or 270° out of phase. Application of these instructions, however, will still apply.)

2. Center the ellipse horizontally and vertically on the CRT screen.

3. Measure the distances A and B on the display as shown in Figure 2-8.

A/B is equal to the sine of the phase difference between the two signals (Sin $\phi = \frac{A}{B}$).

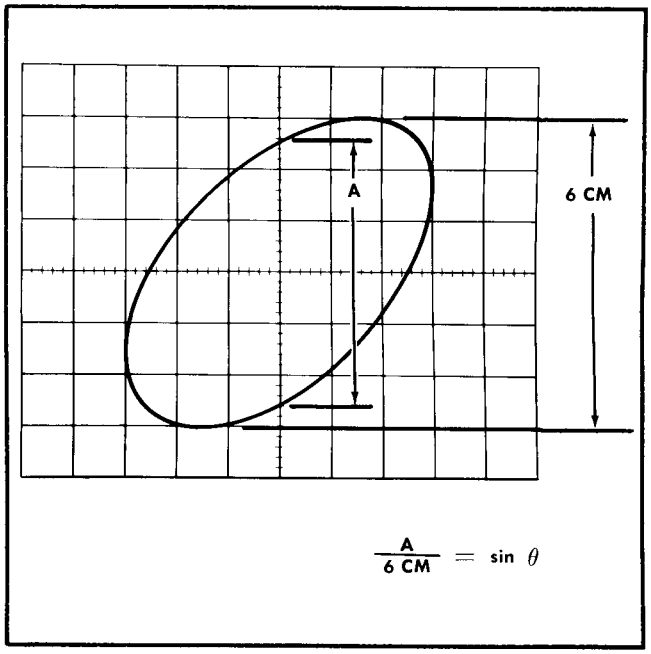


Fig. 2-8. X-Y method of calculating phase difference (Θ) of two sine waves.

Direct Connection to the CRT Plates

In some applications it may be desirable to connect a signal directly to one or both sets of CRT deflection plates, bypassing the internal oscillscope amplifiers. The vertical deflection plate pins are located on the side of the neck of the CRT, and the horizontal deflection plate pins are located at the bottom of the neck of the CRT.

With a signal connected directly to the CRT pins, it is possible, under optimum impedance matching conditions and with connections kept as short as possible, to obtain a bandwidth on the order of 100 MHz with the Type 503. However, limitations of the sweep magnifier at the faster sweep rates discussed earlier in this section must be kept in mind when making risetime measurements on fast-rise waveforms. The vertical and horizontal deflection factors of the CRT are approximately 20 volts per centimeter and 16 volts per centimeter, respectively.

The diagram in Fig. 2-9 shows how a signal may be AC coupled to the CRT deflection plates. This method of AC coupling permits the use of front panel controls to position the display on the screen. The SENSITIVITY control of the bypassed amplifier should be placed in the 20 VOLTS/CM position, and both INPUT switches should be placed in the GND position. The value of the capacitors shown in Fig. 2-9 will depend upon the characteristics of the signal to be displayed.

To DC couple a signal to the deflection plates, remove the amplifier leads and connect the signal directly to the CRT pins. Tape the ends of the loose amplifier leads to prevent accidental shocks to operating personnel. For best performance, the average of the voltages at the two plates must be kept close to +150 volts: otherwise, the display will be defocused and slightly bowed, and the sweep rate, if the sweep is used, will not be accurate. Actually, if these

effects can be tolerated, it is possible to have both plates in the vicinity of ground and still obtain a useful display. Typically, the sweep rate is about 8% slow when a ground level signal is connected to the vertical deflection pins.

Care should be exercised in connecting and disconnecting the CRT pin leads, as the pins can be easily bent or broken.

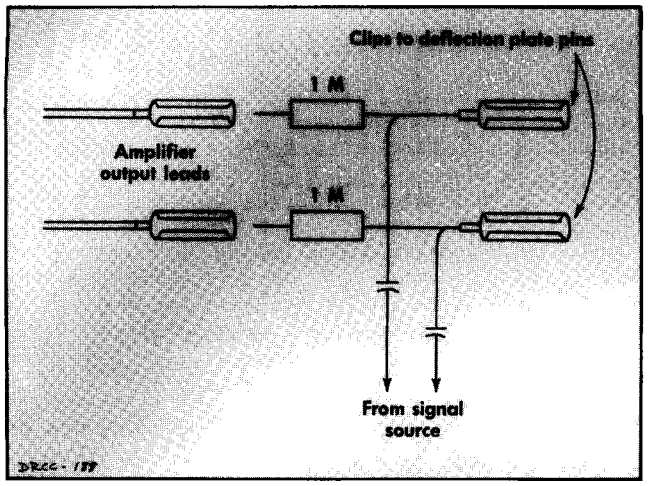


Fig. 2-9. Typical circuit for AC coupling to the CRT deflection plates.

USE OF PROBES

Use of an attenuator probe with the Type 503 will reduce the capacitive and resistive loading on a circuit under test, but at the same time will also reduce the oscilloscope sensitivity.

As an example, a 10× probe such as the Tektronix P6006, connected to the Type 503 input, presents a characteristic input impedance of 10 megohms paralleled by approximately 9.5 pF, and has an attenuation factor of 10. Also, the voltage rating of the probe used must be considered. Exceeding this rating, either in DC volts or peak AC volts, may damage the probe.

When making amplitude measurements with an attenuator probe, be sure to multiply the observed amplitude on the CRT by the attenuation factor of the probe. If the waveform being displayed contains fast-changing signals, it will generally be necessary to clip the probe ground lead to the chassis of the equipment under test.

Probe Compensation

Most general-purpose probes use an adjustable capacitor to compensate for variations in input capacitance from one instrument to another, or between two input connectors of one instrument. To insure the accuracy of pulse and transient measurements, always check the compensation before using a probe. To check or adjust the probe compensation, display several cycles of the Calibrator waveform on the CRT by connecting a test lead between the 500 mV CAL. OUT connector and the VERTICAL +INPUT connector. For this display set the VERTICAL SENSITIVITY control to .1 VOLTS/CM, the +INPUT switch to DC, the Triggering LEVEL control to AUTO., and the —INPUT switch to GND.

Carefully observe the waveform display on the CRT, and particularly note the general shape of the leading corner of each positive pulse. Then disconnect the test lead between the CAL. OUT and +INPUT connectors, and connect the probe to the +INPUT connector. Set the VERTICAL SENSITIVITY control to 10 mV/CM and touch the probe tip to the 500 mV CAL. OUT connector. Square waves having the same amplitude as the previous display should now appear on the CRT. Carefully adjust the probe capacitance, if necessary, until the leading corners of the positive pulses have the same shape as those in the previous display.

To compensate the probe on the horizontal channel, a sawtooth sweep voltage must be applied to the vertical channel to obtain a vertical display of the calibrator waveform. The displayed waveform will then appear somewhat similar to that shown in Fig. 2-10. However, if both the horizontal and vertical input capacitances are adjusted correctly (47 pF), a probe compensated on the vertical channel will function properly on the horizontal channel. The procedure for checking the input capacitance is given in Section 6 under Adjust Attenuator Compensation.

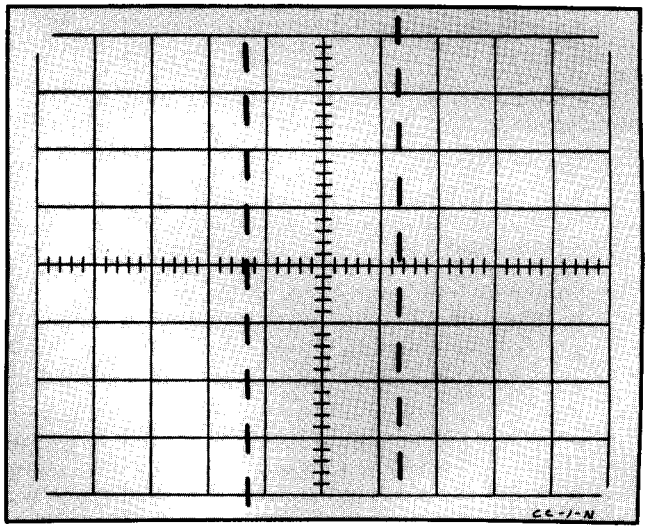


Fig. 2-10. Triggered vertical sweep.

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SECTION 3

CIRCUIT DESCRIPTION

Introduction

This section of the manual contains detailed circuit description and analysis. To follow the theory of circuit operation as presented, refer to the Schematic Diagram section in this manual.

VERTICAL AMPLIFIER

General Description

The Vertical Amplifier consists of two identical input circuits, two matching step attenuators, a two-stage Input Amplifier, and a DC-coupled push-pull Output Amplifier. The Input Amplifier first stage is made up of two hybrid feedback pairs which drive a DC-coupled push-pull Output Amplifier. Vertical sensitivity is controlled by step attenuation at the inputs, and by changing the gain of the Input Amplifiers. Variable attenuation is accomplished by degeneration in the cathode circuit of the Output Amplifier.

Input Circuits

The separate input connectors permit the Input Amplifier to be operated either single ended or as a differential amplifier. For single-ended operation, either input connector can be used, while the other input connector is grounded. Convenient input switches at each connector allow DC or AC coupling, or grounding of the inputs. The lower frequency limit of the amplifier with AC coupling is approximately 7.5 Hz (0.75 Hz with 10× probe).

In the 1 mV/CM to .2 VOLTS/CM positions of the SENSITIVITY switch, the signal is applied without attenuation to the grid circuit (or circuits) of the Input Amplifier; changes in sensitivity are accomplished by changing the Input Amplifier gain (i.e., switching R408). In the .5 VOLTS/CM to 2 VOLTS/CM positions of the SENSITIVITY switch, a ×10 attenuator network is inserted in addition to gain changing. In the 5 VOLTS/CM to 20 VOLTS/CM switch positions, a ×100 attenuation network is inserted in addition to gain changing.

The attenuating networks are composed of resistance and capacitance dividers. For DC and low-frequency signals, the attenuators act as resistance dividers, because the reactance of the capacitors at low frequencies is so high that their effect on the input signal can be neglected; at the higher frequencies, however, the lower capacitive reactance becomes effective. Near the upper frequency range of the amplifier, the reactance of the capacitors becomes so low that the attenuators are primarily capacitive dividers.

In addition to providing the correct degree of attenuation, the resistance values are chosen so that the input resistance is a constant 1 megohm shunted by 47 pF, regardless of the setting of the SENSITIVITY switch.

Input Amplifier

The operation of the Input Amplifier will be described using the amplifier with single-ended input.

NOTE

At Instrument Serial Number 6997, each half of the dual-triode input stage was replaced by a nuvistor-type triode, to improve the amplifier drift characteristics. Since circuit number designations were changed at the same time, reference to each half of the input stage will be made by association with the input to which it is connected; i.e., +INPUT grid or —INPUT grid.

The Input Amplifier consists of two high gain, feedback amplifiers, V434, Q454 and V444, Q464. Due to feedback the gain is one from V434 grid to the junction of R408, R419 and R436. The gain from V444 grid to the junction of R408, R419 and R446 is also one.

Note that Q454 and Q464 emitters are returned to a common point. The voltage at the common point is held virtually constant because as the current in Q454 is decreased the current in Q464 is increased a like amount. This fixed potential is reflected to V434 and V444 plate loads through Q454 and Q464 emitter-base junctions. If V434 and V444 plate loads see a constant voltage the current must be constant. Therefore, the current in V434 and V444 is held constant (changes in Q454 and Q464 base current will appear in V434 and V444 but is small enough to be ignored).

Assume that the +INPUT is grounded (+INPUT AC-DC-GND switch is in the GND position) and a positive going signal is applied to the —INPUT. Since the +INPUT is grounded and the gain from V444 grid to the junction of R408, R419 and R446 is one, the junction will not move when the positive going signal on V434 causes the junction of R408, R419 and R436 to move positive. A current is forced to flow through R408 and R419 but since the current in V434 and V444 cannot change, the current must come from Q464 and flow through R467, to R457 and Q454. The current change through R467 and R457 will force Q464 collector to move negative and Q454 collector to move positive. The ratio of the signal out (measured between Q454 and Q464 collectors) to signal in of the amplifier may be expressed as:

$$A = 1 + \frac{R457 + R467}{R^*} + \frac{R457}{R438}, \text{ where}$$

R* = R408 in parallel with R419. R438 appears in the equation because as R* becomes large (.05, .1 and .2 V ranges) R438 will contribute some current in R457, causing an increase in gain by the ratio $\frac{R457}{R438}$.

The second stage of the Input Amplifier is provided with a positive feedback path network from the collector of each side to the base of the other. This positive feedback increases the amplifier gain (open loop) to infinity, thus allowing the feedback components R457, R467 and R408

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to determine the amplifier gain. The amount of positive feedback is controlled by varying R460. The second stage provides its own driving current and none is diverted from the plate circuit of the first stage. The effect of R460 is most pronounced in the 1 mV/CM position of the SENSITIVITY switch since a higher open-loop gain is required in this postion.

Output Amplifier

The Output Amplifier stage (V474-V484) drives the deflection plates of the CRT. The gain of this stage is adjusted by means of the .2 V GAIN ADJ. R478 and the VARIABLE control R488.

Vertical positioning of the CRT beam is accomplished by a cross-connected dual POSITION control R470. Adjustment of this control increases the current through one tube while decreasing the current through the other tube, thereby changing the DC level at one output-tube plate in the opposite direction from the other. At the same time, a current (proportional to the POSITION control rotation) is applied to the feedback resistors R457 and R467 of the hybrid feedback pairs. This current causes the grid potential of V474 and V484 to change so that the cathode potentials remain constant. This assures that all of the current change in R476 also occurs in V474, and all of the current change in R486 occurs in V484. Thus no positioning current flows in R488, R478, and R479. Therefore, rotation of the VARIABLE SENSITIVITY control will not cause trace shift when the trace is anywhere on the CRT screen.

Sweep triggering is accomplished by sampling a portion of V474 output through a divider network consisting of R490, R491, and R492. When the SOURCE switch is in the INT. position, this signal is applied to the Trigger Input Amplifier.

HORIZONTAL AMPLIFIER

X-Y Operation

With the Type 503 set for X-Y operation (HORIZONTAL DISPLAY) switch in the HORIZ. AMPLIFIER (SWEEP DISABLED) position, the Horizontal Amplifier is virtually identical to the Vertical Amplifier. A given signal or signals applied to the Horizontal Amplifier input connectors will produce the same deflection as the same signal or signals applied to the Vertical Amplifier, but in the horizontal plane, rather than the Vertical plane. The HORIZONTAL DISPLAY switch disables the sweep by opening the cathode circuits of the Sweep Gating Multivibrator tubes, V135A and V145A. This mode of operation is used for plotting two time-related functions against one another.

Sweep Operation

In this mode of operation, the Horizontal Input Amplifier is connected for single-ended input, with one input grounded and the sawtooth waveform from the Sweep Generator applied to the other input. Neither of the input attenuators is connected in the circuit.

The feedback circuits which control the gain of the Horizontal Amplifier operate in the same manner for sweep operation, except that a different set of resistors is used in the Input Amplifier cathode circuit. Also, the VARIABLE control is shorted out by the HORIZONTAL DISPLAY switch, and one section of the dual POSITION control is removed from the circuit. Beam positioning is accomplished by using half of the POSITION control to change the current through the divider resistors R326 and R327, changing the DC level at the grid of V334.

SWEEP TRIGGER

The Sweep Trigger circuit consists of the Trigger Input Amplifier V24 and the Trigger Multivibrator V45. The Trigger Input Amplifier has the dual function of amplifying the triggering signal, or amplifying and inverting the triggering signal. The Trigger Multivibrator produces rectangular pulses whose leading edges are differentiated to produce negative spikes to trigger the Sweep Generator.

Trigger Source

Three trigger sources may be selected by means of the SOURCE switch. In the INT. position, the triggering signal is taken from the output of the Trigger Pickoff network of the Vertical Amplifier. In the EXT. position, the Trigger Input Amplifier is connected to the EXT. TRIG. IN connector on the front panel. In the LINE position, the Trigger Input Amplifier is connected to the 6.3 VAC heater winding terminal 10 of power supply transformer T601.

Trigger Slope

The negative-going pulse required at the output of the Trigger Multivibrator is produced only when a negative-going signal appears at the grid of the multivibrator input section (V45A). With the SLOPE switch in the — position, a negative-going signal at the grid of V24A appears at the plate of V24B as a negative-going signal. With the SLOPE switch in the + position, a positive-going signal applied to the grid of V24B is inverted, and appears as a negative-going signal at the input of the Trigger Multivibrator.

Trigger Level

The Trigger Input Amplifier operates as a comparator circuit as follows: with the SLOPE switch in the — position, the LEVEL control sets the DC level at the grid of V24B. When the grid of V24A is driven to the same level by the incoming signal, the plate of V24B passes through the hysteresis range of the multivibrator, and causes the multivibrator to switch states. With the SLOPE switch in the + position, the LEVEL control is connected to V24A grid and the signal appears on V24B grid. When the signal drives V24B grid to the same level as V24A grid (set by the LEVEL control), V248 plate will pass through the hystresis point of the Trigger Multivibrator, causing it to switch states.

Trigger Multivibrator

A cathode-coupled multivibrator (Schmitt circuit) is used to generate a fixed amplitude and risetime (period dependent on input signal period) square wave which is differentiated and used to start the sweep. When the LEVEL control

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is in AUTO, feedback is added to the circuit converting it to a free-running 50-Hz multivibrator. In the AUTO mode, the circuit recognizes trigger pulses that occur at a rate greater than 50 Hz. For these signals, it will function just as if the LEVEL control were set up for a stable display.

The operation of the circuit is as follows: assume that V45A is conducting and is ready to receive a triggering signal. When a negative-going signal from the plate of V24B arrives the grid of V45A is driven downward. Since the tube is conducting, the cathode is also driven downward, until a point is reached where the lowered cathode voltage permits current flow to start in V45B. At the same time, V45A begins to cut off. As V45A cuts off, a positive step appears at the plate of V45A which is coupled to the grid of V45B, causing V45B cathode to move more positive, cutting off V45A. The voltage level at V45A grid when this switching occurs is known as the lower hysteresis point of the Schmitt multivibrator. A negative step is produced at the plate of V45B when the multivibrator switches. This negative step is differentiated by C43 and R44 and used to initiate a sweep.

When the trigger signal goes positive, the reverse action takes place. As the grid of V45A goes positive, a point is reached where V45A begins to conduct and the current through V45B begins to decrease, causing a negative step at the plate of V45A. This negative step is coupled to the grid of V45B, driving it toward cutoff. As the grid of V45A goes more positive, and the cathode follows, the cathode of V45B also goes more positive, reinforcing V45B cutoff. When this switching occurs, V45A grid is at a voltage level known as the upper hysteresis point of the Schmitt multivibrator. A positive step is produced at the plate of V45B when the multivibrator switches. This positive pulse has no function and is bypassed by diode D44 to AC ground in the +250 volt power supply.

Automatic Triggering

NOTE

The action of the LEVEL control in AUTO position, which causes a free running Trigger Multivibrator, should not be confused with the action of the LEVEL control turned clockwise to the FREE RUN position. In the clockwise position, the FREE RUN switch permits the sweep generator to free run. This operation is explained under the operation of the Sweep Generator.

The AUTO position of the switch couples the grid of V45B to the grid circuit of V45A through R40, and removes the DC coupling between the Trigger Input Amplifier and the Trigger Multivibrator. The action of the multivibrator in this mode is similar to that described in the bistable mode, with the exception that a feedback network (C31 and R40) has been added.

AUTO operation can be described as follows: assume that V45A is conducting and V45B is cut off. In this state, V45B grid is negative with respect to V45A grid. Thus C31 will attempt to charge to the voltage level of V45B grid through R40. As C31 charges to this level, it moves V45A grid negative to the lower hysteresis point, causing the multivibrator to change states. (The action was described in the early part of the Trigger Multivibrator discussion.) In this new state, V45B grid is more positive than V45A grid. C31 will change its charge and move V45A grid toward the new more positive level on V45B grid. As V45A grid moves positive, it passes through the upper hysteresis point, causing the multivibrator to again switch states. This switching occurs at a rate of approximately 50 Hz. Hence, in the absence of a triggering signal, the multivibrator provides a trigger to the sweep generator a a rate of approximately 50 Hz. The sweep produced by this trigger provides a base line from which to make voltage measurements, and also indicates that the instrument is adjusted to display any signal that might be applied to the instrument.

SWEEP GENERATOR

The Sweep Generator, upon receipt of a trigger pulse from the Sweep Trigger, produces a linearly rising (sawtooth) voltage which is applied through the Horizontal Amplifier to the CRT deflection plates. This causes the spot to move from left to right on the CRT screen and form the sweep. The amplitude of the sawtooth voltage is about 100 volts. Its rate of rise is controlled by the values of the timing capacitor and timing resistor switched into the circuit by the SWEEP TIME/CM switch on the front panel.

The Sweep Generator consists of three main circuits; the Sweep-Gating Multivibrator, the Miller Runup Circuit, and the Hold-off Circuit. The Sweep-Gating Multivibrator consists of V135A, V135B, and V145A. The essential components of the Miller Runup Circuit are: the Miller Runup Tube, V160A; the Runup Cathode Follower, V160B; the Disconnect Diodes, V152A and D152 (V152A and V152B SN 101-4229); the Timing Capacitor, C160; and the Timing Resistor, R160. The Hold-Off Circuit consists of the Hold-Off Diode, V152B; the Hold-Off Cathode Follower, V145B; the Hold-Off Resistor, R181; and the Hold-Off Capacitor, C160 (the Hold-Off Circuit makes use of some of the same timing capacitors as the Miller Runup Circuit).

In the quiescent state, that is, when no sweep is being generated, V135A is conducting the V145A is cut off. The plate of V145A is at about —2.5 volts with respect to ground. The Disconnect Diodes are conducting and hold both sides of the Timing Capacitor at about —2.5 volts. With its cathode grounded and its grid at —2.5 volts, V160A is conducting heavily and its plate is at about +30 volts.

Sweep Generation

A negative trigger pulse, arriving at the grid of V135A from the Sweep Trigger circuit, causes the Sweep-Gating Multivibrator to switch rapidly to its other state. That is, V135A cuts off and V145A conducts. As V145A conducts, its plate voltage goes down, cutting off the Disconnect Diodes. When the Disconnect Diodes cut off, the plates of the Timing Capacitor are no longer held at —2.5 V, and the Timing Capacitor starts to charge toward the instantaneous potential difference between the —100-volt supply and potential on the cathode of V160B. However, as the lower plate of the Timing Capacitor starts to move in a negative direction, it takes the grid of V160A with it. This produces a positive swing at the plate of V160A which is coupled, through B167 and V160B, to the upper plate of the Timing Capacitor. This increases the voltage to which the Timing Capacitor is trying to charge. The effect is to straighten out the charging curve by increasing the charging voltage with each increment of charge on the capacitor.

The positive voltage swing on the upper plate of the Timing capacitor also tends to prevent the lower plate from swinging negatively. Since the gain of V160A is about 200, the potential on the upper plate moves about 100 volts with respect to ground while the potential on the lower plate moves about one-half volt. The result is an extremely linear ramp at the cathode of V160B, which is applied through the Horizontal Amplifier to the Horizontal deflection plates of the CRT.

Sweep Length

The length of the sweep, that is, the distance the spot moves across the CRT, is determined by the setting of the SWP. LENGTH control, R176. As the sweep voltage rises linearly at the cathode of V160B, there will be a linear rise in the voltage at the wiper arm of the SWP. LENGTH control. This will increase the voltage at the plate, and therefore the cathode, of V152B and at the grid and cathode of V145B. As the voltage at the cathode of V145B rises, the voltage at the grid of V135A will rise. When the voltage at this point rises to a point where V135A comes out of cutoff, the Sweep-Gating Multivibrator will rapidly revert to its original state with V135A conducting and V145A cut off. The voltage at the plate of V145A will then rise, carrying with it the voltage at the plates of the Disconnect Diodes.

D152 starts conducting, and brings the grid of V160A quickly back up to its quiescent level. The rise in voltage at the grid causes the tube to conduct more, so the plate voltage drops, carrying with it the grid and cathode of V160B. When the voltage at the cathode of V160B returns to about −2.5 V, V152A conducts, clamping the voltage at this point. The circuit has now returned to its quiescent level and is ready for the next trigger.

Hold-Off

The Hold-Off Circuit prevents the Sweep Generator from being triggered during the sweep retrace interval. It does this by holding the grid of V135A positive enough to keep V135A in conduction until after the Miller Runup Circuit has stabilized in the quiescent condition.

Under quiescent conditions, normal conduction through V152B allows the Hold-Off Capacitor, C160, to be charged to about 70 volts. During the latter part of the sweep, the rising voltage at the cathode of V152B discharges this capacitor to a lower voltage, in the vicinity of about 55 volts. At the end of the sweep, when the voltage at the cathode of V160B drops, the voltage at the SWP. LENGTH wiper arm also drops and V152B cuts off. The cathode tries to follow the drop in voltage at the plate but is held up by the charge on the Hold-Off Capacitor. The Hold-Off Capacitor charges again exponentially toward −100 volts, carrying the cathode of V152B and the grid of V145B negative. The cathode of V145B, and therefore the grid of V135A, follows the grid of V145B. At some point in this exponential charging curve, depending upon the settings of the STABILITY ADJUST control and the FREE RUN switch, the grid of V135A will become negative enough that a negative trigger pulse coming from the Sweep Trigger circuit can again take V135A into cutoff.

The hold-off time, then, is determined by the value of C160 switched into the Hold-Off Circuit by the SWEEP TIME/CM switch. The amount of hold-off time required is determined by the sweep rate. For this reason the SWEEP TIME/CM switch changes the amount of capacitance in the Hold-Off Circuit simultaneously with that in the Timing Circuit.

Sweep Stability

The STABILITY ADJUST control. R111, regulates the DC level at the grid of V135A. This control is adjusted so that the voltage at the grid of V135A is just high enough to prevent the circuit from free running. When it is adjusted in this manner, a sweep can be produced only when a negative trigger pulse from the Sweep Trigger can drive V135A into cutoff. Turning the LEVEL switch fully clockwise closes the FREE RUN switch and shorts out R111. This places a more negative voltage on the grid of V135A such that V135A cuts off immediately upon decay of the hold-off voltage, at which time the next sweep is initiated. The result is a free-running sweep whose period is the total of the sweep time plus the hold-off time at any given setting of the SWEEP TIME/CM switch. (This is compared to a maximum repetition rate of about 50 Hz when the LEVEL switch is turned fully counterclockwise to the AUTO. position.)

Unblanking

The positive rectangular pulse appearing at the cathode of V135B during sweep time is applied as an unblanking pulse to the CRT. Action of this pulse is discussed under the description of the CRT circuit later in this section. It should be noted that, when the HORIZONTAL DISPLAY switch is in the HORIZ. AMPLIFIER position, the Sweep-Gating Multivibrator is disabled, and there is no current flowing through V135A or V145A. Therefore, the cathode of V135B is held at +210 volts and the CRT is continuously unblanked.

CRT CIRCUIT

The CRT in the Type 503 oscilloscope makes use of an extra set of deflection plates for unblanking during sweep time. One of these plates has a fixed potential of about +210 volts on it; the other is tied to the cathode of V135B in the Time-Base Generator. Quiescently, this latter plate is held at a relatively low potential, in the vicinity of +80 volts. Therefore, the electron beam in the CRT is deflected and absorbed by the +210-volt plate; none of it reaches the screen. During sweep time, however, the unblanking pulse from V135B raises the potential of the second plate from +80 volts to about +210 volts. When this happens, both unblanking deflection plates attract the electron beam in the same amount with the net result that the beam is not deflected toward either plate, but passes on through to the CRT screen.

The INTENSITY control varies the control grid of the CRT from about −20 volts to −150 volts with respect to the cathode. Connections are provided on the rear of the oscilloscope cabinet to couple an AC signal to the control grid to provide intensity modulation of the trace is desired.

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CALIBRATOR

The calibrator provides a 500-millivolt square wave and a 5-millivolt square wave for use in calibrating the gain of the Horizontal and Vertical Amplifiers. The two amplitudes are obtained by tapping off at different points in a voltage divider network.

The square wave is produced by the turning off and on of B886. This is accomplished by the combined action of B886, B883, and C883. B886 and B883 are neon tubes which nominally drop about 60 volts when they are conducting. However, if they are not conducting, they require about 80 volts across them to start conduction.

During the time that B886 is turned off, B883 is conducting. This causes C883 to discharge which allows both plates of B883 to move in a positive direction (60 volts apart). When the common connection at the top of the two neon tubes reaches a potential of about +80 volts with respect to ground, B886 conducts. The current through R886 and R887 produces a 0.5-volt drop across them and the voltage at the upper end of B886 is, therefore, about +60.5 volts with respect to ground. Since the upper plate of C883 is now at about +20 volts with respect to ground, the potential across B883 in only about 40 volts, and B883 stops conducting. With no current through B883 to maintain the charge on C883, the upper plate of C883 starts to move in a negative direction. The upper end of B883 is held steady at +60.5 volts by the drop across B886, R886, and R887, so when the upper plate of C883 becomes −20 volts with respect to ground, B883 conducts. This drops the voltage at the upper end of the two neon tubes to +40 volts, and B886 cuts off, completing one cycle of the square wave.

It should be noted that the potentials mentioned in the foregoing discussion (except the drop across R886 and R887) are typical nominals only, and may vary considerably among different units. The only effect will be a slight variation in the frequency and symmetry of the output waveform.

The CAL. ADJ. control, R880, provides a means of adjusting the voltage drop across R886 and R887 by controlling the current through them.

POWER SUPPLY

T601 provides filament power for the graticule lights, all of the tubes, except the first stage of the Input Amplifier, and B+ voltage (about 500 volts) for the power supply oscillator tube, V620. The rest of the voltages used in the oscilloscope are provided by the secondary of T620.

V620, the primary of T620, and part of the secondary of T620 form an Armstrong oscillator circuit to drive T620 at about 30 kHz. Each of the outputs of the secondary of T620 bears a fixed turns ratio to the others such that a change in one effects a proportional change in each of the others. Adjustment and regulation of all of the output voltages are accomplished through adjustment and regulation of just one output, the −100 volt output. This, in turn, is referenced to the 85-volt drop across the voltage regulator tube, V659.

Adjustment of the output voltages is accomplished by means of the −100 V ADJ. control as follows: moving the wiper arm of the −100 V ADJ. control in a positive direction reduces the bias on V634B. This, in turn, lowers the voltage at the plate of V634B and, therefore, at the grid of V634A. This causes an increase in voltage at the plate of V634A which, in turns increases the screen voltage of V620. Increasing the screen voltage of V620 increases the G_m, and therefore the gain, of the tube, and thereby increases the amplitude of oscillations in the secondary of T620. This results in greater output from all of the supplies.

Regulation is accomplished in virtually the same manner. A lowering of any of the output voltages due to loading, causes the volts per turn in the secondary of T620 to decrease. This causes the −100-volt supply to drop (move positively) with the resulting rise in the grid voltage of V634B. This results, as before, in a rise in the screen voltage of V620 and an increase in the amplitude of oscillations, bringing the power supply outputs back to their nominal values.

An increase in any of the output voltages, whatever the reason, has the opposite effect on the screen voltage of V620 and decreases the amplitude of oscillations in T620.

Regulation of the power supply outputs will be accomplished as long as the source voltage remains between 105 and 125 for 117-volt operation, or between 210 volts and 250 volts for 234-volt operation.

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NOTES

SECTION 4
MAINTENANCE

Introduction

This section of the manual contains maintenance information for use in preventive maintenance, corrective maintenance or troubleshooting of the Type 503.

PREVENTIVE MAINTENANCE

Visual Inspection

Every few months, the oscilloscope should be visually inspected so that possible circuit defects may be detected. These defects may include such things as loose or broken connections, damaged binding posts, improperly seated tubes, scorched wires or resistors, missing tube shields, and broken terminal strips. For most visual troubles the remedy is apparent; however, particular care must be taken when heat-damaged components are detected. Overheating of parts is often the result of other, less apparent, defects in the circuit. It is essential to determine the cause of overheating before replacing heat-damaged parts, in order to prevent further damage.

Calibration

The Type 503 Oscilloscope is a stable instrument which should provide many hours of trouble-free operation. However, to insure the reliability of measurements we suggest calibration of the instrument after each 500 hours of operation (or every six months if used intermittently). A complete step-by-step procedure for calibrating the instrument is presented in the Calibration section of this manual.

CORRECTIVE MAINTENANCE

General

Procedures required for replacement of many parts in the Type 503 Oscilloscope are obvious. Detailed instructions for their removal are therefore not required. Other parts, however, can best be removed if a definite procedure is followed. Instructions for the removal of some of these parts are contained in the following paragraphs. Because of the nature of the instrument, replacement of certain parts will require recalibration of sections of the oscilloscope to insure proper operation. Refer to the Calibration section of this manual.

Obtaining Replacement Parts

Standards Parts. All electrical and mechanical part replacements for the Type 503 can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained locally in less time than is required to order them from Tektronix, Inc. Before purchasing or ordering replacement parts, consult the Parts List for value, tolerance, and rating.

Special Parts. In addition to the standard electronic components, some special parts are used in the Type 503. These parts are manufactured or selected by Tektronix, Inc. to meet specific performance requirements, or are manufactured for Tektronix, Inc. in accordance with our specifications. These special parts are indicated in the Parts List by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your Tektronix Field Office or representative.

Ordering Parts. When ordering replacement parts from Tektronix, include the following information:

1. Instrument Type.
2. A descirpition of the part (if electrical, include circuit number).
3. Tektronix Part Number.
4. Instrument Serial Number.

Removal of Panels

The panels of the Type 503 Oscilloscope are held in place by screwhead fasteners. To remove the side panels, use a screwdriver to rotate the fasteners approximately two turns counterclockwise; then pull the upper portion of the panels outward from the carrying handles (see Fig. 4-1). Panels are replaced by reversing the order of their removal.

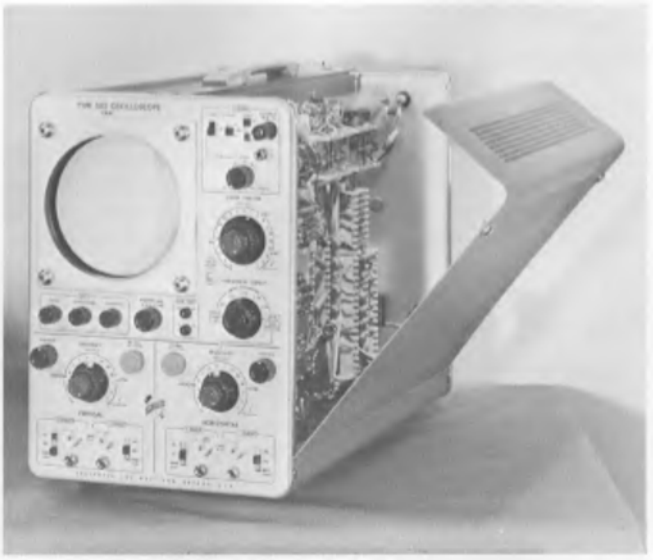


Fig. 4-1. Removing the oscilloscope side panels.

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Replacement of the Cathode-Ray Tube

To remove the cathode-ray tube, first disconnect the tube socket and all leads connected to the neck of the tube. Remove the graticule cover, spacer washers, graticule, and graticule light shield. Loosen the tube clamp at the base of the CRT. Remove the CRT straight out through the front panel (see Fig. 4-2).



Fig. 4-2. Removing the cathode-ray tube.

When the new CRT is in place, the leads can be properly connected to the neck of the tube by following the color code information provided on the tube shield. After replacement of the CRT, it may be necessary to calibrate certain portions of the oscilloscope. Special attention should be given to calibration of the sweep and the vertical deflection factor.

Replacement of Switches

Methods for removal of defective switches are, for the most part, obvious and only a normal amount of care is required. Single wafers are normally not replaced on the switches used in the Type 503. If one wafer is defective, the entire switch should be replaced. Switches can be ordered from Tektronix, either wired or unwired, as desired.

Tube or Transistor Replacement

Care should be taken both in preventive and corrective maintenance that tubes or transistors are not replaced unless they are actually causing trouble. Often during trouble-shooting it will be necessary to remove tubes or transistors from their sockets. It is important that these tubes or transistors be returned to their same sockets unless they are actually defective; unnecessary switching of tubes or transistors will often necessitate recalibration of the instrument. If tubes or transistors do require replacement, it is recommended that they be replaced by previously checked high-quality components.

Each checked pair of nuvistors used in the Type 503 Vertical and Horizontal Amplifiers[1] is mounted in a temperature-stabilizing assembly, and shock-mounted to minimize microphonic effects. If replacement of these tubes is indicated, they should be replaced in pairs. While the removal and replacement procedure is quite simple, reference to Figs. 4-4 and 4-5 may aid in locating and replacing the tubes. Use the following procedure:

1. With a short screwdriver, remove the mounting screw and shockmounting stop bracket.

2. Grasp the temperature-stabilizing cover with the fingers and pull toward the rear of the instrument, using a rocking motion.

NOTE

When the cover lifts off, the nuvistors may remain in their sockets, or may come off with the cover. Care should be used in removing the tubes to avoid bending the tube pins or the shield tabs.

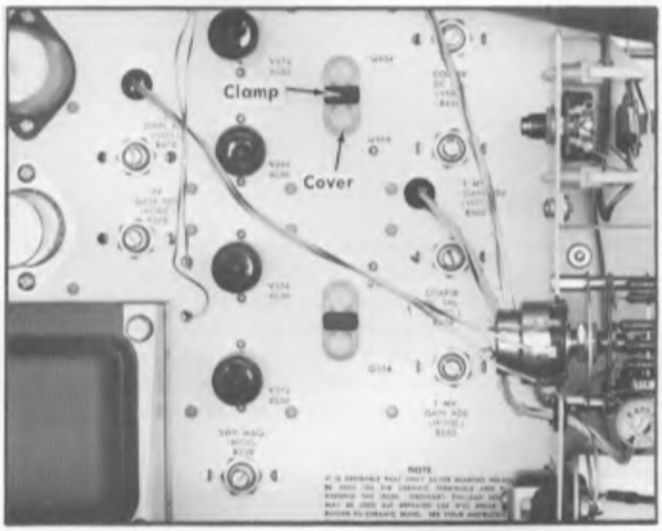


Fig. 4-3. Transistor heat-stabilizing covers used in instruments serial numbered 6997 and later.

3. Insert the replacement nuvistors in their sockets, orienting the tubes so that the wide shield tabs can be pushed into the wide keyways (Fig. 4-4).

4. Replace the temperature-stabilizing cover, the shock-mounting stop bracket, and mounting screw.

At Type 503 Serial Numbers 6997 and later, transistors Q354, Q364, Q454, and Q464 are secured by heat-stabilizing covers (see Fig. 4-3). The covers are held in place by plastic holders, and are removed by pulling straight out. To replace, insert the holder tips in the mounting holes, and push in until secure.

[1]**At Serial Number 6997 and later, tube types 6DJ8 have been replaced by nuvistor tube types 8393 in the Vertical and Horizontal Amplifier input stages.**

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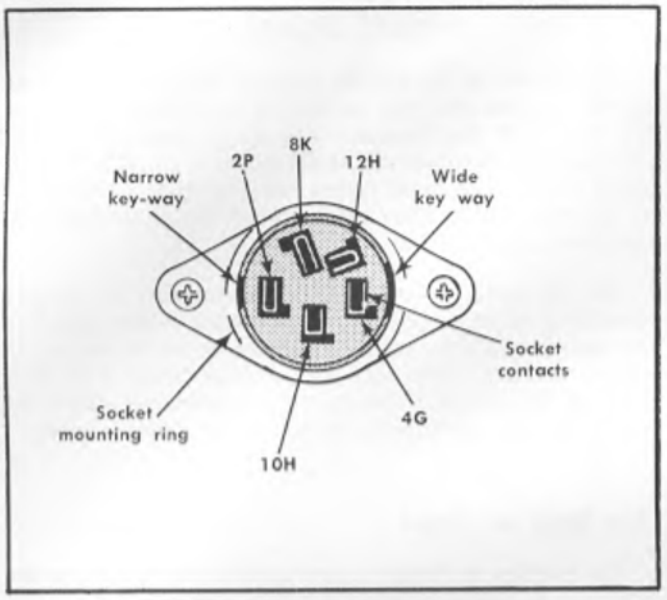


Fig. 4-4. Nuvistor socket detail, showing location of key-ways, (top view).

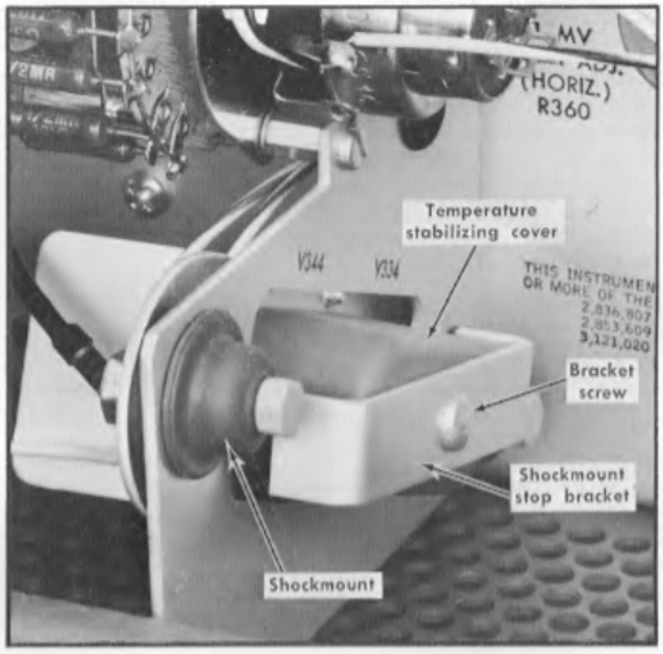


Fig. 4-5. Location of nuvistor temperature-stabilizing and shock-mounting assembly (left side view).

Soldering Precautions

In the production of Tektronix instruments, a special silver bearing solder is used to establish a bond to the ceramic terminal strips. This bond can be broken by repeated use of ordinary tin-lead solder, or by the application of too much heat. However, occasional use of ordinary solder will not break the bond if too much heat is not applied.

Solder containing about 3% silver is generally available commercially, or may be purchased from Tektronix in one-pound rolls (order by Part No. 251-0514-00).

Because of the shape of the terminals on the ceramic terminal strips, it is advisable to use a wedge-shaped tip in the soldering iron when removing or replacing parts from the strips. A wedge-shaped tip allows application of heat directly to the solder in the terminals, and reduction of the amount of heat required. It is important to use as little heat as possible.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate trouble-shooting of the Type 503 if trouble develops. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component.

Troubleshooting Aids

Diagrams. Circuit diagrams are given on foldout pages in Section 9. The circuit number and electrical value of each component in this instrument are shown on the diagrams. Important voltages and waveforms are also shown on the diagrams.

Component Numbering. The circuit number of each electrical part is shown on the circuit diagram. Each main circuit is assigned a series of circuit numbers. Table 4-1 lists the main circuits in the Type 503 and the series of circuit numbers assigned to each. For example, using Table 4-1, a resistor numbered R477 is identified as being located in the Vertical Amplifier.

TABLE 4-1

Circuit Numbers on Schematics	Circuit
1-99	Sweep Trigger
100-199	Sweep Generator
300-399	Horizontal Amplifier and Attenuator Switch
400-499	Vertical Amplifier and Attenuator Switch
600-699	Power Supply
800-899	CRT Circuit and Calibrator

Switch Wafer Identification. Switch wafers shown on the diagrams are coded to indicate the position of the wafer in the complete switch assembly. The numbered portion of the code refers to the wafer number counting from the front, or mounting end of the switch, toward the rear. The letters F and R indicate whether the front or rear of the wafer performs the particular switching function. For example a wafer designated 2R indicates that the rear of the second wafer is used for this particular switching function.

Wiring Color-Code. All insulated wire used in the Type 503 is color-coded (where praticable) according to the EIA standard color-code (as used for resistors) to facilitate circuit

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tracing. The widest color stripe identifies the first color of the code. Low-voltage power-supply voltages can be identified by one or more color stripes and the following background color-code: white, positive voltage; black, negative voltage. Table 4-2 shows the wire color-coding for the Type 503 power supply test points. The remainder of the wiring in the Type 503 is color-coded with two or less stripes, or has a solid background color with no stripes. The color-coding helps to trace wiring from one point in the instrument to another.

TABLE 4-2

Supply	Background Color	1st Stripe	2nd Stripe	3rd Stripe
+250	White	Red	Green	Brown
+100	White	Brown	Black	Brown
+12.6	White	Black	Red	None
−100	Black	Brown	Black	Brown
−3000	White	Orange	None	None

Resistor Color-Code. Composition resistors are color-coded according to the EIA standard resistor color-code.

Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks assure proper connection, operation and calibration. If the trouble is not located by these checks, the remaining steps aid in locating the defective component. When the defective component is located, it should be replaced following the replacement procedures given in this section.

1. Check Asscіated Equipment. Before proceeding with troubleshooting of the Type 503, check that the equipment used with the Type 503 is operating correctly. Check that the signal is properly connected and that the inter-connecting cables or probes are not defective. Also, check the power source.

2. Check Control Settings. Incorrect control settings can indicate a trouble that does not exist. For example, incorrect setting of the SWEEP TIME/CM VARIABLE control appears as an uncalibrated sweep; incorrect setting of the SENSITIVITY VARIABLE controls appears as incorrect gain, etc. If there is any question about the correct function or operation of any control, see the Operating Insructions section of this manual.

3. Check Instrument Calibration. Check the calibration of the instrument, or the affected circuit if the trouble exists in one circuit. The indicated trouble may be only a result of misadjustment or may be corrected by calibration. Complete instructions are given in the Calibration section of this manual. Individual calibration steps can be performed out of sequence. However, if the circuit affects the calibration of other circuits in the instrument, a more complete calibration may be necessary.

4. Isolate Trouble to a Circuit. The Type 503 consists of 6 basic circuits, as shown in Table 4-1. By analyzing trouble symptoms, localizing a trouble to a single circuit will facilitate repairs.

CIRCUIT ISOLATION

This portion of the trouble shooting procedure lists some of the troubles that can be caused by a circuit failure in the Type 503 Oscilloscope. It also describes checks that can be made to isolate the faulty circuit or circuits. In some cases simple front panel checks can determine which circuit is defective, but in other cases internal checks and/or measurements are required.

The following troubleshooting information is divided according to the various types of trouble. Upon detecting an apparent trouble, use the symptoms to locate the proper circuit to check. After determining which circuit is at fault, refer to the Circuit Troubleshooting information, where the procedure for troubleshooting within the circuit is given.

No Spot or Trace

The inability to display a spot or trace on the face of the CRT may be due to a defective power supply, an unbalanced condition in either or both of the deflection amplifiers, a defect in the Sweep Generator, or a defective CRT Circuit.

To determine which circuit is at fault, turn the INTENSITY and FOCUS controls fully clockwise. (The clockwise position of the FOCUS control will de-focus any trace that appears, and will prevent accidental damage to the CRT phosphor.) Set the LEVEL control to FREE RUN and the SWEEP TIME/CM control to the 1 mSEC position. Set the HORIZONTAL DISPLAY switch to the SWEEP NORMAL ×1 position.

The first section to check for trouble is the Power Supply. If the output voltages of the Power Supplies are correct, proceed to the next step.

A quick check for correct operation of the Sweep Generator is to turn the HORIZONTAL DISPLAY switch to the HORIZ. AMPLIFIER position. Adjust the VERTICAL POSITION and the HORIZONTAL POSITION controls. A spot should appear if the Sweep Generator is defective.

If a spot does not appear with HORIZONTAL DISPLAY switch in the HORIZ. AMPLIFIER position, short the vertical deflection plates together. Be careful not to short either pin to the metal shield around the CRT. Adjust the HORIZONTAL POSITION control and see if a spot appears on the CRT. If so, a state of unbalance in the vertical deflection system is indicaed.

If no spot appeared during the previous check, short the horizontal deflection plates together. Adjust the VERTICAL POSITION control and see if a spot now appears on the screen. If so, a state of unbalance in the horizontal deflection system is indicated.

If neither of the previous checks indicates the source of trouble, check pin 7 of the CRT and the cathode voltage of V135B; these point should be about +210 volts. This voltage is the unblanking potential for the CRT and must be applied to the CRT to obtain a spot or trace.

If none of the previous checks indicates the source of trouble, a defective CRT or trouble in the CRT Circuit is indicated.

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Insufficient Vertical Deflection, Waveform Distortion, or Low Differential Input Rejection Ratio

These troubles are all caused by a defective vertical amplifier. Refer to the Circuit Troubleshooting section of the Troubleshooting procedure.

Insufficient or No Horizontal Deflection

Either of these conditions can be produced by the Sweep Generator or the Horizontal Amplifier. If the sweep is shortened but the timing is not affected, the trouble is probably in the Sweep Generator. If both the sweep length and the timing are affected, the trouble is probably in the Horizontal Amplifier.

As an additional check to determine which circuit is defective, place the HORIZONTAL DISPLAY switch in the HORIZ. AMPLIFIER position. Set the HORIZONTAL SENSITIVITY switch to the .1 VOLTS/CM position and the VARIABLE control fully clockwise. Connect the 500 mV calibrator signal to the +INPUT connector of the horizontal channel.

Two dots, spaced 5 cm apart, should appear when the positioning controls are adjusted. If the deflection is correct, the trouble is probably in the Sweep circuit. If the deflection is not correct, the trouble is in the Horizontal Amplifier.

Nonlinear Horizontal Sweep

The linearity of the horizontal deflection can be checked by connecting a marker generator or the calibrator output to a vertical input of the oscilloscope. If the sweep is linear, the markers or the calibrator waveform will be spaced equidistant along the sweep. A nonlinear sweep can be caused by either the Sweep Generator or the Horizontal Amplifier.

To determine which circuit is defective, place the HORIZONTAL DISPLAY switch in the HORIZ. AMPLIFIER position. Set the HORIZONTAL SENSITIVITY control to .5 VOLTS/CM position and the VARIABLE control fully clockwise. Connect the 500 mV signal from the CAL. OUT connector to the +INPUT connector of the Horizontal Channel.

Two dots, spaced 1 cm apart, should appear when the positioning controls are ajusted. If the spacing between dots remains the same as they are moved across the screen with the HORIZONTAL POSITION control, the nonlinearity is probably in the Sweep Generator. If the spacing between dots varies, the trouble is in the Horizontal Amplifier.

Improper Sweep Timing

If the timing is off in some, but not all, positions of the SWEEP TIME/CM switch, one of the timing resistors or timing capacitors has changed in value. A check of the Timing Switch diagram will show which components are common to these positions, and will assist in pinpointing the defective components.

If the timing is off in all positions of the SWEEP TIME/CM switch, the Horizontal Amplifier is probably the circuit at fault. However, it is imoprtant that the power supply voltages be checked. Check to see if the timing circuits can be calibrated in accordance with the instructions presented in the Calibration section of this manual. If the circuits cannot be adjusted for correct timing, refer to the section on troubleshooting the Horizontal Amplifier.

Improper Triggering

If the waveform observed cannot be triggered (locked into position) properly, the trouble can be misadjustment of the STABILITY control or malfunction of some other part of the Sweep circuit or the Trigger circuit.

Check the adjustment of the STABILITY control as described in the Calibration section of this manual. If the trace can be turned on and off by rotating the LEVEL control into and out of the FREE RUN position, the Trigger circuit is probably causing the trouble. If the trace cannot be turned off with the LEVEL control, the Sweep circuit is likely at fault.

CIRCUIT TROUBLESHOOTING

This portion of the Troubleshooting procedure contains information for locating a defective stage within a given circuit. Once the stage at fault is known, the component or components causing the trouble can be located by tube and component substitution, voltage and resistance measurements, or by short and continuity checks.

As mentioned previously, tube failure is the most prevalent cause of circuit failure. For this reason, the first step in troubleshooting any circuit is to check for defective tubes, preferably by direct substitiution. Be sure to return any tubes found to be good to their original sockets.

If replacement of a defective tube does not correct the trouble, then check to see that components through which the tube draws current have not been damaged. Shorted tubes will often overload and damage plate load and cathode resistors. These components can sometimes be located by a visual inspection of the circuit. If no damaged components are apparent, however, it will be necessary to make measurements or other checks within the circuit to locate the trouble.

Troubleshooting the Power Supply

Proper operation of every circuit in the Type 503 Oscilloscope depends on proper operation of the Power Supply. The voltages must remain within their specified tolerances for the instrument to maintain its calibration.

No Output Voltage. If the graticule lamps do not operate when the POWER switch is turned on, check the POWER switch, the fuse and line voltage. Shorts in the primary and secondary circuits of T601 will cause the fuse to blow. If the fuse is not blown and line voltage is correct, next check the primary windings of the power transformer.

If the graticule lamps operate correctly, the primary circuit of the power transformer (T601) is operating normally and the trouble lies some where in the secondary circuit of the oscillator circuit (V620, T620).

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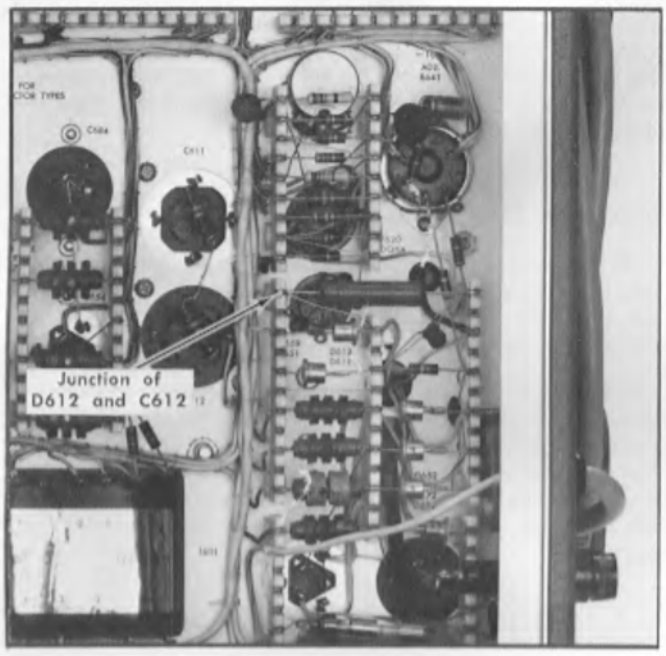


Fig. 4-6. Location of D612 and C612 junction test point, (right side of instrument).

To check the secondary circuit of T601, measure the voltage at the junction of D612 and C612 (Fig. 4-6). This voltage should be approximately +500 volts. Check the secondary winding of T601 and the voltage doubler circuit if the voltage is not correct. A reading of approximately 600 volts or more at the junction of D612 and C612 indicates the oscillator circuit (V620, T620) is inoperative or the line voltage is too high. Before replacing V620, check for defective parts associated with V620. Some of the parts to check, for example, are T620, C620, C621, and R621.

If the proper output voltage is obtained from at least one of the power supplies, the oscillator circuit need not be checked. In this case, check the rectifier and components associated with the inoperative supply.

Failure to Regulate at the Correct Voltage. If the supplies fail to regulate at the proper voltages, first check the line voltage. The supplies are designed to regulate between an input voltage of 105 and 125 volts (or 210 and 250 volts), with the design center at 117 volts (or 234 volts), RMS. Improper line voltage may cause the supply voltages to be off.

If the output of any of the supplies is off by only a small amount, it may be possible to readjust the —100 ADJ. control to obtain the proper voltage. It should be noted that when the setting of the —100 ADJ. control is changed, the entire instrument must be recalibrated according to the procedure given in Section 6 of this manual.

If the supplies fail to regulate, check the tubes (if this has not already been done). Then make sure that the voltage at the junction of D612 and C612 is approximately +500 volts. Check for off-value resistors, especially in the dividers, and for open or leaky capacitors associated with V634.

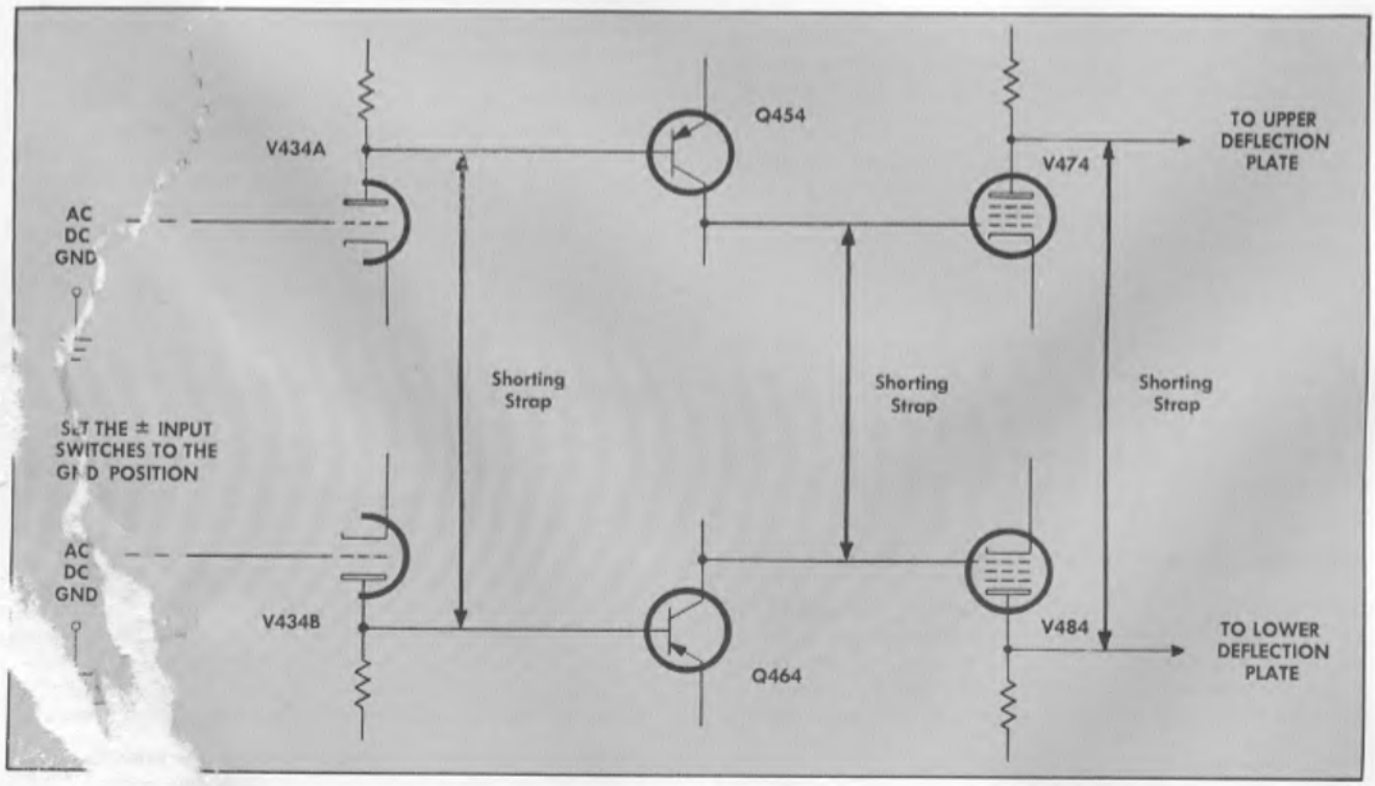


Fig. 4-7. Checking the Vertical Amplifier for an unbalance condition.

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If there is excessive ripple on only one of the supplies, check for open or leaky capacitors in that circuit.

CRT Circuit

Trouble other than power supply trouble which affects the CRT Circuit will generally be caused by defects in the intensity and focus voltage dividers, defects in the divider associated with pins 7 and 11 of the CRT, by the astigmatism control, or by the CRT itself. These parts (except for the CRT) can be checked by voltage and resistance measurements. If the circuits check out satisfactorily replace the CRT.

Vertical Amplifier

No Spot or Trace. As mentioned earlier in the troubleshooting procedure, if a spot is visible when the vertical plates are externally shorted together, but disappears when the short is removed, the Vertical Amplifier is in a state of DC unbalance. To locate the defective stage, first set both INPUT switches to the GND position and the SENSITIVITY switch to the .2 VOLTS/CM position. Then, with an insulated shorting strap, short between the points shown in Fig. 4-7, starting at the right and progressing toward the left. As the points are shorted in turn, the spot should appear on the screen as each connection is made. Readjustment of the POSITION control may be necessary when shorting between plates of the input stage. With the input stage grounded, the DC BAL. control may have to be readjusted.

When a point is reached where the spot does not return to the screen, the stage immediately following this point is at fault. The trouble may be caused by a defective tube, transistor, resistor, capacitor, or broken lead.

Insufficient or No Vertical Deflection. Insufficient vertical deflection indicates a change in the gain characteristics of the Vertical Amplifier. If the change in gain is small, the Vertical Amplifier can usually be calibrated for gain. In this event, refer to the Calibration section of this manual.

If the change in gain is more pronounced, or if there is not vertical deflection at all, the tubes and transistors should first be checked. Then check for components which can affect the gain of the circuit but not the DC balance. Such parts are common cathode resistors in the Input and Output Amplifier stages, or plate dropping resistors which are common to both sides of the amplifier.

Insufficient vertical deflection will also occur if the frequency limits of the amplifier are exceeded.

Waveform Distortion. Waveform distortion can be divided into two categories—low frequency and high frequency. If a square wave is applied to an input of the oscilloscope, the type of distortion can be determined by the shape of the displayed waveform. High frequency distortion will primarily affect the leading edge and trailing edge of the applied square wave while low frequency distortion will primarily affect the mid portion of the waveform.

Waveforms showing low frequency distortion and two types of high frequency distortion are shown in Fig. 4-8. The shapes of these waveforms will vary widely, however, with the cause of the distortion and the frequency of the applied waveform. A nominal amount of low frequency distortion is normal for very low input frequencies when AC coupling is used, and a nominal amount of high frequency distortion is normal at the upper frequency limits of the instrument. It is only when this distortion is excessive in the normal frequency range of the nstrument that it constitutes a trouble.

Low frequency distortion is usually caused by a change in the time constant of the input coupling circuit. If tubes become gassy, however, their resultant grid current will establish a time constant network which will affect the low frequency response of the circuit.

Factors which can affect the high frequency response of the vertical amplifier are mainly related to the high frequency compensation networks. An overshoot waveform can be caused by excessive high-frequency peaking or by a tube condition known as cathode interface. If this type of distortion is detected, check the tubes in the amplifier. If tube replacement does not completely correct the trouble,

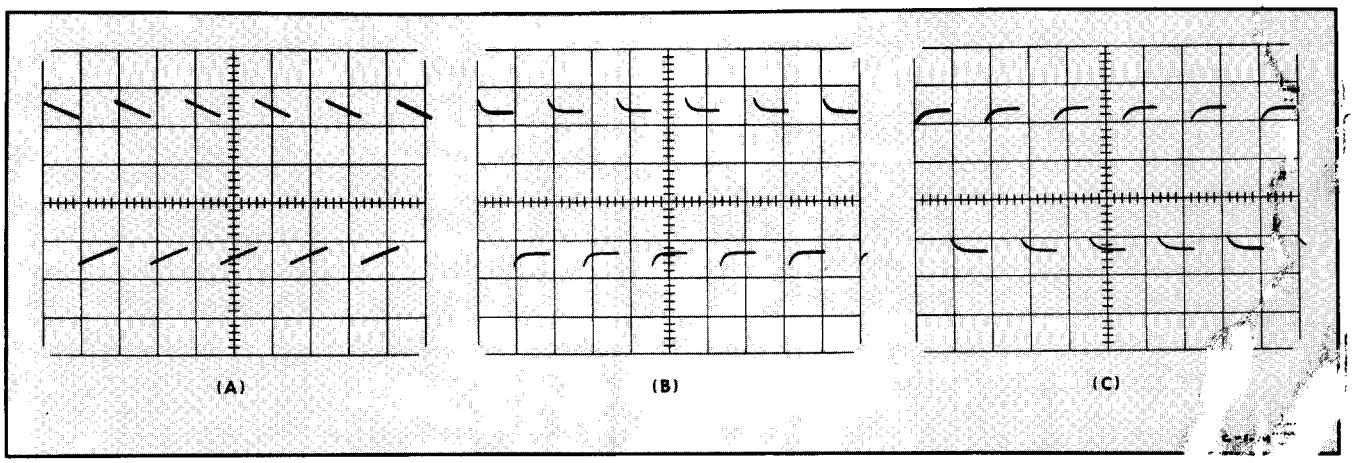


Fig. 4-8. Frequency distortion. (A) Low-frequency distortion of an AC-coupled 100-Hz square wave due to attenuation of low frequency components of the waveform. (B) High-frequency distortion of a 1000-Hz square wave due to excessive boost of the high frequency components of the waveform. (C) High-frequency distortion of a 1000-Hz wave due to attenuation of the high-frequency components of the waveform.

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check the adjustment of C406 and C416 and the high frequency compensation networks in the attenuators. Refer to the Calibration section of this manual.

NOTE

If tubes are replaced, phasing adjustments and Common Mode Rejection must be re-checked.

Undershoot or rounding can be caused by insufficient high frequency peaking and by tubes. If tube replacement does not correct this type of distortion, then check the adjustments of C406 and C416 and the divider networks in the attenuators.

Low Common Mode Rejection Ratio. Low rejection ratio is usually caused by tubes or transistors. If replacement of tubes or transistors does not correct the trouble, check for components which can affect the balance of the circuit.

Horizontal Amplifier

If a spot is visible when the horizontal deflection plates are externally shorted together, but disappears when the short is removed, the Horizontal Amplifier is in a state of unbalance.

When the HORIZONTAL DISPLAY switch is in the HORIZ. AMPLIFIER position, the operation of the Horizontal Amplifier is virtually identical to that of the Vertical Amplifier. Therefore, the procedure for troubleshooting the Horizontal Amplifier is the same as that explained previously for troubleshooting the Vertical Amplifier.

Sweep Trigger Circuit

Switch the LEVEL control to FREE RUN and establish that the Sweep Generator is functioning. To determine which stage is defective, rotate the TRIGGER LEVEL control fully counterclockwise to the AUTO. position. With no triggering signal, the sweep should appear on the CRT. If the sweep does not appear, either the Trigger Multivibrator is inoperative or the SWEEP STABILITY ADJUST is misadjusted. Refer to the Calibration section for adjustment procedures for the SWEEP STABILITY ADJUST.

A check on the Trigger Amplifier circuit may be made as follows: with the LEVEL control still in the AUTO. position, measure the voltage at the plate, pin 6, of V24B. This voltage should be approximately +98 volts. If the voltage is incorrect, the trigger amplifier circuit is defective. The trouble will probably exist in the tube, resistors, or switches of the circuit. Measure the voltage at pins 2 and 7 of V24; the voltage should be 0. If the grids measure 0 volts and the voltage at pin 6 is incorrect, V24 is probably defective.

If the voltage measured at pin 6 of V24B is correct, rotate the LEVEL control completely through its range while monitoring the voltage at this point. The voltage should vary between approximately 70 and 130 volts. An incorrect voltage range indicates a defective amplifier or LEVEL control. If the voltage range is correct, the trouble is in the trigger multivibrator. A trouble in the multivibrator will probably be due to a defective tube or resistor. The voltage divider network between the plate of V45A and the grid of V45B is particularly critical.

Sweep Generator Circuit

Familiarity with the operation of the Sweep Generator circuit is important before proceeding with any extensive investigation of the circuit. For this reason, we suggest a thorough study of that portion of the Circuit Description that pertains to this circuit.

No Horizontal Sweep. If the sweep circuit is not producing a sawtooth waveform when the TRIGGER LEVEL control is in the FREE RUN position, some defect in the circuit is causing the output to remain at some fixed voltage. A clue to the cause of this trouble can be obtained by measuring the plate voltage of the Miller tube, V160A.

NOTE

All voltages in this section should be measured with a 20,000 ohms - per - volt voltmeter or a vacuum-tube voltmeter.

The voltage reading obtained will probably be approximately +200 volts, or approximately +30 volts. A reading of 200 volts indicates that the Miller stage has run up and has not been reset, while the reading of 30 volts indicates that the Miller stage is not being allowed to run up. The condition that actually exists will depend on the type of trouble occuring in the circuit. The two conditions of the plate voltage will be handled separately in the following paragraphs.

+200 V at the plate of the Miller tube, V160A, indicates the tube is cut off. This can result from any one of the following conditions: (1) The Disconnect Diodes do not conduct, (2) Sweep-Gating Multivibrator does not reset, and, (3) Runup Cathode Follower (V152B) does not drive the Hold-Off Circuit. The defective stage can be detected by a series of systematic voltage measurements. When an improper voltage reading is obtained, this will indicate the defective stage.

Check the voltage at the grid of the Miller tube, pin 2, V160A. The static voltage at the Miller grid is determined by conduction through the Timing Resistor, R160 (from —100-volt bus), the lower diode, D152, and resistor R147. If the voltage reading is less than —4 volts, D152 is probably conducting normally and can be eliminated as a possible cause of the trouble. If the voltage is more negative than approximately —20 volts, the diode is probably not conducting. Check V152A, D152 and resistor R147.

Measure the voltage at the output of the Sweep Generator circuit (pin 8 of V160B). If this voltage is approximately +150 volts, the Runup Cathode Follower stage may be assumed to be operating correctly. If this voltage is low, however, the stage is defective and its grid and cathode circuits should be checked. If the grid voltage is low, B167 (neon) may possibly be open.

Next, measure the voltage at the cathode of V145B, pin 3. If this voltage is more positive than —55 volts the trouble is in the Sweep-Gating Multivibrator. Check the tubes and resistors in this circuit. The voltage divider network in the cathode of V135B is particularly critical.

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If the voltage at the cathode of V145B, pin 3, is more negative than —55 volts, check the tubes in the Hold-Off Circuit, the Hold-Off capacitor, and resistors in the cathode circuit of the two tubes.

Low voltage at the plate of the Miller tube indicates that the tube is conducting quite heavily and is not being allowed to perform its normal runup operation. If this trouble exists on only a few ranges of the SWEEP TIME/CM switch, the trouble is likely to be an open timing resistor. If the trouble exists on all ranges of the SWEEP TIME/CM switch, the trouble is probably due to a defective Sweep-Gating Multivibrator.

To check the Sweep-Gating Multivibrator, monitor the voltage at pin 3 of V145B and adjust the STABILITY ADJUST control for a reading of —66 volts on the voltmeter. With this voltage, the Sweep-Gating Multivibrator and the sweep should free run. If the multivibrator does not free run, check the resistances in the stage.

If the voltage at pin 3 of V145B remains relatively constant as the STABILITY ADJUST control is rotated, a defect in the Hold-Off Circuit is indicated. One cause of this condition could be a shorted hold-off capacitor. If the voltage does not adjust to the proper level, check the resistors in the cathode circuit of V145B.

Nonlinear Sweep. A nonlinear sweep voltage will be generated if the circuit charging the Timing Capacitor does not remain constant. If the nonlinearity exists at all sweep rates, a defective Miller tube (V160A) is the probable cause of the trouble. If the nonlinearity occurs only at certain sweep rates, a faulty Miller tube or a leaky Timing Capacitor is the probable cause.

Insufficient Horizontal Deflection. If the horizontal trace starts at the left-hand side of the screen, but does not extend to the right-hand side, the Hold-Off Circuit is resetting the Sweep-Gating Multivibrator before the sweep is complete. If the sweep cannot be adjusted to normal length with the SWP. LENGTH control, R176, the resistance in the cathode circuit of V160B should be checked.

Improper Triggering. If the sweep cannot be triggered properly, the gating pulse from the Multivibrator (assuming the multivibrator is operating properly), is not turning the Disconnect Diodes (V152A and D152) off and on properly. The start of the gating pulse, which turns the diodes off and starts the sweep, is initiated by the triggering pulse at the grid of V135A. The end of the gating pulse, which turns the diodes on and initiates the retrace, is controlled by the hold-off waveform at the grid of V135A. The main component to check, in addition to the tubes, is the differentiating capacitor C131. Misadjustment of the STABILITY ADJUST control (R111) will also cause the Sweep Generator to trigger improperly. Refer to the Calibration section for correct adjustment.

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NOTES

SECTION 5

PERFORMANCE CHECK

Introduction

This section of the manual provides a means of rapidly checking the performance of the Type 503. It is intended to check the calibration of the instrument without the need for performaing the complete Calibration Procedure. The Performance Check does not provide for the adjustment of any internal controls. Failure to meet the requirements given in this procedure indicates the need for internal checks or adjustments, and the user should refer to the Calibration Procedure in this manual.

Recommended Equipment

The following equipment is recommended for a complete performance check. Specifications given are the minimum necessary to perform this procedure. All equipment is assumed to be calibrated and operating within the orignal specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

For the most accurate and convenient performance check, special calibration fixtures are used in this procedure. These calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Test Oscilloscope; minimum deflection factor, 1 mV/div; bandwidth, DC to 450 kHz. Tektronix Type 503 recommended.

2. Square-wave generator. Range, 0.5 volts to 20 volts at 1 kHz; risetime, 70 nanoseconds or faster. Tektronix Type 106 recommended.

3. Constant-amplitude sine-wave generator. Signal frequencies, 50 kHz, 350 kHz, and 450 kHz; output 0 to 5 volts. Tektronix Type 191 recommended.

4. Standard Amplitude Calibrator. Accuracy, 0.25%; output, 5 mV to 100-volt square waves. Tektronix Calibration Fixture Part No. 067-0502-00 recommended.

5. Time-mark generator. Markers from 1 μs through 5 seconds; accuracy, 0.2% or better. Tektronix Type 184 recommended.

6. 10× probe. Tektronix Type P6006, Part No. 010-0125-00 recommended.

7. Input time-constant standardizer, 47 pF, with UHF connectors. Tektronix Part No. 011-0068-00.

8. 50 Ω termination with UHF connectors, Tektronix Part No. 011-0045-00.

9. 50 Ω cables with UHF connectors. Tektronix Part No. 012-0001-00 (2 required).

10. Adapter, UHF T, Tektronix Part No. 103-0026-00.

11. Adapter, GR and UHF female. Tektronix Part No. 017-0022-00.

12. Adapter, UHF quick-connect. Tektronix Part No. 003-0028-00 (2 required).

13. Adapter, male BNC and female UHF. Tektronix Part No. 103-0032-00.

14. Attenuator, 10:1 with UHF connectors. Tektronix Part No. 011-0031-00.

15. 6-inch patch cord with banana plug terminals. Tektronix Part No. 012-0028-00.

PRELIMINARY

General

In the following procedure, test equipment connections or control settings should not be changed except as noted. If only a partial check is desired, refer to the preceding step(s) for setup information.

The following procedure uses the equipment listed under Recommended Equipment. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. Connect the Type 503 to a suitable power source (nominally 117 VAC RMS).

2. Set the instrument controls as follows:

SLOPE	+
COUPLING	AC
SOURCE	INT.
LEVEL	FREE RUN
SWEEP TIME/CM	1 mSEC
VARIABLE	CALIBRATED (fully clockwise)
INTENSITY	Fully counterclockwise
HORIZONTAL DISPLAY	HORIZ AMPLIFIER (SWEEP DISABLED)
FOCUS	Fully clockwise
VERTICAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED (fully clockwise)
POSITION	Midrange
+INPUT	GND
−INPUT	GND
HORIZONTAL	
SENSITIVITY	.2 VOLTS/CM

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VARIABLE	CALIBRATED (fully clockwise)
POSITION	Midrange
+INPUT	GND
—INPUT	GND

3. Turn the POWER AND SCALE ILLUM. control clockwise and adjust the graticule illumination as desired.

4. Allow the Type 503 to warm up for at least 5 minutes before proceeding further.

PERFORMANCE CHECK PROCEDURE

1. Check Focus and Astigmatism

a. Requirement—De-focused spot should be round or slightly elliptical; focused spot should be sharp.

b. Rotate the INTENSITY control clockwise until the de-focused spot appears in the graticule area.

c. Check—The spot should be round or slightly elliptical. A distorted spot indicates a misadjusted ASTIGMATISM control.

NOTE

On instruments having serial numbers lower than 000270, the ASTIGMATISM control is located on the front panel and is easily adjusted during operation of the oscilloscope.

d. Adjust the FOCUS control for a sharply-focused spot while decreasing the INTENSITY to avoid damage to the CRT phosphor.

e. Check—At optimum intensity, the spot should be sharp and well focused.

2. Check Coarse DC Balance Adjustment—Vertical

a. Requirement—No vertical shift of the trace as the SENSITIVITY switch is rotated from 1 mV/CM to .2 VOLTS/CM.

b. Change the SENSITIVITY switch to 1 mV/CM.

c. With the DC BAL. control, adjust the trace to the same position in the .2 VOLTS/CM switch position.

d. Change the SENSITIVITY switch to .2 VOLTS/CM.

e. Check—No vertical shift of the trace as the SENSITIVITY switch is changed from 1 mV/CM to .2 VOLTS/CM.

3. Check Coarse DC Balance Adjustment—Horizontal

a. Requirement—No horizontal shift of the display (spot) as the Horizontal SENSITIVITY switch is changed from 1 mV to .2 VOLTS/CM.

b. Change the HORIZONTAL DISPLAY switch to the HORIZ. AMPLIFIER (SWEEP DISABLED) position, adjusting the INTENSITY control to avoid damage to the CRT phosphor.

c. Change the HORIZONTAL SENSITIVITY switch to 1 mV/CM.

d. With the DC BAL control, adjust the spot to the same position noted in the .2 VOLTS/CM switch position.

e. Change the SENSITIVITY switch to .2 VOLTS/CM.

f. Check—No horizontal shift of the spot as the SENSITIVITY switch is rotated from 1 mV/CM to .2 VOLTS/CM.

4. Check CRT Horizontal Trace Alignment

a. Requirement—Trace parallel to the center horizontal graticule line.

b. Change the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1).

c. With the Vertical POSITION control, move the trace to the center graticule line.

d. Check—Trace parallel to the center horizontal graticule line.

5. Check .2 VOLTS/CM Gain—Vertical

a. Requirement—Vertical deflection accuracy ±3%.

b. Set the instrument controls as follows:

VERTICAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	GND
—INPUT	GND
POSITION	Centered
HORIZONTAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	GND
—INPUT	GND
POSITION	Centered
HORIZONTAL DISPLAY	SWEEP NORMAL (×1)
LEVEL	FREE RUN

c. Set the Standard Amplitude Calibrator for a 1-volt square-wave output.

d. Connect the Standard Amplitude Calibrator output through a BNC to UHF adapter, a 50-ohm cable and quick-connect adapter (item 12 of Recommended Equipment) to the Type 503 VERTICAL +INPUT connector, and change the VERTICAL +INPUT switch to DC.

e. Adjust the SWEEP TIME/CM switch to a setting which will present an easily-viewed display with a minimum of flicker (.1 mSEC or 50 μSEC).

f. Center the display in the graticule viewing area with the VERTICAL POSITION control.

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g. Check—The display amplitude should be 5 cm ±1.5 mm.

6. Check Variable Control Ratio—Vertical

a. Requirement—Display amplitude with control in CALIBRATED position should be ≥2.5 times the display amplitude with the control in full counterclockwise position.

b. Rotate the control fully counterclockwise.

c. Check—Display amplitude should be 2 cm or less, indicating a ratio of ≥2.5:1.

d. Return the VARIABLE control to the CALIBRATED position.

7. Check 1 mV/CM Gain—Vertical

a. Requirement—Vertical deflection accuracy ±3%.

b. Change the Standard Amplitude Calibrator output to 5 millivolts.

c. Change the VERTICAL SENSITIVITY switch to 1 mV/CM, and adjust the VERTICAL POSITION control to center the display, if necessary.

d. Check—Display amplitude of 5 cm, ±1.5 mm (3%).

8. Check .2 VOLTS/CM Gain—Horizontal

a. Requirement—Horizontal deflection accuracy ±3%.

b. Set the VERTICAL +INPUT selector switch to GND.

c. Set HORIZONTAL +INPUT switch to DC.

d. Set the HORIZONTAL DISPLAY switch to HORIZ. AMPLIFIER (SWEEP DISABLED).

CAUTION

Whenever the sweep is disabled, check that the CRT beam INTENSITY control is adjusted to prevent damage to the CRT phosphor.

e. Set the Standard Amplitude Calibrator to supply a 1-volt square wave, and connect the signal to the HORIZONTAL +INPUT connector.

f. Set the HORIZONTAL SENSITIVITY switch to .2 VOLTS/CM.

g. The display should now consist of two dots spaced horizontally in the graticule area. Center the display with the HORIZONTAL POSITION control.

h. Check—The dot spacing should be 5 cm ± 1.5 mm.

9. Check Variable Control Ratio—Horizontal

a. Requirement—Horizontal deflection with the control in the CALIBRATED position should be ≥2.5 times the horizontal deflection with the control in the full counterclockwise position.

b. Rotate the HORIZONTAL VARIABLE control fully counterclockwise.

c. Check—The dot spacing should be ≤2 cm, indicating a ratio of ≥2.5:1.

d. Return the VARIABLE control to the CALIBRATED position.

10. Check 1 mV/CM Gain—Horizontal

a. Requirement—Horizontal deflection accuracy ±3%.

b. Change the Standard Amplitude Calibrator to 5 millivolts.

c. Change the HORIZONTAL SENSITIVITY switch to 1 mV/CM.

d. Check—Dot spacing 5 cm ±1.5 mm.

11. Check Compression or Expansion—Horizontal

a. Requirement—≤1.5 mm amplitude change in a 2-cm display.

b. Change the HORIZONTAL SENSITIVITY switch to .2 VOLTS/CM.

c. Change the Standard Amplitude Calibrator to 0.5 V output.

d. With the VARIABLE control, adjust the dot spacing for exactly 2 cm, and center the display horizontally and vertically.

e. With the HORIZONTAL POSITION control, move the right-hand dot to the 10-cm vertical graticule line.

f. Check—Dot spacing 2 cm ±1.5 mm.

g. Move the left-hand dot to the left edge (0-cm) of the graticule.

h. Check—Dot spacing 2 cm ±1.5 mm.

i. Return the VARIABLE control to the CALIBRATED position.

12. Check Amplifier Balance—Horizontal (DC Common Mode Rejection)

a. Connect an additional 50-ohm cable to the Standard Amplitude Calibrator output, using a UHF T adapter, and a quick-connect adapter on the output end of the cable.

b. Set the HORIZONTAL —INPUT to DC, and connect the cable added in step (a) to the —INPUT connector.

c. Change the Standard Amplitude Calibrator output to 5 volts, and the HORIZONTAL SENSITIVITY switch to .2 VOLTS/CM.

d. The display will be two dots spread horizontally. With the HORIZONTAL POSITION control, move the display to the right-hand and then to the left-hand vertical graticule line.

e. Check—The total horizontal amplitude of the display should not exceed 2.5 mm anywhere in the graticule area (CMRR 100:1).

(C)

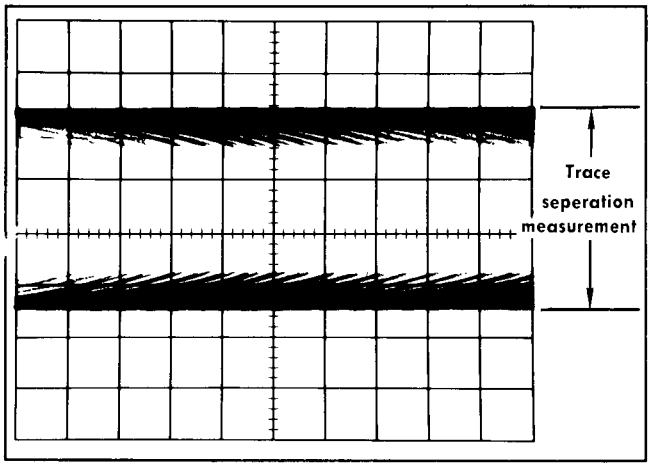


Fig. 5-1. Typical display, amplifier balance check (DC common-mode rejection ratio) —vertical amplifier; 1 mV/CM sensitivity.

f. Change the Standard Amplitude Calibrator output to 0.5 volts, and the HORIZONTAL SENSITIVITY switch to 1 mV/CM, and repeat step (d).

g. Check—The horizontal amplitude of the display should not exceed 5 cm anywhere in the graticule area.

h. Change the HORIZONTAL SENSITIVITY switch to .5 VOLTS/CM, and the Standard Amplitude Calibrator to 50 volts, and repeat step (d).

i. Check—The horizontal amplitude of the display should not exceed 2 cm anywhere in the graticule are, (50:1 CMRR).

j. Change the HORIZONTAL SENSITIVITY switch to 5 VOLTS/CM and the Calibrator output to 100 volts; repeat step (d).

k. Check—The horizontal amplitude of the display should not exceed 4 mm anywhere in the graticule area.

13. Check Compression or Expansion—Vertical

a. Requirement—Display amplitude change not more than ±1.5 mm with a 2-cm display.

b. Change the Standard Amplitude Calibrator output to .5 volts.

c. Set the VERTICAL +INPUT switch to DC, and the HORIZONTAL + and —INPUT to GND.

d. Move the Calibrator signal from the HORIZONTAL +INPUT connector to the VERTICAL +INPUT connector, and set the VERTICAL SENSITIVITY switch to .2 VOLTS/CM.

e. The display should consist of two dots spaced vertically; center the display vertically and horizontally.

f. With the VERTICAL VARIABLE control, adjust the dot spacing for 2 cm exactly, and move the display to the top 2 cm of the graticule.

g. Check—Dot spacing 2 cm ±1.5 mm.

h. Move the display to the bottom 2 cm of the graticule.

i. Check—Dot spacing 2 cm ±1.5 mm.

j. Return the VARIABLE control to CALIBRATED.

14. Check Amplifier Balance—Vertical (DC Common Mode Rejection)

a. Requirement—Rejection ratios and deflection tolerances as listed in Table 5-1, with specified input signals and deflection sensitivities.

b. Set the VERTICAL —INPUT switch to DC, and move the Calibrator signal from the HORIZONTAL —INPUT connector to the VERTICAL —INPUT connector.

c. Change the Standard Amplitude Calibrator to 5 volts.

d. Change the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1). The INTENSITY may have to be increased to view the display.

e. With the VERTICAL POSITION control, move the display to the top line of the graticule, and then to the bottom line of the graticule.

f. Check—Deflections as indicated in Table 5-1. See Fig. 5-1 for a typical display.

TABLE 5-1

Input Signal	Deflection Sensitivity	Rejection Ratio	[1]Maximum Deflection (trace separation)
5 volts	.2 VOLTS/CM	100:1	2.5 mm
0.5 volts	1 mV/CM	100:1	5 cm
50 volts	.5 VOLTS/CM	50:1	2 cm
100 volts	5 VOLTS/CM	50:1	4 mm

[1]**The degree of trace separation should be checked by positioning the display over the entire graticule area.**

15. Check Attenuator Accuracy—Vertical +Input and —Input

a. Requirement—Vertical deflection accuracy within ±3%.

b. Set the VERTICAL —INPUT switch to GND.

c. Change the Standard Amplitude Calibrator output to 5 mV, and change the VERTICAL SENSITIVITY switch to 1 mV/CM.

d. Check—Vertical deflection of 5 cm ±1.5 mm.

e. Set the Standard Amplitude Calibrator output and VERTICAL SENSITIVITY switch as indicated in Table 5-2, checking for the deflections listed.

f. Change the VERTICAL +INPUT switch to GND, and change the VERTICAL —INPUT switch to DC.

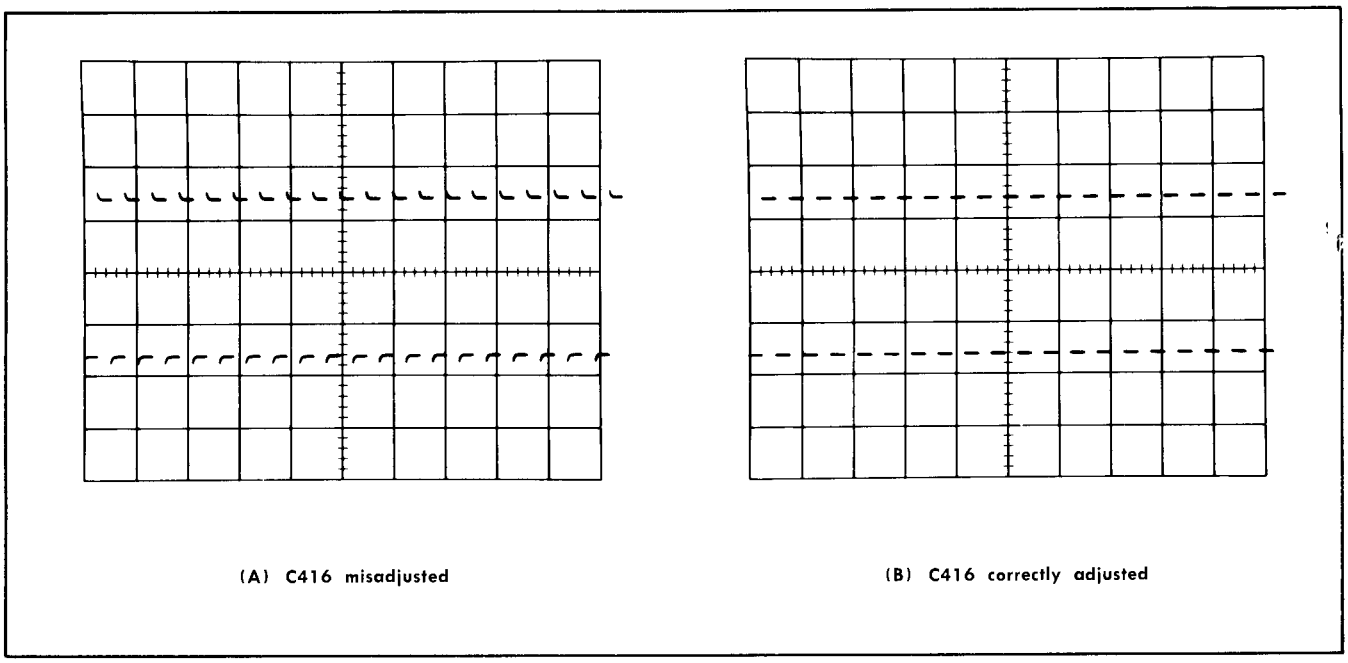
g. Repeat step (e).

16. Check Attenuator Accuracy—Horizontal +Input and —Input

a. Requirement—Horizontal deflection accuracy within ±3%.

b. Move the two 50-ohm cables from the VERTICAL +INPUT and —INPUT connectors to the HORIZONTAL +INPUT and —INPUT connectors.

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(A) C416 misadjusted

(B) C416 correctly adjusted

Fig. 5-2. Typical displays, Vertical Amplifier attenuator compensation check; 1 kHz square-wave input; sweep speed, 2 milliseconds/cm.

TABLE 5-2

SENSITIVITY Setting	Std. Amplitude Calibrator	Deflection
1 mV/CM	5 mV	5 cm ±1.5 mm
2 mV/CM	10 mV	5 cm ±1.5 mm
5 mV/CM	20 mV	4 cm ±1.2 mm
10 mV/CM	50 mV	5 cm ±1.5 mm
20 mV/CM	0.1 V	5 cm ±1.5 mm
50 mV/CM	0.2 V	4 cm ±1.2 mm
.1 VOLTS/CM	0.5 V	5 cm ±1.5 mm
.2 VOLTS/CM	1 V	5 cm ±1.5 mm
.5 VOLTS/CM	2 V	4 cm ±1.2 mm
1 VOLTS/CM	5 V	5 cm ±1.5 mm
2 VOLTS/CM	10 V	5 cm ±1.5 mm
5 VOLTS/CM	20 V	4 cm ±1.2 mm
10 VOLTS/CM	50 V	5 cm ±1.5 mm
20 VOLTS/CM	100 V	5 cm ±1.5 mm

c. Check that the HORIZONTAL +INPUT switch is set to DC, and the —INPUT switch is set to GND.

d. Change the HORIZONTAL DISPLAY switch to HORIZ. AMPLIFIER (SWEEP DISABLED), and adjust the INTENSITY as desired.

e. Repeat step 15(e), using the HORIZONTAL SENSITIVITY switches. The display will be 2 dots.

f. Change the HORIZONTAL +INPUT switch to GND, and change the HORIZONTAL —INPUT switch to DC.

g. Repeat step 15(e), using the HORIZONTAL SENSITIVITY switches. The display will be 2 dots.

h. Remove the Standard Amplitude Calibrator signal.

i. Return the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1).

17. Check Trace Shift Due to Input Grid Current

a. Requirement—Trace shift not more than 1 cm.

b. Set the VERTICAL and HORIZONTAL + and —INPUT switches to GND.

c. Set the VERTICAL and HORIZONTAL SENSITIVITY switches to 1 mV/CM.

d. With the short patch cord (item 15 of Recommended Equipment), ground the VERTICAL +INPUT connector.

e. Change the VERTICAL +INPUT switch to AC.

f. Check—Vertical shift of the trace not more than 1 cm.

g. Repeat steps (d), (e), and (f) with the VERTICAL —INPUT connector, and the HORIZONTAL + and —INUPUT connectors.

h. Remove the patch cord.

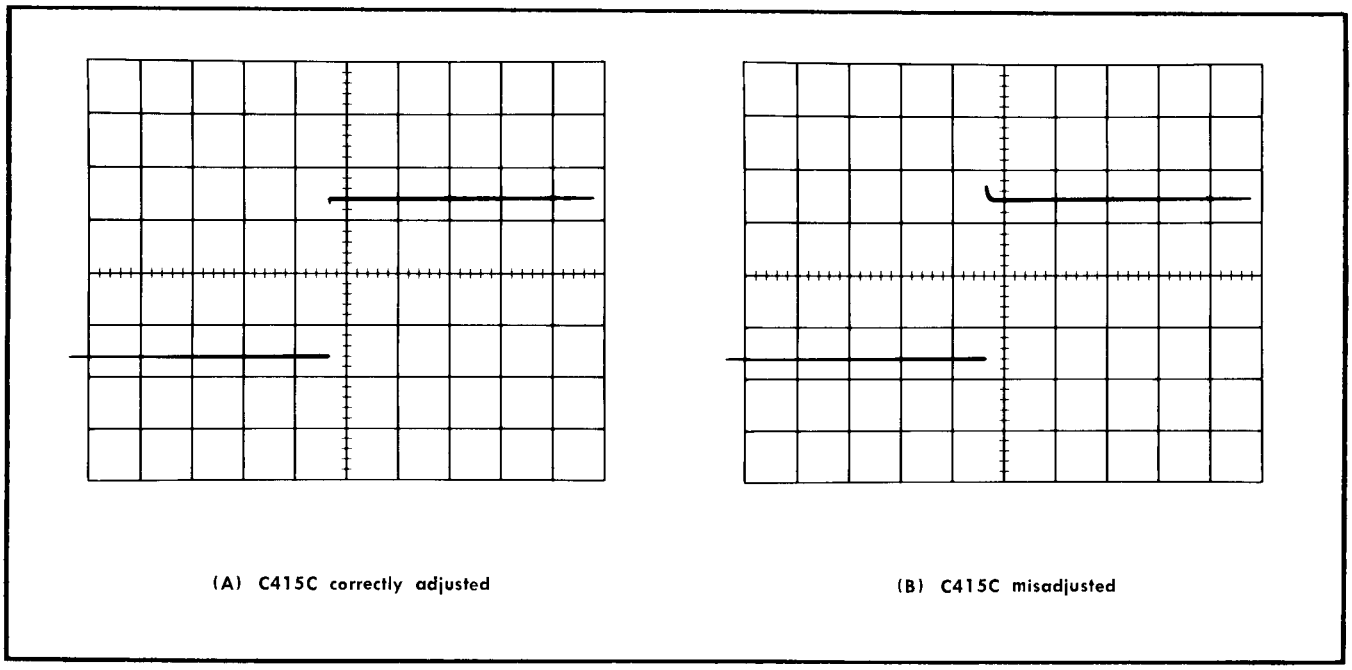
18. Check Attenuator Compensation—Vertical

a. Requirement — Waveform with no more than 2% rounding, overshoot, or tilt.

b. Set the Type 503 controls as follows:

TRIGGER	
SLOPE	—
COUPLING	AC
SOURCE	INT.
LEVEL	FREE RUN
SWEEP TIME/CM	2 mSEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	SWEEP NORMAL (×1)

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(A) C415C correctly adjusted

(B) C415C misadjusted

Fig. 5-3. Typical displays, Vertical Amplifier attenuator compensation change; 1 kHz square-wave input; sweep speed, 0.1 milliseconds/cm.

VERTICAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	DC
—INPUT	GND

c. Set the Square Wave Generator (item 2 of Recommended Equipment) to supply a 1-kHz square wave.

d. Connect the generator output through a 50-ohm termination, (or a ×10 attenuator), a 50-ohm cable, and a 47 pF Input Time-constant Standardizer, to the VERTICAL +INPUT connector in the order given.

NOTE

To attain the desired deflection at different attenuator settings, it will be necessary to add or remove the 50-ohm termination and/or the X10 attenuator. This will not affect the accuracy of the time-constant checks.

e. Adjust the generator output for a display 3 cm in amplitude, and center the display in the graticule viewing area.

f. Rotate the LEVEL control counterclockwise to obtain a stable display (near 0).

g. Check—Square-wave display with no more than 2% aberrations. See Fig. 5-2 for typical displays.

h. Change the SWEEP TIME/CM to .1 mSEC.

i. Check—Square front corner on waveform, with no overshoot, rounding, or tilt exceeding 2% of the display amplitude.

j. Check the square wave response in all remaining positions of the VERTICAL SENSITIVITY switch, alternately switching between the 2 mSEC and .1 mSEC positions of the SWEEP TIME/CM switch.

NOTE

All attenuator compensation checks are made with a display amplitude of 3 cm. Insert or remove attenuation and/or adjust the signal generator output to maintain this display amplitude.

k. Change the VERTICAL +INPUT switch to GND, the VERTICAL —INPUT switch to DC, and move the generator signal from the VERTICAL +INPUT connector to the VERTICAL —INPUT connector.

l. Repeat the procedure outlined in steps (e) through (j).

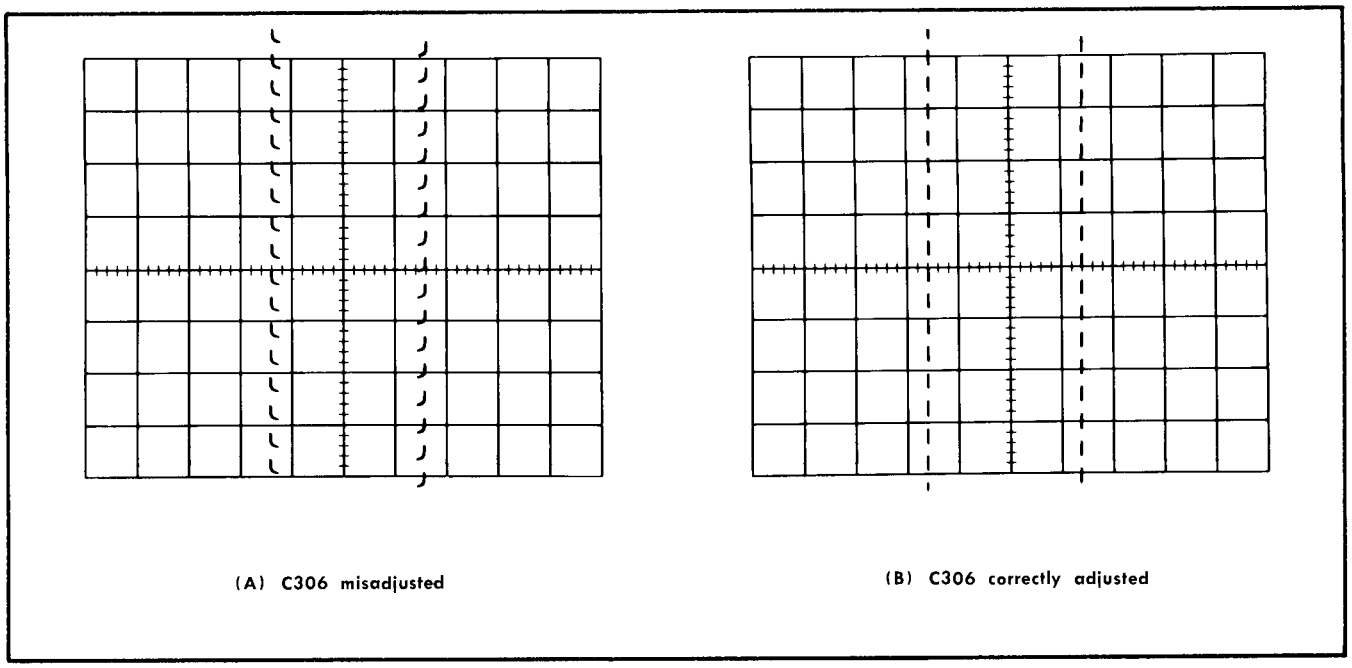
19. Check Attenutor Compensation—Horizontal

a. Requirement—Square waveform showing no more than 2% overshoot, rounding, or tilt.

b. Set the Type 503 controls as follows:

TRIGGER	
SLOPE	+
COUPLING	AC
SOURCE	INT.
LEVEL	FREE RUN
SWEEP TIME/CM	2 mSEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	HORIZ. AMPLIFIER (SWEEP DISABLED)

©



(A) C306 misadjusted

(B) C306 correctly adjusted

Fig. 5-4. Typical display, Horizontal Amplifier attenuator compensation check; 1 kHz square-wave input; SWEEP TIME/CM switch setting, 2 mSEC.

VERTICAL	
SENSITIVITY	1 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	DC
—INPUT	GND
HORIZONTAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	DC
—INPUT	GND
Test Oscilloscope (Type 503)	
Sweep Time/cm	2 mSEC
Trigger Source	Ext.
Trigger Level	Adjust for stable display
Horizontal Display	Sweep Normal (×1)

c. Remove the right side panel from the test oscilloscope.

d. Connect a 10X probe to the VERTICAL +INPUT connector, and connect the probe tip to pin 8 of V160 in the test oscilloscope (i.e., a test point to obtain a sawtooth waveform).

e. Connect a 1-kHz square-wave signal from the square-wave generator through a 50-ohm termination (or 10× attenuator), a 50-ohm cable, a UHF T connector, and a 47 pF Input Time-constant Standardizer to the HORIZONTAL +INPUT connector, in the order given.

f. Connect another 50-ohm cable from the UHF T connector to the test oscilloscope Ext Trig. In connector.

g. Adjust the test oscilloscope Trigger Level control to obtain a stable display on the Type 503. The display should be similar to Fig. 5-4.

h. Adjust the generator output for a 3-cm spacing horizontally, and center the display with the HORIZONTAL POSITION control.

i. Check—Square waveform showing no more than 2% overshoot, rounding, or tilt.

j. Change the test oscilloscope Sweep Time/cm to .1 millisecond.

k. Check—Square front corner on waveform, showing no more than 2% rounding or overshoot. See Fig. 5-5 for typical displays.

l. Check the square wave response in all remaining HORIZONTAL SENSITIVITY switch positions, alternately switching between the 2 millisecond and 0.1 millisecond Sweep Time/cm switch positions in the test oscilloscope.

NOTE

All attenuator compensation checks are made with a display amplitude of 3 cm. Insert or remove attenuation and/or adjust the signal generator output to maintain this amplitude.

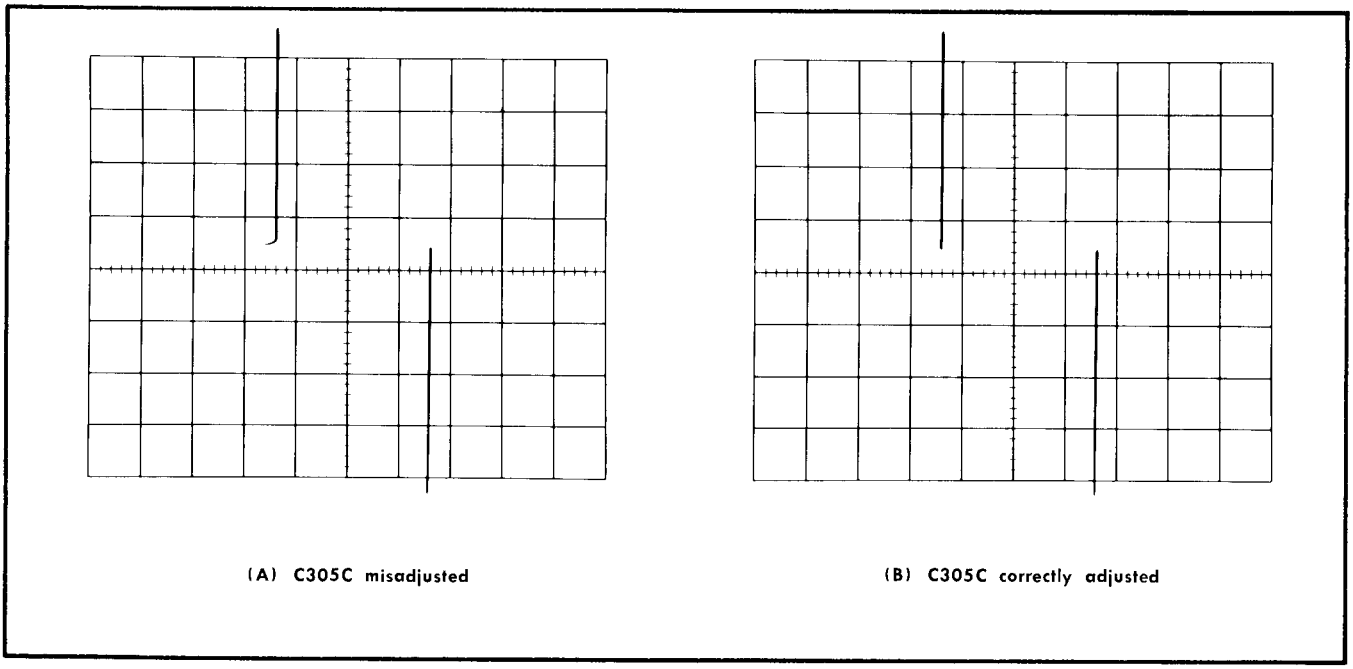
m. Change the HORIZONTAL +INPUT switch to GND, the HORIZONTAL —INPUT switch to DC, and move the Time-constant Standardizer to the HORIZONTAL —INPUT connector.

n. Repeat steps (g) through (l).

20. Check Amplifier Phasing—1 mV/CM to .2 VOLTS/CM

a. Requirement—Phase shift not more than 1° to 450 kHz.

b. Set the Type 503 controls as follows:



(A) C305C misadjusted

(B) C305C correctly adjusted

Fig. 5-5. Horizontal Amplifier attenuator compensation check; 1 kHz square-wave input; SWEEP TIME/CM switch setting, .1 mSEC.

SLOPE	+
COUPLING	AC
SOURCE	INT.
LEVEL	FREE RUN
HORIZONTAL DISPLAY	HORIZ. AMPLIFIER (SWEEP DISABLED)
VERTICAL	
SENSITIVITY	1 mV/CM
VARIABLE	CALIBRATED
POSITION	Midrange
+INPUT	DC
—INPUT	GND
HORIZONTAL	
SENSITIVITY	1 mV/CM
VARIABLE	CALIBRATED
POSITION	Midrange
+INPUT	GND
—INPUT	GND

c. Connect a 50-ohm termination, a UHF T connector, and two 50-ohm cables to the output connector of the constant-amplitude signal generator. If desired, two quick-connect adapters (item 12 of Recommended Equipment) may be installed at the Type 503 input ends of the cables, to permit easy cable-switching.

NOTE

The two 50-ohm cables should be identical to assure symmetrical input to the two amplifiers for phasing checks.

d. Connect the two cables to the VERTICAL and HORIZONTAL +INPUT connectors.

e. Adjust the generator output for a 6-cm display (a vertical line trace) at a frequency of 50 kHz, and center the display vertically and horizontally.

f. Change the HORIZONTAL +INPUT switch to DC. The display will change to a single trace at a 45° angle, or an extremely flattened ellipse with a small separation at the center of the ellipse.

g. Check—Trace separation at the center (measured on the graticule center Vertical line) must be not more than 1 mm (corresponding to 1°). See Fig. 5-6 for method of measuring phase difference.

h. Change the generator frequency to 350 kHz and adjust the generator output for a 6-cm display horizontally and vertically.

i. Check—Trace separation not more than 1 mm, measured as in step (g).

j. Change the generator frequency to 450 kHz, and adjust the generator for a 6-cm display horizontally and vertically.

k. Check—Trace separation not more than 1 mm, measured as in step (g).

l. Check the remaining attenuator positions through .2 VOLTS/CM, using steps (e) through (k) as a guide, and referring to Table 5-3 for attenuator settings, generator frequencies, and trace separation tolerances.

m. Change the VERTICAL and HORIZONTAL +INPUT switches to GND, the VERTICAL and HORIZONTAL —INPUT switches to DC, and move the signal cables from the VERTICAL and HORIZONTAL +INPUT connectors to the VERTICAL and HORIZONTAL —INPUT connectors.

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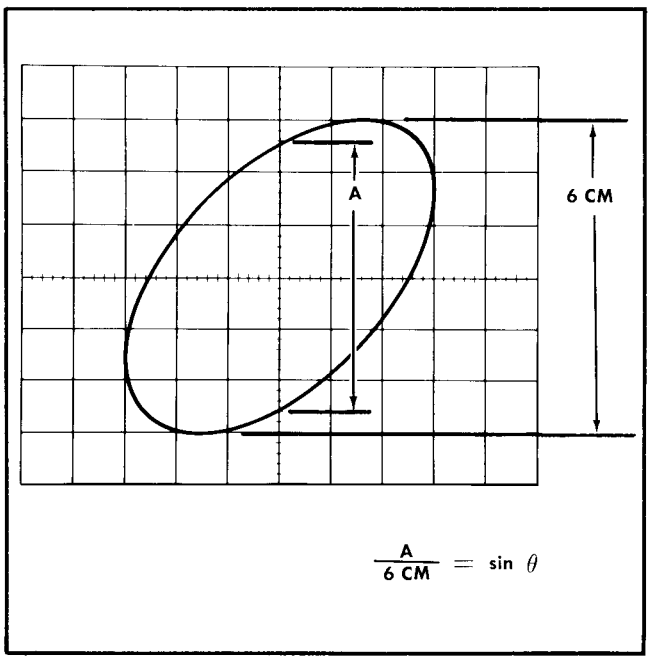


Fig. 5-6. X-Y method of calculating phase difference (Θ) of two sine waves.

n. Repeat the checks as outlined in Table 5-3, and steps (e) through (k).

TABLE 5-3

Sensitivity Horizontal and Vertical	Generator Frequency	Maximum [2]Trace Separation
1 mV/CM	50 kHz 350 kHz 450 kHz	1 mm
2 mV/CM	50 kHz 350 kHz 450 kHz	1 mm
5 mV/CM	50 kHz 350 kHz 450 kHz	1 mm
10 mV/CM	50 kHz 350 kHz 450 kHz	1 mm
20 mV/CM	50 kHz 350 kHz 450 kHz	1 mm
.1 VOLTS/CM	50 kHz 350 kHz 450 kHz	1 mm
.2 VOLTS/CM	50 kHz 350 kHz 450 kHz	1 mm

[2]All measurement made with a display amplitude of 6 cm, horizontal and vertical.

21. Check Common Mode Rejection Ratio (AC)

a. Requirement—Maximum display amplitudes as indicated in Table 5-4, with specified signal inputs and deflection sensitivities.

b. Set the HORIZONTAL + and —INPUT switches to GND.

c. Set the VERTICAL +INPUT to DC, and the —INPUT to GND.

d. Set the constant amplitude generator frequency to 50 kHz, and connect the 50-ohm cables to the VERTICAL + and —INPUT connectors.

e. Set the VERTICAL SENSITIVITY to 1 VOLTS/CM, and adjust the generator output for a trace 4 cm in amplitude.

f. Change the VERTICAL —INPUT switch to DC, and change the VERTICAL SENSITIVITY switch to .2 VOLTS/CM.

g. With the VERTICAL POSITION control, move the display to the top, then to the bottom of the graticule.

h. Check—Vertical deflection (trace separation) not more than 2 mm anywhere in the graticule area.

NOTE

In all succeeding Common Mode Rejection Ratio checks, the display should be moved over the entire graticule area during the check, as indicated in steps (g) and (h).

i. Check the remaining vertical attenuator settings listed in Table 5-4. The generator output (4 V) is not changed for the checks in Table 5-4.

j. Set the VERTICAL + and —INPUT switches to GND, and change the HORIZONTAL + and —INPUT switches to DC.

k. Move the signal cables to the HORIZONTAL INPUT connectors, and set the HORIZONTAL SENSITIVITY switch to .2 VOLTS/CM.

TABLE 5-4

SENSITIVITY Settings HORIZONTAL/ VERTICAL	Signal Amplitude	Maximum Deflection
.2 VOLTS/CM	4 volts	2 mm
.1 VOLTS/CM	4 volts	4 mm
50 mV/CM	4 volts	8 mm
20 mV/CM	4 volts	2 cm
10 mV/CM	4 volts	4 cm

l. With the HORIZONTAL and VERTICAL POSITION controls, move the display within the graticule viewing area.

m. Check—Horizontal deflection not more than 2 mm.

n. Check the remaining horizontal attenuator settings listed in Table 5-4, leaving the generator output at 4 V.

o. Change the HORIZONTAL SENSITIVITY switch to 0.1 VOLTS/CM.

p. Change the HORIZONTAL —INPUT switch to GND, and adjust the generator output for a trace 5 cm long (0.5 V output).

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q. Change the HORIZONTAL —INPUT to DC, and the HORIZONTAL SENSITIVITY switch to 5 mV/CM.

r. Check—Horizontal display not more than 1 cm long.

s. Change the Horizontal SENSITIVITY to 2 mV/CM.

t. Check—Display not more than 2.5 cm long.

u. Change the HORIZONTAL SENSITIVITY to 1 mV/CM.

v. Check—Display not more than 5 cm long.

w. Change both HORIZONTAL INPUT switches to GND.

x. Set the VERTICAL SENSITIVITY switch to 5 mV/CM.

y. Set the VERTICAL + and —INPUT switches to DC.

z. Move the two signal cables from the HORIZONTAL INPUT connectors to the VERTICAL INPUT connectors.

aa. Check—Amplitude of the display not more than 1 cm anywhere in the graticule area.

ab. Change the VERTICAL SENSITIVITY switch to 2 mV/CM.

ac. Check—Display amplitude not more than 2.5 cm in the graticule area.

ad. Change the VERTICAL SENSITIVITY switch to 1 mV/CM.

ae. Check—Display amplitude not more than 5 cm.

22. Check Vertical Amplifier Frequency Response

a. Requirement—Response not more than —3 dB at 450 kHz.

b. Remove the UHF T connector and one 50-ohm cable, and connect the other cable from the 50-ohm termination to the VERTICAL +INPUT connector.

c. Set the HORIZONTAL + and —INPUT switches to GND, the VERTICAL +INPUT to DC, and the VERTICAL —INPUT to GND.

d. Set the SWEEP TIME/CM switch to .1 mSEC, and the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1).

e. Set the VERTICAL SENSITIVITY to 1 mV/CM and adjust the generator output for a display 6 cm in amplitude.

f. Change the generator frequency to 450 kHz. The display amplitude will decrease.

g. Check—The display amplitude should be equal to or greater than 4.2 cm (—3 dB).

h. Repeat the frequency response check for all positions of the VERTICAL + and —INPUT attenuator (SENSITIVITY) switch.

23. Check Horizontal Amplifier Frequency Response

a. Requirement—Response not more than 3 dB down at 450 kHz.

b. Set the VERTICAL + and —INPUT switches to GND, the HORIZONTAL +INPUT to DC, and connect the signal to the HORIZONTAL +INPUT connector.

c. Change the HORIZONTAL DISPLAY switch to HORIZ. AMPLIFIER (SWEEP DISABLED).

d. Check that the HORIZONTAL SENSITIVITY switch is set to 1 mV/CM.

e. Set the generator frequency to 50 kHz, and adjust the generator output for a trace 6 cm long.

f. Change the generator frequency to 450 kHz. The trace will shorten.

g. Check—The trace should be equal to or greater than 4.2 cm long (—3 dB).

h. Repeat the frequency response checks (steps (e), (f), and (g) for all positions of the HORIZONTAL + and —INPUT attenuator SENSITIVITY) switch.

24. Check Sweep Stability Adjustment

a. Requirement—A free-running trace.

b. Set all + and —INPUT switches to GND.

c. Set the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1), and the SWEEP TIME/CM to .1 mSEC.

d. Set the LEVEL control to AUTO.

e. Check—A free-running trace should be visible at an approximate 50 Hz rate.

25. Check Triggering—External High Frequency

a. Requirement—A stable display may be obtained at the + and — positions of the SLOPE switch at 450 kHz.

b. Set the instrument controls as follows:

SLOPE	+
COUPLING	AC
SOURCE	EXT.
LEVEL	AUTO.
HORIZONTAL DISPLAY	SWEEP NORMAL (×1)
VERTICAL	
SENSITIVITY	.1 VOLTS/CM
VARIABLE	CALIBRATED
POSITION	Midrange
+INPUT	DC
—INPUT	GND
SWEEP TIME/CM	5 μSEC
Test Oscilloscope (Type 503)	
Vertical Sensitivity	10 mV/cm
Vertical +Input	DC (all other inputs at GND)
Sweep Time/cm	1 millisecond/cm
Slope	+
Source	Int.
Level	Auto.

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c. Connect a 50-ohm termination, a UHF T connector, and two 50-ohm cables to the output connector of the constant-amplitude signal generator, in the order given.

d. Connect one cable to the Type 503 VERTICAL +INPUT connector, and the other cable to the EXT. TRIG. IN connector.

e. Connect a 10× probe to the test oscilloscope Vertical +Input connector, and connect the probe tip to the EXTERNAL TRIG. IN connector.

f. Set the generator frequency to 50 kHz, and adjust the output to 0.5 V, as indicated on the test oscilloscope by a display amplitude of 5 cm.

g. Remove the test probe from the EXTERNAL TRIG. IN connector.

h. Change the generator frequency to 450 kHz.

i. Check—A stable display may be obtained in the + and — positions of the SLOPE switch by adjusting the LEVEL control.

j. Rotate the LEVEL control to the AUTO. position.

k. Check—A stable display may be obtained in both positions of the SLOPE switch.

l. Remove the probe.

26. Check Triggering—Internal High Frequency

a. Requirement—Stable displays in both positions of the SLOPE and COUPLING switches, and in AUTO.

b. Change the SOURCE switch to INT., and the constant-amplitude generator signal frequency to 50 kHz.

c. Turn the LEVEL control to FREE RUN, and adjust the generator output for a display 0.5 cm in amplitude.

d. Adjust the LEVEL control for a stable display.

e. Check—A stable display may be obtained with the SLOPE switch in either position, and with the COUPLING switch in either position, by adjustment of the LEVEL control.

f. Change the LEVEL control to FREE RUN, and adjust the generator output for a 0.8 cm display.

g. Change the LEVEL control to AUTO.

h. Check—Stable displays may be obtained with the SLOPE and COUPLING switches in either position.

i. Change the LEVEL control to FREE RUN, the generator frequency to 450 kHz, and adjust the generator output for a 2-cm display.

j. Check—Stable displays with the SLOPE and COUPLING switches in either position by adjusting the LEVEL control.

k. Adjust the generator output for a 2.5-cm display, and turn the LEVEL control to the AUTO. position.

l. Check—Stable displays with the SLOPE and COUPLING switches in either position.

m. Remove the constant-amplitude generator signal.

27. Check Triggering—External (1 kHz Square Wave)

a. Requirement—Stable display in + and —SLOPE switch positions, and in AUTO. triggering.

b. Connect a UHF T connector and two 50-ohm cables to the output connector of the Standard Amplitude Calibrator (item 4 of Recommended Equipment).

c. Connect one cable to the EXTERNAL TRIG. IN connector.

d. Set the Standard Amplitude Calibrator to supply a 0.5-volt square wave.

e. Change the SWEEP TIME/CM to 2 mSEC.

f. Check—A stable display may be obtained with the SLOPE switch in both positions by adjustment of the LEVEL control, and with the LEVEL control in AUTO.

28. Check Triggering—Internal (1 kHz Square Wave)

a. Requirement—Stable displays in + and — SLOPE, AC or DC trigger COUPLING, and in AUTO. triggering.

b. Change the SOURCE switch to INT.

c. Set the Standard Amplitude Calibrator to 50 millivolts.

d. Check—A stable display may be obtained with the SLOPE switch in both positions, by adjustment of the LEVEL CONTROL, and with the LEVEL control in AUTO.

e. Position the display to the graticule center, and obtain a stable display with the LEVEL control.

f. Change the COUPLING switch to DC.

g. Check—A stable display may be obtained in both positions of the SLOPE switch by adjustment of the VERTICAL POSITION control. The bottom of the square-wave display (zero DC level) should be within ±1 cm of the graticule center line when the SLOPE switch is in either position.

h. Disconnect the calibrator signal.

29. Check Line Triggering

a. Requirement—Stable triggering at line frequencies.

b. Connect a 10× probe to the VERTICAL +INPUT connector.

c. Connect the probe tip to a suitable line voltage source (i.e., the line fuse terminal at the inside rear panel of the test oscilloscope).

d. Set the VERTICAL SENSITIVITY switch to 5 VOLTS/CM, and the SWEEP TIME/CM to 5 mSEC.

e. Change the SOURCE switch to LINE.

f. Check—A stable display may be obtained with the SLOPE switch in either position by adjustment of the LEVEL control.

g. Change the LEVEL control to AUTO.

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h. Check—A stable display in both positions of the SLOPE switch.

i. Remove the 10× probe.

30. Check Sweep Timing—1 mSEC/CM

a. Requirement—Sweep accuracy ±3% (2.4 mm in 8 cm).

b. Set the controls as follows:

SLOPE	+
COUPLING	AC
SOURCE	INT.
LEVEL	Triggered (not AUTO.)
HORIZONTAL DISPLAY	SWEEP NORMAL (×1)
VERTICAL	
SENSITIVITY	Set to produce a 3-cm display
VARIABLE	Set to produce a 3-cm display
POSITION	Midrange
+INPUT	AC
—INPUT	GND
HORIZONTAL	
+INPUT	GND
—INPUT	GND
SWEEP TIME/CM	1 mSEC

c. Set the time-mark generator (item 5 of Recommended Equipment) to supply 1-millisecond markers.

d. Connect a 50-ohm cable from the time-mark generator output connector to the VERTICAL +INPUT connector.

e. Set the VERTICAL SENSITIVITY and the VARIABLE control so that the display amplitude is approximately 3 cm.

f. Check—1 marker/cm, ±3% (2.4 mm in 8 cm).

31. Check Sweep Length

a. Requirement—Sweep length 10.2 to 10.8 cm.

b. Change the SWEEP TIME/CM to 1 mSEC, the time-mark generator output to 1-millisecond markers, and the SOURCE switch to INT.

c. Check—A sweep length of 10.2 cm to 10.8 cm.

32. Check Sweep Timing—10 μSEC/CM

a. Requirement—Sweep accuracy ±3% (2.4 mm in 8 cm).

b. Change the generator output to 10-microsecond markers.

c. Change the SWEEP TIME/CM switch to 10 μSEC.

d. Check—One marker/cm, ±3%.

33. Check Sweep Timing—1 μSEC/CM

a. Requirement—Sweep accuracy ±3% (2.4 mm in 8 cm)

b. Change the time-mark generator output to 1-microsecond markers.

c. Change the SWEEP TIME/CM switch to 1 μSEC.

d. Connect a 50-ohm cable from the time-mark generator trigger output connector to the EXTERNAL TRIG. IN connector, and set the generator to supply 10-microsecond triggers.

e. Change the SOURCE switch to EXT.

f. Check—One marker/cm, ±3%.

34. Check Variable Control Ratio

a. Requirement—≥2.5:1 reduction in sweep rates.

b. Rotate the SWEEP TIME/CM VARIABLE control fully counterclockwise.

c. Check—≥2.5 times as many markers in a given display area.

d. Return the VARIABLE control fully clockwise.

35. Check Sweep Timing

a. Requirement—Sweep accuracy ±3% (2.4 mm in 8 cm) in all SWEEP TIME/CM ranges.

b. Set the time-mark generator and Type 503 as indicated in Table 5-5, checking for timing accuracy tolerances as shown.

TABLE 5-5

SWEEP TIME/CM Setting	Time-mark Generator Setting	Check
2 mSEC	1 ms	2 marks/cm
5 mSEC	5 ms	1 mark/cm
10 mSEC	10 ms	1 mark/cm
20 mSEC	10 ms	2 marks/cm
50 mSEC	50 ms	1 mark/cm
.1 SEC	100 ms	1 mark/cm
.2 SEC	100 ms	2 marks/cm
.5 SEC	500 ms	1 mark/cm
1 SEC	1 sec	1 mark/cm
2 SEC	1 sec	2 marks/cm
5 SEC	5 sec	1 mark/cm
.5 mSEC	500 μs	1 mark/cm
.2 mSEC	100 μs	2 marks/cm
.1 mSEC	100 μs	1 mark/cm
10 μSEC	10 μs	1 mark/cm
20 μSEC	10 μs	2 marks/cm
50 μSEC	50 μs	1 mark/cm
1 μSEC[3]	1 μs	1 mark/cm
2 μSEC[3]	1 μs	2 marks/cm
5 μSEC	5 μs	1 mark/cm

[3]Use external triggering; i.e., connect a UHF T connector and an additional 50-ohm cable from the time-mark generator to the EXTERNAL TRIG. IN connector, change the SOURCE switch to EXT., and obtain a stable display with the LEVEL control.

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36. Check Sweep Magnifier Registration

a. Requirement—≤0.5 cm shift from magnified sweep to normal sweep.

b. Set the SWEEP TIME/CM to 1 mSEC.

c. Set the time-mark generator to supply 5-millisecond markers.

d. Check that the SOURCE switch is set to INT., and adjust the LEVEL control.

e. Center the first time mark to the graticule vertical center line with the HORIZONTAL POSITION control.

f. Change the HORIZONTAL DISPLAY switch to ×50, and recenter the first time mark to the graticule center line.

g. Change the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1).

h. Check—No more than 0.5 cm shift of the first time mark as the HORIZONTAL DISPLAY switch is changed from ×50 to ×1.

37. Check Horizontal Drift

a. Requirement—≤4 mm drift from the magnified display to the normal display.

b. Set the HORIZONTAL DISPLAY SWEEP MAGNIFIED switch to ×50, and check that the first time-mark is at the graticule center.

c. Change the HORIZONTAL DISPLAY SWEEP MAGNIFIED switch to ×1.

d. Check—After 30 seconds, the marker drift should not be more than 4 mm.

38. Check Magnifier Accuracy

a. Requirement—Magnifier accuracy ±5%, as indicated in Table 5-6.

b. Set the time-mark generator to supply 1-millisecond and 100-microsecond markers.

c. Adjust the LEVEL control to obtain a stable display. The display should consist of one large mark/cm and 10 small marks/cm.

d. Change the HORIZONTAL DISPLAY SWEEP MAGNIFIED switch to X2.

e. Check—1 large mark/2 cm, ±1 mm/2 cm.

f. Set the HORIZONTAL DISPLAY switch as indicated in Table 5-6, checking for magnifier tolerances as shown.

TABLE 5-6

HORIZONTAL DISPLAY	Check	Tolerance (±5%)
×2	1 large mark/2 cm	±1 mm/2 cm
×5	1 large mark/5 cm	±2.5 mm/5 cm
×10	1 small mark/cm	±0.5 mm/cm
×20	1 small mark/2 cm	±1 mm/2 cm
×50	1 small mark/5 cm	±2.5 mm/5 cm

39. Check Sweep Jitter

a. Requirement—Horizontal jitter 2 mm or less (Sweep Magnified ×50).

b. Connect 1-microsecond time marks from the time-mark generator to the VERTICAL +INPUT connector.

c. Connect a 50-ohm cable from the time-mark generator trigger output connector to the EXTERNAL TRIG. IN connector.

d. Set the SOURCE switch to EXT., the SWEEP TIME/CM to 5 μSEC, and the HORIZONTAL DISPLAY switch to ×50.

e. Set the time-mark generator to supply 10-microsecond triggers, and adjust the LEVEL control to obtain a stable display.

f. Use the HORIZONTAL POSITION to display the last marker of the magnified sweep.

g. Check—Horizontal jitter 2 mm or less.

h. Remove the time-mark generator signals.

40. Check Z Axis Operation

a. Requirement — Intensity modulation with a 10-volt signal.

b. Change the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1), the SWEEP TIME/CM to 1 mSEC, and the LEVEL control clockwise to the FREE RUN position.

c. Connect a 50-ohm cable from the Standard Amplitude Calibrator output connector to the CRT GRID binding post of the EXTERNAL INPUT connectors (on the rear panel of the Type 503).

d. Set the Standard Amplitude Calibrator to supply a 10-volt square wave.

e. Remove the strap connecting the CRT GRID and GND binding posts.

f. Check—Intensity modulation of the trace should be visible.

g. Replace the strap connecting the CRT GRID and GND binding posts, and remove the signal from the binding post.

41. Check Amplitude Calibrator

a. Requirement—Amplitude accuracy, ±3%.

b. Set the VERTICAL SENSITIVITY to 1 mV/CM, and the VERTICAL + and — INPUT switches to DC, and the LEVEL control to AUTO.

c. Set the SWEEP TIME/CM to 20 μSEC, and the HORIZONTAL DISPLAY to SWEEP NORMAL (×1).

d. Set the Standard Amplitude Calibrator to supply a 5-millivolt square wave, and connect a 50-ohm cable from the Calibrator to the VERTICAL +INPUT connector.

e. Connect a short patch cord from the 5 mV CAL. OUT connector to the VERTICAL —INPUT connector. The display will be the difference between the Standard Calibrator voltage and the Type 503 CALIBRATOR voltage.

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f. Check—Trace separation at the vertical center of the display should not exceed 1.5 mm (3%).

g. Change the VERTICAL SENSITIVITY switch to .1 VOLTS/CM.

h. Change the Standard Amplitude Calibrator to 0.5 volts.

i. Move the patch cord from the 5 mV CAL. OUT connector to the 500 mV CAL. OUT connector.

j. Check—Trace separation at the display center not to exceed 1.5 mm (3%).

42. Check Calibrator Symmetry

a. Requirement—Ratio between adjacent half-cycles 2:1 or less.

b. Change the VERTICAL +INPUT switch to GND.

c. Change the SWEEP TIME/CM to .2 mSEC, and adjust the LEVEL control for a stable display.

d. Rotate the SWEEP TIME/CM VARIABLE control counterclockwise until one cycle of the calibrator waveform occupies 10 cm of the graticule.

e. Check—The calibrator waveform symmetry should be within a ratio of 2:1.

43. Check Calibrator Frequency

a. Requirement—Calibrator frequency 350 Hz ±50%.

b. Return the SWEEP TIME/CM VARIABLE to CALIBRATED.

c. Change the SWEEP TIME/CM to 1 mSEC.

d. Check—The length of one calibrator cycle should be between 1.9 and 5.7 cm (350 Hz ±50%).

44. Check Calibrator Jitter

a. Requirement—Horizontal jitter not more than 1.5 cm.

b. Change the HORIZONTAL DISPLAY switch to X50. The INTENSITY may have to be increased to view the display.

c. Rotate the HORIZONTAL POSITION control counterclockwise to center the leading edge of the last cycle of the calibrator waveform.

d. Check—Horizontal jitter not more than 1.5 cm.

e. Disconnect all equipment.

SECTION 6

CALIBRATION

Introduction

The Type 503 Oscilloscope is a stable instrument and should not require frequent calibration. However, it will be necessary to calibrate certain parts of the instrument when tubes or components are changed. Also, a periodic calibration is desirable from the standpoint of preventive maintenance.

Apparent trouble in the instrument may be due to improper calibration of one or more circuits. Consequently this section of the manual should be used in conjunction with the Maintenance section during troubleshooting work. If trouble occurs in the instrument, be sure that it is not due to improper calibration before proceeding with more detailed troubleshooting.

In the instructions that follow, the steps are arranged in the proper sequence for a complete calibration of the instrument. Each numbered step contains the information required to make one adjustment or a series of related adjustments. Controls not mentioned in a given step are assumed to be set at the positions they were left in during the preceding step.

If a single control requires adjustment, and the particular control is known, it can often be adjusted without calibrating the entire instrument, provided the control does not interact with other adjustments. In such cases, the control is adjusted in the normal manner, as described in the applicable calibration step. It may be necessary, however, to refer to the calibration steps immediately preceding the adjustment desired to determine the proper setting for the controls not mentioned in that step. Due to the interaction beween adjustments in the horizontal and vertical amplifiers, single adjustments in these circuits usually cannot be made. When amplifier adjustments are required, the entire amplifier should be calibrated. In addition, if the —100-volt supply is adjusted, the entire instrument must be calibrated.

RECOMMENDED EQUIPMENT

General

The following list of equipment, or its equivalent, is recommended for complete calibration of the Type 503. Specifications given are the minimum necessary for accurate calibration of this instrument. All test equipment is assumed to be correctly calibrated and operating within the original specifications. If equipment is substituted, it must meet or exceed the specifications of the original equipment.

Special Test Equipment

For the quickest and most accurate calibration, special calibration fixtures are used where necessary. All calibration fixtures listed under Recommended Equipment can be obtained from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Test Oscilloscope. Minimum vertical deflection factor, 1 mV/div; bandwidth, DC to 450 kHz. Tektronix Type 503 recommended.

2. DC voltmeter. Calibrated to 1% accuracy at 12.6, 85, 100 and 250 volts DC, within 3% accuracy at 3000 volts DC. For example, Simpson Model 260-5P, or Triplett Model 630PLK.

3. Variable autotransformer. Range, 105 VAC to 125 VAC to at least 150 volts-amperes; with RMS meter.

4. Square-wave generator. Range, 0.5 volts to 20 volts at 1 kHz; risetime, 120 nanoseconds or faster. Tektronix Type 106 recommended.

5. Constant-amplitude sine-wave generator. Signal frequencies, 50 kHz, 350 kHz, and 450 kHz; output 0 to 5 volts Tektronix Type 191 recommended.

6. Standard Amplitude Calibrator. Accuracy, 0.25%; output, 5 mV to 100 volt square waves. Tektronix Calibration Fixture Part No. 067-0502-00 recommended.

7. Time-mark generator. To provide markers from 1 μs through 5 seconds; accuracy, 0.2% or better. Tektronix Type 184 recommended.

8. 10× probe. Tektronix Type P6006, Part No. 010-0125-00 recommended.

9. 1× probe with UHF connector. Tektronix Type P6027, Part No. 010-0070-00 recommended.

10. Input time-constant normalizer, 47 pF, with UHF connectors. Tektronix Part No. 011-0068-00.

11. 50 Ω termination with UHF connectors, Tektronix Part No. 011-0045-00.

12. 50 Ω cables with UHF connectors. Tektronix Part No. 012-0001-00 (2 required).

13. Adapter, UHF T, Tektronix Part No. 103-0026-00.

14. Adapter, GR to UHF female. Tektronix Part No. 017-0022-00.

15. Adapter, UHF quick-connect. Tektronix Part No. 003-0028-00 (2 required).

16. Adapter, male BNC and female UHF. Tektronix Part No. 103-0032-00.

17. Attenuator, 10:1 with UHF connectors. Tektronix Part No. 011-0031-00.

18. Insulated alignment screwdriver. Tektronix Part No. 003-0000-00.

19. Insulated alignment tool. Tektronix Part No. 003-0003-00.

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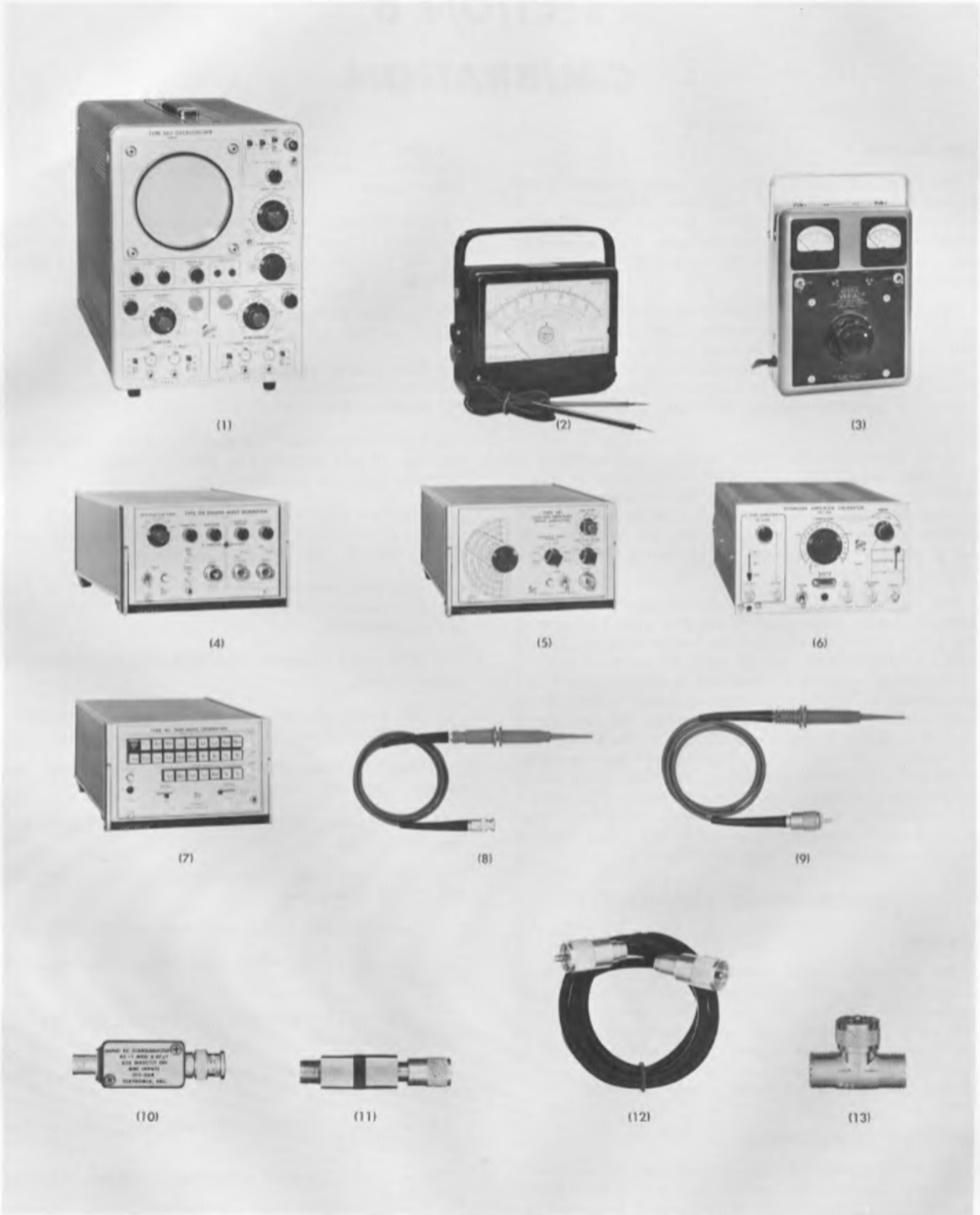


Fig. 6-1. Recommended equipment for calibration of the Type 503 Oscilloscope.

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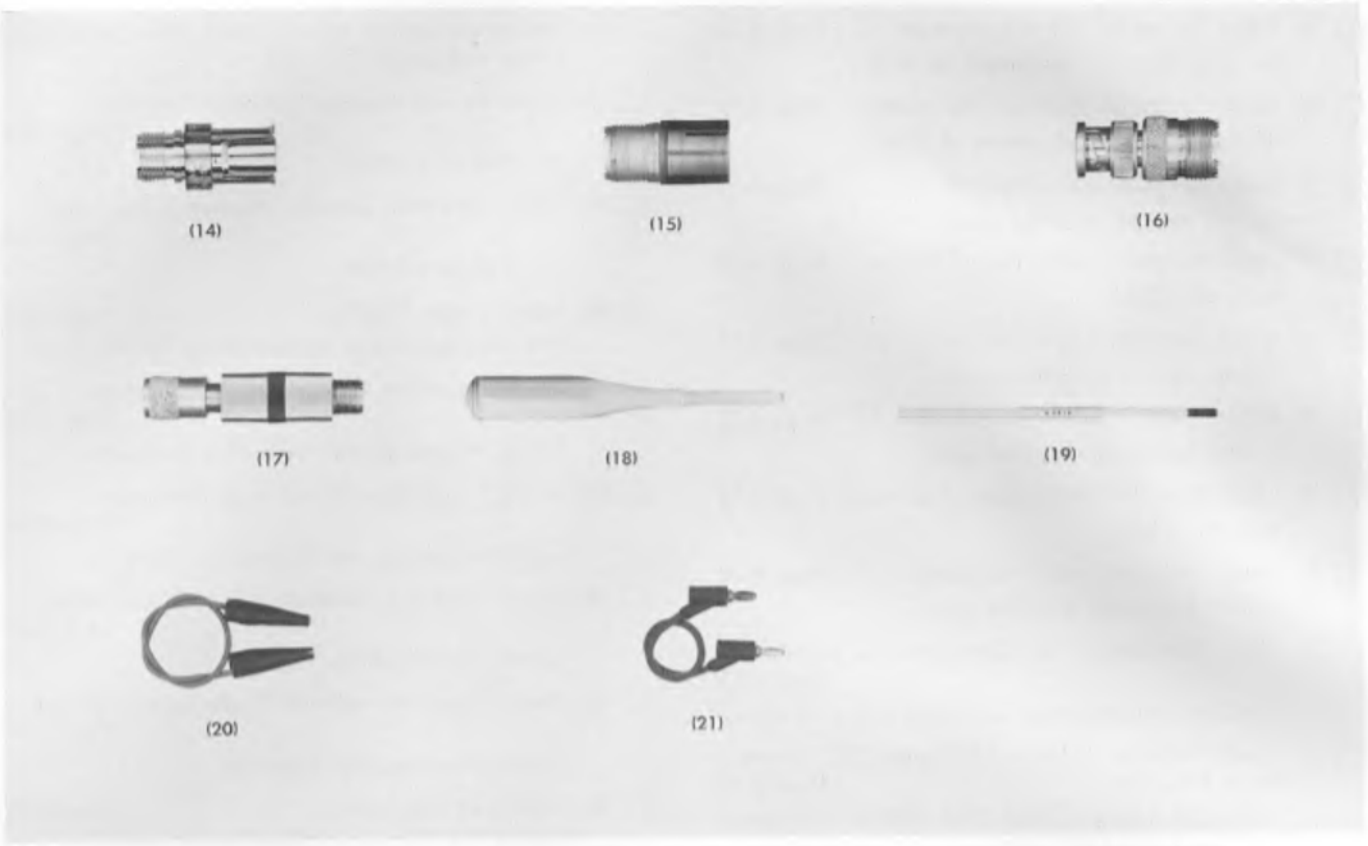


Fig. 6-2. Recommended equipment for calibration of the Type 503 Oscilloscope.

20. 6-inch jumper lead with miniature alligator clip terminals.

21. 6-inch patch cord with banana plug terminals. Tektronix Part No. 012-0028-00.

CALIBRATION RECORD AND INDEX

This abridged Calibration Procedure is provided to aid in checking the operation of the Type 503. It may be used as a calibration guide by the experienced calibrator, or it may be used as a calibration record. Since the step numbers and titles correspond to those used in the complete Calibration Procedure, the following procedure serves as an index to locate a step in the complete Calibration Procedure. Characteristics are those listed in the Characteristics section of the Instruction Manual.

Type 503 Serial No. _____

Calibration Date _____

☐ 1. Adjust —100 Volt Supply. Page 6-6
—100 volts, ±2%.

☐ 2. Check +12.6 Volt Supply. Page 6-7
+12.6 volts, ±0.63 volts (5%).

☐ 3. Check +100 Volt Supply. Page 6-7
+100 volts, ±5 volts.

☐ 4. Check +250 Volt Supply. Page 6-7
+250 volts, ±12.5 volts.

☐ 5. Check —3000 Volt Supply. Page 6-7
—3000 volts, ±150 volts.

☐ 6. Check Power Supply Ripple and Regulation. Page 6-8
—100 volts, ±2% from 105 to 125 VAC RMS; 120-Hz ripple not more than 15 mV.

☐ 7. Check Focus and Astigmatism. Page 6-9
Sharp, well-defined displays.

☐ 8. Check CRT Horizontal Trace Alignment. Page 6-9
Trace parallel to the center horizontal graticule line.

☐ 9. Check Horizontal Geometry. Page 6-9
≤1 mm bowing in the graticule area.

☐ 10. Check Vertical Geometry. Page 6-9
Maximum tilt 1 mm right or left.

☐ 11. Check Focus. Page 6-10
Optimum resolution of 1 mm markers.

☐ 12. Adjust Magnifier Registration (Preliminary). Page 6-10
Marker centering with R339 adjustment.

☐ 13. Check Horizontal Drift (Preliminary). Page 6-10
Display drift not more than 4 mm.

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☐ 14. Adjust Coarse DC Balance—Vertical. Page 6-10
DC balancing by adjustment of R436.

☐ 15. Adjust Coarse DC Balance—Horizontal. Page 6-10
DC balancing by adjustment of R346.

☐ 16. Adjust .2 V/CM Gain—Vertical. Page 6-11
Correct vertical amplifier gain.

☐ 17. Check Variable Control Ratio—Vertical. Page 6-12
Ratio of $\leq$2.5:1.

☐ 18. Adjust 1 mV/CM Gain—Vertical. Page 6-12
Correct vertical amplifier gain.

☐ 19. Adjust .2 V/CM Gain—Horizontal. Page 6-12
Correct horizontal amplifier gain.

☐ 20. Check Variable Control Ratio—Horizontal. Page 6-12
Ratio of $\geq$2.5:1.

☐ 21. Adjust 1 mV/CM Gain—Horizontal. Page 6-12
Correct horizontal amplifier gain.

☐ 22. Check Compression or Expansion—Horizontal. Page 6-13
$\pm$1.5 mm compression or expansion with 2 cm signal.

☐ 23. Check Amplifier Balance—Horizontal (DC Common Mode Rejection). Page 6-13
Horizontal Amplifier CMRR 100:1 and 50:1 with specified inputs and sensitivities.

☐ 24. Check Compression or Expansion—Vertical. Page 6-13
$\pm$.15 mm compression or expansion with 2 cm signal.

☐ 25. Check Amplifier Balance—Vertical (DC CMRR). Page 6-13
Common mode rejection ratio 100:1 and 50:1 with specified inputs and sensitivities.

☐ 26. Check Attenuator Accuracy—Vertical +INPUT and −INPUT. Page 6-14
Vertical deflection +1.5 mm with 5 cm signal (3%).

☐ 27. Check Attenuator Accuracy—Horizontal +INPUT and −INPUT. Page 6-14
Horizontal deflection $\pm$1.5 mm with 5 cm signal (3%).

☐ 28. Re-check Trace Shift Due to Input Grid Current. Page 6-14
Trace shift $\leq$1 cm.

☐ 29. Adjust Attenuator Compensation—Vertical. Page 6-15
Waveform flat-topped; no more than 2% overshoot or rounding.

☐ 30. Adjust Attenuator Compensation—Horizontal. Page 6-18
Waveform flat-topped; no more than 2% overshoot or rounding.

☐ 31. Adjust Amplifier Phasing. Page 6-21
Phase difference not more than 1° (1 mm).

☐ 32. Check Common Mode Rejection Ratio. Page 6-23
Horizontal/Vertical rejection ratio 100:1 with sensitivities and signals specified.

☐ 33. Check Vertical Amplifier Frequency Response. Page 6-24
$\leq$−3 dB at 450 kHz.

☐ 34. Check Horizontal Amplifier Frequency Response. Page 6-24
$\leq$−3 dB at 450 kHz.

☐ 35. Adjust Sweep Stability. Page 6-25
Free running trace at approximately 50 kHz rate.

☐ 36. Check Triggering—External High Frequency. Page 6-26
Correct triggering; see Calibration Procedure.

☐ 37. Check Triggering—Internal High Frequency. Page 6-26
Correct triggering; see Calibration Procedure.

☐ 38. Check Triggering—External (1 kHz Square Wave). Page 6-27
Correct low frequency triggering.

☐ 39. Check Triggering—Internal (1 kHz Square Wave). Page 6-27
Correct low frequency triggering.

☐ 40. Check Line Triggering. Page 6-27
Correct line frequency triggering.

☐ 41. Adjust Sweep Timing—1 mSEC/CM. Page 6-28
Timing accuracy, $\pm$3% (2.4 mm in 8 cm).

☐ 42. Adjust Sweep Length. Page 6-28
Sweep length 10.2 to 10.8 cm.

☐ 43. Adjust Sweep Timing—10 μSEC/CM. Page 6-28
Timing accuracy, $\pm$3%.

☐ 44. Adjust Sweep Timing—1 μSEC/CM. Page 6-29
Timing accuracy, $\pm$3%.

☐ 45. Check Variable Control Ratio. Page 6-29
Sweep Time/cm Variable Control ratio $\geq$2.5:1.

☐ 46. Check Sweep Timing. Page 6-29
Timing accuracy, +3% at all switch settings.

☐ 47. Adjust Sweep Magnifier Registration. Page 6-29
$\leq$0.5 cm horizontal shift.

☐ 48. Re-check Horizontal Drift. Page 6-30
Marker drift $\leq$4 mm after 30 seconds.

☐ 49. Check Magnifier Accuracy. Page 6-30
Accuracy tolerance $\pm$ 5%.

☐ 50. Check Sweep Jitter. Page 6-30
Horizontal jitter 2 mm or less.

☐ 51. Check Z-axis Operation. Page 6-31
Intensity modulation with 10-volt signal.

☐ 52. Adjust Amplitude Calibrator—5 mV. Page 6-31
Amplitude 5 mV $\pm$3%.

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☐ 53. Check Calibrator Accuracy—500 mV. Page 6-31

Amplitude 500 mV ±3%.

☐ 54. Check Calibrator Symmetry. Page 6-31

Symmetry ratio not more than 2:1.

☐ 55. Check Calibrator Frequency. Page 6-31

Frequency 350 Hz ±50%.

☐ 56. Check Calibrator Jitter. Page 6-31

Horizontal Jitter not more than 1.5 cm.

CALIBRATION PROCEDURE

General

In the following calibration procedure, a test equipment setup is shown for each major setup change. Complete control settings are listed following the first equipment setup. In subsequent setups, only the controls which have been changed from the preceding step are listed. Controls which are not shown on the setup list may be left in any position. If only a partial calibration is performed, start with the nearest setup preceding the desired portion.

NOTE

When performing a complete recalibration, best performance will be provided if each adjustment is made to the exact setting, even if the Check is within the allowable tolerance.

The following procedure uses the equipment listed under Recommended Equipment. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. Remove the side covers from the Type 503.

2. Connect the Type 503 to the autotransformer, and set the autotransformer to 117 volts.

3. Turn the POWER AND SCALE ILLUM. control clockwise and adjust the graticule illumination as desired.

4. Allow the Type 503 to warm up for at least 5 minutes before proceeding further.

NOTES

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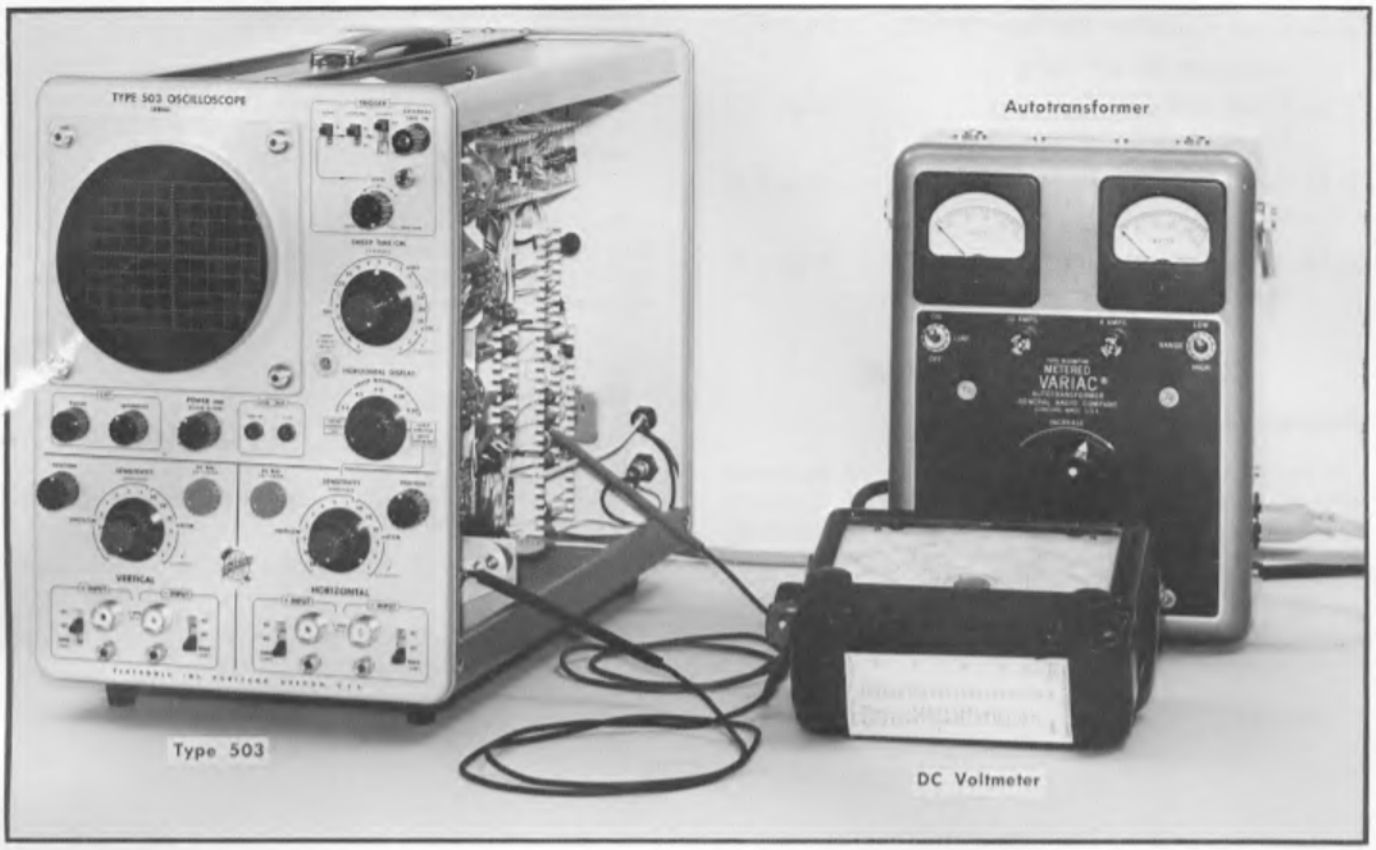


Fig. 6-3. Equipment setup for power supply adjust and check.

SLOPE	+
COUPLING	AC
SOURCE	INT.
LEVEL	Counterclockwise (but not AUTO)
SWEEP TIME/CM	1 mSEC
VARIABLE	CALIBRATED (fully clockwise)
INTENSITY	Fully counterclockwise
HORIZONTAL DISPLAY	SWEEP NORMAL (X1)
VERTICAL	
SENSITIVITY	.1 VOLTS/CM
VARIABLE	CALIBRATED (fully clockwise)
POSITION	Midrange
+INPUT	DC
—INPUT	GND
HORIZONTAL	
SENSITIVITY	.1 VOLTS/CM
VARIABLE	CALIBRATED (fully clockwise)
POSITION	Midrange
+INPUT	GND
—INPUT	GND

1. Adjust —100 Volt Supply

a. Test equipment setup is shown in Fig. 6-3.

b. Set the DC voltmeter (item 2 of Recommended Equipment) to the appropriate scale, and connect the leads to the Type 503 chassis ground and the —100 volt test point (see Fig. 6-4 for test point locations).

c. Check—Voltmeter reading of —100 volts, ±2%.

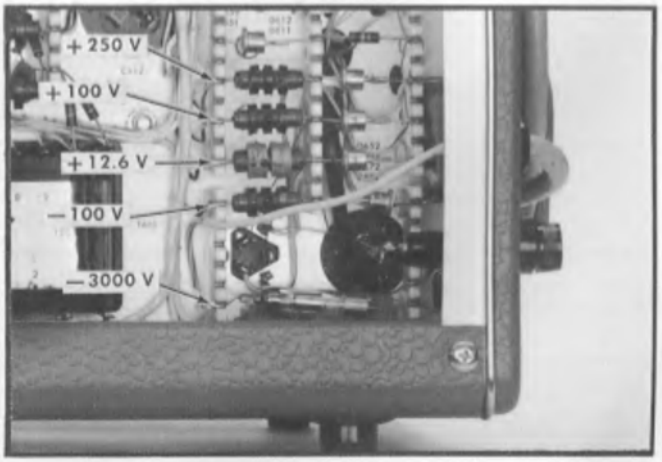


Fig. 6-4. Location of power supply test points.

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NOTE

Do not adjust the —100 ADJ. control unless one or more of the supply voltages are out of tolerance, or unless a complete recalibration of the instrument is planned.

d. Adjust R641 for a voltmeter reading of —100 volts. —100 ADJ. R641 is accessible on the left side of the instrument (see Fig. 6-5).

NOTE

Beginning with Serial Number 3140 and later, the physical appearance of some of the adjusting potentiometers was changed; the double-end adjusting feature was changed to single-end adjust. The functions remain the same.

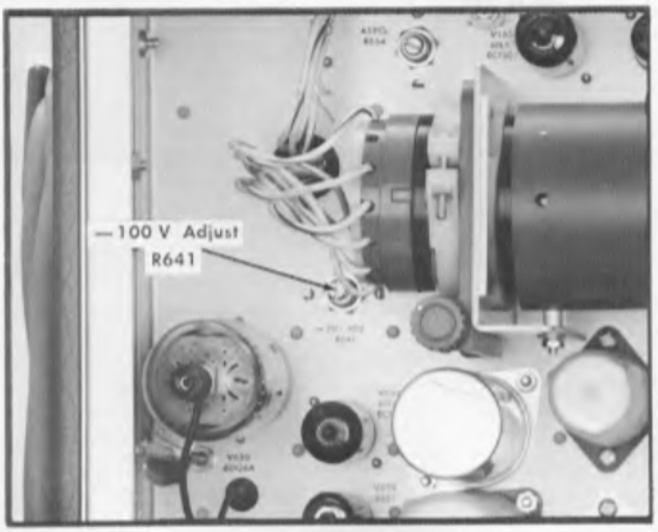


Fig. 6-5. Location of —100 volt adjustment (left side of instrument).

2. Check +12.6 Volt Supply

a. Remove the meter lead from the —100 volt test point and set the meter scale for checking 12.6 volts.

b. Connect the meter positive lead to the 12.6 volt test point (Fig. 6-5), and the negative lead to chassis ground.

c. Check——A meter reading of +12.6 volts, ±0.63 volts (5%).

3. Check +100 Volt Supply

a. Change the meter scale for a 100-volt reading.

b. Connect the positive meter lead to the +100 volt test point (Fig. 6-5).

c. Check—A meter reading of +100 volts, ±5 volts.

4. Check +250 Volt Supply

a. Set the meter scale for a 250-volt reading.

b. Connect the meter lead to the +250-volt test point (Fig. 6-5).

c. Check—A meter reading of +250 volts, ±12.5 volts.

5. Check —3000 Volt Supply

a. Remove the meter lead from the +250-volt test point.

b. Set the meter to the scale for reading 3000 volts.

c. Connect the negative meter lead to the —3000 volt test point (Fig. 6-5), and the positive meter lead to chassis ground.

d. Check—A meter reading of —3000 volts, ±150 volts.

e. Remove the meter leads.

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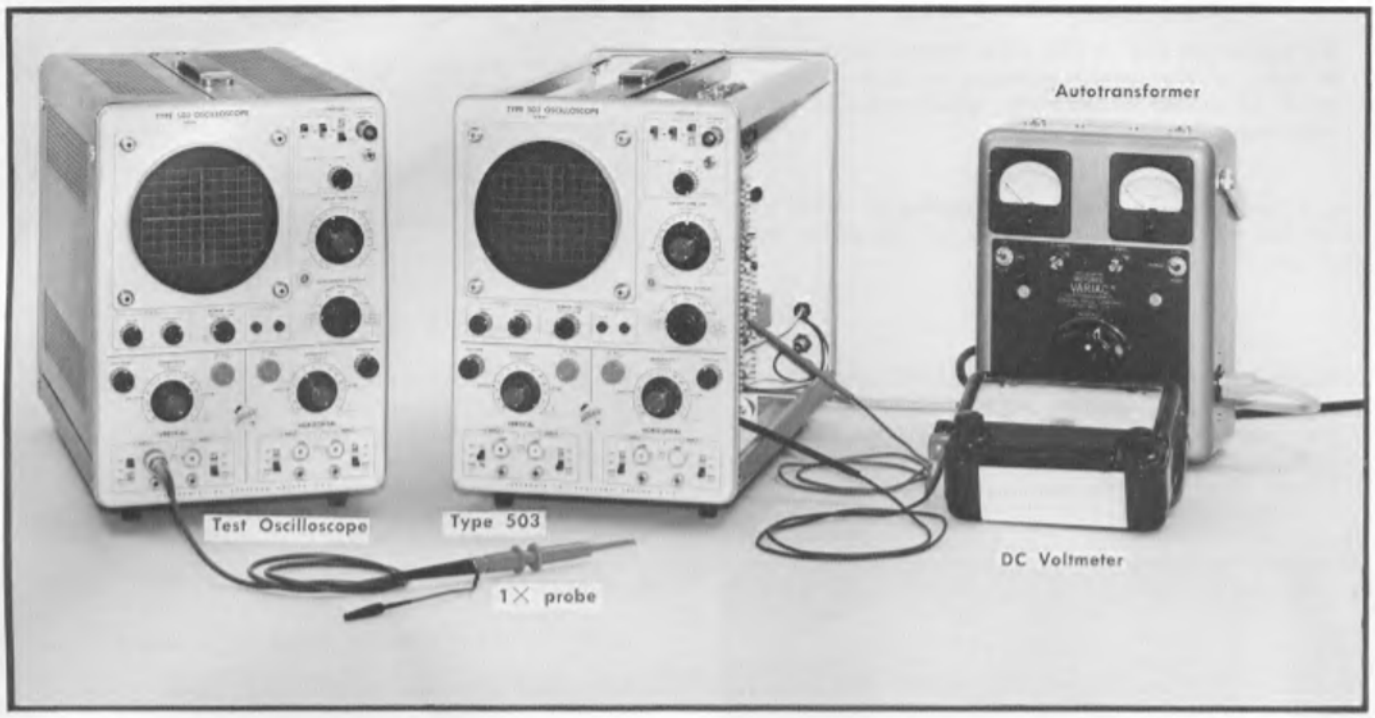


Fig. 6-6. Test equipment setup for power supply ripple and regulation check.

6. Check Power Supply Ripple and Regulation

a. Test equipment setup is shown in Fig. 6-6. The Type 503 control settings remain as in Step 1.

b. Set the DC voltmeter to the appropriate scale and connect the leads to the —100 volt test point and chassis ground.

c. Set the test oscilloscope vertical deflection sensitivity to 10 millivolts/cm, AC coupled, and the sweep time/cm to 5 milliseconds/cm.

d. Connect the 1× probe to the —100 volt test point.

e. Vary the autotransformer output voltage between 105 and 125 volts while monitoring the DC voltmeter and the test oscilloscope.

f. Check—The —100 volt supply should remain within the ±2% tolerance from the 105 to 125 V setting of the autotransformer; the 120-Hz ripple should not exceed 15 millivolts.

g. Repeat steps (b) through (e) for the +12.6 V, +100 V, and +250 V supplies, checking for regulation and 120 Hz ripple tolerance as indicated in Table 6-1.

CAUTION

Do not attempt to check the ripple on the —3000 volt supply, as the input voltage rating on the test oscilloscope will be exceeded.

h. Move the 1× probe to the —100 V test point indicated in Fig. 6-7. (The test points indicated in the figure were selected to avoid excessive 30 kHz ripple from the 30 kHz power oscillator.)

TABLE 6-1

Power Supply Voltage	Voltage Tolerance	Ripple Tolerance	
		120 Hz	30 kHz
—100 V	±2 V	15 mV	5 mV
+12.6 V	±1.26 V	15 mV	5 mV
+100 V	±5 V	15 mV	5 mV
+250 V	±12.5 V	50 mV	20 mV

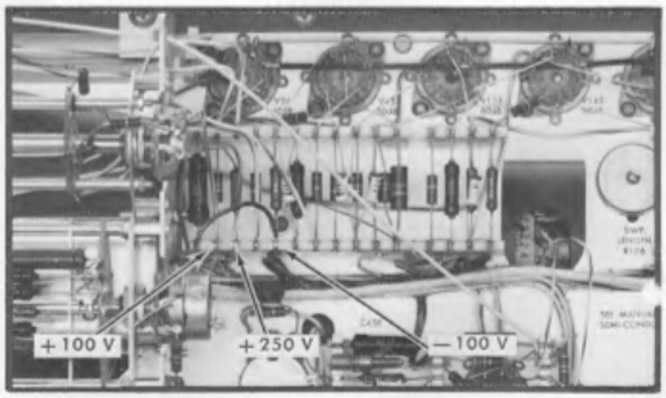


Fig. 6-7. Test point locations for checking 30 kHz power supply ripple.

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i. Change the test oscilloscope Time/cm switch to 0.1 milliseconds.

j. Set the autotransformer output to 117 V.

k. Check—No more than 5 mV of 30 kHz ripple.

l. Repeat steps (h) and (k) for the +100 V, and +250 V, referring to Fig. 6-7 for the location of the test points.

m. Check—30 kHz ripple tolerance as indicated in Table 6-1.

n. Connect the test probe to pin 12 of V344. (See Fig. 6-8 for test point location).

NOTE

For instruments prior to Serial Number 6997, the +12.6 V test point is at pin 4 of the type 6DJ8 V344.

o. Check—No more than 5 mV of 30 kHz ripple.

p. Disconnect the DC voltmeter leads and the 1× probe.

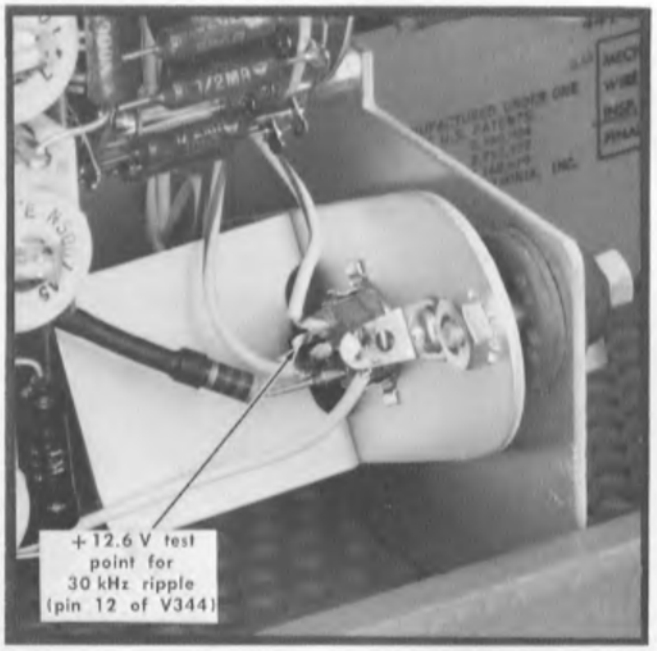


Fig. 6-8. Location of test point for 30 kHz ripple check on +12.6 V supply.

7. Check 2nd Adjust Focus and Astigmatism[1]

a. Change the TRIGGER LEVEL control to the FREE RUN (fully clockwise) position.

b. Rotate the FOCUS control fully clockwise.

c. Set the HORIZONTAL DISPLAY switch to the HORIZ. AMPLIFIER (SWEEP DISABLED) position.

[1]**Make this adjustment only on instruments having serial number 000270 or higher. On instruments having serial numbers lower than 000270, the ASTIGMATISM control is located on the front panel and is easily adjusted during operation of the oscilloscope.**

d. Slowly increase the INTENSITY (clockwise rotation) until a defocused spot is visible. It may be necessary to adjust the HORIZONTAL and VERTICAL POSITION controls.

e. Check—The defocused spot should be round or slightly elliptical.

f. Adjust ASTIG. R864 (Fig. 6-9) for as round a spot as possible.

g. Adjust the FOCUS control for a sharply focused spot while decreasing the INTENSITY to avoid damage to the CRT phosphor.

8. Adjust CRT Horizontal Trace Alignment ◐

a. Change the HORIZONTAL DISPLAY switch to SWEEP NORMAL (X1), and increase the INTENSITY for a normal display.

b. Check—Trace parallel to the center horizontal graticule line.

c. Adjust the CRT rotation knob (Fig. 6-9) until the trace is parallel to the center horizontal graticule line.

NOTE

Steps 9, 10, and 11 are to be performed only if the CRT has been replaced in the instrument.

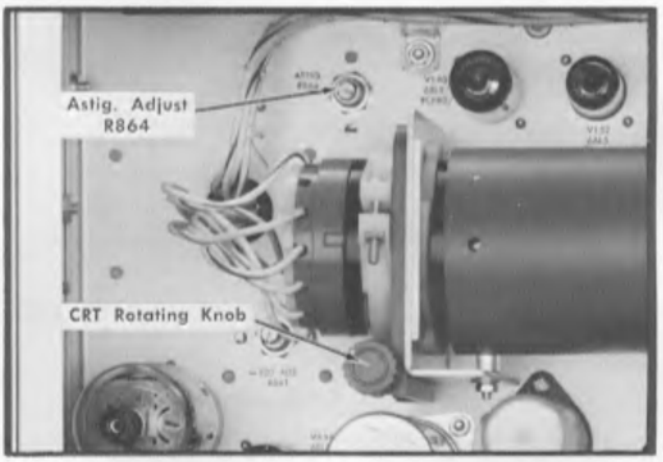


Fig. 6-9. CRT alignment and astigmatism adjustment control locations.

9. Check Horizontal Geometry

a. With the VERTICAL POSITION control, position the trace over the entire graticule area.

b. Check—Not more than 1 mm bowing in the graticule area.

10. Check Vertical Geometry

a. Change the SWEEP TIME/CM switch to .5 mSEC.

b. Set the time-mark generator (item 7 of Recommended Equipment) to supply 1-millisecond markers, and connect a 50-ohm cable from the marker output to the Type 503 VERTICAL +INPUT connector.

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c. Adjust the VERTICAL SENSITIVITY switch and VARIABLE control so that the markers fill the vertical graticule area, and turn the TRIGGER LEVEL fully counterclockwise to AUTO.

d. Adjust the SWEEP TIME/CM switch and VARIABLE control for 1 marker/cm.

e. Change the time-mark generator output to 0.1 millisecond. The display should now consist of markers 1 mm apart filling the graticule area.

f. Check—Maximum tilt of vertical markers not to exceed 1 mm right or left of vertical graticule lines.

11. Check Focus

a. Adjust FOCUS control for optimum focus.

b. Check—1-mm markers should be resolved over entire graticule area with optimum setting of FOCUS control.

c. Return the VERTICAL and SWEEP TIME/CM VARIABLE controls to CALIBRATED.

12. Adjust Magnifier Registration (Preliminary) ◐

a. Change the SWEEP TIME/CM to 1 mSEC.

b. Change the time-mark generator to supply 5-millisecond markers.

c. Adjust the VERTICAL SENSITIVITY and VARIABLE control to display markers 3 cm in amplitude.

d. Change the HORIZONTAL DISPLAY switch to ×50.

e. With the HORIZONTAL POSITION control, center the middle markers to the graticule center vertical line.

f. Change the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1).

g. Adjust SWP/MAG REGIS. R339 to re-center the middle marker to the graticule center vertical line.

13. Check Horizontal Drift—Preliminary

a. Change the HORIZONTAL DISPLAY switch to ×50.

b. Check—The magnified display should not drift more than 4 mm.

c. Change the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1), and remove the time-mark generator signal.

d. Return the VERTICAL SENSITIVITY VARIABLE control to CALIBRATED.

14. Adjust Coarse DC Balance—Vertical ◐

a. Set the TRIGGER LEVEL control clockwise to FREE RUN.

b. Change the VERTICAL SENSITIVITY switch to .2 VOLTS/CM, and the VERTICAL +INPUT to GND.

c. Center the Vertical POSITION control knob.

d. Set the DC BAL control to midrange (found by rotating the knob fully clockwise and counterclockwise; then setting to the approximate midrange).

e. Position the trace to the center horizontal line with the Vertical POSITION control.

f. Change the Vertical SENSITIVITY switch to 50 mV/CM.

g. Re-center the trace with the COARSE DC BAL. (VERT.) R436. See Fig. 6-10 for R436 location.

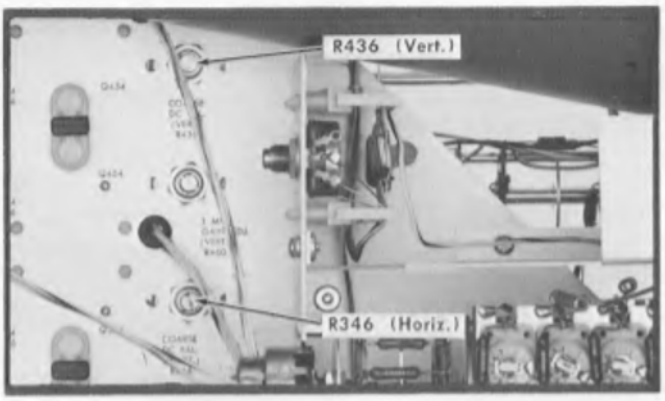


Fig. 6-10. Location of Coarse DC Balance adjustments, (left side).

NOTE

In some cases, it may be necessary to re-center the trace with the DC BAL control if R436 does not bring the trace to the graticule center line.

h. Change the Vertical SENSITIVITY switch to 10 mV/CM.

i. Re-center the trace with the COARSE DC BAL control, using the DC BAL control if necessary.

j. Change the Vertical SENSITIVITY switch to 1 mV/CM.

k. Repeat step i.

l. Change the Vertical SENSITIVITY switch to 50 mV/CM; note the position of the trace.

m. Change the Vertical SENSITIVITY switch to 1 mV/CM.

n. With the DC BAL control, position the trace to the same point noted in step 1.

15. Adjust Coarse DC Balance—Horizontal ◐

a. Decrease the trace intensity, to avoid CRT phosphor damage when the sweep is removed (next step).

b. Set the HORIZONTAL DISPLAY switch to HORIZ. AMPLIFIER (SWEEP DISABLED), and set the HORIZONTAL SENSITIVITY to .2 VOLTS/CM.

c. Center the Horizontal POSITION control knob.

d. Repeat steps 14d through 14n, using the appropriate Horizontal SENSITIVITY and POSITION controls. The display will be a spot, positioned horizontally by the Horizontal DC BAL, COARSE DC BAL. (HORIZ.) R346, and Horizontal POSITION controls.

e. After completing step 14n, return the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1), and adjust the trace to normal viewing intensity.

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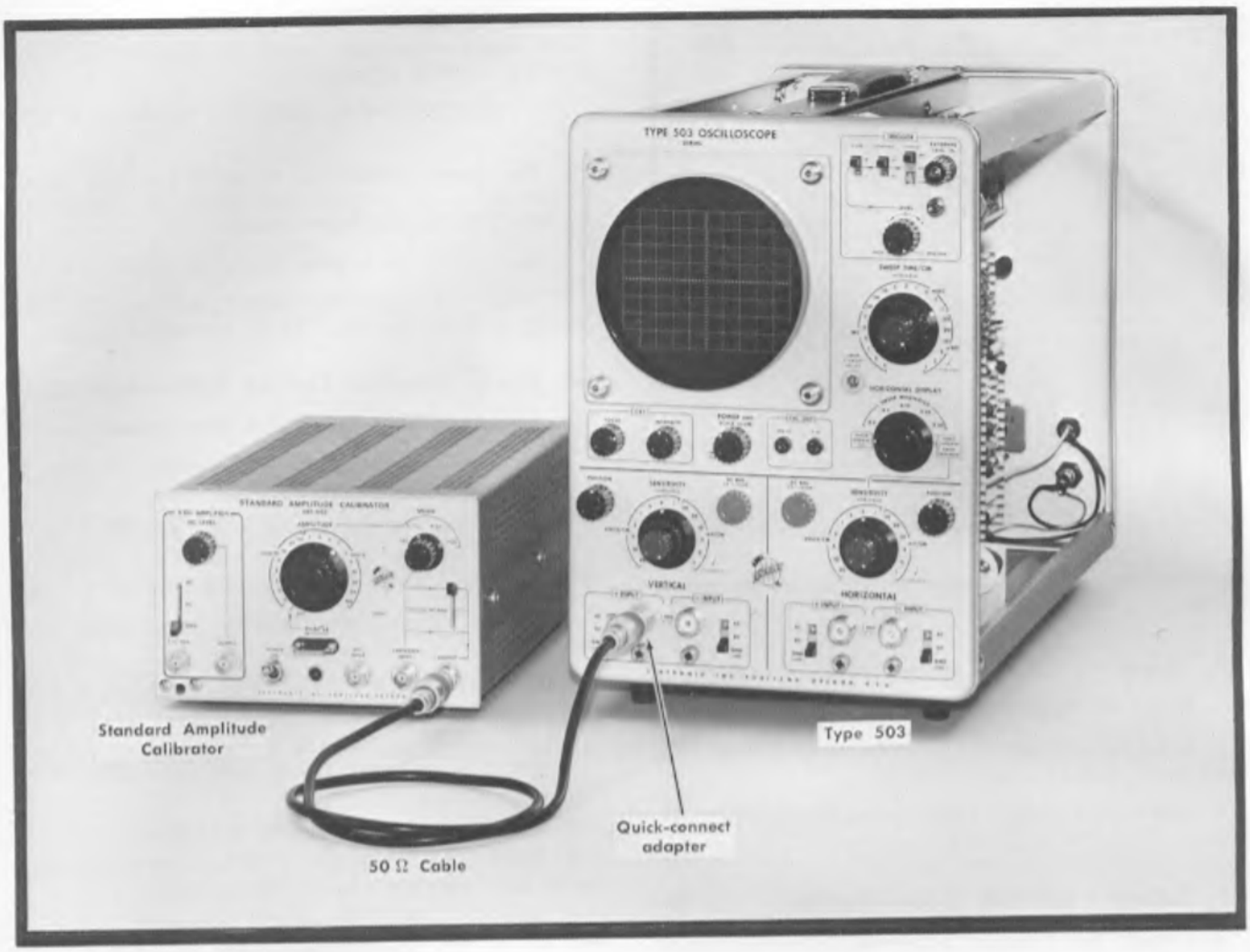


Fig. 6-11. Test setup for Vertical and Horizontal amplifier gain adjustments.

Control Settings:

VERTICAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	GND
—INPUT	GND
POSITION	Centered
HORIZONTAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	GND
—INPUT	GND
POSITION	Centered
HORIZONTAL DISPLAY	SWEEP NORMAL (×1)
LEVEL	FREE RUN

16. Adjust .2 V/CM Gain—Vertical

a. The test setup is shown in Fig. 6-11.

b. Set the Standard Amplitude Calibrator for a 1-volt square-wave output.

c. Connect the Standard Amplitude Calibrator output through a BNC to UHF adapter, a 50 Ω cable and quick-connect adapter (item 15 of Recommended Equipment) to the Type 503 VERTICAL +INPUT connector, and change the VERTICAL +INPUT switch to DC.

d. Adjust the SWEEP TIME/CM switch to a setting which will present an easily-viewed display with a minmum of flicker (.1 mSEC or 50 μSEC).

e. Center the display in the graticule viewing area with the VERTICAL POSITION control.

f. Check—The display amplitude should be 5 cm ±1.5 mm.

g. Adjust .2 V GAIN ADJ. (VERT.) R478 for a display amplitude of 5 cm. (See Fig. 6-12 for R478 location.)

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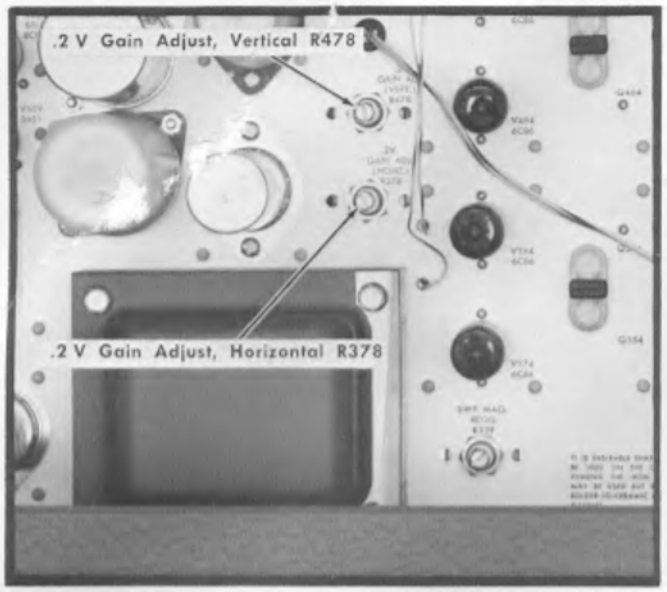


Fig. 6-12. Location of .2 V Vertical and Horizontal gain adjustments.

17. Check Variable Control Ratio—Vertical

a. Rotate the VARIABLE control fully counterclockwise.

b. Check—The display amplitude should be 2 cm or less, indicating a ratio of $\geq$2.5:1.

c. Return the VARIABLE control to the CALIBRATED position.

18. Adjust 1 mV/CM Gain—Vertical ◐

a. Change the Standard Amplitude Calibrator output to 5 millivolts.

b. Change the VERTICAL SENSITIVITY switch to 1 mV/CM, and adjust the VERTICAL POSITION control to center the display, if necessary.

c. Check—Display amplitude of 5 cm, $\pm$1.5 mm (3%).

d. Adjust 1 MV GAIN ADJ. (VERT.) R460 for a display amplitude of 5 cm. (See Fig. 6-13 for R460 location.)

e. Interaction—The .2 V and 1 mV gain adjustments interact. Repeat steps 16 (b), (e), (f), and (g) and steps 18 (a) through (d) until no further adjustments are necessary.

19. Adjust .2 V/CM Gain—Horizontal ◐

a. Set the VERTICAL +INPUT selector switch to GND.

b. Set the HORIZONTAL +INPUT switch to DC.

c. Set the HORIZONTAL DISPLAY switch to HORIZ. AMPLIFIER (SWEEP DISABLED).

CAUTION

Whenver the sweep is disabled, check that the CRT beam INTENSITY control is adjusted to prevent damage to the CRT phosphor.

d. Set the Standard Amplitude Calibrator to supply a 1-volt square wave, and connect the signal to the HORIZONTAL +INPUT connector.

e. Set the HORIZONTAL SENSITIVITY switch to .2 VOLTS/CM.

f. The display should now consist of two dots spaced horizontally in the graticule area. Center the display with the HORIZONTAL POSITION control.

g. Check—The dot spacing should be 5 cm $\pm$1.5 mm.

h. Adjust .2 V GAIN ADJ. (HORIZ.) R378 to obtain dot spacing of 5 cm. (See Fig. 6-12 for location of R378.)

20. Check Variable Control Ratio—Horizontal

a. Rotate the VARIABLE control fully counterclockwise.

b. Check—Dot spacing $\leq$2 cm, indicating a ratio of 2.5:1 or better.

c. Return the VARIABLE control to CALIBRATED.

21. Adjust 1 mV/CM Gain—Horizontal ◐

a. Set the Standard Amplitude Calibrator output to 5 millivolts.

b. Change the HORIZONTAL SENSITIVITY switch to 1 mV/CM.

c. The display should again consist of two dots spaced horizontally. Center the display with the HORIZONTAL POSITION control.

d. Check—Dot spacing of 5 cm $\pm$1.5 mm.

e. Adjust 1 MV GAIN ADJ. (HORIZ.) R360 for dot spacing of 5 cm. (See Fig. 6-13 for R360 location.)

f. Interaction—The .2 V and 1 mV gain adjustments interact. Repeat steps 19 (e) through (h), and steps 21 (a) through (e) until no further adjustment is necessary.

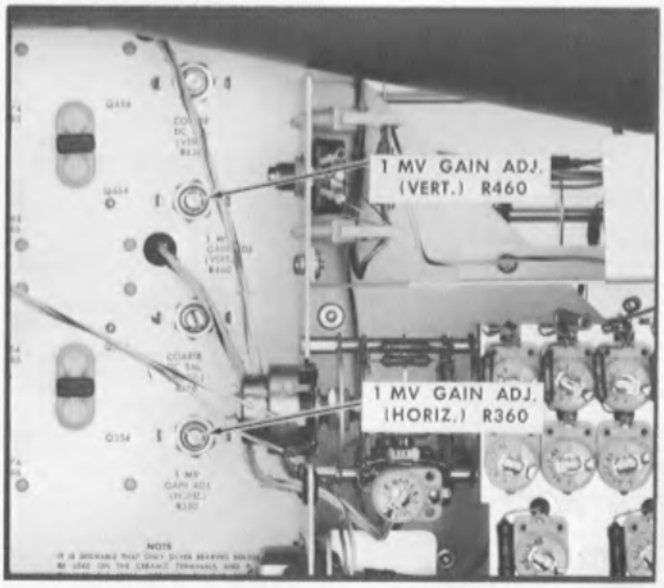


Fig. 6-13. Location of 1 mV Vertical and Horizontal gain adjustments.

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22. Check Compression or Expansion—Horizontal

a. Check that the SENSITIVITY switch is set to .2 VOLTS/CM.

b. Change the Standard Amplitude Calibrator to .5 V output.

c. With the VARIABLE control, adjust the dot spacing for exactly 2 cm, and center the display horizontally and vertically.

d. With the HORIZONTAL POSITION control, move the right-hand dot to the 10-cm vertical graticule line.

e. Check—Dot spacing 2 cm ±1.5 mm.

f. Move the left-hand dot to the left edge (0-cm) of the graticule.

g. Check—Dot spacing 2 cm ±1.5 mm.

h. Return the VARIABLE control to CALIBRATED.

23. Check Amplifier Balance—Horizontal (DC Common Mode Rejection)

a. Connect an additional 50-ohm cable to the Standard Amplitude Calibrator output, using a UHF T adapter, and a quick-connect adapter on the output end of the cable.

b. Set the HORIZONTAL —INPUT connector to DC, and connect the cable added in step (a) to the —INPUT connector.

c. Change the Standard Amplitude Calibrator output to 5 volts, and the HORIZONTAL SENSITIVITY switch to .2 VOLTS/CM.

d. The display will be two dots spaced horizontally. With the HORIZONTAL POSITION control, move the display to the right-hand and then to the left-hand vertical graticule line.

e. Check—The total horizontal amplitude of the display should not exceed 2.5 mm anywhere in the graticule area (CMRR 100:1).

f. Change the Standard Amplitude Calibrator output to 0.5 volts, and the HORIZONTAL SENSITIVITY switch to 1 mV/CM, and repeat step (d).

g. Check—The horizontal amplitude of the display should not exceed 5 cm anywhere in the graticule area.

h. Change the HORIZONTAL SENSITIVITY switch to .5 VOLTS/CM, and the Standard Amplitude Calibrator to 50 volts, and repeat step (d).

i. Check—The horizontal amplitude of the display should not exceed 2 cm anywhere in the graticule area, (50:1 CMRR).

j. Change the HORIZONTAL SENSITIVITY switch to 5 VOLTS/CM and the Calibrator output to 100 volts; repeat step (d).

k. Check—The horizontal amplitude of the display should not exceed 4 mm anywhere in the graticule area.

24. Check Compression or Expansion—Vertical

a. Set the Standard Amplitude Calibrator to .5 volts, and change the HORIZONTAL + and —INPUT switches to GND.

b. Move the Standard Amplitude Calibrator signal from the HORIZONTAL +INPUT connector to the VERTICAL +INPUT connector, and change the VERTICAL +INPUT switch to DC.

c. Set the VERTICAL SENSITIVITY switch to .2 VOLTS/CM.

d. The display should consist of two dots spaced vertically. With the VERTICAL VARIABLE control, adjust the dot spacing for exactly 2 cm, and center the display vertically.

e. Move the display to the top 2 cm of the graticule.

f. Check—Dot spacing 2 cm ±1.5 mm.

g. Move the display to the bottom 2 cm of the graticule.

h. Check—Dot spacing 2 cm ±1.5 mm.

i. Return the VARIABLE control to CALIBRATED.

25. Check Amplifier Balance—Vertical (DC CMRR)

a. Move the Standard Amplitude Calibrator signal from the HORIZONTAL —INPUT connector to the VERTICAL —INPUT connector.

b. Change the Calibrator signal to 5 volts, and set the VERTICAL —INPUT switch to DC.

c. Change the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1), and center the display vertically and horizontally. It may be necessary to adjust the INTENSITY control.

d. With the VERTICAL POSITION control, move the display to the top line of the graticule, and then to the bottom line of the graticule.

e. Check—Trace separation not to exceed 2.5 mm (CMRR 100:1).

f. Change the VERTICAL SENSITIVITY to 1 mV/CM, and change the Standard Amplitude Calibrator output to 0.5 volt.

g. Repeat step (d).

h. Check—Trace separation not to exceed 5 cm.

NOTE

A typical display is shown in Fig. 6-14. The trace separation is indicated at the low-frequency portion of the square-wave signal.

i. Change the VERTICAL SENSITIVITY switch to .5 VOLTS/CM and the Standard Amplitude Calibrator output to 50 Volts.

j. Check—Trace separation not to exceed 2 cm anywhere within the graticule area.

k. Change the VERTICAL SENSITIVITY switch to 5 VOLTS/CM and the Standard Amplitude Calibrator output to 100 Volts.

l. Check—Trace separation not to exceed 4 mm anywhere within the graticule area.

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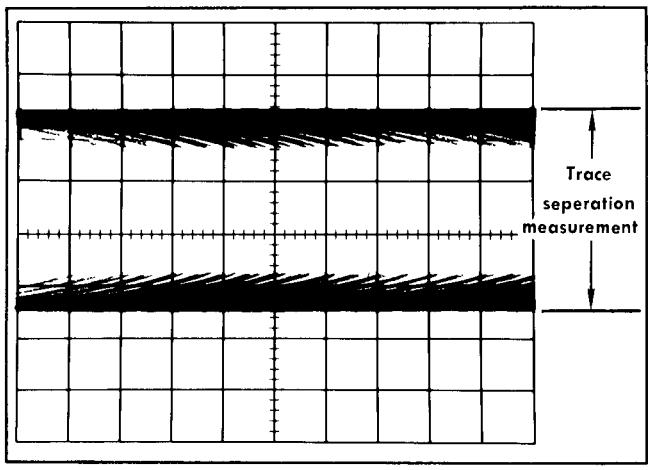


Fig. 6-14. Typical display, amplifier balance check (DC common-mode rejection ratio) — vertical amplifier; 1 mV/CM sensitivity.

26. Check Attenuator Accuracy—Vertical +Input and —Input

a. Set the VERTICAL —INPUT switch to GND.

b. Change the Standard Amplitude Calibrator output to 5 mV, and change the VERTICAL SENSITIVITY switch to 1 mV/CM.

c. Check—Vertical deflection of 5 cm ±1.5 mm.

d. Set the Standard Amplitude Calibrator output and VERTICAL SENSITIVITY switch as indicated in Table 6-2, checking for the deflections listed.

e. Change the VERTICAL +INPUT switch to GND, and change the VERTICAL —INPUT switch to DC.

f. Repeat step (d).

27. Check Attenuator Accuracy—Horizontal +Input and —Input

a. Move the two 50 Ω cables from the VERTICAL +INPUT and —INPUT connectors to the HORIZONTAL +INPUT and —INPUT connectors.

b. Check that the HORIZONTAL +INPUT switch is set to DC, and the —INPUT switch is set to GND.

c. Change the HORIZONTAL DISPLAY switch to HORIZ. AMPLIFIER (SWEEP DISABLED), and adjust the INTENSITY as desired.

d. Repeat step 26 (d) using the HORIZONTAL SENSITIVITY switches. The display will be 2 dots.

e. Change the HORIZONTAL +INPUT switch to GND, and change the HORIZONTAL —INPUT switch to DC.

f. Repeat step 26 (d) using the HORIZONTAL SENSITIVITY switches. The display will be 2 dots.

g. Remove the Standard Amplitude Calibrator signal.

h. Return the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1).

TABLE 6-2

SENSITIVITY Setting	Std. Amplitude Calibrator	Deflection
1 mV/CM[2]	5 mV	5 cm ±1.5 mm
2 mV/CM	10 mV	5 cm ±1.5 mm
5 mV/CM	20 mV	4 cm ±1.2 mm
10 mV/CM	50 mV	5 cm ±1.5 mm
20 mV/CM	0.1 V	5 cm ±1.5 mm
50 mV/CM	0.2 V	4 cm ±1.2 mm
.1 VOLTS/CM	0.5 V	5 cm ±1.5 mm
.2 VOLTS/CM[2]	1 V	5 cm ±1.5 mm
.5 VOLTS/CM	2 V	4 cm ±1.2 mm
1 VOLTS/CM	5 V	5 cm ±1.5 mm
2 VOLTS/CM	10 V	5 cm ±1.5 mm
5 VOLTS/CM	20 V	4 cm ±1.2 mm
10 VOLTS/CM	50 V	5 cm ±1.5 mm
20 VOLTS/CM	100 V	5 cm ±1.5 mm

[2]**Adjusted previously.**

28. Check Trace Shift Due to Input Grid Current

a. Set the VERTICAL and HORIZONTAL + and —INPUT switches to GND.

b. Set the VERTICAL and HORIZONTAL SENSITIVITY switches to 1 mV/CM.

c. With the short patch cord (item 20 of Recommended Equipment) ground the VERTICAL +INPUT connector.

d. Change the VERTICAL +INPUT switch to AC.

e. Check—Trace shift not more than 1 cm.

f. Repeat steps (c), (d), and (e) with the VERTICAL —INPUT connector, and the HORIZONTAL + and —INPUT connectors.

g. Remove the patch cord.

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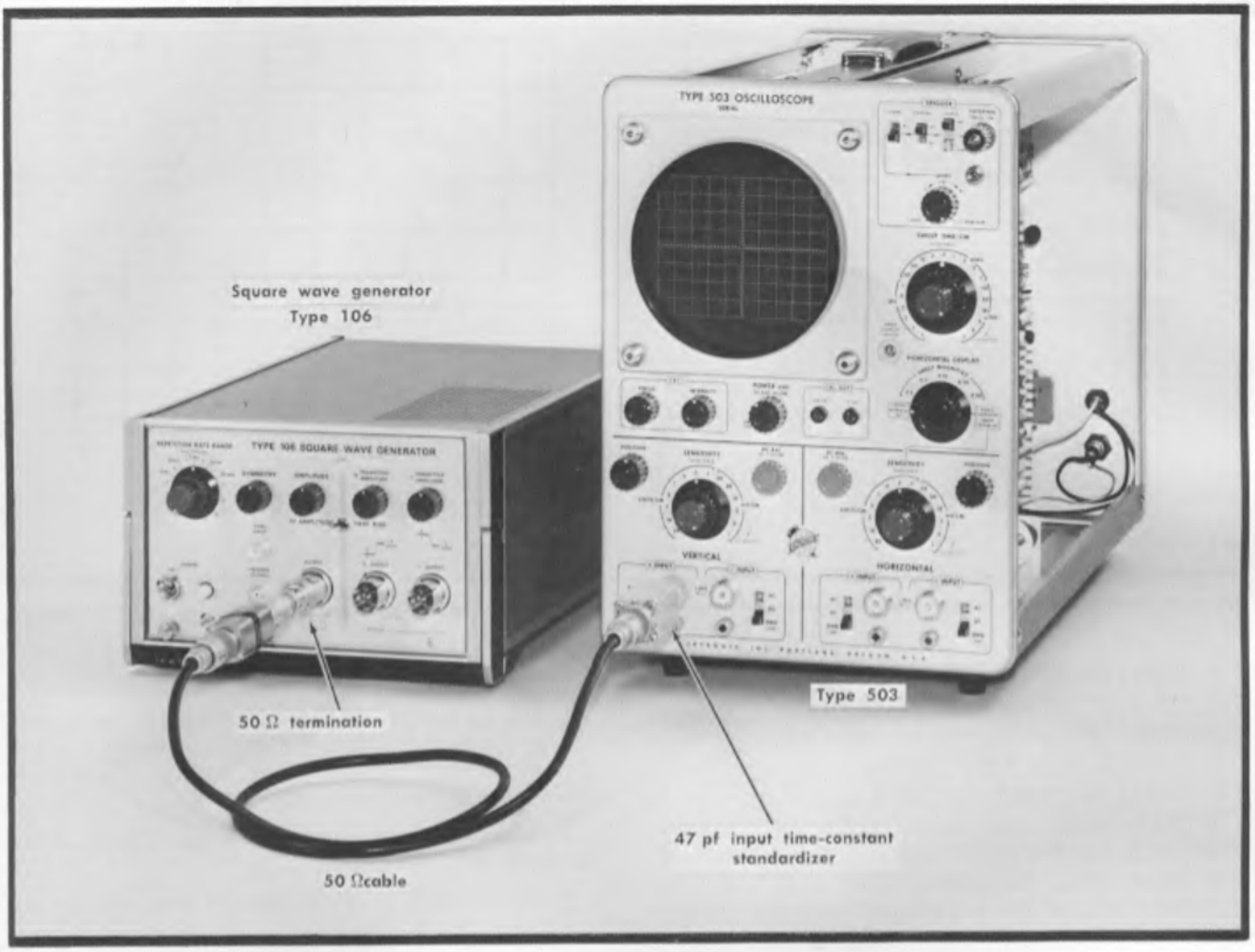


Fig. 6-15. Equipment setup for adjusting Vertical Amplifier attenuator compensation.

Control Settings:

TRIGGER	
SLOPE	—
COUPLING	AC
SOURCE	INT.
LEVEL	FREE RUN
SWEEP TIME/CM	2 mSEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	SWEEP NORMAL (X1)
VERTICAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	DC
—INPUT	GND

29. Adjust Attenuator Compensation—Vertical ❶

a. The equipment setup is shown in Fig. 6-15.

b. Set the square-wave generator (item 4 of Recommended Equipment) to supply a 1-kHz square wave.

c. Connect the generator output through a 50-ohm termination, (or a ×10 attenuator), a 50-ohm cable, and a 47 pF Input Time-constant Normalizer to the Vertical +INPUT, in the order given.

NOTE

To attain the desired deflection it will be necessary to add or remove the 50-ohm termination and/or the X10 attenuator. This will not affect the accuracy of the time-contsant adjustments.

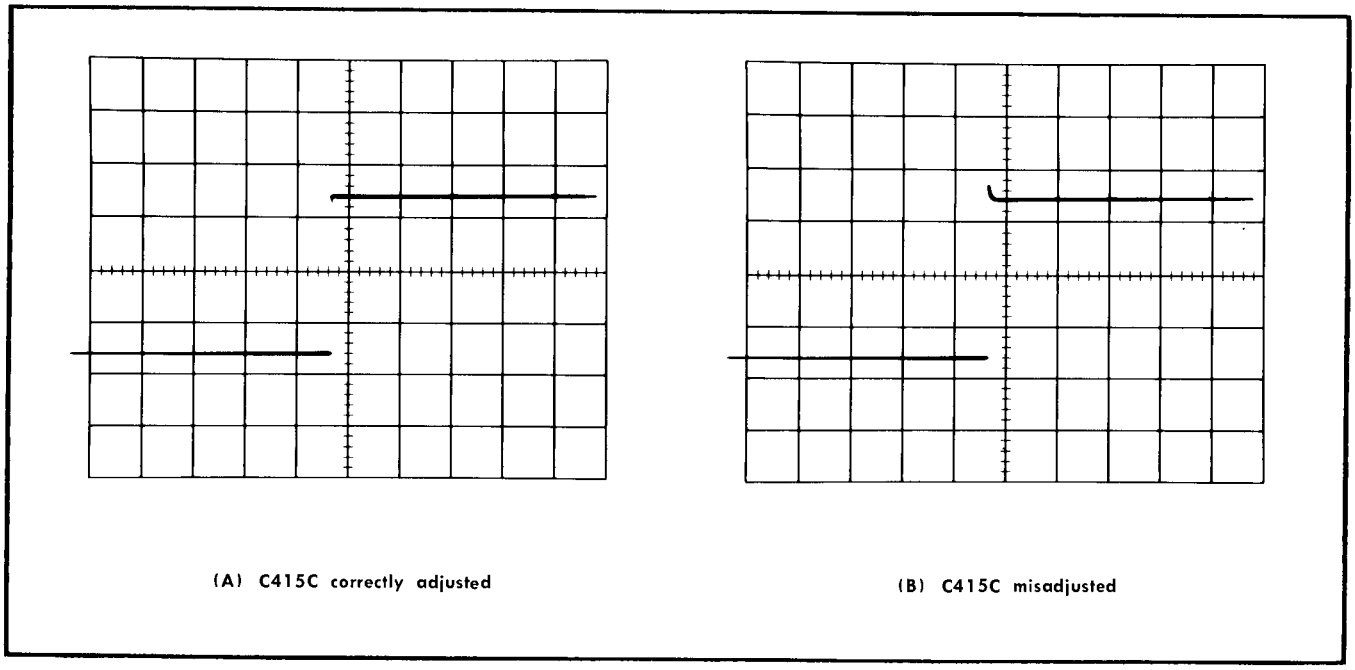
d. Adjust the generator output for a display 3 cm in amplitude, and center the display in the graticule viewing area.

e. Rotate the LEVEL control counterclockwise to obtain a stable display (near 0).

f. Check—Optimum square-wave with flat top (see Fig. 6-16 A and B for typical displays).

g. Adjust C416 for optimum square-wave with flat top. Fig. 6-18.

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(A) C415C correctly adjusted

(B) C415C misadjusted

Fig. 6-16. Typical displays, Vertical Amplifier attenuator compensation adjustments; 1 kHz square-wave input; sweep speed, 2 milliseconds/cm.

h. Change the VERTICAL SENSITIVITY switch to .5 VOLTS/CM, and adjust the generator output for a 3-cm display.

i. Check—Optimum flat top on square wave display.

j. Adjust C415B for a level flat top.

k. Change the SWEEP TIME/CM to .1 mSEC.

l. Check—Square front corner on waveform, with no overshoot or rounding exceeding 2% of display amplitude.

m. Adjust C415C for optimum front corner waveform. A typical display of fast time-constant adjustment is shown in Fig. 6-17.

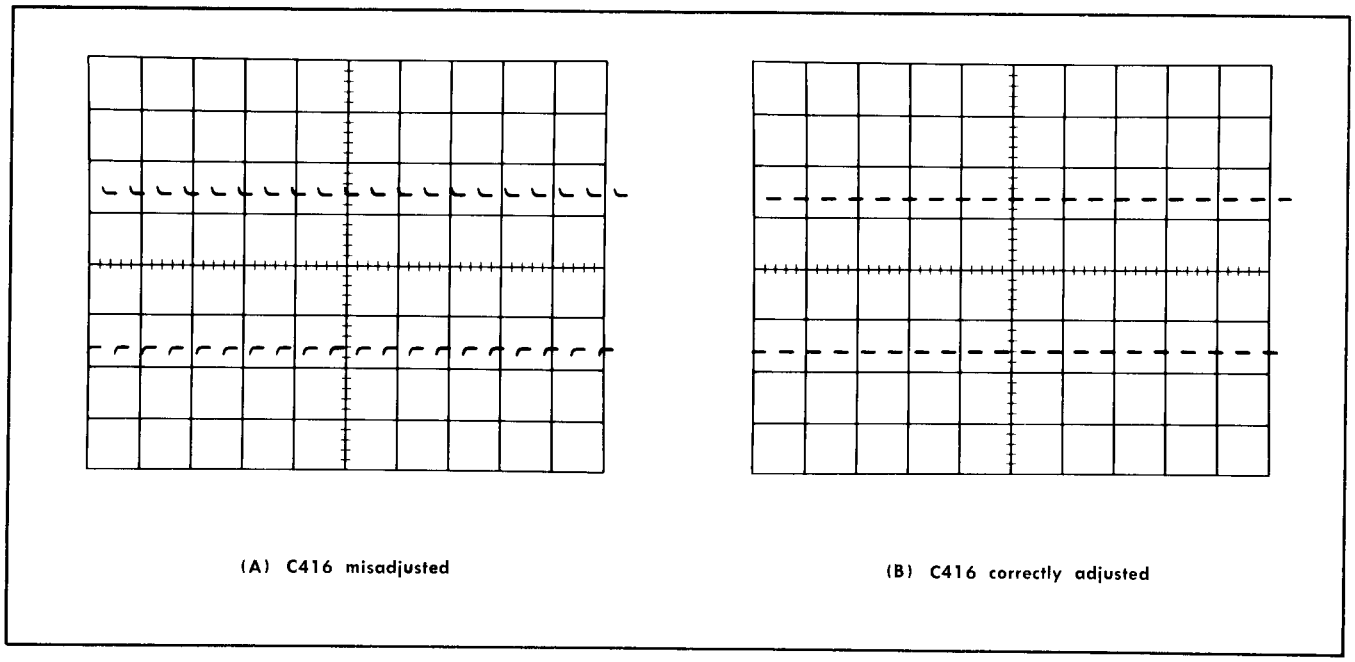
n. Change the SWEEP TIME/CM switch to 2 mSEC.

o. Change the VERTICAL SENSITIVITY switch to 5 VOLTS/CM, and adjust the generator output to maintain a 3-cm display. (It may be necessary to remove attenuation to obtain sufficient generator output signal.)

p. Check—Optimum flat top on square-wave display as in Fig. 6-16 (B).

q. Adjust C414B to obtain optimum level and flat top.

r. Change the SWEEP TIME/CM switch to .1 mSEC.



(A) C416 misadjusted

(B) C416 correctly adjusted

Fig. 6-17. Typical displays, Vertical Amplifier attenuator compensation adjustments; 1 kHz square-wave input; sweep speed, 0.1 milliseconds/cm.

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s. Check—Square front corner on waveform, with overshoot or rounding not exceeding 2% of display amplitude.

t. Adjust C414C for optimum front corner of waveform.

u. Check the square wave response in all remaining VERTICAL SENSITIVITY switch positions, alternately switching between the 2 mSEC and .1 mSEC positions of the SWEEP TIME/CM switch.

NOTE

All attenuator compensation adjustments or checks are made with a display amplitude of 3 cm. Insert or remove attenuation and/or adjust the signal generator output to maintain this display amplitude.

v. Change the SWEEP TIME/CM switch to 2 mSEC.

w. Change the VERTICAL +INPUT switch to GND, the VERTICAL —INPUT switch to DC, and move the generator signal from the VERTICAL —INPUT connector to the VERTICAL —INPUT connector.

x. Repeat the procedure outlined in steps (d) through (u), referring to Table 6-3 for control settting adjustments required, and waveform tolerances. The VERTICAL —INPUT attenuator adjustment locations are shown in Fig. 6-18.

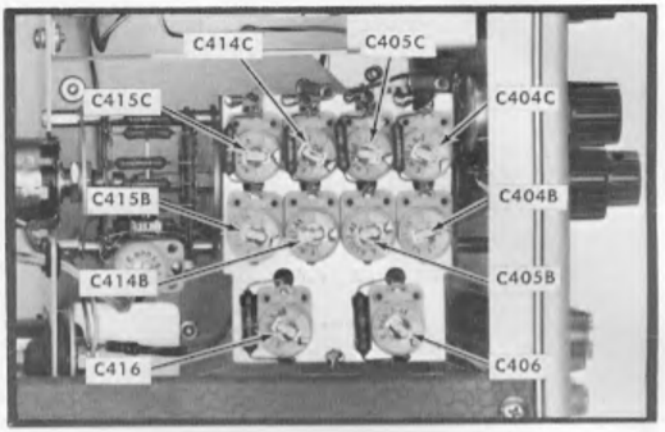


Fig. 6-18. Attenuator compensation adjustment locations, Vertical Amplifier (left side).

TABLE 6-3

Input	Attenuator Setting	TIME/CM Setting	Adjust	Tolerance
VERTICAL +	.2 VOLTS/CM	2 mSEC	C416	Aberrations not more than 2% of display amplitude in all attenuator positions.
	.5 VOLTS/CM	2 mSEC	C415B	
	.5 VOLTS/CM	.1 mSEC	C415C	
	5 VOLTS/CM	2 mSEC	C414B	
	5 VOLTS/CM	.1 mSEC	C414C	
VERTICAL —	.2 VOLTS/CM	2 mSEC	C406	
	.5 VOLTS/CM	2 mSEC	C405B	
	.5 VOLTS/CM	.1 mSEC	C405C	
	5 VOLTS/CM	2 mSEC	C404B	
	5 VOLTS/CM	.1 mSEC	C404C	

NOTES

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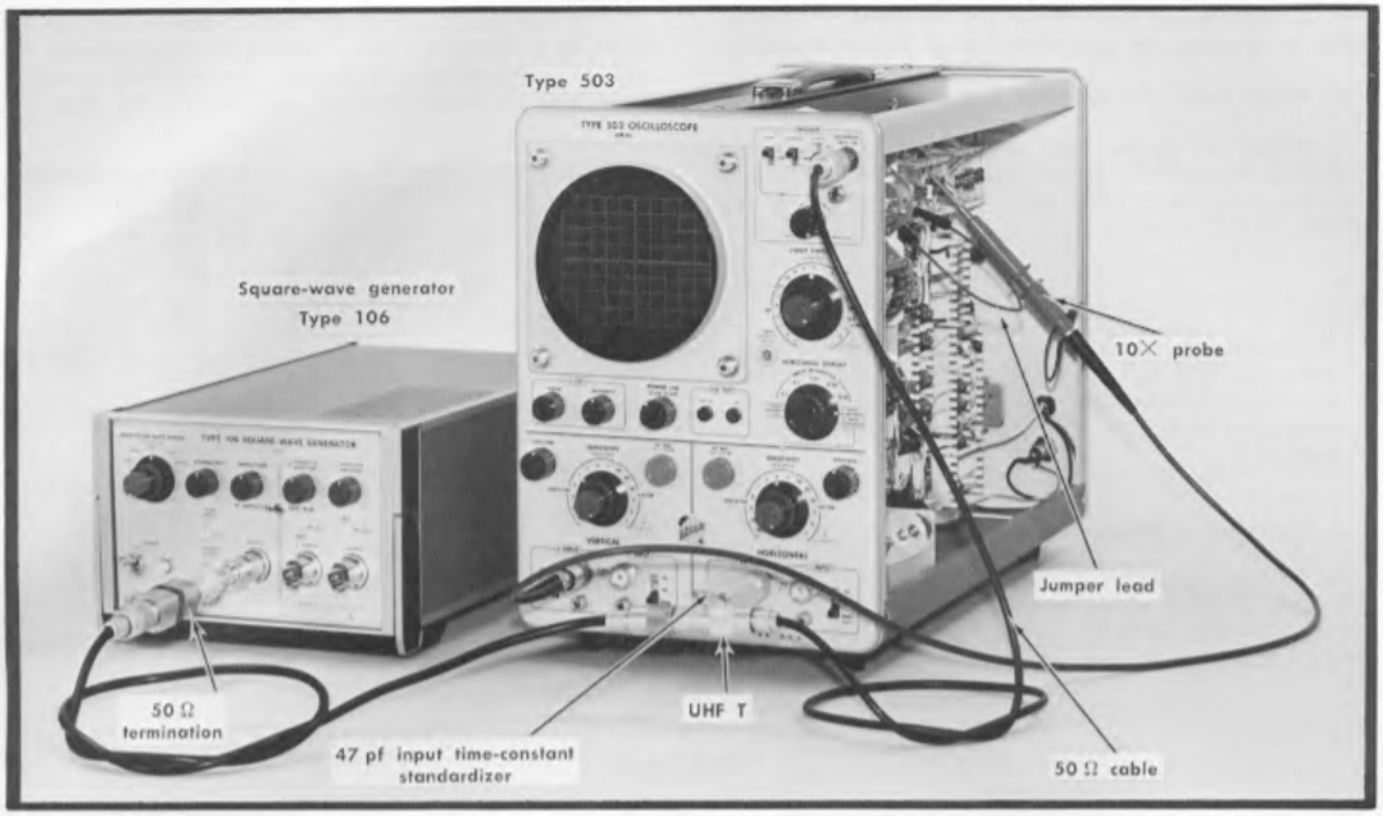


Fig. 6-19. Test setup for Horizontal Amplifier attenuator compensation adjustments.

Control Settings:

TRIGGER	
SLOPE	+
COUPLING	AC
SOURCE	EXT.
LEVEL	FREE RUN
SWEEP TIME/CM	2 mSEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	HORIZ. AMPLIFIER (SWEEP DISABLED)
VERTICAL	
SENSITIVITY	1 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	DC
—INPUT	GND
HORIZONTAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
+INPUT	DC
—INPUT	GND

30. Adjust Attenuator Compensation—Horizontal

a. Test setup is shown in Fig. 6-19.

b. Connect a short jumper lead between R144 and the —100 V supply, as shown in Fig. 6-20.

c. Connect a 10× probe from the VERTICAL +INPUT connector to pin 8 of V160, as shown in Fig. 6-20.

d. Connect a 1-kHz square-wave signal from the square-wave generator through a 50-ohm termination, a 50-ohm cable, a UHF T connector, and a 47-pF Input Time-constant Normalizer to the HORIZONTAL +INPUT connector, in the order given.

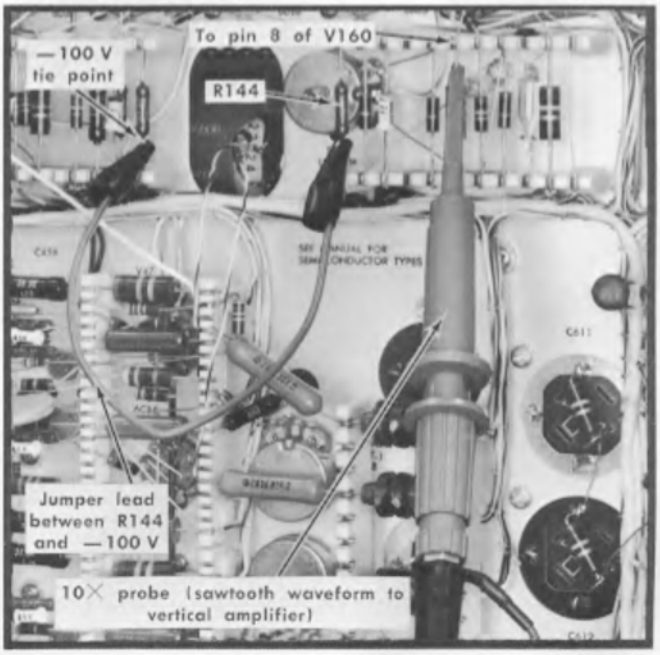


Fig. 6-20. Method of obtaining sawtooth waveform for Horizontal Amplifier attenuator adjustments.

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e. Connect a 50-ohm cable from the UHF T connector to the EXTERNAL TRIG. IN connector.

f. Rotate the LEVEL control to a point near 0 to obtain a stable display, similar to Fig. 6-22.

g. Adjust the generator output for a 3-cm spacing horizontally, and center the display with the HORIZONTAL POSITION control.

NOTE

To attain the desired deflection it will be necessary to add or remove the 50-ohm termination and/or the X10 attenuator. This will not affect the accuracy of the time-constant adjustments.

h. Check—For an optimum square wave with flat top, similar to Fig. 6-22 (B).

i. Adjust C306 for an optimum square wave with flat top. (See Fig. 6-21 for adjustment locations.)

j. Change the HORIZONTAL SENSITIVITY switch to .5 VOLTS/CM, and adjust the generator output for a 3-cm display.

k. Check—For an optimum square wave with a flat top, as in step (i).

l. Adjust C305B for best square wave with a flat top.

m. Change the SWEEP TIME/CM switch to .1 mSEC.

n. Check—Square front corner on waveform, with overshoot or rounding not exceeding 2% of the display amplitude. (See Fig. 6-23 for typical displays.)

o. Adjust C305C for waveform front corner with minimum aberrations.

p. Change the HORIZONTAL SENSITIVITY switch to 5 VOLTS/CM.

q. Change the SWEEP TIME/CM to 2 mSEC, and adjust the display for a horizontal deflection of 3 cm. Remove attenuation as necessary to maintain a 3-cm display.

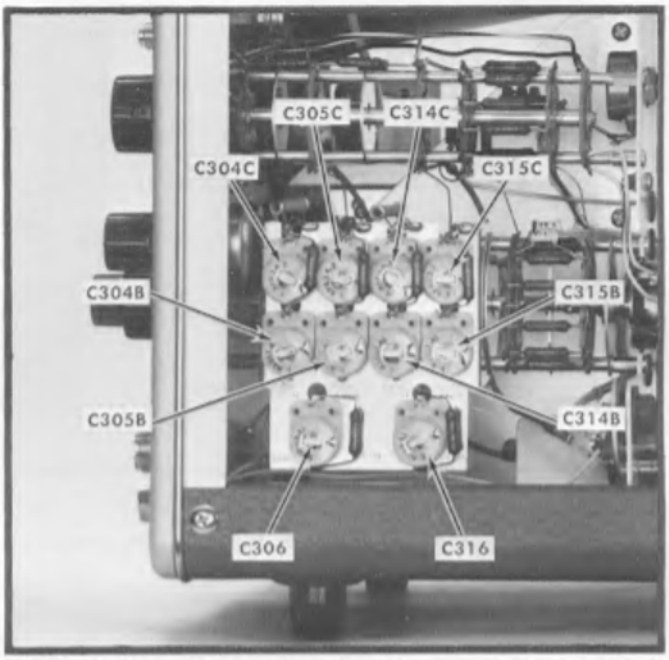
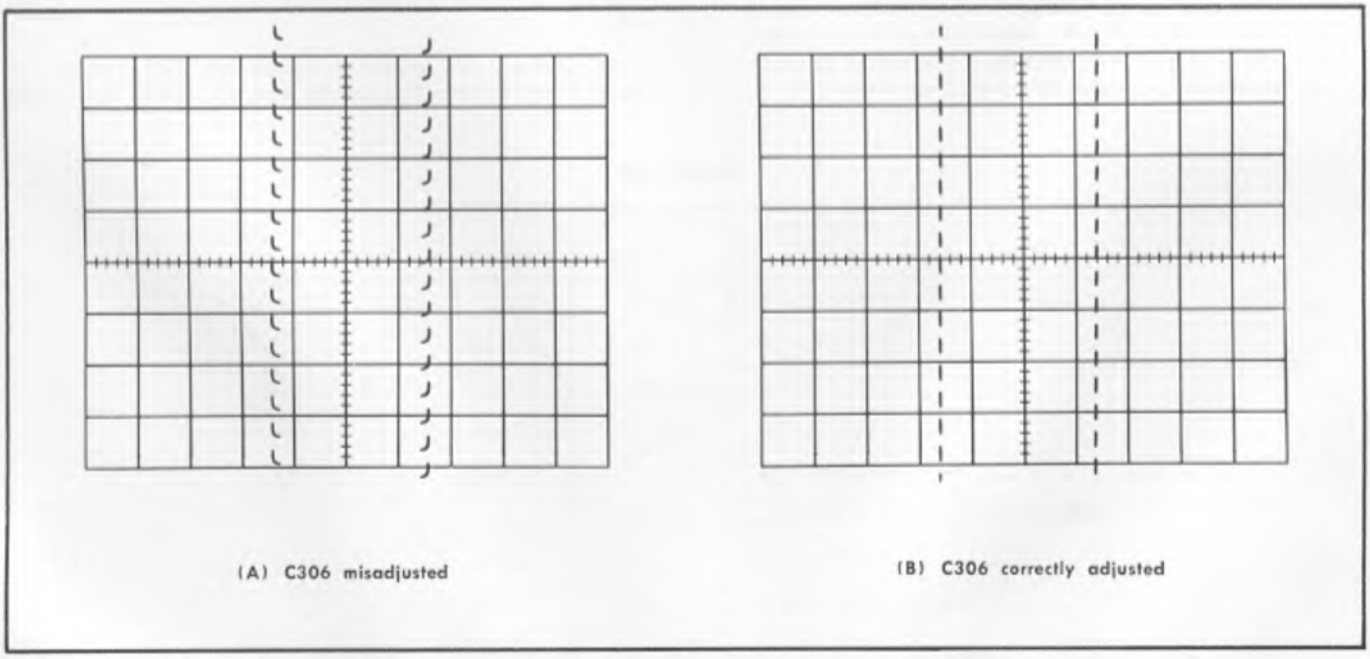


Fig. 6-21. Horizontal Amplifier attenuator compensation adjustment location (instrument right side).

r. Check—For optimum square-wave level and flat top.

s. Adjust C304B for optimum square-wave level and flat top.

t. Change the SWEEP TIME/CM to .1 mSEC.

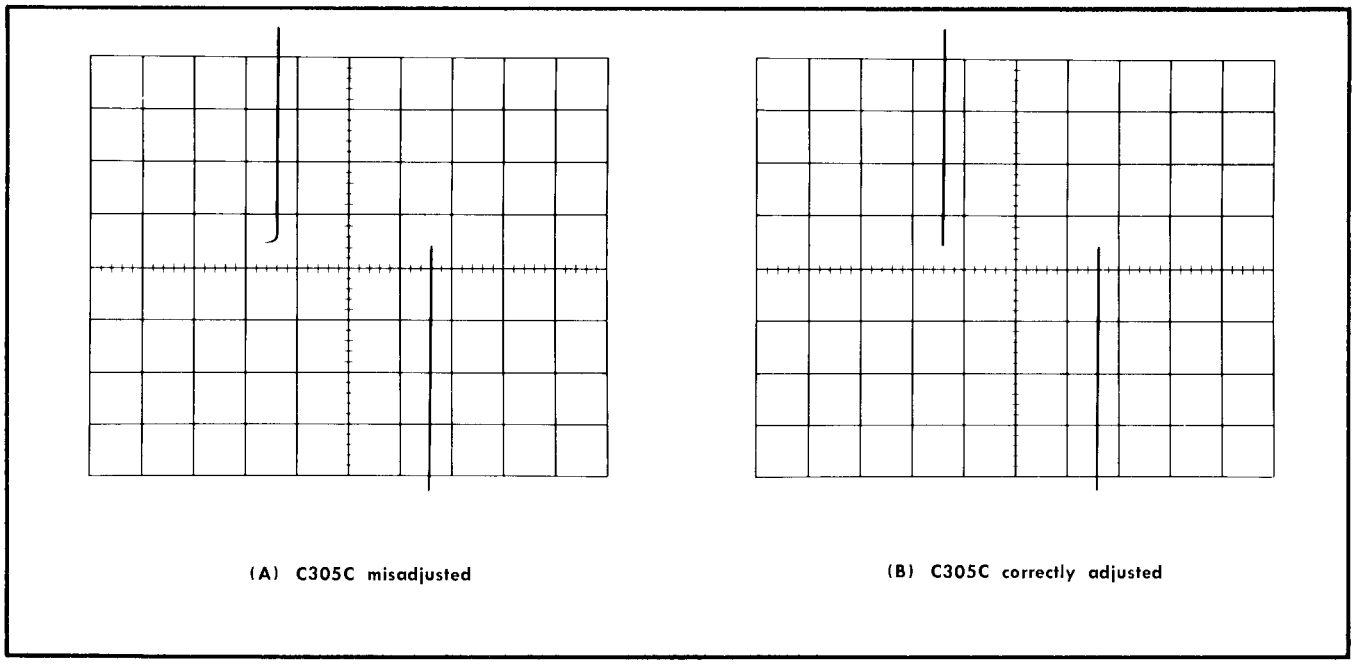


(A) C306 misadjusted

(B) C306 correctly adjusted

Fig. 6-22. Typical display, Horizontal Amplifier attenuator compensation adjustments; 1 kHz square-wave input; SWEEP TIME/CM switch setting, 2 mSEC.

©



(A) C305C misadjusted

(B) C305C correctly adjusted

Fig. 6-23. Horizontal Amplifier attenuator compensation; 1 kHz square-wave input; SWEEP TIME/CM switch setting, .1 mSEC.

u. Check—Square wave front corner, with overshoot or rounding not exceeding 2% of display amplitude.

v. Adjust C304C for optimum square wave front corner.

w. Check the square-wave response in all remaining HORIZONTAL SENSITIVITY switch positions, alternately switching between the 2 mSEC and .1 mSEC positions of the SWEEP TIME/CM switch.

NOTE

All attenuator compensation adjustments or checks are made with a display amplitude of 3 cm. Insert or remove attenuation, or adjust the signal generator output to maintain this signal amplitude.

x. Change the SWEEP TIME/CM switch to 2 mSEC, and the SLOPE switch to —.

y. Change the HORIZONTAL +INPUT switch to GND, the HORIZONTAL —INPUT to DC, and move the Time-constant Normalizer to the HORIZONTAL —INPUT connector.

z. Repeat the procedure outlined in steps (h) through (y), referring to Table 6-4 for control settings, adjustments required, and waveform tolerances. The HORIZONTAL —INPUT attenuator adjustment locations are shown in Fig. 6-21.

aa. Remove the generator signal, the 10× probe, the Input Time-constant Normalizer, and all cables and leads.

TABLE 6-4

Input	Attenuator Setting	TIME/CM Setting	Adjust	Tolerance
HORIZONTAL +	.2 VOLTS/CM	2 mSEC	C306	Aberrations not more than 2% of display amplitude in all attenuator positions.
	.5 VOLTS/CM	2 mSEC	C305B	
	.5 VOLTS/CM	.1 mSEC	C305C	
	5 VOLTS/CM	2 mSEC	C304B	
	5 VOLTS/CM	.1 mSEC	C304C	
HORIZONTAL —	.2 VOLTS/CM	2 mSEC	C316	
	.5 VOLTS/CM	2 mSEC	C315B	
	.5 VOLTS/CM	.1 mSEC	C315C	
	5 VOLTS/CM	2 mSEC	C314B	
	5 VOLTS/CM	.1 mSEC	C314C	

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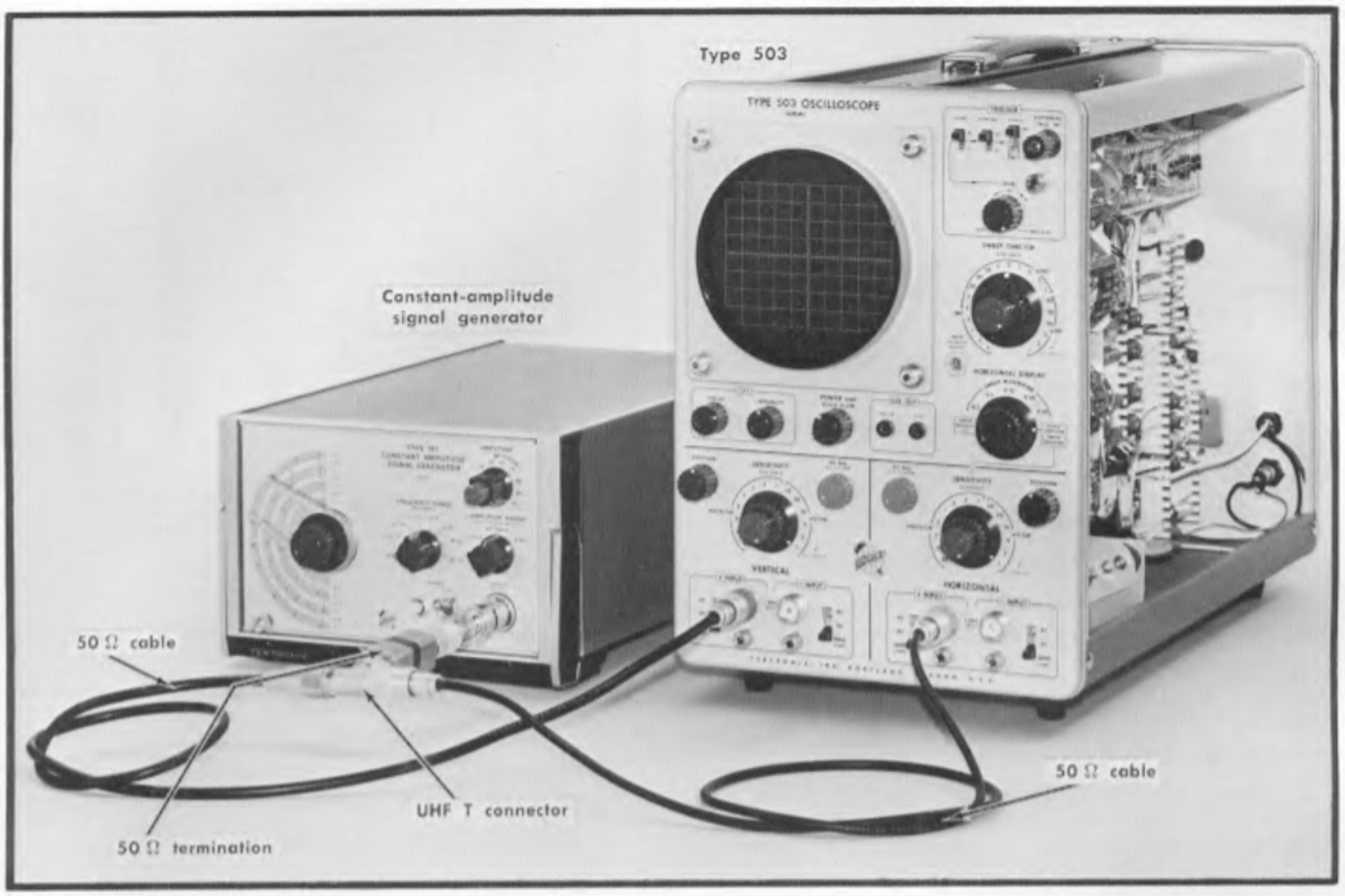


Fig. 6-24. Test setup for adjusting amplifier phasing.

Control Settings:

SLOPE	+
COUPLING	AC
SOURCE	INT.
LEVEL	FREE RUN
HORIZONTAL DISPLAY	HORIZ. AMPLIFIER (SWEEP DISABLED)
VERTICAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
POSITION	Midrange
+INPUT	DC
—INPUT	GND
HORIZONTAL	
SENSITIVITY	.2 VOLTS/CM
VARIABLE	CALIBRATED
POSITION	Midrange
+INPUT	GND
—INPUT	GND

31. Adjust Amplifier Phasing ◐

NOTE

At Serial Number 560, capacitors C356 and C456 were changed from fixed units to variable units. At Serial Number 6997, capacitors C368 and C468 were installed.

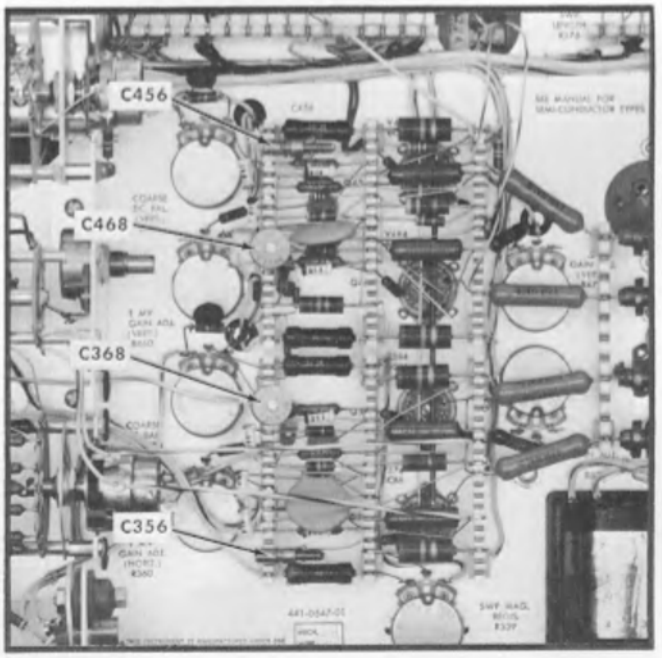


Fig. 6-25. Location of phasing adjustments (instrument right side).

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a. Test setup is shown in Fig. 6-24.

b. Connect a 50 Ω termination, a UHF T connector, and two 50-ohm cables to the output connector of the constant-amplitude signal generator. If desired, two quick-connect adapters (item 15 of Recommended Equipment) may be installed at the Type 503 input ends of the cables, to permit easy cable-switching.

NOTE

The two 50-ohm cables should be identical to assure a symmetrical input to the two amplifiers for phasing adjustments.

c. Connect the two cables to the VERTICAL and HORIZONTAL +INPUT connectors.

d. Adjust the generator output for a 6-cm display at a frequency of 50 kHz, and center the display exactly with the VERTICAL and HORIZONTAL POSITION controls.

e. Change the generator frequency to 450 kHz.

f. Check—A vertical trace $\geq$4.2 cm in length.

g. Adjust C419 for a trace $\geq$4.2 cm in length. See Figs. 6-25 and 6-26 for interaction of phasing adjustments.

h. Move the signal cable from the VERTICAL +INPUT connector to the VERTICAL —INPUT connector, change the VERTICAL +INPUT switch to GND, the VERTICAL —INPUT switch to DC, and repeat steps (e), (f), and (g).

i. Change the VERTICAL —INPUT switch to GND, and the HORIZONTAL +INPUT switch to DC. The trace will now be a horizontal line.

j. Repeat steps (e), (f), and (g) for the horizontal trace.

k. Dress the CRT deflection plate leads (instrument left side) for a trace $\geq$4.2 cm in length.

l. Change the HORIZONTAL +INPUT switch to GND, and the HORIZONTAL —INPUT switch to DC.

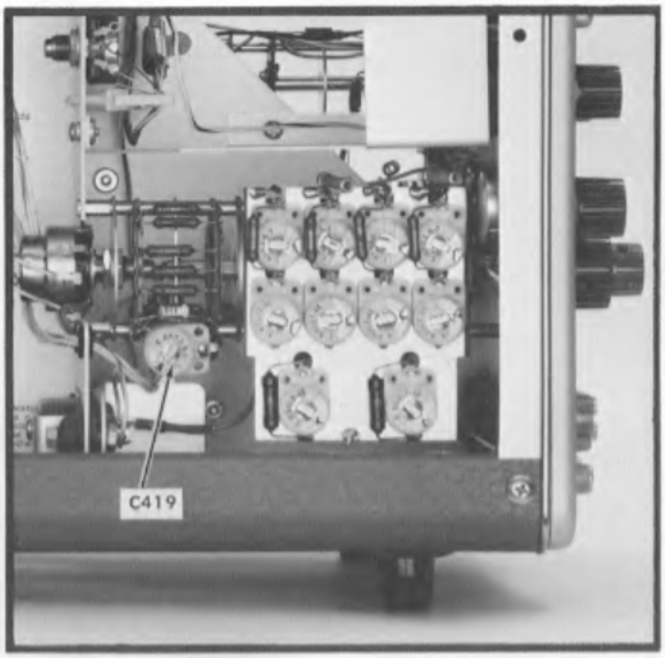


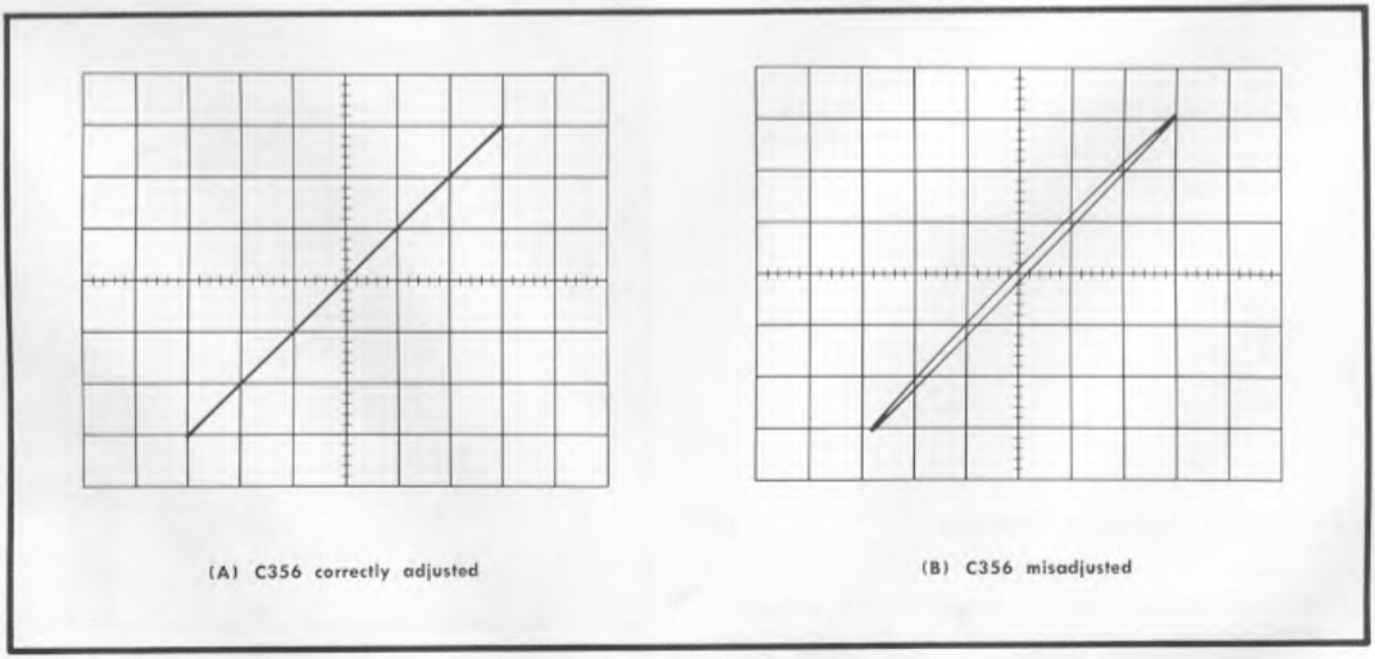
Fig. 6-26. Location of phasing adjustment C419 (instrument left side).

m. Move the signal cable from the HORIZONTAL +INPUT connector to the HORIZONTAL —INPUT connector.

n. Repeat the checks as in steps (e), (f), and (g).

o. Increase the generator output (at 450 kHz) to display a trace exactly 6 cm long.

p. Change the VERTICAL —INPUT switch to DC. The trace will change to a straight line or flattened ellipse at a 45° angle across the CRT screen. See Fig. 6-27 for typical displays.



(A) C356 correctly adjusted

(B) C356 misadjusted

Fig. 6-27. Typical displays, amplifier phasing adjustment.

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q. Check—Trace separation (measured on the graticule center vertical line) at the widest part of the ellipse not more than 1 mm (1°).

r. Adjust C368 for minimum trace separation; adjust as necessary for minimum trace separation at 350 kHz and 450 kHz.

NOTE

A compromise adjustment of C368 may be necessary to achieve minimum trace separation at both 350 kHz and 450 kHz.

s. Move both signal cables to the HORIZONTAL and VERTICAL +INPUT connectors, and change both +INPUT switches to DC, and both —INPUT switches to GND.

t. Check—Trace separation not more than 1 mm.

u. Adjust C468 for minimum trace separation; adjust as necessary for minimum trace separation at 350 kHz and 450 kHz.

NOTE

Slight re-adjustment of C419 may be required to obtain minimum trace separation.

v. Change the VERTICAL and HORIZONTAL SENSITIVITY switches to 1 mV/CM.

w. Adjust the generator output for an X and Y deflection of 6 cm at 450 kHz, and center the trace.

x. Check—Trace separation not more than 1 mm.

y. Adjust C356 for minimum trace separation; adjust as necessary for minimum trace separation at 350 kHz and 450 kHz.

z. Change the signal cables to the —INPUT connectors, set the —INPUT switches to DC, and the +INPUT switches to GND.

aa. Check—Trace separation not more than 1 mm.

ab. Adjust C456 for minimum trace separation; adjust as necessary for minimum trace separation at 350 kHz and 450 kHz.

ac. Check the remaining attenuator positions for both the HORIZONTAL and VERTICAL Amplifiers, referring to Table 6-5 for attenuator settings, generator frequencies, and trace separation tolerances.

NOTE

In all cases, adjust the display amplitude to 6 cm for the checks in Table 6-5.

ad. Interaction—The adjustments to C356, C456, and C368, C468 interact. Changes to the adjustments of one of the capacitors may require adjustment of the others.

ae. Re-check the amplifier bandwidth, using steps 31 (a) through (o) as a guide. This completes the phasing recalibration and check.

TABLE 6-5

SENSITIVITY HORIZONTAL and VERTICAL	Generator Frequency	Maximum Trace Separation
1 mV/CM	50 kHz	1 mm
	350 kHz	
	450 kHz	
2 mV/CM	50 kHz	1 mm
	350 kHz	
	450 kHz	
5 mV/CM	50 kHz	1 mm
	350 kHz	
	450 kHz	
10 mV/CM	50 kHz	1 mm
	350 kHz	
	450 kHz	
20 mV/CM	350 kHz	1 mm
	50 kHz	
	450 kHz	
.1 VOLTS/CM	50 kHz	1 mm
	350 kHz	
	450 kHz	
.2 VOLTS/CM	50 kHz	1 mm
	350 kHz	
	450 kHz	

32. Check Common Mode Rejection Ratio

a. Set the HORIZONTAL + and —INPUT switches to GND.

b. Set the VERTICAL +INPUT to DC, and the —INPUT to GND.

c. Set the constant-amplitude signal generator frequency to 50 kHz, and connect the 50-ohm cables to the VERTICAL + and —INPUT connectors.

d. Set the VERTICAL SENSITIVITY to 1 VOLTS/CM, and adjust the generator output for a trace 4 cm in amplitude.

e. Change the VERTICAL —INPUT switch to DC, and change the VERTICAL SENSITIVITY switch to .2 VOLTS/CM.

f. With the VERTICAL POSITION control, move the display to the top, and then to the bottom of the graticule.

g. Check—Vertical deflection (trace separation) not more than 2 mm anywhere in the graticule area.

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NOTE

In all succeeding Common Mode Rejection Ratio checks, the display should be moved over the entire graticule area during the check, as indicated in steps (f) and (g).

h. Check the remaining vertical attenuator settings listed in Table 6-6. The generator output (4 V) is not changed for the checks in Table 6-6.

i. Set the VERTICAL + and —INPUT switches to GND, and change the HORIZONTAL + and —INPUT switches to DC.

j. Move the signal cables to the HORIZONTAL INPUT connectors, and set the HORIZONTAL switch to .2 VOLTS/CM.

TABLE 6-6

SENSITIVITY Settings HORIZONTAL/VERTICAL	Signal Amplitude	Maximum Deflection
.2 VOLTS/CM	4 volts	2 mm
.1 VOLTS/CM	4 volts	4 mm
50 mV/CM	4 volts	8 mm
20 mV/CM	4 volts	2 cm
10 mV/CM	4 volts	4 cm

k. With the HORIZONTAL and VERTICAL POSITION controls, move the display within the graticule viewing areas.

l. Check—Horizontal deflection not more than 2 mm.

m. Check the remaining horizontal attenuator settings litsed in Table 6-6, leaving the generator output at 4 V.

n. Change the HORIZONTAL SENSITIVITY switch to 0.1 VOLTS/CM.

o. Change the HORIZONTAL —INPUT switch to GND, and adjust the generator output for a trace 5 cm long (0.5 V output).

p. Change the HORIZONTAL —INPUT to DC, and the HORIZONTAL SENSITIVITY switch to 5 mV/CM.

q. Check—Horizontal display not more than 2 cm long.

r. Change the HORIZONTAL SENSITIVITY to 2 mV/CM.

s. Check—Display not more than 5 cm long.

t. Change the HORIZONTAL SENSITIVITY to 1 mV/CM.

u. Check—Display not more than 10 cm long.

v. Change both HORIZONTAL INPUT switches to GND.

w. Set the VERTICAL SENSITIVITY switch to 5 mV/CM.

x. Set the VERTICAL + and —INPUT switches to DC.

y. Move the two signal cables from the HORIZONTAL INPUT connectors to the VERTICAL INPUT connectors.

z. Check—Amplitude of the display not more than 2 cm anywhere in the graticule area.

aa. Change the VERTICAL SENSITIVITY switch to 2 mV/CM.

ab. Check—Display amplitude not more than 5 cm in the graticule area.

ac. Change the VERTICAL SENSITIVITY switch to 1 mV/CM.

ad. Check—Display amplitude not more than 10 cm.

33. Check Vertical Amplifier Frequency Response

a. Remove the UHF T connector and one 50-ohm cable, and connect the other cable from the 50-ohm termination to the VERTICAL +INPUT connector.

b. Set the HORIZONTAL + and —INPUT switches to GND, the VERTICAL +INPUT to DC, and the VERTICAL —INPUT to GND.

c. Set the SWEEP TIME/CM switch to .1 mSEC, and the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1).

d. Set the VERTICAL SENSITIVITY to 1 mV/CM and adjust the generator output for a display 6 cm in amplitude.

e. Change the generator frequency to 450 kHz. The display amplitude will decrease.

f. Check—The display amplitude should be equal to or greater than 4.2 cm (—3 dB).

g. Repeat the frequency response check for all positions of the VERTICAL + and —INPUT attenuator (SENSITIVITY) switch.

34. Check Horizontal Amplifier Frequency Response

a. Set the VERTICAL + and —INPUT switches to GND, the HORIZONTAL +INPUT to DC, and connect the signal to the HORIZONTAL +INPUT.

b. Change the HORIZONTAL DISPLAY switch to HORIZ. AMPLIFIER (SWEEP DISABLED).

c. Check that the HORIZONTAL SENSITIVITY switch is set to 1 mV/CM.

d. Set the generator frequency to 50 kHz, and adjust the generator output for a trace 6 cm long.

e. Change the generator frequency to 450 kHz. The trace will shorten.

f. Check—The trace should be equal to or greater than 4.2 cm long (—3 dB).

g. Repeat the frequency response check steps d, e, and f for all positions of the HORIZONTAL + and —INPUT attenuator (SENSITIVITY) switch.

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35. Adjust Sweep Stability

a. Set all + and —INPUT switches to GND.

b. Set the HORIZONTAL DISPLAY to SWEEP NORMAL (×1), and the SWEEP TIME/CM to .1 mSEC.

c. Set the LEVEL control to AUTO.

d. Check—A free-running trace at approximately a 50-Hz rate should be visible.

e. With a screwdriver, rotate the SWEEP STABILITY ADJUST control (on the front panel) counterclockwise until the trace disappears. Note the position of the adjusting screw slot.

f. Rotate the SWEEP STABILITY ADJUST control clockwise until the trace brightens suddenly. Again note the position of the adjusting slot.

g. Adjust the control midway between the positions noted in steps (e) and (f).

NOTES

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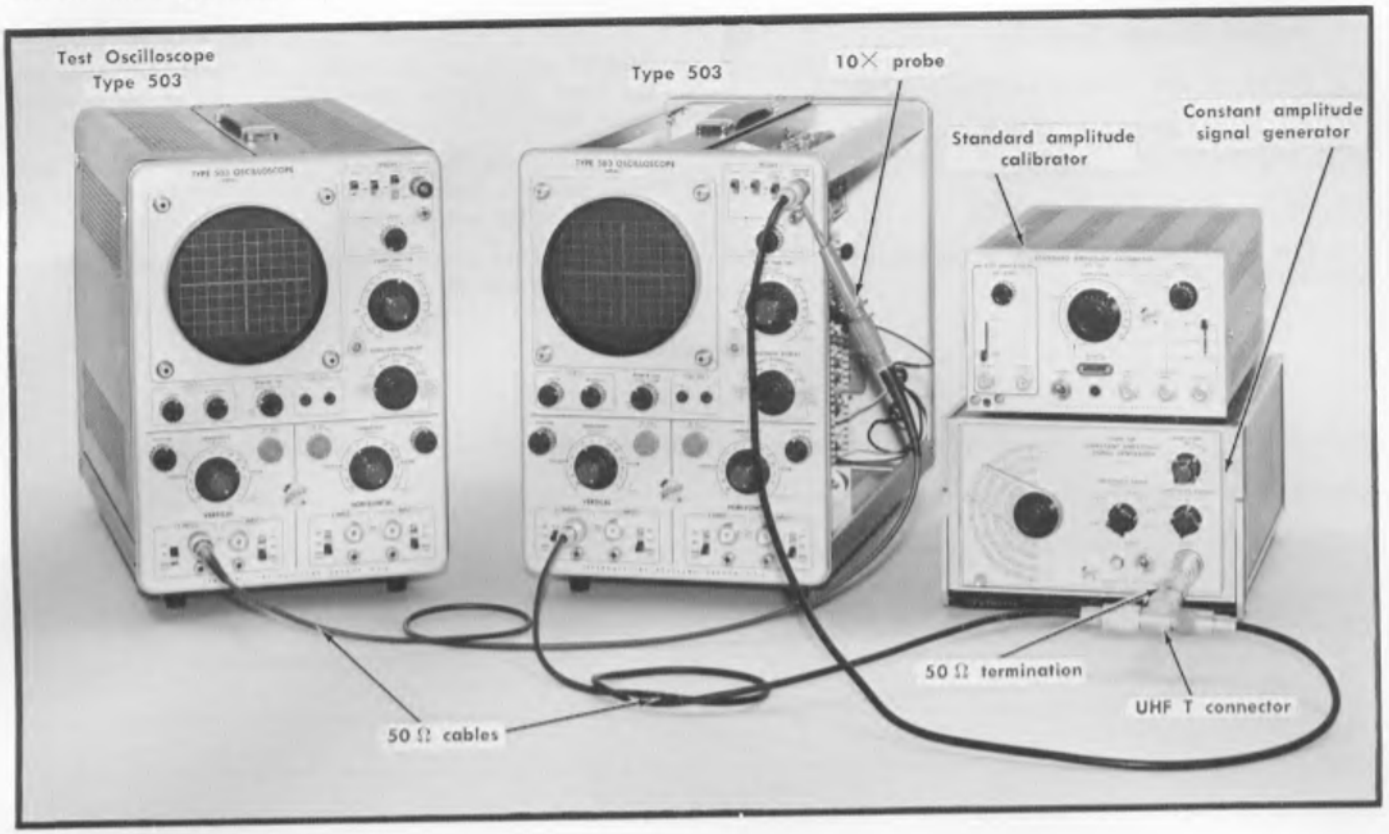


Fig. 6-28. Initial test seup for checking sweep triggering.

Control Settings:

SLOPE	+
COUPLING	AC
SOURCE	EXT.
LEVEL	AUTO.
HORIZONTAL DISPLAY	SWEEP NORMAL (×1)
VERTICAL	
SENSITIVITY	.1 VOLTS/CM
VARIABLE	CALIBRATED
POSITION	Midrange
+INPUT	DC
—INPUT	GND
SWEEP TIME/CM	5 μSEC
Test Oscilloscope (Type 503)	
Vertical Sensitivity	10 mV/cm
Vertical +Input	DC (all other inputs at Gnd)
Sweep Time/cm	1 mSEC
Slope	+
Coupling	AC
Source	Int.
Level	Auto.

36. Check Triggering—External High Frequency

a. The initial test setup is shown in Fig. 6-28.

b. Connect a 50-ohm termination, a UHF T connector, and two 50-ohm cables to the output connector of the constant-amplitude signal generator in the order given.

c. Connect one cable to the Type 503 VERTICAL +INPUT connector, and the other to the EXTERNAL TRIG. IN connector.

d. Connect a 10× probe to the test oscilloscope Vertical +Input connector, and connect the probe tip to the EXTERNAL TRIG. IN connector.

e. Set the generator frequency to 50 kHz, and adjust the output to 0.5 V, as indicated on the test oscilloscope by a display amplitude of 5 cm.

f. Remove the test probe from the EXTERNAL TRIG. IN connector.

g. Change the generator frequency to 450 kHz.

h. Check—A stable display may be obtained in the + and — positions of the SLOPE switch by adjusting the LEVEL control.

i. Rotate the LEVEL control to the AUTO position.

j. Check—A stable display may be obtained in both positions of the SLOPE switch.

37. Check Triggering—Internal High Frequency

a. Change the SOURCE switch to INT., and the constant-amplitude signal generator frequency to 50 kHz.

b. Turn the LEVEL control to FREE RUN, and adjust the generator output for a display 0.5 cm in amplitude.

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c. Adjust the LEVEL control for a stable display.

d. Check—A stable display may be obtained with the SLOPE switch in either position, and with the COUPLING switch in either position, by adjustment of the LEVEL control.

e. Change the LEVEL control to FREE RUN, and change the generator frequency to 450 kHz.

f. Adjust the generator output for a 2 cm display.

g. Check—A stable display may be obtained with the SLOPE switch in either position, and with the COUPLING switch in either position, by adjustment of the LEVEL control.

h. Remove the constant-amplitude generator signal.

38. Check Triggering—External (1 kHz Square Wave)

a. Connect a UHF T connector and two 50-ohm cables to the output connector of the Standard Amplitude Calibrator (item 6 of Recommended Equipment).

b. Connect one cable to the EXTERNAL TRIG. IN connector.

c. Set the Standard Amplitude Calibrator to supply a 0.5-volt square wave.

d. Change the SWEEP TIME/CM to 2 mSEC.

e. Check—A stable display may be obtained with the SLOPE switch in both positions by adjustment of the LEVEL control, and with the LEVEL control in AUTO.

39. Check Triggering—Internal (1 kHz Square Wave)

a. Change the SOURCE switch to INT.

b. Set the Standard Amplitude Calibrator to 50 millivolts.

c. Check—A stable display may be obtained with the SLOPE swich in both positions, by adjustment of the LEVEL control, and with the LEVEL control in AUTO.

d. Position the display to the graticule center, and obtain a stable display with the LEVEL control.

e. Change the COUPLING switch to DC.

f. Check—A stable display may be obtained in both positions of the SLOPE switch by adjustment of the VERTICAL POSITION control. The bottom of the square-wave display (zero DC level) should be within ±1 cm of the graticule center line when the SLOPE switch is in either position.

g. Disconnect the calibrator signal.

40. Check Line Triggering

a. Connect a 10× probe to the VERTICAL +INPUT connector.

b. Connect the probe tip to the line fuse terminal at the inside rear panel of the Type 503.

c. Change the SOURCE switch to LINE.

d. Set the SWEEP TIME/CM to 5 mSEC.

e. Check—A stable display may be obtained with the SLOPE switch in either position by adjustment of the LEVEL control.

f. Change the LEVEL control to AUTO.

g. Check—A stable display in both positions of the SLOPE switch.

h. Remove the 10× probe.

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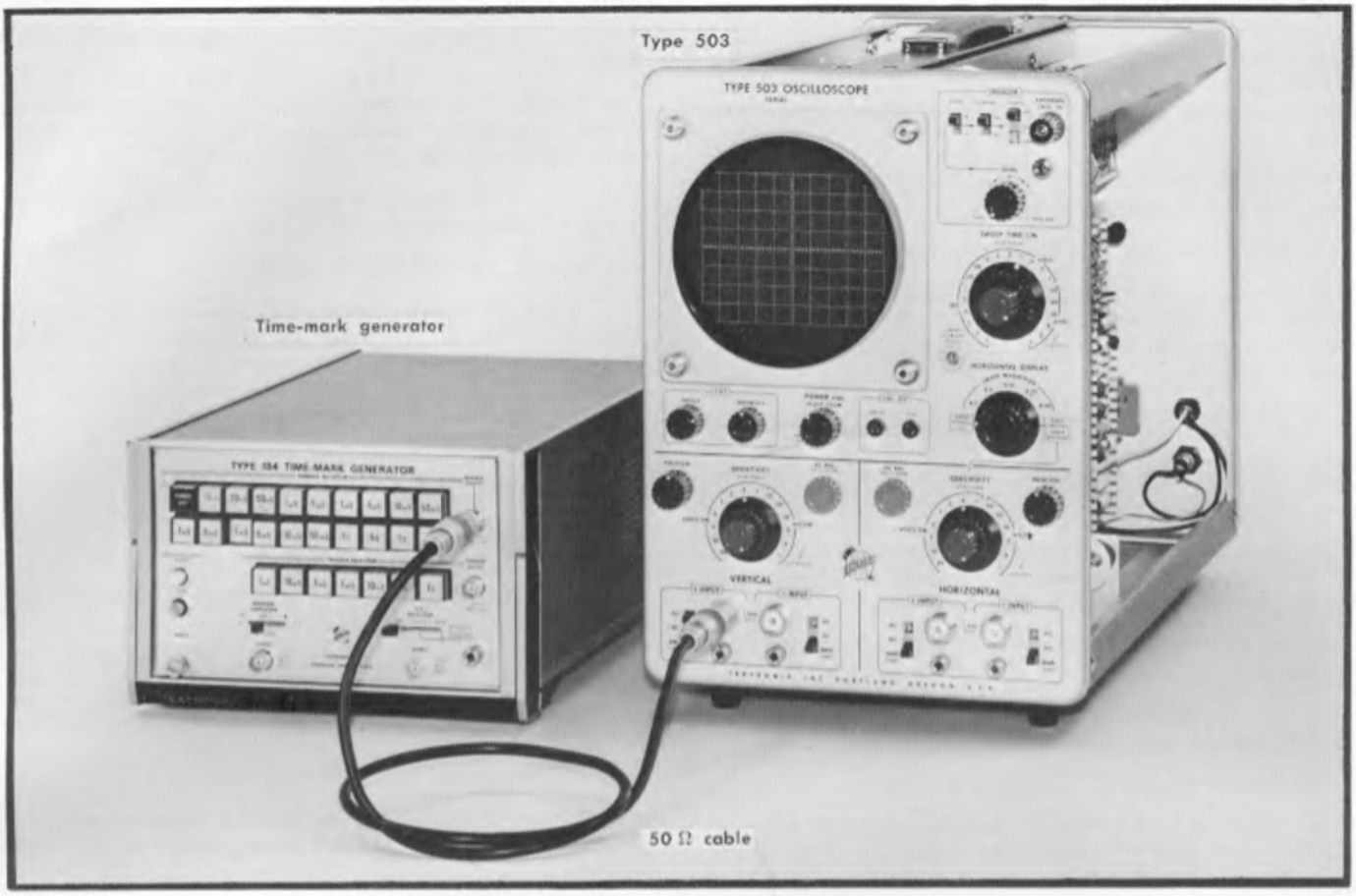


Fig. 6-29. Test seup for sweep timing adjustments.

Control Settings:

SLOPE	+
COUPLING	AC
SOURCE	INT.
LEVEL	Triggered (not AUTO.)
HORIZONTAL DISPLAY	SWEEP NORMAL (×1)
VERTICAL	
SENSITIVITY	Set to produce a 3-cm display
VARIABLE	Set to produce a 3-cm display
POSITION	Midrange
+INPUT	AC
—INPUT	GND
HORIZONTAL	
+INPUT	GND
—INPUT	GND
SWEEP TIME/CM	1 mSEC

41. Adjust Sweep Timing—1 mSEC/CM

a. Test setup is shown in Fig. 6-29.

b. Set the time-mark generator (item 7 of Recommended Equipment) to supply 1-millisecond markers.

c. Connect a 50-ohm cable from the time-mark generator output connector to the VERTICAL +INPUT connector.

d. Set the VERTICAL SENSITIVITY and the VARIABLE control so that the display amplitude is approximately 3 cm.

e. Check—1 marker/cm, ±3% (2.4 mm in 8 cm).

f. Adjust SWP. CAL R322 for 1 marker/cm. (The location of R322 is shown in Fig. 6-31.)

g. Fig. 6-30 shows a Typical display.

42. Adjust Sweep Length

a. Change the SWEEP TIME/CM to 1 mSEC, the time-mark generator output to 1-millisecond markers, and the SOURCE switch to INT.

b. Check—A sweep length of 10.5 cm.

c. Adjust SWP. LENGTH R176 for a sweep length of 10.5 cm.

43. Adjust Sweep Timing—10μSEC/CM

a. Change the generator output to 10-microsecond markers.

b. Change the SWEEP TIME/CM switch to 10 μSEC.

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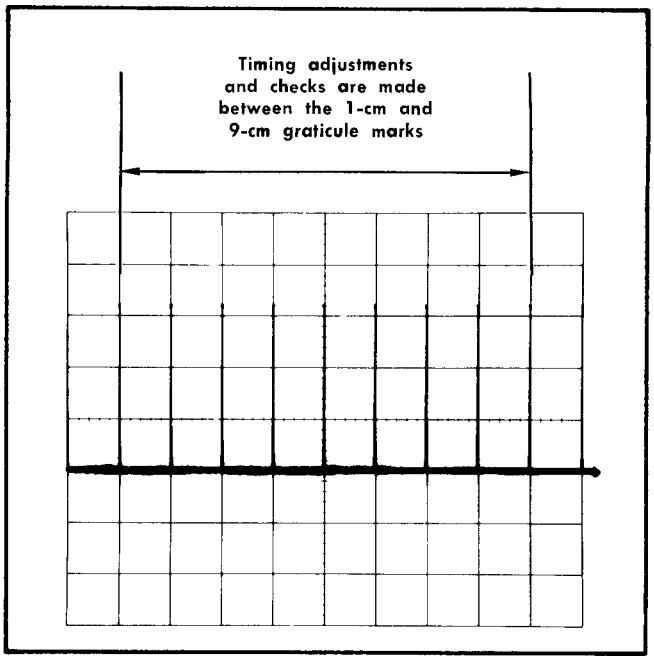


Fig. 6-30. Typical display, sweep timing adjustment; 1 millisecond markers; SWEEP TIME/CM switching, 1 mSEC.

c. Check—One marker/cm, ±3%.

d. Adjust C160C for one marker/cm.

44. Adjust Sweep Timing—1 μSEC/CM ◐

a. Change the time-mark generator output to 1-microsecond markers.

b. Change the SWEEP TIME/CM switch to 1 μSEC.

c. Connect a 50-ohm cable from the time-mark generator trigger output connector to the EXTERNAL TRIG. IN connector, and set the generator to supply 10-microsecond triggers.

d. Change the SOURCE switch to EXT.

e. Check—One marker/cm, ±3%.

f. Adjust C160A for one marker/cm.

45. Check Variable Control Ratio

a. Rotate the SWEEP TIME/CM VARIABLE control fully counterclockwise.

b. Check—2.5 times as many markers in a given display area.

c. Return the VARIABLE control fully clockwise.

46. Check Sweep Timing

a. Set the time-mark generator and Type 503 as indicated in Table 6-7, checking for timing accuracy tolerances as shown.

NOTE

The 1 mSEC timing adjustment (SWP. CAL R322) may be readjusted as necessary, within the tolerance limits, to bring all other timing ranges within performance requirements.

TABLE 6-7

SWEEP TIME/CM Setting	Time-Mark Generator Setting	Check	Tolerance
2 mSEC	1 ms	2 marks/cm	±3%
5 mSEC	5 ms	1 mark/cm	±3%
10 mSEC	10 ms	1 mark/cm	±3%
20 mSEC	10 ms	2 marks/cm	±3%
50 mSEC	50 ms	1 mark/cm	±3%
.1 SEC	100 ms	1 mark/cm	±3%
.2 SEC	100 ms	2 marks/cm	±3%
.5 SEC	500 ms	1 mark/cm	±3%
1 SEC	1 sec	1 mark/cm	±3%
2 SEC	1 sec	2 marks/cm	±3%
5 SEC	5 sec	1 mark/cm	±3%
.5 mSEC	500 μs	1 mark/cm	±3%
.2 mSEC	100 μs	2 marks/cm	±3%
.1 mSEC	100 μs	1 mark/cm	±3%
10 μSEC	10 μs	1 mark/cm	±3%
20 μSEC	10 μs	2 marks/cm	±3%
50 μSEC	50 μs	1 mark/cm	±3%
1 μSEC[1]	1 μs	1 mark/cm	±3%
2 μSEC[1]	1 μs	2 marks/cm	±3%
5 μSEC	5 μs	1 mark/cm	±3%

47. Adjust Sweep Magnifier Registration ◐

a. Set the SWEEP TIME/CM to 1 mSEC.

b. Set the time-mark generator to supply 5-millisecond markers.

c. Check that the SOURCE switch is set to INT., and adjust the LEVEL control.

d. Center the first time mark to the graticule center vertical line with the HORIZONTAL POSITION control.

e. Change the HORIZONTAL DISPLAY switch to ×50, and re-center the first time mark to the graticule center line.

f. Change the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1).

g. Check—No more than 0.5 cm shift of the first time mark as the HORIZONTAL DISPLAY switch is changed from ×50 to ×1.

h. Adjust SWP/MAG. REGIS. R339 to center the first time mark to the graticule center vertical line.

i. Interaction—Repeat steps (e) through (h) until the first time mark remains centered through all positions of the HORIZONTAL DISPLAY SWEEP MAGNIFIED switch.

[1]Use external triggering; i.e., connect a UHF T connector and an additional 50-ohm cable from the time-mark generator to the EXTERNAL TRIG. IN connector, change the SOURCE switch to EXT., and obtain a stable display with the LEVEL control.

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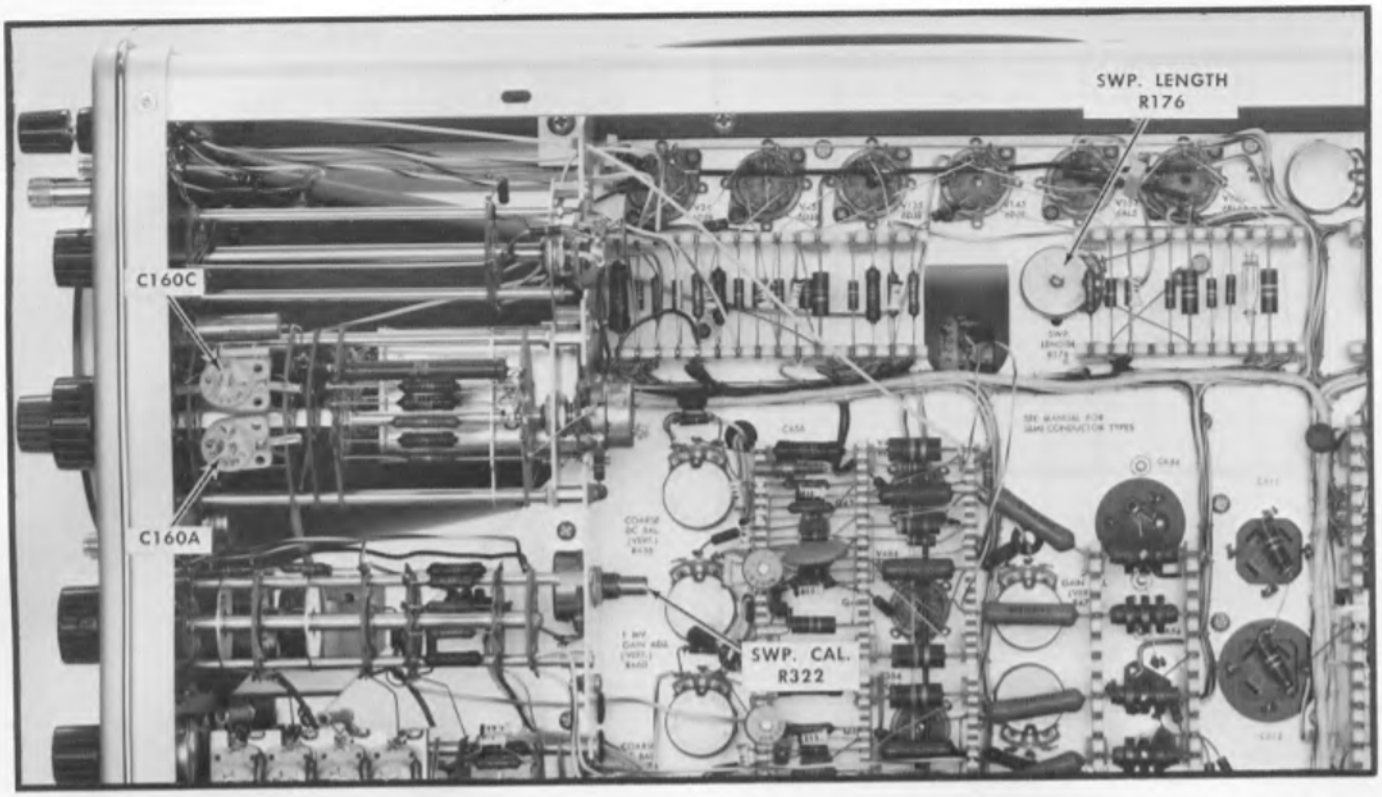


Fig. 6-31. Sweep timing adjustment locations.

48. Recheck Horizontal Drift

a. Set the HORIZONTAL DISPLAY SWEEP MAGNIFIED switch to ×50, and check that the first time mark is at the graticule center.

b. Change the HORIZONTAL DISPLAY SWEEP MAGNIFIED switch to ×1.

c. Check—After 30 seconds, the marker drift should not be more than 4 mm as the HORIZONTAL DISPLAY SWEEP MAGNIFIED switch is changed from ×50 to ×1.

49. Check Magnifier Accuracy

a. Set the time-mark generator to supply 1-millisecond and 100-microsecond markers.

b. Adjust the LEVEL control to obtain a stable display. The display should consist of one large mark/cm and 10 small marks/cm.

c. Change the HORIZONTAL DISPLAY switch to ×2.

d. Check—1 large mark/2 cm, ±1 mm/2 cm.

e. Set the HORIZONTAL DISPLAY switch as indicated in Table 6-8, checking for magnifier tolerances shown.

50. Check Sweep Jitter

a. Connect 1-microsecond time marks from the time-mark generator to the VERTICAL +INPUT connector.

b. Connect a 50-ohm cable from the time-mark generator trigger output connector to the EXTERNAL TRIG. IN connector.

c. Set the SOURCE switch to EXT., the SWEEP TIME/CM to 5 μSEC, and the HORIZONTAL DISPLAY switch to ×50.

d. Set the time-mark generator to supply 10-microsecond triggers, and adjust the LEVEL control to obtain a stable display.

e. Position display to the last marker.

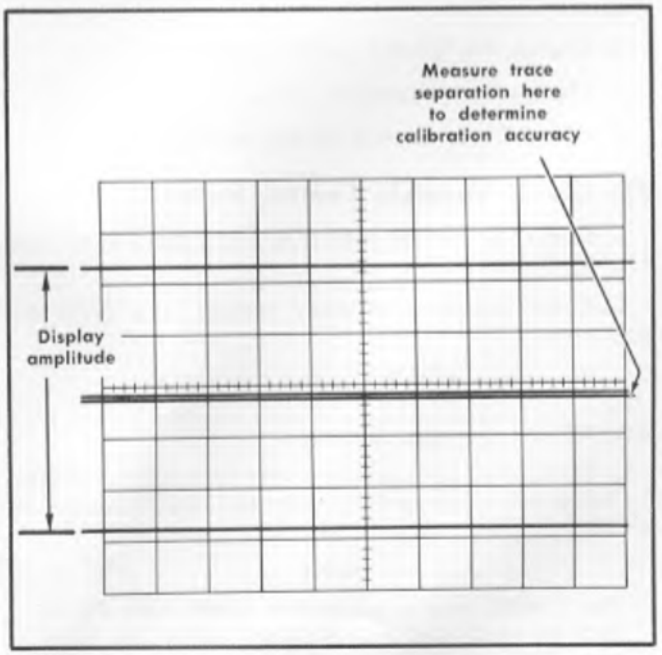


Fig. 6-32. Illustrating method of measuring calibrator accuracy.

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f. Check—Horizontal jitter, 2 mm or less.

g. Remove the time-mark generator signals.

51. Check Z Axis Operation

a. Change the HORIZONTAL DISPLAY switch to SWEEP NORMAL (×1), the SWEEP TIME/CM to 1 mSEC, and the LEVEL control clockwise to the FREE RUN position.

b. Connect a 50-ohm cable from the Standard Amplitude Calibrator output connector to the CRT GRID binding post of the EXTERNAL INPUT connectors (on the rear panel of the Type 503).

c. Set the Standard Amplitude Calibrator to supply a 10-volt square wave.

d. Remove the strap connecting the CRT GRID and GND binding posts.

e. Check—Intensity modulation of the trace should be visible.

f. Replace the strap connecting the CRT GRID and GND binding posts, and remove the signal from the binding post.

52. Adjust Amplitude Calibrator—5 mV ◐

a. Set the VERTICAL SENSITIVITY to 1 mV/CM, and the VERTICAL + and —INPUT switches to DC and Trigger control to AUTO.

b. Set the SWEEP TIME/CM to 20 μSEC, and the HORIZONTAL DISPLAY to SWEEP NORMAL (×1).

c. Set the Standard Amplitude Calibrator to supply a 5-millivolt square wave, and connect a 50-ohm cable from the output connector to the VERTICAL +INPUT connector.

d. Connect a short patch cord from the 5 mV CAL. OUT connector to the VERTICAL —INPUT connector.

e. Check—Trace separation at the vertical center of the display should not exceed 1.5 mm (3%).

NOTE

See Fig. 6-32. The display amplitude in the illustration has been reduced with the VARIABLE control to allow presentation of the display within the graticule area; the actual display with the control settings outlined in steps (a) through (d) should have an amplitude of 10 cm, with the center trace either a single line, or separated by the amount of difference between the Standard Amplitude Calibrator voltage and the Type 503 CAL. OUT voltage.

f. Adjust CAL. ADJ. R880 for no trace separation at the center of the display.

TABLE 6-8

DISPLAY HORIZONTAL	Check	Tolerance (±5%)
X2	1 large mark/2 cm	±1 mm/2 cm
X5	1 large mark/5 cm	±2.5 mm/5 cm
X10	1 small mark/cm	±0.5 mm/cm
X20	1 small mark/2 cm	±1 mm/2 cm
X50	1 small mark/5 cm	±2.5 mm/5 cm

53. Check Calibrator Accuracy—500 mV

a. Change the VERTICAL SENSITIVITY switch to .1 VOLTS/CM.

b. Change the Standard Amplitude Calibrator to 0.5 volts output.

c. Move the patch cord from the 5 mV CAL. OUT connector to the 500 mV CAL. OUT connector.

d. Check—Trace separation at the display center not to exceed 1.5 mm.

54. Check Calibrator Symmetry

a. Change the VERTICAL +INPUT switch to GND.

b. Change the SWEEP TIME/CM to .2 mSEC, and adjust the LEVEL control for a stable display.

c. Rotate the SWEEP TIME/CM VARIABLE control counterclockwise until one cycle of the calibrator waveform occupies 10 cm of the graticule.

d. Check—The horizontal length of the positive and negative portions of the displayed cycle should not differ from each other by a ratio of more than 2:1.

55. Check Calibrator Frequency

a. Return the SWEEP TIME/CM VARIABLE to CALIBRATED.

b. Change the SWEEP TIME/CM switch to 1 mSEC.

c. Check—The length of one calibrator cycle should be between 1.9 and 5.7 cm (350 Hz ±50%).

56. Check Calibrator Jitter

a. Change the HORIZONTAL DISPLAY switch to ×50. The INTENSITY may have to be increased to view the display.

b. Rotate the HORIZONTAL POSITION control counterclockwise to center the leading edge of the last cycle of the calibrator waveform.

c. Check—Horizontal jitter not to exceed 1.5 cm.

d. Disconnect all equipment.

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NOTES

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
Δ	increment
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
°	degrees
°C	degrees Celsius (degrees centigrade)
°F	degrees Fahrenheit
°K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
elect.	electrolytic
EMC	electrolytic, metal cased
EMI	electromagnetic interference (see RFI)
EMT	electrolytic, metal tubular
ε	epsilon—2.71828 or % of error
$\geq$	equal to or greater than
$\leq$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GHz	gigahertz
GMV	guaranteed minimum value
GR	General Radio
$>$	greater than
H or h	henry
h	height or high
hex.	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in.	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
kHz	kilohertz
L	inductance
λ	lambda—wavelength
$\gg$	large compared with
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
MHz	megahertz
mm	millimeter
ms	millisecond
—	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
+	plus
$\pm$	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
pwr	power
Q	figure of merit
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference (see EMI)
RHB	round head brass
ρ	rho—resistivity
RHS	round head steel
r/min or rpm	revolutions per minute
RMS	root mean square
s or sec.	second
SE	single end
Si	silicon
SN or S/N	serial number
$\ll$	small compared with
T	tera or 10^{12}
TC	temperature compensated
TD	tunnel diode
THB	truss head brass
θ	theta—angular phase displacement
thk	thick
THS	truss head steel
tub.	tubular
UHF	ultra high frequency
V	volt
VAC	volts, alternating current
var	variable
VDC	volts, direct current
VHF	very high frequency
VSWR	voltage standing wave ratio
W	watt
w	wide or width
w/	with
w/o	without
WW	wire-wound
xmfr	transformer

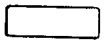
PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
	Screwdriver adjustment.
	Control, adjustment or connector.

SECTION 7

ELECTRICAL PARTS LIST

Ckt. No.	SN Range	Description					Tektronix Part No.
		Bulbs					
B167		Neon, Type NE-2					150-002
B601		Incandescent, #47					150-001
B602		Incandescent, #47					150-001
B883		Neon, Type NE-2, Checked					Use *150-009
B886		Neon, Type NE-2, Checked					Use *150-009
		Fuses					
F601		1.25 amp 3 AG Slo-Blo 117 v operation 50 & 60 cycles					159-041
F601		.7 amp 3 AG Slo-Blo 234 v operation 50 & 60 cycles					159-040
		Capacitors					
Tolerance ±20% unless otherwise indicated.							
C10		.005 μf	Cer.	Fixed	500 v		283-001
C15		.001 μf	Cer.	Fixed	500 v		283-000
C20		.001 μf	Cer.	Fixed	500 v		283-000
C31		.01 μf	Cer.	Fixed	500 v		283-002
C37		22 μμf	Cer.	Fixed	500 v		281-510
C43		47 μμf	Cer.	Fixed	500 v		281-518
C131		22 μμf	Cer.	Fixed	500 v	10%	281-511
C141		4.7 μμf	Cer.	Fixed	500 v	±1 μμf	281-501
C160A		3-12 μμf	Cer.	Var.			281-007
C160B	101-809	82 μμf	Cer.	Fixed	500 v		Use 281-574
C160B	810-up	82 μμf	Cer.	Fixed	500 v	10%	281-574
C160C		4.5-25 μμf	Cer.	Var.			281-010
C160D	101-9789	.001 μf		Fixed		±½%	*291-008
C160E C160F C160G	101-9789	.01 μf .1 μf 1 μf		Fixed		Timing Series ±½%	*291-029
C160D C160E C160F C160G	9790-up	.001 μf .01 μf .1 μf 1 μf			Checked Assy		*295-0109-00
C167		.001 μf	Cer.	Fixed	500 v		283-000
C181	X400-up	15 μμf	Cer.	Fixed	500 v	±1.5 μμf	281-509
C300[1]		.022 μf	PTM	Fixed	600 v	Selected	*295-063
C304B		7-45 μμf	Cer.	Var.			281-012
C304C		1.5-7 μμf	Cer.	Var.			281-005
C304E		198 μμf	Cer.	Fixed	500 v	10%	281-560
C305B		7-45 μμf	Cer.	Var.			281-012
C305C		1.5-7 μμf	Cer.	Var.			281-005
C306		3-12 μμf	Cer.	Var.			281-007
C308A	X1270-up	8 μμf	Cer.	Fixed	500 v	±0.5 μμf	281-503
C308C	X1270-up	18 μμf	Cer.	Fixed	500 v	10%	281-542

[1]C300 and C310 selected ±5% each other, furnished as a unit.

Capacitors *(Cont)*

Ckt. No.	SN Range	Description					Tektronix Part No.
C308E	X1621-2169X	47 μμf	Cer.	Fixed	500 v	5%	281-583
C308G	X1621-2169X	100 μμf	Cer.	Fixed	500 v	5%	281-584
C308J	X1621-2169X	270 μμf	Cer.	Fixed	500 v	5%	281-585
C308L	101-559X	470 μμf	Cer.	Fixed	500 v		281-525
C308L	X1621-2169X	750 μμf	Mica	Fixed	500 v	5%	283-524
C308N	101-559X	1800 μμf	Cer.	Fixed	500 v	10%	281-561
C308N	X1621-2169X	2000 μμf	Mica	Fixed	500 v	1%	283-555
C310[2]		.022 μf	PTM	Fixed	600 v	Selected	*295-063
C314B		7-45 μμf	Cer.	Var.			281-012
C314C		1.5-7 μμf	Cer.	Var.			281-005
C314E		198 μμf	Cer.	Fixed	500 v	10%	281-560
C315B		7-45 μμf	Cer.	Var.			281-012
C315C		1.5-7 μμf	Cer.	Var.			281-005
C316		3-12 μμf	Cer.	Var.			281-007
C330		.005 μf	Cer.	Fixed	500 v		283-001
C336		.005 μf	Cer.	Fixed	500 v		283-001
C340		.005 μf	Cer.	Fixed	500 v		283-001
C346		.005 μf	Cer.	Fixed	500 v		283-001
C350		47 μμf	Cer.	Fixed	500 v		281-518
C353		.1 μf	Cer.	Fixed	200 v		Use 283-057
C356	101-559	2.2 μμf	Cer.	Fixed	500 v		281-500
C356	560-6996	1.5-7 μμf	Cer.	Var.			281-029
C356	6997-up	.7-3 μμf	Tub.	Var.			281-0027-00
C357	101-2169	18 μμf	Cer.	Fixed	500 v		281-542
C357	2170-up	12 μμf	Cer.	Fixed	500 v		281-505
C360		47 μμf	Cer.	Fixed	500 v		281-518
C365	X6997-up	2.7 μμf	Cer.	Fixed	500 v	10%	281-0547-00
C366	101-2169X	2.2 μμf	Cer.	Fixed	500 v	±.5 μμf	281-500
C367	101-2169	18 μμf	Cer.	Fixed	500 v	10%	281-542
C367	2170-up	12 μμf	Cer.	Fixed	500 v	10%	281-505
C368	X6997-up	3-12 μμf	Cer.	Var.			281-0036-00
C390		1 μμf	Cer.	Fixed	500 v		281-538
C400[3]		.022 μf	PTM	Fixed	600 v	Selected	*295-063
C404B		7-45 μμf	Cer.	Var.			281-012
C404C		1.5-7 μμf	Cer.	Var.			281-005
C404E		198 μμf	Cer.	Fixed	500 v	10%	281-560
C405B		7-45 μμf	Cer.	Var.			281-012
C405C		1.5-7 μμf	Cer.	Var.			281-005
C406		7-45 μμf	Cer	Var.			Use 281-012
C408A	X1270-up	8 μμf	Cer.	Fixed	500 v	±0.5 μμf	281-503
C408C	X1270-up	18 μμf	Cer.	Fixed	500 v	10%	281-542
C408E	X1621-2169X	47 μμf	Cer.	Fixed	500 v	5%	281-583
C408G	X1621-2169X	100 μμf	Cer.	Fixed	500 v	5%	281-584
C408J	X1621-2169X	270 μμf	Cer.	Fixed	500 v	5%	281-585
C408L	101-559X	470 μμf	Cer.	Fixed	500 v		281-525
C408L	X1621-2169X	750 μμf	Mica	Fixed	500 v	5%	283-524
C408N	101-559X	1800 μμf	Cer.	Fixed	500 v	10%	281-561
C408N	X1621-2169X	2000 μμf	Mica	Fixed	500 v	1%	283-555
C410[3]		.022 μf	PTM	Fixed	600 v	Selected	*295-063
C414B		7-45 μμf	Cer.	Var.			281-012
C414C		1.5-7 μμf	Cer.	Var.			281-005
C414E		198 μμf	Cer.	Fixed	500 v	10%	281-560
C415B		7-45 μμf	Cer.	Var.			281-012
C415C		1.5-7 μμf	Cer.	Var.			281-005

[2]C300 & C310 selected ±5% each other, furnished as a unit.
[3]C400 & C410 selected ±5% each other, furnished as a unit.

Capacitors (Cont)

Ckt. No.	SN Range	Description					Tektronix Part No.
C416		7-45 μμf	Cer.	Var.			Use 281-012
C419	X560-up	1.5-7 μμf	Cer.	Var.			Use 281-0005-00
C430		.005 μf	Cer.	Fixed	500 v		283-001
C436		.005 μf	Cer.	Fixed	500 v		283-001
C440		.005 μf	Cer.	Fixed	500 v		283-001
C446		.005 μf	Cer.	Fixed	500 v		283-001
C450		47 μμf	Cer.	Fixed	500 v		281-518
C453		.1 μf	Cer.	Fixed	200 v		Use 283-057
C456	101-559	2.2 μμf	Cer.	Fixed	500 v		281-500
C456	560-6996	1.5-7 μμf	Cer.	Var.			281-029
C456	6997-up	.7-3 μμf	Tub.	Var.			281-0027-00
C457	101-2169	18 μμf	Cer.	Fixed	500 v	10%	281-542
C457	2170-up	12 μμf	Cer.	Fixed	500 v	10%	281-505
C460		47 μμf	Cer.	Fixed	500 v		281-518
C465	X6997-up	2.7 μμf	Cer.	Fixed	500 v		281-0547-00
C466	101-2169X	2.2 μμf	Cer.	Fixed	500 v	±.5 μμf	281-500
C467	101-2169	18 μμf	Cer.	Fixed	500 v	10%	281-542
C467	2170-up	12 μμf	Cer	Fixed	500 v	10%	281-505
C468	X6997-up	1.5-7 μμf	Cer.	Var.			281-0029-00
C605		.05 μf	Cer.	Fixed	50 v		Use 283-010
C611		125 μf	EMC	Fixed	350 v		*290-052
C612		125 μf	EMC	Fixed	350 v		*290-044
C614	X1440-up	.02 μf	Cer.	Fixed	1400 v		283-022
C620		.01 μf	Mica	Fixed	600 v	5%	Use 283-575
C621		.005 μf	Cer.	Fixed	500 v		283-001
C624	X1210-up	10 μf	EMC	Fixed	15 v		290-106
C628		.001 μf	Cer.	Fixed	500 v		283-000
C629	X2660-up	.001 μf	Discap.	Fixed	500 v		283-000
C630		.001 μf	Cer.	Fixed	500 v		283-000
C642		.005 μf	Cer.	Fixed	500 v		283-001
C646		.01 μf	Cer.	Fixed	500 v		283-002
C652A		10 μf	EMC	Fixed	350 v		Use 290-0126-00
C652B		50 μf	EMC	Fixed	150 v		
C652C		100 μf	EMC	Fixed	50 v		
C654A		10 μf	EMC	Fixed	350 v		Use 290-0126-00
C654B		50 μf	EMC	Fixed	150 v		
C654C		100 μf	EMC	Fixed	50 v		
C682		2 x 10 μf	EMC	Fixed	250 v		Use 290-0075-00
C684		2 x 40 μf	EMC	Fixed	150 v		Use 290-0023-00
C692A,B		.005 μf	Cer.	Fixed	4000 v		Use 283-034
C851A,B		.005 μf	Cer.	Fixed	4000 v		Use 283-034
C854		.001 μf	Cer.	Fixed	6000 v		283-033
C858		.005 μf	Cer.	Fixed	500 v		283-001
C883		.0022 μf	PTM	Fixed	400 v		285-543
C886	X2215-up	.0022 μf	Discap.	Fixed	50 v		283-028

Inductors

L319	101-559	3.9 mh		Fixed			108-204
L319	560-up	4.7 mh		Fixed			*108-165
L373	101-869	3.9 mh		Fixed			Use 108-224
L373	870-up	3.9 mh		Fixed			108-224
L383	101-869	3.9 mh		Fixed			Use 108-224

Inductors (Cont)

Ckt. No.	SN Range	Description			Tektronix Part No.
L383	870-up	3.9 mh	Fixed		108-224
L419	101-559	3.9 mh	Fixed		108-204
L419	560-up	4.7 mh	Fixed		108-165
L473		3.9 mh	Fixed		Use 108-224
L483	101-869	3.9 mh	Fixed		Use 108-224
L483	870-up	3.9 mh	Fixed		108-224
L654		1 mh	Fixed		108-207
L664		1 mh	Fixed		108-207
L672		1 mh	Fixed		108-205
L684		1 mh	Fixed		108-207

Resistors

R14		1 meg	½ w	Fixed	Comp.	10%	302-105
R15		470 k	½ w	Fixed	Comp.	10%	302-474
R17		1 meg		Var.	Comp.	30%	311-184
R19	101-8679	2.2 meg	½ w	Fixed	Comp.	10%	302-225
R19	8680-up	2.2 meg	½ w	Fixed	Comp.	5%	301-0225-00
R20	101-8679	270 k	½ w	Fixed	Comp.	10%	302-274
R20	8680-up	270 k	½ w	Fixed	Comp.	5%	301-0274-00
R22		470 Ω	½ w	Fixed	Comp.	10%	302-471
R23		470 Ω	½ w	Fixed	Comp.	10%	302-471
R25		27 k	½ w	Fixed	Comp.	10%	302-273
R26	101-2199	100 k	½ w	Fixed	Comp.	10%	302-104
R26	2200-up	120 k	½ w	Fixed	Prec.	1%	309-091
R28	101-2199	33 k	1 w	Fixed	Comp.	10%	304-333
R28	2200-up	33 k	1 w	Fixed	Prec.	1%	310-070
R34		680 Ω	½ w	Fixed	Comp.	10%	302-681
R35		2.7 k	½ w	Fixed	Comp.	10%	302-272
R36	X870-up	470 Ω	½ w	Fixed	Comp.	10%	302-471
R37		370 k	½ w	Fixed	Prec.	1%	309-055
R38		500 k	½ w	Fixed	Prec.	1%	309-003
R40		2.7 meg	½ w	Fixed	Comp.	10%	302-275
R43		4.7 k	½ w	Fixed	Comp.	10%	302-472
R44		10 k	½ w	Fixed	Comp.	10%	302-103
R46		22 k	1 w	Fixed	Comp.	10%	304-223
R111		15 k		Var.	Comp.	20%	311-112
R112	101-269	27 k	½ w	Fixed	Comp.	10%	302-273
R112	270-up	27 k	½ w	Fixed	Comp.	5%	301-273
R113	101-269	56 k	½ w	Fixed	Comp.	10%	302-563
R113	270-up	51 k	½ w	Fixed	Comp.	5%	301-513
R134		82 k	½ w	Fixed	Prec.	1%	309-043
R135		180 k	½ w	Fixed	Comp.	5%	301-184
R137		100 Ω	½ w	Fixed	Comp.	10%	302-101
R141		100 k	½ w	Fixed	Prec.	1%	309-045
R143		25.6 k	½ w	Fixed	Prec.	1%	309-136
R144		20 k	½ w	Fixed	Prec.	1%	309-153
R146		100 Ω	½ w	Fixed	Comp.	10%	302-101
R147	101-7441	1.5 k	½ w	Fixed	Comp.	10%	302-152
R147	7442-up	1 k	½ w	Fixed	Comp.	10%	302-0102-00
R160A		1 meg	½ w	Fixed	Prec.	1%	309-014
R160B		2 meg	½ w	Fixed	Prec.	1%	309-023
R160C		5 meg	½ w	Fixed	Prec.	1%	309-087
R160D		10 meg	½ w	Fixed	Prec.	1%	309-095
R160E		10 meg	½ w	Fixed	Prec.	1%	309-095
R160F		30 meg	2 w	Fixed	Prec.	1%	310-505

®

Resistors *(Cont)*

Ckt. No.	SN Range	Description					Tektronix Part No.
R160X		82 k	½ w	Fixed	Comp.	10%	302-823
R160Y		200 k		Var.	Comp.	20%	311-182
R164		150 k	1 w	Fixed	Comp.	10%	304-154
R167		1 meg	½ w	Fixed	Comp.	10%	302-105
R168		100 k	½ w	Fixed	Comp.	10%	302-104
R171		100 Ω	½ w	Fixed	Comp.	10%	302-101
R174		27 k	1 w	Fixed	Comp.	10%	304-273
R176		5 k	½ w	Var.	Comp.	20%	Use 311-368
R178		8.2 k	½ w	Fixed	Comp.	10%	302-822
R181		4.7 meg	½ w	Fixed	Comp.	10%	302-475
R304C	101-8329	990 k	½ w	Fixed	Prec.	1%	309-145
R304C	8330-up	990 k	½ w	Fixed	Prec.	1%	323-0614-00
R304E	101-8329	10.1 k	⅛ w	Fixed	Prec.	1%	318-009
R304E	8330-up	10.1 k	⅛ w	Fixed	Prec.	1%	321-0614-00
R305C	101-8329	900 k	½ w	Fixed	Prec.	1%	309-142
R305C	8330-up	900 k	½ w	Fixed	Prec.	1%	323-0611-00
R305E	101-8329	111 k	⅛ w	Fixed	Prec.	1%	318-006
R305E	8330-up	111 k	⅛ w	Fixed	Prec.	1%	321-0617-00
R306		1 meg	½ w	Fixed	Prec.	1%	309-014
R308A		10 k	½ w	Fixed	Prec.	1%	309-100
R308C		3.33 k	½ w	Fixed	Prec.	1%	309-283
R308E		1.11 k	½ w	Fixed	Prec.	1%	309-284
R308G		526 Ω	½ w	Fixed	Prec.	1%	309-285
R308J		256 Ω	½ w	Fixed	Prec.	1%	309-286
R308L		101 Ω	½ w	Fixed	Prec.	1%	309-287
R308N	101-869	50 Ω	½ w	Fixed	Prec.	1%	309-128
R308N	870-8709	50.9 Ω	½ w	Fixed	Prec.	1%	309-216
R308N	8710-up	49.9 Ω	½ w	Fixed	Prec.	1%	323-0068-00
R314C	101-8329	990 k	½ w	Fixed	Prec.	1%	309-145
R314C	8330-up	990 k	½ w	Fixed	Prec.	1%	323-0614-00
R314E	101-8329	10.1 k	⅛ w	Fixed	Prec.	1%	318-009
R314E	8330-up	10.1 k	⅛ w	Fixed	Prec.	1%	321-0614-00
R315C	101-8329	900 k	½ w	Fixed	Prec.	1%	309-142
R315C	8330-up	900 k	½ w	Fixed	Prec.	1%	323-0611-00
R315E	101-8329	111 k	⅛ w	Fixed	Prec.	1%	318-006
R315E	8330-up	111 k	⅛ w	Fixed	Prec.	1%	321-0617-00
R316		1 meg	½ w	Fixed	Prec.	1%	309-014
R318A		10 k	½ w	Fixed	Prec.	1%	309-100
R318C		2.5 k	½ w	Fixed	Prec.	1%	309-181
R318E		1.11 k	½ w	Fixed	Prec.	1%	309-284
R318G		526 Ω	½ w	Fixed	Prec.	1%	309-285
R318J		204 Ω	½ w	Fixed	Prec.	1%	309-237
R319		21.5 k	½ w	Fixed	Prec.	1%	309-290
R320		193 k	½ w	Fixed	Prec.	1%	309-243
R321		3.92 k	½ w	Fixed	Prec.	1%	309-270
R322		750 Ω	½ w	Var.	Comp.	20%	Use 311-0372-00
R326		4.7 meg	½ w	Fixed	Comp.	10%	302-475
R327		180 k	½ w	Fixed	Comp.	5%	Use 301-184
R330		100 k	½ w	Fixed	Comp.	10%	302-104
R331		470 Ω	½ w	Fixed	Comp.	10%	302-471
R334		50 k	½ w	Fixed	Prec.	1%	309-090

Resistors *(Cont)*

Ckt. No.	SN Range	Description					Tektronix Part No.
R336		250 Ω	½ w	Var.	Comp.	20%	311-181
R337	101-6996	68 Ω	½ w	Fixed	Comp.	10%	302-680
R337	6997-up	100 Ω	½ w	Fixed	Comp.	10%	302-0101-00
R338		38.3 k	1 w	Fixed	Prec.	1%	310-074
R339		1 k	½ w	Var.	Comp.	20%	Use 311-365
R340		100 k	½ w	Fixed	Comp.	10%	302-104
R341		470 Ω	½ w	Fixed	Comp.	10%	302-471
R344		50 k	½ w	Fixed	Prec.	1%	309-090
R346		250 Ω	½ w	Var.	Comp.	20%	Use 311-367
R347	101-6996	68 Ω	½ w	Fixed	Comp.	10%	302-680
R347	6997-up	100 Ω	½ w	Fixed	Comp.	10%	302-0101-00
R348		38.3 k	1 w	Fixed	Prec.	1%	310-074
R350	101-8899	1.5 k	½ w	Fixed	Comp.	10%	302-152
R350	8900-up	1 k	½ w	Fixed	Comp.	10%	302-0102-00
R352		8.2 k	1 w	Fixed	Comp.	5%	303-822
R353	101-1269	10 k	½ w	Fixed	Comp.	5%	301-103
R353	1270-2169	6.8 k	½ w	Fixed	Comp.	5%	301-682
R353	2170-up	10 k	½ w	Fixed	Comp.	5%	301-103
R354	X1270-2169X	3.3 k	½ w	Fixed	Comp.	5%	301-332
R356		390 k	¼ w	Fixed	Comp.	10%	316-394
R357		12.5 k	½ w	Fixed	Prec.	1%	309-228
R358		1 meg	½ w	Fixed	Comp.	10%	302-105
R360	101-8899	20 k	½ w	Var.	Comp.	20%	Use 311-364
R360	8900-up	5 k		Var.	Comp.	20%	311-0117-00
R365	X6997-up	47 Ω	½ w	Fixed	Comp.	10%	302-0470-00
R366		390 k	¼ w	Fixed	Comp.	10%	316-394
R367		12.5 k	½ w	Fixed	Prec.	1%	309-228
R368		1 meg	½ w	Fixed	Comp.	10%	302-105
R370		2 x 20 k		Var.	Comp.	20%	311-190
R371		100 Ω	½ w	Fixed	Comp.	10%	302-101
R373		30 k	8 w	Fixed	WW	5%	308-105
R376		15 k	5 w	Fixed	WW	5%	308-108
R377		12 k	2 w	Fixed	Comp.	10%	306-123
R378	101-809	2 k		Var.	Comp.	30%	Use 311-363
R378	810-up	1 k	½ w	Var.	Comp.	20%	Use 311-365
R379	X810-up	402 Ω	½ w	Fixed	Prec.	1%	309-102
R381		100 Ω	½ w	Fixed	Comp.	10%	302-101
R383		30 k	8 w	Fixed	WW	5%	308-105
R386		15 k	5 w	Fixed	WW	5%	308-108
R387		12 k	2 w	Fixed	Comp.	10%	306-123
R388		2.5 k	½ w	Var.	WW	20%	Use 311-375
R404C	101-8329	990 k	½ w	Fixed	Prec.	1%	309-145
R404C	8330-up	990 k	½ w	Fixed	Prec.	1%	323-0614-00
R404E	101-8329	10.1 k	⅛ w	Fixed	Prec.	1%	318-009
R404E	8330-up	10.1 k	⅛ w	Fixed	Prec.	1%	321-0614-00
R405C	101-8329	900 k	½ w	Fixed	Prec.	1%	309-142
R405C	8330-up	900 k	½ w	Fixed	Prec.	1%	323-0611-00
R405E	101-8329	111 k	⅛ w	Fixed	Prec.	1%	318-006
R405E	8330-up	111 k	⅛ w	Fixed	Prec.	1%	321-0617-00
R406		1 meg	½ w	Fixed	Prec.	1%	309-014
R408A		10 k	½ w	Fixed	Prec.	1%	309-100
R408C		3.33 k	½ w	Fixed	Prec.	1%	309-283

®

Resistors *(Cont)*

Ckt. No.	SN Range	Description					Tektronix Part No.
R408E		1.11 k	½ w	Fixed	Prec.	1%	309-284
R408G		526 Ω	½ w	Fixed	Prec.	1%	309-285
R408J		256 Ω	½ w	Fixed	Prec.	1%	309-286
R408L		101 Ω	½ w	Fixed	Prec.	1%	309-287
R408N	101-869	50 Ω	½ w	Fixed	Prec.	1%	309-128
R408N	870-8709	50.9 Ω	½ w	Fixed	Prec.	1%	309-216
R408N	8710-up	49.9 Ω	½ w	Fixed	Prec.	1%	323-0068-00
R414C	101-8329	990 k	½ w	Fixed	Prec.	1%	309-145
R414C	8330-up	990 k	½ w	Fixed	Prec.	1%	323-0614-00
R414E	101-8329	10.1 k	⅛ w	Fixed	Prec.	1%	318-009
R414E	8330-up	10.1 k	⅛ w	Fixed	Prec.	1%	321-0614-00
R415C	101-8329	900 k	½ w	Fixed	Prec.	1%	309-142
R415C	8330-up	900 k	½ w	Fixed	Prec.	1%	323-0611-00
R415E	101-8329	111 k	⅛ w	Fixed	Prec.	1%	318-006
R415E	8330-up	111 k	⅛ w	Fixed	Prec.	1%	321-0617-00
R416		1 meg	½ w	Fixed	Prec.	1%	309-014
R419		21.5 k	½ w	Fixed	Prec.	1%	309-290
R430		100 k	½ w	Fixed	Comp.	10%	302-104
R431		470 Ω	½ w	Fixed	Comp.	10%	302-471
R434		50 k	½ w	Fixed	Prec.	1%	309-090
R436		250 Ω	½ w	Var.	Comp.	20%	Use 311-367
R437	101-6996	68 Ω	½ w	Fixed	Comp.	10%	302-680
R437	6997-up	100 Ω	½ w	Fixed	Comp.	10%	302-0101-00
R438		38.3 k	1 w	Fixed	Prec.	1%	310-074
R440		100 k	½ w	Fixed	Comp.	10%	302-104
R441		470 Ω	½ w	Fixed	Comp.	10%	302-471
R444		50 k	½ w	Fixed	Prec.	1%	309-090
R446		250 Ω		Var.	Comp.	20%	311-181
R447	101-6996	68 Ω	½ w	Fixed	Comp.	10%	302-680
R447	6997-up	100 Ω	½ w	Fixed	Comp.	10%	302-0101-00
R448		38.3 k	1 w	Fixed	Prec.	1%	310-074
R450	101-8899	1.5 k	½ w	Fixed	Comp.	10%	302-152
R450	8900-up	1 k	½ w	Fixed	Comp.	10%	302-0102-00
R451	X2170-up	470 Ω	½ w	Fixed	Comp.	10%	302-471
R452	101-7739	8.2 k	1 w	Fixed	Comp.	5%	303-822
R452	7740-up	4.3 k	1 w	Fixed	Comp.	5%	303-0432-00
R453	101-1269	10 k	½ w	Fixed	Comp.	5%	301-103
R453	1270-2169	6.8 k	½ w	Fixed	Comp.	5%	301-682
R453	2170-7739	10 k	½ w	Fixed	Comp.	5%	301-103
R453	7740-up	15 k	½ w	Fixed	Comp.	5%	301-0153-00
R454	X1270-2169X	3.3 k	½ w	Fixed	Comp.	5%	301-332
R455	X2170-up	18 k	1 w	Fixed	Comp.	10%	304-183
R456		390 k	¼ w	Fixed	Comp.	10%	316-394
R457		12.5 k	½ w	Fixed	Prec.	1%	309-228
R458		1 meg	½ w	Fixed	Comp.	10%	302-105
R459	X7740-up	3.3 k	½ w	Fixed	Comp.	5%	301-0332-00
R460	101-8899	20 k	½ w	Var.	Comp.	20%	Use 311-364
R460	8900-up	5 k		Var.	Comp.	20%	311-0117-00
R465	X6997-up	47 Ω	½ w	Fixed	Comp.	10%	302-0470-00
R466		390 k	¼ w	Fixed	Comp.	10%	316-394
R467		12.5 k	½ w	Fixed	Prec.	1%	309-228
R468		1 meg	½ w	Fixed	Comp.	10%	302-105
R470		2 x 20 k		Var.	Comp.	20%	311-190

Resistors *(Cont)*

Ckt. No.	SN Range	Description					Tektronix Part No.
R471		100 Ω	½ w	Fixed	Comp.	10%	302-101
R473		30 k	8 w	Fixed	WW	5%	308-105
R476		15 k	5 w	Fixed	WW	5%	308-108
R477		12 k	2 w	Fixed	Comp.	10%	306-123
R478	101-809	2 k		Var.	Comp.	30%	Use 311-363
R478	810-up	750 Ω	½ w	Var.	Comp.	20%	Use 311-372
R479	X810-up	402 Ω	½ w	Fixed	Prec.	1%	309-102
R481		100 Ω	½ w	Fixed	Comp.	10%	302-101
R483		30 k	8 w	Fixed	WW	5%	308-105
R486		15 k	5 w	Fixed	WW	5%	308-108
R487		12 k	2 w	Fixed	Comp.	10%	306-123
R488		2 k		Var.	Comp.	20%	311-189
R490		470 k	½ w	Fixed	Comp.	10%	302-474
R491		47 k	½ w	Fixed	Comp.	10%	302-473
R492		330 k	½ w	Fixed	Comp.	10%	302-334
R601†		50 Ω		Var.	WW		311-057
R605		47 k	½ w	Fixed	Comp.	10%	302-473
R606	X1100-up	100 Ω	½ w	Fixed	Comp.	10%	302-101
R607	X1100-up	100 Ω	½ w	Fixed	Comp.	10%	302-101
R611		150 k	1 w	Fixed	Comp.	10%	304-154
R612		150 k	1 w	Fixed	Comp.	10%	304-154
R621		100 k	½ w	Fixed	Comp.	10%	302-104
R623		4.7 k	½ w	Fixed	Comp.	10%	302-472
R624	X1210-up	22 Ω	½ w	Fixed	Comp.	10%	302-220
R626		40 k	8 w	Fixed	WW	5%	308-168
R628		470 Ω	½ w	Fixed	Comp.	10%	302-471
R630		680 k	½ w	Fixed	Comp.	10%	302-684
R631		2.2 meg	½ w	Fixed	Comp.	10%	302-225
R632		100 Ω	½ w	Fixed	Comp.	10%	302-101
R634		33 k	½ w	Fixed	Comp.	10%	302-333
R635		56 k	½ w	Fixed	Comp.	10%	302-563
R637		470 k	½ w	Fixed	Comp.	10%	302-474
R640	101-7509	154 k	½ w	Fixed	Prec.	1%	309-234
R640	7510-up	115 k	½ w	Fixed	Prec.	1%	323-0391-00
R641		20 k	½ w	Var.	Comp.	20%	Use 311-364
R642	101-7509	174 k	½ w	Fixed	Prec.	1%	309-151
R642	7510-up	130 k	½ w	Fixed	Prec.	1%	323-0396-00
R644		470 k	½ w	Fixed	Comp.	10%	302-474
R646		15 k	½ w	Fixed	Comp.	10%	302-153
R659	101-7509	100 k	½ w	Fixed	Comp.	10%	302-104
R659	7510-up	51 k	1 w	Fixed	Comp.	5%	303-0513-00
R692		4.3 Ω	½ w	Fixed	Comp.	5%	307-056
R840		820 k	1 w	Fixed	Comp.	10%	304-824
R841		820 k	1 w	Fixed	Comp.	10%	304-824
R842		820 k	1 w	Fixed	Comp.	10%	304-824
R844	101-9859	1 meg		Var.	Comp.		311-041
R844	9860-up	1 meg		Var.	Comp.		311-0041-02
R845		470 k	½ w	Fixed	Comp.	10%	302-474
R847	101-1209	500 k		Var.	Comp.	20%	311-188
R847	1210-up	200 k		Var.	Comp.	20%	311-242
R849		47 k	½ w	Fixed	Comp.	10%	302-473

† R601 ganged with SW601. Furnished as a unit.

Resistors (Cont)

Ckt. No.	SN Range	Description					Part No. Tektronix
R851		1.5 meg	½ w	Fixed	Comp.	10%	302-155
R852	101-1209	2.2 meg	½ w	Fixed	Comp.	10%	302-225
R852	1210-up	1.5 meg	½ w	Fixed	Comp.	10%	302-155
R854		100 k	½ w	Fixed	Comp.	10%	302-104
R857		39 k	½ w	Fixed	Comp.	10%	Use 302-393
R858		100 k	½ w	Fixed	Comp.	10%	302-104
R860		220 k	½ w	Fixed	Comp.	10%	302-224
R862		100 k	½ w	Fixed	Comp.	10%	302-104
R864	101-269	500 k		Var.	Comp.	20%	311-183
R864	270-up	500 k	½ w	Var.	Comp.	20%	Use 311-366
R880		500 k	½ w	Var.	Comp.	20%	Use 311-366
R881		1.75 meg	½ w	Fixed	Prec.	1%	309-019
R883		2.2 meg	½ w	Fixed	Comp.	10%	302-225
R886		4.95 k	½ w	Fixed	Prec.	1%	309-239
R887	101-869	50 Ω	½ w	Fixed	Prec.	1%	309-128
R887	870-up	49.5 Ω	½ w	Fixed	Prec.	1%	309-215

Switches

			Wired Unwired
SW5	101-5019	single pole triple throw slide SOURCE	*260-251
SW5	5020-up	single pole triple throw slide SOURCE	260-0450-00
SW10	101-5019	single pole double throw slide COUPLING	*260-145
SW10	5020-up	single pole double throw slide COUPLING	260-0449-00
SW17		2 section 11 position rotary TRIG LEVEL	*262-325 *260-322
SW20	101-5019	double pole double throw slide SLOPE	*260-212
SW20	5020-up	double pole double throw slide SLOPE	260-0447-00
SW160	101-9789	6 section 21 position rotary TIME/CM	*262-322 *260-320
SW160	9790-up	6 section 21 position rotary TIME/CM	*262-0322-01 260-0320-00
SW300	101-5019	single pole triple throw slide AC/DC +INPUT	*260-316
SW300	5020-up	single pole triple throw slide AC/DC +INPUT	260-0448-00
SW304		6 section 14 position rotary HORIZ. SENS.	Use *262-548 *260-319
SW310	101-5019	single pole triple throw slide AC/DC —INPUT	*260-316
SW310	5020-up	single pole triple throw slide AC/DC —INPUT	260-0448-00
SW318		6 section 7 position rotary HORIZ. DISPLAY	*262-324 Use *260-704
SW400	101-5019	single pole triple throw slide AC/DC —INPUT	*260-316
SW400	5020-up	single pole triple throw slide AC/DC —INPUT	260-0448-00
SW404		6 section 14 position rotary VERT. SENS.	Use *262-526 *260-318
SW410	101-5019	single pole triple throw slide AC/DC +INPUT	*260-316
SW410	5020-up	single pole triple throw slide AC/DC +INPUT	260-0448-00
SW601[5]			311-057

Transformers

T601	101-1099	LV Power	*050-039
T601	1100-up	LV Power	*120-203
T620	101-1269	High Voltage	Use *120-199
T620	1270-up	High Voltage	*120-199

Diodes

D44		Germanium, T12-G	152-008
D152	X4230-7441	Replacement Kit	Use *050-0290-00
	7442-up	Silicon Assembly	*152-0249-00
D352	X1270-2659	Germanium, T12-G	152-008
	2660-up	Silicon Replaceable by 1N3605	Use *152-0185-00

[5]SW601 ganged with R601. Furnished as a unit.

Diodes (Cont)

Ckt. No.	SN Range	Description	Tektronix Part No.
D362	X1270-2659	Germanium, T12-G	152-008
	2660-up	Silicon Replaceable by 1N3605	Use *152-0185-00
D452	X1270-2659	Germanium, T12-G	152-008
	2660-up	Silicon Replaceable by 1N3605	Use *152-0185-00
D454	X7740-9549	Zener, 1N980A 0.4 w, 62 v, 10%	152-0176-00
D454	9550-up	Zener 1N980B 0.4 w, 62 v, 5%	152-0285-00
D462	X1270-2659	Germanium, T12-G	152-008
	2660-up	Silicon Replaceable by 1N3605	Use *152-0185-00
D611	101-9649	Silicon, 600 v PIV 500 MA 1N2864	152-048
D611	9650-up	Silicon 1N2615	152-0040-00
D612	101-9649	Silicon, 600 v PIV 500 MA 1N2864	152-048
D612	9650-up	Silicon 1N2615	152-0040-00
D652		Silicon, Selected for short recovery time-600 PIV, 500 MA	*153-008
D662		Silicon, Selected for short recovery time-400 PIV, 500 MA	*153-007
D672		Silicon, Selected for short recovery time-400 PIV, 500 MA	*153-007
D682		Silicon, Selected for short recovery time-400 PIV, 500 MA	*153-007

Transistors

Q354	101-2169	2N1637	151-045
Q354	2170-4779	Replacement Kit	Use *050-0251-00
Q354	4780-up	Selected from 2N3251	*151-133
Q364	101-2169	2N1637	151-045
Q364	2170-4779	Replacement Kit	Use *050-0251-00
Q364	4780-up	Selected from 2N3251	*151-133
Q454	101-2169	2N1637	151-045
Q454	2170-4779	Replacement Kit	Use *050-0251-00
Q454	4780-up	Selected from 2N3251	*151-133
Q464	101-2169	2N1637	151-045
Q464	2170-4779	Replacement Kit	Use *050-0251-00
Q464	4780-up	Selected from 2N3251	*151-133

Electron Tubes

V24		6DJ8		154-187
V45		6DJ8		154-187
V135		6DJ8		154-187
V145		6DJ8		154-187
V152	101-4229	6BJ7		Use 154-0453-00
V152	4230-up	6AL5		154-0016-00
V160		6BL8/ECF80		154-278
V334	101-6996X	6DJ8	Checked	Use *157-066
V334, V344	X6997-10179	8393	Checked pair	*157-0109-00
V334, V344	10180	8393	Checked pair	*157-0127-00
V374	101-10169	6CB6		154-030
V374	10170	8136		154-0367-00
V384	101-10169	6CB6		154-030
V384	10170	8136		154-0367-00
V434	101-6996X	6DJ8	Checked	Use *157-066

Electron Tubes *(Cont)*

Ckt. No.	SN Range	Description	Tektronix Part No.
V434, V444	X6997-10179	8393 Checked pair	*157-0109-00
V434, V444	10180	8393 Checked pair	*154-0127-00
V474	100-10169	6CB6	154-030
V474	10170	8136	154-0367-00
V484	100-10169	6CB6	154-030
V484	10170	8136	154-0127-00
V620		6DQ6	154-277
V634		6BL8/ECF80	154-278
V659		5651	154-052
V692		5642	154-051
V859		T5030-2 CRT Standard Phosphor	*154-265

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations which appear on the pullout pages immediately following the Diagrams section of this instruction manual.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the Description column.

Assembly and/or Component
Detail Part of Assembly and/or Component
mounting hardware for Detail Part
Parts of Detail Part
mounting hardware for Parts of Detail Part
mounting hardware for Assembly and/or Component

Mounting hardware always appears in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Mounting hardware must be purchased separately, unless otherwise specified.

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ABBREVIATIONS AND SYMBOLS

For an explanation of the abbreviations and symbols used in this section, please refer to the page immediately preceding the Electrical Parts List in this instruction manual.

INDEX OF MECHANICAL PARTS LIST ILLUSTRATIONS
(Located behind diagrams)

FIG. 1 FRONT

FIG. 2 SWITCHES

FIG. 3 CRT SHIELD

FIG. 4 CHASSIS & REAR

FIG. 5 CABINET

FIG. 6 ACCESSORIES

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MECHANICAL PARTS LIST

SECTION 8

FIG. 1 FRONT

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-1	200-0382-00			1	COVER, graticule
	- - - - - -			-	graticule includes:
-2	354-0116-00			1	RING, ornamental
	- - - - - -			-	mounting hardware: (not included w/cover)
-3	210-0816-00			4	WASHER, rubber
-4	210-0424-00			4	NUT, knurled, 3/8-24 x 9/16 inch
-5	331-0056-00			1	GRATICULE, 5 inches, 8 x 10 cm
-6	337-0187-00			1	SHIELD, graticule light
-7	366-0066-00	101	5019	1	KNOB, black—FOCUS
	366-0148-00	5020		1	KNOB, charcoal—FOCUS
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-8	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-9	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
-10	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-11	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-12	200-0238-00			1	COVER, variable resistor, plastic
-13	366-0066-00	101	5019	1	KNOB, black—INTENSITY
	366-0148-00	5020		1	KNOB, charcoal—INTENSITY
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-14	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-15	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
-16	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-17	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-18	366-0044-00	101	5019	1	KNOB, black—POWER AND SCALE ILLUMINATION
	366-0113-00	5020		1	KNOB, charcoal—POWER AND SCALE ILLUMINATION
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-19	200-0152-00			1	COVER, variable resistor and switch
-20	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-21	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
-22	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-23	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch

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FIG. 1 FRONT *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-24	366-0044-00	101	5019	2	KNOB, black—POSITION
	366-0113-00	5020		2	KNOB, charcoal—POSITION
	- - - - - -			-	each knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-25	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-26	210-0207-00			1	LUG, solder, 3/8 ID x 5/8 inch OD, SE
-27	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
-28	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-29	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-30	366-0101-00			2	KNOB, gray—DC BAL
	- - - - - -			-	each knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-31	- - - - - -			2	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-32	210-0207-00			1	LUG, solder, 3/8 ID x 5/8 inch OD, SE
-33	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
-34	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-35	366-0031-00			2	KNOB, red—VARIABLE
	- - - - - -			-	each knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-36	366-0040-00	101	5019	2	KNOB, black—SENSITIVITY
	366-0160-00	5020		2	KNOB, charcoal—SENSITIVITY
	- - - - - -			-	each knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-37	366-0042-00	101	5019	1	KNOB, black—HORIZONTAL DISPLAY
	366-0117-00	5020		1	KNOB, charcoal—HORIZONTAL DISPLAY
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-38	366-0038-00			1	KNOB, red—VARIABLE
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-39	366-0058-00	101	5019	1	KNOB, black—SWEEP TIME/CM
	366-0144-00	5020		1	KNOB, charcoal—SWEEP TIME/CM
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-40	366-0044-00	101	5019	1	KNOB, black—LEVEL
	366-0113-00	5020		1	KNOB, charcoal—LEVEL
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-41	129-0036-00	101	5019	1	POST, binding, black
	129-0063-00	5020		1	POST, binding, charcoal
	- - - - - -			-	mounting hardware: (not included w/post)
-42	358-0036-00	101	5019	1	BUSHING, binding post, black
	358-0169-00	5020		1	BUSHING, binding post, charcoal
-43	210-0445-00	101	3719	2	NUT, hex., 10-32 x 3/8 inch
	220-0410-00	3720		1	NUT, keps, 10-32 x 3/8 inch
	210-0010-00	101	3719X	1	LOCKWASHER, internal, #10
	210-0206-00	101	3719X	1	LUG, solder, SE #10

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FIG. 1 FRONT *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty 1 2 3 4 5	Description
1-	129-0051-00			1	ASSEMBLY, binding post
	- - - - - -			-	assembly includes:
-44	200-0182-00			1	CAP
-45	355-0507-00			1	STEM, adapter
	- - - - - -			-	mounting hardware: (not included w/assembly)
-46	210-0223-00			1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
-47	210-0455-00			1	NUT, hex., 1/4-28 x 3/8 inch
-48	260-0212-00	101	5019	1	SWITCH, slide—SLOPE
	260-0447-00	5020		1	SWITCH, slide—SLOPE
	- - - - - -			-	mounting hardware: (not included w/switch)
-49	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-50	260-0145-00	101	5019	1	SWITCH, slide—COUPLING
	260-0449-00	5020		1	SWITCH, slide—COUPLING
	- - - - - -			-	mounting hardware: (not included w/switch)
-51	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-52	260-0251-00	101	5019	1	SWITCH, slide—SOURCE
	260-0450-00	5020		1	SWITCH, slide—SOURCE
	- - - - - -			-	mounting hardware: (not included w/switch)
-53	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-54	136-0106-00	101	2178	2	SOCKET, banana jack
	136-0138-00	2179	5019	2	SOCKET, banana jack
	136-0140-00	5020		2	SOCKET, banana jack, charcoal
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-55	210-0895-00			1	WASHER, insulating
-56	210-0465-00			2	NUT, hex., 1/4-32 x 3/8 inch
-57	210-0223-00			1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
-58	260-0316-00	101	5019	4	SWITCH, slide—AC-DC-GND
	260-0448-00	5020		4	SWITCH, slide—AC-DC-GND
	- - - - - -			-	mounting hardware for each: (not included w/switch)
-59	210-0406-00			2	NUT, hex., 4-40 x 3/16 inch
-60	131-0081-00			4	CONNECTOR, coaxial, 1 contact, female (UHF)
	- - - - - -			-	each connector includes:
-61	- - - - - -			1	NUT
-62	- - - - - -			1	LOCKWASHER

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FIG. 1 FRONT *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
1-	129-0053-00			4	ASSEMBLY, binding post
	- - - - - -			-	each assembly includes:
-63	200-0103-00			1	CAP
-64	355-0507-00			1	STEM, adapter
	- - - - - -			-	mounting hardware for each: (not included w/assembly)
-65	210-0223-00			1	LUG, solder, 1/4 ID x 7/16 inch OD, SE
-66	210-0455-00			1	NUT, hex., 1/4-28 x 3/8 inch
-67	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-68	210-0494-00			1	NUT, hex., 3/8-32 x 1/2 inch
-69	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD
-70	358-0010-00			1	BUSHING, 3/8-32 x 9/16 inch long
-71	333-0601-00	101	269	1	PANEL, front
	333-0606-00	270		1	PANEL, front
-72	387-0198-00			1	PLATE, front subpanel
	- - - - - -			-	plate includes:
-73	354-0057-00			1	RING, ornamental
-74	355-0043-00			4	STUD, graticule (replacement)
	- - - - - -			-	each stud includes:
	212-0507-00			1	SCREW, 10-32 x 3/8 inch, PHS
	210-0010-00			1	LOCKWASHER, internal, #10

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FIG. 2 SWITCHES

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
2-1	262-0326-00	101	2659	1	SWITCH, wired—VERTICAL SENSITIVITY
	262-0526-00	2660		1	SWITCH, wired—VERTICAL SENSITIVITY
	- - - - - -			-	switch includes:
	260-0318-00			1	SWITCH, unwired
-2	384-0209-00			1	ROD, extension
-3	376-0014-00			1	COUPLING
-4	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-5	210-0413-00	X3140		2	NUT, hex., 3/8-32 x 1/2 inch
-6	210-0012-00	X3140		1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-7	406-0573-00			1	BRACKET, capacitor mounting
-8	- - - - - -			10	CAPACITOR
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-9	213-0034-00	101	938	2	SCREW, thread cutting, 4-40 x 5/16 inch, RHS
	214-0153-00	939		1	FASTENER, plastic snap-in
	- - - - - -			-	mounting hardware: (not included w/switch)
-10	211-0029-00			2	SCREW, 5-40 x 3/16 inch, PHS
	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD (not shown)
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch (not shown)
-11	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-13	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-14	337-0365-00			1	SHIELD, focus and intensity
	- - - - - -			-	mounting hardware: (not included w/shield)
-15	211-0507-00			3	SCREW, 6-32 x 5/16 inch, PHS
-16	406-0571-00	101	6996	1	BRACKET, attenuator switch
	406-0571-01	6997		1	BRACKET, attenuator switch
-17	348-0003-00			2	GROMMET, rubber, 5/16 inch diameter
-18	210-0202-00			1	LUG, solder, SE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
-19	211-0504-00			1	SCREW, 6-32 x 1/4 inch, PHS
-20	210-0407-00			1	NUT, hex., 6-32 x 1/4 inch
-21	441-0609-01	X6997		1	CHASSIS, nuvistor
	- - - - - -			-	mounting hardware: (not included w/chassis)
-22	348-0058-00			2	SHOCKMOUNT, rubber
-23	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch

FIG. 2 SWITCHES *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
2-24	136-0087-00	101	6996	1	SOCKET, tube, 9 pin, w/shockmount spring
	136-0188-00	6997	7569	2	SOCKET, nuvistor, 5 pin
	136-0131-00	7570		2	SOCKET, nuvistor, 5 pin
	- - - - - -			-	mounting hardware: (not included w/socket)
	211-0007-00	101	6996X	2	SCREW, 4-40 x 3/16 inch, PHS
	210-0004-00	101	6996X	2	LOCKWASHER, internal, #4
	210-0406-00	101	6996X	2	NUT, hex., 4-40 x 3/16 inch
-25	210-0201-00	X6997		1	LUG, solder, SE #4
	- - - - - -			-	mounting hardware: (not included w/lug)
-26	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-27	337-0736-00	X6997		1	SHIELD, nuvistor
	- - - - - -			-	mounting hardware: (not included w/shield)
-28	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-29	262-0325-00			1	SWITCH, wired—LEVEL
	- - - - - -			-	switch includes:
	260-0322-00			1	SWITCH, unwired
	- - - - - -			-	switch includes:
	337-0248-00	101	2358	1	SHIELD
	337-0108-00	2359	4989X	1	SHIELD
	210-0004-00	101	4989X	2	LOCKWASHER, internal, #4
	210-0406-00	101	4989X	2	NUT, hex., 4-40 x 3/16 inch
	210-0549-00	101	4989X	2	NUT, hex., 5-40 x 5/16 inch
	211-0029-00	101	4989X	2	SCREW, 5-40 x 3/16 inch, PHS
-30	376-0014-00			1	COUPLING
-31	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-32	210-0413-00			2	NUT, hex., 3/8-32 x 1/2 inch
-33	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
	- - - - - -			-	mounting hardware: (not included w/switch)
-34	211-0007-00			2	SCREW, 4-40 x 3/16 inch, PHS
	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD (not shown)
	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD (not shown)
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch (not shown)

FIG. 2 SWITCHES (Cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
2-35	262-0322-00			1	SWITCH, wired—SWEEP TIME/CM
	- - - - - -			-	switch includes:
	260-0320-00			1	SWITCH, unwired
-36	384-0209-00			1	ROD, extension
-37	376-0014-00			1	COUPLING
-38	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-39	210-0413-00			2	NUT, hex., 3/8-32 x 1/2 inch
-40	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-41	386-0450-00			1	PLATE, switch mounting
	179-0475-00	X471		1	CABLE HARNESS (not shown)
	- - - - - -			-	mounting hardware: (not included w/switch)
-42	211-0029-00			2	SCREW, 5-40 x 3/16 inch, PHS
-43	210-0201-00			1	LUG, solder, SE #4
	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD (not shown)
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch (not shown)
-44	262-0324-00			1	SWITCH, wired—HORIZONTAL DISPLAY
	- - - - - -			-	switch includes:
	260-0321-00	101	4759	1	SWITCH, unwired
	260-0704-00	4760		1	SWITCH, unwired
	- - - - - -			-	mounting hardware: (not included w/switch)
-45	211-0007-00			2	SCREW, 4-40 x 3/16 inch, PHS
	210-0013-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD (not shown)
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch (not shown)
-46	262-0323-00	101	3409	1	SWITCH, wired—HORIZONTAL SENSITIVITY
	262-0548-00	3410		1	SWITCH, wired—HORIZONTAL SENSITIVITY
	- - - - - -			-	switch includes:
	260-0319-00			1	SWITCH, unwired
-47	384-0209-00			1	ROD, extension
-48	376-0014-00			1	COUPLING
-49	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-50	210-0413-00	X3140		2	NUT, hex., 3/8-32 x 1/2 inch
-51	210-0012-00	X3140		1	LOCKWASHER, internal, 3/8 ID x 1/2 inch OD
-52	406-0574-00			1	BRACKET, capacitor mounting
-53	- - - - - -			10	CAPACITOR
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-54	213-0034-00	101	938	2	SCREW, thread cutting, 4-40 x 5/16 inch, RHS
	214-0153-00	939		1	FASTENER, plastic, snap-in
	- - - - - -			-	mounting hardware: (not included w/switch)
-55	211-0029-00			2	SCREW, 5-40 x 3/16 inch, PHS
	210-0012-00			1	LOCKWASHER, internal, 3/8 ID x 11/16 inch OD (not shown)
	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch (not shown)

FIG. 2 SWITCHES *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
2-56	406-0572-00	101	6996	1	BRACKET, attenuator switch
	406-0572-01	6997		1	BRACKET, attenuator switch
	- - - - - -			-	mounting hardware: (not included w/bracket)
-57	212-0039-00			1	SCREW, 8-32 x 3/8 inch, THS
	210-0458-00			1	NUT, keps, 8-32 x 11/32 inch (not shown)
-58	211-0507-00			3	SCREW, 6-32 x 5/16 inch, PHS
-59	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-60	210-0006-00			2	LOCKWASHER, internal, #6
-61	210-0407-00			4	NUT, hex., 6-32 x 1/4 inch
-62	- - - - - -			1	RESISTOR, variable
	- - - - - -			-	mounting hardware: (not included w/resistor)
-63	210-0840-00			1	WASHER, flat, 0.390 ID x 9/16 inch OD
-64	210-0413-00			1	NUT, hex., 3/8-32 x 1/2 inch
-65	210-0202-00			1	LUG, solder, SE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
-66	210-0407-00			1	NUT, hex., 6-32 x 1/4 inch
-67	211-0504-00			1	SCREW, 6-32 x 1/4 inch, PHS
-68	348-0003-00			3	GROMMET, rubber, 5/16 inch diameter
-69	348-0031-00			9	GROMMET, plastic, 1/4 inch diameter
-70	441-0609-01	X6997		1	CHASSIS, nuvistor
	- - - - - -			-	mounting hardware: (not included w/chassis)
-71	348-0058-00			2	SHOCKMOUNT, rubber
-72	210-0457-00			2	NUT, keps, 6-32 x 5/16 inch
-73	136-0087-00	101	6996	1	SOCKET, tube, 9 pin, w/shockmount spring
	136-0188-00	6997	7569	2	SOCKET, nuvistor, 5 pin
	136-0131-00	7570		2	SOCKET, nuvistor, 5 pin
	- - - - - -			-	mounting hardware: (not included w/socket)
	211-0007-00	101	6996X	2	SCREW, 4-40 x 3/16 inch, PHS
	210-0004-00	101	6996X	2	LOCKWASHER, internal, #4
	210-0406-00	101	6996X	2	NUT, hex., 4-40 x 3/16 inch
-74	210-0201-00	X6997		1	LUG, solder, SE #4
	- - - - - -			-	mounting hardware: (not included w/lug)
-75	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-76	337-0736-00	X6997		1	SHIELD, nuvistor
	- - - - - -			-	mounting hardware: (not included w/shield)
-77	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-78	179-0408-00			1	CABLE HARNESS, vertical attenuator, #1
-79	179-0409-00			1	CABLE HARNESS, vertical attenuator, #2
-80	179-0410-00	101	8119X	1	CABLE HARNESS, horizontal attenuator, #1
-81	179-0411-00			1	CABLE HARNESS, horizontal attenuator, #2

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Fig. & Index	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5 Description
2-82	214-0210-00	X1269		1	ASSEMBLY, solder spool
	- - - - - -			-	assembly includes:
	214-0209-00			1	SPOOL, solder
	- - - - - -			-	mounting hardware: (not included w/assembly)
	361-0007-00			1	SPACER, plastic, 0.188 inch long
-83	407-0142-00	X6997		2	BRACKET, shockmounting stop
	- - - - - -			-	mounting hardware for each: (not included w/bracket)
	211-0517-00			1	SCREW, 6-32 x 1 inch, PHS
	210-0006-00			1	LOCKWASHER, internal, #6
-84	200-0554-00	X6997		2	COVER, temperature stabilizer
-85	377-0103-00	X6997		4	INSERT, temperature stabilizer

FIG. 3 CRT SHIELD

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
3-1	124-0022-00			1	STRIP, felt
-2	136-0035-00			2	SOCKET, graticule light
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-3	211-0534-00			1	SCREW, sems, 6-32 x 5/16 inch, PHS
-4	210-0803-00			1	WASHER, flat, 0.150 ID x 3/8 inch OD
-5	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
-6	337-0364-00			1	SHIELD, CRT
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0538-00			5	SCREW, 6-32 x 5/16 inch, FHS (not shown)
-7	210-0006-00			6	LOCKWASHER, internal, #6
-8	210-0407-00			6	NUT, hex., 6-32 x 1/4 inch
-9	211-0513-00			1	SCREW, 6-32 x 5/8 inch, PHS
-10	385-0127-00	101	3899	1	ROD, hex., 1/4 x 9/32 inch
	166-0107-00	3990		1	TUBE, spacing, 1/4 x 7/32 inch
-11	210-0803-00			2	WASHER, flat, 0.150 ID x 3/8 inch OD
-12	406-0239-00			3	BRACKET, CRT spring
-13	136-0076-00	101	1519	1	SOCKET, CRT
	387-0344-00	101	1519	1	PLATE, CRT socket back
	211-0038-00	101	1519	2	SCREW, 4-40 x 5/16 inch, 100° csk, FHS
	136-0103-00	1520		1	ASSEMBLY, CRT socket
	- - - - - -			-	assembly includes:
	136-0117-00			1	SOCKET, CRT
	131-0178-00			9	CONNECTOR, CRT pin
-14	387-0393-00			1	PLATE, back
-15	213-0087-00			2	SCREW, thread cutting, 2-32 x 1/2 inch, RHS
-16	354-0103-00			1	ASSEMBLY, clamping ring
	- - - - - -			-	assembly includes:
-17	210-0502-00			1	NUT, CRT rotator, 10-32 x 3/8 inch
-18	211-0560-00			1	SCREW, 6-32 x 1 inch, RHS
-19	210-0407-00			1	NUT, hex., 6-32 x 1/4 inch
-20	432-0022-00			1	BASE, CRT rotator
	- - - - - -			-	mounting hardware: (not included w/base)
-21	211-0561-00			2	SCREW, 6-32 x 3/8 inch, hex., socket, FHS
-22	210-0503-00			1	NUT, CRT rotator securing
-23	354-0078-00	101	2379	1	RING, securing
	354-0178-00	2380		1	RING, securing
-24	355-0049-00			1	STUD, 10-32 x 3 1/4 inches
-25	366-0032-00			1	KNOB, red
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch, HSS
-26	406-0569-00			1	BRACKET, CRT support
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0507-00			2	SCREW, 6-32 x 5/16 inch, PHS (not shown)
	210-0803-00			1	WASHER, flat, 0.150 ID x 3/8 inch OD (not shown)
-27	175-0582-00			1	WIRE, CRT lead, striped brown
	175-0583-00			1	WIRE, CRT lead, striped red
	175-0584-00			1	WIRE, CRT lead, striped green
	175-0596-00			1	WIRE, CRT lead, striped blue
	- - - - - -			-	each wire includes:
-28	131-0049-00			1	CONNECTOR, CRT cable

FIG. 4 CHASSIS & REAR

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
4-1	441-0316-00	101	4110	1	CHASSIS, main
	441-0547-00	4111	6996	1	CHASSIS, main
	441-0547-01	6997		1	CHASSIS, main
	- - - - - -			-	mounting hardware: (not included w/chassis)
-2	212-0040-00			5	SCREW, 8-32 x 3/8 inch, 100° csk, FHS
	212-0039-00			2	SCREW, 8-32 x 3/8 inch, THS (not shown)
-3	343-0042-00			2	CLAMP
	- - - - - -			-	mounting hardware for each: (not included w/clamp)
-4	210-0407-00			1	NUT, hex., 6-32 x 1/4 inch
-5	210-0006-00			1	LOCKWASHER, internal, #6
-6	210-0803-00			1	WASHER, flat, 0.150 ID x 3/8 inch OD
-7	211-0507-00			1	SCREW, 6-32 x 5/16 inch, PHS
-8	136-0015-00			6	SOCKET, tube, 9 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-9	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-10	136-0008-00			5	SOCKET, tube, 7 pin, w/ground lugs
	- - - - - -			-	mounting hardware for each: (not included w/socket)
-11	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-12	136-0015-00	101	4229	1	SOCKET, tube, 9 pin, w/ground lugs
	136-0044-00	4230		1	SOCKET, tube, 7 pin, w/ground lugs
	- - - - - -			-	mounting hardware: (not included w/socket)
	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-13	136-0011-00			1	SOCKET, tube, 8 pin, w/ground lugs
	- - - - - -			-	mounting hardware: (not included w/socket)
-14	213-0044-00			2	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-15	- - - - - -			10	RESISTOR, variable
	- - - - - -			-	mounting hardware for each: (not included w/resistor)
-16	210-0413-00	X3140		1	NUT, hex., 3/8-32 x 1/2 inch
-17	210-0840-00	X3140		1	WASHER, flat, 0.390 ID x 9/16 inch OD
-18	136-0095-00	X270	4480	4	SOCKET, transistor, 4 pin
	136-0181-00	4481		4	SOCKET, transistor, 3 pin
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	213-0113-00	X270	4480	2	SCREW, thread forming, 2-32 x 5/16 inch, RHS
-19	354-0234-00	4481		1	RING, locking, transistor socket

FIG. 4 CHASSIS & REAR *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
4-20	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-21	211-0534-00			2	SCREW, sems, 6-32 x 5/16 inch, PHS
-22	386-0253-00			1	PLATE, metal
-23	210-0006-00			1	LOCKWASHER, internal, #6
-24	210-0202-00			1	LUG, solder, SE #6
-25	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
-26	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-27	211-0534-00			2	SCREW, sems, 6-32 x 5/16 inch, PHS
-28	386-0253-00			1	PLATE, metal
-29	210-0006-00			2	LOCKWASHER, internal, #6
-30	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
-31	200-0256-00			1	COVER, capacitor
-32	200-0256-00	101	7109	1	COVER, capacitor
	200-0532-00	7110		1	COVER, capacitor
-33	- - - - - -			2	CAPACITOR
	- - - - - -			-	mounting hardware for each: (not included w/capacitor)
-34	211-0534-00			2	SCREW, sems, 6-32 x 5/16 inch, PHS
-35	386-0252-00			1	PLATE, fiber
-36	210-0006-00			2	LOCKWASHER, internal, #6
-37	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
-38	200-0258-00			1	COVER, capacitor
-39	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-40	211-0534-00			2	SCREW, sems, 6-32 x 5/16 inch, PHS
-41	386-0254-00			1	PLATE, fiber
-42	210-0006-00			2	LOCKWASHER, internal, #6
-43	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
-44	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
-45	211-0534-00			2	SCREW, sems, 6-32 x 5/16 inch, PHS
-46	386-0255-00			1	PLATE, metal
-47	210-0006-00			2	LOCKWASHER, internal, #6
-48	210-0407-00			2	NUT, hex., 6-32 x 1/4 inch
-49	406-0583-00	X1100		1	BRACKET, transformer (see ref. #50)
	- - - - - -			-	mounting hardware: (not included w/bracket)
	212-0039-00			1	SCREW, 8-32 x 3/8 inch, THS (not shown)
	210-0458-00			1	NUT, keps, 8-32 x 11/32 inch (not shown)

FIG. 4 CHASSIS & REAR *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
4-50	- - - - - -			1	TRANSFORMER
	- - - - - -			-	transformer includes:
	406-0583-00	101	1099X	1	BRACKET, transformer (see ref. #49)
-51	212-0517-00			4	SCREW, 10-32 x 1¾ inches, HHS
-52	210-0812-00			4	WASHER, fiber, #10
	- - - - - -			-	mounting hardware: (not included w/transformer)
-53	220-0410-00			4	NUT, keps, 10-32 x ⅜ inch
-54	343-0074-00	X2320		1	CLAMP, tube
	- - - - - -			-	mounting hardware: (not included w/clamp)
-55	355-0070-00			1	STUD, 8-32 x 4¾ inches
-56	210-0409-00			2	NUT, hex., 8-32 x 5/16 inch
-57	210-0008-00			2	LOCKWASHER, internal, #8
-58	210-0201-00			6	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
-59	213-0044-00			1	SCREW, thread forming, 5-32 x 3/16 inch, PHS
-60	210-0202-00			1	LUG, solder, SE #6
-61	- - - - - -			1	TRANSFORMER
	- - - - - -			-	mounting hardware: (not included w/transformer)
-62	211-0504-00			4	SCREW, 6-32 x ¼ inch, PHS
-63	210-0803-00			4	WASHER, flat, 0.150 ID x ⅜ inch OD
-64	348-0003-00			5	GROMMET, rubber, 5/16 inch diameter
-65	348-0006-00			1	GROMMET, rubber, ¾ inch diameter
-66	387-0199-00			1	PLATE, rear subpanel
	- - - - - -			-	plate includes:
-67	354-0057-00			1	RING, ornamental
-68	387-0200-00			1	PLATE, rear overlay
	- - - - - -			-	mounting hardware: (not included w/plate)
-69	213-0104-00			2	SCREW, thread forming, 6-32 x ⅜ inch, THS
-70	386-0427-00			1	PLATE, ground
-71	129-0036-00	101	5019	1	POST, binding, black
	129-0063-00	5020		1	POST, binding, charcoal
	- - - - - -			-	mounting hardware: (not included w/post)
	210-0010-00	101	3719X	1	LOCKWASHER, internal, #10
	210-0445-00	101	3719	1	NUT, hex., 10-32 x ⅜ inch
-72	220-0410-00	3720		1	NUT, keps, 10-32 x ⅜ inch

FIG. 4 CHASSIS & REAR *(Cont)*

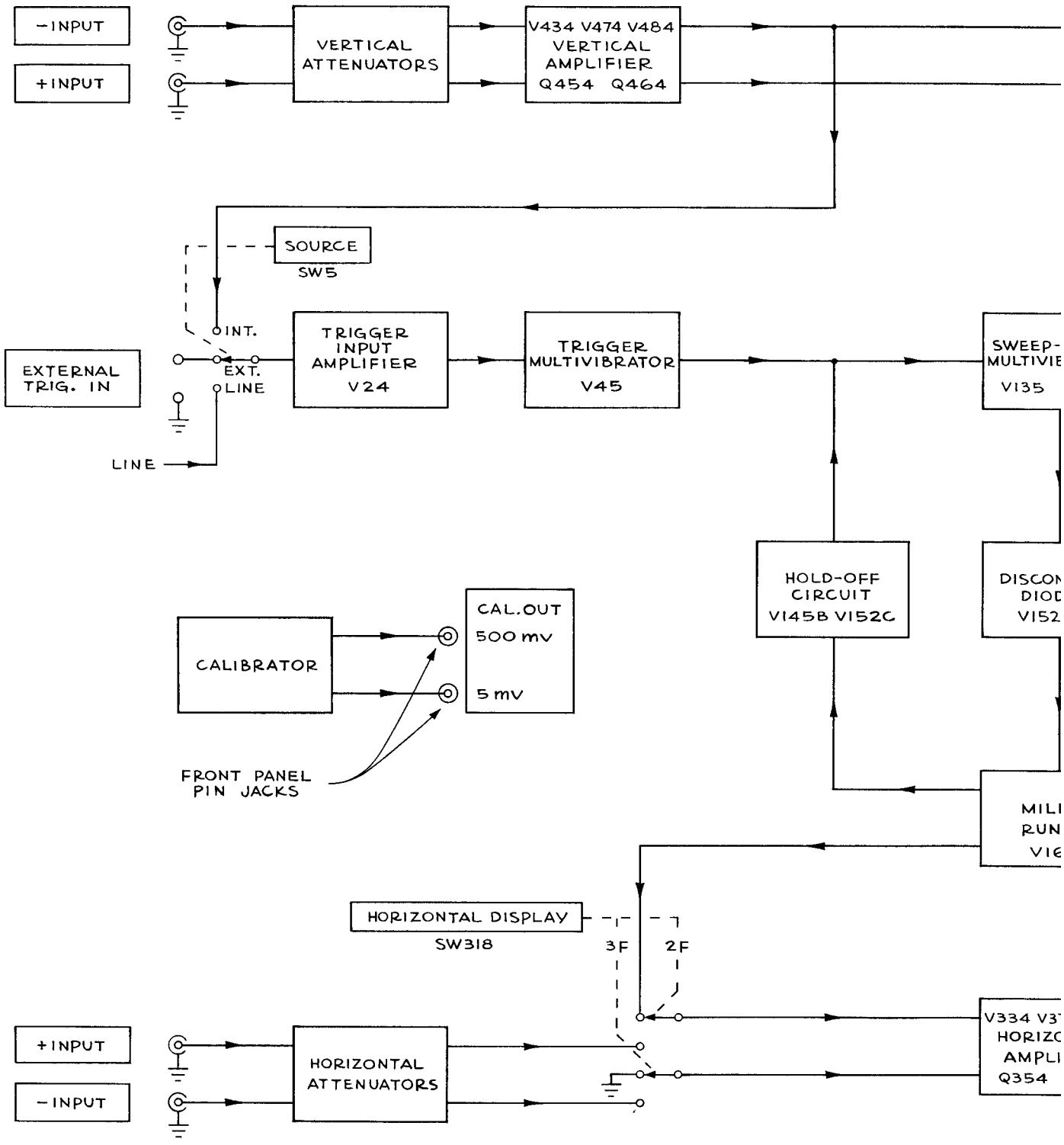
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
4-73	129-0036-00	101	5019	1	POST, binding, black
	129-0063-00	5020		1	POST, binding, charcoal
	- - - - - -			-	mounting hardware: (not included w/post)
-74	358-0036-00	101	5019	1	BUSHING, binding post, black
	358-0169-00	5020		1	BUSHING, binding post, charcoal
	210-0010-00	101	3719X	1	LOCKWASHER, internal, #10
	210-0206-00	101	3719X	1	LUG, solder, SE #10
	210-0445-00	101	3719	2	NUT, hex., 10-32 x 3/8 inch
-75	220-0410-00	3720		1	NUT, keps, 10-32 x 3/8 inch
-76	352-0028-00			2	HOLDER, power cord
	- - - - - -			-	mounting hardware for each: (not included w/holder)
-77	212-0061-00			1	SCREW, 8-32 x 1 1/2 inch, OHS
-78	210-0458-00			1	NUT, keps, 8-32 x 11/32 inch
-79	161-0017-00			1	CORD, power, 8 feet
-80	358-0025-00			1	BUSHING, strain relief
-81	334-0650-00			1	TAG, voltage
	- - - - - -			-	mounting hardware: (not included w/tag)
-82	213-0088-00			2	SCREW, thread forming, #4 x 1/4 inch, PHS
	352-0002-00			1	ASSEMBLY, fuse holder
	- - - - - -			-	assembly includes:
-83	200-0582-00			1	CAP, fuse
-84	352-0010-00			1	HOLDER, fuse
-85	210-0873-00			1	WASHER, rubber, 1/2 ID x 11/16 inch OD
-86	- - - - - -			1	NUT, fuse holder
-87	124-0091-00			11	STRIP, ceramic, 3/4 inch h, w/11 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 9/32 inch long
-88	124-0088-00			2	STRIP, ceramic, 3/4 inch h, w/4 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 9/32 inch long
-89	124-0091-00	101	6996	6	STRIP, ceramic, 3/4 inch h, w/11 notches
	124-0154-00	6997		6	STRIP, ceramic, 7/16 inch h, w/20 notches
	- - - - - -			-	each strip includes:
	355-0046-00	101	6996	2	STUD, plastic
	355-0082-00	6997		2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00	101	6996	2	SPACER, plastic, 9/32 inch long
	361-0039-00	6997		2	SPACER, plastic, 13/32 inch long

FIG. 4 CHASSIS & REAR *(Cont)*

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
4-90	124-0090-00			4	STRIP, ceramic, 3/4 inch h, w/9 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -				mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 9/32 inch long
-91	124-0089-00			2	STRIP, ceramic, 3/4 inch h, w/7 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, plastic
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0009-00			2	SPACER, plastic, 9/32 inch long
-92	124-0086-00			1	STRIP, ceramic, 3/4 inch h, w/2 notches
	- - - - - -			-	strip includes:
	355-0046-00			1	STUD, plastic
	- - - - - -			-	mounting hardware: (not included w/strip)
	361-0007-00			1	SPACER, plastic, 1/16 inch long
-93	179-0413-00	101	269	1	CABLE HARNESS, focus and intensity
	179-0424-00	270		1	CABLE HARNESS, focus and intensity
-94	179-0407-00	101	269	1	CABLE HARNESS, chassis
	179-0442-00	270	399	1	CABLE HARNESS, chassis
	179-0470-00	400		1	CABLE HARNESS, chassis
-95	179-0412-00			1	CABLE HARNESS, 110 volt
-96	200-0247-00	101	3139X	10	COVER, variable resistor
-97	200-0237-00	101	3969X	1	COVER, fuse holder
-98	407-0011-00	X4111		1	BRACKET, chassis
	- - - - - -			-	mounting hardware: (not included w/bracket)
	212-0039-00			2	SCREW, 8-32 x 3/8 inch, THS
	210-0458-00			2	NUT, keps, 8-32 x 11/32 inch
-99	131-0142-00			1	CONNECTOR, cable end, tube
-100	200-0497-00	X6997		2	COVER, transistor
-101	352-0072-00	X6997		2	HOLDER, transistor cover

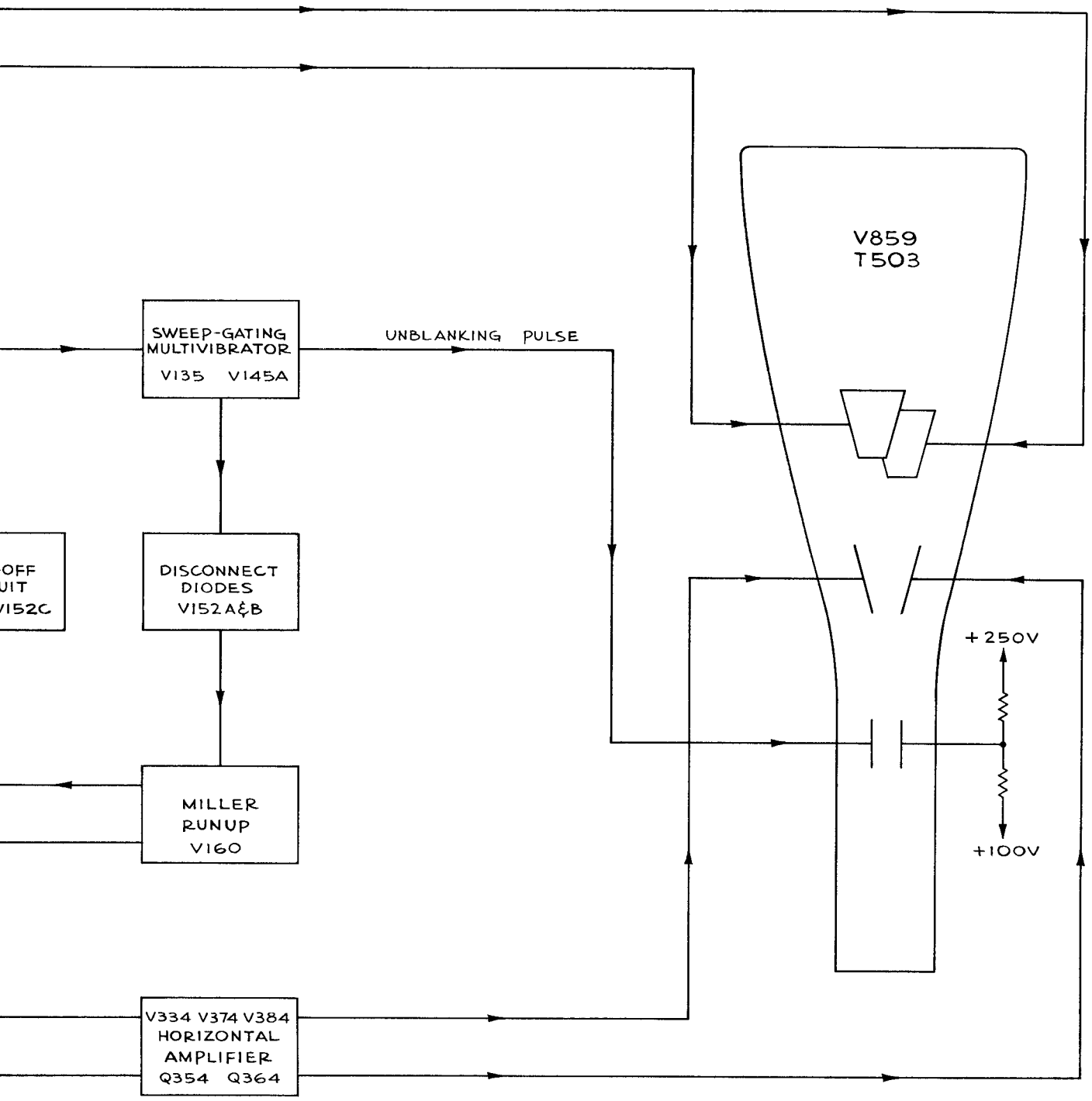
FIG. 5 CABINET & RAILS

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
5-1	387-0201-00			2	PLATE, cabinet side
	- - - - - -			-	each plate includes:
	214-0057-00			2	ASSEMBLY, cabinet fastener
	- - - - - -			-	assembly includes:
-2	210-0480-00			1	NUT, latch, plastic
-3	213-0033-00			1	SCREW, fastening, 8-32 x 1/2 x 1/2 inch
-4	210-0847-00			1	WASHER, plastic, 0.164 ID x 1/2 inch OD
-5	105-0007-00			1	STOP, steel, 7/32 ID x 21/32 inch OD
-6	387-0202-00			1	PLATE, cabinet bottom
	- - - - - -			-	plate includes:
-7	348-0014-00			4	CUSHION, molded, 3/4 OD x 11/16 inch high
-8	348-0015-00			4	CUSHION, rubber ball, 7/16 inch
-9	212-0010-00			4	SCREW, 8-32 x 5/8 inch, PHS
-10	210-0458-00			4	NUT, keps, 8-32 x 11/32 inch
	- - - - - -			-	mounting hardware: (not included w/plate)
-11	212-0039-00			7	SCREW, 8-32 x 3/8 inch, THS
	210-0007-00			3	LOCKWASHER, external, #8 (not shown)
-12	122-0060-00			1	ANGLE, frame, top
	- - - - - -			-	mounting hardware: (not included w/angle)
	211-0559-00			4	SCREW, 6-32 x 3/8 inch, 100° csk, FHS (not shown)
-13	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
-14	122-0060-00	X740		1	ANGLE, frame, top
	- - - - - -			-	mounting hardware: (not included w/angle)
	211-0559-00			4	SCREW, 6-32 x 3/8 inch, 100° csk, FHS (not shown)
-15	210-0457-00			4	NUT, keps, 6-32 x 5/16 inch
-16	381-0172-00	101	3844	1	BAR, top support, w/handle
	381-0229-00	3845		1	BAR, top support, w/handle
	- - - - -			-	bar includes:
	367-0029-00	101	3844	1	ASSEMBLY, handle
	- - - - - -			-	assembly includes:
	[illegible]			1	HANDLE, grip
	[illegible]			2	BAR, handle
	21[illegible]			2	LINK, handle
	[illegible].-00			1	STRAP, handle
	0045-00			2	SCREW, self-tapping, 4-40 x 5/16 inch, PHS
	- - - - -			-	mounting hardware: (not included w/assembly)
	212-0507-00			2	SCREW, 10-32 x 3/8 inch, PHS
	210-0010-00			2	LOCKWASHER, internal, #10
	367-0043-00	3845		1	ASSEMBLY, handle
	- - - - - -			-	assembly includes:
-17	367-0037-00			1	HANDLE
-18	344-0098-00			2	CLIP, handle
-19	212-0518-00	3845	4089	2	SCREW, 10-32 x 5/16 inch, RHS
	212-0566-00	4090	8049	2	SCREW, 10-32 x 5/16 inch, PHS
	212-0507-00	8050		2	SCREW, 10-32 x 3/8 inch, PHS
	210-0010-00	X8050		2	LOCKWASHER, internal, #10 (not shown)
	- - - - - -			-	mounting hardware: (not included w/bar)
-20	212-0039-00			4	SCREW, 8-32 x 3/8 inch, THS
	381-0073-00			2	BAR, retaining (not shown)



TYPE 503 OSCILLOSCOPE

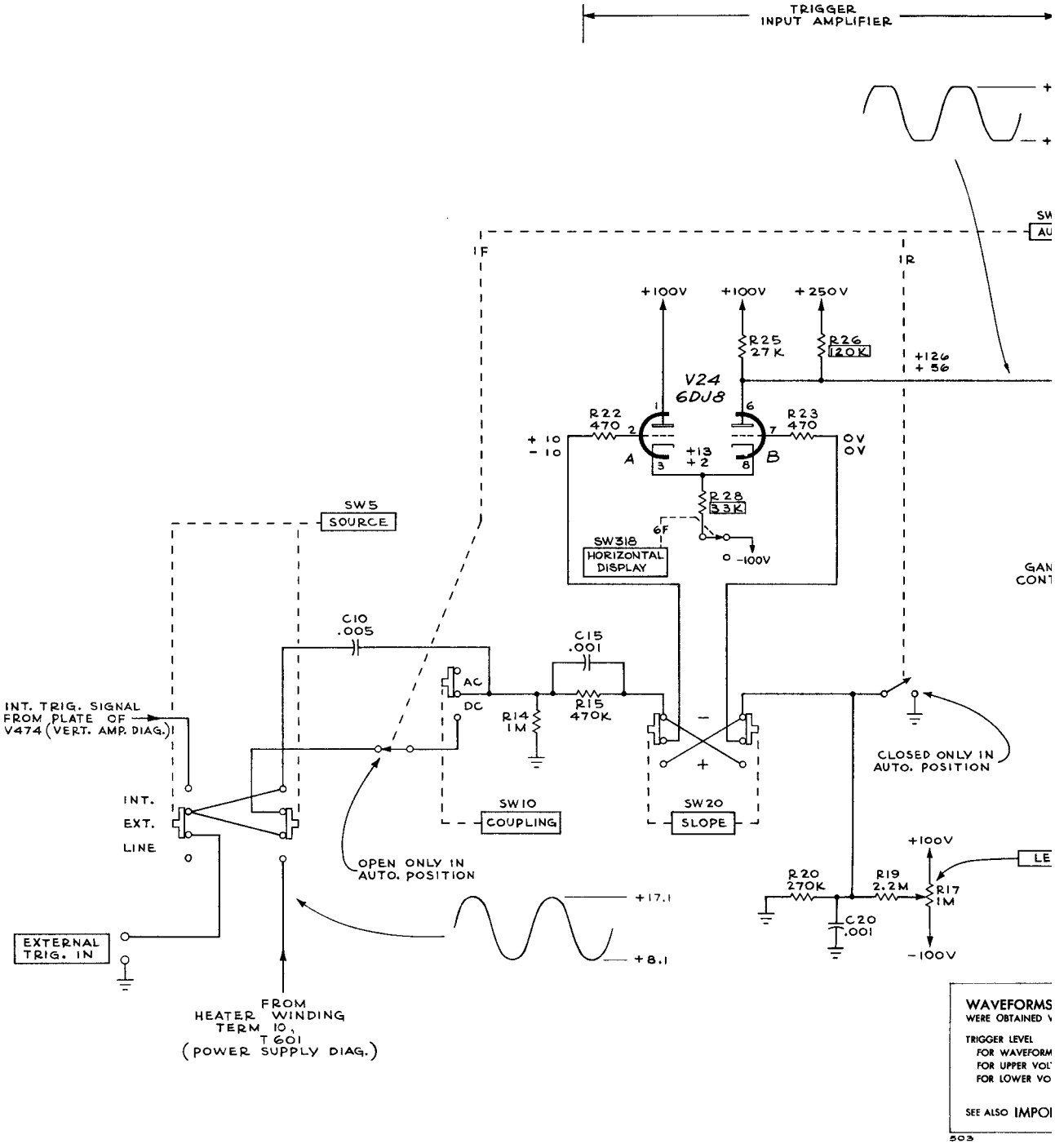
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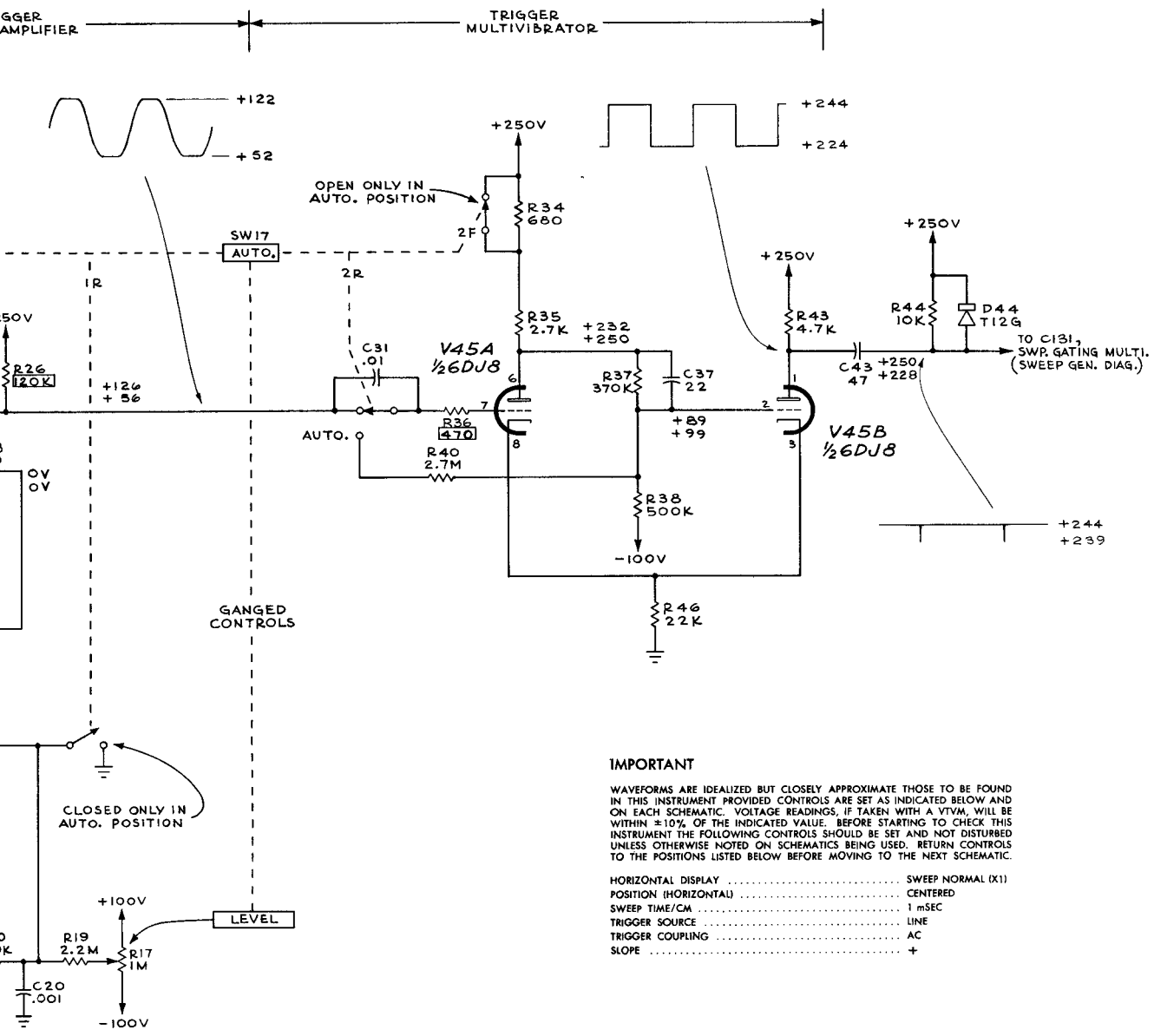
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BLOCK DIAGRAM



TYPE 503 OSCILLOSCOPE



IMPORTANT

WAVEFORMS ARE IDEALIZED BUT CLOSELY APPROXIMATE THOSE TO BE FOUND IN THIS INSTRUMENT PROVIDED CONTROLS ARE SET AS INDICATED BELOW AND ON EACH SCHEMATIC. VOLTAGE READINGS, IF TAKEN WITH A VTVM, WILL BE WITHIN ±10% OF THE INDICATED VALUE. BEFORE STARTING TO CHECK THIS INSTRUMENT THE FOLLOWING CONTROLS SHOULD BE SET AND NOT DISTURBED UNLESS OTHERWISE NOTED ON SCHEMATICS BEING USED. RETURN CONTROLS TO THE POSITIONS LISTED BELOW BEFORE MOVING TO THE NEXT SCHEMATIC.

HORIZONTAL DISPLAY	SWEEP NORMAL (X1)
POSITION (HORIZONTAL)	CENTERED
SWEEP TIME/CM	1 mSEC
TRIGGER SOURCE	LINE
TRIGGER COUPLING	AC
SLOPE	+

WAVEFORMS AND VOLTAGE READINGS

WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

TRIGGER LEVEL	
FOR WAVEFORMS	CENTERED
FOR UPPER VOLTAGE READINGS	FREE RUN
FOR LOWER VOLTAGE READINGS	CCW BUT NOT SWITCHED TO AUTO

SEE ALSO **IMPORTANT** NOTE ON THIS DIAGRAM

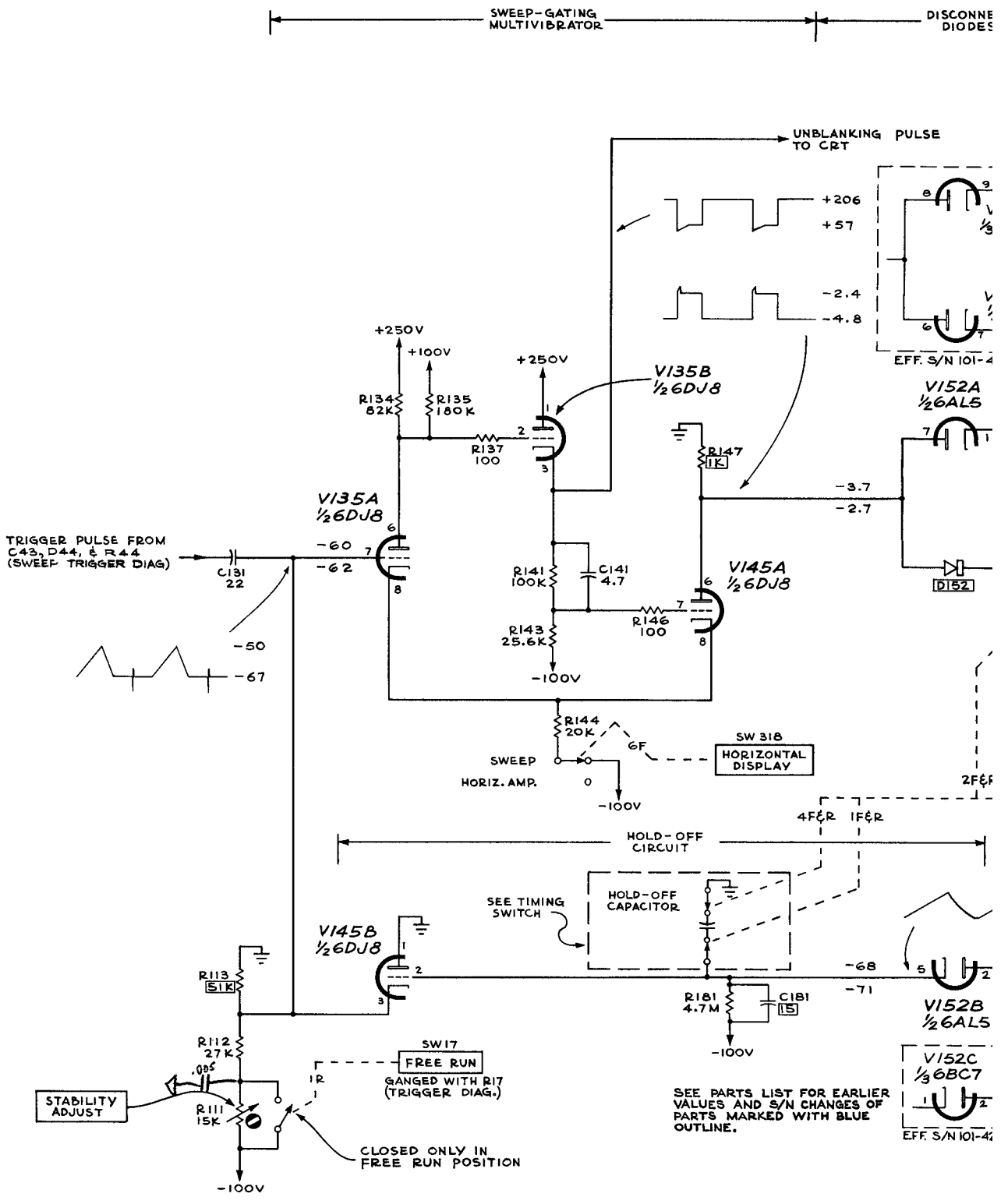
503 A SWEEP TRIGGER

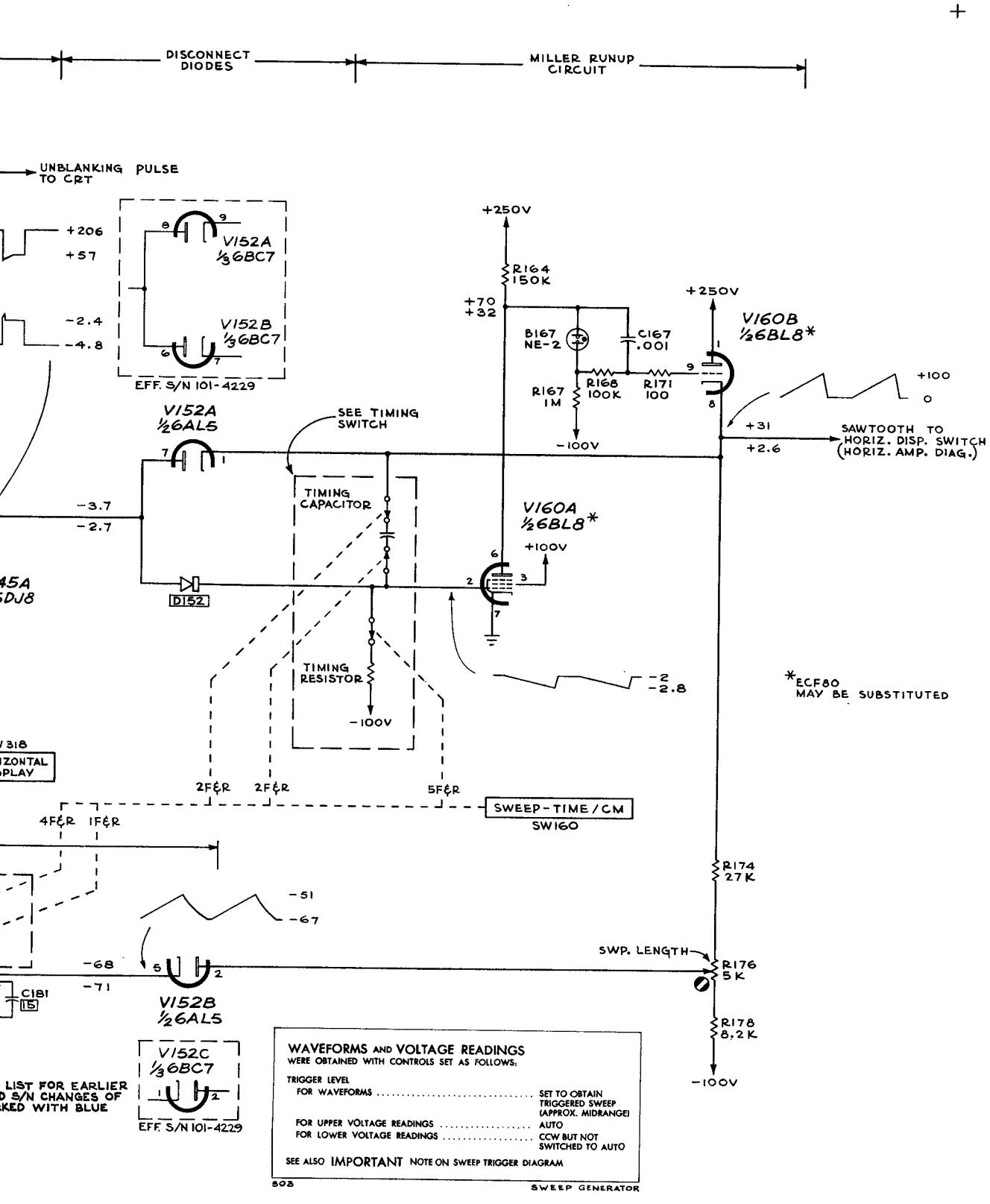
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

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364

D6

SWEEP TRIGGER

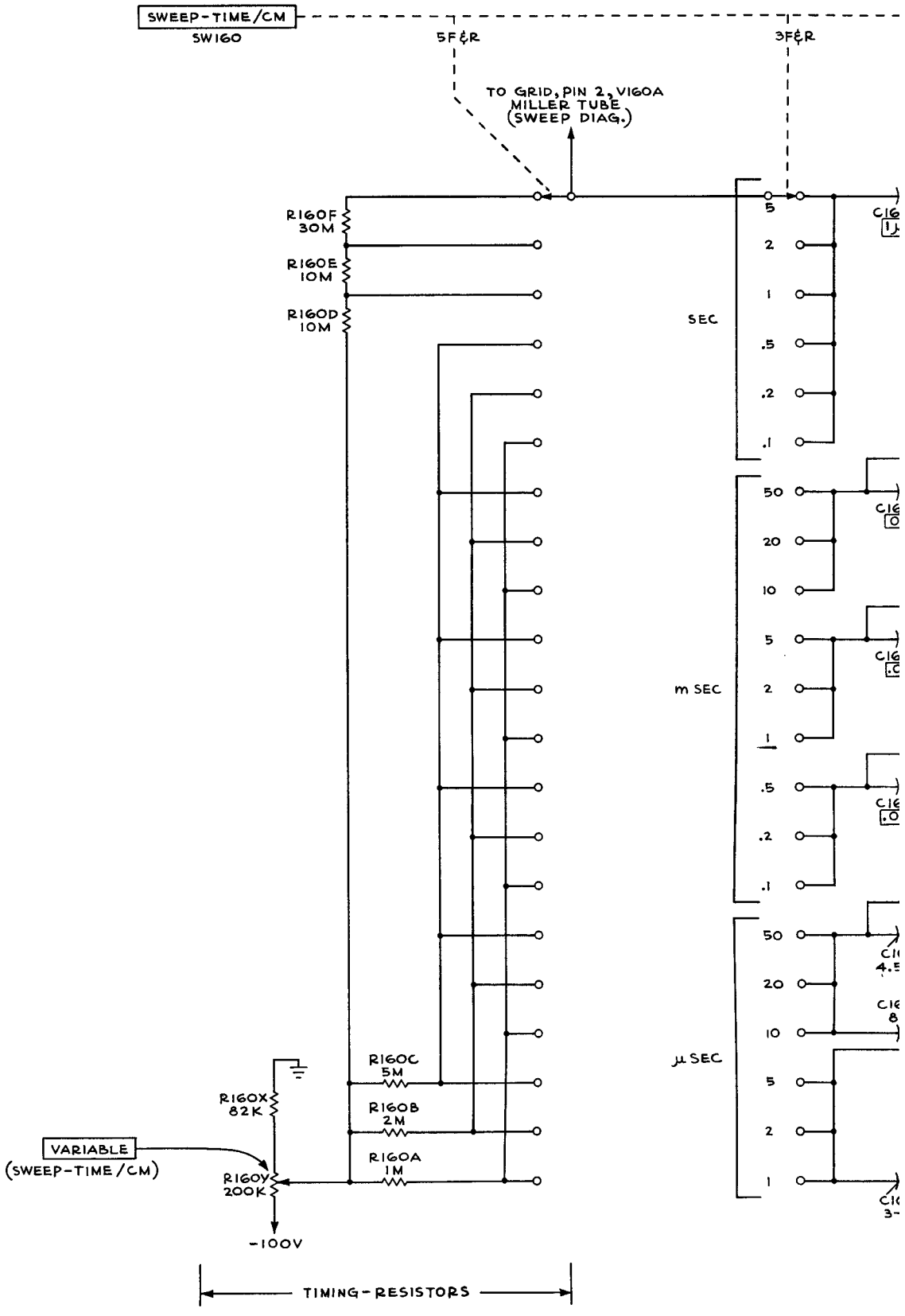

SWEEP-GATING MULTIVIBRATOR
DISCONNE DIODES
UNBLANKING PULSE TO CRT
+206
+57
-2.4
-4.8
EFF. S/N 101-4
+250V
+100V
+250V
V135B ½6DJ8
R134 82K
R135 180K
R137 100
R147 1K
V152A ½6AL5
-3.7
-2.7
V135A ½6DJ8
TRIGGER PULSE FROM C43, D44, & R44 (SWEEP TRIGGER DIAG)
C131 22
-60
-62
R141 100K
C141 4.7
V145A ½6DJ8
D152
R146 100
R143 25.6K
-50
-67
-100V
R144 20K
SW 318
SWEEP
HORIZ. AMP.
6F
HORIZONTAL DISPLAY
-100V
2FÉR
4FÉR
1FÉR
HOLD-OFF CIRCUIT
SEE TIMING SWITCH
HOLD-OFF CAPACITOR
V145B ½6DJ8
R113 51K
-68
-71
R181 4.7M
C181 15
V152B ½6AL5
R112 27K
.005
SW17
FREE RUN
GANGED WITH R17 (TRIGGER DIAG.)
1R
V152C ⅓6BC7
STABILITY ADJUST
R111 15K
CLOSED ONLY IN FREE RUN POSITION
-100V
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.
EFF. S/N 101-42

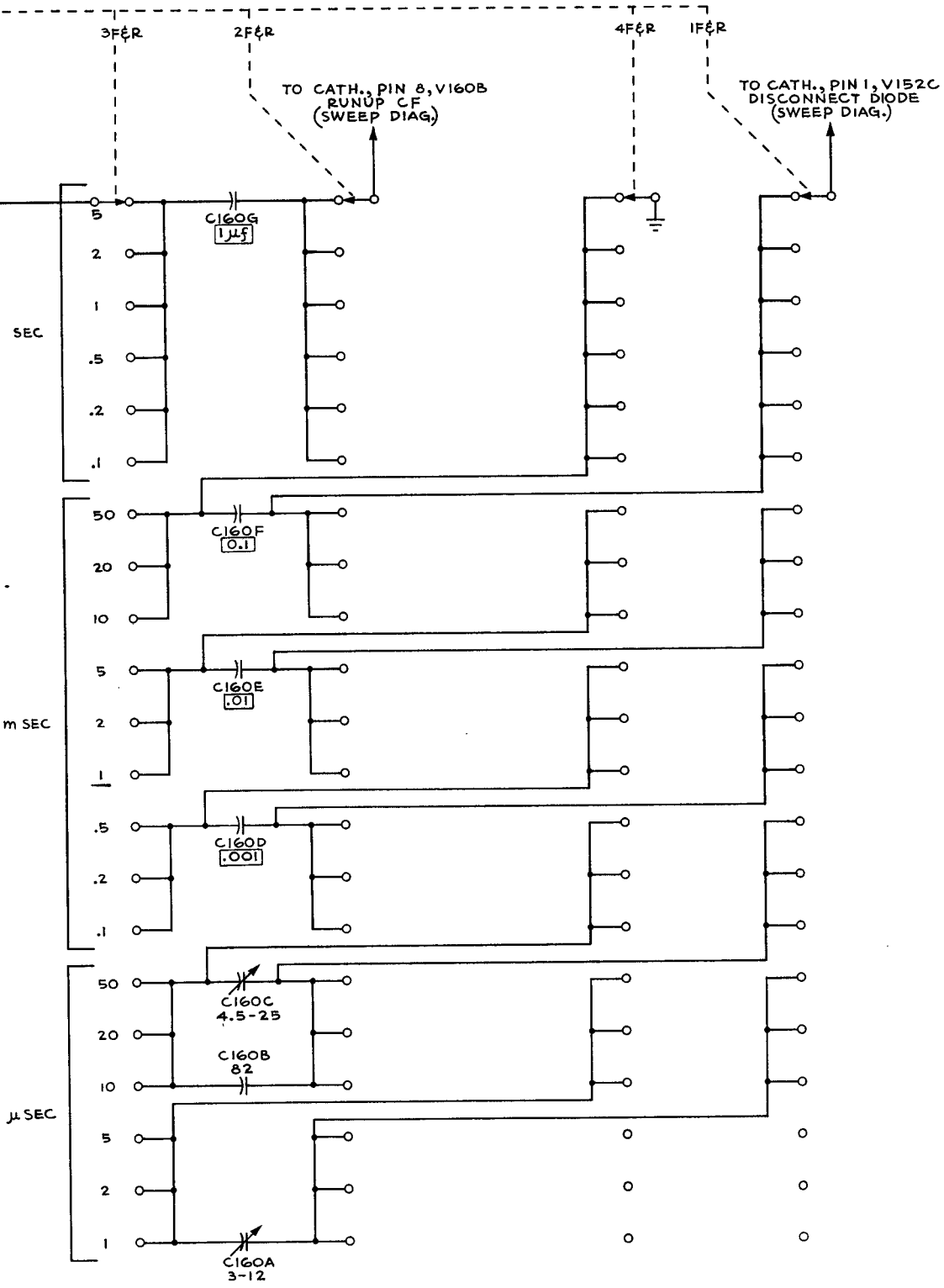


E2

SWEEP GENERATOR

GAB


SWEEP-TIME/CM
SW160
5F&R
3F&R
TO GRID, PIN 2, V160A
MILLER TUBE
(SWEEP DIAG.)
R160F
30M
R160E
10M
R160D
10M
SEC
5
2
1
.5
.2
.1
50
20
10
5
2
1
m SEC
.5
.2
.1
50
20
10
μ SEC
5
2
1
R160C
5M
R160B
2M
R160A
1M
R160X
82K
R160Y
200K
VARIABLE
(SWEEP-TIME/CM)
-100V
TIMING-RESISTORS

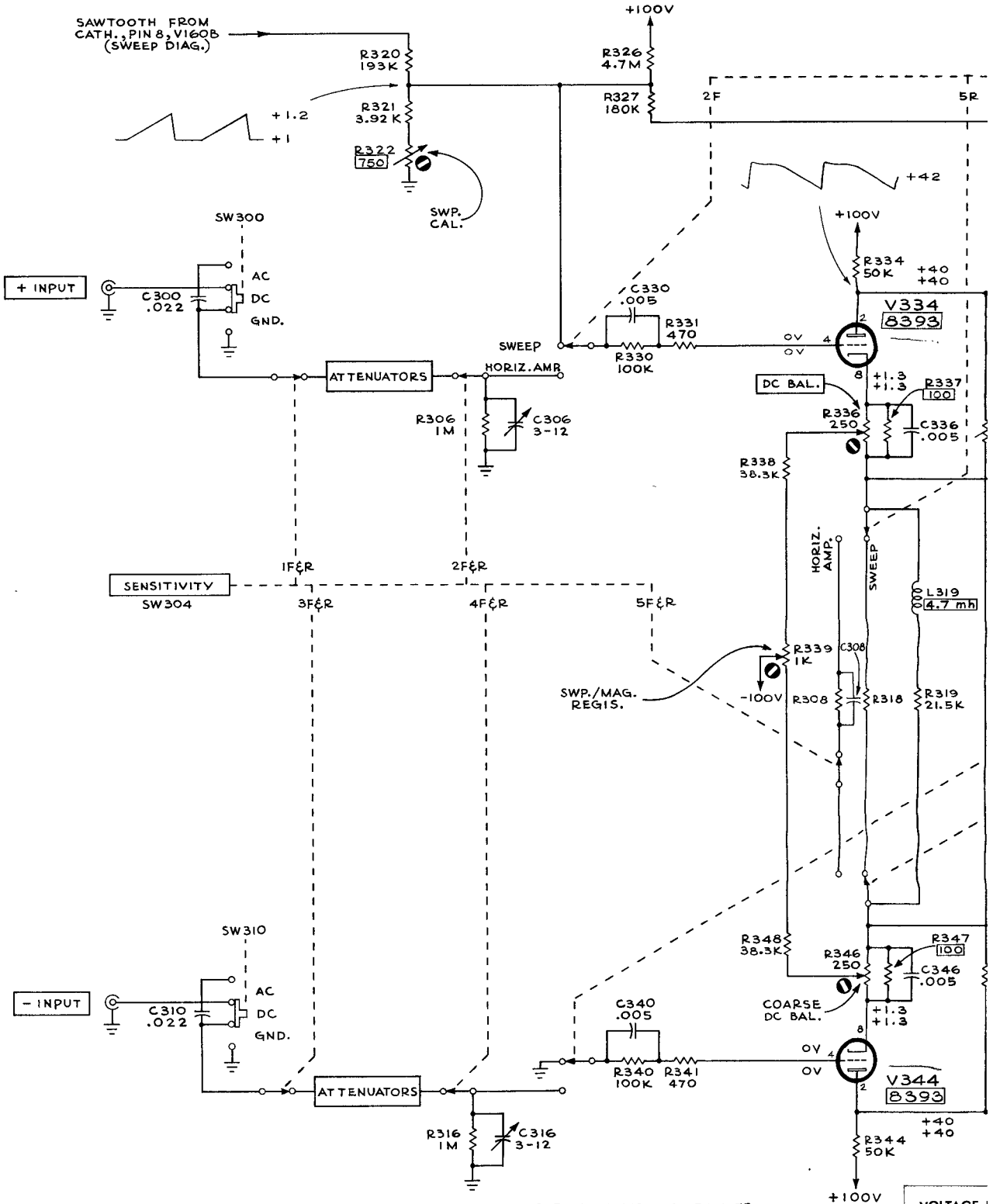


SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

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168

B

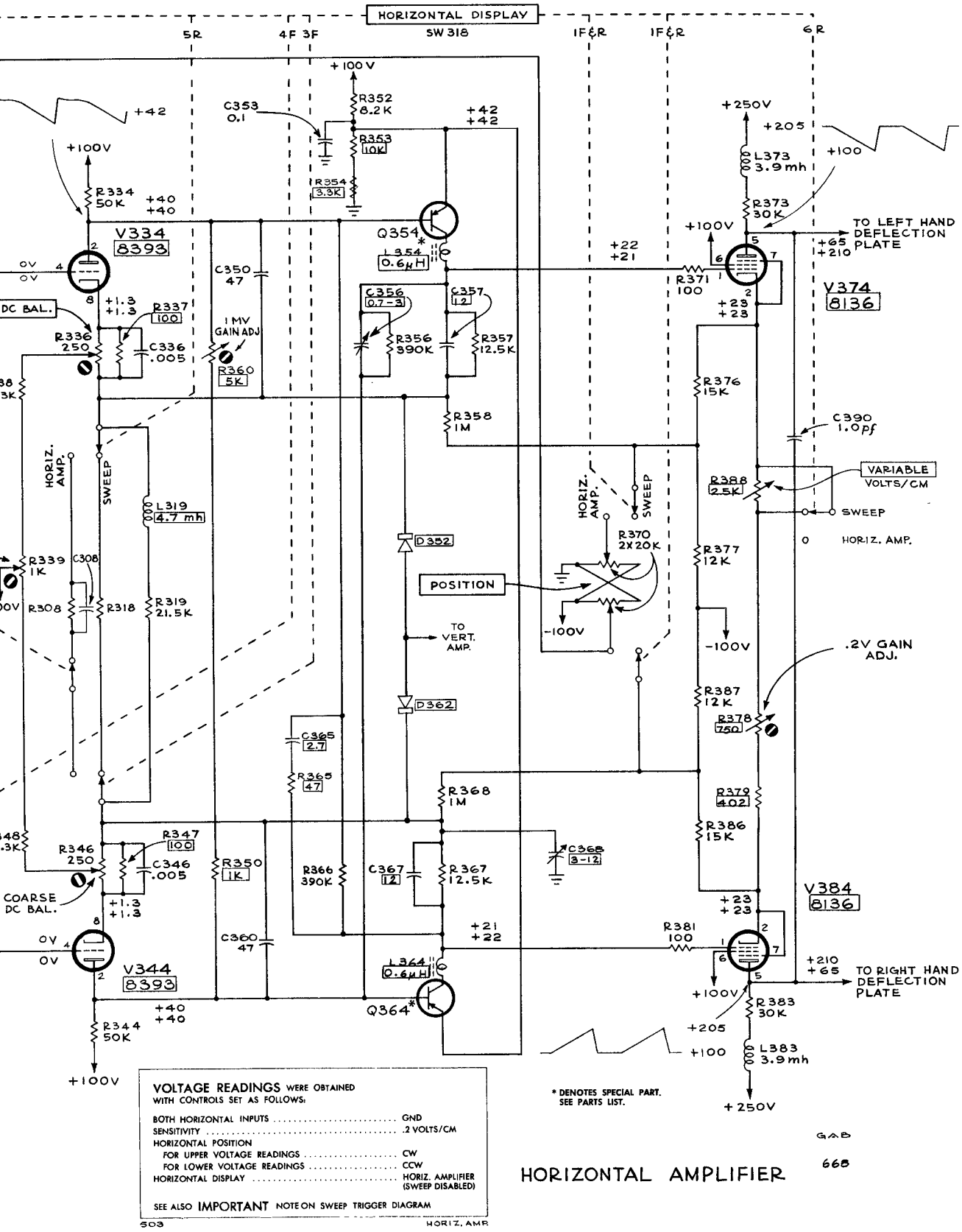
TIMING SWITCH



TYPE 503 OSCILLOSCOPE

VOLTAGE
WITH CONTROL
BOTH HORIZON
SENSITIVITY ...
HORIZONTAL P
FOR UPPER V
FOR LOWER
HORIZONTAL D
SEE ALSO IMP

503



VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

BOTH HORIZONTAL INPUTS	GND
SENSITIVITY	.2 VOLTS/CM
HORIZONTAL POSITION	
FOR UPPER VOLTAGE READINGS	CW
FOR LOWER VOLTAGE READINGS	CCW
HORIZONTAL DISPLAY	HORIZ. AMPLIFIER (SWEEP DISABLED)

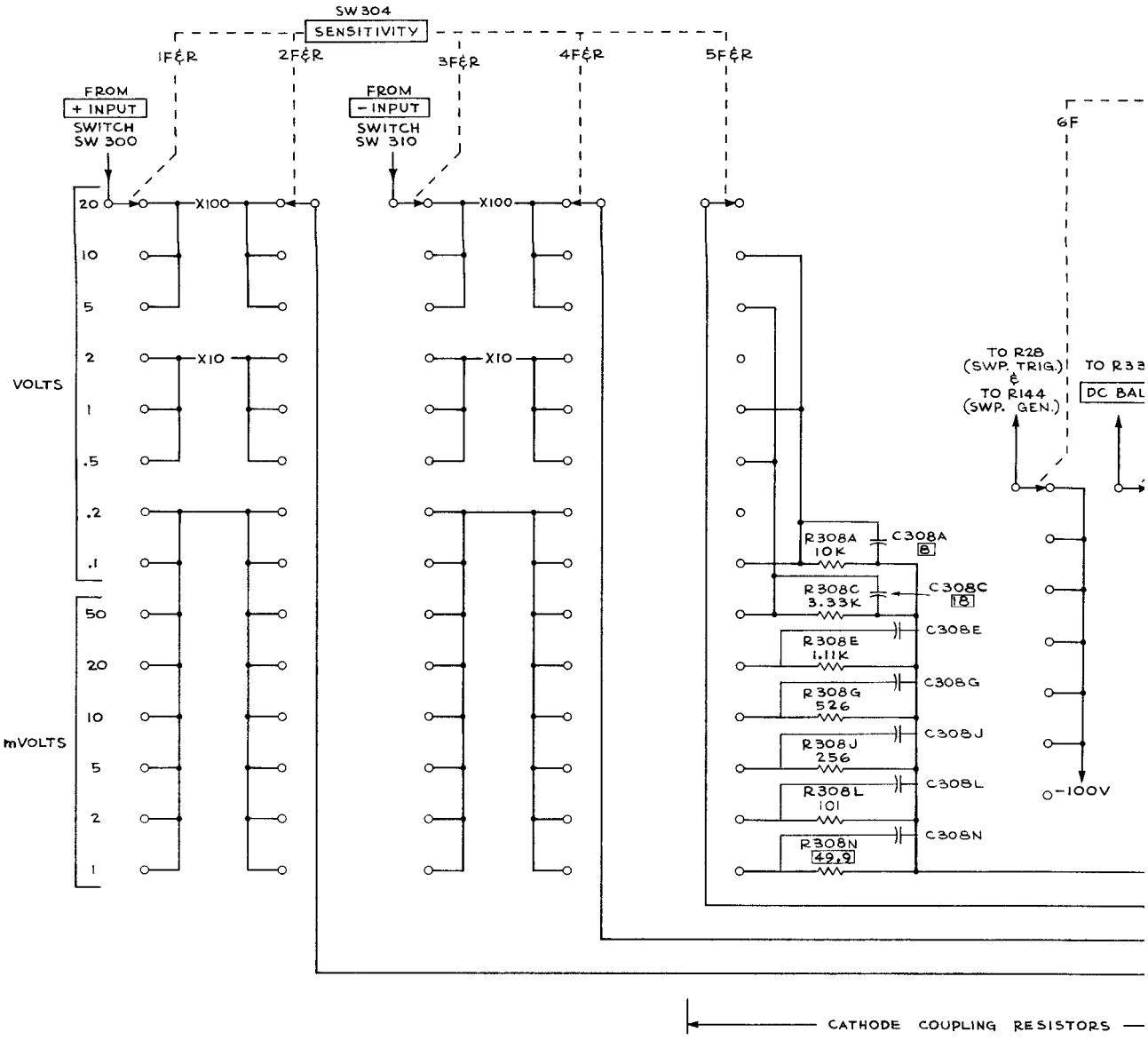
SEE ALSO **IMPORTANT** NOTE ON SWEEP TRIGGER DIAGRAM

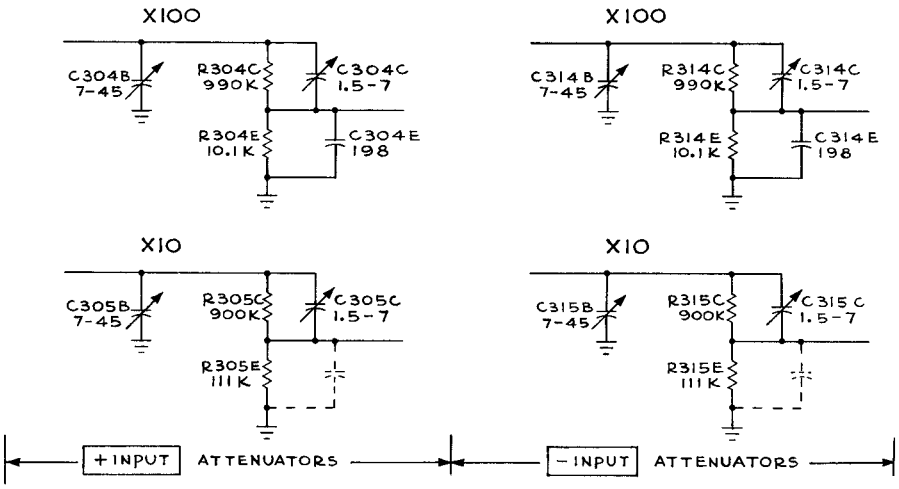
* DENOTES SPECIAL PART. SEE PARTS LIST.

HORIZONTAL AMPLIFIER

GAB

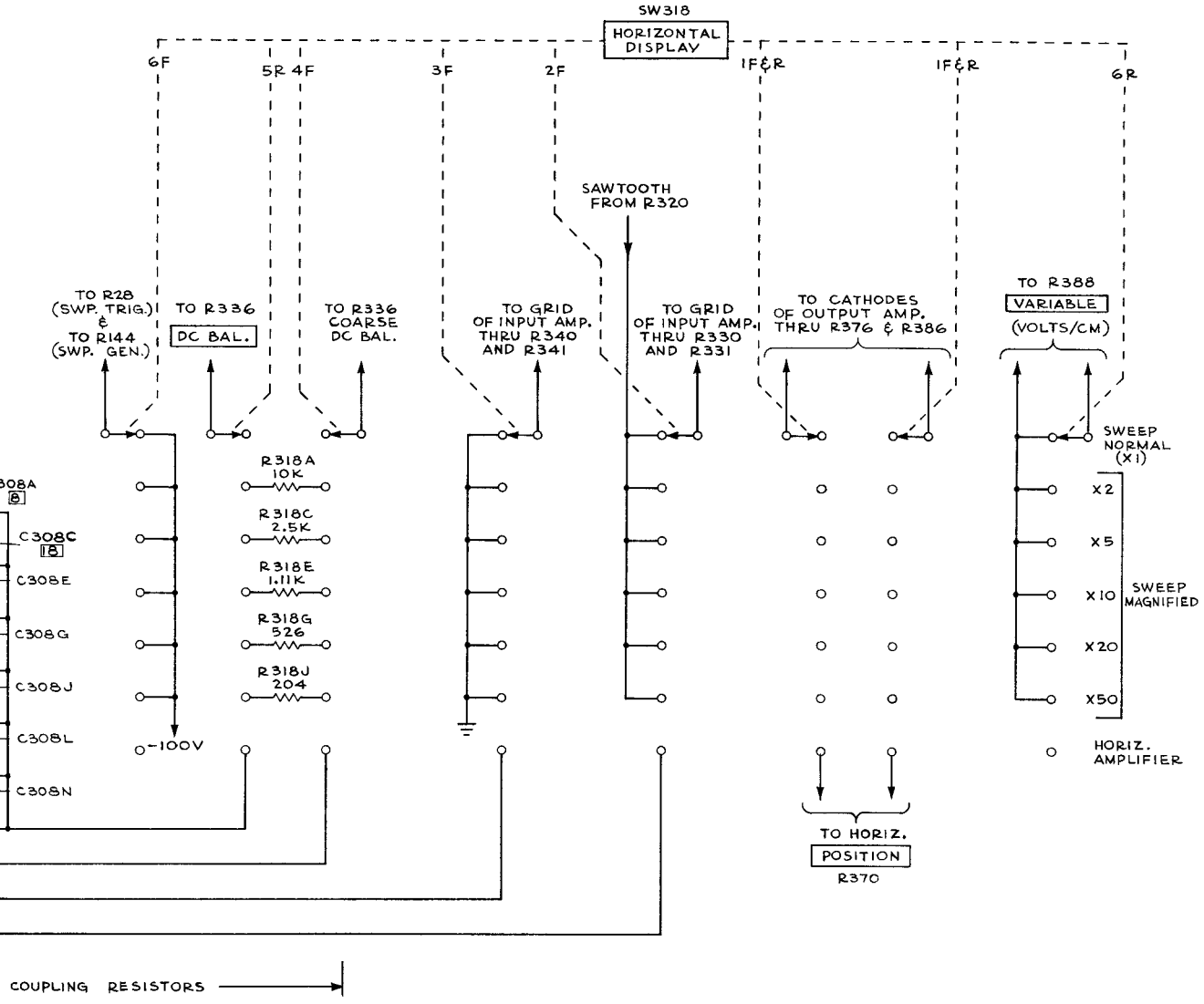
668





SEE PARTS LIST FOR
VALUES AND S/N CHAN
PARTS MARKED WITH
OUTLINE.

TYPE 503 OSCILLOSCOPE

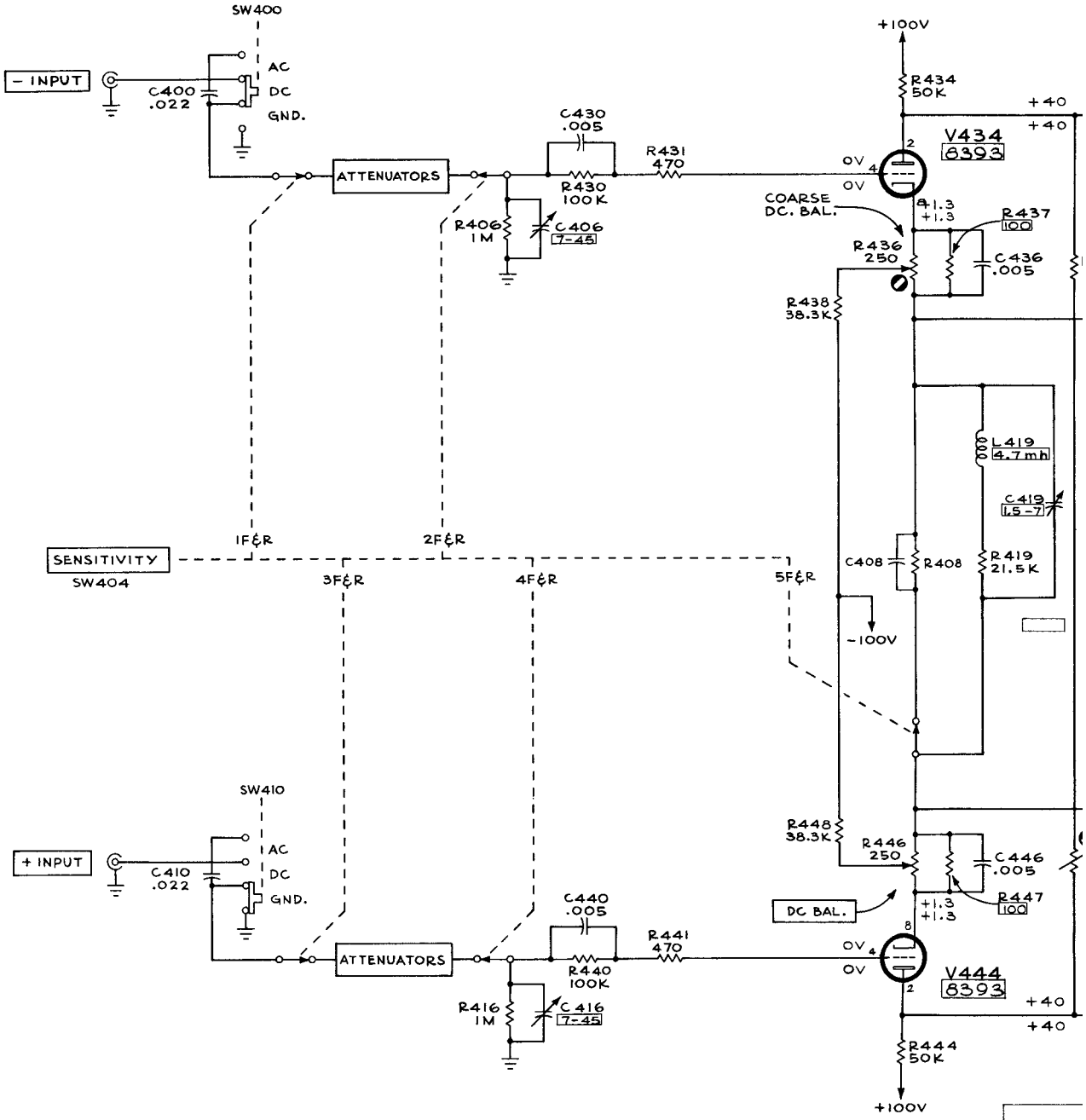


SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

G A B
267

HORIZONTAL DISPLAY SWITCH
HORIZONTAL AMPLIFIER ATTENUATOR SWITCH

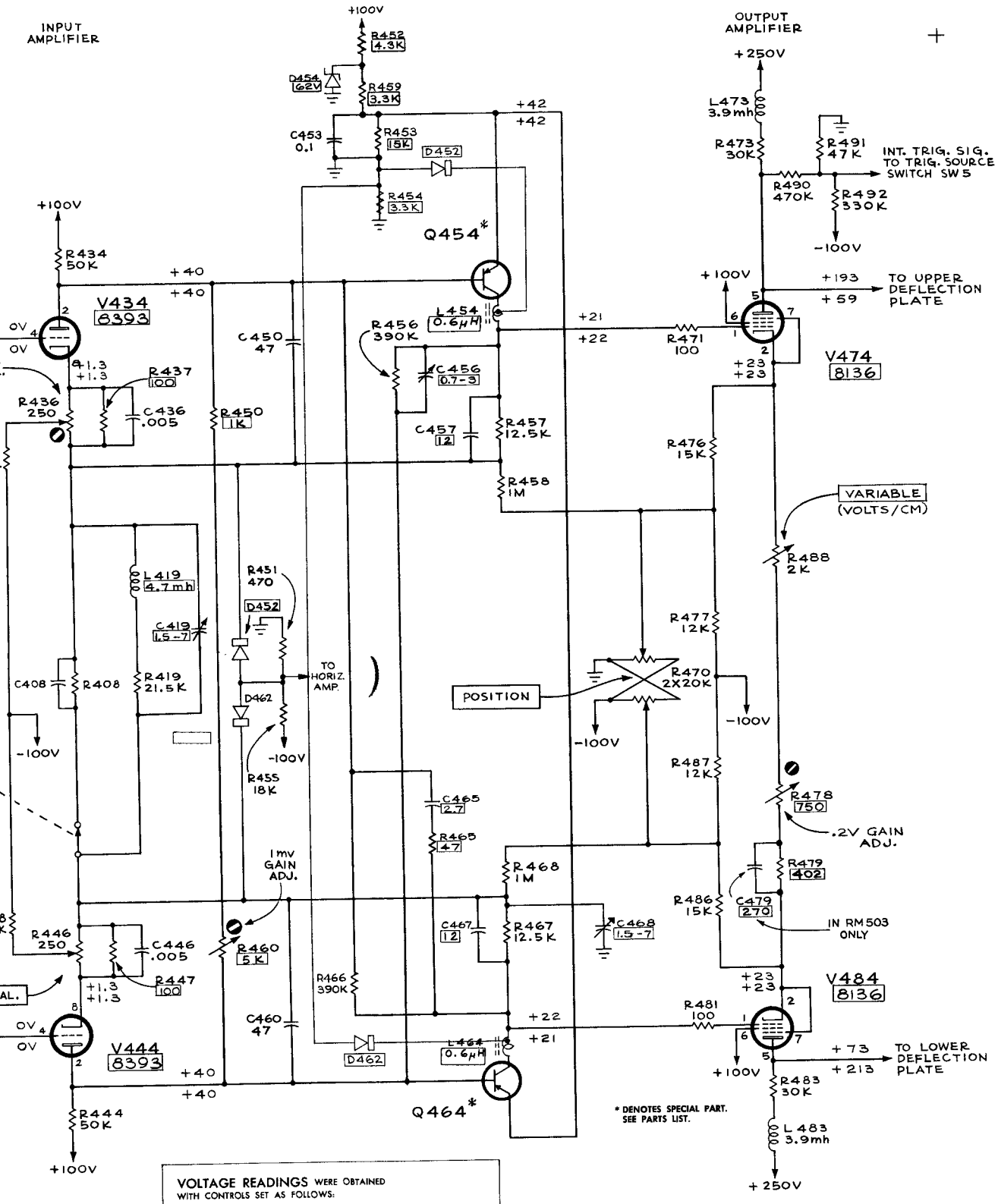
INPUT
AMPLIFIER



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

VOLTAGE
WITH CONTR
BOTH INPUTS
SENSITIVITY
VERTICAL POS
FOR UPPER
FOR LOWE
SEE ALSO IM

TYPE 503 OSCILLOSCOPE



VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

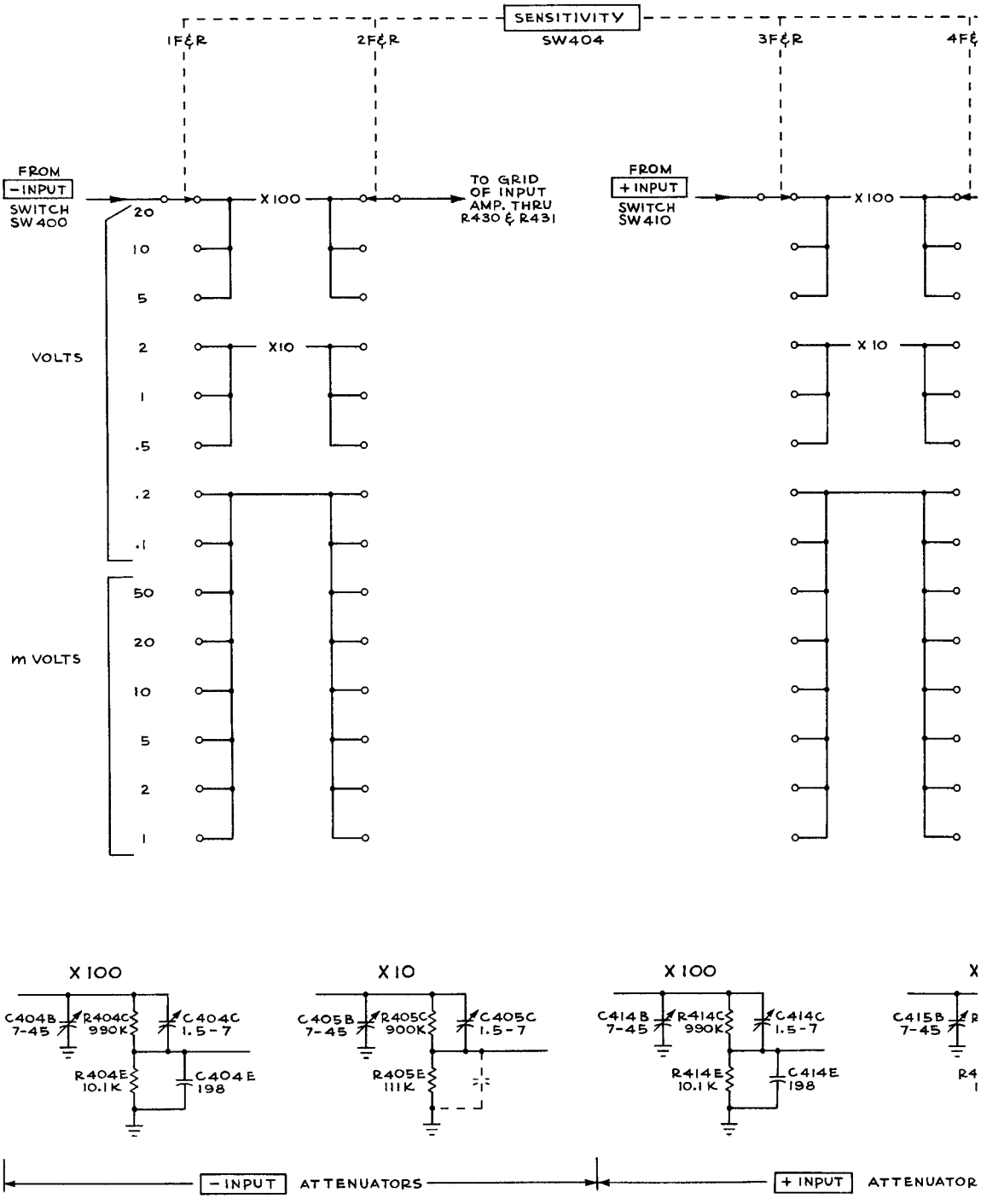
BOTH INPUTS	GND
SENSITIVITY	.2 VOLTS/CM
VERTICAL POSITION	
FOR UPPER VOLTAGE READINGS	CW
FOR LOWER VOLTAGE READINGS	CCW

SEE ALSO **IMPORTANT** NOTE ON SWEEP TRIGGER DIAGRAM

GAB

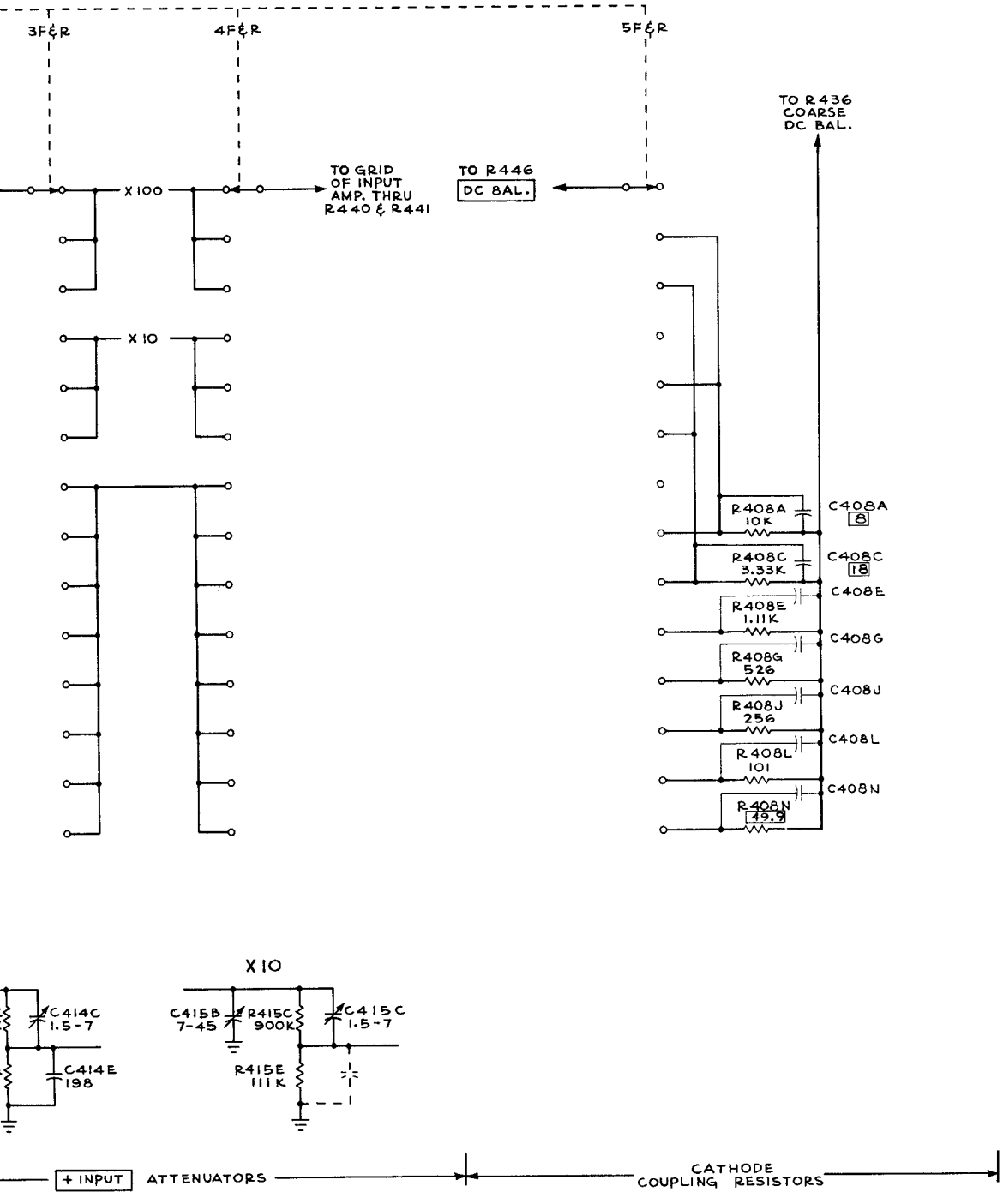
668

VERTICAL AMPLIFIER



TYPE 503 OSCILLOSCOPE

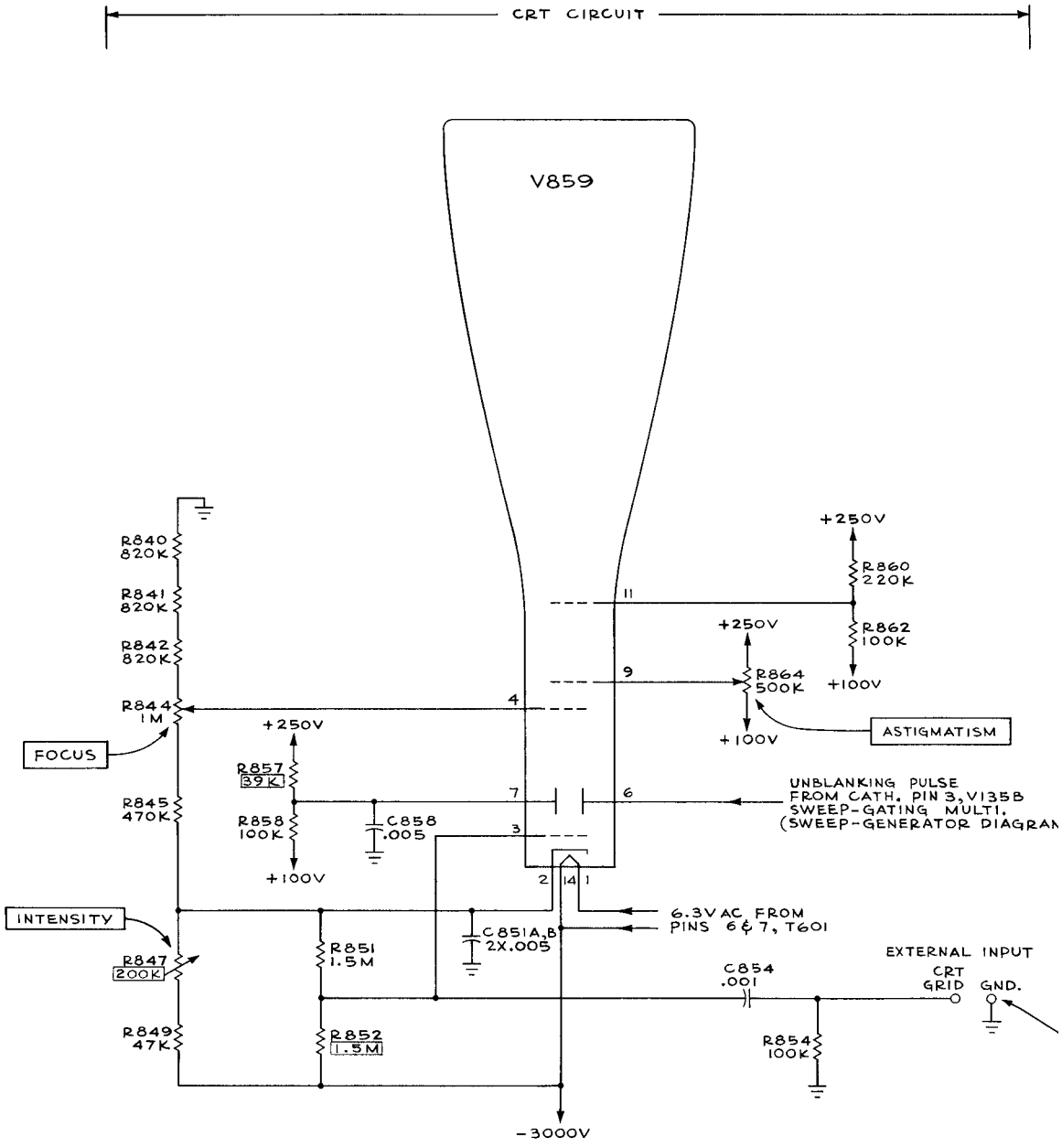
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

267
GAB

VERTICAL AMPLIFIER ATTENUATOR SWITCH

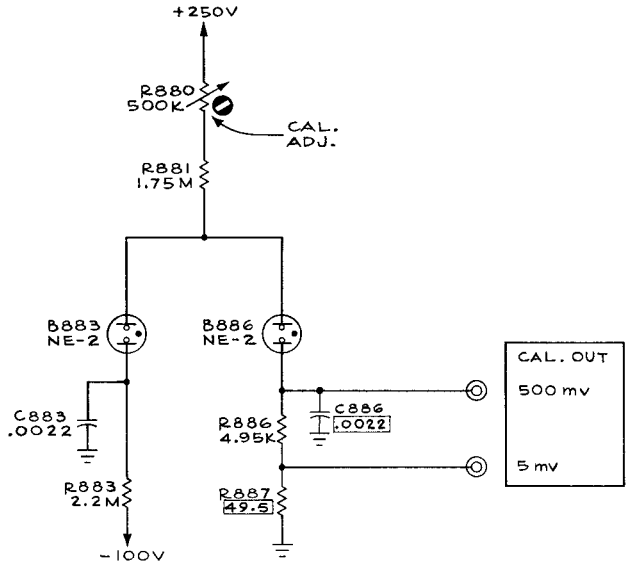


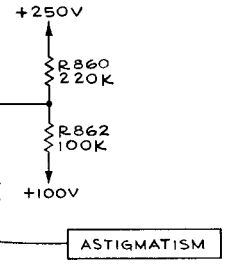
SEE PARTS L
VALUES AND
PARTS MARK
OUTLINE.

TYPE 503 OSCILLOSCOPE

E2

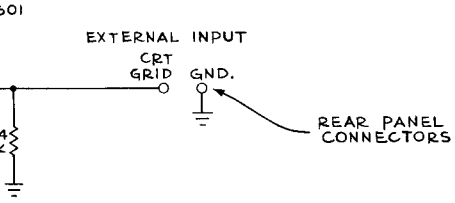
CALIBRATOR





ASTIGMATISM

NBLANKING PULSE
ROM CATH. PIN 3, V135B
WEEP-GATING MULTI.
WEEP-GENERATOR DIAGRAM)

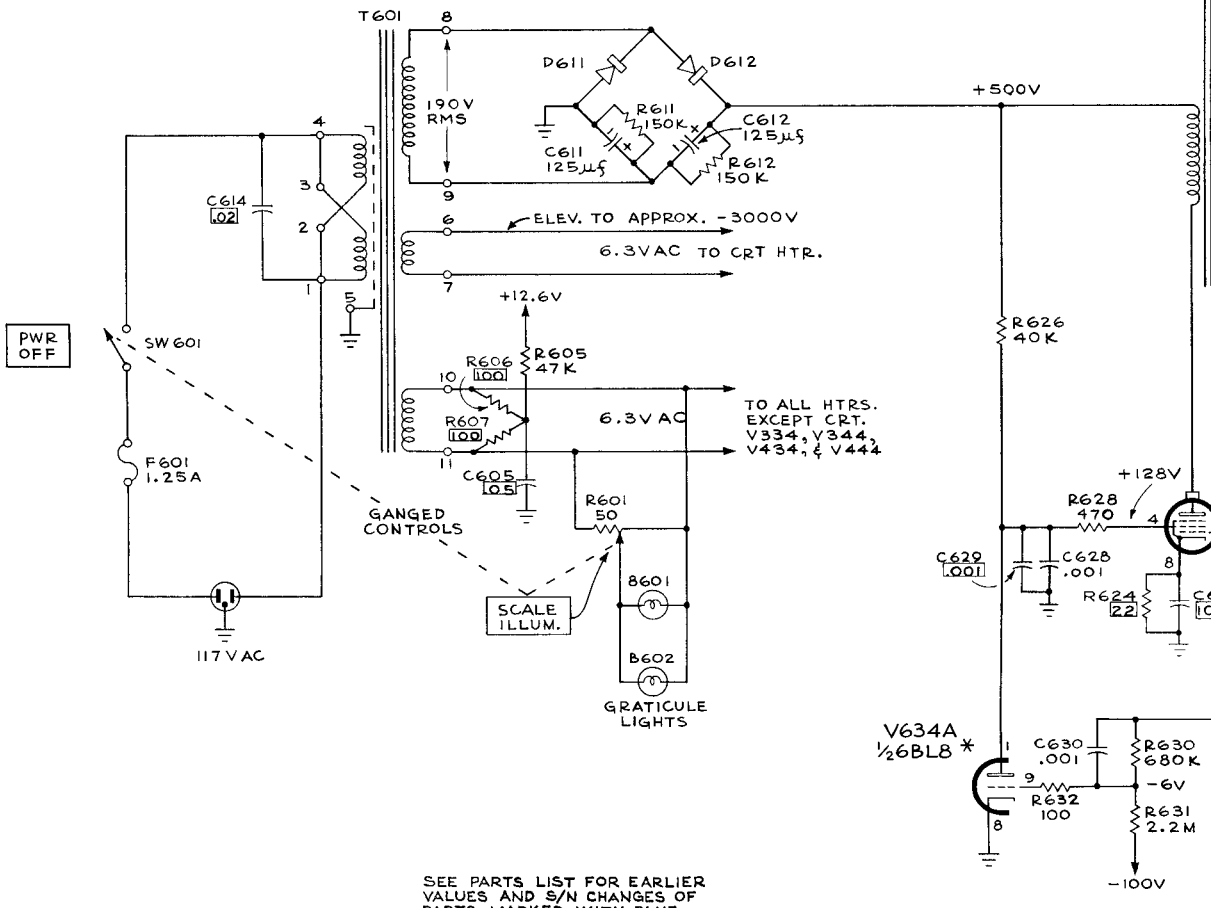


SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

GAB
364

E2

CRT CIRCUIT & CALIBRATOR

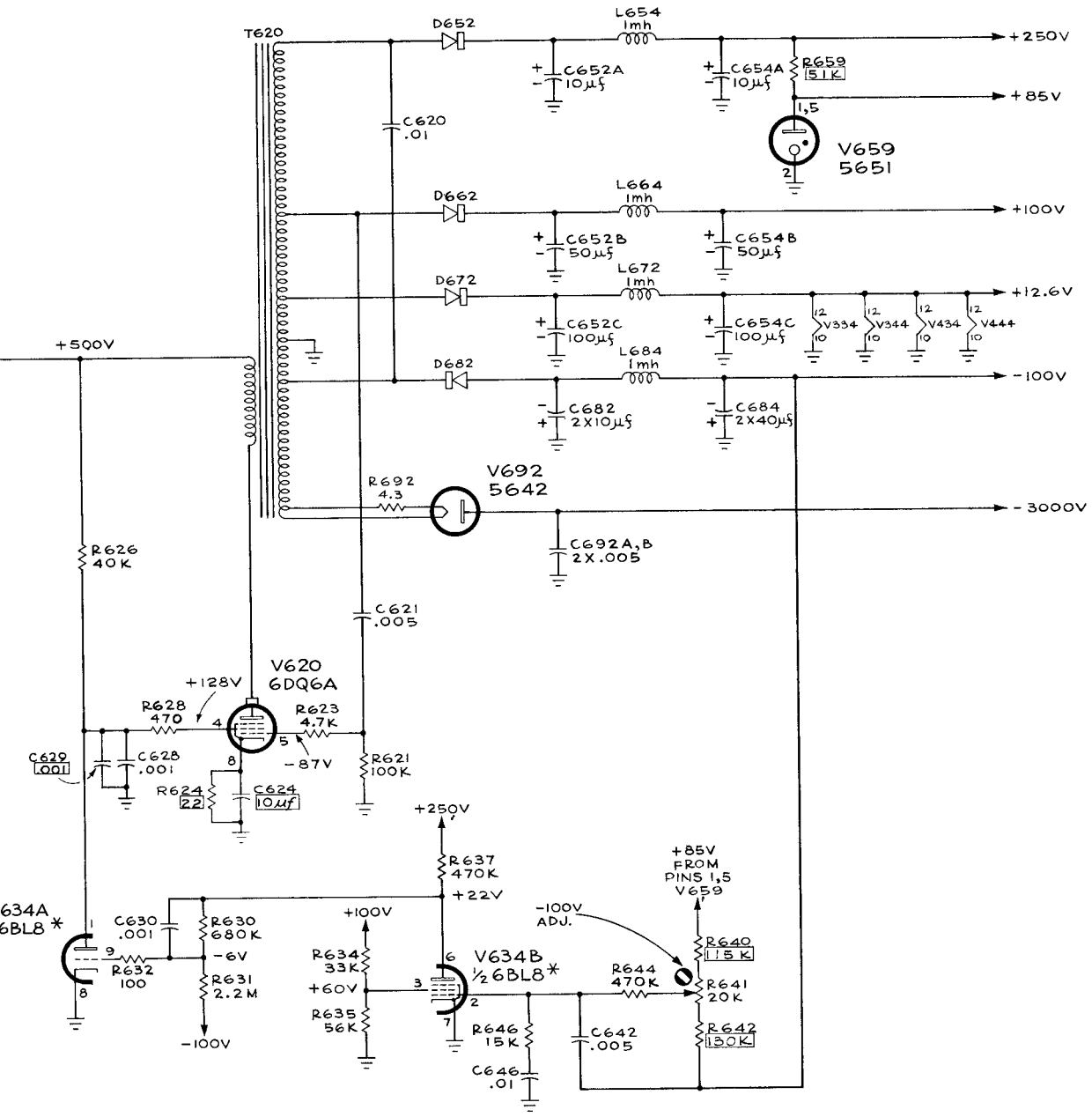


SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE.

* ECF80 MAY BE SUBSTITUTED

VOLTA
WITH CC
LINE VOL
TRIGGER
SEE ALSO

TYPE 503 OSCILLOSCOPE



* ECF80
MAY BE SUBSTITUTED

VOLTAGE READINGS WERE OBTAINED
WITH CONTROLS SET AS FOLLOWS:

LINE VOLTAGE . . . . . 117 V 60 CPS

TRIGGER LEVEL (SWEEP DISABLED) . . . . . CCW BUT NOT SWITCHED TO AUTO

SEE ALSO **IMPORTANT** NOTE ON SWEEP TRIGGER DIAGRAM

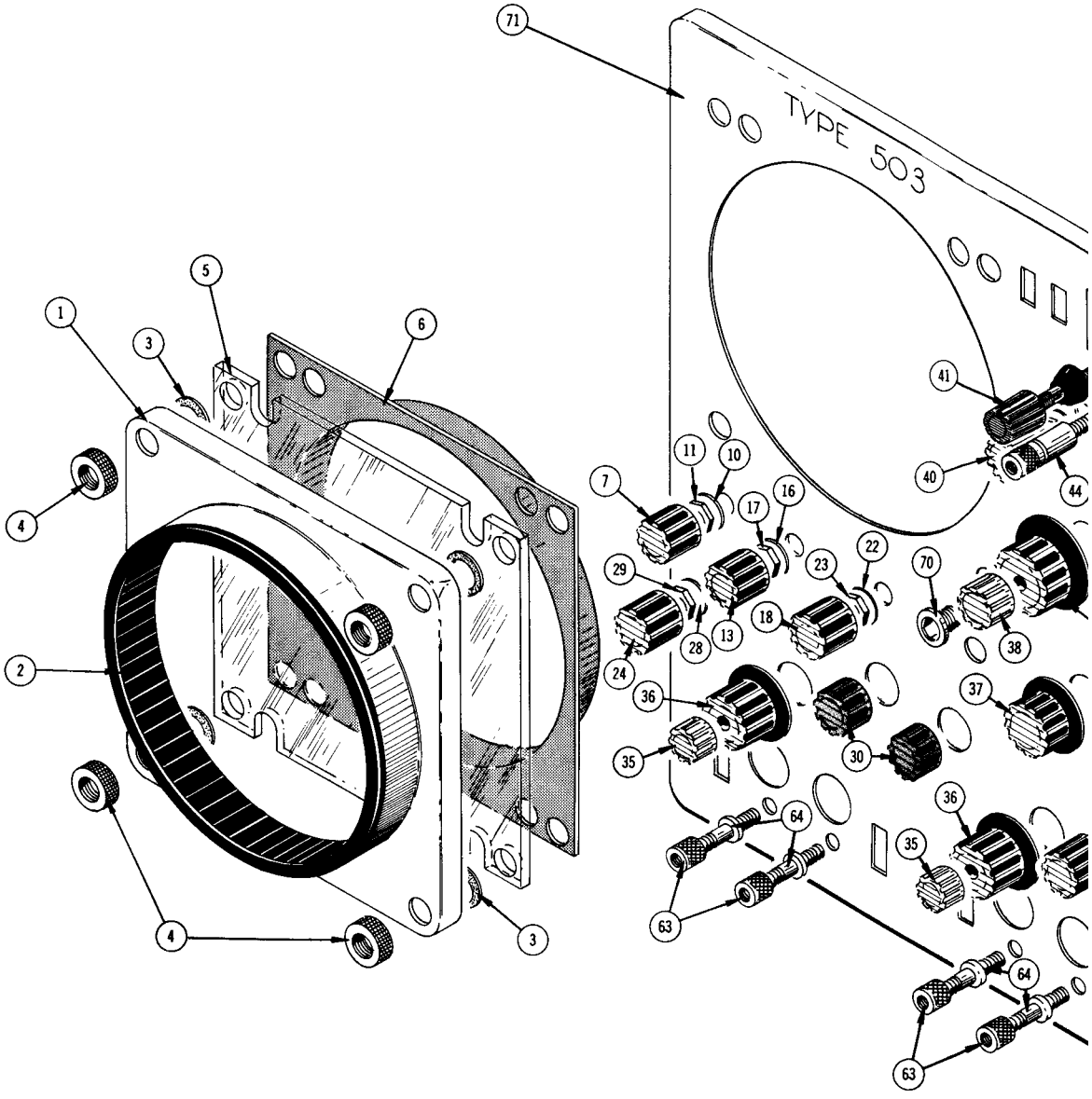
503 A POWER SUPPLY

G.A.B.

266

POWER SUPPLY

FIG. 1 FRONT


TYPE 503
1
2
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72

A

FIG. 1 FRONT

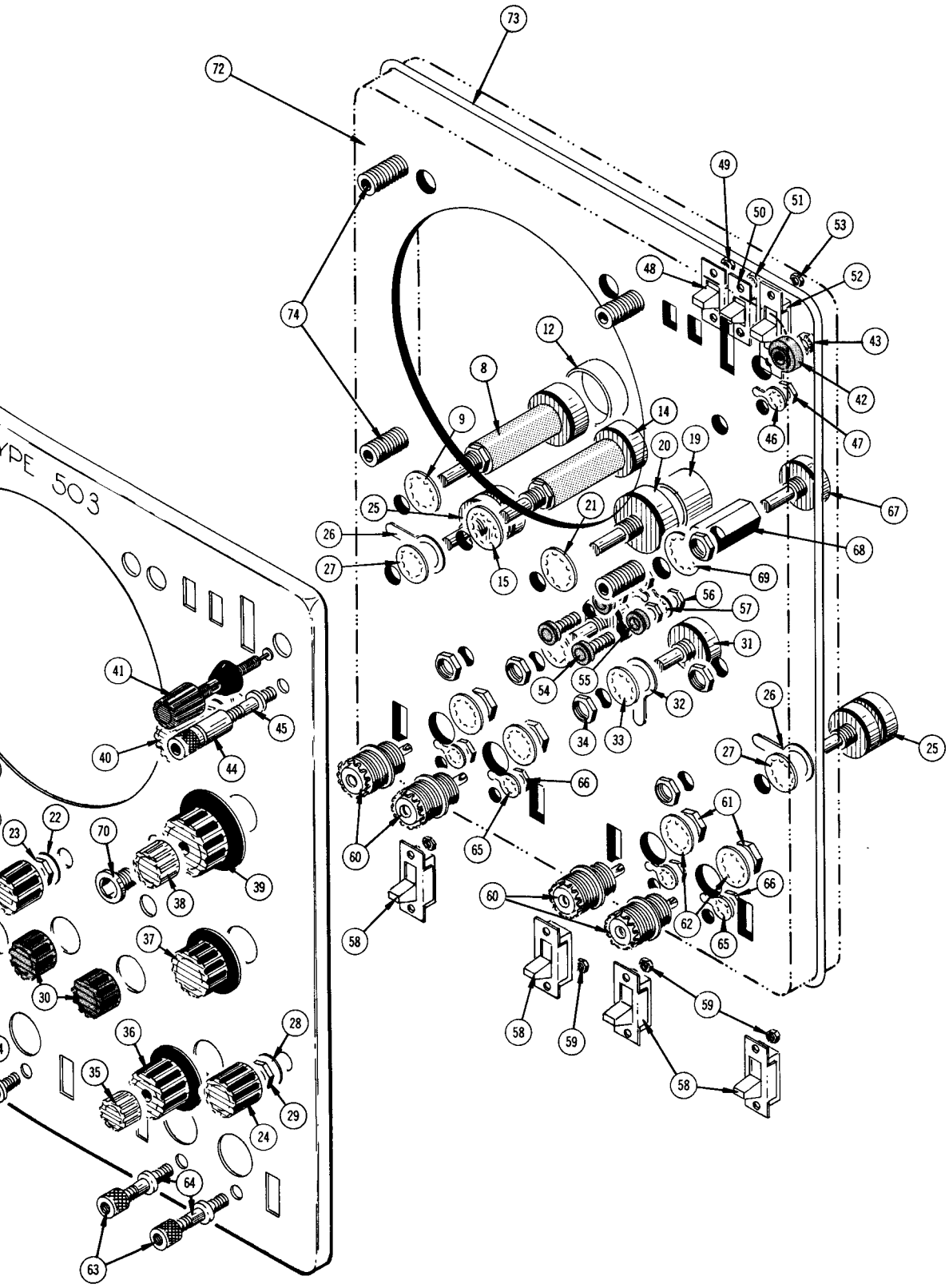


FIG. 2 SWITCHES

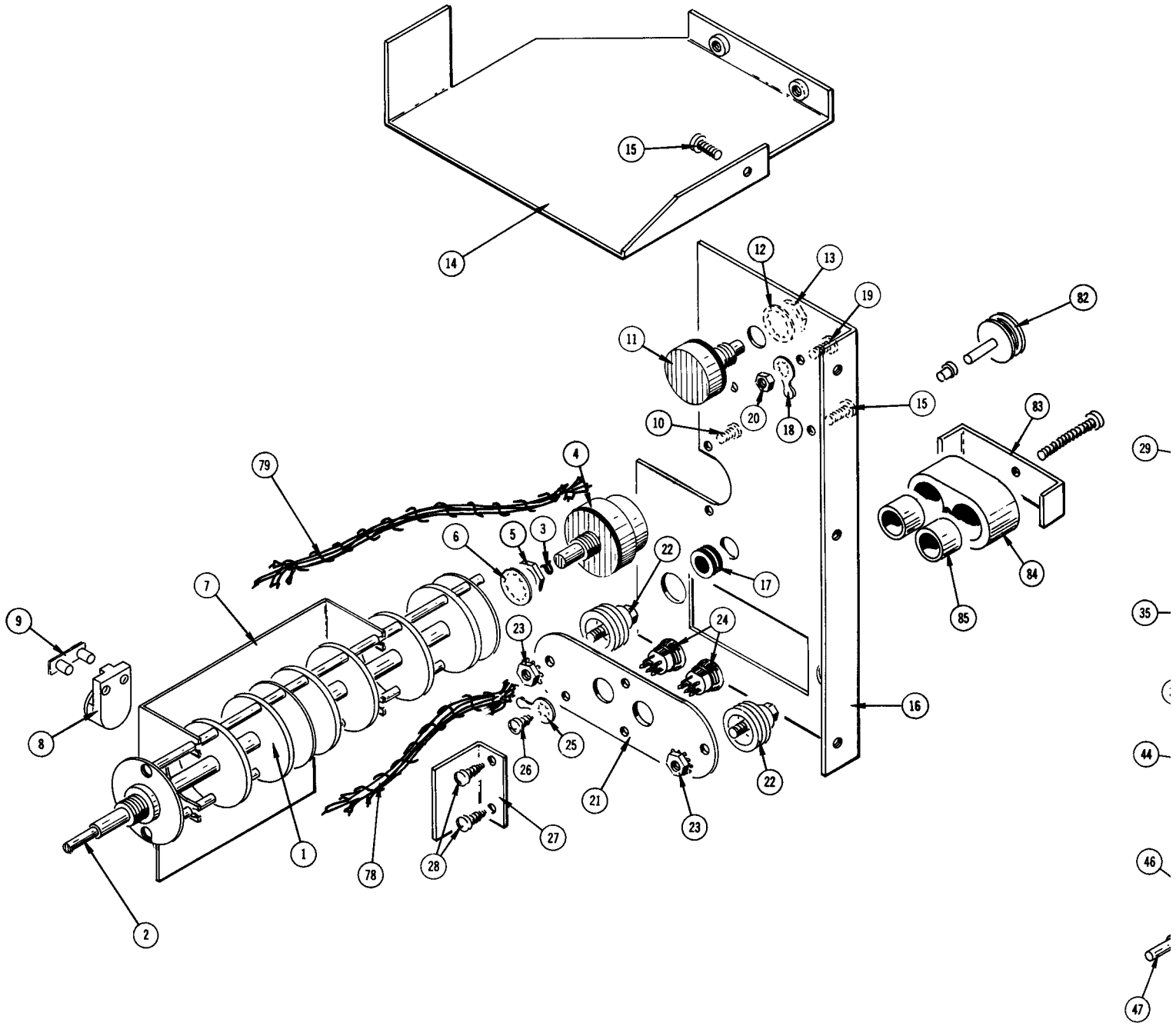


FIG. 2 SWITCHES

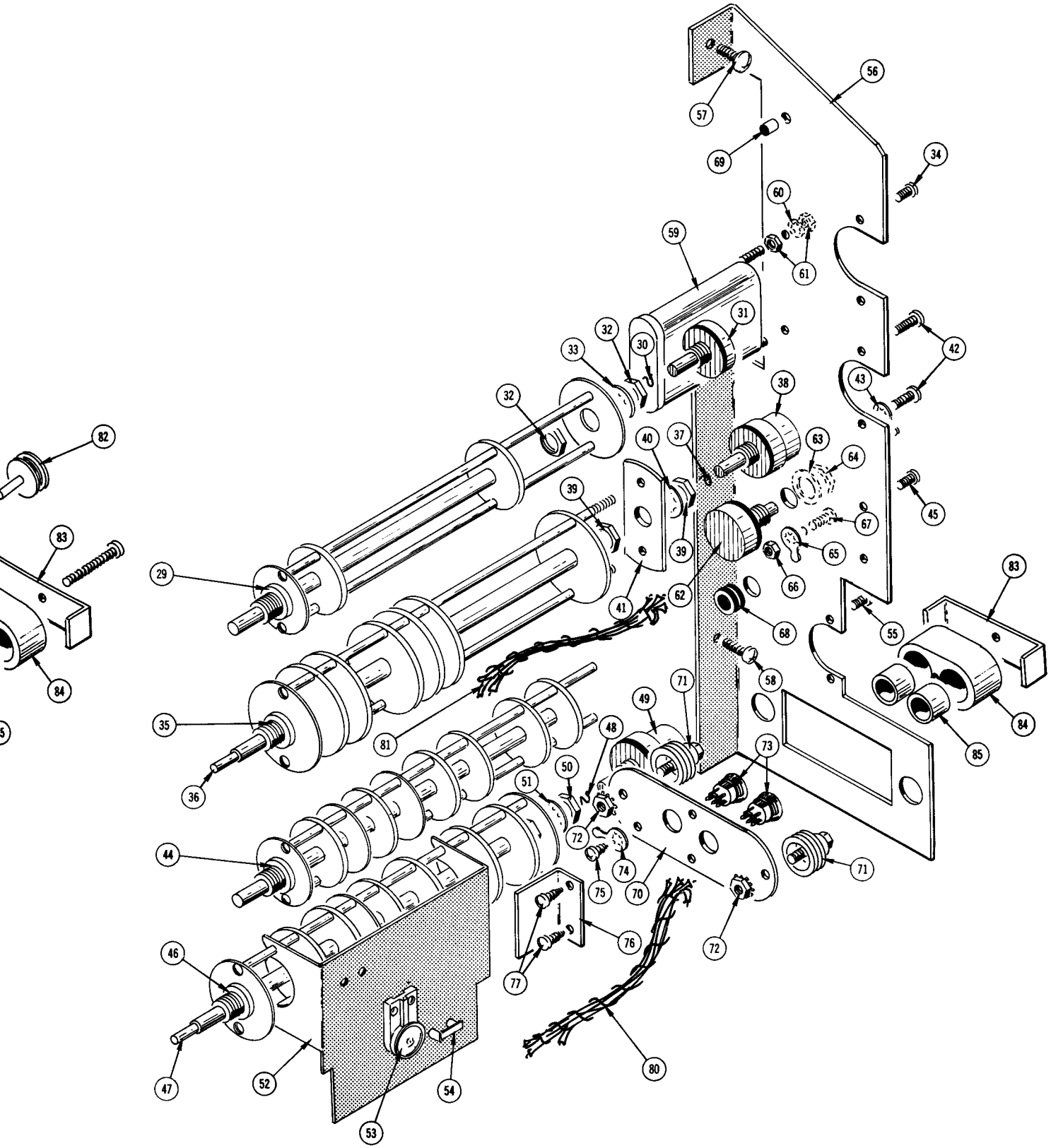


FIG. 3 CRT SHIELD

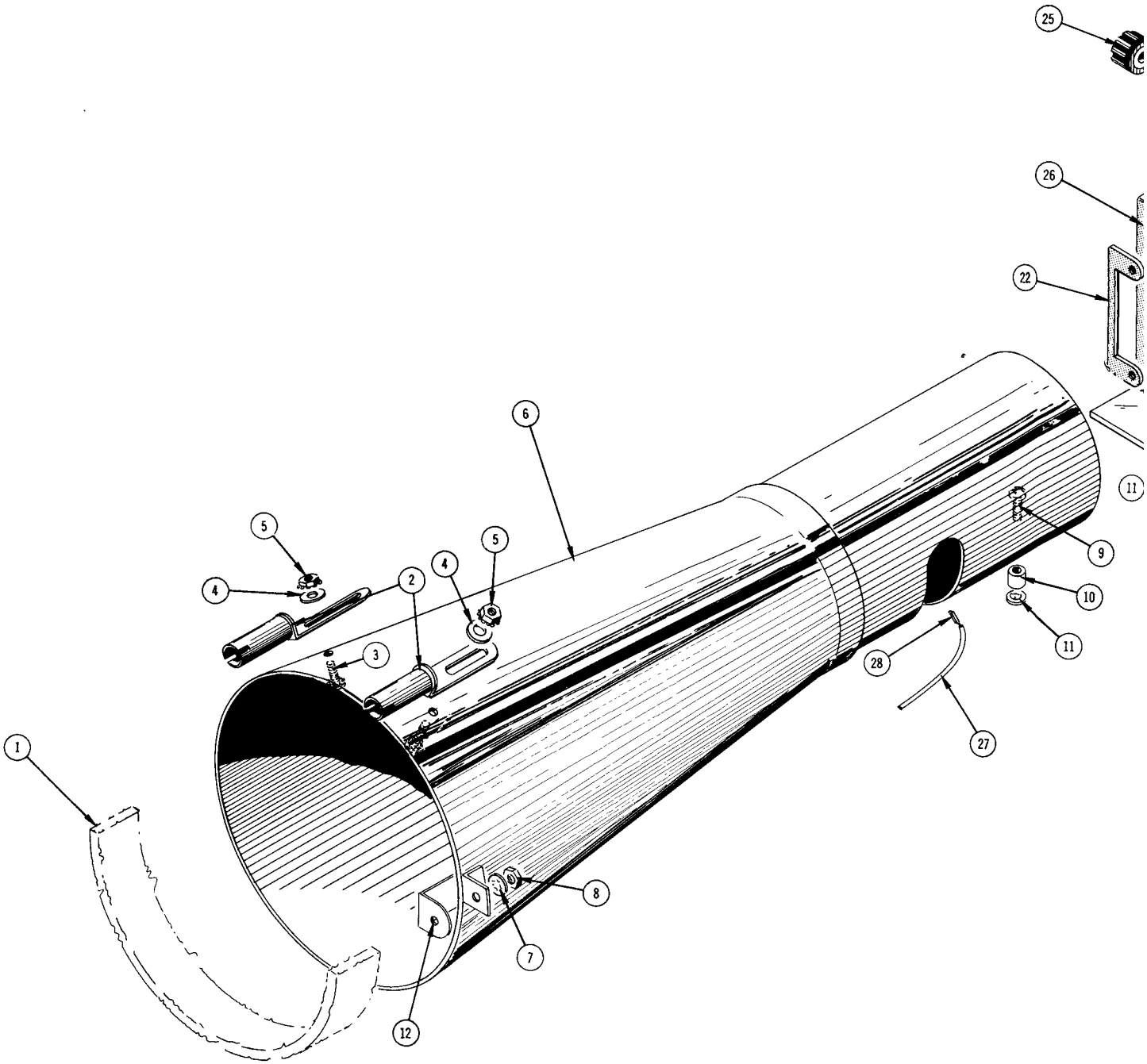


FIG. 3 CRT SHIELD

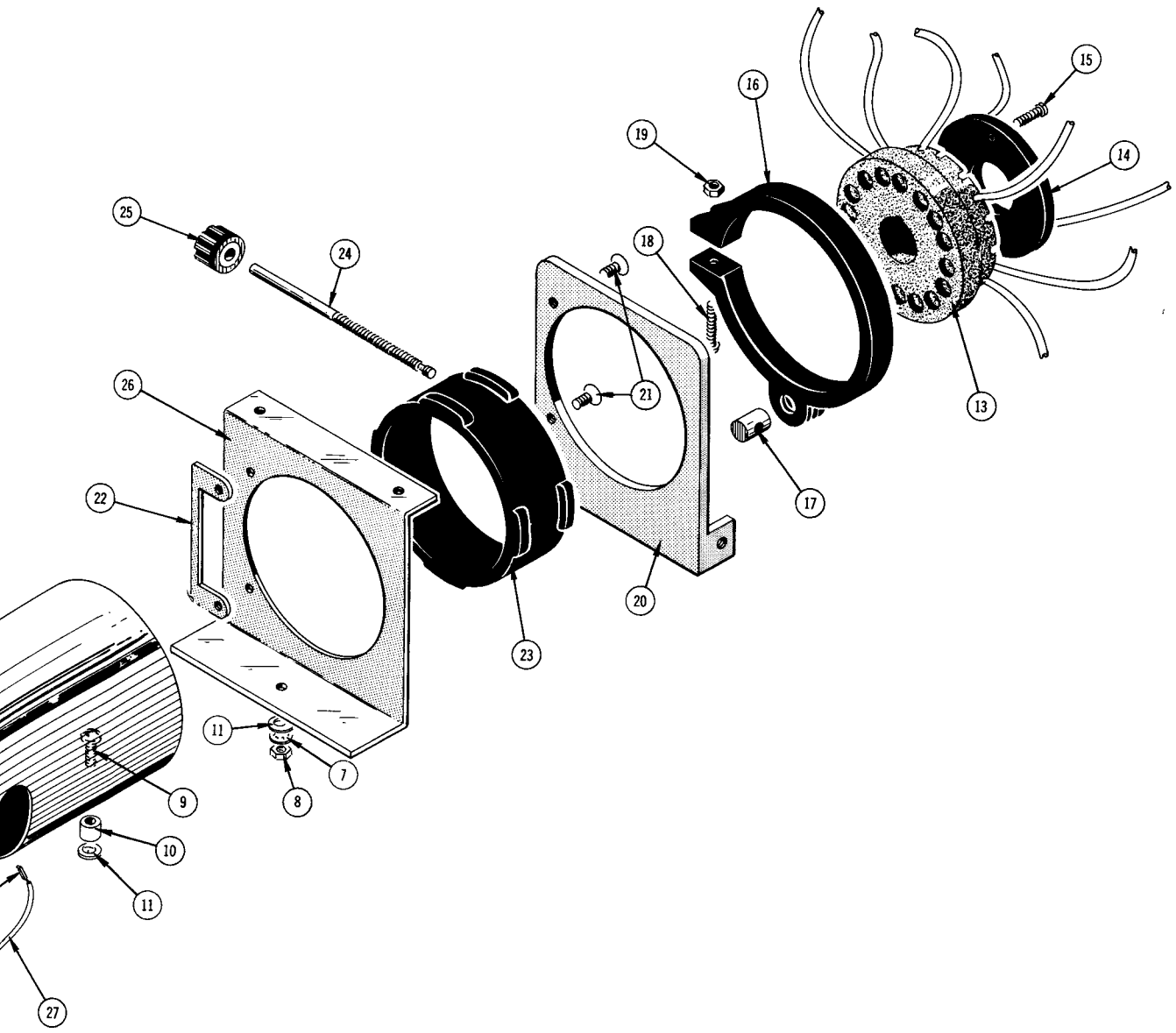
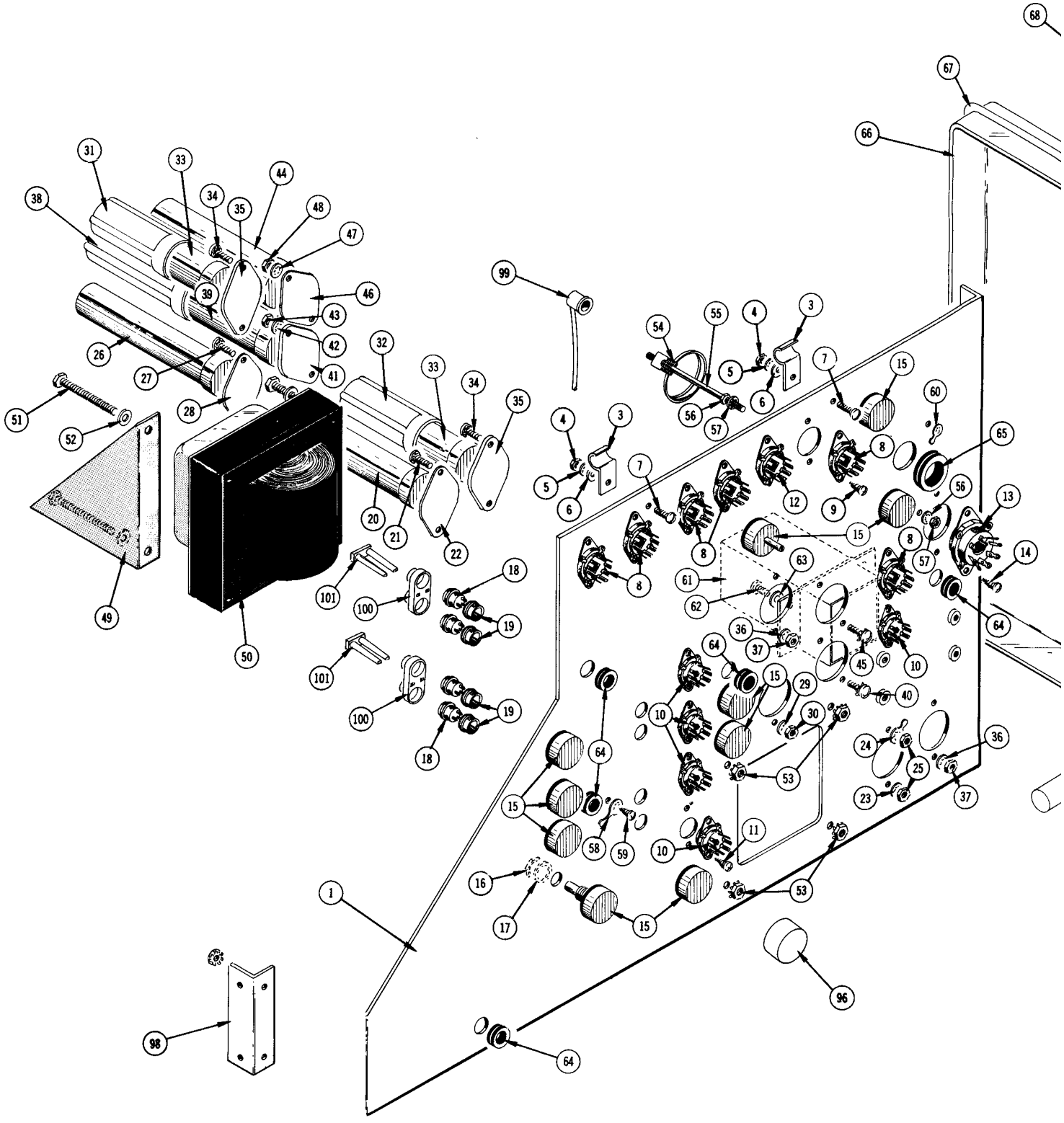


FIG. 4 CHASSIS & REAI



A 1

FIG. 4 CHASSIS & REAR

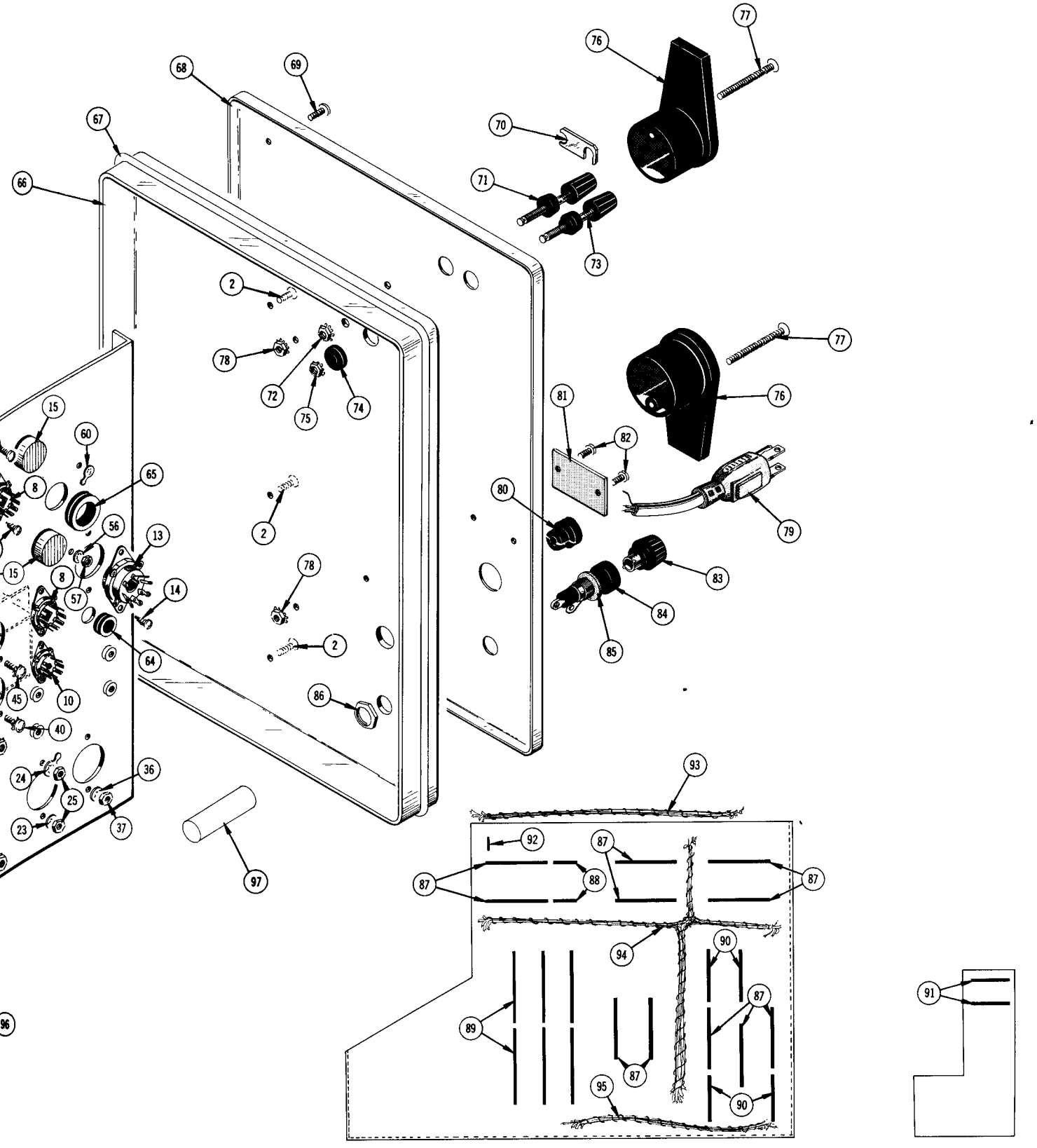
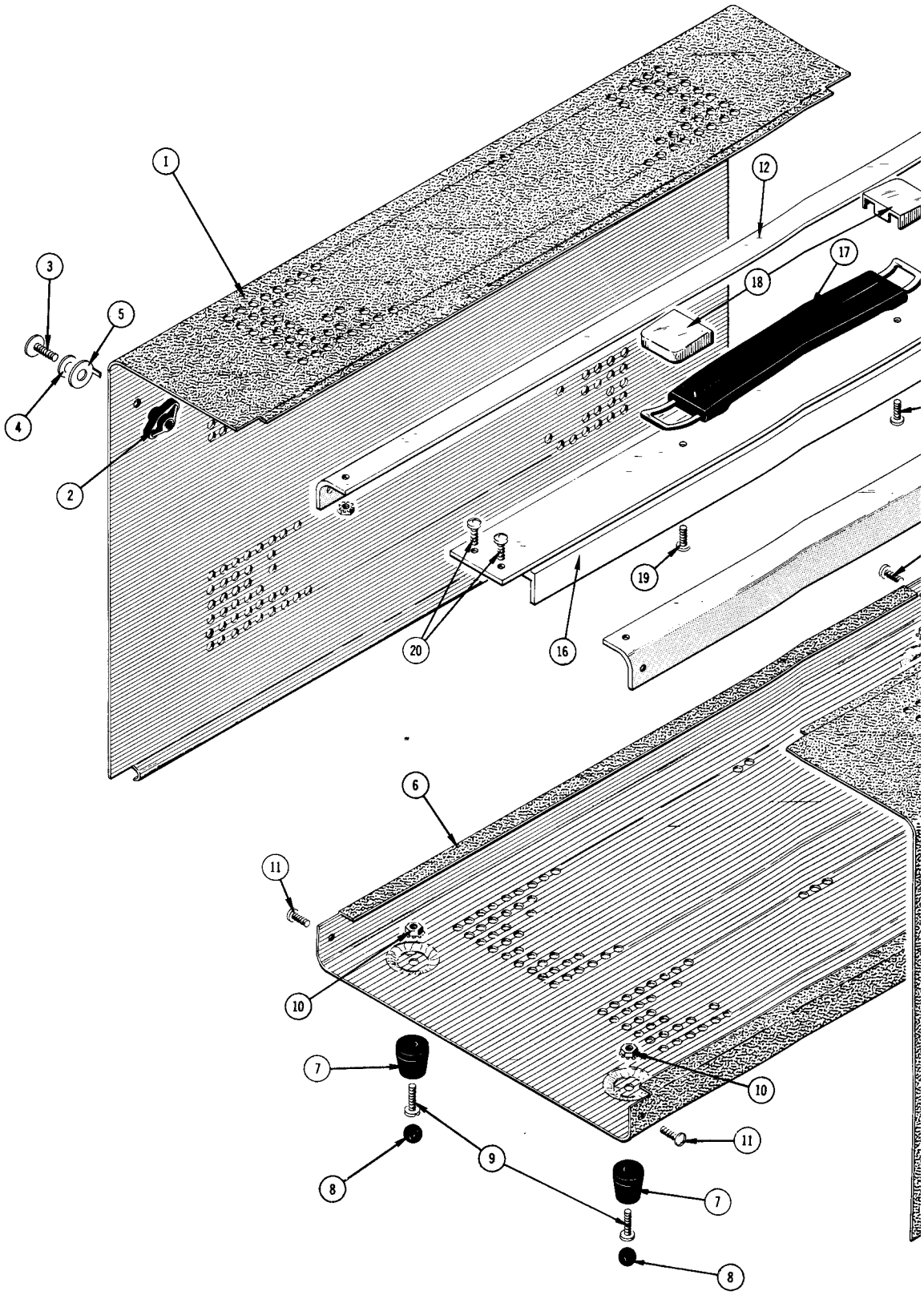


FIG. 5 CABINET



A

FIG. 5 CABINET

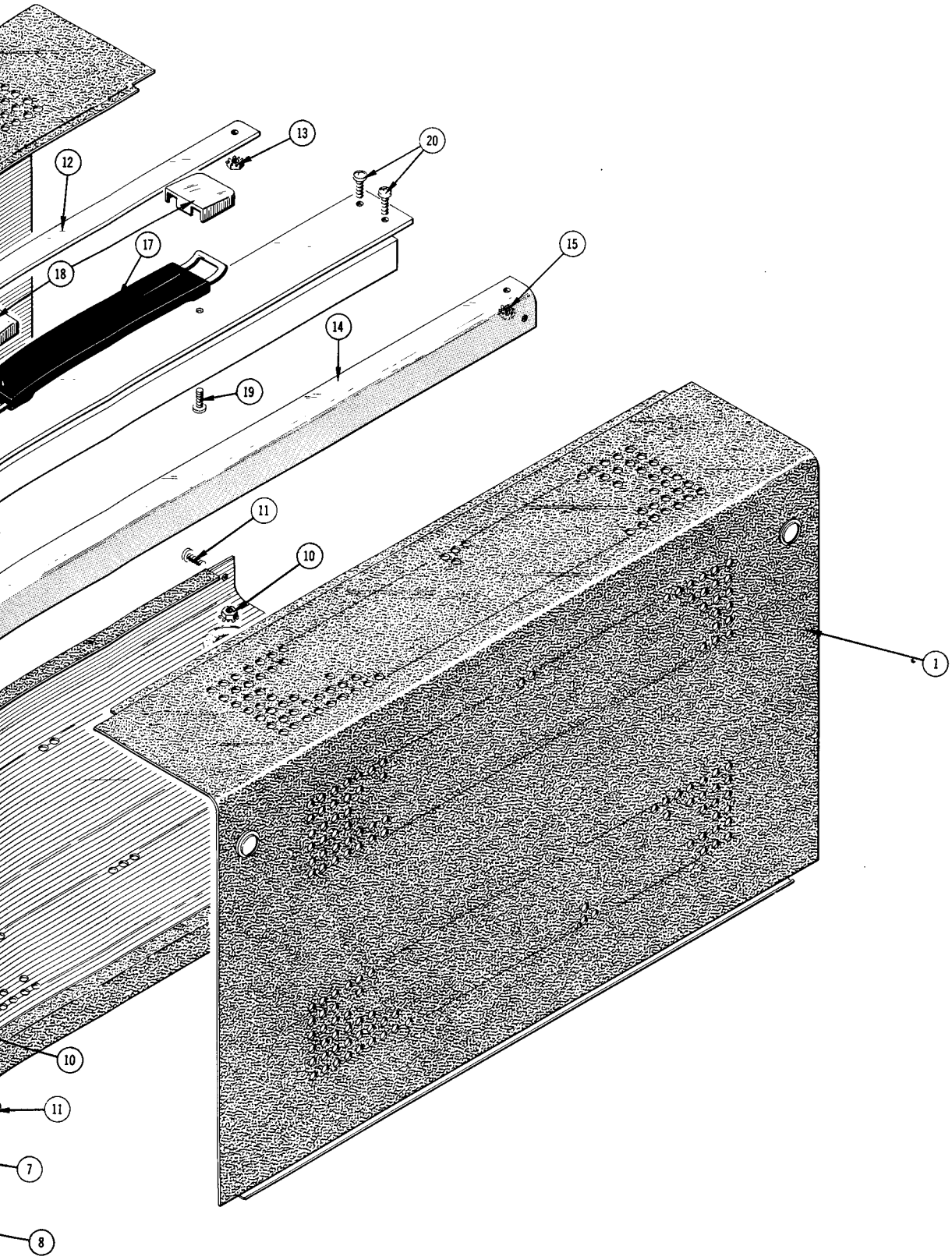
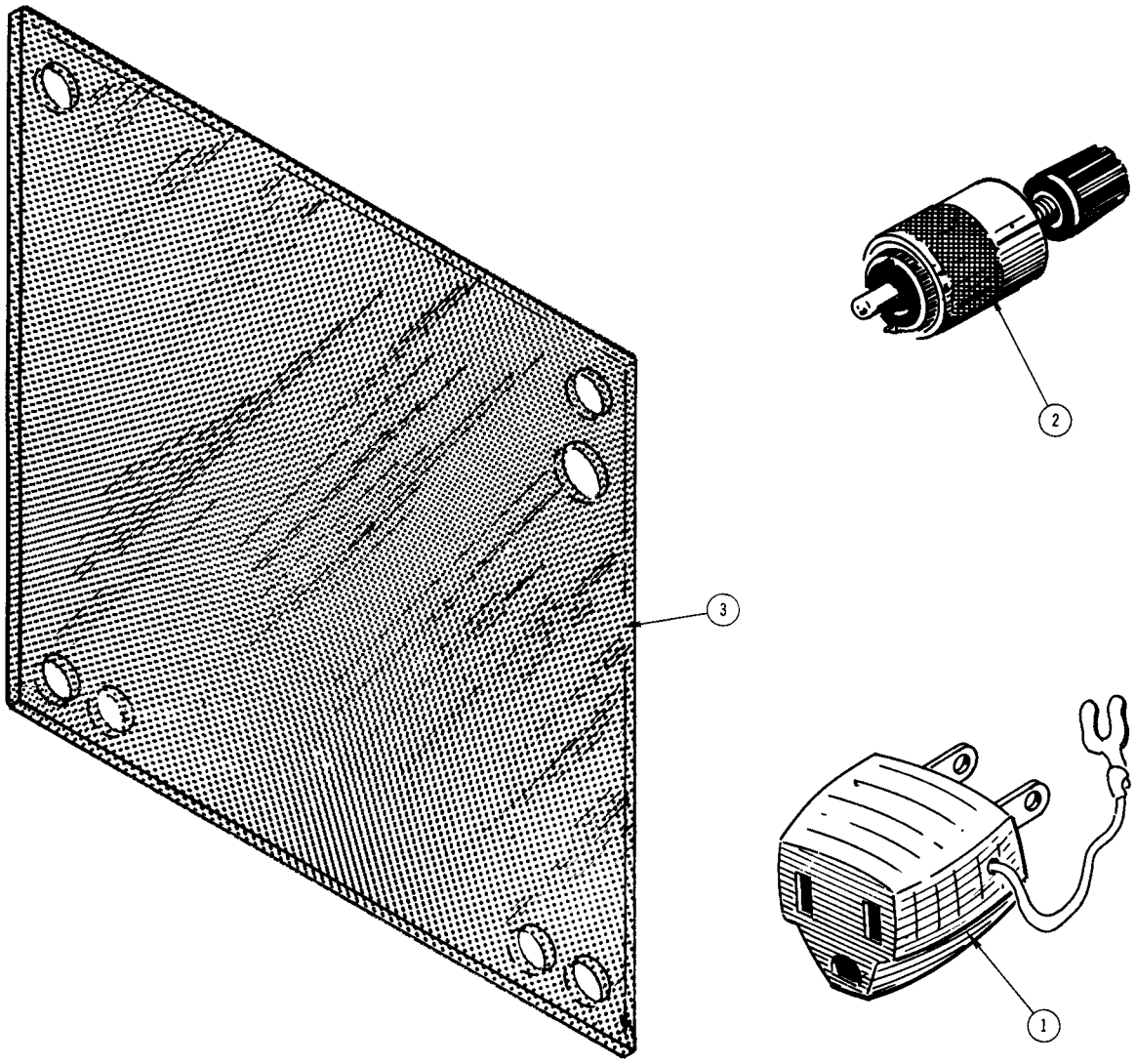


FIG. 6 STANDARD ACCESSORIES



A

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty 1 2 3 4 5	Description
6-1	103-0013-00			1	ADAPTER, power cord, 3 wire to 2 wire
-2	013-0004-00			2	ADAPTER, binding post
-3	378-0522-00	X2340	3059	1	FILTER, light, green
	378-0514-00	3060	7359	1	FILTER, light, green
	378-0567-00	7360		1	FILTER, light, smoke gray
	070-0218-01			2	MANUAL, instruction (not shown)

©

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE 503 TENT SN 10170

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

V374	154-0367-00	8136
V384	154-0367-00	8136
V474	154-0367-00	8136
V484	154-0367-00	8136

M12,949/368

TYPE 503 TENT SN 10180

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

V334 V344	157-0127-00	8393	Checked pair
V434 V444	157-0127-00	8393	Checked pair

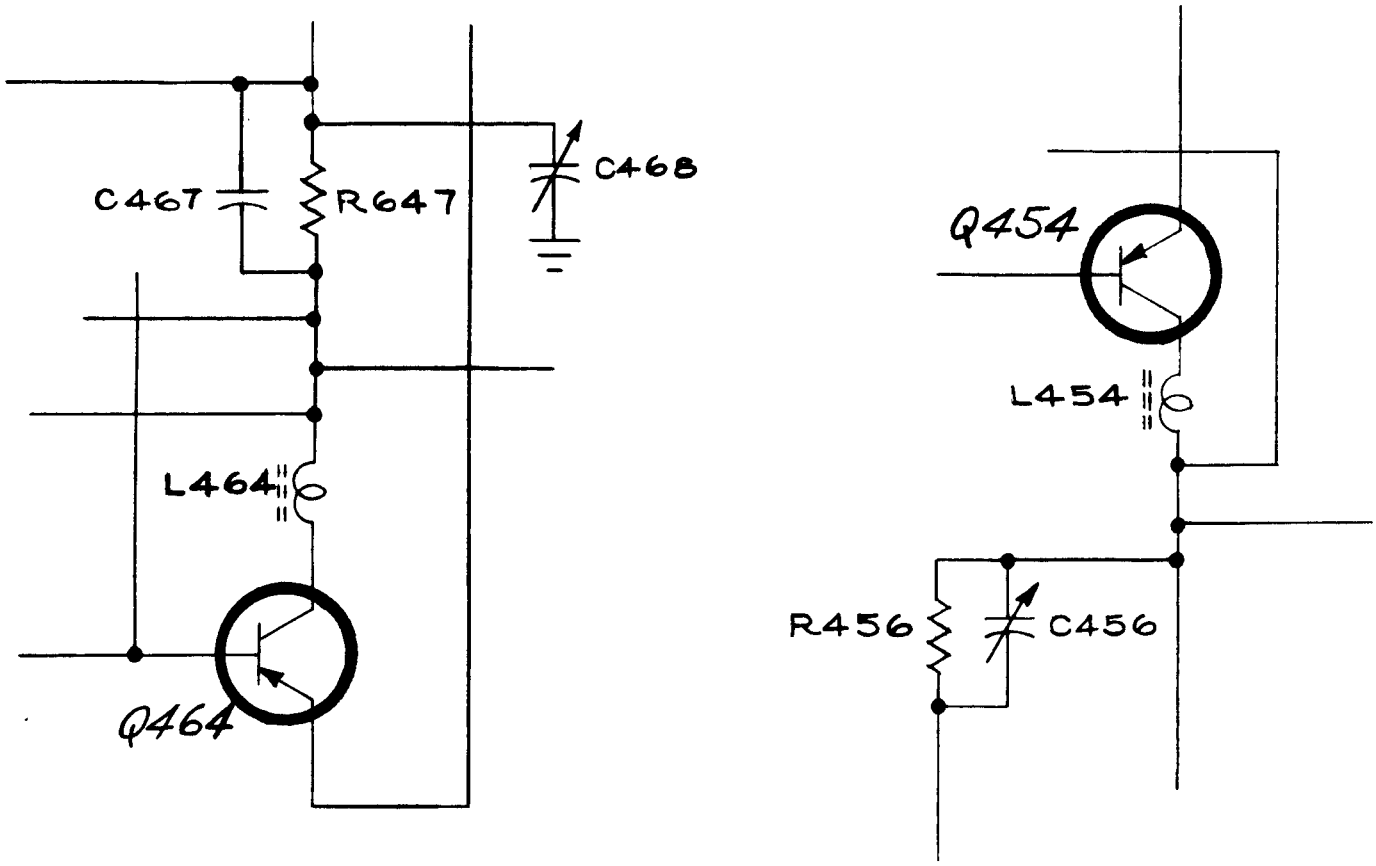
M13,669/468

ELECTRICAL PARTS LIST CORRECTION

ADD:

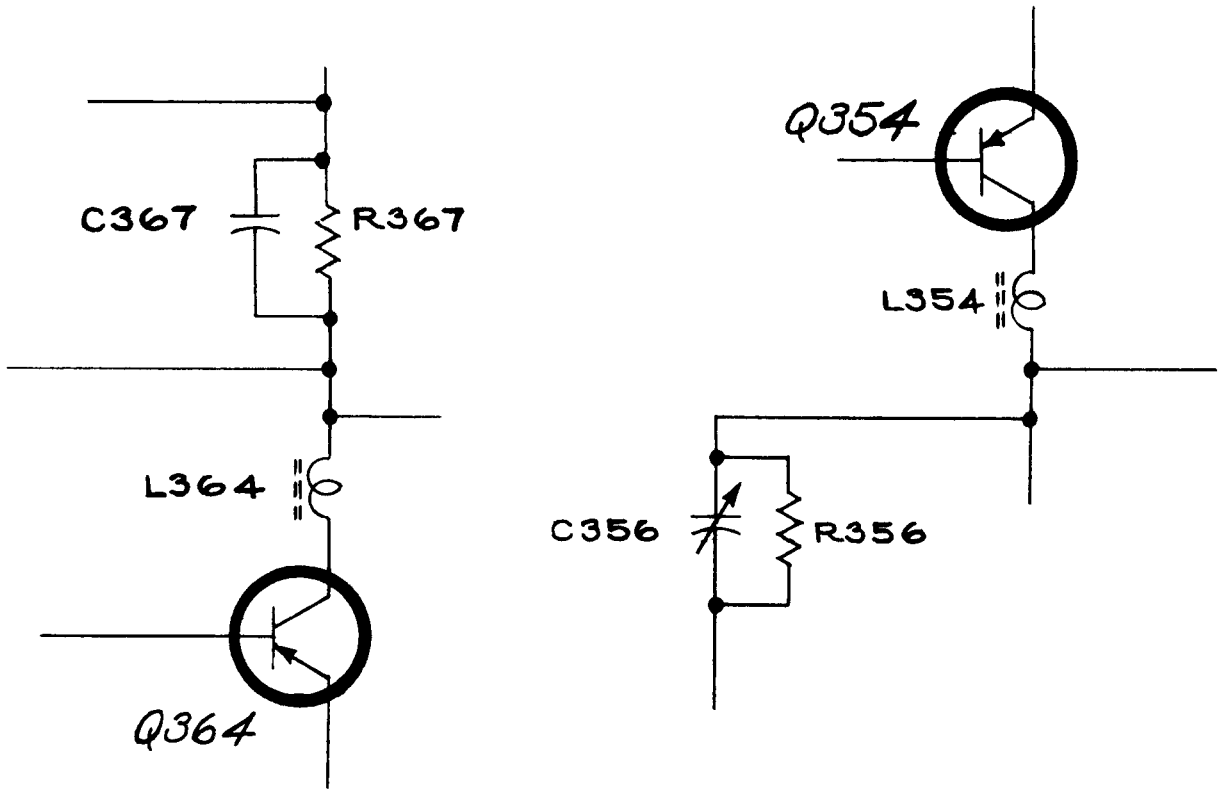
L354	276-0507-00	0.6 μH
L364	276-0507-00	0.6 μH
L454	276-0507-00	0.6 μH
L464	276-0507-00	0.6 μH

SCHEMATIC CORRECTION



PARTIAL
VERTICAL AMPLIFIER

SCHEMATIC CORRECTION



PARTIAL
HORIZONTAL AMPLIFIER