RECOMMENDED

CALIBRATION PROCEDURE

TYPE 561A

070-469

1064

Tektronix, Inc.

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Recommended Calibration Procedure for Tektronix Instruments

TYPE 561A

Introduction

This procedure provides an operational check and complete calibration information. If followed completely, each phase of instrument operation will be checked to the performance requirements listed in the Instruction Manual or Tektronix advertising material.

Specialized Tektronix calibration equipment is used in this procedure where applicable. If this equipment is not available, the equipment substituted must equal or exceed the requirements listed in the 'Equipment Required' section. If the equipment does not meet these requirements, the Type 561A cannot be calibrated to the accuracy given. In such cases, the difference between the accuracy of the equipment used and the specified equipment accuracy must be added to the tolerance listed in the calibration steps.

This procedure may be used as a calibration training aid by following the procedure completely. It may be used to verify instrument operation by checking for the performance requirement or operation listed in each step. It may also be used as a quick calibration guide by performing only those steps entitled 'Adjust . . . .'.

General Information

The Type 516A Oscilloscope should be calibrated every 500 hours of operation or every six months if used infrequently. Any needed maintenance should be performed before proceeding with calibration.

When calibrating a complete 561A system (indicator unit and plug-ins), always calibrate the Type 561A Oscilloscope first. The plug-in units need not be calibrated but must be working properly.

This procedure is arranged in a sequence which will allow the instrument to be calibrated with the least interaction of adjustments and reconnection of equipment. If desired, the steps may be performed out of sequence or a step may be performed individually. However, it may be necessary to refer to the Preliminary Procedure and/or the preceding step(s) for additional setup information. Some adjustments affect the calibration of other circuits within the instrument. If there is interaction, it will be noted; the steps affected will be listed.

NOTE

Steps entitled 'Check' provide a check of an operational standard of the unit. In the 'Adjust' steps, the operation is checked first, and then the adjustment is made if needed.

A pull-out page at the end of this procedure shows the calibration adjustments and test points in the instrument. These pictures will be helpful in locating the adjustments and test points and should be pulled out and referred to throughout this procedure. Waveforms which will be helpful in determining the correct adjustment of a control are shown in the individual steps.

EQUIPMENT REQUIRED

The following equipment is required for complete calibration of the Type 561A (see Fig. 1).

1. Tektronix 2- or 3-series amplifier plug-in unit.*

2. Tektronix 2- or 3-series time-base plug-in unit.*

3. Dc voltmeter. Minimum sensitivity, 20,000 ohms/volt; accuracy, 1% or better up to 300 volts and at least 3% at 4 kv.

4. Type 3M1 CRT Deflection Capacitance Normalizer.**

5. Insulated screwdriver, non-metallic Tektronix Part No. 003-000.

The following additional equipment is required for a complete operational check of the Type 561A (see Fig. 2).

6. Variable autotransformer. Must be capable of supplying at least 350 volt-amperes. If autotransformer does not have an ac voltmeter to indicate output voltage, monitor output with an ac voltmeter (rms) with range of at least 125 volts (250 volts if wired for 234-volt operation).

7. Two maximum loading plug-ins to check power-supply regulation. The following plug-ins provide maximum loading.

Type 3A1
Type 3A2
Type 3A6
Type 3A72
Type 3A74
Type 3A75

Type 2B67 with Type 3B3 Type 3B4

Type 3S76-3T77 (must be used together)

8. 1X probe, BNC connector. Tektronix P6028.

9. Test oscilloscope. Risetime, 0.1 microsecond or less; minimum deflection factor, 0.005 volts/division. Recommended type: Tektronix Type 561A with Type 3A1 and 2A63 amplifier plug-ins and Type 3B4 time-base plug-in, or Tektronix 530-, 540-series oscilloscope with Type H plug-in unit.

10. 3-series dual-trace amplifier unit (use as item 1).

11. 3-series delayed-sweep time-base unit (use as item 2).

12. Standard Amplitude Calibrator. Amplitude accuracy, 0.25%; signal amplitude, 0.2 millivolts to 100 volts; output signals, 1-kc square wave and +dc. Tektronix Part No. 067-502.

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

***Use plug-in units which check maximum performance of the Type 561A. For example, use a high-frequency unit in preference to low-frequency, dual-trace rather than single-trace, etc. Also see items 7, 10 and 11.**

****Normally required only if new crt has been installed or if deflection-plate compensation has been inadvertently misadjusted. Procedure given in the Type 561A Instruction Manual may be used in place of this unit.**

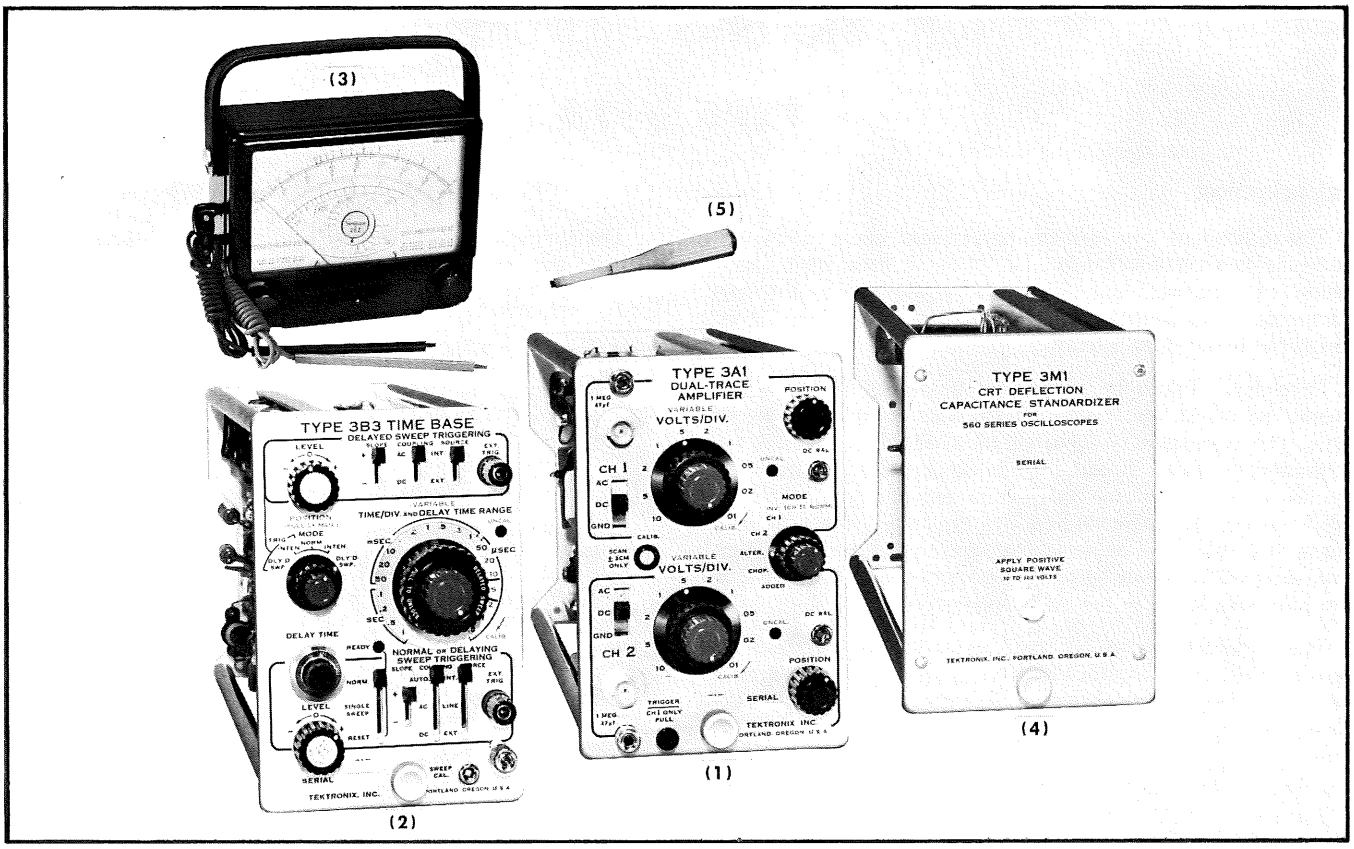


Fig. 1. Required calibration equipment.

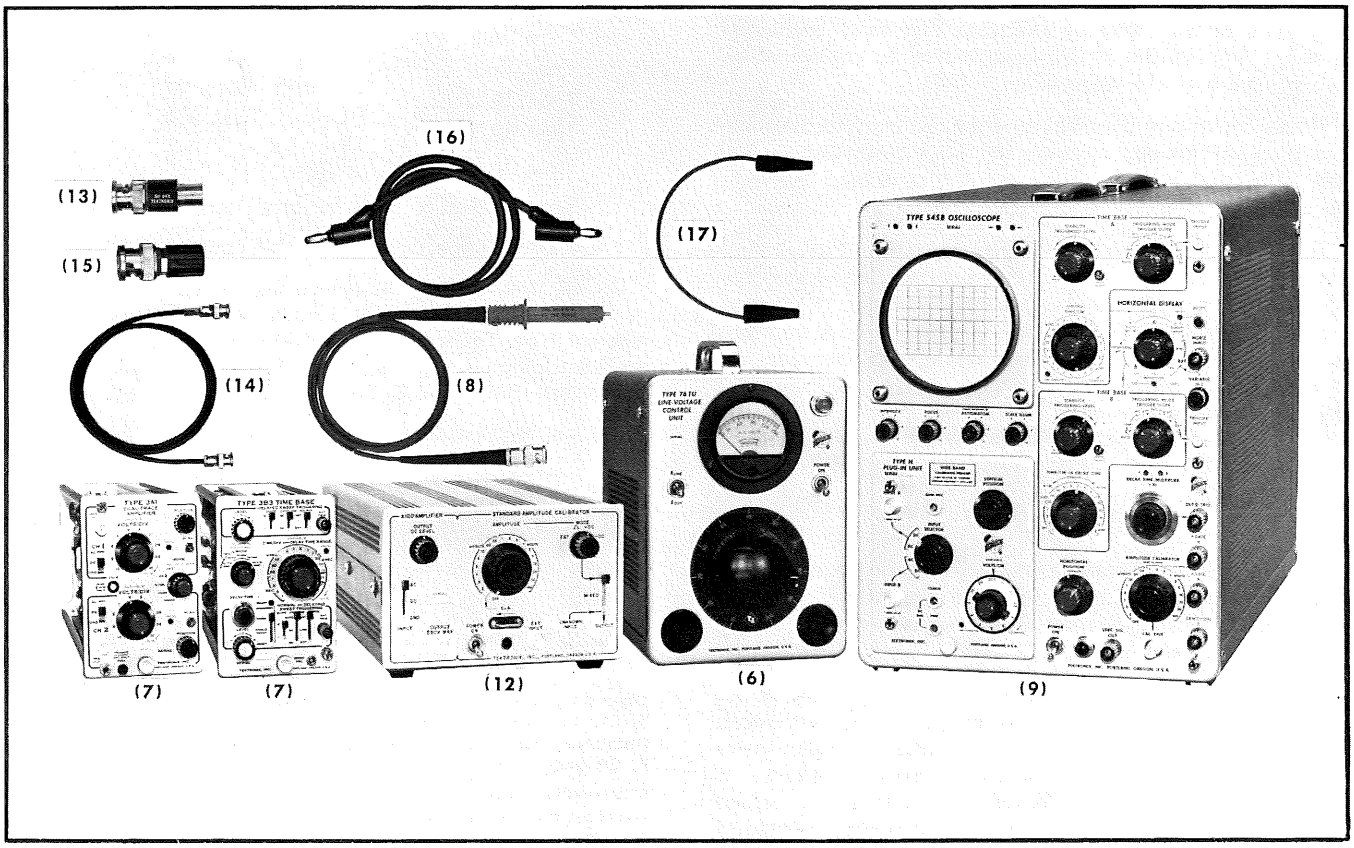


Fig. 2. Equipment needed for operational check.

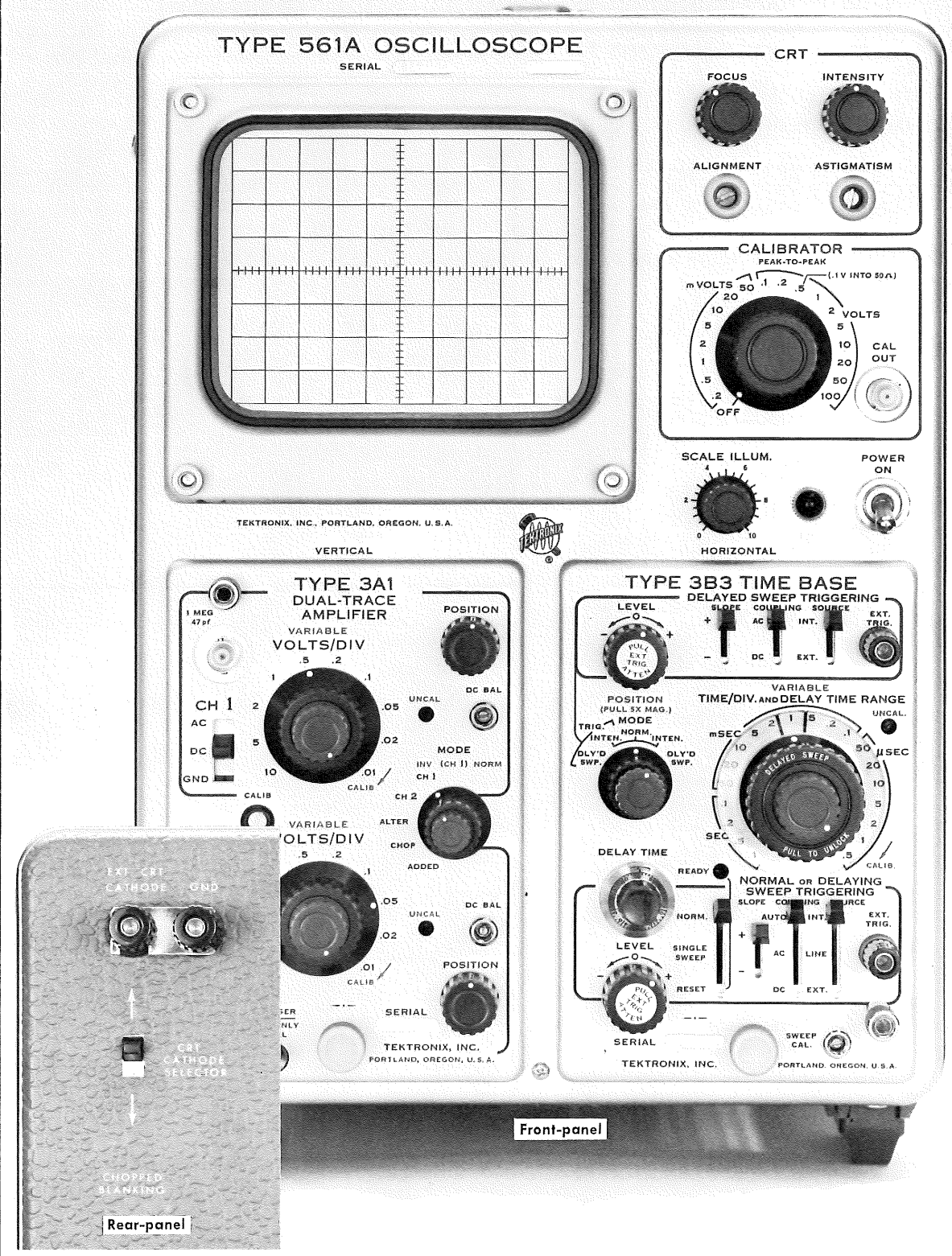


Fig. 3. Type 561A showing control settings for calibration procedure.

14. Cable (two); 50-ohm, 42" long, BNC connectors. Tektronix Part No. 012-057.

15. Adapter; BNC to binding post. Tektronix Part No. 103-033.

16. Jumper lead (two); 18" long, banana plugs. Tektronix Part No. 012-031.

17. Jumper lead; 6" long, insulated alligator clips (not available from Tektronix).

PRELIMINARY PROCEDURE

1. Remove both side panels from the Type 561A.

2. Insert the amplifier plug-in unit in the left plug-in compartment.

3. Insert the time-base plug-in unit in the right plug-in compartment.

4. Preset the Type 561A front-panel controls as follows (see Fig. 3):

FOCUS	Midrange
INTENSITY	Adjust for normal level
CALIBRATOR	OFF
SCALE ILLUM.	Clockwise
POWER	Off
CRT CATHODE SELECTOR	Up

5. Preset the amplifier unit controls (Channel 1 if dual-trace) as follows:

Position	Midrange
Ac Dc Gnd	Ac
Volts/Division	.1
Variable	Calibrated

6. Preset the time-base unit controls as follows:

Position	Midrange
5X Magnifier	Off
Time/Division	10 milliseconds
Variable	Calibrated
Triggering Controls	Set for automatic or free-running

7. Connect the autotransformer (if used) to a suitable power source.

8. Connect the Type 561A power cord to the autotransformer output (or directly to power source).

9. Set the autotransformer output voltage for the nominal operating voltage of the Type 561A (117 or 234 volts).

10. Turn the Type 561A POWER switch ON. Allow about 20 minutes warm up before making any adjustments.

CALIBRATION PROCEDURE

1. Adjust —100-Volt Power Supply (see Fig. 18 'D')

a. Connect the dc voltmeter from the —100-volt test point, (see Fig. 18 '1') to chassis ground.

b. **Check**—Meter reading, —100 volts, ±3%.*

c. **Adjust**— —100 V control, R616, for —100 volts.

d. **Interaction**—Check performance requirements of steps 2—15.

NOTE

The —100-volt power supply provides the reference voltage for the remaining supplies. Proper operation of the remaining supplies depends on proper adjustment and operation of the —100-volt supply.

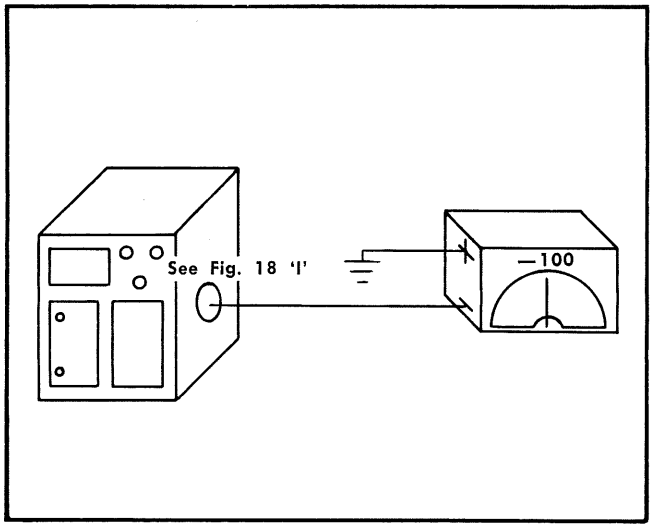


Fig. 4. Test setup for step 1.

2. Adjust +125-Volt Power Supply (see Fig. 18 'M')

a. Connect the dc voltmeter from the +125-volt test point, (see Fig. 18 'J') to chassis ground.

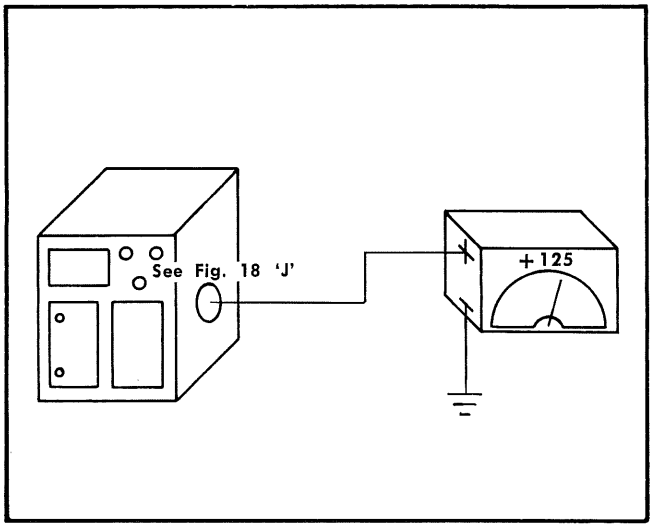


Fig. 5. Test setup for step 2.

b. **Check**—Meter reading, +125 volts, ±3%.*

c. **Adjust**— +125 VOLTS control, R656, for +125 volts.

d. **Interaction**—Check steps 3—15.

3. Adjust +300-Volt Power Supply (see Fig. 18 'L')

a. Conect the dc voltmeter from the +300-volt test point, (see Fig. 18 'K') to chassis ground.

b. **Check**—Meter reading, +300 volts, ±3%.*

c. **Adjust**— +300 VOLTS control, R676, for +300 volts.

d. **Interaction**—Check steps 5—15.

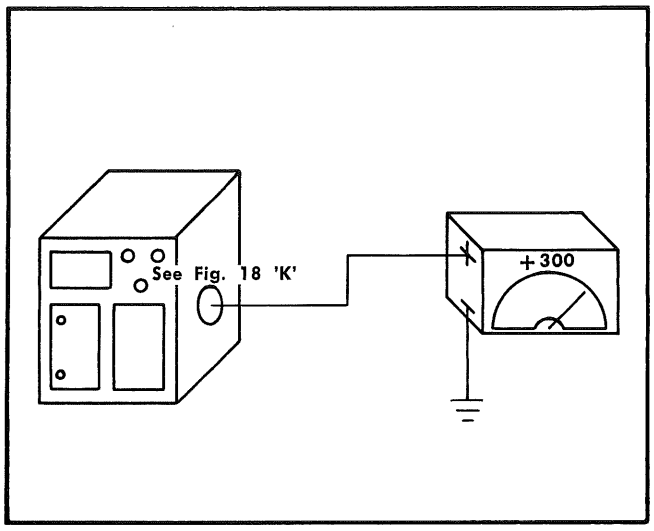


Fig. 6. Test setup for step 3.

4. Adjust —12.2-Volt Power Supply (see Fig. 18 'N')

a. Connect the dc voltmeter from the —12.2-volt test point, (see Fig. 18 'F') to chassis ground.

b. **Check**—Meter reading, —12.2 volts, ±3%.*

c. **Adjust**—12.2 VOLTS control, R730, for —12.2 volts.

d. **Interaction**—Check steps 5—15.

5. Adjust High-Voltage Power Supply (see Fig. 18 'E')

a. Connect the dc voltmeter from the high-voltage test point (see Fig. 18 'G') to chassis ground.

b. **Check**—Meter reading, —3300 volts, ±3%.

c. **Adjust**—HIGH VOLTAGE control, R841, for —3300 volts.

d. **Interaction**—Check steps 7, 9, 11 and 15.

6. Check Low-Voltage Power-Supply Regulation

a. Set autotransformer output voltage to 117 volts.

b. Insert maximum loading plug-in units into the plug-in compartments.

c. Connect the dc voltmeter from the —100-volt test point to chassis ground.

d. Measure the voltage.

e. Set the autotransformer output voltage to 105 volts.

f. Meter reading should be within 1 volt of previous reading (step 6d).

g. Set the autotransformer output voltage to 125 volts.

h. Meter reading should be within 1 volt of value measured in step 6d.

i. Remove the plug-in units from the compartments (mini-load).

j. Meter reading should be within 1 volt of value measured in step 6d.

k. Return the autotransformer output voltage to 105 volts.

***When used with sampling plug-in units the Type 561A power supplies must be checked to a tolerance of ½% or better for proper plug-in operation. Use a dc voltmeter with ¼% accuracy.**

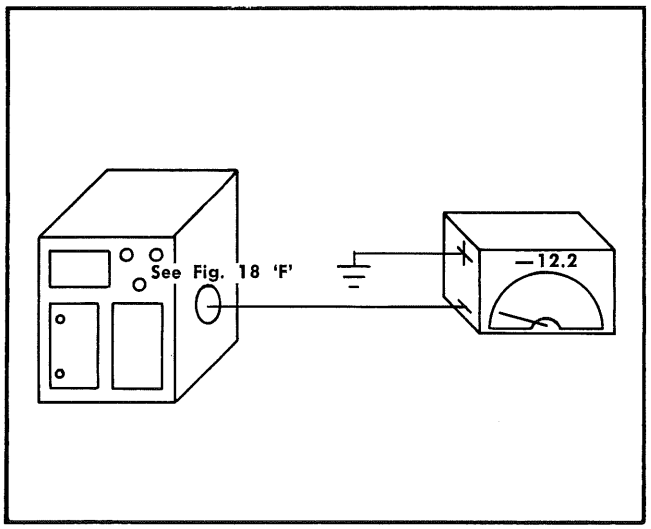


Fig. 7. Test setup for step 4.

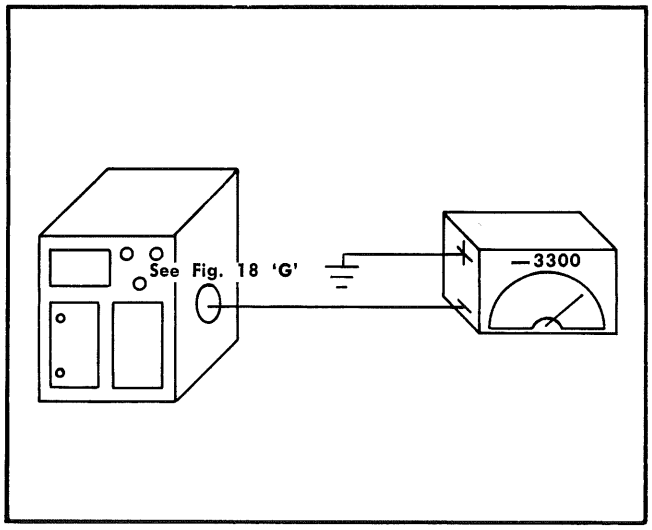


Fig. 8. Test setup for step 5.

l. Meter reading should be within 1 volt of value measured in step 6d.

m. Repeat this procedure for each low-voltage supply. Table I shows maximum voltage deviation allowable for each supply. Test point locations are shown in Fig. 18.

NOTE

150 milliamp minimum load current may be necessary for proper regulation of the —12.2-volt supply. Minimum-load regulation in this condition can be checked by placing an 82 ohm, 5 watt resistor between pins 5 and 16 of either interconnecting plug.

7. Check High-Voltage Power-Supply Regulation

a. Set the autotransformer output voltage to 117 volts.

b. Connect the dc voltmeter from the high-voltage test point to chassis ground.

c. Measure the voltage.

d. Set the autotransformer output voltage to 105 volts.

e. Meter reading should be within 100 volts of value measured in steps 7c.

f. Set the autotransformer output votlage to 125 volts.

g. Meter reading should be within 100 volts of value measured in step 7c.

h. Return the autotransformer output voltage to 117 volts and disconnect the voltmeter.

TABLE I

Power Supply	Maximum Voltage Deviation	Maximum Ripple (millivolts)
—100 volt	1 volt	5
+125 volt	1.25 volt	10
+300 volt	3 volts	80
—12.2 volt	0.12 volt	3
—3300 volt	100 volts	DO NOT MEASURE

8. Check Power-Supply Ripple

a. Connect the P6028 probe to the input of the test oscilloscope.

b. Set the test oscilloscope Volts/Division switch to .005.

c. Connect the probe tip to the —100-volt test point.

d. Measure the 120-cycle ripple as shown on the test oscilloscope crt. Should not exceed 5 millivolts.

e. Repeat this procedure for each low-voltage supply. Table I shows maximum ripple for each supply. Test point locations are shown in Fig. 18.

CAUTION

Do not attempt to measure the ripple of the —3300-volt supply.

9. Adjust Astigmatism
(see Fig. 18 'A')

a. Adjust the FOCUS and ASTIGMATISM controls for a sharp, well-defined display over the entire trace length.

b. Slight readjustment of these controls may be necessary during normal operation.

10. Adjust Trace Alignment
(see Fig. 18 'B')

a. Adjust the amplifier unit Position control to move the trace to the horizontal graticule centerline.

b. **Check**—The trace should be parallel with the centerline.

c. **Adjust**—ALIGNMENT control, R860, so the trace is parallel with the horizontal graticule lines.

11. Adjust Cathode-Ray Tube Geometry
(see Fig. 18 'H')

a. Set the Standard Amplitude Calibrator Amplitude control to 10 Volts, the Mode switch to the square wave position, the function switch up and the Power switch On. (If the test oscilloscope has a 1-Kc Calibrator, it may be used for this adjustment step.)

b. Connect the Standard Amplitude Calibrator Output connector to the amplifier unit input connector.

c. Adjust the amplifier unit Volts/Div switch so the display is 8 centimeters in amplitude.

d. Set the time-base Time/Division switch to 1 millisecond.

e. Adjust the time-base Position and Variable time/division controls so the rising portion of the waveform coincides with the right and left graticule lines. (The INTENSITY control may need to be advanced slightly to view the rising portion of the waveform.)

f. **Adjust**—GEOMETRY control, R865, for best linearity at the right and left edges of the graticule.

12. Adjust Calibrator Amplitude
(see Fig. 18 'C')

a. Connect the dc voltmeter from the calibrator test point (see Fig. 18 'Q') to chassis ground.

b. Be sure the CALIBRATOR switch is set to OFF.

c. **Check**—Meter reading, +100 volts, ±3%.

d. **Adjust**—CAL. AMPL. control, R871, for +100 volts.

13. Check Calibrator Accuracy

a. Set the Standard Amplitude Calibrator controls as follows:

Amplitude	100 Volts
Mode	+DC
Function	Mixed
Power	On
Ac Dc Gnd	Dc

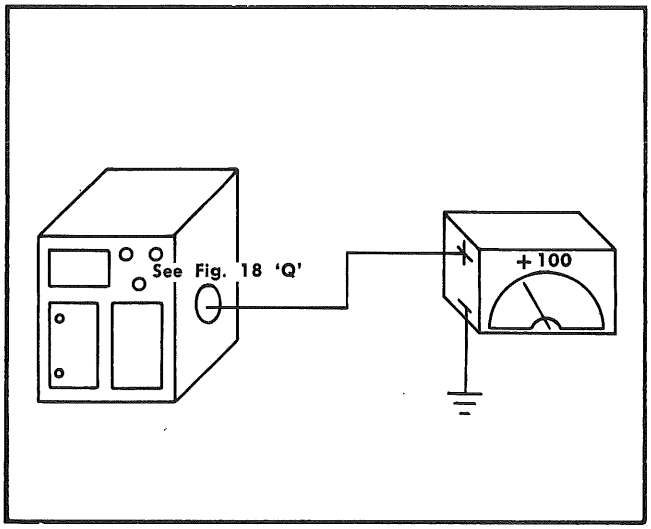


Fig. 9. Test setup for step 12.

b. Connect the CAL. OUT connector to the Standard Amplitude Calibrator Unknown Input with a 50-ohm cable.

c. Connect the Standard Amplitude Calibrator Output connector to the input of the test oscilloscope (minimum deflection factor of 0.005 volts/division) with a 50-ohm cable.

d. Connect a jumper lead from Pin 8 of V884 (see Fig. 18 'R') to chassis ground.

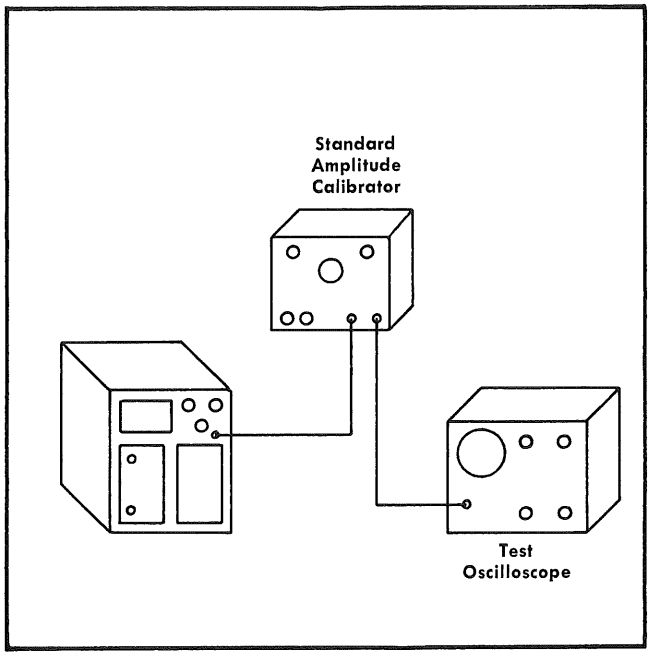


Fig. 10. Test setup for step 13.

e. Difference between the Standard Amplitude Calibrator output signal and the Type 561A CALIBRATOR output signal will be shown as a display on the test oscilloscope similar to Fig. 11. Table II shows maximum allowable display for 3% CALIBRATOR accuracy and the control settings for measuring accuracy of the steps between 100 VOLTS and .1 VOLTS.

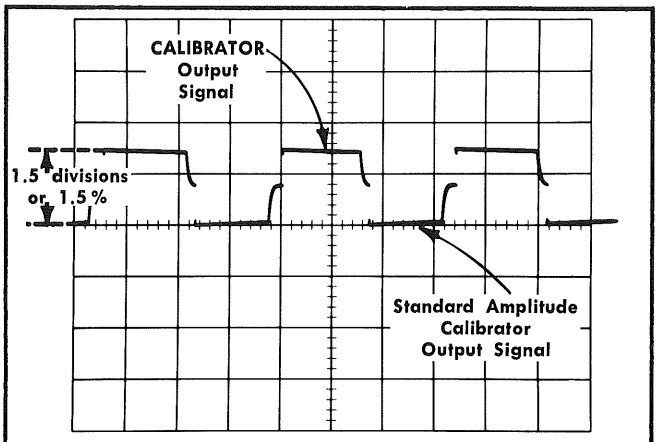
f. Set the CALIBRATOR switch to the .1 V INTO 50 Ω position.

g. Connect the 50-ohm termination to the CAL. OUT connector and the 50-ohm cable to the output of the termination.

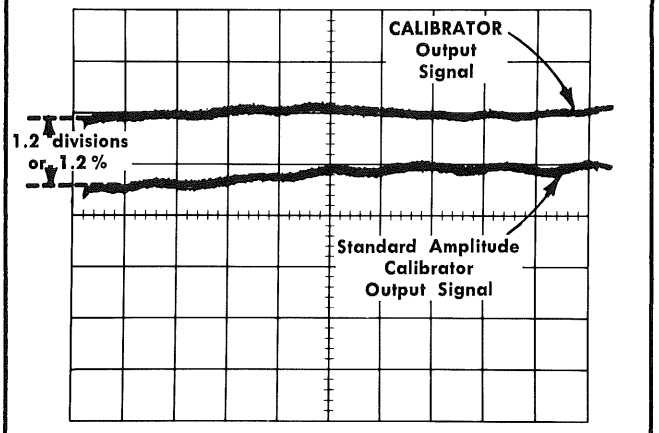
h. Set the test oscilloscope Volts/Division control to .005.

i. Leave the Standard Amplitude Calibrator Amplitude switch set to .1 Volts.

j. The test oscilloscope display should be less than 1.2 division.*



a. Typical waveform showing about +1.5% error in the 10 VOLTS output signal. 0.1 volts/division, vertical; 5 milliseconds/division horizontal.



b. Typical waveform showing about +1.2% error in the 10 mVOLTS output signal. 20 millivolts/division vertical; 0.2 milliseconds/division horizontal; using X100 Amplifier section.

Fig. 11. Waveform showing a difference between Standard Amplitude Calibrator output signal and Type 561A CALIBRATOR output signal.

k. Remove the 50-ohm termination and reconnect the 50-ohm cable to the CAL. OUT connector.

l. Connect the Standard Amplitude Calibrator Output connector to the Input connector of the X100 Amplifier section.

m. Connect the Output ±50 V Max connector to the input of the test oscilloscope.

***6% error allowable due to 3% accuracy of termination.**

n. Set the test oscilloscope Time/Division switch to 0.2 milliseconds. Adjust the Standard Amplitude Calibrator Output Dc Level control to center the trace on the screen.

o. Use Table II to measure accuracy of the CALIBRATOR switch positions between 50 mVOLTS and .2 mVOLTS.

p. Disconnect the cable from the CAL. OUT connector and the jumper lead from pin 8 of V884.

14. Check Calibrator Risetime and Symmetry

a. Connect the CAL. OUT connector to the vertical input of the test oscilloscope with the 50-ohm cable.

b. Set the test oscilloscope Time/Division control to 1 microsecond.

c. Set the CALIBRATOR switch to 1 VOLTS.

d. Adjust the test oscilloscope Volts/Division and Variable control for a five division display.

TABLE II

Type 561A CALIBRATOR setting and Standard Amplitude Calibrator setting	Test Oscilloscope Volts/Division Switch Setting	Maximum Display Amplitude for 3% Accuracy (divisions)
100 VOLTS	1 Volt	3*
50 VOLTS	.5 Volt	3
20 VOLTS	.2 Volt	3
10 VOLTS	.1 Volt	3
5 VOLTS	50 Millivolts	3
2 VOLTS	20 Millivolts	3
1 VOLTS	10 Millivolts	3
.5 VOLTS	5 Millivolts	3
.2 VOLTS	5 Millivolts	1.2
.1 VOLTS	5 Millivolts	0.6
50 mVOLTS	50 Millivolts	3
20 mVOLTS	20 Millivolts	3
10 mVOLTS	10 Millivolts	3
5 mVOLTS	5 Millivolts	3
2 mVOLTS	5 Millivolts	1.2
1 mVOLTS	5 Millivolts	.6
.5 mVOLTS	5 Millivolts	.3
.2 mVOLTS	5 Millivolts	.12

***For maximum Calibrator accuracy, reset the CAL. AMPL. control for minimum deflection.**

e. Check risetime. Should be less than 5 microseconds as shown by less than 5 horizontal divisions between the 10 and 90% points on the test oscilloscope display (see Fig. 12).

f. Set the test oscilloscope Time/Division switch to a setting that shows one complete cycle or more.

g. Measure the length of the top portion of the waveform. It should be 8.3 milliseconds, ±20%. The bottom portion of the waveform should also be 8.3 milliseconds, ±20%.

h. Disconnect the CALIBRATOR signal from the test oscilloscope.

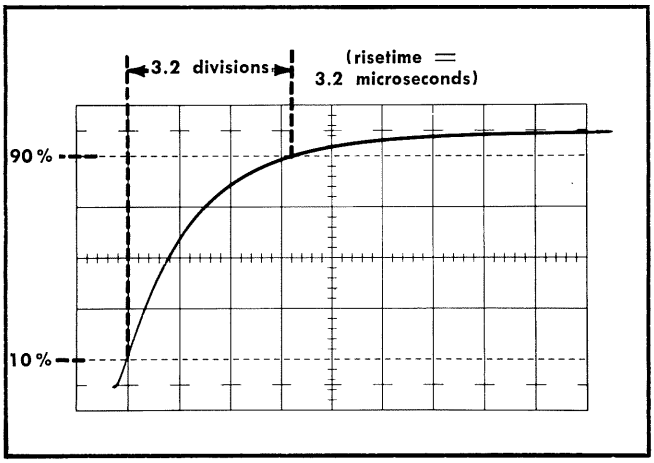


Fig. 12. Measuring CALIBRATOR output signal risetime. Sweep rate, 1 μSec/division.

15. Adjust Vertical and Horizontal Compensation

(see Fig. 18 'O' and 'S')

a. Insert the Type 3M1 CRT Deflection Capacitance Normalizer into the left plug-in compartment.

b. Connect the CAL. OUT connector to the 3M1 input connector.

c. Set the CALIBRATOR switch to 100 VOLTS.

d. Set the Time/Division switch to .2 millisecond.

e. Adjust the time-base triggering controls so the leading edge of the waveform can be viewed.

NOTE

The INTENSITY control setting may need to be increased slightly to observe the leading edge.

f. **Check**—Waveform should be flat with no overshoot or roll-off. Fig. 13 shows the display when correctly and incorrectly compensated.

g. **Adjust**—C760 for optimum flat top on the waveform.

h. Interchange plug-ins and adjust C761 for an optimum flat-top waveform. Fig. 14 shows the waveform obtained when checking horizontal compensation. The FOCUS control will need readjusting when the plug-ins are interchanged.

i. Remove the Type 3M1 and replace the amplifier unit in the left compartment and the time-base unit in the right compartment.

16. Check Intensity (Z-Axis) Modulation

a. Set the CRT CATHODE SELECTOR switch to the up position.

b. Remove the ground strap between the rear-panel binding posts.

c. Place the BNC to binding post adapter on the CAL. OUT connector and connect the jumper leads between the

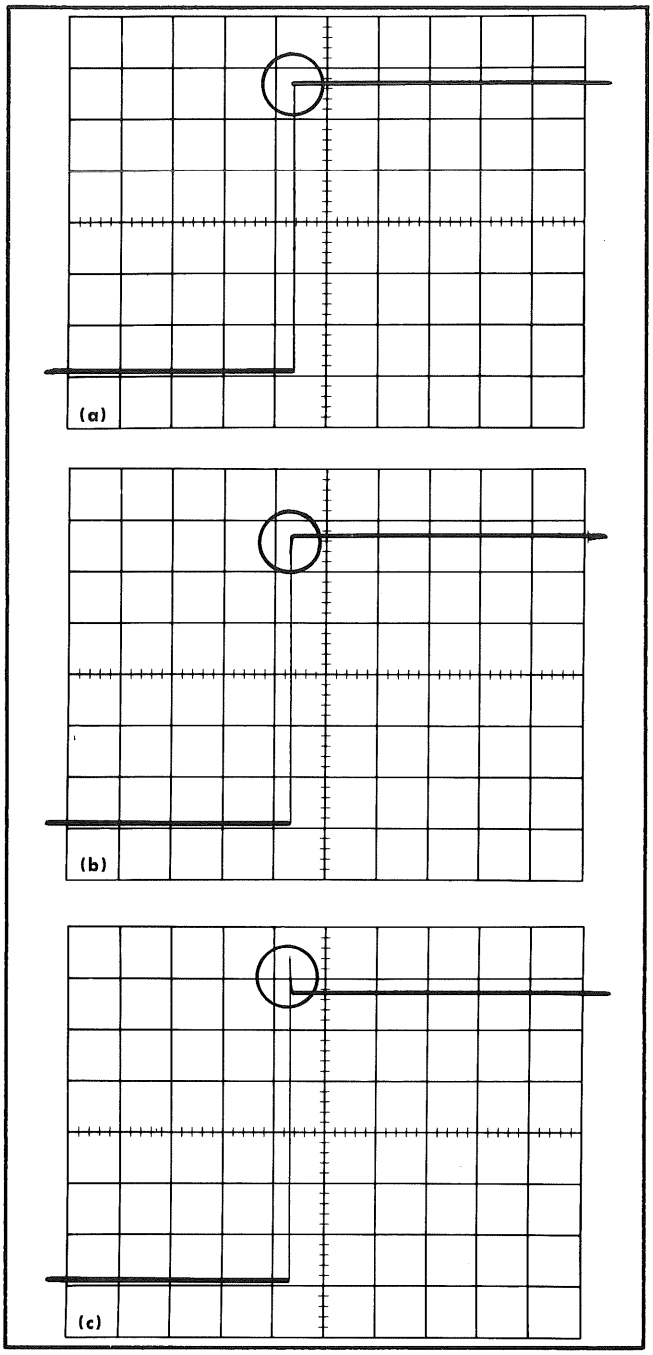


Fig. 13. Vertical deflection plate capacitance compensation. (a) Correct adjustment, (b) Under-compensated, (c) Over-compensated.

CAL. OUT connector and the EXT. CRT CATHODE binding post.

d. Set the CALIBRATOR switch to 5 VOLTS.

e. If necessary, readjust the time-base triggering controls to produce a trace.

f. Check the display for intensified dots (see Fig. 15). It may necessary to turn the INTENSITY control counter-clockwise slightly to see the dots.

g. Remove the jumper leads and replace the ground strap.

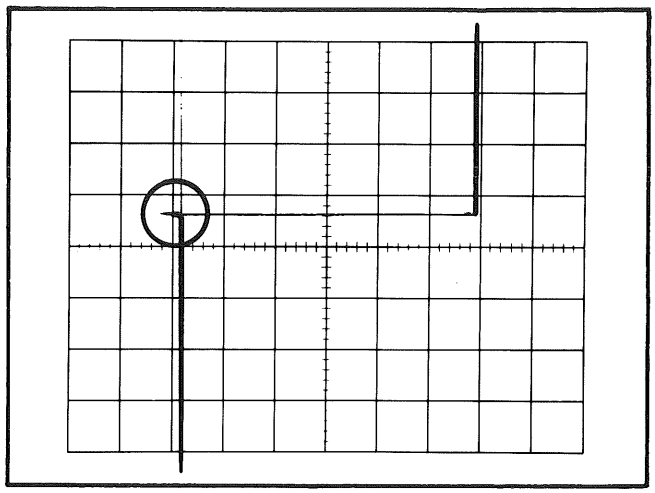


Fig. 14. Typical waveform obtained when adjusting horizontal deflection plate capacitance compensation.

17. Check Dual-Trace Chopped Blanking

a. Set the amplifier unit Mode switch to Chop. (This check can be made only with a dual-trace plug-in unit.)

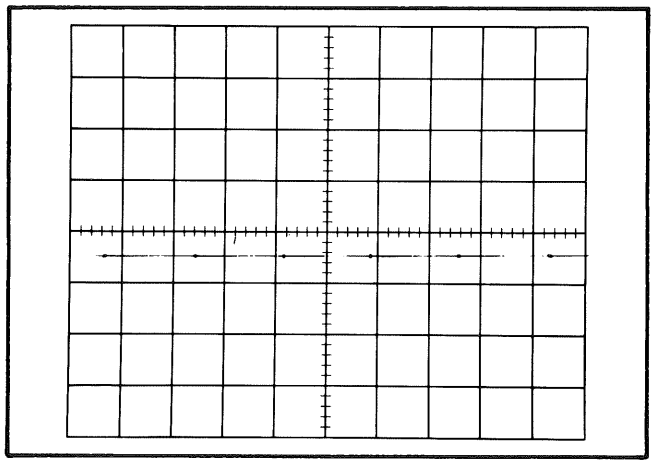


Fig. 15. Intensity modulated display. Sweep rate 10 milliseconds/division.

b. Set the amplifier unit Ac Dc Gnd switches to Gnd.

c. Position the traces so they are about three divisions aparts.

d. Set the time-base Time/Division switch to display several cycles of the waveform.

e. Adjust the time-base triggering controls for a stable display.

f. With the CRT CATHODE SELECTOR switch in the up position, notice the overshoot on the display (see Fig. 16).

g. Set the CRT CATHODE SELECTOR switch to CHOPPED BLANKING. The between-channel switching transients should be removed from the display.

h. Set the MODE switch to display channel 1 and the Ac Dc Gnd switch to Dc.

18. Check D838-D839 Junction Voltage

a. Connect the voltmeter from the D838-D839 test point (see Fig. 18 'P') to chassis ground.

b. Voltage should be less than +0.6 volts dc. Higher voltages could damage a time-base unit with an intensifying circuit.

19. Check CRT Intensified Circuit

a. Set the time-base Time/Division switch to 1 millisecond and the delayed sweep Time/Division switch to 0.1 millisecond. (This check can be made only with a delayed sweep plug-in unit.)

b. Adjust the triggering controls to obtain a free-running trace.

c. Adjust the INTENSITY control for a normal viewing level.

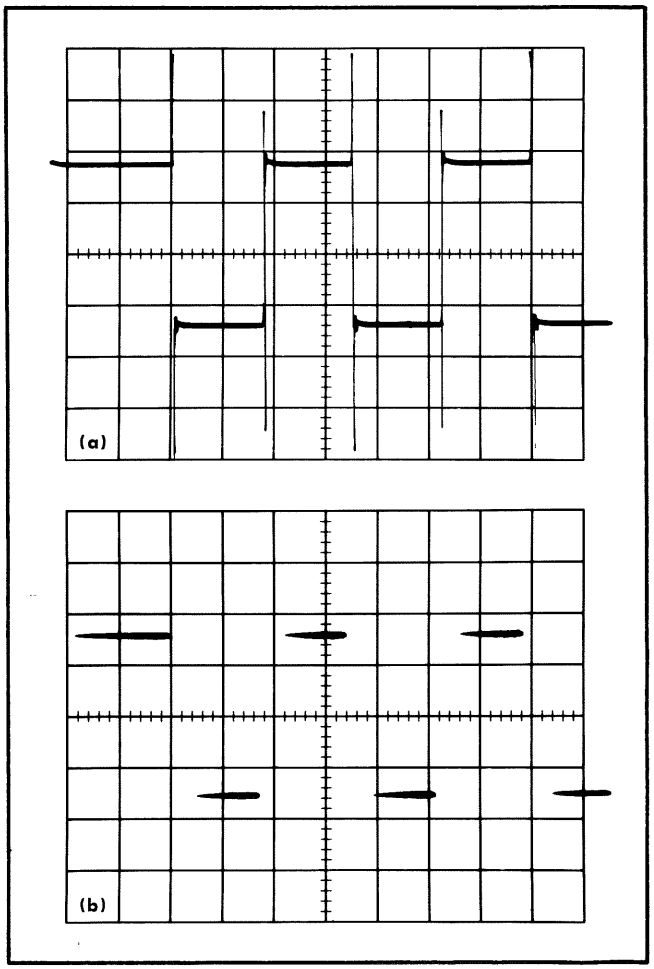


Fig. 16. Waveforms showing (a) chopped transients with CRT CATHODE SELECTOR switch up, (b) transients removed with CRT CATHODE SELECTOR switch in the CHOPPED BLANKING position. Sweep rate, 2 μSec/division.

d. Turn the time-base Mode switch to Intensified (not triggered).

e. An intensified portion should appear on the crt (see Fig. 17). If the display appears only as a shortened trace, increase the INTENSITY slightly until the complete trace, showing an intensified portion, appears.

f. Turn the delay time control and check if the intensified portion moves on the trace.

NOTE

In steps 20 and 21 be careful not to short the crt deflection pins to chassis ground.

20. Check Crt Vertical Sensitivity

a. Connect the voltmeter between the vertical deflection plates. Be careful not to bend the pins.

b. Set the amplifier unit Mode switch to display only one channel.

c. Adjust the time-base triggering controls to free-run the trace.

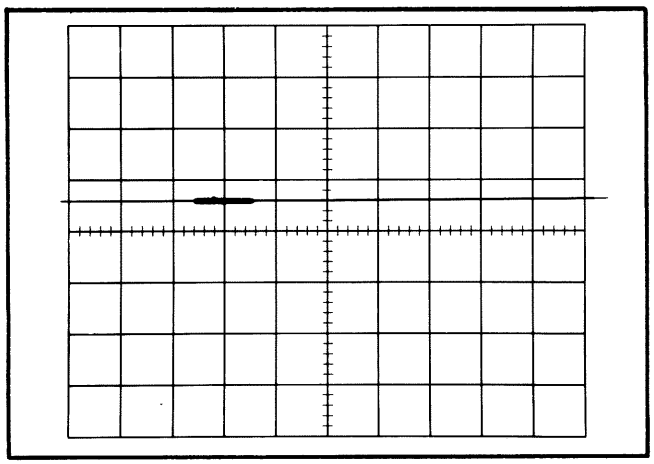


Fig. 17. Delayed sweep intensification pulse.

d. Turn the amplifier unit Position control to move the trace to the top of the graticule.

e. Note the meter reading with this Position control setting.

f. Turn the amplifier unit Position control to move the trace to the bottom of the graticule.

g. Again note the meter reading.

h. Calculate the difference in voltage between step 20e and g. Divide this value by 8 to determine the deflection voltage/division (crt sensitivity).

i. Sensitivity should be 19.5 volts/division, ±1 volt.

21. Check Crt Horizontal Sensitivity

a. Interchange the plug-ins so the time-base unit is in the left compartment and the amplifier unit is in the right compartment.

b. Connect the voltmeter between the horizontal deflection pins. Be careful not to bend the pins.

c. Adjust the time-base triggering controls to free-run the trace.

d. Turn the amplifier Position control to move the trace to the left side of the graticule.

e. Note the meter reading with this Position control setting.

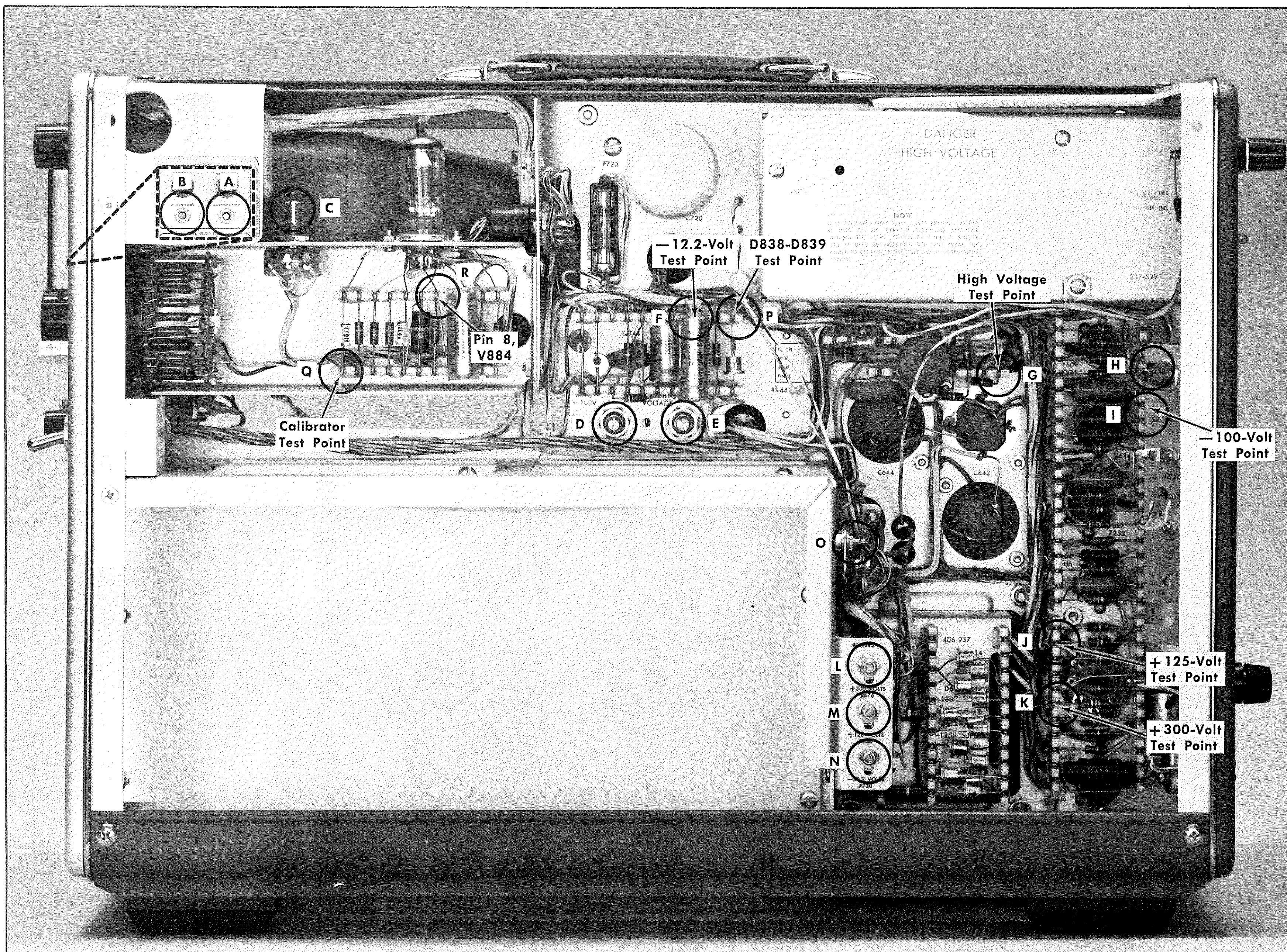
f. Turn the amplifier unit Position control to move the trace to the right side of the graticule.

g. Again note the meter reading.

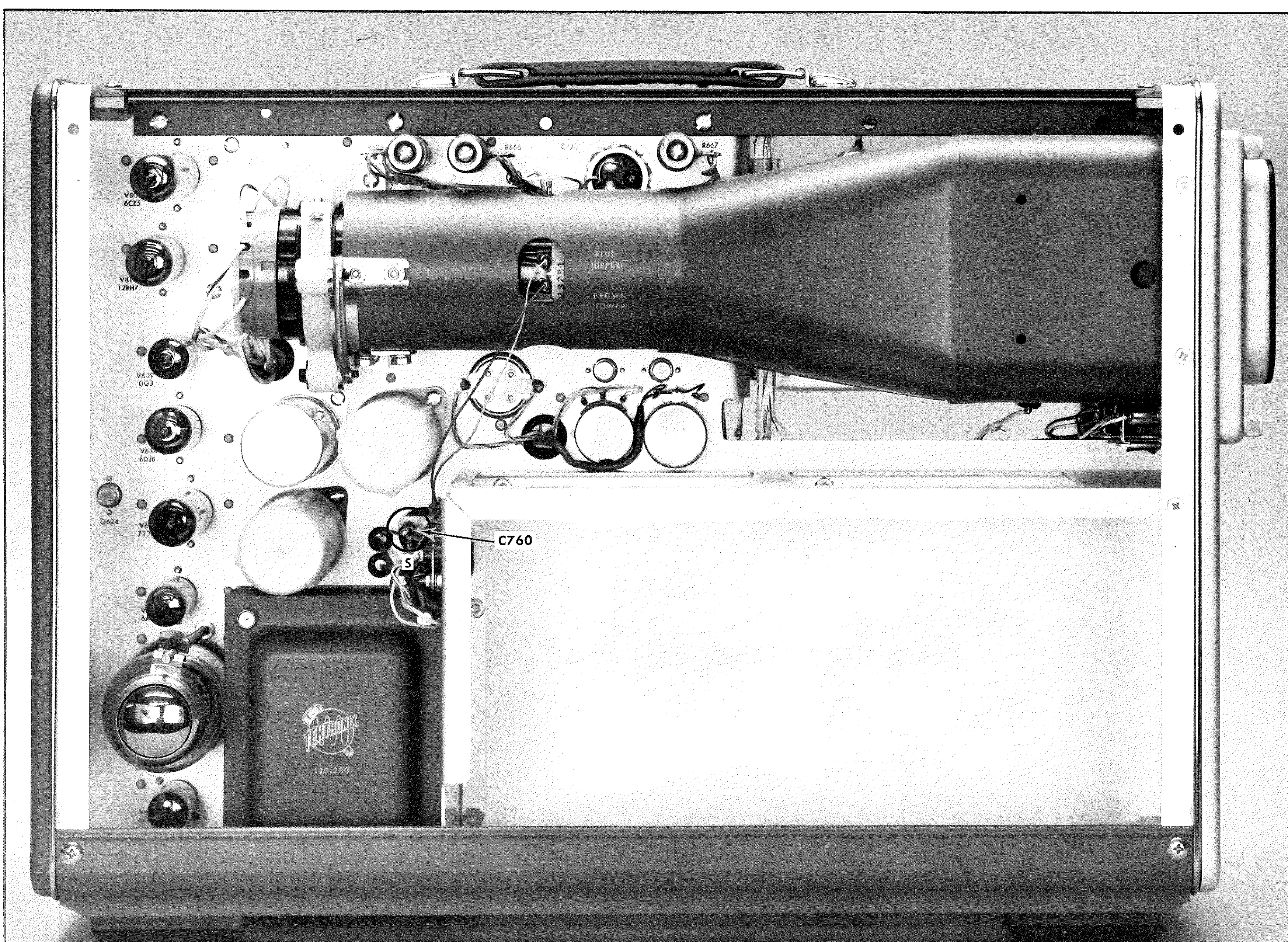
h. Calculate the difference in voltage between step 21e and g. Divide this value by 10 to determine the deflection voltage/division (crt sensitivity).

i. Sensitivity should be 18.4 volts/division, $\pm$0.9 volts.

This completes the Type 561A calibration procedure and operational check. Disconnect all test equipment and interconnecting cables. Replace the side panels on the unit. The gain of the amplifier plug-in unit and sweep timing of the time-base unit should be checked before using the system.



Right Side



Left Side

Fig. 18. Calibrator adjustments and test points.

"CALIBRATION ADJUSTMENT LOCATIONS"