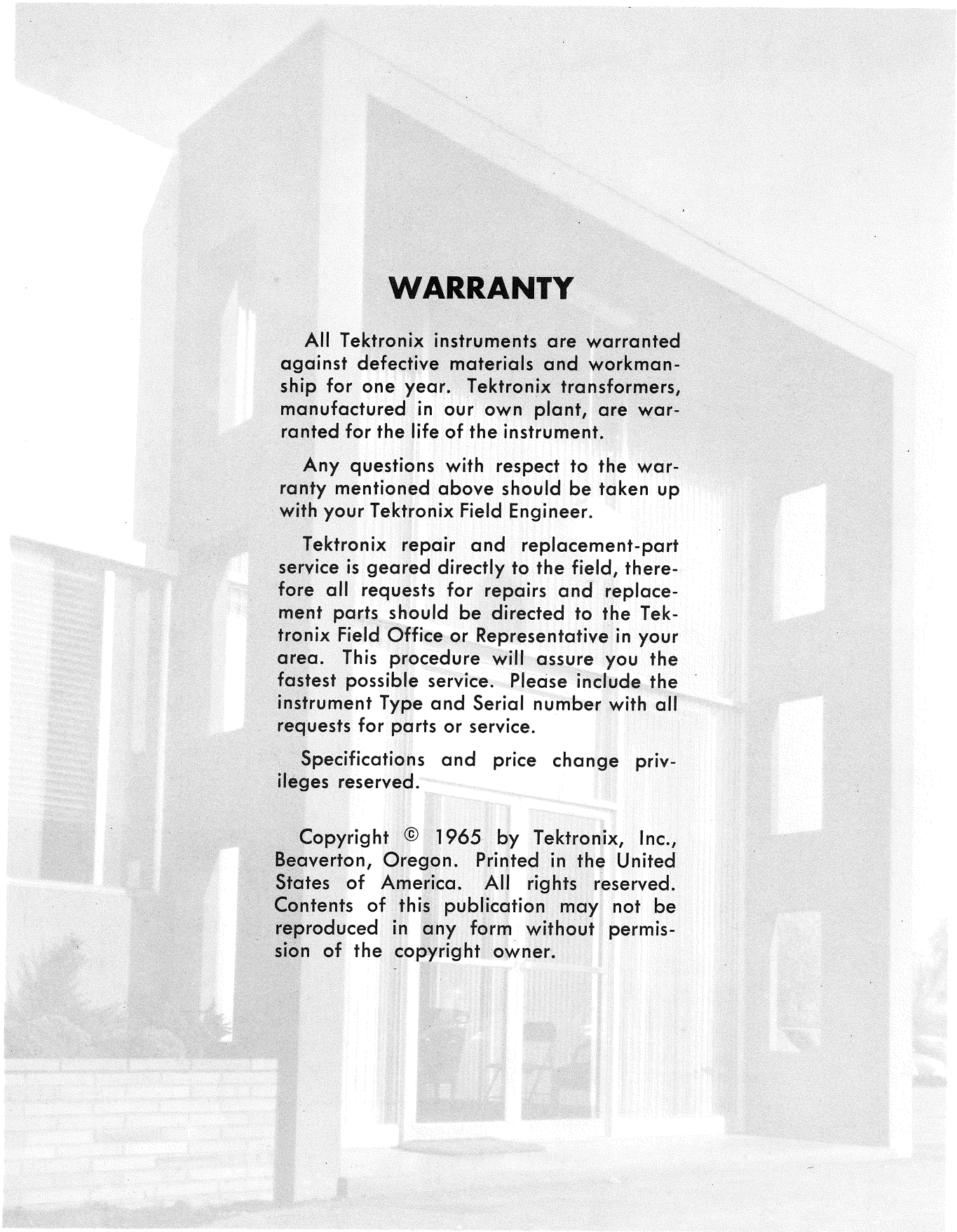
INSTRUCTION MANUAL

Serial Number 582

TYPE 10A1 PLUG-IN UNIT

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



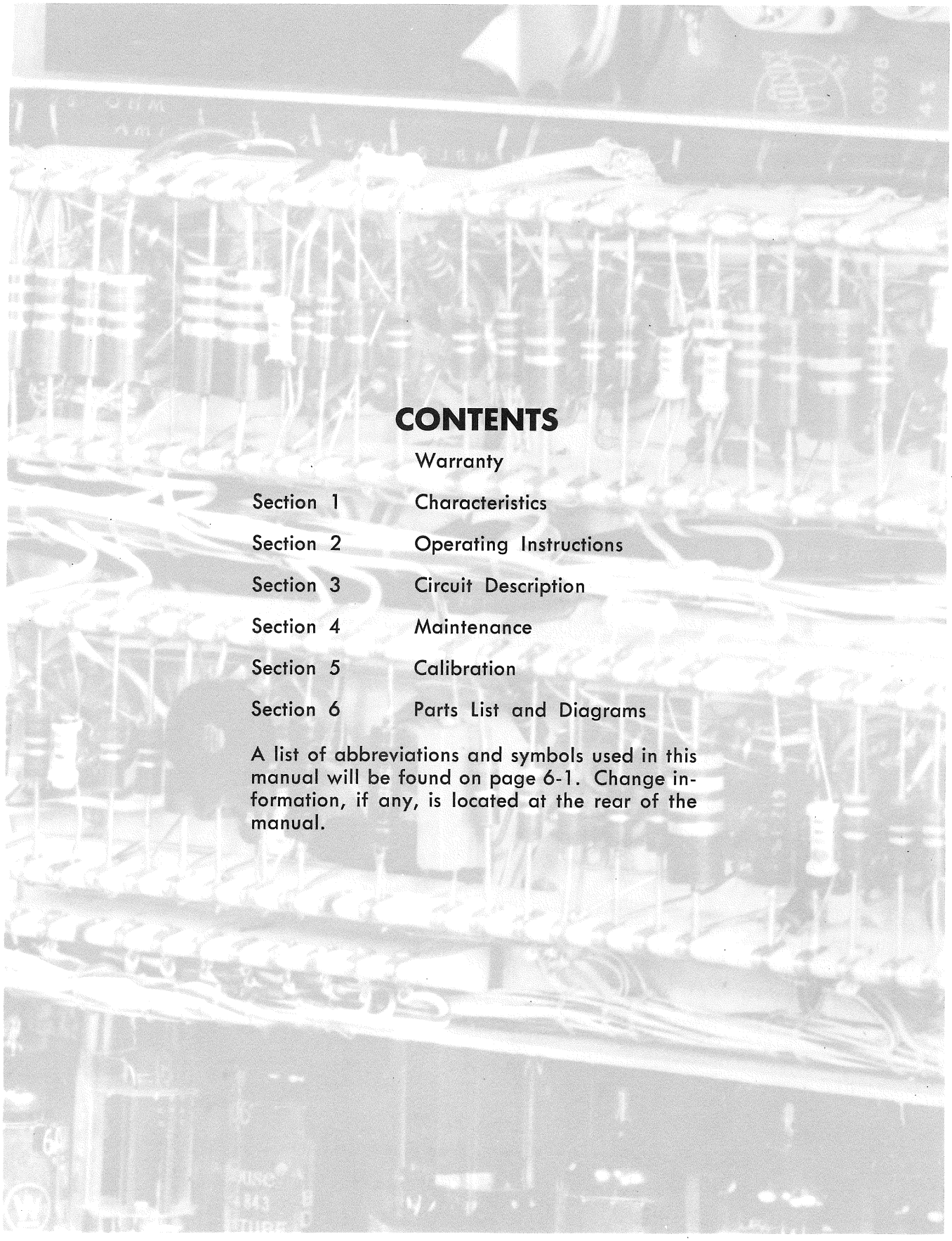
WARRANTY

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

Warranty

Section 1 Characteristics

Section 2 Operating Instructions

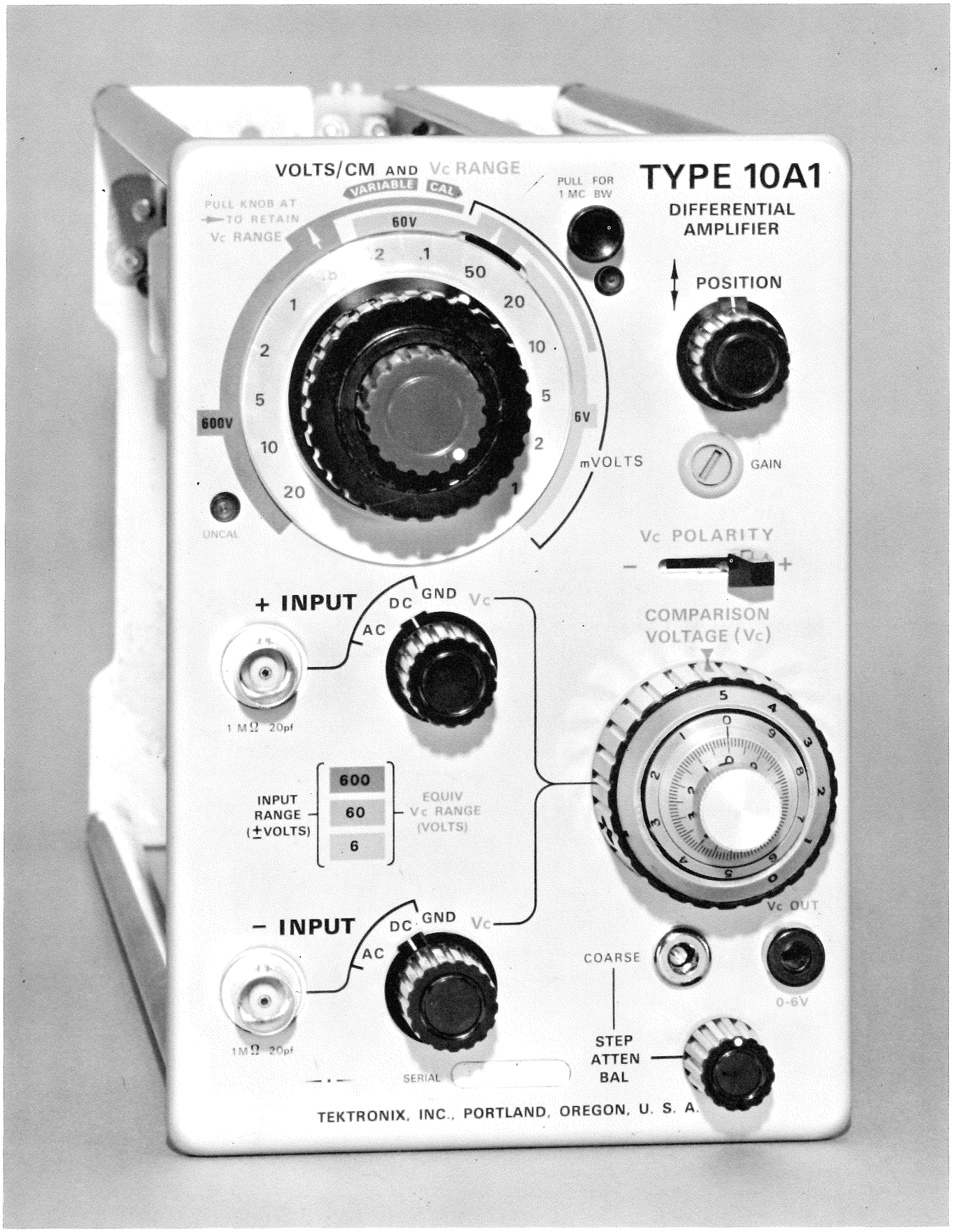
Section 3 Circuit Description

Section 4 Maintenance

Section 5 Calibration

Section 6 Parts List and Diagrams

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.


VOLTS/CM AND Vc RANGE
VARIABLE
CAL
PULL KNOB AT
TO RETAIN
Vc RANGE
60V
2
.1
50
20
10
5
1
2
5
10
20
600V
6V
2
1
mVOLTS
UNCAL
PULL FOR
1 MC BW
TYPE 10A1
DIFFERENTIAL
AMPLIFIER
POSITION
GAIN
Vc POLARITY
–
+
COMPARISON
VOLTAGE (Vc)
+ INPUT
DC
GND
Vc
AC
1 MΩ 20pf
INPUT
RANGE
(±VOLTS)
600
60
6
EQUIV
Vc RANGE
(VOLTS)
– INPUT
DC
GND
Vc
AC
1MΩ 20pf
SERIAL
Vc OUT
COARSE
0-6V
STEP
ATTEN
BAL
TEKTRONIX, INC., PORTLAND, OREGON, U. S. A.

SECTION 1
CHARACTERISTICS

General Information

The Type 10A1 Differential Amplifier is a multi-purpose vertical plug-in unit for the Type 647 Oscilloscope. It combines these features: high-gain, ac or dc input coupling, wide-band; operates as a conventional amplifier, a differential amplifier or a differential comparator.

As a conventional amplifier, passband is greater than 45 mc at calibrated deflection factors of 5 mv/cm to 20 v/cm. At a maximum sensitivity of 1 mv/cm, the passband is greater than 35 mc.

As a differential amplifier, common-mode rejection (CMR) exceeds 20,000:1 below 100 kc and 10,000:1 to 1 mc. CMR is defined as the ratio of common-mode input voltage to a differential output voltage. Differential output voltage is the peak-to-peak display amplitude in centimeters multiplied by the vertical deflection factor.

As a differential comparator, the slide-back technique is used to make voltage measurements. The built-in highly-accurate comparison voltage (Vc) is applied differentially to the Type 10A1 input stage so precise voltage measurements can be made. Comparison voltage ranges are in direct-reading equivalent ranges of 6, 60 and 600 volts. The range in use is selected by means of a combination switch that simultaneously selects the vertical deflection factor and Vc range. Table 1-1 lists the order of selection.

TABLE 1-1

Vc RANGE	Volts/Cm	
	Normal Use	When using "Pull Knob To Retain Vc Range"
6 v	1 mv through 20 mv	
60 v	50 mv through 0.2 v	10 mv through 0.2 v
600 v	0.5 v through 20 v	0.1 v through 20 v

The electrical characteristics are divided into groups according to the following operating modes: conventional amplifier, differential amplifier and differential comparator.

AS A CONVENTIONAL AMPLIFIER

Deflection Factors

1 mv/cm to 20 v/cm in 14 calibrated steps. Sequence is 1-2-5. A variable control with at least 2.5:1 uncalibrated range provides for continuously-variable adjustment between steps and extends the 20 volts/cm deflection factor to 50 volts/cm.

Volts/Cm Accuracy

TABLE 1-2

Volts/Cm*	0° C to +40° C	−30° C to +65° C
1 mv (also 10 mv and 0.1 v in retained Vc range)	±2.5%	±4%
2 mv through 2 v (except 10 mv and 0.1 v in retained Vc range)	±1.5%	±2.5%
5 v through 20 v	±3%	±4%

***Measured after GAIN control has been accurately adjusted at 5 mv/cm. Standard Square-Wave Calibrator signal (1 kc, amplitude accuracy ¼ %) applied to produce 4 cm vertical deflection.**

Risetime and Equivalent Frequency Response

Table 1-3 lists the system risetime and equivalent frequency response for signals that do not overscan the screen. To obtain the system-risetime measurement, a 1.5-nsec risetime pulse is used to drive the Type 10A1 in a Type 647 Oscilloscope.

The equivalent upper frequency response is the −30% voltage point. This is determined by using the following formula:

$$\text{Equivalent Frequency Response (at 30\% down point)} = \frac{0.35}{\text{System Risetime}}$$

TABLE 1-3

Volts/Cm	0° C to +40° C	−30° C to +65° C
5 mv to 20 v, dc-coupled.	Risetime: ≤7.8 nsec. Equivalent Response: dc to ≥ 45 mc.	Risetime: ≤8.75 nsec. Equivalent Response: dc to ≥ 40 mc.
1 mv and 2 mv; 10 mv, 20 mv, 0.1 v and 0.2 v in retained Vc range; dc-coupled.	Risetime: ≤ 10 nsec. Equivalent Response: dc to ≥ 35 mc	Risetime: ≤11.7 nsec. Equivalent Response: dc to ≥ 30 mc.

Low-Frequency Response Using AC Coupling: ≥ 2 cps at −30% voltage point.

Limited Bandwidth Frequency Response: With PULL FOR 1 MC BW switch pulled out and VOLTS/CM switch set to any position, frequency response is dc to 1 mc (±10%) using dc coupling; ≤ 2 cps to 1 mc (±10%) using ac coupling. The limited-bandwidth switch position is useful for reducing on-screen noise at high sensitivities.

Input R and C

1 megohm (±1%) paralleled by approximately 20 pf.

Maximum Dynamic Linear Range — Maximum Combined DC and Peak AC Input Voltage

TABLE 1-4

Input Voltage		
Dynamic range, linear	Max. combined DC and Peak AC	Volts/Cm
±6 v	±20 v	1 mv/cm to 20 mv/cm
±60 v	±600 v	10 mv/cm to 0.2 v/cm*
±600 v	±600 v	0.1 v/cm to 20 v/cm**

*10 and 20 mv/cm in retained range.

**0.1 and 0.2 v/cm in retained range.

Maximum Input Grid Current

≤1 nanoampere. Equivalent to ≤1 cm trace displacement at 1 mv/cm.

Input Isolation

≥5000:1. Measured with driven grid in Gnd or Vc, undriven grid in Gnd, 1 mv/cm deflection factor, and using a 10-v peak-to-peak 100-kc square wave as the drive signal.

Input Crosstalk

≤10 mv or ≤1%, whichever is smaller.

Measured when driven grid is dc-coupled, 5 mv/cm deflection factor, using a 5-v peak-to-peak 1-kc square wave as the drive signal. Undriven grid is switched from DC to Gnd and peak-to-peak change in amplitude of front corner is noted.

DC Thermal Drift

≤ 0.5 mv/°C.

Environmental Capability

Non-operating: —55° C to +75° C to 50,000 ft.

Operating: —30° C to +65° C to 15,000 ft.

The Type 10A1 Differential Amplifier can be stored alone, or in the Type 647 Oscilloscope at any temperature between —55° C or +75° C. After storage at either extreme, the instrument must be allowed sufficient time for all components to return to the operating ambient temperature range of —30° C to +65° C.

AS A DIFFERENTIAL AMPLIFIER

Input Voltage

See Table 1-4.

Overload Recovery Time

For an off-screen to on-screen step of as much as 6 v applied in the 1-mv/cm position, the amplifier recovers within ±2 mv of the final signal value in less than 0.5 μsec; within ±0.5 mv in less than 1 msec. 0° C to +40° C.

Common-Mode Rejection (CMR)

TABLE 1-5

Common-Mode Rejection*

Common-Mode Input Voltage Peak-to-Peak	Input Coupling	Input Voltage Sine-Wave Frequency	Common-Mode Rejection
10 v	dc	dc to 100 kc	≥20,000:1
10 v	dc	100 kc to 1 mc	≥10,000:1
5 v	dc	2 mc	≥5,000:1
2 v	dc	5 mc	≥2,000:1
1 v	dc	10 mc	≥1,000:1
1 v	dc	20 mc	≥100:1
10 v	ac	60 cps	≥2,000:1

*Volts/CM switch set to 1 mv/cm; 0° C to +40° C.

Common-Mode rejection ratio of 10× attenuator (10 and 20 mv/cm in retained range; 50 mv to .2 v) is ≥ 2,000:1 using a 20-v peak-to-peak 10-kc sine-wave common-mode input signal.

Input Attenuation Accuracy

TABLE 1-6

Attenuator[1]	Volts/Cm	Input Attenuation Accuracy	
		0° C to +40° C	—30° C to +65° C
10×	10 mv/cm to 0.2 v/cm[2]	≤ ±0.125%	≤ ±0.25%
100×	0.1 v/cm to 2 v/cm[3]	≤ ±0.25%	≤ ±0.5%
1000×	5 v/cm to 20 v/cm	≤ ±2%	≤ ±2.5%

[1] Attenuators are automatically switched into the amplifier input circuits when Volts/Cm switch is set to positions listed in second column.

[2] 10 and 20 mv/cm in retained range.

[3] 0.1 and 0.2 v/cm in retained range.

Input Resistance Matching

1× input resistance adjustable to match 10× resistance within ±0.2% (0° C to +40° C), within ±0.4% (—30° C to +65° C).

AS A DIFFERENTIAL COMPARATOR

Comparison Voltage (Vc) Range

0 to ±6 v.

Comparison Voltage Accuracy

±(0.1% +5 mv), 0° C to +40° C.

±(0.15% +8 mv), −30° C to +65° C.

Slide-Back Measurement Accuracy

TABLE 1-7

Equivalent Range At Input	Slide-Back Measurement Accuracy*	
	0° C to +40° C	−30° C to +65° C
0 to ±6 v	±(0.1% + 5 mv)	±(0.15% + 8 mv)
0 to ±60 v	±(0.225% + 50 mv)	±(0.4% + 80 mv)
0 to ±600 v	±(0.35% + 0.5 v)	±(0.65% + 0.8 v)

***Accuracy is the sum of the Vc accuracy and attenuator accuracy.**

TABLE 1-8

Equivalent Range At P6023 Probe Tip	Slide-Back Measurement Accuracy With P6023 Probe*	
	0° C to +40° C	−30° C to +65° C
0 to ±60 v	±(0.225% +50 mv)	±(0.4% + 80 mv)
0 to ±600 v	±(0.5% + 0.5 v)	±(0.95% + 0.8 v)
0 to ±6000 v**	±(1% + 5 v)	±(2% + 8 v)

***Probe attenuation is matched to 10X attenuator and accuracy includes effect of input resistance tolerance.**

****Input voltage rating of P6023 Probe is 1000 v maximum.**

Readout Resolution

≤0.5 mv on 6-v range. Measured by taking the difference between two Vc readings. Vc controls were rotated to the zero differential reference point from opposite directions to obtain the two readings. Resulting readings are a combination of readout and resolution.

Input Attenuation Accuracy

See Table 1-6.

Input Voltage Rating

See Table 1-4.

MECHANICAL

Construction

Aluminum-alloy chassis with chrome-plated brass side rails.

Finish

Anodized aluminum panel.

Dimensions

6¼ inches high, 4¼ inches wide, 14½ inches deep overall.

Accessories

Information on accessories for use with this instrument is included at the rear of the mechanical parts list.

NOTES

SECTION 2
OPERATING INSTRUCTIONS

FUNCTION OF FRONT-PANEL CONTROLS

VOLTS/CM and Vc RANGE — Provides 14 calibrated-display vertical deflection factors, three ranges of equivalent comparison voltages and three dynamic linear input voltage ranges (see Fig. 2-1). The black-line area on the edge of the clear plastic flange indicates the Vc RANGE as well as maximum input voltage according to the color band. The white dot on the black knob indicates the VOLTS/CM position.

When the black knob is pulled outward in the .5 VOLTS or the 50 mVOLTS position and turned clockwise to either of the next two switch positions in the overlapping color-band area, the white dot points to the deflection factor while the flange indicates the retained Vc RANGE and maximum input voltage for linear operation.

NOTE

The green-tinted color bands indicate the maximum input voltage ranges for linear operation. For example, dark green indicates that up to ±600 volts can be applied to the + or —INPUT connectors. Dark green also indicates that the Vc, when used, is equivalent to a ±600-v range at the input connector.

All the VOLTS/CM switch positions are calibrated when the red VARIABLE knob is set to CAL, a switch detent position.

VARIABLE (VOLTS/CM) — Red knob concentric with the VOLTS/CM switch provides continuously variable reduction in amplifier gain (uncalibrated) to at least 2.5 to 1. For example, if the VOLTS/CM switch is in the .1 position as shown in Fig. 2-1, the VARIABLE control will vary the sensitivity between the deflection factors of 0.1 volt/cm and about 0.25 volt/cm. When used in conjunction with the oscilloscope calibrator voltage, this control permits setting any specific deflection factor within the range of the instrument.

UNCAL — A neon lamp that lights when the VARIABLE control is turned away from its CAL position.

PULL FOR 1 MC BW — A two-position switch for selecting bandwidth. The "in" position is the normal bandwidth position. When the knob is pulled out, bandwidth is limited to 1 mc ±10%. This position is useful for reducing on-screen noise at high sensitivities. A neon, adjacent to the knob, lights to indicate the "out" position.

POSITION — A control that varies the vertical position of the trace.

GAIN — A screwdriver adjustment that permits the deflection factor of the amplifier to be correctly set at 5 mv/cm.

Vc POLARITY — Two-position lever switch to select the polarity of the comparison voltage.

+INPUT — A four-position input selector switch. The positions are as follows:

AC: Couples the ac component of a signal to the +input side of the Type 10A1 amplifier.

DC: Both ac and dc components of the input signal are displayed.

GND: Grounds the +input side of the amplifier but does not ground the signal.

Vc: Applies the comparison voltage to the +input side of the amplifier.

COMPARISON VOLTAGE (Vc) — Dual controls which select the comparison voltage within the range set by the Vc RANGE switch; permits a 4-digit readout (see Fig. 2-1).

—INPUT — A four-position input selector switch which has the same function as the +INPUT switch except that it refers to the —input side of the amplifier.

NOTE

A signal applied to the +INPUT connector produces a display of the same polarity as the input signal, while a signal applied to the —INPUT connector produces an inverted display (see Fig. 2-2).

COARSE — A screwdriver adjustment that serves as a very coarse dc balance control to center the trace on the screen when the POSITION and STEP ATTEN BAL controls are set to midrange.

STEP ATTEN BAL — A dual-range or coarse-fine type of control that dc balances the amplifier; so that with no signal applied there is no vertical shift of the trace as the VOLTS/CM switch is moved from the 20 mVOLTS position to the 1 mVOLTS position. The control has 60° of fine adjustment; if this range is exceeded, the coarse range takes over to provide a fast coarse setting.

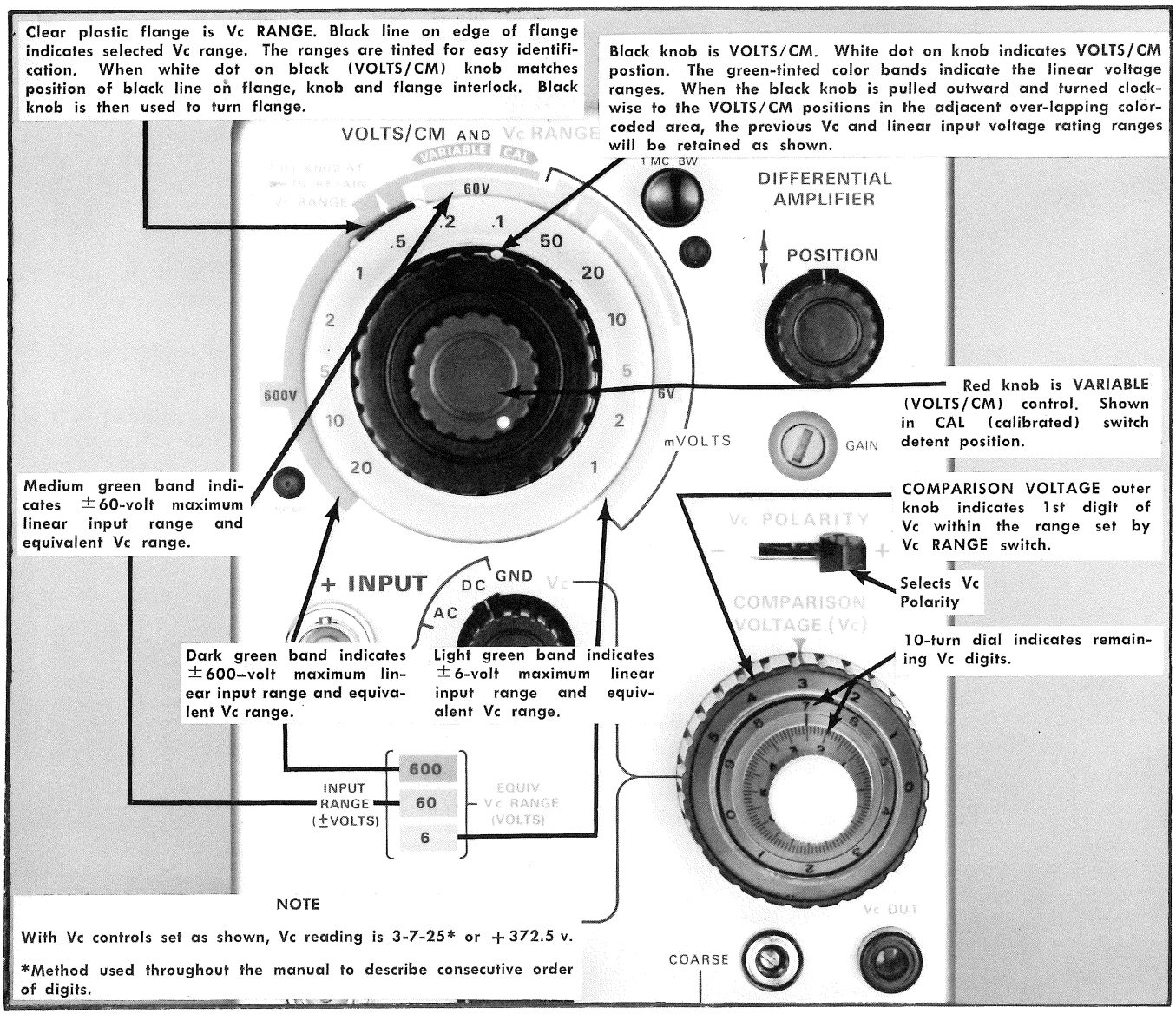


Fig. 2-1. Function of the VOLTS/CM and Vc controls.

Vc OUT
0-6 V

Comparison voltage output jack. Voltage is set by the Vc RANGE, Vc POLARITY, and COMPARISON VOLTAGE controls. The range of this voltage is 0 to ±6 volts **except** when using the 5, 10 and 20 VOLTS positions of the VOLTS/CM switch.

FIRST-TIME OPERATION

The Type 10A1 should be inserted into the left-hand (Y-axis) opening of the Type 647 Oscilloscope. A time-base plug-in unit such as the Type 11B1 should be inserted in the right-hand (X-axis) opening.

The following procedure should help you become familiar with th Type 10A1 operation.

1. Set the front-panel controls as follows:

VOLTS/CM	20 mVOLTS
Vc RANGE	6 VOLTS
VARIABLE	CAL
PULL FOR 1 MC BW	Pushed in
POSITION	Midrange
Vc POLARITY	+
+INPUT	GND
COMPARISON VOLTAGE	4-5-0
—INPUT	GND
STEP ATTEN BAL	As is

2. With the Intensity control of the oscilloscope turned fully counterclockwise, switch on the oscilloscope power.

3. Wait about 15 minutes for the oscilloscope and plug-ins to warm up and stabilize.

4. Turn up the Intensity control and set the time-base controls to obtain a 0.5-msec/cm free-running sweep. The trace should appear near graticule center of the crt.

NOTE

If the trace is off the screen, adjust the STEP ATTEN BAL control to get the trace on the screen. If the control does not have enough range, refer to the Operational Adjustments on this page for COARSE and STEP ATTEN BAL adjustment procedures.

5. Set the +INPUT switch to DC and apply a 0.1-v signal from the oscilloscope calibrator to **both** Type 10A1 input connectors. Check the time-base controls for a triggered-sweep operation so a stable display is obtained. Use the Type 10A1 POSITION control to align the display with the graticule lines. The display will be square-waves which are 5 cm in amplitude. This is an example of dc-coupled conventional amplifier operation using the +INPUT connector.

NOTE

If 5-cm vertical deflection is not obtained, the GAIN control may not be adjusted properly. Refer to Operational Adjustments on this page.

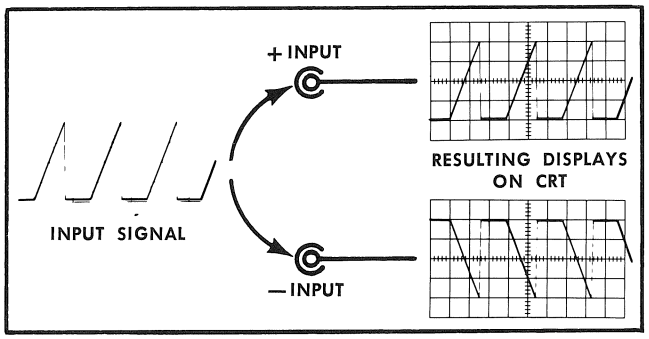


Fig. 2-2. A signal applied to the +INPUT connector produces an upright display, while a signal applied to the —INPUT connector is inverted.

6. Set the +INPUT switch to GND and the —INPUT switch to DC. Adjust the Type 10A1 POSITION control to center the display. This is an example of dc-coupled conventional amplifier operation using the —INPUT side of the amplifier.

7. Set the +INPUT switch to DC and the oscilloscope calibrator for 5 volts output. Five volts of common-mode signal is now dc-coupled to both sides of the amplifier as an example of differential-amplifier mode of operation. Because of the high CMR (common-mode rejection) of the Type 10A1, the 5-volt signals cancel in passing through the amplifier and no square waves will be displayed. Only a trace with dim spikes will appear on the screen.

8. For differential comparator mode of operation, set the +INPUT and —INPUT switches to GND. Use the POSITION control to position the trace so it coincides with graticule center. Set the +INPUT switch to DC and the —INPUT switch to Vc. Rotate the COMPARISON VOLTAGE control slowly clockwise until the tops of the square waves are positioned to coincide with graticule center. Note the setting of the COMPARISON VOLTAGE control. The knob and 10-turn dial should indicate a reading between 4-9-0 (+4.9 v) and 5-1-0 (+5.1 v) because the calibrator signal amplitude is about +5 volts (±2%) peak to peak in amplitude, referenced to ground.

OPERATIONAL ADJUSTMENTS

Introduction

Before the Type 10A1 is used for accurate measurements, the COARSE, STEP ATTEN BAL and GAIN adjustments should be checked and adjusted if necessary. The STEP ATTEN BAL and GAIN adjustments, in particular, should be checked each time the Type 10A1 is moved from one Type 647 Oscilloscope to another.

COARSE Adjustment

a. Perform steps 1 through 3 in the First-Time Operation procedure.

b. Set the time-base controls to obtain a 0.5-msec/cm free-running sweep.

c. Set the STEP ATTEN BAL control to midrange.

d. Turn up the oscilloscope Intensity control for normal brightness. If the trace is not at graticule center, slowly adjust the COARSE control (located on the front panel) to center the trace.

NOTE

The COARSE adjustment changes the heater voltage on the Input C.F. tubes V113 and V313. Therefore, when making the adjustment, allow time for the trace to stabilize as the heaters and cathodes reach their normal operating temperature. Once the COARSE control is adjusted, it need not be readjusted as long as the STEP ATTEN BAL control (described next) has sufficient range.

STEP ATTEN BAL Adjustment

a. Perform steps 1 through 3 in the First-Time Operation procedure.

b. Set the time-base controls to obtain a 0.5-msec/cm free-running sweep.

c. Set the oscilloscope Intensity control for normal trace brightness.

d. Adjust the STEP ATTEN BAL control to position the trace to graticule center.

e. Set the VOLTS/CM switch to 1 mVOLTS.

f. Check that the trace is at graticule center. If it is not, adjust the STEP ATTEN BAL control to position the trace to graticule center.

g. Set the VOLTS/CM switch to 20 mVOLTS.

h. Check that the trace coincides with graticule center. If it does not, use the POSITION control to center the trace.

i. Repeat the procedure as often as necessary to minimize trace shift as the VOLTS/CM switch is changed from 20 mVOLTS to 1 mVOLTS.

GAIN Adjustment

a. Set the Type 10A1 front-panel controls as follows:

Vc RANGE	6 Volts
VOLTS/CM	5 mVOLTS
VARIABLE	CAL
PULL FOR 1 MC BW	Pulled out
+INPUT	DC
—INPUT	GND
STEP ATTEN BAL	Adjusted to minimize trace shift as the VOLTS/CM switch is changed from 20 mVOLTS to 1 mVOLTS.

b. Apply exactly 20 mv peak-to-peak calibrator signal to the +INPUT connector.

c. Set the time-base controls to obtain a 0.1 msec/cm free-running sweep. Adjust the oscilloscope Intensity control for suitable trace brightness.

d. Using the POSITION control, center the display on the screen.

e. Check that the traces are exactly 4 cm apart. If they are not, adjust the GAIN control (located on the front panel) so the display is exactly 4 cm in amplitude.

f. Disconnect the calibrator signal.

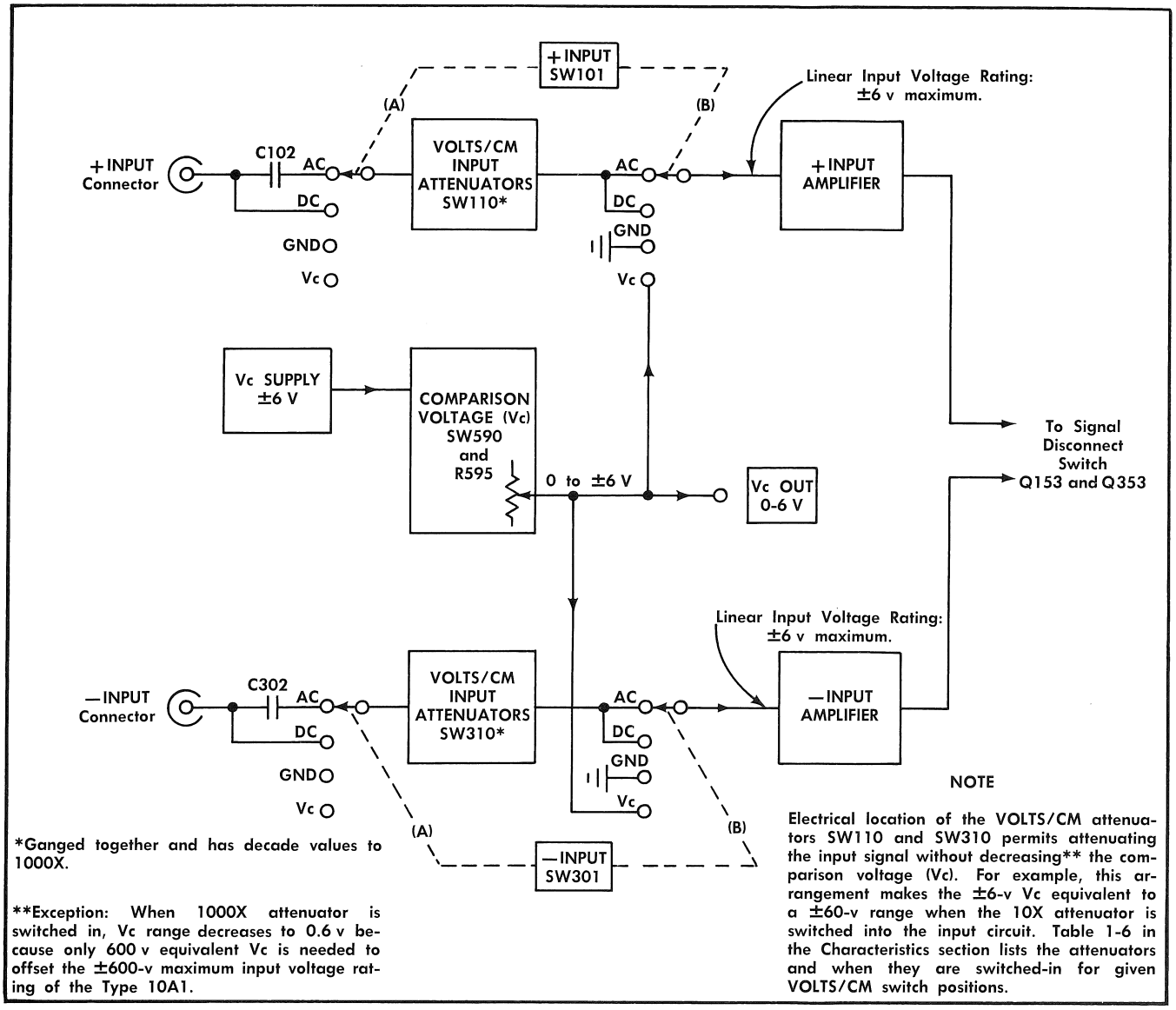


Fig. 2-3. Simplified block diagram showing, in particular, where signal attenuation takes place and comparison voltage (Vc) is applied.

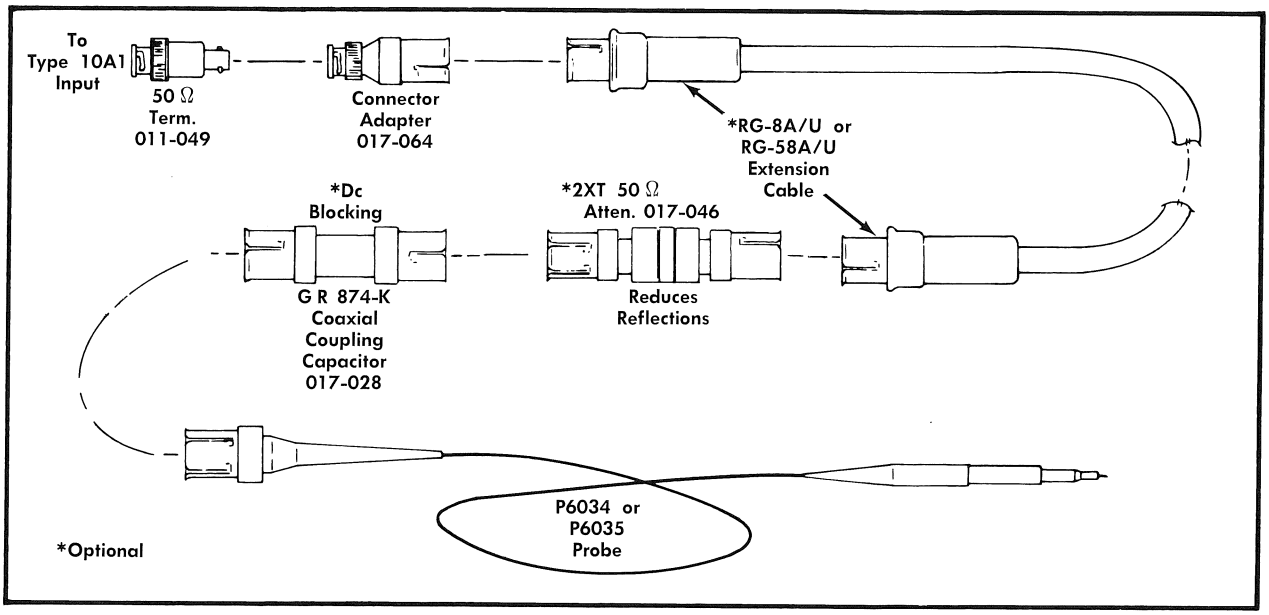


Fig. 2-4. Recommended component sequence when using the P6034 or P6035 Probe.

GENERAL INFORMATION

Block Diagram

The simplified block diagram shown in Fig. 2-3 illustrates the electrical location of the +INPUT, —INPUT, VOLTS/CM input attenuators, Vc RANGE and COMPARISON VOLTAGE controls. Particularly, the diagram shows where the input attenuators are located with respect to the comparison voltage (Vc) source.

When a **signal** is applied to the Type 10A1 input connector(s), it is attenuated in the VOLTS/CM attenuator before being applied via the + and/or —INPUT switch to the Input Amplifier(s). In contrast, the **comparison voltage** is not attenuated, but is applied via the + and/or —INPUT switch directly to the Input Amplifier(s). The only exception is that when the 1000× attenuator is switched in, only 0.6-v Vc is used to obtain an equivalent Vc of 600 v at the input connector.

Direct application of the Vc to the Input Amplifier makes the ±6-v Vc appear equivalent to the product of the Vc and the attenuation factor of the attenuator when "looking" at the input connector. Thus, at the maximum attenuation factor of 1000× (using ±0.6-v Vc) and at an attenuation factor of 100× (using ±6-v Vc), the equivalent Vc at the input connector is ±600 v. If a 10× probe is used, the equivalent Vc at the tip of the probe would be ±6000 v. This gives the Type 10A1 greater slideback capabilities than are usually needed in practical applications. For example, if a P6023 Probe is used, the maximum equivalent Vc will never be used because the input voltage rating of the probe is 1000 v. Thus, the probe, rather than the Type 10A1, is the limiting factor.

Input Signal Connections

Before connecting signals to the + and/or —INPUT connectors, consider the method of coupling that will be used. Table 2-1 lists a choice of eight different methods. For each method the table lists the advantages, limitations, accessories required, source loading and precautions to consider. Check through the table and select the method which is suitable for your particular application. Fig. 2-4 shows a pictorial diagram for using Method 7.

Input Coupling

To display both the ac and dc components of an applied signal, set the appropriate +INPUT or —INPUT switch to DC. To display only the ac component of a signal, set the switch to AC. In the AC position the dc component of the signal is blocked by a capacitor (C102 or C302, Fig. 2-3) in the input circuit. The low-frequency ac 30%-down point is about 2 cps when the source impedance is low; therefore, some low-frequency distortion of signals can be expected when using the AC position.

When using a 10× 10-megohm probe, the low-frequency response is about 0.2 cps in the AC position. If a 100X 10-megohm probe is used, low-frequency response is 2 cps.

When the + or —INPUT switch is set to GND, the corresponding Type 10A1 amplifier input is grounded and the input signal is disconnected.

NOTE

The GND position provides an easy method for determining the zero dc reference of the trace. However, this method does not take into account trace-voltage deviation from exact zero due to a ground-loop current. If this voltage is significant and utmost measurement accuracy is desired, touch the probe tip to chassis ground on the device under test.

When the + or —INPUT switch is set to Vc, the comparison voltage is applied to the corresponding Input Amplifier. The signal, if applied to the associated connector, will be internally disconnected automatically as shown in Fig. 2-3.

TABLE 2-1

Signal Coupling Methods

Method	Advantages	Limitations	Accessories Required	Source loading	Precautions
1. Open test leads.	Simplicity.	Limited frequency response. Subject to stray pickup.	BNC to Banana Jack adapter (103-033). Two test leads.	1 meg Ω & 20 pf at input, plus test leads.	Stray pickup. Insert a 47-ohm resistor in series with the leads.
2. Unterminated coax cable.	Full sensitivity.	Limited frequency response. High capacitance of cable.	Coax cable with BNC connector(s).	1 meg Ω & 20 pf plus cable capacitance.	High capacitive loading.
3. Terminated coax cable. Termination at 10A1 input.	Full sensitivity. Total 10A1/647 bandwidth. Relatively flat-response resistive loading. Long cable with uniform response.	Presents R_o (typically 50 Ω) loading at end of coax. May need blocking capacitor to prevent dc loading or damage to termination.	Coax cable with BNC connector(s) R_o termination at 10A1 input. (BNC 50 Ω Termination 011-049).	R_o plus 20 pf at 10A1 end of coax can cause reflections.	Reflection from 20 pf at input. Dc and ac load-on test point. Power limit of termination.
4. Same as 3, with coax attenuator at termination.	Less reflection from 20 pf at termination.	Sensitivity is reduced (increased deflection factor).	BNC coaxial attenuators.	R_o only.	Dc and ac loading on test point. Power limit of attenuator.
5. Tap into terminated coax system. (BNC Tee: UG-274/U at 10A1 input.)	Permits signal to go to normal load. Dc or ac coupling without coaxial attenuators.	20-pf load at tap point.	BNC Tee and BNC connectors on signal cables.	1 meg Ω & 20 pf at tap point.	Reflection from 20 pf input.
6. 10×, 10 meg Ω probe except P6023. 100X, 9.1 meg Ω probe. 1000X, 100 meg Ω probe.	Reduced resistive and capacitive loading; nearly full bandwidth of 10A1/647.	X0.1 sensitivity. X0.01 sensitivity. X0.001 sensitivity.	P6006, P6008, and P6023 are 10X. P6007: 100X. P6015: 1000X.	P6006: ≈ 7 pf, 10 meg Ω. P6008: ≈ 7.5 pf, 10 meg Ω. P6023: ≈ 12 pf, 8 meg Ω. P6007: ≈ 2 pf, 10 meg Ω. P6015: ≈ 2.7 pf, 100 meg Ω.	Check probe frequency compensation. Use square wave frequency less than 5 kc, preferably 1 kc.
7. 500 Ω and 5 kΩ probes. (Must be terminated in 50 Ω at 10A1 input.)	Reduced capacitive loading to about 0.7 pf. Bandwidth that of 10A1/647.	Resistive loading. X0.1 or X0.01 sensitivity. May need blocking capacitor to prevent dc loading or damage to termination. Limited low-frequency response when ac coupled. See Fig. 2-4.	P6034: 10X P6035: 100X. Items in Fig. 2-4.	P6034: 500 Ω, 0.7 pf. P6035: 5 kΩ, 0.6 pf.	Dc and ac loading. Voltage rating of probe.
8. Current transformer. Terminated in 50 Ω at 10A1. Bandwidth that of 10A1/647.	Current transformer can be permanent part of test circuit. Less than 2.2 pf to test circuit chassis. Measure signal currents in transistor circuits: CT-1—20 amps pk. CT-2 — 100 amps pk.	RMS current rating: CT-1—0.5 amps. CT-2—2.5 amps. Sensitivity: CT-1—5 mv/ma. CT-2—1 mv/ma.	CT-1: coax, adapter and BNC termination. CT-2: Nothing extra (perhaps additional coax cable for either transformer).	CT-1: Insertion; 1 Ω paralleled by about 5 μh. Up to 1.5 pf. CT-2: Insertion; 0.04 Ω paralleled by about 5 μh. Up to 2.2 pf.	Not a quick-connect device. CT-1: Low-frequency limit about 75 kc. CT-2: Low-frequency limits about 1.2 kc, and is 1/5th as sensitive as the CT-1.

Deflection Factor

The amount of vertical deflection produced by a signal is determined by the signal amplitude, the attenuation factor of a probe, the setting of the VOLTS/CM switch, and the setting of the VARIABLE (VOLTS/CM) control. Calibrated deflection factors indicated by the VOLTS/CM switch apply only when the VARIABLE control is set fully clockwise to the CAL position.

The range of the VARIABLE control is at least 2.5:1 to provide variable (uncalibrated) vertical deflection factors between calibrated settings of the VOLTS/CM switch.

The VARIABLE control extends the vertical deflection factor of the Type 10A1 to about 50 volts/cm.

CONVENTIONAL AMPLIFIER OPERATION

Voltage Measurements

To measure the voltage between two points on a signal (such as peak-to-peak volts), measure the vertical distance in graticule divisions between the two points and multiply by the setting of the VOLTS/CM switch and the attenuation factor of the probe, if one is used. Be certain the VARIABLE control is in the CAL position.

For example, assume a 10× probe is used, the VOLTS/CM switch is set to 20 mVOLTS, and the vertical deflection of the display is 4 cm. In this case, (4) (20 mv/cm) = 80 mv. This voltage times the probe attenuation factor of 10 shows a true peak-to-peak voltage of 800 mv or 0.8 v.

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

1. Set the VOLTS/CM switch so the expected voltage (at the input connector) will produce a maximum vertical deflection of 6 cm. Be sure the VARIABLE control is in the CAL position.

2. Set the time-base controls so the sweep free runs.

3. Set the +INPUT switch to DC and the —INPUT switch to GND.

4. Touch the probe tip to the chassis of the device under test and use the POSITION control to align the trace with one of the graticule lines. This line is ground (or zero) reference. The position selected for this reference line depends on the polarity and amplitude of the signal to be measured. Do not move the POSITION control once the reference line has been established.

5. Connect the probe tip to the test point in the device under test and set the time-base triggering controls for a stable display.

6. Measure the vertical distance in cm from the ground (zero) reference line to the point on the waveform that you wish to measure.

7. Multiply the distance in cm by the setting of the VOLTS/CM switch and the probe attenuation factor. This is the instantaneous dc level with respect to ground.

Check the zero reference line at any time by disconnecting the probe tip from the test point and connecting it to ground (as in step 4). If extreme accuracy is not important, leave the probe connected to the test point and set the +INPUT switch to GND to establish or check zero reference.

To use a reference other than zero, set the +INPUT switch to DC and touch the probe to the reference voltage; then use the POSITION control to align the trace with a reference graticule line.

DIFFERENTIAL AMPLIFIER OPERATION

The primary purpose of differential amplifier operation is to eliminate undesirable common-mode signals such as hum or noise. This mode of operation can also be used to observe the signal across one circuit element while effectively eliminating the remainder of the circuit from the observations. This is accomplished by connecting the signal at one end of the element to one input of the Type 10A1 and the signal at the other end of the element to the other input of the unit.

For maximum common-mode rejection ratio, within the bandwidth limits of the system, set both INPUT switches to the same position; that is, both to DC or both to AC.

To obtain high common-mode rejection when using probes, use probes that have variable R and C such as the Tektronix Type P6023 Probe. To properly adjust the Type P6023 Probe for use with the Type 10A1, refer to the Type P6023 Probe Adjustment Procedure which is the next topic.

Differential or common-mode rejection ratio is a function of frequency in practical amplifiers. For the Type 10A1 it is greater than 20,000-to-1 below 100 kc, greater than 10,000-to-1 to 1 mc and greater than 1000-to-1 at 10 mc.

Common-mode rejection ratio of the Type 10A1 describes the ability of the unit to reject common-mode signals. This ratio can also be defined as the ratio of common-mode input voltage to differential output voltage. For example, assume a 10-v peak-to-peak 60-cps signal is dc-coupled to both INPUT connectors and the VOLTS/CM switch is set to 1 mVOLTS. Since the Type 10A1 has 20,000-to-1 or greater common-mode rejection at this frequency, the vertical deflection is expected to be 10 v divided by 20,000 (or greater) or 0.5 mv or less. This is equal to 5 mm or less vertical deflection on the screen.

NOTE

The maximum input voltage for linear operation that can be applied to the Type 10A1 is listed in Table 1-4 in the Characteristics section and indictated on the front panel of the unit.

Type P6023 Probe Adjustment Procedure

For this procedure the following equipment is recommended:

1 — Type 647 Oscilloscope.

1 — Type 10A1 Differential Amplifier plug-in unit.

1 — Type 11B1 Time-Base plug-in unit, or equivalent.

1 — Type P6023 Probe (two required for differential operation).

1 — BNC dual binding post adapter. Tektronix Part No. 103-035.

1 — Resistor, fixed, 1.2 megohm, 1/8 w to 1/2 w, 1%.

1 — 50-ohm (nominal impedance) coaxial cable, 18" long, with a BNC connector on each end.

Procedure:

a. Insert the plug-in units into their respective compartments in the Type 647 Oscilloscope. Turn on the oscilloscope and allow about 15 minutes for warm up.

b. Set the front panel controls as follows:

Type 647

1 KC Calibrator	50 Volts
Horiz Position	Centered

Time-Base Unit

Time/Cm	.2 mSec
Trig Mode	Auto
Slope	+
Coupling	AC
Source	Int

Type 10A1

Vc RANGE	60 Volts
VOLTS/CM	10 mVOLTS (in retained range)
PULL FOR 1 MC BW	Pulled outward
POSITION	Centered
Vc POLARITY	+
COMPARISON VOLTAGE	49 v (4-9-0)
+INPUT	GND
—INPUT	GND

c. Check that the oscilloscope Intensity control is set for normal brightness. Position the trace to graticule center with the Type 10A1 STEP ATTEN BAL control. Using the oscilloscope Horiz Position control, position the trace to start near the left side of the graticule.

d. Connect a coaxial cable to the +INPUT connector and to the oscilloscope Cal Out connector.

e. Set the +INPUT switch to DC and the —INPUT switch to Vc.

f. Set the COMPARISON VOLTAGE control so the top of the waveform (about +50 v) is positioned to graticule center as shown in Fig. 2-5a.

g. Set the +INPUT switch to Vc and adjust the POSITION control to center the trace.

h. Set the +INPUT switch to DC and readjust the COMPARISON VOLTAGE control to center the display as shown in Fig. 2-5a.

IMPORTANT

Leave the COMPARISON VOLTAGE control at this setting for the rest of the procedure.

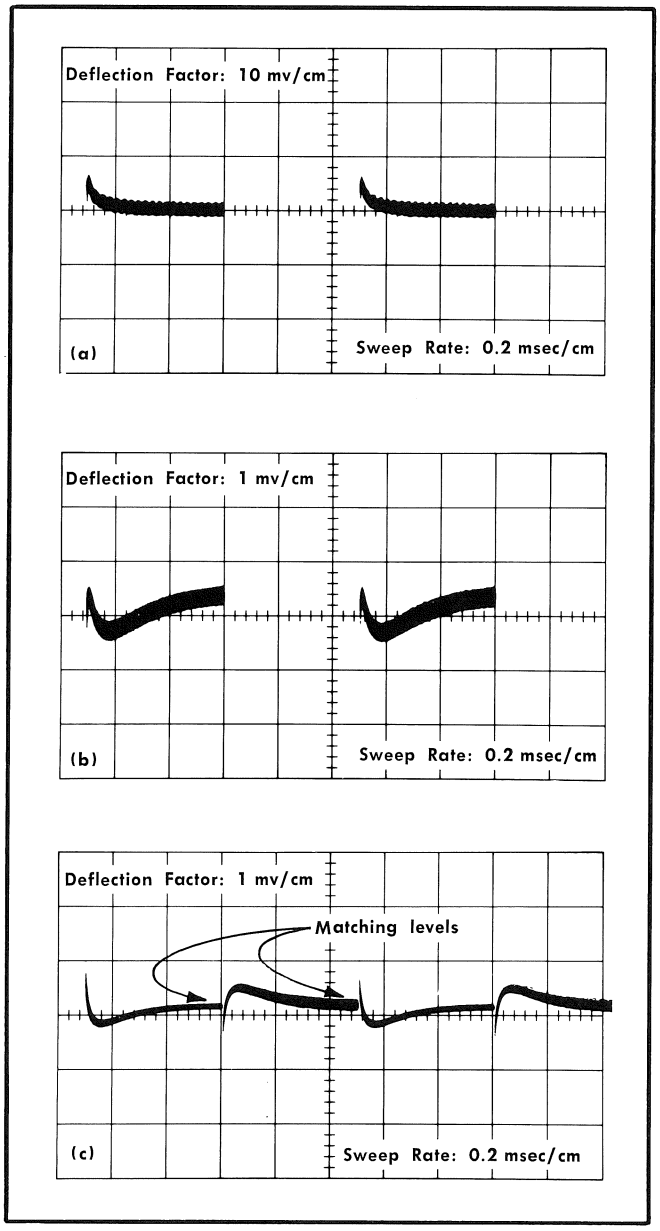


Fig. 2-5. (a) Typical waveform display obtained at completion of step f in the P6023 Probe adjustment procedure, (b) shows typical display obtained when the probe is adjusted properly, and (c) shows display obtained when the second probe matches the first.

i. Remove the coaxial cable. Connect a 1.2 megohm (1%) resistor between the binding posts on a dual binding post adapter and connect the adapter to the oscilloscope Cal Out connector.

j. Connect the cable end of a P6023 probe to the +INPUT connector and connect the probe tip to the red terminal (Cal Out) on the adapter. Set the VOLTS/CM switch to 1 mVOLTS.

k. Set the +INPUT switch to Vc.

l. Using the POSITION control, position the trace to graticule center.

m. Set the +INPUT switch to DC. Adjust the DC Atten Calibration control on the probe to position the top of the waveform into view. Then, adjust the probe AC Comp Fine Adjust, AC Coarse Comp (if AC Comp Fine Adjust has insufficient range), and DC Atten Calibration controls to duplicate the display obtained in step f as near as possible. Fig. 2-5b shows a typical waveform that should be obtained if the probe is properly adjusted.

n. Repeat steps k through m to check that the adjustments have been made correctly. Resolution of the display is 0.02%/cm. Due to the high resolution the probe adjustments act rather coarsely when adjusted.

o. To adjust a second probe for differential operation, disconnect the tip of the first probe from the adapter and remove the adapter from the Cal Out connector. Use the same procedure to adjust the second probe but with these exceptions:

Use the —INPUT connector for making the connections, use the —INPUT switch in place of the +INPUT switch and the +INPUT switch instead of the —INPUT switch when following the procedure. The displays that are obtained will be similar to Figs. 2-5a and 2-5b but inverted. In steps f and m, the bottom of the waveform will be positioned to graticule center.

p. To match the probes for differential operation, reconnect the tip of the first probe to the Cal Out connector (red terminal on adapter). With both probe tips connected to the same calibrator-signal source, set the +INPUT and —INPUT switches to Vc and position the trace to graticule center using the POSITION control. Set the +INPUT and —INPUT switches to DC and adjust the second probe R and C adjustments for minimum display amplitude and matching trailing-edge levels (see Fig. 2-5c).

CALIBRATED DIFFERENTIAL COMPARATOR OPERATION

When one of the INPUT switches is set to Vc and the other is set to AC or DC, the Type 10A1 is operating as a calibrated differential comparator or slide-back voltmeter. The calibrated comparison voltage, which has selectable equivalent voltage ranges of 0 to ±6 v, 0 to ±60 v and 0 to ±600 v, can be added differentially to the input signal to obtain a null. For linear operation, Table 1-4 in the Characteristics section of this manual lists the maximum input signal or voltage that can be applied to the Type 10A1 INPUT connector at a given VOLTS/CM switch position.

For precise measurement accuracy when using a probe with the Type 10A1, use a probe that has variable R and C such as the Type P6023 Probe. To properly adjust the probe, refer to the Type P6023 Probe Adjustment Procedure which starts on page 2-7.

In differential comparator operation the calibrated dc comparison voltage is internally applied, to differentially offset any unwanted portion of the applied signal; thereby allowing measurements of relatively small ac or dc signals riding on top of relatively large ac or dc signals. Fig. 2-3 shows how the comparison voltage is applied.

The dc comparison voltage is set by two controls: the Vc RANGE switch and the COMPARISON VOLTAGE control. The Vc RANGE switch has three ranges: 0 to 6 v, 0 to 60 v, and 0 to 600 v. The COMPARISON VOLTAGE control, consisting of a six-position switch and a 10-turn dial, varies the comparison voltage over the range selected by the Vc RANGE switch. The COMPARISON VOLTAGE control indicates the precise comparison voltage as shown in the example given in Fig. 2-1. The comparison voltages as read from the COMPARISON VOLTAGE control is independent of the VOLTS/CM and VARIABLE controls, **providing** the Vc RANGE is not changed when the VOLTS/CM switch is set to another position during the readout.

NOTE

The comparison voltage supply in the Type 10A1 stays constant and is accurate as long as the Type 647 Oscilloscope regulated power supplies are in regulation and within their output voltage tolerance ratings. Be sure the regulated power supplies in the oscilloscope are operating properly.

When using the COMPARISON VOLTAGE control for Vc measurements, the VOLTS/CM and VARIABLE controls act as null resolution or sensitivity controls. If sensitivity is changed **during** a readout, possible trace shift may occur due to slight changes in the Type 10A1 amplifier dc levels. To make sure the readout has not been affected, recheck the measurement. Check that the pre-established reference and the Vc-offset trace positions agree. For example, refer to step h in the Measuring DC Voltages procedure.

NOTE

If trace shift occurs as either the VOLTS/CM switch or VARIABLE control is changed in setting, adjust the STEP ATTEN BAL control for minimum trace shift as described on page 2-3.

Differential comparator mode of operation may be used to make the following voltage measurements: (1) measuring dc voltages, (2) measuring small ac or dc signals superimposed on dc, (3) measuring small ac signal variations on large ac, and (4) measuring high-amplitude low-frequency ac signals.

(1) Measuring DC Voltages

When the Type 10A1 is used to make dc voltage measurements, the following general procedure, using the +INPUT as an example, can be used.

a. Place the + and —INPUT switches to GND.

b. Preset the Vc RANGES, VOLTS/CM, Vc POLARITY and COMPARISON VOLTAGE controls to suitable positions.

For example, suppose a 10× probe is used and it will be connected to a +225-v dc source. For this example, the controls could be preset as follows: Vc RANGE to 60, VOLTS/CM to 50 VOLTS, Vc POLARITY to + (set to same polarity as the polarity of the voltage to be measured), and set the COMPARISON VOLTAGE control to 2-2-50. Note that the Vc RANGE is set to 60 because this range is sufficient to offset the voltage (about +22.5 v) that is expected to appear at the +INPUT connector due to the 10× attenuation factor of the probe.

c. Check that the STEP ATTEN BAL control is properly adjusted.

d. Establish a reference line on the crt. This line will usually be the horizontal centerline of the graticule. Use the POSITION control to set the trace to the reference line. Once the trace is set, do not move the POSITION control until the measurement has been made or a recheck is necessary.

NOTE

For greatest accuracy in establishing a reference, set the +INPUT switch to DC and touch the probe tip to ground on the device under test. Then position the trace to the reference line.

e. Set the +INPUT switch to DC and the —INPUT switch to Vc.

f. Connect the +input probe to the dc voltage to be measured.

g. Rotate the COMPARISON VOLTAGE 10-turn control to bring the trace onto the crt. Set the trace exactly on the reference line established in step d.

h. Recheck the reference by setting the +INPUT and —INPUT switches to GND (or, instead, set the —INPUT switch to GND and touch the probe tip to the device-under-test ground as in step d). If the trace does not coincide with the reference established in step d, reposition the trace to the reference with the POSITION control. Return the +INPUT switch to DC and the —INPUT switch to Vc. If the trace position does not coincide with the reference line, readjust the COMPARISON VOLTAGE control to reposition the trace.

i. Now the voltage can be determined by using the following formula:

Equivalent Comparison Voltage in Volts = COMPARISON VOLTAGE Control Readout in Volts X Probe Attenuation Factor

The applied dc voltage is equal to the equivalent comparison voltage.

NOTE

To increase the resolution when matching the reference line and trace as in step g, set the VOLTS/CM switch to a higher sensitivity (lower deflection factor). Re-establish the reference and repeat the measurement as described in steps h and i. The formula given in step i applies regardless of the VOLTS/CM switch position.

(2) Measuring Small AC or DC Signals Superimposed on DC

Small ac or dc signals superimposed on a large dc component can be measured accurately by first using the comparison voltage to effectively eliminate the large dc component. The general procedure, using the +INPUT as the example, is as follows:

Use the same procedure as described in (1) Measuring DC Voltages, except in this case it is **not** necessary to establish a zero voltage reference line. Instead, use the COMPARISON VOLTAGE control to offset the large dc component; then, use the COMPARISON VOLTAGE control to measure the difference between the lowest and highest points on the small ac or dc signal. Substitute this information in the following formula:

P-P Signal in Volts = COMPARISON VOLTAGE Control Difference Measurement in Volts X Probe Attenuation Factor

If the small ac or dc signal display does not overscan the screen when the COMPARISON VOLTAGE control is used to bring it into view, the small signal can be measured by using the conventional-amplifier operation formula as follows:

P-P Signal in Volts = Vertical Deflection in cm X VOLTS/CM Switch Position X Probe Attenuation Factor

(3) Measuring Small AC Signal Variations on Large AC

The technique for measuring small ac-signal component variations on a large ac signal is essentially the same as that described for measuring small ac or dc signals superimposed on dc. The only difference is that the INPUT switch can be set to AC to block any dc component (if desired). The COMPARISON VOLTAGE control is then used to position the small ac signal component into view so the measurement can be made. Either of the two methods previously described in (2) can be used to make the measurement.

(4) Measuring High-Amplitude AC Signals

High-amplitude ac signals up to about 1 mc which do not exceed the voltage rating of the probe and Type 10A1 can be measured using the slide-back technique. This type of measurement is very similar to dc measurements except that it is **not** necessary to establish a zero voltage reference line.

The following procedure uses the +INPUT connector as the example and describes how to measure the peak-to-peak amplitude of an ac signal.

a. Set the +INPUT switch to AC, the —INPUT switch to Vc and the Vc POLARITY switch to —.

b. Preset the Vc RANGE, VOLTS/CM and COMPARISON VOLTAGE controls to suitable positions.

c. Connect the probe to the test point in the device under test.

d. Use the COMPARISON VOLTAGE control to position the bottom of the waveform to graticule center. Note the Vc reading.

e. Set the Vc POLARITY switch to +.

f. Use the COMPARISON VOLTAGE control to position the top of the waveform to graticule center. Note the Vc reading.

g. Find the difference voltage between the two Vc readings obtained in steps d and f. Then, substitute this information in the formula that follows:

P-P Signal in Volts = COMPARISON VOLTAGE Control Difference Measurement in Volts X Probe Attenuation Factor

Vc OUT 0-6V Jack

The Vc OUT 0-6V jack, mounted on the front panel of the Type 10A1, permits monitoring of the comparison voltage. The voltage at the jack is set up by the Vc RANGE, Vc POLARITY and COMPARISON VOLTAGE controls. Comparison voltage out at the jack is between 0 and 6 volts, except when the VOLTS/CM control is at 5, 10 or 20 V/CM. At these settings, Vc OUT is 0 to 0.6 volts. Impedance varies from 1 k to about 4 k.

When monitoring the voltage at the jack, the voltage is not affected if an "infinite-impedance type" voltmeter (such as a digital voltmeter or any null type meter which draws negligible current) is used for monitoring purposes.

If the Vc OUT 0-6 V jack is loaded by an external meter, the comparison voltage available at the jack and applied to the input of the amplifier will not be the same as indicated by the COMPARISON VOLTAGE control. However, the voltmeter which is connected to the jack will indicate the actual slideback voltage. Therefore, it is possible to load the circuit considerably and still be able to read the comparison voltage accurately as long as the reading of the voltmeter is used instead of the COMPARISON VOLTAGE control indication.

NOTES

SECTION 3

CIRCUIT DESCRIPTION

BLOCK DIAGRAM DESCRIPTION

This description is based primarily on the block diagram located in Section 6 of this manual. Signals applied to the + and —INPUT connectors pass through the + and —INPUT switches and input attenuators to the Input Amplifier stages. The INPUT switches control mode of operation and the input attenuators control the magnitude of the signals applied to the input stages.

Accurate ±dc comparison voltages are obtained from the Vc supply. These voltages can be applied to the input of either Input Amplifier by means of the + and —INPUT switches. In differential-comparator mode of operation, for example, the voltage is applied to one Input Amplifier and the signal is applied to the other.

The low-capacitance, high-impedance input of the Input Amplifier stages isolate the input circuit from the suceeding stages. The Input Amplifier stages are designed to accept input signals as great as ±6 volts without being overloaded. Special constant-current and bootstrap circuits prevent the input cathode followers from cutting off or drawing grid current when large signals (±6 v) are applied.

The output from either Input Amplifier stage is applied to the Signal Disconnect Switch. This stage limits overload signals so they do not overdrive the following stages. Immediately following the Signal Disconnect Switch is the Differential Amplifier. This stage amplifies differential signals but not common-mode signals within the operational limits of the Type 10A1.

Differential signals from the Differential Amplifier are applied to the Gain Switching stage, which provides a 20-to-1 gain switching ratio so signals do not overdrive the following stages. Gain switching is accomplished by means of the VOLTS/CM switch.

Signals from the Gain Switching stage are applied to the Output Amplifier. Here the signals are further amplified and then applied to the input of the oscilloscope vertical amplifier through pins 5 and 7 of the interconnecting plug.

Signals from the Output Amplifier are also applied to the Trigger Amplifier stage. This stage provides + and — internal triggers to drive the trigger generator circuit in the time-base plug-in unit.

In the detailed description that follows, refer to the schematic diagrams in Section 6 of this manual.

DETAILED CIRCUIT DESCRIPTION

Comparison Voltage Supply

To make the Type 10A1 comparison voltage (Vc) supply operate at its specified accuracy, the Vc supply must maintain a constant voltage independent of environmental temperature changes and differences in the regulated power supply voltages between one oscilloscope and another. To obtain this high accuracy the comparison voltage is derived from a temperature-stable reference element D582. Its output is nominally 9 volts and this voltage remains constant within 0.001% per degree centigrade change.

When the Vc POLARITY switch SW580 is set to —, D582 cathode is connected to ground and the anode is connected through R580 to the —15-volt supply. The 6V CAL adjustment R583 is set so the Vc is exactly —6 volts at the top end of the Kelvin-Varley divider. Resistors R587A through R587G make up the divider. The top end of the divider is the end farthest from ground or the top end of R587A. For the adjustment to be made properly, SW710 must be set to a "straight-thru" position (see 1F and 1R of SW710 on the Switch Details diagram). All 1F and 1R positions of SW710 are straight through except the 5, 10 or 20 VOLTS/CM positions.

When the Vc POLARITY switch SW580 is set to +, D582 cathode connects through R580 to the +15-volt supply and the anode connects to ground. Thus, a +6-volt comparison voltage is now applied to the divider load for all VOLTS/CM positions except those mentioned in the previous paragraph.

Comparison Voltage Ranges

The internal comparison voltage ranges are actually two basic ranges: 0 to 6 volts and 0 to 0.6 volts (refer to the Comparison Voltage Generator schematic diagram). For all VOLTS/CM switch positions except 5, 10 and 20 v/cm (see SW710 Switch Details), the 6-volt comparison voltage is applied to the Kelvin-Varley divider. In the 5, 10 and 20 VOLTS/CM switch positions divider resistors R727 and R730 are connected into the circuit dividing the voltage by 10 and supplying the Kelvin-Varley divider with a 0.6-volt range.

Comparison Voltage Output Circuit

The comparison voltage output circuit consists of the COMPARISON VOLTAGE (Vc) control and associated circuitry. The COMPARISON VOLTAGE control is a combination of two controls to provide direct 4-digit readout. Switch SW590 is a Kelvin-Varley bridge that selects the first digit within the range set by SW710 and the 10-turn potentiometer R595 selects the remaining digits.

Seven resistors in the bridge, R587A through R587G, make up the divider for SW590. As mentioned previously, the comparison voltage is applied to the top end of the divider; the bottom end is connected to ground. A shunt divider consisting of R590, R594 and R595 is connected across two of the resistors in the divider by means of switch SW-590. The equivalent resistance of the shunted portion of the divider is equal to 1 k. The 1V CAL control R590 provides the means for setting this resistance accurately. Thus the divider is actually divided into six equal divisions of 1000 Ω each. If the Vc output is 6 volts, for example, there will be one-volt drop across each 1000 Ω divisions of resistance.

Switch SW710 has 6 positions to permit switching the shunt divider across two resistors at a time along the string

of resistors in the divider. Each position corresponds to one digit of voltage. Variable control R595 in the shunt circuit is the vernier control for dividing the comparison voltage further so the remaining digits of voltage can be measured.

The comparison voltage set by R595 is applied through the + and/or —INPUT switches directly to the corresponding Input Amplifier stages. In contrast, any signals applied to the + or —INPUT connectors must pass through input attenuators before being applied to the Input Amplifiers. SW110 and SW310 of the VOLTS/CM switch are used to select the input attenuation of the signal as follows: 1×, 10×, 100×, and 1000×.

The comparison voltage is also applied directly to the Vc OUT 0-6 V jack. This jack permits connecting any null type, or an "infinite-impedance-type" of voltmeter to this point for the purpose of monitoring the comparison voltage. The output voltage at this jack is very limited in current output; therefore, meters which draw negligible current should be the type used to prevent measurement errors. For further information refer to topic "Vc OUT 0-6 V Jack" in the Operating Instructions section of this manual.

INPUT Switches

The separate + and —INPUT switches control the mode of operation for the Type 10A1. SW101 controls the +input side of the amplifier and SW301 controls the —input side. These switches permit connecting one input or the other, or both, to the Input Amplifier stages. The Vc position of the INPUT switches applies the comparison voltage, instead of the signal, to one or both sides of the amplifier.

NOTE

The two sides of the Type 10A1 differential amplifier are similar. To minimize duplication, the +input side of the amplifier is described in more detail throughout this description.

When the +INPUT switch SW101 is set to AC, the ac component of the input signal is coupled through C102 and then through the input attenuator to the grid of V113; the dc component is blocked by C102. When SW101 is set to DC, both ac and dc components of the signal are fed through the input attenuator; C102 is disconnected.

In the GND position of SW101, the grid of V113 is connected to ground and the signal is disconnected but not grounded. In the Vc position of SW101 the comparison voltage is applied directly to the grid and the signal is automatically disconnected.

Input Attenuators

SW110 and SW310 of the VOLTS/CM switch select the various attenuator sections for both inputs simultaneously. There are four attenuators that can be switched into the input circuits to attenuate the signal to the desired amplitude. These are: ×1, ×10, ×100 and ×1000 (see Attenuators schematic).

The attenuator networks are frequency-compensated rc dividers. At dc and very low frequencies, the dividers are resistive because the impedance of the capacitors is high and their effect in the circuit is negligible. As the frequency of the input signal increases, however, the impedance of the capacitors decreases and their effect in the circuit becomes more pronounced.

When the VOLTS/CM switch is set to 50 mVOLTS, for example, R106E adjusts the dc attenuator ratio so it is exactly 10 to 1. For higher frequencies, C106C is used to frequency-compensate the divider so the capacitive reactance ratio is equal to the resistance ratio. The adjustments in the 10× attenuator of the —input side of the amplifier are adjusted the same as the +input adjustments. When the input attenuator adjustments are accurately set so the + and —input attenuators match each other, optimum common-mode rejection is achieved.

C106A in the 10× attenuator is adjusted so the input rc of the attenuator is 20 pf × 1 meg, using an Input Time-Constant Standardizer as the reference. Each attenuator is "standardized" in this manner. Thus, an attenuator probe, when connected to either input connector and properly adjusted, will work into the same input time constant regardless of the VOLTS/CM switch position.

To prevent trace shift on the screen due to grid current, the GRID CURRENT BAL controls in the grid circuit are adjusted so a small negative voltage will offset the current.

Input Amplifier Stage

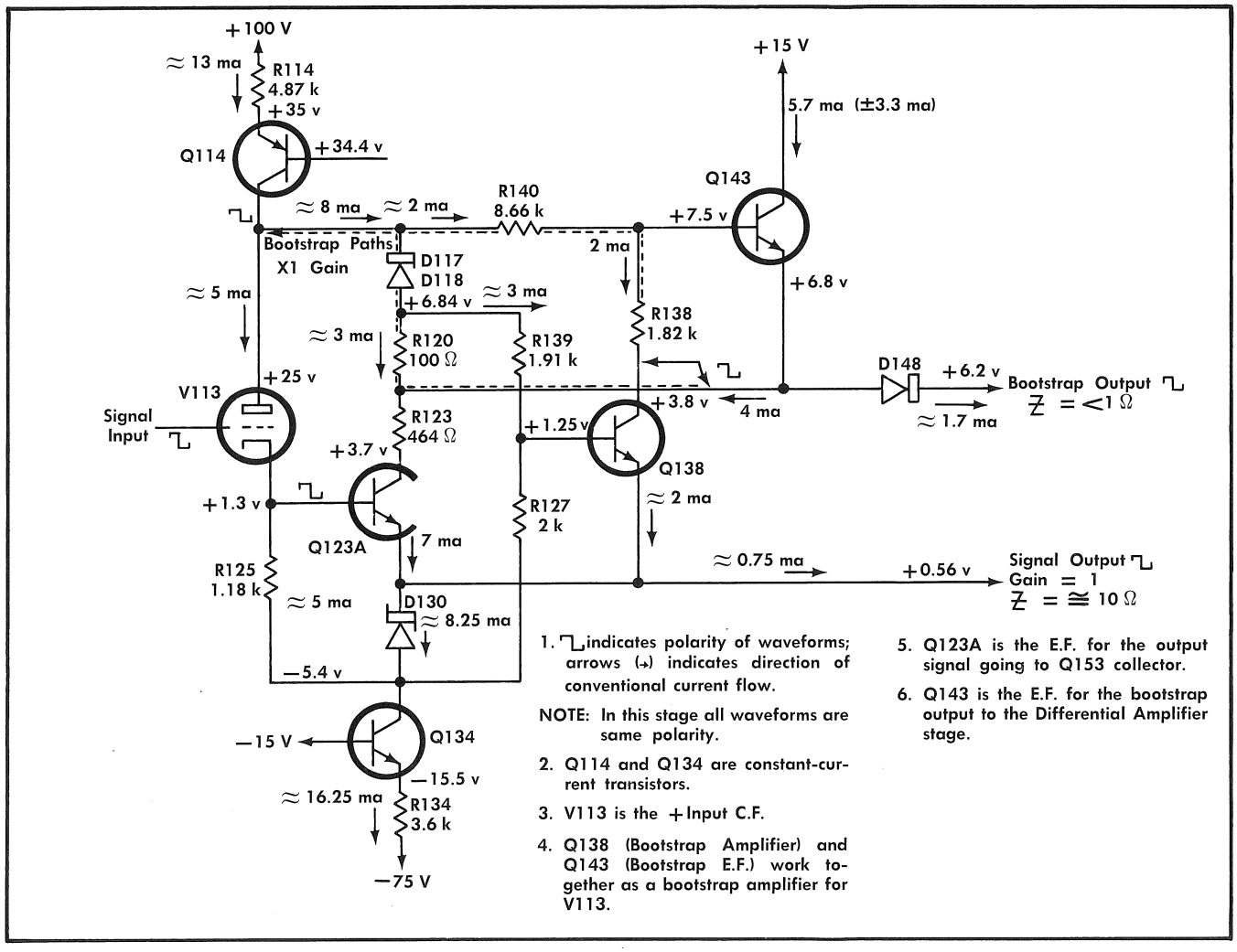
A signal from the +INPUT connector is applied to the +Input Amplifier stage. This stage consists of V113, Q114, Q123A, Q134, Q138 and Q143 with associated components. Fig. 3-1 is a simplified schematic of the stage to show the important operating conditions.

This stage provides ×1 gain at low output impedance. It has a linear operating range for signals up to ±6 volts in amplitude. Dc drift is low and is free of thermal effects down to the 0.2-mv level.

Tube V113 functions as the input cathode follower and it has a wide dynamic operating range because constant-current operation and bootstrapping is used. Q134 and Q114 are the constant-current transistors. Q138 and Q143 work together as a bootstrap amplifier for V113. Q143 also supplies a bootstrap signal to a common-mode point in the Differential Amplifier stage. Q123A is the emitter follower for the singal from V113 cathode. Capacitors C118 and C130 prevent noise, originating in the Zeners (D117 and D118), from getting into the signal path. Bootstrapping minimizes V113 changes in characteristics by keeping the plate-to-cathode voltage change as small as possible with large signal swings.

Diode D111 protects V113 against extreme turn-on conditions such as those encountered when plugging the Type 10A1 in a turned-on oscilloscope. During turn on, the diode conducts and limits the grid-to-cathode bias voltage to about +0.6 volt until V113 starts conducting normally.

The COARSE adjustment R275 adjusts the heater voltages of the input cathode follower tubes V113 and V313. This control is adjusted to balance the bias on the tubes. Thus, tubes that vary considerably in characteristics can be made to operate at about the same bias. The +BAL adjustment R130 is adjusted so the Q123A collector-to-emitter voltage is equal to the voltage across the collector load thermal-balance resistor R123 under no signal conditions.



1. ⌐⌙ indicates polarity of waveforms; arrows (→) indicate direction of conventional current flow.

NOTE: In this stage all waveforms are same polarity.

2. Q114 and Q134 are constant-current transistors.
3. V113 is the +Input C.F.
4. Q138 (Bootstrap Amplifier) and Q143 (Bootstrap E.F.) work together as a bootstrap amplifier for V113.
5. Q123A is the E.F. for the output signal going to Q153 collector.
6. Q143 is the E.F. for the bootstrap output to the Differential Amplifier stage.

Fig. 3-1. Simplified +Input Amplifier stage.

High-frequency common-mode adjustments are provided in the +Input Amplifier stage. These are: C111, C115 and C125. C111 is adjusted to make the high frequency drive to the grid of V113 equal to the drive to V313 grid. C115 loads the plate of V113 to balance up the bootstrapping and C125 sets the high-frequency loading on V113 cathode so the voltage equals the voltage at the cathode of V313.

Signal Disconnect Switch Stage

The signal from the emitter of Q123A is applied to the collector of Q153 in the Signal Disconnect Switch stage. The active components that make up this stage are Q153, Q353, D155 and D156 (see Fig. 3-2). The main purpose of this stage is to limit overload signal amplitude so the following stage is not overdriven.

Under normal signal conditions, Q153 and Q353 are in saturation. Diodes D155 and D156 are zero biased. Thus, a signal applied to the +input side (collector of Q153) passes through Q153 and appears at the emitter of Q153. There is no signal attenuation because gain is ×1 for signals up to ±0.6 volt in amplitude. However, if a positive going overdrive signal is applied, D156 conducts and Q353 disconnects the −Input Amplifier. The result is that both sides of the amplifier are connected to the +input side through D156 and Q353 emitter-base junction.

Differential Amplifier Stage

The Differential Amplifier stage consists of Q158, Q164, Q174, Q184, Q374 and Q384 with associated components and circuitry. Fig. 3-3 is a simplified diagram of the stage. Q158 operates as a constant-current transistor, Q164A and B with associated components is the differential amplifier and the remaining transistors form a common-base stage.

The stage provides ×2.5 voltage gain per side for single and differential signals but virtually no gain for common-mode signals. It remains linear for signal amplitudes of 1.2 volts or less and is able to handle common-mode signals up to 12 volts.

Variable capacitor C365 is a common-mode adjustment which balances the stray capacitance so Q184 and Q384

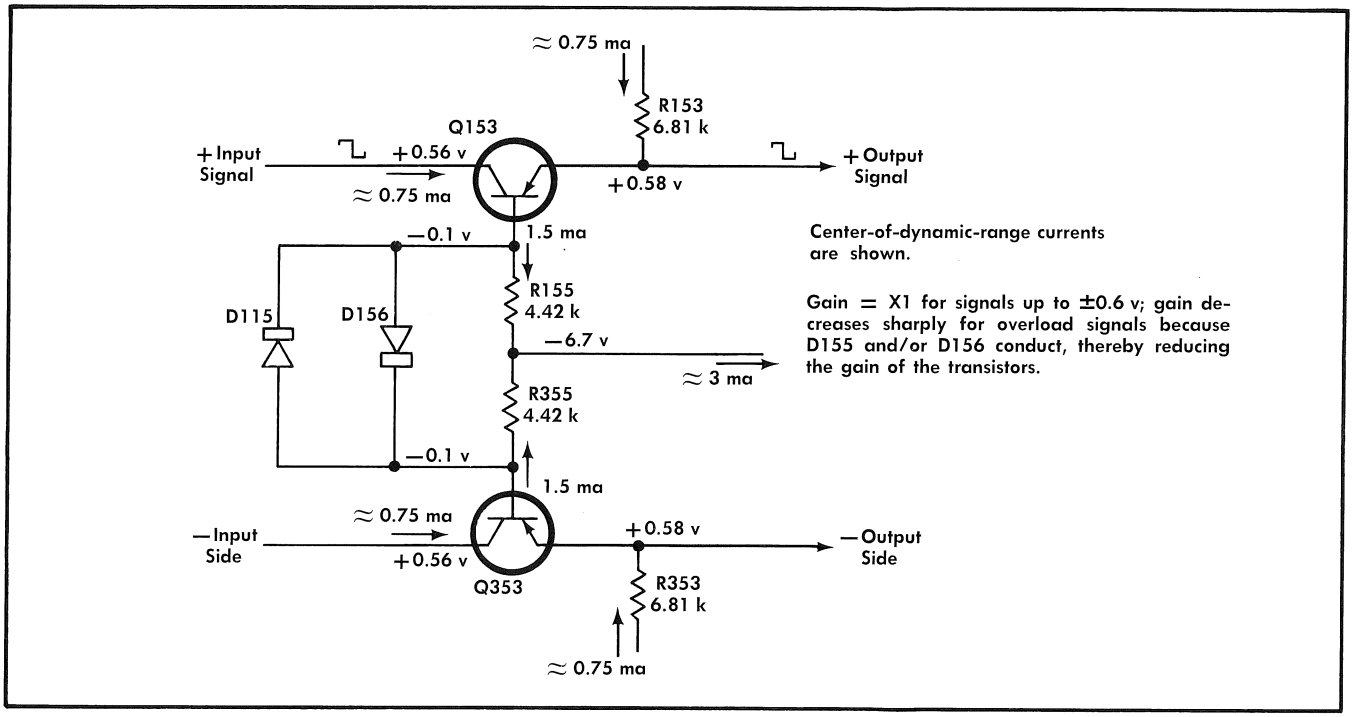
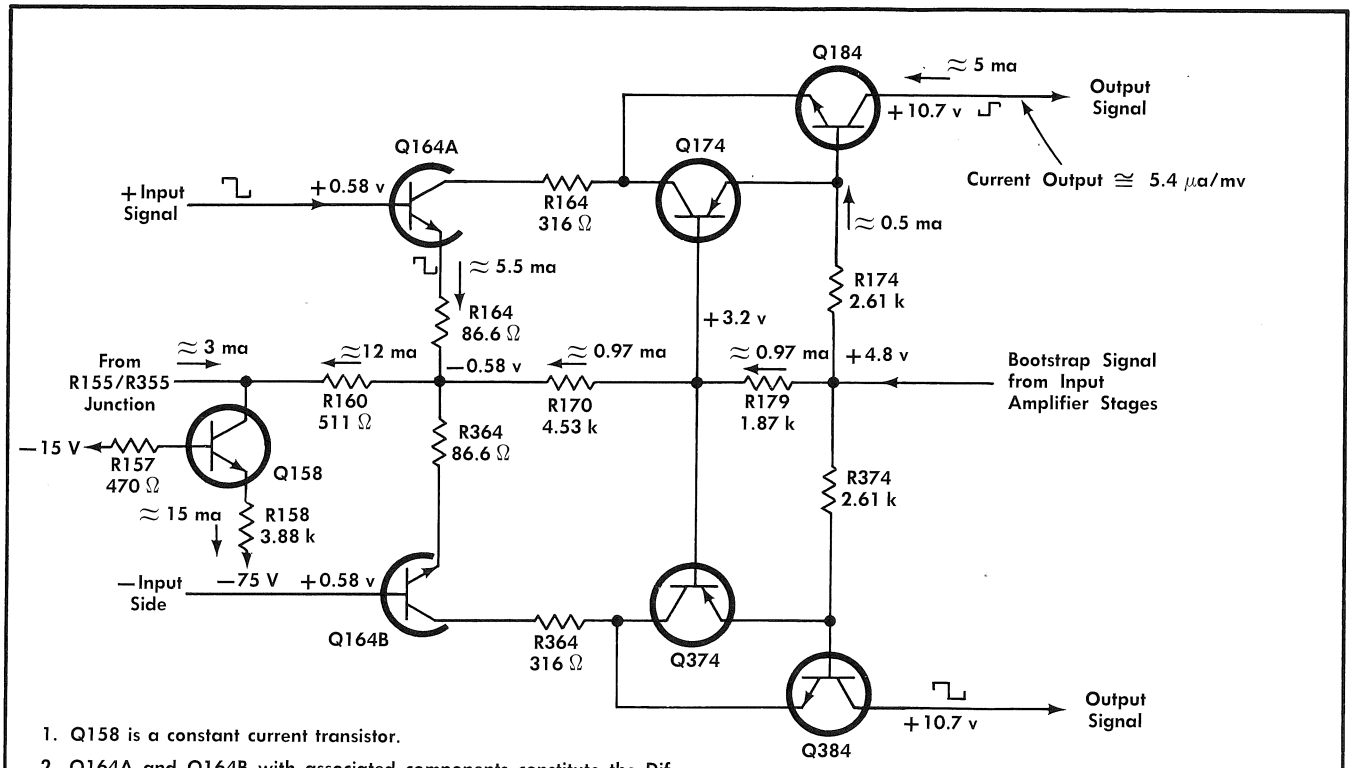


Fig. 3-2. Schematic diagram of Signal Disconnect Switch stage.



1. Q158 is a constant current transistor.
2. Q164A and Q164B with associated components constitute the Differential Amplifier.
3. Q174 and Q184 with associated components form a Common Base stage for one side while Q374 and Q384 are used in the Common Base stage for the other side.

Fig. 3-3. Simplified Differential Amplifier stage.

high-frequency currents are equal. The COMMON-MODE BAL control R183 is adjusted to provide proper voltage to Q164 for thermal balance.

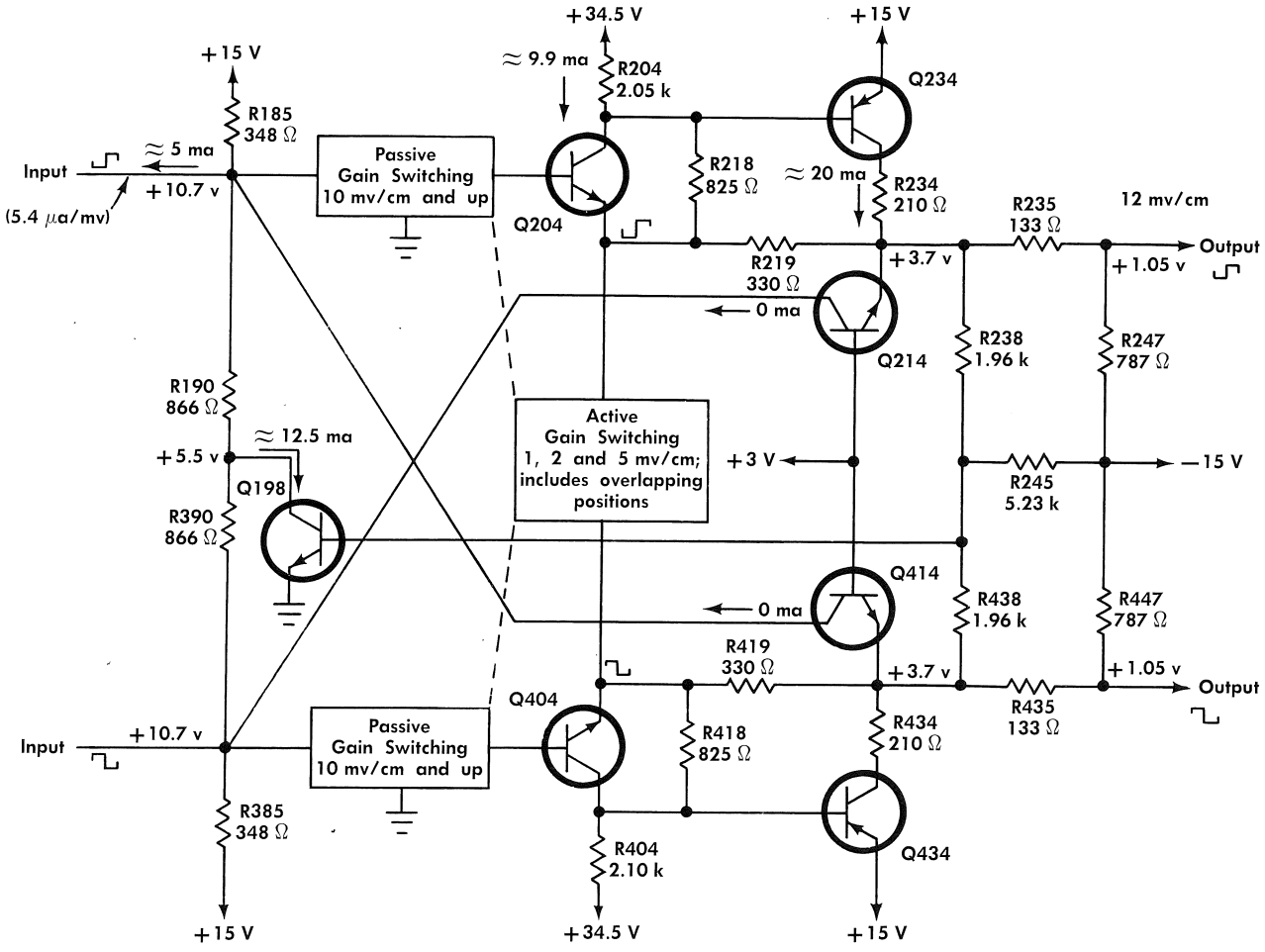
Gain Switching Stage

As shown in Fig. 3-4, the Gain Switching stage consists of seven transistors: Q198, Q204, Q404, Q214, Q414, Q234 and Q434. The function of each trasistor is briefly described in the illustration.

Passive gain switching by means of rc-type dividers is one method used for changing the gain of the stage. Switching of the dividers is accomplished by wafers 2 and 3 of the VOLTS/CM switch SW701 (see Switch Details schematic). Resistors R713B and R715 are the shunt values, R703 and R720 are the series values of resistance. They provide 1×, 2× and 4× attenuation.

Active gain switching is the other method used for controlling gain. Active gain switching takes place in the emitter circuit of Q204 and Q404 by means of wafers 4 and 5 of the VOLTS/CM switch. Attenuation is 1×, 2× and 5× for the 1, 2 and 5 mv/cm positions respectively. For the overlapping ranges, wafers 4 and 5 are actuated to provide the 2× and 1× attenuation. For 5× attenuation the circuit between 4F and 5R is open to provide maximum emitter-to-emitter resistance for signal degeneration; 2× attenuation takes place when R735B is added as shunt resistance; 1× attenuation takes place when a wire strap is connected between 4F and 5R. The combination of the two attenuation methods provides 20 to 1 gain switching ratio.

The Gain Switching stage must be able to handle 6.5 ma



1. Q198 feeds back common-mode signals; aids action of Q214 and Q414.
2. Q214 and Q414 are an overload Limiter stage using cross-coupled feedback. For normal signals Q214 and Q414 do not conduct.
3. Q204 and Q234 with associated circuitry constitute a two-stage feedback amplifier for one side while Q404 and Q434 are used in the amplifier for the other side.

Fig. 3-4. Simplified Gain Switching stage.

of signal swing. Q214 and Q414 act as signal limiters for overdrive signals. For proper phase feedback, cross coupling is used. Only one side conducts at any one time. Q198 provides common-mode negative feedback which cancels the common-mode signal caused by Q214 or Q414 conducting.

The STEP ATTEN BAL control R389 is a coarse-fine type of dual control. One section (with wiper arm connected to R387) provides coarse adjustment and the other (with wiper arm connected to R392) is a vernier control having a 60° range before the coarse adjustment is actuated. Under no-signal conditions, the control is adjusted to minimize trace shift as the VOLTS/CM switch is changed from 20 mVOLTS/CM to 5 mVOLTS/CM position. An INT DC BAL control R200 is provided to minimize trace shift as the VOLTS/CM switch is changed from the 5 mVOLTS/CM to 1 mVOLTS/CM position. Once both controls are adjusted as described, the STEP ATTEN BAL control is used to maintain overall dc balance during normal operation of the unit.

The VAR ATTEN BAL R215 is adjusted so the voltage drop across the VARIABLE R252 control is zero under no-signal conditions. Adjustment C213 is a high-frequency peaking control and R213 provides damping. The PULL FOR 1 MC BW switch SW255, when pulled outward, connects C253 in shunt with the output of the Gain Switching Stage to limit bandwidth. At the same time one end of R255 is connected to ground to complete the path for igniting neon B255.

Output Amplifier

The Output Amplifier consists of two stages: a Driver stage Q504 and Q604, and an Output-Feedback stage. Four transistors are used in the Output-Feedback stage: Q524 and Q534 on one side, Q624 and Q634 on the other side.

At the bases of Q504 and Q604 the signal input is 12 mv/cm per side and the output is 280 μa/cm per side. The Driver stage is an emitter-degeneration type with a GAIN R513 adjustment in its emitter circuit. Purpose of the stage is to provide current drive for the stage that follows. Current gain is about 2.7.

The I_b BAL R601 control is adjusted to zero the base current of Q504 to keep the base current from flowing through the VARIABLE control.

The Output-Feedback stage Q524-Q534-Q624-Q634 is current input type and it has a 93-ohm output for reverse termination of the vertical amplifier delay line. Current input is 280 μa/cm and the output is 75 mv/cm per side at pins 5 and 7 of the interconnecting plug. The POSITION control R521 in the input circuit has a range of about $\pm$10 cm. Feedback for the stage is from the emitter of Q534 through R538 to the base of Q524 for one side and through R638 for the other side.

Variable adjustments C540 and R540 are peaking and damping adjustments.

Output signal polarity at pin 5 is the same polarity as the polarity of the signal applied to the +INPUT connector. At pin 7 the signal polarity is opposite to that of pin 5 and the +INPUT connector.

Trigger Amplifier

Push-pull signals are taken from the emitter circuit of Q534 and Q634 for application to the Trigger Amplifier stage. Four transistors are used in the stage: Q564 and Q574 in one side, Q664 and Q674 in the other side.

Input voltage swing is 28 mv/cm per side. Output swing is 100 mv/cm into a 100-ohm load. Current gain is approximately 20. Output dc level is zero volts (within $\pm$0.2 v) when the difference voltage between the collectors of Q574 and Q674 is zero.

Output signal polarity at pin 13 is the same as the polarity of the signal applied to the +INPUT connector. At pin 15 the signal polarity is opposite to that at pin 13 and the +INPUT connector.

SECTION 4

MAINTENANCE

Cleaning the Front Panel

Loose dust may be removed with a cloth and a dry paint brush. Water and mild detergents such as Kelite or Spray White may be used.

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.

Cleaning the Interior

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

One way to clean the interior is by using low-pressure compressed air (high-velocity air could damage certain components). Hardened dirt may be removed with a soft, dry paint brush, cotton-tipped swab, or cloth dampened with a water and mild detergent solution. Avoid the use of chemical cleaning agents that might damage the plastic parts.

Visual Inspection

The instrument should be inspected occasionally for such defects as poor connections, broken or damaged ceramic terminal strips, improperly seated tubes or transistors, and heat-damaged parts. The remedy for most visible defects is obvious. But, damage from overheating is usually a symptom of less obvious trouble; and unless the cause is determined before parts are replaced, the damage may be repeated.

Tube and Transistor Checks

Periodic preventive maintenance checks on the tubes and transistors used in the instrument are not recommended. The circuits within the instrument generally provide the most satisfactory means of checking tube or transistor usability. Performance of the circuits is thoroughly checked during recalibration so that substandard tubes and transistors will usually be detected at that time.

Recalibration

To insure accurate measurements, the instrument calibration should be checked after each 500 hours of operation or every six months if used intermittently. Complete calibration instructions are contained in Section 5.

The calibration procedure can be helpful in isolating major troubles in the instrument. Moreover, minor troubles not apparent during regular operation may be revealed and corrected during calibration.

CORRECTIVE MAINTENANCE

General Information

Replacement of some parts in the instrument should be done in accordance with definite replacement procedures.

Many electrical components are mounted in a particular way and selected for a particular physical size and shape to reduce or control stray capacitance. After repair, portions of the instrument may require recalibration; see Section 5.

Standard Parts

Many components in the instrument are standard electronic parts available locally. However, all parts can be obtained through your Tektronix Field Engineer or Field Office. Before purchasing or ordering, consult the parts list to determine the value, tolerance, and rating required.

Special Parts

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

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 to get into tight places.

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.

Replacement of Ceramic Terminal Strips

Fig. 4-1 shows an assembled ceramic terminal strip.

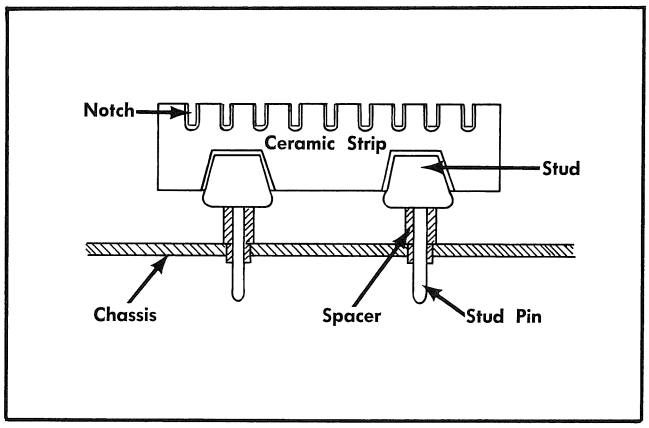


Fig. 4-1. Ceramic terminal strip assembly.

Replacement strips with studs attached are supplied under a single part number and spacers under another number. The original spacers may be reused if undamaged.

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

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

Rotary Switches

Individual wafers normally are not replaced in switch assemblies. Replacement switches may be ordered through your Tektronix Field Engineer or Field Office either unwired or wired. See the parts list in Section 6.

Replacing the VOLTS/CM-Vc RANGE Switch

The VOLTS/CM-Vc RANGE switch as a replacement wired unit contains such additional component parts as the VARIABLE control, PULL FOR 1 MC BW switch, 6 V CAL and 1 V CAL adjustments. The casting with its associated mechanical parts, however, is not included with a wired replacement switch. The following suggested procedure describes how to replace the switch as a complete wired unit.

1. Make a drawing to show where the color-coded leads are connected to the switch.

2. Unsolder the leads where they attach to the switch.

3. Set the Vc RANGE switch to 6 Volts and the VOLTS/CM switch to 20 mVOLTS.

4. Remove the front-panel knobs from the switch shafts.

5. On the back side of the sub-panel, make pencil reference marks where the casting fits against the panel. (The pencil marks aid in properly aligning the casting when installing the new switch.) Remove the hex bushing that holds the switch to the front panel.

6. Remove the two screws that hold the rear mounting bracket in place.

7. Disengage the VOLTS/CM-Vc RANGE switch from the PULL FOR 1 MC BW and input attenuator switch shafts. Remove the VOLTS/CM-Vc RANGE switch as one complete unit.

8. Make pencil marks on the mechanical parts that fit in the casting to show their relationship to each other. Loosen the setscrew that holds the casting to the front mount (next to the detent section) of the switch. (Do not loosen the setscrew in the casting that holds the pinion gear.) Loosen the setscrews that lock the nylon gear to the switch outer drive shaft.

9. Carefully slide the casting, with all associated parts intact, off the switch shaft and onto the replacement wired switch.

IMPORTANT

In removing the casting, hold the parts together carefully, or slip them onto a dummy shaft to keep them in proper order. If the parts are dropped, refer to the mechanical parts drawing in the Parts List section of the manual for reassembly information.

10. Check that the replacement switch shafts are set to the same positions as the original switch.

11. Mount the switch in the Type 10A1. When tightening the front-panel hex bushing and the setscrews, be sure the casting is properly aligned so the slotted-shaft drive to the input attenuator switches does not bind as the VOLTS/CM-Vc RANGE switch shafts are rotated.

12. Resolder all the wire leads to their respective terminals on the switch.

Replacing the Input Attenuator Switches

The input attenuator switches, SW110 and SW310, and the +INPUT and —INPUT switches are one complete wired unit. C102 and C302 are also part of the unit. Procedure for removing and replacing the wired switch as a unit is as follows:

1. Remove the +INPUT and —INPUT switch knobs.

2. Remove the outer shield cover.

3. Unsolder the leads going to the + and —INPUT connectors.

CAUTION

Use care when unsoldering or soldering. The plastic parts, especially the plastic switch wafers, can be damaged by using too much heat applied for too long a time.

4. Unsolder the V113 and V313 leads where they connect on the +INPUT and —INPUT switch wafers.

5. Set the VOLTS/CM switch to 1 mVOLTS position.

6. Remove the +INPUT and —INPUT switch nuts that hold the unit to the front panel.

7. Loosen (completely) the nuts on the + and —INPUT connectors.

8. Loosen the rear end of the spacer rod that runs from the front sub-panel to the rear plate.

9. Slide the wired-switch unit back and remove. (Hold the shock-mounted chassis shield back and the spacer rod outward so the unit can be removed.)

10. Install the replacement wired unit by reversing the above procedure. Observe the CAUTION note given in step 3.

Tubes and Transistors

Tubes and transistors should not be replaced unless actually defective. However, temporary substitution is often the fastest and best way to detect a defective component. Before substituting a tube or transistor, it is suggested that circuit conditions be checked to be certain that the replacement part will not be subject to damage. In some cases, these checks will also show whether or not the tube or transistor is at fault.

When circuit conditions are known to be safe, install a tube or transistor of the same type, known to be good, and check for proper operation. If the original component is thus proved acceptable, return it to the socket from which it came to avoid unnecessary recalibration.

CAUTION

Turn off the indicator unit power before replacing tubes or transistors. When replacing Q123 or Q164, be sure the metal indexing tab on Q123 faces to the front and the tab on Q164 faces to the rear when inserting them into their sockets. The emitter leads on these transistors are located at the opposite end from the tabs.

If Q123 is replaced and the Type 10A1 does not meet common-mode requirements during recalibration, interchange Q143 and Q343. Recalibrate the unit by repeating the pertinent dc balance, gain and common-mode steps in the Calibration procedure. If common-mode requirements are still not reached, then interchange Q138 and Q338. Repeat the dc balance, gain and common-mode adjustment steps.

If Q143, Q343, Q138 and Q338 are replaced, the same procedure should be tried if common-mode requirements are not met; that is, Q143 and Q343 should be interchanged first and then Q138 and Q338.

If tube V113 or V313 is replaced, it is recommended that both tubes be replaced at the same time. Checked tubes can be obtained through your Tektronix Field Engineer or Field Office.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting the Type 10A1 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 and waveforms 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 driven end of the switch towards 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 wires used in the Type 10A1 are color-coded to facilitate circuit tracing. The widest color stripe identifies the first color of the code. Regulated voltages supplied by the indicator unit can be identified by three color stripes and the following background color-code: white, positive voltage; tan, negative voltage.

+100 volts	Brown-black-brown on white
+15 volts	Brown-green-black on white
—15 volts	Brown-green-black on tan
—75 volts	Violet-green-black on tan

The remainder of the wiring in the Type 10A1 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.

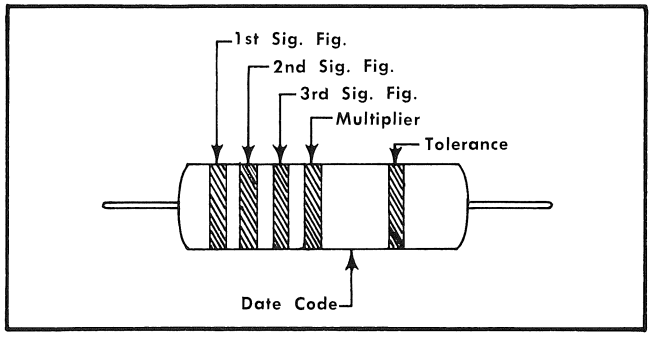


Fig. 4-2. Standard EIA color code for metal-film resistors.

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

Fig. 4-3 identifies the polarity of the various diode types used in Tektronix instruments.

Test Equipment. The following equipment will be useful in troubleshooting the Type 10A1.

1. Dynamic Transistor Tester

   Purpose: To test transistors and diodes used in the Type 10A1.

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

2. VOM

   Purpose: To check resistances and operating voltages in the unit.

   Description: 20,000 ohms/volt dc.

3. Test oscilloscope

   Purpose: To check circuit operation using the signal-tracing method.

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

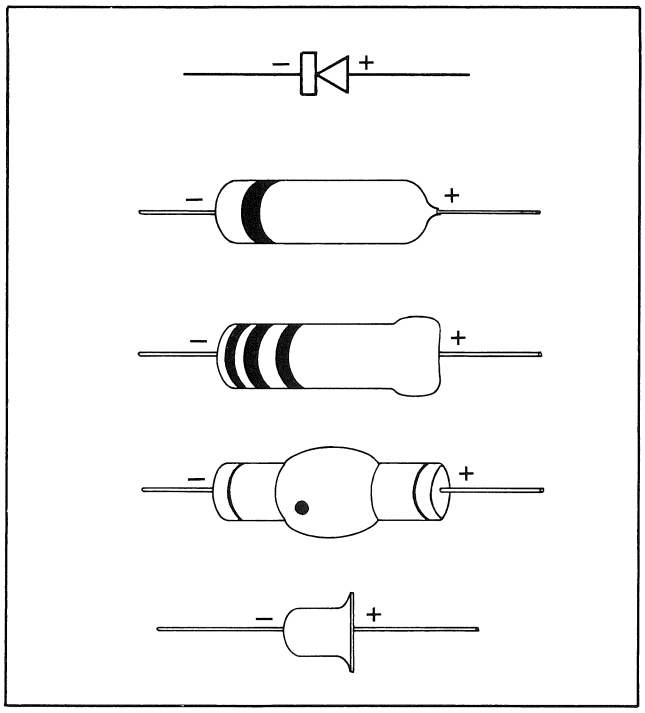


Fig. 4-3. Diode polarities.

4. Flexible Plug-In Extension Cable

   Purpose: Permits maximum accessibility to the Type 10A1 while operating the unit outside of the plug-in compartment.

   Description: 30", 32-pin. Tektronix Part No. 012-080.

Interconnecting-Plug Resistance Checks. Table 4-2 lists the typical resistances measured between the interconnecting-plug pins and ground. These readings are particularly useful for locating a possible short circuit or low-resistance path in the Type 10A1, if such a trouble occurs.

The resistance measurements are not absolute and may vary considerably since semiconductors are used in the circuitry. Different types of ohmmeters, even if the same ranges are used, will give different readings. Therefore, space is provided in the table for logging your own measurements and the type of meter used for future reference.

Significant differences between ohmmeter types are: (1) the amount of internal voltage they use, (2) the currents they require to make the meter needle deflect full scale for each range, and (3) the scale readings on the meter itself.

Operational Checks

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 settings. An incorrectly set control can produce an apparent trouble. If in doubt as to the proper setting of a control or adjustment, see "Operational Adjustments" in Section 2.

TABLE 4-2

Typical Resistances at Interconnecting Plug

[1]Pin No.	Type of Meter		VOM, Simpson Model 262	Type of Meter: Manufactured By: Model No.: Type 10A1 Serial No.:		
	Resistance Readings		Ohms Ranges	Resistance Readings		Ohms Range
	+Grnd[2]	—Grnd[3]	Used	+Grnd[2]	—Grnd[3]	Used
1	6 k	26 k	RX1K, RX10K			
3	33 Ω	33 Ω	RX10			
5	195 Ω	195 Ω	RX100			
7	195 Ω	195 Ω	RX100			
12	0 Ω	0 Ω	RX1			
13	1 k	1 k	RX1K			
14	0 Ω	0 Ω	RX1			
15	1 k	1 k	RX1K			
16	0 Ω	0 Ω	RX1			
18	515 Ω	500 Ω	RX100			
20	6 k	6 k	RX1K			

[1]Pin numbers not listed in this column have no circuit connection (infinite resistance). For pin 18 resistance reading, Vc POLARITY switch is set to +.

[2]Plus (+) polarity ohmmeter lead connected to chassis.

[3]Minus (—) polarity ohmmeter lead connected to chassis.

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 known to be operating properly. If the trouble persists after the substitution, the indicator unit or time base is defective.

Trouble Location. If the Type 10A1 is definitely at fault, make a careful operational check of the unit. Note the effect that each front-panel control has on the symptom. The normal or abnormal operation of each control 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. Also, observe the CAUTION note given earlier concerning tubes and transistors on page 4-3.

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 troubles to a portion of the circuit if possible.

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

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

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

NOTES

SECTION 5

CALIBRATION

Introduction

The Type 10A1 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 unit 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. When referring to preceding step(s), a list of the front-panel control settings is provided at major points in the procedure so a start can be made at any of those points.

NOTE

This procedure is written to provide a performance check of the unit along with a complete calibration. Steps entitled 'Check' are the performance checks. All other steps are entitled 'Adjust'. The symbol ⊘ is included in the 'adjust' title so these steps can be located easily.

As an additional aid, a calibration record is provided at the end of this section. It lists all the 'check' and 'adjust' steps. Boxes are provided so each step can be checked off as it is completed. Blanks are provided to list important voltages, serial number of the unit and date calibrated.

NOTE

If desired, make a copy of the check-off list prior to calibrating the unit. Use the copy during the procedure. When completed, it can be used as a record of the calibration.

EQUIPMENT REQUIRED

The following equipment, or equivalent, is required for a complete calibration of the Type 10A1.

(1) Type 647 Oscilloscope with a Type 11B1 or 11B2 time-base plug-in unit. This procedure assumes the oscilloscope and time-base unit are calibrated.

(2) Standard Amplitude Calibrator (optional).

Description: Output frequency of about 1 kc; peak-to-peak output amplitudes of 5, 10, 20 and 50 mv, 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50 and 100 v; amplitude accuracy of ±0.25% or better at constant ambient temperature. Tektronix Part No. 067-502.

Purpose: For use in performing steps 9 and 45 of the calibration procedure if greater accuracy than that provided by the oscilloscope calibrator is needed.

(3) Square-Wave Generator, Tektronix Type 105.

Required characteristics: Output frequencies of 100 and 500 cps, 1, 10 and 100 kc. Output impedance of 600 Ω or less. Output amplitude of about 100 volts peak-to-peak when unterminated. Risetime of 1 μsec or less when unterminated.

(4) Sine-wave generator. Tektronix Type 190B Constant-Amplitude Signal Generator.

Required characteristics: Output frequencies of 50 kc (reference), 500 kc, 1, 2, 5, 10 and 20 mc; output amplitude must be adjustable (manually or automatically) for a constant amplitude at the stated frequencies; output amplitude range adjustable from 40 mv to 10 volts peak-to-peak.

(5) Audio sine-wave generator.

Required characteristics: Output frequencies of 60 cps, 1, 10 and 100 kc at 20 volts peak-to-peak (10 volts peak referenced to ground).

(6) Dc voltmeter (VOM). Sensitivity of 20,000 Ω/v at full deflection.

(7) Precision dc voltmeter. Nulling type with infinite impedance at null.

Required characteristics: Accuracy of 0.05% or better; resolution of 50 μvolts or better. If a John Fluke Differential Voltmeter is available, use Model 801B or equivalent. If an accuracy of ±0.01% is desired, use a Model 821A.

(8) Precision Dc Divider. 10× and 100× attenuation; Tektronix Part No. 067-503.

(9) Type TU-5 Pulser package, Tektronix Part No. 015-043, contains the following items*:

Qty.	Description	Part Number
1	Type TU-5 Pulser (alone) with BNC plug-and-jack connector fittings.	015-038
1	50-ohm 10× attenuator with BNC plug-and-jack connector fittings.	011-059
1	50-ohm termination with BNC plug-and-jack connector fittings.	011-049
1	Connector adapter with UHF-plug and BNC-jack connector fittings.	103-015
1	50-ohm (nominal impedance) coaxial cable, 42" long, with a BNC connector on each end.	012-057

***If desired, any of the foregoing items can be ordered separately through your local Tektronix Field Engineer or Field Office. When ordering, give complete description and part number.**

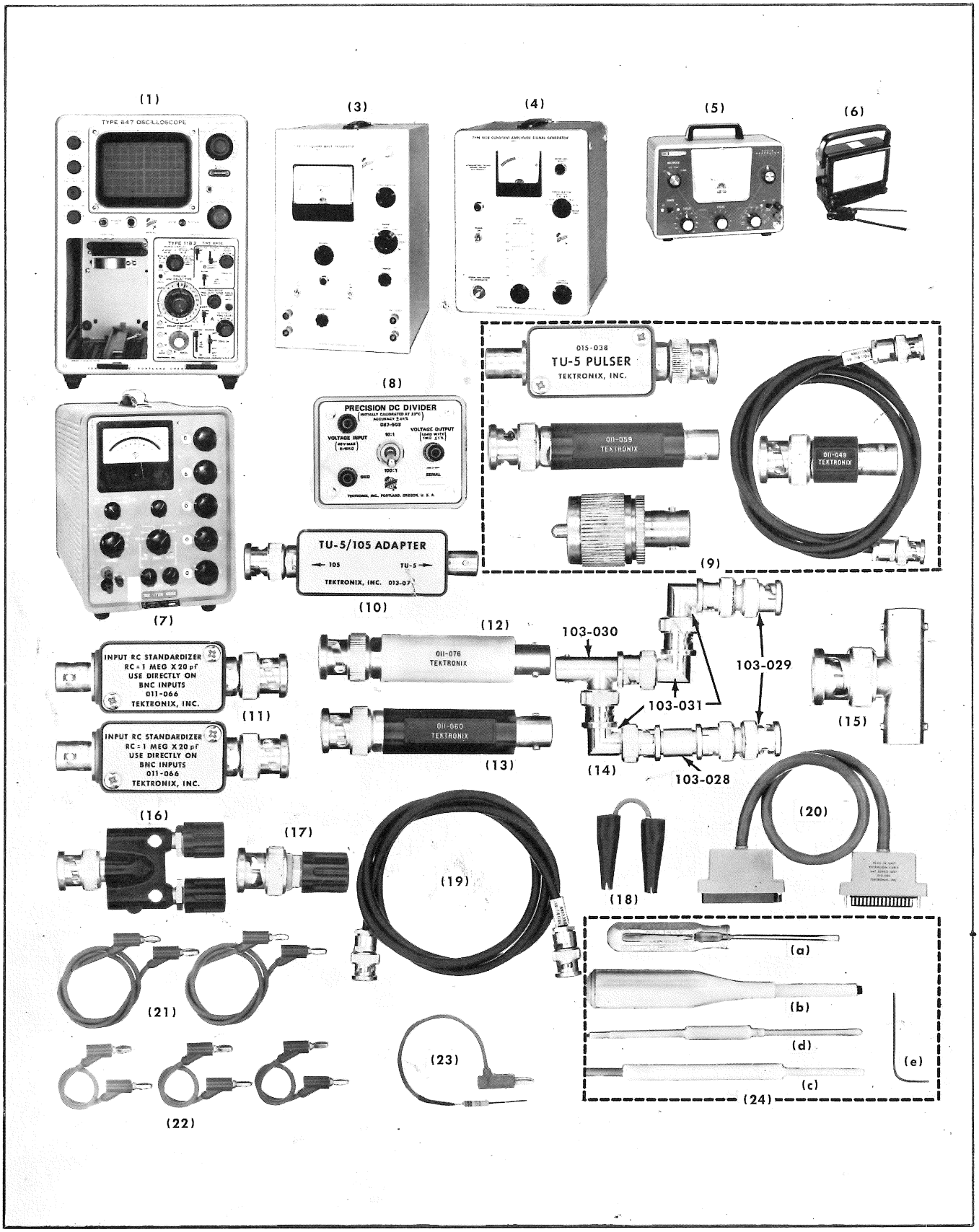


Fig. 5-1. Equipment required for a complete calibration of the Type 10A1. Item 2 (optional) is not shown.

TU-5 Pulser (015-038) characteristics:

Input Drive Signal — +100-volt (from ground) square wave capable of supplying 10 ma. (The Type 647 Oscilloscope 1 KC Calibrator does not fullfill the 10-ma requirement. Therefore, the Type 105 Square-Wave Generator, item 3, must be used to drive the TU-5 Pulser. Since the Type 105 output is a negative-going square wave, a special adapter, item 10, must also be used. Use of the Type 105 will provide a bright display due to its high repetition-rate capabilities.)

Output Amplitude — At least 200 mv with 50-ohm termination; 20 mv with 10× attenuation and 50-ohm termination.

Output Pulse Risetime—Less than or equal to 0.3 nsec into 50 ohms.

(10) TU-5/105 Adapter, Tektronix Part No. 013-075.

Purpose: Adapts the Type 105 for use as the driving source for the TU-5 Pulser.

(11) Two input time-constant standardizers.

Description: RC ≅ 1 meg × 20 pf; 2× voltage attenuation; equipped with one BNC plug and one BNC jack connector fittings; Tektronix Part No. 011-066.

(12) 2.5× 50-ohm attenuator, ½ w, with BNC plug-and-jack connector fittings. Tektronix Part No. 011-076.

(13) 5× 50-ohm attenuator, ½ w, with BNC plug-and-jack connector fittings. Tektronix Part No. 011-060.

(14) Special dual input connector (see Fig. 5-1). Made by using the following BNC connector fittings:

Qty.	Description	Tektronix Part No.
2	BNC Male to Male	103-029
1	BNC Female to Female	103-028
3	BNC Elbow	103-031
1	BNC T Male to 2 Female	103-030

(15) BNC T connector. Fits one BNC jack and accepts two BNC plugs. Tektronix Part No. 103-030.

(16) BNC dual binding post. Tektronix Part No. 103-035.

(17) Connector adapter. Single-binding post fitted with a BNC-plug connector. Binding post accepts a banana plug. Tektronix Part No. 103-033.

(18) Jumper lead, about 1" long, with miniature alligator clips on each end.

(19) 50-ohm (nominal impedance) coaxial cable, 42" long, with a BNC connector on each end. Tektronix Part No. 012-057.

(20) Flexible extension cable for plug-in unit. Tektronix Part No. 012-080.

(21) Two patch cords, 18" long, equipped with banana plug-and-jack combination connector on each end. Tektronix Part No. 012-031.

(22) Three patch cords, 6" long, equipped with banana plug-and-jack combination connector on each end. Tektronix Part No. 012-024.

(23) Resistor, 1 megohm, ¼ or ½ w, 1%. Tektronix Part No. 323-481 for ½-w resistor. Solder a 4" lead to one lead of the resistor. Solder a banana plug to the other resistor lead.

(24) Miscellaneous:

a. Small screwdriver with a ⅛" wide tip to fit the small screwdriver-adjust potentiometers.

b. Insulated low-capacitance screwdriver, Jaco No. 125, 1½" long shank, ⅛" wide metal tip. Tektronix Part No. 003-000.

c. Alignment tool, consisting of a handle (Part No. 003-307), a gray nylon insert with a wire pin (Part No. 003-308) and a nylon insert with a metal screwdriver tip (Part No. 003-334).

d. Plastic rod, 5" long, ⅛" shank diameter, screwdriver shaped tip on one end. Tektronix Part No. 003-301.

e. Hexagonal wrench, 0.050". To fit COMPARISON VOLTAGE 10-turn dial knob setscrew.

PRELIMINARY PROCEDURE

(1) Remove the left side panel from the oscilloscope.

(2) Insert the Type 10A1 and the time-base plug-in units into their respective plug-in compartments.

(3) Connect the oscilloscope power cord to the operating voltage for which the oscilloscope is wired.

(4) Turn on the oscilloscope and allow about 15 minutes for warm up.

(5) Set the Type 10A1 front-panel controls as follows:

VOLTS/CM	20 mVOLTS
VARIABLE	CAL (fully clockwise)
Vc RANGE	6 Volts
PULLED FOR 1 MC BW	Pulled outward
POSITION	Centered
Vc POLARITY	+
COMPARISON VOLTAGE	6 v (5-10-0)
+INPUT	GND
—INPUT	GND
STEP ATTEN BAL	Centered

(6) Set the time-base unit for a 0.5 msec/cm free-running sweep. Adjust the oscilloscope Intensity control so the trace is of suitable brightness.

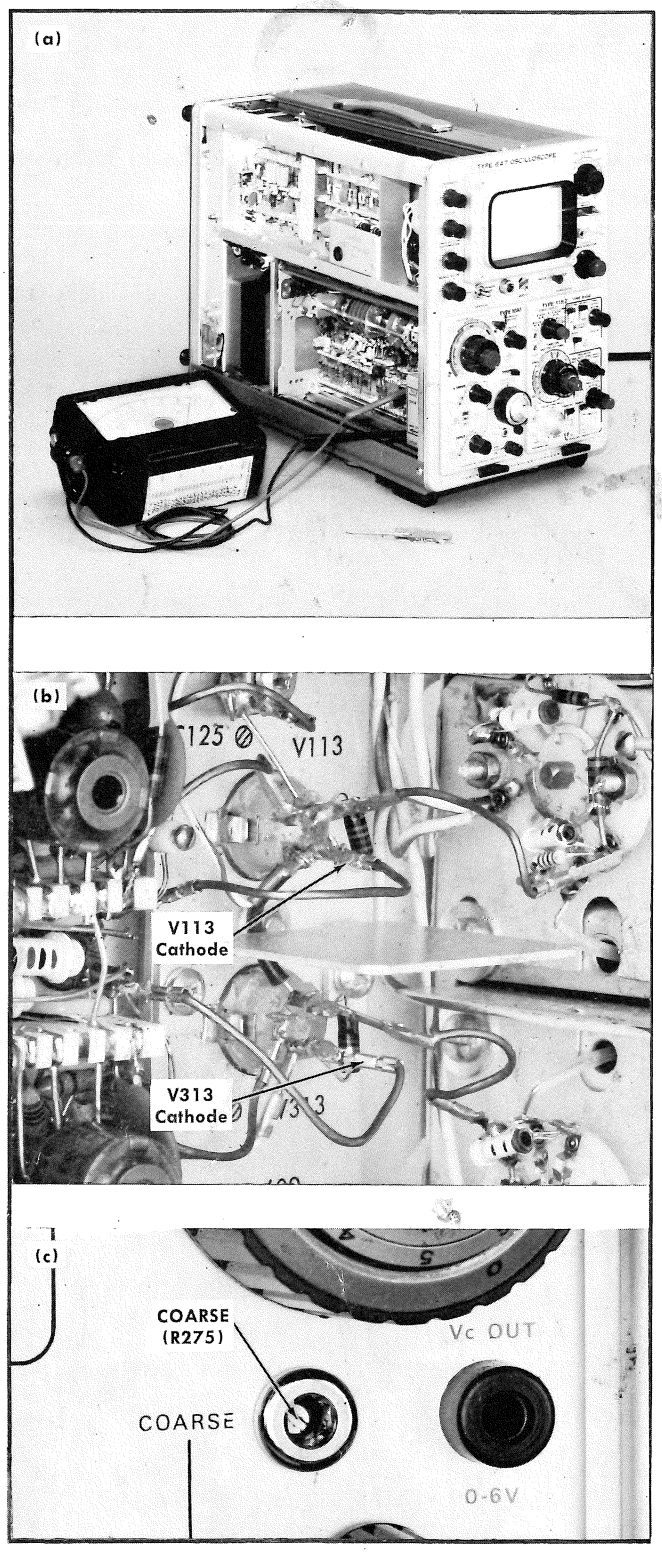


Fig. 5-2. (a) Test setup, (b) test point locations, and (c) location of COARSE adjustment for performing step 1.

CHECK AND ADJUSTMENT PROCEDURE

1. Adjust COARSE (R275)

Fig. 5-2 shows the equipment setup and locations of test points and adjustments for this step.

NOTE

Steps 1 through 8 and 11 through 13 are dc balance adjustments.

a. Connect a dc voltmeter between the cathode of V113 and ground. Note the voltage reading.

b. Connect the voltmeter between the cathode of V313 and ground. Note the voltage reading. If the readings are not the same, adjust the front-panel COARSE control for equal voltages. Typical voltage is about +1.2 volts.

c. Disconnect the voltmeter.

2. Adjust +BAL R130

Fig. 5-2 shows the equipment setup for this step. Test points and adjustments are shown in Fig. 5-3.

a. Connect a dc voltmeter between C152/R152 junction and the collector of Q123A. Note the voltage reading.

b. Connect the voltmeter between the collector of Q123A and the L123/R117 junction. Note the voltage reading. If the readings are not the same, adjust the +BAL R130 control for equal voltages. Voltage should be about 3 volts.

c. Disconnect the voltmeter.

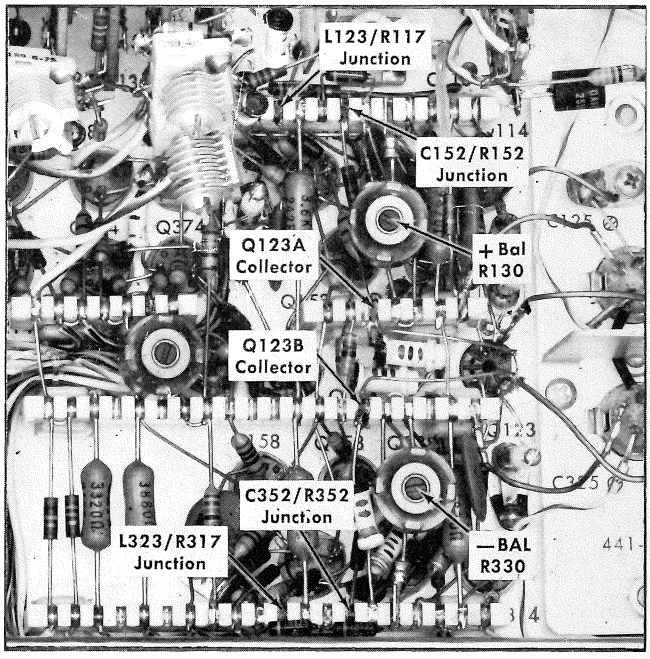


Fig. 5-3. Test point and adjustment locations for performing steps 2 and 3.

3. Adjust —BAL R330

Fig. 5-3 shows the locations of adjustments in this step.

a. Connect the voltmeter between C352/R352 junction and the collector of Q123B. Note the voltage reading.

b. Connect the voltmeter between the collector of Q123B and the L323/R317 junction. Note the voltage reading. If the readings are not the same, adjust the —BAL R330 control for equal voltages. Voltage should be about 3 volts.

c. Disconnect the voltmeter.

4. Adjust STEP ATTEN BAL (R389)

a. Check that the Type 10A1 front-panel controls are set as follows:

VOLTS/CM	20
VARIABLE	CAL
+INPUT	GND
—INPUT	GND
STEP ATTEN BAL	Centered

b. Check that the trace is centered on the screen. If it is not, preadjust the INT DC BAL R200 control (see Fig. 5-4a) to position the trace to graticule center.

c. Set the VOLTS/CM switch to 5 mVOLTS.

d. Adjust the front-panel STEP ATTEN BAL control (see Fig. 5-4b) to reposition the trace to graticule center.

e. Set the VOLTS/CM switch to 20 mVOLTS. Note the position of the trace.

f. Set the VOLTS/CM switch to 5 mVOLTS and adjust the STEP ATTEN BAL control for 1/3 over-correction. For example, if the trace shifted downward 3 cm when switching from 20 mVOLTS to 5 mVOLTS, adjust the STEP ATTEN BAL control so the trace is positioned 1 cm above the trace location noted in step 4e.

g. Repeat steps 4e and 4f for minimum trace shift as the VOLTS/CM switch is set to these positions: 5, 10 and 20 mVOLTS. Use the INT DC BAL adjustment as a positioning control to keep the trace centered on the screen.

5. Adjust INT DC BAL R200

a. Check that the VOLTS/CM switch is set to 5 mVOLTS and note the position of the trace.

b. Set the VOLTS/CM switch to 1 mVOLTS and note the distance the trace shifts.

c. Adjust the INT DC BAL R200 control (see Fig. 5-4a) to over-correct the trace position by 1/4.

d. Using the POSITION control, position the trace to graticule center.

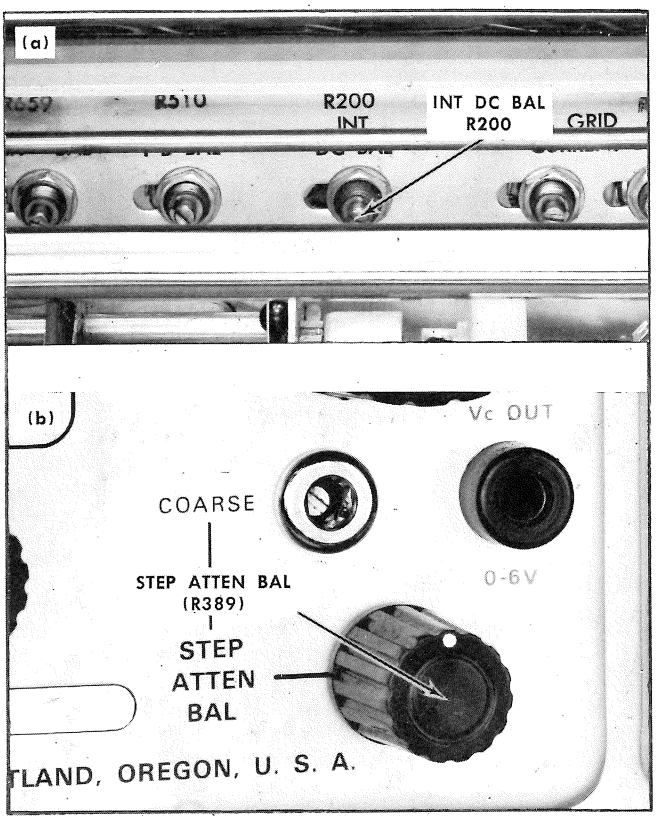


Fig. 5-4. (a) Location of INT DC BAL R200 adjustment and (b) STEP ATTEN BAL control, step 4.

e. Set the VOLTS/CM switch to 5 mVOLTS and check for trace shift away from graticule center. If the trace shifted, repeat steps 5a through 5d for no trace shift as the VOLTS/CM switch is set from 5 mVOLTS to 1 mVOLTS.

f. Due to interaction, recheck steps 4 and 5. Readjust, if necessary.

NOTE

The step attenuators in the Differential Amplifier stage should now be dc balanced from 1 through 20 mVOLTS.

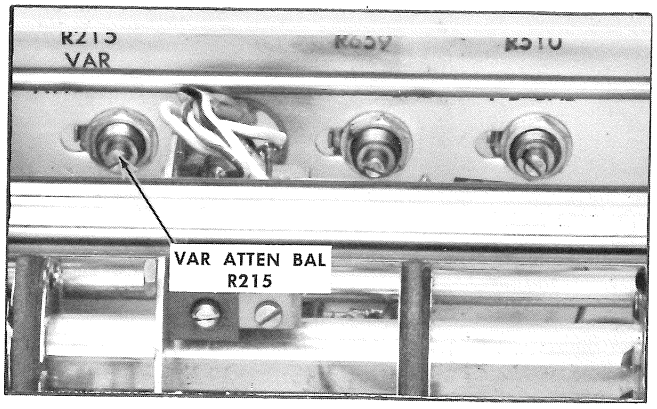


Fig. 5-5. Location of VAR ATTEN BAL adjustment, step 6.

6. Adjust VAR ATTEN BAL R215

a. Set the VOLTS/CM switch to 20 mVOLTS.

b. Check that the trace is located at graticule center. If it is not, rotate the POSITION control to reposition the trace.

c. Rotate the VARIABLE control to its fully counterclockwise position. Note the position of the trace.

d. The trace should be at graticule center. If it is not, adjust the VAR ATTEN BAL R215 control (see Fig. 5-5) to over-correct in the same direction the trace shifted by 3/5 the amount of trace shift. When the VAR ATTEN BAL control is adjusted properly, the trace should be at about the same position at both ends of the VARIABLE control rotation. The trace may move from that position in the center of the VARIABLE control rotational range, but this will be corrected by performing the next step.

7. Adjust I_b BAL R601

a. Rotate the VARIABLE control to the center of its range.

b. Adjust the I_b BAL R510 (see Fig. 5-6) to over-correct by two times the initial trace shift.

c. Using the POSITION control, position the trace to graticule center. If the I_b BAL control is adjusted properly, there should be no trace shift as the VARIABLE control is rotated through the center portion of rotational range.

NOTE

Due to interaction between adjustments, repeat steps 6 and 7 until the trace remains stationary as the VARIABLE control is rotated throughout its range.

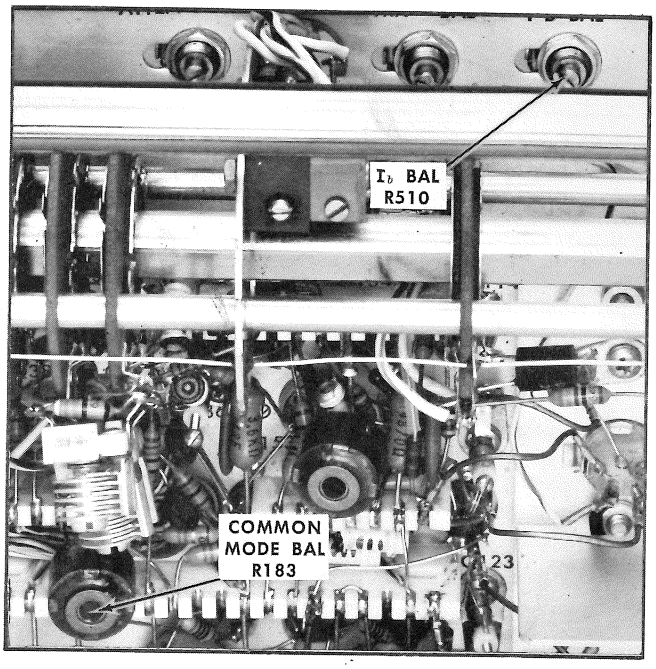


Fig. 5-6. Location of adjustments for performing steps 7 and 8.

8. Adjust COMMON MODE BAL R183

a. Check that the Type 10A1 controls are set as follows:

Vc POLARITY	+
COMPARISON VOLTAGE	5-10-0
—INPUT	GND

b. Set the VOLTS/CM switch to 1 mVOLTS, the VARIABLE control to CAL and the +INPUT switch to Vc.

c. Set the +INPUT switch to GND and observe if the trace returns quickly to its original position. If it does not, adjust the COMMON MODE BAL R183 control (see Fig. 5-6) for proper results.

d. Set the Vc POLARITY switch to — and the +INPUT switch to Vc.

e. Repeat step 8c and note if the trace returns quickly to its former position. If not, readjust the COMMON MODE BAL R183 control. The trace should return quickly to its original position within a tolerance of 0.5 mv (0.5 cm) or less with the Vc POLARITY switch in the + or — position.

9. Adjust GAIN (R513)

a. Set the +INPUT switch to DC and the VOLTS/CM switch to 5 mVOLTS.

b. Apply a 20-mv peak-to-peak calibrator signal to the +INPUT connector (see Fig. 5-7a). If possible, use an accurate calibration signal source.

c. Center the display with the POSITION control. The free-running display of the calibrator signal should be exactly 4 cm in amplitude (see Fig. 5-7b). If it is not, adjust the front-panel GAIN control (see Fig. 5-7a) so the display is proper amplitude.

d. Disconnect the calibrator signal.

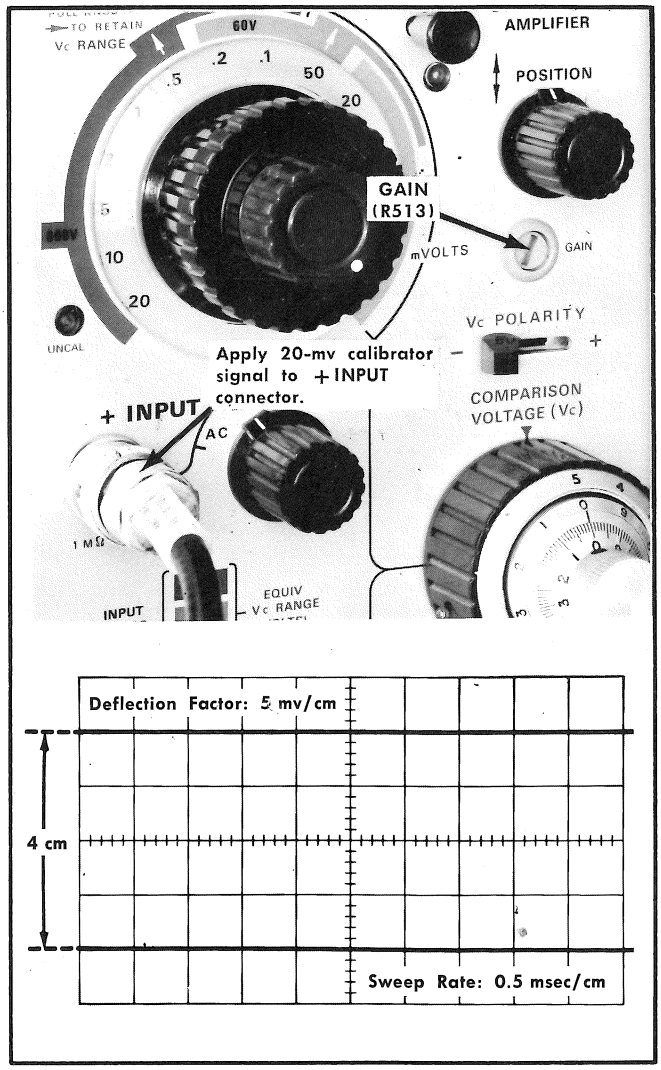


Fig. 5-7. (a) Shows where calibration signal is applied and location of GAIN adjustment for performing step 9; (b) shows display obtained when GAIN control is properly adjusted.

10. Check Microphonics

a. Set the VOLTS/CM switch to 1 mVOLTS and the +INPUT switch to GND.

b. Center the trace with the POSITION control.

c. With the finger tips, lightly tap the top of the oscilloscope frame and check for microphonics. Microphonics should be less than 1 mv in overall amplitude or less than 1 cm.

11. Adjust +GRID CURRENT BAL R136

a. Note the position of the trace.

b. Set the +INPUT switch to DC. The trace should be at the same position as noted in step 11a. If it is not, adjust the +GRID CURRENT BAL R136 (see Fig. 5-8) so the trace is positioned to the same point. To check on the accuracy of the adjustment, set the +INPUT switch to GND and back to DC. There should be no trace shift.

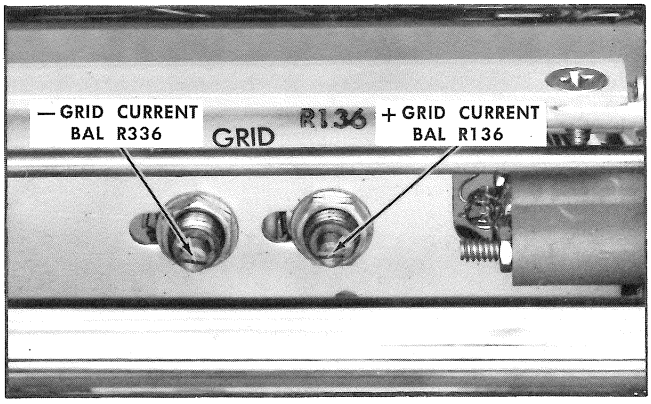


Fig. 5-8. Location of R136 and R336, steps 11 and 12.

12. Adjust —GRID CURRENT BAL R336

a. Set the +INPUT switch to GND.

b. Note the position of the trace.

c. Set the —INPUT switch to DC. The trace should be at the same position as noted in step 12b. If it is not, adjust the —GRID CURRENT BAL R336 (see Fig. 5-8) to return the trace to its original position. To check on the accuracy of the adjustment, set the —INPUT switch to GND and back again to DC. There should be no trace shift.

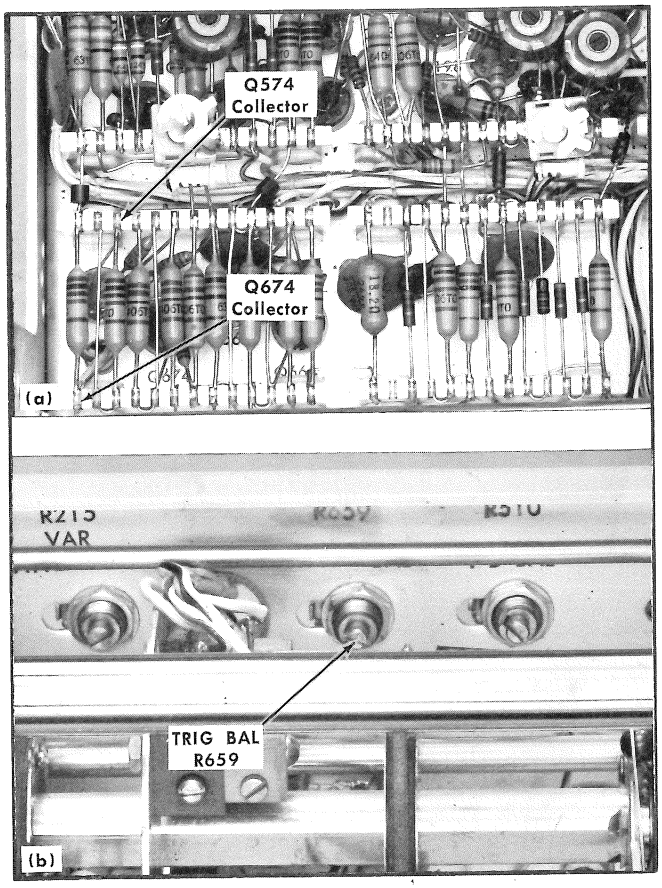


Fig. 5-9. (a) Location of test points and (b) TRIG BAL R659 adjustment for performing step 13.

13. Adjust TRIG BAL R659

a. Center the trace with the POSITION control.

b. Set the —INPUT switch to GND.

c. Remove the time-base plug-in unit part way out of its compartment to disconnect the plug-in connector.

d. Connect a dc voltmeter between the collectors of Q574 and Q674 (see Fig. 5-9a). The voltmeter reading should be zero. If it is not, carefully adjust the TRIG BAL R659 control (see Fig. 5-9b) to obtain the zero reading.

NOTE

Due to drift, exact zero is difficult to obtain. A reading within ±0.2 volt is satisfactory.

e. Disconnect the voltmeter and reinsert the time-base unit fully into its compartment.

14. Check Minimum Vc

a. Set the COMPARISON VOLTAGE control (switch and 10-turn dial) for minimum reading; that is, a reading at (or near) zero volts (0-0-0). At the fully counterclockwise rotation of the 10-turn dial, its reading may be in the range 0 to 0.5 mv; that is, 0 to ½ minor division as set during the previous calibration period.

b. Set the Vc POLARITY switch to +.

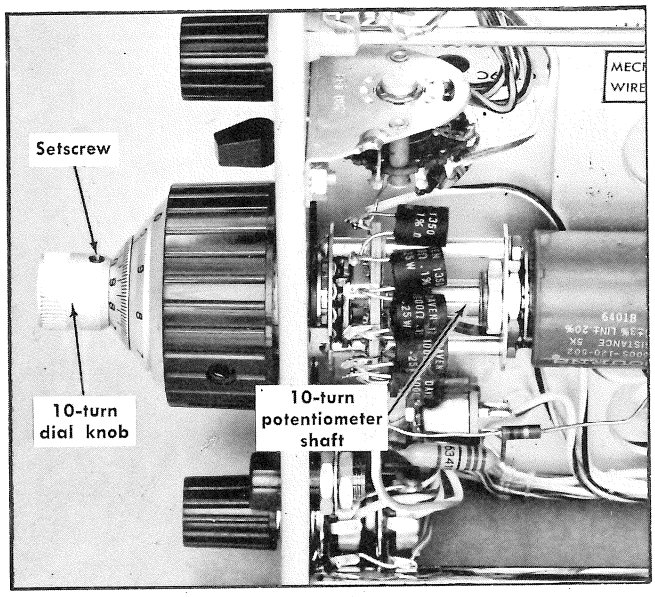


Fig. 5-10. Zero volts mechanical calibration, step 14.

c. At this point in the procedure, the remaining Type 10A1 front-panel controls should be at these positions:

VOLTS/CM	1 mVOLTS
VARIABLE	CAL
Vc RANGE	6
PULL FOR 1 MC BW	Pulled outward
POSITION	Adjusted so trace is at graticule center
+INPUT	GND
—INPUT	GND
STEP ATTEN BAL	Adjusted for minimum trace shift as the VOLTS/CM switch is set from 20 mVOLTS to 1 mVOLTS or vice versa

d. Note the position of the trace.

e. Set the +INPUT switch to Vc and measure the amount of residual Vc voltage. The voltage should be 0.5 mv or less; that is, when switching the +INPUT switch from GND to Vc, trace shift should be 0.5 cm or less. If the residual voltage does not agree with 10-turn dial setting, loosen the setscrew in the 10-turn dial knob with a 0.050" hexagonal wrench. Turn off the oscilloscope power, remove the Type 10A1 plug-in, hold the COMPARISON VOLTAGE potentiometer shaft (see Fig. 5-10) in its fully counterclockwise position, and turn the 10-turn knob so the reading is the same as the amount of residual voltage. **(If the knob can be reset on the shaft without removing the unit, do so.)** Accuracy of this mechanical adjustment should be within 0.5 mv. Tighten the setscrew, reinsert the unit into the plug-in compartment and turn on the oscilloscope power.

15. Adjust 6V CAL R583

Fig. 5-11a shows the test equipment used in steps 15 through 18.

a. Set the +INPUT switch to GND and the COMPARISON VOLTAGE control to +6 volts (5-10-0).

b. Set the non-loading dc voltmeter to +6 volts.

c. Connect the non-loading voltmeter between the Vc OUT 0-6 V jack (located on the front panel of the Type 10A1) and ground. Use the ground connector on a dual binding post to make a ground connection on the Type 10A1 (see Fig. 5-11a).

d. There should be a null reading on the voltmeter. If there is not, note the amount of error. If it is more than 1 mv, adjust the 6 V CAL R583 control (see Fig. 5-11b) for a null reading.

e. Disconnect the voltmeter and set it to —6 volts.

f. Set the Vc POLARITY switch to — and reconnect the voltmeter to the Type 10A1 as directed in step 15c. Check the amount of error from —6 volts. If it is more than 1 mv, adjust the 6 V CAL R583 control for a compromise adjustment of ±6 volts, within ±1 mv. (To check on compromise adjustment accuracy, repeat steps 15a through 15 f.)

g. Disconnect the voltmeter.

16. Adjust 1V CAL R590

a. Set the Vc POLARITY switch to + and the COMPARISON VOLTAGE control to +1 volt (0-10-0).

b. Set the non-loading voltmeter to +1 volt.

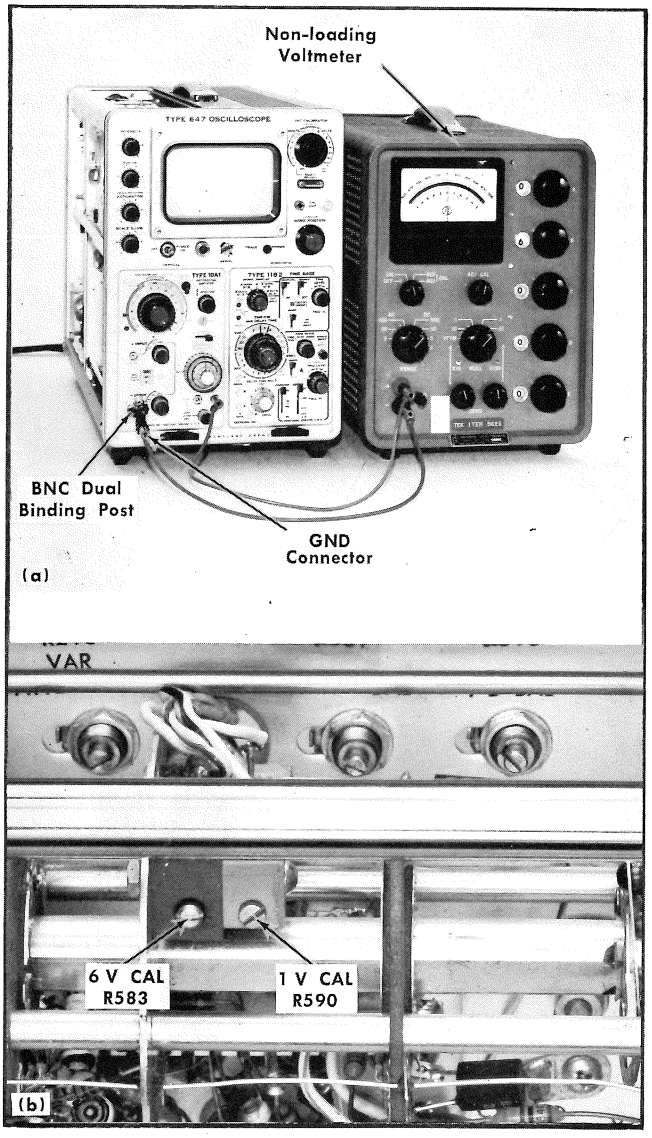


Fig. 5-11. (a) Shows test setup for performing steps 15 through 18 and (b) location of adjustments for performing steps 15 and 16.

c. Connect the voltmeter between the Vc OUT 0-6 V jack and ground. Use the dual binding post ground connector for the ground connection as shown in Fig. 5-11a.

d. There should be a reading of not more than 0.5 mv error on the voltmeter. If there is more, adjust the 1 V CAL R590 control (see Fig. 5-11b) to obtain a null reading.

e. Due to interaction of adjustments, repeat steps 15 and 16.

17. Check Vc Divider (COMPARISON VOLTAGE Switch)

Using the same connections as described in step 16c, use the non-loading voltmeter to check the Vc divider voltages. For example, set the voltmeter to +2 and check for null reading (within 2.5 mv) when the COMPARISON VOLTAGE control outer knob is set to 1. Check remaining voltages in a similar manner; that is, for the 2, 3 and 4 outer knob settings the voltages should be +3 (within 3 mv), +4 (within 3.5 mv) and +5 (within 3.5 mv), respectively.

18. Check COMPARISON VOLTAGE 10-Turn Potentiometer Linearity

a. Set the COMPARISON VOLTAGE control for minimum reading (0-0-0).

b. Use the non-loading voltmeter to check the comparison voltage for each major division of the COMPARISON VOLTAGE 10-turn dial; that is, at 0-1-0, 0-2-0, 0-3-0, etc. Voltage reading should be 0.1 v, 0.2 v, 0.3 v, etc., respectively, within a tolerance of ±4 mv.

c. Disconnect the voltmeter.

19. Check COMPARISON VOLTAGE 10-Turn Potentiometer for Combined Readout and Resolution Error

a. Set the —INPUT switch to Vc and check that the +INPUT switch is set to GND.

b. Set the COMPARISON VOLTAGE control to 0 v (0-0-0).

c. Using the POSITION control, position the trace to the top graticule line.

d. Rotate the COMPARISON VOLTAGE 10-turn dial slowly in a clockwise direction so the trace is positioned to graticule center. Be sure the trace is positioned to exact center and **no** farther as the dial is turned clockwise. Read the dial setting as accurately as possible and note the reading.

e. Continue rotating the COMPARISON VOLTAGE 10-turn dial clockwise until the trace is positioned to the bottom graticule line, and then turn the dial slowly counterclockwise to position the trace back to graticule center. Use care in rotating the dial, because this time the trace must be positioned to exact center and no farther as the dial is turned in a counterclockwise direction. Note the dial reading. The difference between the readings obtained in steps 19d and 19e is the combined readout and resolution error. The error must be equal to or less than 0.5 mv (½ minor division on the dial).

20. Adjust R106E (+Input 10X Attenuator)

a. Turn off the oscilloscope power, remove the Type 10A1 plug-in unit, connect a flexible extension cable between the Type 10A1 and oscilloscope. Lay the Type 10A1 on its right side.

b. Remove Q945 located in the Type 647 Oscilloscope (see Fig. 5-12b) and turn on the power.

c. Connect a BNC dual binding post to the +INPUT connector.

d. Connect a binding post adapter to the oscilloscope Cal Out connector.

e. Connect an 18" patch cord from the oscilloscope Cal Out connector to the +INPUT connector.

f. Connect a 6" patch cord from the +INPUT connector to the Precision Dc Divider Voltage Input connector.

g. Set the COMPARISON VOLTAGE control outer knob between the 1 and 0 detent positions. (This internally disconnects the Type 10A1 comparison voltage.)

NOTE

Leave the outer knob between 1 and 0 through step 23.

h. Connect a 6" patch cord between the Vc OUT 0-6V jack and the Precision Dc Divider Voltage Output connector.

i. Connect a 1-megohm 1% resistor between the Precision Dc Divider Voltage Output connector and the Gnd connector.

j. Connect a 6" patch cord between the Precision Dc Divider Gnd connector and the ground connector on the BNC dual binding post.

k. Set the Precision Dc Divider Voltage 10:1-100:1 switch to 10:1. The complete setup is shown in Fig. 5-12a.

l. Set the Vc RANGE switch to the 60-volt range and the VOLTS/CM switch to 10 mVOLTS in the retained 60-volt range.

m. Set the oscilloscope 1 KC Calibrator switch to 50 volts. (Setup loading reduces the calibrator voltage to about 35 volts.)

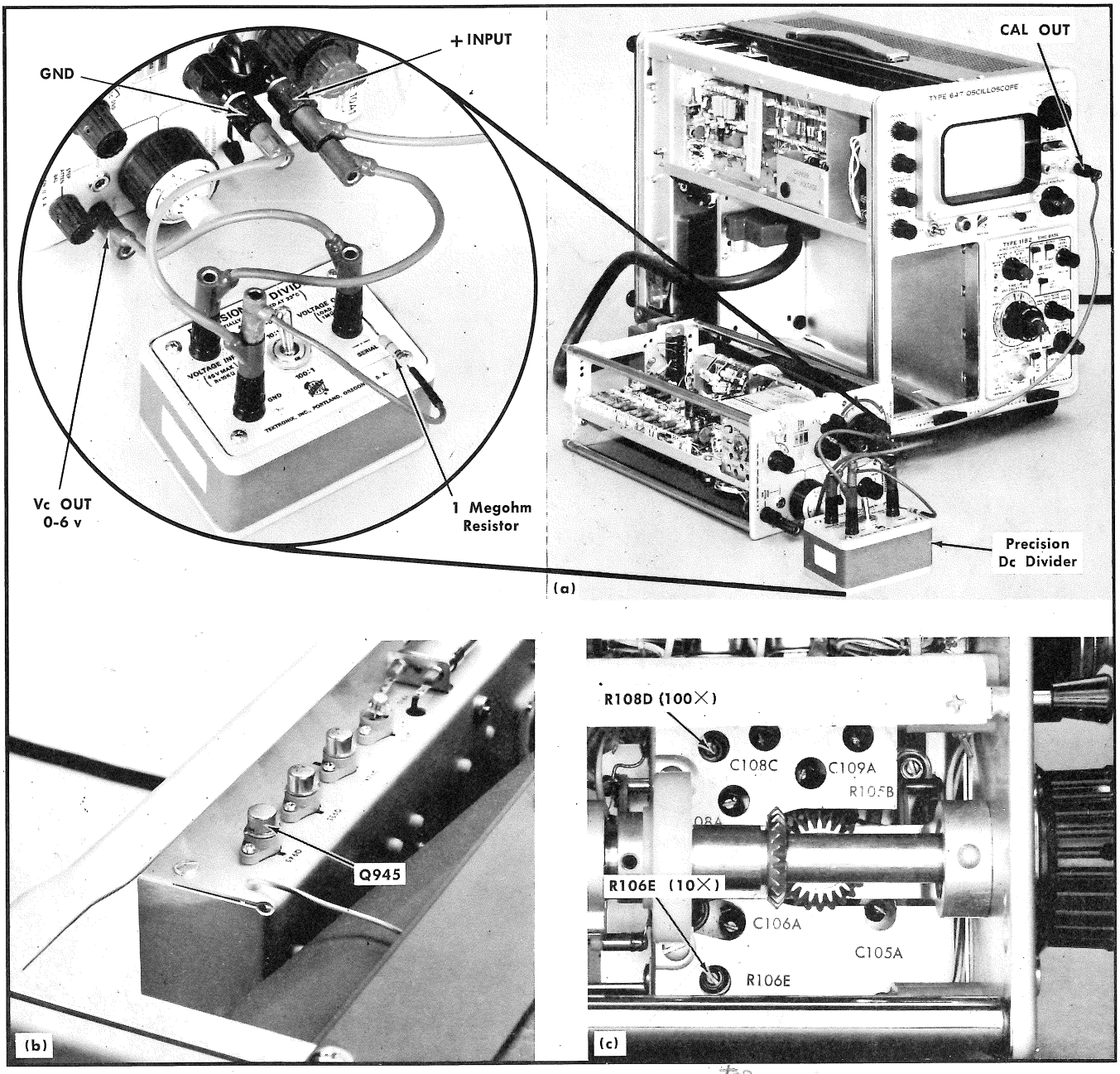


Fig. 5-12. (a) Setup used for steps 20 and 21; (b) location of Q945; (c) location of +input attenuator adjustments.

n. Set the +INPUT and —INPUT switches to Vc. Adjust the POSITION control to position the trace to graticule center.

o. Set the +INPUT switch to DC. Check that the trace is located at graticule center. If it is not, adjust R106E (see Fig. 5-12c) to return the trace to graticule center. As a double check on the accuracy of the adjustment, set the +INPUT switch to Vc and back to DC. There should be no trace shift.

NOTE

When performing steps where stray pickup results in a wide trace, placing the hand over the input circuit area of the Type 10A1 will help to minimize trace noise.

21. Adjust R108D (+Input 100X Attenuator)

a. Set the Vc RANGE switch to 600 volts and the VOLTS/CM switch to .1 VOLTS in the retained 600-volt range.

b. Set the +INPUT switch to Vc.

c. Set the Precision Dc Divider 10:1-100:1 switch to 100:1.

d. Using the POSITION control, position the trace to graticule center.

e. Set the +INPUT switch to DC. Check that the trace coincides with graticule center. If it does not, adjust R108D (see Fig. 5-12c) so the trace is coincident. As a double check, set the +INPUT switch to Vc and back to DC. There should be no trace shift.

22. Adjust R306E (—Input 10X Attenuator)

a. Set the +INPUT switch to Vc.

b. Disconnect the BNC dual binding post (with leads attached) from the +INPUT connector and reconnect the dual binding post to the —INPUT connector. This is the same setup as shown in Fig. 5-12a except the —INPUT connector is being used instead of the +INPUT connector.

c. Set the Precision Dc Divider 10:1-100:1 switch to 10:1.

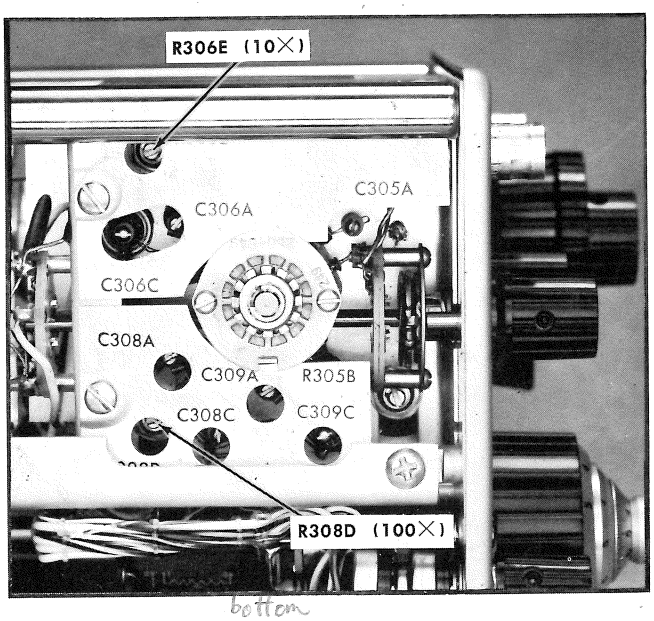


Fig. 5-13. Location of —input attenuator adjustments, steps 22 and 23.

d. Set the Vc RANGE switch to the 60-volt range and the VOLTS/CM switch to 10 mVOLTS in the retained 60-volt range.

e. Using the POSITION control, position the trace to graticule center.

f. Set the —INPUT switch to DC. Check that the trace is located at graticule center. If it is not, adjust R306E (see Fig. 5-13) to return the trace to graticule center. To double check on the adjustment accuracy, set the —INPUT switch to Vc and back to DC. There should be no trace shift.

23. Adjust R308D (—Input 100X Attenuator)

a. Set the Vc RANGE switch to 600 volts and the VOLTS/CM switch to .1 VOLTS in the retained 600-volt range.

b. Set the —INPUT switch to Vc.

c. Set the Precision Dc Divider 10:1-100:1 switch to 100:1.

d. Position the trace to graticule center using the POSITION control.

e. Set the —INPUT switch to DC. Check that the trace is centered. If it is not, adjust R308D (see Fig. 5-13) to return the trace to graticule center. As a check on the adjustment accuracy, set the —INPUT switch to Vc and back to DC. The trace should remain at graticule center for each of the —INPUT switch positions given in this step.

f. Set the +INPUT and —INPUT switches to GND.

g. Turn off the oscilloscope power, set the 1 KC Calibrator switch to Off, insert Q945 into its socket, and turn on the oscilloscope power.

h. Disconnect the Precision Dc Divider and all interconnecting leads.

24. Adjust R105B (+Input 1X Attenuator)

a. Connect the BNC dual binding post to the +INPUT connector.

b. Connect the 1-megohm, 1% resistor between the +INPUT connector and the Vc OUT 0-6 V jack.

c. Set the Vc RANGE switch to 60 volts and the VOLTS/CM switch to 50 mVOLTS.

d. Set the COMPARISON VOLTAGE control to 6 volts (5-10-0).

e. Set the +INPUT switch to DC.

f. Connect the non-loading voltmeter between the +INPUT connector and ground on the Type 10A1 (see Fig. 5-14a for setup). About +3 volts will be applied to the voltmeter.

g. Set the non-loading voltmeter for a null reading.

h. Set the Vc RANGE switch to 6 volts and the VOLTS/CM switch to 20 mVOLTS.

i. Check for a null reading on the voltmeter. If a null is not obtained, adjust R105B (see Fig. 5-14b) for a null reading.

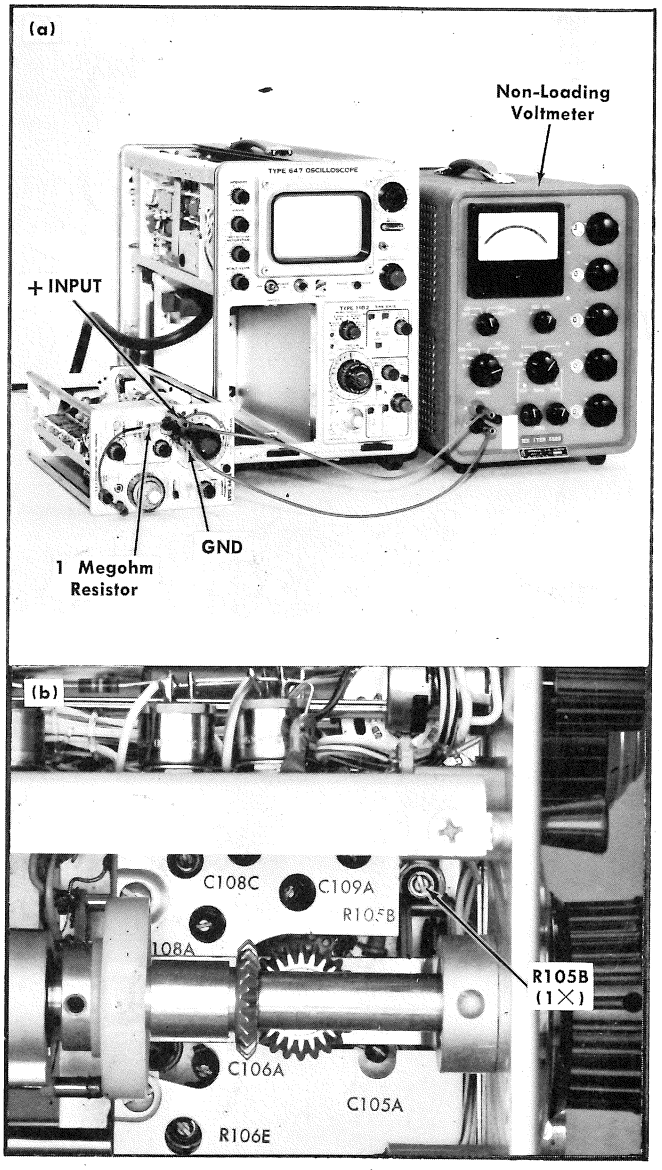


Fig. 5-14. (a) Setup for performing step 24, and (b) location of R105B.

25. Adjust R305B (—Input 1X Attenuator)

a. Set the +INPUT switch to GND, Vc RANGE switch to 60 volts and the VOLTS/CM switch to 50 mVOLTS.

b. Set the —INPUT switch to DC.

c. Disconnect the BNC dual binding post (with leads attached) from the +INPUT connector and reconnect the binding post to the —INPUT connector. This is the same set-up as shown in Fig. 5-14a except the —INPUT connector is being used.

d. Set the non-loading voltmeter to obtain a null reading.

e. Set the Vc RANGE switch to 6 volts and the VOLTS/CM switch to 20 mVOLTS.

f. Check for a null reading on the voltmeter. If the reading is not obtained, adjust R305B (see Fig. 5-15) for a null reading.

g. Disconnect the voltmeter, resistor and dual binding post.

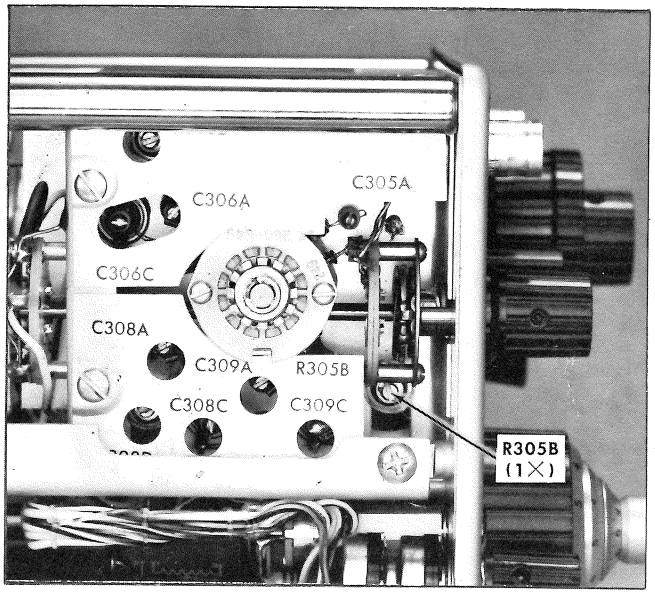


Fig. 5-15. Location of adjustment R305B.

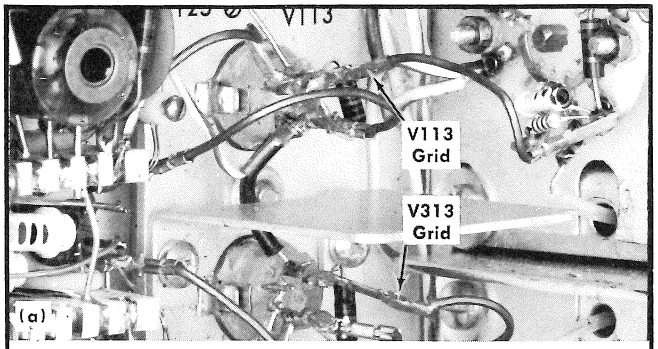
26. Check Dc Common-Mode Rejection

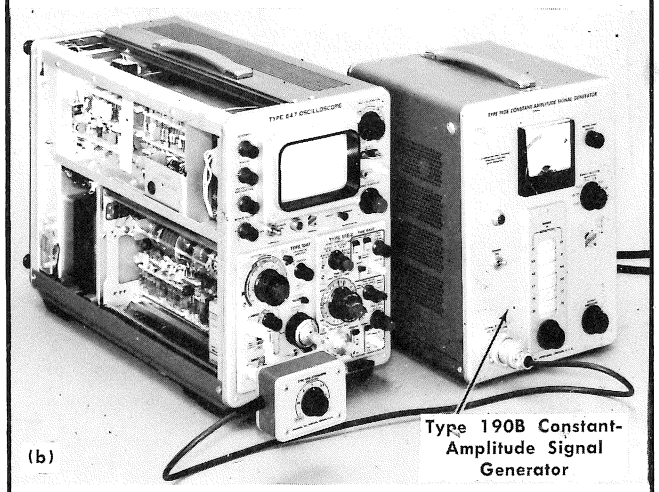
a. Turn off the oscilloscope power, remove the plug-in extension cable, and insert the Type 10A1 directly into the plug-in compartment.

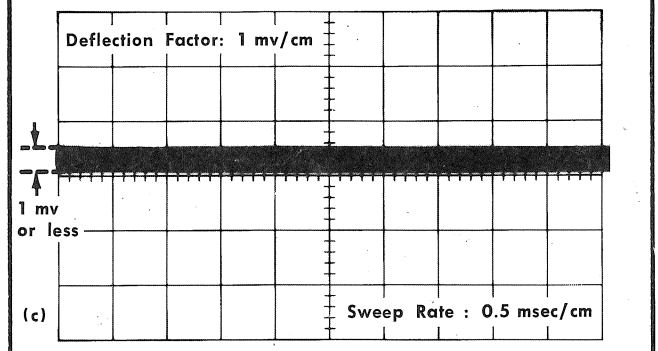
b. Set the —INPUT switch to GND, Vc RANGE switch to 6 volts, and the VOLTS/CM switch to 1 mVOLTS.

c. At this point in the procedure, the remaining Type 10A1 front-panel controls should be set as follows:

Vc RANGE	6 Volts
PULL FOR 1 MC BW	Pulled outward
POSITION	Trace positioned to graticule center
COMPARISON VOLTAGE	6 v (5-10-0)
+INPUT	GND







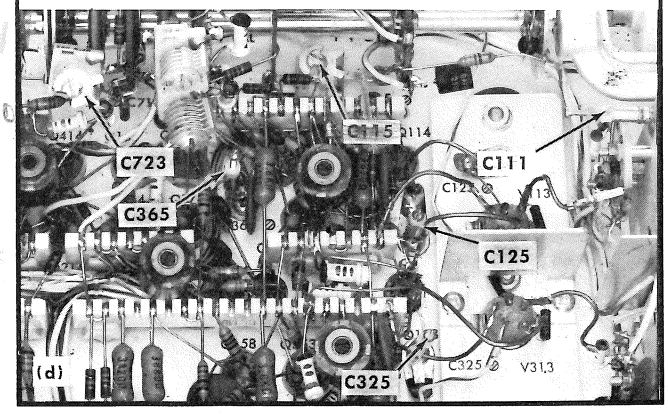


Fig. 5-16. (a) Test-point locations for performing step 27, (b) test setup and (c) adjustment locations for steps 27 through 29. (d) Shows typical display obtained when completing step 27.

STEP ATTEN BAL	Adjusted for minimum trace shift as the VOLTS/CM switch is set from 20 mVOLTS to 1 mVOLTS

d. Set the +INPUT and —INPUT switches to Vc. In this step the 6 volts dc is applied from the Vc supply to both sides of the amplifier.

e. Check that the trace shift from graticule center is less than 0.3 cm. Disregard any trace shift due to slow drift.

27. Adjust C723, C365, C125 and C325 (Ac Common-Mode Rejection)

a. Set the +INPUT and —INPUT switches to GND.

b. Connect a short jumper lead from V113 grid to V313 grid (see Fig. 5-16a).

c. Apply a 10-mc, 1-volt peak-to-peak, sine-wave signal from the Type 190B Constant-Amplitude Signal Generator, or equivalent, to the +INPUT and —INPUT connectors. Use a special dual-input connector (item 14) so coaxial connections of equal lengths are used to apply the signal to the Type 10A1. Fig. 5-16b shows the setup.

d. Push the PULL FOR 1 MC BW knob in; set the +INPUT and —INPUT switches to DC.

e. Check the amplitude of the display. It should be about 1 mv peak-to-peak or less (see Fig. 5-16c). If it is not, adjust C723 (see Fig. 5-16d) for a minimum amplitude display. Then, adjust C365, C125 and C325 (see Fig. 5-16d), to obtain a minimum amplitude display similar to the one shown in Fig. 5-16c. Allow for capacitance effect of the alignment tool.

f. Due to interaction between adjustments, repeat step 27e to obtain a display of minimum amplitude.

28. Adjust C115 (Ac Common-Mode Rejection)

a. Set the Type 190B for 1-mc, 10-volt peak-to-peak output signal.

b. Adjust C115 (see Fig. 5-16d) to obtain a minimum amplitude display similar to the one shown in Fig. 5-16c except that the amplitude is typically about 1.5 mv.

29. Adjust C111 (Ac Common-Mode Rejection)

a. Set the Type 190B for 10-mc, 1-volt peak-to-peak output signal.

b. Remove the short jumper lead from the grids of V113 and V313.

c. Adjust C111 (see Fig. 5-16d) for a display of minimum amplitude. The display should be 1 mv peak-to-peak or less, similar to the one shown in Fig. 5-16c. Set the Type 190B for 1 mc, 10-volt peak-to-peak output and check for 1 mv or less display amplitude. If the display amplitude is more than 1 mv, repeat steps 27 through 29 for proper display amplitude to meet the 1-mv or less common-mode rejection requirement.

30. Check Common-Mode Rejection Requirements

a. Using the same setup as used in completing the previous step and as illustrated in Fig. 5-16b, check common-mode rejection according to the data given in Table 5-1.

TABLE 5-1

Common-Mode Rejection

Input Voltage Sine-Wave Frequency	Common-Mode peak-to-peak Input Voltage	Common-Mode Rejection Requirement	Display Amplitude Peak-to-Peak
20 mc	1 v	≥100:1	≤10 mv
5 mc	2 v	≥2000:1	≤1 mv
2 mc	5 v	≥5000:1	≤1 mv
500 kc	10 v	≥10,000:1	≤1 mv
100 kc[1]	10 v	≥10,000:1	≤1 mv
10 kc	10 v	≥20,000:1	≤0.5 mv
1 kc	10 v	≥20,000:1	≤0.5 mv
60 cps dc-coupled	10 v	≥20,000:1	≤0.5 mv
60 cps[2] ac-coupled	10 v	≥2000:1	≤5 mv

[1] For sine-wave frequencies 100 kc and lower use the audio generator in place of the Type 190B.

[2] For ac coupling set the +INPUT and —INPUT switches to AC.

b. Disconnect the audio generator and dual input connector.

31. Adjust C106C (+Input 10X Attenuator Series Compensation)

a. Turn off the oscilloscope power.

b. Remove the Type 10A1 plug-in unit; connect a flexible extension cable between the Type 10A1 and oscilloscope.

c. Turn on the oscilloscope power.

d. Set the Type 10A1 front-panel controls as follows:

Vc RANGE	60 Volts
VOLTS/CM	50 mVOLTS
—INPUT	GND

At this point in the procedure, the remaining controls should be at the following settings:

VARIABLE	CAL
PULL FOR 1 MC BW	Pushed in
POSITION	Trace positioned to graticule center
Vc POLARITY	+
COMPARISON VOLTAGE	60 v (5-10-0)
+INPUT	DC
STEP ATTEN BAL	Adjusted for minimum trace shift as VOLTS/CM switch is set from 20 mVOLTS to 1 mVOLTS

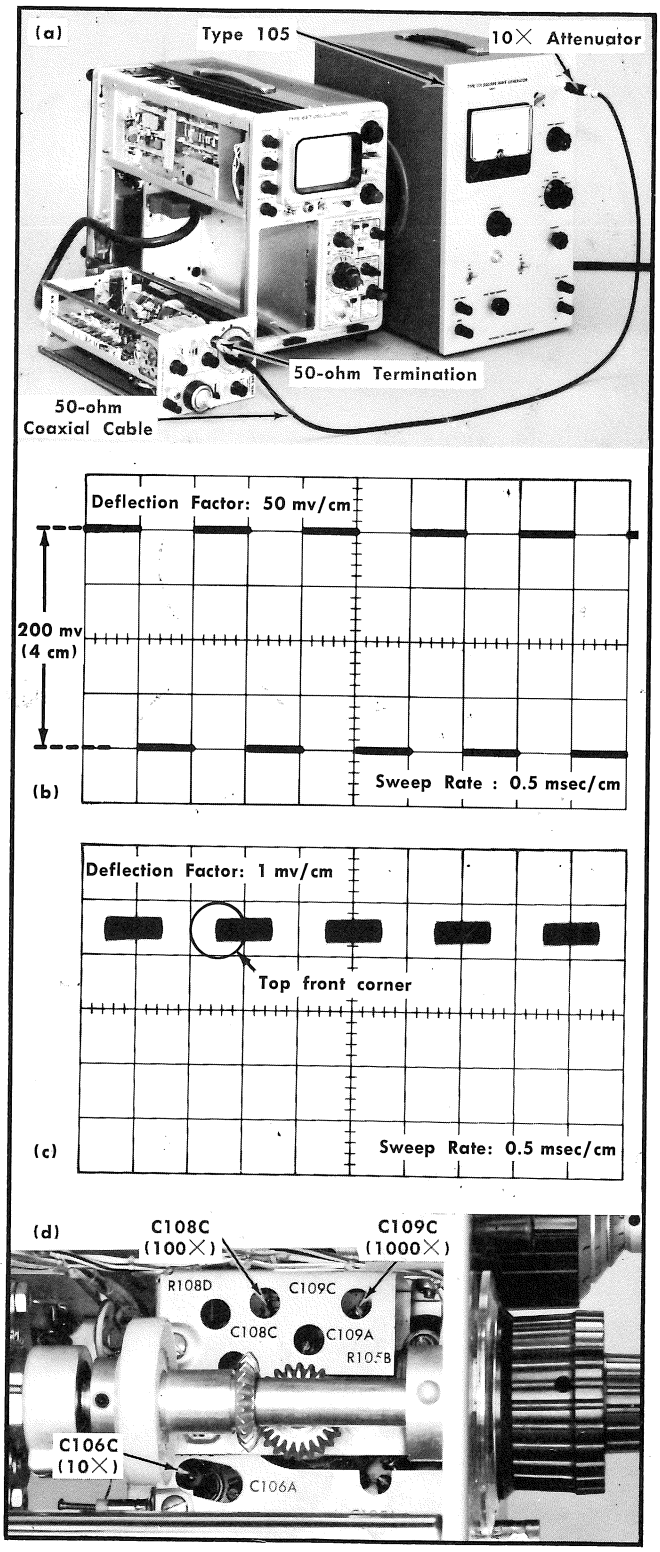


Fig. 5-17. (a) Setup at completion of step 31e, (b) 200-mv waveform at 50 mv/cm, (c) at 1 mv/cm, and (d) location of + input attenuator series compensation adjustments.

e. Set the Type 105 Square-Wave Generator for 1-kc output signal. Apply the signal from the Type 105 Output connector, through a 50-ohm 10× attenuator, coaxial cable, and termination (in that order, as shown in Fig. 5-17a) to the +INPUT connector.

NOTE

When using the plug-in extension cable, place the Type 10A1 in any convenient position that allows access to the input attenuator adjustments.

f. Adjust the Type 105 Output Amplitude control for a 200-mv, peak-to-peak display on the crt. When adjusting the Type 105 to obtain the 200-mv display, set the oscilloscope Trig Mode to Auto and adjust the Trig Level control so a stable display such as that shown in Fig. 5-17b is obtained.

NOTE

For the remaining portion of this calibration procedure, use the Type 10A1 POSITION and the time-base unit Horiz Position controls whenever it is necessary to position the display for best viewing.

g. Set the VOLTS/CM switch to 1 mVOLTS and observe the top front corner of the square wave (see Fig. 5-17c).

h. Set the VOLTS/CM switch to .5 VOLTS.

i. Remove the 10× attenuator and connect the coaxial cable directly to the Type 105 Output connector.

j. Adjust the Type 105 Output Amplitude control so the display is 2 volts (4 cm) peak-to-peak in amplitude.

k. Set the Vc RANGE switch to 60 Volts and the VOLTS/CM switch to 10 mVOLTS in the retained 60-volt range.

l. Check the display. It should appear similar to the one obtained in step 31g and as shown in Fig. 5-17c. If it does not, adjust series capacitor C106C (Fig. 5-17d) in the +Input 10× attenuator for best duplication of the waveform.

32. Adjust C108C (+Input 100X Attenuator Series Compensation)

a. Set the VOLTS/CM switch to 5 VOLTS.

b. Remove the 50-ohm termination and connect the coaxial cable directly to the +INPUT connector.

c. Set the Type 105 Output Amplitude control for a display 20 volts (4 cm) peak-to-peak in amplitude (similar to Fig. 5-17b).

d. Set the VOLTS/CM switch to .1 VOLTS in the 600-volt Vc retained range.

e. Check the display. The waveform should appear similar to the one obtained in Fig. 5-17c. If the top front corner of the square wave has a fast-rise spike or rolloff, adjust C108C (see Fig. 5-17d) for the proper waveshape.

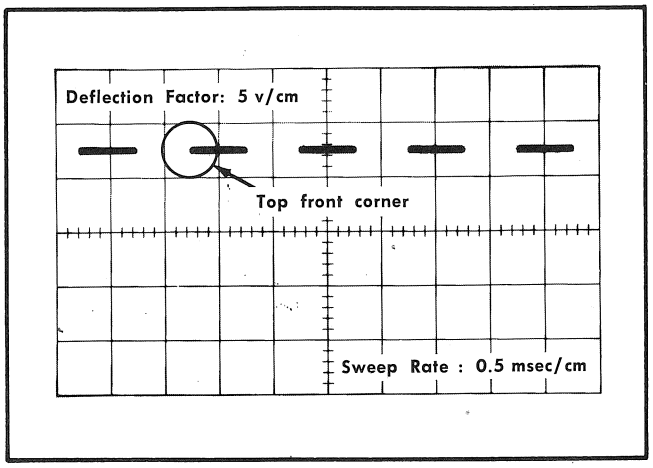


Fig. 5-18. C109C adjusted for best top front corner.

33. Adjust C109C (+Input 1000X Attenuator Series Compensation)

a. Set the VOLTS/CM switch to 5 VOLTS.

b. Set the Type 105 Output Amplitude control fully clockwise for maximum signal output.

c. Check the display. It should appear similar to Fig. 5-18. If it does not, adjust C109C (see Fig. 5-17d) for best top front corner on the waveform; that is, there should be no fast-rise spike or rolloff on the front corner of the square wave.

34. Adjust C105A (+Input 1X Attenuator Shunt Compensation)

a. Set the Type 105 Output Amplitude control for minimum output signal.

b. Starting at the Type 105 Output connector, connect a 10× 50-ohm attenuator, a 50-ohm coaxial cable, a 50-ohm termination, and a 20-pf Input RC Standardizer in that order (see Fig. 5-19a) to the +INPUT connector on the Type 10A1.

c. Set the VOLTS/CM switch to 50 mVOLTS.

d. Adjust the Type 105 Output Amplitude control to obtain a display 200-mv in amplitude same as that shown in Fig. 5-17b.

e. Set the VOLTS/CM switch to 1 mVOLTS.

f. Set the time-base sweep rate to .2 msec/cm.

g. Check the display. It should appear similar to the one shown in Fig. 5-19c. If the front corner aberration is not equal in amplitude above and below the flat-top level of the square wave, adjust shunt capacitor C105A (see Fig. 5-19b) in the +Input 1× attenuator for best leading top corner.

35. Adjust C106A (+Input 10X Attenuator Shunt Compensation)

a. Set the VOLTS/CM switch to .5 VOLTS.

b. Remove the 10× attenuator and connect the coaxial cable directly to the Type 105 Output connector.

c. Adjust the Type 105 Output Amplitude control so the display is 2 volts (4 cm) peak-to-peak in amplitude (similar display to Fig. 5-17b except for sweep rate).

d. Set the Vc RANGE switch to 60 Volts and the VOLTS/CM switch to 10 mVOLTS in the retained 60-volt range.

e. Check the display. It should appear similar to the one shown in Fig. 5-19d. If the front corner aberration amplitudes are not equal, adjust shunt capacitor C106A (see Fig. 5-19b) in the +Input 1000× attenuator for best front corner.

36. Adjust C108A (+Input 100X Attenuator Shunt Compensation)

a. Set the VOLTS/CM switch to 5 VOLTS.

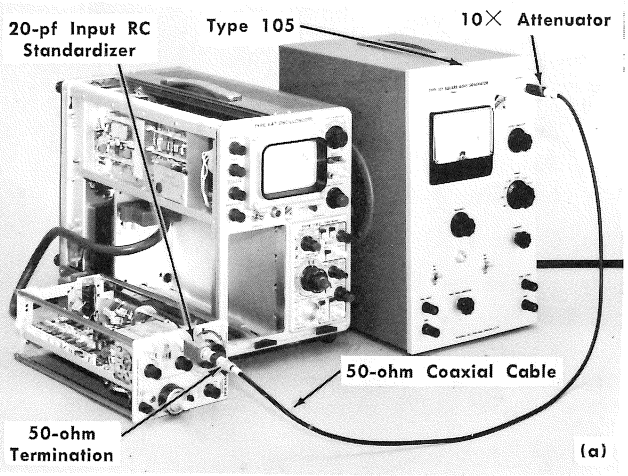
b. Remove the 50-ohm termination and connect the coaxial cable directly to the 20-pf Input RC Standardizer.

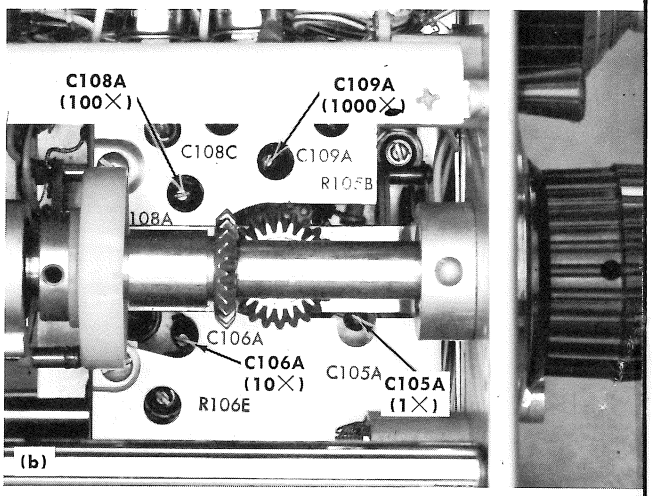
c. Set the time-base Time/Cm switch to .5 mSec/Cm.

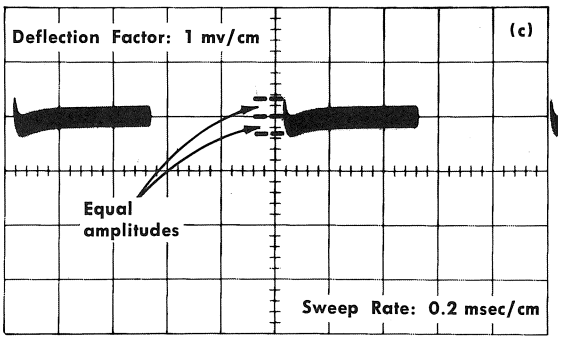
d. Set the Type 105 Output Amplitude control for a display 20 volts (4 cm) peak-to-peak in amplitude (similar to Fig. 5-17b).

e. Set the VOLTS/CM switch to .1 VOLTS in the 600-volt Vc retained range.

f. Check the display. The waveform should appear similar to the one obtained in Fig. 5-17c. If the front corner has a peak or is rolled off, adjust shunt capacitor C108A (see Fig. 5-19b) in the +Input 100× attenuator for best top front corner.







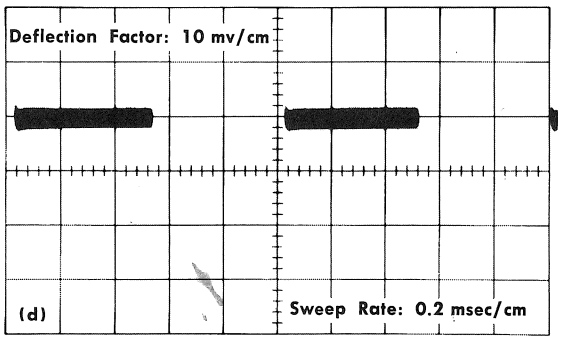


Fig. 5-19. (a) Setup at completion of step 34b, (b) location of +input attenuator shunt compensation adjustments. Waveform (c) shows typical display when C105A is properly adjusted and (d) when C106A is properly adjusted.

37. Adjust C109A (+Input 1000X Attenuator Shunt Compensation)

a. Set the VOLTS/CM switch to 5 VOLTS.

b. Set the Type 105 Output Amplitude control fully clockwise for maximum signal output.

c. Check the display. It should appear similar to the display shown in Fig. 5-18. There should be no peak or roll-off on the top front corner. If there is, adjust shunt capacitor C109A (see Fig. 5-19b) in the +Input 1000× attenuator for best top front corner.

38. Adjust C306C (—Input 10X Attenuator Series Compensation)

a. Set the Type 105 Output Amplitude control fully counterclockwise.

b. Replace the 20-pf Input RC Standardizer with a 50-ohm termination and connect the termination through the special dual input connector to the +INPUT and —INPUT connectors (see Fig. 5-20a for setup).

c. Set the VOLTS/CM switch to 1 VOLTS.

(+ INput to DC)

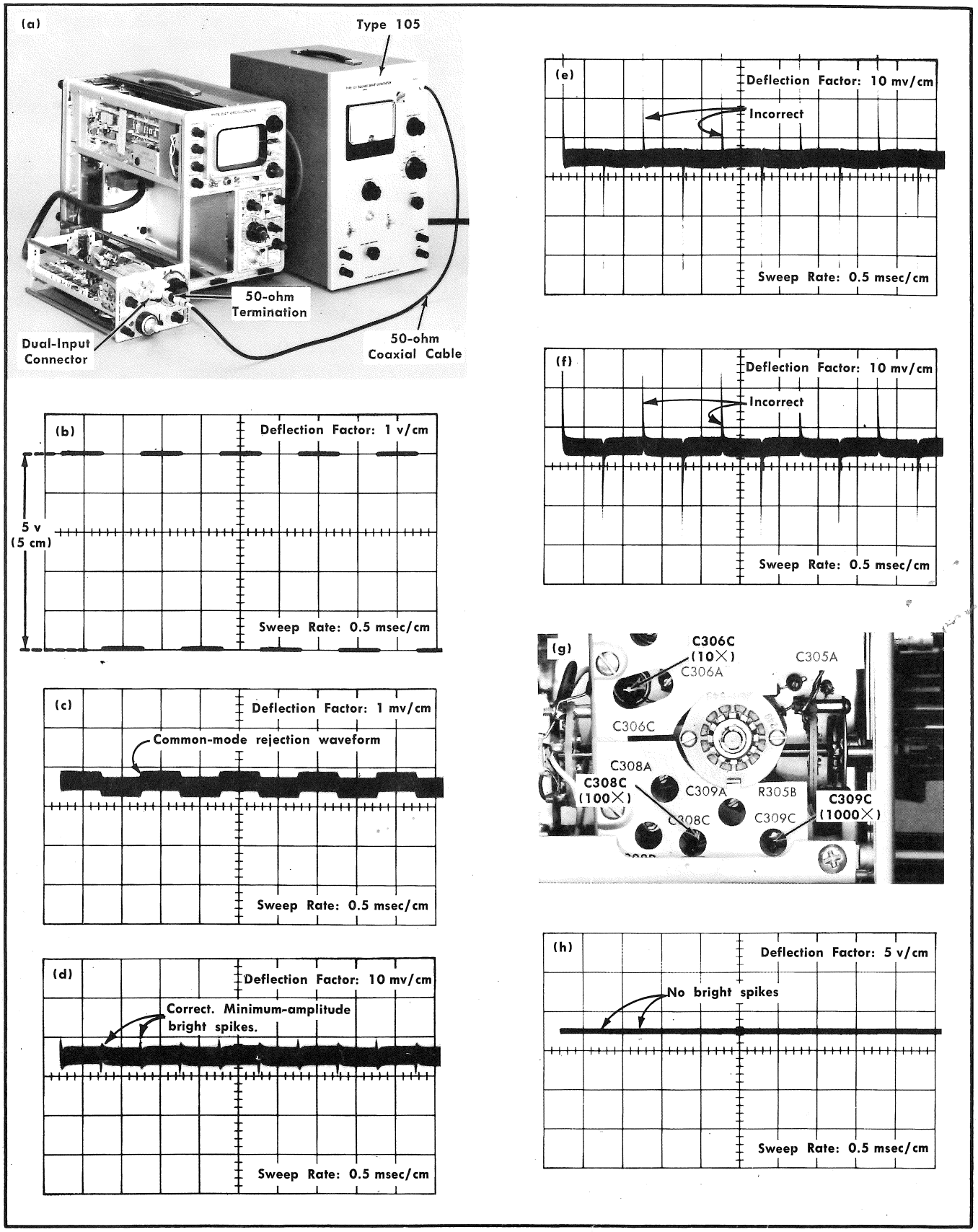


Fig. 5-20. (a) Setup at completion of step 38b; (b) displaying a 5-volt peak-to-peak signal; (c), (d), (e), (f) and (h) shows common-mode rejection displays; (g) location of the —input attenuator series compensation adjustments.

d. Set the Type 105 Output Amplitude control for 5 volts peak-to-peak signal output; that is, 5 cm of deflection on the crt (see Fig. 5-20b).

e. Set the —INPUT switch to DC and the VOLTS/CM switch to 1 mVOLTS.

f. Observe the common-mode rejection waveform. Fig. 5-20c shows a typical display that is obtained.

g. Set the VOLTS/CM switch to 10 VOLTS and the —INPUT switch to GND.

h. Remove the termination and connect the coaxial cable directly to the dual input connector.

i. Set the Type 105 Output Amplitude control for 50 volts peak-to-peak signal output. The display on the crt should be similar to Fig. 5-20b.

j. Set the —INPUT switch to DC, Vc RANGE switch to 60 Volts and the VOLTS/CM switch to 10 mVOLTS in the 60-volt Vc retained range.

k. Check the display. It should appear similar to the display obtained in step 38f. Any bright spikes on the rising and falling portions of the waveform should be minimum in amplitude. Fig. 5-20d is an example of a correct waveform obtained from the same unit as was used to obtain Fig. 5-20c. Figs. 5-20e and 5-20f are incorrect waveforms from the same unit. If necessary, adjust series capacitor C306C (Fig. 5-20g) in the —Input 10× attenuator to minimize the spike amplitude.

39. Adjust C308C (—Input 100X Attenuator Series Compensation)

a. Set the Vc RANGE switch to 600 Volts and the VOLTS/CM switch to .1 VOLTS in the 600-volt Vc retained range.

b. Set the Type 105 Output Amplitude control fully clockwise for full output.

c. Check the common-mode rejection display for minimum bright-spike amplitude. If spike amplitude is not minimum, adjust series capacitor C308C (Fig. 5-20g) in the —Input 100× attenuator for minimum bright-spike amplitude (similar to Fig. 5-20c waveform).

40. Adjust C309C (—Input 1000X Attenuator Series Compensation)

a. Set the VOLTS/CM switch to 5 VOLTS.

b. Adjust the time-base Trig Level control for a stable display.

c. Check the display for minimum bright-spike amplitude. If necessary, adjust series capacitor C309C (Fig. 5-20g) in the —Input 1000× attenuator for minimum bright spikes. Fig. 5-20h shows a typical display obtained when C309C is adjusted properly.

41. Adjust C305A (—Input 1X Attenuator Shunt Compensation)

a. Set the Type 105 Output Amplitude control to minimum.

b. Disconnect the special dual input connector. In its place connect the coaxial cable through a 50-ohm termination and a 20-pf Input RC Standardizer to the +INPUT connector. The setup is the same as shown in Fig. 5-19a but no 10× attenuator is used.

c. Set the VOLTS/CM switch to 1 VOLTS and the —INPUT switch to GND.

d. Adjust the Type 105 Output Amplitude control for a 4-volt peak-to-peak signal output. The display should be similar to the 4-cm display obtained in Fig. 5-17b.

e. Set the Vc RANGE switch to 60 Volts and the VOLTS/CM switch to 10 mVOLTS in the 60-volt retained Vc range.

f. Observe the display. It will appear similar to the waveform shown in Fig. 5-17c.

g. Remove the 20-pf Input RC Standardizer and connect a second 20-pf Input RC Standardizer in its place. Mark #1 on the first standardizer and #2 on the second standardizer so this procedure can be followed easily.

h. Check the display. It should be the same as the one obtained in step 41f. If it is not, adjust the variable capacitor in the #2 standardizer. Now the two standardizers match each other.

i. Disconnect the #2 standardizer from the +INPUT connector and connect it to the —INPUT connector. Connect #1 standardizer to the +INPUT connector. Disconnect the 50-ohm termination. Connect the special dual input connector between the standardizers and the coaxial cable (see Fig. 5-21a).

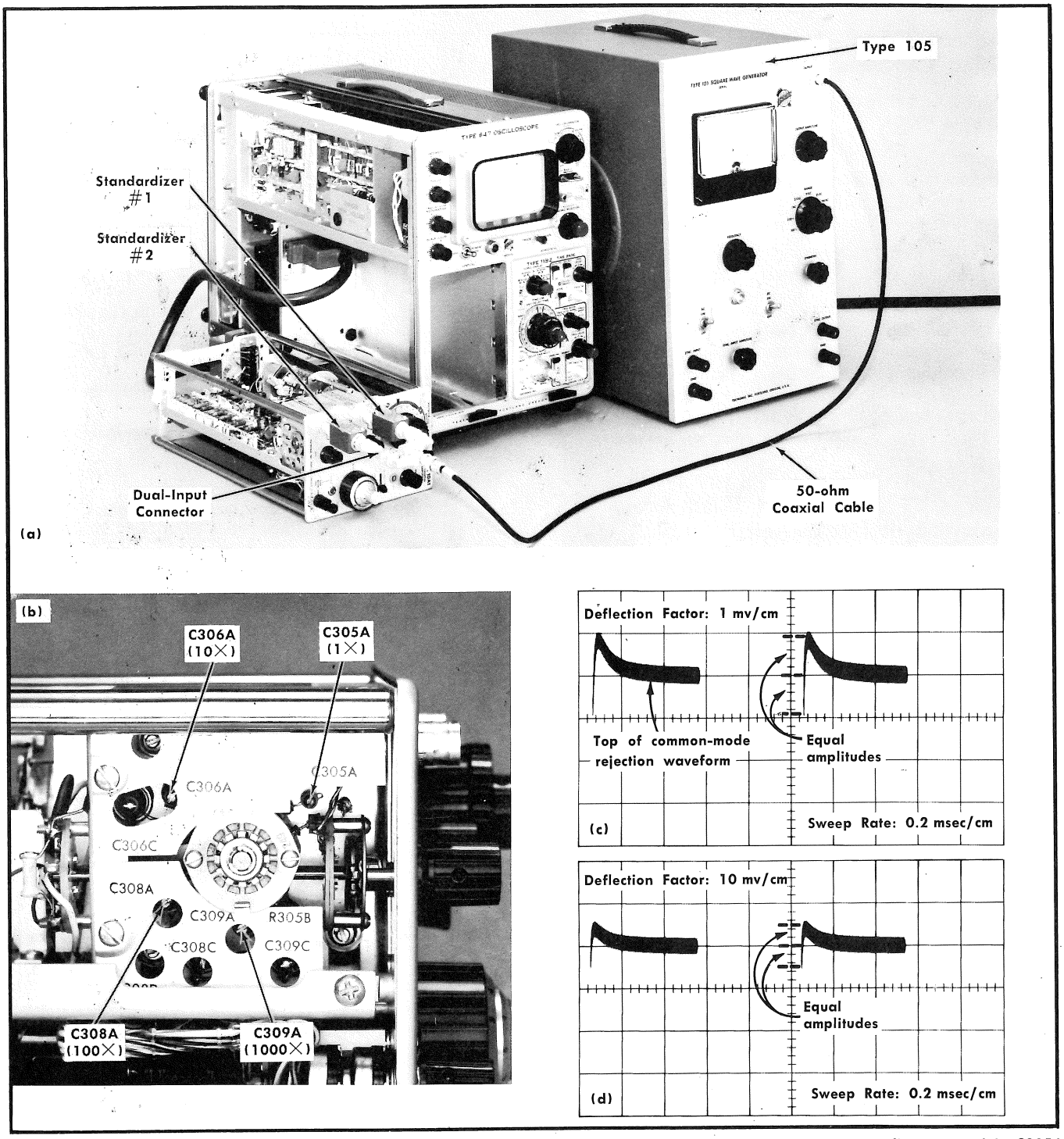


Fig. 5-21. (a) Setup at completion of step 41i, (b) location of the —input attenuator shunt compensation adjustments, (c) C305A adjusted correctly, (d) C306A adjusted correctly.

j. Set the VOLTS/CM switch to 1 VOLTS.

k. Adjust the Type 105 Output Amplitude control for 5 volts peak-to-peak output signal; that is, for 5-cm display similar to the one shown in Fig. 5-20b.

l. Set the —INPUT switch to DC and the VOLTS/CM switch to 1 mVOLTS.

m. Check the display. It should appear similar to the one obtained in step 38f and illustrated in Fig. 5-20c. However, due to the ±2% tolerance in the standardizer resistance values, the common-mode rejection waveform with its front corner aberration will be much greater in amplitude. If the display overscans the screen, position either the top or bottom onto the screen. If the front corner aberration is not equal in amplitude above and below the flat-top portion of the common-mode waveform, set the time-base Time/Cm switch to .2 mSec/Cm and adjust shunt capacitor C305A (Fig. 5-21b) in the —Input 1× attenuator for proper front corner similar to the waveform shown in Fig. 5-21c.

42. Adjust C306A (—Input 10X Attenuator Shunt Compensation)

a. Set the VOLTS/CM switch to 10 VOLTS and the —INPUT switch to GND.

b. Set the Type 105 Output Amplitude control for about 50 volt peak-to-peak output signal as displayed on the crt. The display should be about 5 cm in amplitude similar to the waveform shown in Fig. 5-20b except for sweep rate.

c. Set the —INPUT switch to DC, Vc RANGE switch to 60 Volts and the VOLTS/CM switch to 10 mVOLTS in the 60-volt retained Vc range.

d. Check the display. The front-corner aberration of each cycle should appear similar to the waveform shown in Fig. 5-21d. If it does not, adjust shunt capacitor C306A (Fig. 5-21b) in the —Input 10× attenuator so the front-corner aberration is equal in amplitude above and below the flat-top portion of the common-mode rejection waveform.

43. Adjust C308A (—Input 100X Attenuator Shunt Compensation)

a. Set the VOLTS/CM switch to .1 VOLTS in the 600-volt Vc retained range.

b. Set the Type 105 Output Amplitude control for full output.

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

d. Check the display. If necessary, adjust shunt capacitor C308A (Fig. 5-21b) in the —Input 100× attenuator for optimum square corner on the waveform so it matches the one obtained when performing step 39c. Fig. 5-22 is a typical waveform that should be obtained if C308A is adjusted properly.

44. Adjust C309A (—Input 1000X Attenuator Shunt Compensation)

a. Set the VOLTS/CM switch to 5 VOLTS.

b. Check the display. If necessary, adjust shunt capacitor C309A (Fig. 5-21b) in the —Input 1000× attenuator for optimum front corner on the display so it matches the display obtained in step 40c. The correct waveform should appear similar to the display shown in Fig. 5-20h.

c. Turn off the Type 105 and disconnect the 20 pf RC Time-Constant Standardizers from the Type 10A1.

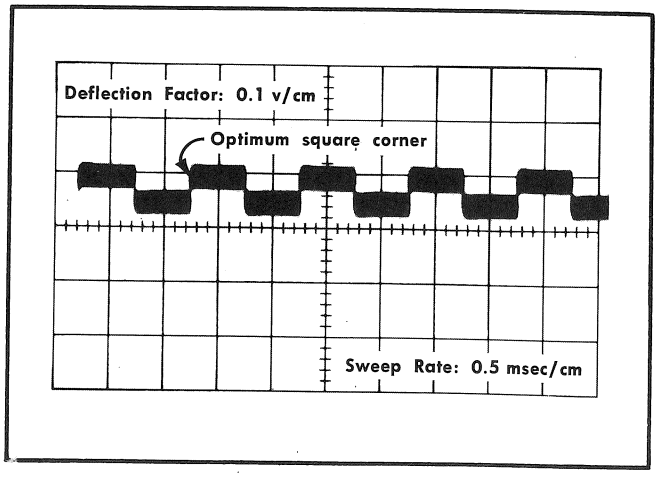


Fig. 5-22. Typical common-mode rejection waveform obtained when C308A is adjusted properly.

d. Turn off the oscilloscope power, disconnect the flexible extension cable and insert the Type 10A1 directly into the oscilloscope plug-in compartment. Turn on the oscilloscope power.

45. Check VOLTS/CM Switch

a. Set the Vc RANGE switch to 6 Volts and the VOLTS/CM switch to 1 mVOLTS.

b. Set the —INPUT switch to GND and the PULL FOR 1 MC BW switch to its outward position.

c. At this point in the procedure, the remaining Type 10A1 front-panel controls should be at the following positions:

VARIABLE	CAL
POSITION	Trace positioned to graticule center
Vc POLARITY	+
COMPARISON VOLTAGE	6 v (5-10-0)
+INPUT	DC
STEP ATTEN BAL	Adjusted for minimum trace shift as VOLTS/CM switch is set from 20 mVOLTS to 1 mVOLTS

d. Apply a 5 mv peak-to-peak calibrator signal to the +INPUT connector on the Type 10A1 (see Fig. 5-23).

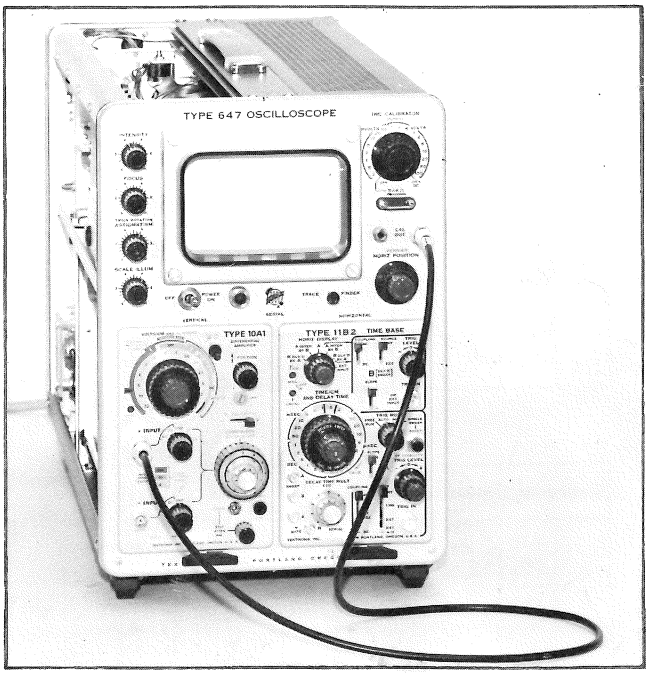


Fig. 5-23. Setup at completion of step 45d when an oscilloscope calibrator is used as the signal source.

TABLE 5-2

VOLTS/CM Switch Position	Calibrator Output (Peak-to-Peak)	Vertical Deflection in cm	% Accuracy[1]
1 mVOLTS	5 mVolts	5	±2.5%
2 mVOLTS	10 mVolts	5	±1.5%
5 mVOLTS	20 mVolts	4	[2]Previously adjusted
10 mVOLTS	50 mVolts	5	±1.5%
20 mVOLTS	.1 Volt	5	±1.5%
50 mVOLTS	.2 Volt	4	±1.5%[3]
10 mVOLTS[4]	50 mVolts	5	±2.5%
20 mVOLTS[4]	.1 Volt	5	±1.5%
.1 VOLTS	.5 Volt	5	±1.5%
.2 VOLTS	1 Volt	5	±1.5%
.5 VOLTS	2 Volts	4	±1.5%[3]
.1 VOLTS[4]	.5 Volt	5	±2.5%
.2 VOLTS[4]	1 Volt	5	±1.5%
1 VOLTS	5 Volts	5	±1.5%
2 VOLTS	10 Volts	5	±1.5%
5 VOLTS	20 Volts	4	±3%
10 VOLTS	50 Volts	5	±3%
20 VOLTS	100 Volts	5	±3%

[1]Includes ±0.25% accuracy of calibrator source.

[2]GAIN control adjusted accurately for 4-cm deflection when performing step 9 in this procedure.

[3]×10 and ×100 input attenuators were previously adjusted in steps 20 and 21.

[4]In retained Vc range.

NOTE

If greater accuracy than provided by the oscilloscope calibrator is desired, use the optional amplitude calibrator (item 2) to perform this step.

e. Using Table 5-2 as a guide, check the VOLTS/CM switch positions for proper calibrated vertical deflection factors. Amplitude accuracy percentage given in the last column is based on an accurate setting of the GAIN control when the VOLTS/CM switch was set to 5 mVOLTS (step 9 in the procedure). In addition, the percentage accuracy includes ±0.25% which is the accuracy of the Standard Square-Wave Calibrator (optional) if used as a signal source. Operating temperature range should be between 0° C and +40° C.

46. Check VARIABLE (VOLTS/CM) Control

a. With the VOLTS/CM switch set to 20 VOLTS and the 100 volts peak-to-peak square wave applied to the +INPUT connector, rotate the VARIABLE control fully counterclockwise and check that the display amplitude is 2 cm or less.

b. Check that the UNCAL neon lamp is lit.

c. Reset the VARIABLE control to CAL and check that the UNCAL lamp is extinguished.

d. Turn off the calibrator and disconnect the coaxial cable.

47. Adjust R540, C540, R213 and C213 (+Input High-Frequency Transient Response at 5 mVOLTS/CM)

a. Turn on the Type 105 and set the Output Amplitude control to minimum.

b. Starting at the Type 105 Output connector, connect the following items in this order: TU-5/105 Adapter, 50-ohm coaxial cable, TU-5 Pulser, 50-ohm 10× attenuator and a 50-ohm termination to the +INPUT connector. Fig. 5-24a shows the entire setup.

c. Set the Type 10A1 front-panel controls as follows:

Vc RANGE	6 Volts
VOLTS/CM	5 mVolts
PULL FOR 1 MC BW	Pushed inward
+INPUT	AC

At this point in the procedure, check that the remaining front-panel controls are set as follows:

VARIABLE	CAL
POSITION	Trace positioned to graticule center
Vc POLARITY	+

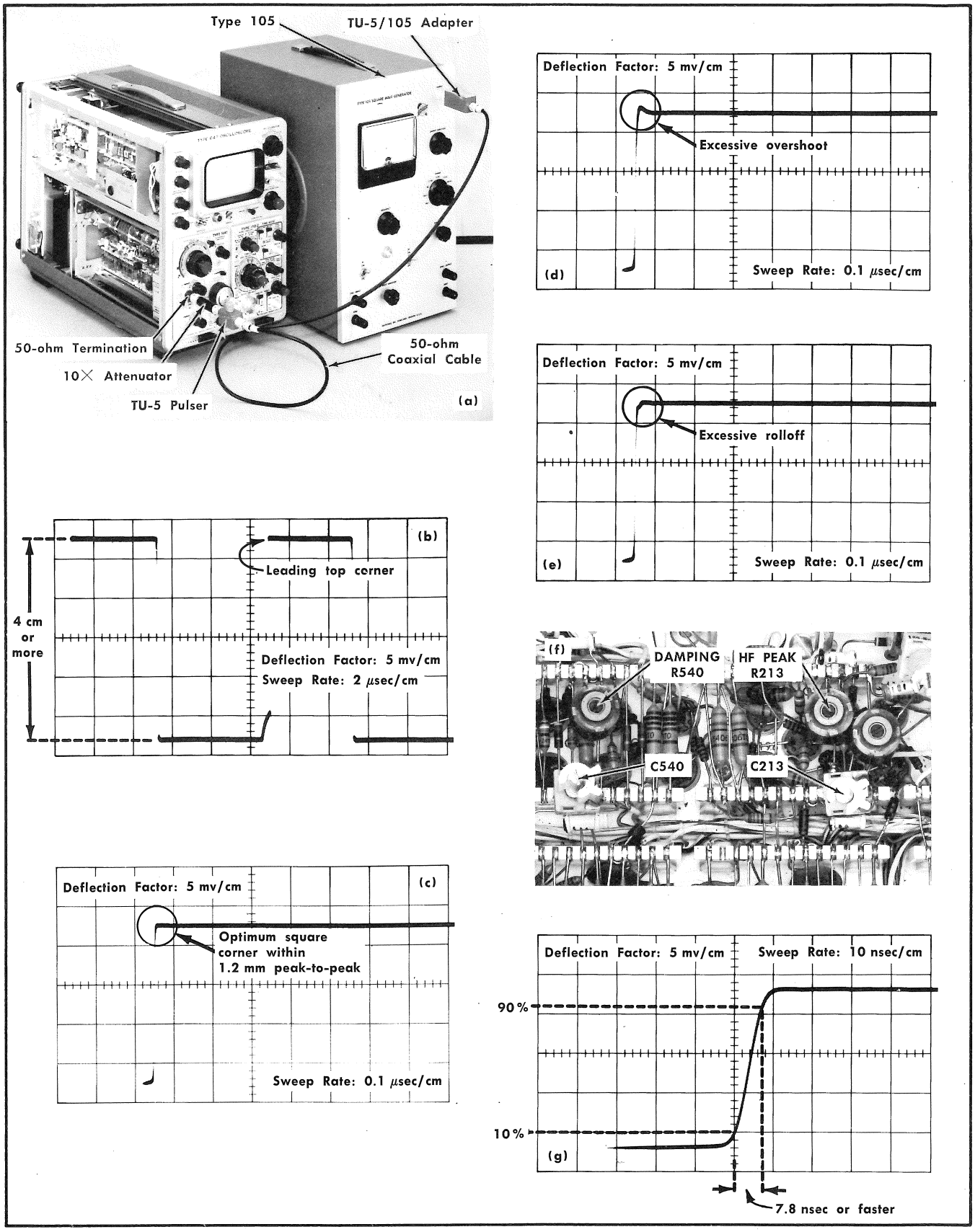


Fig. 5-24. (a) Setup at completion of step 47b and (b) shows waveform when TU-5 Pulser triggers. Waveform (c) shows optimum transient response; (d) and (e) show excessive aberrations. (f) Shows location of the adjustments and (g) measuring the risetime.

COMPARISON VOLTAGE	6 v (5-10-0)
—INPUT	GND
STEP ATTEN BAL	Adjusted for minimum trace as VOLTS/CM switch is set from 20 mVOLTS to 1 mVOLTS

d. Set the Type 105 for 100-kc signal output and set the Output Amplitude control for about 100 volts peak-to-peak signal output.

e. Set the time-base unit for a 2 μsec/cm sweep rate.

f. Turn the TU-5 Pulser knob fully counterclockwise. Next, rotate the knob slowly clockwise until the tunnel diode in the pulser triggers; that is, the deflection jumps from about 0.5 cm to 4 cm or more. Adjust the time-base unit Trig Level control for a stable display (see Fig. 5-24b).

NOTE

The TU-5 Pulser knob should be set only a few degrees clockwise from the triggering point to obtain an optimum square wave from the pulser. If the knob is advanced too far, the leading top corner on the square wave will roll off excessively, resulting in an undesirable waveform.

g. Set the time-base unit for a 0.1 μsec/cm sweep rate and adjust the Trig Level control for a stable display as shown in Fig. 5-24c.

h. Set the VARIABLE control so the pulse amplitude is about 4 cm. Examine the leading top corner of the waveform for square corner. Aberrations should not exceed 4% (1.6 mm) peak-to-peak Fig. 5-24c is a typical display that shows optimum transient response. Figs. 5-24d and 5-24e show excessive aberrations. If the display has excessive overshoot or rolloff, adjust R540, C540, R213 and C213 (see Fig. 5-24f) for optimum square corner. Adjustments R213 and C213 affect the immediate corner at the top of the rising portion of the waveform. R540 and C540 affect the top of the waveform next to the immediate corner.

i. Set the time-base unit Mag switch to ×10. The sweep rate is now 10 nsec/cm. Check risetime of the waveform as show in Fig. 5-24g. Use the VARIABLE control to set amplitude for exactly 4-cm deflection. Risetime should be 7.8 nsec or faster as measured between the 10% and 90% amplitude levels on the rising portion of the waveform (see Fig. 5-24g).

48. Adjust C715 (+Input High-Frequency Transient Response at 10 mVolts/Cm)

a. Set the VOLTS/CM switch to 10 mVOLTS.

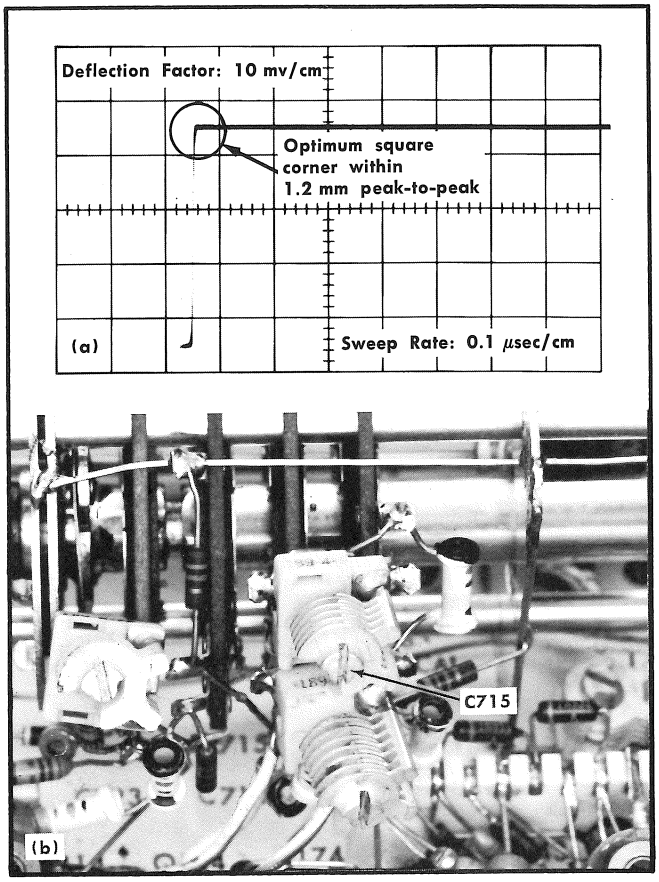


Fig. 5-25. (a) Typical square-cornered display at 10 mv/cm and (b) location of adjustment C715.

b. Remove the 50-ohm 10× attenuator and replace it with a 5× attenuator.

c. Set the time-base unit Mag switch to Off so the sweep rate is 0.1 μsec/cm.

d. Check the display for optimum square corner. Typical waveform that can be expected is shown in Fig. 5-25a. Front-corner aberrations should not exceed 4% (1.6 mm) peak-to-peak. If aberrations are excessive, adjust C715 (see Fig. 5-25b) for optimum front corner.

e. Set the time-base Mag switch to ×10 to obtain a 10-nsec/cm sweep rate.

f. Check the risetime of the display. It should be 7.8 nsec or faster as shown in Fig. 5-24g.

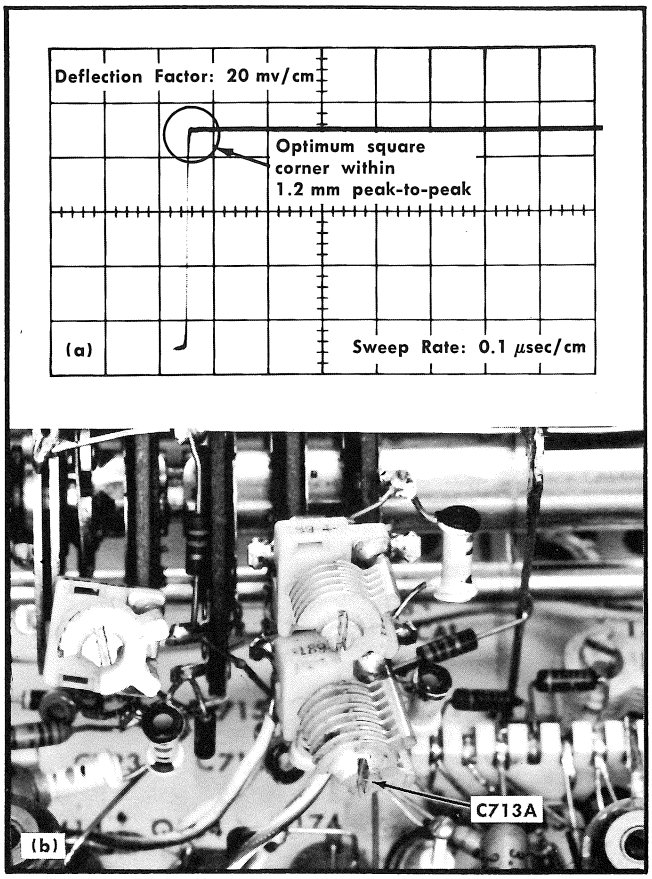


Fig. 5-26. (a) Typical display at 20 mv/cm and (b) location of adjustment C713A.

49. Adjust C713A (+Input High-Frequency Transient Response at 20 mVolts/Cm)

a. Set the VOLTS/CM switch to 20 mVOLTS.

b. Remove the 50-ohm 5× attenuator and replace it with a 50-ohm 2.5× attenuator.

c. Set the time-base unit Mag switch to Off so the sweep rate is 0.1 μsec/cm.

d. Check the display for optimum square corner. Fig. 5-26a shows a typical waveform that can be used as a guide. Front-corner aberrations should not exceed 4% (1.6 mm) peak-to-peak. If aberrations are excessive, adjust C713A (see Fig. 5-26b) for optimum front corner.

e. Set the time-base Mag switch to ×10 so the sweep rate is 10 nsec/cm.

f. Check the risetime of the waveform. It should be 7.8 nsec or faster as shown in Fig. 5-24g.

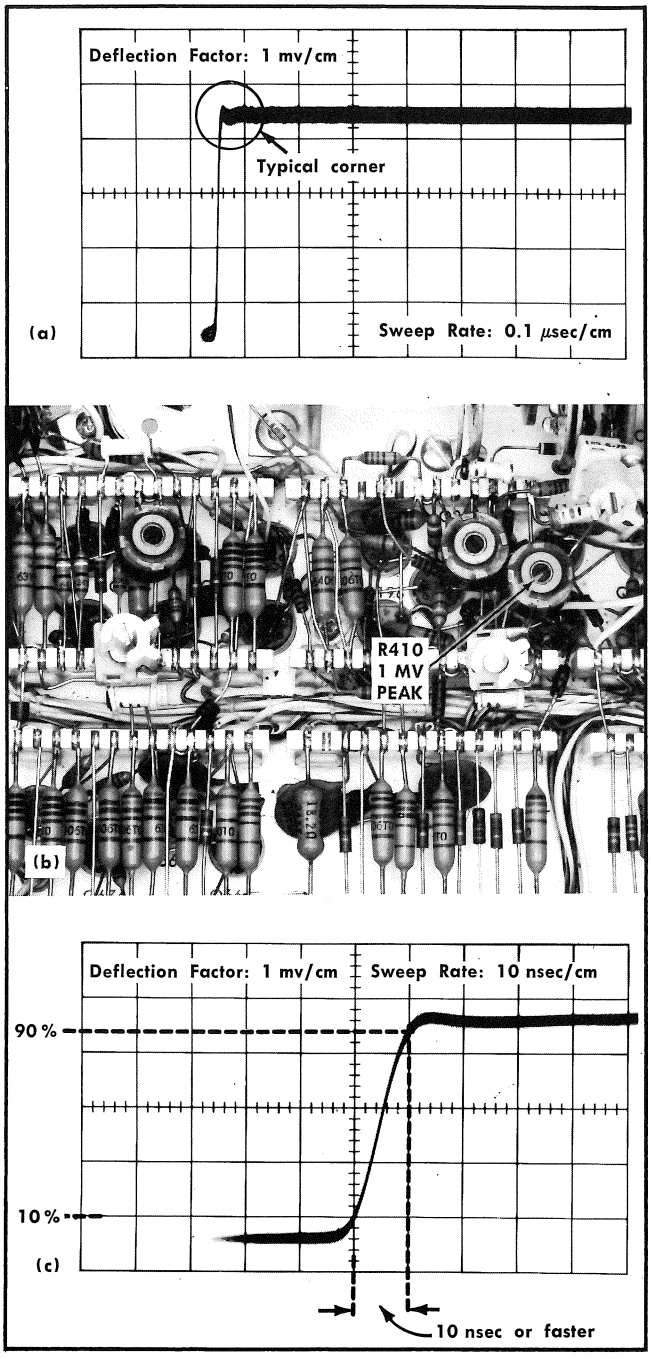


Fig. 5-27. (a) Typical display obtained at 1 mv/cm, (b) location of R410 and (c) measuring the risetime.

50. Adjust R410 (+Input High-Frequency Transient Response at 1 mVolt/Cm)

a. Remove the 2.5× attenuator and in its place connect 10× and 5× attenuators in series.

b. Set the VOLTS/CM switch to 1 mVOLTS.

c. Set the time-base unit Mag switch to Off so the sweep rate is 0.1 μsec/cm.

d. Check the display for square corner. Typical waveform for use as a guide is shown in Fig. 5-27a. Front-corner aberrations should not exceed 4% peak-to-peak or 1.6 mm peak-to-peak. If aberrations are excessivee, adjust R410 (see Fig. 5-27b) for optimum front corner.

e. Set the time-base Mag switch to ×10 so the sweep rate is 10 nsec/cm.

f. Check the risetime of the waveform. It should be 10 nsec or faster as shown in Fig. 5-27c.

51. Check +Input High-Frequency Transient Response at 2 mVolts/Cm

a. Set the VOLTS/CM switch to 2 mVOLTS.

b. Remove the 5× attenuator and replace it with a 2.5× attenuator.

c. Check the risetime of the waveform. It should be 10 nsec or faster, similar to the waveform shown in Fig. 5-27c.

d. Set the time-base unit Mag switch to Off so the sweep rate is 0.1 μsec/cm.

e. Check the display for transient response. Typical waveform that can be expected is shown in Fig. 5-28.

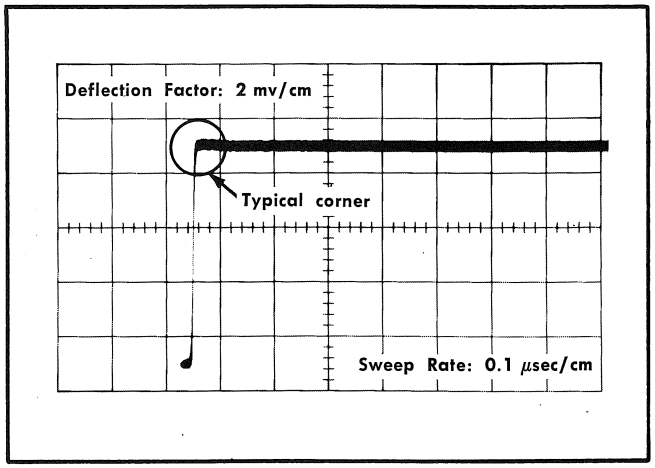


Fig. 5-28. Typical display obtained at 2 mv/cm.

52. Check —Input High-Frequency Transient Response at 1 mVolt/Cm through 20 mVolts/Cm

a. Apply the TU-5 Pulser signal to the —INPUT connector (see Fig. 5-29a).

b. Set the +INPUT switch to GND and the —INPUT switch to AC.

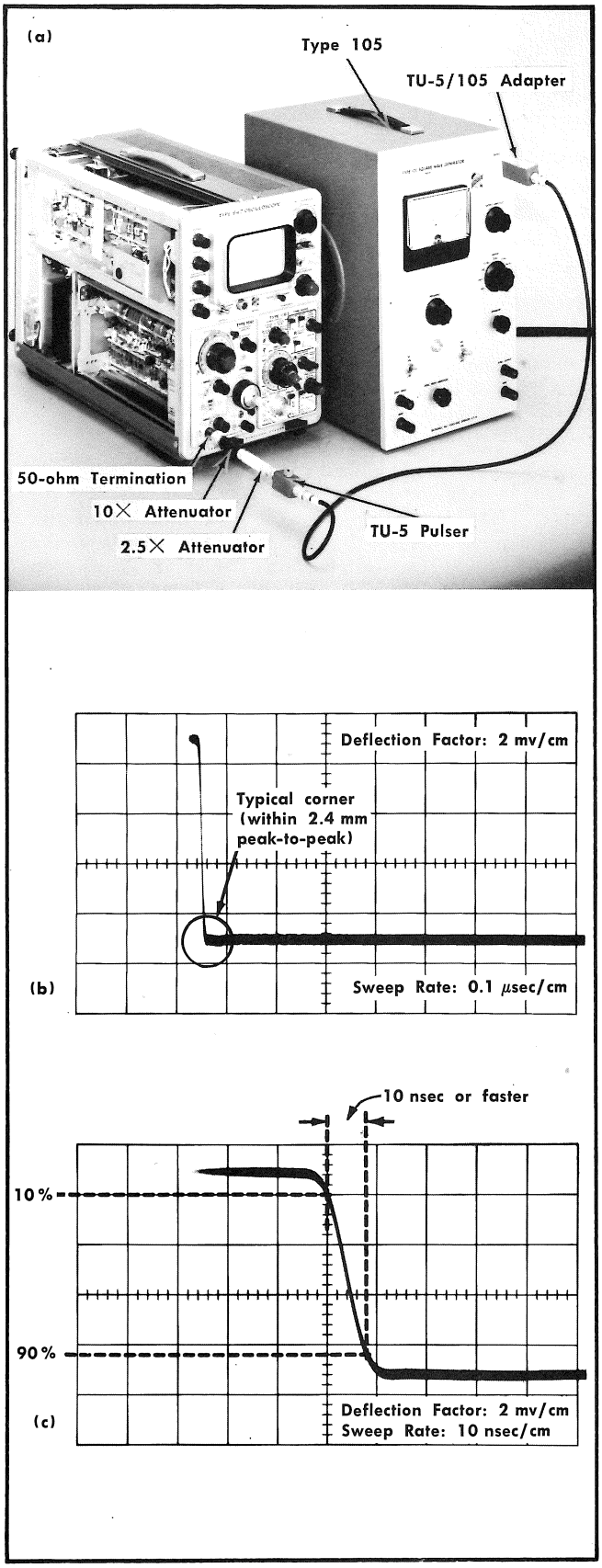


Fig. 5-29. (a) Setup for performing step 52, (b) checking transient response, and (c) checking risetime.

c. Set the time-base unit trigger Slope switch to —.

d. Check waveform for square corner at a sweep rate of 0.1 μsec/cm. Corner aberrations should not exceed 8% (3.2 mm) peak-to-peak. A typical display is shown in Fig. 5-29b.

e. Set the time-base Mag switch to ×10 so the sweep rate is 10 nsec/cm. Check the risetime of the waveform between the 10% and 90% levels on the negative-going pulse as shown in Fig. 5-29c. With the VOLTS/CM switch set to the 2 mVOLTS position, the risetime should be 10 nsec or faster.

f. Using Table 5-3 as a guide, check the transient response and risetime for the 1, 5, 10 and 20 mVOLTS positions of the VOLTS/CM switch.

g. Disconnect the TU-5 Pulser and associated devices from the —INPUT connector.

TABLE 5-3

VOLTS/CM Switch Position	Attenuator(s) Connected in Series between TU-5 Pulser and Termination	Check display for transient response* and risetime similar to these illustrations:
1 mVOLTS	5× and 10×	Figs. 5-29b and 5-29c.
5 mVOLTS	10× Only	Figs. 5-24c and 5-24g but inverted.
10 mVOLTS	5× Only	Figs. 5-25a and 5-24g but inverted.
20 mVOLTS	2.5× Only	Figs. 5-26a and 5-24g but inverted.

***For the —input, corner aberrations should not exceed 8% peak-to-peak or 3.2 mm peak-to-peak.**

53. Check High-Frequency Sine-Wave Response

a. Set the time base for a 0.5-msec/cm sweep rate.

b. Set the Type 10A1 VARIABLE control to CAL, the VOLTS/CM switch to 1 mVOLTS and the —INPUT switch to DC. At this point in the procedure, the remaining front-panel controls should be at these positions:

Vc RANGE	6 Volts
PULL FOR 1 MC BW	Pushed in
POSITION	Trace positioned to graticule center
Vc POLARITY	+
COMPARISON VOLTAGE	6 v (5-10-0)
+INPUT	GND
STEP ATTEN BAL	Adjusted for minimum trace shift as VOLTS/CM switch is set from 20 mVOLTS to 1 mVOLT

c. Apply a 50-kc 4-mv peak-to-peak sine-wave reference signal from the Type 190B to the —INPUT connector. Use a 10× attenuator and a 50-ohm termination, connected in series, to reduce and terminate the signal output from the Type 190B attenuator head so the vertical deflection is 4 cm. Fig. 5-30a shows the setup. Fig. 5-30b shows the display that should be obtained.

d. Set the Type 190B for 35-mc sine-wave output.

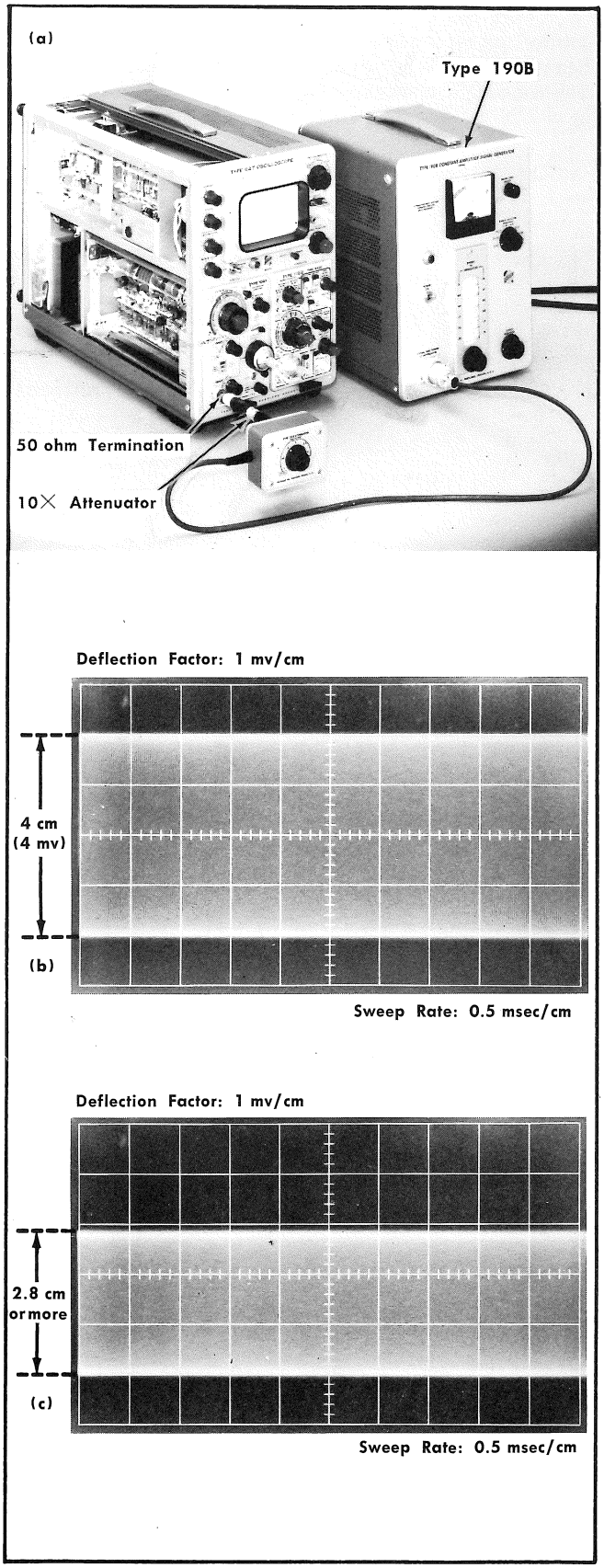


Fig. 5-30. (a) Setup for checking high-frequency sine-wave response, step 53, (b) shows 50-kc reference waveform, and (c) shows response amplitude at 35 mc.

e. Check the amplitude of the display. It should be 2.8 cm or more in amplitude, which corresponds to the 30% (or less) down requirement.

f. Set the VOLTS/CM switch to 2 mVOLTS and repeat steps 53c through 53e with a signal 8 mv in amplitude to obtain 4 cm of vertical deflection.

g. In a similar manner, check frequency response of the 5, 10 and 20 mVOLTS positions. Response should be not more than 30% down at 45 mc.

h. Set the +INPUT switch to DC and the —INPUT switch to GND. Apply the Type 190B signal to the +INPUT connector and check the high-frequency response in a manner similar to that for steps 53c through 53g.

54. Check PULL FOR 1 MC BW Switch

a. Use the same setup as is used when completing step 53h. Check that the VOLTS/CM switch is set to 20 mVOLTS and the signal is applied to the +INPUT connector.

b. Set the Type 190B for 50-kc signal output and check that the display is 4 cm in amplitude, similar to the display obtained in Fig. 5-30b.

c. Set the Type 190B for 1-mc signal output and set the PULL FOR 1 MC BW switch to its outward position. Check the amplitude of the display. It should be about 2.8 cm. Set the Type 190B output frequency so the display is exactly 2.8 cm in amplitude and note the frequency. It should be within ±10% of 1 mc, or between 900 kc and 1.1 mc.

d. Disconnect the Type 190B signal.

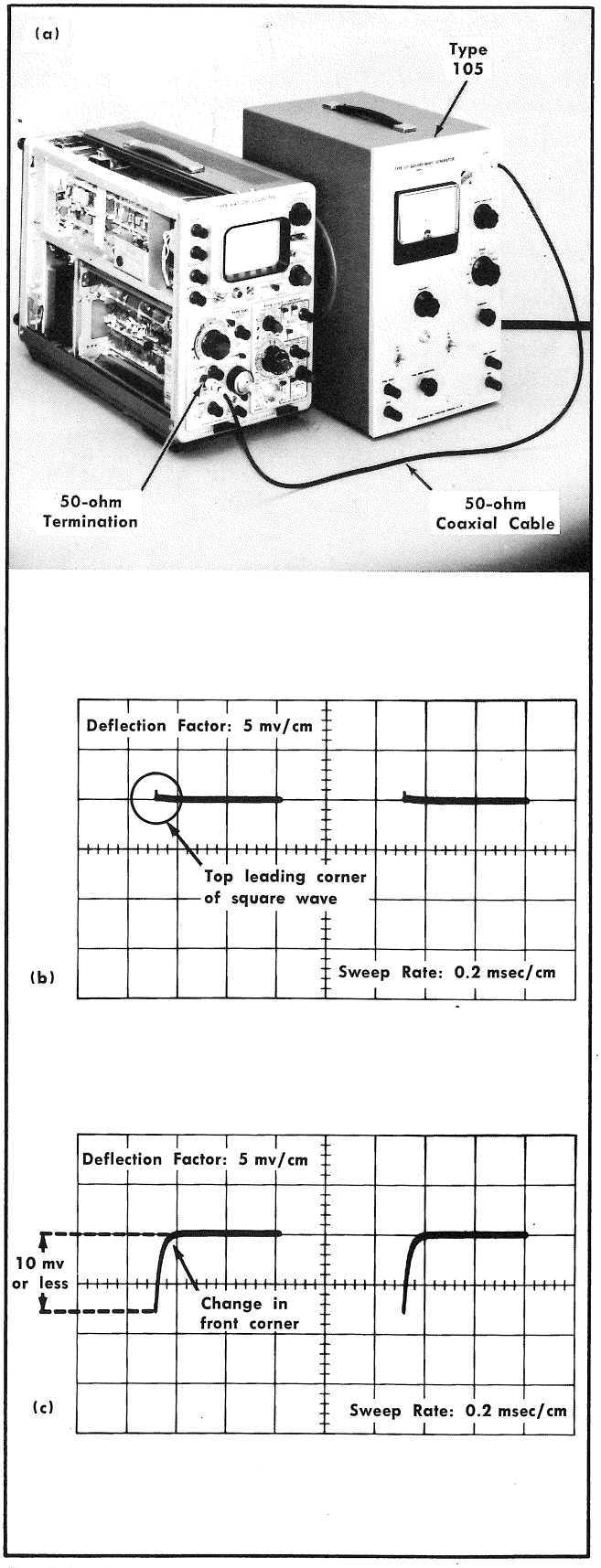


Fig. 5-31. (a) Setup used for performing step 55, (b) shows normal display of square-wave top corner, and (c) corner rolled off due to crosstalk.

55. Check Input Crosstalk

a. Set the VOLTS/CM switch to 1 VOLTS.

b. Apply a 1-kc peak-to-peak signal from the Type 105 through a coaxial cable and 50-ohm termination to the +INPUT connector. See Fig. 5-31a for setup.

c. Adjust the Type 105 Output Amplitude control so the display is 5 cm (5 v) in amplitude.

d. Set the time base for a 0.2-msec/cm sweep rate and the trigger Slope switch to +.

e. Set the VOLTS/CM switch to 5 mVOLTS.

f. Position the top leading corner of the square wave for best viewing (see Fig. 5-31b).

g. Set the —INPUT switch to DC and measure the peak-to-peak amplitude of the rounded corner (see Fig. 5-31c). Ignore the spike. The change in amplitude of the rounded corner when switching the —INPUT switch from GND to DC should be equal to or less than 10 mv peak-to-peak.

h. Set the —INPUT switch to GND and the VOLTS/CM switch to 10 mVOLTS.

i. Insert a 5× and a 10× attenuator in series between the termination and the coaxial cable to reduce the Type 105 output signal amplitude.

j. Adjust the Type 105 Output Amplitude control so the display is 5 cm (50 mv) in amplitude.

k. Set the VOLTS/CM switch to 1 mVOLTS.

l. Position the top corner into view and note the shape of the corner.

m. Set the —INPUT switch to DC and note the peak-to-peak amplitude of the rounded corner. The change in amplitude of the rounded corner should be equal to 0.5 mv (1%) or less.

n. Apply the signal to the —INPUT connector. Set the +INPUT switch to GND.

o. Set the time-base trigger Slope switch to — and adjust the Trig Level control for a stable display of the bottom corner of the square wave.

p. Use the procedure of step 55m, then of steps 55a through g to check the amount of front-corner change. However, for this procedure be sure to use the +INPUT switch when switching from GND to DC to make the check. The resulting displays should be similar to Figs. 5-31b and 5-31c, but inverted.

56. Check Input Connector Isolation

a. Set the +INPUT switch to DC and the —INPUT switch to GND.

b. Set the VOLTS/CM switch to 2 VOLTS.

c. Set the time base for a 5-μsec/cm sweep rate and the trigger Slope switch to +.

d. Set the Type 105 for 100-kc signal output, apply the signal through the coaxial cable and 50-ohm termination to the +Input connector (similar to Fig. 5-31a setup). Adjust

the Output Amplitude control so the display is 5 cm (10 v) in amplitude.

e. Set the + INPUT switch to GND and the VOLTS/CM switch to 1 mVOLTS.

f. Adjust the time-base Trig Level control so a stable display is obtained.

g. Check the peak amplitude of the feed-thru signal. It should be 2 mv (2 cm) or less for $\geq$ 5000:1 isolation (see Fig. 5-32a).

h. Set the COMPARISON VOLTAGE control to 0 volts (0-0-0) and the +INPUT switch to Vc.

i. Check the peak-to-peak amplitude of the feed-thru signal (see Fig. 5-32b). It should meet the same requirement as given in step 56g.

j. Check the —INPUT connector in a similar manner. That is, set the +INPUT switch to GND, connect the signal to the —INPUT connector and check the display. It should be similar to Fig. 5-32a. Then, set the —INPUT switch to Vc. The resulting display will be similar to Fig. 5-32b.

57. Check Recovery Time and DC Error

a. Connect a binding post adapter to the time-base unit Trig In connector.

b. Connect a patch cord from the Trig In connector to the Type 105 Sync Output connector.

c. Set the time-base trigger Source switch to Ext and the Time/Cm switch to 5 mSec. Check that the Slope switch is set to +.

d. Set the VOLTS/CM switch to 2 VOLTS, the —INPUT switch to GND and the +INPUT switch to DC.

e. Set the Type 105 for 10 kc output and adjust the Output Amplitude control so the display is 3 cm (6 v) peak-to-peak in amplitude.

f. Set the time-base sweep rate to 0.1 μsec/cm and adjust the Horiz Position control so the rising portion of the square wave starts at a point one cm from the left edge of the graticule. Using the POSITION control, position the zero level of the square wave to coincide with graticule center (see Fig. 5-33a).

g. Set the VOLTS/CM switch to 1 mVOLTS and the time-base sweep rate to 50 μsec/cm.

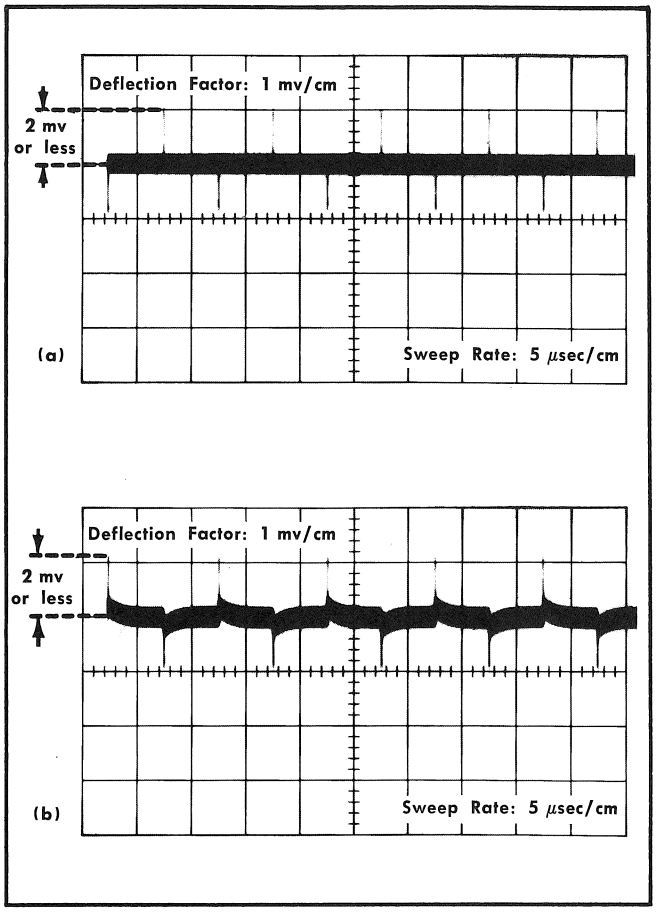


Fig. 5-32. (a) Feed-thru display obtained when +INPUT switch is set to GND, and (b) the switch is set to Vc.

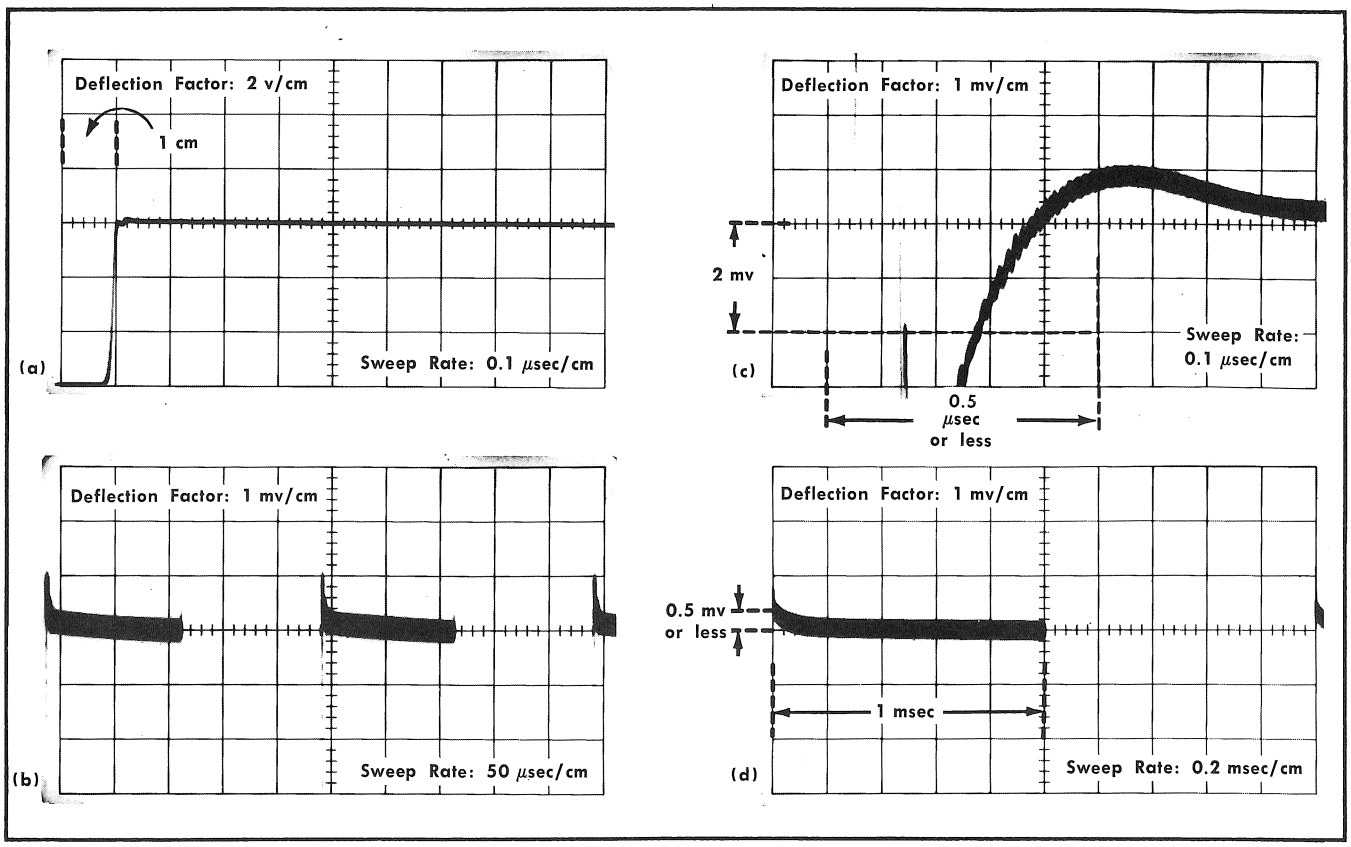


Fig. 5-33. Step 57 waveforms.

h. Using the POSITION control, position the top of the square waves so they coincide with graticule center (see Fig. 5-33b).

i. Set the Time/Cm switch to .1 μsec/cm. Check the recovery time (see Fig. 5-33c). Recovery time is the time required for the signal to return to the prescribed level within ±2 mv of graticule center. It should be 0.5 μsec or less.

j. Set the Time/Cm switch to .2 msec/cm.

k. Set the Type 105 for 500-cps output. Position the display to start at left side of the graticule. Note the dc error recovery time duration. Recovery DC error is the level to which the signal must return at the end of a prescribed time interval. For the Type 10A1 the waveform should return to within ±0.5 mv of the zero level after a recovery time of 1 msec (see Fig. 5-33d).

l. Set the time-base trigger Slope switch to — and the sweep rate to 50 μsec/cm.

m. Set the +INPUT switch to GND and the —INPUT switch to DC. Apply the signal to the —INPUT connector and repeat steps 57d through 57k. Use Figs. 5-33a through 5-33d as a guide for checking the waveform. The displays that will be obtained are inverted from those shown in the illustrations.

CALIBRATION RECORD

Tektronix Type 10A1 Serial No._____

☐ 1. Adjust COARSE (R275).
V113 cathode-to-ground volts +_____.

V313 cathode-to-ground volts +_____.

☐ 2. Adjust +BAL R130.
C152/R152 junction to Q123A collector volts _____.

Q123A to L123/R117 junction volts _____.

☐ 3. Adjust —BAL R330.
C352/R352 junction to Q123B collector volts _____.

Q123B to L323/R317 junction volts _____.

☐ 4. Adjust STEP ATTEN BAL (R389).

☐ 5. Adjust INT DC BAL R200.

☐ 6. Adjust VAR ATTEN BAL R215.

☐ 7. Adjust I_b BAL R601.

☐ 8. Adjust COMMON MODE BAL R183.

☐ 9. Adjust GAIN (R513).

☐ 10. Check microphonics.

☐ 11. Adjust +GRID CURRENT BAL R136.

☐ 12. Adjust —GRID CURRENT BAL R336.

☐ 13. Adjust TRIG BAL R659.

☐ 14. Check minimum Vc.

☐ 15. Adjust 6 V CAL R583.

☐ 16. Adjust 1 V CAL R590.

☐ 17. Check Vc Divider (COMPARISON VOLTAGE switch).

☐ 18. Check COMPARISON VOLTAGE 10-turn potentiometer linearity.

☐ 19. Check COMPARISON VOLTAGE 10-turn potentiometer for combined readout and resolution error.

☐ 20. Adjust R106E (+input 10× attenuator).

☐ 21. Adjust R108D (+input 100× attenuator).

☐ 22. Adjust R306E (—input 10× attenuator).

☐ 23. Adjust R308D (—input 100× attenuator).

☐ 24. Adjust R105B (+input 1× attenuator).

☐ 25. Adjust R305B (—input 1× attenuator).

☐ 26. Check dc common-mode rejection.

☐ 27. Adjust C723, C365, C125 and C325 (ac common-mode rejection.

☐ 28. Adjust C115 (ac common-mode rejection).

☐ 29. Adjust C111 (ac common-mode rejection).

☐ 30. Check common-mode rejection requirements.

☐ 31. Adjust C106C (+input 10× attenuator series compensation).

☐ 32. Adjust C108C (+input 100× attenuator series compensation).

☐ 33. Adjust C109C (+input 1000× attenuator series compensation).

☐ 34. Adjust C105A (+input 1× attenuator shunt compensation).

☐ 35. Adjust C106A (+input 10× attenuator shunt compensation).

☐ 36. Adjust C108A (+input 100× attenuator shunt compensation).

☐ 37. Adjust C109A (+input 1000× attenuator shunt compensation).

☐ 38. Adjust C306C (—input 10× attenuator series compensation).

☐ 39. Adjust C308C (—input 100× attenuator series compensation).

☐ 40. Adjust C309C (—input 1000× attenuator series compensation).

☐ 41. Adjust C305A (—input 1× attenuator shunt compensation).

☐ 42. Adjust C306A (—input 10× attenuator shunt compensation).

☐ 43. Adjust C308A (—input 100× attenuator shunt compensation).

☐ 44. Adjust C309A (—input 1000× attenuator shunt compensation).

☐ 45. Check VOLTS/CM switch.

☐ 46. Check VARIABLE (VOLTS/CM) control.

☐ 47. Adjust R540, C540, R213, C213 (+input high-frequency transient response at 5 mvolts/cm).

☐ 48. Adjust C715 (+input high-frequency transient response at 10 mvolts/cm).

☐ 49. Adjust C713A (+input high-frequency transient response at 20 mvolts/cm).

☐ 50. Adjust R410 (+input high-frequency transient response at 1 mvolt/cm).

☐ 51. Check —input high-frequency transient response at 2 mvolts/cm.

☐ 52. Check —input high-frequency transient response at 1 mvolt/cm through 20 mvolt/cm.

☐ 53. Check High-Frequency Sine-Wave Response.

☐ 54. Check PULL FOR 1 MC BW switch.

☐ 55. Check input crosstalk.

☐ 56. Check input connector isolation.

☐ 57. Check recovery time and dc error.

Calibration Engineer _____

DATE _____

SECTION 6
PARTS LIST and DIAGRAMS

PARTS ORDERING INFORMATION

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

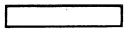
Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information 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.

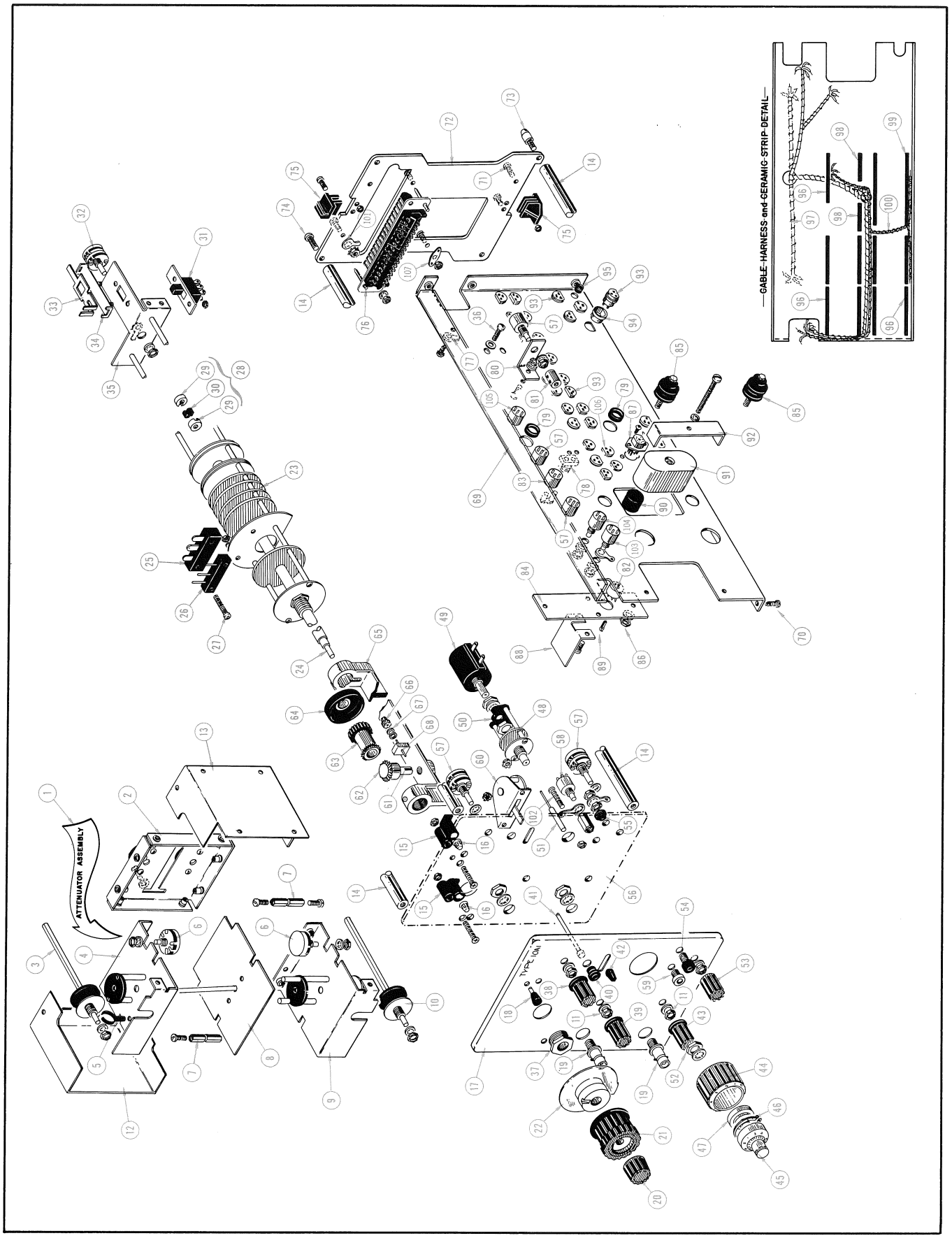
ABBREVIATIONS AND SYMBOLS

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.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	644-0012-00	100	179	1	ASSEMBLY, attenuator (see ref. #11)
	644-0013-00	180		1	ASSEMBLY, attenuator (see ref. #11)
	- - - - - -			-	attenuator assembly includes:
2	260-0652-00	100	179	1	SWITCH, unwired— +INPUT and —INPUT (rear)
	260-0652-01	180		1	SWITCH, unwired— +INPUT and —INPUT (rear)
	- - - - - -			-	mounting hardware: (not included w/switch alone)
	211-0007-00			4	SCREW, 4-40 x 3/16 inch BHS
	210-0851-00			4	WASHER, .119 ID x 3/8 inch OD
3	260-0651-00			1	SWITCH, unwired— +INPUT (front)
4	260-0648-00			1	SWITCH, unwired—VOLTS/CM (+input attenuator)
5	352-0068-00			2	HOLDER, delrin
6	- - - - - -			6	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot alone)
	210-0046-00			1	LOCKWASHER, internal, .400 OD x .261 inch ID
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex, 1/4-32 x 5/16 inch
7	361-0086-00			2	SPACER, center shield
	- - - - - -			-	mounting hardware for each: (not included w/spacer alone)
	211-0503-00			2	SCREW, 6-32 x 3/16 inch BHS
8	337-0730-00			1	SHIELD, attenuator, center
9	260-0649-00			1	SWITCH, unwired—VOLTS/CM (—input attenuator)
10	260-0650-00			1	SWITCH, unwired— —INPUT (front)
11	- - - - - -			-	mounting hardware: (not included w/attenuator assembly)
	210-0940-00	100	289	2	WASHER, 1/4 ID x 3/8 inch OD
	210-0905-00	290		2	WASHER, 0.265 ID x 7/16 inch OD
	210-0583-00			2	NUT, hex, 1/4-32 x 5/16 inch
12	337-0729-00			1	SHIELD, attenuator, left
	- - - - - -			-	mounting hardware: (not included w/shield)
	213-0054-00			1	SCREW, thread cutting, 6-32 x 5/16 inch PHS phillips
	211-0007-00			2	SCREW, 4-40 x 3/16 inch BHS
13	337-0728-00			1	SHIELD, attenuator, right
	- - - - - -			-	mounting hardware: (not included w/shield)
	211-0007-00			6	SCREW, 4-40 x 3/16 inch BHS
14	384-0615-00			4	ROD, spacer, plug-in
15	352-0067-00			2	HOLDER, single neon
	- - - - - -			-	mounting hardware for each: (not included w/holder)
	211-0031-00			1	SCREW, 4-40 x 1 inch FHS
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
16	378-0541-00			2	FILTER, lens, neon indicator light
17	333-0864-00			1	PANEL, front
18	384-0346-00			1	ROD, slide switch
19	131-0106-00			2	CONNECTOR, coaxial, 1 contact, female, BNC
	- - - - - -			-	each connector includes:
	- - - - - -			1	LOCKWASHER, internal
	- - - - - -			1	NUT, hex
20	366-0038-00			1	KNOB, small red—VARIABLE CAL
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
21	366-0288-00			1	KNOB, large charcoal—VOLTS/CM
	- - - - - -			-	knob includes:
	213-0022-00			2	SCREW, set, 4-40 x 3/16 inch HSS
22	331-0147-00			1	DIAL, window
	- - - - - -			-	dial includes:
	213-0022-00			2	SCREW, set, 4-40 x 3/16 inch HSS
23	262-0699-00	100	519	1	SWITCH, wired—VOLTS/CM
	262-0699-01	520		1	SWITCH, wired—VOLTS/CM
	- - - - - -			-	wired switch includes:
	260-0646-00			1	SWITCH, unwired—VOLTS/CM
24	384-0384-00			1	ROD, shaft
25	- - - - - -			1	POT
26	- - - - - -			-	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
27	211-0100-00			2	SCREW, 2-56 x 3/4 inch RHS
	210-0001-00			2	LOCKWASHER, internal, #2
	210-0405-00			2	NUT, hex, 2-56 x 3/16 inch
28	376-0050-00			1	COUPLING, flexilble
	- - - - - -			-	coupling includes:
29	354-0251-00			2	RING, coupling
	213-0022-00			4	SCREW, set, 4-40 x 3/16 inch HSS
30	376-0046-00			1	COUPLING, delrin
31	260-0447-00			1	SWITCH, slide
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
32	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0223-00	100	122X	1	LUG, solder, 1/4 inch
	210-0840-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex, 1/4-32 x 5/16 inch
33	214-0563-00			1	ACTUATOR, slide switch
34	406-0949-00			1	BRACKET, slide switch
35	407-0121-00			1	BRACKET, switch
	- - - - - -			-	mounting hardware: (not included w/bracket)
	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
36	- - - - - -			-	mounting hardware: (not included w/wired switch)
	211-0507-00			2	SCREW, 6-32 x 5/16 inch BHS
37	358-0254-00			1	BUSHING, hex
38	366-0225-00			1	KNOB, small charcoal—POSITION
	- - - - - -			-	knob includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch HSS
39	366-0225-00			1	KNOB, small charcoal— +INPUT
	- - - - - -			-	knob includes:
	213-0020-00			1	SCREW, set, 6-32 x 1/8 inch HSS
40	358-0216-00			1	BUSHING, front panel
41	384-0350-00			1	ROD, shaft, gain

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
42	366-0215-01			1	KNOB, lever—Vc POLARITY
43	366-0225-00			1	KNOB, small charcoal— —INPUT
44	366-0290-00			1	KNOB, large charcoal—COMPARSION VOLTAGE (Vc)
	- - - - - -			-	knob includes:
	213-0020-00			2	SCREW, set, 6-32 x 1/8 inch HSS
45	331-0153-00			1	DIAL, counting
46	354-0265-00			1	RING, internal
47	214-0546-00			1	HUB, support index
48	262-0700-00			1	SWITCH, wired—COMPARISON VOLTAGE (Vc) (see Ref #52)
	- - - - - -			-	wired switch includes:
	260-0647-00			1	SWITCH, unwired—COMPARISON VOLTAGE (Vc)
49	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot alone)
	210-0590-00			1	NUT, hex, 3/8-32 x 7/16 inch
	210-0840-00			2	WASHER, .390 ID x 9/16 inch OD
50	426-0261-00			1	MOUNT, flexible
	- - - - - -			-	mounting hardware: (not included w/mount alone)
	210-0938-00	X350		2	WASHER, flat, 0.109 ID x 0.250 inch OD
	210-0053-00			2	LOCKWASHER, #2 split
	210-0405-00			2	NUT, hex, 2-56 x 3/16 inch
51	384-0347-00			1	ROD, pot shaft
52	- - - - - -			-	mounting hardware: (not included w/wired switch)
	210-0012-00			1	LOCKWASHER, internal, 3/8 x 1/2 inch
	210-0413-00			1	NUT, hex, 3/8-32 x 1/2 inch
53	366-0153-00			1	KNOB, small charcoal—STEP ATTEN BAL
	- - - - - -			-	knob includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
54	136-0140-00			1	SOCKET, banana jack
	- - - - - -			-	mounting hardware: (not included w/socket)
55	210-0895-00			1	WASHER, insulating
	210-0465-00			2	NUT, hex, 1/4-32 x 3/8 inch
	210-0223-00			1	LUG, solder, 1/4 inch
56	386-0136-00			1	PLATE, front sub-panel
57	- - - - - -			5	POT
	- - - - - -			-	mounting hardware for each: (not included w/pot)
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex, 1/4-32 x 5/16 inch
58	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0223-00			1	LUG, solder, 1/4 inch
	210-0471-00			1	NUT, hex, 1/4-32 x 5/16 inch
59	358-0054-00			1	BUSHING, banana jack
60	260-0653-00			1	SWITCH, lever—Vc POLARITY
	- - - - - -			-	mounting hardware: (not included w/switch)
	210-0586-00			2	NUT, keps, 4-40 x 1/4 inch
61	385-0182-00			1	ROD, shaft, attenuator
	354-0219-00			1	RING, snap (not shown)

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
62	214-0272-00			1	GEAR, miter
	- - - - - -			-	gear includes:
	213-0020-00			2	SCREW, set, 6-32 x 1/8 inch HSS
63	214-0551-00			1	GEAR ASSEMBLY
64	401-0027-00			1	WHEEL, index
	- - - - - -			-	wheel includes:
	213-0020-00			2	SCREW, set, 6-32 x 1/8 inch HSS
65	426-0249-00			1	FRAME, attenuator
	- - - - - -			-	frame includes:
	213-0004-00			1	SCREW, set, 6-32 x 3/16 inch HSS
	213-0048-00			1	SCREW, set, 4-40 x 1/8 inch HSS
66	214-0541-00			1	GEAR, index
67	210-0938-00			2	WASHER, #2 flat
68	214-0499-00			1	NEEDLE, bearing
69	441-0608-00	100	179	1	CHASSIS, aluminum
	441-0608-01	180		1	CHASSIS, aluminum
	- - - - - -			-	mounting hardware: (not included w/chassis)
70	213-0054-00			1	SCREW, thread cutting, 6-32 x 5/16 inch PHS phillips
	213-0068-00			3	SCREW, thread cutting, 6-32 x 5/16 inch FHS phillips
71	211-0507-00			3	SCREW, 6-32 x 5/16 inch BHS
72	387-0777-00			1	PLATE, rear
	- - - - - -			-	mounting hardware: (not included w/plate)
73	214-0370-00			2	PIN, locating
74	212-0044-00			2	SCREW, 8-32 x 1/2 inch RHS phillips
75	351-0063-00			2	GUIDE, shoe, plug-in
	- - - - - -			-	mounting hardware for each: (not included w/guide)
	211-0013-00			2	SCREW, 4-40 x 3/8 inch RHS
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
76	131-0096-00			1	CONNECTOR, 32 contact, male
	- - - - - -			-	mounting hardware: (not included w/connector)
	211-0008-00			2	SCREW, 4-40 x 1/4 inch BHS
	210-0004-00			2	LOCKWASHER, internal, #4
	210-0406-00			2	NUT, hex, 4-40 x 3/16 inch
77	210-0201-00			10	LUG, solder, SE #4
	- - - - - -			-	mounting hardware for each: (not included w/lug)
	213-0044-00			1	SCREW, thread cutting, 5-32 x 3/16 inch PHS phillips
78	- - - - - -			1	CAPACITOR
	- - - - - -			-	mounting hardware: (not included w/capacitor)
	214-0456-00			1	FASTENER, delrin
79	348-0063-00			2	GROMMET, 1/2 inch
80	407-0042-00			1	BRACKET, pot
	- - - - - -			-	mounting hardware: (not included w/bracket)
	211-0507-00			1	SCREW, 6-32 x 5/16 inch BHS
	210-0006-00			1	LOCKWASHER, internal, #6
	210-0407-00			1	NUT, hex, 6-32 x 1/4 inch

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
81	376-0029-00			1	COUPLING, shaft
	- - - - - -			-	coupling includes:
	213-0075-00			2	SCREW, set, 4-40 x 3/32 inch HSS
82	136-0188-00			2	SOCKET, 5 pin
83	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0223-00			1	LUG, solder, 1/4 inch
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex, 1/4-32 x 5/16 inch
84	441-0609-00			1	CHASSIS, aluminum
	- - - - - -			-	mounting hardware: (not included w/chassis)
85	348-0058-00			2	SHOCKMOUNT, rubber
86	210-0006-00			2	LOCKWASHER, internal, #6
	210-0407-00			2	NUT, hex, 6-32 x 1/4 inch
87	136-0078-00			2	SOCKET, 8 pin miniature
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	213-0055-00			2	SCREW, thread forming, 2-32 x 3/16 inch PHS phillips
88	337-0736-00			1	SHIELD, aluminum
	- - - - - -			-	mounting hardware: (not included w/shield)
	213-0044-00			2	SCREW, thread cutting, 5-32 x 3/16 inch PHS phillips
89	131-0374-00			18	CONNECTOR, tab, socket
90	377-0103-00			2	INSERT, heat stabilizer
91	200-0554-00			1	COVER, heat stabilizer
	- - - - - -			-	mounting hardware: (not included w/cover)
	211-0517-00			1	SCREW, 6-32 x 1 inch BHS
	210-0006-00			1	LOCKWASHER, internal, #6
92	407-0142-00			1	BRACKET, stop, shock mounting
93	136-0181-00			30	SOCKET, 3 pin transistor
	- - - - - -			-	mounting hardware for each: (not included w/socket)
94	354-0234-00			1	RING, locking, transistor socket
95	348-0055-00			2	GROMMET, 1/4 inch
96	124-0147-00			9	STRIP, ceramic, 7/16 inch x 13 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0008-00			2	SPACER, nylon, .188 inch
97	179-0949-00			1	CABLE HARNESS, voltage
98	124-0149-00			2	STRIP, ceramic, 7/16 inch x 7 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0008-00			2	SPACER, nylon, .188 inch

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
99	124-0145-00			2	STRIP, ceramic, 7/16 inch x 20 notches
	- - - - - -			-	each strip includes:
	355-0046-00			2	STUD, nylon
	- - - - - -			-	mounting hardware for each: (not included w/strip)
	361-0008-00			2	SPACER, nylon, .188 inch
100	179-0948-00	100	179	1	CABLE HARNESS, chassis
	179-0948-01	180		1	CABLE HARNESS, chassis
101	210-0202-00			1	LUG, solder, SE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
	211-0504-00			1	SCREW, 6-32 x 1/4 inch BHS
	210-0407-00			1	NUT, hex, 6-32 x 1/4 inch
102	211-0016-00			1	SCREW, 4-40 x 5/8 inch RHS
	210-0406-00			1	NUT, hex, 4-40 x 3/16 inch
103	- - - - - -	100	179X	1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0223-00			1	LUG, solder, 1/4 inch
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex, 1/4-32 x 5/16 inch
104	- - - - - -	100	179X	1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex, 1/4-32 x 5/16 inch
105	- - - - - -			1	POT
	- - - - - -			-	mounting hardware: (not included w/pot)
	210-0223-00	X253		1	LUG, solder, 1/4 inch
	210-0940-00			1	WASHER, 1/4 ID x 3/8 inch OD
	210-0583-00			1	NUT, hex, 1/4-32 x 5/16 inch
106	136-0181-00	100	339	2	SOCKET, 3 pin transistor
	136-0182-00	340		2	SOCKET, 4 pin transistor
	- - - - - -			-	mounting hardware for each: (not included w/socket)
	354-0234-00			1	RING, locking, transistor socket
107	210-0204-00	X410		1	LUG, solder, DE #6
	- - - - - -			-	mounting hardware: (not included w/lug)
	211-0504-00			1	SCREW, 6-32 x 1/4 inch, PHS
	210-0457-00			1	NUT, keps, 6-32 x 5/16 inch
					STANDARD ACCESSORIES
	070-0464-00			2	MANUAL, instruction (not shown)

ELECTRICAL PARTS

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description				S/N Range
		Bulbs				
B255	150-0035-00	Neon, A1D				
B260	150-0035-00	Neon, A1D		UNCAL		
		Capacitors				
Tolerance ±20% unless otherwise indicated.						
C102†	*295-077	0.1 μf	PTM	600 v	+5%—15%	100-429
C102†	*295-0081-00	0.1 μf	MT	600 v	10%	430-up
C103	283-078	0.001 μf	Cer	500 v		
C105A	281-064	0.2-1.5 pf	Tub. Var			
C106A	281-043	0.7-3 pf	Tub. Var			
C106B	281-500	2.2 pf	Cer	500 v	±0.5 pf	
C106C	281-104	0.2-1.6 pf	Tub. Var			
C106D		0.5 pf	Mica		10%	
C106E	283-107	51 pf	Cer	200 v	5%	
C106F	281-544	5.6 pf	Cer	500 v	10%	
C108A	281-027	0.7-3 pf	Tub. Var			
C108B	281-544	5.6 pf	Cer	500 v	10%	
C108C	281-0113-00	0.2-1.5 pf	Tub. Var			
C108D		100 pf	Mica		10%	
C109A	281-027	0.7-3 pf	Tub. Var			
C109B	281-544	5.6 pf	Cer	500 v	10%	
C109C	281-108	0.2-1.6 pf	Tub. Var			
C109D		1000 pf	Mica		10%	
C110	281-613	10 pf	Cer	200 v	10%	
C111	281-095	0.2-1.5 pf	Plstc Var			
C112	281-610	2.2 pf	Cer	200 v	±0.1 pf	
C115	281-101	1.5-9.1 pf	Air Var			
C118	290-183	1 μf	EMT	35 v	10%	
C120	283-079	0.01 μf	Cer	250 v		
C123	281-622	47 pf	Cer	500 v	10%	
C125	281-0112-00	0.2-1.5 pf	Plstc Var			
C130	290-183	1 μf	EMT	35 v	10%	
C139	281-623	650 pf	Cer	500 v	5%	
C143	283-079	0.01 μf	Cer	250 v		
C152	283-000	0.001 μf	Cer	500 v		
C164	283-000	0.001 μf	Cer	500 v		
C177	281-503	8 pf	Cer	500 v	±0.5 pf	
C193	281-558	18 pf	Cer	500 v		
C205	283-000	0.001 μf	Cer	500 v		

†C102 and C302 matched within ±1% of each other. Furnished as a unit.

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C209	281-523	100 pf	Cer	350 v		
C213	281-079	1.5-9.1 pf	Air Var			
C219	281-557	1.8 pf	Cer	500 v		
C234	283-000	0.001 μf	Cer	500 v		
C252	281-0519-00	47 pf	Cer	500 v	10%	X130-up
C253	281-633	910 pf	Cer	500 v	5%	
C265	283-079	0.01 μf	Cer	250 v		
C266	283-0000-00	0.001 μf	Cer	500 v		X410-up
C267	283-079	0.01 μf	Cer	250 v		
C268	283-0000-00	0.001 μf	Cer	500 v		X410-up
C302†	*295-077	0.1 μf	PTM	600 v	+5%—15%	100-429
C302†	*295-0081-00	0.1 μf	MT	600 v	10%	430-up
C305A	281-064	0.2-1.5 pf	Tub. Var			
C306A	281-043	0.7-3 pf	Tub. Var			
C306B	281-500	2.2 pf	Cer	500 v	±0.5 pf	
C306C	281-104	0.2-1.6 pf	Tub. Var			
C306D		0.5 pf	Mica		10%	
C306E	283-107	51 pf	Cer	200 v	5%	
C306F	281-544	5.6 pf	Cer	500 v	10%	
C308A	281-027	0-7-3 pf	Tub. Var			
C308B	281-544	5.6 pf	Cer	500 v	10%	
C308C	281-0113-00	0.2-1.5 pf	Tub. Var			
C308D		100 pf	Mica		10%	
C309A	281-027	0.7-3 pf	Tub. Var			
C309B	281-544	5.6 pf	Cer	500 v	10%	
C309C	281-108	0.2-1.6 pf	Tub. Var			
C309D		1000 pf	Mica		10%	
C310	281-613	10 pf	Cer	200 v	10%	
C311	281-534	3.3 μf	Cer	500 v	±0.25 pf	
C317	281-604	2.2 pf	Cer	500 v	±0.25 pf	
C318	290-183	1 μf	EMT	35 v	10%	
C320	283-079	0.01 μf	Cer	250 v		
C323	281-622	47 pf	Cer	500 v	1%	
C325	281-0112-00	0.2-1.5 pf	Plstc Var			
C330	290-183	1 μf	EMT	35 v	10%	
C339	281-623	650 pf	Cer	500 v	5%	
C343	283-079	0.01 μf	Cer	250 v		
C352	283-000	0.001 μf	Cer	500 v		
C364	283-000	0.001 μf	Cer	500 v		
C365	281-0112-00	0.2-1.5 pf	Plstc Var			
C393	281-558	18 pf	Cer	500 v		
C409	281-549	68 pf	Cer	500 v	10%	100-469
C409	281-0512-00	27 pf	Selected (nominal value)			470-up
C419	281-557	1.8 pf	Cer	500 v		
C434	283-000	0.001 μf	Cer	500 v		
C504	283-000	0.001 μf	Cer	500 v		
C526	283-000	0.001 μf	Cer	500 v		
C536	283-000	0.001 μf	Cer	500 v		

†C302 and C102 matched within ±1% of each other. Furnished as a unit.

Capacitors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
C539	281-549	68 pf	Cer	500 v	10%	
C540	281-081	1.8-13 pf	Air Var			
C543	281-512	27 pf	Cer	500 v	10%	
C604	283-000	0.001 μf	Cer	500 v		
C676	283-079	0.01 μf	Cer	250 v		
C679	283-079	0.01 μf	Cer	250 v		
C680	283-0000-00	0.001 μf	Cer	500 v		X410-up
C703	281-564	24 pf	Cer	500 v	5%	
C713A	Use 281-0103-00	1.8-13 pf	Air Var			
C713B	281-503	8 pf	Cer	500 v	±0.5 pf	
C715	Use 281-0101-00	1.5-9.1 pf	Air Var			
C720	281-564	24 pf	Cer	500 v	5%	
C273	Use 281-0103-00	1.8-13 pf	Air Var			
C735	281-558	18 pf	Cer	500 v		

Diodes

D111	*152-165	Silicon	Selected from 1N3579	
D117	152-123	Zener	1N935A 0.4 w, 9.1 v, 5% T.C.	
D118	152-123	Zener	1N935A 0.4 w, 9.1 v, 5% T.C.	
D130	152-034	Zener	1N753 0.4 w, 6.2 v, 10%	100-549
D130	152-0280-00	Zener	1N753A 0.4 w, 6.2 v, 5%	550-up
D148	*152-185	Silicon	Replaceable by 1N4152	
D155	152-141	Silicon	1N4152	
D156	152-141	Silicon	1N4152	
D222	*152-185	Silicon	Replaceable by 1N4152	
D311	*152-165	Silicon	Selected from 1N3579	
D317	152-123	Zener	1N935A 0.4 w, 9.1 v, 5% T.C.	
D318	152-123	Zener	1N935A 0.4 w, 9.1 v, 5% T.C.	
D330	152-034	Zener	1N735 0.4 w, 6.2 v, 10%	100-549
D330	152-0280-00	Zener	1N753A 0.4 w, 6.2 v, 5%	550-up
D348	*152-185	Silicon	Replaceable by 1N4152	
D582	152-124	Zener	1N938A 0.5 w, 9 v, 5% T.C.	

Inductors

LR106A	*108-286	0.17 μh	(wound on a 36 Ω resistor)	
L123	*108-215	1.1 μh		
L184	276-532	Core, Shield Bead		100-309
L184	276-0507-00	Core, ferramic Suppressor		310-up
L202	276-532	Core, Shield Bead		100-309
L202	276-0507-00	Core, ferramic Suppressor		310-519X
L214	*120-342	Toroid, 10T		
L234	276-0507-00	Core, ferramic suppressor		X253-519X
L235	276-0507-00	Core, ferramic suppressor		X253-519X
L238	*108-215	1.1 μh		
L323	*108-215	1.1 μh		
L384	276-532	Core, Shield Bead		100-309
L384	276-0507-00	Core, ferramic Suppressor		310-up
LR306A	*108-286	0.17 μh	(wound on a 36 Ω resistor)	
L402	276-532	Core, Shield Bead		100-309

Inductors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
L402	276-0507-00	Core, ferramic Suppressor	310-519X
L414	*120-342	Toroid, 10T	
L434	276-0507-00	Core, ferramic suppressor	X253-519X
L435	276-0507-00	Core, ferramic suppressor	X253-519X
L438	*108-215	1.1 μh	
L502	276-532	Core, Shield Bead	100-309
L502	276-0507-00	Core, ferramic suppressor	310-up
L504	276-532	Core, Shield Bead	100-309
L504	276-0507-00	Core, ferramic suppressor	310-up
L524	*108-260	0.1 μh	
L545	*108-327	0.06 μh	
L602	276-532	Core, Shield Bead	100-309
L602	276-0507-00	Core, ferramic suppressor	310-up
L604	276-532	Core, Shield Bead	100-309
L604	276-0507-00	Core, ferramic suppressor	310-up
L624	*108-260	0.1 μh	
L645	*108-327	0.06 μh	
L676	276-532	Core, Shield Bead	100-309
L676	276-0507-00	Core, ferramic suppressor	310-up
L679	276-532	Core, Shield Bead	100-309
L679	276-0507-00	Core, ferramic suppressor	310-up

Transistors

Q114	*151-133	Selected from 2N3251	
Q123	*151-139	Dual, Selected 2N918's	
Q134	*151-108	Replaceable by 2N2501	
Q138	*151-108	Replaceable by 2N2501	
Q143	*151-109	Selected from 2N918	
Q153	*151-0134-00	Replaceable by 2N2905	100-229
Q153	*151-0199-00	Replaceable by MPS-3640	230-up
Q158	*151-108	Replaceable by 2N2501	
Q164	*151-139	Dual, Selected 2N918's	
Q174	*151-133	Selected from 2N3251	
Q184	*151-109	Selected from 2N918	
Q198	*151-103	Replaceable by 2N2219	
Q204	*151-109	Selected from 2N918	
Q214	*151-109	Selected from 2N918	
Q234	*151-142	Selected from 2N3546	
Q314	*151-133	Selected from 2N3251	
Q334	*151-108	Replaceable by 2N2501	
Q338	*151-108	Replaceable by 2N2501	
Q343	*151-109	Selected from 2N918	
Q353	*151-0134-00	Replaceable by 2N2905	100-229
Q353	*151-0199-00	Replaceable by MPS-3640	230-up
Q374	*151-133	Selected from 2N3251	
Q384	*151-109	Selected from 2N918	
Q404	*151-109	Selected from 2N918	
Q414	*151-109	Selected from 2N918	
Q434	*151-142	Selected from 2N3546	
Q504	*151-109	Selected from 2N918	
Q524	*151-109	Selected from 2N918	
Q534	*151-120	Selected from 2N2475	
Q564	*151-120	Selected from 2N2475	
Q574	*151-120	Selected from 2N2475	
Q604	*151-109	Selected from 2N918	

Transistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
Q624	*151-109	Selected from 2N918	
Q634	*151-120	Selected from 2N2475	
Q664	*151-120	Selected from 2N2475	
Q674	*151-120	Selected from 2N2475	

Resistors

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

R105A	323-680	988 k	½ w		Prec	1%	
R105B	311-519	30 k		Var			
R105C	321-289	10 k	⅛ w		Prec	1%	100-179X
R106B†	325-004	900 k	¼ w		Prec	1/10%	
R106D††	325-003	99.8 k	⅛ w		Prec	1/10%	
R106E	311-518	500 Ω		Var			
R106G	321-097	100 Ω	⅛ w		Prec	1%	100-179X
R108B	323-681	990 k	½ w		Prec	½%	
R108C	321-637	9.9 k	⅛ w		Prec	½%	
R108D	311-517	250 Ω		Var			
R109B	323-623	999 k	½ w		Prec	1%	
R109C	321-193	1 k	⅛ w		Prec	1%	
R110	317-201	200 Ω	1/10 w			5%	
R111	315-681	680 Ω	¼ w			5%	
R113	315-470	47 Ω	¼ w			5%	
R114	308-351	4.87 k	3 w		WW	1%	
R115	315-512	5.1 k	¼ w			5%	
R116	315-471	470 Ω	¼ w			5%	
R117	315-101	100 Ω	¼ w			5%	
R123	321-161	464 Ω	⅛ w		Prec	1%	
R125	321-200	1.18 k	⅛ w		Prec	1%	
R127	321-222	2 k	⅛ w		Prec	1%	
R130	311-442	250 Ω		Var		+BAL	
R132	315-471	470 Ω	¼ w			5%	
R134	308-349	3.6 k	3 w		WW	1%	
R135	317-107	100 meg	⅛ w			5%	100-179X
R136	311-390	25 k		Var		+GRID CURRENT BAL	100-179X
R137	315-104	100 k	¼ w			5%	100-179X
R138	321-218	1.82 k	⅛ w		Prec	1%	
R139	321-220	1.91 k	⅛ w		Prec	1%	
R140	321-283	8.66 k	⅛ w		Prec	1%	
R143	315-150	15 Ω	¼ w			5%	
R150	321-131	226 Ω	⅛ w		Prec	1%	
R152	315-101	100 Ω	¼ w			5%	

†Matched pair, furnished as a unit with R306B.

††Matched pair, furnished as a unit with R306D.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description			S/N Range
R153	321-273	6.81 k	1/8 w	Prec	1%	
R155	321-255	4.42 k	1/8 w	Prec	1%	
R157	315-471	470 Ω	1/4 w		5%	
R158	308-350	3.88 k	3 w	WW	1%	
R160	321-165	511 Ω	1/8 w	Prec	1%	
R162	321-091	86.6 Ω	1/8 w	Prec	1%	
R164	321-145	316 Ω	1/8 w	Prec	1%	
R170	321-256	4.53 k	1/8 w	Prec	1%	
R174	321-233	2.61 k	1/8 w	Prec	1%	
R179	321-219	1.87 k	1/8 w	Prec	1%	
R183	311-462	1 k	Var		COMMON MODE BAL	
R185	321-149	348 Ω	1/8 w	Prec	1%	
R190	321-187	866 Ω	1/8 w	Prec	1%	
R193	321-180	732 Ω	1/8 w	Prec	1%	
R200	311-326	10 k	Var		INT DC BAL	
R202	315-333	33 k	1/4 w		5%	
R203	315-0150-00	15 Ω	1/4 w		5%	X520-up
R204	323-223	2.05 k	1/2 w	Prec	1%	
R205	308-348	3.32 k	3 w	WW	1%	
R209	321-069	51.1 Ω	1/8 w	Prec	1%	
R210	315-910	91 Ω	1/4 w		5%	100-519
R210	315-0121-00	120 Ω	1/4 w		5%	520-up
R211	321-167	536 Ω	1/4 w	Prec	1%	
R213	311-442	250 Ω	Var		H F PEAK	100-519
R213	311-0480-00	500 Ω	Var		H F PEAK	520-up
R215	311-390	25 k	Var		VAR ATTEN BAL	
R216	321-173	619 Ω	1/8 w	Prec	1%	
R217	315-223	22 k	1/4 w		5%	
R218	321-185	825 Ω	1/8 w	Prec	1%	
R219	315-331	330 Ω	1/4 w		5%	
R222	315-113	11 k	1/4 w		5%	
R234	323-128	210 Ω	1/2 w	Prec	1%	
R235	321-109	133 Ω	1/8 w	Prec	1%	
R236	315-0270-00	27 Ω	1/4 w		5%	X520-up
R238	321-221	1.96 k	1/8 w	Prec	1%	
R240	323-234	2.67 k	1/2 w	Prec	1%	
R242	315-152	1.5 k	1/4 w		5%	
R243	315-622	6.2 k	1/4 w		5%	
R245	321-259	4.87 k	1/8 w	Prec	1%	
R247	323-183	787 Ω	1/2 w	Prec	1%	
R252†	311-422	500 Ω	Var		VARIABLE	
R254	321-141	287 Ω	1/8 w	Prec	1%	
R255	315-823	82 k	1/4 w		5%	
R260	315-823	82 k	1/4 w		5%	
R265	315-100	10 Ω	1/4 w		5%	
R267	315-100	10 Ω	1/4 w		5%	
R270	308-344	18.2 Ω	3 w	WW	1%	

†R252 ganged with SW252, furnished as a unit.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description				S/N Range
R272	323-105	121 Ω	½ w	Prec	1%	
R275	311-169	100 Ω	Var		COARSE	
R277	323-105	121 Ω	½ w	Prec	1%	
R305A	323-680	988 k	½ w	Prec	1/10%	
R305 B	311-519	30 k	Var			
R305C	321-289	10 k	⅛ w	Prec	1%	100-179X
R306B†	325-004	900 k	¼ w	Prec	1/10%	
R306D††	325-003	99.8 k	⅛ w	Prec	1/10%	
R306E	311-518	500 Ω	Var			
R306G	321-097	100 Ω	⅛ w	Prec	1%	100-179X
R308B	323-681	990 k	½ w	Prec	½%	
R308C	321-637	9.9 k	⅛ w	Prec	½%	
R308D	311-517	250 Ω	Var			
R309B	323-623	999 k	½ w	Prec	1%	
R309C	321-193	1 k	⅛ w	Prec	1%	
R310	317-201	200 Ω	1/10 w		5%	
R311	315-681	680 Ω	¼ w		5%	
R313	315-470	47 Ω	¼ w		5%	
R314	308-351	4.87 k	3 w	WW	1%	
R316	315-471	470 Ω	¼ w		5%	
R317	315-101	100 Ω	¼ w		5%	
R323	321-161	464 Ω	⅛ w	Prec	1%	
R325	321-200	1.8 k	⅛ w	Prec	1%	
R327	321-222	2 k	⅛ w	Prec	1%	
R330	311-442	250 Ω	Var		—BAL	
R332	315-471	470 Ω	¼ w		5%	
R334	308-349	3.6 k	3 w	WW	1%	
R335	317-107	100 meg	⅛ w		5%	100-179X
R336	311-390	25 k	Var		—GRID CURRENT BAL	100-179X
R338	321-218	1.82 k	⅛ w	Prec	1%	
R339	321-220	1.91 k	⅛ w	Prec	1%	
R340	321-283	8.66 k	⅛ w	Prec	1%	
R343	315-150	15 Ω	¼ w		5%	
R350	321-131	226 Ω	⅛ w	Prec	1%	
R352	315-101	100 Ω	¼ w		5%	
R353	321-273	6.81 k	⅛ w	Prec	1%	
R355	321-255	4.42 k	⅛ w	Prec	1%	
R362	321-091	86.6 Ω	⅛ w	Prec	1%	
R364	321-145	316 Ω	⅛ w	Prec	1%	
R374	321-233	2.61 k	⅛ w	Prec	1%	
R385	321-149	348 Ω	⅛ w	Prec	1%	

†Matched pair, furnished as a unit with R106B.

††Matched pair, furnished as a unit with R106D.

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R387	315-133	13 k	1/4 w			5%	
R389	311-520	2 x 10 k		Var		STEP ATTEN BAL	
R390	321-187	866 Ω	1/8 w		Prec	1%	
R392	315-104	100 k	1/4 w			5%	
R393	321-180	732 Ω	1/8 w		Prec	1%	
R403	315-0150-00	15 Ω	1/4 w			5%	X520-up
R404	323-224	2.1 k	1/2 w		Prec	1%	
R409	321-060	41.2 Ω	1/8 w		Prec	1%	
R410	311-442	250 Ω		Var		1 MV PEAK	
R416	321-173	619 Ω	1/8 w		Prec	1%	
R418	321-185	825 Ω	1/8 w		Prec	1%	
R419	315-331	330 Ω	1/4 w			5%	
R434	323-128	210 Ω	1/2 w		Prec	1%	
R435	321-109	133 Ω	1/8 w		Prec	1%	
R436	315-0270-00	27 Ω	1/4 w			5%	X520-up
R438	321-221	1.96 k	1/8 w		Prec	1%	
R440	323-234	2.67 k	1/2 w		Prec	1%	
R442	315-152	1.5 k	1/4 w			5%	
R447	323-183	787 Ω	1/2 w		Prec	1%	
R504	321-096	97.6 Ω	1/8 w		Prec	1%	
R505	321-229	2.37 k	1/8 w		Prec	1%	
R508	315-363	36 k	1/4 w			5%	
R510	311-390	25 k		Var		I_b BAL	
R512	321-097	100 Ω	1/8 w		Prec	1%	
R513	311-169	100 Ω		Var		GAIN	
R515	321-127	205 Ω	1/8 w		Prec	1%	
R517	323-193	1 k	1/2 w		Prec	1%	
R520	315-512	5.1 k	1/4 w			5%	
R521	311-389	2 x 10 k		Var		POSITION	
R524	321-125	196 Ω	1/8 w		Prec	1%	
R526	323-125	196 Ω	1/2 w		Prec	1%	
R529	322-101	110 Ω	1/4 w		Prec	1%	
R534	322-094	93.1 Ω	1/4 w		Prec	1%	
R536	323-082	69.8 Ω	1/2 w		Prec	1%	
R538	321-097	100 Ω	1/8 w		Prec	1%	
R539	315-472	4.7 k	1/4 w			5%	
R540	311-442	250 Ω		Var		DAMPING	
R543	321-059	40.2 Ω	1/8 w		Prec	1%	
R549	323-169	562 Ω	1/2 w		Prec	1%	
R553	323-184	806 Ω	1/2 w		Prec	1%	
R555	323-168	549 Ω	1/2 w		Prec	1%	
R562	321-165	511 Ω	1/8 w		Prec	1%	
R564	321-125	196 Ω	1/8 w		Prec	1%	
R572	323-185	825 Ω	1/2 w		Prec	1%	
R574	323-193	1 k	1/2 w		Prec	1%	
R580	321-179	715 Ω	1/8 w		Prec	1%	

Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R583	311-509	1 k		Var		6 V CAL	
R584	308-346	2.55 k	1/8 w		WW	1/10%	
R587A thru G†	308-345	1 k	1/4 w		WW	1/10%	
R590	311-266	500 Ω		Var		1 V CAL	
R594	308-347	3.1 k	1/8 w		WW	1/10%	
R595††	311-360	5 k		Var			100-479
R595††	311-0360-02	5 k		Var			480-up
R599	315-102	1 k	1/4 w			5%	
R604	321-096	97.6 Ω	1/8 w		Prec	1%	
R605	321-229	2.37 k	1/8 w		Prec	1%	
R617	323-193	1 k	1/2 w		Prec	1%	
R620	315-512	5.1 k	1/4 w			5%	
R624	321-125	196 Ω	1/8 w		Prec	1%	
R634	322-094	93.1 Ω	1/4 w		Prec	1%	
R638	321-097	100 Ω	1/8 w		Prec	1%	
R649	323-169	562 Ω	1/2 w		Prec	1%	
R653	323-184	806 Ω	1/2 w		Prec	1%	
R657	315-103	10 k	1/4 w			5%	
R659	311-390	25 k		Var		TRIG BAL	
R662	321-165	511 Ω	1/8 w		Prec	1%	
R664	321-125	196 Ω	1/8 w		Prec	1%	
R669	321-057	38.3 Ω	1/8 w		Prec	1%	
R672	323-185	825 Ω	1/2 w		Prec	1%	
R674	323-193	1 k	1/2 w		Prec	1%	
R703	321-151	365 Ω	1/8 w		Prec	1%	
R707	315-363	36 k	1/4 w			5%	
R713A	315-151	150 Ω	1/4 w			5%	
R713B	321-650	650.4 Ω	1/8 w		Prec	1/4%	
R715	321-192	976 Ω	1/8 w		Prec	1%	
R720	321-151	365 Ω	1/8 w		Prec	1%	
R723	315-133	13 k	1/4 w			5%	
R727	321-263	5.36 k	1/8 w		Prec	1%	
R730	321-176	665 Ω	1/8 w		Prec	1%	
R735A	315-271	270 Ω	1/4 w			5%	100-519
R735A	315-0391-00	390 Ω	1/4 w			5%	520-up
R735B	321-115	154 Ω	1/8 w		Prec	1%	

Switches

Unwired	Wired				S/N Range
SW101A 260-651 SW101B††† 260-652 SW110 260-648	Use *050-0260-00	Rotary Rotary Rotary	+INPUT VOLTS/CM	(front) (rear) (+Input Atten)	100-179
SW101A 260-0651-00 SW101B††† 260-0652-01 SW110 260-0648-00	*644-0013-00††††	Rotary Rotary Rotary	+INPUT VOLTS/CM	(front) (rear) (+Input Atten)	180-up

† Set of 7, matched within 0.02% of each other.

†† R595 ganged with SW590.

††† SW101B and SW301B furnished as a unit.

†††† *644-0013-00 (SW101A, SW101B, SW110) and *644-0013-00 (SW301A, SW301B, SW310) furnished as a unit.

Switches *(Cont'd)*

Ckt. No.	Tektronix Part No.	Description	S/N Range
SW252†	311-422		
SW255	260-447	Slide PULL FOR 1 MC BW	
SW301A	260-650	Rotary (front)	
SW301B††	260-652 Use *050-0260-00	Rotary —INPUT (rear)	
SW310	260-649	Rotary VOLTS/CM (—Input Atten)	100-179
SW301A	260-0650-00	Rotary (front)	
SW301B††	260-0652-01 *644-0013-00†††	Rotary —INPUT (rear)	
SW310	260-0649-00	Rotary VOLTS/CM (—Input Atten)	180-up
SW580	260-653	Lever Vc POLARITY	
SW590††††	260-647 *262-700	Rotary COMPARISON VOLTAGE (Vc)	
SW710	260-646 *262-699	Rotary VOLTS/CM (Gain Switching)	100-519
SW710	260-0646-00 *262-0699-01	Rotary VOLTS/CM (Gain Switching)	520-up

Electron Tubes

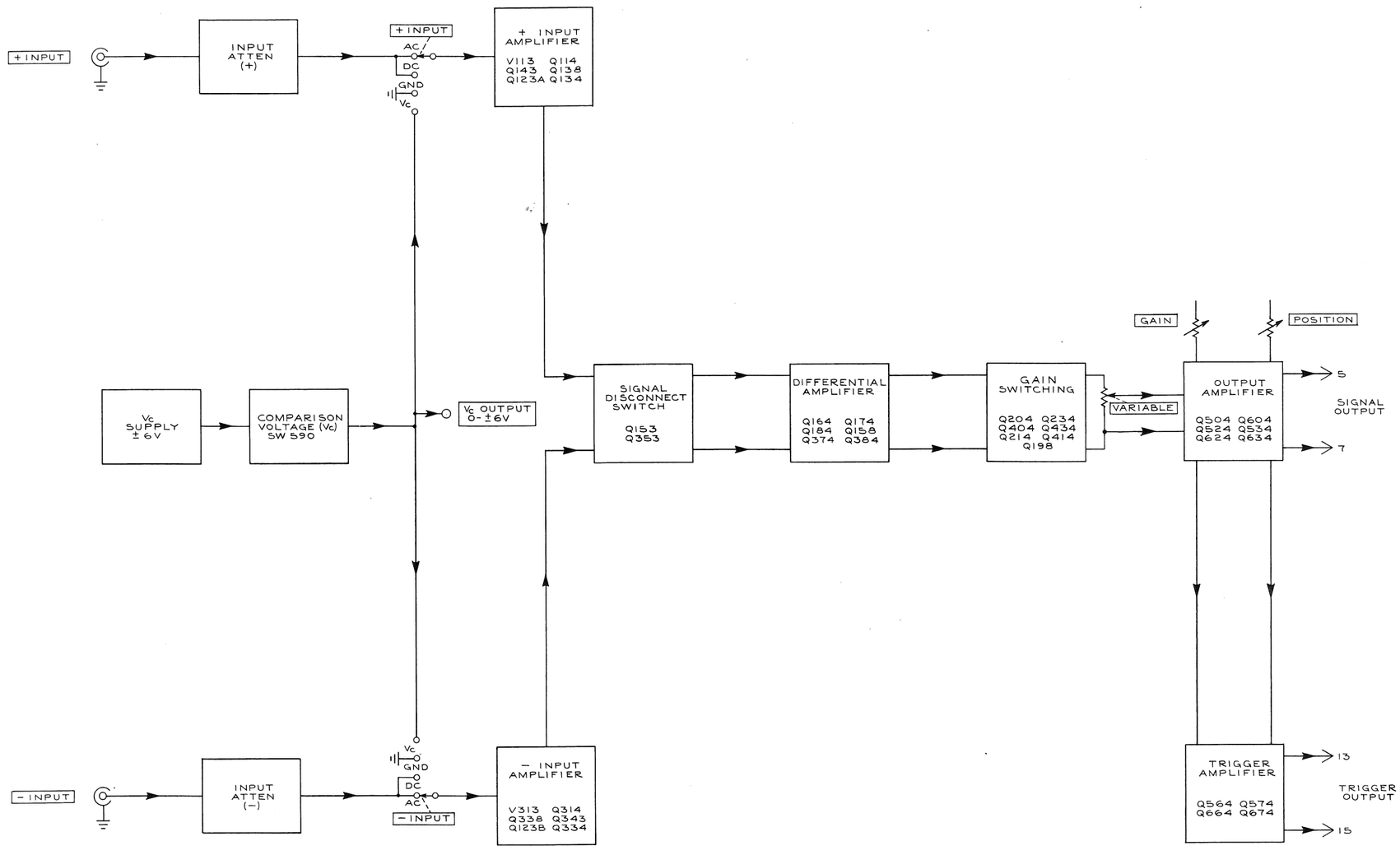
V113 V313	*157-099	8056, matched pair	

†SW252 ganged with R252, furnished as a unit.

†† SW301B and SW101B furnished as a unit.

††† *644-0013-00 (SW101A, SW101B, SW110) and *644-0013-00 (SW301A, SW301B, SW310) furnished as a unit.

†††† SW590 ganged with R595.



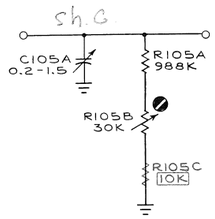
TYPE 10A1 PLUG-IN UNIT

A

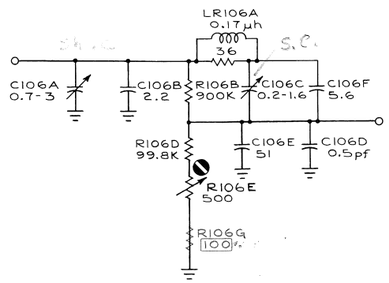
BLOCK DIAGRAM

PLM
165

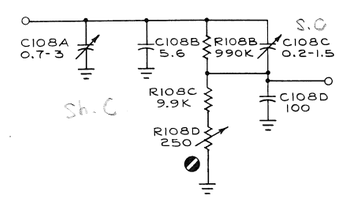
1X



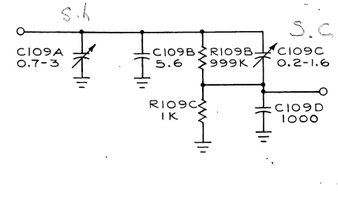
10X



100X

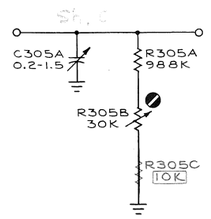


1000X

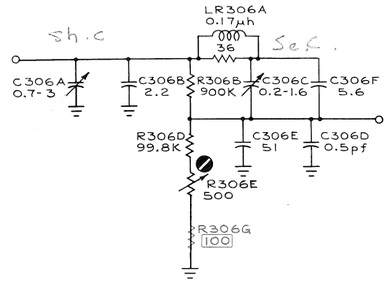


+ INPUT

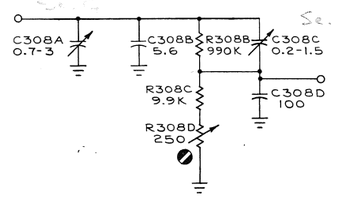
1X



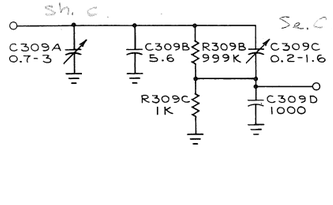
10X



100X



1000X



− INPUT

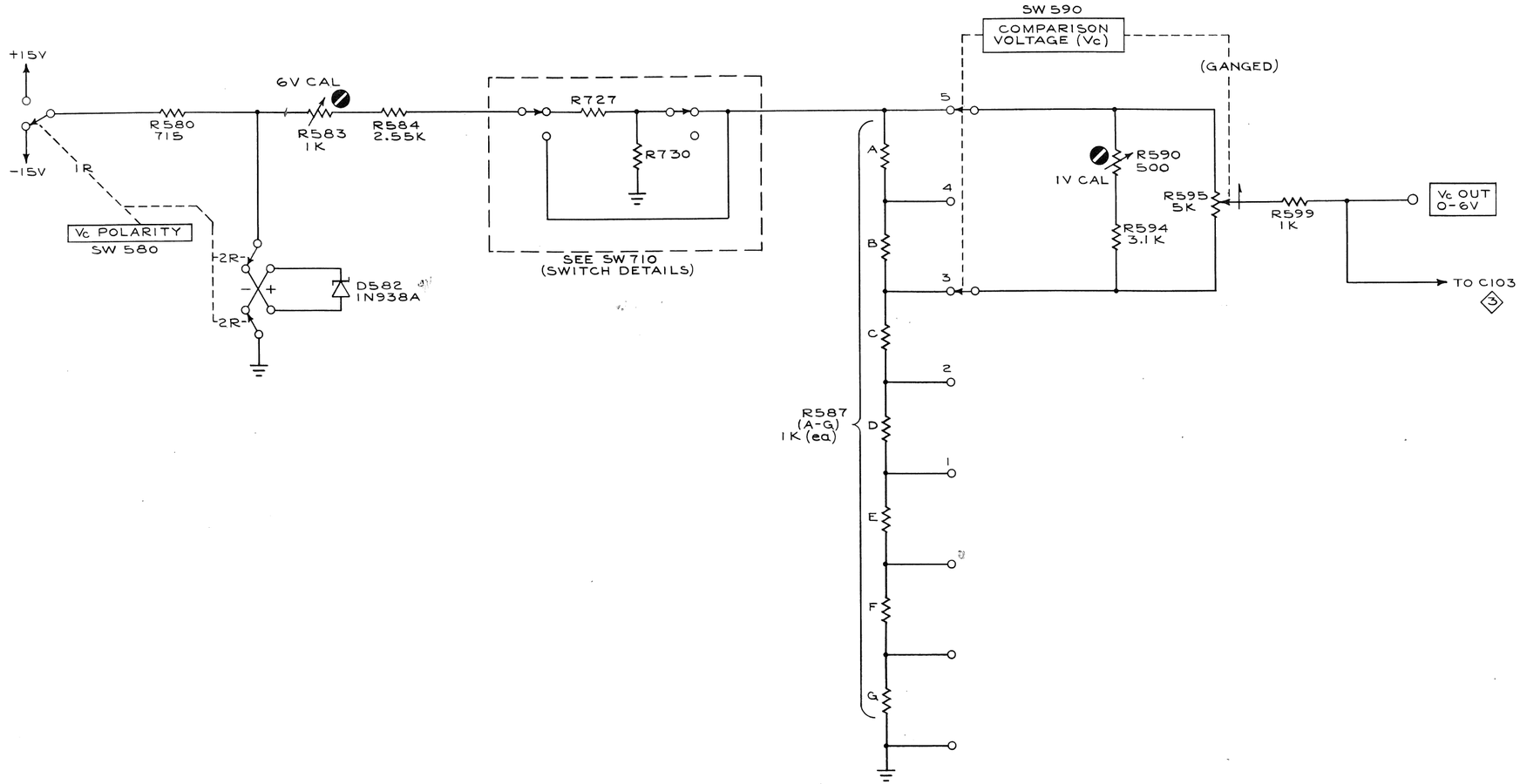
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

TYPE 10AI PLUG-IN UNIT

B

ATTENUATORS ◇1
PLM
1265

AT ATTENUATOR



REFERENCE DIAGRAMS
3 INPUT AMPLIFIER

IMPORTANT:

Circuit voltages were obtained with a 20,000 Ω/Volt VOM. All readings are in volts.

Voltage and waveform amplitude measurements are not absolute and may vary from unit to unit. For these measurements, a 30" flexible extension cable (012-080) was used to operate the Type 10A1 out of the oscilloscope plug-in compartment.
Actual waveform photographs are shown with the test oscilloscope set for +Ext triggering on the same signal applied to the Type 10A1 to show waveform polarities.

VOLTAGES AND WAVEFORM READINGS were obtained under the following common conditions:

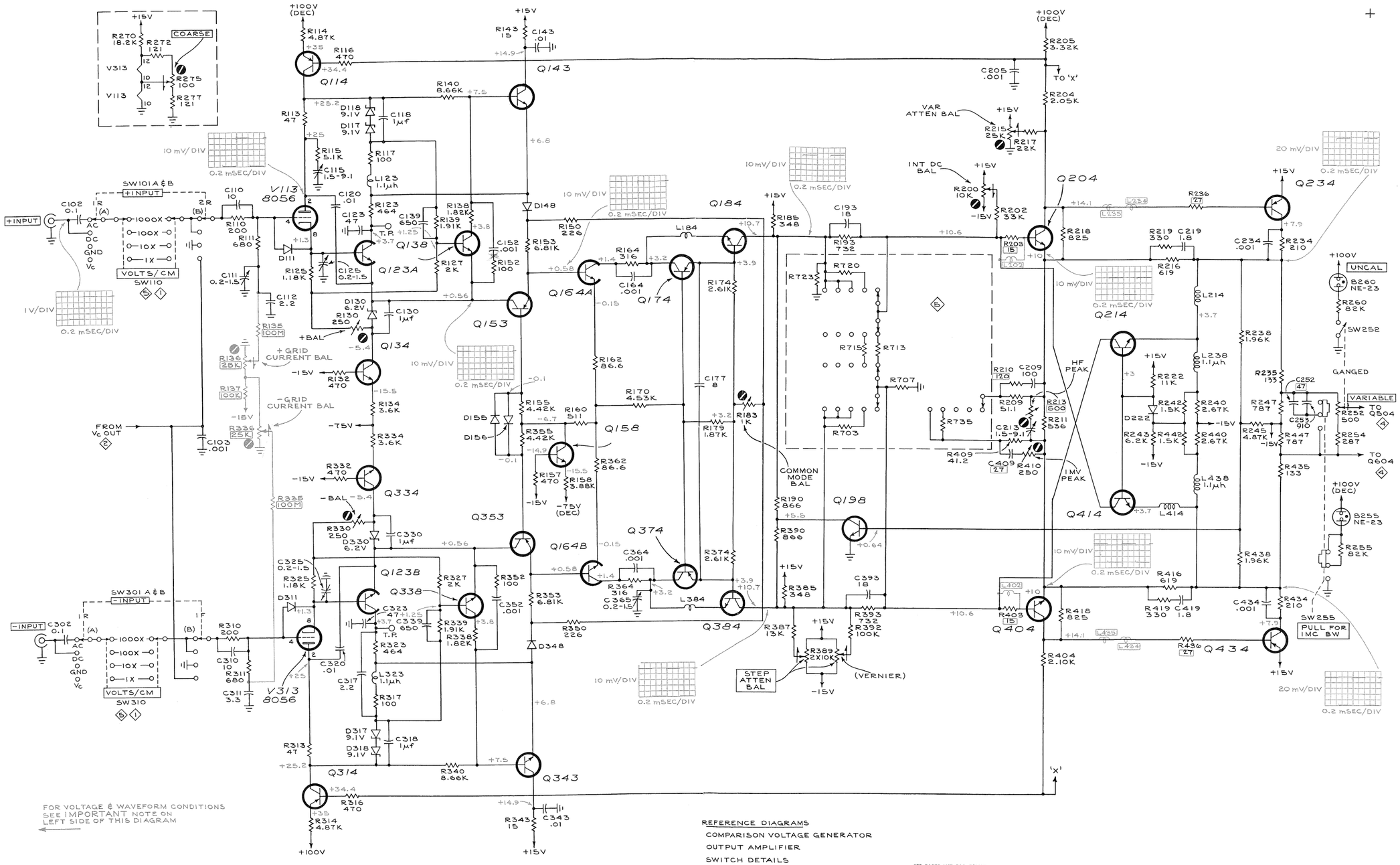
Vc RANGE	600 Volts
VOLTS/CM	1 VOLTS
VARIABLE (VOLTS/CM)	CAL
PULL FOR 1 MC BW	Pushed inward
POSITION	Centered
+INPUT	DC
—INPUT	GND
STEP ATTEN BAL	Centered
COARSE	Set for equal voltages at: V113 cathode to ground and V313 cathode to ground.
Other Controls	As is

QUIESCENT VOLTAGE READINGS:

Signal to +INPUT connector: None

WAVEFORMS

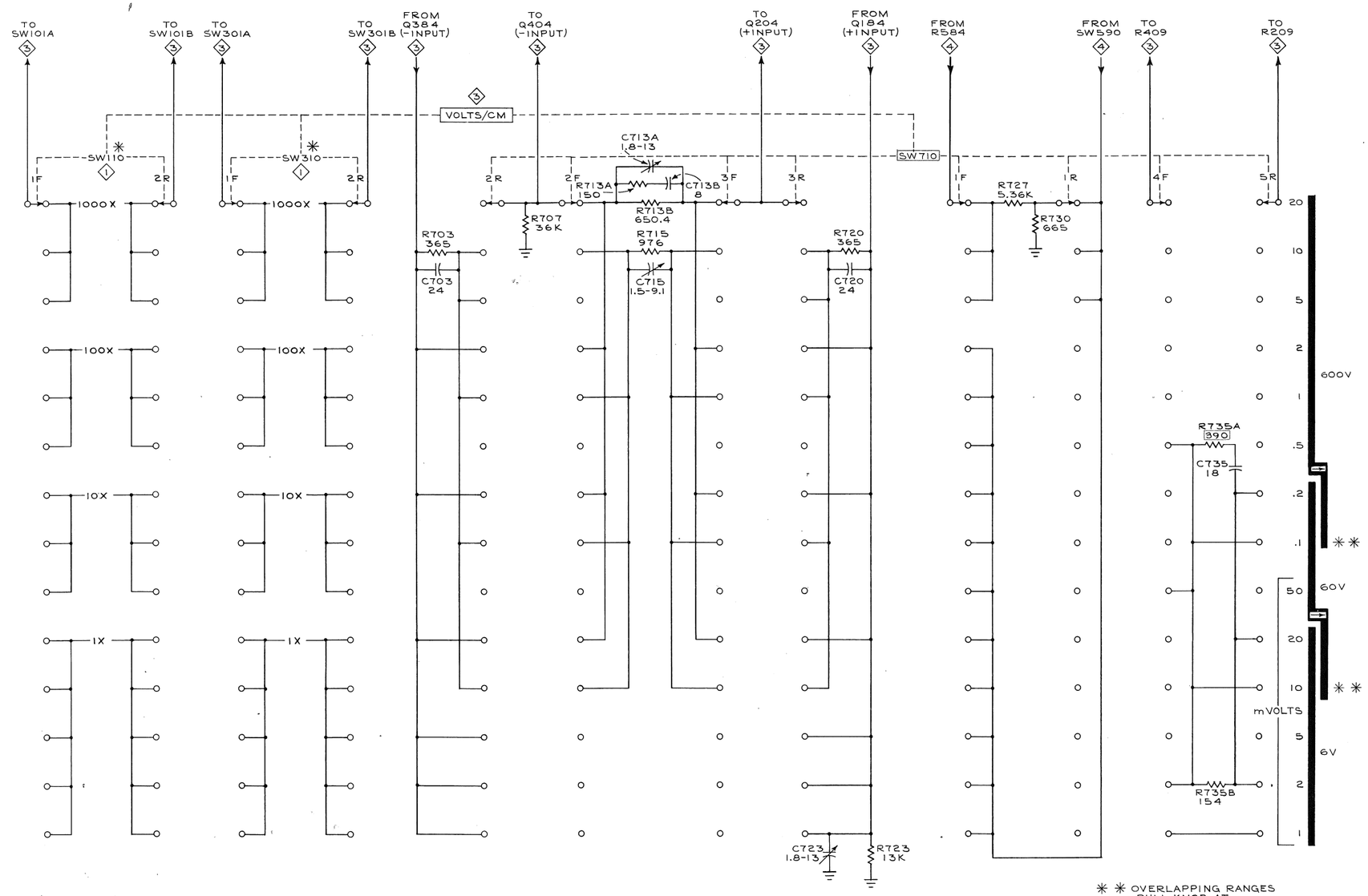
Signal to +INPUT connector: 5-volt peak-to-peak 1-kc oscilloscope calibrator signal.



TYPE 10A1 PLUG-IN UNIT

INPUT AMPLIFIER ◇3

PLM 768

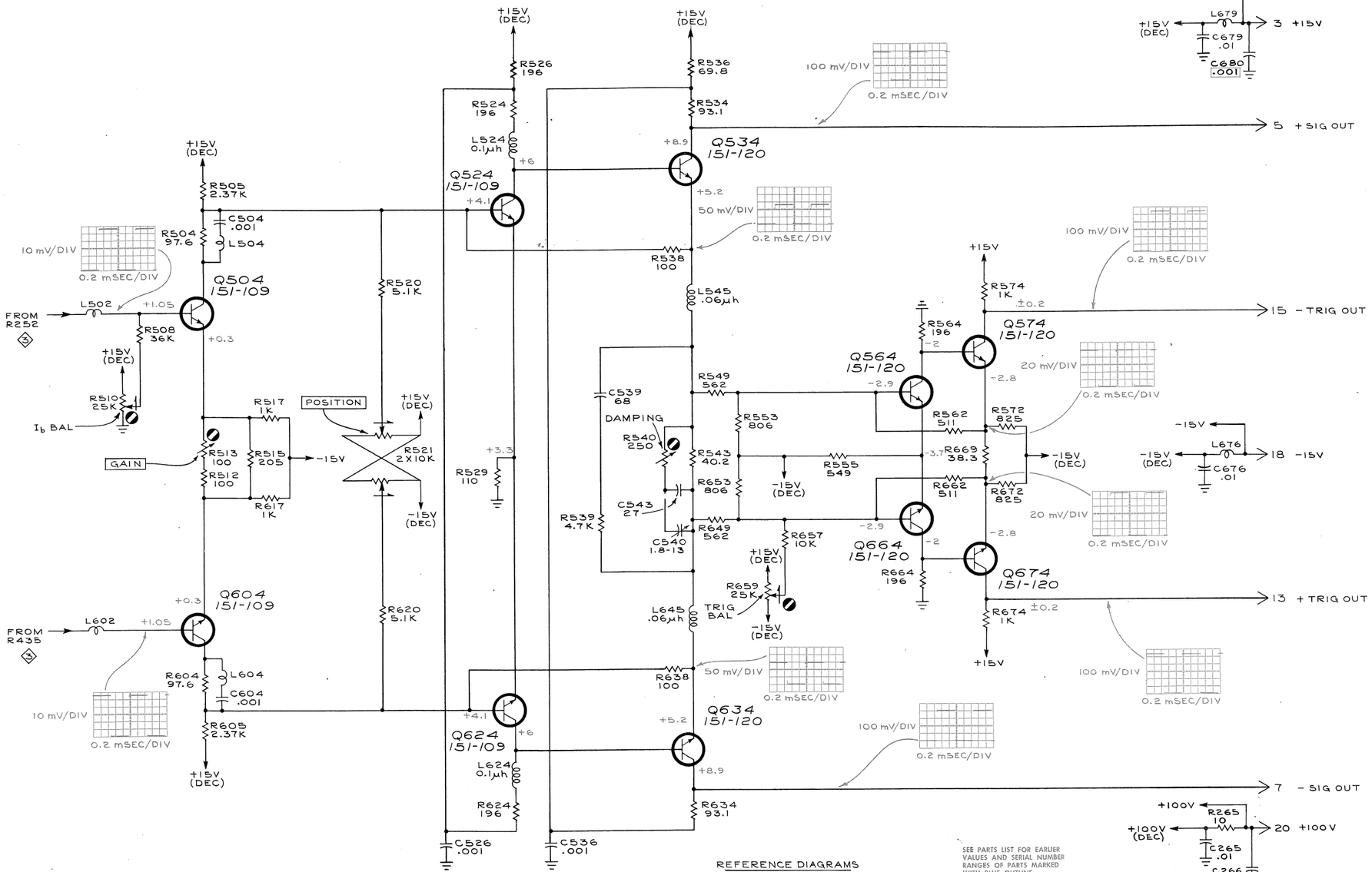


* DRIVEN BY SAME SWITCH SHAFT

REFERENCE DIAGRAMS
1 ATTENUATORS
3 INPUT AMPLIFIER
4 OUTPUT AMPLIFIER

** OVERLAPPING RANGES
PULL KNOB AT → TO RETAIN Vc RANGE

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.



FOR VOLTAGE & WAVEFORM CONDITIONS SEE IMPORTANT NOTE ON LEFT SIDE OF INPUT AMPLIFIER DIAGRAM

REFERENCE DIAGRAMS

3 INPUT AMPLIFIER

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

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 10A1 TENT SN 590

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

D155	152-0141-02	Silicon	1N4152
D156	152-0141-02	Silicon	1N4152

M13,721/1168

TYPE 10A1 TENT SN 550

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

D130	152-0280-00	1N753A	0.4 w, 6.2 V, ±5%
D330	152-0280-00	1N753A	0.4 w, 6.2 V, ±5%

M11,191/468