INSTRUCTION MANUAL

TYPE 561S OSCILLOSCOPE SYSTEM

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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.

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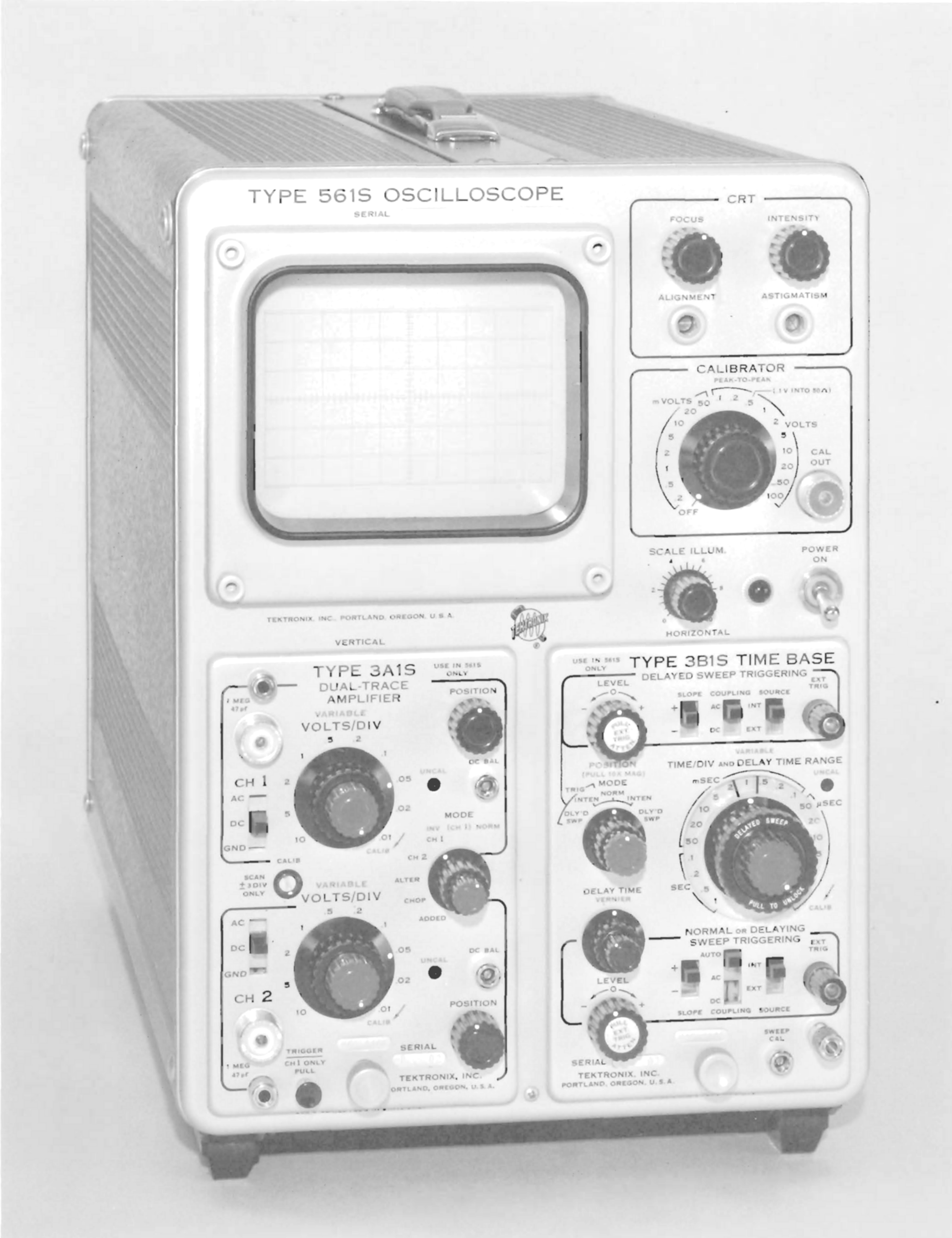
CONTENTS



Type 561S Oscilloscope System.

SECTION 1

CHARACTERISTICS

General Information

The Type 561S Oscilloscope system consists of a plug-in dual-trace amplifier (Type 3A1S), a plug-in delaying sweep time-base unit (Type 3B1S) and the indicator unit (Type 561S). The indicator and plug-in units are not interchangeable with units that are not suffixed with the letter 'S'. One exception is that any Tektronix 2- or 3-Series (non-sampling) plug-in unit can be operated in the right-hand opening of the Type 561S.

Type 561S

Crt	Type T5033. Deflection factor: vertical 11.1 to 12.3 volts/cm and horizontal 19.4 to 21.4 volts/cm.
Accelerating Potential	3.5 kv.
Amplitude Calibrator	Square-wave output from 0.2 mvolts to 100 volts peak-to-peak at line frequency. Voltage accuracy is ±3%. Risetime is about 5 μsec.
Line Voltage Requirements	105-125/210-250 volts rms with a line frequency of 50-400 cps.
Power Requirement	210-240 watts.
Ambient Temperature Range*	20° F to 120° F (—7° C to 49° C).
Mechanical Features	Construction: Aluminum-alloy chassis with a three-piece cabinet. Dimensions: 14½ in. high by 10 in. wide by 21⅛ in. deep. Net Weight: 28 lbs.

Type 3A1S

Sensitivity	10 mv/div to 10 v/div in 10 fixed steps (1, 2, 5 sequence). Accuracy is 3% when the VARIABLE control is set to CALIB.
Bandwidth	Dc to 25 mc with a corresponding risetime of about 14 nsec, (3 db down, ±1 db, at 25 mc).
Input Coupling	Ac or dc. Ac coupling limits the low-frequency response to about 2 cps (0.2 cps with a 10× passive probe).
Input Impedance	1 megohm (±1%) paralleled by about 47 pf.
Operating Modes	Channel 1 or 2 only, alternate or chopped dual-trace operation and algebraic addition or subtraction. The chopping frequency in the chopped mode of operation is about 100 kc.
Between-Channel Isolation	About 47 db.
Input Connectors	Female UHF.
Dynamic Deflection Range	±3 cm with respect to crt center.
Mechanical Features	Dimensions: 6½ in. high by 4¼ in. wide by 14½ in. deep. Net Weight: 5 lbs.

Type 3B1S

Sweep Rates	0.5 μsec/div to 1 sec/div in twenty fixed steps (1, 2, 5 sequence). Accuracy is 3% when the VARIABLE (Time/Div) control is set to CALIB.
Sweep Magnification	A 10X sweep magnifier increases the sweep rate ten times at any setting of the TIME/DIV switch. Accuracy is 5%.
Sweep Delay	Sweep delay can be varied (uncalibrated) from 0.5 μsec to 10 sec. Time jitter is less than 1 part in 20,000.
Trigger Source	Internal or external (both time-base circuits).
Trigger Coupling	Automatic, ac or dc in the Normal or Delaying Sweep Triggering mode. Ac and dc in the Delayed Sweep Triggering mode.
Trigger Slope	+ or —.
Trigger Signal Requirements	Internal: Displayed amplitude must be at least 4 mm at 1 kc. External: Two ranges available; ±0.5 to ±15 volts and ±5 to ±150 volts. Frequency: Dc to 5 megacycles with reduced sensitivity at higher frequencies.
Mechanical Features	Dimmensions: 6½ in. high by 4¼ in. wide by 14½ in deep. Net Weight: 5¼ lbs.

Accessories

	Tektronix Part No.
1 — Power cord	161-010
1 — 3-wire to 2-wire adapter	103-013
1 — Light filter	378-525
2 — P6006 Probe packages	020-007
2 — Instruction manuals	070-417

*The Type 561S is equipped with a thermal cutout which disconnects instrument power if the temperature exceeds safe operating limits. At sea level and with the line voltage within the nominal range, the cutout will actuate if the internal temperature of the instrument exceeds about 160° F or if the ambient temperature exceeds about 122° F.

SECTION 2
OPERATING INSTRUCTIONS

FUNCTION OF FRONT-PANEL CONTROLS AND CONNECTORS

Type 561S

FOCUS	Provides adjustment for a well-defined display.
INTENSITY	Controls brightness of the display.
ALIGNMENT	Aligns the trace with the horizontal graticule markings.
ASTIGMATISM	Used in conjunction with the FOCUS control in obtaining a well-defined display.
CALIBRATOR	Rotary 19-position switch that selects the calibrator voltage at the CAL OUT connector.
CAL OUT	UHF female connector for making connection to the calibrator.
SCALE ILLUM	Controls graticule illumination.
POWER ON	Toggle switch for turning the instrument on and off.
CRT CATHODE SELECTOR (Rear Panel)	Switch should be in the down position when the vertical plug-in unit is operated in the dual-trace chopped mode. Switch should be in the up position during normal operation or when an external blanking signal is applied to the EXT CRT CATHODE binding post.
EXT CRT CATHODE	Binding post that is ac coupled to the crt cathode.
GND	Binding post ground connection.

Type 3A1S

Functions of the input connectors, VOLTS/DIV, VARIABLE, AC-DC-GND, POSITION, and DC BAL controls are the same for both channels.

INPUTS	Female UHF connectors for applying the signal to be displayed.
POSITION	Controls vertical position of the display.
VOLTS/DIV	Sets vertical deflection factor. (VARIABLE control must be set to CALIB for the deflection factors to be as indicated by the VOLTS/DIV switch.)
VARIABLE	Varies the deflection factor at any given setting of the VOLTS/DIV switch by a ratio of about 2.5:1.
UNCAL	Lamp that lights to warn when the VARIABLE control is not set to CALIB.
DC BAL	Screwdriver adjustment that sets the amplifier for no trace shift when the VARIABLE control is turned (with no signal applied).
CALIB	Screwdriver adjustment that matches the basic deflection factor of the plug-in unit to the vertical deflection factor of the indicator-unit crt.
MODE	CH 1: Allows only Channel 1 to display a signal. CH 2: Allows only Channel 2 to display a signal. ALTER: Allows both channels to display a signal; alternating after each sweep. CHOP: Allows both channels to display a signal alternately during each sweep. ADDED: Allows both channels to operate simultaneously. The resultant display is the algebraic sum or difference of the two channels.
INV (CH 1) NORM	Inverts the Channel 1 display in the INV position. Provides algebraic subtraction of two signals when the MODE switch is set to ADDED.
AC-DC-GND (Input Coupling Switch)	AC: Blocks the dc component of an applied signal from the input stage of the instrument. DC: Directly couples the applied signal to the input stage of the instrument. GND: Grounds the input of the instrument (without grounding the input signal).
TRIGGER CH 1 ONLY PULL	A pull switch that internally couples only the Channel 1 signal to the triggering circuit. The signal is free from any between-channel switching transients.

Type 3B1S

MODE	NORM: Selects a normal sweep at a rate set by the TIME/DIV switch and triggering controlled by the NORMAL SWEEP TRIGGERING controls. INTEN: Intensifies a portion of the delaying sweep display. Width of the intensified portion is determined by the setting of the DELAY TIME RANGE and the position on the display is controlled by the DELAY TIME control. DLY'D SWP: Expands the intensified portion across the full crt width. The sweep rate of this display is set by the DELAYED SWEEP knob. TRIG INTEN: Intensifies a portion of the delaying sweep display. The delayed sweep must be triggered for the intensified portion to appear. The position of the intensified portion depends on the setting of the Delayed Sweep Triggering LEVEL control and the DELAY TIME control.

	TRIG DLY'D SWP: Expands the intensified portion of the display (set in the TRIG INTEN position) across the full width of the crt. The sweep rate of this display is set by the DELAYED SWEEP switch.
POSITION	Moves the display horizontally. The POSITION control also serves as the 10× MAG switch; pull out to increase the sweep rate by 10×.
TIME/DIV AND DELAY TIME RANGE	Two switches in one. The large black knob has a white dot on its edge. When the white dot is set between the two black stripes on the plastic ring, the switches are locked together and the knobs set the sweep rate for both the normal and delayed sweeps. When the black knob is pulled out, it unlocks and may be turned to set the sweep rate of the delayed sweep and the delay time range. The TIME/DIV switch of the normal sweep (clear plastic ring) remains in position and the DELAYED SWEEP knob can be set independently.
VARIABLE	Red knob mounted concentrically with the TIME/DIV and DELAY TIME RANGE switch. Provides a continuously variable sweep rate from 0.5 μsec to 2.5 sec/div (uncalibrated). When the MODE switch is in the NORM position, the VARIABLE TIME/DIV control varies the time per division of the normal sweep. In all other positions of the MODE switch the control varies the time per division of the delayed sweep. When the VARIABLE TIME/DIV control is turned fully clockwise it clicks into the CALIB position. When the control is not in the CALIB position, the neon UNCAL lamp lights.
DELAY TIME	Sets the point on the display where the delayed sweep starts (this is the beginning of the intensified portion when the MODE switch is in one of the INTEN positions).
VERNIER	A fine adjustment for the DELAY TIME control.
SWEEP CAL	A screwdriver adjustment to compensate for the slight variations between indicator units.
EXT TRIG	Jacks for applying an external trigger signal to the desired sweep circuit. The corresponding SOURCE switch must be set to EXT to trigger externally.
SOURCE	Selects either an internal or external triggering signal for the corresponding sweep circuit.
COUPLING	Selects either ac or dc coupling of the triggering signal. The AC position blocks any dc component of the triggering signal. The COUPLING switch of the Normal or Delaying Sweep Triggering block has an AUTO position which automatically free runs the sweep in the absence of a triggering signal. A suitable trigger signal, however, will override the auto circuity and stable triggering will result when the LEVEL control is set properly.
SLOPE	Determines whether the sweep starts on the rising (+) or falling (—) portion of the triggering signal.
LEVEL	Determines the amplitude point on the triggering signal where sweep triggering occurs. The + direction allows the sweep to trigger at some higher positive point on the triggering signal and the — direction triggers the sweep at some higher negative point on the triggering signal. When the LEVEL control is pulled, a trigger attenuator is switched in to allow greater triggering range for external triggering.

Preliminary Operation

The following steps demonstrate the basic operation of the Type 561S Oscilloscope system.

1. Insert the Type 3A1S into the left-hand plug-in compartment and the Type 3B1S into the right-hand plug-in compartment of the Type 561S. Apply power and allow sufficient time for warmup.
2. Set the system controls as follows:

Type 561S

CALIBRATOR	1 VOLTS*
FOCUS	Midrange
INTENSITY	Counterclockwise
ASTIGMATISM	Midrange
SCALE ILLUM	Clockwise
CRT CATHODE SELECTOR	CHOPPED BLANKING

Type 3A1S

POSITION (both)	Midrange
VOLTS/DIV (both)	.5 VOLTS
VARIABLE (both)	CALIB
MODE	CHOP
INV (CH 1) NORM	NORM
AC-DC-GND	DC
TRIGGER CH 1 ONLY	Pull out

Type 3B1S

MODE	NORM
POSITION	Midrange and pushed in
TIME/DIV AND DELAY TIME RANGE	10 mSEC

*To use the P6006 Probes with the Type 3A1S, set the Type 561S CALIBRATOR switch to 10 VOLTS.

VARIABLE TIME/DIV	CALIB
DELAY TIME	Midrange
VERNIER	Midrange
SOURCE (both)	INT
COUPLING (both)	AC
SLOPE (both)	+
LEVEL (both)	0 and pushed in

3. Connect the jumper leads between the Type 3A1S input connectors and the Type 561S CAL OUT connector.

4. Slowly turn the Type 561S INTENSITY control clockwise to set the displayed traces at the desired viewing level. (The POSITION controls of the vertical unit may require adjustment to get both traces into the viewing area of the graticule.)

5. Adjust the Type 3A1S POSITION controls slightly to associate the two displays with their respective channels. Set the ASTIGMATISM and FOCUS controls for a well-defined display.

6. Set the VOLTS/DIV switch of Channel 2 to 1; the Channel 2 display should cover 1 graticule division and the Channel 1 display should cover 2 divisions. If not, the CALIB control needs adjustment; see "CALIB Adjustment" in this section. Return the Channel 2 VOLTS/DIV switch to .5

7. Turn one of the Type 3A1S VARIABLE controls. Notice that the verical deflection of one of the displays decreases a ratio of approximately 2.5:1. Return the VARIABLE control to CALIB.

8. Set the Type 3B1S TIME/DIV AND DELAY TIME RANGE switch to 20 mSEC. Twice as many cycles of the calibrator waveform are now displayed on the crt. Return the TIME/DIV AND DELAY TIME RANGE to 10 mSEC.

9. Set the Type 3B1S MODE switch to INTEN (non-triggered).

10. Pull out the DELAYED SWEEP knob and set for a delay time range of 1 msec.

11. Adjust the INTENSITY control so that the intensified portion of the display is easily visible (the intensified portion of the display should be about 1 division long and be near the middle of the display).

12. Set the delay time of the Type 3B1S so that one of the rising portions of the calibrator waveform is intensified.

13. Set the Type 3B1S MODE switch to DLY'D SWP (non-triggered). The display should now be an expanded version (10×) of the intensified portion of the waveform observed in the previous step.

14. Vary the DELAY TIME control setting and notice that virtually any part of the display in step 12 can be observed in magnified form.

NOTE

The sweep rate of the delayed sweep is determined by the setting of the DELAYED SWEEP knob. Therefore, the displayed sweep rate of step 14 is 1 msec/div. Since the sweep rate of the intensified display was 10 msec/div, the delayed sweep display is magnified 10 times (e.g. 10 msec divided by 1 msec).

15. Set the Type 3B1S MODE switch to TRIG INTEN.

16. Vary the Delayed Sweep Triggering LEVEL control setting. Notice that the intensifed portion of the display appears and disappears as the control is turned. Set the control so the intensified portion is stable.

17. Vary the DELAY TIME control setting and notice that the intensified portion of the display jumps from one point on the waveform to the next rather than moving smoothly. This is because, after the delay period ends, the delayed sweep must be triggered before it will start.

Connections

It is often possible to make signal connections to the Type 3A1S with short unshielded test leads. This is particularly true for high-level, low-frequency signals. When such leads are used, make a ground connection between the Type 3A1S or oscilloscope chassis ground and the chassis of the equipment under test. Position the leads away from any stray electric or magnetic field to avoid erroneous displays.

In many low-level applications, unshielded leads are unsatisfactory for making signal connections because of stray signal pickup. To prevent unwanted signal pickup, use shielded (coaxial) cables or the attenuator probes. Be sure the cable ground conductors are connected to the chassis of both the oscilloscope and the signal source with short leads.

Loading

As nearly as possible, simulate actual operating conditions in the equipment under test. For example, the equipment should work into a load impedance equal to that which it will see in actual use.

Consider the effect of loading on the equipment under test caused by the input circuit of the Type 3A1S. The input circuit can be represented by a resistance of 1 megohm (±1%) shunted by a capacitance of about 47 pf. A few feet of shielded cable increases the capacitance considerably.

Use of Probes

The attenuator probes supplied with the Type 561S reduce both capacitive and resistive circuit loading to a minimum and, at the same time, reduces plug-in sensitivity. The attenuation introduced by the probe permits measurements of higher signal voltages than the Type 3A1S can accommodate alone. When making amplitude measurements with the probes, be sure to multiply the observed amplitude by the probe attenuation.

To assure the accuracy of pulse or high-frequency measurements, check the probe compensation. Compensation instructions are given in the probe manual.

CALIB Adjustment

If the Type 3A1S is moved from one Type 561S Oscilloscope to another, adjust the gain as follows to compensate for differences in crt sensitivities:

1. Set the Channel 1 AC-DC-GND switch to DC and the MODE switch to CH 1.
2. Set the Channel 1 and 2 VOLTS/DIV switches to 0.2 and the VARIABLE VOLTS/DIV controls fully clockwise (CALIB). Be sure the neon lamps (UNCAL) are not lit.
3. Set the time-base triggering contols for automatic triggering.
4. Connect a jumper from the oscilloscope calibrator to the Channel 1 input connector and apply a 100-mvolt signal.
5. Set the CALIB control for exactly 5 major divisions of deflection.
6. Turn the MODE switch to CH 2 and apply the 100-mvolt signal to the Channel 2 input connector. There should be 5 divisions of deflection. If the deflection is not 5 divisions, refer to the CH 2 GAIN procedure in Section 5.

DC BAL Adjustment

If the dc balance of a channel is not properly adjusted, the position of a no-signal trace will shift on the crt as the VARIABLE VOLTS/DIV control of that channel is turned. The dc balance should be checked occasionally during normal use. To properly set the dc balance proceed as follows:

1. Allow about 20 minutes warmup.
2. Set both AC-DC-GND switches to GND.
3. Turn the MODE switch to CH 1 and position a free-running (or AUTO coupling) sweep to the center of the graticule.
4. Set the Channel 1 DC BAL control so there is no trace shift when the VARIABLE VOLTS/DIV control is turned.
5. Repeat the preceding steps for Channel 2.

Voltage Measurements

To measure the potential difference between two points on a signal (such as peak-to-peak ac volts), measure the vertical distance in graticule divisions, between the two points. Then multiply by the setting of the VOLTS/DIV switch and the attenuation factor, if any, of the probe. Be sure the VARIABLE VOLTS/DIV control is in the CALIB position.

To measure the dc level at a given point on a waveform, proceed as follows:

1. Set the VOLTS/DIV switch so the expected voltage (at the input connector) is no more than six times the setting. Be sure the VARIABLE VOLTS/DIV control is in the CALIB position.
2. Set the time-base triggering controls for automatic triggering.
3. Set the AC-DC-GND switch to GND and use the POSITION control to align the trace with one of the horizontal graticule lines. This line will be used as a ground (or zero) reference. The position of the reference line should be chosen for the polarity and amplitude of the signal to be measured. Do not move the POSITION control once the reference line has been established.
4. Set the AC-DC-GND switch to DC.
5. Apply the signal to the input connector and set the time-base triggering controls for a stable display.
6. Measure the vertical distance, in graticule divisions, from the ground (zero) reference line to the point you wish to measure on the waveform.
7. Multiply this distance by the setting of the VOLTS/DIV switch and any probe attenuation factor. This is the instantaneous dc level of the point measured.

You can reestablish the zero reference line at any time by setting the AC-DC-GND switch to GND. It is not necessary to disconnect the signal probe from the Type 3A1S. To establish a reference other than zero, set the AC-DC-GND switch to DC and touch the signal probe to the desired reference voltage; then use the POSITION control to align the trace with a reference graticule line.

Voltage Comparison Measurements

In some applications you may want to establish a set of vertical sensitivity values other than those selected by the VOLTS/DIV switch. This is convenient when you compare signals that are exact multiples of a given reference. To establish a set of sensitivity values based on some specific reference, proceed as follows:

1. Apply the reference signal to either input connector. Set the VOLTS/DIV and VARIABLE VOLTS/DIV controls to adjust the amplitude of the display for an exact number of graticule divisions. Do not move the VARIABLE VOLTS/DIV control after this setting.
2. Divide the amplitude of the reference signal (in volts) by the product of the deflection established in step 1 (in graticule divisions) and the setting of the VOLTS/DIV switch. The result is the sensitivity Conversion Factor

$$\text{Conversion Factor} = \frac{\text{Amplitude of Ref. Signal (in volts)}}{\text{Amount of Deflection (in graticule divisions)} \times \text{VOLTS/DIV Switch Setting}}$$

3. To calculate the true sensitivity at any setting of the VOLTS/DIV switch, multiply the switch setting by the sensitivity Conversion Factor:

True Sensitivity = VOLTS/DIV Switch Setting × Conversion Factor

This new set of sensitivity values applies to this channel only, and only as long as the VARIABLE VOLTS/DIV control is not moved.

Phase-Difference Measurements

A phase comparison between two sine waves of the same frequency can be made by using the dual-trace feature of the Type 3A1S. To make this comparison, proceed as follows:

1. Apply one signal to each of the input connectors, and set the MODE switch to CHOP or ALTER. Pull out TRIGGER CH 1 ONLY switch and internally trigger the Type 3B1S.

2. Use the POSITION controls to center both signals vertically on the graticule.

3. Set the time-base sweep rate so one cycle of one waveform covers exactly 9 graticule divisions horizontally. Thus, each division represents 40° of one cycle at this sweep rate.

4. Measure the horizontal distance, in graticule divisions, between the leading waveform and the lagging waveform at the horizontal center graticule line. Multiply this distance by 40° per division to obtain the phase difference between the two signals.

For more precise measurements, increase the horizontal sweep rate with the 10× magnifier of the Type 3B1S. In step 3, each division on the graticule represents 40°. If the sweep rate is increased 10 times, then each division represents 4°.

Triggering

The choice of triggering depends on the type and portion of the signal you want to see. For example, if the display starts on the leading edge of the signal and you want to start on the trailing edge, push the SLOPE switch to the opposite position.

The COUPLING switch AUTO position is useful from 15 cps to 10 mc. It also has the advantage of displaying a trace when the signal is removed, or when the amplifier input is grounded. This makes it easy to check a reference graticule line, since the trigger controls need not be touched.

The COUPLING switch AC position is the same as the AUTO position except the display does not free-run. Both the AUTO and AC positions reject any dc component present in the signal from the vertical amplifier plug-in unit. Adjusting the POSITION control on the vertical amplifier plug-in unit does not affect triggering in the AUTO or AC positions.

In the COUPLING switch DC position, the sweep will trigger in the range from dc to 10 mc. This position should be used with signals that change slowly, such as a slow-rising sawtooth. The Normal Sweep LEVEL control is used to trigger the sweep at any voltage point on these slow-rising signals.

External triggering should be used when signals are checked at several points within a device, such as in point to point troubleshooting. With external triggering, the trigger controls do not have to be adjusted for each point check.

Triggered Delayed Sweep

This type of display has the advantage of practically eliminating jitter in the display during delayed-sweep operation. Each sweep is triggered by the expanded portion of the waveform and not by the waveform at the beginning of the normal sweep. For example, if you want to examine a small pulse, 5 μsec from the start of a pulse train from a computer circuit, use the TIME/DIV and the DELAYED SWEEP switches and the MODE switch TRIG DLY'D SWP position to expand the display to show only the small pulse. Then adjust the Delayed Sweep LEVEL control for a steady display. The sweep will then be triggered by the expanded portion and not by the start of the pulse train.

The SLOPE, COUPLING, and SOURCE switches work the same as their counterparts in normal-sweep operation. The proper position for these switches depends on the type of waveform being examined. A full description of the delayed sweep and trigger circuits will be found in Section 4.

Sweep Magnification

The display can be expanded to 10 times its normal length by pulling out the 10× MAG switch (POSITION control). Each part of the expanded display can be examined by turning the POSITION control throughout its range.

The sweep magnifier extends the range of the TIME/DIV switch 10 times. For example, with the TIME/DIV switch set at .5 μSEC and the 10× MAG switch pulled out, the actual time per division is 0.05 μsec (VARIABLE control in the CALIB position). The magnifier works the same for either normal or delayed sweep.

Sweep Calibration

Sweep calibration should be checked and adjusted, if necessary, whenever the Type 3B1S is used with another Type 561S since the deflection-plate sensitivity may not be the same. The accuracy of this check depends on whether the frequency of the power line supplying the instrument is exactly 60 cps, since this frequency is used as the reference frequency in the following procedure.

Check and adjust sweep calibration as follows:

1. Set the MODE switch to NORM.

2. Set the TIME/DIV switch to 5 mSEC (be sure the 10× MAG switch (POSITION control) is pushed in.)

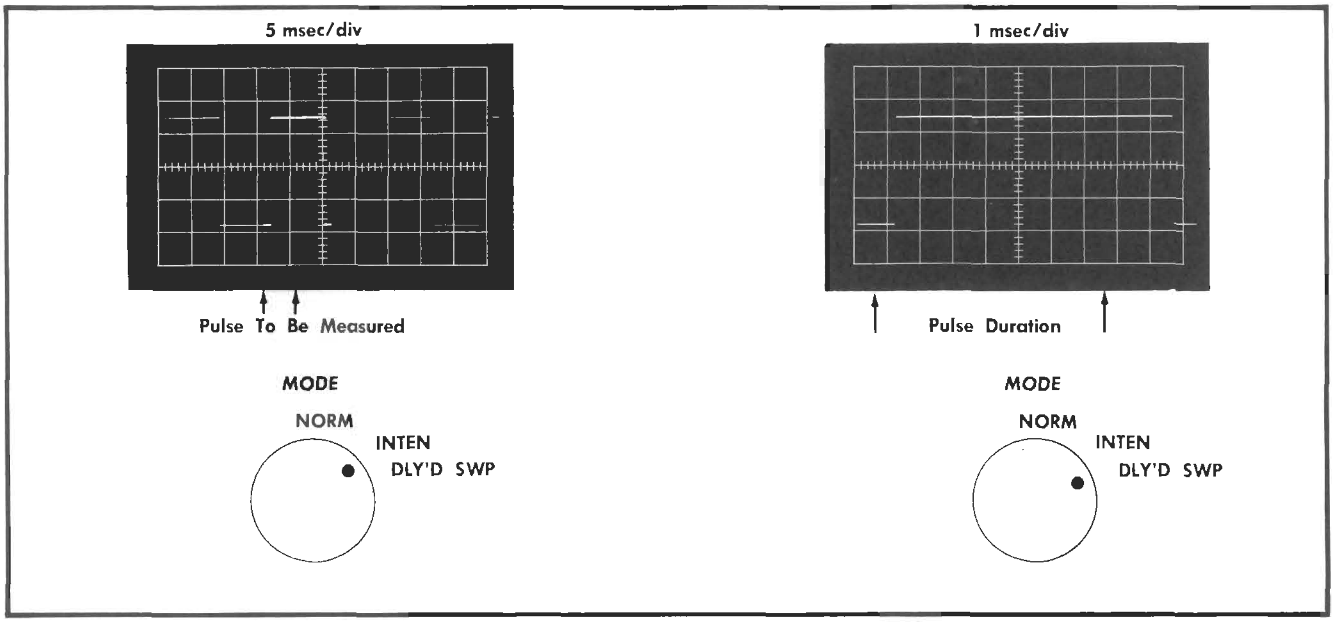


Fig. 2-1. Pulse width measurement.

3. Connect a cable from the oscilloscope calibrator to the vertical amplifier plug-in unit and adjust the normal-sweep triggering controls for a steady display.
4. There should be exactly 3 cycles of the calibrator signal across the 10 divisions of the graticule; if not, adjust the front-panel SWEEP CAL control.

Time Measurements

Since the Type 3B1S sweeps are calibrated, any horizontal distance on the crt represents a definite time interval. Thus, the time interval between points on a display can be accurately measured (within 3%).

For example, assume you have a normal-sweep crt display similar to Fig. 2-1, and you wish to measure the width of the pulse appearing in the 4th division:

1. Make sure the VARIABLE control is set to CALIB, and pull out the DELAYED SWEEP knob and turn it two clicks to the right.
2. Set the MODE switch to INTEN, and adjust the Type 561S INTENSITY for an intensified zone on the display.
3. Turn the DELAY TIME control until the desired pulse is intensified.
4. Turn the MODE switch to DLY'D SWP and measure the horizontal distance from the 50% point on the rise of the pulse to the 50% point on the fall of the pulse. Multiply this distance by the setting of the DELAYED SWEEP switch (setting of white dot on large black knob).

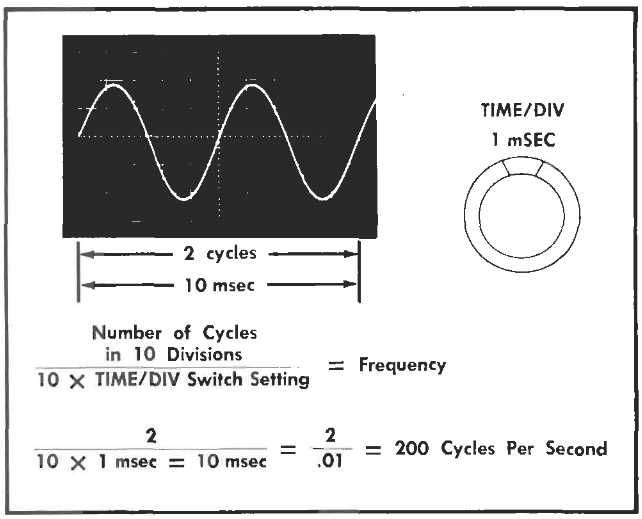


Fig. 2-2. Frequency measurement.

Frequency Measurements

Time measurements may also be used for frequency measurements. Since frequency and time are reciprocal functions, the frequency of any signal is the reciprocal of the period (time) for one cycle. For example, if the time for one cycle is 0.2 μsec, the frequency is 5 megacycles.

With any sweep rate, the number of cycles displayed across 10 graticule divisions depends on the frequency of the waveform (see Fig. 2-2). To determine the frequency, proceed as follows:

1. Set the TIME/DIV switch to display several cycles of the waveform (be sure the VARIABLE TIME/DIV control is in the CALIB position).
2. Count the number of cycles across 10 graticule divisions.
3. Divide this number by 10 times the TIME/DIV switch setting. This is the frequency of the waveform.

SECTION 3

CIRCUIT DESCRIPTION

TYPE 561S

Introduction

The Tektronix Type 561S Oscilloscope contains a low-voltage power supply circuit, a cathode-ray tube circuit, and a calibrator.

The low-voltage power supply circuit provides the regulated and unregulated power used by the instrument and the plug-in units.

The crt circuit contains the necessary controls and input facilities to present a sharp trace of desired intensity for displaying a signal. Two negative high-voltage power supplies provide the voltages for the crt cathode, focus element, and control grid.

Amplitude-calibrated square waves are produced by the calibrator.

Low-Voltage Power Supply

Power for the Type 561S Oscilloscope and the plug-in units is supplied through power transformer T601. The two primary windings of T601 are connected in parallel for 117-volt operation, or in series for 234-volt operation, as shown on the schematic diagram.

The low-voltage power supply provides regulated outputs of —100, —12.2, +125, and +300 volts, and an unregulated output of +420 volts. Each circuit is series-regulated and employs silicon diodes for rectifiers. A series regulator circuit uses a vacuum tube (or transistor, in the case of the —12.2-volt supply) in series with the load. This tube controls the current through the load to maintain a constant voltage drop across the load. For example, if the load increases (resistance of load decreases) the series tube allows more current to flow; if the load decreases it allows less current to flow.

—100-Volt Supply. Reference voltage for the —100-volt supply is established by gas diode V609. The constant voltage drop across V609 establishes a fixed potential of about —85 volts at the grid of V634B. Voltage at the grid of V634A is established by divider R616, R617, and R618. The difference in voltage between the two grids of V634 determines the place current of V634A. Plate current of V634A determines the base voltage of transistor Q624 which in turn determines the grid voltage of series tube V627. The series tube controls the current through the load to hold the load voltage constant. R616 (—100 v adjustment) determines the percentage of the total divider voltage applied to the grid of V634A and thus controls the output voltage. When this control is properly adjusted, the output is exactly —100 volts.

Should the output voltage tend to change because of a change in input voltage or a change in load current, the potential at the grid of V634A will change a proportional amount. Any change at the grid of V634A is amplified by V634A and Q624 and applied to the grid of V627. The resulting grid change at V627 will cause the load current to change in the direction needed to bring the output back to —100 volts. C616 improves the response of the regulator to sudden changes in output voltage.

+125-Volt Supply. The —100-volt supply serves as a reference for the +125-volt supply. With the lower end of R651 fixed at —100 volts, any change in the +125-volt output produces a proportional change at the grid of V654. This change is amplified and supplied to the grid of series regulator tube V667A. The change at the grid of V667A changes the load current in the manner needed to bring the output voltage back to a nominal +125 volts. C650 improves the response of the regulator to sudden changes in output voltage.

A small sample of the unregulated-bus ripple appears at the screen of V654 through R657. The ripple at the screen (which acts as an injector grid) produces a ripple at the grid of V667A which is opposite in polarity to the ripple at the plate of V667A. This tends to cancel ripple at the output. This same circuit also improves the regulation of the circuit in the presence of line-voltage variations.

+300-Volt Supply. The +300-volt supply functions in the same manner as the +125-volt supply. To supply the voltage for the +300-volt regulator, rectified voltage from transformer terminals 21 and 22 is added to the voltage supplying the +125-volt regulator.

The +300-volt supply provides an unregulated output of +420 volts for the crt circuit.

—12.2-Volt Supply. Operation of the —12.2-volt regulating circuit is essentially the same as that of the other regulating circuits, except that transistors are used instead of vacuum tubes. The base of Q734 is fixed near —12 volts by voltage divider R731-R732 between —100 volts and ground. Any variation of the —12.2-volt output at the emitter of Q734 is amplified by Q734 and Q744 to change the emitter-collector current of Q757 which is in series with the supply load. F720 protects the transistors in case of an overload on the —12.2-volt supply.

The collector of Q757 is connected to pin 5 of the interconnecting socket. This provides a return separate from the chassis and prevents large chassis currents.

Crt Circuit

The crt circuit contains the cathode-ray tube and two high-voltage supplies (one for the crt cathode and focus element, the other for the control grid). The circuit also contains the necessary controls and signal input facilities.

Cathode-Ray Tube. A Tektronix T5033 glass envelope cathode-ray tube is used in the Type 561S. The accelerating potential is approximately 3500 volts, developed by about —3300 volts at the cathode and an average deflection-plate voltage of about +200 volts. With this accelerating potential, the nominal vertical and horizontal deflection factors are 12.0 and 20.4 volts/cm respectively.

Deflection blanking of the crt is employed in the Type 561S. The crt contains a special set of deflection plates (pins 6 and 7) for this purpose. Both plates are connected to +125 volts; however, pin 6 is also driven by the right-hand plug-in unit.

During sweep time, or if no plug-in unit is installed, both plates rest at +125 volts and permit the beam to pass on to the crt face. During sweep retrace, however, pin 6 is driven considerably away from +125 volts. This scatters the beam and prevents it from reaching the crt face.

High-Voltage Supplies. Energy for both high-voltage supplies is furnished by T801. V800, the primary of T801, and the circuit capacitance (shown by the dotted capacitor symbol on the schematic) form a Hartley oscillator which operates at about 45 kc.

One secondary winding of T801 provides voltage for the crt cathode and focus element. This voltage, rectified by V822, is about —3300 volts at the cathode, and between about —2000 and —3000 volts at the focusing element, depending on the setting of the FOCUS control. (The 6.3-volt crt heater is also elevated to the cathode potential.)

The output of the other secondary winding of T801 is rectified by V832 for the control grid. The grid voltage ranges from —3100 to —3400 volts, depending on the setting of the INTENSITY control. The reference to ground for this supply is determined by the voltage at the junction of diodes D838 and D839. The voltge at this junction, plus the setting of the INTENSITY control, determines the crt bias and therefore the intensity of the display.

Regulation of the high-voltage supplies is accomplished through feedback from the arm of R841. If, due to loading or a change in input voltage, the output of the high-voltage supply changes, a proportionate change occurs at the arm of R841. This change is amplified by V814 and is coupled to the screen grid of V800. A change at the screen of V800 will increase or decrease the amplitude of oscillations in V800. Thus the output voltage of T801 changes in the direction needed to return it to the desired level. HIGH VOLTAGE control R841 controls the output voltage by setting the bias on V814B.

Deflection Signals. Signals for the deflection plates are equal in amplitude but opposite in polarity (push-pull) and appear at pins 17 and 21 of the interconnecting socket.

Intensifying Signals. Two signals may be used to modulate the intensity of the crt display. First, intensifying signals from a two-sweep (delaying-sweep) time-base plug-in unit are applied to the grid supply through terminal 14 of the right-hand interconnecting socket. When the overall display intensity is reduced with the INTENSITY control, positive intensifying pulse from a two-sweep time-base unit will brighten any desired portion of the display. Diodes D838 and D839 provide a low-impedance return for the grid supply which reduces intensity modulation caused by normal supply ripple.

Other external intensifying signals can be fed to the crt cathode from the EXT CRT CATHODE binding post. Depending on the setting of the INTENSITY control, a negative pulse of 5 volts or more will turn the crt beam on.

Crt Controls

INTENSITY control R835 has a range of about 300 volts to control the crt bias and permit changing the intensity of the display.

FOCUS control R844 adjusts the focus of the crt by varying the voltage at the focusing anode from about —2000 to —3000 volts.

ASTIGMATISM control R864 has a 300-volt adjustment range.

GEOMETRY control R865 adjusts the geometry by varying the voltage of the crt isolation shield from +180 to +246 volts.

Calibrator

The calibrator for the Type 561S Oscilloscope produces a line-frequency amplitude-calibrated square wave.

The 6.3-volt (approximately 18 volts peak-to-peak) ac heater voltage for V884 is applied through C876 to the cathode of V884A, driving that tube into and out of cutoff at the line-frequency rate. The signal at the plate of V884A is then coupled to the grid of V884B to turn that tube on and off. Regenerative feedback from the plate of V884B to the grid of V884A speeds up the switching action of V884A.

The voltage present at the cathode of V884B during the time that V884B is conducting can be set to exactly 100 volts with CAL AMPL adjustment R871. The voltage divider in the cathode circuit of V884B contains precision resistors to provide an output accuracy of 3% or better at the various settings of the CALIBRATOR control.

TYPE 3A1S

The Type 3A1S Dual-Trace Amplifier contains two indentical input channels, a common output amplifier, a switching circuit, and a trigger amplifier. The output of either or both input channel amplifiers may be fed to the output amplifier, depending on the condition of the switching circuit. Thus, the switching circuit makes it possible to display one signal as a single trace on the crt, two signals simultaneously in a dual-trace display, or the algebraic sum or difference of two signals as a single trace. Fig, 3-1 is a block diagram of the Type 3A1S.

Input Channel Amplifiers

Each input channel consists of an attenuation network, an input cathode-follower, and a three-stage amplifier with switched outputs. Input cathode followers V113 and V123 (Channel 1) and V213 and V223 (Channel 2) isolate the attenuator input circuitry from emitter followers Q133 and Q134 (Channel 1) and Q233 and Q243 (Channel 2). Q134 and Q144 (Channel 1), and Q234 and Q244 (Channel 2) provide low-impedance drive to the next stage. The output of these stages is fed to the diode gates in the switching circuits which select the signals to be fed to the common

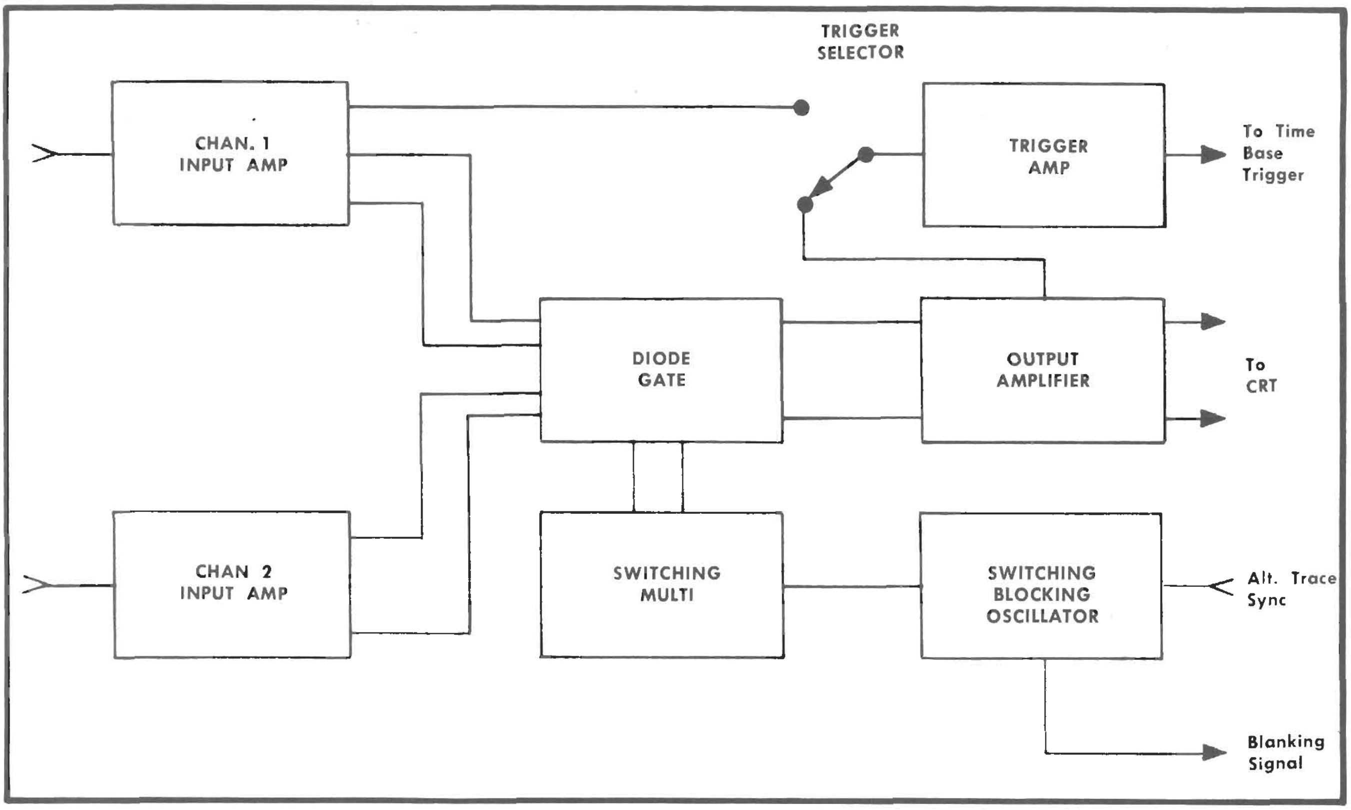


Fig. 3-1. Type 3A1S block diagram.

output amplifier. The gain of the last stages in the input amplifiers is variable, with two calibration adjustments: R149 (Channel 1) and R249 (Channel 2) set the gain of the stage with the VOLTS/DIV switches in the .01 position, R147 (Channel 1) and R247 (Channel 2) set the gain of the stage in the remaining positions of the VOLTS/DIV switches. The VARIABLE VOLTS/DIV control increases cathode degeneration when moved from the CALIB position.

The input attenuators are resistive dividers with capacitive compensation. The attenuators maintain an input impedance of 1 megohm paralleled by 47 pf. With the VOLTS/DIV switch in the .01 and .02 positions, the input is fed directly to cathode-follower stages V113 and V213. The 10 MV GAIN controls adjust the amplifier sensitivity with the VOLTS/DIV switches in the .01 position and the 20 MV GAIN controls adjust the sensitivity in the remaining positions. In the VOLTS/DIV switch positions, which provide an input deflection factor greater than 20 mv/div (.05 to 10 on VOLTS/DIV switch), the attenuator sections are stacked. In the .05 VOLTS/DIV switch position, the 2.5× attenuator increases the basic 20 mv/div deflection factor to 50 mv/div. The 5× attenuator is used to increase the deflection factor to 100 mv/div in the .1 VOLTS/DIV switch position. These three positions (1×, 2.5×, and 5×) are preceded by the ×10 or ×100 attenuators in the higher deflection-factor positions of the VOLTS/DIV switch.

The DC BAL controls in the grid circuit of V123 and V223 adjust the potential at both emitters of each input amplifier for no current through R139 and R149 (Channel 1), and R239 and R249 (Channel 2) under no-signal conditions. Otherwise, the position of a no-signal trace would shift on the crt as the VARIABLE VOLTS/DIV control or channel gain adjustments were turned.

In the INV position, the INV (CH 1) NORM switch (SW155) inverts the Channel 1 output to the diode gates.

The Channel 1 input amplifier contains a three-stage trigger amplifier. The first stage is an emitter-coupled paraphase amplifier (Q164 and Q174) with double-ended input and single-ended output. The dc level of the output is set by CHAN 1 TRIG DC LEVEL control R171. The output of this stage is fed to emitter-follower Q173. Q173 drives the third stage, Q184, which is collector-coupled to the trigger-amplifier section of the output amplifier.

Switching Circuits

The switching circuit consists of two diode gates, a switching multivibrator, and a switching blocking oscillator, all of which drive the multivibrator. In the following discussion, assume that the MODE switch is in the CH 1 position.

Each diode gate consists of two series diodes and two shunting diodes. When signals are to pass through the gate to the output amplifier, the series diodes are forward biased, and the shunt diodes are back biased, allowing the signal to drive the bases of Q304 and Q314. Voltage to hold the series diodes (D155 and D158 in Channel 1) in conduction is supplied through the emitter-base junctions of Q304 and Q314. Collector current for Q134 and Q144 flows through the series diodes. Shunt diodes D156 and D157 are back biased and thus cut off by MODE switch SW289, holding Q285 in the "off" state. Q275 is "off", and the junction of D156 and D157 is at —1.18 volts. The dc level in the signal output lines from the Channel 1 input amplifier is —1.65 volts, and thus the shunt diodes are back biased.

In the Channel 2 diode gate, D256 and D257 are held at about —4.7 volts by Q285, which is "off". This holds the Channel 2 output lines at about —4.3 volts. Since the outputs of the diode gates are about —2 volts, D255 and D258 are back biased. With D225 and D258 cut off, the signal is not transmitted to the output amplifier. In addition, D256 and D257, when conducting, from a low-impedance path for any signals coming to the diode gate from the Channel 2 input amplifier.

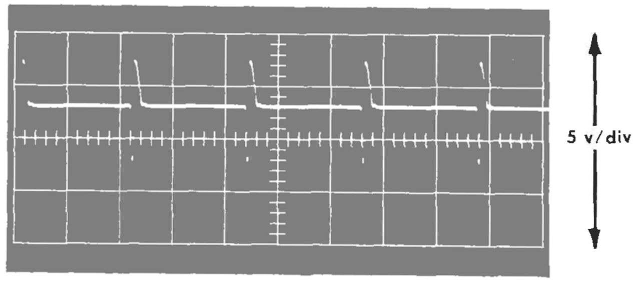
When the MODE switch is in the CH 2 position, the conditions of the diode gate are reversed. In the Channel 2 diode gate, D256 and D257 are back-biased and the signal from the Channel 2 input amplifier passes through D255 and D258 to the output amplifier.

When the MODE switch is in either the ALTER or CHOP positions, Q275 and Q285 operate as a common Eccles-Jordan bistable multivibrator. Positive pulses from the switching blocking oscillator pass through D278 or D288 to the collector of the "off" state transistor. This pulse is transmitted by either C277 or C287 to the base of the "on" transistor, turning it "off". The collector of the "off" transistor moves toward the —12.2-volt supply, turning the other transistor "on" because of the coupling through either C277 or C287. Resistive dividers R277-R286 and R287-R276 set the levels at the transistor bases. The levels are designed so switching action can occur when pulses are received from the blocking oscillator.

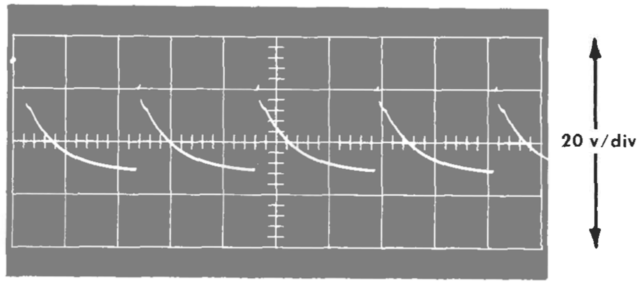
Operation of the diode gates in ALTER and CHOP is the same as described in the CH 1 and CH 2 positions of the MODE switch. However, the multivibrator is free to switch states when it receives a trigger signal, and thus operate the diode gates and transmit a signal to the output amplifier from Channel 1 and Channel 2 alternately. Also, in the ALTER and CHOP positions of the MODE switch, R292 is bypassed and the —12.2-volt supply is connected directly to the multivibrator circuit. In the other positions of the MODE switch, the multivibrator draws current through R292 and is not able to switch the diode gates. In the CH 1 position, additional current is supplied through R289; in the CH 2 position, current is supplied through R279.

When the MODE switch is in the ADDED position, current is supplied to the output amplifier through R293 and R294, holding the series diodes in both diode gates in conduction. Since the multivibrator transistors are both near cutoff, the diode-gate shunt diodes are back biased and thus inoperative.

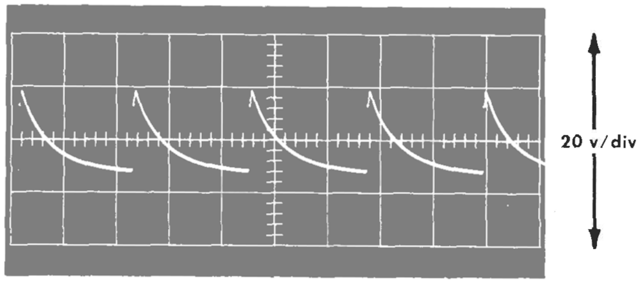
In the CHOP and ALTER positions of the MODE switch, Q260 (the switching blocking oscillator) is energized, supplying pulses to the switching multivibrator. Fig. 3-2 shows the blocking oscillator waveforms with the MODE switch in the CHOP position. In the ALTER mode, the emitter of Q260 is connected to the —12.2-volt supply through R260. The collector is also connected to the —12.2-volt supply through the emitter winding of blocking oscillator transformer T263. When a positive pulse is fed from the time-base plug-in unit



(a) Signal at base of Q260



(b) Signal at collector of Q260



(c) Output to pin 24 of Interconnecting Plug

Fig. 3-2. Signals in blocking oscillator circuit. Oscilloscope, ac coupled. Sweep rate, 2 μsec/div.

through terminal 3 of the interconnecting plug, the emitter voltage rises. The transistor conducts, drawing current through the collector winding of blocking oscillator transformer T263, driving Q260 further into conduction. A normal blocking-oscillator cycle occurs, with the backswing cutting the transistor off. The emitter circuit is damped so the transistor is not turned on again until another sync pulse is received.

In the CHOP position of the MODE switch, the emitter of Q260 is connected to ground through R262. Normal blocking oscillator action occurs; however, when a cycle is completed, the base is forward biased since it is connected to the —12.2 volt supply. The blocking oscillator is thus automatically triggered and free-runs at a 150-kc rate.

Pulses from the collector circuit of Q260 are fed to the switching multivibrator through C266. Only the positive pulses, which occur at the beginning of the blocking oscillator cycle, will switch the multivibrator. The collector pulse is also fed to pin 24 of the interconnecting plug for use as a blanking pulse in the Type 561S.

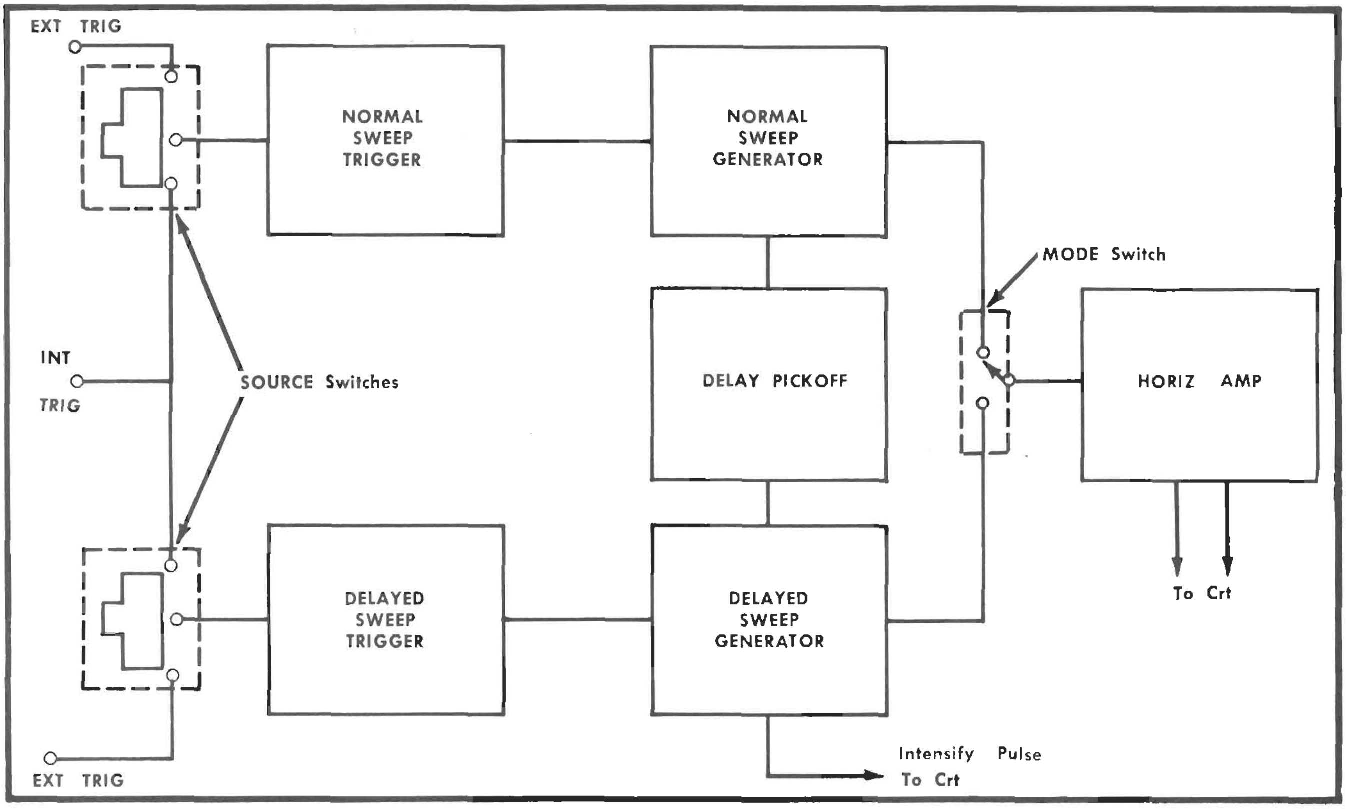


Fig. 3-3. Type 3B1S block diagram.

Output Amplifier

The output of the diode gates passes to the bases of Q304 and Q314. These transistors are connected as a common-emitter push-pull amplifier. R302 and R314 are connected from the collector to the base of the transistors to provide feedback stabilization. The push-pull output signal of this stage passes to the bases of the next amplifier stage Q323 and Q333.

The Q323-Q333 stage is also feedback stabilized with R324 and R334. The following push-pull stage consists of V334A and V334B. Variable high-frequency peaking of this stage is accomplished with L326, L341, L336, L351, C339, and C337. OUTPUT DC LEVEL adjustment R328 sets the operating point of the remaining stages so that the output voltage at the deflection plates of the crt is 150 volts.

The last stage of the Output Amplifier is a hybrid cascoded push-pull amplifier. The output of this amplifier drives the deflection plates of the crt. CALIB adjustment R373 matches the gain of the instrument to the deflection factor of the crt. Gain of the stage is maximum with the CALIB adjustment set for minimum resistance (minimum emitter degeneration).

TYPE 3B1S

The Type 3B1S is a conventional time-base plug-in unit with delayed sweep. Fig. 3-3 shows the relationship of the major circuits. The schematic diagrams at the rear of this manual fold out for easy reference when studying this circuit description.

The Normal Sweep Trigger circuit receives a signal from either the Vertical Amplifier plug-in unit or an external source. The Normal Sweep Trigger circuit converts the signal to a trigger for the Normal Sweep Generator. The trigger pulse switches a tunnel diode in the Normal Sweep Generator and starts the sweep ramp. When the ramp voltage reaches a preset point (normal sweep length), the ramp ends and the crt beam (now blanked) reverts to its starting point. A holdoff period delays the start of the next sweep. When this period ends, the next trigger pulse starts another sweep.

The sweep ramp from the Normal Sweep Generator passes to the MODE switch. If this switch is set to NORM, INTEN, or TRIG INTEN, the normal sweep passes to the Horizontal Amplifier. In the DLY'D SWP or TRIG DLY'D SWP positions, the normal sweep is not connected to the Horizontal Amplifier.

The Horizontal Amplifier converts the sweep ramp to a push-pull output and applies it to the horizontal deflection plates of the crt.

The Delayed Sweep Trigger circuit operates only when the MODE switch is in the TRIG INTEN or TRIG DLY'D SWP position. This circuit is identical to the Norm Sweep Trigger circuit and uses a signal from either the Vertical Amplifier or an external source.

The trigger formed by the Delayed Sweep Trigger circuit passes to the Delayed Sweep Generator and starts the delayed sweep ramp. The ramp ends when it reaches a preset point (delayed sweep length). During the ramp run-up, a positive pulse is coupled to the crt grid to intensify the display.

When the MODE switch is set to either DLY'D SWP position, the delayed sweep ramp drives the Horizontal Amplifier.

Thus, in 3 positions (NORM, INTEN, and TRIG INTEN) of the MODE switch, the Normal Sweep Generator furnishes the sweep, and in 2 positions (DLY'D SWP and TRIG DLY'D SWP) the Delayed Sweep Generator furnishes the sweep.

The two INTEN positions of the MODE switch intensify an area of the display that represents both the delayed sweep length and its position on the normal sweep.

Normal Sweep Trigger

The trigger signal (internal or external) enters the circuit through the SOURCE switch and passes to the COUPLING switch. The COUPLING switch passes the signal through C5 in the AUTO or AC positions and bypasses C5 in the DC position. R9 and R10 attenuate the signal and present a high impedance to the signal source to prevent loading.

When the SOURCE switch is in the EXT position and the EXT TRIG ATTEN (LEVEL control) switch is pulled out, R7 is paralleled across R10 and the network becomes a 10:1 attenuator. C7 and C9 are frequency compensating capacitors. Neon bulb B10 provides overload protection against high signal voltages. V13 is a long-tailed cathode follower that couples the signal through D15 to the SLOPE switch. The SLOPE switch directs the signal to either Q24 or Q34, depending on its setting. Q24 and Q34 is a comparator with the signal applied to one base and a dc voltage (set by the LEVEL control through Q23) on the other base. When the signal equals the level voltage, tunnel diode D35 switches. The pulse from D35 is amplified by Q44 and applied to T101.

This transformer couples the pulse to the Normal Sweep Generator.

Normal Sweep Generator

Generating the Sweep Ramp. A trigger pulse coupled through T101 causes tunnel diode D105 to switch. This puts a positive pulse on the base of Q114 and this transistor turns on. As Q114 conducts its collector drops, carrying with it the plates of V152. As V152 cuts off, Timing Capacitor C160 starts to charge toward —100 volts through Timing Resistor R160. As the grid of V161A starts to drop, it allows the plate voltage to rise. The resulting positive voltage swing is coupled through D162 and D161B to the top of C160. This increases the charging voltage with each increment of charge on C160, effectively straightening the capacitor charge curve. The positive swing at the top of C160 also tends to keep the lower side from dropping. This keeps the voltage across R160 essentially constant, providing a constant-current charging source for C160. The result is an extremely linear sawtooth ramp at the cathode of V161B, which is then applied to the Horizontal Amplifier.

Ending the Sweep Ramp. The sweep ramp ends when the voltage applied to the base of Q134 from R168 (NORMAL SWEEP LENGTH control) reaches +15 volts. Fig. 3-4 shows the waveform on the base of Q143 with the condition of the associated diodes. Fig. 3-5 shows the condition of D105 (tunnel diode) during a sweep cycle.

The sweep ramp voltage from R168 starts at about —30 volts and rises in a positive direction. D171 remains back-biased and the ramp voltage cannot reach the base of Q143 until the sweep ramp voltage reaches +1 volt, D171 is forward-biased and the ramp voltage is applied to the base of Q143. The voltage on the emitter of Q143 follows the base voltage. When the emitter rises to ground, D134 is back-biased and no longer supplies current to Q143. The reduced current through Q143 also reduces current through D105. When the emitter of Q143 reaches +15 volts, D143 is forward-biased and Q143 turns off, which forces D105 to point D on the diagram of Fig. 3-5.

When D105 switches, the negative charge turns Q114 off, and its collector goes positive. Disconnect diodes V152 turn on and discharge Timing Capacitor C160, and the sweep ramp ends.

Sweep Holdoff Period

A holdoff period is necessary between each sweep to allow time for the crt beam to retrace to its starting point. This holdoff period is developed by the charge and discharge of Holdoff Capacitor C170. The circuit works as follows:

During sweep run-up, the sweep voltage couples across D170 and charges C170. When the sweep ends, C170 discharges on an RC curve. When the capacitor charge drops to about —3 volts, D172 becomes forward-biased and this voltage is applied to the base of Q143. Current through Q143 increases and the current through D105 moves to point A on the tunnel diode diagram (Fig. 3-5).

Automatic Sweep

If the COUPLING switch is set to AUTO, a third source of current supplies Q143 through Q134 and D132. This added current switches D105 (at the end of the holdoff period) and the sweep free-runs. To trigger in the AUTO position, tunnel diode D115 is switched by trigger pulses from T101. When D115 switches (to its high state), Q124 turns on and Q134 turns off. This removes Q134 as a current source for Q143 and the circuit is set for normal triggered operation.

If a trigger pulse does not switch D105 within about 5 msec, the circuit will reset itself and free-run the sweep. When Q124 turns on, the voltage across C122 starts to drop toward —12 volts. Before it reaches —12 volts, D122 becomes forward-biased and reduces current through D115. D115 switches to its low state, Q124 turns off, C122 charges through R125 and R122 until the emitter of Q134 is +0.3 volts. Q134 then turns on, and the sweep free-runs. Because of the reset feature of the AUTO circuit, the sweep will not trigger at a repetition rate slower than about 15 cps.

Crt Unblanking

The electron beam in the crt is unblanked by a negative pulse coupled from the plate of V194A through pin 13 of

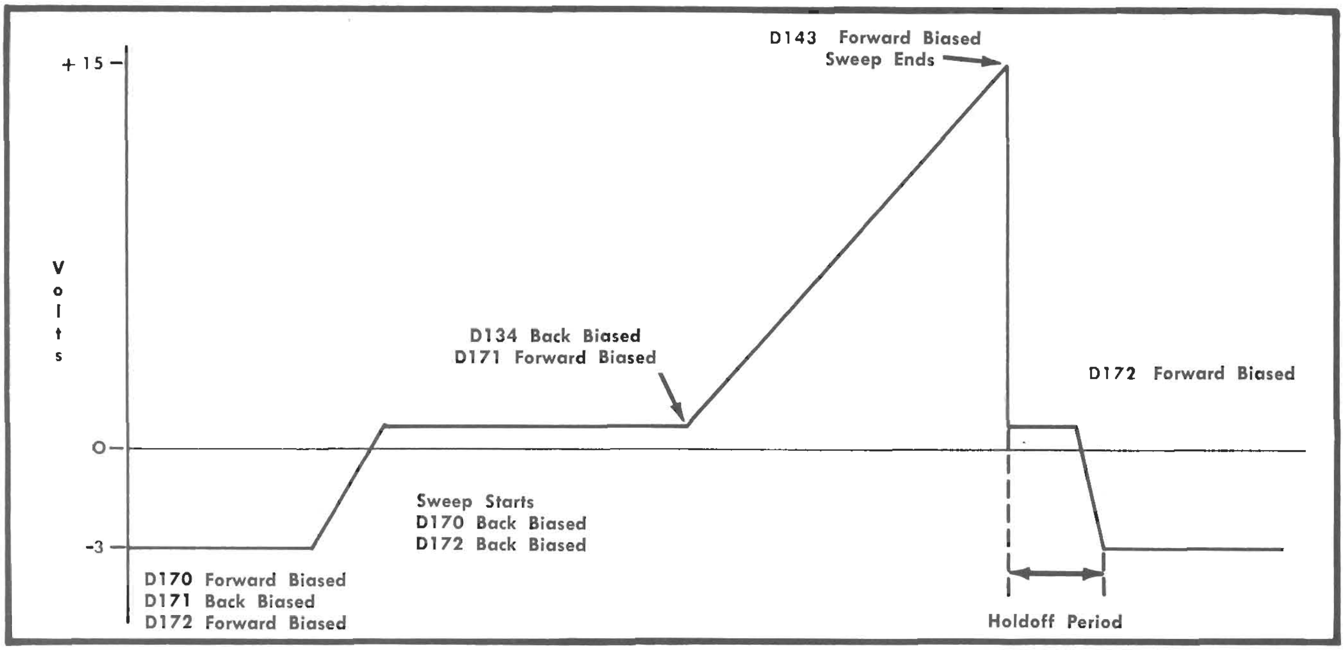


Fig. 3-4. Waveform at base of Q143 during sweep and condition of associated diodes.

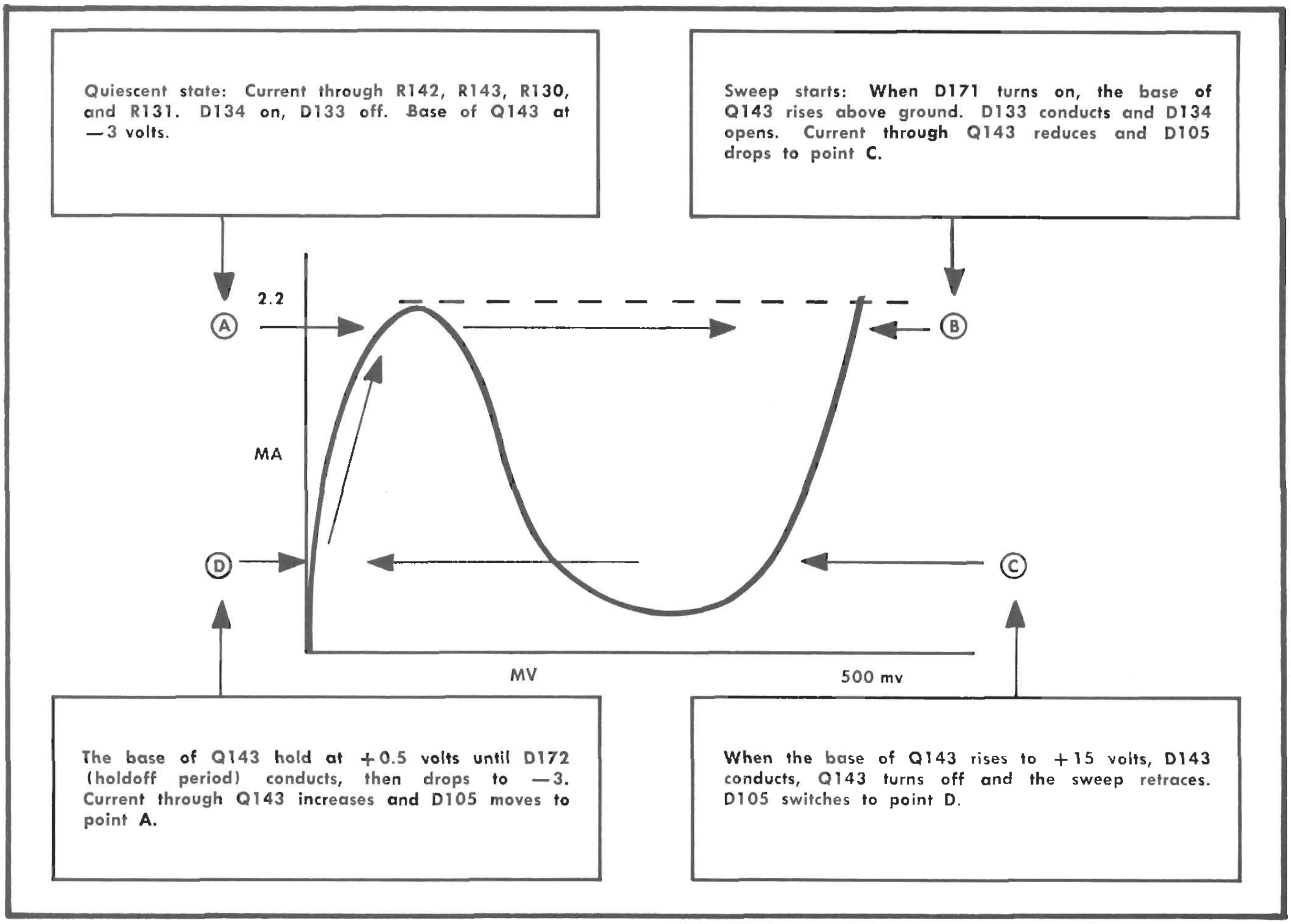


Fig. 3-5. Condition of tunnel diode D105 during sweep and holdoff periods.

the interconnecting plug to the blanking plates in the crt. The unblanked period coincides with the time that tunnel diode D105 is in its high state (sweep period). When D105 switches to its high state, Q114 turns on and a negative pulse from the collector of Q114 is applied to the base of Q183. This transistor is connected as an emitter follower and the negative pulse passes from the emitter to the MODE switch. From the MODE switch, the negative pulse passes to the base of Q194 (when normal sweep is used) where it is amplified and coupled to the grid of V194A. A clamp circuit (D195 and R195) prevents the plate of V194A from dropping below +125 volts.

The direct coupling from the collector of Q194 to D105 (through R103 and C103) ends the normal sweep ramp when the MODE switch is in either DLY'D position. When delayed sweep is used, the unblanking signal comes from the Delayed Sweep Generator circuit. When the positive pulse on the grid of V194A ends, its trailing edge is coupled back through C103 and R103 to switch D105 and end the sweep.

Delayed Sweep Trigger

This circuit is almost identical to the Normal Sweep Trigger circuit and the detailed description is the same. The only difference is the supply voltage for the comparator (Q74 and Q84). The +125-volt supply is connected through the MODE switch and is only present in the TRIG positions. In all other positions of the MODE switch the Delayed Sweep Trigger circuit is inoperative.

Delayed Sweep Generator

The Delayed Sweep ramp circuit operates the same as in the Normal Sweep Generator. The major difference between the two sweep generators is the method of starting the sweep. With the MODE switch in the INTEN or DLY'D SWP position, current for Q234 and tunnel diode D205 comes from three sources in the sweep-gating network. The tunnel diode is set at the ready point and is switched by a pulse through R203 from the Delay Pickoff circuit.

When the MODE switch is in the TRIG INTEN or TRIG DLY'D SWP position, R229 in the Sweep Gating network is removed. The remaining current through Q243 plus the pulse from the Delay Pickoff circuit raises the tunnel diode to the ready point. A trigger pulse coupled through T201 is needed to switch the tunnel diode and start the delayed sweep. In this condition the delayed sweep is triggered.

The negative pulse (during sweep) at the collector of Q214 passes directly to the base of Q283. This emitter follower sends the pulse in three directions: (1) to Q294 to intensify the display (2) to the Delay Pickoff circuit to reset D445 and (3) to the MODE switch for unblanking the crt.

Delay Pickoff Circuit

This circuit sets the start point for the delayed sweep. V414 is a comparator with the normal-sweep ramp voltage applied to one grid, and a positive dc voltage from the DELAY TIME control applied to the other. At the start of a normal sweep, V414B is conducting and V414A is cut off. V194B is the current source for the comparator. When the normal sweep voltage applied to the grid of V414A rises to equal the delay-time voltage, the comparator switches and V414A turns on while V414B cuts off. At this point, tunnel diode D415 switches to its lower state and puts a sharp pulse on the base of Q424. The pulse is inverted in polarity by the transistor and coupled from the collector through C424 and D425 to the cathode of tunnel diode D445. This tunnel diode switches and its cathode drops to —0.5 volts. This voltage change passes through R451 to the base of Q453.

The junction of R453 and R455 in the collector circuit of Q453 quiescently sits at —15 volts. This forward-biases D455 and holds D205 in the Delayed Sweep Generator circuit at —12 volts. When the —0.5-volt signal is applied to the base of Q453, the junction of R453 and R455 rises to —10 volts.

This change back-biases D455, and tunnel diode D205 can be switched (switches immediately in free-run or by the next trigger pulse in a triggered mode). This condition will remain as long as tunnel diode D445 is in its high state. At the end of a delayed sweep, a positive pulse is coupled through C445 and R445 to reset tunnel diode D445. This pulse comes from Q283 in the Delayed Sweep Generator circuit and is formed from the trailing edge (positive-going) of the unblanking pulse.

With the MODE switch in either DLY'D SWP position, —100 volts is connected to R441. This voltage back-biases D444 and prevents the Normal Sweep Generator pulse from resetting D445. In this condition, the delayed sweep will always run-up to the length set by R268 (DELAYED SWEEP LENGTH control).

Horizontal Amplifier

The sweep voltage enters the circuit through the MODE switch. When this switch is in NORM or either INTEN position, the normal-sweep ramp voltage drives the Horizontal Amplifier. In the two DLY'D SWP positions, the delayed-sweep ramp voltage drives the amplifier.

The sweep voltage is attenuated by R310 and R312 (SWEEP CAL control) and applied to the emitter of Q314. The POSITION control is also connected to this emitter. Since the amplifier is completely dc-coupled, a voltage change by the POSITION control passes through the circuits to the output.

Q314 is a grounded base amplifier and the sweep voltage appears in the collector circuit (no change in polarity). The sweep voltage then drives the base of Q323 (emitter follower) and passes from its emitter to the base of Q354. (Q333 balances any changes in Q323 due to temperature drift.)

The positive-going ramp voltage drives Q354, which in turn, drives V383A (grounded-grid amplifier). The output circuit is a paraphase amplifier with single-ended input and push-pull output.

As the sweep voltage rises, the current through Q354 and V383A increases. This causes the voltage at the plate of V383A to decrease. The emitter of Q354 follows the base and rises from about —12 to —5 volts. The voltage drop across R364, connected between the emitters of Q354 and Q364, increases as the sweep voltage increases. The positive-going increase at the emitter of Q364 decreases current through Q364 and V383B and the plate of this tube rises toward +300 volts. The result is a push-pull output from the plates of V383A and V383B.

The gain of the paraphase amplifier depends on the size of common-emitter resistor R364. When this resistor is made smaller, the gain increases and the amplifier output swing becomes greater. This is the basis of the 10× magnifier. The 10× MAG switch connects R354 and R355 (MAG GAIN control) across R364 and increases the amplifier gain 10 times (calibrated by the MAG GAIN adjustment).

C364, C354, and C355 across R364 compensate for distributed capacitance at the output tube plates that affects the sweep VOLTAGE at fast-ramp rates.

The push-pull output voltage from the plates of V383A and V383B pass directly to the crt horizontal deflection plates.

Timing Switches

The Normal and Delayed Sweep Timing Switches contain the resistors and capacitors that set the sweep rate and holdoff period. Both Timing Switches are the same except for VARIABLE TIME/CM control R160Y. In the NORM position of the MODE switch, the control (R160Y) is connected to Normal Sweep Timing Resistor R160. In all other positions of the MODE switch, the control is connected to Delayed Sweep Timing Resistor R260.

The VARIABLE TIME/CM control (R160Y) extends the sweep time by reducing the voltage supplied to the Timing Resistors. When this control is fully clockwise, SW160Z switches a short across it and —100 volts is applied to the Timing Resistors. Any other position of the control reduces the —100 volts and thus reduces the sweep rate. SW160Z also removes the voltage from R160W and the NE-2 (B160W) so the lamp is off in the calibrated position.

SECTION 4

TROUBLESHOOTING AND MAINTENANCE

PREVENTIVE MAINTENANCE

Side-Panel Removal

The side panels of the Type 561S are held in place with coin-slotted fasteners. Turn each fastener counterclockwise about two turns to free the panels.

Cleaning the Interior

Internal cleaning should precede calibration since the cleaning process could alter the setting of certain calibration controls.

One way to clean the interior is by vacuum and/or low-pressure compressed air (high-velocity air could damage certain components). Hardened dirt may be removed with a soft paint brush, cotton-tipped swab, or cloth dampened with a mild water and detergent solution. Pay special attention to high-voltage circuits where dust can cause corona or arcing.

Visual Inspection

Inspect the instrument occasionally for defects such as poor connections, broken or damaged ceramic terminal strips, improperly seated tubes or transistors, and heat-damaged components. A heat-damaged component usually indicates an unseen trouble in the circuit and should be corrected before replacing the damaged part. Otherwise, the damage might be repeated.

Tube and Transistor Checks

Preventive maintenance checks on the tubes or transistors in the instrument are not recommended. A complete operational check of the instrument is the most satisfactory method of checking the performance of the tubes and transistors. Substandard tubes and transistors will nearly always be detected during calibration of the instrument.

Recalibration

To insure accurate measurements, check the calibration of the instrument after each 500 hours of operation or every six months if used intermittently. Complete calibration instructions appear in Section 5 of this manual.

The calibration procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles, not apparent during normal use, may be revealed and/or corrected by calibration.

Cleaning the Exterior

Loose dust may be removed with a cloth and a dry paint brush. Water and mild detergents such as Kelite or Spray White may be used, but not abrasive cleansers.

The faceplate of the crt may be cleaned with a soft, lint-free cloth dampened with denatured alcohol.

CORRECTIVE MAINTENANCE

Component Replacement

Certain parts in the instrument are easier to replace by following a definite procedure. The procedures for removing these parts are outlined in the following paragraphs.

Many electrical components are mounted in a particular way to reduce or control stray capacitance and inductance. When selecting replacement parts, remember that the physical nature of a component can affect its performance at high frequencies. After repair, check calibration of the instrument.

Standard Parts

Many of the components in the instrument are standard electronic parts that can be purchased locally. However, all parts in the instrument can be obtained through your Tektronix Field Engineer or Field Office. Before purchasing or ordering any parts, check with the parts list in Section 6 to determine the value, tolerance, and rating required.

Special Parts

Some of the parts in the instrument are manufactured or selected by Tektronix to satisfy specific requirements, or are manufactured for Tektronix to our specifications. These and most mechanical parts should be ordered through your Tektronix Field Engineer or Field Office. See "Parts Ordering Information" and "Special Notes and Symbols" on the first page of Section 6.

Soldering

Special silver-bearing solder is used to establish a bond to the ceramic terminal strips in Tektronix instruments. This bond can be broken by repeated soldering (especially if ordinary tin-lead solder is used) or by excessive heating. Solder containing about 3% silver is recommended. A small supply of this solder is provided on a spool mounted inside the Type 561S. Additional silver-bearing solder can usually be purchased locally; however, it may be purchased through your Tektronix Field Engineer or Field Office — specify part number 251-514.

The following is recommended when soldering to ceramic terminal strips:

1. Use a wedge-shaped soldering-iron tip about 1/8 inch wide. This allows heat to be applied directly to the solder in the terminal strip, thereby reducing the amount of heat required.
2. Maintain a clean, properly tinned tip.

3. Use a hot iron for a short time. A 50- to 75-watt iron having good heat transfer and storage properties is adequate.

4. Avoid putting pressure on the strip. Excess pressure may crack or chip the strip.

Ceramic Terminal Strips

Fig. 4-1 shows an assembled ceramic terminal strip. Replacement strips with studs attached are supplied under a single part number and the spacers are supplied under another part number. The old spacers may be reused if they are not damaged.

Usually a strip can be pried out of the chassis or pulled out with a pair of pliers. If desired, you may use a hammer and punch to drive out the studs from the opposite side of the chassis.

When the damaged strip has been removed, place the new or used but undamaged spacers in the chassis holes. Then, carefully force the studs of the new strip into the spacers until they are completely seated. If necessary, use a soft-faced mallet and tap lightly directly over the stud area of the strip.

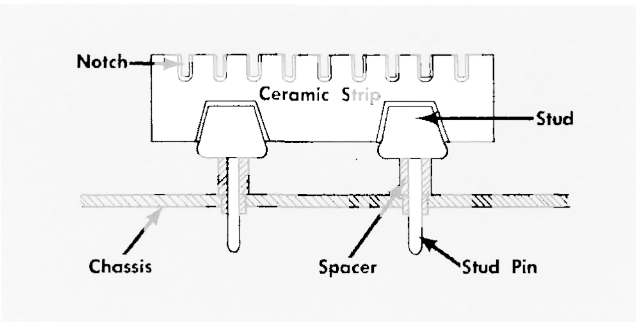


Fig. 4-1. Ceramic strip assembly.

Switch Replacement

Individual wafers are normally not replaced in the switch assemblies. Replacement switches may be ordered from Tektronix either wired or unwired. See the parts list for the part numbers.

When soldering to a switch assembly, do not let the solder flow around and beyond the terminal rivet since this may destroy the spring tension of the contact.

Tubes and Transistors

Tubes and transistors should not be replaced unless they are actually defective. When a trouble is suspected, check the circuit conditions to insure that the replacement tube or transistor will not immediately be damaged. In some cases, these checks will show if the tube or transistor is faulty.

When circuit conditions are known to be safe, install the good tube or transistor and check for proper operation. If the original tube or transistor is thus proved acceptable, return it to its original socket to avoid unnecessary recalibration.

Cathode-Ray Tube

The following procedure outlines the removal and replacement of the crt:

WARNING

Use care when handling a crt. Avoid striking it on any object that might cause it to crack and implode. Flying glass from an imploding crt can cause serious injury. Wear safety glasses or a plastic face mask.

1. Remove power from the instrument.
2. Remove the graticule cover and the graticule.
3. Remove the left-hand side panel of the Type 561S.
4. Loosen the crt socket clamp with a screwdriver.
5. Disconnect the crt socket and the four deflection plate leads.
6. Remove the crt through the front of the instrument. Be careful not to bend the crt deflection plates pins. Replace the crt by reversing the preceding steps. After replacing the crt, the trace should be paralleled with the horizontal graticule lines using the ALIGNMENT control. The SWEEP CAL and CALIB adjustments of the Type 3B1S and Type 3A1S should be checked and adjusted as required.

Troubleshooting Aids

This manual and the instrument contain many features intended to simplify maintenance. A block diagram which provides an overall picture of instrument operation is included in the back of this manual.

The schematic diagrams in the back of this manual give the circuit reference number for each electrical component as well as important operating voltages, signals, and conditions for their measurement. The range of circuit reference numbers associated with a particular diagram is given on each diagram.

Most of the wire in the instrument is color coded to aid in circuit tracing. All regulated low-voltage power supply leads are coded as follows:

1. The basic wire color indicates voltage polarity; tan for negative, white for positive.
2. The stripe colors indicate supply voltage according to the standard EIA color code. Read the stripes in order of decreasing width. For example, the —100-volt supply leads are tan wire (negative) bearing strips of brown (one), black (zero), and brown (one zero). The +125-volt supply is coded as +120 to avoid four digits.

The instrument contains a number of stable metal-film resistors identified by their gray background color and color coding. If a resistor has three significant figures and a multiplier, it will be EIA color coded. If it has four significant figures and a multiplier, the value will be printed on the resistor. For example, a 333 k resistor will be color coded,

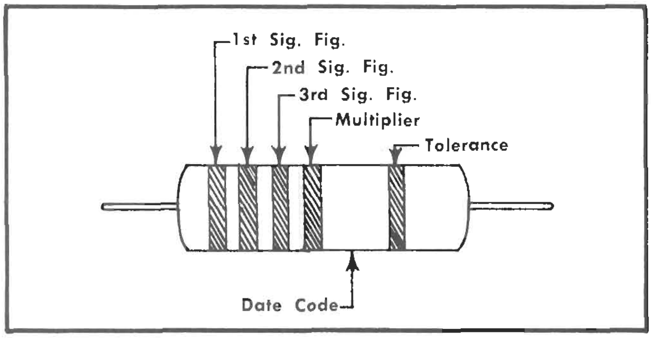


Fig. 4-2. Standard EIA color code for metal-film resistors.

but a 333.5 k resistor will have its value printed on the resistor body. The color coding sequence is shown in Fig. 4-2 and Table 4-1.

TABLE 4-1
Color Code Sequence

Color	1st Sig. Fig.	2nd Sig. Fig.	3rd Sig. Fig.	Multiplier	(±) % Tolerance
Black	0	0	0	1	—
Brown	1	1	1	10	1
Red	2	2	2	100	2
Orange	3	3	3	1,000	—
Yellow	4	4	4	10,000	—
Green	5	5	5	100,000	0.50
Blue	6	6	6	1,000,000	0.25
Violet	7	7	7	10,000,000	0.10
Gray	8	8	8	100,000,000	0.05
White	9	9	9	1,000,000,000	—
Gold				0.1	5
Silver				0.01	—
No Color					10

Switch wafers shown on the circuit diagrams are coded to indicate the physical positions of the wafers on a rotary switch. The number portion of the code refers to the wafer position as counted from the front or driven end of the switch shaft. Letters F and R indicate the front or rear of the wafer.

SYSTEM TROUBLESHOOTING

This part of the manual isolates a trouble occurring within the instrument to one of the plug-in units or to the Type 561S.

If you have more than two plug-in units (one or more spares), one way to isolate a trouble is to replace each plug-in unit, one at a time, with one known to be in proper operating condition. If replacement of the two plug-in units does not produce proper operation, then the trouble is probably in the Type 561S.

If a trouble occurs, first make sure it is not due to an improper control setting. (For example, improper settings of the SOURCE or COUPLING switches on the Type 3B1S can produce apparent triggering troubles; an improperly set VARIABLE control can cause an apparent decrease in sensitivity.) Then check the front-panel calibration adjustments. (An improper SWEEP CAL adjustment on the Type 3B1S can cause apparent timing problems; and an improper DC BAL setting can cause the trace to be positioned completely off the crt when the POSITION control is set at midrange.)

When it has been determined that a trouble definitely exists, and that trouble has been isolated to a circuit within a unit, perform a complete visual check of that circuit. Many troubles, such as loose wires, faulty switches, and improperly seated tubes can be found easily by visual inspection. Check also for heat-damaged parts. Find and eliminate the cause of overheating before replacing a heat-damaged part.

For more convenient access to the plug-in units during troubleshooting, a plug-in extension is recommended (Tektronix part number 013-034).

Normally, a trouble in the oscilloscope system will be discovered through an erroneous display (or no display at all) on the crt. For this reason, the following troubleshooting information is divided according to the symptoms presented to the operator.

No Trace or Spot

If you are unable to obtain a trace, pull out both plug-in units and adjust the INTENSITY control. A spot should appear on the crt. If not, the trouble is in the Type 561S. If a spot appears when both plug-in units are pulled out, reinsert each one separately and adjust its POSITION control. If the spot or trace cannot be returned to the approximate center of the crt when one of the plug-ins is inserted, the trouble is in that plug-in unit.

Insufficient Deflection

If the horizontal or vertical deflection cannot be set to the proper value with the CALIB or SWEEP CAL adjustment on the plug-in unit front panel, first check the power supply voltages at pins 10, 15, 16 and 23 of the plug-in connectors, and the high voltage (—3300 volts at the high-voltage test point. If the voltages are all within the tolerances shown on the schematic diagrams, the trouble is in one of the plug-in uints. If there is insufficient vertical deflection, the trouble is in the Type 3A1S; if there is improper horizontal deflection, the trouble is in the Type 3B1S.

If the power supply voltages are not as specified on the schematic diagrams, remove both plug-in units and check the voltages again. If they still are not as specified, the trouble is in the Type 561S. If the power-supply voltages are correct with both plug-in units removed but incorrect when inserted, check the resistances at the plug-in connectors of the plug-in units. If the resistance measurements of either of the plug-in units do not agree with the schematic diagram for that plug-in unit, the trouble is in that plug-in unit. If all resistances are as specified, the trouble is in the power supply circuit of the Type 561S.

Improper Sweep Timing

If improper sweep timing is encountered (and cannot be eliminated by adjustment of the front-panel SWEEP CAL adjustment on the Type 3B1S), first check the power-supply voltages at the plug-in connectors and the high voltage (—3300 volts) at the high-voltage test point. If the voltages are as specified on the schematic diagram, the trouble is in the Type 3B1S. If one or more of these voltages are not as specified, proceed as described in the preceding paragraph.

Improper Triggering

If external triggering is satisfactory but internal triggering is not, the trouble is probably in the Trigger Pickoff circuit of the Type 3A1S. If satisfactory triggering is not obtained from either triggering source, the trouble is probably in the Type 3B1S.

Waveform Distortion

If there is an excessive amount of waveform distortion, but no other indications of malfunction (such as improper sweep timing or insufficient deflection), the trouble is in the plug-in unit which is amplifying the distorted waveform.

TYPE 561S TROUBLESHOOTING

The first step in troubleshooting the Type 561S is to determine whether the trouble is in the low-voltage power supply or the crt circuit. Two plug-in units which have been checked for proper resistance between the plug-in connectors and ground should be inserted. If any or all of the voltages are improper, the trouble is in the low-voltage power supply or the power source. To check these, refr to "Troubleshooting the Power Supply". If all of the voltages are proper, the trouble is in the Crt Circuit (refer to "Troubleshooting the Crt Circuit").

Troubleshooting the Power Supply

If there is no power anywhere in the Type 561S (power-supply outputs, graticule lights tube filaments) check the primary circuit of T601. Check especially the fuse, the thermal-cutout switch, the POWER ON switch, and the power source. If all of these are satisfactory, check the primary of T601 for continuity. If the graticule lights or any of the tube filaments are lighted, the primary circuit of T601 is operating properly.

If one or more of the supplies fail to regulate, check the line voltage; it should be between 105 and 125 volts rms for an instrument wired for 117-volt operation, or between 210 and 250 volts rms for an instrument wired for 234-volt operation. If not, then the power source should be brought within these limits for the instrument to perform properly.

If the line voltage is within the specified limits, and one of the power-supply output voltages is not correct, check that particular regulator circuit. If none of the voltages are correct, the trouble is probably in the —100-volt supply, since this voltage serves as a reference for the other three regulated circuits.

To check a regulator circuit, first replace the tubes as described previously. If this does not eliminate the trouble, check the rest of the circuit by voltage and resistance measurements. One cause of insufficient voltage might be an open or shorted rectifier diode.

If there is excessive ripple on any of the supplies, replace the filter capacitor or capacitors (C640A, C642A, C644, or C720).

Troubleshooting the Crt Circuit

To locate a trouble within the Crt Circuit, first remove the high-voltage shield and see if the filament of the high-voltage rectifier, V822, is glowing. If it is, measure the voltage at the plate of V822; it should be about —3400 volts with respect to ground.

If the voltage at the plate of V822 is about —3400 volts, measure the potentials in the high-voltage divider and at the other points in the circuit for which typical voltages are given on the schematic diagram. If all of these voltages are correct, then the crt itself is probably faulty and should be checked.

If the filament of V822 is glowing but the voltage at its plate is significantly less than —3400, turn off the power and measure the resistance from the plate of V822 to ground; it should be about 20 megohms. If it is, then the trouble is in V822 or in the secondary of T801. If the resistance between the plate of V822 and ground is significantly less than 20 megohms, locate the trouble by performing resistance checks throughout the rest of the circuit.

If the filament of V822 is not glowing, measure the voltage at the grid of V800. It should be at least —50 volts with respect to ground. If it is, the high-voltage oscillator is operating and the trouble lies in V822 or in the secondary of T801. If the voltage at the grid of V800 is significantly less than —50 volts, then the oscillator is not operating properly. However, make circuit checks before replacing V800 to prevent possible damage to the replacement tube. First, measure the voltage at the plate of V800; it should be about +400 volts. If it is not, then the trouble lies in the plate circuit. If the voltage at the plate of V800 is about +400 volts, check the resistance of the primary and secondary of T801. The resistance of the primary should be about 40 ohms, and the resistance of the secondary (between the filament of V822 and ground) should be about 170 ohms. Check C807 and C822 to make sure that they are not shorted. Also check the resistance between the plate of V822 and ground; it should be about 20 megohms. If all of these resistances are correct, then replace V800 and V814. If tube replacement does not eliminate the trouble, check the rest of the circuit by voltage and resistance measurements.

TYPE 3B1S TROUBLESHOOTING

Use the following information to troubleshoot the Type 3B1S. While troubleshooting, compare the information from this section with information from other parts of the manual, particularly the circuit description and calibration sections.

Be sure the front-panel controls are set properly. Operate the front-panel controls to see the effect they have on the trouble symptom. The normal or abnormal operation of a control may help to establish the source of the trouble.

Once the trouble symptoms are established, look for the obvious causes. Check to see that there is power, feel for irregularities in control operation, listen for unusual sounds, and visually check the entire plug-in unit. The type of symptom should show the checks to make.

In general, troubleshooting consists of circuit isolation (Table 4-2) and circuit troubleshooting (Table 4-3). The general procedure helps isolate the defective circuit. However, if the circuit isolation procedure does not locate the faulty circuit, other checks will be required. When the faulty circuit has been found, a detailed check within the circuit will usually lead to the cause of the trouble symptom.

Circuit Isolation

The following table lists possible trouble symptoms and the individual circuits that may be the cause. When the trouble has been pinned down to a particular circuit, use the portion of Table 4-3 that applies to that circuit.

TABLE 4-2

CIRCUIT ISOLATION

Trouble Symptom	Circuit to Check
1. No sweep in any position of front-panel controls.	Horizontal Amplifier Normal Sweep Generator
2. No sweep in either DLY'D SWP position of MODE switch.	Delayed Sweep Generator Delay Pickoff
3. No intensified area on display in either INTEN position of MODE switch.	Delayed Sweep Generator
4. Sweep too short in both normal and delayed sweep.	Horizontal Amplifier
5. Sweep is short only in delayed sweep.	Delayed Sweep Generator
6. Sweep nonlinear in normal and delayed sweep.	Horizontal Amplifier
7. Sweep timing incorrect in all positions of TIME/DIV switch.	Normal Sweep Generator
8. Sweep timing incorrect only in some positions of TIME/DIV switch.	Normal Sweep Generator
9. No sweep in AC or DC position of the normal sweep trigger COUPLING switch.	Normal Sweep Trigger
10. No delayed sweep in either TRIG position of MODE switch.	Delayed Sweep Trigger

NOTE

Because the normal and delayed sweep are similar, trouble can often be isolated to one or the other by operating each one independently. The delayed sweep can be operated without the normal sweep by intermittently shorting across R243 in the Delayed Sweep Generator circuit.

TABLE 4-3

CIRCUIT TROUBLESHOOTING

Trouble Symptom	Check
Normal Sweep Generator	
1. No sweep	1. Crt may not be unblanked. Check V194, Q183, and Q194. 2. If B164 is turned on, check V161. 3. Miller circuit check: Turn the TIME/DIV switch to 1 SEC. Short the collector terminal of Q114 to —12 volts; the voltage at the base of Q143 should start to rise (remove short when voltage reaches +15 volts). If not, check V161 and D171. 4. Sweep gating check: Remove Q114 and connect dc voltmeter across R144 (in collector circuit of Q143). Set COUPLING switch to AUTO; voltmeter should read between +5 and +6 volts. If not, check Q143. Turn LEVEL control to midrange, voltage should drop to +4 volts. If not, check D105. Set COUPLING switch to DC and LEVEL control fully clockwise. Connect test oscilloscope probe to the junction of R144-D105. Intermittently short across R143; switching action of D105 should be seen.
2. Sweep appears in AUTO coupling only.	Check D102.
3. Sweep will not trigger in AUTO coupling.	Check D119 and D115.
Horizontal Amplifier	
1. No sweep	1. Measure voltage at the collector of Q314, vary POSITION control, voltage should change from —5 to —13 volts. 2. Voltage at the base of Q354 should change from —5 to —13 when POSITION control is turned. Voltage on the cathode of V383 should vary between +2 and +7 as POSITION control is turned. 3. Connect test oscilloscope to the plates of V383. Waveform shown on schematic should be seen.
2. Sweep will not cover width of crt.	Check Q354, Q364, and V383.
Normal Trigger Circuit	
1. Display cannot be triggered.	1. Use test oscilloscope to check for triggering signal on both sides of D15.

Trouble Symptom	Check
	2. Voltage at the emitter of Q23 should vary from —10 to +14 volts as LEVEL control is turned throughout its range. 3. Voltage at the junction of R29-D24-D34 should vary from —9 to +3 volts as LEVEL control is turned throughout its range. 4. Move the SLOPE switch to the opposite polarity and repeat measurement of previous step. These two measurements check Q24 and Q34. 5. Check for —12.5 volts at the emitter of Q44. This checks Q44. 6. Connect test oscilloscope to the emitter of Q44. Should be 0.5 volt square wawve as shown on schematic. This checks D35.
2. Triggers only on large signals.	V13 weak. D35 open.
3. Triggering unstable.	Check power supply regulation.
Delayed Sweep Trigger	
1. Delayed Sweep cannot be triggered.	1. Use test oscilloscope to check for triggering signal on both sides of D65. 2. Voltage at the emitter of Q73 should vary from —10 to +14 as the Delayed Sweep LEVEL control is turned throughout its range. 3. Voltage at the junction of R79-D74-D84 should vary from —9 to +3 volts as the Delayed Sweep LEVEL control is turned throughout its range. (Be sure MODE switch is in TRIG DLY'D SWP position.) 4. Check for about —12.5 volts at the emitter of Q94. This checks Q94. Connect the test oscilloscope probe to the emitter of Q94. Should be a 0.5 volt square wave as shown on schematic. This checks D85.
2. Triggers only on large signals.	V63 possibly weak. D85 open.
Delayed Sweep Generator	
1. No Delayed Sweep.	1. If B264 is turned on, check V261. 2. Miller circuit check: Turn DELAYED SWEEP switch to 1 SEC. Short the collector terminal of Q214 to —12 volts. Voltage on the base of Q243 should start to rise (remove short when voltage reaches +15 volts). If not, check V161 and D171. 3. Short collector of Q214 to —12 volts. 4. Sweep gating check. Connect test oscilloscope probe to the junction of R244-D205. Intermittently short the emitter of Q243 to ground, switching of D205 should be seen. If not, Q243 may be open, or D205 defective.
2. No Delayed Sweep in TRIG DLY'D SWP position of MODE switch.	Check D202 and D201.
3. Delayed Sweep free-runs, will not trigger.	D243 or D233 may be shorted.
4. Delayed Sweep non-linear at all sweep rates.	Check V261 for nonlinear amplification.
5. Delayed Sweep non-linear at only one sweep rate.	Check applicable timing capacitor for leakage.
6. No holdoff period on sweep waveform.	D270 possibly open.
7. Trace not intensified in INTEN position of MODE switch.	Q294 defective.
Delay Pickoff	
1. No Delayed Sweep.	1. Voltage at the junction of R453-R455 should be between —12 and —15 volts and should change as the trigger LEVEL control is turned. If it does, check D455. If it does not, check Q453. 2. Adjust controls for a normal display. Connect test oscilloscope probe to the junction of D445-D444, waveform should be the switching pulse of D445. 3. Check for waveform at collector of Q424. 4. Connect test oscilloscope to the plate of V414A. Vary DELAY control, amplitude of waveform should change from 0.5 volts peak-to-peak to 2 volts, peak-to-peak.

TYPE 3A1S TROUBLESHOOTING

Use the following information to troubleshoot the Type 3A1S.

If trouble occurs in the Type 3A1S, try to isolate it by quick operational and visual checks. First check the settings of all controls. Then operate the controls to see their effect, if any, on the trouble. The normal or abnormal operation of each control may help establish the trouble symptoms.

After the trouble symptoms are established, look first for simple causes. Check that the pilot light of the oscilloscope is on, feel for any irregularities in the operation of the controls, listen for any unusual sound, see if tube filaments are lit, and visually check the entire plug-in unit. The type of symptom will generally indicate the checks to make.

In general, a troubleshooting procedure consists of two parts: circuit isolation (Table 4-4) and circuit troubleshooting. First, isolate the circuit, then troubleshoot in the circuit to find the cause of the trouble.

Voltages are shown at many test points on the schematics. When necessary, the conditions under which the voltages were obtained also appear on the schematics.

NOTE

Because the output amplifier should be balanced, a bad tube or transistor will usually shift the trace off the crt. If the vertical signal is low or absent, but the trace is normal, the trouble will be a component that is common to both transistors or tubes in an amplifier pair.

TABLE 4-4
CIRCUIT ISOLATION

Trouble Symptom	Probable Cause	Check
1. No spot or trace on either channel regardless of MODE switch setting.	Output amplifier not balanced. Bad tube or transistor in output amplifier.	Connect a short across the vertical deflection pins on the crt. If a trace appears, the vertical amplifier is unbalanced. Check for voltage difference across each pair of amplifiers starting from the first output amplifier stage.
2. No vertical signal on crt from either channel.	Defective component in one of the balanced output amplifiers.	Signal trace through each stage of the output amplifier.
3. Vertical signal only on one channel. POSITION control of defective channel does not operate but trace is normal.	Shorted multivibrator transistor. Shorted or open diode in diode gates.	Check Q275 and Q285. Check diodes in diode gate of defective channel (D155 and D158, D255 and D258).
4. Unit will not operate in alternate. (ALTER mode)	Blocking oscillator Q260 not operating. Diodes D278 or D288 open or shorted. Multivibrator not operating.	Check for sync pulse at the emitter and collector of Q260. Check diodes. Check multivibrator transistors Q275 and Q285, and diodes D278 and D288.
5. Unit will not operate in the CHOP mode.	Blocking oscillator not operating.	Check blocking oscillator Q260 for trigger waveform to multivibrator (Q275 and Q285).
6. Sweep will not trigger in either position of TRIGGER CH 1 ONLY switch.	Multivibrator not operating. Trigger cathode follower not operating.	Check multivibrator transistors Q275 and Q285, and diodes D278 and D288. Check V383.
7. Sweep will not trigger when TRIGGER CH 1 ONLY switch is pulled out.	Channel 1 trigger amplifier. CHAN 1 TRIG DC LEVEL R171 not correctly set.	Check Q164, Q174, Q173 and Q183. Check calibration procedure for correct setting of R171.
8. Dc reference-level shift. Trace shifts when AC-DC-GND switch is changed from DC to GND.	DC BAL R119 and R219 not adjusted correctly. Input cathode-follower tubes gassy.	Refer to calibration procedure for adjustment of DC BAL controls. Check V123 and V223.

SECTION 5
CALIBRATION

Introduction

The Type 561S Oscilloscope system should be calibrated after each 500 hours of operation or every six months if used intermittently.

This procedure contains complete calibration instructions for the Indicator Unit (Type 561S), the Vertical Unit (Type 3A1S), and the Time-Base Unit (Type 3B1S). Any of the units may be calibrated separately without calibrating the whole system. However, if either of the plug-in units are to be calibrated separately, the Type 561S must be properly calibrated. When calibrating the Type 561S, it is only necessary that the plug-in units produce a display.

TYPE 561S CALIBRATION

Equipment Required

The following items, or their equivalent, are required for a complete calibration of the Type 561S.

1. A Tektronix Type 3A1S Dual-Trace Amplifier plug-in unit.
2. A Tektronix Type 2- or 3-Series time-base plug-in unit such as the Type 3B1S.
3. Variable autotransformer for supplying the line voltage to the Type 561S. The autotransformer must be capable of supplying at least 350 volt-amperes.
4. DC voltmeter with the following minimum specifications:
   Sensitivity 5,000 Ω/volt
   Accuracy 1% or better up to 300 volts and at least 3% at 4 kv.
5. Ac voltmeter (rms) with a range of at least 125 volts (250 volts if the Type 561S is wired for 234-volt operation).

Preliminary Instructions

To set up the Type 561S for calibration, insert the Type 3A1S into the left-hand opening and the Type 3B1S into the right-hand opening. Connect the autotransformer to a suitable power source and connect the Type 561S to the output of the autotransformer. Set the output voltage of the autotransformer to the nominal operating voltage of the Type 561S (117 volts or 234 volts). Turn on the Type 561S and allow the system to warm up for about 10 minutes before proceeding.

Power Supply

With the dc voltmeter, measure the voltage at pin 23 of either interconnecting plug and set the —100 VOLTS adjustment for exactly 100 volts on the meter.

Connect the voltmeter to pin 10 of either interconnecting plug and set the +300 VOLTS adjustment for exactly 300 volts on the meter.

Connect the voltmeter to pin 15 of either interconnecting plug and set the +125 VOLTS adjustment for exactly 125 volts on the meter.

Connect the voltmeter to pin 16 of either interconnecting plug and set the —12.2 VOLTS adjustment for exactly 12.2 volts on the meter.

Measure the voltage at the HV TEST POINT (see Fig. 5-1) and set the HIGH VOLTAGE adjustment for exactly 3300 volts on the meter.

Power Supply Ripple Check

Set the system front-pannel controls as follows:

Type 561S

INTENSITY	Midrange
FOCUS	Midrange

Type 3A1S

CH 1 AC-DC-GND	AC
CH 1 POSITION	Midrange
CH 1 VOLTS/DIV	.1
CH 1 VARIABLE	CALIB
MODE	CH 1

Type 3B1S

TIME/DIV	10 mSEC
MODE (if applicable)	NORM
POSITION	Midrange
Triggering Controls	Set for an AUTO or free-running sweep.

Connect a patch cord between the CH 1 input connector of the Type 3A1S and pin 10 (+300-volt supply) of either interconnecting plug. The peak-to-peak ripple voltage of this supply should not exceed 80 mvolts (0.8 graticule division of vertical deflection).

Connect the patch cord to pin 23 of either interconnecting plug and set the CH 1 VOLTS/DIV switch of the Type 3A1S to .01. The ripple voltage of this supply (—100 v) should not exceed 5 mvolts, peak-to-peak (0.5 graticule division of vertical deflection).

Connect the patch cord to pin 15 of either interconnecting plug and observe the amount of ripple voltage. The ripple voltage of this supply (+125 v) should not exceed 10 mvolts, peak-to-peak (1.0 graticule division of vertical deflection).

Connect the patch cord to pin 16 of either interconnecting plug and observe the amount of ripple voltage. The ripple voltage of this supply (—12.2 v) should not exceed 3 mvolts, peak-to-peak (0.3 graticule division of vertical deflection).

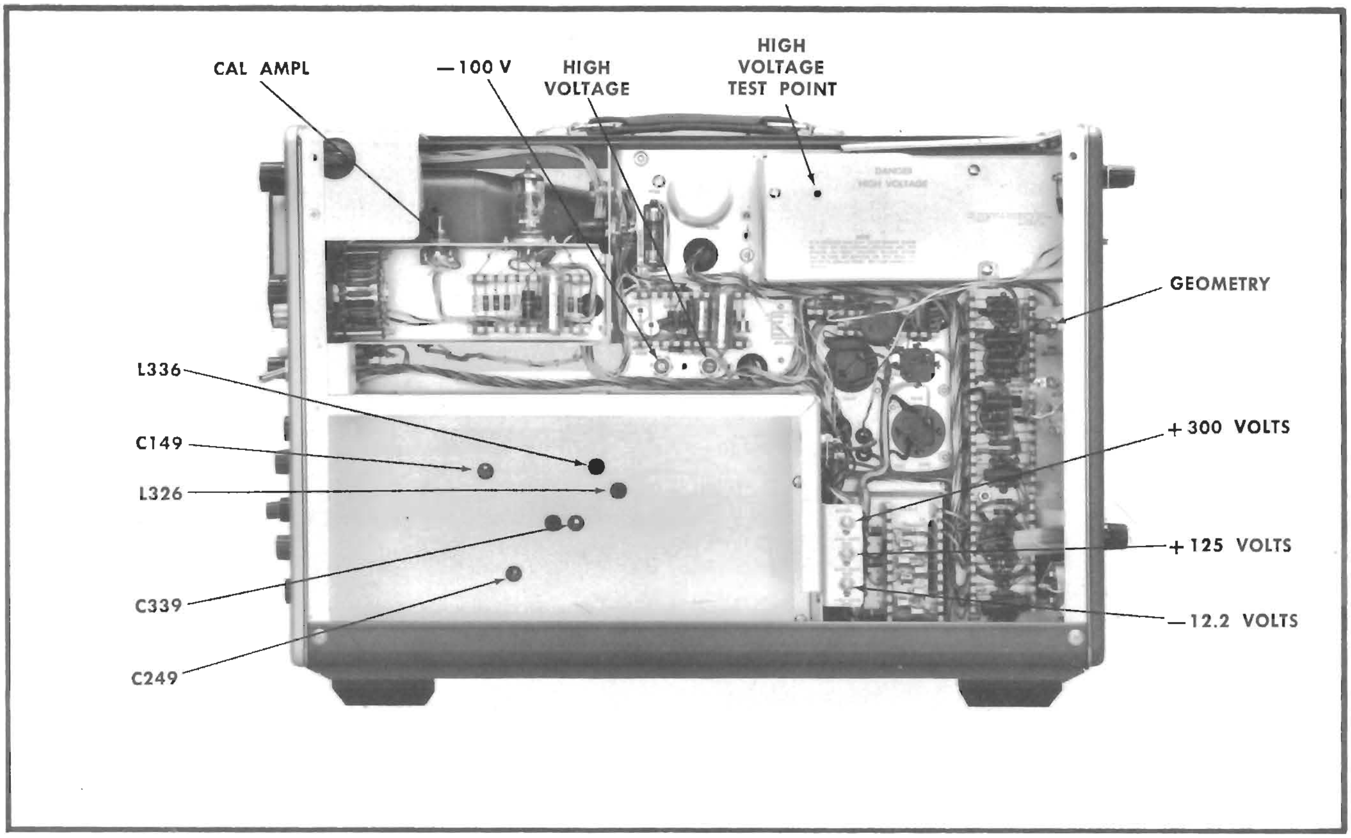


Fig. 5-1. HV test point location.

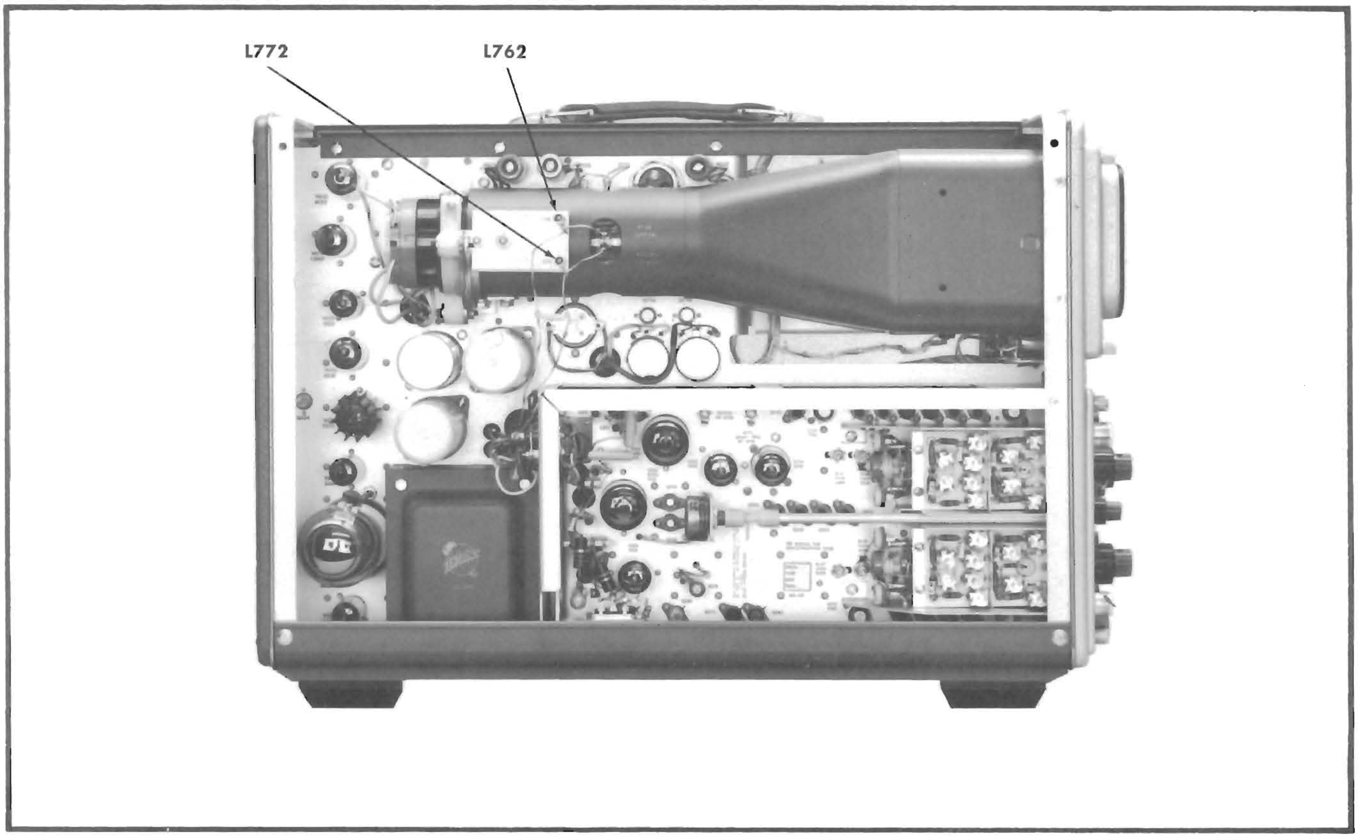


Fig. 5-2. L722 and L762 location.

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Calibrator

Set the Type 561S CALIBRATOR switch to OFF and set the CAL AMPL (Fig. 5-1) adjustment so the voltage monitored at pin 7 of V884 is exactly 100 volts. Calibration of individual CALIBRATOR switch settings is not necessary.

Cathode-Ray Tube

Remove the graticule cover and graticule from the Type 561S. With a straight-edge, check to see if the crt is flush with the front panel of the instrument. If not, loosen the crt clamp screw and move the tube by a slight pull or push on the tube socket. Then, retighten the crt clamp screw.

Set the Type 3B1S coupling switch to AUTO. With no signal applied to the Type 3A1S, set its VOLTS/DIV switch to 10 and position the trace to the graticule horizontal centerline using the Type 3A1S POSITION control. Adjust the Type 561S FOCUS, INTENSITY, and ASTIGMATISM controls for the narrowest and best defined trace. Adjust the ALIGNMENT control so that the trace is exactly parallel with the horizontal graticule lines.

Cathode-Ray Tube Geometry

The GEOMETRY control is set to achieve minimum curvature of the vertical lines displayed at the two sides of the graticule.

From the time-mark generator apply time markers of 100 μsec and 1 msec to the CH 1 input of the Type 3A1S. Set the CH 1 VOLTS/DIV switch to 1 and adjust the Type 3B1S for a stable display. Set the Type 3A1S CH 1 VOLTS/DIV switch to .05 and position the baseline downward and off the crt and display only the vertical lines of the time markers. Adjust the GEOMETRY control (Fig. 5-1) for minimum curvature of the vertical lines at the left and right ends of the graticule.

TYPE 3B1S CALIBRATION

Equipment Required

The following items of equipment, or their equivalent, are required for a complete calibration of the Type 3B1S.

1. A calibrated Tektronix Type 561S Oscilloscope.
2. Tektronix Type 3A1S, Dual-Trace Amplifier plug-in unit.
3. Time-mark generator with crystal-controlled markers at 1 μsec, 10 μsec, 50 μsec, 100 μsec, 1msec, 5 msec, 10 msec, 100 msec, and 1 sec. The generator must also have an accurate 10-mc sine-wave output. Tektronix Type 180A Time-Mark Generator recommended.
4. A Tektronix 560-Series Plug-In Extension Part No. 013-034.
5. A coaxial cable about 3 feet long with UHF plug connectors on each end, such as Tektronix 42″ 50 Ω cable, Part No. 012-001.
6. Dc voltmeter, 20,000 ohms per volt (or better), 3% accuracy.
7. Insulated screwdriver for adjusting variable capacitors, such as Jaco 1½″ shank No. 125, Tektronix Part No. 003-000.
8. A 6″ clip lead with a small insulated alligator clip on each end.
9. Two 18″ banana-tip patch cords, such as Tektronix PC18R, Part No. 012-031.

Preliminary Instructions

Install the Type 3A1S into the left-hand compartment of the oscilloscope. Install the Type 3B1S into the right-hand compartment with the Tektronix 560-Series plug-in extension. Set the Type 3B1S front-panel controls as follows:

POSITION	Midrange
MODE	NORM
10 × MAG	off (pushed in)
TIME/DIV	5 mSEC
DELAYED SWEEP	5 mSEC
VARIABLE TIME/DIV	CALIB
NORMAL SWEEP COUPLING	AUTO
DELAY TIME and VERNIER	Midrange

Turn on the power and allow a 10-minute warmup before starting calibration.

Procedure

1. Check +15-Volt Supply

a. Measure the voltage across Zener diode D398 (see Fig. 5-3) with the dc voltmeter; the voltage should be +15 volts, ±10%.

2. Adjust Normal Sweep Gating Threshold

a. Set the Normal Sweep COUPLING switch to AC.

b. Connect the short clip lead (with insulated alligator clips) across R143 (see Fig. 5-3).

c. Adjust R130, the NORMAL SWP GATING THRESHOLD control (see Fig. 5-4), to just produce a free-running sweep.

d. Remove the jumper from R143, the trace should disappear.

3. Adjust Delayed Sweep Gating Threshold

a. Set the Normal Sweep COUPLING switch to AUTO. The trace should appear.

b. Set the MODE switch to TRIG DLY'D SWP.

c. Connect the short clip lead across R243 (see Fig. 5-3).

d. Adjust R230, the DELAYED SWP GATING THRESHOLD control (see Fig. 5-4), to just produce a free-running sweep.

e. Remove the jumper from R243. The trace should disappear.

4. Adjust Sweep Calibration

a. Set the MODE switch to NORM, the Normal Sweep SOURCE switch to INT, the COUPLING switch to AUTO, the SLOPE switch to +, and the TIME/DIV switch to 1 mSEC.

b. Set the Delayed Sweep SOURCE switch to INT, the COUPLING switch to AC, the SLOPE switch to +, and the DELAY SWEEP knob to 1 mSEC.

c. Connect the time-mark generator to the Type 3A1S vertical amplifier, and set the generator for 1 msec time marks.

d. Adjust the SWEEP CAL control, (front-panel screwdriver adjustment) for exactly 1 time marker per major graticule division.

e. Set the MODE switch to TRIG DLY'D SWP and check the timing accuracy. Readjust the SWEEP CAL control to reduce any timing error by 50 percent.

f. Set the MODE switch to NORM and see if the Normal Sweep now has a timing error equal and opposite to the Delayed Sweep timing error. The SWEEP CAL control is adjusted properly when any basic timing errors of the two sweep generators are equal and opposite.

NOTE

Timing adjustments should always be made with the trace beginning at the left edge of the graticule. Make visual measurements between the 2nd and 9th major graticule divisions.

5. Adjust Normal Sweep Length

a. Use the same setup as in step 4, and adjust NORMAL SWEEP LENGTH R168 (see Fig. 5-4), for 10.5 major graticule divisions of horizontal deflection.

6. Adjust Delayed Sweep Length

a. Use the same setup as in step 4.

b. Set the MODE switch to TRIG DLY'D SWP, the TIME/DIV switch to 2 mSEC, the DELAYED SWEEP knob to 1 mSEC, and adjust the Delayed Sweep LEVEL control for a stable display.

c. Adjust DELAYED SWEEP LENGTH R268 (see Fig. 5-4), for 10.5 major graticule divisions of horizontal deflection.

7. Adjust MAG GAIN

a. Set the MODE switch to NORM, and the TIME/DIV switch to 1 mSEC.

b. Set the time-mark generator for 1-msec and 100-μsec time marks.

c. Adjust the Normal Sweep LEVEL control for a stable display.

d. Pull the 10× MAG switch out and adjust MAG GAIN R335 (see Fig. 5-4) for one large time mark every 10 major graticule divisions and 1 small time mark every 1 major graticule division.

e. Check linearity over the entire magnified sweep by moving the POSITION control throughout its range.

8. Adjust Sweep Magnifier Registration

a. Use the same setup as in step 7.

b. Pull the 10× MAG switch out and position the display so the first full large time mark falls on the graticule centerline.

c. Push the 10× MAG switch in and adjust SWP MAG REGIS R368 (see Fig. 5-4) so the first time mark again falls on the graticule centerline.

d. Repeat this adjustment until there is no shift in the start of the display when the 10× MAG switch is pulled out.

9. Adjust Delay Stop

a. Push the 10× MAG switch in. Set the MODE switch to INTEN and turn the DELAY TIME and VERNIER controls fully clockwise.

b. Adjust the oscilloscope intensity so the intensified part of the display is clearly visible.

c. Adjust DELAY STOP R435 (see Fig. 5-4), so the intensified part of the display starts at the 2nd 100 μsec marker to the right of the 11th 1 msec marker.

d. Turn the DELAY TIME and VERNIER controls fully counterclockwise; the intensified part of the display should start between the first 2 major graticule divisions.

10. Check Normal and Delayed Sweep Rates

a. Set the front-panel controls as follows:

MODE	NORM
TRIGGERING (Normal Sweep)	+ AC INT
TRIGGERING (Delayed Sweep)	+ AC INT
TIME/DIV	50 μSEC
DELAYED SWEEP	50 μSEC

b. Set the time-mark generator for 50-μsec time marks.

c. Adjust the Normal Sweep LEVEL control for a stable display.

d. Check for 1 time mark at each major graticule division between the 2nd and 9th division lines.

e. Set the MODE switch to TRIG DLY'D SWP and adjust the Delayed Sweep LEVEL control for a stable display.

f. Check for 1 time mark at each major graticule division between the 2nd and 9th division lines.

g. Repeat step (f) at each of the settings shown in Table 5-1. Notice that the TIME/DIV and DELAYED SWEEP switches are set to the same position for each check.

TABLE 5-1

TIME/DIV and DELAYED SWEEP Switches	Time Marks	Time Marks/Div
50 μSEC	50 μsec	1
.1 mSEC	100 μsec	1
.2 mSEC	100 μsec	2
.5 mSEC	500 μsec	1
1 mSEC	1 msec	1
2 mSEC	1 msec	2
5 mSEC	5 msec	1
10 mSEC	10 msec	1
20 mSEC	10 msec	2
50 mSEC	50 msec	1
.1 SEC	100 msec	1
.2 SEC	100 msec	2
.5 SEC	500 msec	1
1 SEC	1 sec	1

NOTE

The timing error for all sweep rates must be within 3% (1.2 minor graticule divisions). Timing checks are made over 8 major graticule divisions between the 2nd and the 9th division lines.

11. Check the VARIABLE TIME/DIV Control

a. Set the MODE switch to NORM, the TIME/DIV switch to 1 mSEC, the DELAYED SWEEP switch to .2 mSEC, and the time-mark generator for 10-msec time marks.

b. Obtain a triggered display of a time marker at the left and right edges of the graticule.

c. Turn the VARIABLE TIME/DIV control fully counterclockwise. The markers should now be not more than 4 divisions apart with a ratio of at least 2.5 to 1.

12. Adjust Fast Normal Sweep Rates

a. Remove the plug-in extension, and install the Type 3B1S directly into the oscilloscope.

b. Set the VARIABLE TIME/DIV control to CALIB.

c. Perform the adjustments as shown in Table 5-2.

13. Adjust Fast Delayed Sweep Rates

a. Set the MODE switch to TRIG DLY'D SWP. Use Table 5-2 and substitute DELAYED SWEEP switch settings for the TIME/DIV settings.

TABLE 5-2

TIME/DIV Switch	Time Marks	Adjustment	Time Marks/Div
10 μSEC	10 μsec	C160D	1
20 μSEC	10 μsec	check	2
5 μSEC	5 μsec	check	1
1 μSEC	1 μsec	C160B	1
2 μSEC	1 μsec	check	2
.5 μSEC	1 μsec	check	1 per 2 div
15 μSEC	10 megacycles	Pull out 10× MAG switch	1 cycle per 2 div

b. At 10 μSEC, adjust C260D, and at 1 μSEC, adjust C260B (Fig. 5-4).

c. Check the 10-megacycle display as shown in Table 5-2 for the Normal Sweep.

TYPE 3A1S CALIBRATION

Equipment Required

1. Tektronix Type 561S Oscilloscope.
2. Tektronix time-base plug-in unit such as the Type 3B1S.
3. Dc voltmeter, 5000 ohms/volt, 2% accuracy.
4. Square-wave generator with a frequency output of about 1 kc Risetime of about 20 nsec or less, and at least 0.25-volt output amplitude such as the Tektronix Type 105 Square-Wave Generator.
5. Fast-rise square-wave generator with a frequency output of about 400 kc. Risetime of about 3.5 nsec or less, (into 50 ohms) and at least 0.1-volt output amplitude such as the Tektronix Type 107 Square-Wave Generator.
6. UHF 50-ohm termmination such as Tektronix Part No. 011-045.
7. UHF 50-ohm 5×T attenuator such as Tektronix Part No. 011-032.
8. Tektronix input time-constant standardizer, Part No. 011-030.
9. UHF 50-ohm coaxial cable such as Tektronix Part No. 012-001.
10. Nonmetal alignment tool, such as Tektronix Part No. 003-301.
11. Nonmetal alignment tool, such as Tektronix Part No. 003-307 and 003-310.
12. Tektronix 560-Series plug-in extension, Part No. 013-034.

Preliminary Instructions

Install the Type 3A1S in the left-hand opening of the oscilloscope, and the Type 3B1S with the plug-in extension in the right-hand opening. Remove both side covers of the oscilloscope. Turn the oscilloscope power on and allow at least 10 minutes for warmup. Set the Type 3B1S for a 1 msec/div free-running or AUTO sweep. Set the controls for both channels of the Type 3A1S as follows:

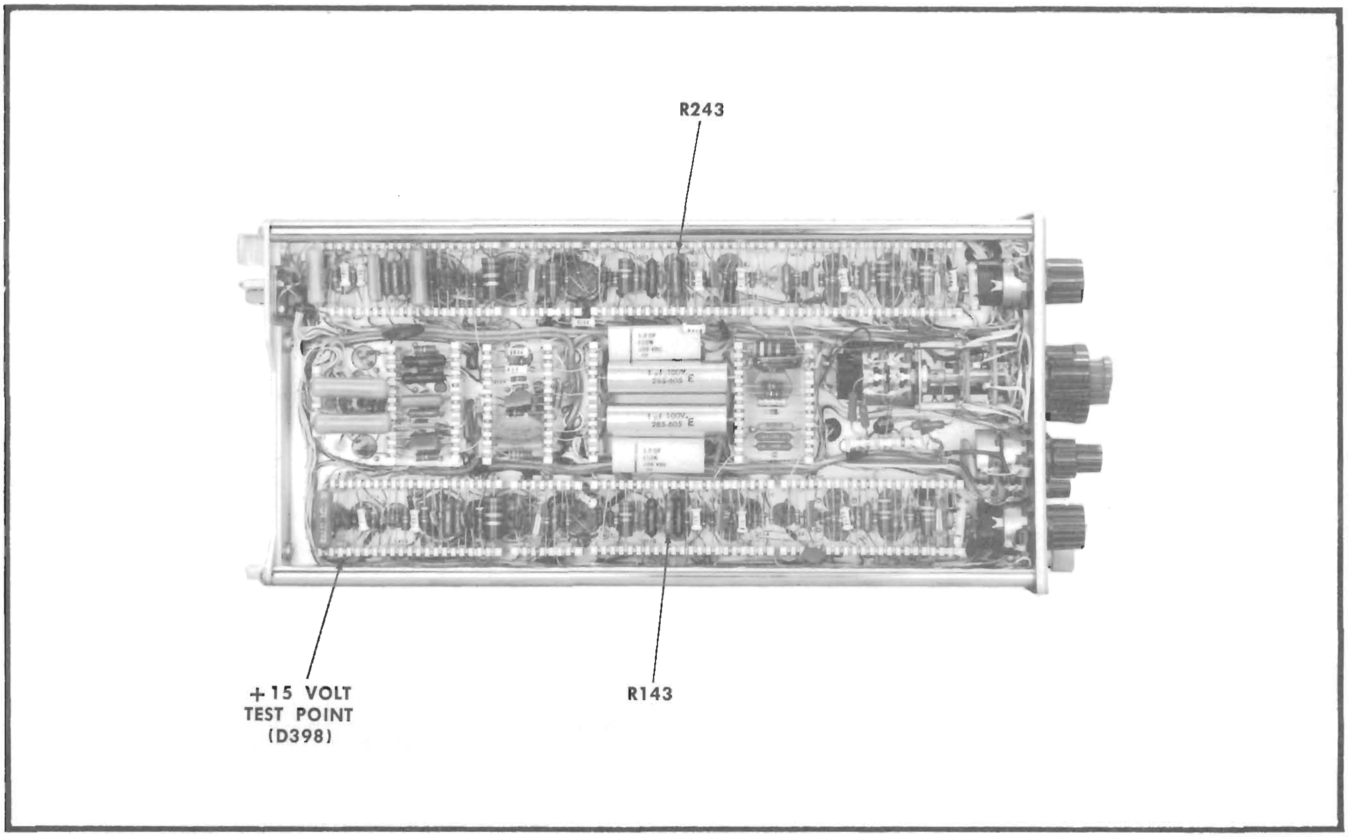

Fig. 5-3. Type 3B1S, left side view.

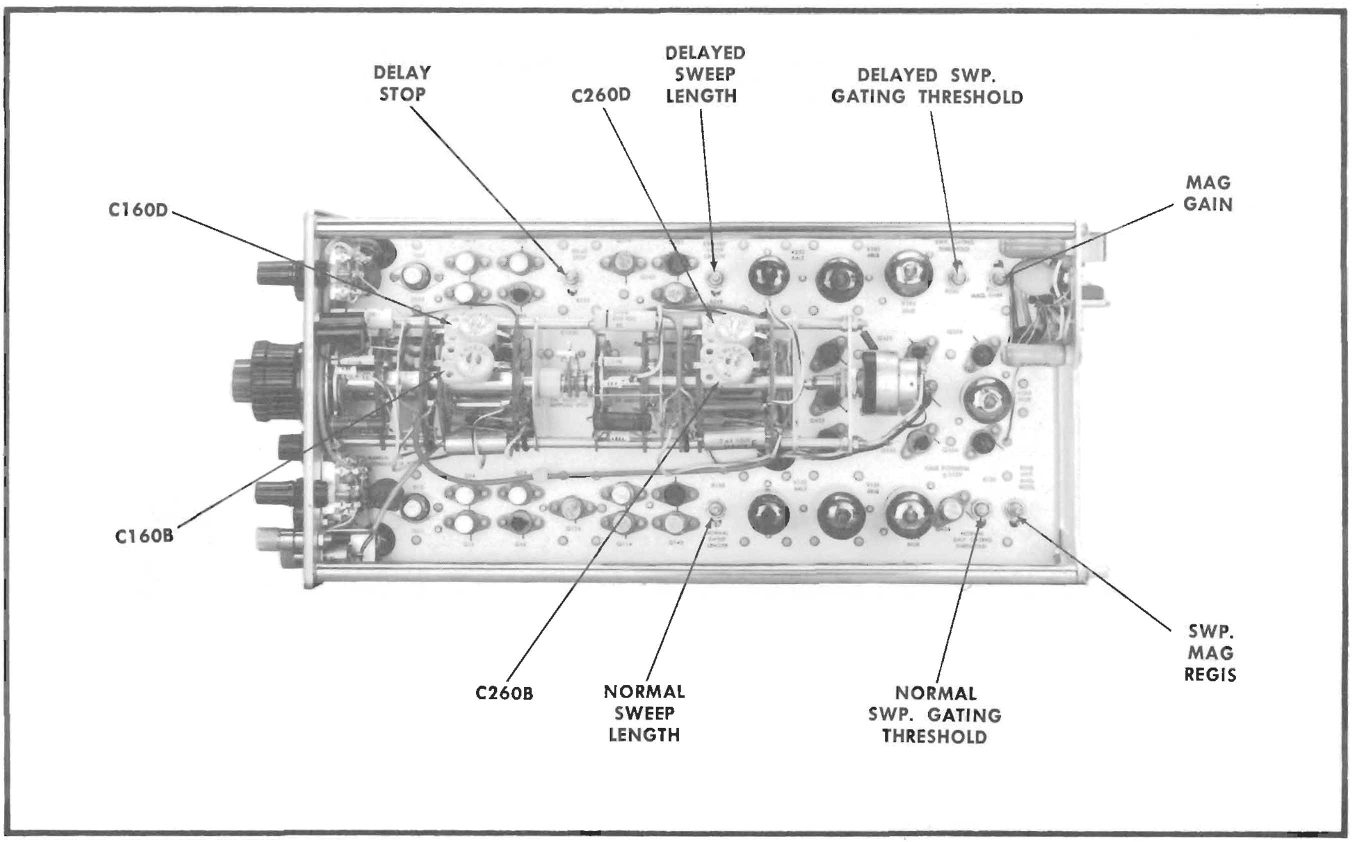

Fig. 5-4. Type 3B1S, right side view.

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POSITION	Midrange
VOLTS/DIV	.01
VARIABLE VOLTS/DIV	CALIB
AC-DC-GND	GND
MODE	ALTER
INV (CH 1) NORM	NORM
CALIB	Midrange
DC BAL	Midrange

Procedure

1. Adjust Output Dc Level

a. Push in the TRIGGER CH 1 ONLY switch.

b. Position the trace to the graticule horizontal centerlines.

c. Measure the dc voltage from each of the crt vertical deflection plates to ground.

d. Adjust OUTPUT DC LEVEL R328 (Fig. 5-5) so the average of the two voltages is +150 volts; for example, one plate at +140 and the other at +160 volts.

2. Adjust Channel 1 and 2 Dc Balance

a. Position the Channel 1 trace to the graticule horizontal centerline.

b. Adjust DC BAL R119 (Channel 1 front-panel adjustment) so the trace does not move as the Channel 1 VARIABLE VOLTS/DIV control is turned throughout its range.

c. Repeat this adjustment for DC BAL R219 in Channel 2 as the Channel 2 VARIABLE VOLTS/DIV control is turned.

3. Adjust Channel 1 Trigger Dc Level

a. Turn the MODE switch to CH 1.

b. Pull out the TRIGGER CH 1 ONLY switch.

c. Connect the dc voltmeter to R389 at switch SW390 (see Fig. 5-5).

d. Adjust CHAN 1 TRIG DC LEVEL R171 (Fig. 5-5) for zero volts on the meter.

e. Push in the TRIGGER CH 1 ONLY switch.

4. Adjust Channel 1 Gain and Calibration

a. Set the Channel 1 AC-DC-GND switch to DC.

b. Set the VOLTS/DIV switch to .01 and the VARIABLE VOLTS/DIV control to CALIB.

c. Connect a 50-mv signal from the calibrator output to the Channel 1 input.

d. Adjust 10 MV GAIN R149 for five major divisions of vertical deflection.

e. Set the VOLTS/DIV switch to .02 and the oscilloscope calibrator output for 100 mv.

f. Adjust 20 MV GAIN R147 (Fig. 5-5) for five major divisions of vertical deflection.

5. Adjust Channel 2 Gain

a. Connect another cable from the oscilloscope calibrator output to the Channel 2 input connector.

b. Set the Channel 2 AC-DC-GND switch to DC.

c. Set both VOLTS/DIV switches to .01.

d. Set the calibrator output for 50 mv.

e. Set the MODE switch to ADDED and the INV (CH 1) NORMAL switch to INV.

f. Adjust 10 MV GAIN R249 (Fig. 5-5) for cancellation of the display shown by a single line of trace.

g. Set the calibrator output for 100 mv and both VOLTS/DIV switches to .02.

h. Adjust 20 MV GAIN R247 (Fig. 5-5) to cancel the display.

6. Check Both VARIABLE VOLTS/DIV Controls

a. Set both VOLTS/DIV switches to .01 and both VARIABLE VOLTS/DIV controls to CALIB.

b. Set the INV (CH 1) NORM switch to NORM.

c. Connect a 50-mv signal from the oscilloscope calibrator to the input of both channels.

d. Set the MODE switch to CH 1; there should be 5 major divisions of vertical deflection.

e. Turn the Channel 1 VARIABLE VOLTS/DIV control fully counterclockwise; there should be 2 (or less) major divisions of vertical deflection.

f. Check to see that the UNCAL neon is lighted.

g. Return the Channel 1 VARIABLE VOLTS/DIV control to CALIB; the UNCAL neon should extenguish.

h. Turn the MODE switch to CH 2 and repeat this check for the Channel 2 VARIABLE VOLTS/DIV control.

7. Check Alternate Mode Operation

a. Set the MODE switch to ALTER and position the two traces about 2 major divisions apart.

b. Set the Type 3B1S for a sweep rate of 0.1 sec/div and check to see that the trace alternates between Channel 1 and 2.

8. Check Chopped Mode Operation

a. Set the Type 3B1S for a sweep rate of 5 μsec/div and the Type 3A1S MODE switch to CHOP. The chopped trace on the crt should show about 1 sample for each major horizontal graticule division.

9. Check For Gassy Input Amplifier

a. Set the VOLTS/DIV switch to .02 and the AC-DC-GND switch first to GND then to AC. The trace should not shift vertically more than 1 minor graticule division.

10. Adjust Channel 1 and 2 Input Capacitance

a. Connect the square-wave generator through the 5×T attenuator and the capacitance standardizer to the Channel 1 input connector.

b. Set the generator for a 1-kc output signal.

c. Set the Channel 1 VOLTS/DIV switch to .01.

d. Set the generator output signal amplitude for 4 major graticule divisions of deflection and adjust C111 for an optimum flat-topped waveform.

e. Set the VOLTS/DIV switch to .02 and adjust C112 for an optimum flat-topped waveform (see attenuator shields in the instrument for capacitor locations).

f. Remove the signal from Channel 1 and connect it to Channel 2.

g. Set the Channel 2 VOLTS/DIV switch to .01 and adjust C211 for an optimum flat-topped waveform.

h. Set the Channel 2 VOLTS/DIV switch to .02 and adjust C212 for an optium flat-topped waveform.

11. Adjust Channel 1 and 2 VOLTS/DIV

a. With the same test setup as in step 10, adjust the square-wave generator for a 1-kc output signal with 4 major graticule divisions of amplitude.

b. Perform the adjustments indicated in Table 5-3 for Channel 1 and then connect the square-wave generator to the Channel 2 input connector and perform the same adjustments for Channel 2.

TABLE 5-3

VOLTS/DIV Switch Setting	Adjust for Optimum Square Corner		Adjust for Optimum Flat Top	
	Channel 1	Channel 2	Channel 1	Channel 2
.05	C103C	C203C	C103B	C203B
.1	C105C	C205C	C105B	C205B
.2	C107C	C207C	C107B	C207B
2	C109C	C209C	C109B	C209B

12. Adjust High-Frequency Compensation

a. Set the Channel 1 VOLTS/DIV switch to .01 and the VARIABLE to CALIB.

b. Set the Type 3A1S MODE switch to CH 1.

c. Set the INV (CH 1) NORM switch to NORM.

d. Set the CH 1 AC-DC-GND switch to DC.

e. Set the Type 3B1S TIME/DIV switch to .5 μSEC.

f. Apply the output of the fast-rise square-wave generator to the Channel 1 input connector through a 5×T attenuator, a 50-ohm coaxial cable and a 50-ohm termination. (Connect the termination directly to the input of the Type 3A1S; then connect the coaxial cable between the termination and attenuator.)

g. Adjust the Type 3B1S triggering controls for a stable display of the generator signal.

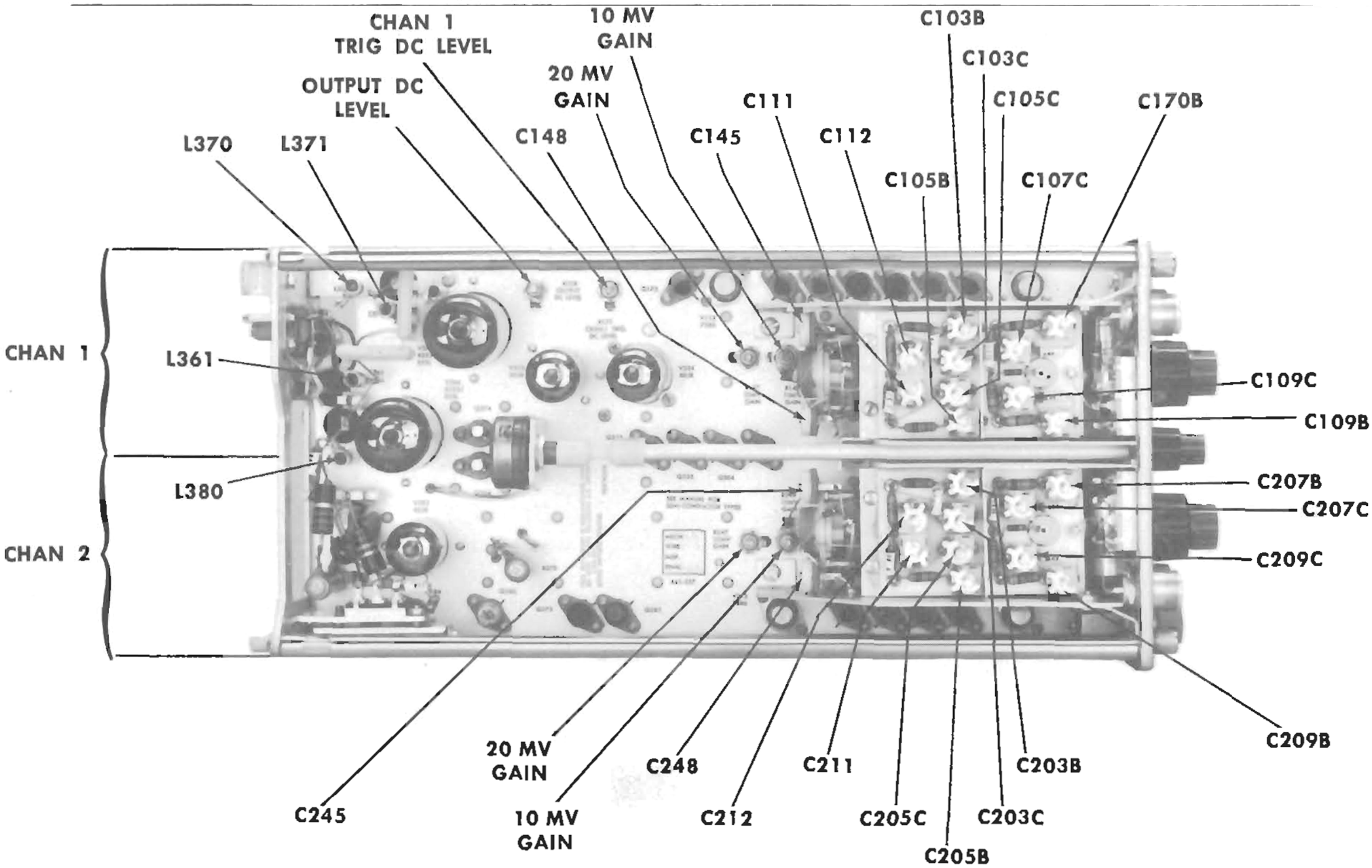

Fig. 5-5. Type 3A1S, left side view.

h. Adjust the output amplitude of the generator for about 4 divisions of deflection.

i. Adjust C339 (see Fig. 5-1) for the flattest top on the square wave.

j. Pull the Type 3B1S 10× MAG switch to on and set the POSITION control to display the rising edge of the waveform.

k. Adjust L326 and L336 (Fig. 5-1) for maximum peaking on the rising edge of the waveform. (It is important that L326 and L336 be adjusted just to the point where maximum peaking occurs; if they are adjusted too far in one direction, a dip will appear near the leading corner on the top of the waveform.)

l. Adjust C145 and C149 (Fig. 5-1 and 5-5) for the squarest corner.

m. Adjust L361, L371, L370, and L380 (Fig. 5-5) for the flattest area immediately following the leading corner on the top of the waveform. (L370 and L380 affect the area of the waveform closest to the leading corner while L361 and L371 affect the waveform at a slightly later point.

n. Set the Type 3A1S Channel 1 VOLTS/DIV switch to .02.

o. Adjust the output amplitude of the square-wave generator for 4 divisions of deflection.

p. Adjust C148 (Fig. 5-5) for the squarest corner on the waveform.

q. Repeat the preceding steps, making minor adjustments, to obtain a square and flat corner on the displayed waveform. Maximum aberrations are 1 mm.

r. Set the Type 3A1S MODE switch to CH 2.

s. Remove the signal from the Channel 1 input and apply it to the Channel 2 input as described in step (f).

t. Set the Channel 2 VOLTS/DIV switch to .01 and adjust the output of the generator for 4 divisions of deflection.

u. Adjust C245 and C249 (Figs. 5-1 and 5-5) for a square leading corner on the waveform.

v. Set the Channel 2 VOLTS/DIV switch to .02 and adjust the output of the generator for 4 divisions of deflection.

w. Adjust C248 (Fig. 5-5) for a square leading corner on the waveform.

x. Set the Type 3A1S MODE switch to CH 1.

y. Apply the signal to the Channel 1 input as described in step (f).

z. Readjust as necessary for the best compromise in response between the two channels.

SECTION 6

PARTS LIST and DIAGRAMS

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description			S/N Range

Bulbs

B601	150-001	Incandescent, GE #44	*Graticule Light*		
B602	150-001	Incandescent, GE #44	Graticule Light		
B603	150-018	Incandescent, GE #12	Pilot Light		
B856	150-025	Neon, NE-2E			
B857	150-025	Neon, NE-2E			

Capacitors

Tolerance ±20% unless otherwise indicated.

Tolerance of all electrolytic capacitors as follows (with exceptions):

5 V — 50 V = −10%, + 250%

51 V — 350 V = −10%, + 100%

351 V — 450 V = −10%, + 50%

C611	285-510	0.01 μf	MT	400 v	
C616	285-510	0.01 μf	MT	400 v	
C640A,B	*290-228	340 μf x 10 μf	EMC	250 v	
C642A,B	*290-227	340 μf x 10 μf	EMC	250 v	
C644A,B	*290-228	340 μf x 10 μf	EMC	250 v	
C650	285-510	0.01 μf	MT	400 v	
C667	290-002	8 μf	EMT	450 v	
C670	285-511	0.01 μf	PTM	600 v	
C720	290-166	2 x 2000 μf	EMC	25 v	
C732	290-201	100 μf	EMT	15 v	
C737	283-026	0.2 μf	Cer	25 v	
C757	290-015	100 μf	EMT	25 v	
C801	283-006	0.02 μf	Cer	600 v	
C803	283-000	0.001 μf	Cer	500 v	
C807	285-502	0.001 μf	MT	1000 v	
C822	283-071	0.0068 μf	Cer	5000 v	
C830	283-071	0.0068 μf	Cer	5000 v	
C832	283-071	0.0068 μf	Cer	5000 v	
C837	283-036	0.0025 μf	Cer	6000 v	
C841	285-519	0.047 μf	MT	400 v	
C842	283-071	0.0068 μf	Cer	5000 v	
C853	283-036	0.0025 μf	Cer	6000 v	
C876	290-025	6.25 μf	EMT	300 v	
C878	281-523	100 pf	Cer	350 v	
C884	281-524	150 pf	Cer	500 v	
C897	283-000	0.001 μf	Cer	500 v	

Diodes

Ckt. No.	Tektronix Part No.	Description	S/N Range
D640A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D642A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D644A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D627	*152-107	Silicon Replaceable by 1N647	
D663	*152-107	Silicon Replaceable by 1N647	
D664	*152-107	Silicon Replaceable by 1N647	
D720	152-035	Silicon 1N1563A	
D721	152-035	Silicon 1N1563A	
D838	*152-047	Silicon Replaceable by 1N2862	
D839	*152-047	Silicon Replaceable by 1N2862	

Fuses

F601	159-005	3 Amps	3AG	Slo-Blo	117 v operation
F720	159-023	2 Amps	3AG	Slo-Blo	

Inductors

L760	*108-088	3.2 μh
L770	*108-088	3.2 μh
L860	*108-285	Beam Rotator

Transistors

Q624	*151-087	Replaceable by 2N1131
Q734	151-040	2N1302
Q744	151-042	2N1378
Q757	151-046	2N1529

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R601	311-055	50 Ω		Var	WW	SCALE ILLUM
R602	308-142	30 Ω	3 w		WW	5%
R609	302-106	10 meg	½ w			
R610	302-104	100 k	½ w			
R611	302-102	1 k	½ w			
R612	302-272	2.7 k	½ w			
R616	311-015	10 k		Var	WW	—100 VOLTS
R617	308-186	80 k	½ w		WW	1%
R618	308-226	10 k	½ w		WW	1%
R619	302-224	220 k	½ w			

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R624	302-473	47 k	½ w				
R625	302-222	2.2 k	½ w				
R626	302-184	180 k	½ w				
R627	302-102	1 k	½ w				
R628	308-176	4 k	20 w		WW	5%	
R632	302-102	1 k	½ w				
R633	302-473	47 k	½ w				
R635	301-302	3 k	½ w			5%	
R640	304-100	10 Ω	1 w				
R642	304-100	10 Ω	1 w				
R644	304-100	10 Ω	1 w				
R650	309-101	330 k	½ w		Prec	1%	
R651	309-162	250 k	½ w		Prec	1%	
R652	302-102	1 k	½ w				
R653	302-225	2.2 meg	½ w				
R654	302-474	470 k	½ w				
R655	302-685	6.8 meg	½ w				
R656	311-068	500 k	.2 w	Var		+125 VOLTS	
R657	302-684	680 k	½ w				
R658	302-273	27 k	½ w				
R659	302-333	33 k	½ w				
R663	302-102	1 k	½ w				
R664	302-102	1 k	½ w				
R666	308-176	4 k	20 w		WW	5%	
R667	308-176	4 k	20 w		WW	5%	
R670	309-156	1.024 meg	½ w		Prec	1%	
R671	309-053	333 k	½ w		Prec	1%	
R672	302-102	1 k	½ w				
R673	302-105	1 meg	½ w				
R675	302-825	8.2 meg	½ w				
R676	311-068	500 k	.2 w	Var		+300 VOLTS	
R677	304-224	220 k	1 w				
R678	302-394	390 k	½ w				
R679	302-333	33 k	½ w				
R729	302-823	82 k	½ w				
R730	311-068	500 k	.2 w	Var		−12.2 VOLTS	
R731	309-104	2.05 k	½ w		Prec	1%	
R732	310-115	15 k	1 w		Prec	1%	
R733	301-394	390 k	½ w			5%	
R734	302-334	330 k	½ w			5%	
R735	302-272	2.7 k	½ w				
R737	302-151	150 Ω	½ w				
R744	308-231	220 Ω	3 w		WW	5%	
R754	302-471	470 Ω	½ w				
R759	302-104	100 k	½ w				

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R770	302-564	560 k	½ w			
R801	306-681	680 Ω	2 w			
R802	302-562	5.6 k	½ w			
R803	306-273	27 k	2 w			
R806	302-104	100 k	½ w			
R807	302-472	4.7 k	½ w			
R813	302-101	100 Ω	½ w			
R815	302-474	470 k	½ w			
R816	302-102	1 k	½ w			
R831	302-104	100 k	½ w			
R832	302-106	10 meg	½ w			
R833	311-314	2 meg		Var	INTENSITY	
R834	302-105	1 meg	½ w			
R835A	306-515	5.6 meg	2 w			
R835B	306-515	5.6 meg	2 w			
R835C	306-515	5.6 meg	2 w			
R835D	306-685	6.8 meg	2 w			
R835E	306-685	6.8 meg	2 w			
R836	302-223	22 k	½ w			
R837	302-471	470 Ω	½ w			
R838	301-242	2.4 k	½ w		5%	
R839	302-104	100 k	½ w			
R840	301-125	1.2 meg	½ w		5%	
R841	311-042	2 meg		Var	HIGH VOLTAGE	
R842A	306-335	3.3 meg	2 w			
R842B	306-335	3.3 meg	2 w			
R842C	306-275	2.7 meg	2 w			
R842D	306-275	2.7 meg	2 w			
R844	311-313	5 meg		Var	FOCUS	
R846	302-225	2.2 meg	½ w			
R849	302-223	22 k	½ w			
R851	302-104	100 k	½ w			
R852	302-273	27 k	½ w			
R853	302-471	470 Ω	½ w			
R854	302-105	1 meg	½ w			
R860	311-317	2 x 1 k		Var	ALIGNMENT	
R861	302-680	68 Ω	½ w			
R862	302-823	82 k	½ w			
R863	302-823	82 k	½ w			
R864	311-206	250 k		Var	ASTIGMATISM	
R865	311-026	100 k		Var	GEOMETRY	
R870	301-392	39 k	½ w		5%	
R871	311-315	20 k		Var	CAL AMPL	
R872	301-154	150 k	½ w		5%	
R873	302-103	10 k	½ w			

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R876	301-153	15 k	½ w		5%	
R877	301-183	18 k	½ w		5%	
R878	301-564	560 k	½ w		5%	
R879	301-114	100 k	½ w		5%	
R883	305-223	22 k	2 w		5%	
R885	309-121	9.5 k	½ w	Prec	1%	
R886	309-119	6.375 k	½ w	Prec	1%	
R887	309-117	2.1 k	½ w	Prec	1%	
R888	309-116	1.025 k	½ w	Prec	1%	
R889	309-113	610 Ω	½ w	Prec	1%	
R890	309-073	200 Ω	½ w	Prec	1%	
R891	309-112	100 Ω	½ w	Prec	1%	
R892	309-067	60 Ω	½ w	Prec	1%	
R893	309-066	40 Ω	½ w	Prec	1%	
R896	309-045	100 k	½ w	Prec	1%	
R897	309-112	100 Ω	½ w	Prec	1%	
R898	309-112	100 Ω	½ w	Prec	1%	
R899	*308-090	¼ Ω	1 w	WW		

Switches

	Unwired	Wired		
SW601	260-014		Toggle	POWER ON
SW870	260-253	*262-497	Rotary	CALIBRATOR
SW854	260-449		Slide	CRT CATHODE SELECTOR
TK601	260-157		Thermal Cutout 160°	

Transformers

T601	*120-280	L. V. Power
T801	*120-275	H. V. Power

Electron Tubes

V609	154-291	0G3
V627	154-307	7233
V634	154-187	6DJ8
V654	154-022	6AU6
V667	154-020	6AS7
V674	154-022	6AU6
V800	154-167	6CZ5
V814	154-046	12BH7
V822	154-051	5642
V832	154-051	5642
V859	*154-430	T5031-31 CRT Standard Phosphor
V884	154-278	6BL8

Values are fixed unless marked Variable.

Bulbs

Ckt. No.	Tektronix Part No.	Description		S/N Range
B113	150-027	Neon, NE-23	UNCAL	
B150	150-027	Neon, NE-23		
B213	150-027	Neon, NE-23		
B250	150-027	Neon, NE-23	UNCAL	

Capacitors

Tolerance ±20% unless otherwise indicated.

Tolerance of all electrolytic capacitors as follows (with exceptions):

3 V — 50 V = —10%, + 250%
51 V — 350 V = —10%, + 100%
351 V — 450 V = —10%, + 50%

Ckt. No.	Tektronix Part No.	Description					S/N Range
C101	*285-609	0.1 μf	MT		600 v	10%	
C103A	281-501	4.7 pf	Cer		500 v	±1 pf	
C103B	281-081	1.8 - 13 pf	Air	Var			
C103C	281-081	1.8 - 13 pf	Air	Var			
C103D	281-541	6.8 pf	Cer		500 v	10%	
C105A	281-501	4.7 pf	Cer		500 v	±1 pf	
C105B	281-081	1.8 - 13 pf	Air	Var			
C105C	281-079	1.7 - 9.1 pf	Air	Var			
C105E	281-503	8 pf	Cer		500 v	±0.5 pf	
C107A	281-509	15 pf	Cer		500 v	10%	
C107B	281-081	1.8 - 13 pf	Air	Var			
C107C	281-079	1.7 - 9.1 pf	Air	Var			
C107E	281-513	27 pf	Cer		500 v		
C109A	281-509	15 pf	Cer		500 v	10%	
C109B	281-081	1.8 - 13 pf	Air	Var			
C109C	281-079	1.7-9.1 pf	Air	Var			
C109E	283-541	500 pf	Mica		500 v	10%	
C110	281-509	15 pf	Cer		500 v	10%	
C111	281-081	1.8-13 pf	Air	Var			
C112	281-079	1.7-9.1 pf	Air	Var			
C113	283-068	0.01 μf	Cer		500 v		
C114	281-500	2.2 pf	Cer		500 v	±0.5 pf	
C115	283-057	0.1 μf	Cer		200 v		
C123	283-003	0.01 μf	Cer		150 v		
C125	283-003	0.01 μf	Cer		150 v		
C134	281-504	10 pf	Cer		500 v	10%	
C144	281-504	10 pf	Cer		500 v	10%	
C145	281-013	8-50 pf	Cer	Var			
C148	281-013	8-50 pf	Cer	Var			
C149	281-022	8-50 pf	Cer	Var			

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
C185	281-543	270 pf	Cer		500 v	10%	
C187	281-528	82 pf	Cer		500 v	10%	
C201	*285-609	0.1 μf	MT		600 v		
C203A	281-501	4.7 pf	Cer		500 v	±1 pf	
C203B	281-081	1.8-13 pf	Air	Var			
C203C	281-081	1.8-13 pf	Air	Var			
C203D	281-541	6.8 pf	Mica		500 v	10%	
C205A	281-501	4.7 pf	Cer		500 v	±1 pf	
C205B	281-081	1.8-13 pf	Air	Var			
C205C	281-079	1.7-9.1 pf	Air	Var			
C205E	281-503	8 pf	Cer		500 v	±0.5 pf	
C207A	281-509	15 pf	Cer		500 v	10%	
C207B	281-081	1.8-13 pf	Air	Var			
C207C	281-079	1.7-9.1 pf	Air	Var			
C207E	281-513	27 pf	Cer		500 v		
C209A	281-509	15 pf	Cer		500 v	10%	
C209B	281-081	1.8-13 pf	Air	Var			
C209C	281-079	1.7-9.1 pf	Air	Var			
C209E	283-541	500 pf	Mica		500 v	10%	
C210	281-509	15 pf	Cer		500 v		
C211	281-081	1.8-13 pf	Air	Var			
C212	281-079	1.7-9.1 pf	Air	Var			
C213	283-068	0.01 μf	Cer		500 v		
C214	281-500	2.2 pf	Cer		500 v	±0.5 pf	
C215	283-057	0.1 pf	Cer		200 v		
C223	283-003	0.01 μf	Cer		150 v		
C225	283-003	0.01 μf	Cer		150 v		
C234	281-504	10 pf	Cer		500 v	10%	
C244	281-504	10 pf	Cer		500 v	10%	
C245	281-013	8-50 pf	Cer	Var			
C248	281-013	8-50 pf	Cer	Var			
C249	281-022	8-50 pf	Cer	Var			
C260	283-067	0.001 μf	Cer		200 v	10%	
C261	281-523	100 pf	Cer		350 v		
C263	283-003	0.01 μf	Cer		150 v		
C266	281-513	27 pf	Cer		500 v		
C268	283-003	0.01 μf	Cer		150 v		
C277	281-523	100 pf	Cer		350 v		
C287	281-523	100 pf	Cer		350 v		
C291	283-003	0.01 μf	Cer		150 v		
C304	281-513	27 pf	Cer		500 v		
C307	283-003	0.01 μf	Cer		150 v		
C309	281-508	12 pf	Cer		500 v		
C314	281-513	27 pf	Cer		500 v		

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
C319	281-508	12 pf	Cer		500 v	±0.6 pf	
C327	283-000	0.001 μf	Cer		500 v		
C337	281-557	1.8 pf	Cer		500 v		
C339	281-036	3-12 pf	Cer	Var			
C340	283-003	0.01 μf	Cer		150 v		
C358	283-003	0.01 μf	Cer		150 v		
C360	283-006	0.02 μf	Cer		600 v		
C370	283-001	0.005 μf	Cer		500 v		
C373	281-526	1.5 pf	Cer		500 v	±0.5 pf	
C374	281-504	10 pf	Cer		500 v	10%	
C378	283-026	0.2 μf	Cer		25 v		
C381	281-526	1.5 pf	Cer		500 v	±0.5 pf	
C385	283-003	0.01 μf	Cer		150 v		
C387	281-528	82 pf	Cer		500 v	10%	
C391	283-003	0.01 μf	Cer		150 v		
C394	283-003	0.01 μf	Cer		150 v		
C395	283-026	0.2 μf	Cer		25 v		
C396	290-134	22 μf	EMT		15 v		
C397	283-003	0.01 μf	Cer		150 v		
C398	283-003	0.01 μf	Cer		150 v		
C399	283-006	0.01 μf	Cer		600 v		

Diodes

Ckt. No.	Tektronix Part No.	Description			S/N Range
D130	152-008	Germanium			
D131	152-008	Germanium			
D132	152-008	Germanium			
D140	152-008	Germanium			
D155	152-071	Germanium	ED-2007		
D156	152-071	Germanium	ED-2007		
D157	152-071	Germanium	ED-2007		
D158	152-071	Germanium	ED-2007		
D230	152-008	Germanium			
D231	152-008	Germanium			
D232	152-008	Germanium			
D240	152-008	Germanium			
D255	152-071	Germanium	ED-2007		
D256	152-071	Germanium	ED-2007		
D257	152-071	Germanium	ED-2007		
D258	152-071	Germanium	ED-2007		
D278	*152-075	Germanium	Tek Spec		
D288	*152-075	Germanium	Tek Spec		
D364	152-141	Silicon	1N3605		
D374	152-141	Silicon	1N3605		
D378	152-024	Zener	1N3024B	15 v	
D397	152-057	Zener	1N3807B	56 v	

Inductors

Ckt. No.	Tektronix Part No.	Description		S/N Range
LR103	*108-283	.13 μh (on a 43 Ω resistor)		
LR105	*108-286	.17 μh (on a 36 Ω resistor)		
LR107	*108-283	.13 μh (on a 43 Ω resistor)		
LR203	*108-283	.13 μh (on a 43 Ω resistor)		
LR205	*108-286	.17 μh (on a 36 Ω resistor)		
LR207	*108-283	.13 μh (on a 43 Ω resistor)		
L326	*114-072	4-7.5 μh	Var	
L336	*114-072	4-7.5 μh	Var	
L341	*108-105	1.8 μh		
L351	*108-105	1.8 μh		
L361	*114-053	3.3-6 μh	Var	
L371	*114-053	3.3-6 μh	Var	
L370	*114-078	1.9-4 μh	Var	
L378	*108-200	40 μh		
L380	*114-078	1.9-4 μh	Var	
L388	*108-046	5 μh		
L396	*108-016	29 μh		

Transistors

Q133	151-089	2N962
Q134	151-089	2N962
Q143	151-089	2N962
Q144	151-089	2N962
Q164	151-076	2N2048
Q173	151-089	2N962
Q174	151-076	2N2048
Q184	*151-103	Replaceable by 2N2219
Q233	151-089	2N962
Q234	151-089	2N962
Q243	151-089	2N962
Q244	151-089	2N962
Q260	151-091	2N1226
Q275	151-076	2N2048
Q285	151-076	2N2048
Q304	151-089	2N962
Q314	151-089	2N962
Q323	151-089	2N962
Q333	151-089	2N962
Q364	*151-127	Selected from 2N2369
Q374	*151-127	Selected from 2N2369

Resistors

Ckt. No.	Tektronix Part No.	Description					S/N Range
Resistors are fixed, composition, ±10% unless otherwise indicated.							
R101	302-100	10 Ω	½ w				
R103C	322-643	600 k	¼ w		Prec	1%	
R103E	322-644	666.6 k	¼ w		Prec	1%	
R105C	322-620	800 k	¼ w		Prec	1%	
R105E	322-614	250 k	¼ w		Prec	1%	
R107C	322-621	900 k	¼ w		Prec	1%	
R107E	322-608	11 k	¼ w		Prec	1%	
R109A	315-101	100 Ω	¼ w			5%	
R109C	322-624	990 k	¼ w		Prec	1%	
R109E	322-605	10.1 k	¼ w		Prec	1%	
R109D	315-510	51 Ω	¼ w			5%	
R109F	316-150	15 Ω	¼ w				
R110	315-470	47 Ω	¼ w			5%	
R111	322-481	1 meg	¼ w		Prec	1%	
R113	315-105	1 meg	¼ w			5%	
R114	316-101	100 Ω	¼ w				
R115	302-221	220 Ω	½ w				
R116	301-562	5.6 k	½ w			5%	
R119	311-321	2x500 k		Var		CH 1 DC BAL	
R120	316-335	3.3 meg	¼ w				
R121	316-274	270 k	¼ w				
R123	316-182	1.8 k	¼ w				
R124	316-101	100 Ω	¼ w				
R125	316-101	100 Ω	¼ w				
R126	301-562	5.6 k	½ w			5%	
R133	301-431	430 Ω	½ w			5%	
R134	315-271	270 Ω	¼ w			5%	
R135	309-117	2.1 k	½ w		Prec	1%	
R138	315-391	390 Ω	¼ w			5%	
R139†	*311-319	375 Ω		Var		CH 1 VARIABLE	
R140	315-471	470 Ω	¼ w			5%	
R142	309-028	1.48 k	½ w		Prec	1%	
R143	301-431	430 Ω	½ w			5%	
R144	315-271	270 Ω	¼ w			5%	
R145	309-117	2.1 k	½ w		Prec	1%	
R146	315-470	47 Ω	¼ w			5%	
R147	311-258	100 Ω		Var		20 MV GAIN	
R148	315-151	150 Ω	¼ w			5%	
R149	311-258	100 Ω		Var		10 MV GAIN	
R150	316-104	100 k	¼ w				
R151	302-683	68 k	½ w				
R152	301-163	16 k	½ w			5%	
R153	311-114	2 x 250 k		Var		CH 1 POSITION	
R154	302-683	68 k	½ w				
R164	315-622	6.2 k	¼ w			5%	

†Furnished as a unit with SW150.

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Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R167	315-151	150 Ω	¼ w			5%	
R170	315-471	470 Ω	¼ w			5%	
R171	311-159	20 k		Var		TRIG DC LEVEL	
R172	316-333	33 k	¼ w				
R173	301-152	1.5 k	½ w			5%	
R174	315-622	6.2 k	¼ w			5%	
R175	315-513	51 k	¼ w			5%	
R176	316-332	3.3 k	¼ w				
R184	301-332	3.3 k	½ w			5%	
R185	315-151	150 Ω	¼ w			5%	
R187	316-473	47 k	¼ w				
R188	316-105	1 meg	¼ w				
R201	302-100	10 Ω	½ w				
R203C	322-643	600 k	¼ w		Prec	1%	
R203E	322-644	666.6 k	¼ w		Prec	1%	
R205C	322-620	800 k	¼ w		Prec	1%	
R205E	322-614	250 k	¼ w		Prec	1%	
R207C	322-621	900 k	¼ w		Prec	1%	
R207E	322-608	111 k	¼ w		Prec	1%	
R209A	315-101	100 Ω	¼ w			5%	
R209C	322-624	990 k	¼ w		Prec	1%	
R209E	322-605	10.1 k	¼ w		Prec	1%	
R209D	315-510	51 Ω	¼ w			5%	
R209F	316-150	15 Ω	¼ w				
R210	315-470	47 Ω	¼ w			5%	
R211	322-481	1 meg	¼ w		Prec	1%	
R213	315-105	1 meg	¼ w			5%	
R214	316-101	100 Ω	¼ w				
R215	302-221	220 Ω	½ w				
R216	301-562	5.6 k	½ w			5%	
R219	311-321	2 x 500 k		Var		CH 2 DC BAL	
R220	316-335	3.3 meg	¼ w				
R221	316-274	270 k	¼ w				
R223	316-182	1.8 k	¼ w				
R224	316-101	100 Ω	¼ w				
R225	316-101	100 Ω	¼ w				
R226	301-562	5.6 k	½ w			5%	
R233	301-431	430 Ω	½ w			5%	
R234	315-271	270 Ω	½ w			5%	
R235	309-117	2.1 k	½ w		Prec	1%	
R238	315-391	390 Ω	¼ w			5%	
R239†	*311-319	375 Ω		Var		CH 2 VARIABLE	
R242	309-028	1.48 Ω	½ w		Prec	1%	
R243	301-431	430 Ω	½ w			5%	
R244	315-271	270 Ω	¼ w			5%	

†Furnished as a unit with SW250.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R245	309-117	2.1 k	½ w		Prec	1%	
R246	315-470	47 Ω	¼ w			5%	
R247	311-258	100 Ω		Var		20 MV GAIN	
R248	315-151	150 Ω	¼ w			5%	
R249	311-258	100 Ω		Var		10 MV GAIN	
R250	316-104	100 k	¼ w				
R251	302-683	68 k	½ w				
R252	301-163	16 k	½ w			5%	
R253	311-114	2x 250 k		Var		CH 2 POSITION	
R254	302-683	68 k	½ w				
R260	316-222	2.2 k	¼ w				
R262	302-153	15 k	½ w				
R263	302-470	47 Ω	½ w				
R265	301-223	22 k	½ w			5%	
R266	301-183	18 k	½ w			5%	
R268	316-101	100 Ω	¼ w				
R271	302-103	10 k	½ w				
R273	315-102	1 k	¼ w			5%	
R275	315-302	3 k	¼ w			5%	
R276	309-121	9.5 k	½ w		Prec	1%	
R277	318-099	3 k	⅛ w		Prec	1%	
R278	309-407	400 Ω	½ w		Prec	1%	
R279	302-561	560 Ω	½ w				
R285	315-302	3 k	¼ w			5%	
R286	309-121	9.5 k	½ w		Prec	1%	
R287	318-099	3 k	⅛ w		Prec	1%	
R288	309-407	400 Ω	½ w		Prec	1%	
R289	302-561	560 Ω	½ w				
R291	302-100	10 Ω	½ w				
R292	315-152	1.5 k	¼ w			5%	
R293	321-211	1.54 k	⅛ w		Prec	1%	
R294	321-211	1.54 k	⅛ w		Prec	1%	
R302	321-161	464 Ω	⅛ w		Prec	1%	
R304	315-201	200 Ω	¼ w			5%	
R305	315-621	620 Ω	¼ w			5%	
R307	302-270	27 Ω	½ w				
R308	315-131	130 Ω	¼ w			5%	
R309	321-117	162 Ω	⅛ w		Prec	1%	
R312	321-161	464 Ω	⅛ w		Prec	1%	
R314	315-201	200 Ω	¼ w			5%	
R315	315-621	620 Ω	¼ w			5%	
R319	321-117	162 Ω	⅛ w		Prec	1%	
R321	315-301	300 Ω	¼ w			5%	
R323	315-361	360 Ω	¼ w			5%	
R324	321-153	343 Ω	⅛ w		Prec	1%	
R325	315-470	47 Ω	¼ w			5%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.			Description			S/N Range
R326	322-200	1.18 k	¼ w		Prec	1%	
R327	316-331	330 Ω	¼ w				
R328	311-323	1.5 k		Var		OUTPUT DC LEVEL	
R329	303-103	10 k	1 w			5%	
R330	315-822	8.2 k	¼ w			5%	
R333	315-361	260 Ω	¼ w			5%	
R334	321-153	383 Ω	⅛ w		Prec	1%	
R335	315-470	47 Ω	¼ w			5%	
R336	322-200	1.18 k	¼ w		Prec	1%	
R337	315-821	820 Ω	¼ w			5%	
R339	303-103	10 k	1 w			5%	
R340	301-471	470 Ω	½ w			5%	
R341	315-470	47 Ω	¼ w			5%	
R347	301-622	6.2 k	½ w			5%	
R351	315-470	47 Ω	¼ w			5%	
R356	321-375	78.7 k	⅛ w		Prec	1%	
R357	301-622	6.2 k	½ w			5%	
R358	321-286	9.31 k	⅛ w		Prec	1%	
R359	306-221	220 Ω	2 w		WW	5%	
R360	308-055	1.5 k	10 w				
R361	*310-612	800 Ω	4 w		Prec	1%	
R362	323-094	93.1 Ω	½ w		Prec	1%	
R363	323-107	127 Ω	½ w		Prec	1%	
R364	315-822	8.2 k	¼ w			5%	
R365	315-470	47 Ω	¼ w			5%	
R366	315-104	100 k	¼ w			5%	
R367	315-470	47 Ω	¼ w			5%	
R368	302-272	2.7 k	½ w				
R369	316-470	47 Ω	¼ w				
R370	316-470	47 Ω	¼ w				
R371	*310-612	800 Ω	4 w		Prec	1%	
R372	323-094	93.1 Ω	½ w		Prec	1%	
R373	311-308	50 Ω		Var		CALIB	
R374	315-822	8.2 k	¼ w			5%	
R375	315-470	47 Ω	¼ w			5%	
R376	315-104	100 k	¼ w			5%	
R377	315-470	47 Ω	¼ w			5%	
R378	308-232	320 Ω	5 w		WW	5%	
R379	316-470	47 Ω	¼ w				
R381	323-440	374 k	½ w		Prec	1%	
R382	321-422	243 k	⅛ w		Prec	1%	
R384	316-101	100 Ω	¼ w				
R385	316-471	470 Ω	¼ w				
R387	302-473	47 k	½ w				
R388	316-221	220 Ω	¼ w				

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R389	306-123	12 k	2 w			
R390	316-101	100 Ω	¼ w			
R391	316-471	470 Ω	¼ w			
R392	302-473	47 k	½ w			
R394	302-121	120 Ω	½ w			
R395	308-230	2.7 k	3 w	WW	5%	
R397	302-034	8.2 Ω	½ w			
R398	316-270	27 Ω	¼ w			
R399	307-034	8.2 Ω	½ w			

Switches

Ckt. No.	Unwired	Wired	Description	
SW101	260-448		Slide	CH 1 AC - DC Gnd
SW110	260-607	*262-650	Rotary	CH 1 VOLTS/DIV
SW150†		*311-319		CH 1 CALIB
SW155††	260-422		Rotary	CH 1 INV/NORM
SW201	260-448		Slide	CH 1 AC - DC Gnd
SW210	260-607	*262-650	Rotary	CH 2 VOLTS/DIV
SW250†††		*311-319		CH 2 CALIB
SW290††	260-442		Rotary	MODE
SW390	260-447		Slide	CH 1 TRIGGER

Transformer

Ckt. No.	Tektronix Part No.	Description
T263	*120-281	Toroid 7T Bifilar

Electron Tubes

Ckt. No.	Tektronix Part No.	Description
V113	154-306	7586
V123	154-306	7586
V213	154-306	7586
V223	154-306	7586
V334	154-187	6DJ8
V353	154-187	6DJ8
V364	154-361	8233
V374	154-361	8233
V383	154-187	6DJ8

† Furnished as a unit with R139.

†† SW155 and SW290 are furnished as a unit.

††† Furnished as a unit with R239.

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Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description					S/N Range
		Bulbs					
B10	150-027	Neon, NE-23					
B60	150-027	Neon, NE-23					
B160W	150-027	Neon, NE-23				UNCALIBRATED	
B164	150-027	Neon, NE-23					
B264	150-027	Neon, NE-23					

Capacitors

Tolerance ±20% unless otherwise indicated.

Tolerance of all electrolytic capacitors as follows (with exceptions):

3V — 50V = −10%, +250%
51V — 350V = −10%, +100%
351V — 450V = −10%, +50%

Ckt. No.	Tektronix Part No.	Description					S/N Range
C5	283-002	0.01 μf	Cer		500 v		
C7	281-560	198 pf	Cer		500 v	10%	
C9	281-578	18 pf	Cer		500 v	5%	
C11	283-000	0.001 μf	Cer		500 v		
C13	283-003	0.01 μf	Cer		150 v		
C16	283-003	0.01 μf	Cer		150 v		
C18	283-003	0.01 μf	Cer		150 v		
C37	283-026	0.2 μf	Cer		25 v		
C39	281-524	150 pf	Cer		500 v		
C55	283-002	0.01 μf	Cer		500 v		
C57	281-560	198 pf	Cer		500 v	10%	
C59	281-578	18 pf	Cer		500 v	5%	
C61	283-000	0.001 μf	Cer		500 v		
C63	283-003	0.01 μf	Cer		150 v		
C66	283-003	0.01 μf	Cer		150 v		
C68	283-003	0.01 μf	Cer		150 v		
C87	283-026	0.2 μf	Cer		25 v		
C89	281-524	150 pf	Cer		500 v		
C103	281-523	100 pf	Cer		350 v		
C104	283-026	0.2 μf	Cer		25 v		
C106	283-026	0.2 μf	Cer		25 v		
C109	281-525	470 pf	Cer		500 v		
C113	281-518	47 pf	Cer		500 v		
C122	290-167	10 μf	EMT		15 v		
C144	281-524	150 pf	Cer		500 v		
C152	281-546	330 pf	Cer		500 v	10%	
C160A	281-505	12 pf	Cer		500 v	10%	
C160B	281-010	4.5 - 25 pf	Cer	Var			
C160C	283-534	82 pf	Cer		500 v	5%	
C160D	281-010	4.5 - 25 pf	Cer	Var			

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
C160E	*295-067	0.001 μf				TIMING SERIES†	
C160F		0.01 μf					
C160G		0.1 μf					
C160H		1 μf					
C162	283-003	0.01 μf	Cer		150 v		
C167	281-524	150 pf	Cer		500 v		
C170A	281-523	100 pf	Cer		350 v		
C170B	285-501	0.001 μf	MT		600 v		
C170C	285-569	0.01 μf	PTM		200 v		
C170D	285-572	0.1 μf	PTM		200 v		
C170E	285-576	1 μf	PTM		100 v	10%	
C170F	281-518	47 pf	Cer		500 v		
C188	281-573	11 pf	Cer			10%	
C195	283-004	0.02 μf	Cer		150 v		
C197	283-003	0.01 μf	Cer		150 v		
C206	283-026	0.2 μf	Cer		25 v		
C209	281-525	470 pf	Cer		500 v		
C213	281-518	47 pf	Cer		500 v		
C244	281-524	150 pf	Cer		500 v		
C252	281-546	330 pf	Cer		500 v	10%	
C260A	281-505	12 pf	Cer		500 v	10%	
C260B	281-010	4.5 - 25 pf	Cer	Var			
C260C	283-534	82 pf	Mica		500 v	5%	
C260D	281-010	4.5 - 25 pf	Cer	Var			
C260E	*295-067	0.001 μf				TIMING SERIES†	
C260F		0.01 μf					
C260G		0.1 μf					
C260H		1 μf					
C262	283-003	0.01 μf	Cer		150 v		
C267	281-524	150 pf	Cer		500 v		
C270A	281-523	100 pf	Cer		350 v		
C270B	285-501	0.001 μf	MT		600 v		
C270C	285-569	0.01 μf	PTM		200 v		
C270D	285-572	0.1 μf	PTM		200 v		
C270E	285-576	1 μf	PTM		100 v	10%	
C270F	281-518	47 pf	Cer		500 v		
C303	283-026	0.2 μf	Cer		25 v		
C336	283-026	0.2 μf	Cer		25 v		
C354	281-536	0.001 μf	Cer		500 v	10%	
C356	283-526	0.001 μf	Mica		500 v	1%	
C358	281-536	0.001 μf	Cer		500 v	10%	
C364	283-519	360 pf	Mica		500 v	5%	
C394	283-026	0.2 μf	Cer		25 v		
C396	283-006	0.02 μf	Cer		600 v		

† Furnished as a unit with C160E,F,G,H, and C260E,F,G,H.

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Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C397	283-006	0.02 μf	Cer	600 v		
C399	283-057	0.1 μf	Cer	200 v		
C412	283-004	0.02 μf	Cer	150 v		
C414	283-000	0.001 μf	Cer	500 v		
C417	283-000	0.001 μf	Cer	500 v		
C423	283-003	0.01 μf	Cer	150 v		
C424	281-546	330 pf	Cer	500 v	10%	
C427	283-012	0.1 μf	Cer	100 v		
C435	283-057	0.1 μf	Cer	200 v		
C441	281-523	100 pf	Cer	350 v		
C445	281-523	100 pf	Cer	350 v		

Diodes

Ckt. No.	Tektronix Part No.	Description		
D14	152-141	Silicon	1N3605	
D15	*152-061	Silicon	Tek Spec	
D16	152-141	Silicon	1N3605	
D24	152-141	Silicon	1N3605	
D34	152-141	Silicon	1N3605	
D35	152-081	Tunnel	TD-2	2.2 MA
D64	152-141	Silicon	1N3605	
D65	*152-061	Silicon	Tek Spec	
D66	152-141	Silicon	1N3605	
D74	152-141	Silicon	1N3605	
D84	152-141	Silicon	1N3605	
D85	152-081	Tunnel	TD-2	2.2 MA
D101	*152-075	Germanium		Tek Spec
D102	*152-075	Germanium		Tek Spec
D105	152-093	Tunnel	TD-3	4.7 MA
D113	*152-075	Germanium		Tek Spec
D115	152-081	Tunnel	TD-2	2.2 MA
D119	*152-075	Germanium		Tek Spec
D122	152-008	Germanium		
D132	152-095	Silicon	1N625	
D133	152-095	Silicon	1N625	
D134	152-095	Silicon	1N625	
D143	152-095	Silicon	1N625	
D162	152-091	Zener	1N982	75 v
D170	*152-061	Silicon		Tek Spec
D171	*152-061	Silicon		Tek Spec
D172	*152-061	Silicon		Tek Spec
D189	*152-075	Germanium		Tek Spec
D195	*152-061	Silicon		Tek Spec
D198	*152-075	Germanium		Tek Spec

Diodes *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
D201	*152-075	Germanium Tek Spec	
D202	*152-075	Germanium Tek Spec	
D205	152-093	Tunnel TD-3 4.7 MA	
D213	*152-075	Germanium Tek Spec	
D233	152-095	Silicon 1N625	
D234	152-095	Silicon 1N625	
D243	152-095	Silicon 1N625	
D262	152-091	Zener 1N982 75 v	
D270	*152-061	Silicon Tek Spec	
D271	*152-061	Silicon Tek Spec	
D272	*152-061	Silicon Tek Spec	
D292	*152-075	Germanium Tek Spec	
D398	152-031	Zener 1N718A 15 v	
D415	152-081	Tunnel TD-2 2.2 MA	
D425	*152-075	Germanium Tek Spec	
D444	*152-075	Germanium Tek Spec	
D445	152-081	Tunnel TD-2 2.2 MA	
D455	152-092	Silicon HD 5004	

Inductors

L35	*108-146	5 μh	
L85	*108-146	5 μh	
L303	108-249	12 μh	

Transistors

Q23	151-063	2N2207	
Q24	151-063	2N2207	
Q34	151-063	2N2207	
Q44	*151-108	Replaceable by 2N2501	
Q73	151-063	2N2207	
Q74	151-063	2N2207	
Q84	151-063	2N2207	
Q94	*151-108	Replaceable by 2N2501	
Q124	*151-062	Selected from TI N101	
Q134	151-041	2N1303	
Q114	*151-062	Selected from TI N101	
Q143	*151-087	Replaceable by 2N1131	
Q183	151-076	2N2048	
Q194	151-076	2N2048	
Q214	*151-062	Selected from TI N101	

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q243	*151-087	Replaceable by 2N1131	
Q283	151-076	2N2048	
Q294	*151-108	Replaceable by 2N2501	
Q314	151-076	2N2048	
Q323	*151-108	Replaceable by 2N2501	
Q333	*151-108	Replaceable by 2N2501	
Q354	*151-103	Replaceable by 2N2219	
Q364	*151-103	Replaceable by 2N2219	
Q424	*151-062	Selected from TI N101	
Q453	151-076	2N2048	

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R7	315-753	75 k	¼ w			5%	
R9	301-914	910 k	½ w			5%	
R10	301-275	2.7 meg	½ w			5%	
R11	315-224	220 k	¼ w			5%	
R12	316-101	100 Ω	¼ w				
R13	316-102	1 k	¼ w				
R14	303-243	24 k	1 w			5%	
R16	301-623	62 k	½ w			5%	
R17	315-124	120 k	¼ w			5%	
R18	316-470	47 Ω	¼ w				
R19	316-824	820 k	¼ w				
R20	315-562	5.6 k	¼ w			5%	
R21	301-393	39 k	½ w			5%	
R23†	311-311	200 k		Var		LEVEL	
R29	303-363	36 k	1 w			5%	
R35	309-345	225 Ω	½ w		Prec	1%	
R37	316-101	100 Ω	¼ w				
R39	315-270	27 Ω	¼ w			5%	
R44	302-563	56 k	½ w				
R57	315-753	75 k	¼ w			5%	
R59	301-914	910 k	½ w			5%	
R60	301-275	2.7 meg	½ w			5%	
R61	315-224	220 k	¼ w			5%	
R62	316-101	100 Ω	¼ w				
R63	316-102	1 k	¼ w				
R64	303-243	24 k	1 w			5%	
R66	301-623	62 k	½ w			5%	
R67	315-124	120 k	¼ w			5%	
R68	316-470	47 Ω	¼ w				
R69	316-824	820 k	¼ w				

† Furnished as a unit with SW 6.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.			Description			S/N Range
R70	315-562	5.6 k	¼ w			5%	
R71	301-393	39 k	½ w			5%	
R73†	311-311	200 k		Var		LEVEL	
R79	303-363	36 k	1 w			5%	
R85	309-345	225 Ω	½ w		Prec	1%	
R87	316-101	100 Ω	¼ w				
R89	315-330	33 Ω	¼ w			5%	
R94	302-563	56 k	½ w				
R102	315-102	1 k	¼ w			5%	
R103	316-102	1 k	¼ w				
R104	316-101	100 Ω	¼ w				
R106	316-470	47 Ω	¼ w				
R109	315-331	330 Ω	¼ w			5%	
R110	315-823	82 k	¼ w			5%	
R112	302-683	68 k	½ w				
R113	316-332	3.3 k	¼ w				
R116	309-409	2.4 k	½ w		Prec	1%	
R117	309-158	1.19 k	½ w		Prec	1%	
R118	309-090	50 k	½ w		Prec	1%	
R119	315-681	680 Ω	¼ w			5%	
R122	316-391	390 Ω	¼ w				
R123	315-823	82 k	¼ w			5%	
R124	315-331	330 Ω	¼ w			5%	
R125	301-753	75 k	½ w			5%	
R130	311-110	100 k		Var	NORMAL SWP GATING THRESHOLD		
R131	309-354	45 k	½ w		Prec	1%	
R142	309-354	45 k	½ w		Prec	1%	
R143	309-036	18 k	½ w		Prec	1%	
R144	316-102	1 k	¼ w				
R152	316-221	220 Ω	¼ w				
R160A	309-380	250 k	½ w		Prec	1%	
R160B	309-380	250 k	½ w		Prec	1%	
R160C	309-140	500 k	½ w		Prec	1%	
R160D	309-141	750 k	½ w		Prec	1%	
R160E	309-141	750 k	½ w		Prec	1%	
R160F	309-017	1.5 meg	½ w		Prec	1%	
R160G	309-399	7.5 meg	½ w		Prec	1%	
R160H	309-399	7.5 meg	½ w		Prec	1%	
R160W	302-104	100 k	½ w				
R160X	301-103	10 k	½ w			5%	
R160Y††	311-108	20 k		Var		VARIABLE	
R161	316-101	100 Ω	¼ w				
R162	306-683	68 k	2 w				
R164	315-224	220 k	¼ w			5%	
R165	316-101	100 Ω	¼ w				

† Furnished as a unit with SW56.

†† Furnished as a unit with SW160Y.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R167	301-682	6.8 k	½ w			5%	
R168	311-310	5 k		Var.		NORMAL SWEEP LENGTH	
R169	303-183	18 k	1 w			5%	
R170	316-184	180 k	¼ w				
R172	316-104	100 k	¼ w				
R184	316-182	1.8 k	¼ w				
R183	316-332	3.3 k	¼ w				
R186	316-332	3.3 k	¼ w				
R187	315-124	120 k	¼ w			5%	
R188	315-752	7.5 k	¼ w			5%	
R190	316-152	1.5 k	¼ w				
R192	316-470	47 Ω	¼ w				
R194	308-213	25 k	7 w		WW	5%	
R195	316-102	1 k	¼ w				
R196	302-274	270 k	½ w				
R197	316-121	120 Ω	¼ w				
R198	315-162	1.6 k	¼ w			5%	
R202	315-102	1 k	¼ w			5%	
R203	316-102	1 k	¼ w				
R206	316-470	47 Ω	¼ w				
R209	315-331	330 Ω	¼ w			5%	
R210	315-823	82 k	¼ w			5%	
R212	302-683	68 k	½ w				
R213	316-332	3.3 k	¼ w				
R229	301-753	75 k	½ w			5%	
R230	311-110	100 k		Var	DELAYED SWP GATING THRESHOLD		
R231	309-354	45 k	½ w		Prec	1%	
R242	309-354	45 k	½ w		Prec	1%	
R243	309-036	18 k	½ w		Prec	1%	
R244	316-102	1 k	¼ w				
R252	316-221	220 Ω	¼ w				
R260A	309-380	250 k	½ w		Prec	1%	
R260B	309-380	250 k	½ w		Prec	1%	
R260C	309-140	500 k	½ w		Prec	1%	
R260D	309-141	750 k	½ w		Prec	1%	
R260E	309-141	750 k	½ w		Prec	1%	
R260F	309-017	1.5 meg	½ w		Prec	1%	
R260G	309-399	7.5 meg	½ w		Prec	1%	
R260H	309-399	7.5 meg	½ w		Prec	1%	
R261	316-101	100 Ω	¼ w				
R262	306-683	68 k	2 w				
R264	315-224	220 k	¼ w			5%	
R265	316-101	100 Ω	¼ w				
R267	303-682	6.8 k	1 w			5%	
R268	311-310	5 k		Var		DELAYED SWP LENGTH	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R269	303-183	18 k	1 w			5%	
R270	316-184	180 k	1/4 w				
R272	316-104	100 k	1/4 w				
R283	316-332	3.3 k	1/4 w				
R284	316-182	1.8 k	1/4 w				
R286	301-623	62 k	1/2 w			5%	
R287	315-752	7.5 k	1/4 w			5%	
R288	301-473	47 k	1/2 w			5%	
R292	301-104	100 k	1/2 w			5%	
R294	316-332	3.3 k	1/4 w				
R310	309-418	18.7 k	1/2 w		Prec	1%	
R312	311-326	10 k		Var		SWEEP CAL	
R313	316-334	330 k	1/4 w				
R314	309-343	107 k	1/2 w		Prec	1%	
R316A,B	311-455	500 k x 200 k		Var		POSITION	
R317	309-041	60 k	1/2 w		Prec	1%	
R318	309-201	2.85 k	1/2 w		Prec	1%	
R319	309-108	80 k	1/2 w		Prec	1%	
R323	302-423	47 k	1/2 w				
R330	302-423	47 k	1/2 w				
R335	309-100	10 k	1/2 w		Prec	1%	
R336	309-388	6 k	1/2 w		Prec	1%	
R352	315-330	33 Ω	1/4 w			5%	
R354	321-097	100 Ω	1/8 w		Prec	1%	
R355	311-169	100 Ω		Var		MAG GAIN	
R356	315-330	33 Ω	1/4 w			5%	
R357	308-054	10 k	5 w		WW	5%	
R358	315-471	470 Ω	1/2 w			5%	
R362	315-330	33 Ω	1/4 w			5%	
R364	309-347	1.22 k	1/2 w		Prec	1%	
R367	308-053	8 k	5 w		WW	5%	
R368	311-310	5 k		Var		SWP MAG REGIS	
R381	316-101	100 Ω	1/4 w				
R382	308-178	15 k	8 w		WW	5%	
R384	316-101	100 Ω	1/4 w				
R385	308-178	15 k	8 w		WW	5%	
R391	301-151	150 Ω	1/2 w			5%	
R392	301-151	150 Ω	1/2 w			5%	
R394	301-910	91 Ω	1/2 w			5%	
R396	308-003	2 k	5 w		WW	5%	
R398	316-334	330 k	1/4 w				
R411	316-101	100 Ω	1/4 w				
R412	316-101	100 Ω	1/4 w				
R413	316-103	10 k	1/4 w				
R414	309-118	4.23 k	1/2 w		Prec	1%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
R415	309-100	10 k	1/2 w		Prec	1%	
R417	316-220	22 Ω	1/4 w				
R419	302-423	47 k	1/2 w				
R423	316-101	100 Ω	1/4 w				
R424	316-222	2.2 k	1/4 w				
R425	316-472	4.7 k	1/4 w				
R426	309-043	82 k	1/2 w		Prec	1%	
R427	309-231	16.69 k	1/2 w		Prec	1%	
R428	316-101	100 Ω	1/4 w				
R429	309-270	3.92 k	1/2 w		Prec	1%	
R431	315-335	3.3 meg	1/4 w			5%	
R432†	311-338	50 k		Var		VERNIER	
R433	315-104	100 k	1/4 w			5%	
R434†	311-338	50 k		Var		DELAY TIME	
R435	311-310	5 k		Var		DELAY STOP	
R437	309-159	5 k	1/2 w		Prec	1%	
R439	305-393	39 k	2 w			5%	
R441	302-823	82 k	1/2 w				
R442	315-912	9.1 k	1/4 w			5%	
R443	315-104	100 k	1/4 w			5%	
R445	315-681	680 Ω	1/4 w			5%	
R449	315-912	9.1 k	1/4 w			5%	
R451	315-561	560 Ω	1/4 w			5%	
R453	315-332	3.3 k	1/4 w			5%	
R455	301-333	33 k	1/2 w			5%	

Switches

	Unwired	Wired		
SW3	260-447		Slide	SOURCE
SW5	260-450		Slide	COUPLING
SW6††	311-311			PULL EXT TRIG ATTEN
SW19	260-447		Slide	SLOPE
SW53	260-447		Slide	SOURCE
SW55	260-449		Slide	COUPLING
SW56†††	311-311			PULL EXT TRIG ATTEN
SW69	260-447		Slide	SLOPE
SW81	260-608	*262-651	Rotary	MODE
SW160 } SW260 }	260-455	*262-499	Rotary	TIME/CM (Normal Sweep) TIME/CM (Delayed Sweep)
SW367††††	311-455			PULL 5X MAG

†R432 and R434 furnished as a unit.

††Furnished as a unit with R23.

†††Furnished as a unit with R73.

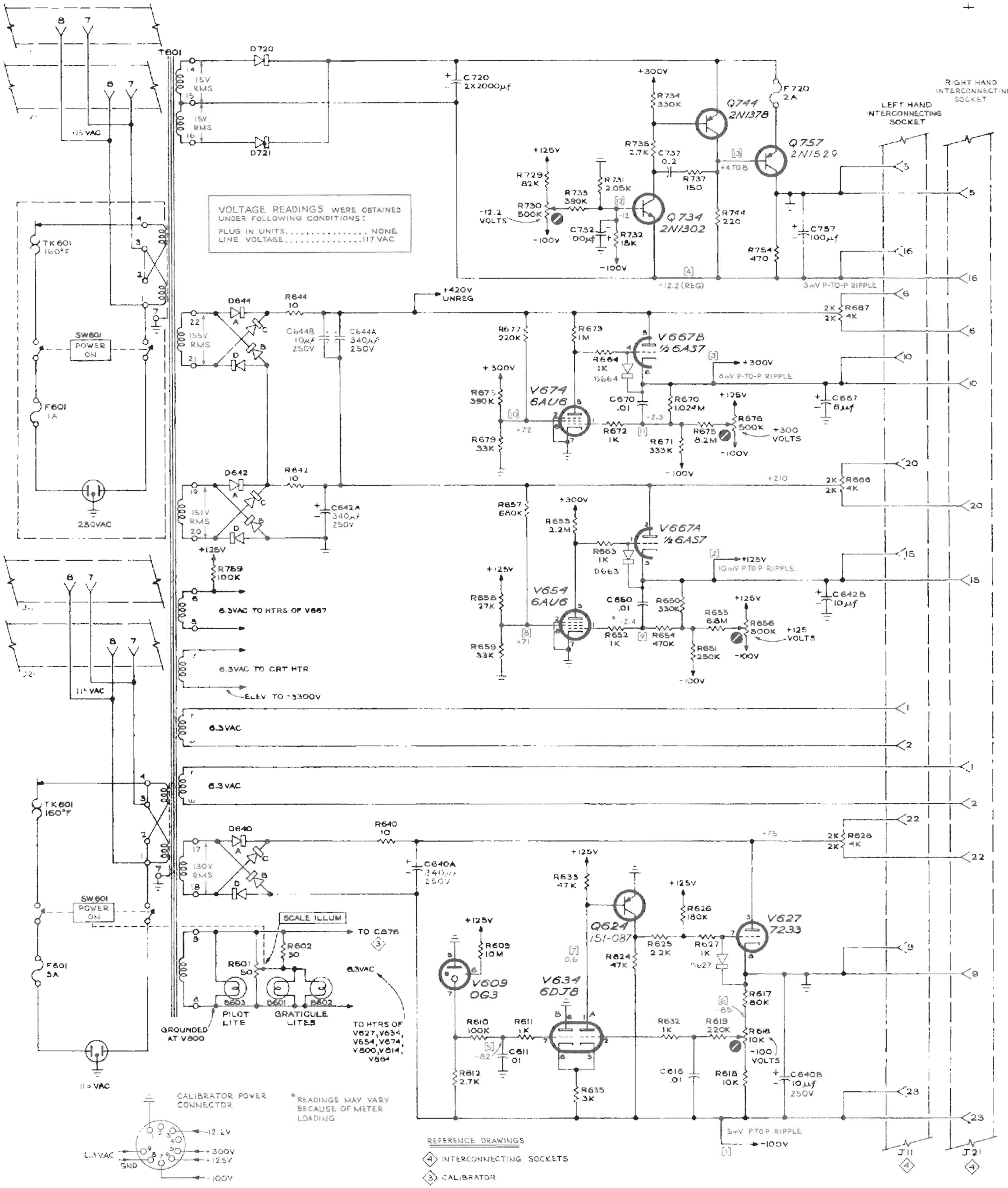
††††Concentric with R316. Furnished as a unit.

Transformers

Ckt. No.	Tektronix Part No.	Description	S/N Range
T101	*120-278	Toroid, 3-8 turn winding	
T201	*120-277	Toroid, 2-8 turn winding	

Electron Tubes

V13	154-378	7895	
V63	154-378	7895	
V152	154-016	6AL5	
V161	154-278	6BL8	
V194	154-187	6DJ8	
V261	154-278	6BL8	
V252	154-016	6AL5	
V383	154-187	6DJ8	
V414	154-187	6DJ8	
V439	154-370	ZZ-1000	

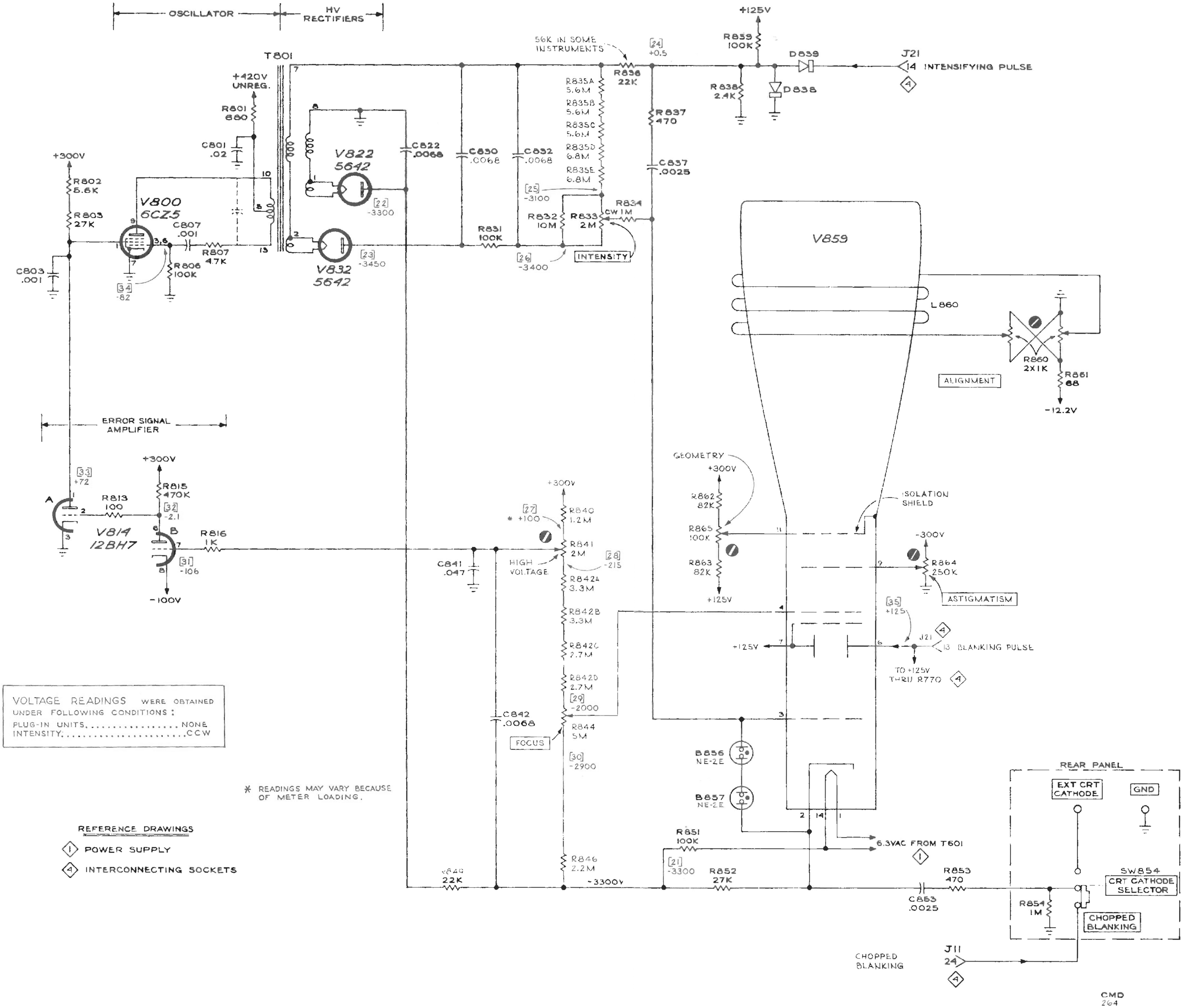


CMD 264

TYPE 561-S OSCILLOSCOPE

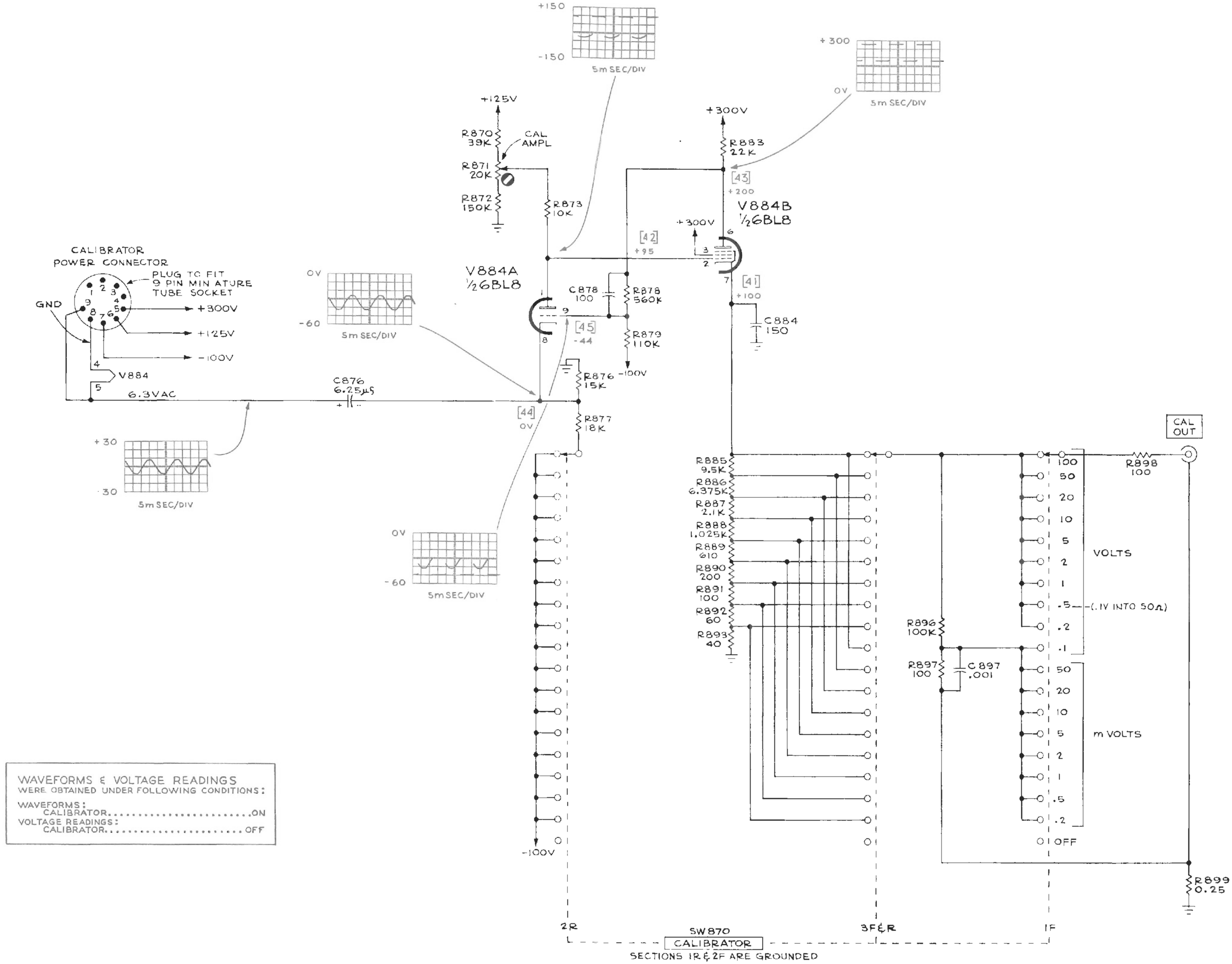
A

POWER SUPPLY



TYPE 561-S OSCILLOSCOPE

CRT CIRCUIT 2

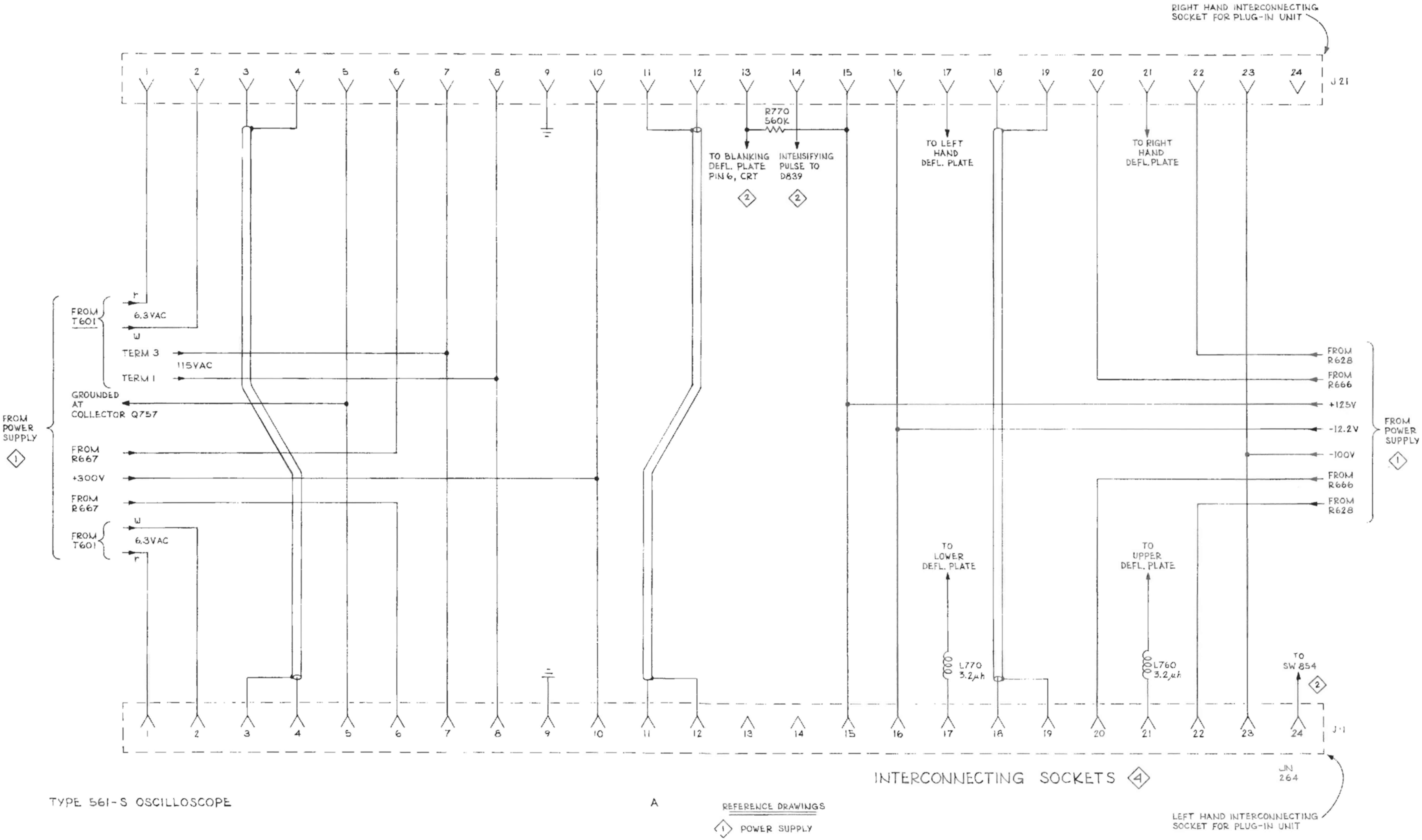


TYPE 561-S OSCILLOSCOPE

A

CALIBRATOR (3)

GAB
264



INTERCONNECTING SOCKETS ④

JN 264

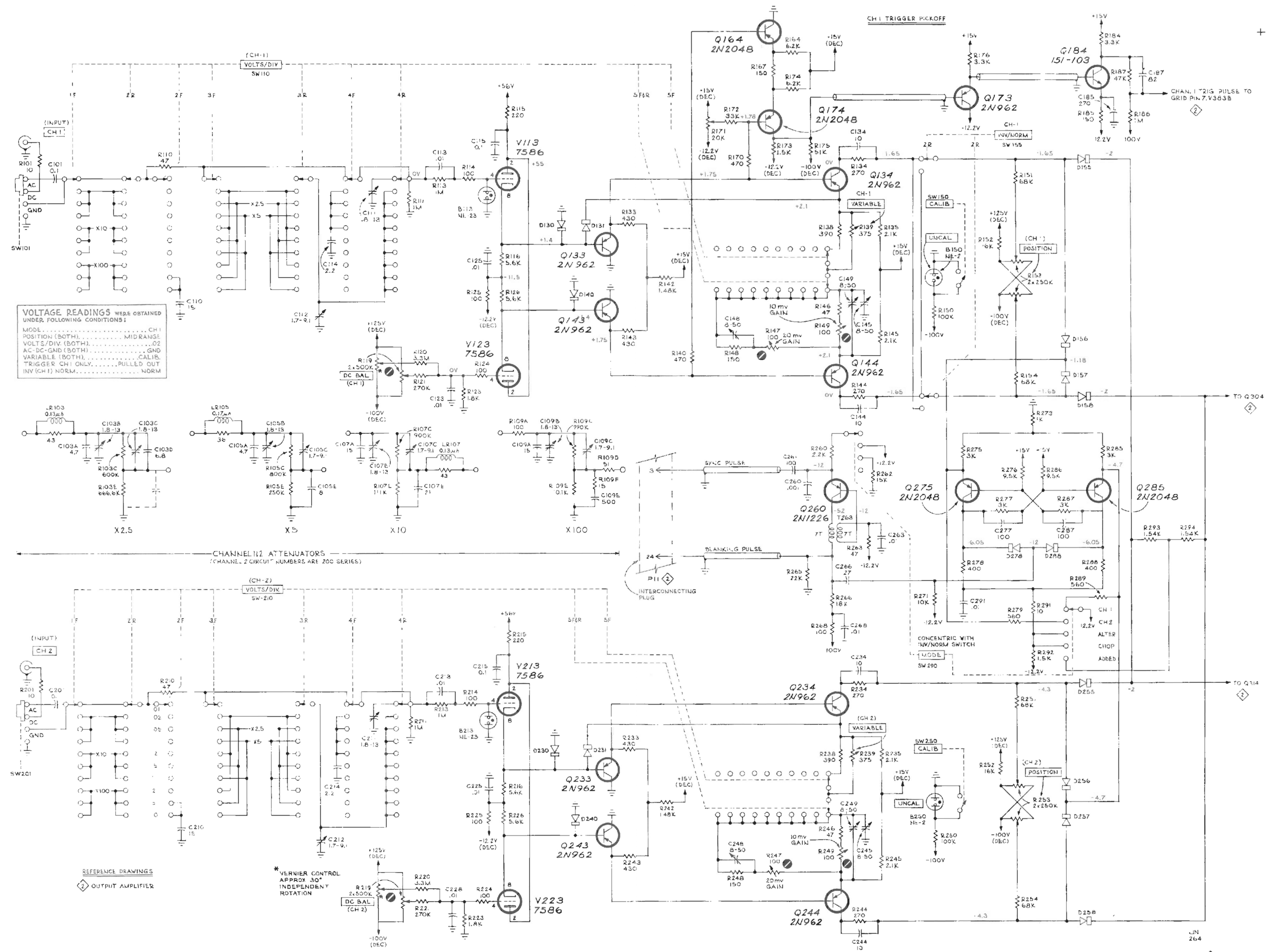
TYPE 561-S OSCILLOSCOPE

A

REFERENCE DRAWINGS

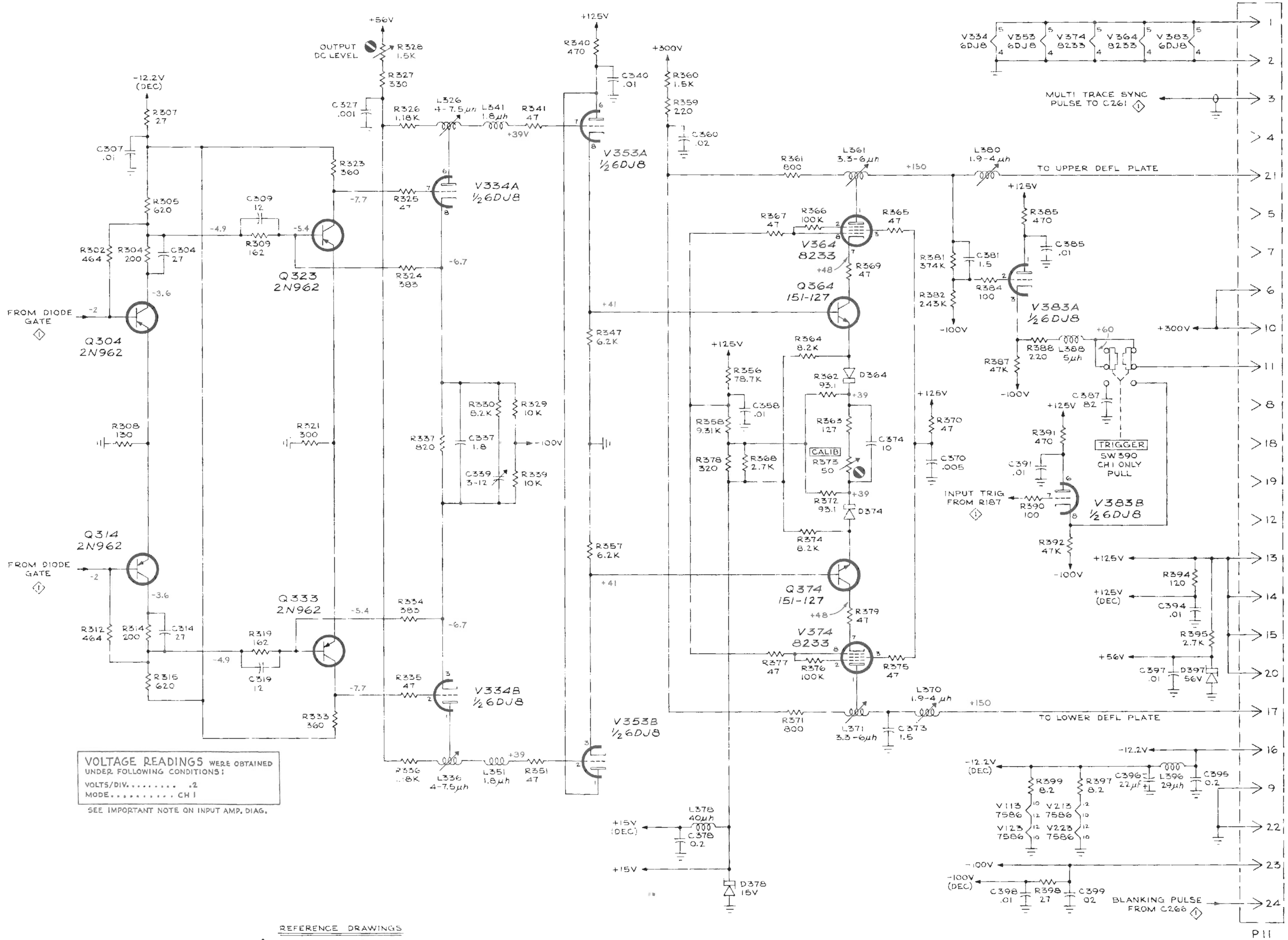
① POWER SUPPLY

② CRT CIRCUIT



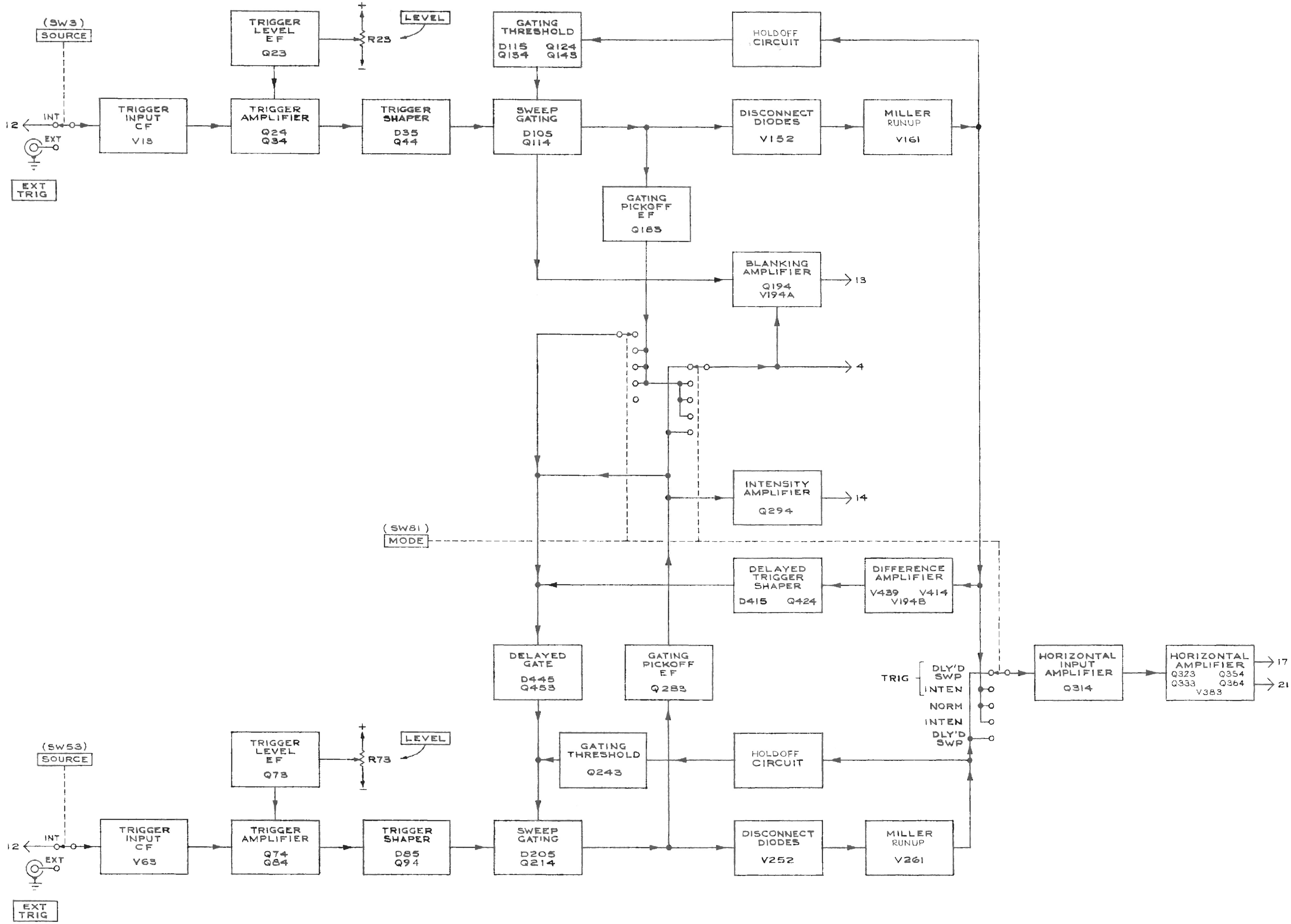
TYPE 3A1-S PLUG-IN

INPUT AMPLIFIER & SWITCHING CIRCUIT 1

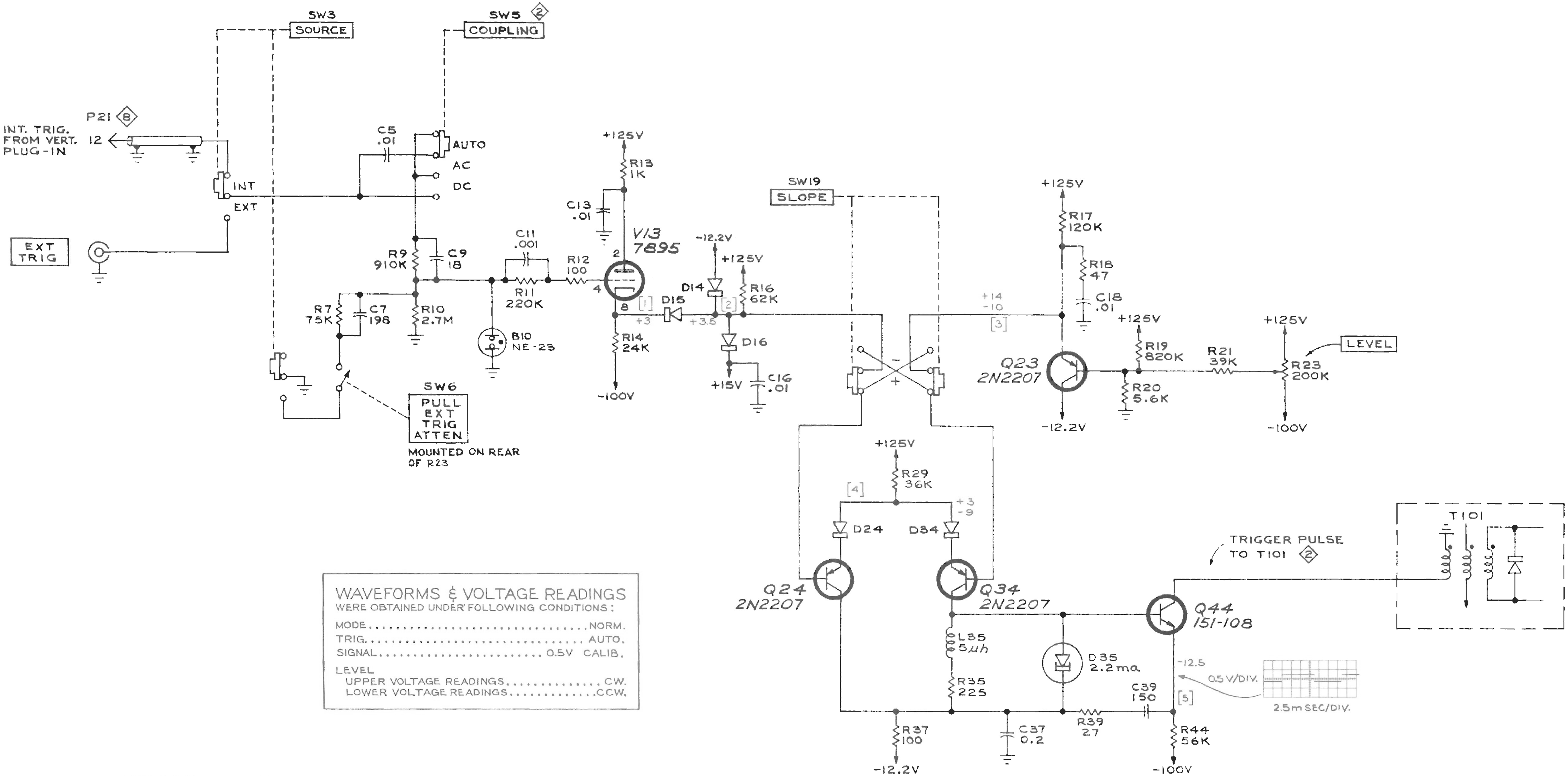


REFERENCE DRAWINGS

(1) INPUT AMPLIFIER & SWITCHING CIRCUIT


(SW3)
SOURCE
TRIGGER LEVEL EF Q23
LEVEL
R23
GATING THRESHOLD D115 Q124 Q134 Q143
HOLDOFF CIRCUIT
12
INT
EXT
EXT TRIG
TRIGGER INPUT CF V18
TRIGGER AMPLIFIER Q24 Q34
TRIGGER SHAPER D35 Q44
SWEEP GATING D105 Q114
DISCONNECT DIODES V152
MILLER RUNUP V161
GATING PICKOFF EF Q183
BLANKING AMPLIFIER Q194 V194A
13
4
INTENSITY AMPLIFIER Q294
14
(SW81)
MODE
DELAYED TRIGGER SHAPER D415 Q424
DIFFERENCE AMPLIFIER V439 V414 V194B
DELAYED GATE D445 Q453
GATING PICKOFF EF Q283
TRIG
DLY'D SWP
INTEN
NORM
INTEN
DLY'D SWP
HORIZONTAL INPUT AMPLIFIER Q314
HORIZONTAL AMPLIFIER Q323 Q354 Q333 Q364 V383
17
21
(SW53)
SOURCE
TRIGGER LEVEL EF Q73
LEVEL
R73
GATING THRESHOLD Q243
HOLDOFF CIRCUIT
12
INT
EXT
EXT TRIG
TRIGGER INPUT CF V63
TRIGGER AMPLIFIER Q74 Q84
TRIGGER SHAPER D85 Q94
SWEEP GATING D205 Q214
DISCONNECT DIODES V252
MILLER RUNUP V261

MRH
264



REFERENCE DRAWINGS

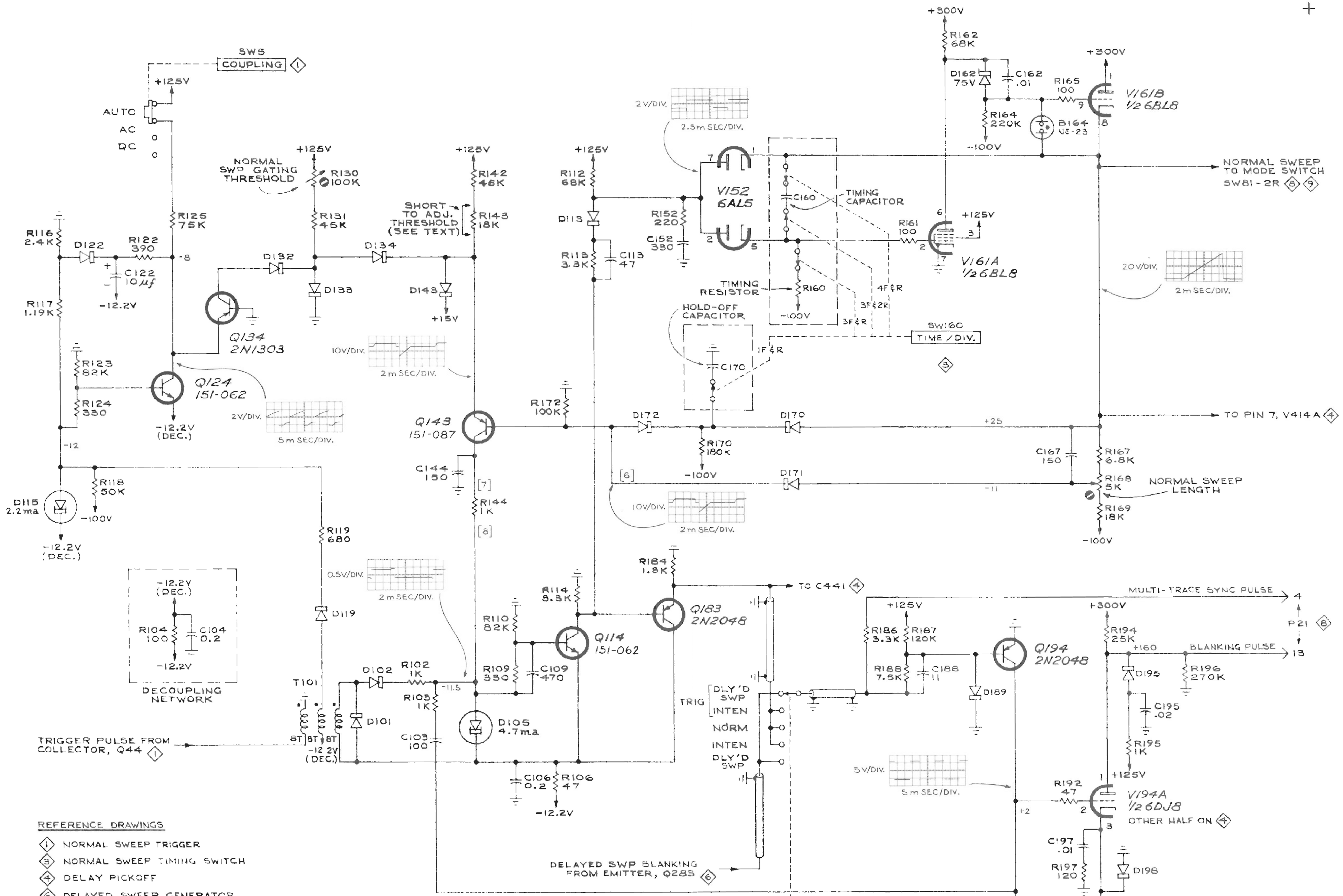
2 NORMAL SWEEP GENERATOR

8 HORIZONTAL AMPLIFIER

TYPE 381-S PLUG-IN

MRH
264

NORMAL SWEEP TRIGGER 1



REFERENCE DRAWINGS

1. NORMAL SWEEP TRIGGER
3. NORMAL SWEEP TIMING SWITCH
4. DELAY PICKOFF
6. DELAYED SWEEP GENERATOR
8. HORIZONTAL AMPLIFIER
9. MODE SWITCH

WAVEFORMS & VOLTAGE READINGS WERE OBTAINED UNDER FOLLOWING CONDITIONS:

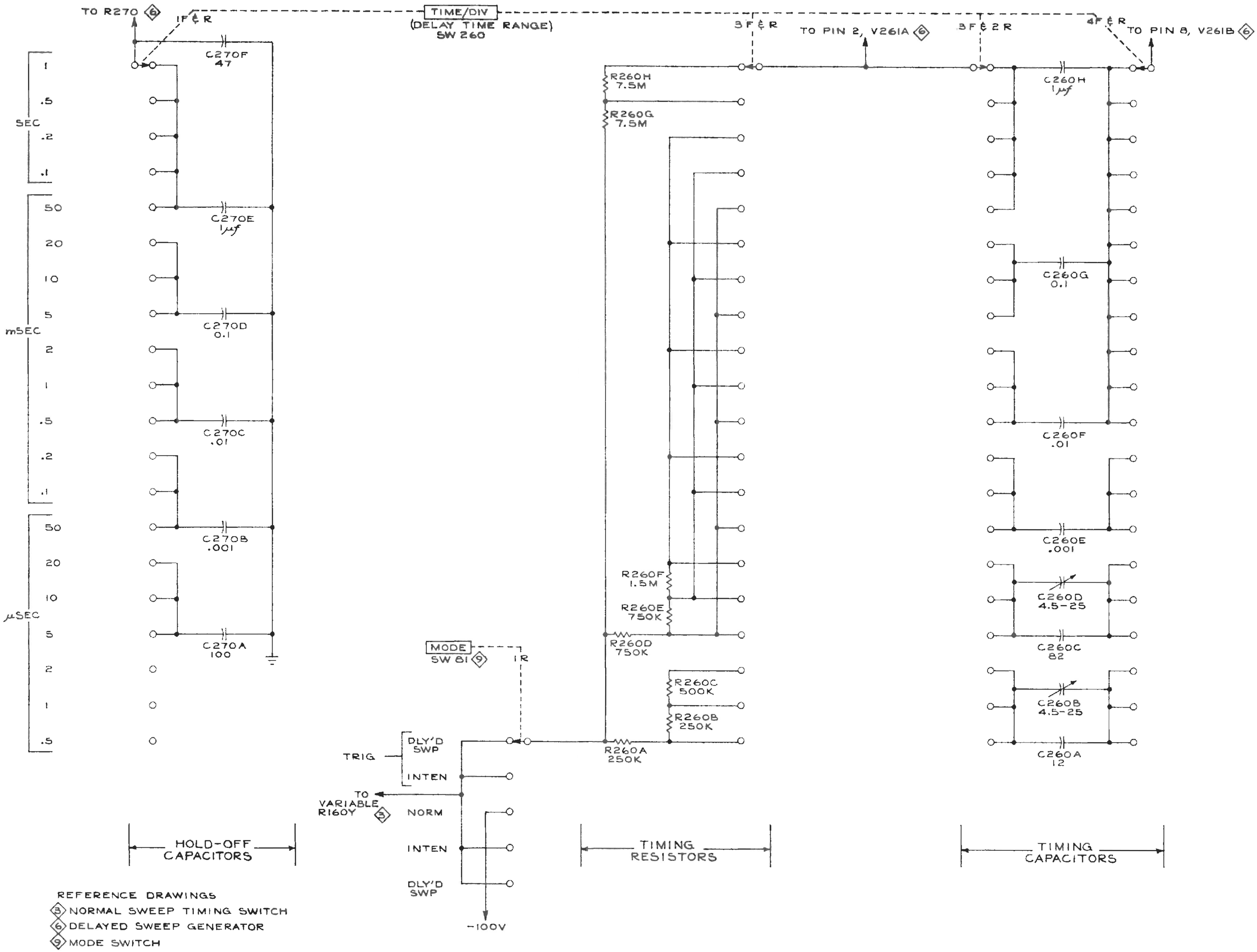
MODE.................................NORM.
TRIG.................................AUTO.
SIGNAL.........................0.5V CALIB.

MRH 264

TYPE 381-S PLUG-IN

A

NORMAL SWEEP GENERATOR 2

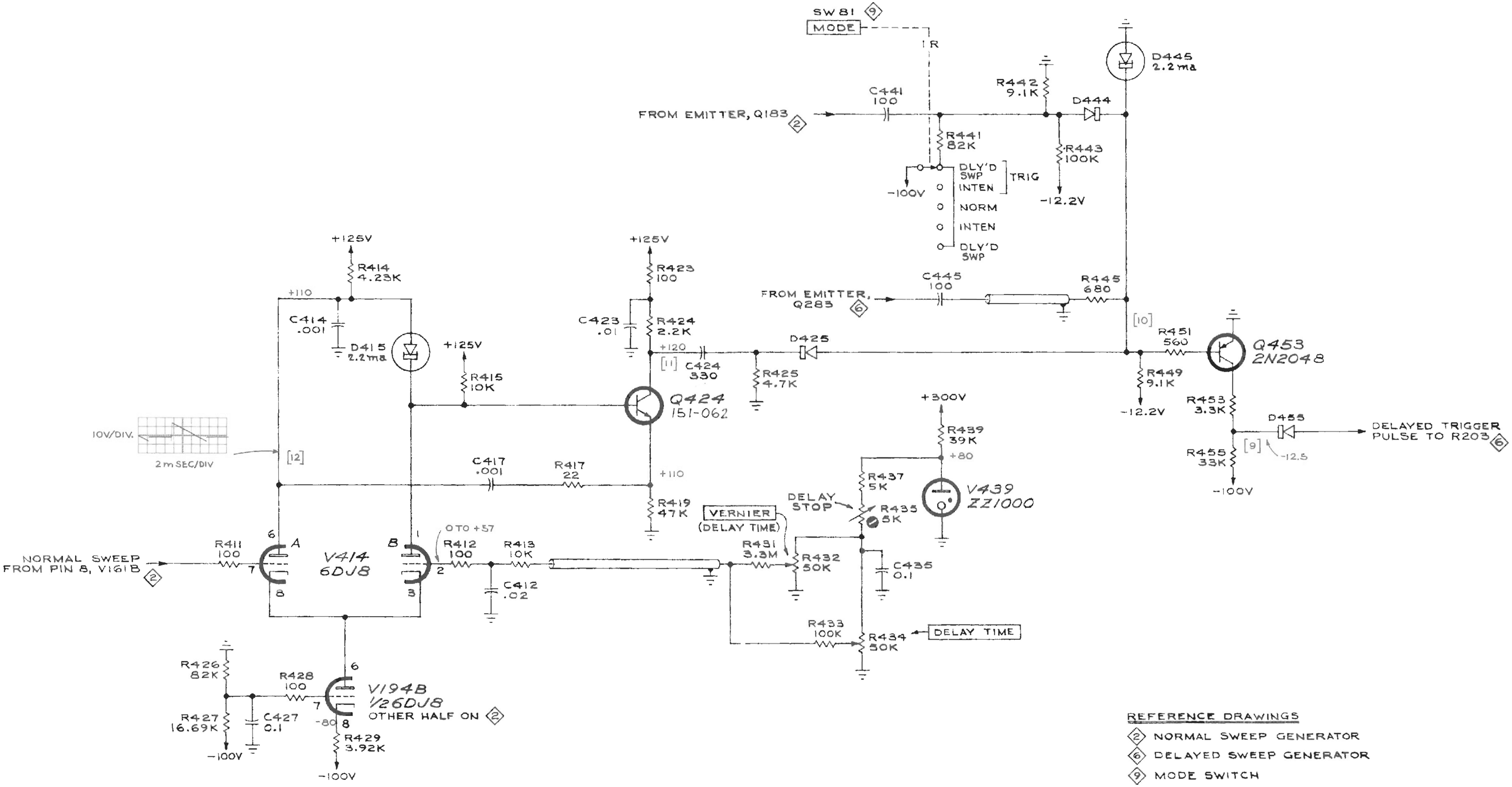


TYPE 3B1-S PLUG-IN

A

PLM 264

DELAYED SWEEP TIMING SWITCH 7



REFERENCE DRAWINGS
⟨2⟩ NORMAL SWEEP GENERATOR
⟨6⟩ DELAYED SWEEP GENERATOR
⟨9⟩ MODE SWITCH

WAVEFORMS & VOLTAGE READINGS
WERE OBTAINED UNDER FOLLOWING CONDITIONS:
MODE........................TRIG. DEL'D
TRIG............................AUTO.
SIGNAL......................0.5V CALIB.

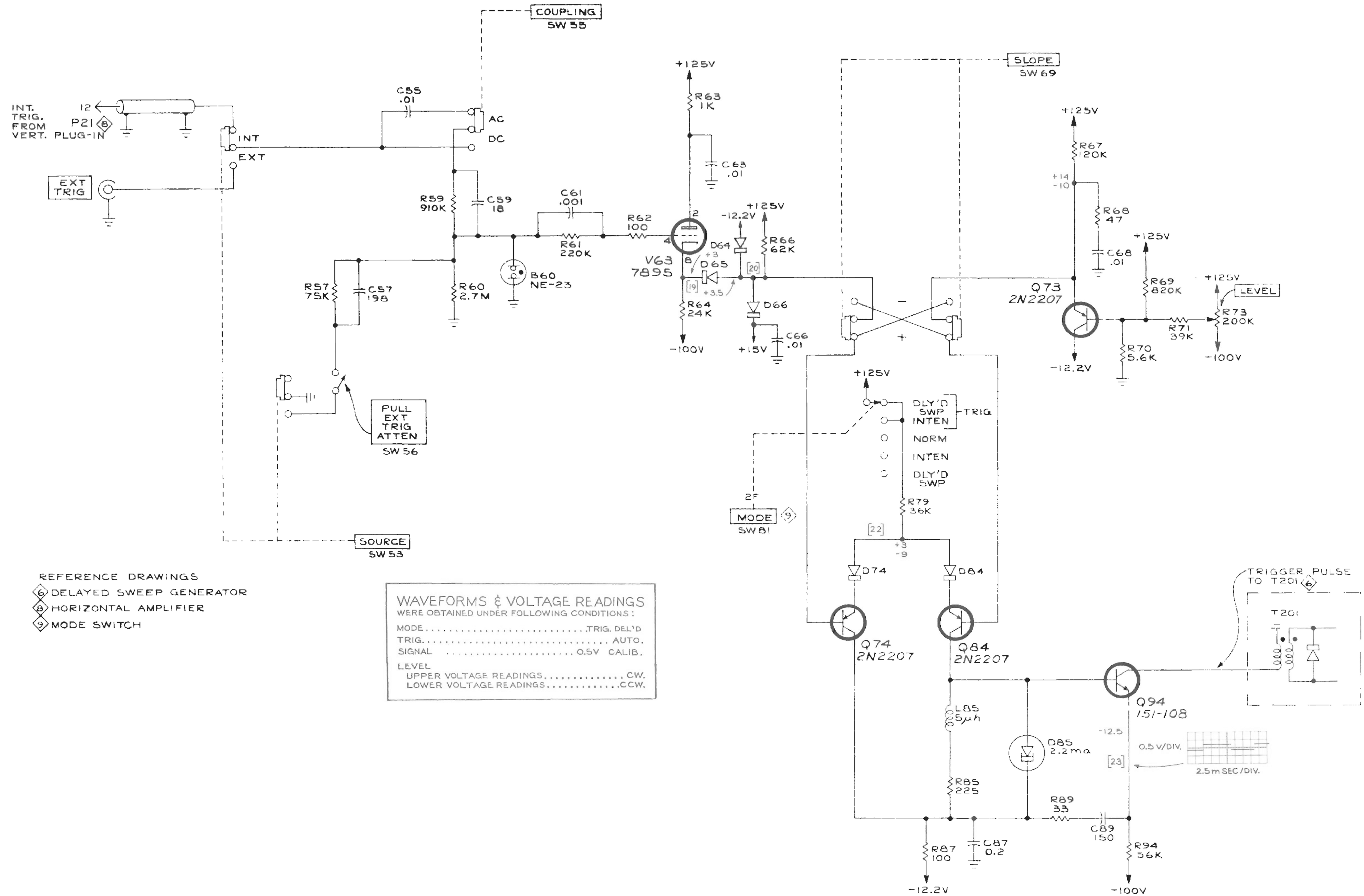
MRH
264

TYPE 381-S PLUG-IN

A

DELAY PICKOFF ⟨4⟩

CIRCUIT NUMBERS 400 THRU 459



REFERENCE DRAWINGS
6 DELAYED SWEEP GENERATOR
8 HORIZONTAL AMPLIFIER
9 MODE SWITCH

WAVEFORMS & VOLTAGE READINGS
WERE OBTAINED UNDER FOLLOWING CONDITIONS:

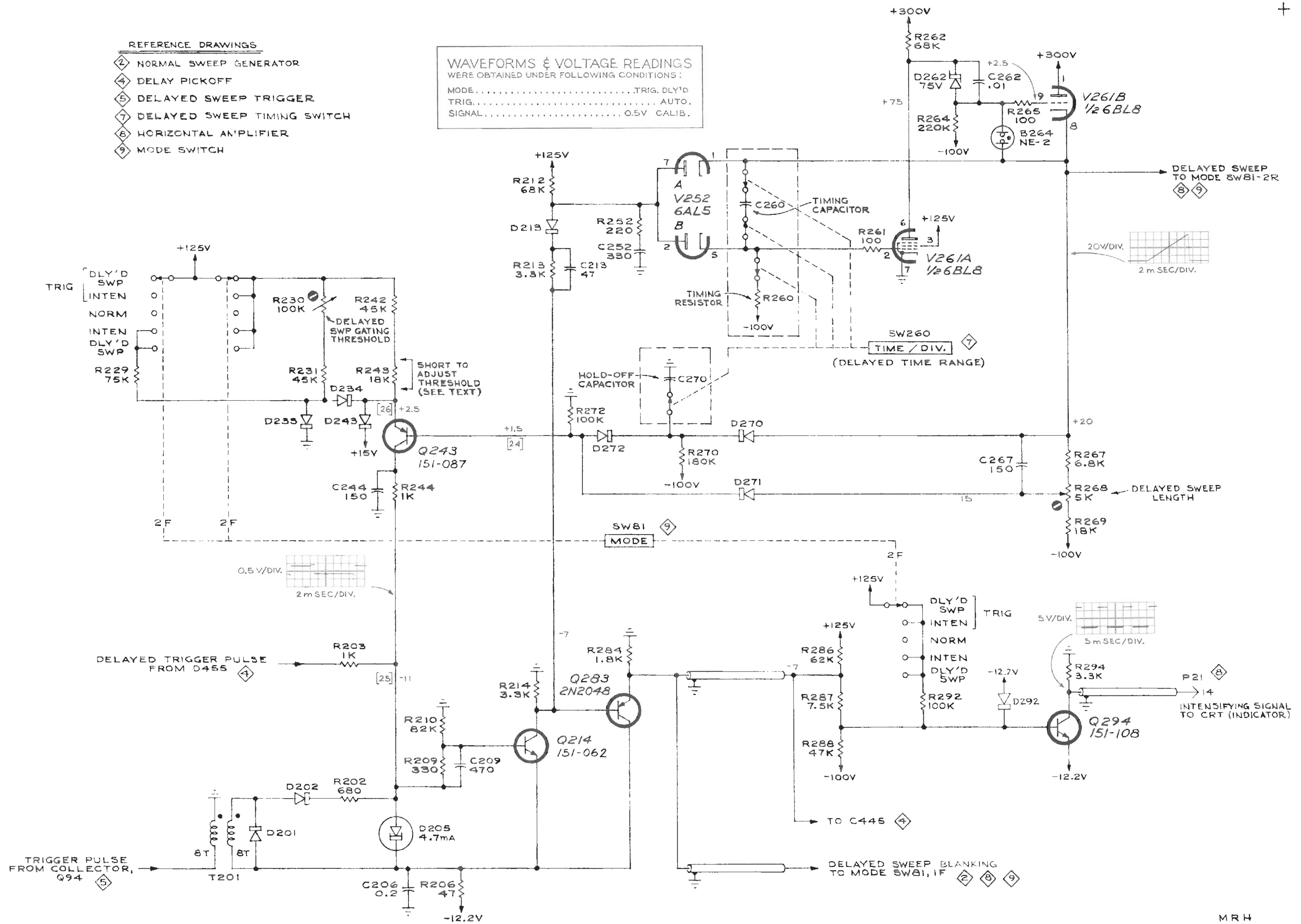
MODE .... TRIG. DEL'D
TRIG. .... AUTO.
SIGNAL .... 0.5V CALIB.
LEVEL
UPPER VOLTAGE READINGS .... CW.
LOWER VOLTAGE READINGS .... CCW.

TYPE 3B1-S PLUG-IN

A

PLM
264

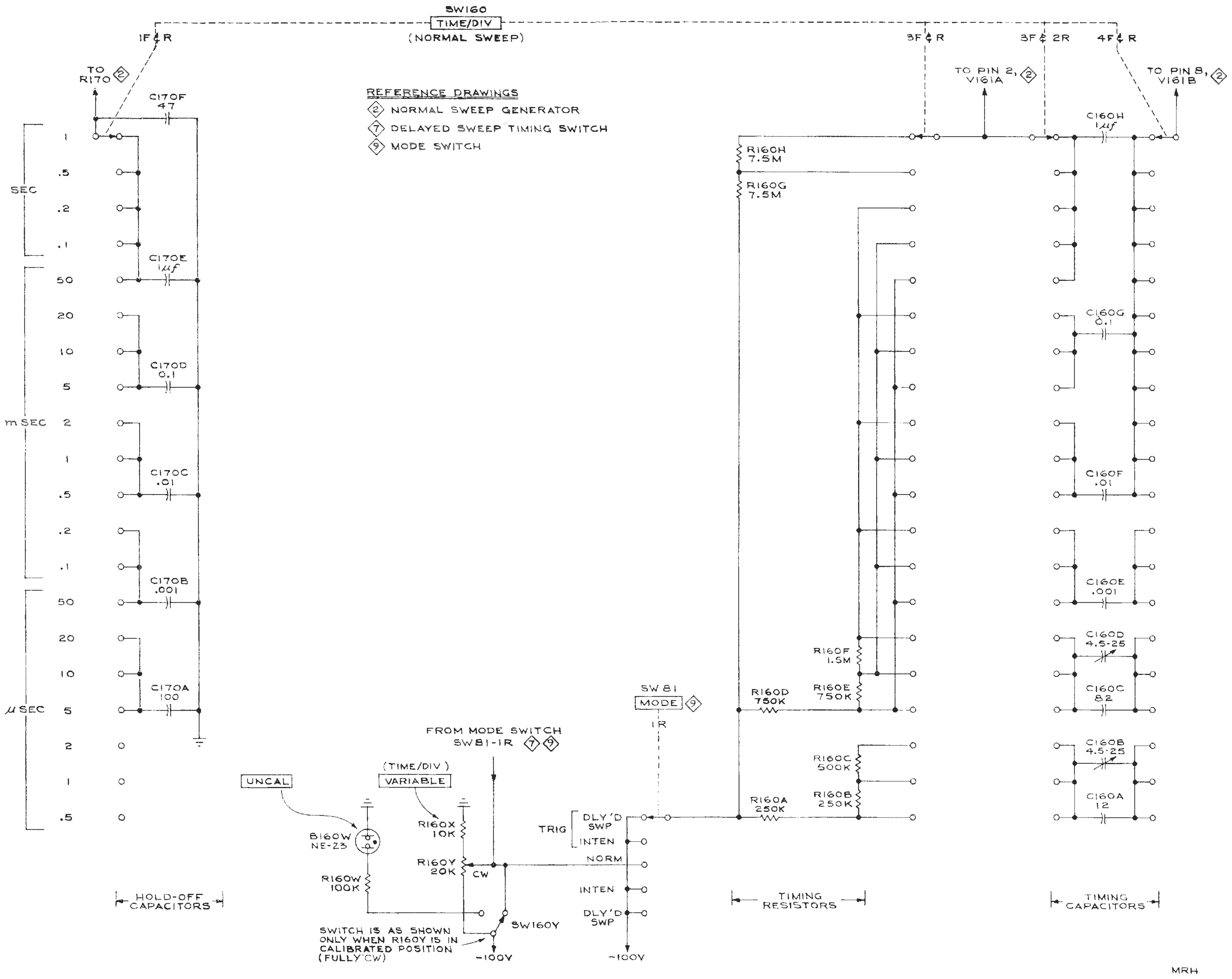
DELAYED SWEEP TRIGGER 5



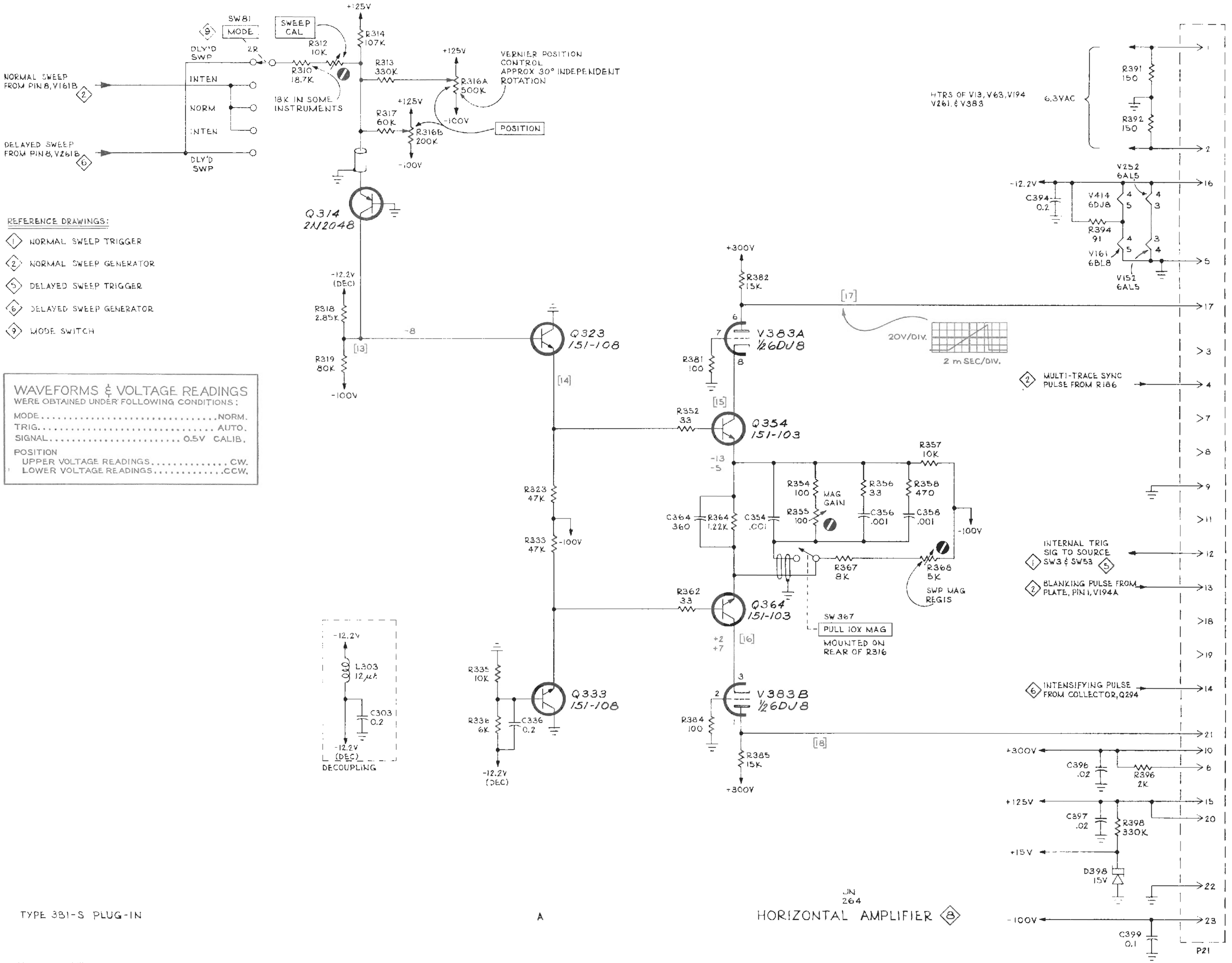
TYPE 381-S PLUG-IN

A

DELAYED SWEEP GENERATOR 6



NORMAL SWEEP TIMING SWITCH 3

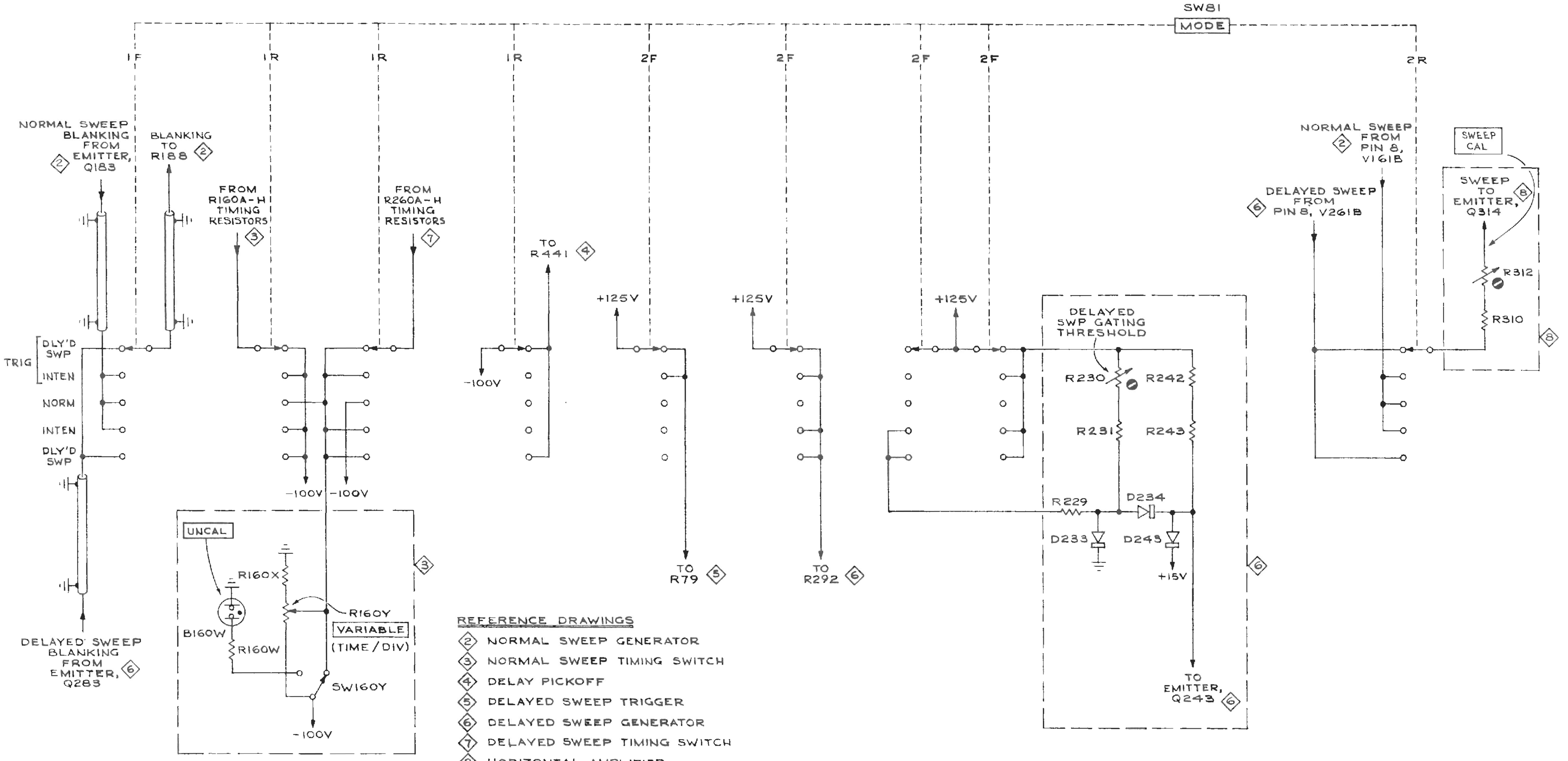


TYPE 381-S PLUG-IN

A

JN
264

HORIZONTAL AMPLIFIER ⟨8⟩



REFERENCE DRAWINGS

2. NORMAL SWEEP GENERATOR
3. NORMAL SWEEP TIMING SWITCH
4. DELAY PICKOFF
5. DELAYED SWEEP TRIGGER
6. DELAYED SWEEP GENERATOR
7. DELAYED SWEEP TIMING SWITCH
8. HORIZONTAL AMPLIFIER

MRH
264

TYPE 381-S PLUG-IN

A

MODE SWITCH (9)

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 3B1S - TENT. S/N 460

PARTS LIST CORRECTION

CHANGE TO:

R439	305-363	36k	2w	5%

M8100/464

TYPE 561S - TENT. S/N 420
TYPE 3A1S - TENT. S/N 345
TYPE 3B1S - TENT. S/N 353

Change 561S CAL OUT and 3A1S inputs from UHF to BNC connectors.

Change 3B1S EXT TRIG from binding posts to BNC connectors.

ACCESSORIES

CHANGE TO:

2 - P6006 Probe packages	020-013

ADD:

2 - Adapter, BNC to binding post	103-033

M8275/464

TYPE 3A1S - TENT. S/N 340

PARTS LIST CORRECTION

CHANGE TO:

C103B	281-103	1.8 - 13 pf	Air	Var	
C103C	281-103	1.8 - 13 pf	Air	Var	
C105B	281-103	1.8 - 13 pf	Air	Var	
C105C	281-101	1.5 - 9.1 pf	Air	Var	
C107B	281-103	1.8 - 13 pf	Air	Var	
C107C	281-101	1.5 - 9.1 pf	Air	Var	
C109B	281-103	1.8 - 13 pf	Air	Var	
C109C	281-101	1.5 - 9.1 pf	Air	Var	
C111	281-103	1.8 - 13 pf	Air	Var	
C112	281-101	1.5 - 9.1 pf	Air	Var	
C203B	281-103	1.8 - 13 pf	Air	Var	
C203C	281-103	1.8 - 13 pf	Air	Var	
C205B	281-103	1.8 - 13 pf	Air	Var	
C205C	281-101	1.5 - 9.1 pf	Air	Var	
C207B	281-103	1.8 - 13 pf	Air	Var	
C207C	281-101	1.5 - 9.1 pf	Air	Var	
C209B	281-103	1.8 - 13 pf	Air	Var	
C209C	281-101	1.5 - 9.1 pf	Air	Var	
C211	281-103	1.8 - 13 pf	Air	Var	
C212	281-101	1.5 - 9.1 pf	Air	Var	
SW110	260-607	*262-665	Rotary	CH 1	VOLTS/DIV
SW210	260-607	*262-665	Rotary	CH 2	VOLTS/DIV

M7976/364