INSTRUCTION MANUAL

Serial Number ____________

TYPE

9A1

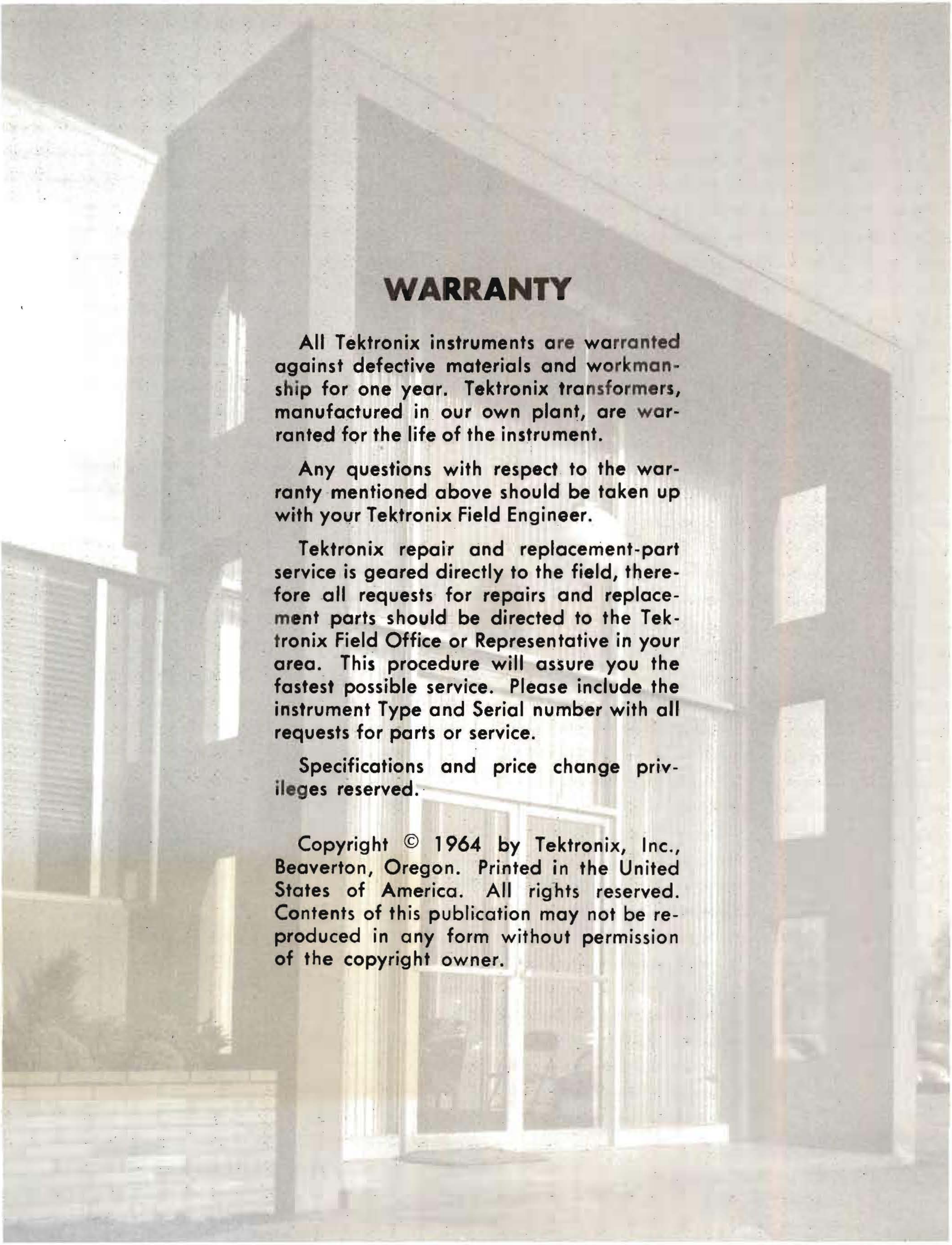
DUAL-TRACE AMPLIFIER

Tektronix, Inc.

S.W. Millikan Way • P. O. Box 500 • Beaverton, Oregon • Phone MI 4-0161 • Cables: Tektronix

070-446

864



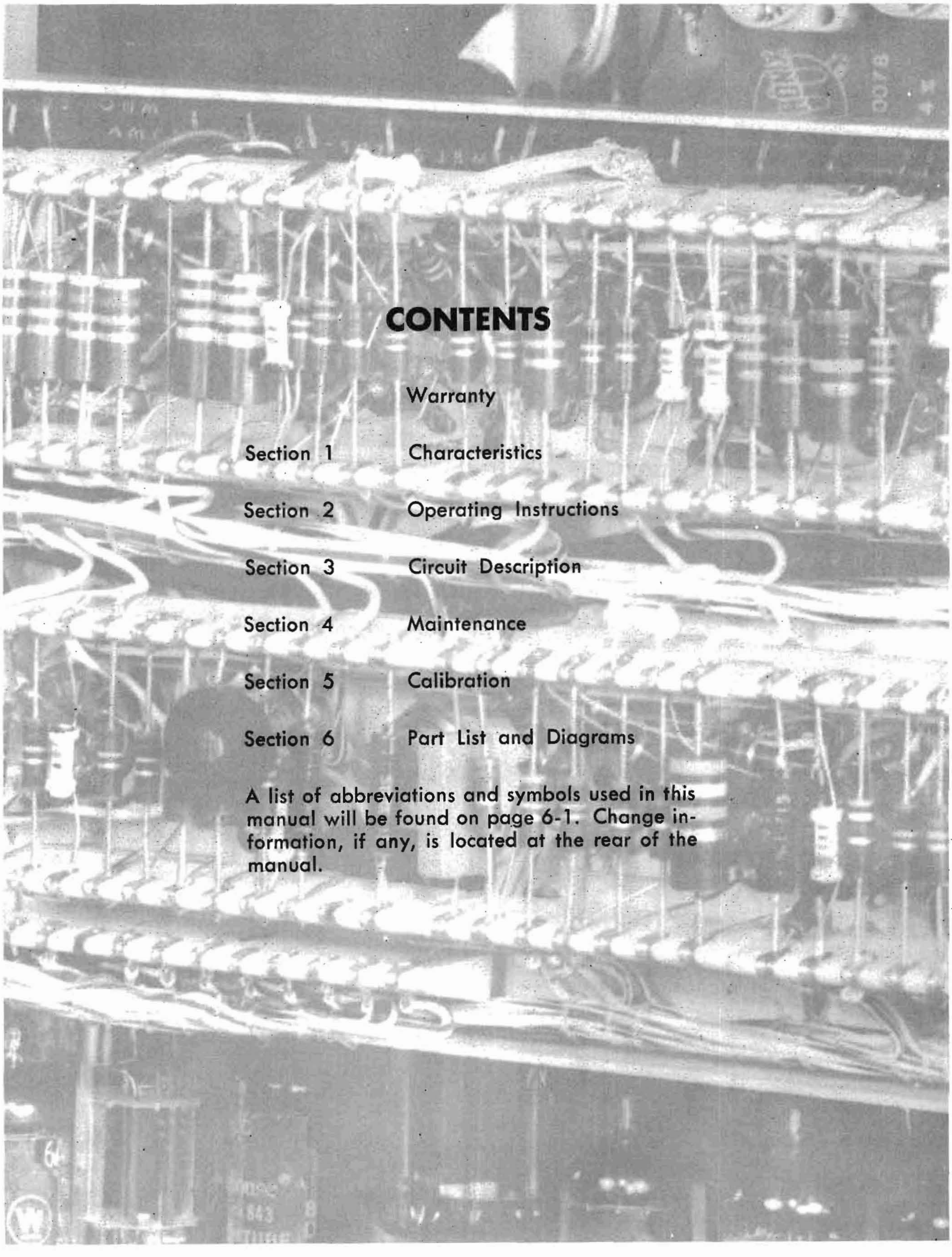
WARRANTY

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

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

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

Specifications and price change privileges reserved.



CONTENTS

A list of abbreviations and symbols used in this manual will be found on page 6-1. Change information, if any, is located at the rear of the manual.

Type 9A1 Dual-Trace Amplifier

Ⓐ

SECTION 1
CHARACTERISTICS

Introduction

The Type 9A1 Dual-Trace Amplifier is designed for use with Tektronix indicator units such as the Type 506 Oscilloscope. It contains two identical amplifier channels which can be used independently for a single-trace display, or the two channels can be electronically switched for a dual-trace display. Also, the two channels can be added algebraically and the resultant waveform displayed on the indicator unit crt.

Frequency Response

Dc to 23 Mc (not more than 3 db down at 24 Mc) with a corresponding typical risetime of 14.5 nanoseconds.

Deflection Factors

Ten calibrated steps for each channel; .01, .02, .05, .1, .2, .5, 1, 2, 5 and 10 volts/division. Variable control in each channel provides uncalibrated deflection factor to at least 2.5 times VOLTS/DIV setting or a maximum of about 25 volts/division in the 10 position.

Accuracy

Within $\pm 3\%$ of indicated deflection with VARIABLE in the CALIB position.

Input Characteristics

Impedance—1 megohm $\pm 1\%$, paralleled by about 47 pf.

Coupling—Ac or dc coupled, selected by front-panel switch. In the AC position low-frequency response is limited to about 2 cps (0.2 cps with 10× attenuator probe).

Voltage rating—600 volts combined dc and peak ac.

Operating Modes

Channel 1 only.

Channel 2 only.

Alternate between channels.

Chopped between channels.

Added algebraically.

Polarity Inversion

Polarity of Channel 1 can be changed to provide 180° inversion. No polarity inversion of Channel 2.

Channel Isolation

5,000:1 or greater at 20 Mc.

Triggering

Internal triggering signals for time-base unit are provided from both channels or from Channel 1 only, determined by front-panel switch.

Mechanical Features

Input connectors—BNC jacks.

Construction—Aluminum-alloy chassis and panel.

Finish—Photo-etched, anodized front panel.

Net Weight—5 lbs.

NOTES

SECTION 2

OPERATING INSTRUCTIONS

FUNCTION OF FRONT-PANEL CONTROLS AND CONNECTORS

The function of all controls and connectors except the CALIB, MODE, INV (CH 1) NORM and TRIGGER CH 1 ONLY is identical for both channels.

Input	Signal input connector.
POSITION	Controls vertical position of the display.
VOLTS/DIV	Selects vertical deflection factor. (VARIABLE control must be in CALIB position for indicated deflection factor.)
VARIABLE	Provides continuously variable attenuation to about 2.5 times setting of VOLTS/DIV switch.
UNCAL	Light indicates that VARIABLE control is not set to CALIB.
DC BAL	Screwdriver adjustment to set dc balance of the amplifier.
AC DC GND	Selects method of coupling signal to grid of input amplifier. AC: Blocks dc component of applied signal. DC: Directly couples the applied signal to grid of input stage. GND: Grounds grid of input stage (does not ground applied signal).
CALIB	Screwdriver adjustment to set the basic gain of the plug-in unit.
MODE	Selects mode of operation. CH 1: Displays Channel 1 signal only. CH 2: Displays Channel 2 signal only. ALTER: Alternate-trace display of both channels, switched at end of each sweep. CHOP: Dual-trace display of both Channel 1 and 2 signals. Each channel is displayed for about 4 micoseconds at about 125-kc frequency. ADDED: Displays algebraic sum of Channel 1 and 2 signals.
INV (CH 1) NORM	Inverts the Channel 1 display when in the INV position.
TRIGGER CH 1 ONLY PULL	Selects triggering from Channel 1 signal when pulled out. When pushed in, triggering signal is obtained from composite Output Amplifier signal.

FIRST-TIME OPERATION

The following steps are intended to acquaint the operator with the basic overall operation and function of the Type 9A1. More specific operation and basic application information is given later in this section.

1. Insert the Type 9A1 into the left (Y-axis) plug-in compartment of the indicator unit. Insert a time-base plug-in unit such as a Tektronix Type 3B3 into the right (X-axis) plug-in compartment.

2. Set the front-panel controls as follows:

AC DC GND	DC (both channels)
VOLTS/DIV	.5 (both channels)
VARIABLE	CALIB (both channels)
POSITION	Midrange (both channels)
MODE	CH 1
INV (CH 1) NORM	NORM
TRIGGER	Pushed in

3. Turn on the indicator unit power. If there is any doubt as to the operation of the indicator unit or time-base unit, see the instruction manuals for these units.

4. Set the indicator unit calibrator for 1-volt output and the time base for a sweep rate of 5 milliseconds/division.

5. Connect the calibrator output to both the Channel 1 and Channel 2 input connectors. Adjust the time-base triggering controls for a stable display.

6. Turn the Channel 1 POSITION control to move the display above the graticule centerline.

7. Set the MODE switch to CH 2. A two-division display similar to the previous display should be seen. Turn the Channel 2 POSITION control to move the display below the graticule centerline.

8. Set the MODE switch to ALTER; the Channel 1 and 2 displays as set up in steps 6 and 7 should be seen. Turn the time-base time/division switch to a faster sweep rate. Notice that the flicker between traces decreases as the sweep rate is increased. Return the time/division switch to 5 milliseconds/division.

9. Set the AC DC GND switch to AC. Notice the slope of the flat portion of the 60-cycle calibrator waveform which indicates loss of low frequencies due to the coupling capacitor. Return the switch to the DC position.

10. Turn one of the VARIABLE controls throughout its range. The deflection of that channel should decrease by a factor of at least 2.5 to 1. Return the VARIABLE to CALIB.

11. Set the MODE switch to CHOP; the display should be identical to ALTER but with less flicker between traces. Turn the time-base time/division switch to 10 microseconds. Notice the switching between channels as shown by the segmented trace. Reduce the sweep rate slowly and notice that the trace appears solid at about 0.1 milliseconds/division. This is the fastest rate at which CHOP mode can be used for transient signals and still obtain a satisfactory display.

12. Set the time/division switch to 2 microseconds and readjust the triggering controls for a stable display. With the Crt Cathode Selector switch in the up position, increase the intensity slightly and notice the overshoot on the display. This is the between-channel switching transient. Now set the Crt Cathode Selector switch to Chopped Blanking. The switching transient is removed from the display. Return the time/division switch to 5 milliseconds/division.

13. Set the MODE switch to ADDED. The display should be 4 divisions in amplitude. The Channel 1 and 2 signals (2 divisions each) are added for this display. Note that either POSITION control will move the trace.

14. Set the INV (CH 1) NORM switch to INV. The display should be a straight line. Since both displays are two divisions in amplitude but of opposite polarity, the algebraic sum is zero.

15. Set either VOLTS/DIV switch to 1. A square wave is again displayed indicating that the algebraic sum of Channel 1 and 2 is no longer zero.

CALIB Adjustment

Whenever the Type 9A1 is inserted into a plug-in compartment, check and adjust the gain to compensate for the differences between indicator units. Allow about 10 minutes warm up before performing this adjustment.

1. Set both AC DC GND switches to DC.

2. Set the MODE switch to CH 1.

3. Set both VOLTS/DIV switches to .02.

4. Turn the VARIABLE controls fully clockwise so the UNCAL lights are off.

5. Set the time-base controls for automatic triggering.

6. Connect the calibrator output to Channel 1 input.

7. Set the indicator unit calibrator to 100 millivolts.

8. Set the CALIB control for exactly 5 major divisions of deflection.

9. Set the MODE switch to CH 2.

10. Connect the calibrator output to Channel 2 input.

11. The deflection should be exactly 5 divisions. If incorrect, refer to the Channel 2 gain adjust procedure in Section 5.

DC BAL Adjustment

Check. To check the dc balance of either channel, set the AC DC GND switch to GND and the VOLTS/DIV switch to .01. Set the time-base controls for automatic triggering. Rotate the VARIABLE control throughout its range. If the trace moves vertically, adjust the DC BAL control according to the procedure which follows.

Adjustment. The following procedure can be used to adjust the dc balance of either channel. Set the MODE switch to display the desired channel. Allow about 10 minutes warm up before performing this adjustment.

1. Set the AC DC GND switch to GND.

2. Set the VOLTS/DIV switch to .01.

3. Set the time-base controls for automatic triggering.

4. Turn the POSITION control to midrange.

5. With the VARIABLE control in the CALIB position adjust the DC BAL control to bring the trace near graticule center.

NOTE

Both DC BAL controls are the dual-range or coarse-fine type. To use this type of control, turn the control slightly past the desired point of adjustment (coarse adjust). Then, reverse the direction of rotation and use the fine adjustment (about 30° range) to establish balance.

6. Adjust the DC BAL control so there is no trace shift as the VARIABLE control is rotated throughout its range. This may take several readjustments of the DC BAL control.

Signal Connections

In general, 10× attenuator probes offer the best means of coupling a signal to the input of the Type 9A1. The 10× attenuator probe offers a higher input impedance and allows the circuit under test to operate more closely to actual operating conditions. The signal probes are shielded to prevent pickup of any electrostatic or electromagnetic interference.

In some cases, the signal can be connected to the Type 9A1 inputs with short, unshielded leads. This is particulary true with high-level, low-frequency signals. When such leads are used, be sure to establish a common ground between the Type 9A1 and the equipment under test. Attempt to position the leads away from any source of interference to avoid errors in the display. If interference is excessive with unshielded leads, use a coaxial cable or a probe.

In high-frequency applications requiring maximum overall bandwidth, use coaxial cables terminated in their characteristic impedance at the input of the Type 9A1.

Loading Effect of the Type 9A1

As nearly as possible, simulate actual operating conditions in the equipment under test. Otherwise, the equipment under test may not produce a normal signal. The 10× attenuator probes mentioned previously offer the least circuit loading. Tektronix 10× attenuator probes have an input resistance of 10 megohms with very low shunt capacitance.

When the signal is coupled directly to the input of the Type 9A1, the input impedance is 1 megohm (±1%) paralleled by about 47 pf. When the signal is coupled to the input of the Type 9A1 through a coaxial cable, the input capacitance is greatly increased. Just a few feet of coaxial cable can increase the input capacitance to well over 100 pf.

Input Coupling

The Channel 1 and 2 AC DC GND switches allow a choice of input coupling. To display both the ac and dc components of an applied signal, set the switch to DC. In the AC position, only the ac component of the input signal is allowed to pass. The GND position connects the input grid to ground but does not ground the input signal.

The DC position can be used for most applications. However, if the dc component of the signal is large enough to drive the display off the crt viewing area or if the dc component is much larger than the ac component, use the AC position.

In the AC position of the switch, the dc component of the signal is blocked by a capacitor in the input circuit. The low-frequency response in the AC position is about 2 cps, 3 db down. Therefore, some low-frequency distortion can be expected near this frequency limit. Distortion will also appear in square waves which have low-frequency components.

The GND position provides a ground reference at the input of the Type 9A1. The signal applied to the input connector is internally disconnected but not grounded. The grid of the input tube is at ground potential, eliminating the need to externally ground the input to establish a zero dc reference.

Internal Triggering

Single-Trace Displays. In the CH 2 and ADDED positions of the MODE switch, push the TRIGGER switch in. When the time-base trigger coupling switch is set to dc, the setting of the POSITION controls will affect the setting of the trigger level control. Proper triggering can be obtained in the CH 1 position of the MODE switch in either TRIGGER switch position. However, in the CH 1 ONLY position (TRIGGER switch pulled out) the POSITION controls have no affect on dc triggering.

Dual-Trace Displays. To obtain proper triggering in the CHOP mode, pull out the TRIGGER switch. Then, the internal trigger signal coupled to the time base does not contain the dual-trace chopping signal. It is difficult to get a stable display if the TRIGGER switch is pushed in because of the switching transient.

In the ALTER mode, the TRIGGER switch can be in either position, depending upon the application. When the TRIGGER switch is pushed in, the time base will be triggered from the signal on each channel. This provides stable display of two unrelated signals, but does not indicate the time relationship between the signals. To display signals showing true time relationship, pull the TRIGGER switch out to trigger from Channel 1 only. If the signals on the two channels are not time related, the Channel 2 display will not be stable.

In the ALTER mode, dc trigger coupling cannot be used if the TRIGGER switch is pushed in. Proper triggering can be obtained with the TRIGGER switch pulled out to the CHANNEL 1 ONLY position.

Dual-Trace Operation

Chopped Mode. The chopped display is produced by electronic switching between channels. To blank out the switching transients, set the Crt Cathode Selector switch on the rear of the indicator unit to the Chopped Blanking position.

In general, use the CHOP position (chopped-mode operation) with sweep rates slower than 0.1 millisecond/division. At higher sweep rates the chopped switching becomes apparent.

Two signals which are time related can be displayed in the chopped mode showing true time relationship. However, if the signals are not time related, the Channel 2 display will appear unstable.

Single-shot, transient or random signals which occur within the time interval determined by the time-base time/division switch (10 times sweep rate) can be compared using the chopped mode. To trigger the sweep, the Channel 1 signal must precede the Channel 2 signal. Since the signals show true time relationship, time difference measurements can be made.

Alternate Mode. The ALTER position (alternate-mode operation) can be used at any sweep rate. However, for time comparison measurements requiring sweep rates below about 20 milliseconds/division, use the chopped mode for best results.

Algebraic Addition

To display signals using the ADDED mode, observe the following precautions:

Do not exceed the input voltage rating of the amplifier.

Do not apply signals that will exceed an equivalent of 20 major divisions of deflection. As an example, with a VOLTS/DIV switch setting of 1, the voltage applied to that channel should not exceed 20 volts. If this limit is exceeded, signal distortion will result.

Before displaying signals in the ADDED mode, set the MODE switch to ALTER or CHOP and position both channel signals to the center of the display area. This is also a precaution against display distortion.

BASIC APPLICATIONS

The following information describes the procedures and techniques for making basic measurements with a Type 9A1 and an associated Tektronix indicator unit and time base. No attempt has been made to describe these applications in detail as each one must be adapted to the individual requirements. Familiarity with the Type 9A1 will enable these basic techniques to be applied to a wide variety of uses.

Voltage Measurements—AC

To measure the voltage level of an ac signal, set the AC DC GND switch to AC. In this position the dc component of the signal will be blocked. However, if the ac signal is very low frequency, the DC position should be used to avoid distortion of the signal.

To make a peak-to-peak measurement, use the following procedure:

1. Set the VOLTS/DIV switch to a setting at least $1/8$ of the expected voltage. For example, if the voltage will be about 10 volts in amplitude, set the VOLTS/DIV switch to 2 (.2 if 10× probe is used).
2. Apply the signal to either input connector.
3. Set the MODE switch to the channel used.
4. Set the AC DC GND switch to AC.
5. Set the time-base triggering controls to obtain a stable display. Set the time/division switch to a position that will display several cycles of the waveform.
6. Turn the POSITION control so the lower portion of the waveform coincides with one of the graticule lines below the centerline. With the time-base Position control, move the display so one of the upper peaks lies near the vertical centerline (see Fig. 2-1).
7. Measure the divisions of vertical peak-to-peak deflection. Make sure the VARIABLE control is in the CALIB position.
8. Multiply the peak-to-peak distance measured in step 7 by the VOLTS/DIV setting. Also include the attenuation factor of the probe, if any.

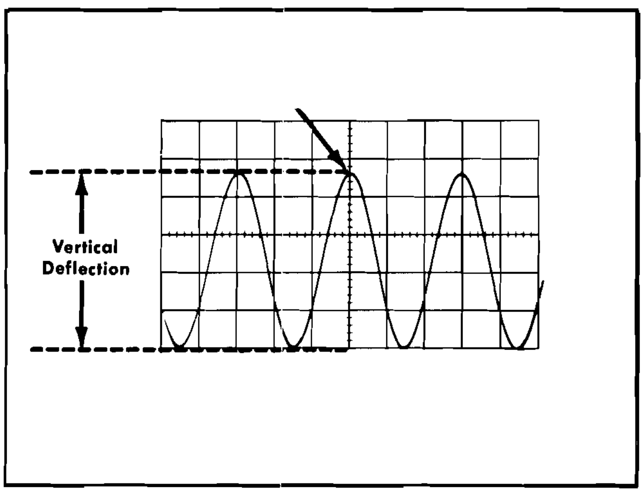


Fig. 2-1. Measuring the peak-to-peak voltage of a waveform.

As an example of this method of measurement, assume that the peak-to-peak vertical deflection is 4.6 divisions (see Fig. 2-1) using a 10× attenuator probe and a VOLTS/DIV setting of .5.

Using the formula:

$$\text{Volts Peak-to-Peak} = \text{vertical deflection (divisions)} \times \text{VOLTS/DIV setting} \times \text{probe attenuation factor}$$

Substituting the values given above:

Volts Peak-to-Peak = 4.6 × .5 × 10

The peak-to-peak voltage would be 23 volts.

Voltage Measurements—Instantaneous DC

To measure the dc level at a given point on a waveform, use the following procedure:

1. Set the VOLTS/DIV switch to a setting at least $1/8$ of the expected voltage. For example, if the voltage will be about 10 volts in amplitude, set the VOLTS/DIV switch to 2 (.2 if 10× probe is used).
2. Connect the signal to either input connector.
3. Set the MODE switch to the channel used.
4. Set the AC DC GND switch to GND.
5. Adjust the triggering controls for automatic triggering.
6. Align the trace with the bottom line of the graticule or other reference line. If the voltage is negative with respect to ground, set the INV (CH 1) NORM switch to INV and then align the trace with the reference line. Do not move the POSITION control after this reference line has been established.

NOTE

To measure a voltage level with respect to another voltage rather than ground, make the following changes in the above procedure. Set the AC DC GND switch to DC. Apply the reference voltage to the input and position the trace to the reference line.

7. Set the AC DC GND switch to DC. The ground reference can be checked at any time by switching to the GND position.
8. Set the time-base triggering controls to obtain a stable display. Set the time/division switch to a setting that will display several cycles of the waveform.

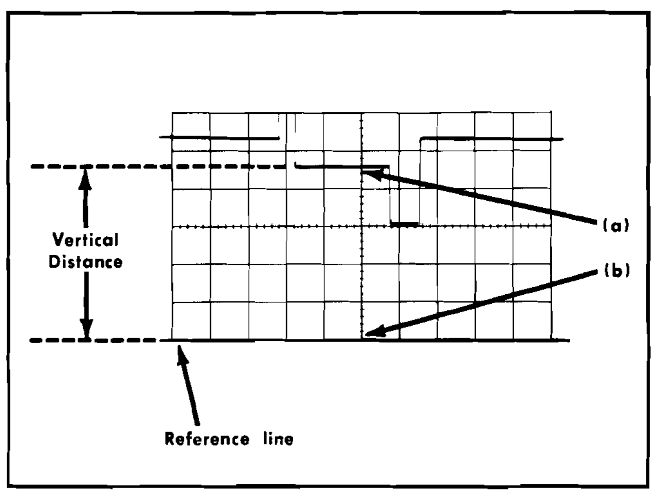


Fig. 2-2. Measuring instantaneous dc voltage with respect to a reference.

Ⓐ

9. Measure the distance in divisions between the ground reference line established in step 6 and the point on the waveform to be measured. For example, in Fig. 2-2 the measurement is made between points (a) and (b).

10. Establish the polarity of the signal. If the waveform is above the reference line with the INV (CH 1) NORM switch set to NORM, the voltage is positive. If the INV (CH 1) NORM switch is set to INV, the voltage is negative.

11. Multiply the distance measured in step 9 (include polarity) by the VOLTS/DIV setting. Include the attenuation factor of the probe, if any.

As an example of this method of measurement, assume that the vertical distance is 4.6 divisions (see Fig. 2-2), INV (CH 1) NORM switch set to INV, using a 10X attenuator probe and a VOLTS/DIV setting of 2.

Using the formula:

$$\text{Instantaneous Voltage} = \text{vertical distance (divisions)} \times \text{polarity} \times \text{VOLTS/DIV setting} \times \text{probe attenuation factor}$$

Substituting the values given above:

$$\text{Instantaneous Voltage} = 4.6 \times -1 \times 2 \times 10$$

The instantaneous voltage would be —92 volts.

Voltage Comparison Measurements

In some applications it may be necessary to establish a set of deflection factors other than those indicated by the VOLTS/DIV switch. This is useful for comparing signals which are exact multiples of a reference voltage amplitude. To establish a set of deflection factors based upon some specific reference amplitude, proceed as follows:

1. Apply a reference signal of known amplitude to the Channel 1 input connector and adjust the size of the display for an exact number of graticule divisions using the Channel 1 VOLTS/DIV switch and VARIABLE control. Do not move the VARIABLE control after obtaining the desired deflection.

2. Divide the amplitude of the reference signal (volts) by the product of the deflection in divisions (established in step 1) and the VOLTS/DIV switch setting. This is the Deflection Conversion Factor.

$$\text{Deflection Conversion Factor} = \frac{\text{reference signal amplitude (volts)}}{\text{deflection (divisions)} \times \text{VOLTS/DIV setting}}$$

3. To calculate the Adjusted Deflection Factor at any setting of the Channel 1 VOLTS/DIV switch, multiply the VOLTS/DIV switch setting by the Deflection Conversion Factor obtained in step 2.

$$\text{Adjusted Deflection Factor} = \text{VOLTS/DIV setting} \times \text{Deflection Conversion Factor}$$

This adjusted Deflection Factor applies only to Channel 1 and is correct only if the VARIABLE control is not moved from the position set in step 1.

4. To determine the peak-to-peak amplitude of a signal compared to a reference, disconnect the reference and apply the signal to Channel 1.

5. Set the Channel 1 VOLTS/DIV switch to a setting that will provide sufficient deflection to make the measurement. Do not readjust the VARIABLE control.

6. Measure the vertical deflection in divisions and determine the amplitude by the following formula:

$$\text{Signal Amplitude} = \text{Adjusted Deflection Factor} \times \text{deflection (divisions)}$$

As an example of this method of measurement, assume a reference signal amplitude of 30 volts, a VOLTS/DIV setting of 5 and a deflection of 4 divisions. Substituting these values in the Deflection Conversion Factor formula (step 2):

$$\text{Deflection Conversion Factor} = \frac{30}{4 \times 5} = 1.5$$

Then, with a VOLTS/DIV switch setting of 10 the Adjusted Deflection Factor (step 3) would be:

$$\text{Adjusted Deflection Factor} = 10 \times 1.5 = 15 \text{ volts/division}$$

To determine the peak-to-peak amplitude of an applied signal which produces a vertical deflection of 4.5 divisions use the Signal Amplitude formula (step 6):

$$\text{Signal Amplitude} = 15 \times 4.5 = 67.5 \text{ volts}$$

Time-Difference Measurements

The calibrated sweep rate of the time base and the dual-trace feature of the Type 9A1 allow measurement of time difference between two events. To measure time difference, use the following procedure:

1. Set the AC DC GND switches to the same position, depending on the type of coupling desired.

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

3. Set the MODE switch to either CHOP or ALTER. In general, the CHOP position is more suitable for low-frequency signals and the ALTER position is more suitable for high-frequency signals. For more information on determining the mode, see "Dual-Trace Operation" and "Internal Triggering" in this section.

4. Pull the TRIGGER switch out to provide triggering from the Channel 1 signal only.

5. Set the VOLTS/DIV switches so the voltages applied to the input connectors will provide suitable deflection on the crt.

6. Apply the reference signal to Channel 1 ond the comparision signal to Channel 2. Use coaxial cables or probes which have equal time delay.

7. Set the triggering controls for a stable display.

8. Set the time/division switch for a sweep rate which shows a two to three division spacing between the two signals.

9. Adjust the POSITION control to center each display (or the points on the display between which the measurement is being made) in relation to the graticule horizontal centerline.

10. Measure the exact horizontal distance between the reference waveform and the Channel 2 waveform (see Fig. 2-3).

11. Multiply the measured distance by the setting of the time/division switch to obtain the apparent time interval. The actual time interval is determined by dividing this value by the sweep magnification, if sweep magnification is used.

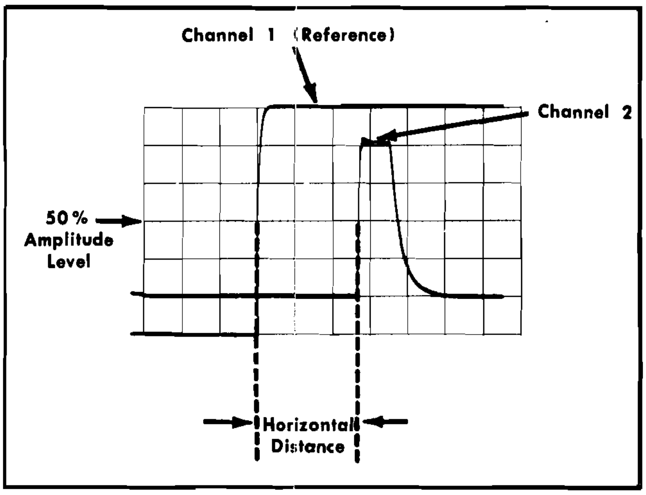


Fig. 2-3. Measuring time delay between pulses.

For example, assume that the time/division switch is set to 5 microseconds, the 5$\times$ magnifier is on and the horizontal distance between waveforms is 2.7 divisions (see Fig. 2-3).

Using the formula:

$$\text{Time Delay} = \frac{\text{TIME/DIV setting} \times \text{horizontal distance (divisions)}}{\text{sweep magnification}}$$

Substituting the values given above:

$$\text{Time Delay} = \frac{5 \times 2.7}{5}$$

The time delay would be 2.7 micoseconds.

Phase Measurements

Phase comparison between two signals of the same frequency can be made using the dual-trace feature of the Type 9A1. To make the comparision, proceed as follows:

1. Follow the procedure given in the first seven steps under "Time-Difference Measurements".

2. Set the time/division control for a sweep rate which displays less than 1 cycle of the waveform.

3. Adjust the VARIABLE control so the displays are equal and about six divisions in height. Reset the VOLTS/DIV switches, if necessary, to obtain equal amplitude displays.

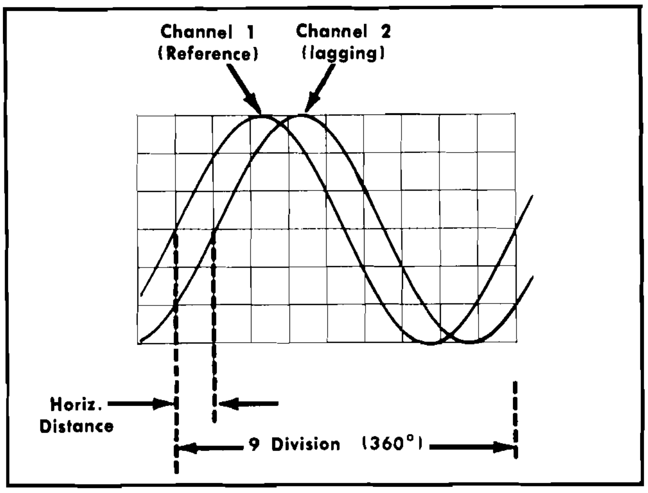


Fig. 2-4. Measuring phase shift.

4. Move the waveforms to the center of the graticule with the POSITION controls.

5. Turn the Variable time/division control counterclockwise until 1 cycle of the reference signal (Channel 1 signal) occupies exactly 9 divisions horizontally. Each division of the graticule represents 40° of the cycle (360° $\div$ 9 divisions = 40°/division, see Fig. 2-4).

6. Measure the horizontal distance between corresponding points on the waveforms. Note whether the Channel 2 waveform is leading or lagging the reference waveform on Channel 1.

7. Multiply the measured distance (in divisions) by 40° to obtain the exact amount of phase difference.

For example, with a horizontal distance of 1.1 divisions as shown in Fig. 2-4, the phase difference would be:

$$\text{Phase difference} = 1.1 \times 40° = 44°$$

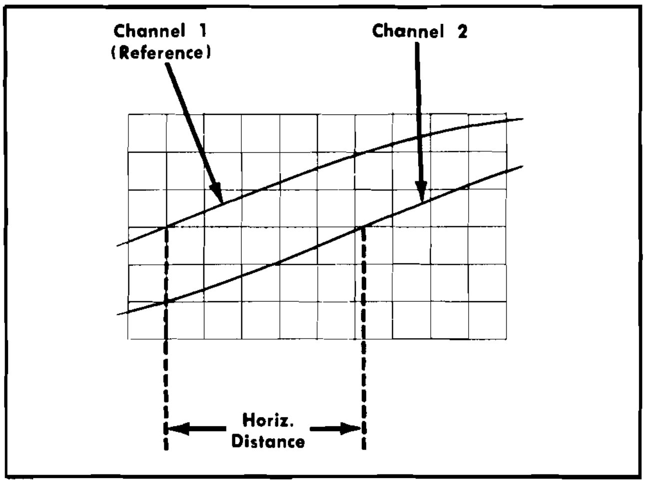


Fig. 2-5. Accurate phase measurement with sweep rate increased 5 times.

Ⓐ

8. Phase difference can be measured more accurately by increasing the sweep rate of the time base. Do not change the setting of the Variable time/division control. One of the easiest ways to increase the sweep rate is with the 5× magnifier. The adjusted phase factor is determined by dividing 40° by the increase in sweep rate.

For example, if the sweep rate were increased 5 times with the 5× magnifier, the new phase factor would be $40° \div 5 = 8°$/division (see Fig. 2-5).

NOTES

SECTION 3
CIRCUIT DESCRIPTION

The Type 9A1 Dual-Trace Amplifier contains two identical input amplifiers, 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 alternately in a dual-trace display or the algebraic sum or difference of two signals as a single trace. Fig. 3-1 shows a block diagram of the Type 9A1.

Input Amplifier

Each input amplifier consists of an attenuation network, an input cathode follower and a two-stage differential amplifier with switched outputs. Input cathode followers V113 and V123 (Channel 1) and V213 and V223 (Channel 2) isolate the emitter followers Q133 and Q143 (Channel 1) and Q233 and Q243 (Channel 2) from the input attenuators. Q134 and Q144 (Channel 1), and Q234 and Q244 (Channel 2) drive the Output Amplifier.

The input attenuators are resistive dividers with capacitive compensation. An input impedance of 1 megohm $\pm 1\%$ paralleled by about 47 pf is maintained in each position of the attenuator switch. When the VOLTS/DIV switch is in the .01 and .02 positions, input signals are coupled directly through the attenuator switch to cathode-follower stage V113 or V213. In the remaining attenuator positions resistive dividers are used to increase the basic deflection factor. In the .05 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 position. The 1×, 2.5× and 5× attenuators are used in conjunction with the 10× or 100× attenuators to provide higher deflection factors in the remaining positions of the VOLTS/DIV switch.

The DC BAL controls in the grid circuit of V123 and V223 adjust the dc voltage level of each input amplifier so current does not flow through R139 (Channel 1) and R239 (Channel 2) under no-signal conditions. Otherwise, the position of a no-signal trace would shift on the crt as the VARIABLE control was turned or gain adjustments were made.

The gain of the last stage in each input amplifier is set by two internal calibration adjustments: R149 (Channel 1) and R249 (Channel 2) set the gain of the stage in the .01 position of the VOLTS/DIV switches; R147 (Channel 1) and R247 (Channel 2) set the gain of the stage in the remaining positions of the VOLTS/DIV switches. The VARIABLE controls

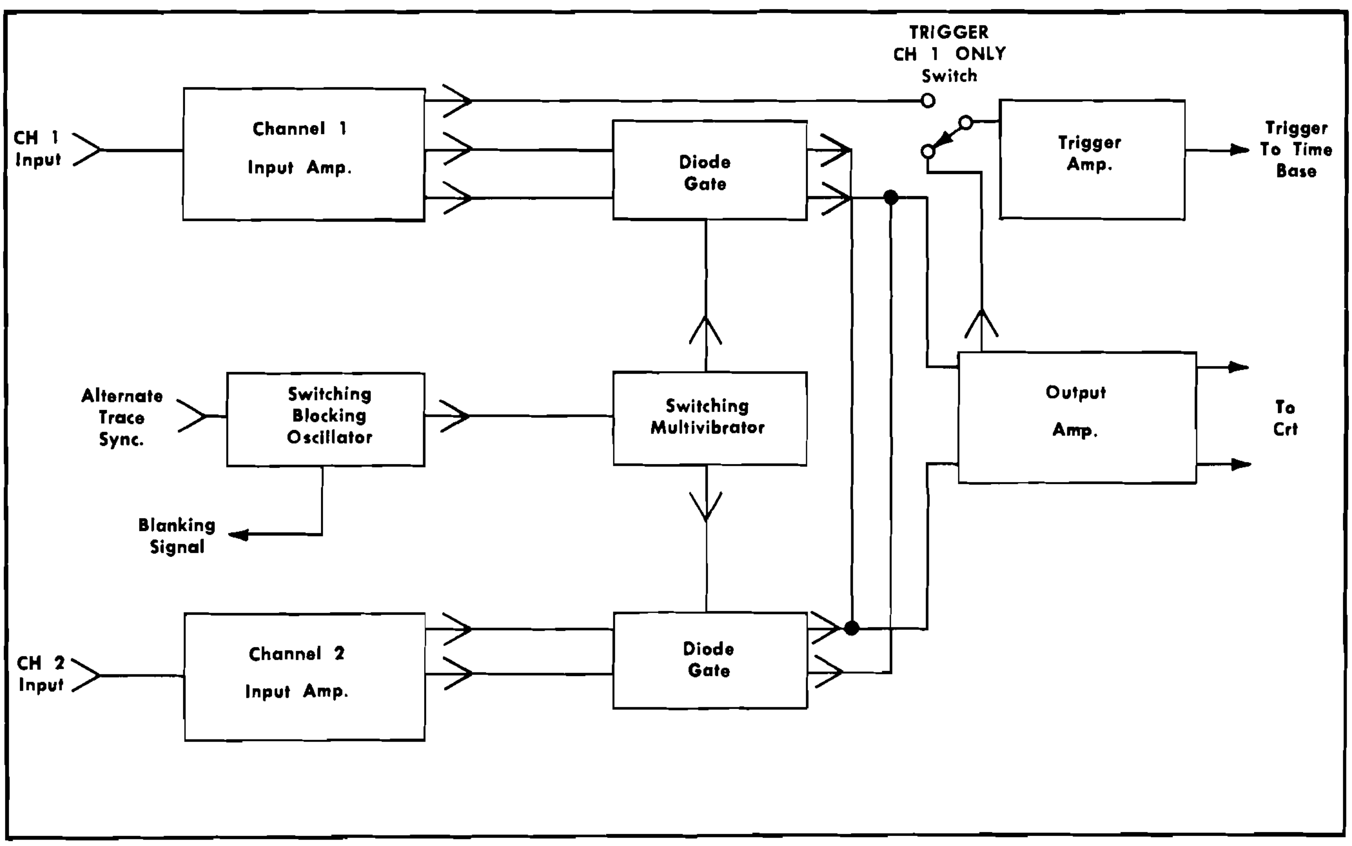


Fig. 3-1. Block diagram of Type 9A1.

increase emitter degeneration when moved from the CALIB position.

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

Switching Circuit

The switching circuit consists of two diode gates, a switching multivibrator and a switching blocking oscillator.

Each diode gate consists of two series diodes and two shunt diodes. For a signal to pass through the diode gates to the bases of Q304 and Q314 in the Output Amplifier, the series diodes must be forward biased, and the shunt diodes must be back biased.

In the CH 1, CH 2 and ADDED positions of the MODE switch, the switching multivibrator is inoperative (i.e., neither transistor is conducting). In the ALTER and CHOP positions of the MODE switch, the switching multivibrator operates as a bistable multivibrator. In this case, the multivibrator is switched by the blocking oscillator. The blocking oscillator operates as either a "triggered" oscillator in the ALTER mode or an "astable" (free running) oscillator in the CHOP mode.

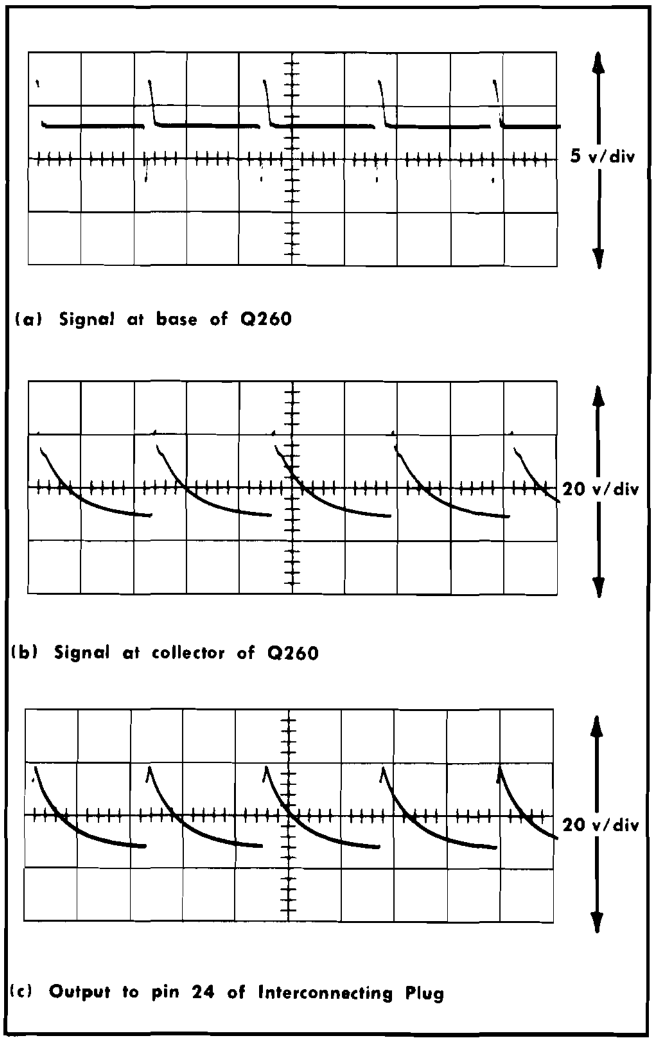
When the MODE switch is in the CH 1 position, collector current of Q134 and Q144 flows through the series diodes. The MODE switch SW290 reverse biases Q285 and holds it in the "off" state. Q275 is also "off", and holds the junction of D156 and D157 at —1.18 volts. Since the dc level in the signal output from Channel 1 input amplifier is —1.65 volts, the shunt diodes are back biased. The cathodes of the Channel 2 shunt diodes, D256 and D257, are held at about —4.7 volts by Q285. D256 and D257 are conducting and hold the Channel 2 output at about —4.3 volts. Since the output of the diode gates is at about —2 volts, D255 and D258 are back biased. With D255 and D258 cut off, the Channel 2 signal is not transmitted to the Output Amplifier. In addition, since D256 and D257 are conducting, they form 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 gates are reversed. The Channel 2 shunt diodes D256 and D257 and the Channel 1 series diodes D155 and D158 are back biased. Therefore, the signal from the Channel 2 input amplifier passes through D255 and D258 to the Output Amplifier and the Channel 1 signal is blocked by D155 and D158.

When the MODE switch is in either the ALTER or CHOP positions, Q275 and Q285 operate as a bistable multivibrator. Positive pulses from the switching blocking oscillator, Q260, 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 this "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 R276-R287 set the levels at the transistor bases. The voltage levels allow switching action to occur when a pulse is 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 from the blocking oscillator, and thus operate the diode gates and transmit a signal to the Output Amplifier from Channel 1 and Channel 2 alternately. In the ALTER and CHOP positions of the MODE switch, R292 is bypassed and the collector loads, R278 and R288, of the multivibrator transistors are connected to the —12.2-volt supply, allowing the multivibrator to switch.

In the CHOP and ALTER positions of the MODE switch, Q260 (switching blocking oscillator) is energized and supplies tigger pulses to the switching multivibrator. In the ALTER mode, the emitter of Q260 is connected to the —12.2-volt supply through R260. The collector is connected to the —100-volt supply through the collector winding of blocking oscillator transformer T263. When a positive pulse is fed from the time-base plug-in unit through terminal 3 of the interconnecting plug, the emitter voltage rises. The transistor conducts, drawing current through the collector winding of transformer T263, driving Q260 further into conduction. A normal blocking-oscillator cycle occurs, with the backswing cutting the transistor off. The transistor is biased so it does not turn on again until another sync pulse is received.



(a) Signal at base of Q260

(b) Signal at collector of Q260

(c) Output to pin 24 of Interconnecting Plug

Fig. 3-2. Blocking oscillator waveforms for chopped mode operation. Test oscilloscope ac coupled at sweep rate of 2 μsec/division.

In the CHOP position of the MODE switch, the emitter of Q260 is connected to ground through R262. The base is connected to the —12.2-volt supply, forward biasing the transistor. The blocking oscillator is automatically triggered and free-runs at about a 250-kc rate. Fig. 3-2 shows the blocking oscillator waveforms with the MODE switch in the CHOP position.

The positive output pulses produced by Q260 in the ALTER or CHOP position of the MODE switch are coupled to the switching multivibrator through C266. These positive pulses forward bias diode D278 or D288 to switch the multivibrator. Q260 also provides the blanking pulse to blank out the chopping transient.

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 shunt diodes are back biased and thus inoperative. The signals from both Channel 1 and 2 are allowed to pass to the Output Amplifier and algebraically add or subtract depending on their polarity.

Output Amplifier

The output of the diode gate passes to the bases of Q304 and Q314. These transistors are connected as a common-emitter differential amplifier. The feedback networks from collector to base of Q304 and Q314 form an amplifier with low input and output impedance. The amplifier stage Q323-Q333 connects the signal to the grids of the V334A-V334B stage.

The T-coils in the plate circuits of V344A and V344B improve the high-frequency response. The signals from the plates of V344A and V344B are coupled directly to the control grids of the cathode followers V353A and V353B. These cathode followers drive the transistors Q364 and Q374 which in turn drive the output tubes V364 and V374.

The CALIB adjustment R373 adjusts the gain of the last stage by changing the emitter degeneration of Q364 and Q374. This permits the gain of the plug-in unit to be matched to the deflection factor of the indicator unit cathode-ray tube.

Trigger Amplifiers

The Type 9A1 contains a trigger amplifier to supply an internal trigger signal to the time-base circuitry. The TRIGGER switch SW390 selects the triggering signal from either of two trigger pickoff circuits: V383B, Channel 1, or V383A, Output Amplifier.

The Channel 1 trigger signal is obtained from the Q133-Q143 stage. The CHAN 1 TRIG DC LEVEL control R171 provides a means of adjusting the dc level of the Channel 1 trigger signal. The composite trigger signal is obtained from the output stage.

NOTES

SECTION 4
MAINTENANCE

PREVENTIVE MAINTENANCE

Recalibration

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

Visual Inspection

The Type 9A1 should be inspected occasionally for such defects as broken connections, broken or damaged ceramic strips, improperly seated tubes or transistors and heat-damaged parts.

The remedy for most visible defects is obvious; however, particular care must be taken if heat-damaged parts are located. Overheating is usually only a symptom of trouble. For this reason, it is essential to determine the actual cause of overheating before the heat-damaged parts are replaced; otherwise, the damage may be repeated.

Cleaning

The Type 9A1 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical conduction path.

To clean the interior of the Type 9A1, blow off the accumulated dust with dry, low-pressure air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning ceramic terminal strips.

The front panel of the Type 9A1 can be cleaned with a soft cloth dampened with a mild solution of water and detergent. Do not use abrasive cleaners.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this unit. Avoid chemicals such as benzene, toluene, xylene, acetone, or similar solvents.

CORRECTIVE MAINTENANCE

Soldering

Ceramic Terminal Strips. Solder used on the ceramic terminal strips should contain about 3% silver. Ordinary tin-lead solder can be used occasionally without damage to the ceramic terminal strips. Use a 40- to 75-watt soldering iron with a 1/8" wide chisel-shaped tip. If ordinary solder is used repeatedly or if excessive heat is applied, the solder-to-ceramic bond can be broken.

Solder containing 3% silver is usually available locally or it can be purchased from Tektronix in one pound rolls; order by Tektronix part number 251-514.

The following precautions should be observed when soldering ceramic terminal strips:

1. Use a hot iron for a short time. Apply only enough heat to make the solder flow freely.

2. Maintain a clean, properly tinned tip.

3. Avoid putting pressure on the ceramic terminal strip.

4. Do not attempt to fill the terminal-strip notch with solder; use only enough solder to cover the wires adequately.

Metal Terminals. When soldering metal terminals (e.g. interconnecting plug pins, switch terminals, potentiometers, etc.), ordinary 60/40 solder can be used. The soldering iron should have a 40- to 75-watt rating with a 1/8" wide chisel-shaped tip.

Observe the following precautions when soldering metal terminals.

1. Apply only enough heat to make the solder flow freely.

2. If a wire extends beyond the solder joint, clip the excess close to the joint.

3. Apply only enough solder to form a solid connection. Excess solder may impair the function of the part.

Component Replacement

Certain parts in the instrument are easier to replace if a definite procedure is followed. The procedures for replacing these parts are outlined in the following paragraphs.

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

NOTE

Turn off the indicator unit power before replacing any components.

Standard Parts

All electrical and mechanical part replacements for the Type 9A1 can be obtained through your local Tektronix Field Office or representative. However, since many of the electronic components are standard parts, they can generally be obtained locally in less time than is required to order them from the factory. Before purchasing replacement parts, consult the Parts List for value, tolerance, rating and Tektronix part number.

Special Parts

In addition to the standard electronic components, some special parts are used in the production of the Type 9A1. These parts are manufactured or selected by Tektronix to meet specific performance requirements, or are manufactured for Tektronix in accordance with our specifications. Most of the mechanical parts used in this instrument have been manufactured by Tektronix. These special parts are indicated in the Parts List by an asterisk preceding the part number. Order all special parts directly from your Tektronix Field Office or representative.

Ceramic Terminal Strip Replacement

A complete ceramic terminal strip assembly is shown in Fig. 4-1. Replacement strips (including studs) and spacers are supplied under separate part numbers. The old spacers may be reused unless they are damaged.

After the damaged strip has been removed, place the undamaged spacers in the chassis holes. Then, carefully press the studs into the spacers until they are completely seated. If necessary, use a soft mallet and tap lightly, directly over the stud area of the strip.

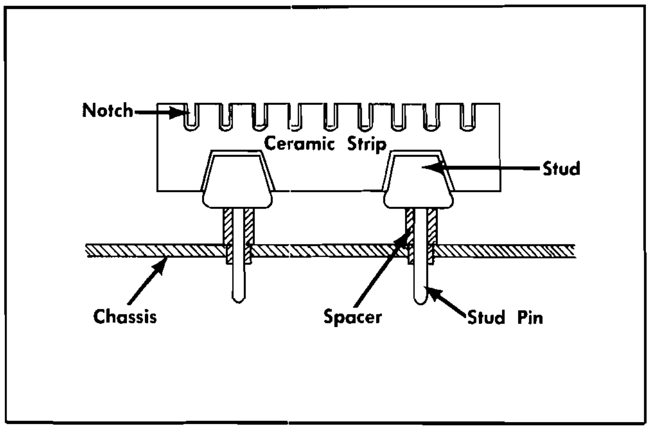


Fig. 4-1. Ceramic terminal strip assembly.

Tubes and Transistors

Do not replace tubes or transistors unless they are actually defective. If tubes or transistors are removed during routine maintenance, return them to their original sockets.

Static tube- or transistor-testers are not recommended for locating a defective tube or transistor. These testers often indicate a defective component when it is operating satisfactorily in a circuit, or may fail to indicate a characteristic which affects circuit performance. Since dynamic testers check operation under simulated circuit conditions, they provide a better check of component operation. However, the best overall test of tube or transistor performance is to substitute a new component or one which has been previously checked.

If a tube or transistor performs satisfactorily, do not replace it. Unnecessary replacement of components may require recalibration of the instrument. If tubes or transistors are replaced, check the operation of the unit.

Rotary Switches

Individual wafers or mechanical parts of rotary switches are normally not replaced. If a switch is defective, replace the entire assembly. Replacement switches can be ordered either wired or unwired; refer to the Parts List for part numbers.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting of the Type 9A1 if trouble develops. During troubleshooting, information contained in this section of the manual should be used along with information obtained from other sections (e.g., Diagrams, Operating Instructions, etc.).

Troubleshooting Aids

Schematic Diagrams. Circuit diagrams are given on pull-out pages in Section 6. The circuit numbers for each electronic component in this unit along with important voltages are shown on these diagrams.

Switch wafers shown on the diagrams are coded to indicate the position of the wafer in the complete switch assembly. The number portion of the code refers to the wafer number counting from the front or mounting end of the switch toward the rear. The letters "F" and "R" indicate whether the front or rear of the wafer is used to perform the particular switching function.

Wiring Color-Code. All insulated wire used in the Type 9A1 is color-coded to facilitate circuit tracing. The widest color stripe identifies the first color of the code. Regulated voltage supplied by the indicator unit can be identified by three color stripes and the following background color-code: white, positive voltage; tan, negative voltage.

+300 volts	Orange-black-brown on white
+125 volts	Brown-red-brown on white
—12.2 volts	Brown-red-black on tan
—100 volts	Brown-black-brown on tan

The heater wiring is indicated by a white background with a blue first stripe. The remainder of the wiring in the Type 9A1 is color-coded to facilitate point-to-point circuit tracing.

Resistor Color-Code. Some stable metal-film resistors are used in this instrument. These resistors can be identified by their gray body color. If a metal-film resistor has a value indicated by three significant figures and a multiplier, it will be color-coded according to the EIA standard. If it has a value indicated by four significant figures and a multiplier, the value will be printed on the body of the resistor. For example, a 333-k resistor will be color-coded, but a 333.5-k resistor will have its value printed on the resistor body. The color-code sequence is shown in Fig. 4-2 and Table 4-1.

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

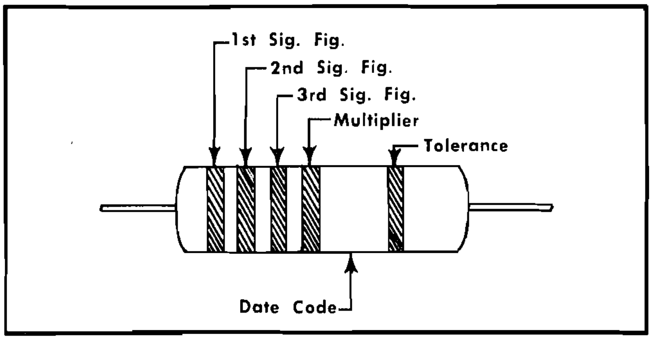


Fig. 4-2. Color-coding of metal-film resistors.

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

Test Equipment

The following equipment will be useful in troubleshooting the Type 9A1.

1. Dynamic Transistor Tester

   Purpose: To test transistors and diodes used in the Type 9A1.

   Description: Tektronix Type 575 Transistor-Curve Tracer, or equivalent.

2. Dc Voltmeter

   Purpose: To check operating voltages in the unit.

   Description: 20,000 ohms/volt.

3. Test Oscilloscope

   Purpose: To check circuit operation.

   Description: Tektronix Type 561A with Type 3A75 and Type 2B67 plug-in units, or equivalent.

4. Flexible Plug-In Extension Cable

   Purpose: Permits maximum accessibility to the Type 9A1 while operating the unit outside of the plug-in compartment.

   Description: 30", 24-pin. Tektronix Part No. 012-066.

Check Front-Panel Controls

Before proceeding with extensive troubleshooting, check the front-panel control settings. In addition, check the front-panel screwdriver adjustments for proper adjustment. An incorrect control setting can produce an apparent trouble. If in doubt as to the proper setting of a control or adjustment, see "First-Time Operation" in Section 2.

Check Indicator Unit and Time Base

The indicator unit and time base can be checked for proper operation by substituting another amplifier plug-in unit—preferably another Type 9A1—which is known to be operating properly. If the trouble persists after substitution, the indicator unit or time base is defective.

Trouble Location

If the Type 9A1 is definitely at fault, make a careful operational check of the unit. Note the effect that each front-panel control has on the symptom. Also check the effect of the calibration adjustments. The normal or abnormal operation of each control or adjustment may help isolate the trouble to the defective circuit.

After the trouble has been isolated to a particular circuit, perform a complete visual check of that circuit. Many troubles can be found most easily by visual means. If a visual check fails to detect the cause of trouble, check the tubes or transistors used in the circuit by replacing them with tubes or transistors known to be good (or check with a dynamic tester). Most of the troubles which occur result from tube or transistor failures. Be sure to return any tubes or transistors found to be good to their original sockets.

The following procedure may aid in location of the defective component after the tubes or transistors have been found to be good.

1. Isolate the trouble to a portion of the circuit if possible.

2. Recheck the reaction of the front-panel controls and calibration adjustments on the affected circuit.

3. Check the voltages in the circuit. Typical operating voltages are given on the schematic diagrams.

4. Check waveforms in the circuit with a test oscilloscope.

5. Check the components in the circuit (i.e., check for faulty capacitors, off-tolerance resistors, etc.).

NOTES

SECTION 5
CALIBRATION

Introduction

The Type 9A1 should be calibrated every 500 hours or every six months if used intermittently. If transistors, tubes, or other components are replaced, the calibration of the repaired circuit should be checked.

The following procedure is arranged in a sequence which will allow the instrument to be calibrated with the least interaction of adjustments and reconnection of equipment. If desired, the steps may be performed out of sequence or a step may be performed individually. However, it may be necessary to refer to the preceding step(s) and/or Preliminary Procedure for additional setup information.

All calibration adjustments in this unit are shown in Fig. 5-1. Fig. 5-2 shows the holes in the indicator unit which provide access to the calibration adjustments on the right side of the Type 9A1.

NOTE

This procedure is written to provide a performance check of the instrument along with complete calibration. Steps entitled 'Check' provide a check of an operational standard of the unit. 'Adjust' steps provide a check of performance and adjustment procedure, if necessary.

EQUIPMENT REQUIRED

The following equipment, or equivalent, is required for a complete calibration of the Type 9A1.

1. Calibrated Type 506 Oscilloscope with Type 3B3 Time Base plug-in unit, or equivalent instruments.

2. Dc voltmeter; 20,000 ohms/volt, 2% accuracy.

3. Square-wave generator: frequency, 100 cps to 300 kc; risetime, 20 nanoseconds or less; output amplitude, about 0.8 volts into 50 ohms. Tektronix Type 105 Square-Wave Generator recommended.

4. Fast-rise square-wave generator: frequency, 400 kc; risetime, 3.5 nanoseconds or less; amplitude, 0.1 volt or greater. Tektronix Type 107 Square-Wave Generator recommended.

5. Constant amplitude sine-wave generator: frequency, 50 kc and 25 Mc; amplitude, 40 millivolts. Tektronix Type 190B Constant-Amplitude Signal Generator recommended.

6. Input capacitance standardizer; 47 pf, BNC connectors. Tektronix Part No. 011-068.

7. Termination; 50 ohm, BNC connectors. Tektronix Part No. 011-049.

8. Attenuator; 50 ohm, 5 XT, BNC connectors. Tektronix Part No. 011-060.

9. Cable; 50 ohm, 30" long, BNC connectors. Tektronix Part No. 012-057.

10. BNC "T" connector. Tektronix Part No. 103-030.

11. Screwdriver; non-metallic, Tektronix Part No. 003-000.

12. Alignment tool; non-metallic. Tektronix Part No. 003-301.

13. Flexible plug-in extension. Tektronix Part No. 012-066.

PRELIMINARY PROCEDURE

1. Remove both side panels from the indicator unit.

2. Insert the Type 9A1 in the left plug-in compartment.

3. Insert the time-base plug-in in the right plug-in compartment using the plug-in extension.

4. Preset the indicator unit front-panel controls as follows:

Calibrator	50 mVOLTS

The remaining controls can be adjusted to provide a suitable display.

5. Preset the time-base controls as follows:

Mode	Norm.
Time/Div.	1 mSEC
Triggering	
Level	Centered
Slope	+
Coupling	Auto
Source	Int.

6. Preset the Type 9A1 controls (both channels where applicable) as follows:

POSITION	Midrange
AC DC GND	GND
VOLTS/DIV	.01
VARIABLE	CALIB
MODE	CH 1
INV (CH 1) NORM	NORM
TRIGGER	Pushed in

7. Connect the indicator unit to the correct line voltage and turn the POWER switch ON. Allow at least 20 minutes warm up before making adjustments.

CALIBRATION PROCEDURE

1. Adjust Channel 1 and 2 Dc Balance

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

b. **Check**—Rotate Channel 1 VARIABLE throughout its range. If the trace moves vertically, adjust the DC BAL control as follows:

c. Turn the DC BAL control to bring the trace near graticule center.

NOTE

Both DC BAL controls are the dual-range or coarse-fine type. To use this type of control, turn the control slightly past the desired point of adjustment (coarse adjust). Then, reverse the direction of rotation and use the fine adjustment (about 30° range) to establish balance.

d. Adjust the DC BAL control so there is no trace shift as the VARIABLE control is rotated throughout its range. This may take several readjustments of the DC BAL control.

e. Set the MODE switch to CH 2 and repeat the above procedure for Channel 2.

2. Check Chopped Mode Operation

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

b. Set the time-base Time/Div. switch for a sweep rate of 5 μSec.

c. Check the display for about one trace segment per major graticule division.

3. Check Alternate Mode Operation

a. Set the MODE switch to ALTER.

b. Turn the time-base Time/Div. switch throughout its range.

c. Check for trace alternation between Channel 1 and 2 at each Time/Div. setting.

4. Adjust Output Dc Level

a. Position both traces to the graticule centerline.

b. Connect a jumper between the crt vertical deflection pins (on left side of crt).

c. Measure the dc voltage from the vertical deflection pins to ground.

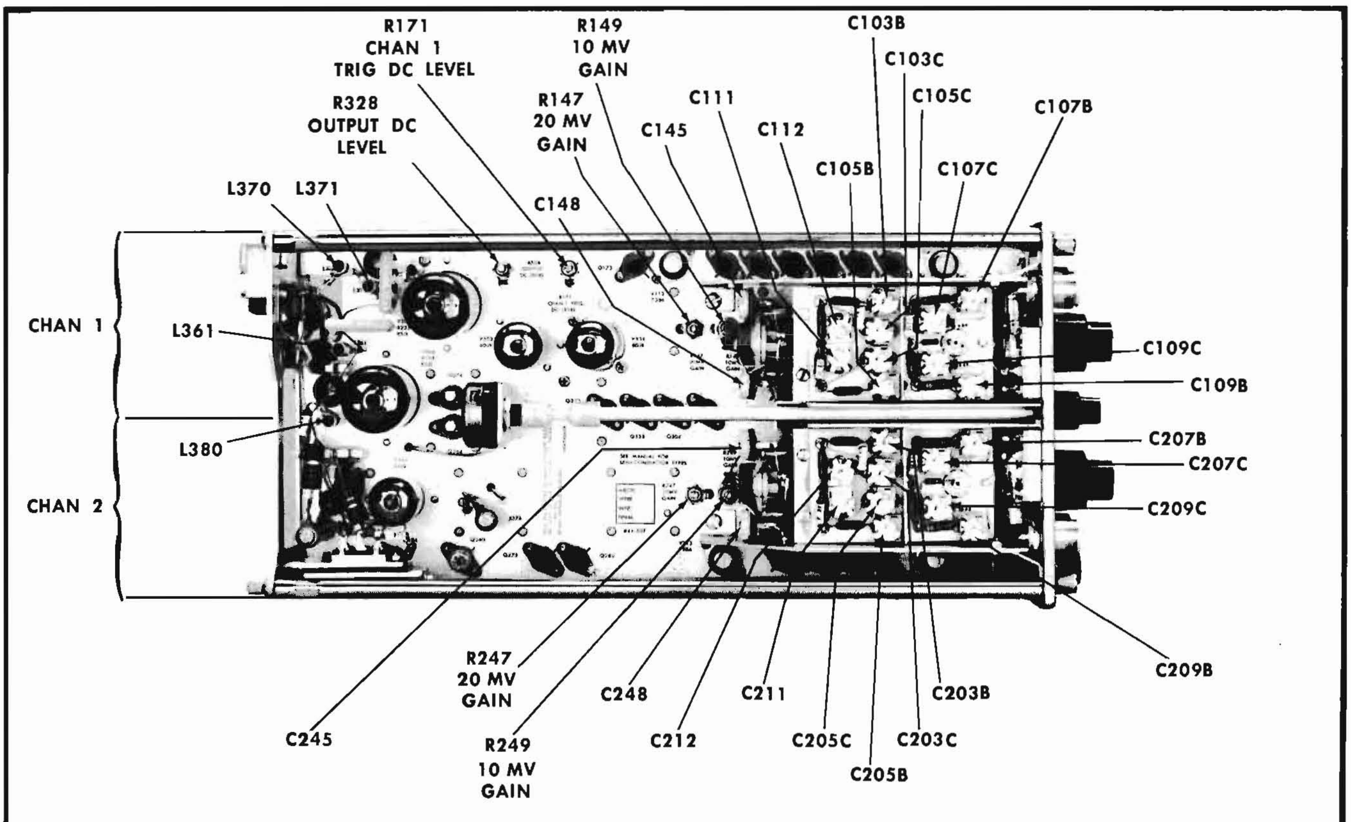


Fig. 5-1. Calibration adjustments in Type 9A1 (left-side view).

Ⓐ

d. **Check**—Voltage should be +150 volts. If not, adjust according to the following step.

e. Adjust OUTPUT DC LEVEL R328 for voltage reading of +150 volts.

5. Adjust Channel 1 Trigger Dc Level

a. Turn the MODE switch to CH 1.

b. Pull the TRIGGER switch out to the CHANNEL 1 ONLY position.

c. Connect the dc voltmeter to pin 12 of the Horizontal plug-in interconnecting plug.

d. **Check**—Voltage reading should be zero volts. If not, adjust as follows:

e. Adjust CHAN 1 TRIG DC LEVEL R171 for zero-volt reading on the meter.

6. Adjust Channel 1 10 Mv Gain

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

b. Make sure the VARIABLE control is set to CALIB (UNCAL light off).

c. Connect the 50-millivolt signal from the indicator unit Cal. Out connector to Channel 1 input.

d. Turn the CALIB control to midrange.

c. **Check**—Check for 5 major divisions of deflection. If incorrect, adjust as follows:

f. Adjust 10 MV GAIN R149 for 5 major divisions of vertical deflection.

7. Adjust Channel 1 20 Mv Gain

a. Set the Channel 1 VOLTS/DIV switch to .02.

b. Set the indicator unit calibrator to .1 Volts.

c. **Check**—Check for 5 major divisions of deflection. If incorrect, adjust as follows:

d. Adjust 20 MV GAIN R147 for 5 major divisions of vertical deflection.

8. Adjust Channel 2 10 Mv Gain

a. Connect the calibrator output to both inputs using the BNC "T" connector and a 50-ohm cable.

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

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

d. Make sure both VARIABLE controls are set to CALIB (UNCAL light off).

e. Set the calibrator for 50 mVolts output.

f. Position both traces to the center of the graticule.

g. Set the MODE switch to ADDED and the INV (CH 1) NORM switch to INV.

h. **Check**—Check for a straight line indicating identical gain in Channels 1 and 2. If square-wave signal is seen, adjust as follows:

i. Adjust 10 MV GAIN R249 for complete cancellation of the Channel 1 signal indicated by a straight line.

9. Adjust Channel 2 20 Mv Gain

a. Set the calibrator to .1 Volts.

b. Set both VOLTS/DIV switches to .02

c. **Check**—Check for a straight line indicating identical gain in Channels 1 and 2. If square-wave signal is seen, adjust as follows:

d. Adjust 20 MV GAIN R247 for a straight line.

10. Check Both VARIABLE Controls

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

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

c. Connect a 50 mVolts signal from the calibrator to the input of both channels.

d. Set the MODE switch to CH 1. The display should be 5 divisions high.

e. Turn the Channel 1 VARIABLE control fully counterclockwise. The display should be reduced to 2 major divisions or less.

f. Check that the Channel 1 UNCAL light is on.

g. Return the Channel 1 VARIABLE to CALIB; the UNCAL light should go out.

h. Set the MODE switch to CH 2. Repeat steps e, f and g with Channel 2 controls to check the Channel 2 VARIABLE control.

i. Disconnect the calibrator signal from the input connectors.

11. Check Grid Current

a. Set both VOLTS/DIV switches to .02 and VARIABLE controls to CALIB.

b. Set both AC DC GND switches to GND.

c. Set the MODE switch to CH 1.

d. Note Channel 1 trace vertical position in the GND position and then set the Channel 1 AC DC GND switch to AC. Trace shift should not exceed 2 minor divisions (4 mm).

e. Set the MODE switch to CH 2 and repeat step d for Channel 2.

12. Adjust Channel 1 and 2 Input Capacitance

a. Connect the square-wave generator (Type 105) to the Channel 1 input through the 5×T and the capacitance standardizer.

b. Set the generator output frequency to 1 kc.

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

d. Set the Channel 1 AC DC GND switch to DC.

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

f. Set the generator output amplitude for 4 major divisions of deflection.

g. Set the time-base Time/Div. switch to .2.

h. Adjust C111 for optimum flat-top waveform.

i. Set the Channel 1 VOLTS/DIV switch to .02.

j. Adjust C112 for optimum flat-top waveform.

k. Remove the signal from Channel 1 input and connect to Channel 2 input.

l. Set the MODE switch to CH 2.

m. Set the Channel 2 VOLTS/DIV switch to .01.

n. Set the Channel 2 AC DC GND switch to DC.

o. Adjust C211 for optimum flat-top waveform.

p. Set the Channel 2 VOLTS/DIV switch to .02.

q. Adjust C212 for optimum flat-top waveform.

13. Adjust Channel 1 and 2 VOLTS/DIV Compensation

a. Use the same test setup used in step 12.

b. Adjust the Channel 2 VOLTS/DIV compensation as shown in Table 5-1. Readjust the generator output with each setting of the VOLTS/DIV switch to provide 4 divisions of deflection (except in the 2 position where the maximum deflection will be about 1 division).

c. Connect the generator signal to Channel 1 input.

d. Set the MODE switch to CH 1 and adjust the Channel 1 VOLTS/DIV compensation as shown in Table 5-1.

TABLE 5-1

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

14. Adjust High-Frequency Compensation

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

b. Set the MODE switch to CH 1.

c. Set the time-base Time/Div. switch to .5 μSec.

d. Connect the fast-rise square-wave generator (Type 107) signal to Channel 1 input through a 5×T attenuator and a 50-ohm termination.

e. Set the generator output frequency to 400 kc.

f. Set the generator output amplitude for a 4-division display.

g. Adjust C339 (See Fig. 5-2) for the flattest top on the square wave.

h. Pull the time-base magnifier switch on and set the Position control to display the rising edge of the waveform.

i. Adjust L326 and L336 (Fig. 5-2) 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.)

j. Adjust C145 and C149 (Fig. 5-2) for the squarest corner.

k. Adjust L361, L370, L371 and L380 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.)

l. Set Channel 1 VOLTS/DIV switch to .02.

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

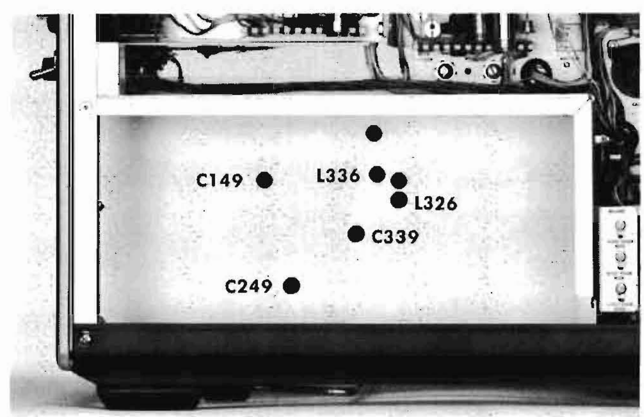


Fig. 5-2. Indicator unit access holes used to calibrate the Type 9A1.

n. Adjust C148 for the squarest corner on the waveform.

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

p. Set the MODE switch to CH 2.

q. Remove the signal from Channel 1 input and apply it to Channel 2 input.

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

s. Adjust C245 and C249 (Fig. 5-2) for a square leading corner on the waveform.

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

u. Adjust C248 for a square leading corner on the waveform.

v. Set the MODE switch to CH 1.

w. Apply the signal to Channel 1 input.

x. Check Channel 1 compensation and readjust as necessary for best compromise in response between the two channels.

15. Check VOLTS/DIV Attenuation Ratios

a. Set the indicator unit Calibrator for 50 mVolts output.

b. Connect the Cal. Out connector to the Channel 1 input with a 50-ohm cable.

c. Set the time-base Time/Div. switch to 5 mSec.

d. Set the MODE switch to CH 1.

e. Check for proper vertical deflection in each position of the Channel 1 VOLTS/DIV switch using Table 5-2 as a guide.

f. Set the MODE switch to CH 2 and connect the Cal. Out signal to Channel 2 input. Check the attenuation of Channel 2 VOLTS/DIV switch using Table 5-2 as a guide.

g. Disconnect the calibrator signal from the input connector.

NOTE

Since the indicator unit calibrator accuracy is ±3% and the rated accuracy of the input attenuators is ±3%, the maximum allowable deviation from the indicated deflection is ±6%.

TABLE 5-2

VOLTS/DIV Switch Setting	Calibrator Output (peak-to-peak)	Vertical Deflection in Divisions
.01	50 mVolts	5
.02	.1 Volts	5
.05	.2 Volts	4
.1	.5 Volts	5
.2	1 Volts	5
.5	2 Volts	4
1	5 Volts	5
2	10 Volts	5
5	20 Volts	4
10	50 Volts	5

16. Check Bandpass

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

b. Set the MODE switch to CH 1.

c. Connect the constant amplitude sine-wave generator to Channel 1 input through a 50-ohm termination.

d. Set the generator output frequency to 50 kc and adjust the output amplitude for a 4-division display.

e. Without changing the output amplitude, change the generator frequency to 23 Mc.

f. Amplitude of the display should be 2.8 divisions or greater.

17. Check Channel Isolation

a. Use the same test setup used in step 16.

b. Set the generator output frequency to 20 Mc.

c. Set the Channel 1 VOLTS/DIV switch to 10 and the Channel 2 VOLTS/DIV switch to .01.

d. Set the MODE switch to ALTER.

e. Adjust the generator output amplitude for 1 division of deflection.

f. Channel 2 deflection should be 2 mm or less, indicating channel isolation of 5,000:1 or better

NOTE

The attenuators are not shielded adequately unless the indicator unit side panels are in place. Therefore, to obtain an accurate measurement of channel isolation, replace the left side panel.

NOTES

SECTION 6
PARTS LIST and DIAGRAMS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix Field Office.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix Field Office will contact you concerning any change in part number.

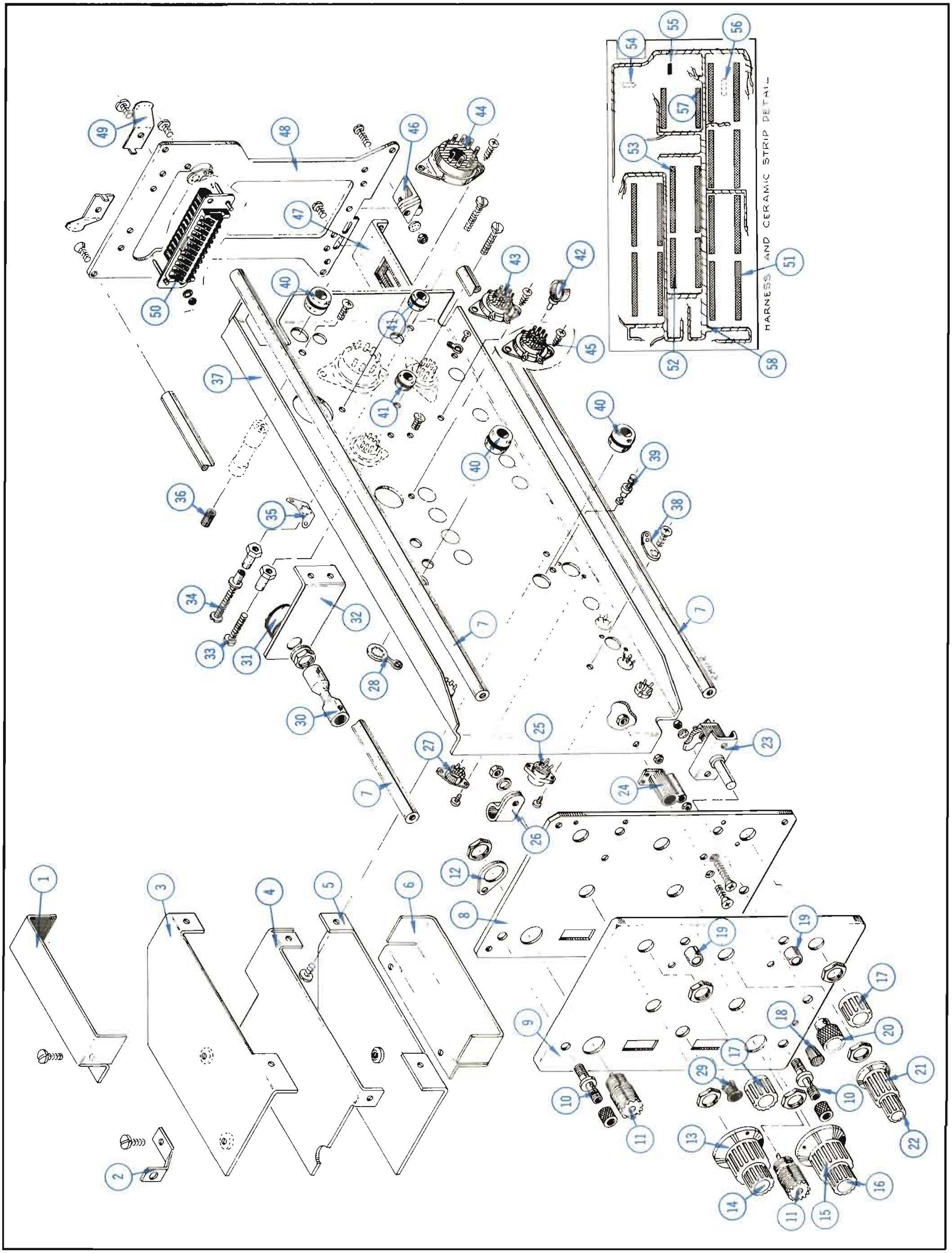
ABBREVIATIONS AND SYMBOLS

a or amp	amperes
BHS	binding head steel
C	carbon
cer	ceramic
cm	centimeter
comp	composition
cps	cycles per second
crt	cathode-ray tube
CSK	counter sunk
dia	diameter
div	division
EMC	electrolytic, metal cased
EMT	electroyltic, metal tubular
ext	external
f	farad
F & I	focus and intensity
FHS	flat head steel
Fil HS	fillister head steel
g or G	giga, or 10^9
Ge	germanium
GMV	guaranteed minimum value
h	henry
hex	hexagonal
HHS	hex head steel
HSS	hex socket steel
HV	high voltage
ID	inside diameter
incd	incandescent
int	internal
k or K	kilohms or kilo (10^3)
kc	kilocycle
m	milli, or 10^{-3}
mc	megacycle
mm	millimeter
meg or M	megohms or mega (10^6)
met.	metal
μ	micro, or 10^{-6}
n	nano, or 10^{-9}
Ω	ohm
OD	outside diameter
OHS	oval head steel
p	pico, or 10^{-12}
PHS	pan head steel
piv	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
Prec	precision
PT	paper tubular
PTM	paper or plastic, tubular, molded
RHS	round head steel
rms	root mean square
sec	second
Si	silicon
S/N	serial number
t or T	tera, or 10^{12}
TD	toroid
THS	truss head steel
tub.	tubular
v or V	volt
Var	variable
w	watt
w/	with
w/o	without
WW	wire-wound

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number.
000X	Part removed after this serial number.
*000-000	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, or reworked or checked components.
Use 000-000	Part number indicated is direct replacement.
	Internal screwdriver adjustment.
	Front-panel adjustment or connector.

EXPLODED VIEW



EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
1	337-507			1	SHIELD, $\frac{7}{16} \times \frac{23}{32} \times 3\frac{5}{8}$ inch
	- - - -			-	mounting hardware: (not included w/shield)
	211-503			2	SCREW, 6-32 x $\frac{3}{16}$ inch BHS
2	406-845			2	BRACKET, ground $\frac{15}{16} \times \frac{25}{32} \times \frac{7}{16}$ inch
	- - - -			-	mounting hardware for each: (not included w/bracket)
	211-503			1	SCREW, 6-32 x $\frac{3}{16}$ inch BHS
3	337-675			1	SHIELD, top $\frac{1}{2} \times 2\frac{1}{2} \times 5\frac{1}{4}$ inch
	- - - -			-	mounting hardware: (not included w/shield)
	211-503			2	SCREW, 6-32 x $\frac{3}{16}$ inch BHS
4	337-510			1	SHIELD, $\frac{1}{2} \times 2\frac{1}{2} \times 4\frac{7}{32}$ inch
	- - - -			-	mounting hardware: (not included w/shield)
	211-503			1	SCREW, 6-32 x $\frac{3}{16}$ inch BHS
5	337-676			1	SHIELD, bottom $\frac{1}{2} \times 2\frac{1}{2} \times 5\frac{1}{4}$ inch
	- - - -			-	mounting hardware: (not included w/shield)
	211-503			2	SCREW, 6-32 x $\frac{3}{16}$ inch BHS
6	337-506			1	SHIELD, bottom box $\frac{7}{16} \times \frac{3}{4} \times 2\frac{1}{2}$ inch
	- - - -			-	mounting hardware: (not included w/shield)
	211-503			2	SCREW, 6-32 x $\frac{3}{16}$ inch BHS
7	384-615			4	ROD, spacer $12\frac{1}{4}$ inch long
	- - - -			-	mounting hardware for each: (not included w/rod)
	212-044			1	SCREW, 8-32 x $\frac{1}{2}$ inch RHS
8	387-660			1	PLATE, sub-panel front
9	333-871			1	PANEL, front 9A1
10	129-035			2	POST, binding assembly
	- - - -			-	each post includes:
	355-507			1	STEM, binding post adapter
	200-103			1	CAP, binding post
	210-011			1	LOCKWASHER, steel internal $\frac{1}{4}$ inch
	210-455			1	NUT, hex steel $\frac{1}{4}$-28 x $\frac{3}{8}$ inch
11	131-126			2	CONNECTOR, chassis mounted BNC
12	210-241			2	LUG, ground, $\frac{15}{16}$ inch long

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
13	366-160			1	KNOB, large charcoal—VOLTS/DIV. (Channel 1)
	- - - -			-	knob includes:
	213-004			1	SCREW, set 6-32 x 3/16 inch HSS
14	366-031			1	KNOB, small red—VARIABLE (Channel 1)
	- - - -			-	knob includes:
	213-004			1	SCREW, set 6-32 x 3/16 inch HSS
15	366-160			1	KNOB, large charcoal—VOLTS/DIV. (Channel 2)
	- - - -			-	knob includes:
	213-004			1	SCREW, set 6-32 x 3/16 inch HSS
16	366-031			1	KNOB, small red—VARIABLE (Channel 2)
	- - - -			-	knob includes:
	213-004			1	SCREW, set 6-32 x 3/16 inch HSS
17	366-148			1	KNOB, small charcoal—POSITION (Channel 1)
	- - - -			-	knob includes:
	213-004			1	SCREW, set 6-32 x 3/16 inch HSS
18	384-245			1	ROD, extension, switch assembly w/molded knob
19	358-075			2	BUSHING, brass pot mounting
20	366-109			1	KNOB, plug-in securing 9/16 inch aluminum
	- - - -			-	knob includes:
	213-006			1	SCREW, 8-32 x 3/16 inch HSS
21	366-175			1	KNOB, charcoal—MODE
	- - - -			-	knob includes:
	213-004			1	SCREW, set 6-32 x 3/16 inch HSS
22	366-189			1	KNOB, red—INV (CH 1) NORM
	- - - -			-	knob includes:
	213-004			1	SCREW, set 6-32 x 3/16 inch HSS
23	214-052			1	FASTENER, right w/stop
	- - - -			-	mounting hardware: (not included w/fastener)
	210-004			2	LOCKWASHER, internal #4
	210-406			2	NUT, hex 4-40 x 3/16 inch
24	352-067			2	HOLDER, neon, single
	- - - -			-	mounting hardware: (not included w/holder)
	211-031			1	SCREW, 4-40 x 1 inch FHS
	210-406			1	NUT, hex, 4-40 x 3/16 inch
25	136-101			4	SOCKET, 5 pin
	- - - -			-	mounting hardware for each: (not included w/socket)
	213-055			2	SCREW, thread forming 2-56 x 3/16 inch

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO.		Q T Y.	DESCRIPTION
		EFF.	DISC.		
26	343-006			2	CLAMP, cable $\frac{1}{2}$ inch plastic
	- - - -			-	mounting hardware for each: (not included w/clamp)
	210-803			1	WASHER, 6L x $\frac{3}{8}$ inch
	210-457			1	NUT, keps, 6-32 x $\frac{5}{16}$ inch
27	136-095			21	SOCKET, 4 pin transistor
	- - - -			-	mounting hardware for each: (not included w/socket)
	213-113			2	SCREW, thread forming 2-32 x $\frac{5}{16}$ inch RHS
28	210-223			2	LUG, solder $\frac{1}{4}$ inch
29	358-178			1	BUSHING, front panel charcoal
30	376-011			1	COUPLING, insulating
31	- - - -			-	POT
	- - - -			-	mounting hardware: (not included w/pot)
	210-413			1	NUT, hex $\frac{3}{8}$-32 x $\frac{1}{2}$ inch
	210-840			1	WASHER, .390 ID x $\frac{9}{16}$ inch OD
32	406-814			1	BRACKET, $1\frac{1}{2}$ x $2\frac{1}{2}$ x $\frac{1}{2}$ inch
	- - - -			-	mounting hardware: (not included w/bracket)
	211-504			2	SCREW, 6-32 x $\frac{1}{4}$ inch BHS
33	- - - -			-	RESISTOR
	- - - -			-	mounting hardware: (not included w/resistor)
	210-478			1	NUT, hex $\frac{5}{16}$ x $\frac{21}{32}$ inch long
	211-507			1	SCREW, 6-32 x $\frac{5}{16}$ inch BHS
	211-544			1	SCREW, 6-32 x $\frac{3}{4}$ inch THS
34	- - - -			-	RESISTOR
	- - - -			-	mounting hardware: (not included w/resistor)
	211-553			1	SCREW, 6-32 x $1\frac{1}{2}$ inch RHS
	210-601			1	EYELET, tapered barrel
	210-478			1	NUT, hex, $\frac{5}{16}$ x $\frac{21}{32}$ inch long
	211-507			1	SCREW, 6-32 x $\frac{5}{16}$ inch BHS
35	210-204			1	LUG, solder DE #6
36	276-511			2	CORE, powder iron
37	441-550			1	CHASSIS, main
	- - - -			-	mounting hardware: (not included w/chassis)
	211-538			2	SCREW, 6-32 x $\frac{5}{16}$ inch FHS
	211-507			2	SCREW, 6-32 x $\frac{5}{16}$ inch BHS
38	210-201			10	LUG, solder SE #4
	- - - -			-	mounting hardware for each: (not included w/lug)
	213-044			1	SCREW, thread forming 5-32 x $\frac{3}{16}$ inch PHS
39	131-183			2	CONNECTOR, terminal feed-thru
40	348-004			5	GROMMET, rubber $\frac{3}{8}$ inch
41	348-003			1	GROMMET, rubber $\frac{5}{16}$ inch

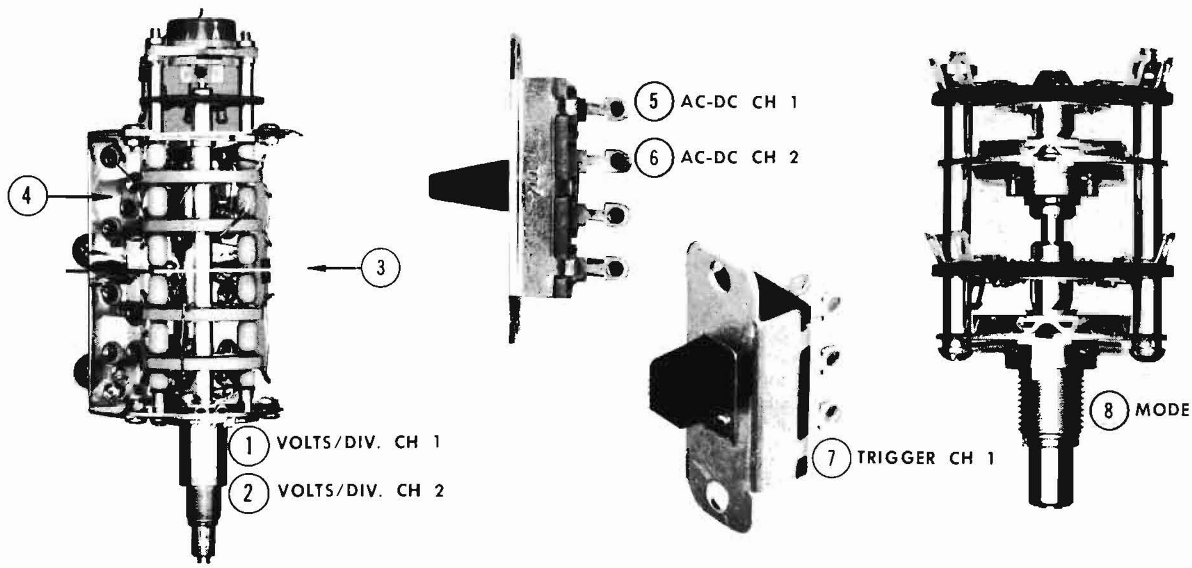
EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
42	426-121			1	MOUNT, toroid holder
43	136-015			2	SOCKET, STM9G
	- - - -			-	mounting hardware for each: (not included w/socket)
	213-044			2	SCREW, thread forming 5-32 x 3/16 inch PHS
44	136-174			2	SOCKET, 9 pin
	- - - -			-	mounting hardware for each: (not included w/socket)
	213-004			2	SCREW, thread forming 5-32 x 3/16 inch PHS
45	136-014			1	SOCKET, STM9G
	- - - -			-	mounting hardware: (not included w/socket)
	213-044			2	SCREW, thread forming 5-32 x 3/16 inch
46	351-037			1	GUIDE, plug-in delrin
	- - - -			-	mounting hardware: (not included w/guide)
	211-013			1	SCREW, 4-40 x 3/8 inch RHS
	210-004			1	LOCKWASHER, internal #4
	210-406			1	NUT, hex 4-40 x 3/16 inch
47	406-800			1	BRACKET, switch slide
	- - - -			-	mounting hardware: (not included w/bracket)
	211-504			2	SCREW, 6-32 x 1/4 inch
	406-918			1	BRACKET, slide switch actuator (not shown)
	406-949			1	BRACKET, slide switch (not shown)
48	387-647			1	PLATE, sub-panel
49	214-276			2	SPRING, ground 29/64 x 1/2 x 1 1/16 inch
	- - - -			-	mounting hardware for each: (not included w/spring)
	211-504			1	SCREW, 6-32 x 1/4 inch BHS
	210-006			1	LOCKWASHER, internal #6
	210-407			1	NUT, hex 6-32 x 1/4 inch
50	131-149			1	CONNECTOR, chassis mounted 24 contact
	- - - -			-	mounting hardware: (not included w/connector)
	211-008			2	SCREW, 4-40 x 1/4 inch BHS
	210-004			2	LOCKWASHER, internal #4
	210-406			2	NUT, hex 4-40 x 3/16 inch

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	DISC.	QTY.	DESCRIPTION
51	124-146			12	STRIP, ceramic $^7/_{16}$ inch x 16 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-009			2	SPACER, nylon
52	124-147			2	STRIP, ceramic $^7/_{16}$ inch x 13 notches
	- - - -			-	each strip includes:
	355-046			1	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-009			1	SPACER, nylon
53	124-145			2	STRIP, ceramic $^7/_{16}$ inch x 20 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-009			2	SPACER, nylon
54	124-092			1	STRIP, ceramic $^7/_{16}$ inch x 3 notches
	- - - -			-	strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware: (not included w/strip)
	361-009			2	SPACER, nylon
55	124-118			1	STRIP, ceramic $^7/_{16}$ inch x 1 notch
	- - - -			-	strip includes:
	355-046			1	STUD, nylon
	- - - -			-	mounting hardware: (not included w/strip)
	361-009			1	SPACER, nylon
56	124-088			1	STRIP, ceramic $^3/_4$ inch x 4 notches
	- - - -			-	strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware: (not included w/strip)
	361-009			2	SPACER, nylon
57	124-148			2	STRIP, ceramic $^7/_{16}$ inch x 9 notches
	- - - -			-	each strip includes:
	355-046			2	STUD, nylon
	- - - -			-	mounting hardware for each: (not included w/strip)
	361-009			2	SPACER, nylon
58	179-880			1	CABLE HARNESS

SWITCHES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	262-665			1	SWITCH—VOLTS/DIV. CH 1
2	262-665			1	SWITCH—VOLTS/DIV. CH 2
	- - - -			-	each switch includes:
	131-182			1	CONNECTOR, terminal feed-thru
	210-004			4	LOCKWASHER, internal #4
	210-406			2	NUT, hex, 4-40 x $^3/_{16}$ inch
	211-007			4	SCREW, 4-40 x $^3/_{16}$ inch BHS
3	337-680			1	SHIELD, attenuator
	358-135			1	BUSHING, teflon
4	441-564			1	CHASSIS, attenuator, silver plate
	260-607			1	SWITCH—VOLTS/DIV. unwired
	- - - -			-	mounting hardware for each: (not included w/switch)
	210-012			1	LOCKWASHER, internal $^3/_8$ x $^1/_2$ inch
	210-413			1	NUT, hex $^3/_8$-32 x $^1/_2$ inch
5	260-448			1	SWITCH—AC-DC-GND CH 1
6	260-448			1	SWITCH—AC-DC-GND CH 2
	- - - -			-	mounting hardware for each: (not included w/switch)
	210-406			2	NUT, hex 4-40 x $^3/_{16}$ inch
7	260-447			1	SWITCH, trigger, Channel 1
	- - - -			-	mounting hardware: (not included w/switch)
	213-105			2	SCREW, shoulder, 6-32 x $^{21}/_{64}$ inch
8	260-442			1	SWITCH, mode, wired
	- - - -			-	mounting hardware: (not included w/switch)
	210-012			1	LOCKWASHER, internal $^3/_8$ x $^1/_2$ inch
	210-413			1	NUT, hex $^3/_8$-32 x $^1/_2$ inch

ELECTRICAL PARTS

Values are fixed unless marked Variable.

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

Capacitors

Tolerance ±20% unless otherwise indicated.

C101	*285-609	0.1 μf	PTM		600 v	10%	
C103A	281-501	4.7 pf	Cer		500 v	±1 pf	
C103B	281-103	1.8-13 pf	Air	Var			
C103C	281-103	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	281-103	1.8-13 pf	Air	Var			
C105C	281-101	1.5-9.1 pf	Air	Var			
C105E	281-503	8 pf	Cer		500 v	±0.5 pf	
C107A	281-509	15 pf	Cer		500 v	10%	
C107B	281-103	1.8-13 pf	Air	Var			
C107C	281-101	1.5-9.1 pf	Air	Var			
C107E	281-513	27 pf	Cer		500 v		
C109A	281-509	15 pf	Cer		500 v	10%	
C109B	281-103	1.8-13 pf	Air	Var			
C109C	281-101	1.5-9.1 pf	Air	Var			
C109E	283-541	500 pf	Mica		500 v	10%	
C110	281-509	15 pf	Cer		500 v	10%	
C111	281-103	1.8-13 pf	Air	Var			
C112	281-101	1.5-9.1 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 pf	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	PTM		600 v	10%	
C203A	281-501	4.7 pf	Cer		500 v	±1 pf	
C203B	281-103	1.8-13 pf	Air	Var			
C203C	281-103	1.8-13 pf	Air	Var			
C203D	281-541	6.8 pf	Cer		500 v	10%	
C205A	281-501	4.7 pf	Cer		500 v	±1 pf	
C205B	281-103	1.8-13 pf	Air	Var			
C205C	281-101	1.5-9-1 pf	Air	Var			
C205E	281-503	8 pf	Cer		500 v	±0.5 pf	
C207A	281-509	15 pf	Cer		500 v	10%	
C207B	281-103	1.8-13 pf	Air	Var			
C207C	281-101	1.5-9.1 pf	Air	Var			
C207E	281-513	27 pf	Cer		500 v		
C209A	281-509	15 pf	Cer		500 v	10%	
C209B	281-103	1.8-13 pf	Air	Var			
C209C	281-101	1.5-9.1 pf	Air	Var			
C209E	283-541	500 pf	Mica		500 v	10%	
C210	281-509	15 pf	Cer		500 v	10%	
C211	281-103	1.8-13 pf	Air	Var			
C212	281-101	1.5-9.1 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 pf	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		
C319	281-508	12 pf	Cer		500 v		

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description					S/N Range
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		500 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		500 v		

Diodes

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	Silicon	1N3605	
D364	152-141	Silicon	1N3605	
D374	152-141	Germanium	Tek Spec	
D378	152-024	Zener	1N3024B	1 w, 15 v, 5%
D397	152-057	Zener	1N3807B	1 w, 56 v, 5%

Inductors

Ckt. No.	Tektronix Part No.	Description			S/N Range
LR103	*108-283	0.13 μh (wound on a 43 Ω resistor)			
LR105	*108-286	0.17 μh (wound on a 36 Ω resistor)			
LR107	*108-283	0.13 μh (wound on a 43 Ω resistor)			
LR203	*108-283	0.13 μh (wound on a 43 Ω resistor)			
LR205	*108-286	0.17 μh (wound on a 36 Ω resistor)			
LR207	*108-283	0.13 μh (wound on a 43 Ω resistor)			
L326	*114-072	4-7.5 μf	Var	Core 276-506	
L336	*114-072	4-7.5 μf	Var	Core 276-506	
L341	*108-105	1.8 μh			
L351	*108-105	1.8 μh			
L361	*114-053	3.3-6 μh	Var	Core 276-506	
L370	*114-078	1.9-4 μh	Var	Core 276-506	
L371	*114-053	3.3-6 μh	Var	Core 276-506	
L378	*108-200	40 μh			
L380	*114-078	1.9-4 μh	Var	Core 276-506	
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

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

Ckt. No.	Tektronix Part No.	Description					S/N Range
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	2 x 500 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 Ω	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.

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	2 x 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	463 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	383 Ω	⅛ w		Prec	1%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R325	315-470	47 Ω	1/4 w			5%
R326	322-200	1.8 k	1/4 w		Prec	1%
R327	316-331	330 Ω	1/4 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	1/4 w			5%
R333	315-361	260 Ω	1/4 w			5%
R334	321-153	383 Ω	1/8 w		Prec	1%
R335	315-470	47 Ω	1/4 w			5%
R336	322-200	1.18 k	1/4 w		Prec	1%
R337	315-821	820 Ω	1/4 w			5%
R339	303-103	10 k	1 w			5%
R340	301-471	470 Ω	1/2 w			5%
R341	315-470	47 Ω	1/4 w			5%
R347	301-622	6.2 k	1/2 w			5%
R351	315-470	47 Ω	1/4 w			5%
R356	321-375	78.7 k	1/8 w		Prec	1%
R357	301-622	6.2 k	1/2 w			5%
R358	321-286	9.31 k	1/8 w		Prec	1%
R359	306-221	220 Ω	2 w			
R360	308-055	1.5 k	10 w		WW	5%
R361	*310-612	800 Ω	4 w		Prec	1%
R362	323-094	93.1 Ω	1/2 w		Prec	1%
R363	323-107	127 Ω	1/2 w		Prec	1%
R364	315-822	8.2 k	1/4 w			5%
R365	315-470	47 Ω	1/4 w			5%
R366	315-104	100 k	1/4 w			5%
R367	315-470	47 Ω	1/4 w			5%
R368	302-272	2.7 k	1/2 w			
R369	316-470	47 Ω	1/4 w			
R370	316-470	47 Ω	1/4 w			
R371	*310-612	800 Ω	4 w		Prec	1%
R372	323-094	93.1 Ω	1/2 w		Prec	1%
R373	311-308	50 Ω		Var		CALIB
R374	315-822	8.2 k	1/4 w			5%
R375	315-470	47 Ω	1/4 w			5%
R376	315-104	100 k	1/4 w			5%
R377	315-470	47 Ω	1/4 w			5%
R378	308-232	320 Ω	5 w		WW	5%
R379	316-470	47 Ω	1/4 w			
R381	232-440	374 k	1/2 w		Prec	1%
R382	321-422	243 k	1/8 w		Prec	1%
R384	316-101	100 Ω	1/4 w			
R385	316-471	470 Ω	1/4 w			
R387	302-473	47 k	1/2 w			

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R388	316-221	220 Ω	¼ w			
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	307-034	8.2 Ω	½ w			
R398	316-270	27 Ω	¼ w			
R399	307-034	8.2 Ω	½ w			

Switches

	Unwired	Wired		
SW101	260-448		Slide	CH 1 AC-DC-GND
SW110	260-607	*262-665	Rotary	CH 1 VOLTS/DIV
SW150†	*311-319			CH 1 CALIB
SW155††	260-422		Rotary	CH 1 INV/NORM
SW201	260-448		Slide	CH 2 AC-DC-GND
SW210	260-607	*262-665	Rotary	CH 2 VOLTS/DIV
SW250†††	*311-319			CH 2 CALIB
SW290††	260-442		Rotary	MODE
SW390	260-447		Slide	CH 1 TRIGGER

Transformer

T263	*120-281	Toroid 7T Bifilar

Electron Tubes

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.

IMPORTANT:

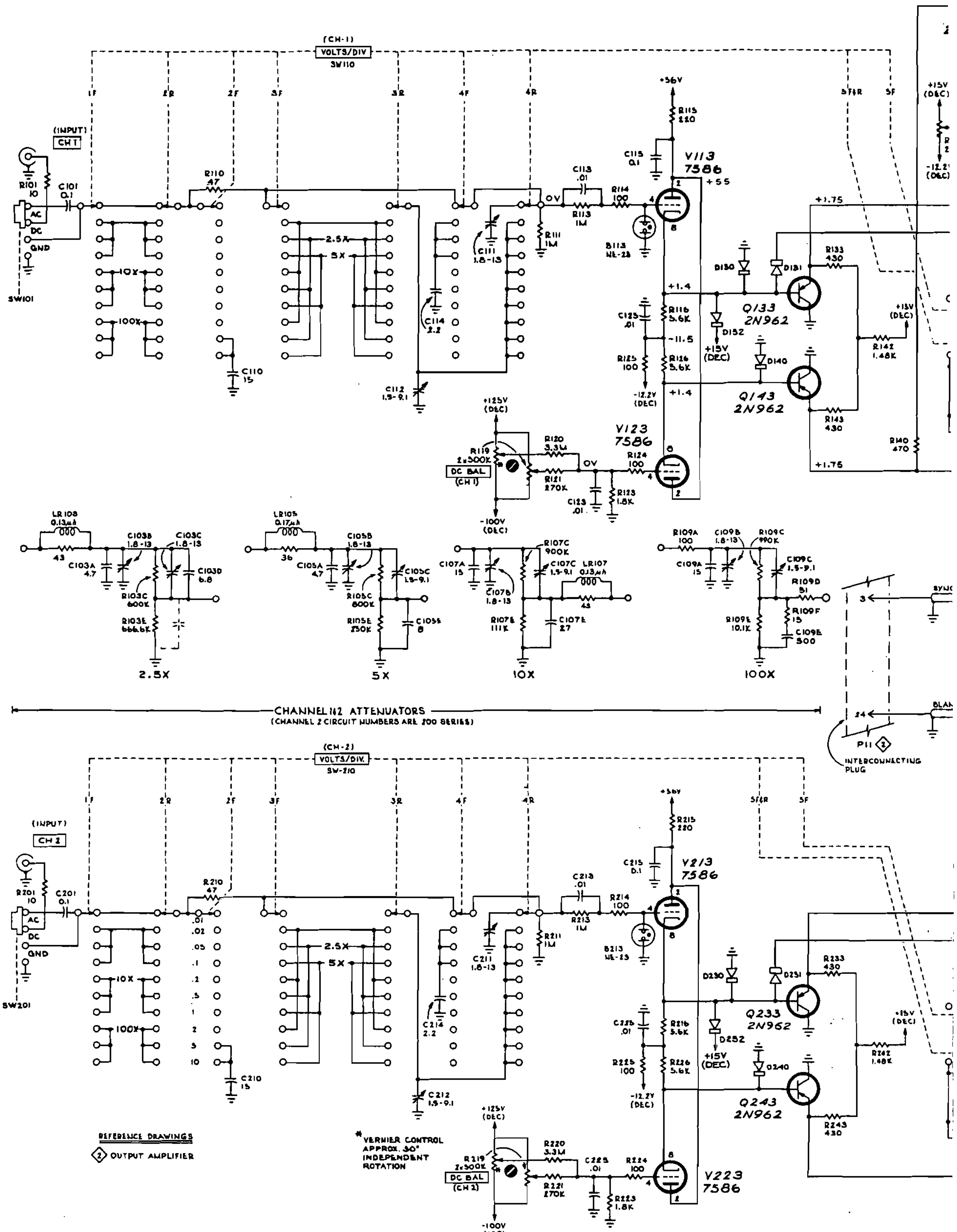
Circuit voltages measured with 20,000 Ω/volt VOM. All readings in VOLTS.

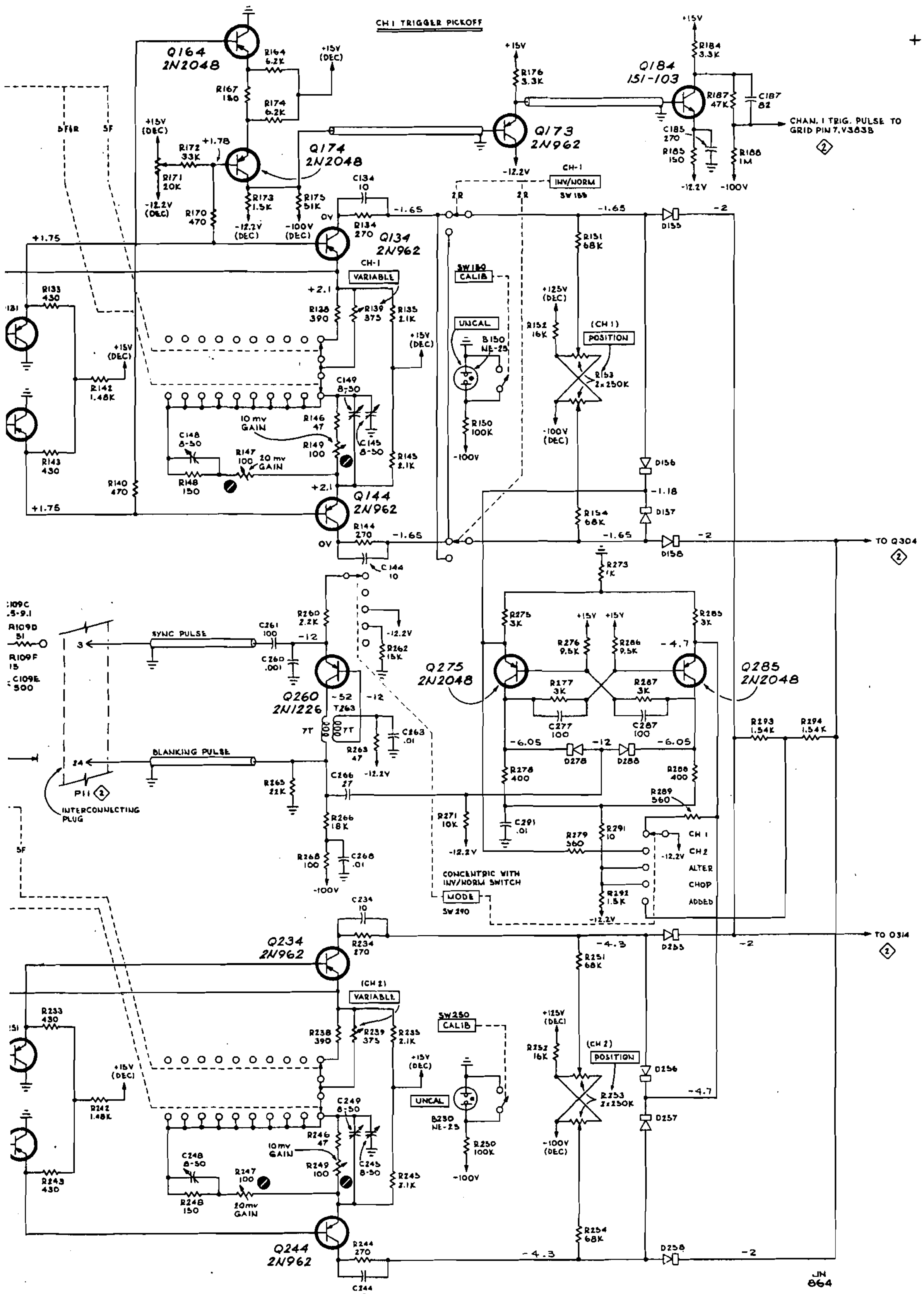
Voltage measurements are not absolute and may vary from unit to unit. For these measurements, a 30" flexible plug-in extension cable (012-066) was used to operate the Type 9A1 outside of the indicator unit plug-in compartment.

The time-base unit used with the Type 9A1 was set for automatic triggering at a 1 millisecond/division sweep rate.

VOLTAGE READINGS were obtained under the following conditions (control settings apply to both channels):

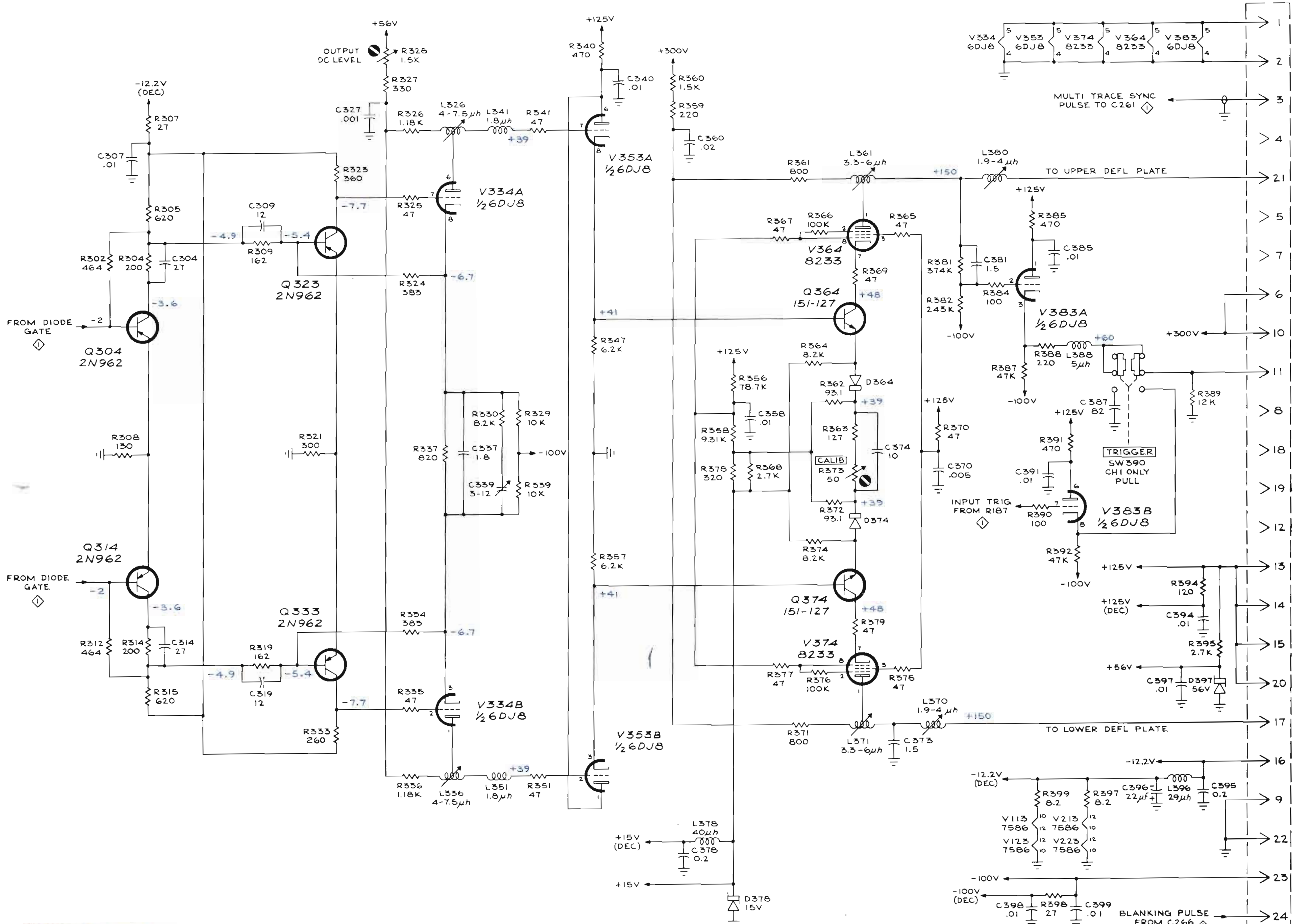
Input Signal	None
AC DC GND	GND
VOLTS/DIV	.2
VARIABLE	CALIB
POSITION	Centered
MODE	CH 1
INV (CH 1) NORM	NORM
TRIGGER	Pushed in


(CH-1)
VOLTS/DIV
SW110
(INPUT)
CH 1
V113
7586
V123
7586
Q133
2N962
Q143
2N962
DC BAL
(CH 1)
2.5X
5X
10X
100X
CHANNEL 1&2 ATTENUATORS
(CHANNEL 2 CIRCUIT NUMBERS ARE 200 SERIES)
P11
INTERCONNECTING PLUG
(CH-2)
VOLTS/DIV.
SW-210
(INPUT)
CH 2
V213
7586
V223
7586
Q233
2N962
Q243
2N962
DC BAL
(CH 2)
REFERENCE DRAWINGS
OUTPUT AMPLIFIER
*VERNIER CONTROL APPROX. 30° INDEPENDENT ROTATION



INPUT AMPLIFIER & SWITCHING CIRCUIT ①

INPUT AMPLIFIERS



FOR VOLTAGE CONDITIONS SEE INPUT AMPLIFIER DIAGRAM

REFERENCE DRAWINGS

① INPUT AMPLIFIER & SWITCHING CIRCUIT

A1

OUTPUT AMPLIFIER ②

DON 964

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.

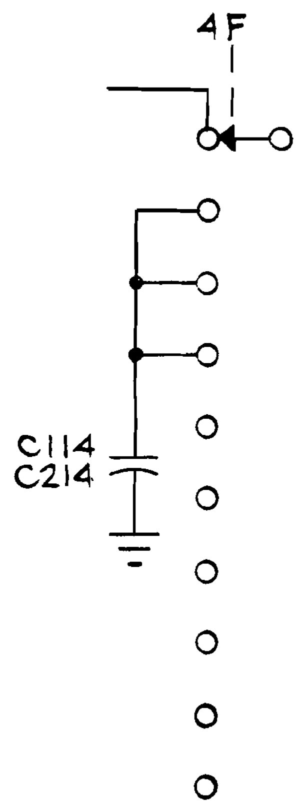
Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE 3A1 -- TENT. S/N 7720
TYPE 3A1S -- TENT. S/N 640
TYPE 3A6 -- TENT. S/N 250
TYPE 9A1 -- TENT. S/N 170

SCHEMATIC CORRECTIONS

SW110 and SW210,

CHANGE TO:



3A1 - 3A1S - 3A6 - 9A1 PART. SW. CKT

TYPE 3A1S -- TENT. S/N 640

TYPE 9A1 -- TENT. S/N 270

PARTS LIST CORRECTIONS

CHANGE TO:

R146	315-390		39 Ω	1/4 w		5%
R148	315-121		120 Ω	1/4 w		5%
R246	315-390		39 Ω	1/4 w		5%
R248	315-121		120 Ω	1/4 w		5%
R363	323-110		137 Ω	1/2 w		1%
R373	311-003		100 Ω	2 w	Var	CALIB
SW110	260-607	*262-695		Rotary		CH 1 VOLTS/DIV
SW210	260-607	*262-695		Rotary		CH 2 VOLTS/DIV

M8753/1164