Tektronix®

COMMITTED TO EXCELLENCE

T912
10 MHz
STORAGE
OSCILLOSCOPE
With Options

INSTRUCTION MANUAL

BEFORE READING

PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL.

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TEKTRONIX®

T912
10 MHz
STORAGE OSCILLOSCOPE
With Options

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
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Tektronix warrants that this product is free from defects in materials and workmanship. The warranty period is one (1) year from the date of shipment. Tektronix will, at its option, repair or replace the product if Tektronix determines it is defective within the warranty period and if it is returned, freight prepaid, to a service center designated by Tektronix.

Tektronix is not obligated to furnish service under this warranty

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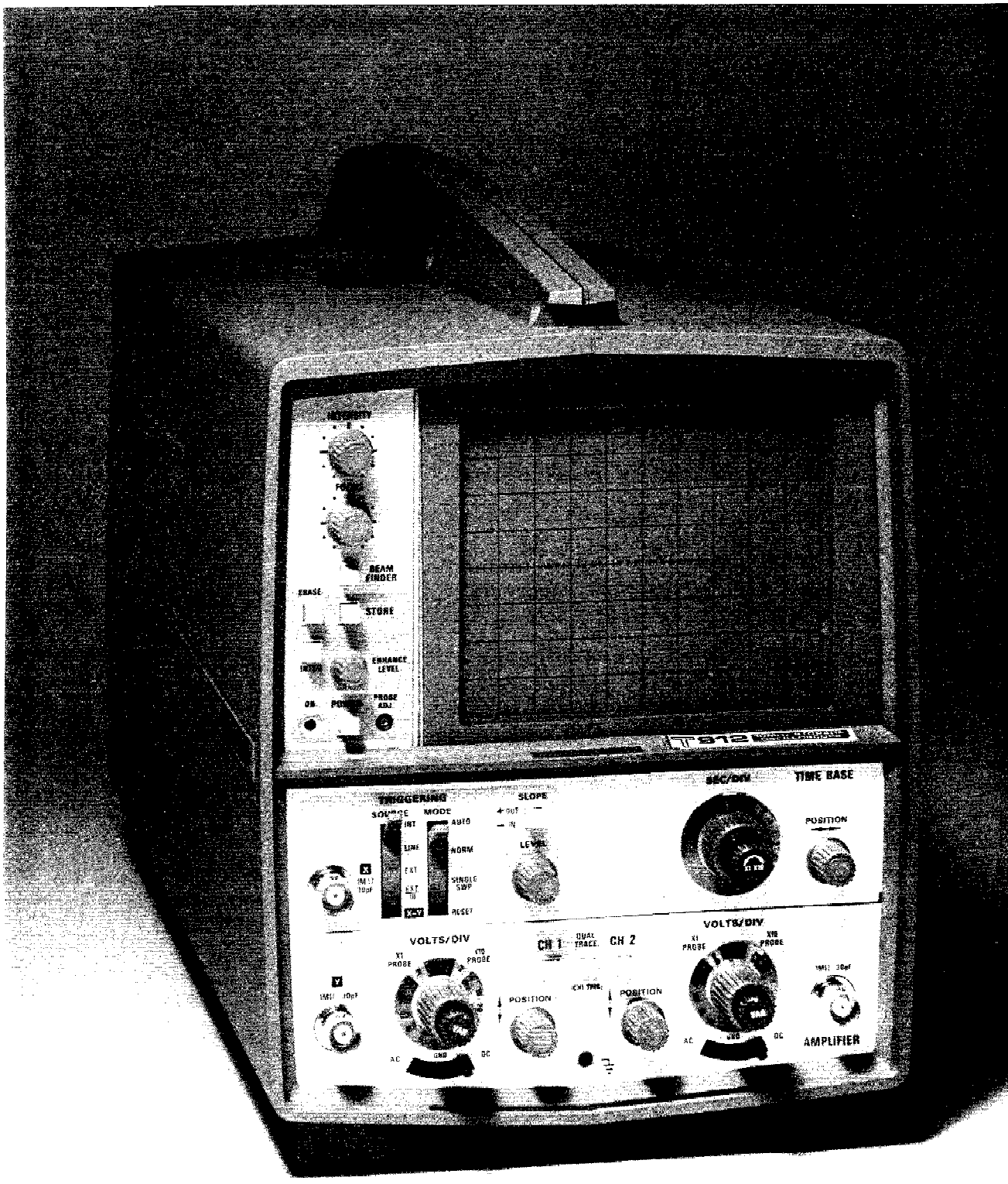
TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES



1981-1

Fig. 1-1. T912 10 MHz Storage Oscilloscope.

SPECIFICATIONS

The T912 is a 10 MHz, dual trace, portable oscilloscope. The T912 bistable storage system has a writing speed of up to 250 cm/ms in the ENHANCED mode. The Vertical AMPLIFIER provides calibrated deflection factors from 2 mV to 10 V/div. The TIME BASE provides stable triggering over the full bandwidth of the Vertical AMPLIFIER. Calibrated sweep rates are from 0.5 s to 0.5 μs/div. A variable X1 to X10 magnifier extends the maximum sweep rate of 50 ns/div.

The following instrument specifications apply over an ambient temperature range of 0°C to +45°C unless otherwise indicated. The Adjustment Procedure in Section 4, when performed completely, allows the T912 to meet the Electrical Specifications listed in Table 1-1. Items listed in the Performance Requirements column are verified by completing the Performance Check in Section 5 of this manual.

Table 1-1

ELECTRICAL

Characteristic	Performance Requirement
A. DISPLAY	
Probe Adjust Output	
Voltage (0°C to +40°C)	Approximately 0.5 V.
Repetition Rate	Approximately 1 kHz.
Z-Axis Input	
Sensitivity	5 volt signal causes a noticeable decrease in intensity.
Signal Polarity	Positive going from ground.
Usable Frequency Range	Dc to 5 MHz.
Maximum Input Voltage	30 V (dc + peak ac) 30 V p-p at 1 kHz or less.
Input Impedance	Approximately 10 kΩ.
Power Source	
Line Voltage Ranges (ac, rms)	
120 V Range	HI—108 to 132 V. LO—90 to 110 V.
240 V Range	HI—216 to 250 V. LO—198 to 242 V.

Table 1-1 (cont)

Characteristic	Performance Requirement
A. DISPLAY (cont)	
Line Frequency	50 to 60 Hz.
Maximum Power Consumption	80 watts, 100 VA, at 60 Hz.
CRT Display	
Display Area	8 X 10 cm.
Trace Rotation Range	Adequate to align trace with horizontal center line.
Standard Phosphor	P1
Nominal Accelerating Potential	2,760 V.
Storage Display	
Writing Rate	At least 25 cm/ms.
Enhanced Writing Rate	At least 250 cm/ms.
Storage Viewing Time	One hour or less. (Storage time longer than 1 hour will make erasure difficult.)
B. VERTICAL AMPLIFIER	
Deflection Factor	
Range	2 mV/div to 10 V/div; 12 steps in a 1-2-5 sequence.
Accuracy	
+20°C to +30°C	Within 3%
0°C to +45°C	Within 4%.
Uncalibrated (VAR) Range	Continuously variable between settings. Extends deflection factor to at least 25 V/div (at least 2.5:1).
Frequency Response	
Bandwidth	Dc to at least 10 MHz (5 division reference signal centered vertically from a 25 Ω source with VOLTS/DIV VAR control in calibrated detent).
Risetime	35 ns or less.

Table 1-1 (cont)

Characteristic	Performance Requirement
B. VERTICAL AMPLIFIER (cont)	
Chopped Mode Repetition Rate	Approximately 250 kHz.
Input Resistance	Approximately 1 MΩ.
Input Capacitance	Approximately 30 pF.
Maximum Input Voltage	
DC Coupled	400 V (dc + peak ac). 800 V (p-p ac) at 1 kHz or less.
AC Coupled	400 V (dc + peak ac). 800 V (p-p ac) at 1 kHz or less.
C. TIME BASE	
Sweep Rate	
Calibrated Range	0.5 s/div to 0.5 μs/div; 19 steps in a 1-2-5 sequence. Variable X1 to X10 magnifier extends maximum sweep rate to 50 ns/div.
Accuracy	Accuracy specification applies over center 8 divisions. Exclude first 50 ns of sweep for both magnified and unmagnified sweep rates and anything beyond the 100th magnified division.
+20° C to +30° C	
Unmagnified	Within 3%.
Magnified	Within 5%.
0° C to +45° C	
Unmagnified	Within 4%.
Magnified	Within 6%.
Variable Magnifier	10:1.
X-Y Operation	
Deflection Factor	
Variable Magnifier	
X10	Approximately 100 mV/div.
X1	Approximately 1 V/div.
X-Axis Bandwidth	Dc to at least 1 MHz with 10 div reference signal.

Table 1-1 (cont)

Characteristic	Performance Requirement
C. TIME BASE (cont)	
Input Resistance	Approximately 1 MΩ.
Input Capacitance	Approximately 30 pF.
Phase Difference Between X- and Y-Axis Amplifiers	5° or less from dc to 50 kHz.
Triggering	
Sensitivity	0.5 div internal or 100 mV external from 2 Hz to 1 MHz, increasing to 1.5 div internal or 150 mV external at 10 MHz.
External Trigger Input	
Maximum Input Voltage	400 V (dc + peak ac). 800 V (p-p ac) (1 kHz or less).
Input Resistance	Approximately 1 MΩ.
Input Capacitance	Approximately 30 pF.
Level Range	
EXT	+0.5 V to −0.5 V.
EXT / 10	+5 V to −5 V.

Table 1-2

ENVIRONMENTAL

Characteristic	Performance Requirement
Temperature	
Storage	−55° C to +75° C.
Operating	0° C to +45° C.
Altitude	
Storage	To 50,000 feet.
Operating	To 15,000 feet. Maximum operating temperature decreases 1° C/1,000 feet above 5,000 feet.

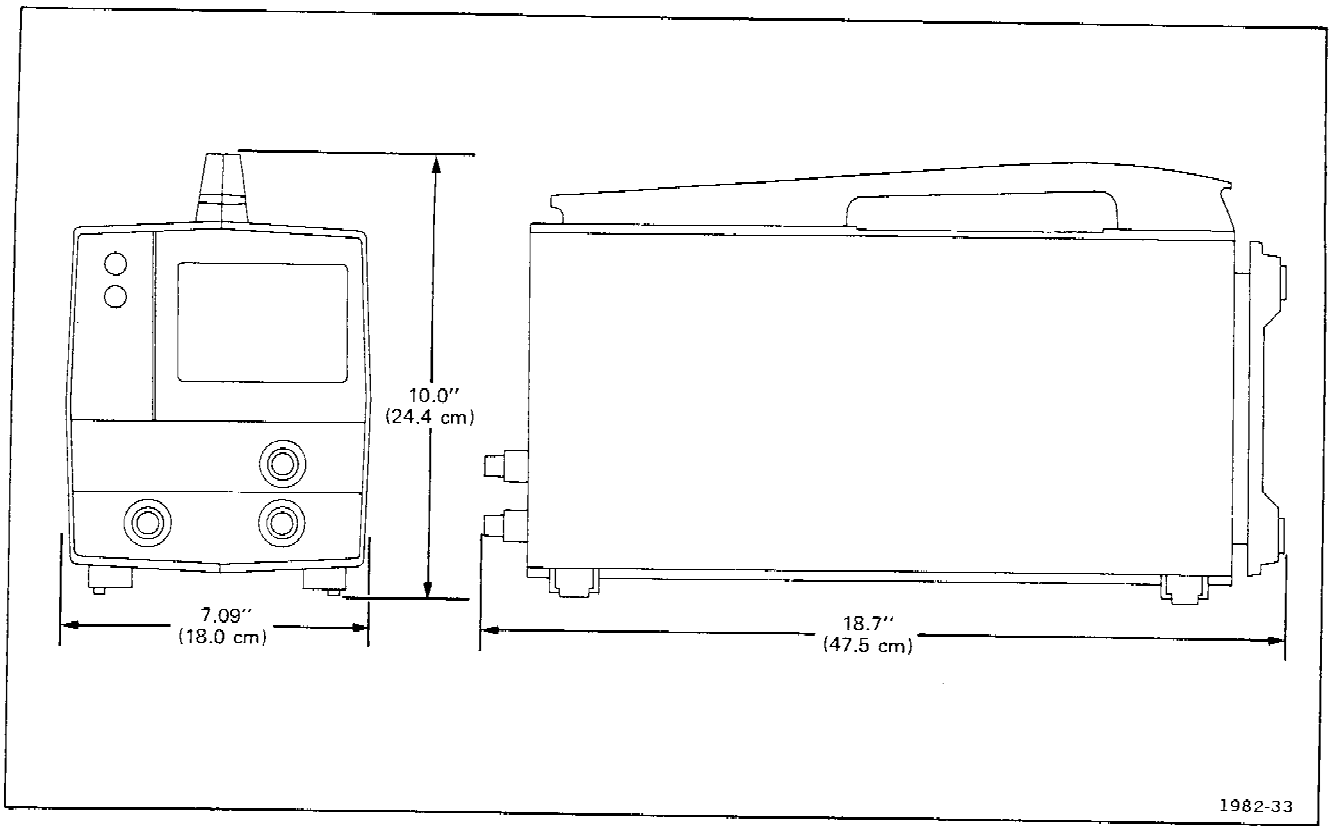


Fig. 1-2. Dimensional drawing.

Table 1-3

PHYSICAL

Characteristic	Performance Requirement
Weight	
With Panel Cover, Accessories and Accessory Pouch	18.0 lbs. (8.2 kg).
Without Panel Cover, Accessories and Accessory Pouch	17.5 lbs. (7.9 kg).
Overall Dimensions	Refer to Fig. 1-2.

STANDARD ACCESSORIES

1	Instruction Manual
2	Probes
1	Clear Light Filter

(See Accessories tab page at back of this manual for further accessory information.)

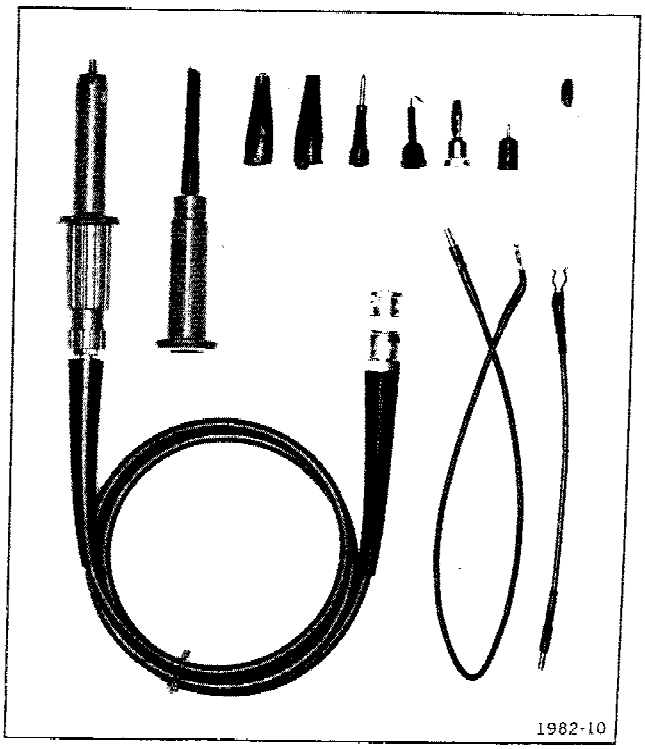


Fig. 1-3. P6006 probe.

RECOMMENDED ACCESSORIES

NOTE

The following accessories have been selected from our catalog specifically for your instrument. They are listed as a convenience to help you meet your measurement needs. For detailed information and prices, refer to a Tektronix Products Catalog or contact your local Tektronix Field Representative.

COVERS

FRONT COVER: Protects the instrument front panel during transport or storage and provides storage for small accessories (probes, cables, etc.). Made of blue plastic to match the instrument case.

Order **016-0340-00**

PROTECTIVE WATERPROOF COVER: Blue vinyl cover provides protection for the entire oscilloscope during transport or storage.

Order **016-0361-00**

STAND

PORTABLE STAND: The Portable Stand sits on the floor and holds the instrument at an angle to provide easy viewing and access. Also provides storage for small accessories (probe, cables, etc.).

Order **209**

PROBES

P6101 GENERAL PURPOSE 1X VOLTAGE PROBE: Input capacitance is 54 picofarads (plus input capacitance of oscilloscope).

Order **010-6101-03**

P6062A SWITCHABLE 1X-10X VOLTAGE PROBE: Provides full bandwidth capabilities of T900-series instruments. Can be compensated to match the vertical input capacitance.

Order **010-6062-13**

P6009 GENERAL PURPOSE 100X VOLTAGE PROBE: Provides full bandwidth capabilities of T900-series instruments. Can be compensated to match the vertical input capacitance.

Order **010-0264-01**

P6015 GENERAL PURPOSE 1000X VOLTAGE PROBE: Provides full bandwidth capabilities of T900-series instruments. Can be compensated to match the vertical input capacitance.

Order **010-0172-00**

P6021 AC CURRENT PROBE: Provides a bandwidth from 120 Hz to the upper bandwidth of T900-series instruments. Spring-loaded slide opens (up to 0.150 inches) to allow measurement of current without breaking the circuit under test.

Order **015-0140-02**

CAMERAS

C-5B Option 3 Camera: Provides graticule illumination with xenon flash lamp powered by two AA penlight batteries. Recommended for, and molded to fit all bench version T900-series instruments. Fixed focus, fixed aperture *f*/16 lens with 0.67 or 0.85 user adjustable magnification. Mechanical shutter with speeds of 1/5 to 1/25 s, plus bulb and time.

Order . . . . . **C-5B Option 3**

OPERATING INSTRUCTIONS

OPERATING VOLTAGE

WARNING

To prevent electric shock, do not remove instrument cover. Refer servicing to qualified personnel.

Your instrument will operate from either a 120 V or 240 V ac 50 to 60 Hz nominal power input source. Check that the Power Input Voltage Selector (120 V/240 V) switch and the Regulating Range Selector (HI/LO) switch are set to positions that include the value of the applied power input voltage. In the United States, the 120 V/240 V switch is normally set for 120 V and the HI/LO switch is normally set for HI at the factory. In Europe, the 120 V/240 V switch is set for 240 V and the HI/LO switch is normally set for LO. The POWER indicator lamp will blink when the applied power input voltage varies more than about 10% (either high or low) from the value for which the switches are set.

CAUTION

Your instrument may be damaged if it is operated from a 240 V power input voltage source with the 120 V/240 V switch set for 120 V. The 120 V/240 V switch and the HI/LO switch are both visible from the bottom of the instrument in all T900-series bench version oscilloscopes, but the 120 V/240 V switch is not adjustable from outside of the cabinet. Refer 120 V/240 V power input voltage selection to qualified service personnel.

The T912 has a 3-wire cord with a 3-terminal polarized plug for connection to the power source and safety-earth. The ground terminal of the plug is directly connected to the metal parts of the instrument. For electric-shock protection, insert this plug in a mating outlet with a safety-earth contact.

FUNCTIONS OF CONTROLS, CONNECTORS, AND INDICATORS

Before you turn the instrument on, read this portion of the manual to familiarize yourself with the controls, connectors, and indicators.

A. DISPLAY

Front Panel (Fig. 2-1)

(1) **INTENSITY**—Adjusts the brightness of the crt display. Set for the lowest visible display to prolong crt life.

(2) **FOCUS**—Adjusts for optimum spot size and definition.

(3) **BEAM FINDER**—Locates off-screen displays. Compresses the crt display to within the graticule area independently of the position control or applied signals.

To locate an off-screen display:

a. Set the vertical POSITION and INTENSITY controls to midrange and rotate the horizontal POSITION control clockwise.

b. If a display or dot still is not visible, press BEAM FINDER and hold in. A compressed display or dot should appear. If not, increase the INTENSITY until a display appears.

If a dot or vertical line appears, the sweep is not triggered. Set the trigger MODE switch to AUTO to obtain a display. Use the vertical and horizontal POSITION controls to move the display near the center of the graticule. Release the BEAM FINDER button and adjust the trigger level control for a stable display.

If a compressed display appears, adjust the VOLTS/DIV switch and the horizontal and vertical POSITION controls for a stable display.

(4) **STORE**—Selects storage mode (pushbutton in) or non-store (pushbutton out) conventional oscilloscope operation.

(5) **ERASE**—Press to erase a stored display.

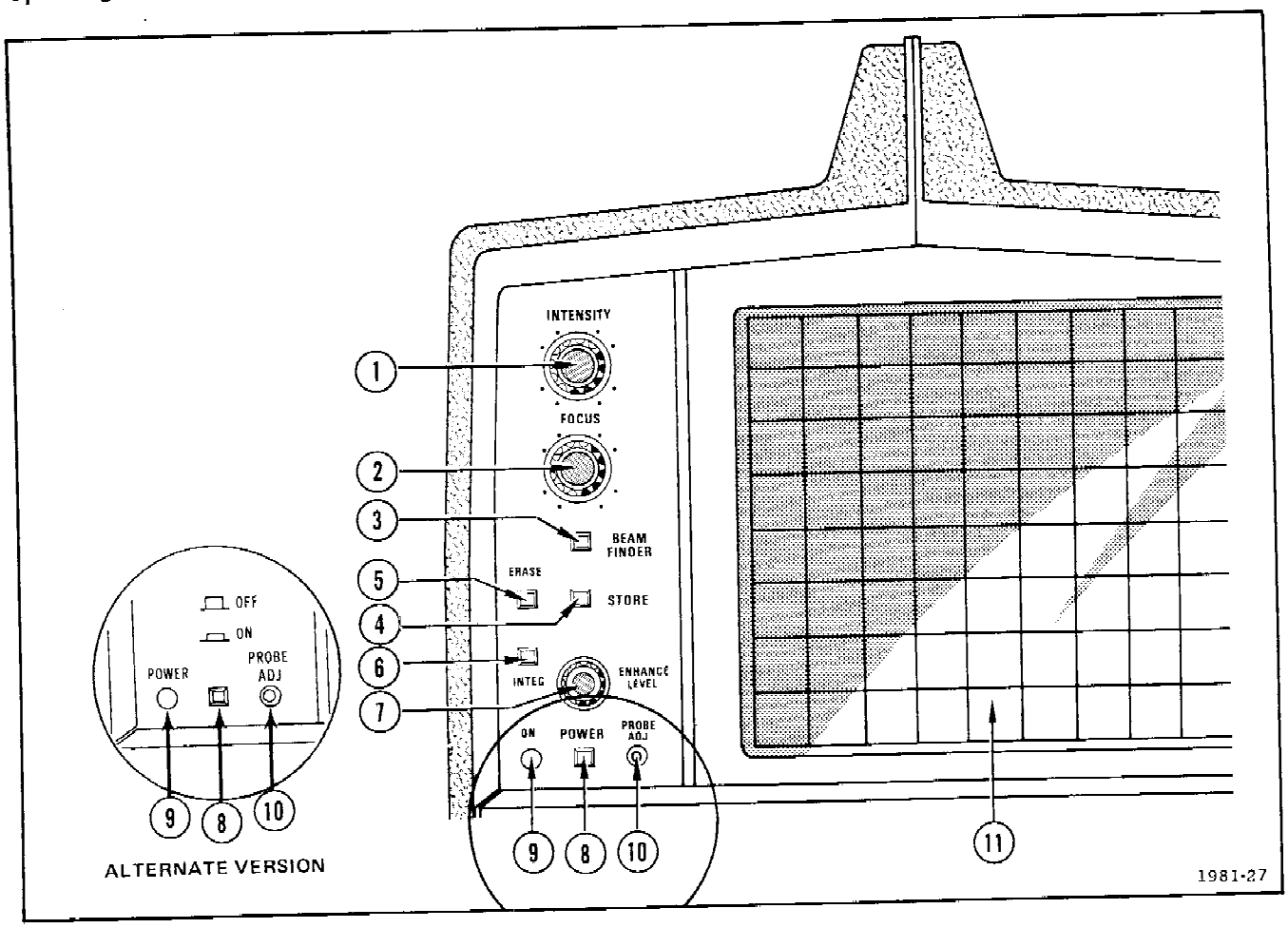


Fig. 2-1. Display front panel controls and connectors.

(6) **INTEG**—When held down, stores repetitive signals too fast to store normally by allowing a charge to build up on the crt storage target before the signal is stored.

(7) **ENHANCE LEVEL**—Increases the stored writing rate to at least 250 cm/s. Automatically switches on in SINGLE SWP.

(8) **ON-OFF**—Push-push switch turns the instrument power on (button in) and off (button out). (In some versions this switch is labeled POWER.)

(9) **POWER**—Indicator lamp lights when ON-OFF button is depressed to ON (in) position and applied power input voltage does not vary more than about 10% from the value indicated by the 120 V/240 V and HI/LO voltage selector switch settings. When applied power input voltage varies more than about 10% (either high or low) from the selected value, the lamp will blink. (In some versions this lamp is labeled ON.)

(10) **PROBE ADJ**—Provides a square-wave output of approximately 0.5 V (negative-going with respect to ground) at approximately 1 kHz, for compensating voltage probes.

(11) **Internal graticule**—Eliminates parallax. Risetime amplitude and measurement points are indicated at the left edge of the graticule.

Left Side of Cabinet (Fig. 2-2)

(12) **ASTIG**—Screwdriver adjustment used with FOCUS control to obtain a well-defined display. Requires little or no adjustment once set.

(13) **TR ROT**—Trace rotation screwdriver adjustment. Aligns trace with the horizontal graticule lines.

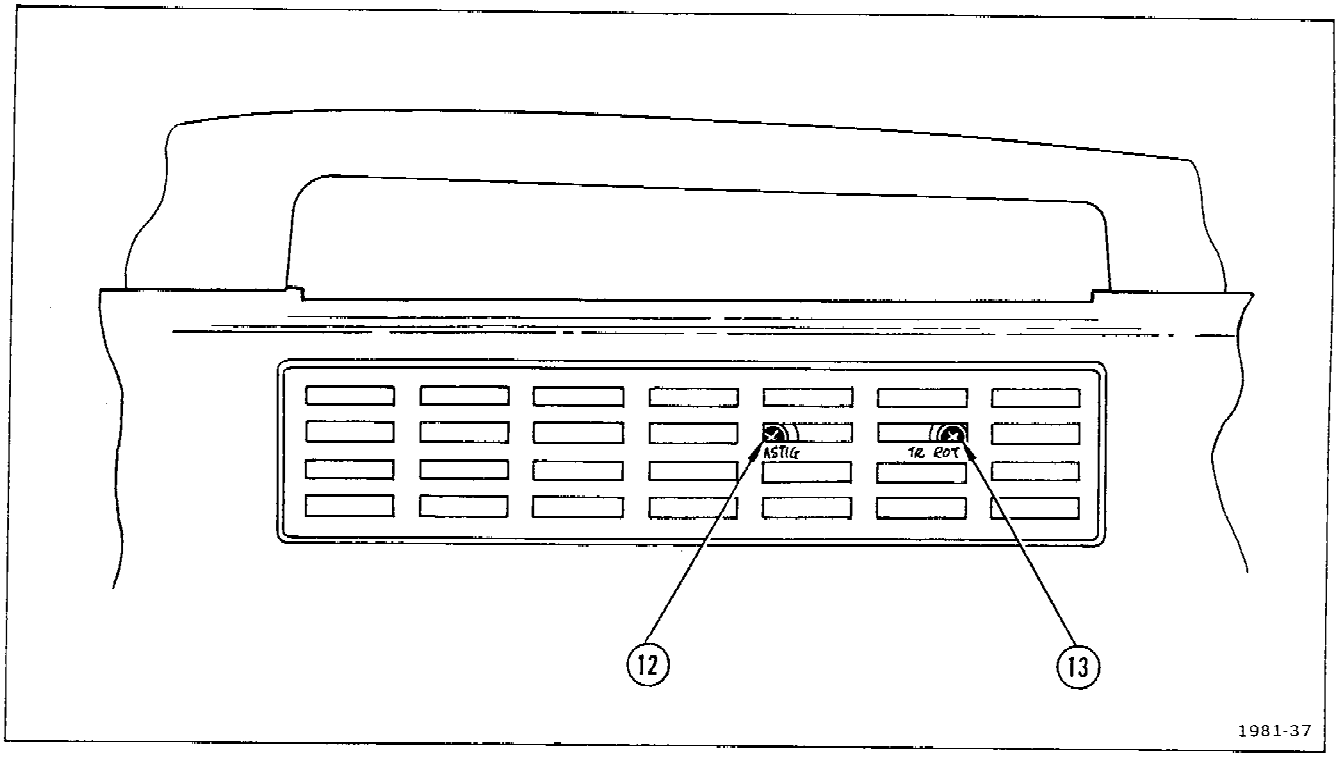


Fig. 2-2. Left side of cabinet.

Rear Panel (Fig. 2-3)

(14) **EXT Z AXIS INPUT**—Bnc connector for applying signals to intensity modulate the crt display. Signals must be time-related to the display for a stable display.

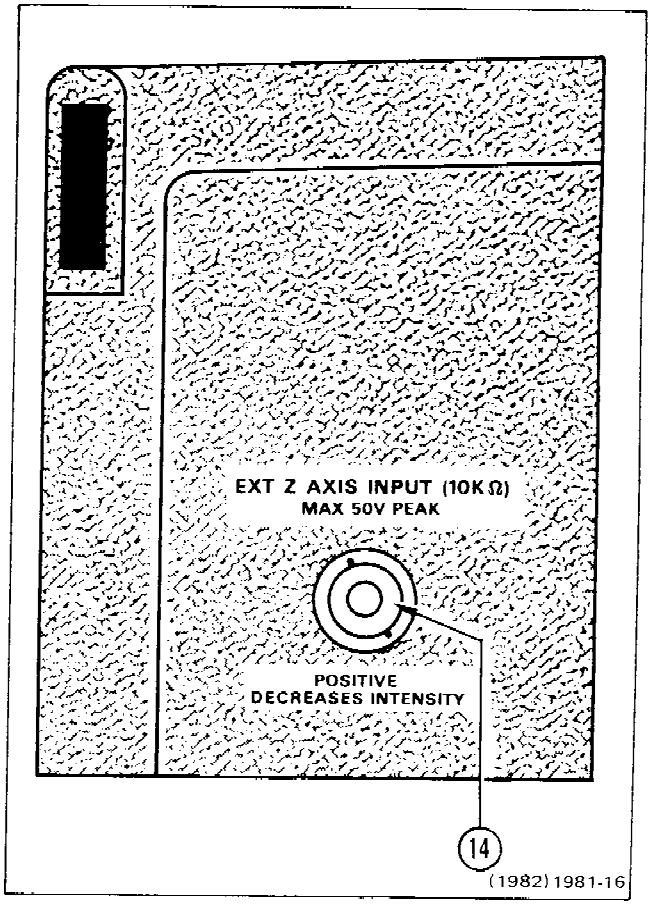


Fig. 2-3. Rear panel controls and connectors.

Bottom of Cabinet (Fig. 2-4)

(15) **120 V/240 V**—Switch selects operation from either 120 V or 240 V nominal power input voltage (is visible, but not adjustable from outside of cabinet).

(16) **HI/LO**—Externally adjustable screwdriver actuated switch selects operation from either high or low power input voltage regulating range: LO selects 90 to 110 V or 198 to 242 V, and HI selects 108 to 132 V or 216 to 250 V (depending on setting of 120 V/240 V switch).

(17) **CH 1 DC BAL**—Screwdriver adjustment. When properly adjusted, prevents trace shift when switching between adjacent positions of the CH 1 VOLTS/DIV switch.

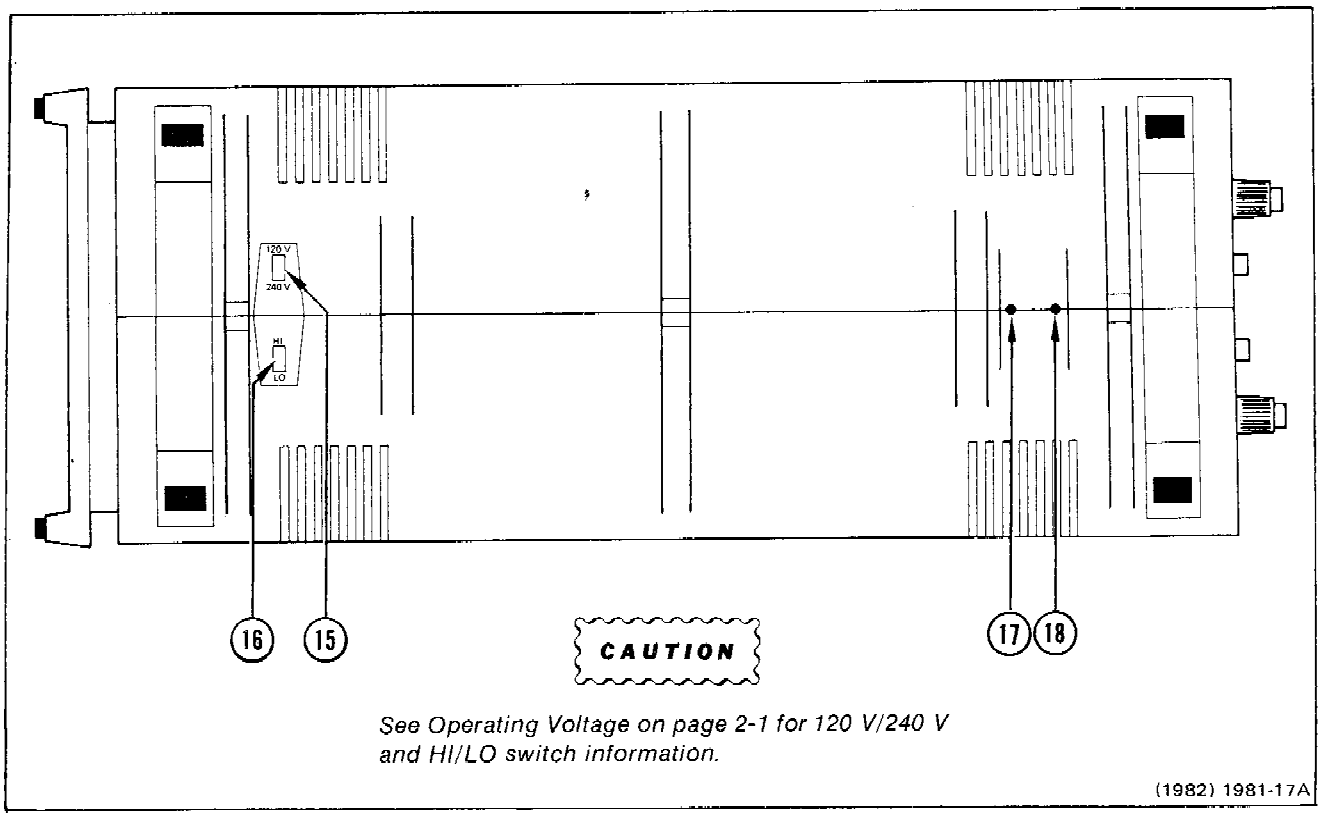


Fig. 2-4. Bottom of cabinet.

(18) **CH 2 DC BAL**—Screwdriver adjustment. When properly adjusted, prevents trace shift when switching between adjacent positions of the CH 2 VOLTS/DIV switch.

B. VERTICAL AMPLIFIER

Front Panel (Fig. 2-5)

(1) **VOLTS/DIV**—Selects the vertical deflection factor in a 1-2-5 sequence (VAR control must be in detent position to obtain the indicated deflection factors). Read the correct deflection factor for a 1X probe from the 1X position and a 10X probe from the 10X position.

(2) **VAR**—Provides continuously variable uncalibrated deflection factors between the calibrated steps of the VOLTS/DIV switches. Extends the maximum deflection factor to 25 V/div in the 10 V position. Detent position provides calibrated VOLTS/DIV deflection factors.

(3) **Input Coupling**—Selects the method of coupling the input signal to the vertical input signal amplifier.

AC: Signals are coupled capacitively. Any dc signal component is blocked. Low frequencies are attenuated (3 dB down at about 1 Hz using a 10X probe). Ac coupling causes tilting of square waves below about 1 kHz.

GND: Grounds the input of the vertical amplifier to provide a ground reference display. Connects the input signal to ground through the input coupling capacitor and a 1 MΩ resistor to allow the input coupling capacitor to be precharged by the input signal.

DC: All components of the input signal are passed to the vertical amplifier.

(4) **Channel 1 or Y Input**—Connector for applying an external signal to the vertical deflection system. Provides the Y input in the X-Y mode when CH 1 vertical mode button is in.

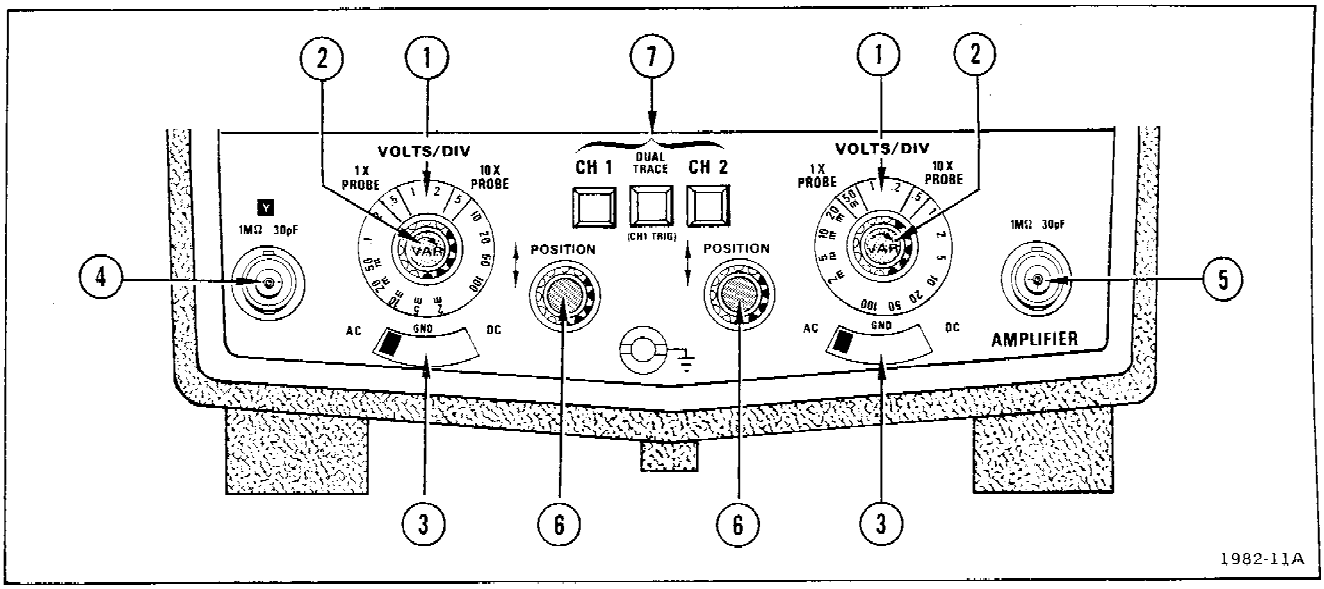


Fig. 2-5. Vertical amplifier front panel controls.

(5) **Channel 2 Input**—Connector for applying an external signal to the vertical deflection system.

(6) **POSITION**—Controls the vertical position of the crt display.

(7) **Vertical Mode**—Selects the vertical amplifier operating mode.

CH 1: Displays only signal applied to the CH 1 input connector. This button must be latched in for X-Y operation.

CH 2: Displays only signal applied to the CH 2 input connector.

DUAL TRACE: Displays CH 1 and CH 2 input signals alternately. Chop or Alternate mode is selected automatically by the SEC/DIV switch. For SEC/DIV switch settings of 1 ms and slower, Chop is selected. For settings of .5 ms and faster, Alternate is selected. In DUAL TRACE mode, the trigger signal is derived from CH 1. When the DUAL TRACE and CH 2 buttons are locked in at the same time, the trigger signal comes from CH 2 (instead of CH 1) while DUAL TRACE signals are displayed.

C. TIME BASE

Front Panel (Fig. 2-6)

(1) **SOURCE**—Selects the source of the trigger signal.

INT: Uses a sample of the signal displayed on the crt as a trigger signal in the CH 1 or CH 2 modes. In DUAL TRACE mode, the trigger signal is obtained from CH 1. If CH 2 and DUAL TRACE buttons are both latched in, channel 2 is the trigger source.

LINE: Uses a sample of the power-line frequency as a trigger signal.

EXT: Permits triggering on signals applied to the X (external trigger) input connector. External trigger signals must be time-related to the displayed signal for a stable display.

EXT ÷ 10: External trigger signal is attenuated by a factor of 10.

X-Y: Permits x-y display. X (horizontal) input is through the X input connector. Y (vertical) input is normally through the CH 1 or Y input connector (Vertical Mode CH 1 button must be latched in). For special applications, the Y input may be obtained from the CH 2 input connector (CH 2 button latched in), or from both CH 1 and CH 2 (DUAL TRACE button latched in).

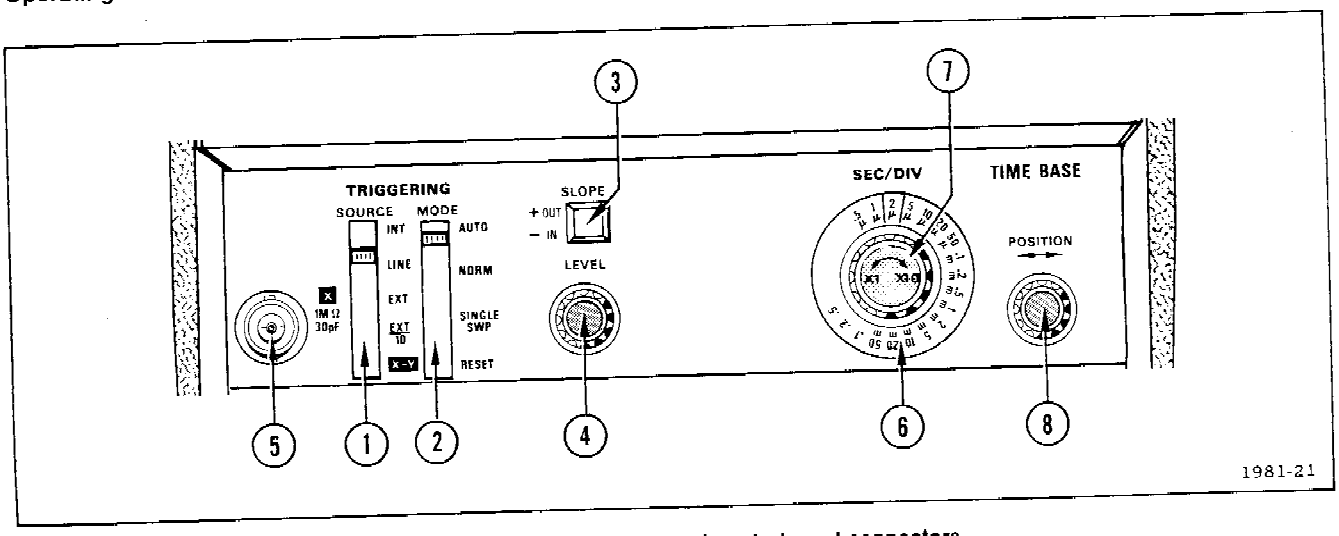


Fig. 2-6. Time base front panel controls and connectors.

(2) **MODE**—Selects the operating mode for the trigger circuit.

AUTO: With the proper LEVEL control setting, the sweep can be triggered by trigger signals with repetition rates above about 20 Hz. In the absence of an adequate trigger signal, or when the LEVEL control is misadjusted, the sweep free runs to provide a reference display.

NORM: Permits triggering on displayed signal. In the absence of an adequate trigger signal, or when the LEVEL control is misadjusted, the sweep does not run and no display is visible. Setting SOURCE to LINE position provides an adequate trigger signal.

SINGLE SWP: Sweep runs once on first triggered event after RESET is pushed. Another sweep cannot be triggered until RESET is pushed again. May be used to store one event or several events in succession.

RESET: Resets the sweep after a single sweep. Must be pushed after a single sweep has occurred for another sweep to run.

(3) **SLOPE**—Selects the positive- or negative-going slope of the trigger waveform.

+OUT: The sweep can be triggered from the positive-going portion of a trigger signal.

-IN: The sweep can be triggered from the negative-going portion of a trigger signal.

(4) **LEVEL**—Selects the amplitude point on the trigger signal at which the sweep is triggered. Usually adjusted for the desired display after trigger SOURCE and SLOPE have been selected.

(5) **X (External Trigger)**—Provides input for external trigger signals or for X axis signals in the X-Y mode.

(6) **SEC/DIV**—Selects calibrated sweep rates in a 1-2-5 sequence. X1-X10 variable control must be in the X1 detent position (fully ccw) to read calibrated sweep rates directly from the SEC/DIV knob. Knob numerals with μ underneath indicates sweep rates in microseconds/division; numerals with **m** underneath indicate sweep rates in milliseconds/division; positions with no symbol under the numerals indicate sweep rates in seconds/division.

(7) **X1-X10**—Provides calibrated sweep rates when in X1 (fully ccw) detent position. Increases the horizontal gain by a factor of 10, providing at least 50 ns/div sweep rate in the X10 detent position (fully cw) with the SEC/DIV knob set to .5 μs.

(8) **POSITION**—Controls the horizontal position of the crt display.

FIRST TIME OPERATION

Use this procedure when you turn the instrument on for the first time. It checks that most functions of the instrument are operational. This procedure requires a probe. (10X probes are supplied as standard accessories.) Read the descriptions of the controls and connectors to familiarize yourself with them before you turn your instrument on.

A complete performance check is given in Section 3.

Only the control settings that affect the check being performed are given. Do not move the control settings unless instructed to do so. Start at the beginning and follow the sequence of steps through to the end. If you skip a step or start in the middle of a check, you won't be able to tell whether a particular function is operational.

Check that the 120 V/240 V and HI/LO switches are properly set (see Operating Voltage, page 2-1).

If the 120 V/240 V and HI/LO switches are properly set, connect the power cord plug to the power source and turn the instrument on. Set the trigger MODE to AUTO, and SOURCE to INT.

You should get a trace on the crt screen. If you don't, push the BEAM FINDER button and hold it in while increasing the INTENSITY (clockwise). A trace, or one or two bright dots, indicates that the instrument is operating. You may also have to adjust the FOCUS and POSITION controls.

Vertical Positioning and Horizontal Operation

1. Set:	LEVEL	mid-range
	SEC/DIV	1 ms
	X1-X10	X1 (fully ccw detent)
	Vertical Mode	CH 1
	STORE	nonstore (button out)

2. Check that the CH 1 POSITION control moves the trace off the top and bottom of the screen. Leave the trace between one and two divisions above the center line. If the trace does not extend across the screen, move the horizontal POSITION control until it does.

3. Set the Vertical Mode switch for CH 2. Check that the CH 2 POSITION control moves the trace off the top and bottom of the screen. Leave the trace between one and two divisions below the center line.

4. Set the Vertical Mode switch for DUAL TRACE. You should have two traces on the crt screen—one above the center line and one below.

5. Check that there are two traces at every setting of the SEC/DIV switch from .5 μs to .5 s.

6. Set the SEC/DIV switch to 1 ms and the Vertical Mode switch to CH 1.

FOCUS and INTENSITY Operation

Adjust the FOCUS and the INTENSITY controls for a fine line at a comfortable brightness level.

Trace Rotation and Vertical Input Operation

Most of the remaining checks require applying the PROBE ADJ signal to the inputs.

NOTE

In the following steps, if you use a 1X probe or coaxial cable, use the 1X PROBE window for VOLTS/DIV settings. If you use a 10X probe (as supplied), use the 10X probe window.

The PROBE ADJ output is a square wave. An incorrectly compensated probe will distort the top and bottom of the signal but will not affect the checks.

If you want to compensate a probe, refer to the Probe Compensation information after this procedure.

1. Set:	CH 1 VOLTS/DIV	.2 V (10X window)
	CH 1 VAR	detent (fully clockwise)
	CH 1 AC-GND-DC	GND

2. Using the CH 1 POSITION control, align the trace with the center graticule line. If the trace is tilted, adjust the trace rotation (control marked TR ROT on the left-cabinet side) for the best alignment of the trace with the center graticule line.

3. Connect the probe to the CH 1 input and hold the probe tip against the PROBE ADJ connector. Set the CH 1 AC-GND-DC switch to DC. You should have approximately 2.5 divisions of display. The square wave will be below the center line. This display may or may not be stable.

4. Set the CH 1 AC-GND-DC switch to AC. The display should be approximately equidistant above and below the center line.

NOTE

If you cannot obtain a display, remove the probe tip from the PROBE ADJ connector. Touch the tip to your hand. Change the VOLTS/DIV setting if necessary to get a display. The display should be a thick (vertically) trace. A thickening trace indicates that the probe is picking up the power line radiation that your body normally picks up. If this occurs, the vertical is usable but the PROBE ADJ output isn't. If the thickening does not occur, you have a defective probe or other instrument malfunction.

5. Rotate the CH 1 VAR control through its range. The display amplitude will decrease. Leave the VAR control fully clockwise (detent)—maximum display amplitude.

6. Set:	Vertical Mode	CH 2
	CH 2 VOLTS/DIV	.2 V
	CH 2 VAR	detent (fully cw)
	CH 2 AC-GND-DC	GND
	CH 2 POSITION	To align trace with center graticule line

7. Connect the probe to the CH 2 input and hold the probe tip against the PROBE ADJ connector.

8. Set the CH 2 AC-GND-DC switch to DC. The square wave will be below the center line.

9. Set the CH 2 AC-GND-DC switch to AC. The square wave will be approximately equidistant above and below the center line.

10. Rotate the CH 2 VAR control through its range. The display amplitude will decrease. Leave the VAR control fully clockwise (in detent).

11. Return the Vertical Mode switch to CH 1.

X-Axis Operation

1. Connect the probe to the X input (if a 1X probe is available, use it; if a 10X probe is used, rotate the X1-X10 control fully clockwise) and hold the probe tip against the PROBE ADJ connector.

2. Set the SOURCE switch to X-Y, and reduce INTENSITY as necessary. Adjust the horizontal POSITION control as needed to locate the display. You should see two dots separated by a distance dependent on the X1-X10 control setting. Return X1-X10 to X1 (fully counter-clockwise detent).

X-Y and Dual Trace Operation

This mode is usable with SEC/DIV settings of 1 ms or slower. Set controls and connect signals as you would for independent X-Y or Dual Trace operation.

Astigmatism Operation

1. Set:	SOURCE	INT

2. Connect the probe to the CH 1 input and hold the probe tip against the PROBE ADJ connector. Rotate the LEVEL control for the most stable display. Adjust the FOCUS control for the display with the sharpest edges both horizontally and vertically over the entire screen. Vertical trace thickness is typically more than the horizontal but the edges should be equally sharp. This is easier to observe at the "corners" of the signal.

3. Set the INTENSITY and FOCUS controls for the best defined display. If the display still appears out of FOCUS, use a small screwdriver to adjust the ASTIG control (through left cabinet side) for the best defined display.

4. Rotate the INTENSITY control fully clockwise. The display will get brighter and defocus (get thicker). Return the INTENSITY control to the preferred brightness level.

Ext Z Axis Input Operation

A positive-going signal will cause a decrease in intensity, and a negative-going signal will increase the intensity level of a low-intensity trace.

X1-X10 and Trigger Operation

1. Note a display with several cycles of the PROBE ADJ waveform. Rotate the X1-X10 control fully clockwise to X10 and note that only one cycle is visible. Return control to X1.

2. Set the SEC/DIV to .1 ms. Position the start of the display (left edge) on the screen. Set the SLOPE button to the +OUT position. Rotate the LEVEL control through its range. The start of the display will move along the positive (rising) slope of the signal until the display becomes unstable.

3. Set the LEVEL control for a stable display that starts at about the middle of the slope.

Now set the SLOPE button to the −IN position. Rotate the LEVEL control through its range. The start of the display will move along the negative (falling) slope of the signal until the display becomes unstable.

4. Set the LEVEL control for a stable display that starts at about the middle of the slope.

5. Set the MODE switch to NORM. The display should start on the negative slope. In the NORM mode the display will disappear if the LEVEL control is improperly adjusted.

6. Set the SLOPE button to the +OUT position. The display should start on the positive slope.

Storage Operation

1. Set:	SOURCE	INT
	STORE	store (button in)

2. Put the MODE switch in SINGLE SWP. A single sweep will occur. Now push the MODE switch to RESET and then put it back in SINGLE SWP. Another sweep will occur. Move the vertical POSITION control while storing single sweeps.

3. Press ERASE. The screen will light up and when the ERASE button is released the entire screen will be erased.

4. Disconnect the probe from the instrument. Set the Channel 1 AC-GND-DC switch to GND. The trace should disappear.

5. Set the SOURCE switch to LINE. If a trace doesn't appear, adjust the LEVEL control until a trace appears.

6. Set:	SOURCE	INT
	MODE	AUTO
	Channel 1 AC-GND-DC	AC
	STORE	non-store (button out)

Your instrument is now ready to operate when you apply a signal to the Channel 1 input.

PROBE COMPENSATION

An incorrectly-compensated probe is one of the greatest sources of operator error. Most attenuator probes are equipped with adjustments to ensure optimum measurement accuracy.

Some probes are compensated by using a small, insulated screwdriver through an access hole to the compensation adjustment. Other probes may have an adjustment system similar to that shown in Fig. 2-7.

Probe compensation is accomplished as follows:

Set the appropriate VOLTS/DIV switch to .1 V, the AC-GND-DC switch to DC, and the SEC/DIV switch to 2 ms.

Connect the probe to the vertical input and touch the probe tip to the PROBE ADJ connector. Notice a display similar to those shown in Fig. 2-8. Adjust the probe for the correct compensation. The effects of incorrect probe compensation on three types of signals are illustrated in Fig. 2-8.

APPLICATIONS

Peak-to-Peak Amplitude Measurements

To measure the amplitude of a signal, multiply the vertical deflection (in divisions) by the VOLTS/DIV switch setting. (Use VOLTS/DIV window to match attenuation factor of probe used.)

Example:

The display amplitude is three divisions (see Fig. 2-9) and the VOLTS/DIV switch is set to .5 V. Substituting the given values:

Amplitude = 3 divisions X 0.5 volt/division = 1.5 V p-p

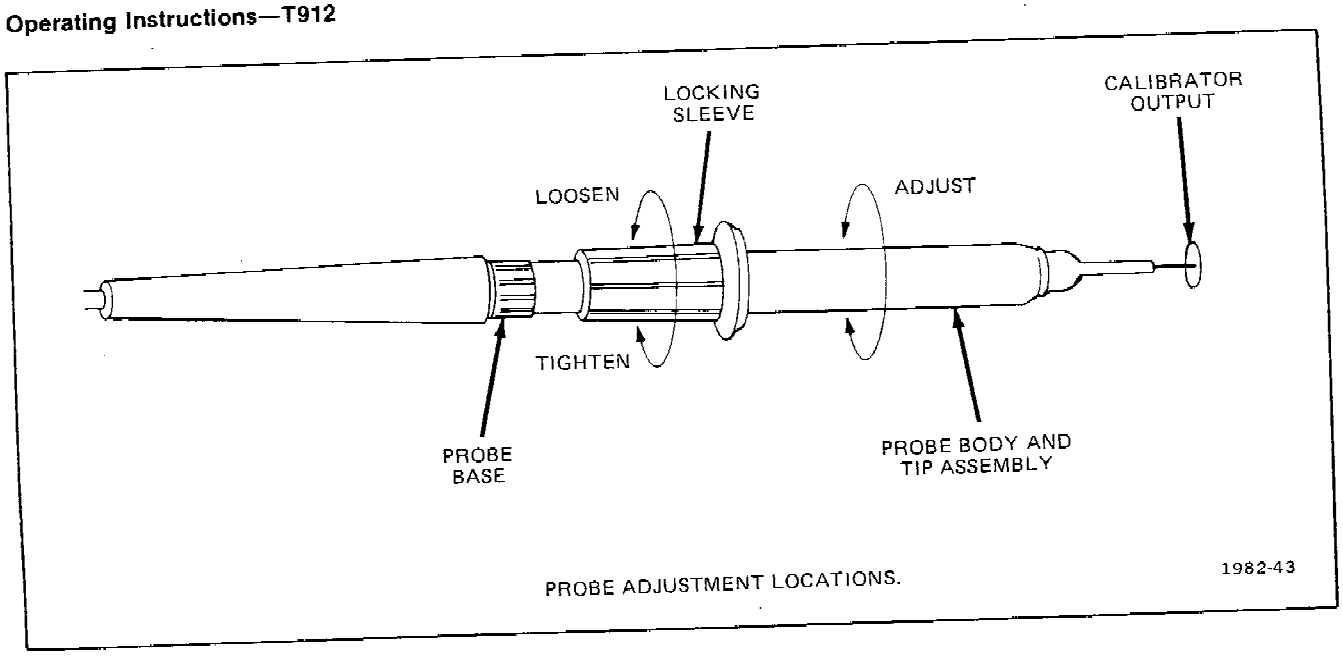


Fig. 2-7. Probe compensation.

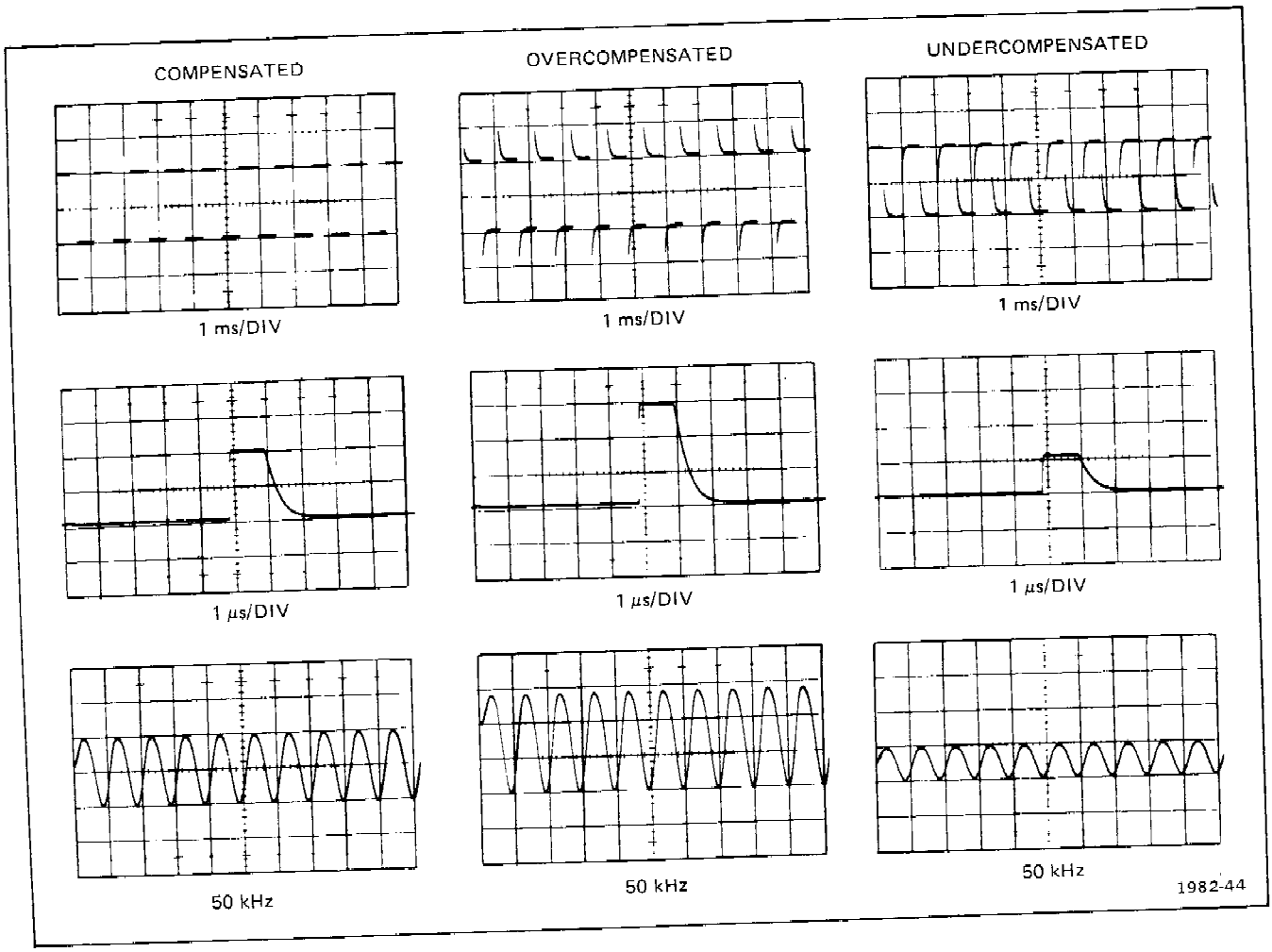


Fig. 2-8. Effects of probe compensation.

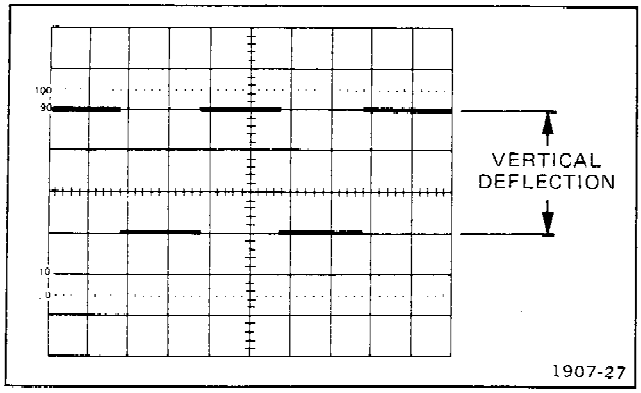


Fig. 2-9. Peak-to-peak voltage measurement.

Instantaneous Amplitude Measurement

The following procedure explains how to measure the amplitude of any point on a waveform with respect to ground.

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

2. Apply the signal to be measured to one of the vertical input connectors. Set the Vertical Mode switch to select the channel used.

3. Obtain a stable display, centered vertically.

4. Set the AC-GND-DC switch to GND. Adjust the trace to some reference line (see Fig. 2-10).

5. Set the AC-GND-DC switch to DC. If the waveform appears above the reference line, the voltage is positive. If the waveform appears below the reference line, the voltage is negative.

6. Measure the vertical difference (in divisions) between the reference line and the desired point on the waveform and multiply by the VOLTS/DIV switch setting.

Example:

The vertical difference is five divisions (see Fig. 2-10). The VOLTS/DIV switch is set to 10 mV. The waveform appears above the reference line.

Substituting the given values:

$$\text{Instantaneous Voltage} = \frac{5}{\text{divisions}} \times \frac{10\ \text{mV}/}{\text{divisions}} = 50\ \text{mV}$$

$$\text{Instantaneous Voltage} = +50\ \text{mV}$$

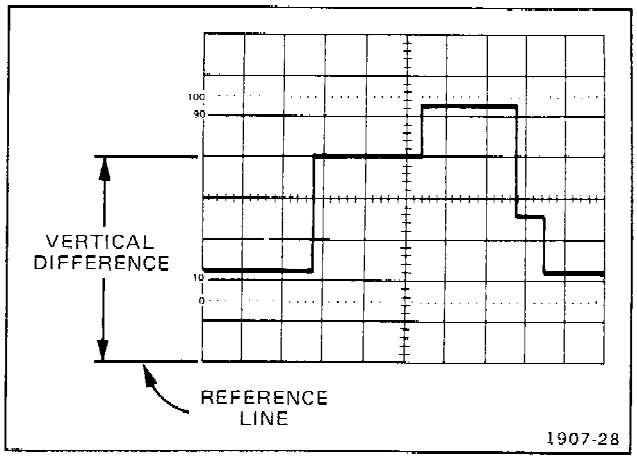


Fig. 2-10. Instantaneous voltage measurement.

Dual Trace Phase Difference Measurement

Phase comparison between two signals of the same frequency can be accomplished using the dual-trace feature. This method of phase difference measurement can be used up to the frequency limit of the vertical system. It is also more accurate and easier to use than the X-Y method. To make the comparison, use the following procedure:

1. Set the AC-GND-DC switches to AC.

2. Set the Vertical Mode switch to DUAL TRACE. Position both traces to the graticule horizontal centerline.

3. Connect the reference signal to the CH 1 input connector and the comparison signal to the CH 2 input connector. Use coaxial cables or probes which have equal time delay to connect the signals to the input connectors.

4. Set the CH 1 and CH 2 VOLTS/DIV switches and the CH 1 and CH 2 VAR controls so that the displays are equal and about five divisions in amplitude.

5. Set the SEC/DIV switch to a sweep rate which displays about one cycle of the reference waveform.

6. Turn the variable (X1-X10) SEC/DIV control until one cycle of the reference signal (Channel 1) occupies exactly eight divisions between the first and ninth graticule lines (see Fig. 2-11). Each division of the graticule represents 45° of the cycle (360° ÷ 8 divisions = 45°/division).

7. Measure the horizontal difference between corresponding points on the waveforms.

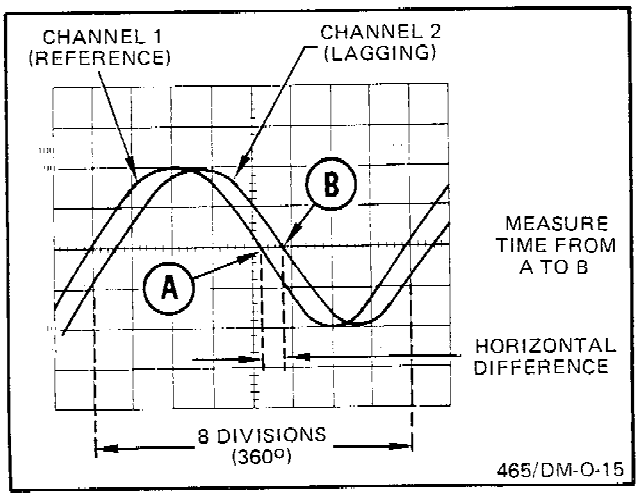


Fig. 2-11. Phase difference.

8. Multiply the measured distance (in divisions) by 45°/division (sweep rate) to obtain the exact amount of phase difference.

Example:

Assume a horizontal difference of 0.6 division with a sweep rate of 45°/division as shown in Fig. 2-11.

Substituting the given values:

$$\text{Phase Difference} = 0.6 \text{ division} \times 45°/\text{division}$$

$$\text{Phase Difference} = 27°$$

Time Duration and Frequency Measurements

To find the time duration between two points on a waveform, multiply the horizontal distance (in divisions) between the two points by the SEC/DIV switch setting. Frequency (in hertz) is the reciprocal of the time duration of one cycle (in seconds).

Example:

The horizontal distance measured is 8.3 divisions (see Fig. 2-12).

The SEC/DIV switch is set to 2 ms.

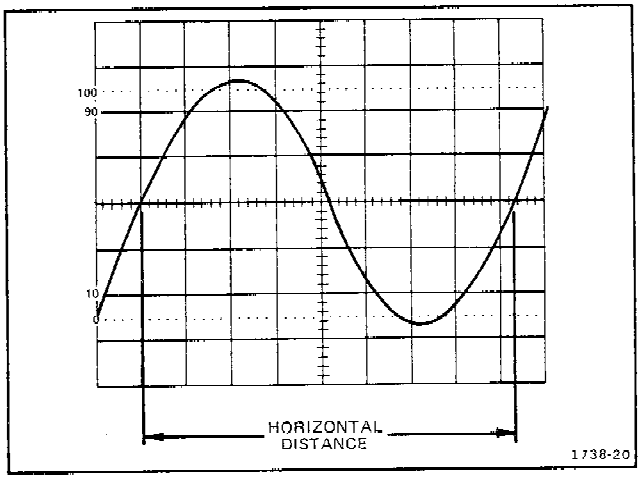


Fig. 2-12. Time duration.

Substituting the given values:

$$\text{Time Duration} = \text{Horizontal distance (divisions)} \times \text{SEC/DIV setting}$$

$$\text{Time Duration} = 8.3 \text{ divisions} \times 2 \text{ ms/division}$$

$$\text{Time Duration} = 16.6 \text{ ms (milliseconds)}$$

and

$$\text{Frequency} = \frac{1}{\text{time duration}}$$

$$\text{Frequency} = \frac{1}{16.6 \text{ ms}^{*}} = 60 \text{ Hz}$$

*16.6 ms = .0166 second.

Risetime Measurements

Risetime measurements are made in the same manner as time duration measurements, except the measurements are made between the 10% and 90% points of the waveform's amplitude (see percentage markings on the left edge of the graticule).

Use the following procedure to measure risetime:

1. Adjust the VOLTS/DIV and VAR controls for a display amplitude of exactly five divisions.

2. Adjust the vertical POSITION control so that the display bottom just touches the 0% graticule line and the display top just touches the 100% graticule line (see Fig. 2-13).

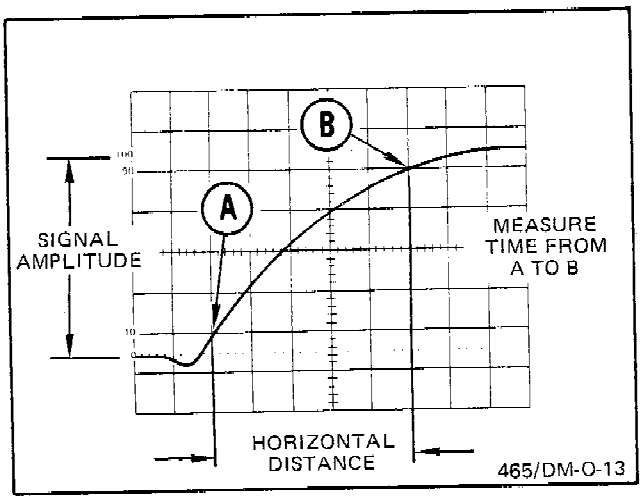


Fig. 2-13. Risetime.

3. Measure the horizontal distance (divisions) between the 10% and 90% points on the waveform (point A to point B, Fig. 2-13).

4. Use the following formula to find risetime:

$$\text{Risetime} = \text{horizontal distance (divisions)} \times \text{SEC/DIV setting}$$

Examples:

The horizontal distance between the 10% and 90% point on the waveform is five divisions with a SEC/DIV switch setting of 1 μs.

Substituting the given values:

Risetime = 5 divisions X 1 μs/division

Risetime = 5 μs

HOW TO STORE A DISPLAY

1. Turn the INTENSITY control fully counterclockwise and press the STORE button in. Note background light level, then press the ERASE button. Notice that the normal storage background light level is present on the storage screen.

2. Rotate the INTENSITY control slowly clockwise to produce a display of normal intensity, then return the INTENSITY control to fully counterclockwise. Notice a stored display of moderate brightness.

3. Press the ERASE button and note that the crt display can be erased.

4. Set the STORE button to the out (non-store) position. Set the TRIGGERING and INTENSITY controls for a stable display of normal brightness.

5. Set the MODE switch to SINGLE SWP and press the STORE button in. Then press the ERASE button.

6. Apply a single sweep trace by pressing the RESET button. Note a stored display on the storage area. If the display is not stored, increase the trace intensity (INTENSITY control clockwise) and repeat the check.

7. Set the SEC/DIV switch to 1 μs and the X1-X10 control to X10 (fully cw). Turn the INTENSITY control fully clockwise.

8. Position the rising portion of the waveform within the graticule area. Re-adjust the INTENSITY control so that the trace is just visible. Press the STORE button in, then press the ERASE button. Note normal storage mode background light on crt.

9. Press the INTEG button momentarily (one second to several seconds is reasonable). Note a fully-stored display. If the trace does not store fully on the first attempt, repeat the integration for a longer time, or with a higher intensity. Press the ERASE button and release the STORE button.

Using Enhanced Mode

To use the enhance feature, first obtain the best possible display of the signal in the normal store mode. Set the MODE switch to SINGLE SWP. Set the ENHANCE LEVEL control to about midrange and apply a single sweep. If the ENHANCE LEVEL control is properly set, the display will be stored with minimum background luminance. Further, the INTENSITY level may have to be set quite high in the enhance mode.

If the ENHANCE LEVEL control is set too high, the background luminance may obscure the desired display. If the ENHANCE LEVEL control is set too low, the display may not be adequately stored. Therefore, experimentation is necessary for an optimum enhanced display.

Integrated Fast-Rise Waveforms

The Integrate circuit permits storage of waveforms of relatively fast sweep rates with relatively low repetition rates. Waveforms that might be difficult to see because of the low sweep duty cycle (or that have poor resolution due to the required high setting of the INTENSITY control) can often be stored using the Integrate method to produce brightness or better resolution.

CAUTION

Do not attempt to store extremely fast-rising or fast-falling portions of waveforms viewed at relatively slow sweep rates. The high trace intensity required (due to the intensity difference between the horizontal and vertical segments) could cause storage target damage.

To use the Integrate function, first obtain a triggered, well-defined display. Then press the INTEG button in (one second to several seconds is reasonable). If all portions of the display are not properly stored, repeat the integrate period with higher trace intensity.

Reduce the trace intensity so that the display is just visible (erase display each time intensity is adjusted). Press the INTEG button in and note that the stored trace is brightened.

Low trace intensity and long integration periods produce optimum resolution on jitter-free signals. However, if the integration period is too long, the stored image may broaden and obscure the desired display.

Care of Storage CRT

To prolong the useful life of the storage screen, the following precautions should be observed:

1. Use the lowest beam intensity necessary to produce a clear, well-defined display. Care must be exercised in the degree of writing beam intensity used, particularly when using slow sweep rates.

2. Do not increase beam intensity to store fast changing portions of the display. See Integrated Fast-Rise Waveforms.

3. Avoid repeated use of the same area of the screen.

4. Do not leave a display on the screen (either written or stored) when the display is not needed.

5. Do not leave the STORE button in when the storage mode is not needed.

Oscilloscope Light Filter and Graticule Illumination Photography Effects

Some oscilloscopes contain a factory installed colored (usually blue or green) plastic light filter in front of the crt faceplate to improve general purpose viewing contrast in ambient lighting conditions (in some applications this device also functions as an implosion safety shield).

In order for the oscilloscope graticule to be photographed along with a crt display, oscilloscopes that do not provide internal graticule (scale) illumination must be used with a camera such as the C5B or C5B Option 3, which provide external flash illumination of the graticule. An exception to this is some storage oscilloscopes operated in the store mode, where the target illumination may also illuminate the graticule lines.

Effectiveness of the graticule illumination flash is severely degraded when used with most colored crt light filters. If a clear light filter was provided as an accessory with your oscilloscope, the colored filter should be removed and the clear filter installed in its place when taking oscilloscope display photographs. The clear filter may also provide improved photograph definition and contrast with reduced oscilloscope display intensity settings (some colored filters reduce effective display intensity as much as 75%). Under no circumstances should the oscilloscope be operated without either a clear or colored light filter when no other implosion shield is provided (optional accessory mesh filters are not intended for implosion protection and must be removed when using an oscilloscope camera).

If your oscilloscope was not provided with a clear light filter accessory, contact your local Tektronix Field Office for ordering information.

For all T900-Series, bench-version oscilloscopes, the instrument cabinet must be removed in order to replace the crt light filter. Only qualified service personnel should remove the instrument cabinet. The part number for the clear light filter to fit T900-Series, bench-version oscilloscopes is 337-2185-03.

PERFORMANCE CHECK

This procedure allows the basic performance specifications to be checked without removing the instrument covers. It is intended for use in incoming inspection to determine acceptability of newly purchased or recently calibrated instruments.

LIMITS AND TOLERANCES

Tolerances given are for the instrument under test and do not include test equipment error. Limits and tolerances in this check are instrument specifications only if they are called out as performance requirements in the specifications section.

TEST EQUIPMENT REQUIRED

You will need the test equipment listed in Table 3-1, or equivalent, to perform a complete Performance Check of the T912. The Specifications given for the equipment are the minimum necessary for accurate results.

Table 3-1

TEST EQUIPMENT

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
1. Amplitude Calibrator	Amplitude accuracy, within 0.5%; signal amplitude, 10 mV to 10 V; output signal, 1 kHz square wave.	Vertical Gain checks, X Gain check.	a. TEKTRONIX PG 506 Calibration Generator.[a] b. TEKTRONIX 067-0502-01 Calibration Fixture.
2. Sine-Wave Generator	Frequency, 50 kHz to at least 10 MHz; output amplitude, variable from 0.5 to 5 V p-p; output impedance, 50 Ω; reference frequency, 50 kHz; amplitude accuracy, constant within 0.3% of reference frequency as output frequency changes.	Vertical Amplifier bandwidth checks, X bandwidth check. Triggering checks. Z axis input check.	a. TEKTRONIX SG 503 Leveled Sine-Wave Generator.[a] (With included precision cable.) b. TEKTRONIX Type 191 Constant Amplitude Signal Generator.
3. Time-Mark Generator	Marker outputs, 50 ns to 0.5 s; marker accuracy within 0.5%; trigger output, 1 ms to 0.1 μs, time coincident with markers.	Timing checks.	a. TEKTRONIX TG 501 Time-Mark Generator.[a] b. TEKTRONIX 2901 Time-Mark Generator.
4. Termination (2)	Impedance, 50 Ω; bnc connectors.	Signal termination.	a. Tektronix Part 011-0049-01.
5. Cable (3)	Impedance, 50 Ω; bnc connectors.	Signal interconnection.	a. Tektronix Part 012-0057-01.

[a]Requires a TM 500 Series Power Module.

REV. A APR 1977

Table 3-1 (cont)

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
6. Dual Input Coupler	Connectors, bnc female to two bnc male.	Signal interconnection.	a. Tektronix Part 067-0525-00.
7. T Connector	Connectors, bnc.	Signal interconnection.	a. Tektronix Part 103-0030-00.
8. Adapter	Bnc female to bnc female.	Signal interconnection.	a. Tektronix Part 103-0028-00.

PRELIMINARY PROCEDURE

Use the following steps to put your instrument into a basic operating mode before proceeding with the Performance Check.

1. Check that the 120 V/240 V and HI/LO switches are properly set (see Operating Voltage, page 2-1).

2. If the 120 V/240 V and HI/LO switches are properly set, connect the power cord plug to the power source and turn the instrument on. Connect test equipment to an appropriate power source and turn it on. Set the trigger MODE to AUTO, and SOURCE to INT.

NOTE

Allow a 20 minute warmup before starting the Performance Check Procedure. This instrument must have been adjusted at an ambient temperature of +25° C within 5° C to ensure that checks in this procedure will meet the specifications listed in Section 1.

3. Set the controls as follows:

Display

BEAM FINDER	Button out
STORAGE	Nonstore (button out)
ENHANCE	Fully cw
INTEG	Off (button out)

Vertical Amplifier

Vertical Mode	CH 1
POSITION (both)	Midrange
VOLTS/DIV (both)[1]	2 mV
VAR (both)	Detent (cw)
CH 1 AC-GND-DC	DC
CH 2 AC-GND-DC	GND

Time Base

SEC/DIV	.5 ms
X1-X10 (variable)	X1 (unmagnified—fully ccw in detent)
SOURCE	INT
MODE	AUTO
POSITION	Midrange
SLOPE	+OUT
LEVEL	Midrange

4. The POWER ON light should be on and a baseline trace should be visible on the graticule. Adjust INTENSITY, FOCUS, and ASTIG controls for low intensity, well-defined trace.

The baseline should be parallel with horizontal graticule lines. If not, adjust R472, TR ROT (trace rotation), in the left side panel until the trace aligns with the horizontal graticule lines.

This ends the preliminary procedure.

[1]**Unless otherwise stated, use the 1X PROBE window for VOLTS/DIV settings throughout the Performance Check Procedure.**

PERFORMANCE CHECK PROCEDURE

1. CH 1 and CH 2 Deflection Accuracy

a. Connect test equipment as shown in Fig. 3-1 (use appropriate POSITION control as needed to center the display within the graticule area).

b. CHECK—Deflection accuracy for CH 1 according to Table 3-2 within 3% (+20° C to +30° C).

Table 3-2
DEFLECTION ACCURACY

VOLTS/DIV (1X PROBE WINDOW)	Amplitude Calibrator Output	Vertical Deflection (divisions)	±3% Tolerance (divisions)
2 mV	10 mV	5	4.85 to 5.15
5 mV	20 mV	4	3.88 to 4.12
10 mV	50 mV	5	4.85 to 5.15
20 mV	.1 V	5	4.85 to 5.15
.2 V	1 V	5	4.85 to 5.15
2 V	10 V	5	4.85 to 5.15

c. Set: CH 1 AC-GND-DC GND
CH 2 AC-GND-DC DC
Vertical Mode CH 2
CH 2 POSITION As needed

d. CHECK—Deflection accuracy for CH 2 according to Table 3-2 within 3% (+20° C to +30° C).

e. Set amplitude calibrator to 0.1 volt.

2. CH 1 and CH 2 VAR (Variable) Volts/Div Range

a. Set CH 1 and CH 2 VOLTS/DIV to 20 mV.

b. CHECK—Display amplitude reduces from five divisions to less than two divisions with CH 2 VAR control turned fully counterclockwise.

c. Set: Vertical Mode CH 1
CH 1 AC-GND-DC DC
CH 2 AC-GND-DC GND

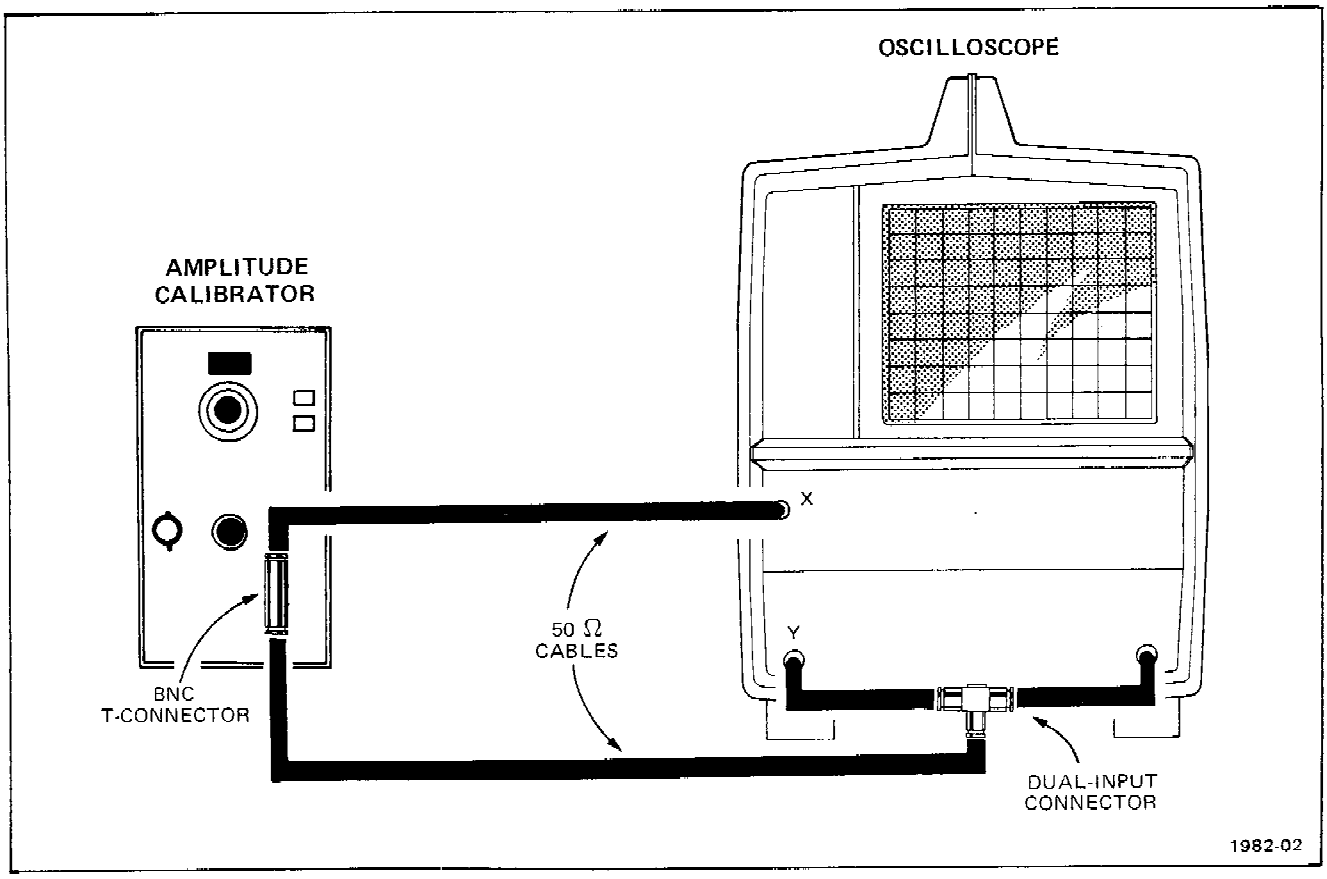


Fig. 3-1. Deflection accuracy check test setup.

d. CHECK—Display amplitude reduces from five divisions to less than 2 divisions with CH 1 VAR control turned fully counterclockwise.

e. Return both VAR controls to detent position.

f. Disconnect test equipment.

3. CH 1 Bandwidth

a. Connect test equipment as shown in Fig. 3-2.

b. Set: VOLTS/DIV (both) 2 mV
AC-GND-DC (both) DC
LEVEL Fully cw
POSITION (all) As required

c. Set generator frequency to 50 kHz (reference) and adjust output amplitude for a 5-division display.

d. Set generator frequency to 10 MHz.

e. CHECK—Display amplitude is at least 3.5 divisions.

4. CH 2 Bandwidth

a. Set: Vertical Mode CH 2

b. Move the sine-wave generator output (through 50 Ω cable and 50 Ω termination) from CH 1 input connector to CH 2 input connector.

c. Set generator frequency to 50 kHz (reference) and adjust output amplitude for a 5-division display.

d. Set generator frequency to 10 MHz.

e. CHECK—Display amplitude is at least 3.5 divisions.

f. Disconnect test equipment.

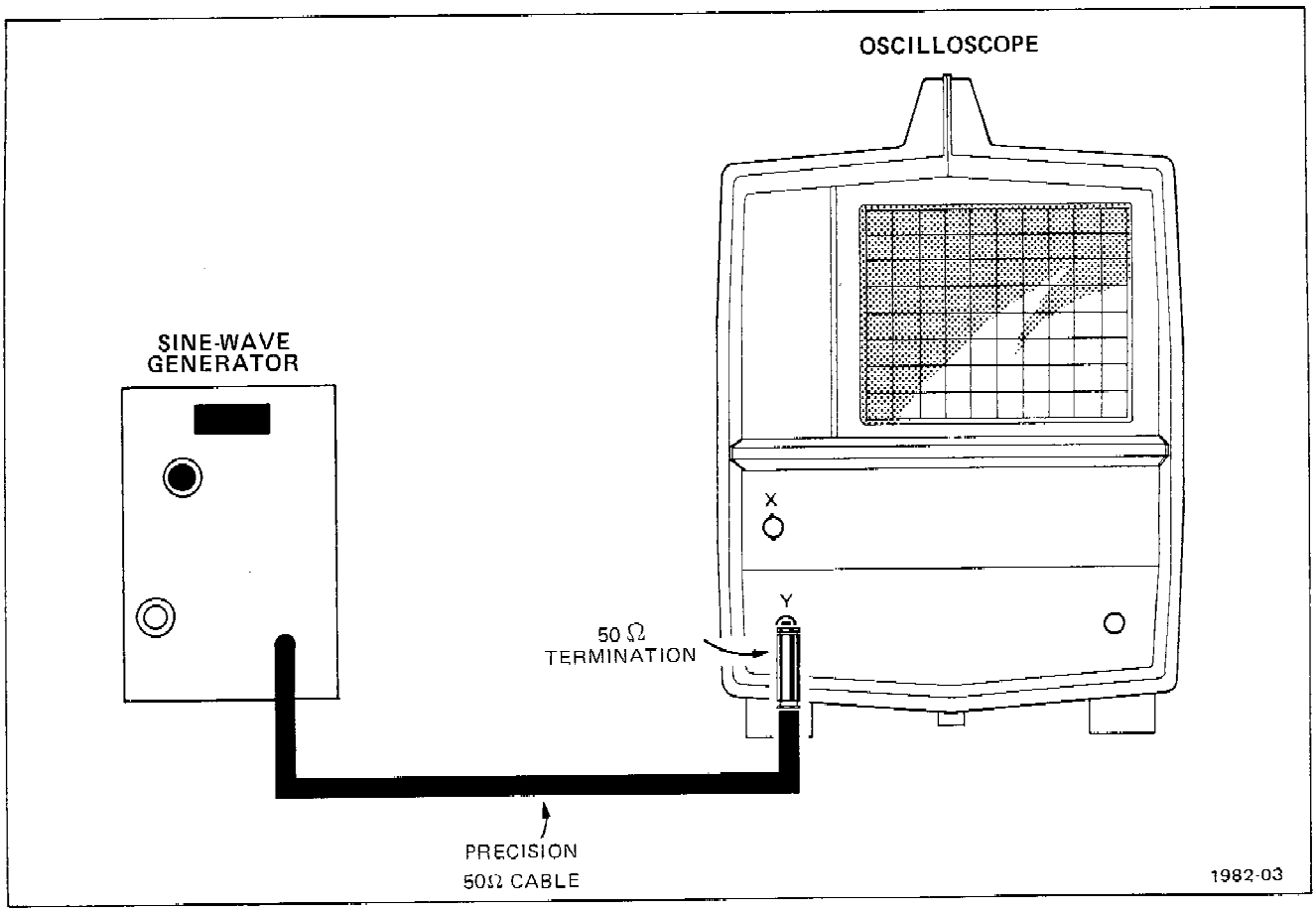


Fig. 3-2. Bandwidth check test setup.

5. X-AXIS GAIN

a. Set: Vertical Mode CH 1
VOLTS/DIV (CH 1) .1 V
SOURCE X-Y
X1-X10 X10 (fully cw)
INTENSITY For visible display
SEC/DIV 0.1 ms

b. Connect test equipment as shown in Fig. 3-3 and set generator output amplitude to .5 V, and frequency to 50 kHz.

c. CHECK—Horizontal deflection between 3.5 and 6.5 divisions (set horizontal POSITION as needed to view start and end of display).

d. Disconnect test equipment.

6. X-AXIS Bandwidth

a. Connect sine-wave generator through 50 Ω cable and 50 Ω termination to X (EXT) input.

b. Set generator frequency to 50 kHz (reference) and adjust output amplitude for 10 divisions (about 1 volt) of horizontal deflection.

c. Set generator frequency to 1 MHz.

d. CHECK—Display amplitude is at least seven divisions.

e. Disconnect test equipment.

f. Set SOURCE to INT; MODE to NORM.

NOTE

When making trigger checks, adjust the LEVEL control, POSITION controls, and INTENSITY as needed for a stable visible display, unless instructed otherwise.

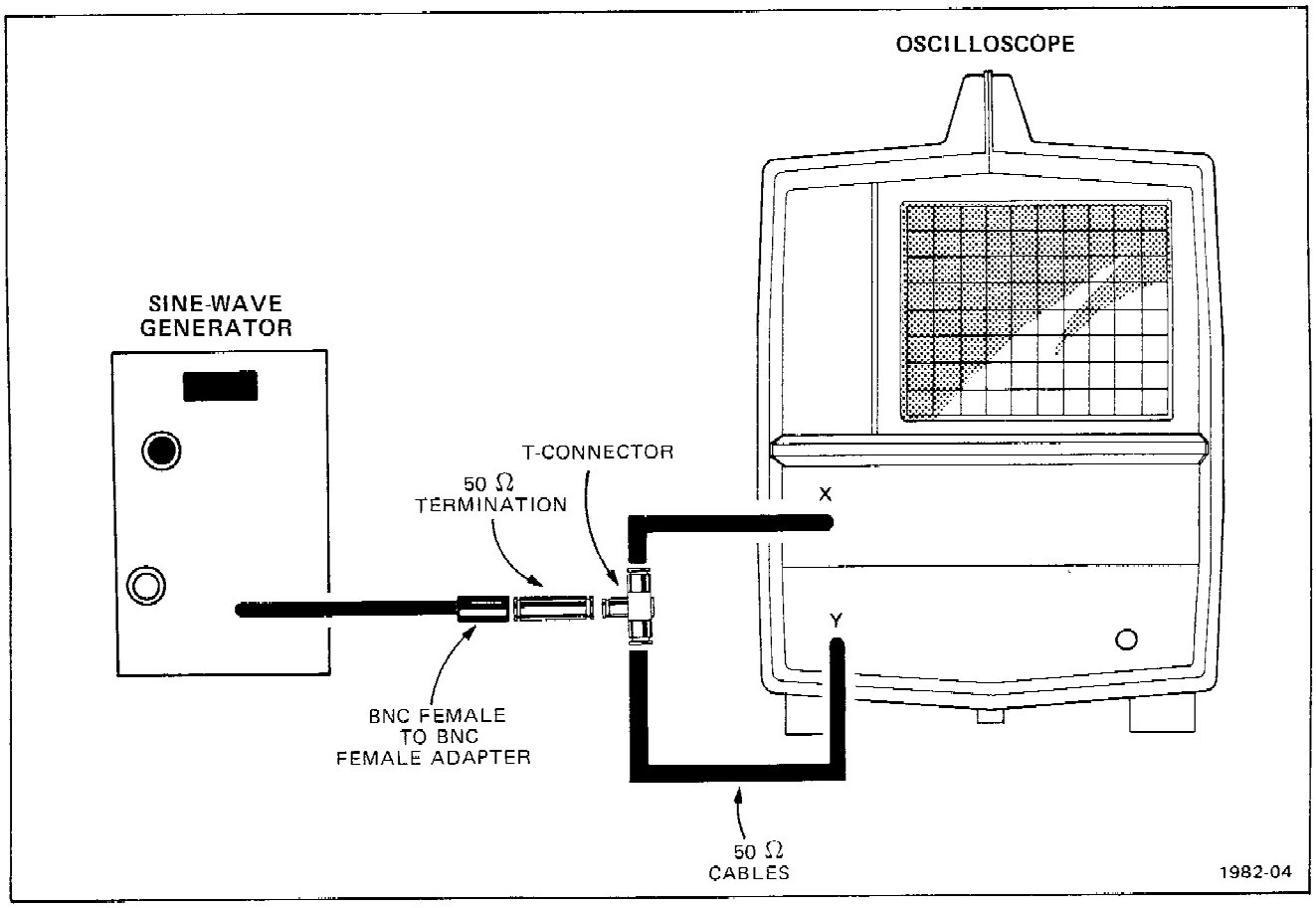


Fig. 3-3. X Gain, Triggering, and Z-axis input check test setup.

7. 1 MHz Internal Triggering

a. Connect test equipment as shown in Fig. 3-3.

b. Set: CH 1 VOLTS/DIV 1 V
SEC/DIV .5 μs
X1-X10 X1 (fully ccw detent)

c. Set sine-wave generator frequency for 1 MHz and adjust output amplitude for a 0.5-division display.

d. CHECK—Stable display can be obtained in both the +OUT and −IN positions of the SLOPE switch for both AUTO and NORM.

8. 1 MHz External Triggering

a. Set: CH 1 VOLTS/DIV .1 V

b. Adjust sine-wave generator output amplitude for 100 mV (one division on crt).

c. Set: SOURCE EXT

d. CHECK—Stable display can be obtained in both the +OUT and −IN positions of the SLOPE switch for both AUTO and NORM.

9. 10 MHz Internal Triggering

a. Set: SOURCE INT
CH 1 VOLTS/DIV 50 mV
X1-X10 X10 (fully cw detent)

b. Set sine-wave generator frequency for 10 MHz and output amplitude for a 3-division display; then set CH 1 VOLTS/DIV to .1 V.

c. CHECK—Stable display can be obtained in both the +OUT and −IN positions of the SLOPE switch for both AUTO and NORM modes.

10. 10 MHz External Triggering

a. Set: SOURCE EXT

b. CHECK—Stable display can be obtained in both the +OUT and −IN positions of the SLOPE switch for both AUTO and NORM.

11. Z-Axis Input

a. Set: CH 1 VOLTS/DIV 1 V
SEC/DIV .1 ms
SOURCE INT
Trigger Mode AUTO
X1-X10 (Variable) X1 (fully ccw detent)

b. Set sine-wave generator frequency to 50 kHz and adjust output amplitude for a 5-division display.

c. Disconnect 50 Ω cable from X (or EXT, external trigger) input, and connect it to EXT Z AXIS connector at rear of instrument.

d. CHECK—Trace modulation is noticeable at normal intensity. (Adjust LEVEL control as required to obtain stable display.)

e. Disconnect test setup.

12. Low Frequency Triggering

a. Set: SEC/DIV 10 ms
X1-X10 (variable) X1 (fully ccw detent)
VOLTS/DIV (CH 1) 2 mV
Channel 1 AC-GND-DC DC
MODE NORM

b. Connect 10X probe to CH 1 input.

c. Lay probe near ac line voltage source and adjust CH 1 VOLTS/DIV switch and VAR control for a 0.4-division display.

d. CHECK—Stable display can be obtained in both the +OUT and −IN positions of the SLOPE switch for AUTO and NORM modes, and LINE and INT SOURCE positions.

e. Remove probe.

f. Return VAR to detent; MODE to NORM; and SOURCE to INT.

13. Sweep Rate Accuracy

a. Connect test setup as shown in Fig. 3-4.

b. Set: CH 1 VOLTS/DIV .2 V
SOURCE INT
MODE NORM
X1-X10 X1 (fully ccw)
SLOPE As needed
LEVEL As needed
POSITION (all) As needed

c. CHECK—SEC/DIV accuracy according to Table 3-3: one or two time marks, as indicated, within 3% (0.24 div) over center eight divisions. Accuracy specifications apply for a temperature range of +20° C to +30° C.

Table 3-3

NORMAL SWEEP TIMING ACCURACY

SEC/DIV Switch Setting	Time-Mark Generator Output	CRT Display (Marker/Division)
.5 μs	0.5 microsecond	1
1 μs	1 microsecond	1
2 μs	1 microsecond	2
5 μs	5 microseconds	1
10 μs	10 microseconds	1
20 μs	10 microseconds	2
50 μs	50 microseconds	1
.1 ms	0.1 millisecond	1
.2 ms	0.1 millisecond	2
.5 ms	0.5 millisecond	1
1 ms	1 millisecond	1
2 ms	1 millisecond	2
5 ms	5 milliseconds	1
10 ms	10 milliseconds	1
20 ms	10 milliseconds	2
50 ms	50 milliseconds	1
.1 s	0.1 second	1
.2 s	0.1 second	2
.5 s	0.5 second	1

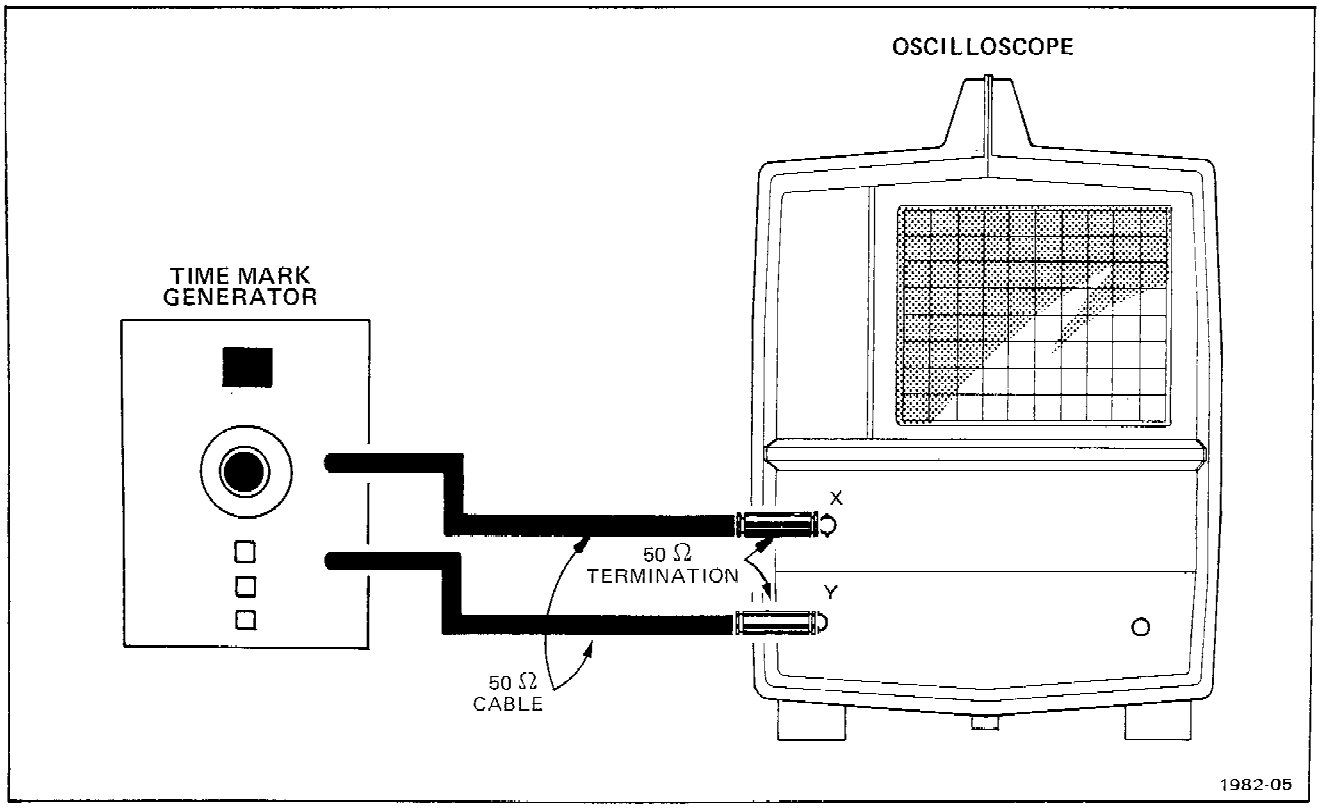


Fig. 3-4. Timing accuracy and writing rate check test setup.

14. Magnified Sweep Accuracy

a. Set: X1-X10 X10 (fully cw)
SEC/DIV 0.5 μs

b. Set time-mark generator to 50 ns (adjust CH 1 VOLTS/DIV, INTENSITY, FOCUS, and POSITION as necessary for a visible display).

NOTE

If you cannot obtain a stable display, connect the time-mark generator trigger output to the X (or EXT, external trigger) connector via a 50 Ω cable and a 50 Ω termination. Set SOURCE to EXT and adjust LEVEL control for a stable display.

c. CHECK—Magnified sweep accuracy according to Table 3-4: one or two time marks, as indicated, within 5% (0.4 div) over center eight divisions. Exclude the first 50 ns after the start of the sweep; (one division for 0.5 μs and 1 μs settings), and anything beyond the 100th magnified division. Accuracy specifications apply for a temperature range of +20° C to +30° C.

d. Return X1-X10 to X1 and SOURCE to INT.

Table 3-4

MAGNIFIED SWEEP TIMING ACCURACY

SEC/DIV Switch Setting	Time-Mark Generator Output	CRT Display (Marker/Division)
.5 μs	50 nanoseconds	1
1 μs	.1 microsecond	1
.5 ms	50 microseconds	1

15. Stored Writing Rate

a. Set the time-mark generator for 0.1 ms.

b. Set: SEC/DIV 0.1 ms
LEVEL For triggered sweep

c. Turn the X1-X10 control until the time marks are spaced 2.5 divisions apart (POSITION as required).

d. Disconnect the time-mark generator, set MODE to AUTO, and center the trace.

e. Set the INTENSITY control for normal brightness.

f. Set: MODE SINGLE SWP
STORE Storage (button in)
ENHANCE LEVEL Fully ccw
SOURCE LINE
LEVEL Midrange (so single sweep will trigger)

g. Press ERASE and release; press MODE switch to RESET position, then let it return to SINGLE SWP position; then vertically reposition the trace. Repeat this process until several traces are stored within the center 6 X 8 division area of the screen.

h. CHECK—That single sweeps store without breaks greater than 0.1 division over the center 6 X 8 divisions of the screen.

16. Enhanced Writing Rate

a. Connect test setup as shown in Fig. 3-4.

b. Set the time-mark generator for 10 μs.

c. Set: SEC/DIV 10 μs
STORE Nonstore (button out)
SOURCE INT
MODE AUTO
INTENSITY Slightly above normal brightness level.
LEVEL As required
POSITION (all) As required

d. Turn the X1-X10 control until the time marks are spaced 2.5 divisions apart.

e. Disconnect the time-mark generator and center the trace.

f. Slowly increase the INTENSITY until the trace begins to defocus rapidly.

g. Set: MODE SINGLE SWP
STORE Storage (button in)
SOURCE LINE

h. Slowly turn the ENHANCE LEVEL control clockwise while storing and erasing single sweeps until the entire screen starts to brighten. Now back off the ENHANCE LEVEL control slightly.

i. Press ERASE and release; press MODE switch to RESET position, then let it return to SINGLE SWP position; then vertically re-position the trace. Repeat this process until several traces are stored within the center 6 X 8 division area of the screen.

j. CHECK—That single sweeps store with no breaks greater than .1 division over the center 6 X 8 divisions of the screen.

k. Release STORE to out position, set SOURCE to INT, MODE to AUTO, X1-X10 to X1 (ccw detent), and INTENSITY control for normal brightness.

ADJUSTMENTS

WARNING

SERVICING INFORMATION IN THE FOLLOWING SECTIONS IS INTENDED FOR USE BY QUALIFIED SERVICE PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT REMOVE INSTRUMENT COVERS OR PERFORM ANY SERVICING UNLESS QUALIFIED TO DO SO.

IMPORTANT—PLEASE READ BEFORE USING THIS PROCEDURE

When done properly, this procedure allows you to adjust the instrument to its original performance specifications. The Adjustment Procedure is not intended as a troubleshooting guide. Any trouble you find during the procedure should be corrected before continuing. Refer to the Service Information section for further information.

LIMITS AND TOLERANCES

Limits and tolerances are instrument specifications only if they are called out as performance requirements in the Specification section. Tolerances given are for the oscilloscope under test and do not include test equipment error.

ADJUSTMENT INTERACTION

Some adjustments interact with others. These are identified with an INTERACTION step.

PARTIAL PROCEDURES

You can perform part of the adjustment procedure after replacing components or just to touch up the performance between major re-adjustments. Do not change the setting of the −8 V supply unless you intend to re-adjust the entire instrument.

To adjust only part of the instrument, set the controls according to the nearest preceding Control Settings and use the test setup given in the step you intend to perform or the setup in a preceding step. To prevent unnecessary re-adjustment of other parts of the instrument, reset an adjustment only if the tolerance given for that step is not met. If it is necessary to reset an adjustment, also check any steps listed in the INTERACTION—part of the step.

TEST EQUIPMENT REQUIRED

The test equipment listed in Table 4-1, or equivalent is required for complete calibration of the oscilloscope. Specifications given for the equipment are the minimum necessary for accurate calibration.

Table 4-1

TEST EQUIPMENT

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
1. Digital Voltmeter	Range, 0 to 250 V dc; accuracy within 0.3%.	Power supply and storage adjustment	a. TEKTRONIX DM 501 Digital Multimeter.[a]
2. Time-Mark Generator	Markers, 0.5 μs to 0.5s; accuracy, within 0.3%.	Geometry adjustment, sweep and timing adjustments.	a. TEKTRONIX TG 501 Time-Mark Generator.[a] b. TEKTRONIX 2901 Time-Mark Generator.
3. Amplitude Calibrator	Signal Amplitude, 10 mV to 50 V square wave; frequency, 1 kHz; amplitude accuracy, within 0.3%.	Vertical gain adjustment.	a. TEKTRONIX PG 506 Calibration Generator.[a]

[a] Requires TM500 Series Power Module

Table 4-1 (cont)

Description	Minimum Specifications	Usage	Examples of Applicable Test Equipment
4. Square-Wave Generator	Frequency, 1 kHz and 100 kHz; risetime, 2 ns or less.	High frequency compensation and vertical attenuator adjustments.	a. TEKTRONIX PG 506 Calibration Generator.[a] b. TEKTRONIX Type 106 Square-Wave Generator.
5. Sine-Wave Generator	Frequency, 2 kHz; frequency accuracy, within 5%.	Storage level adjustment.	a. TEKTRONIX SG 502 Sine-wave Generator.[a] b. TEKTRONIX FG 503 Function Generator.[a]
6. Cable	Length, 42 in.; impedance, 50 Ω; connectors, bnc.	Signal interconnection.	a. Tektronix Part 012-0057-01.
7. Termination	Impedance, 50 Ω; connectors bnc.	Signal termination.	a. Tektronix Part 011-0049-01.
8. Low-Capacitance Alignment Tool		Variable capacitor adjustments. Vertical attenuator and high-frequency compensation adjustment.	a. General Cement adjustment tool G.C. 8722.
9. Screwdriver	Length, 3 in. shaft; bit size, 3/32 in.	Variable resistor adjustments.	a. Xcelite R-3323.
10. 10X Attenuator	Ratio, 10X; impedance, 50 Ω; connectors, bnc.	Vertical attenuator adjustments.	a. Tektronix Part 011-0059-02.
11. Probe, 10X	Attenuation, 10X; Probe can be compensated for input characteristics of T912.	Vertical attenuator compensation.	a. P6006, Tektronix Part 010-0160-00. (Standard accessory for T912.)
12. Adapter	Probe-tip-to-bnc.	Vertical attenuator compensation.	a. Tektronix Part 013-0054-00.

[a]Requires TM500 Series Power Module

PRELIMINARY PROCEDURE

WARNING

Dangerous potentials exist at several points inside your instrument. To prevent electrical shock, do not touch exposed connections or components when the instrument is operated with the cover removed. Disconnect power cord plug from power input voltage source while disassembling or repairing this instrument.

1. Remove the cabinet from the instrument. To remove the cabinet, remove the six retaining screws (three on the top and three on the bottom) and slide the halves apart.

2. Check that the 120 V/240 V and HI/LO switches are properly set (see Operating Voltage Selection, page 5-1).

3. Connect the T912 and test equipment to an appropriate power input source. Turn them on and allow at least 20 minutes warm-up before starting the adjustment procedure.

For best overall accuracy, make adjustments at an ambient temperature of +20° C to +30° C.

A. DISPLAY, POWER SUPPLY, AND STORAGE

Equipment Required

1. Digital Voltmeter
2. Time-Mark Generator
3. Sine-Wave Generator
4. 50 Ω BNC Cable
5. 50 Ω Termination
6. Screwdriver
7. Low-Capacitance Alignment Tool

1. Preliminary Control Settings

NOTE

Do not preset internal controls.

Set:	STORE	nonstore (button out)
	ENHANCE LEVEL	fully ccw
	INTENSITY	midrange
	Vertical Mode	CH 1
	CH 1 VOLTS/DIV	1 V (1X)[1]
	VOLTS/DIV VAR (both)	detent (cw)
	AC-GND-DC (both)	GND
	SEC/DIV	.1 ms
	X1-X10	X1 (fully ccw)
	SOURCE	INT
	MODE	AUTO
	SLOPE	+OUT
	LEVEL	midrange
	CH 1 POSITION	midrange
	Horizontal POSITION	midrange

Set all other controls as desired. The oscilloscope should produce a baseline trace with the controls set as above. Adjust the INTENSITY and FOCUS controls (on front panel), and ASTIG control (left side of cabinet) as needed to maintain a well-defined display.

2. −8 V Power Supply

NOTE

Do not change the setting of the −8 V adjustment unless you intend to re-adjust the entire instrument.

a. Connect digital voltmeter between the −8 V side of R775 and ground (see Fig. 4-1). If meter does not read between −7.96 V and −8.04 V, proceed to part b.

b. ADJUST—R773, −8 V Adj (see Fig. 4-1) for −8.00 V dc.

c. Disconnect digital voltmeter.

3. Trace Rotation

a. Position trace vertically to center horizontal graticule line.

b. ADJUST—TR ROT, R472, to align trace with center horizontal graticule line.

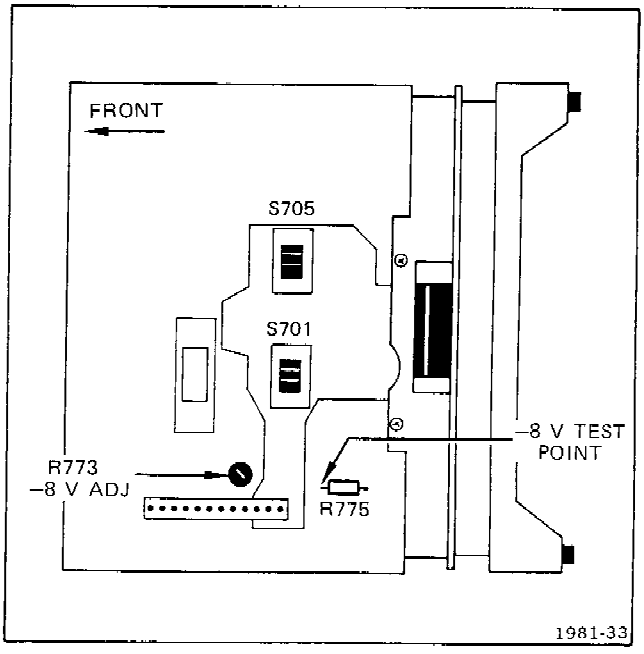


Fig. 4-1. Power supply adjustment location (bottom of T912).

[1]**Refers to window on VOLTS/DIV switch knob. Use 1X probe window unless otherwise specified in individual steps of the procedure.**

4. Geometry

a. Set CH 1 AC-GND-DC to DC; INTENSITY and FOCUS as required.

b. Connect .1 ms markers from time-mark generator to CH 1 input via 50 Ω bnc cable and 50 Ω bnc termination.

c. Set CH 1 VOLTS/DIV and VAR to obtain slightly more than eight divisions of vertical deflection and position display baseline below bottom graticule line (off screen).

d. Set SEC/DIV to obtain about one marker/division and rotate horizontal POSITION to align a marker with center graticule line.

e. ADJUST—Geom, R982 (see Fig. 4-2) for best alignment of markers with the vertical graticule lines.

f. Disconnect time-mark generator.

5A. STORAGE (Below SN B010300)

a. Set:

Vertical Mode	CH 1 (button in)
CH 1 AC-GND-DC	DC
CH 1 VOLTS/DIV	.1 V
SEC/DIV	0.5 ms
STORE	store (button in)
SOURCE	INT
MODE	AUTO
ENHANCE LEVEL	fully ccw
Channel 1 POSITION	fully ccw

b. Rotate the Channel 1 POSITION control clockwise until entire screen is written.

c. Set MODE to SINGLE SWP.

d. Rotate R984, Flood Gun Bias, fully clockwise.

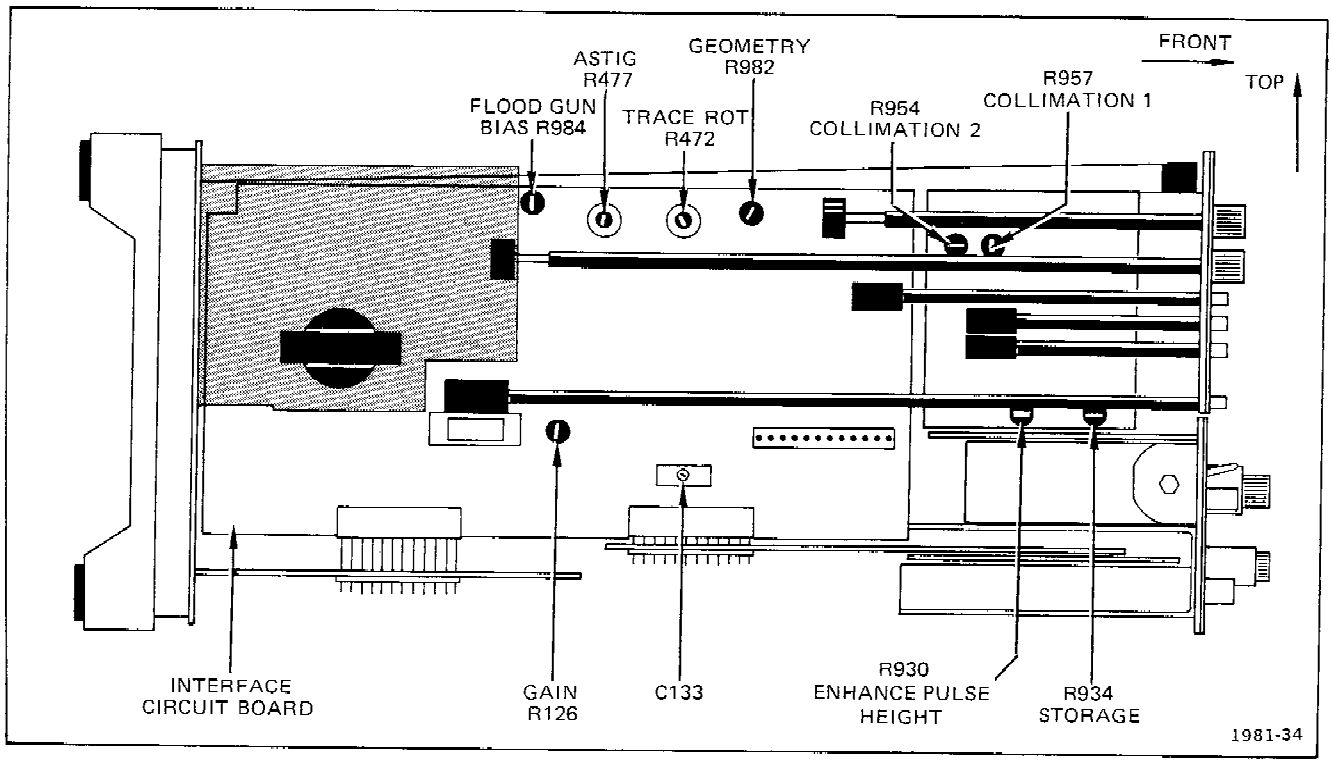


Fig. 4-2. Interface board adjustment locations.

e. ADJUST—R984 (see Fig. 4-2), Flood Gun Bias, counterclockwise until shadows appear in corners, then turn it 10° further clockwise.

f. Rotate R957 (see Fig. 4-2), Collimation 1, fully counterclockwise.

g. ADJUST—R957 for maximum coverage of screen stored area.

h. Rotate R954 (see Fig. 4-2), Collimation 2, fully counterclockwise.

i. ADJUST—R954 so that stored part covers maximum area of screen.

j. INTERACTION—Between Flood Gun Bias, Collimation 1, and Collimation 2 adjustments. Re-adjust R954, R957, and R984 for no dark corners and uniform edges over entire screen.

k. Connect a bnc 50 Ω cable to the sine-wave generator, terminate cable with a 50 Ω termination, and connect the termination to the CH 1 input. (See Fig. 4-3.)

l. Set: MODE — AUTO
INTENSITY — for visible display
STORE — nonstore (button out)

m. Set the generator for a 4-division, 2 kHz display and rotate POSITION to center the display on the graticule. Set CH 1 VOLTS/DIV, VAR, and add or remove attenuators as necessary to obtain a 4-division display (insert attenuators between cable and termination).

n. Set: MODE — SINGLE SWP
STORE — Button in

o. CHECK—For a stored waveform over the center eight divisions, with no breaks and good contrast (press and release ERASE button, then press MODE to RESET and release to SINGLE SWP).

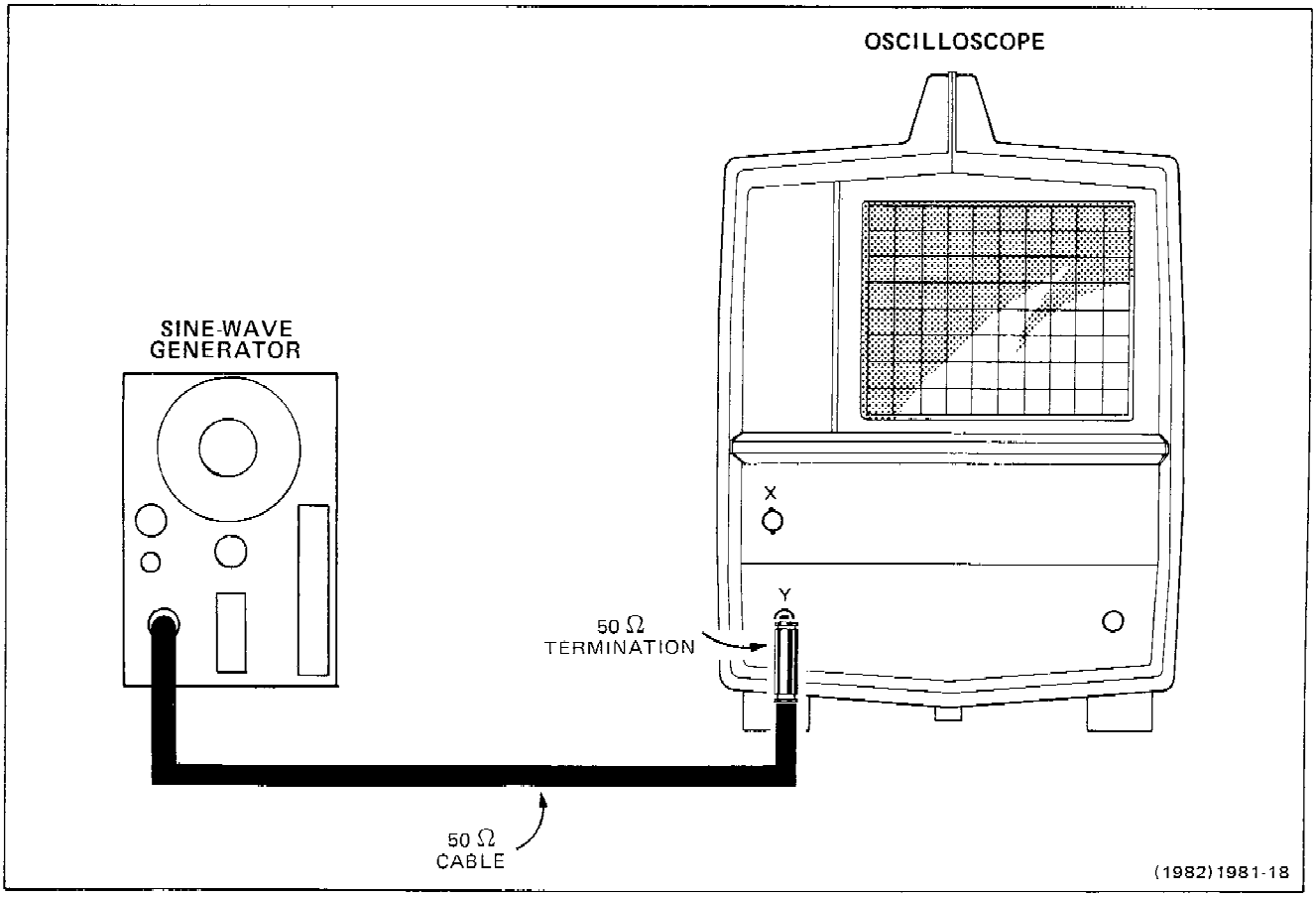


Fig. 4-3. Storage adjustment setup.

p. ADJUST—R934 (see Fig. 4-2), Storage Level, as necessary, for no breaks and maximum contrast over center eight divisions, while storing and erasing single sweeps.

q. Disconnect test equipment.

5B. STORAGE (SN B010300-up)

a. Set:	Vertical Mode	CH 1 (button in)
	CH 1 AC-GND-DC	DC
	CH 1 VOLTS/DIV	.1 V
	SEC/DIV	.5 m
	STORE	Store (button in)
	SOURCE	INT
	MODE	SINGLE SWP
	ENHANCE LEVEL	fully ccw
	INTENSITY	fully ccw

NOTE

Storage adjustments should be made in low ambient lighting conditions or while using a viewing hood.

b. Refer to Fig. 4-2 for location of adjustments in the remainder of this step. If storage circuitry has had major repairs or if misadjustment of controls is suspected, preset R984, R934, R957, and R954 (also R930 for SN B011467-up) to mid-range; otherwise, leave them as previously set and proceed with part c.

c. ADJUST—R984, Flood Gun Bias: press and hold ERASE button in; adjust R984 until graticule display area is flooded and corner shadows just disappear. Release ERASE button.

d. Set voltmeter to 200 V range, and connect negative lead to ground at pin 1 of P470 on Interface board (this is a two-pin plug, marked P9 on some boards). Connect positive lead to anode of CR945 on Storage board.

e. ADJUST—R934, Store Level, fully ccw, then advance it cw until screen abruptly begins to illuminate. Record the meter reading for this point to refer to in part g.

f. Advance R934 setting further cw until screen is abruptly brightly flooded and one or more edges of the brightly flooded portion begin to pull inward; back off the R934 setting slightly ccw to a point just before the brightly flooded edges begin to pull inward. Record the voltmeter reading obtained with this setting of R934.

g. Add the meter readings obtained in parts e and f; divide the sum by 2 and reset R934 for a meter reading equal to this result.

h. ADJUST—R957, Collimation 1: press and hold ERASE in, while adjusting R957 fully ccw— then cw until the brightly flooded area most completely fills the graticule confines.

i. ADJUST—R954, Collimation 2: continue to hold ERASE in, while adjusting R954 fully ccw, then slightly cw for the most uniform, brightly-flooded area that most completely fills the graticule confines.

j. INTERACTION—R984, R934, R957, and R954. Repeat parts c through i to achieve a display in part i with most uniform flooding of graticule area (uniform brightness, no dark corners and uniform edges). Disconnect volt-meter leads from oscilloscope.

k. Connect a bnc 50 Ω cable to the sine-wave generator and terminate the cable with a bnc 50 Ω termination attached to the CH 1 input (see Fig. 4-3).

l. Set:	MODE	AUTO
	STORE	Button out
	INTENSITY	For visible display
	FOCUS	For well-focused trace

m. Set generator for a 4-division, 2 kHz display (add attenuators, and set VOLTS/DIV or VAR VOLTS/DIV as necessary for a 4 division display.

n. Set:	MODE	SINGLE SWP
	STORE	Button in

o. Press ERASE, then release. press MODE to RESET, then release to SINGLE SWP; repeat this sequence and readjust R934 if necessary, while checking for a stored waveform with minimum or no breaks, good contrast, and minimum background illumination (fade-up), for a period of 1 minute.

p. Repeat part l. Set generator for a 20 kHz, 4-division display (SEC/DIV to 50 μ). Repeat part n, then perform part o while adjusting ENHANCE LEVEL cw to obtain an

optimum Enhanced display (wait at least 10 seconds after pressing ERASE button before moving MODE to RESET and letting it return to SINGLE SWP).

q. If satisfactory enhanced storage is still not achieved, increase or decrease INTENSITY and ENHANCE LEVEL settings by small increments and repeat the ERASE/10 second wait/RESET/SINGLE SWP sequence until the waveform can be stored with minimum breaks or fade-up and with good contrast for at least 1 minute. For SN B011467-up, if the desired results are not achieved, also adjust Enhance Pulse Height control R930 for optimum enhanced storage. If ENHANCED LEVEL control operation is too sensitive, and causes sudden blooming at some point as its setting is advanced, decrease the R930 setting (counterclockwise). If storage background fades with the trace and recharges, Enhance Level control R930 setting should be advanced clockwise. Correct adjustment of R930 should result in good enhanced storage without either of the aforementioned extreme conditions. For SN B010300-up, if optimum enhanced storage still cannot be obtained, carefully repeat all of Step 5B, especially the setting of R934.

r. Disconnect test equipment.

B. VERTICAL AMPLIFIER

Equipment Required

1. Digital Voltmeter
2. Amplitude Calibrator
3. Square-Wave Generator
4. 50 Ω BNC Termination
5. 50 Ω BNC Cable
6. Low Capacitance Alignment Tool
7. Screwdriver
8. 10X Probe
9. 10X Attenuator
10. Probe-tip-to-BNC Adapter

Preliminary Control Settings

Set:	ENHANCE LEVEL	fully ccw
	INTENSITY	midrange (for visible trace)
	STORE	nonstore (button out)
	FOCUS	midrange
	Vertical Mode	CH 1
	VOLTS/DIV (both)	2 mV (1X)[1]
	AC-GND-DC (both)	GND
	VAR (both)	detent (cw)
	SEC/DIV	.5 ms
	X1-X10	X1 (fully ccw detent)
	SOURCE	INT
	MODE	AUTO
	SLOPE	+OUT
	LEVEL	midrange
	POSITION (all)	midrange

Set all other controls as desired.

The oscilloscope should produce a baseline trace with the controls set as above. Adjust INTENSITY and FOCUS controls as needed to maintain a well-defined display while making adjustments.

1. Vertical Preamplifier Balance

a. ADJUST—CH 1 DC BAL, R4132 (see Fig. 4-4), for no trace shift while switching CH 1 VOLTS/DIV control between 2 mV and 10 mV.

b. SET: Vertical Mode to CH 2.

c. ADJUST—CH 2 DC BAL, R4232 (see Fig. 4-4), for no trace shift while switching CH 2 VOLTS/DIV control between 2 mV and 10 mV.

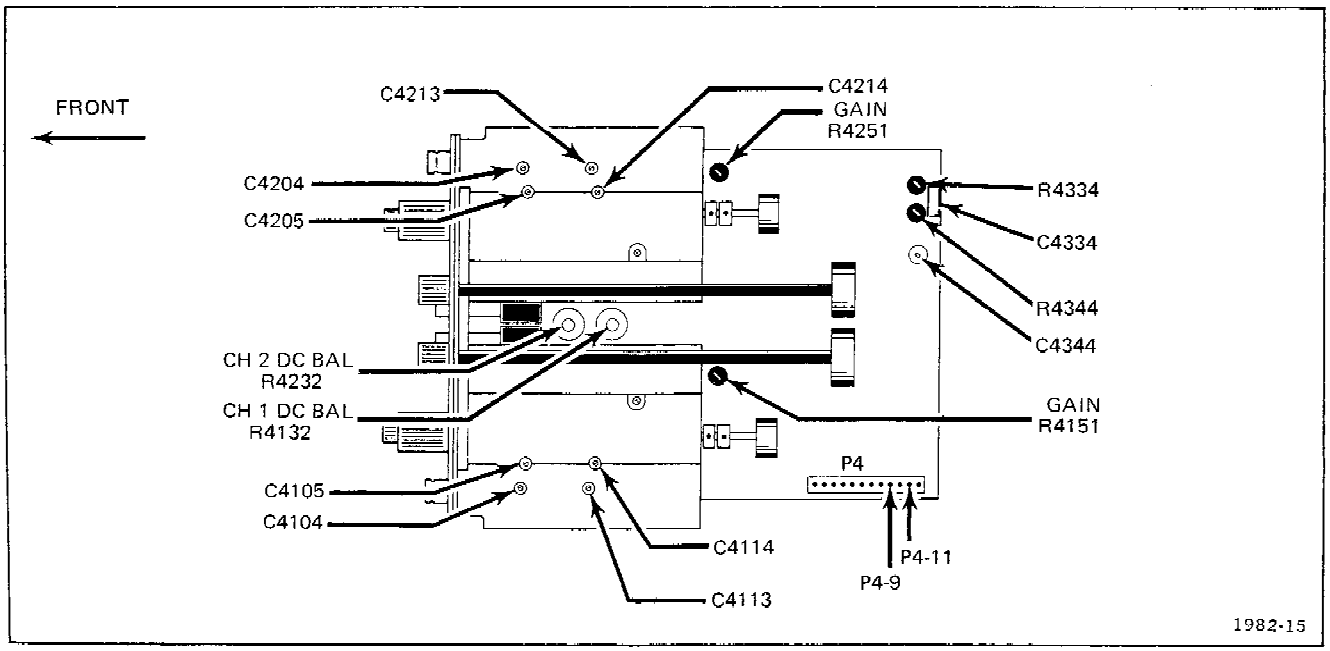


Fig. 4-4. Vertical amplifier adjustment locations (bottom view of T912).

2. Vertical Output Amplifier Gain

NOTE

You should not have to re-adjust the vertical output gain unless you have replaced the crt or other components, or adjustments have accidentally been altered.

a. Set VOLTS/DIV (both) to 5 mV/div and Vertical Mode to CH 1.

b. Set Gain, R126 (see Fig. 4-2), to physical midrange.

c. Connect digital voltmeter between P4-9 and P4-11 (see Fig. 4-4). Select range on meter for at least 500 mV reading.

d. Set vertical POSITION control so trace is aligned with center horizontal graticule line. Note meter reading.

e. Rotate vertical POSITION control until meter reading has changed 150 mV positive from reading in part d (trace moved toward top of screen).

f. Adjust Gain, R126 (see Fig. 4-2), so trace aligns with third graticule line above center horizontal graticule line.

g. Disconnect ditigal voltmeter.

3. Vertical Preamplifier Gain

a. Set:	VOLTS/DIV (both)	5 mV
	AC-GND-DC (both)	DC
	Vertical Mode	CH 1

b. Connect a 1 kHz, 20 mV amplitude calibrator (standard output) signal to CH 1 input via a 50 Ω unterminated cable. Set CH 1 POSITION to center the display vertically.

c. ADJUST—Gain, R4151 (see Fig. 4-4), for 4-division display.

d. Move 20 mV amplitude calibrator signal to CH 2 input and set Vertical Mode to CH 2. Set CH 2 POSITION to center the display vertically.

e. ADJUST—Gain, R4251 (see Fig. 4-4), for 4-division display.

f. INTERACTION—If you cannot adjust CH 1 and CH 2 Preamplifier Gain for 4-division display, repeat steps 2 and 3.

g. Disconnect test equipment.

NOTE

For convenience in the following steps, set the TIME BASE to 1 ms (SEC/DIV to 1 ms and X1-X10 to X1) while adjusting the generator for a 5-division display. Then set TIME BASE to 50 μ (SEC/DIV to .5 μ and X1-X10 to X10) when observing or adjusting leading edge detail.

4. High-Frequency Compensation

a. Set:	Vertical Mode	CH 1
	CH 1 AC-GND-DC	DC
	CH 2 AC-GND-DC	GND
	POSITION (all)	To center display

b. Connect square-wave generator (fast-rise, + transition) to CH 1 input connector via 50 Ω cable, 10X attenuator, and 50 Ω termination (see Fig. 4-5).

c. Set square-wave generator for 100 kHz, fast rise, and amplitude for 5-division display. Set SEC/DIV to .5 μs, and INTENSITY as necessary to view the display.

d. Set POSITION and LEVEL controls to position the leading edge of the signal on screen.

e. ADJUST—R4334, C4334, R4344, C4344 (see Fig. 4-4), and C133 (see Fig. 4-2), for best front corner of waveform using low capacitance screwdriver.

5. CH 1 Attenuator Compensation

a. Set:	CH 1 VOLTS/DIV	20 mV
	CH 1 AC-GND-DC	DC
	Vertical Mode	CH 1
	SEC/DIV	1 ms
	X1-X10	X10 (fully ccw)
	POSITION (all)	As required

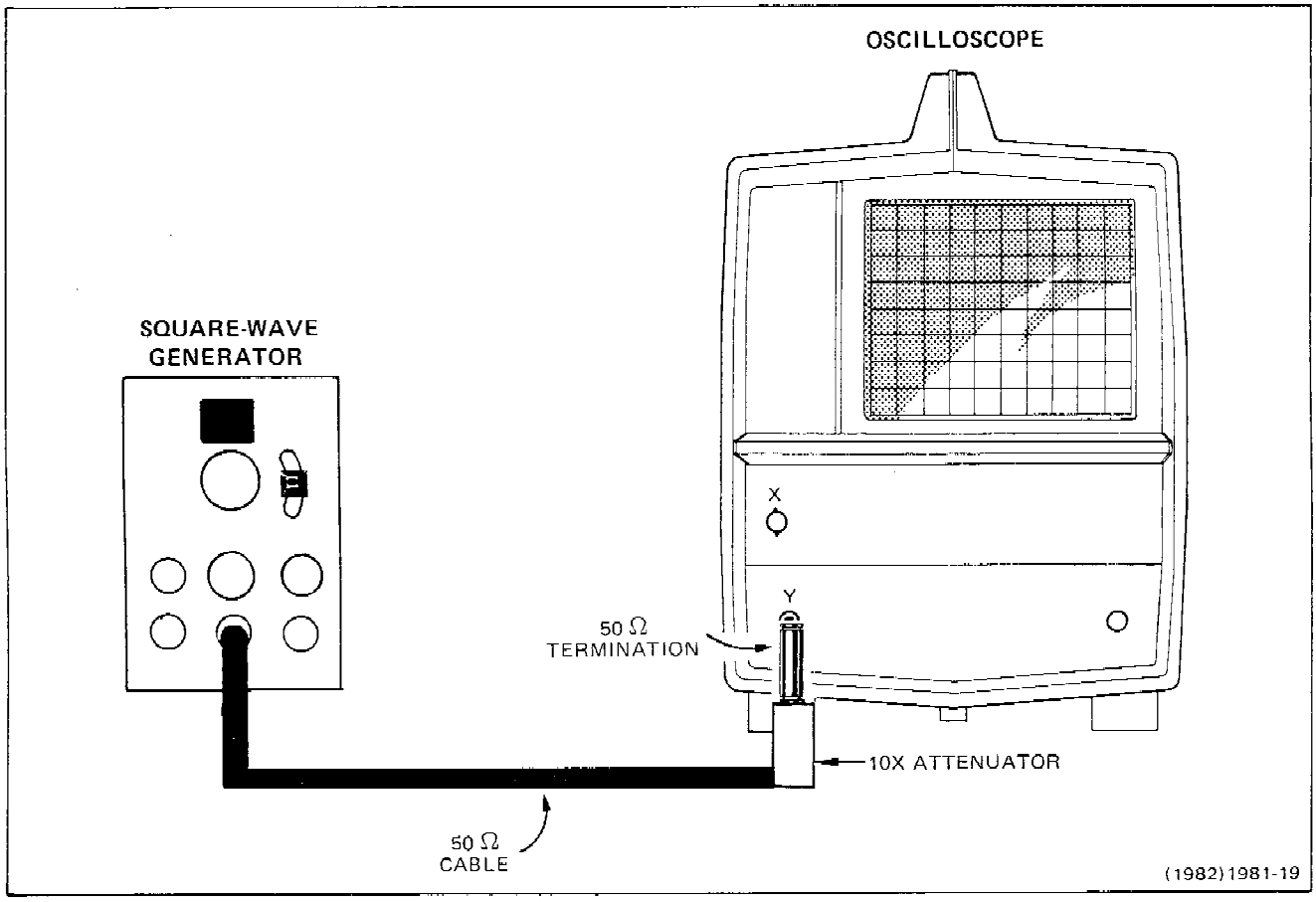


Fig. 4-5. High frequency compensation adjustment setup.

b. Move 50 Ω cable from the fast-rise output to the high-amplitude output of the square-wave generator. Set generator to 1 kHz and adjust for a 5-division display.

c. ADJUST—C4114 (see Fig. 4-4) for best square front corner (see Fig. 4-6 for example).

d. Remove 10X attenuator and set CH 1 VOLTS/DIV to .2 V. Set generator output for a 5-division display.

e. ADJUST—C4105 (see Fig. 4-4) for best square front corner (see Fig. 4-6 for example). Disconnect test equipment.

f. Set CH 1 VOLTS/DIV to 10 mV and X1-X10 to X1 (fully ccw).

g. Connect a 10X probe to the CH 1 input. Connect the probe tip to a probe tip-to-bnc adapter, the adapter to a 50 Ω bnc termination, and the termination to a 50 Ω bnc 10X attenuator attached to the square-wave generator high-amplitude output connector. Set generator for a 5-division, 1 kHz display.

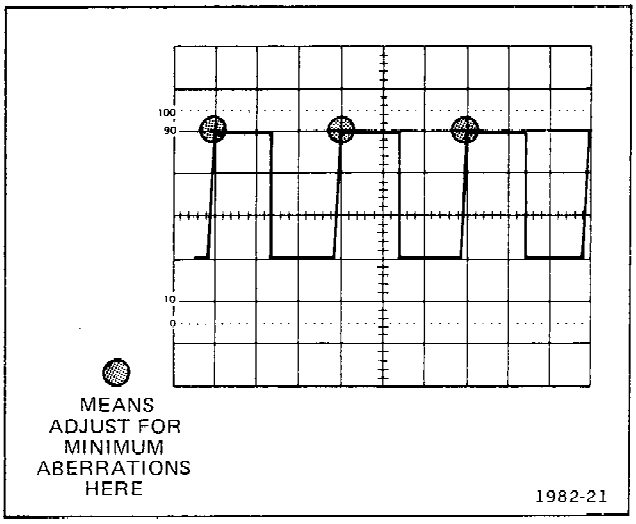


Fig. 4-6. Display of correct (idealized) attenuator compensation.

h. Compensate probe for best front corner of waveform.

i. Set CH 1 VOLTS/DIV to 20 mV and set generator for a 5-division display (remove 10X attenuator if necessary).

j. ADJUST—C4113 for flat top on square wave.

k. Set CH 1 VOLTS/DIV to .2 V, and square-wave generator output for a 5-division display (remove 10X attenuator, and also 50 Ω termination if necessary).

l. ADJUST—C4104 for a flat top on square wave.

m. Disconnect test equipment.

6. CH 2 Attenuator Compensation

a. Set:

CH 2 VOLTS/DIV	20 mV
CH 2 AC-GND-DC	DC
Vertical Mode	CH 2
SEC/DIV	1 ms
X1-X10	X10 (fully cw)
POSITION (all)	As required

b. Connect a 50 Ω cable from the high-amplitude output of the square-wave generator, through a 10X attenuator, and a 50 Ω termination to the CH 2 input connector. Set generator to 1 kHz and adjust for 5-division display.

c. ADJUST—C4214 (see Fig. 4-4) for best square front corner (see Fig. 4-6 for example).

d. Remove 10X attenuator and set CH 2 VOLTS/DIV to .2 V. Set generator output for a 5-division display.

e. ADJUST—C4205 (see Fig. 4-4) for best square front corner (see Fig. 4-6 for example). Disconnect test equipment.

f. Set CH 2 VOLTS/DIV to 10 mV and X1-X10 to X1 (fully ccw).

g. Connect a 10X probe to the CH 2 input. Connect the probe tip to a probe tip-to-bnc adapter, the adapter to a 50 Ω bnc termination, and the termination to a 50 Ω bnc 10X attenuator attached to the square-wave generator high-amplitude output connector. Set generator for a 5-division, 1 kHz display.

h. Compensate probe for best front corner of waveform.

i. Set CH 2 VOLTS/DIV to 20 mV and set generator for a 5-division display (remove 10X attenuator if necessary).

j. ADJUST—C4213 for flat top on square wave.

k. Set CH 2 VOLTS/DIV to .2 V, and square-wave generator output for a 5-division display (remove 10X attenuator, and also 50 Ω termination if necessary).

l. ADJUST—C4204 for a flat top on square wave.

m. Disconnect test equipment.

C. TIME BASE

Equipment Required

1. Time-Mark Generator
2. 50 Ω Termination
3. 50 Ω BNC Cable
4. Low-Capacitance Alignment Tool

Preliminary Control Settings

Set:	ENHANCE LEVEL	fully ccw
	INTENSITY	midrange
	STORE	nonstore (button out)
	FOCUS	midrange
	Vertical Mode	CH 1
	CH 1 VOLTS/DIV	.5 V (or as required)
	CH 1 VAR	detent
	CH 1 AC-GND-DC	DC
	CH 2 AC-GND-DC	GND
	SEC/DIV	.5 ms
	X1-X10	X1 (fully ccw)
	SOURCE	INT
	MODE	AUTO
	SLOPE	+OUT
	LEVEL	midrange
	POSITION (all)	midrange

Set all other controls as desired.

The oscilloscope should produce a baseline trace with the controls set as above. Adjust INTENSITY and FOCUS controls as needed to maintain a well-defined display while making adjustments.

1. Horizontal Calibration

a. Connect a 50 Ω cable from the time-mark generator to a 50 Ω termination at the CH 1 input. Set generator for .5 ms markers. (2KHz)

b. ADJUST—Horiz Cal R2332 (see Fig. 4-7) and set POSITION controls for 1 time marker per division over center eight divisions.

2. Sweep Timing

a. Set SEC/DIV to .5 μs and time-mark generator for .5 μs markers.

b. ADJUST—C2235 (see Fig. 4-7) and horizontal POSITION control for 1 marker per division over center eight divisions.

c. Disconnect the test setup.

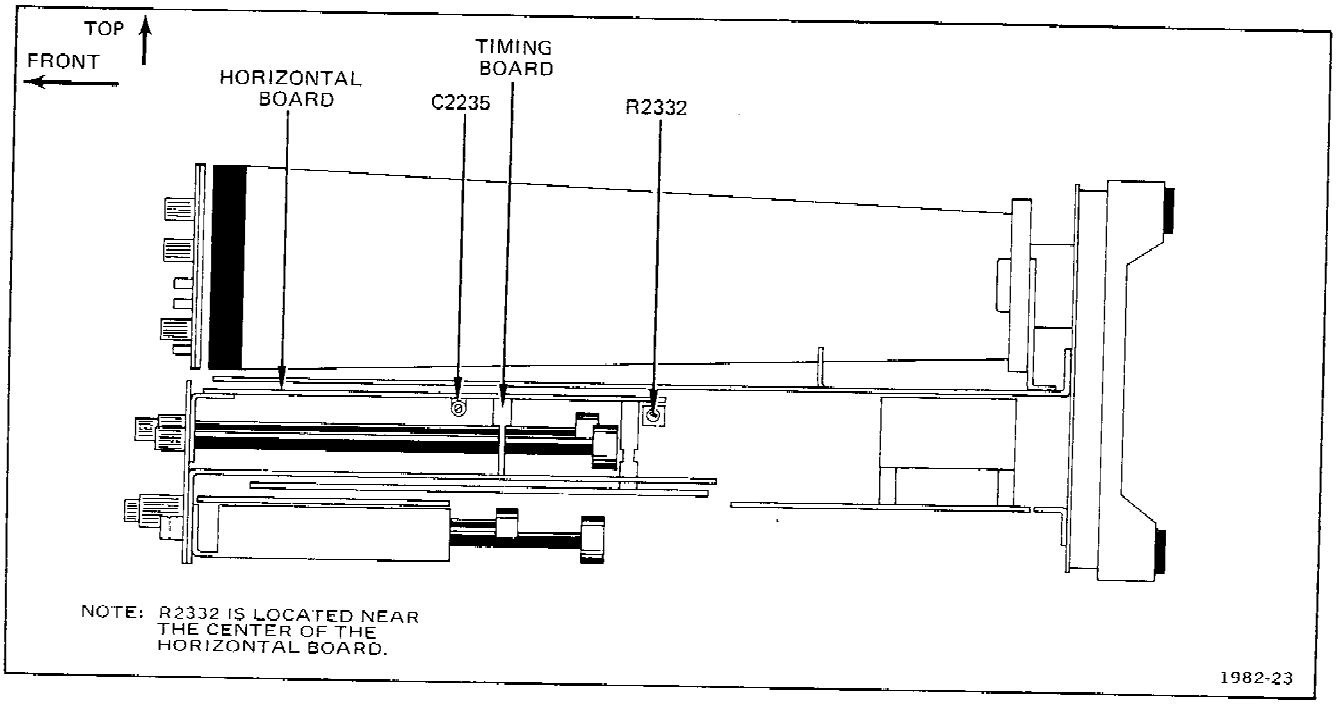


Fig. 4-7. Time base adjustment locations.

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SERVICE INFORMATION

The following information is provided to help you keep your T912 in good operating condition. We recommend that servicing be done by qualified service personnel only. You can, if you like, send your instrument to a Tektronix Service Center for re-adjustment and repair. Contact your local Tektronix representative for information about the Service Centers in your area.

CABINET REMOVAL

WARNING

Dangerous potentials exist at several points throughout the T912. When operating the instrument with the covers off, avoid touching connections and components. Some transistors have elevated cases. Disconnect the power before cleaning the instrument or replacing parts.

To remove the cover, take out the six screws (top and bottom) holding the two halves together. Pull the two halves apart.

To replace the cover, line up the slots on the cover with the front panel and the rear subpanel and slide together. Replace screws.

OPERATING VOLTAGE SELECTION

Your instrument will operate from either a 120 V or 240 V ac 50 to 60 Hz nominal power input source. Check that the Power Input Voltage Selector (120 V/240 V) switch and the Regulating Range Selector (HI/LO) switch are set to positions that include the value of the applied power input voltage. In the United States, the 120 V/240 V switch is normally set for 120 V and the HI/LO switch is normally set for HI at the factory. In Europe, the 120 V/240 V switch is set for 240 V and the HI/LO switch is normally set for LO. The POWER indicator lamp will blink when the applied power input voltage varies more than about 10% (either high or low) from the value for which the switches are set.

CAUTION

Your instrument may be damaged if it is operated from a 240 V power input voltage source with the 120 V/240 V switch set for 120 V. The 120 V/240 V switch and the HI/LO switch are both visible from the bottom of the instrument in all T900-series bench version oscilloscopes, but the 120 V/240 V switch is not adjustable from outside of the cabinet. Refer 120 V/240 V power input voltage selection to qualified service personnel.

The 120 V/240 V switch S701 is accessible in all T900-series instruments when the cabinet is removed. If S701 setting needs to be changed, the value of the line fuse F700 must also be changed. See Fuse Replacement in Corrective Maintenance portion of Service Information section of this manual.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of cleaning the instrument regularly and inspecting it occasionally for broken or damaged parts. Regular maintenance will improve the reliability of your instrument and prevent breakdowns.

Cleaning

Accumulations of dirt and dust on components act as an insulating blanket preventing efficient heat dissipation. Dust on circuit boards and wires can cause arcing and short circuits, resulting in damage to components or even instrument failure. Your instrument should be cleaned before this happens!

The cabinet provides protection from dust and dirt and should be in place during normal operation of the instrument.

CAUTION

Avoid the use of chemical cleaning agents containing benzene, toluene, xylene, acetone or similar solvents. These chemicals may damage the plastics used in this instrument. Recommended cleaning agents are isopropyl alcohol or Kelite (1 part Kelite, 20 parts water).

Exterior. Dust the cabinet with a soft cloth. Dust the front panel controls with a small soft paint brush. Dirt clinging to the surface of the cabinet may be removed with a soft cloth dampened with a mild detergent and water solution. Avoid using abrasive cleaners. They will scratch the cabinet and front panel.

Interior. Dust in the interior of the instruments should be removed before it builds up enough to cause arcing and short circuits during periods of high humidity. Dust is best removed from the interior by dry (approximately 9 lb/in.^{2}), low-pressure air. Dirt clinging to surfaces may be removed with a soft paint brush or cloth dampened with a mild detergent and water solution. Use a cotton-tipped applicator for cleaning in narrow spaces and on the circuit boards.

Switch Contacts

CAUTION

Do not use acetone, MEK, MIBK, benzene, toluene, carbon tetrachloride, trichloroethylene, methyl alcohol, methylene chloride, sulphuric acid, or Freon TC, TE, TF, TA, 12, 22, to clean the switch contacts. Check the contents of spray coolants and cleaners before using.

Most of the switches are cam-actuated assemblies which do not require frequent maintenance. When maintenance is necessary due to accumulated dirt and dust on the contacts, observe the following precautions: Clean the switch contacts with isopropyl alcohol or a solution of one part Kelite to 20 parts water. If these are not available, petroleum ether, white kerosene, or a solution of 1% Joy detergent and 99% water may be used.

Recommended circuit coolants are dry ice and isopropyl alcohol.

The cam switch contacts are designed to operate without lubrication. They do require cleaning periodically to remove accumulations of dust and dirt. The use of lubricants, or cleaners that leave a residue, increase dust attraction and should be avoided.

Visual Inspection

Inspect the interior occasionally for broken connections, improperly seated semiconductors, damaged or improperly installed circuit boards, heat damaged components, etc. If heat damaged components are found, care must be taken to find the cause of the excessive heat and measures must be taken to prevent recurrence of the damage.

Lubrication

Most of the potentiometers are permanently sealed. Both the cam- and lever-type switches are installed with proper lubrication where necessary. Therefore, periodic lubrication is not recommended and only rarely should lubrication even be necessary.

Semiconductor Checks

Periodic checks of the semiconductor devices in this instrument are not recommended. The best check of semiconductor performance is actual operation in the instrument.

Re-adjustment

Re-adjust the instrument whenever the Performance Check indicates the instrument is not meeting specifications. The Performance Check should be performed on a regular basis; for example, every 1000 hours of operation or every six months.

TROUBLESHOOTING

If you perform preventive maintenance on a regular basis, you should correct most problems before your instrument breaks down. Occasionally, you may have to troubleshoot. In addition to the following information, you may find information in the Circuit Description and Diagrams section useful.

Troubleshooting Aids

Troubleshooting Chart. Use the troubleshooting chart (Fig. 5-1) to locate problem areas.

Diagrams. Complete circuit diagrams are located on the foldout pages in the Circuit Description and Diagrams section. The component number and electrical value of each component in the instrument are shown on the diagrams (see the first page of the Diagrams section for the definitions of the reference designators used to identify components). Each main circuit is assigned a series of component numbers to assist in identifying their circuit location. Important voltages and waveforms are also shown on the diagrams. Also a heavy line encloses the portion of the circuit mounted on a circuit board.

Color Codes. The resistors used in this instrument are either brown composition or precision metal-film resistors. The resistors are color-coded with the EIA color-code. (Some metal-film resistors may have the value printed on the body.) Refer to Fig. 5-2. For the values of the thick film resistors, refer to the parts list.

The capacitance values of common disc and some small electrolytic capacitors are marked on the side of the component body. The white ceramic capacitors are color-coded, using a modified EIA code. (See Fig. 5-2.)

The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes, or a dot.

Power Cord Conductor Identification

Conductor	Color	Alternate Color
Ungrounded (Line)	Brown	Black
Grounded (Neutral)	Blue	White
Grounding (Earthing)	Green-Yellow	Green-Yellow

Semiconductor Lead Configuration. Figure 5-3 shows the lead configuration of the semiconductor devices used in this instrument.

Multi-connector Holders. The multi-connector holder is keyed with two triangles, one on the holder and one on the circuit board. When a connection is made perpendicular to a circuit board surface, the orientation of the triangle and the slot numbers on the connector holder are determined by the direction of the nomenclature marking (see Fig. 5-4).

Table 5-1

POWER SUPPLY TOLERANCE

Supply	Tolerance
−8 V	Set within 0.5%
+8 V	Within 3%
+120 V	Within 5%
12.6 V elevated	Within 5% (12.6 V supply is elevated to −120 V)
−120 V	Within 10%
−220 V	Within 5%
+350 V	Unregulated

Troubleshooting Equipment

The following equipment is useful for troubleshooting.

1. Semiconductor Tester

Description: Dynamic-type tester. Must be capable of measuring reverse breakdown voltages of at least 400 V.

Purpose: To test semiconductors.

Example: TEKTRONIX Type 576 Curve Tracer or TEKTRONIX 577 (D1 or D2) Curve Tracer with 177 Test Fixture.

2. Test Oscilloscope

Description: Frequency response, dc to at least 15 MHz. A 10X, 10 MΩ voltage probe should be used to reduce circuit loading for voltage measurements.

Purpose: To check operating waveforms.

3. Multimeter

Description: Non-loading digital multimeter. Voltmeter, 10 MΩ input impedance and 0 to 150 V range; dc voltage accuracy, within 0.15%; display, 4 1/2 digits. Ohmmeter, 0 to 20 MΩ.

Purpose: To check voltages and for general troubleshooting.

4. Variable Autotransformer

Description: Output variable from 0 to 140 V, 1.2 A minimum rating. Must have a three-wire power cord, plug and receptacle.

Purpose: To vary the input line voltage when troubleshooting in the power supply.

Example: General Radio W8MT3VM or W10MT3W Metered Variac Autotransformer.

5. Vertical Amplifier Extender Troubleshooting Fixture

Description: 18 inch ribbon cable with an interface connector at each end (Tektronix part 067-0773-00).

Purpose: To operate the vertical amplifier outside the instrument. Useful for troubleshooting the time base which is inaccessible with the vertical amplifier installed.

Troubleshooting Techniques

The following checklist is arranged so that you check the simple things before you get the instrument taken apart. Start at the beginning.

1. Check the Control Settings. See the Operating Instructions for the correct control settings.

2. Check Associated Equipment and Connectors. Check to see that the signal source is properly connected and that the interconnecting cables are not defective. Also check the power cord and plug and the power source for defects.

3. Check the Performance of the Instrument. If the instrument does not meet specifications, the trouble may be corrected by readjusting the instrument. See the Adjustment Procedure, Section 4, for instructions.

4. Visual Check. A visual check may reveal broken connections, damaged components, semiconductors not firmly mounted, damaged circuit boards, etc.

5. Isolate the Trouble to a Circuit. To isolate trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit where the trouble is located. For example, poor focus indicates that the crt circuit (including the high-voltage supply) is probably at fault. When trouble symptoms appear in more than one circuit, check affected circuits by taking voltage and waveform readings.

Incorrect operation of all circuits often indicates trouble in the power supply. Check first for correct voltage of the individual supplies. However, a defective component elsewhere in the instrument can appear as a power supply trouble and may also affect the operation of other circuits. Table 5-1 lists the tolerances of the power supplies. Voltages are measured between the power supply test points and ground. If a power supply voltage is within the listed tolerance, assume the supply is working correctly.

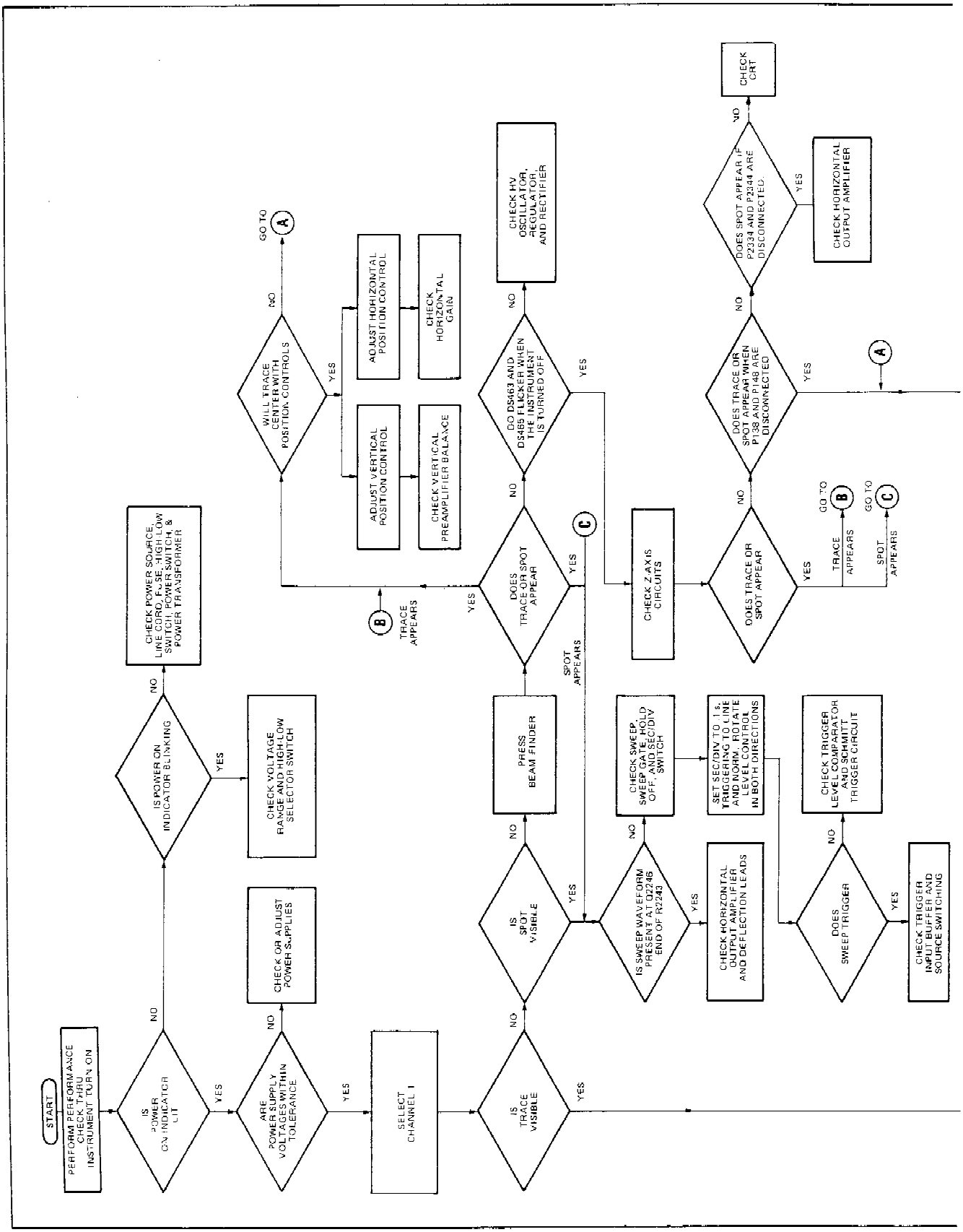


Fig. 5-1. Troubleshooting chart.

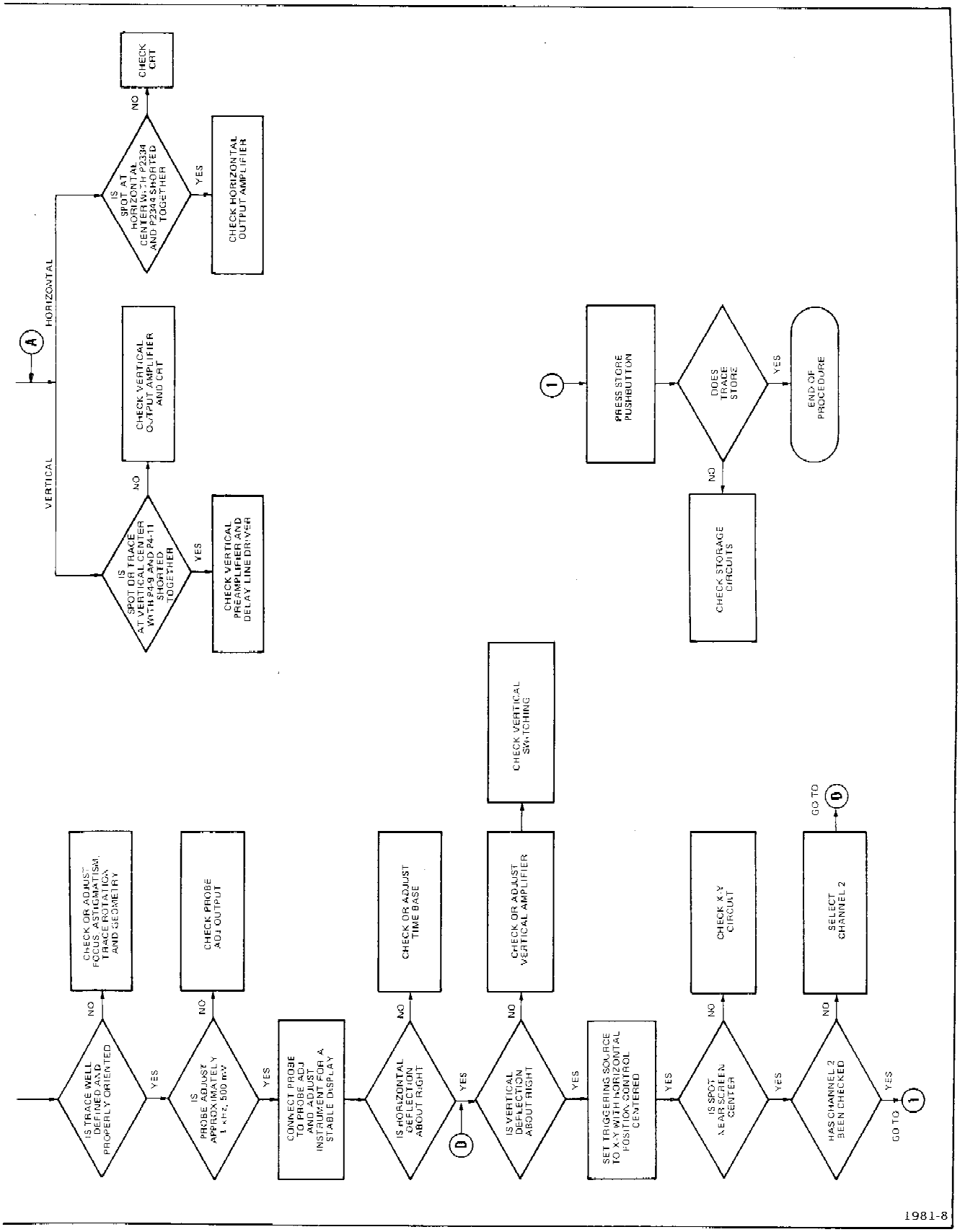
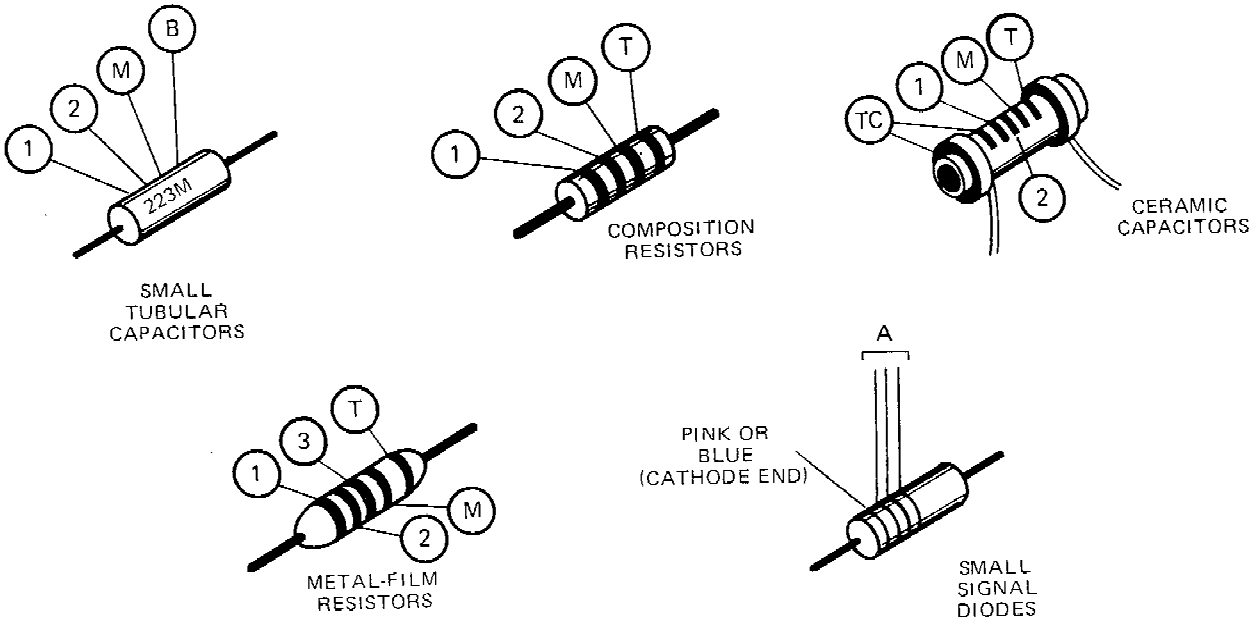


Fig. 5-1. Troubleshooting chart (cont).



(A) COLORS IDENTIFY SIGNIFICANT DIGITS IN TEKTRONIX PART NUMBER (E.G. BROWN, GRAY, GREEN STRIPES INDICATE PART NUMBER 152-0185-00)

(1) (2) and (3) 1ST, 2ND, AND 3RD SIGNIFICANT FIGS.

(M) MULTIPLIER (T) TOLERANCE;

(TC) TEMPERATURE COEFFICIENT.

(B) TOLERANCE; F=±1%, J=5%, K=10%, M=20%

(T) AND/OR (TC) COLOR CODE MAY NOT BE PRESENT ON SOME CAPACITORS;

COLOR	SIGNIFICANT FIGURES	RESISTORS (Ω)		CAPACITORS (pF)		
		MULTIPLIER	TOLERANCE	MULTIPLIER	TOLERANCE	
					over 10 pF	under 10 pF
BLACK	0	1	---	1	±20%	±2 pF
BROWN	1	10	±1%	10	±1%	±0.1 pF
RED	2	10^2 or 100	±2%	10^2 or 100	±2%	---
ORANGE	3	10^3 or 1 K	±3%	10^3 or 1000	+3%	---
YELLOW	4	10^4 or 10 K	±4%	10^4 or 10,000	+100% −9%	---
GREEN	5	10^5 or 100 K	±½%	10^5 or 100,000	±5%	±0.5 pF
BLUE	6	10^6 or 1 M	±¼%	10^6 or 1,000,000	---	---
VIOLET	7	---	±1/10%	---	---	---
GRAY	8	---	---	10^{-2} or 0.01	+80% −20%	+0.25 pF
WHITE	9	---	---	10^{-1} or 0.1	±10%	±1 pF
GOLD	–	10^{-1} or 0.1	±5%	---	---	---
SILVER	–	10^{-2} or 0.01	±10%	---	---	---
NONE	–	---	±20%	---	±10%	±1 pF

1982-31

Fig. 5-2. Color code for resistors and capacitors.

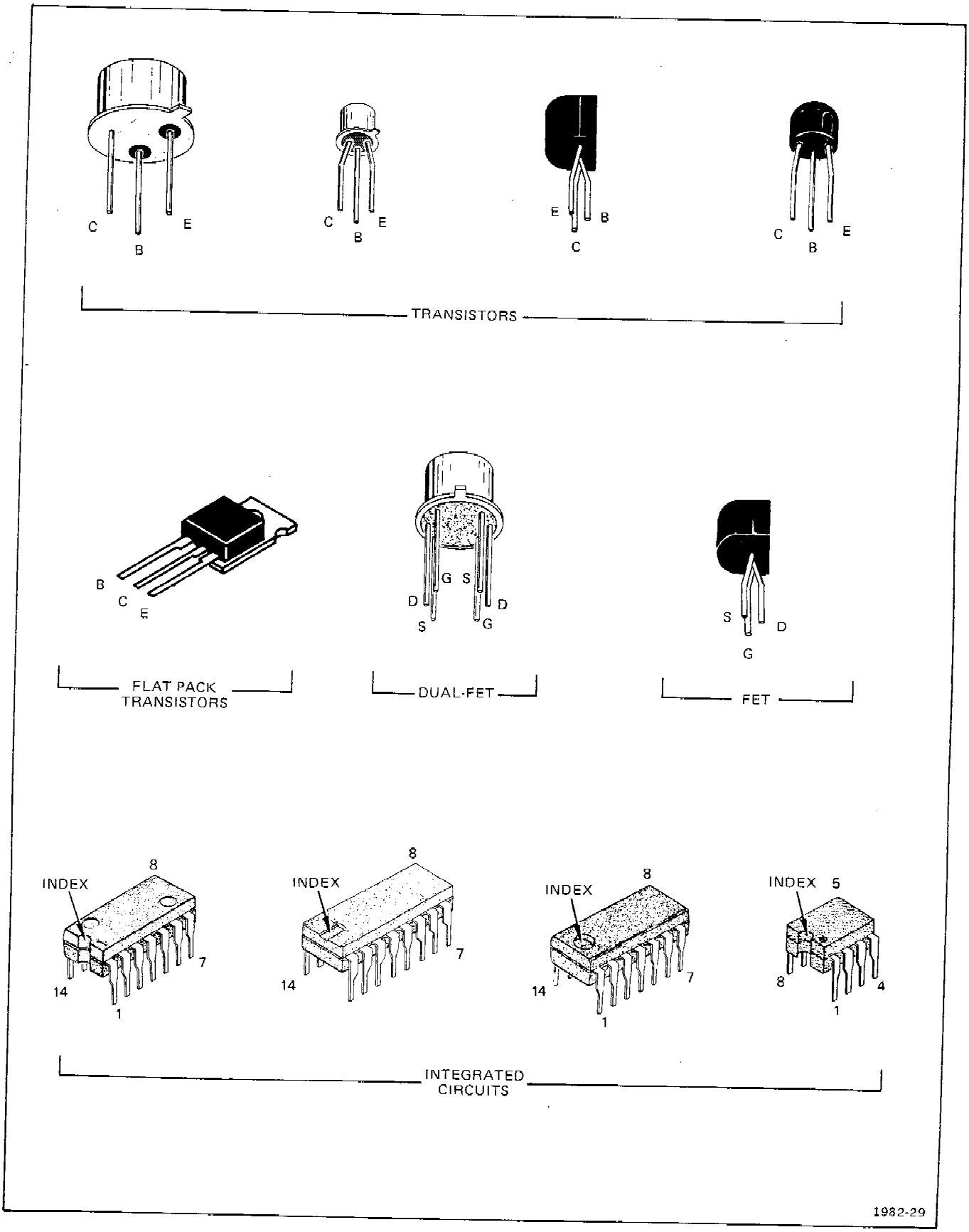


Fig. 5-3. Lead configuration for semiconductor devices.

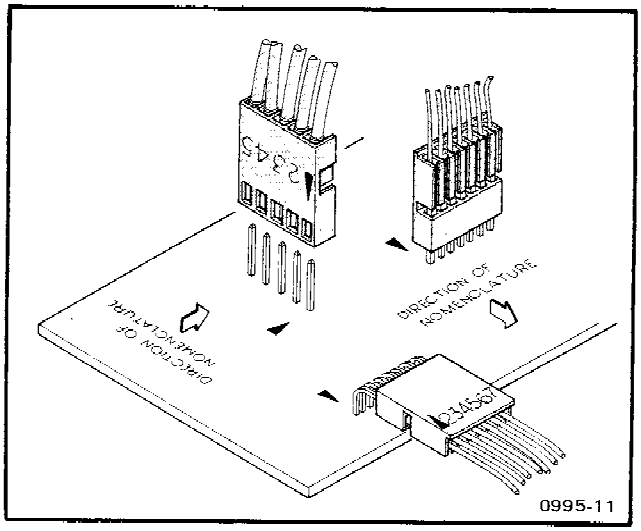


Fig. 5-4. Multi-connector holder orientation.

Use the troubleshooting chart to locate trouble. Not all problems appear on the chart. Continue with this checklist in those cases.

6. Check Voltages and Waveforms. Often a defective component can be located by checking for the correct voltages and waveforms in a circuit.

NOTE

Voltages and waveforms given on the diagrams are not absolute and therefore may vary slightly between instruments. To obtain operating conditions similar to those used to take these readings, see the voltage and waveform setup procedures in the Diagrams section. Individual deviations should be noted on the schematics for future reference.

7. Check the individual components. Remember that the best check of semiconductors—transistors, diodes, IC's—and thick film resistors is actual operation in a circuit. If you suspect that a semiconductor is bad, substitute a new one for it. Before you start checking IC's, read the part of the Circuit Description that covers the circuit.

WARNING

The power switch must be turned off before removing or replacing components to prevent electrical shock or circuit damage.

To check other components, resistors, capacitors, and inductors, clip one lead and lift it. You may have to add a piece of wire when you resolder the connection, however.

Resistors: Check the resistors for discoloration. Then check the resistors with an ohmmeter after disconnecting one end from the circuit. Check the Replaceable Electrical Parts list for the tolerance of the resistors used in this instrument. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

Inductors: Check for open inductors by checking continuity with an ohmmeter. (It may be helpful to disconnect one end of the inductor when checking continuity.) Shorted or partially shorted inductors can also be found by checking the waveform response when high-frequency signals are passed through the circuit. Partial shorting often reduces high-frequency response (increases roll-off).

Capacitors: A leaky or shorted capacitor can be detected by checking resistance with an ohmmeter, on the highest scale, after disconnecting one end from the circuit. Do not exceed the voltage rating of the capacitor (some ohmmeters use 30 volts as source voltage). The resistance reading should be high after initial charge of the capacitor. An open capacitor can also be detected with a capacitance meter or by checking whether the capacitor passes ac signals.

Switches: The most common cause of switch failure is dust between the contact and the pad. Check the suspected contact for continuity with an ohmmeter. If open and not obviously damaged, try cleaning (see Cam Switch Repair and Replacement).

Another frequent cause of switch failure is solder smoke residue. This can occur when replacing a component near the switch. This problem is usually indicated by reduced high-frequency response. Flushing the contact with isopropyl alcohol usually fixes this problem.

If the contact is physically damaged, replace the contact strip. Bending the contact is only a temporary repair. See Cam Switch Repair and Replacement.

8. After repairing a circuit or replacing components, check the performance of the instrument. If the Performance Check is within specifications, it is not necessary to re-adjust the instrument. If the instrument does not meet the specifications, perform the Adjustment Procedure in Section 4.

Troubleshooting Hints.

Power. SYMPTOM—No visible trace and no display when the BEAM FINDER button is pushed (Power ON lamp is lit).

a. Does beam appear on screen? If not, rotate INTENSITY control clockwise while holding BEAM FINDER button in, until beam appears or control is fully clockwise. If beam does not appear, the trouble may be in the power supplies (see Power Supply schematic).

b. Check all low voltage power supplies, starting with −8 V (−8 V is reference supply), then +8 V, and +120 V at appropriate test points.

(1) If no voltage is present, check F700.

(2) If −8 V is low (or zero), check Q772, Q774, Q776, or U742.

(3) If −8 V is correct but +8 V is low (or zero), check Q752, Q754, Q756, and U742 (U742 is used for both −8 and +8 V supplies).

c. Check high-voltage supplies (see Crt & Vertical Amplifier schematic).

(1) Check for −2.7 kV at pin 1, P465, or pin 2, crt base socket. Use DVM for all voltage checks in this circuit to prevent circuit loading.

(2) If no −2.7 kV, check for 50 kHz sine wave (approximately 200 V, peak-to-peak) at pin 5 of T460 (high-voltage transformer primary).

(3) If neither −2.7 kV or 50 kHz sine wave is present, check Q454, Q458, and Q446.

CAUTION

Do not unload the secondary of the high-voltage transformer, T460; the transformer may be damaged.

Z Axis. SYMPTOM—No intensity or no control over intensity (BEAM FINDER button pushed).

a. Does beam come on screen? If not, and low- and high-voltage supplies are correct, trouble may be in Z-Axis circuit (see Crt & Vertical Amplifier schematic).

(1) Check for approximately 60 V swing between crt-socket pins 2 and 3. If no voltage swing, trouble may be in unblanking.

(2) Check for positive-going pulse at Q416 emitter. This pulse amplitude should vary from 20 to 80 mV with change (fully cw to fully ccw) in INTENSITY control position.

(3) Check for 0-40 V, peak-to-peak unblanking pulse (varies with INTENSITY control position) at Q426 collector.

(4) If no unblanking pulse, check Q426, Q424, Q416, or Q434.

Vertical. SYMPTOM 1. —No trace on crt with BEAM FINDER button pushed, or vertical POSITION control does not center display (see Vert Input, Vert Switching, and Crt & Vertical Amplifier schematics).

a. If trace is on screen, but about 2 cm above graticule center, it indicates trouble in vertical amplifier.

b. Short P4-9 to P4-11 (A8, Vertical board). If trace does not center, trouble is in output circuits. Check Q112, Q116, Q122, Q126, Q132, Q142, Q136, and Q146.

c. If trace centers with pin 9 and 11 short circuited, trouble is ahead of P4.

d. Short circuit Q4322 collector to Q4324 collector. If trace centers, trouble is ahead of delay-line drivers, Q4336-Q4346.

e. Check voltage at Q4302 and Q4303 emitters. Each should read approximately +5 V. If emitter voltage okay, trouble is either in Q4302 or Q4303, or in switching circuit (short circuited CR4314, CR4303, or open CR4304).

SYMPTOM 2.—With 50 mV input and VOLTS/DIV set to 10 mV, crt display position is low and does not position above graticule center.

a. Press BEAM FINDER button. If trace does not appear on screen, rotate Vertical POSITION control.

b. If trace appears, but decreases in amplitude at graticule center, suspect vertical output circuit.

c. Short circuit Q136 collector to Q146 collector. If trace centers, short circuit Q112 collector to Q122 collector. Trace should center. If not, suspect Q112, Q116, Q132, or Q136.

Triggering. SYMPTOM 1.—Trace free runs, does not trigger in AUTO or NORM (see Trigger schematic).

a. Set TRIGGERING MODE to AUTO. Turn LEVEL control cw and ccw to both limits. Does the trace flicker? If not, triggering signal is not reaching sweep circuit.

b. Check voltage at junction of R2147, R2152, and R2143. Does voltage vary from −2 to +3 V while turning LEVEL control throughout its range? If yes, check U2156B output. Does U2156 output level change while turning LEVEL control as above?

c. Connect a signal to CH 1. Check for trigger pulse at U2156B output. If no signal, suspect U2156A or B, or related circuits.

SYMPTOM 2.—Does not trigger in AUTO.

a. Check for trigger pulse at pin 6 of U2212B. If none, check for a HI at U2212B, pin 4, while varying the LEVEL control. If pin 4 does not go HI, check for defective U2212B, U2224B, or CR2227.

Sweep. SYMPTOM 1.—No sweep on crt (see Sweep & Horitontal Amplifier schematic).

a. Push BEAM FINDER button. If trace or dot is right of center, check at R2243 (end of resistor toward board center) for a 12 V (approximately) ramp.

b. If ramp is not present, check for approximately 0.7 V at Q2274 base.

c. If voltage at Q2274 base is high (approximately 8.0 volts) check Q2274, Q2242, Q2244, or Q2246.

SYMPTOM 2.—No trace on crt.

a. Repeat sweep symptom 1, parts a and b.

b. Check for a HI at U2234C, pin 8. If not HI, check U2234C.

NOTE

When troubleshooting the sweep or horizontal circuits, the Vertical AMPLIFIER may be removed from the instrument.

Sweep may lock up while troubleshooting. If in doubt, switch instrument power off and back on. If there are no problems, trace should free run.

Horizontal. SYMPTOM 1.—No trace on screen (see Sweep & Horizontal Amplifier schematic).

a. Check output (Q2334-Q2344 collectors) for approximately 40 V ramp. If okay, check for possibly defective crt leads.

SYMPTOM 2.—Trace on screen, but is short.

a. Check horizontal output (Q2334-Q2344 collectors) for approximately 40 V ramp.

b. If no ramp at output, check for 12 V ramp at junction of R2243-R2244-R2245.

c. If ramp is present, check Q2314, Q2326, Q2332, Q2334, or Q2344.

STORAGE. SYMPTOM 1.—Will not go into store mode.

a. Does crt flood or illuminate when in store? If not, check for about 19.3 V on collector of Q944. If none, check Q944 and Q942.

SYMPTOM 2.—Will not erase in store mode.

a. Check for erase pulse at collector of Q944 of about 200 V peak-to-peak. If none, check Q944, Q942, and the ERASE switch S910A.

CORRECTIVE MAINTENANCE

Corrective maintenance consists of repair and parts replacement. This section contains general information, troubleshooting information, and component replacement information.

NOTE

Be sure you are familiar with the soldering techniques and parts replacement procedures before replacing any components.

Soldering Techniques

WARNING

To prevent electrical shock, or damage to the instrument, always disconnect the instrument from the power source before soldering.

The T900 Series uses some single-sided circuit boards, i.e., wiring is plated on only one side. The components are located on the front of the circuit boards. The circuit designations have been silk-screened onto the component side of the circuit board next to the components. The circuit boards are mounted with the component side out to allow access to the components. If it is necessary to replace a component, the leads may be clipped and the new part soldered to the leads of the previous one. However, be careful not to loosen the connection with the etched circuit wiring on the back of the circuit board.

For soldering, use ordinary 60/40 solder and a 15-watt soldering iron. Excessive heat can cause the etched circuit wiring to separate from the board base material. Use caution if using a higher wattage-rated soldering iron on the circuit boards.

NOTE

If the instrument does not work after replacing components by soldering to the leads of the previous one, the connection with the etched circuit wiring may be broken. To check the connections, it is necessary to remove the circuit board from the instrument. Refer to the circuit board replacement information.

Replacement Parts

All parts for the T912 can be ordered from your local Tektronix Field Office, but many of the components are standard items that may be more readily available locally. Check the parts list for value, tolerance, ratings, and description before you replace any components.

When ordering parts from Tektronix, include the following information:

(1) Instrument type.

(2) Instrument serial number.

(3) A description of part (if electrical, include the circuit number).

(4) Tektronix part number.

Component Replacement

WARNING

Disconnect the instrument from the power source before replacing components.

Since the components are located on one side of the circuit boards, it is necessary to remove the circuit boards before replacing some components. Refer to the paragraphs on circuit board replacement for instructions in removal and installation of each circuit board. Also be sure you're familiar with soldering techniques used on single-sided circuit boards.

Semiconductors

Replacement of semiconductors may affect the adjustment of this instrument. After replacing semiconductors, especially if using parts other than those listed in the parts list, check the performance of the instrument to be sure that the performance has not been degraded.

WARNING

Handle silicone grease with care. Avoid getting silicone grease in the eyes. Wash hands thoroughly after use.

Replacement semiconductors should be of the original type or a direct replacement. Lead configuration of the semiconductors used in this instrument are shown in this section. Some plastic case transistors have lead configurations which do not agree with those shown there. If a replacement transistor is made by a different manufacturer than the original, check the manufacturer's basing diagram for correct basing. Most transistors are soldered directly onto the circuit boards. Transistors having heat radiators or those mounted on the chassis use silicone grease to increase heat transfer. Replace the silicone grease when replacing these transistors. Those transistors mounted on the chassis are held in place by a metal clip.

NOTE

After replacing a power transistor, check that the collector is not shorted to ground before applying power.

Fuse Replacement

The line-voltage fuse, F700, is located next to the POWER ON switch, S700, on the Interface board. The high voltage fuse, F722, is located on the Power Supply board. Refer to the Replaceable Electrical Parts list for correct fuse values.

Thick Film Resistor Replacement

To remove the thick film resistors, first remove the solder from the pins and then remove the resistors.

To replace the thick film resistor, R444, match the pins on the resistor with the holes in the circuit board. Re-solder all of the pins to the circuit board.

Interconnecting Cable and Pin Connector Replacement

The interconnecting cable assemblies are factory assembled. They consist of machine installed pin connectors mounted in plastic holders. The plastic holders are easily replaced as individual items, but if the connectors are faulty, the entire cable should be replaced.

It is possible for the pin connectors to become dislodged from the plastic holders. If this happens, the connector can be re-installed as follows (see Fig. 5-5).

1. Bend grooved portion of holder away from cable as shown.

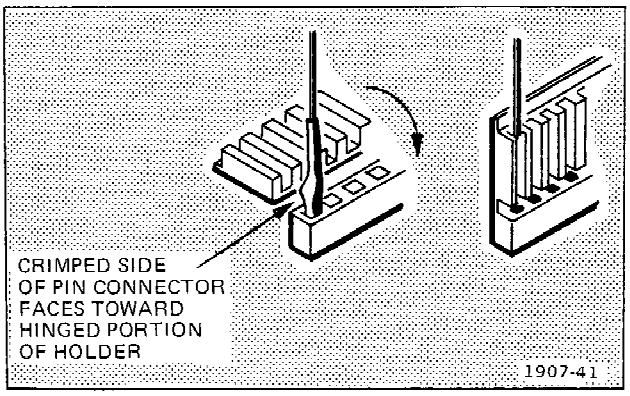


Fig. 5-5. Pin connector replacement.

2. Re-insert connector into its hole in plug-in portion of holder.

NOTE

Holder positions are numbered (number one is identified with a triangle).

3. Bend grooved part of holder so that connector is inserted into groove.

When plugging connector holders onto board pins, be sure to match triangle mark on holder with triangle mark on circuit board.

Shaft-Knob Removal

1. Grip knob end with one hand and shaft end with other hand.

2. Pull on knob, while pushing on shaft, to free recessed portion of shaft from retainer bushing (see Fig. 5-6). Some shaft-knobs may require considerable force to remove.

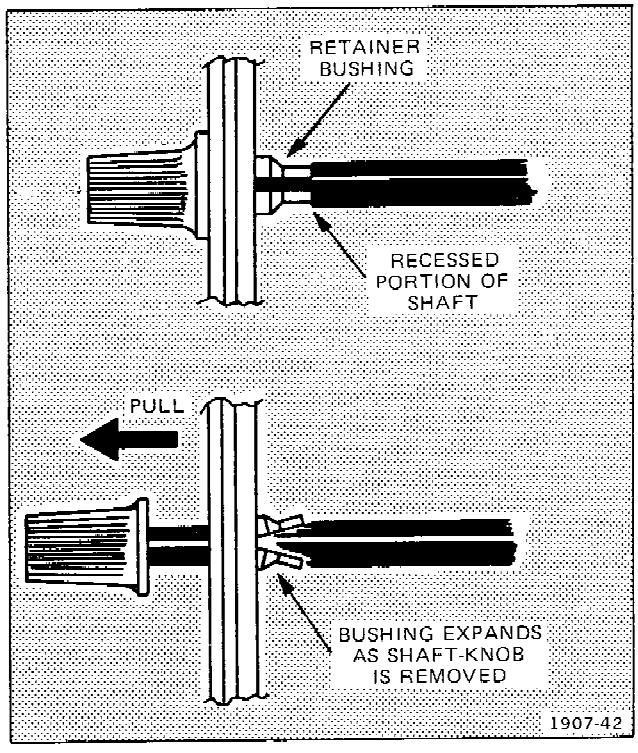


Fig. 5-6. Shaft-knob removal.

CAUTION

The bushing and shaft may separate abruptly. To avoid damage to the potentiometer and circuit board, or personal injury, grip both pieces firmly during shaft-knob removal. It may be helpful to grip the shaft with the tip of a long-nose pliers and use a gentle rocking motion to separate the shaft from the bushing.

Vertical Amplifier Replacement

To remove the vertical amplifier (see Fig. 5-7) from the instrument:

1. Support the vertical amplifier, while removing the retaining screws. One is between the attenuators, one is near R4327, and one is near R4375.

2. Disconnect P4 (see Fig. 5-8) from J4 on the Interface board by lifting the entire vertical amplifier. Be careful not to bend the pins.

To reinstall the vertical amplifier, reverse the above procedure.

NOTE

The front panel, switches, delay line, and attenuators are attached to the Vertical board.

Attenuator Replacement

To remove the attenuator from the instrument:

1. Remove the POSITION control knob and shaft.

2. Remove the VOLTS/DIV VAR knob and shaft. To remove the shaft, loosen the set screws holding the shaft to the potentiometer and pull the shaft out (observe knob orientation for re-assembly reference).

3. Pull the VOLTS/DIV knob and shaft out of the front panel.

4. Remove the three retaining screws from the attenuator shield and the hex nut behind the front panel near the bnc connector.

5. Pull the attenuator assembly off the Vertical Amplifier board. Be careful not to bend the connector pins.

6. To remove the attenuator shield, first unsolder the leads to the bnc connector. Take care not to touch the body of the capacitor with a hot soldering iron. Then remove one retaining screw from the board side. Be careful not to remove the screws holding the cam switch against the attenuator board. Lift the shield off the attenuator.

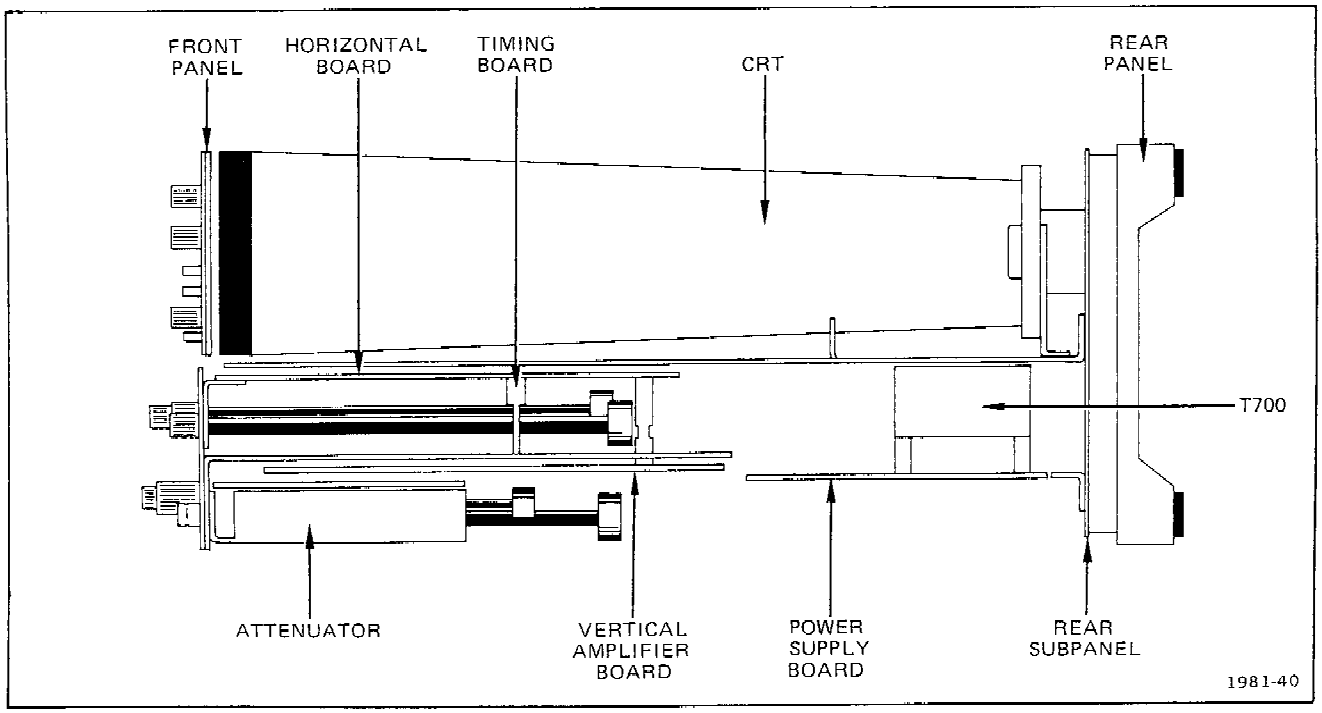


Fig. 5-7. Circuit board locations.

To reinstall the attenuator:

1. Attach the attenuator shield to the board with one screw, and resolder the lead to the bnc connector. Avoid touching the capacitor with a hot soldering iron.

2. Slide the bnc connector and coupling switch into the front panel.

3. Make sure the connecting pins and holders on the bottom of the attenuator board align properly.

4. Press the attenuator board down on the Vertical Amplifier board and secure it with the three retaining screws.

NOTE

The VOLTS/DIV shaft end is molded to form a key that fits into the cam. Attempting to force the shaft into the cam when it is not properly lined up, will damage the cam switch.

5. Line the VOLTS/DIV knob and shaft up with the cam and slide into place. When the shaft and cam are lined up, the shaft slides into the cam easily.

6. Reinstall the VOLTS/DIV VAR knob and shaft, and tighten the set screws.

Cam Switch Repair and Replacement

A cam switch is actually an assembly consisting of a cam rotated by a front panel control and a set of contacts on an adjacent circuit board.

CAUTION

Repair of cam switches should be undertaken only by experienced repair personnel. Switch alignment and spring tension of the contacts must be carefully maintained for proper operation of the switch. For assistance in repair of the cam switches, contact your local Tektronix Field Office or representative.

Cleaning. If the contact is not obviously damaged, try cleaning it before replacing. Follow the cleaning procedures in the order given; the first ones are the easiest.

CAUTION

When cleaning cam switch contacts:

1. Don't use cleaners, detergents, or lubricants which leave a residue. The residue can interfere with the high-frequency response of the contact. Also, the residue will attract dust and cause the contact to require frequent cleaning.

2. Don't use any cleaners which contain fluorocarbons. These will damage the cam portion of the switch. Fluorocarbons also damage the circuit board material used in some instruments.

3. Don't use anything that could snag the contact, like a cotton swab.

4. Don't scrape the pad. If the gold is removed from the pad, the pad will oxidize and cause future problems.

5. Don't bend the contacts. This may temporarily fix the problem. However, bending the contact damages its self-cleaning action and causes problems in the future.

Use the following procedures to clean the contacts:

1. Operate the switch several times. The wiping action may clean the contacts.

2. Blow low pressure air in the area of the contact while operating the switch.

3. Flush the contact with isopropyl alcohol and blow dry with low-pressure air. Isopropyl alcohol is flammable; avoid its use near open flame or other potential sources of ignition.

If the above procedures don't work, replace the contact strip. If cleaning the switch restores continuity, check to ensure that the contact wipes across the pad. If the contact does not wipe, replace the contact strip.

Contact Replacement. Cam Switch contacts in this instrument are part of a contact strip assembly. Refer to the mechanical parts list for ordering information.

If you do not have a replacement contact strip assembly, bend the contact for a temporary repair. If you do bend the contact, make note of its location and the symptom it causes. This will speed repair if the contact fails before you can make permanent repair.

Trigger Switch Board Replacement

If the early production Trigger Switch board is to be replaced, it must be replaced with the late production Trigger Switch board. In this event, C2123, R2117, R2119, and R2120 (located on the A12 Horizontal board), may be removed; they have no effect when the late production Trigger Switch board is used. Refer to Diagram 5 and Circuit Description for the late version when the late production Trigger Switch board is used.

Time Base Replacement

To remove the Time Base from the instrument:

1. Remove the Vertical Amplifier. See Vertical Amplifier Replacement for instructions.

2. Support the TIME BASE while removing the retaining post in the back corner (near the POSITION control), the post by the LEVEL potentiometer, and the screw behind the front panel near R2236.

3. Carefully remove the leads from P2344 (a red on white crt lead to the − side of P2344 and a green on white crt lead to the + side of P2344).

4. Remove P2 (see Fig. 5-8) from J2 on the Interface board by pulling the entire Time Base toward the right side of the instrument. Be careful not to bend the pins.

To reinstall the TIME BASE, reverse the above procedure.

To remove the Trigger board, unsolder the coaxial cable from the X connector and unplug the board from the Horizontal board by pulling out and toward the back of the instrument.

To remove the Timing board, first remove the SEC/DIV knob and the POSITION control knob and shaft assy. Then unplug the Timing board from the Horizontal board and pull the SEC/DIV shaft out of the front panel. To reinstall the timing board, reverse the procedure.

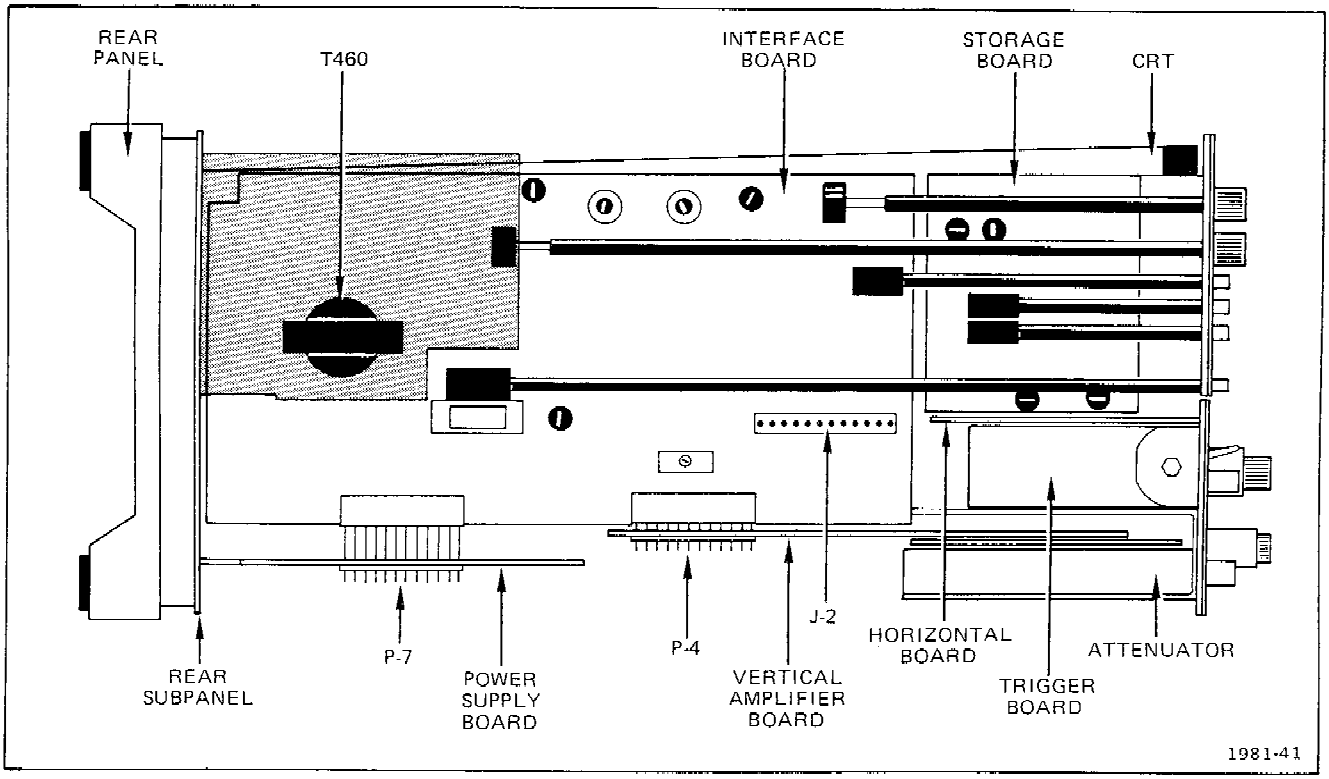


Fig. 5-8. Circuit board locations.

Power Supply Board Replacement

To remove the Low Voltage Power Supply from the instrument:

1. Remove the two retaining screws holding the heat sink to the rear subpanel.

2. Remove the bolts near C738 and Q774 (the ones holding the Power Supply board to the crt shield). The other two bolts hold the transformer to the Power Supply board.

3. Unplug P784 and P720. Disconnect P7 from J7 on the Interface board by lifting the Power Supply board and transformer out. (See Fig. 5-8.)

To reinstall the Power Supply board, reverse the above procedure.

Interface Board Replacement

To remove the Interface board from the instrument:

1. Remove the Vertical Amplifier and Time Base.

2. Use a small screwdriver to remove the clip holding Q458 to the rear subpanel.

3. Remove the front-panel FOCUS and INTENSITY knobs and shafts.

4. Remove the high-voltage shield (two screws) and the two posts underneath the shield.

5. Disconnect the following plugs from the Interface board:

a. CAL OUT (P24, unmarked on some boards), a brown on white wire.

b. P419 from J419 (a red on white wire from Z AXIS connector). Push wire through hole in board.

c. P470 from J470, a two pin plug (mis-marked P9 on some boards); with a red wire and a brown wire from the hole in the crt shield.

d. P9 from J9, a ten pin plug (mis-marked P470 on some boards). Wires to this plug come from storage board.

e. P982 from J982 (a yellow on white single wire from crt neck pin).

f. P70 from J70 (two brown wires inside tubing), some boards are mis-marked J7 for this connector.

g. Carefully lift cable retainer clip with a small screwdriver and slide cable out of clip; then unplug P465 from J465 (a 4 pin plug); P466 (unmarked plug, yellow on white single wire); and P475 from J475 (a 4 pin plug with unmarked index at end next to J982).

h. P138 from J138 (a blue on white wire to unmarked pin near LR138); P148 from J148 (a brown on white wire to unmarked pin near LR148); pull wires down through board.

6. Disconnect J7 from P7 on Power Supply board by lifting the Interface board toward the top and back of the instrument so that the POWER (ON) light pipe disengages from DS796 housing, and the BEAM FINDER and OFF ON (POWER) buttons slide back out of the front panel as J7 and P7 separate.

7. Reverse the above procedure to reinstall the Interface board. Be careful not to let the edges of the high voltage shield touch adjacent component leads on board after reinstallation.

Storage Board Replacement

To remove the Storage board:

1. Remove INTENSITY, FOCUS, and ENHANCE knob-and-shaft assemblies out through the front panel.

2. Unplug P9 from J9 on the Interface board (a ten pin plug, mis-marked P470 on some boards).

3. Unplug P950 (an eight pin plug) from J950.

4. Insert a small screwdriver between the switch shaft tip and extension shaft, and carefully disengage extension shafts from the BEAM FINDER, OFF ON (POWER), INTEG, and ERASE switches. Slide the shafts forward until disengaged, then slide them back through the front panel to remove.

5. Remove the four retaining screws holding the board to the chassis.

6. Lift the board out.

7. To reinstall the Storage board, reverse the above procedure.

Cathode Ray Tube (CRT) Replacement

WARNING

Use care when handling a crt. Protective clothing and safety glasses should be worn. Avoid striking it on any object which might cause it to crack or implode. When storing a crt, place it in a protective carton or set it face down on a smooth surface in a protected location with a soft mat under the faceplate to protect it from scratches. To avoid shock from any residual charge from the normal −2700 volts on the cathode terminal, do not touch the crt pins while removing the crt socket from its base.

To remove the crt from the instrument, disconnect power cord plug from power input source and remove cabinet halves. Turn the front of the instrument toward you, and perform the following steps.

1. Disconnect the 5-wire plug from P950 on the Storage board. (The wires from P950 are connected to the crt and are removed with it. The new crt is supplied with these wires and plug).

2. Disconnect the 2-pin plug (terminating a red wire and a brown wire) from J470 on the Interface board. These are the Trace Rotation (TR ROT) leads. Some boards may have this connector marked P9, rather than J470.

3. Disconnect the 5 individual wire connectors from the pins around the top and left side of the crt neck. For reference when installing the new crt, the color codes of these wires (reading from top right to bottom left) are: green-on-white, red-on-white, yellow-on-white, blue-on-white, and brown-on-white.

4. Grip the 14-pin socket and pull it back off of the base of the crt (see warning preceding step 1).

5. Carefully raise the plastic crt front support ring upward and to the right to disengage the 2 buttons on the bottom and 2 buttons on the left side from the instrument chassis.

NOTE

Although it may be more convenient, it is not necessary to remove any front panel or subpanel controls or parts. The foregoing steps will allow the front of the crt to be moved to the right of its normal position while slightly bending the plastic subpanel to allow clearance for the crt to be pulled forward out of its shield.

6. Gently press forward on the crt base while supporting the front of the crt until the front extends far enough forward to grasp while pulling the crt far enough forward to push the P950 plug and wires down through the hole in the top of the crt shield, then pull the crt the rest of the way out of its shield.

7. To install a new crt, reverse the above procedure. (Push the P950 plug and wires up through the hole in the top of the crt shield before fully inserting the crt.)

REPACKAGING FOR SHIPMENT

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing: owner (with address) and the name of an individual at your firm that can be contacted. Include complete instrument serial number and a description of the service required.

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

Surround the instrument with polyethylene sheeting to protect the finish of the instrument. Obtain a carton of corrugated cardboard of the correct carton strength and having inside dimensions of no less than six inches more than the instrument dimensions. Cushion the instrument by tightly packing three inches of dunnage or urethane foam between carton and instrument, on all sides. Seal carton with shipping tape or industrial stapler.

The carton test strength for your instrument is 275 pounds.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

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

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

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

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

ACTR	ACTUATOR	PLSTC	PLASTIC
ASSY	ASSEMBLY	QTZ	QUARTZ
CAP	CAPACITOR	RECP	RECEPTACLE
CER	CERAMIC	RES	RESISTOR
CKT	CIRCUIT	RF	RADIO FREQUENCY
COMP	COMPOSITION	SEL	SELECTED
CONN	CONNECTOR	SEMICOND	SEMICONDUCTOR
ELCTLT	ELECTROLYTIC	SENS	SENSITIVE
ELEC	ELECTRICAL	VAR	VARIABLE
INCAND	INCANDESCENT	WW	WIREWOUND
LED	LIGHT EMITTING DIODE	XFMR	TRANSFORMER
NONWIR	NON WIREWOUND	XTAL	CRYSTAL

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
00853	SANGAMO ELECTRIC CO., S. CAROLINA DIV.	P O BOX 128	PICKENS, SC 29671
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD,PO BOX 20923	PHOENIX, AZ 85036
05574	VIKING INDUSTRIES, INC.	21001 NORDHOFF STREET	CHATSWORTH, CA 91311
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON STREET	DOVER, NH 03820
13511	AMPHENOL CARDRE DIV., BUNKER RAMO CORP.		LOS GATOS, CA 95030
14433	ITT SEMICONDUCTORS	3301 ELECTRONICS WAY	
		P O BOX 3049	WEST PALM BEACH, FL 33402
14936	GENERAL INSTRUMENT CORP., SEMICONDUCTOR PRODUCTS GROUP	P.O. BOX 600,600 W. JOHN ST.	HICKSVILLE, NY 11802
19396	ILLINOIS TOOL WORKS, INC. PAKTRON DIV.	900 FOLLIN LANE, SE	VIENNA, VA 22180
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
24931	SPECIALTY CONNECTOR CO., INC.	3560 MADISON AVE.	INDIANAPOLIS, IN 46227
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
27264	MOLEX PRODUCTS CO.	5224 KATRINE AVE.	DOWNERS GROVE, IL 60515
50157	MIDWEST COMPONENTS INC.	P. O. BOX 787	
		1981 PORT CITY BLVD.	MUSKEGON, MI 49443
51406	MURATA CORPORATION OF AMERICA	2 WESTCHESTER PLAZA	ELMSFORD, NY 10523
52763	STETTNER-TRUSH, INC.	67 ALBANY STREET	CAZENOVIA, NY 13035
52769	SPRAGUE GOODMAN ELEC., INC.	134 FULTON AVENUE	GARDEN CITY PARK, NY 11040
53944	ELT INC., GLOW LITE DIVISION	BOX 698	PAULS VALLEY, OK 73075
54473	MATSUSHITA ELECTRIC, CORP. OF AMERICA	1 PANASONIC WAY	SECAUCUS, NJ 07094
56289	SPRAGUE ELECTRIC CO.		NORTH ADAMS, MA 01247
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
74276	SIGNALITE DIV., GENERAL INSTRUMENT CORP.	1933 HECK AVE.	NEPTUNE, NJ 07753
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
80031	ELECTRA-MIDLAND CORP., MEPCO DIV.	22 COLUMBIA ROAD	MORRISTOWN, NJ 07960
82389	SWITCHCRAFT, INC.	5555 N. ELSTON AVE.	CHICAGO, IL 60630
90201	MALLORY CAPACITOR CO., DIV. OF P. R. MALLORY AND CO., INC.	3029 E. WASHINGTON STREET	
		P. O. BOX 372	INDIANAPOLIS, IN 46206
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A1	670-3982-00	B010100	B010239	CKT BOARD ASSY:INTERFACE	80009	670-3982-00
A1	670-3982-01	B010240	B011487	CKT BOARD ASSY:INTERFACE	80009	670-3982-01
A1	670-3982-02	B011488	B014678	CKT BOARD ASSY:INTERFACE	80009	670-3982-02
A1	670-3982-03	B014679		CKT BOARD ASSY:INTERFACE	80009	670-3982-03
A2	670-3981-00	B010100	B011487	CKT BOARD ASSY:LV POWER SUPPLY	80009	670-3981-00
A2	670-3981-01	B011488	B013585	CKT BOARD ASSY:LV POWER SUPPLY	80009	670-3981-01
A2	670-3981-02	B013586		CKT BOARD ASSY:LV POWER SUPPLY	80009	670-3981-02
A3	670-3935-00	B010100	B011466	CKT BOARD ASSY:STORAGE	80009	670-3935-00
A3	670-3935-01	B011467		CKT BOARD ASSY:STORAGE	80009	670-3935-01
A6	670-3972-00	B010100	B011062	CKT BOARD ASSY:ATTENUATOR,CHANNEL 1	80009	670-3972-00
A6	670-3972-02	B011063	B012604	CKT BOARD ASSY:ATTENUATOR,CHANNEL 1	80009	670-3972-02
A6	670-3972-05	B012605	B014108	CKT BOARD ASSY:ATTENUATOR,CHANNEL 1	80009	670-3972-05
A6	670-3972-08	B014109		CKT BOARD ASSY:ATTENUATOR,CHANNEL 1	80009	670-3972-08
A7	670-3973-00	B010100	B011062	CKT BOARD ASSY:ATTENUATOR,CHANNEL 2	80009	670-3973-00
A7	670-3973-02	B011063	B012604	CKT BOARD ASSY:ATTENUATOR,CHANNEL 2	80009	670-3973-02
A7	670-3973-05	B012605	B014108	CKT BOARD ASSY:ATTENUATOR,CHANNEL 2	80009	670-3973-05
A7	670-3973-08	B014109		CKT BOARD ASSY:ATTENUATOR,CHANNEL 2	80009	670-3973-08
A8	670-3740-00	B010100	B011359	CKT BOARD ASSY:VERTICAL	80009	670-3740-00
A8	670-3740-01	B011360	B012986	CKT BOARD ASSY:VERTICAL	80009	670-3740-01
A8	670-3740-02	B012987		CKT BOARD ASSY:VERTICAL	80009	670-3740-02
	----- -----			(SEE OPTION 1 FOR ALTERNATE VERSION)		
A11	670-4088-00	B010100	B010314	CKT BOARD ASSY:TRIGGER SWITCH	80009	670-4088-00
A11	670-4088-01	B010315		CKT BOARD ASSY:TRIGGER SWITCH	80009	670-4088-01
A12	670-3735-00	B010100	B011422	CKT BOARD ASSY:HORIZONTAL	80009	670-3735-00
A12	670-3735-01	B011423	B013002	CKT BOARD ASSY:HORIZONTAL	80009	670-3735-01
A12	670-3735-02	B013003		CKT BOARD ASSY:HORIZONTAL	80009	670-3735-02
A13	672-0523-00			CKT BOARD ASSY:A TIMING	80009	672-0523-00
B720	119-0702-01			MOTOR,AC:24V,50/60HZ,W/FAN,CONN & HSG	80009	119-0702-01
C24	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C102	283-0646-00			CAP.,FXD,MICA D:170PF,1%,100V	00853	D151E171F0
C113	281-0770-00			CAP.,FXD,CER DI:0.001UF,20%,100V	72982	8035D9AADX5R102M
C114	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
C123	281-0770-00			CAP.,FXD,CER DI:0.001UF,20%,100V	72982	8035D9AADX5R102M
C125	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C133	281-0125-00			CAP.,VAR,MICA D:90-400PF,175V	52769	GMC30900
C135	281-0770-00			CAP.,FXD,CER DI:0.001UF,20%,100V	72982	8035D9AADX5R102M
C136	285-1099-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	19396	473M02PT605
C145	281-0770-00			CAP.,FXD,CER DI:0.001UF,20%,100V	72982	8035D9AADX5R102M
C412	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C423	281-0529-00			CAP.,FXD,CER DI:1.5PF,+/-0.25PF,500V	72982	301-000C0K0159C
C425	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C433	285-1099-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	19396	473M02PT605
C434	285-1099-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	19396	473M02PT605
C435	285-1099-00			CAP.,FXD,PLSTC:0.047UF,20%,200V	19396	473M02PT605
C443	290-0297-00			CAP.,FXD,ELCTLT:39UF,10%,10V	56289	150D396X9010B2
C444	283-0013-00	XB011769		CAP.,FXD,CER DI:0.01UF,+100-0%,1000V	56289	33C29A7
C455	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C457	283-0104-00			CAP.,FXD,CER DI:2000PF,5%,500V	72982	811-565B202J
C458	290-0414-00			CAP.,FXD,ELCTLT:8UF,+50-10%,200V	90201	TT8R0T200C1C3P
C462	283-0034-00			CAP.,FXD,CER DI:0.005UF,20%,4000V	56289	41C107A
C463	283-0034-00			CAP.,FXD,CER DI:0.005UF,20%,4000V	56289	41C107A
C464	283-0034-00			CAP.,FXD,CER DI:0.005UF,20%,4000V	56289	41C107A
C465	283-0034-00	B010100	B012475	CAP.,FXD,CER DI:0.005UF,20%,4000V	56289	41C107A
C465	283-0404-00	B012476		CAP.,FXD,CER DI:0.01UF,20%,4KV	51406	DHR2825U103M1KV
C466	283-0034-00	B010100	B012475	CAP.,FXD,CER DI:0.005UF,20%,4000V	56289	41C107A
C466	283-0404-00	B012476		CAP.,FXD,CER DI:0.01UF,20%,4KV	51406	DHR2825U103M1KV

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C467	283-0008-00			CAP.,FXD,CER DI:0.1UF,20%,500V	56289	275C8
C468	283-0008-00			CAP.,FXD,CER DI:0.1UF,20%,500V	56289	275C8
C469	283-0008-00			CAP.,FXD,CER DI:0.1UF,20%,500V	56289	275C8
C477	283-0008-00			CAP.,FXD,CER DI:0.1UF,20%,500V	56289	275C8
C478	285-1104-00			CAP.,FXD,PLSTC:0.033UF,5%,200V	19396	333J02PP580
C712	290-0752-00			CAP.,FXD,ELCTLT:10UF,+50-10%,500V	56289	D76246
C720	290-0764-00			CAP.,FXD,ELCTLT:5UF,+50-10%,100V	56289	500D142
C721	281-0662-00	XB011707		CAP.,FXD,CER DI:10PF,+/-0.5PF,500V	72982	301-000H3M0100D
C722	290-0761-00			CAP.,FXD,ELCTLT:100UF,+50-10%,200V	56289	D76254
C738	290-0744-00			CAP.,FXD,ELCTLT:3.3UF,+50-10%,160V	90201	TT3R3U160B013P
C742	290-0751-00			CAP.,FXD,ELCTLT:2200UF,+50-10%,16V	56289	D76245
C743	290-0751-00			CAP.,FXD,ELCTLT:2200UF,+50-10%,16V	56289	D76245
C746	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C756	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C758	290-0743-00			CAP.,FXD,ELCTLT:100UF,+50-10%,16V	56289	500D146
C762	290-0301-00	XB012999		CAP.,FXD,ELCTLT:10UF,10%,20V	56289	150D106X9020B2
C763	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C774	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C778	290-0743-00			CAP.,FXD,ELCTLT:100UF,+50-10%,16V	56289	500D146
C782	290-0760-00			CAP.,FXD,ELCTLT:2200UF,+50-10%,25V	56289	D76253
C796	290-0164-00			CAP.,FXD,ELCTLT:1UF,+50-10%,150V	56289	500D105F150BA7
C801	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
C912	290-0480-00			CAP.,FXD,ELCTLT:0.5UF,+50-10%,200V	80009	290-0480-00
C923	281-0770-00			CAP.,FXD,CER DI:0.001UF,20%,100V	72982	8035D9AADX5R102M
C926	285-0684-00			CAP.,FXD,PLSTC:0.056UF,5%,100V	56289	61F22AC563
C928	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C953	283-0006-00			CAP.,FXD,CER DI:0.02UF,+80-20%,500V	72982	0841545Z5V00203Z
C963	290-0534-00			CAP.,FXD,ELCTLT:1UF,20%,35V	56289	196D105X0035HA1
C964	290-0771-00			CAP.,FXD,ELCTLT:220UF,+50-10%,10VDC	54473	ECE-A10V220L
C2102	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C2112	281-0763-00	B010100	B010314	CAP.,FXD,CER DI:47PF,10%,100V	72982	8035D9AADC1G470K
C2112	281-0651-00	B010315		CAP.,FXD,CER DI:47PF,5%,200V	72982	374001T2H0470J
C2114	281-0764-00	B010100	B010314	CAP.,FXD,CER DI:82PF,5%,100V	72982	8035D9AADC1G820J
C2114	281-0528-00	B010315		CAP.,FXD,CER DI:82PF,+/-8.2PF,500V	72982	301-000U2M0820K
C2116	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C2123	290-0114-00	B010100	B010314X	CAP.,FXD,ELCTLT:47UF,20%,6V	56289	150D476X0006B2
C2132	290-0201-00			CAP.,FXD,ELCTLT:100UF,+75-10%,15V	56289	30D107G015DC9
C2136	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C2144	290-0183-00			CAP.,FXD,ELCTLT:1UF,10%,35V	90201	TAE105K035P1A
C2147	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C2156	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C2160	290-0183-00			CAP.,FXD,ELCTLT:1UF,10%,35V	90201	TAE105K035P1A
C2162	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C2165	290-0183-00			CAP.,FXD,ELCTLT:1UF,10%,35V	90201	TAE105K035P1A
C2182	290-0183-00			CAP.,FXD,ELCTLT:1UF,10%,35V	90201	TAE105K035P1A
C2184	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	72982	8035D9AADC1G220K
C2212	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C2213	281-0634-00	XB010530	B011422	CAP.,FXD,CER DI:10PF,+/-0.25PF,500V	72982	374011C0G100C
C2213	281-0757-00	B011423		CAP.,FXD,CER DI:10PF,20%,100V	72982	8035-D-C0G-100C
C2226	290-0135-00			CAP.,FXD,ELCTLT:15UF,20%,20V	56289	150D156X0020B2
C2233	283-0706-00			CAP.,FXD,MICA D:91PF,+/-1PF,500V	00853	D15-5E910F0
C2234	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C2235	281-0216-00			CAP.,VAR,CER DI:0.8-6.8PF,400V	52763	R-TRIKO-122-09SD
C2236	290-0135-00			CAP.,FXD,ELCTLT:15UF,20%,20V	56289	150D156X0020B2
C2245	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	72982	8035D9AADC1G220K
C2246	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	72982	8035D9AADC1G470K
C2252	295-0179-00			CAP.,SET,MTCHD:0.01UF,1.0UF,1%	80009	295-0179-00
C2253						

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C2274	290-0183-00			CAP.,FXD,ELCTLT:1UF,10%,35V	90201	TAE105K035P1A
C2275	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C2276	281-0758-00			CAP.,FXD,CER DI:15PF,20%,100V	72982	314022C0G0150M
C2317	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C2327	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C2345	290-0135-00			CAP.,FXD,ELCTLT:15UF,20%,20V	56289	150D156X0020B2
C4101	281-0541-00			CAP.,FXD,CER DI:6.8PF,10%,500V	72982	301-000C0H0689D
C4102	285-1124-00			CAP.,FXD,PLSTC:0.022UF,20%,400V	19396	PP721E223M
C4104	281-0207-00			CAP.,VAR,PLSTC:2-18PF,100V	80031	2807C00218MH02F0
C4105	281-0214-00			CAP.,VAR,CER DI:0.5-3PF,400V	80031	2502A0R503VP02F0
C4106	283-0213-00			CAP.,FXD,CER DI:300PF,5%,100V	72982	8121N130C0G0301J
C4113	281-0207-00			CAP.,VAR,PLSTC:2-18PF,100V	80031	2807C00218MH02F0
C4114	281-0214-00	B010100	B010749	CAP.,VAR,CER DI:0.5-3PF,400V	80031	2502A0R503VP02F0
C4114	281-0220-00	B010750	B014108	CAP.,VAR,CER DI:1-5.5PF,400V	80031	2502A015R5VP0ZF0
C4114	281-0214-00	B014109		CAP.,VAR,CER DI:0.5-3PF,400V	80031	2502A0R503VP02F0
C4115	281-0604-00	XB014109		CAP.,FXD,CER DI:2.2PF,+/-0.25PF,500V	72982	301-000C0J0229C
C4116	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	72982	8035D9AADC1G220K
C4123	281-0773-00	B010100	B010549	CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C4123	283-0002-00	B010550		CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C4143	281-0763-00	B010100	B010449X	CAP.,FXD,CER DI:47PF,10%,100V	72982	8035D9AADC1G470K
C4153	281-0584-00			CAP.,FXD,CER DI:100PF,5%,500V	72982	0301000Y5E0101J
C4155	281-0768-00			CAP.,FXD,CER DI:470PF,20%,100V	72982	8035D9AADW5R471M
	----- -----			(C4155, SEE OPTION 1 FOR ALTERNATE VERSION)		
C4158	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
C4165	281-0768-00			CAP.,FXD,CER DI:470PF,20%,100V	72982	8035D9AADW5R471M
	----- -----			(C4165, SEE OPTION 1 FOR ALTERNATE VERSION)		
C4168	283-0065-01			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	0835582Z5E00102J
C4201	281-0541-00			CAP.,FXD,CER DI:6.8PF,10%,500V	72982	301-000C0H0689D
C4202	285-1124-00			CAP.,FXD,PLSTC:0.022UF,20%,400V	19396	PP721E223M
C4204	281-0207-00			CAP.,VAR,PLSTC:2-18PF,100V	80031	2807C00218MH02F0
C4205	281-0214-00			CAP.,VAR,CER DI:0.5-3PF,400V	80031	2502A0R503VP02F0
C4206	283-0213-00			CAP.,FXD,CER DI:300PF,5%,100V	72982	8121N130C0G0301J
C4213	281-0207-00			CAP.,VAR,PLSTC:2-18PF,100V	80031	2807C00218MH02F0
C4214	281-0214-00	B010100	B010749	CAP.,VAR,CER DI:0.5-3PF,400V	80031	2502A0R503VP02F0
C4214	281-0220-00	B010750	B014108	CAP.,VAR,CER DI:1-5.5PF,400V	80031	2502A015R5VP0ZF0
C4214	281-0214-00	B014109		CAP.,VAR,CER DI:0.5-3PF,400V	80031	2502A0R503VP02F0
C4215	281-0604-00	XB014109		CAP.,FXD,CER DI:2.2PF,+/-0.25PF,500V	72982	301-000C0J0229C
C4216	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	72982	8035D9AADC1G220K
C4223	281-0773-00	B010100	B010549	CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C4223	283-0002-00	B010550		CAP.,FXD,CER DI:0.01UF,+80-20%,500V	72982	811-546E103Z
C4243	281-0763-00	B010100	B010449X	CAP.,FXD,CER DI:47PF,10%,100V	72982	8035D9AADC1G470K
C4253	281-0584-00			CAP.,FXD,CER DI:100PF,5%,500V	72982	0301000Y5E0101J
C4255	281-0768-00			CAP.,FXD,CER DI:470PF,20%,100V	72982	8035D9AADW5R471M
	----- -----			(C4255, SEE OPTION 1 FOR ALTERNATE VERSION)		
C4258	283-0220-00			CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
C4265	281-0768-00			CAP.,FXD,CER DI:470PF,20%,100V	72982	8035D9AADW5R471M
	----- -----			(C4265, SEE OPTION 1 FOR ALTERNATE VERSION)		
C4268	283-0065-01			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	0835582Z5E00102J
C4303	----- -----			(SEE OPTION 1)		
C4333	281-0759-00			CAP.,FXD,CER DI:22PF,10%,100V	72982	8035D9AADC1G220K
C4334	281-0214-00			CAP.,VAR,CER DI:0.5-3PF,400V	80031	2502A0R503VP02F0
C4338	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C4344	281-0207-00			CAP.,VAR,PLSTC:2-18PF,100V	80031	2807C00218MH02F0
C4349	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C4362	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C4363	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C4364	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C4365	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C4366	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C4368	283-0103-00	XB010300		CAP.,FXD,CER DI:180PF,5%,500V	56289	40C638
	----- -----			(C4368, SEE OPTION 1)		
C4370	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C4371	283-0065-01			CAP.,FXD,CER DI:0.001UF,5%,100V	72982	0835582Z5E00102J
C4372	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	72982	8035D9AADC1G470K
C4375	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	72982	8005H9AADW5R471K
C4376	281-0775-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8005D9AABZ5U104M
C4377	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	72982	8005H9AADW5R471K
C4385	281-0797-00	XB010300		CAP.,FXD,CER DI:15PF,10%,100V	72982	8035D9AADC0G150K
C4386	281-0770-00			CAP.,FXD,CER DI:0.001UF,20%,100V	72982	8035D9AADX5R102M
C4392	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
C4393	283-0177-00			CAP.,FXD,CER DI:1UF,+80-20%,25V	56289	273C5
C4394	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C4395	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C4396	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C4397	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
CR26	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR27	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR416	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	14433	G866
CR418	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR437	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR443	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR459	152-0107-00			SEMICOND DEVICE:SILICON,400V,400MA	80009	152-0107-00
CR463	152-0639-00			SEMICOND DEVICE:RECT,SI,10KV,10MA	80009	152-0639-00
CR465	152-0639-00			SEMICOND DEVICE:RECT,SI,10KV,10MA	80009	152-0639-00
CR467	152-0586-00			SEMICOND DEVICE:SILICON,600V,500MA	14936	RGP10J
CR468	152-0586-00			SEMICOND DEVICE:SILICON,600V,500MA	14936	RGP10J
CR711	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR712	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR713	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR714	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR721	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR722	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR723	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR724	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR732	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR734	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR737	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR738	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR741	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR742	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR743	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR744	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR758	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR764	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR765	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR778	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR781	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR782	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR783	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR784	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR786	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR912	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR932	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR943	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR945	152-0066-03			SEMICOND DEVICE:RECT,SI,400V,1A	80009	152-0066-03
CR952	152-0242-00	XB010300		SEMICOND DEVICE:SILICON,225V,200MA	07263	FDH5004
CR953	152-0242-00	XB010300		SEMICOND DEVICE:SILICON,225V,200MA	07263	FDH5004
CR2108	152-0141-02	XB010315		SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2112	152-0141-02	XB010315		SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2115	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2116	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2118	152-0141-02	B010100	B010314X	SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2124	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2135	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2182	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2184	152-0141-02	XB013003		SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2185	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2186	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2227	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2233	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2234	152-0141-02	B010100	B010250	SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2234	152-0245-00	B010251		SEMICOND DEVICE:SILICON,10NA AT 5V	80009	152-0245-00
CR2317	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2326	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2331	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	14433	G866
CR2332	152-0075-00			SEMICOND DEVICE:GE,25V,40MA	14433	G866
CR2334	152-0061-00			SEMICOND DEVICE:SILICON,175V,100MA	80009	152-0061-00
CR2342	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR2356	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4123	152-0246-00			SEMICOND DEVICE:SILICON,40V,200MA	80009	152-0246-00
CR4223	152-0246-00			SEMICOND DEVICE:SILICON,40V,200MA	80009	152-0246-00
CR4302	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4303	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4304	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4305	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4312	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4313	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4314	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4315	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4360	----- -----			(SEE OPTION 1)		
CR4361	----- -----			(SEE OPTION 1)		
CR4362	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4363	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4364	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4366	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4367	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
DL4339	119-0733-00	B010100	B011756	DELAY LINE,ELEC:200 NSEC,150 OHM,COIL	80009	119-0733-00
DL4339	119-0733-01	B011757		DELAY LINE,ELEC:200 NSEC,150 OHM,COIL	80009	119-0733-01
DS463	150-0002-00			LAMP,GLOW:0.5 MA 60/125V	74276	NE-2T(T2)
DS465	150-0002-00			LAMP,GLOW:0.5 MA 60/125V	74276	NE-2T(T2)
DS796	150-0035-00			LAMP,GLOW:90V,0.3MA	53944	A1B-3
F700	159-0022-00			FUSE,CARTRIDGE:3AG,1A,250V,FAST-BLOW	71400	AGC 1
	----- -----			(100 TO 120V OPERATION)		
F700	159-0025-00			FUSE,CARTRIDGE:3AG,0.5A,250V,FAST-BLOW	71400	AGC 1/2
	----- -----			(220 TO 240V OPERATION)		
F722	159-0083-00			FUSE,CARTRIDGE:0.15A,250V,FAST-BLOW	71400	AGC 15/100
J2	131-1792-00			CONTACT ASSY,EL:12 MALE CONTACT,FLAT WAFER	27264	09-70-2121

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
J4	131-1795-00			CONNECTOR,RCPT,:12 FEMALE CONTACT,RT-ANGLE	27264	09-62-3121
J7	131-1782-00			CONN,RCPT,ELEC:RT ANGLE,12 FEM,0.045 SQ	27264	09-52-3121
J419	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	13511	31-279
J2100	131-1802-00			CONNECTOR,RCPT,:15 CONTACTS	05574	000201-4831
J2110	131-0106-02			CONNECTOR,RCPT,:BNC	24931	28JR178-1
J2250	131-1801-00			CONNECTOR,RCPT,:9 CONTACTS	05574	000201-4832
J2260	131-1802-00			CONNECTOR,RCPT,:15 CONTACTS	05574	000201-4831
J4110	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	13511	31-279
J4210	131-0955-00			CONNECTOR,RCPT,:BNC,FEMALE,W/HARDWARE	13511	31-279
L472	108-0824-00			COIL,TUBE DEFL:TRACE ROTATOR	80009	108-0824-00
LR138	108-0368-00			COIL,RF:10UH	80009	108-0368-00
LR148	108-0368-00			COIL,RF:10UH	80009	108-0368-00
Q112	151-0224-00			TRANSISTOR:SILICON,NPN	80009	151-0224-00
Q116	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q122	151-0224-00			TRANSISTOR:SILICON,NPN	80009	151-0224-00
Q126	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q132	151-0472-00	B010100	B014678	TRANSISTOR:SILICON,NPN	80009	151-0472-00
Q132	151-0127-00	B014679		TRANSISTOR:SILICON,NPN	80009	151-0127-00
Q136	151-0124-00			TRANSISTOR:SILICON,NPN,SEL FROM 2N3501	80009	151-0124-00
Q142	151-0472-00	B010100	B014678	TRANSISTOR:SILICON,NPN	80009	151-0472-00
Q142	151-0127-00	B014679		TRANSISTOR:SILICON,NPN	80009	151-0127-00
Q146	151-0124-00			TRANSISTOR:SILICON,NPN,SEL FROM 2N3501	80009	151-0124-00
Q416	151-0190-05			TRANSISTOR:SILICON,NPN	80009	151-0190-05
Q424	151-0190-05			TRANSISTOR:SILICON,NPN	80009	151-0190-05
Q426	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q434	151-0350-00			TRANSISTOR:SILICON,PNP	80009	151-0350-00
Q446	151-0126-00			TRANSISTOR:SILICON,NPN	80009	151-0126-00
Q454	151-0188-00			TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q458	151-0423-00	B010100	B013234	TRANSISTOR:SILICON,NPN	01295	EP2970
Q458	151-0358-00	B013235		TRANSISTOR:SILICON,NPN,SEL FROM D44R4	80009	151-0358-00
Q722	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q726	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q734	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q736	151-0497-00			TRANSISTOR:SILICON,NPN	01295	TIP47
Q752	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q754	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q756	151-0478-00			TRANSISTOR:SILICON,NPN	80009	151-0478-00
Q772	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q774	151-0301-00			TRANSISTOR:SILICON,PNP	04713	2N2907A
Q776	151-0478-00			TRANSISTOR:SILICON,NPN	80009	151-0478-00
Q792	151-0224-00			TRANSISTOR:SILICON,NPN	80009	151-0224-00
Q796	151-0347-00			TRANSISTOR:SILICON,NPN	80009	151-0347-00
Q922	151-0410-00			TRANSISTOR:SILICON,PNP	80009	151-0410-00
Q924	151-0443-00			TRANSISTOR:SILICON,PNP	80009	151-0443-00
Q926	151-0302-00			TRANSISTOR:SILICON,NPN	07263	S038487
Q942	151-0444-00			TRANSISTOR:SILICON,NPN	80009	151-0444-00
Q944	151-0444-00			TRANSISTOR:SILICON,NPN	80009	151-0444-00
Q946	151-0279-02			TRANSISTOR:SILICON,NPN,SEL	80009	151-0279-02
Q948	151-0279-02			TRANSISTOR:SILICON,NPN,SEL	80009	151-0279-02
Q964	151-0444-00			TRANSISTOR:SILICON,NPN	80009	151-0444-00
Q2104, Q2106	151-1042-00	XB010315		SEMICOND DVC SE:MATCHED PAIR FET	80009	151-1042-00
Q2108	151-0188-00	XB010315		TRANSISTOR:SILICON,PNP	80009	151-0188-00
Q2114, Q2116	151-1042-00	B010100	B010314X	SEMICOND DVC SE:MATCHED PAIR FET	80009	151-1042-00

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R123	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R124	321-0126-00			RES.,FXD,FILM:200 OHM,1%,0.125W	91637	MFF1816G200R0F
R125	321-0184-00			RES.,FXD,FILM:806 OHM,1%,0.125W	91637	MFF1816G806R0F
R126	311-1559-00			RES.,VAR,NONWIR:10K OHM,20%,0.50W	73138	91A-10001M
R127	321-0184-00			RES.,FXD,FILM:806 OHM,1%,0.125W	91637	MFF1816G806R0F
R131	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R132	323-0137-00			RES.,FXD,FILM:261 OHM,1%,0.50W	75042	CECT0-2610F
R133	321-0088-00			RES.,FXD,FILM:80.6 OHM,1%,0.125W	91637	MFF1816G80R60F
R135	301-0131-00			RES.,FXD,CMPSN:130 OHM,5%,0.50W	01121	EB1315
R136	303-0151-00			RES.,FXD,CMPSN:150 OHM,5%,1W	01121	GB1515
R137	310-0703-00			RES.,FXD,WW:1900 OHM,1%,5.5W	80009	310-0703-00
R138	315-0100-00	XB010240		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R142	323-0137-00			RES.,FXD,FILM:261 OHM,1%,0.50W	75042	CECT0-2610F
R143	321-0107-00			RES.,FXD,FILM:127 OHM,1%,0.125W	91637	MFF1816G127R0F
R145	301-0131-00			RES.,FXD,CMPSN:130 OHM,5%,0.50W	01121	EB1315
R147	310-0703-00			RES.,FXD,WW:1900 OHM,1%,5.5W	80009	310-0703-00
R148	315-0100-00	XB010240		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R412	311-1786-00			RES.,VAR,NONWIR:2K OHM,20%,2W	12697	381-CM40946
R413	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R414	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R416	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R417	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R419	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R423	315-0513-00			RES.,FXD,CMPSN:51K OHM,5%,0.25W	01121	CB5135
R424	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R425	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R426	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R432	315-0223-00			RES.,FXD,CMPSN:22K OHM,5%,0.25W	01121	CB2235
R433	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R434	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R435	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R437	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R441	315-0185-00			RES.,FXD,CMPSN:1.8M OHM,5%,0.25W	01121	CB1855
R443	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R444A-D	307-0495-02			RES NTWK,THK FI:HIGH VOLTAGE,STORAGE	80009	307-0495-02
R446	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R447	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R453	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R455	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R457	301-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.50W	01121	EB1015
R458	301-0510-00	B010100	B012475	RES.,FXD,CMPSN:51 OHM,5%,0.50W	01121	EB5105
R458	308-0218-00	B012476		RES.,FXD,WW:150 OHM,5%,3W	91637	RS2B-B150R0J
R459	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R462	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R463	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R464	315-0226-00			RES.,FXD,CMPSN:22M OHM,5%,0.25W	01121	CB2265
R465	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R466	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R468	311-1784-00			RES.,VAR,NONWIR:5M OHM,20%,1W	12697	381-CM40944
R469	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R472	311-1562-00			RES.,VAR,NONWIR:2K OHM,20%,0.50W	73138	91A R2K
R476	301-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.50W	01121	EB3935
R477	311-1554-00			RES.,VAR,NONWIR:200K OHM,20%,0.50W	73138	91-76-0
R478	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R712	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R722	301-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.50W	01121	EB4735
R726	315-0104-00	B010100	B011706	RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R726	315-0823-00	B011707		RES.,FXD,CMPSN:82K OHM,5%,0.25W	01121	CB8235
R732	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R733	321-0367-00			RES.,FXD,FILM:64.9K OHM,1%,0.125W	91637	MFF1816G64901F
R734	308-0574-00			RES.,FXD,WW:10 OHM,5%,2W	91637	RS2B162K10R00J
R736	321-0392-00			RES.,FXD,FILM:118K OHM,1%,0.125W	91637	MFF1816G11802F
R737	321-0280-00			RES.,FXD,FILM:8.06K OHM,1%,0.125W	91637	MFF1816G80600F
R741	315-0391-00			RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
R742	315-0563-00			RES.,FXD,CMPSN:56K OHM,5%,0.25W	01121	CB5635
R745	315-0432-00			RES.,FXD,CMPSN:4.3K OHM,5%,0.25W	01121	CB4325
R746	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R747	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R752	321-0130-00			RES.,FXD,FILM:221 OHM,1%,0.125W	91637	MFF1816G221R0F
R753	321-0230-00			RES.,FXD,FILM:2.43K OHM,1%,0.125W	91637	MFF1816G24300F
R754	308-0755-00			RES.,FXD,WW:0.75 OHM,5%,2W	75042	BWH-R7500J
R756	321-0671-00			RES.,FXD,FILM:8.51K OHM,0.5%,0.125W	24546	NC55C8511D
R757	321-0671-00			RES.,FXD,FILM:8.51K OHM,0.5%,0.125W	24546	NC55C8511D
R762	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R763	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R764	321-0230-00	B010100	B013585	RES.,FXD,FILM:2.43K OHM,1%,0.125W	91637	MFF1816G24300F
R764	321-0259-00	B013586		RES.,FXD,FILM:4.87K OHM,1%,0.125W	91637	MFF1816G48700F
R765	321-0130-00	B010100	B013585	RES.,FXD,FILM:221 OHM,1%,0.125W	91637	MFF1816G221R0F
R765	321-0159-00	B013586		RES.,FXD,FILM:442 OHM,1%,0.125W	91637	MFF1816G442R0F
R766	301-0391-00	B010100	B013585	RES.,FXD,CMPSN:390 OHM,5%,0.50W	01121	EB3915
R766	301-0561-00	B013586		RES.,FXD,CMPSN:560 OHM,5%,0.50W	01121	EB5615
R772	321-0256-00			RES.,FXD,FILM:4.53K OHM,1%,0.125W	91637	MFF1816G45300F
R773	311-1563-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	73138	91A R1K
R774	321-0232-00			RES.,FXD,FILM:2.55K OHM,1%,0.125W	91637	MFF1816G25500F
R775	308-0755-00			RES.,FXD,WW:0.75 OHM,5%,2W	75042	BWH-R7500J
R792	321-0407-00			RES.,FXD,FILM:169K OHM,1%,0.125W	91637	MFF1816G16902F
R793	321-0283-00			RES.,FXD,FILM:8.66K OHM,1%,0.125W	91637	MFF1816G86600F
R794	321-0398-00			RES.,FXD,FILM:137K OHM,1%,0.125W	91637	MFF1816G13702F
R795	321-0283-00			RES.,FXD,FILM:8.66K OHM,1%,0.125W	91637	MFF1816G86600F
R796	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R797	315-0205-00			RES.,FXD,CMPSN:2M OHM,5%,0.25W	01121	CB2055
R912	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
R913	315-0134-00			RES.,FXD,CMPSN:130K OHM,5%,0.25W	01121	CB1345
R914	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R915	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R922	315-0822-00			RES.,FXD,CMPSN:8.2K OHM,5%,0.25W	01121	CB8225
R923	321-0410-00			RES.,FXD,FILM:182K OHM,1%,0.125W	91637	MFF1816G18202F
R924	321-0328-00			RES.,FXD,FILM:25.5K OHM,1%,0.125W	91637	MFF1816G25501F
R925	321-0247-00			RES.,FXD,FILM:3.65K OHM,1%,0.125W	91637	MFF1816G36500F
R926	311-1817-00			RES.,VAR,NONWIR:PNL,20K OHM,5%,0.5W	12697	389-CM40956
R927	321-0337-00	B010100	B010299	RES.,FXD,FILM:31.6K OHM,1%,0.125W	91637	MFF1816G31601F
R927	321-0327-00	B010300	B011466	RES.,FXD,FILM:24.9K OHM,1%,0.125W	91637	MFF1816G24901F
R927	315-0203-00	B011467		RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R928	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R930	311-1557-00	XB011467		RES.,VAR,NONWIR:25K OHM,20%,0.50W	73138	91A R24K
R932	321-0388-00			RES.,FXD,FILM:107K OHM,1%,0.125W	91637	MFF1816G10702F
R933	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
R934	311-1556-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	73138	91A R50K
R943	301-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.5W	01121	EB1045
R944	301-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.5W	01121	EB1045
R945	303-0683-00			RES.,FXD,CMPSN:68K OHM,5%,1W	01121	GB6835
R946	303-0683-00			RES.,FXD,CMPSN:68K OHM,5%,1W	01121	GB6835
R951	317-0473-00	XB010300	B011466	RES.,FXD,CMPSN:47K OHM,5%,0.125W	01121	BB4735
R951	315-0473-00	B011467		RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R953	315-0823-00			RES.,FXD,CMPSN:82K OHM,5%,0.25W	01121	CB8235
R954	311-1556-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	73138	91A R50K
R955	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R957	311-1556-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	73138	91A R50K
R961	315-0364-00			RES.,FXD,CMPSN:360K OHM,5%,0.25W	01121	CB3645
R962	315-0134-00			RES.,FXD,CMPSN:130K OHM,5%,0.25W	01121	CB1345
R963	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R964	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R982	311-1556-00			RES.,VAR,NONWIR:50K OHM,20%,0.50W	73138	91A R50K
R984	311-1552-00			RES.,VAR,NONWIR:500K OHM,20%,0.50W	73138	91-74-0
R2101	315-0203-00	XB010315		RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R2102	315-0272-00	XB010315		RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R2103	315-0202-00	XB010315		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R2104	315-0272-00	XB010315		RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R2105	315-0201-00	XB010315		RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
R2110	321-0233-00			RES.,FXD,FILM:2.61K OHM,1%,0.125W	91637	MFF1816G26100F
R2111	315-0112-00	B010100	B010314	RES.,FXD,CMPSN:1.1K OHM,5%,0.25W	01121	CB1125
R2111	315-0681-00	B010315		RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R2112	321-0463-00			RES.,FXD,FILM:649K OHM,1%,0.125W	91637	MFF1816G64902F
R2113	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R2114	321-0439-00			RES.,FXD,FILM:365K OHM,1%,0.125W	91637	MFF1816G36502F
R2115	321-0201-00			RES.,FXD,FILM:1.21K OHM,1%,0.125W	91637	MFF1816G12100F
R2116	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R2117	315-0562-00	B010100	B010314X	RES.,FXD,CMPSN:5.6K OHM,5%,0.25W	01121	CB5625
R2118	321-0233-00	B010100	B010314X	RES.,FXD,FILM:2.61K OHM,1%,0.125W	91637	MFF1816G26100F
R2119	315-0431-00	B010100	B010314X	RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R2120	315-0510-00	B010100	B010314X	RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R2121	315-0101-00	XB010300		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R2122	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
R2123	315-0182-00			RES.,FXD,CMPSN:1.8K OHM,5%,0.25W	01121	CB1825
R2124	315-0242-00			RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R2125	315-0561-00			RES.,FXD,CMPSN:560 OHM,5%,0.25W	01121	CB5615
R2126	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R2127	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R2128	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R2132	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R2133	301-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.50W	01121	EB3935
R2134	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R2135	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R2136	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R2137	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R2138	311-1787-00			RES.,VAR,NONWIR:20K OHM,10%,2W	12697	470-CM40947
R2142	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
R2143	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
R2144	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R2145	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
R2146	321-0255-00			RES.,FXD,FILM:4.42K OHM,1%,0.125W	91637	MFF1816G44200F
R2147	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R2152	315-0911-00			RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R2153	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R2160	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R2161	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R2162	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R2163	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R2164	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R2165	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R2167	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R2168	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R2184	321-0220-00			RES.,FXD,FILM:1.91K OHM,1%,0.125W	91637	MFF1816G19100F
R2188	315-0133-00			RES.,FXD,CMPSN:13K OHM,5%,0.25W	01121	CB1335
R2223	315-0152-00	B010100	B010499	RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R2223	315-0911-00	B010500		RES.,FXD,CMPSN:910 OHM,5%,0.25W	01121	CB9115
R2224	315-0272-00	B010100	B010499	RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R2224	315-0242-00	B010500		RES.,FXD,CMPSN:2.4K OHM,5%,0.25W	01121	CB2425
R2226	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R2227	315-0132-00	B010100	B010499	RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
R2227	315-0102-00	B010500		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R2233	315-0122-00			RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R2235	315-0681-00			RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R2236	315-0680-00			RES.,FXD,CMPSN:68 OHM,5%,0.25W	01121	CB6805
R2237	315-0752-00	B010100	B010379	RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R2237	315-0512-00	B010380		RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R2243	308-0212-00			RES.,FXD,WW:10K OHM,5%,3W	91637	CW2B-B10001J
R2244	321-0252-00			RES.,FXD,FILM:4.12K OHM,1%,0.125W	91637	MFF1816G41200F
R2245	321-0326-00			RES.,FXD,FILM:24.3K OHM,1%,0.125W	91637	MFF1816G24301F
R2246	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
R2247	321-0312-00			RES.,FXD,FILM:17.4K OHM,1%,0.125W	91637	MFF1816G17401F
R2252	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R2253	321-0444-00			RES.,FXD,FILM:412K OHM,1%,0.125W	91637	MFF1816G41202F
R2254	321-0377-00	B010100	B010649	RES.,FXD,FILM:82.5K OHM,1%,0.125W	91637	MFF1816G82501F
R2254	321-0377-01	B010650		RES.,FXD,FILM:82.5K OHM,0.5%,0.125W	91637	MFF1816G82501D
R2255	321-0377-00	B010100	B010649	RES.,FXD,FILM:82.5K OHM,1%,0.125W	91637	MFF1816G82501F
R2255	321-0377-01	B010650		RES.,FXD,FILM:82.5K OHM,0.5%,0.125W	91637	MFF1816G82501D
R2256	321-0348-00			RES.,FXD,FILM:41.2K OHM,1%,0.125W	91637	MFF1816G41201F
R2257	321-0281-00	B010100	B010649	RES.,FXD,FILM:8.25K OHM,1%,0.125W	91637	MFF1816G82500F
R2257	321-0281-01	B010650		RES.,FXD,FILM:8.25K OHM,0.5%,0.125W	91637	MFF1816G82500D
R2258	321-0281-00	B010100	B010649	RES.,FXD,FILM:8.25K OHM,1%,0.125W	91637	MFF1816G82500F
R2258	321-0281-01	B010650		RES.,FXD,FILM:8.25K OHM,0.5%,0.125W	91637	MFF1816G82500D
R2262	322-0519-01			RES.,FXD,FILM:2.49M OHM,0.5%,0.25W	91637	HFF143G24903D
R2263	321-0473-00	B010100	B010649	RES.,FXD,FILM:825K OHM,1%,0.125W	91637	MFF1816G82502F
R2263	321-0473-01	B010650		RES.,FXD,FILM:825K OHM,0.5%,0.125W	91637	MFF1816G82502D
R2264	321-0473-00	B010100	B010649	RES.,FXD,FILM:825K OHM,1%,0.125W	91637	MFF1816G82502F
R2264	321-0473-01	B010650		RES.,FXD,FILM:825K OHM,0.5%,0.125W	91637	MFF1816G82502D
R2273	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R2275	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R2276	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R2279	315-0622-00			RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R2312	321-0300-00	B010100	B011422	RES.,FXD,FILM:13K OHM,1%,0.125W	91637	MFF1816G13001F
R2312	321-0299-00	B011423		RES.,FXD,FILM:12.7K OHM,1%,0.125W	91637	MFF1816G12701F
R2313	321-0260-00			RES.,FXD,FILM:4.99K OHM,1%,0.125W	91637	MFF1816G49900F
R2315	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R2316	311-1788-00			RES.,VAR,NONWIR:20K OHM,20%,2W	12697	470-CM40948
R2317	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R2322	311-1789-00			RES.,VAR,NONWIR:100K OHM,10%,1W	12697	381-CM40949
R2323	321-0197-00			RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
R2324	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R2325	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R2326	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R2327	315-0331-00			RES.,FXD,CMPSN:330 OHM,5%,0.25W	01121	CB3315
R2332	311-1814-00	B010100	B010448	RES.,VAR,NONWIR:2K OHM,20%,0.50W	73138	91XR2K
R2332	311-1239-00	B010449		RES.,VAR,NONWIR:2.5K OHM,10%,0.50W	73138	72X-76-0-252K
R2333	315-0162-00			RES.,FXD,CMPSN:1.6K OHM,5%,0.25W	01121	CB1625
R2334	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R2335	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R2336	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R2337	308-0258-00			RES.,FXD,WW:6K OHM,5%,3W	91637	CW2B-6006J
R2342	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R2344	315-0753-00			RES.,FXD,CMPSN:75K OHM,5%,0.25W	01121	CB7535
R2345	315-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R2347	308-0258-00			RES.,FXD,WW:6K OHM,5%,3W	91637	CW2B-6006J
R2352	315-0124-00			RES.,FXD,CMPSN:120K OHM,5%,0.25W	01121	CB1245
R2353	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R2354	315-0123-00			RES.,FXD,CMPSN:12K OHM,5%,0.25W	01121	CB1235
R2355	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R2356	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R2357	315-0752-00			RES.,FXD,CMPSN:7.5K OHM,5%,0.25W	01121	CB7525
R2392	301-0240-00	B010100	B010299	RES.,FXD,CMPSN:24 OHM,5%,0.50W	01121	EB2405
R2392	301-0270-00	B010300		RES.,FXD,CMPSN:27 OHM,5%,0.50W	01121	EB2705
R4102	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R4103	317-0150-00	XB012605		RES.,FXD,CMPSN:15 OHM,5%,0.125W	01121	BB1505
R4104	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R4105	321-0790-01			RES.,FXD,FILM:990K OHM,0.5%,0.125W	91637	MFF1104G99002D
R4106	315-0180-00			RES.,FXD,CMPSN:18 OHM,5%,0.25W	01121	CB1805
R4107	321-1289-01			RES.,FXD,FILM:10.1K OHM,0.5%,0.125W	91637	MFF1816G10101D
R4108	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
R4114	321-0807-01			RES.,FXD,FILM:900K OHM,0.5%,0.125W	91637	MFF1816G90002D
R4116	321-1389-01			RES.,FXD,FILM:111K OHM,0.5%,0.125W	91637	MFF1816G11102D
R4117	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R4118	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R4122	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	91637	MFF1816G10003F
R4123	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R4126	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	MFF1816G20R00F
R4127	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	MFF1816G20R00F
R4128	315-0823-00	XB010550	B012986X	RES.,FXD,CMPSN:82K OHM,5%,0.25W	01121	CB8235
R4129	315-0122-00	XB010550	B012986X	RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R4132	311-1557-00			RES.,VAR,NONWIR:25K OHM,20%,0.50W	73138	91A R24K
R4133	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R4134	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R4136	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R4137	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R4138	321-0077-00			RES.,FXD,FILM:61.9 OHM,1%,0.125W	91637	MFF1816G61R90F
R4143	321-0062-00			RES.,FXD,FILM:43.2 OHM,1%,0.125W	91637	MFF1816G43R20F
R4144	321-0114-00			RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R4145	321-0771-01			RES.,FXD,FILM:50 OHM,0.5%,0.125W	91637	MFF1816G50R00D
R4146	321-0771-01			RES.,FXD,FILM:50 OHM,0.5%,0.125W	91637	MFF1816G50R00D
R4147	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	MFF1816G20R00F
R4151	311-1563-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	73138	91A R1K
R4152	311-1785-00			RES.,VAR,NONWIR:1K OHM,5%,2W	12697	381-CM40945
R4154	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F
R4155	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R4156	321-0172-00			RES.,FXD,FILM:604 OHM,1%,0.125W	91637	MFF1816G604R0F
R4158	315-0113-00			RES.,FXD,CMPSN:11K OHM,5%,0.25W	01121	CB1135
R4161	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392R0F
R4162	321-0070-00			RES.,FXD,FILM:52.3 OHM,1%,0.125W	91637	MFF1816G52R30F
R4163	321-0072-00			RES.,FXD,FILM:54.9 OHM,1%,0.125W	91637	MFF1816G54R90F
R4164	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F
R4165	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R4166	321-0172-00			RES.,FXD,FILM:604 OHM,1%,0.125W	91637	MFF1816G604R0F
R4168	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R4173	321-0039-00			RES.,FXD,FILM:24.9 OHM,1%,0.125W	91637	MFF1816G24R90F
R4174	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
	----- -----			(R4174, SEE OPTION 1 FOR ALTERNATE VERSION.)		

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R4175	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R4175	----- -----			(R4175, SEE OPTION 1 FOR ALTERNATE VERSION.)		
R4202	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R4203	317-0150-00	XB012605		RES.,FXD,CMPSN:15 OHM,5%,0.125W	01121	BB1505
R4204	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R4205	321-0790-01			RES.,FXD,FILM:990K OHM,0.5%,0.125W	91637	HFF1104G990002D
R4206	315-0180-00			RES.,FXD,CMPSN:18 OHM,5%,0.25W	01121	CB1805
R4207	321-1289-01			RES.,FXD,FILM:10.1K OHM,0.5%,0.125W	91637	MFF1816G10101D
R4208	315-0330-00			RES.,FXD,CMPSN:33 OHM,5%,0.25W	01121	CB3305
R4214	321-0807-01			RES.,FXD,FILM:900K OHM,0.5%,0.125W	91637	MFF1816G90002D
R4216	321-1389-01			RES.,FXD,FILM:111K OHM,0.5%,0.125W	91637	MFF1816G11102D
R4217	315-0100-00			RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
R4218	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R4222	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	91637	MFF1816G10003F
R4223	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R4226	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	MFF1816G20R00F
R4227	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	MFF1816G20R00F
R4228	315-0823-00	XB010550	B012986X	RES.,FXD,CMPSN:82K OHM,5%,0.25W	01121	CB8235
R4229	315-0122-00	XB010550	B012986X	RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R4232	311-1557-00			RES.,VAR,NONWIR:25K OHM,20%,0.50W	73138	91A R24K
R4233	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R4234	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R4236	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R4237	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R4238	321-0077-00			RES.,FXD,FILM:61.9 OHM,1%,0.125W	91637	MFF1816G61R90F
R4243	321-0062-00			RES.,FXD,FILM:43.2 OHM,1%,0.125W	91637	MFF1816G43R20F
R4244	321-0114-00			RES.,FXD,FILM:150 OHM,1%,0.125W	91637	MFF1816G150R0F
R4245	321-0771-01			RES.,FXD,FILM:50 OHM,0.5%,0.125W	91637	MFF1816G50R00D
R4246	321-0771-01			RES.,FXD,FILM:50 OHM,0.5%,0.125W	91637	MFF1816G50R00D
R4247	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	MFF1816G20R00F
R4251	311-1563-00			RES.,VAR,NONWIR:1K OHM,20%,0.50W	73138	91A R1K
R4252	311-1785-00			RES.,VAR,NONWIR:1K OHM,5%,2W	12697	381-CM40945
R4254	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F
R4255	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R4256	321-0172-00			RES.,FXD,FILM:604 OHM,1%,0.125W	91637	MFF1816G604R0F
	----- -----			(R4256, SEE OPTION 1 FOR ALTERNATE VERSION.)		
R4258	315-0113-00			RES.,FXD,CMPSN:11K OHM,5%,0.25W	01121	CB1135
R4259	----- -----			(SEE OPTION 1)		
R4261	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392R0F
R4262	321-0070-00			RES.,FXD,FILM:52.3 OHM,1%,0.125W	91637	MFF1816G52R30F
R4263	321-0072-00			RES.,FXD,FILM:54.9 OHM,1%,0.125W	91637	MFF1816G54R90F
R4264	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F
R4265	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R4266	321-0172-00			RES.,FXD,FILM:604 OHM,1%,0.125W	91637	MFF1816G604R0F
R4268	315-0912-00			RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
R4273	321-0039-00			RES.,FXD,FILM:24.9 OHM,1%,0.125W	91637	MFF1816G24R90F
R4274	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R4275	315-0392-00			RES.,FXD,CMPSN:3.9K OHM,5%,0.25W	01121	CB3925
R4301	----- -----			(SEE OPTION 1)		
R4302	315-0361-00	B010100	B010299	RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
R4302	321-0150-00	B010300		RES.,FXD,FILM:357 OHM,1%,0.125W	91637	MFF1816G357R0F
	----- -----			(R4302, SEE OPTION 1 FOR ALTERNATE VERSION.)		
R4303	315-0431-00	B010100	B010299	RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R4303	321-0158-00	B010300		RES.,FXD,FILM:432 OHM,1%,0.125W	91637	MFF1816G432R0F
	----- -----			(R4303, SEE OPTION 1 FOR ALTERNATE VERSION.)		
R4306	311-1787-00			RES.,VAR,NONWIR:20K OHM,10%,2W	12697	470-CM40947

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R4307	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R4310	----- -----			(SEE OPTION 1)		
R4311	----- -----			(SEE OPTION 1)		
R4312	----- -----			(SEE OPTION 1)		
R4313	----- -----			(SEE OPTION 1)		
R4316	311-1787-00			RES.,VAR,NONWIR:20K OHM,10%,2W	12697	470-CM40947
R4317	315-0203-00			RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R4320	----- -----			(SEE OPTION 1)		
R4321	----- -----			(SEE OPTION 1)		
R4322	321-0276-00			RES.,FXD,FILM:7.32K OHM,1%,0.125W	91637	MFF1816G73200F
R4323	321-0276-00			RES.,FXD,FILM:7.32K OHM,1%,0.125W	91637	MFF1816G73200F
R4324	321-0170-00			RES.,FXD,FILM:576 OHM,1%,0.125W	91637	MFF1816G576R0F
R4325	321-0172-00			RES.,FXD,FILM:604 OHM,1%,0.125W	91637	MFF1816G604R0F
R4326	321-0172-00			RES.,FXD,FILM:604 OHM,1%,0.125W	91637	MFF1816G604R0F
R4327	321-0157-00			RES.,FXD,FILM:422 OHM,1%,0.125W	91637	MFF1816G422R0F
R4328	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R4333	315-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.25W	01121	CB4735
R4334	311-1557-00			RES.,VAR,NONWIR:25K OHM,20%,0.50W	73138	91A R24K
R4336	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R4337	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R4338	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4342	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R4344	311-1557-00			RES.,VAR,NONWIR:25K OHM,20%,0.50W	73138	91A R24K
R4346	321-0222-00			RES.,FXD,FILM:2K OHM,1%,0.125W	91637	MFF1816G20000F
R4347	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R4348	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4349	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4358	----- -----			(SEE OPTION 1)		
R4364	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4365	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4366	315-0471-00	XB010300		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
	----- -----			(R4366, USED FOR ALL S/N'S OF OPTION 1)		
R4367	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R4368	315-0101-00	B010100	B010299	RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4368	315-0241-00	B010300		RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R4369	315-0101-00	B010100	B010299	RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4369	315-0241-00	B010300		RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R4370	315-0471-00	XB010300		RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
	----- -----			(R4370, USED FOR ALL S/N'S OF OPTION 1)		
R4371	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4372	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R4373	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4374	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4375	315-0202-00	B010100	B010299	RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R4375	315-0272-00	B010300		RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R4377	315-0202-00	B010100	B010299	RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R4377	315-0272-00	B010300		RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
R4380	----- -----			(SEE OPTION 1)		
R4382	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
R4384	315-0102-00	XB010300		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4385	315-0153-00	B010100	B010299	RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R4385	315-0622-00	B010300		RES.,FXD,CMPSN:6.2K OHM,5%,0.25W	01121	CB6225
R4386	315-0301-00			RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R4392	315-0510-00			RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
	----- -----			(R4392, SEE OPTION 1 FOR ALTERNATE VERSION.)		
R4394	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R4395	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R4396	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R4397	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
RT105	307-0125-00			RES.,THERMAL:500 OHM,10%,25 DEG C	50157	201595
S410	260-1421-00			SWITCH,PUSH:1 STA,MOMENTARY,NON-SHORT	80009	260-1421-00
S700	260-1768-00			SWITCH,PUSH:DPDT,3A,125VAC	82389	14S-7102C
S701	260-1776-00			SWITCH,SLIDE:DPDT,3A,125VAC	82389	11A-1497A
S705	260-1776-00			SWITCH,SLIDE:DPDT,3A,125VAC	82389	11A-1497A
S910A,B	260-1787-00			SWITCH,PUSH:DPDT,2 BUTTON,MOMENTARY	80009	260-1787-00
S915	260-1208-00			SWITCH,PUSH:DPDT,28VDC,PUSH-PUSH	80009	260-1208-00
S2100	214-2288-02			LEVER,SWITCH:STYLE A,17.5 DEG,W/CONTACTS	80009	214-2288-02
S2140	260-1445-02			SWITCH,PUSH:DPDT,W/8 POLESPRING	80009	260-1445-02
S2150	214-2290-01			LEVER,SWITCH:STYLE C,TRIG,RESET,W/CONT	80009	214-2290-01
S2250	----- -----			(REPLACEABLE ONLY AS PART OF A13, 672-0523-00)		
S4100	105-0678-00	B010100	B011062	ACTUATOR,CAM SW:AC-DC GND,W/LEVER	80009	105-0678-00
S4100	105-0678-01	B011063		ACTUATOR,CAM SW:AC-DC GND,CH 1	80009	105-0678-01
S4110	105-0679-00			ACTUATOR,CAM SW:ATTENUATOR	80009	105-0679-00
S4200	105-0678-00	B010100	B011062	ACTUATOR,CAM SW:AC-DC GND,W/LEVER	80009	105-0678-00
S4200	105-0678-02	B011063		ACTUATOR,CAM SW:AC-DC GND,CH 2	80009	105-0678-02
S4210	105-0679-00			ACTUATOR,CAM SW:ATTENUATOR	80009	105-0679-00
S4370	260-1782-00			SWITCH,PUSH:3 BUTTON,DPDT,10MM	80009	260-1782-00
	----- -----			(S4370, SEE OPTION 1 FOR ALTERNATE VERSION.)		
T460	120-0997-00			XFMR,PWR,STU:HV	80009	120-0997-00
T700	120-0995-00	B010100	B011706	XFMR,PWR,SDN&SU:	80009	120-0995-00
T700	120-0995-01	B011707		XFMR,PWR,SDN&SU:	80009	120-0995-01
U24	156-0067-00			MICROCIRCUIT,LI:OPERATIONAL AMPLIFIER	80009	156-0067-00
U742A,B	156-0158-00	B010100	B012699	MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-00
U742A,B	156-0158-04	B012700		MICROCIRCUIT,LI:DUAL OPERATIONAL AMPLIFIER	80009	156-0158-04
U784	156-0285-00			MICROCIRCUIT,LI:VOLTAGE REGULATOR	27014	LM340T-12
U2126A-E	156-0197-03			MICROCIRCUIT,LI:5-XSTR ARRAY	80009	156-0197-03
U2156A-D	156-0030-01			MICROCIRCUIT,DI:QUAD 2-INPUT AND GATE	80009	156-0030-01
U2212A-D	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0030-00
U2224A,B	156-0405-01			MICROCIRCUIT,DI:DUAL RETRIG ONE-SHOT	80009	156-0405-01
U2234A-D	156-0030-00	B010100	B010299	MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0030-00
U2234A-D	156-0113-00	B010300	B010529	MICROCIRCUIT,DI:QUAD 2-INP NAND GATE	80009	156-0113-00
U2234A-D	156-0030-00	B010530		MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0030-00
U4134A-D	156-0197-03			MICROCIRCUIT,LI:5-XSTR ARRAY	80009	156-0197-03
U4234A-D	156-0197-03			MICROCIRCUIT,LI:5-XSTR ARRAY	80009	156-0197-03
U4360	----- -----			(SEE OPTION 1)		
U4364A,B	156-0041-00			MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	27014	DM7474N
U4376A-D	156-0030-00			MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	80009	156-0030-00
V470	154-0733-00	B010100	B012476	ELECTRON TUBE:CRT	80009	154-0733-00
V470	154-0733-01	B012477		ELECTRON TUBE:CRT,T5643-200	80009	154-0733-01
VR412	152-0280-00			SEMICOND DEVICE:ZENER,0.4W,6.2V,5%	80009	152-0280-00
VR476	152-0428-00			SEMICOND DEVICE:ZENER,0.4W,120V,5%	80009	152-0428-00
VR746	152-0306-00			SEMICOND DEVICE:ZENER,0.4W,9.1V,5%	80009	152-0306-00
VR762	152-0195-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0195-00
VR951	152-0427-00	XB010300		SEMICOND DEVICE:ZENER,0.4W,100V,5%	80009	152-0427-00
VR964	152-0287-00			SEMICOND DEVICE:ZENER,0.4W,110V,5%	04713	1N986B
VR2123	152-0279-00	B010100	B010299	SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0279-00
VR2123	152-0226-00	B010300		SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0226-00
VR2392	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0279-00
VR4367	152-0395-00			SEMICOND DEVICE:ZENER,0.4W,4.3V,5%	04713	1N749A
VR4392	152-0279-00			SEMICOND DEVICE:ZENER,0.4W,5.1V,5%	80009	152-0279-00

OPTIONS

Your instrument may be equipped with one or more options. This section describes those options, or directs the reader to where the option is documented.

Option 1	Differential Mode	Described in this Section

(Schematic diagrams for Option 1 are included at the end of the Diagrams section in this manual.)

T912 OPTION 1 DIFFERENTIAL MODE

NOTE

This description includes the operation and maintenance of the added features of Option 1. For all other information concerning the T912, refer to the appropriate section of this manual. Schematic Diagrams for Option 1 are included at the end of the Diagrams section in this manual.

OPERATING INFORMATION

Introduction

The T912 Option 1 includes a fourth vertical mode pushbutton (labeled DIFF) which, when pressed in alone, inverts the CH 2 signal and displays the sum of the CH 1 and CH 2 signals. (If the DUAL TRACE button is pressed along with the DIFF button, CH 2 is inverted and each signal is displayed but not summed.) The algebraic sum (difference) of the CH 1 and CH 2 signals is a useful feature for rejecting unwanted common-mode signals such as line-frequency components. The DIFF button may also be used in conjunction with other mode buttons to provide a variety of modes as shown in the table.

DIFF Mode Operation

To operate the instrument in the DIFF mode, perform the appropriate First Time Operation steps in Section 2 of this manual, then:

1. Connect the signal you wish to view to CH 1 input.

2. Connect a sample of the unwanted signal to CH 2 input.

3. Set: Vertical Mode — DIFF
   SOURCE — For desired trigger condition

4. Adjust the CH 1 and CH 2 VOLTS/DIV and VAR controls to obtain the desired display (null of common-mode signal).

Option 1 Vertical Modes
(button in and display normal unless otherwise stated)

Vertical Mode Button	Displayed Signal	Internal Trigger Source
DIFF & CH 2	CH 2 Inverted	CH 2
DUAL TRACE & DIFF	CH 1 and Inverted CH 2	CH 1
DUAL TRACE, DIFF, & CH 2	CH 1 and Inverted CH 2	CH 2
DUAL TRACE & CH 2	CH 1 and CH 2	CH 2
CH 1 & CH 2	CH 1 & CH 2 Alternate	CH 2
DIFF	Differential (CH 1 — CH 2)	CH 1
All Buttons Out	CH 1 & CH 2 Added	CH 1

CIRCUIT DESCRIPTION

Introduction

The following paragraphs describe circuitry unique to Option 1. Refer to the Circuit Description section of this manual for a description of those portions of the circuitry that are unchanged by Option 1. Note that numbering of the terminals and sections of several integrated circuits in Option 1 differs from their counterparts in the standard instrument.

Refer to the Option 1 schematic diagrams at the back of the Diagrams section of this manual for circuitry discussed in this circuit description.

Digital Logic devices are used to perform some of the functions in this instrument. LO and HI designations are used in this circuit description to indicate the state of the digital circuit. HI indicates the more positive of the two levels. The specific voltages which constitute LO and HI logic states, may vary between individual devices.

Preamplifier

The buffer stages Q4302 and Q4303 isolate the channel 1 preamplifier from the switching diodes and from the delay line driver.

The channel 2 preamplifier is isolated from the switching diodes and the delay line driver by transistors Q4310 and Q4311 or transistors Q4312 and Q4313.

For a normal display (DIFF button not depressed), the channel 2 signal is passed through Q4312 and Q4313 to the switching diodes. Vertical Mode switch S4370 connects approximately +4.4 V from R4302, R4303, and R4313 through R4312 to the bases of Q4312 and Q4313. At the same time, +8 V is connected to Q4310 and Q4311 through R4311 and R4310. This biases off Q4310 and Q4311.

For a DIFF display (DIFF button depressed), the channel 2 signal passes through Q4310 and Q4311 to the switching diodes. S4370 connects +4.4 V from R4302, R4303, R4311, and R4310 to the bases of Q4310 and Q4311. This biases on Q4310 and Q4311. At the same time, +8 V is connected to the bases of Q4312 and Q4313 through R4313 and R4312. This biases off Q4312 and Q4313. The signal that was normally supplied to CR4314, through Q4312, is now supplied to CR4315 through Q4310. The signal normally supplied to CR4315, through Q4313, is now supplied to CR4314 through Q4311. The resulting display is the difference between the signals applied to the CH 1 and CH 2 inputs (CH 1 minus CH 2).

Vertical Switching

The vertical switching circuit determines whether CH 1, CH 2, or both CH 1 and CH 2 are connected to the delay line driver stage. This circuit is controlled by the Vertical Mode switch. In the DUAL TRACE alternate or chopped modes, both channels are alternately displayed on a time shared basis. In the DIFF mode, the channel 2 signal is inverted and both channels are connected to the delay line driver stage at the same time.

The diode gates, consisting of four diodes each, act as switches that allow either or both of the vertical preamplifier signals to be coupled to the delay line driver. Diodes CR4302, CR4303, CR4304, and CR4305 control the channel 1 output and CR4312, CR4313, CR4314, and CR4315 control the channel 2 output. These diodes are controlled by U4364B, U4360 respectively, and by the Vertical Mode switch, S4370.

CH 1 Mode: When the Vertical Mode switch is in the CH 1 position, pin 11 of U4360D is held LO causing pin 13 of U4364B to go HI. At the same time pins 2 and 3 of U4360A are HI causing pin 10 of U4364B to go LO. A LO on pin 10 and a HI on pin 13 of U4364B causes pin 9 to go HI and pin 8 to go LO. A HI at pin 9 (a voltage higher than at the bases of Q4322 and Q4324) reverse biases CR4302 and CR4303 and forward biases CR4304 and CR4305. This allows the channel 1 signal to pass to the delay line driver. When pin 9 is HI, pin 8 is LO, causing the cathodes of CR4312 and CR4313 to be connected to a voltage much lower than on the bases of Q4322 and Q4324. Diodes CR4312 and CR4313 are now forward biased and CR4314 and CR4315 are reverse biased. This prevents the channel 2 signal from passing to the delay line driver.

CH 2 Mode: In the channel 2 mode, the above conditions are reversed, passing the channel 2 signal and blocking the channel 1 signal.

DIFF Mode: In the DIFF mode, pin 11 of U4360D and pins 2 and 3 of U4360A are HI, causing pins 10 and 13 of U4364B to go low. This in turn makes pins 8 and 9 of U4364B go HI. Diodes CR4302, CR4303, CR4312, and CR4313 are no longer reverse biased, and CR4304, CR4305, CR4314, and CR4315 are also forward biased. This allows both channel 1 and channel 2 signals to pass on to the delay line driver stage. The −8 V supplied via S4370 to R4320 and R4321 provides sufficient current to keep both diode gates turned on without altering the dc levels of the delay line driver.

DUAL TRACE Mode: In the DUAL TRACE mode, channel 1 and channel 2 are alternately connected to the delay line driver. There are two dual trace modes: chopped and alternate. These modes are determined by the

SEC/DIV switch setting. Chopped mode is obtained for sweep speeds of 1 ms and slower; alternate mode is obtained for sweep speeds of 0.5 ms and faster.

In the DUAL TRACE mode CR4360 and CR4361 are forward biased so that pins 10 and 13 of U4364B are HI. This allows U4364B to change state upon arrival of a clock pulse.

In the chopped mode, pin 1 of U4376A is ungrounded, allowing the multivibrator, U4376A and U4376B, to free run at about 500 kHz. The output at pin 11 of U4376D serves as a clock pulse for U4364B. The state of U4364B changes on each negative transition of U4376D pin 11. Pins 8 and 9 of U4364B switch the diode gates at a 250 kHz rate.

The clock pulse is also fed to U4364A which provides an output pulse to the Z-axis amplifier to blank out the transitions between channel 1 and channel 2 traces. U4364A, U4376C and associated components form a one-shot. If pin 1 of U4364A goes LO, the output pin 5 is set LO, causing pin 8 of U4376C to go HI. This in turn causes pin 1 of U4364A to go HI after being delayed by C4386 charging through R4386.

The clock pulse applied to pin 3 of U4364A causes pin 5 to go HI, which, after inversion and some delay, moves pin 1 LO again. This causes pin 5 to go LO again. The positive-going voltage pulse (whose width is determined by R4386 and C4386) is converted to current by R4385 and sent to the Z-axis amplifier to blank switching transients.

In the alternate mode, pin 1 of U4376A is grounded, preventing multivibrator operation, thus keeping pin 12 of U4376D HI. At the end of each sweep, the base of Q4372 receives a current pulse driving it into saturation. The resulting negative-going pulse at the collector is fed through C4372 to pin 13 of U4376D, causing pin 11 to go HI. This in turn switches U4364B to pass either channel 1 or channel 2 to the delay line driver at the end of each sweep. Pin 2 of U4364A is grounded through the SEC/DIV switch and prevents an output at pin 5.

For a discussion of the Delay Line and the Delay Line Driver circuits, refer to the Circuit Description section of this manual.

Trigger Pickoff: The Vertical Mode switch also selects the appropriate internal triggering source for channel 1 and channel 2. With the Vertical Mode switch set to CH 1, DUAL TRACE, or DIFF, CR4364 is forward biased and the signal from the channel 1 trigger pickoff goes to the sweep circuit. In these modes, CR4362 is connected to −8 volts, thus reverse biasing CR4366, preventing the channel 2 trigger signal from entering the trigger input amplifier. With the Vertical Mode switch set to CH 2, CR4366 becomes forward biased while CR4364 is reverse biased, because CR4363 is now connected to −8 volts. Refer to the Circuit Description section of this manual for a discussion of the rest of the Trigger Pickoff circuitry, which is common to all versions of the T912.

CMRR PERFORMANCE CHECK (Perform after Step 4 of Section 3 PERFORMANCE CHECK)

Equipment Required

(See Table 3-1 in Section 3 of this manual for equipment specifications and recommended types.)

1. Sine-Wave Generator
2. 50 Ω BNC Cable
3. 50 Ω BNC Termination
4. 50 Ω BNC Dual-Input Coupler

Equipment Setup

Connect the sine-wave generator to the CH 1 and CH 2 inputs via a 50 Ω bnc cable, 50 Ω bnc termination, and dual-input coupler.

Procedure

1. Set: Vertical Mode — CH 1
   CH 1 and CH 2 VOLTS/DIV — 5 mV
   CH 1 and CH 2 AC-GND-DC — AC
   SOURCE — INT
   MODE — AUTO

2. Set generator to 50 kHz. Adjust generator for a six-division display.

3. Set Vertical Mode to DIFF.

4. Adjust one of the VAR VOLTS/DIV controls for minimum vertical deflection (best CMRR).

5. Without readjusting generator amplitude, set generator frequency to 5 MHz.

6. CHECK—Vertical deflection is 0.6 division or less.

DIFFERENTIAL BALANCE ADJUSTMENT (Perform after Step 6 of VERTICAL AMPLIFIER ADJUSTMENTS)

1. Set: CH 1 and CH 2 AC-GND-DC — GND
   Vertical Mode — CH 1

2. Adjust CH 1 POSITION to move the trace to the center horizontal graticule line.

3. Set: Vertical Mode — CH 2
   CH 2 POSITION — Midrange

4. ADJUST—Differential Balance, R4259. Alternately push the CH 2 and DIFF buttons. The adjustment is correct when there is no vertical trace shift while alternately pushing the CH 2 and DIFF buttons. You may need to readjust the CH 2 POSITION control to keep the trace on the screen.

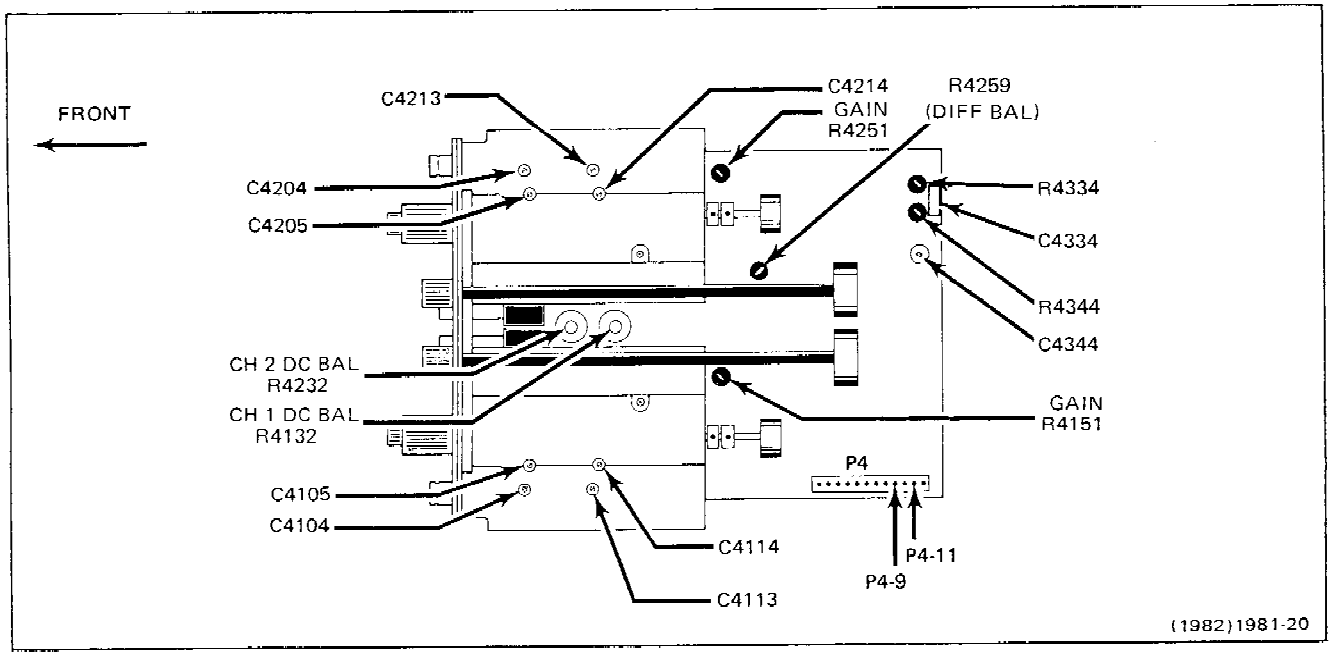


Fig. Option 1-1. Adjustment locations.

Replaceable Electrical Parts

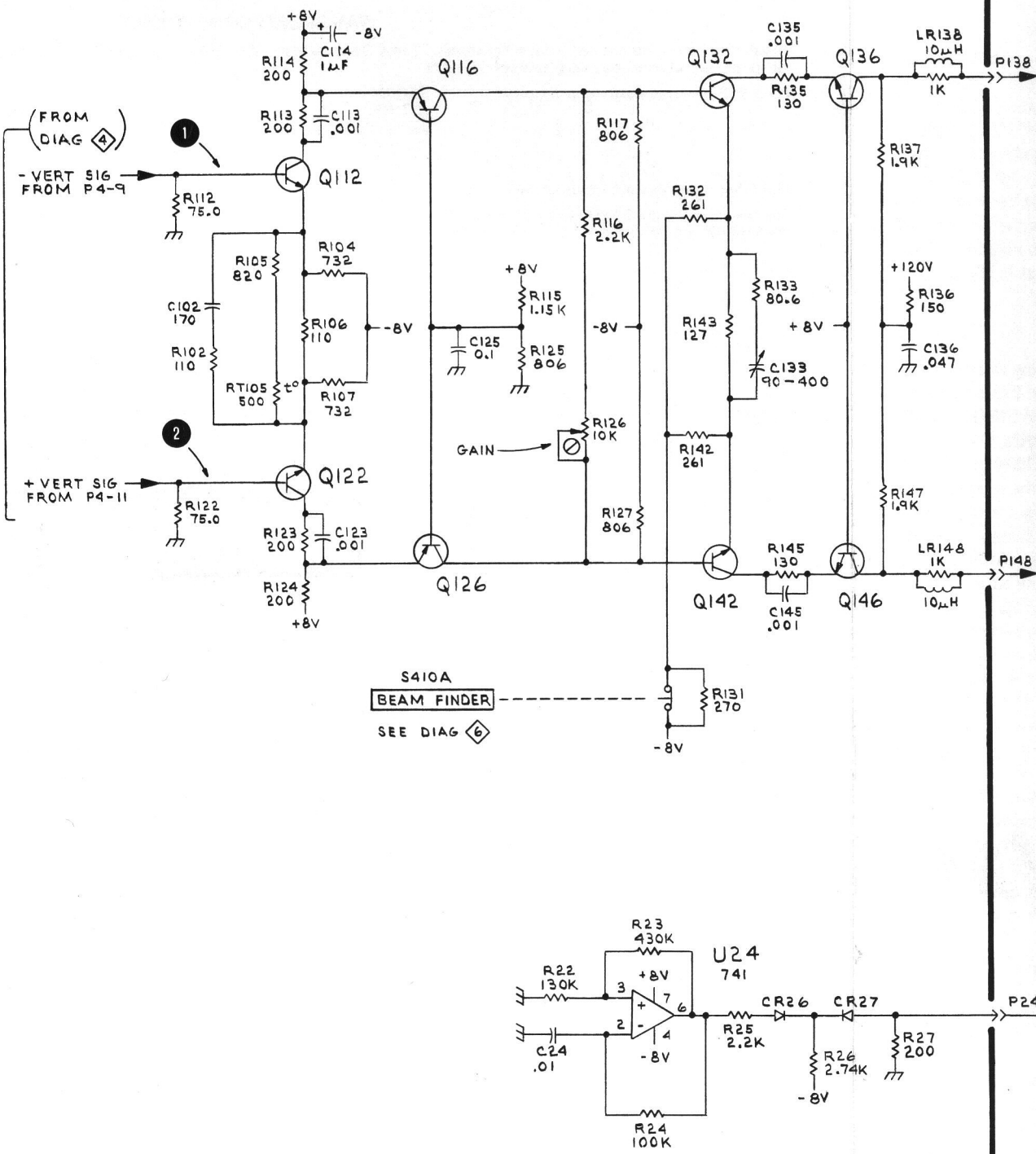
Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
	----- -----			(REPLACEABLE ELECTRICAL PARTS)		
	----- -----			(DIFFERENCES BETWEEN OPTION 1 T912 AND		
	----- -----			STANDARD T912)		
CHANGE TO:						
A8	670-4389-00	B010100	B012986	CKT BOARD ASSY:VERTICAL	80009	670-4389-00
A8	670-4389-01	B012987		CKT BOARD ASSY:VERTICAL	80009	670-4389-01
C4155	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	72982	8005H9AADW5R471K
C4165	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	72982	8005H9AADW5R471K
C4255	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	72982	8005H9AADW5R471K
C4265	281-0788-00			CAP.,FXD,CER DI:470PF,10%,100V	72982	8005H9AADW5R471K
Q4322	151-0434-00			TRANSISTOR:SILICON,PNP	80009	151-0434-00
Q4324	151-0434-00			TRANSISTOR:SILICON,PNP	80009	151-0434-00
R4174	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R4175	321-0251-00			RES.,FXD,FILM:4.02K OHM,1%,0.125W	91637	MFF1816G40200F
R4256	321-0170-00			RES.,FXD,FILM:576 OHM,1%,0.125W	91637	MFF1816G576R0F
R4302	321-0169-00			RES.,FXD,FILM:562 OHM,1%,0.125W	91637	MFF1816G562R0F
R4303	321-0158-00			RES.,FXD,FILM:432 OHM,1%,0.125W	91637	MFF1816G432R0F
R4392	315-0390-00			RES.,FXD,CMPSN:39 OHM,5%,0.25W	01121	CB3905
S4370	260-1823-00			SWITCH,PUSH:VERTICAL MODE,2 POLE INTLK	80009	260-1823-00
ADD:						
C4303	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C4368	283-0103-00			CAP.,FXD,CER DI:180PF,5%,500V	56289	40C638
CR4360	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
CR4361	152-0141-02			SEMICOND DEVICE:SILICON,30V,50NA	01295	1N4152R
Q4310	151-0199-00			TRANSISTOR:SILICON,PNP	80009	151-0199-00
Q4311	151-0199-00			TRANSISTOR:SILICON,PNP	80009	151-0199-00
R4128	315-0823-00	B010100	B012986X	RES.,FXD,CMPSN:82K OHM,5%,0.25W	01121	CB8235
R4129	315-0122-00	B010100	B012986X	RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R4228	315-0823-00	B010100	B012986X	RES.,FXD,CMPSN:82K OHM,5%,0.25W	01121	CB8235
R4229	315-0122-00	B010100	B012986X	RES.,FXD,CMPSN:1.2K OHM,5%,0.25W	01121	CB1225
R4259	311-1568-00			RES.,VAR,NONWIR:50 OHM,20%,0.50W	73138	91A R50
R4301	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4310	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4311	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R4312	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4313	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R4320	321-0263-00			RES.,FXD,FILM:5.36K OHM,1%,0.125W	91637	MFF1816G53600F
R4321	321-0263-00			RES.,FXD,FILM:5.36K OHM,1%,0.125W	91637	MFF1816G53600F
R4358	315-0241-00			RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R4366	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R4370	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R4380	315-0472-00			RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
U4360	156-0043-00			MICROCIRCUIT,DI:QUAD 2-INPUT POS NOR GATE	80009	156-0043-00
REMOVE:						
C4143	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	72982	8035D9AADC1G470K

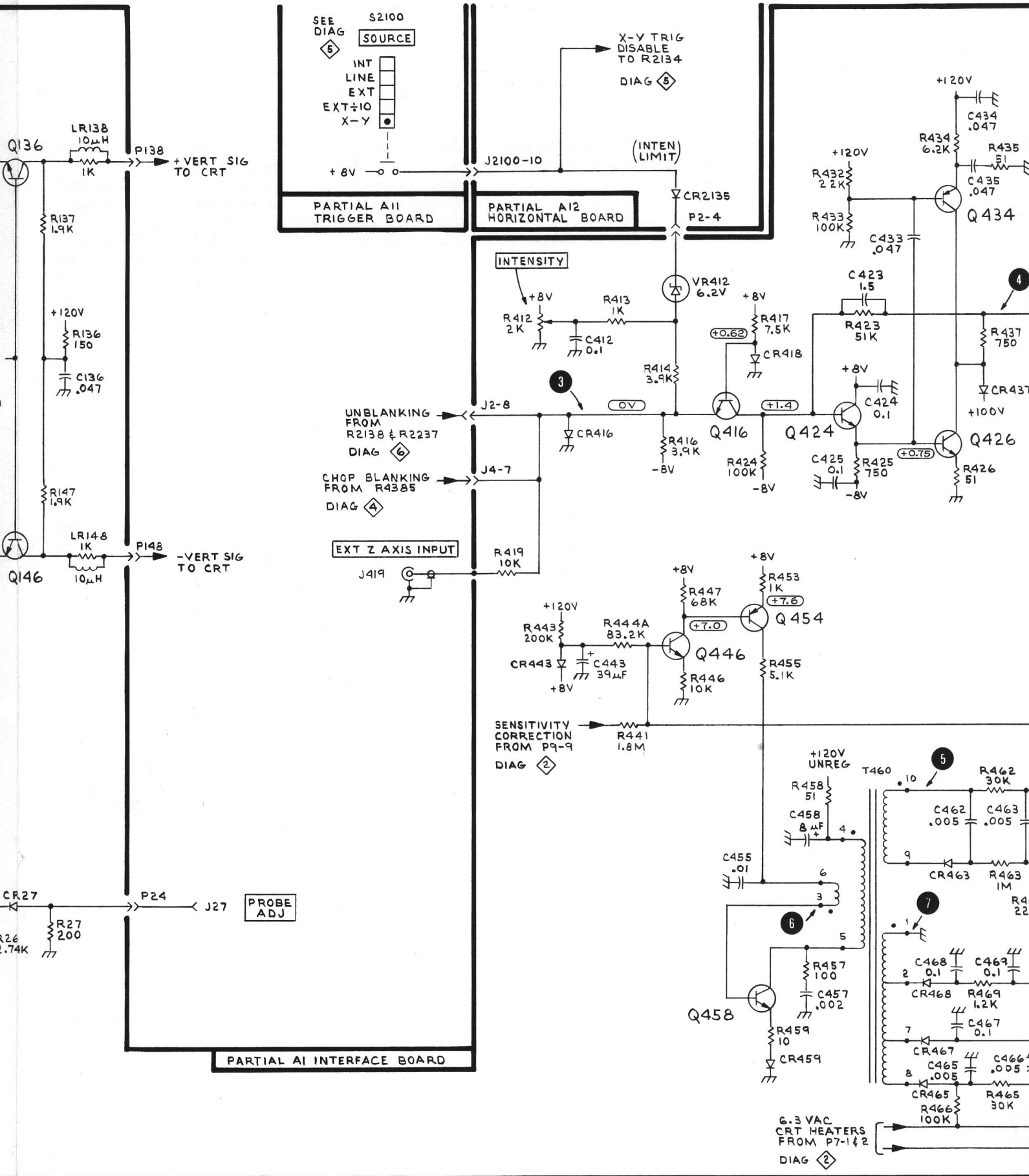
Replaceable Electrical Parts

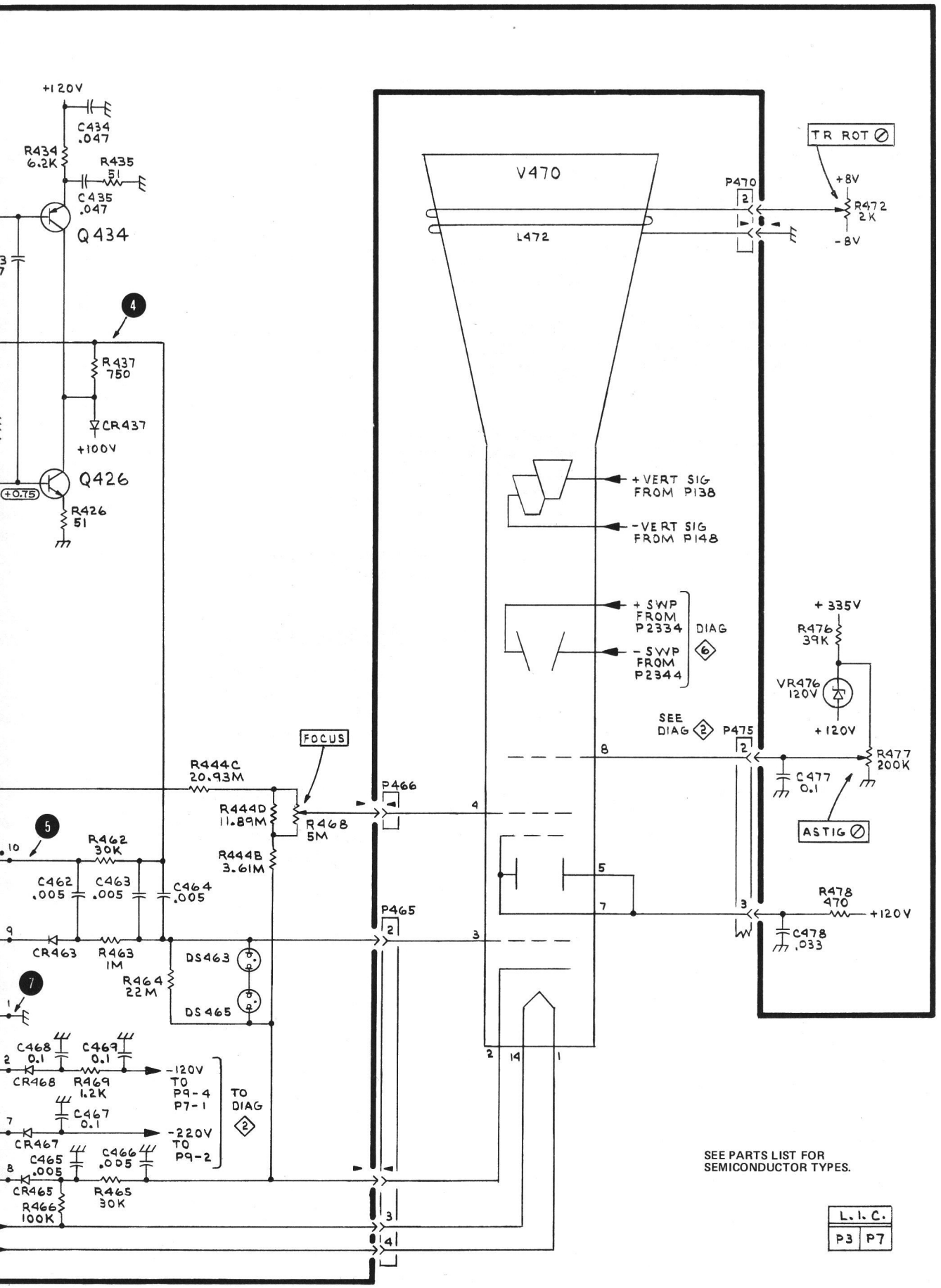
Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C4243	281-0763-00			CAP.,FXD,CER DI:47PF,10%,100V	72982	8035D9AADC1G470K
C4362	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C4363	281-0773-00			CAP.,FXD,CER DI:0.01UF,10%,100V	72982	8005H9AADW5R103K
C4365	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C4366	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
C4397	283-0111-00			CAP.,FXD,CER DI:0.1UF,20%,50V	72982	8121-N088Z5U104M
R4395	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R4397	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705

Replaceable Mechanical Parts

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty 1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
ADD:							
1-130	366-1559-00			1	PUSH BUTTON:GRAY	80009	366-1559-00
-131	426-1072-00			1	FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
DELETE:							
-133	333-2040-00			1	PANEL,FRONT:	80009	333-2040-00
ADD:							
-133	333-2150-00			1	PANEL,FRONT:	80009	333-2150-00
-161	384-1136-00			1	EXTENSION SHAFT:0.95 INCH LONG	80009	384-1136-00
DELETE:							
-164	131-1817-00			1	LINK,TERM,CONN:22 AWG,2.25 INCH LONG	80009	131-1817-00
-164	131-0566-00			1	LINK,TERM,CONNE:	80009	131-0566-00


+8V
-8V
C114 1μF
R114 200
R113 200
C113 .001
Q116
Q132
C135 .001
Q136
LR138 10μH
P138
R135 130
1K
(FROM DIAG 4)
1
-VERT SIG FROM P4-9
Q112
R112 75.0
R105 820
R104 732
C102 170
R106 110
R102 110
RT105 500
R107 732
R117 806
R116 2.2K
R132 261
R137 1.9K
+120V
R136 150
C136 .047
R133 80.6
R143 127
C133 90-400
C125 0.1
R115 1.15K
R125 806
GAIN
R126 10K
R142 261
2
+VERT SIG FROM P4-11
Q122
R122 75.0
R123 200
C123 .001
R124 200
R127 806
R147 1.9K
Q126
Q142
R145 130
C145 .001
Q146
LR148 1K
10μH
P148
S410A
BEAM FINDER
SEE DIAG 6
R131 270
R23 430K
U24 741
R22 130K
C24 .01
CR26
CR27
R25 2.2K
R26 2.74K
R27 200
R24 100K


SEE DIAG 5
S2100
SOURCE
INT
LINE
EXT
EXT÷10
X-Y
+8V
J2100-10
X-Y TRIG DISABLE TO R2134
DIAG 5
(INTEN) LIMIT
CR2135
P2-4
PARTIAL A11 TRIGGER BOARD
PARTIAL A12 HORIZONTAL BOARD
INTENSITY
VR412 6.2V
R412 2K
R413 1K
C412 0.1
R414 3.9K
R417 7.5K
+0.62
CR418
UNBLANKING FROM R2138 & R2237
DIAG 6
J2-8
0V
CR416
R416 3.9K
-8V
Q416
+1.4
R424 100K
-8V
Q424
CHOP BLANKING FROM R4385
DIAG 4
J4-7
EXT Z AXIS INPUT
J419
R419 10K
+120V
C434 .047
R434 6.2K
R435 51
C435 .047
Q434
R432 2.2K
R433 100K
C433 .047
C423 1.5
R423 51K
R437 750
CR437
+100V
C424 0.1
Q426
+0.75
C425 0.1
R425 750
-8V
R426 51
Q136
LR138 10μH
1K
P138
+VERT SIG TO CRT
R137 1.9K
R136 150
C136 .047
R147 1.9K
Q146
LR148 1K
10μH
P148
-VERT SIG TO CRT
+8V
R447 68K
R453 1K
+7.6
Q454
R443 200K
R444A 83.2K
+7.0
Q446
CR443
C443 39μF
R446 10K
R455 5.1K
SENSITIVITY CORRECTION FROM P9-9
DIAG 2
R441 1.8M
+120V UNREG
T460
R458 51
C458 8μF
C455 .01
R462 30K
C462 .005
C463 .005
CR463
R463 1M
R457 100
C457 .002
Q458
R459 10
CR459
C468 0.1
C469 0.1
CR468
R469 1.2K
C467 0.1
CR467
C465 .005
CR465
R465 30K
R466 100K
6.3 VAC CRT HEATERS FROM P7-1 & 2
DIAG 2
CR27
P24
J27
PROBE ADJ
R27 200
PARTIAL A1 INTERFACE BOARD



SEE PARTS LIST FOR SEMICONDUCTOR TYPES.

L.I.C.	
P3	P7

CRT & VERTICAL AMPLIFIER 1

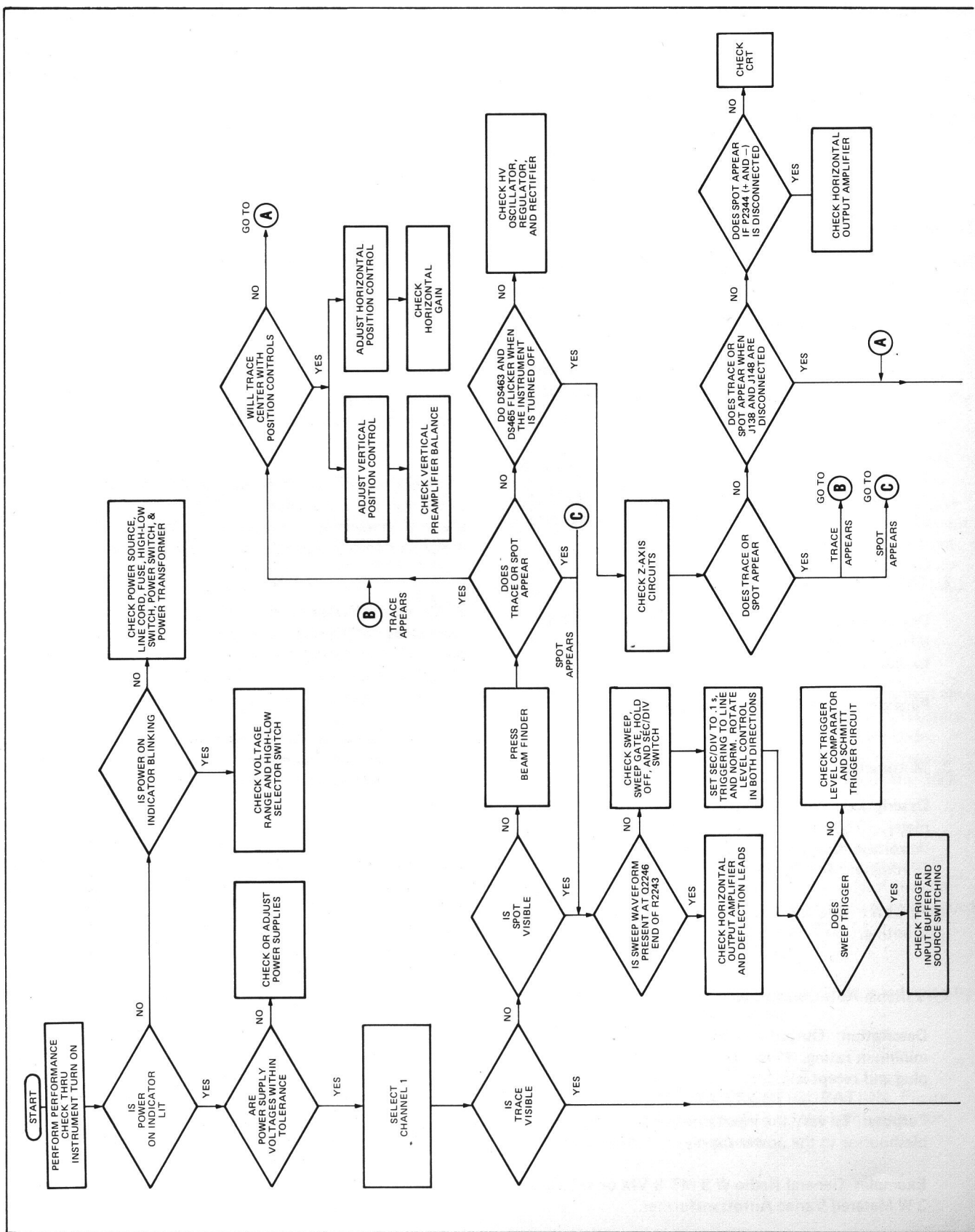


Fig. 5-1. Troubleshooting chart.

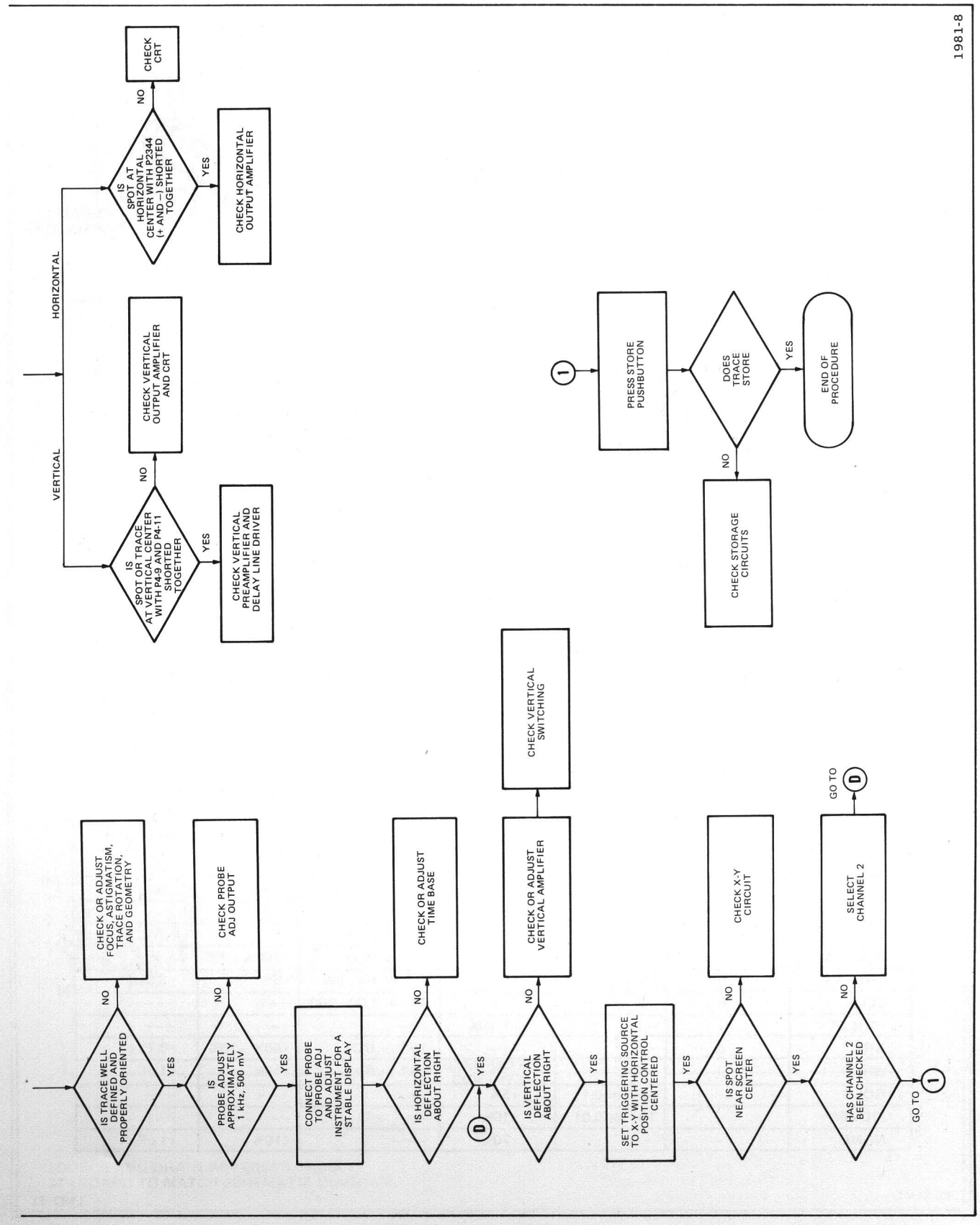
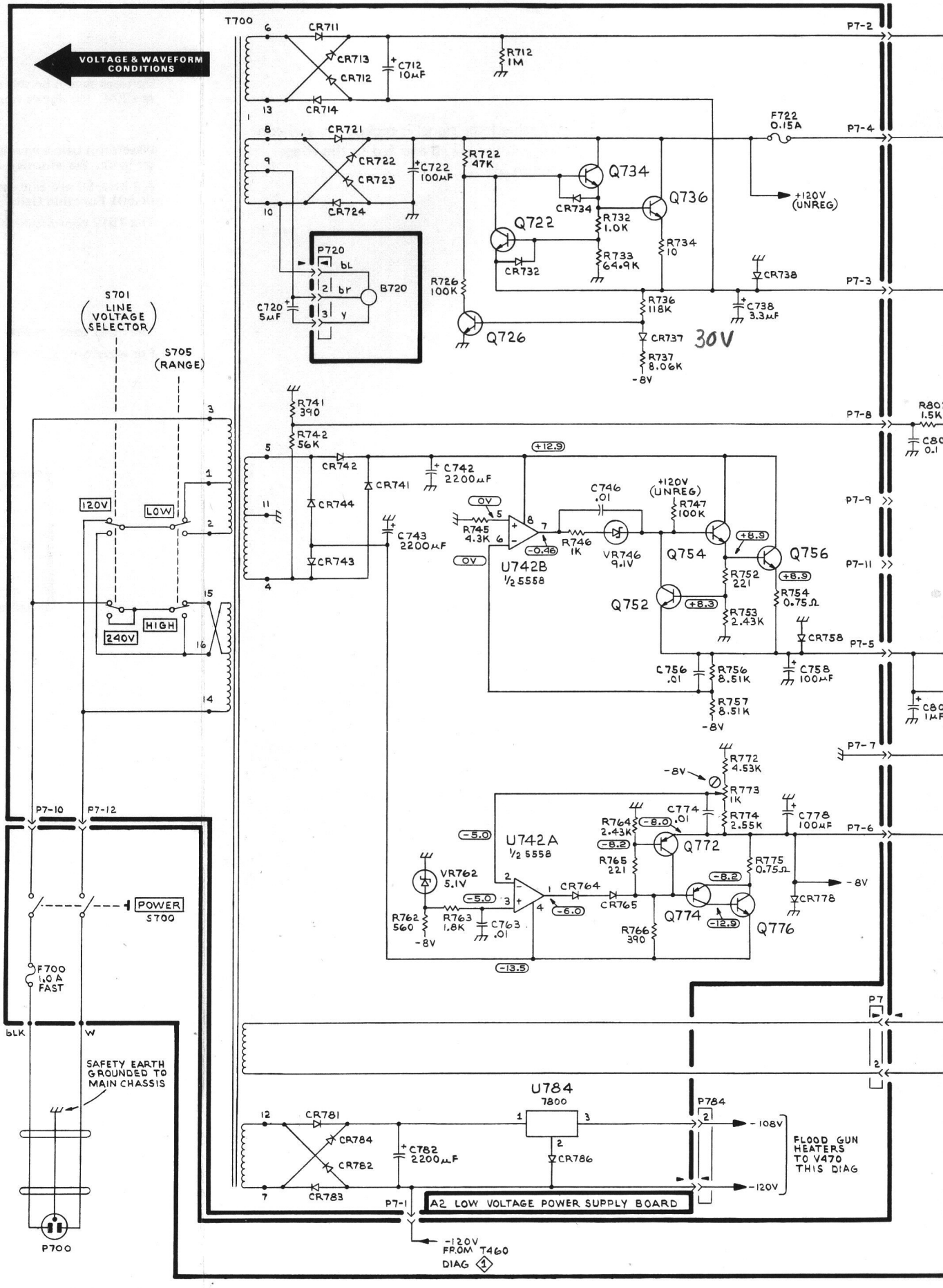
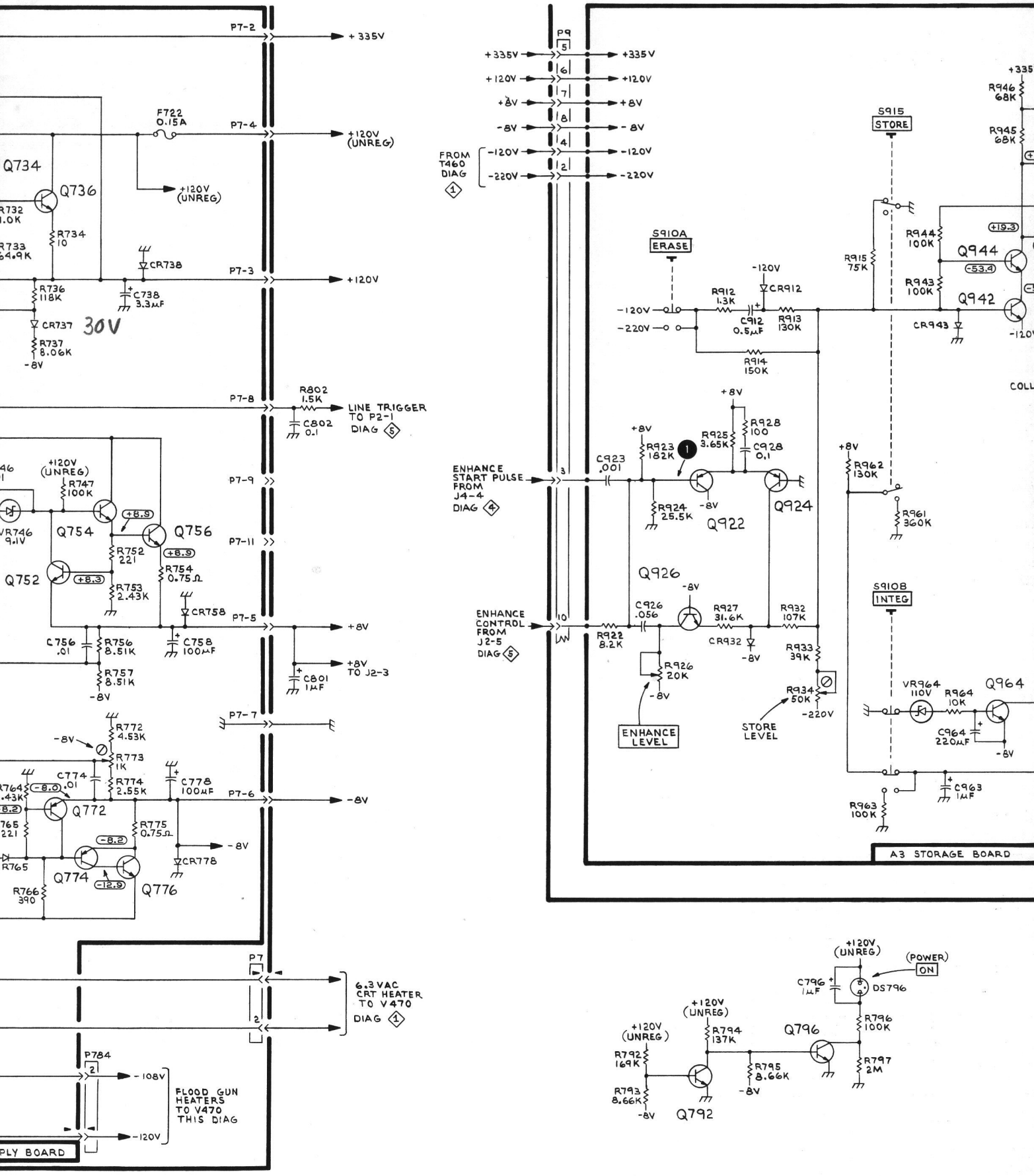
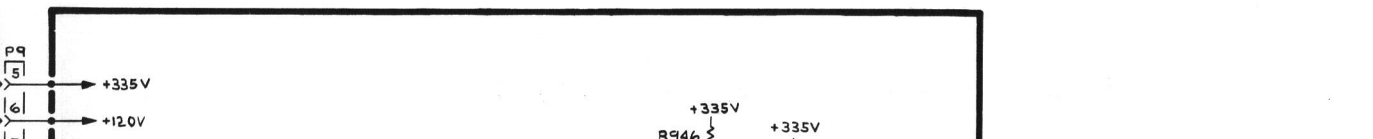


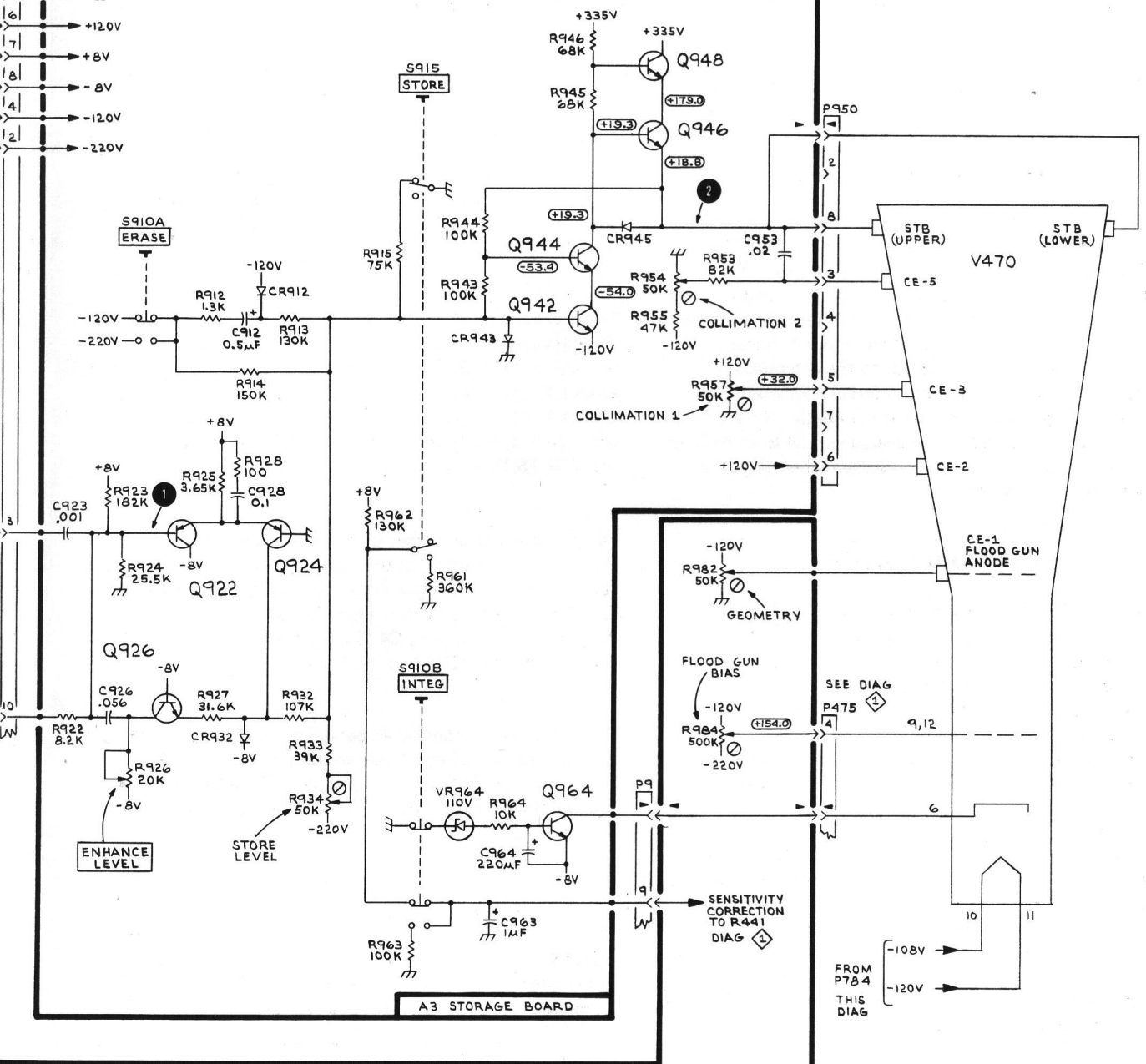
Fig. 5-1. Troubleshooting chart (cont).

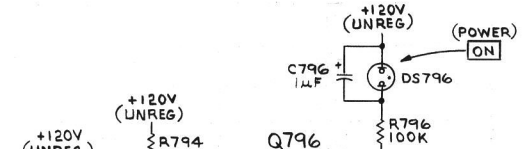

VOLTAGE & WAVEFORM CONDITIONS
T700
CR711
CR713
CR712
CR714
C712 10μF
R712 1M
P7-2
F722 0.15A
P7-4
CR721
CR722
CR723
CR724
C722 100μF
R722 47K
Q734
CR734
Q736
+120V (UNREG)
Q722
R732 1.0K
R733 64.9K
R734 10
CR732
CR738
P7-3
P720
BL
br
y
B720
C720 5μF
R726 100K
Q726
R736 118K
C738 3.3μF
CR737
30V
R737 8.06K
-8V
S701 (LINE VOLTAGE SELECTOR)
S705 (RANGE)
120V
LOW
HIGH
240V
R741 390
R742 56K
P7-8
CR742
CR741
CR744
CR743
C742 2200μF
C743 2200μF
+12.9
C746 .01
+120V (UNREG)
R747 100K
R745 4.3K
R746 1K
VR746 9.1V
U742B 1/2 5558
Q754
Q756
Q752
R752 221
R753 2.43K
R754 0.75Ω
+8.9
+8.3
P7-9
P7-11
CR758
C756 .01
R756 8.51K
C758 100μF
R757 8.51K
P7-5
P7-7
R772 4.53K
R773 1K
R774 2.55K
C774 .01
C778 100μF
P7-6
U742A 1/2 5558
R764 2.43K
Q772
R765 221
R775 0.75Ω
VR762 5.1V
CR764
CR765
CR778
R762 560
R763 1.8K
C763 .01
Q774
Q776
R766 390
P7-10
P7-12
POWER S700
F700 1.0A FAST
BLK
W
SAFETY EARTH GROUNDED TO MAIN CHASSIS
P700
P7
U784 7800
P784
CR781
CR784
CR782
CR783
C782 2200μF
CR786
-108V
-120V
FLOOD GUN HEATERS TO V470 THIS DIAG
P7-1
A2 LOW VOLTAGE POWER SUPPLY BOARD
-120V FROM T460 DIAG 4

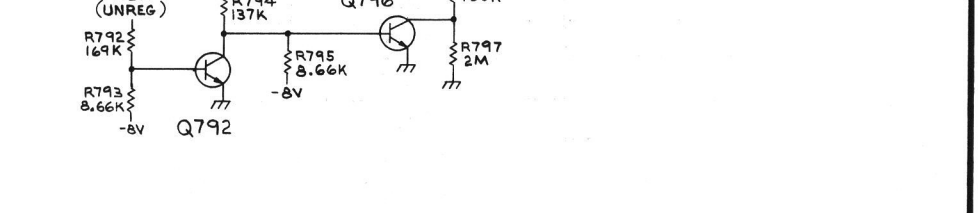
T912


P7-2
+335V
F722
0.15A
P7-4
+120V (UNREG)
Q734
Q736
R732
1.0K
R734
10
R733
64.9K
CR738
P7-3
+120V
R736
118K
C738
3.3μF
CR737
30V
R737
8.06K
-8V
P7-8
R802
1.5K
LINE TRIGGER TO P2-1 DIAG 5
C802
0.1
P7-9
P7-11
+120V (UNREG)
R747
100K
Q754
Q756
+8.9
R752
221
R754
0.75Ω
Q752
+8.3
R753
2.43K
CR758
P7-5
+8V
C756
.01
R756
8.51K
C758
100μF
+8V TO J2-3
C801
1μF
R757
8.51K
-8V
P7-7
R772
4.53K
-8V
R773
1K
C774
.01
R774
2.55K
C778
100μF
P7-6
-8V
-8.0
Q772
R775
0.75Ω
-8.2
-8V
CR778
Q774
-12.9
Q776
R765
R766
390
P7
6.3 VAC CRT HEATER TO V470 DIAG 1
P784
2
-108V
FLOOD GUN HEATERS TO V470 THIS DIAG
-120V
PLY BOARD
P9
5
6
7
8
4
2
+335V
+120V
+8V
-8V
-120V
-220V
FROM T460 DIAG 1
S915
STORE
S910A
ERASE
S910B
INTEG
R912
1.3K
C912
0.5μF
R913
130K
R914
150K
R915
75K
R944
100K
Q944
-53.4
R943
100K
Q942
CR943
+19.3
R946
68K
R945
68K
R928
100
C928
0.1
R925
3.65K
R923
182K
C923
.001
ENHANCE START PULSE FROM J4-4 DIAG 4
R924
25.5K
Q922
Q924
R962
130K
R961
360K
Q926
C926
.056
R927
31.6K
R932
107K
ENHANCE CONTROL FROM J2-5 DIAG 5
R922
8.2K
CR932
R933
39K
R926
20K
R934
50K
ENHANCE LEVEL
STORE LEVEL
VR964
110V
R964
10K
Q964
C964
220μF
C963
1μF
R963
100K
A3 STORAGE BOARD
+120V (UNREG)
(POWER) ON
C796
1μF
DS796
R796
100K
Q796
R797
2M
R794
137K
R795
8.66K
R792
169K
R793
8.66K
Q792
PARTIAL A1 INTERFA





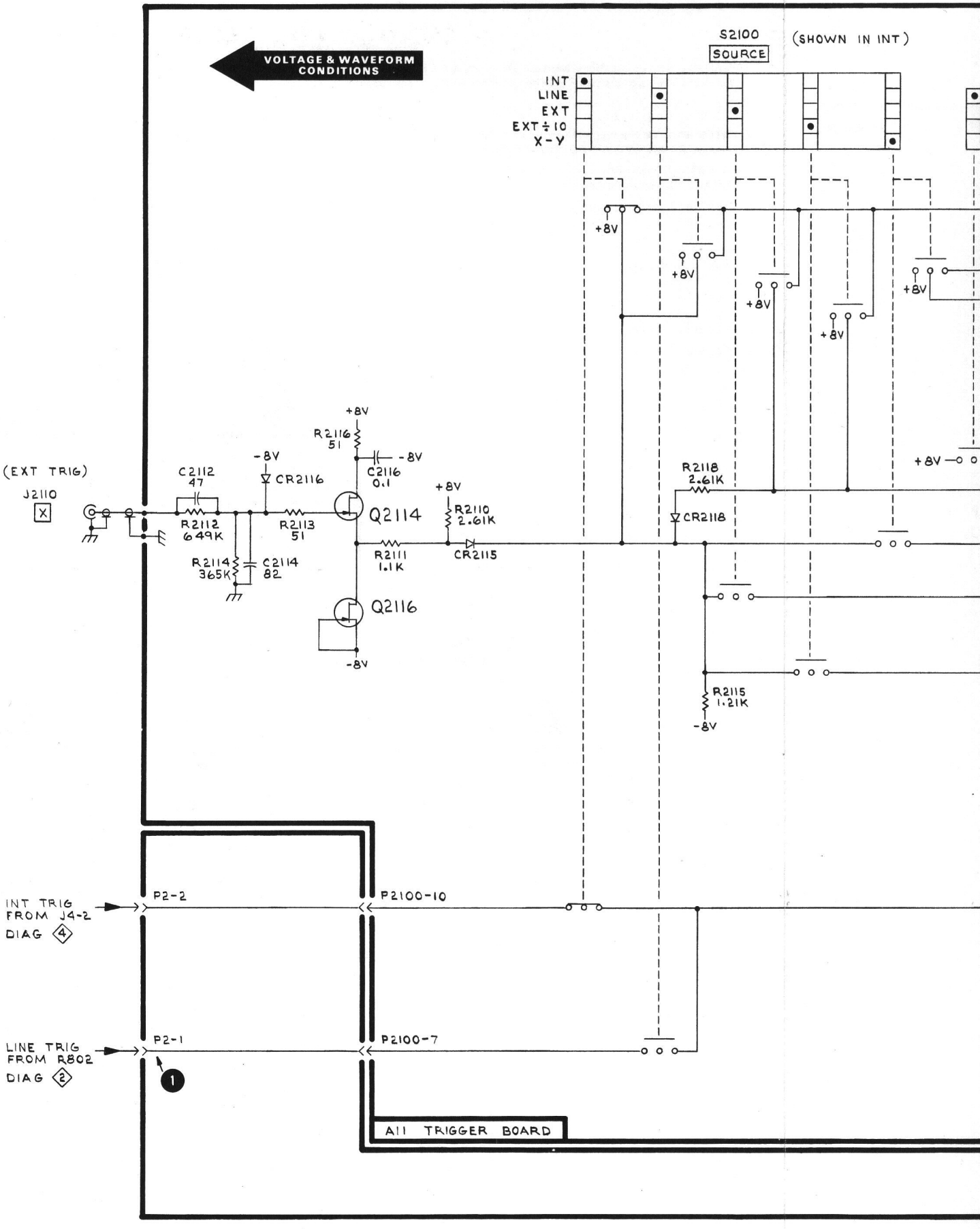


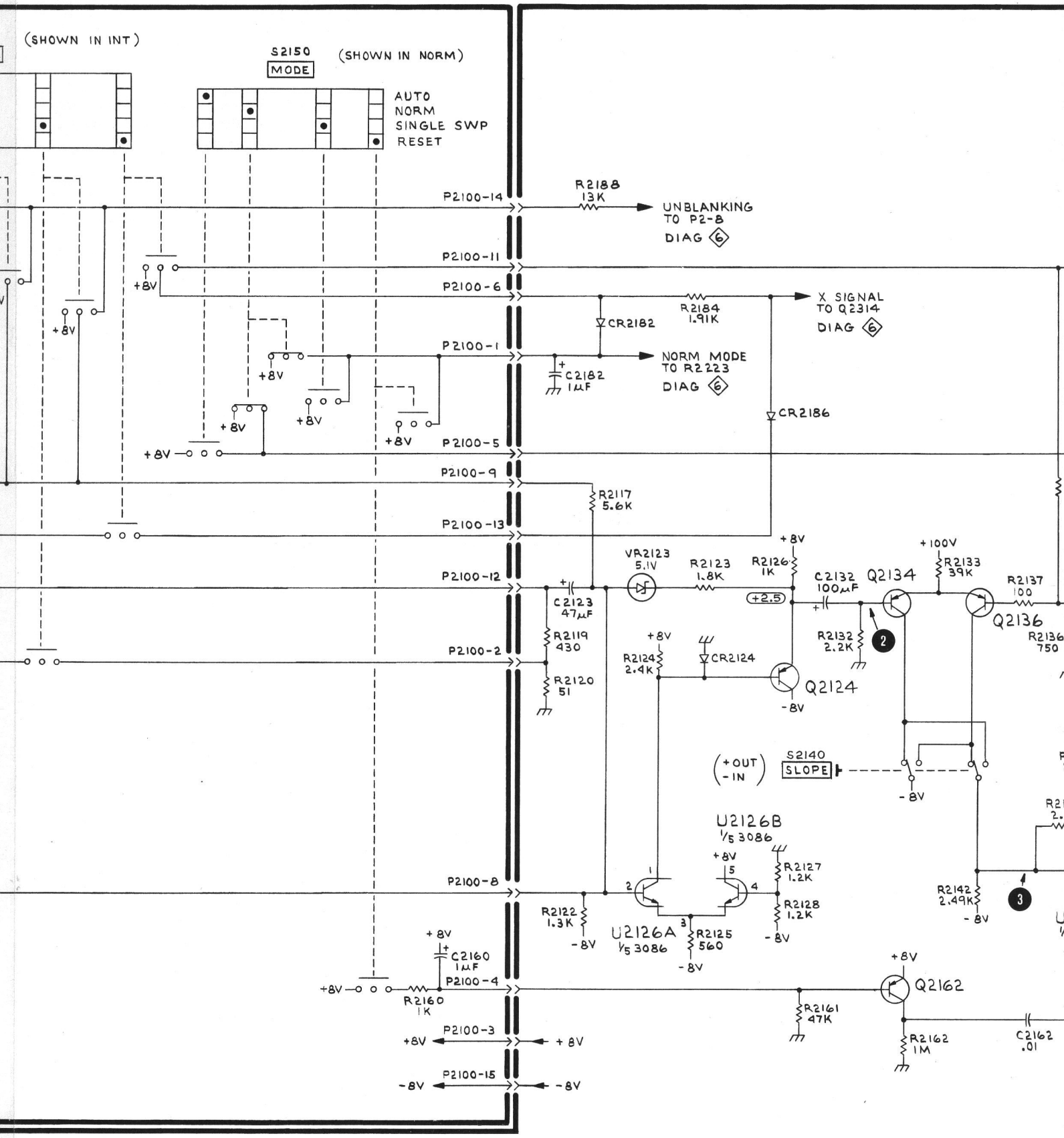


SEE PARTS LIST FOR SEMICONDUCTOR TYPES.

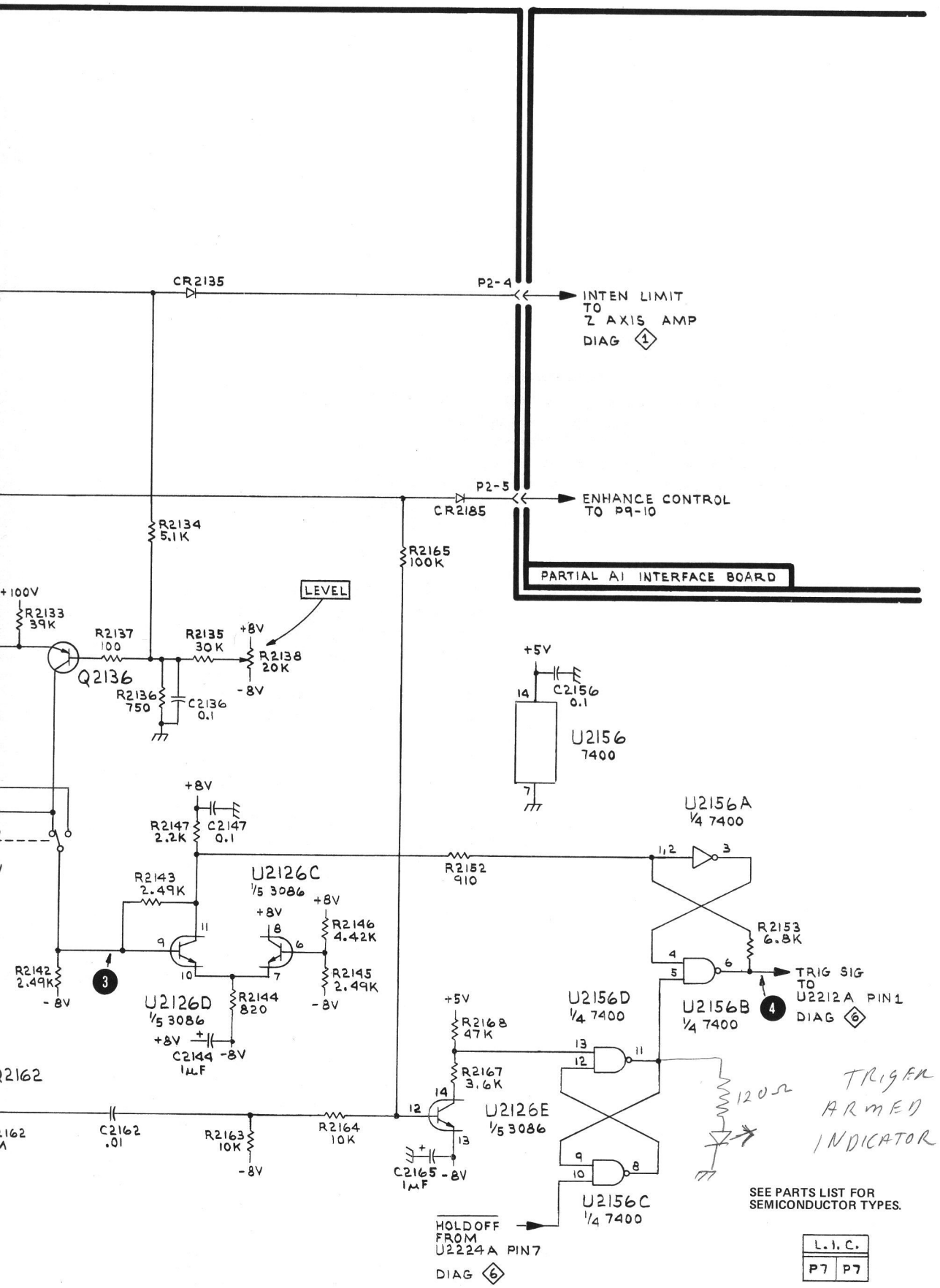
L.I.C.	
P7	P7

POWER SUPPLY & STORAGE 2

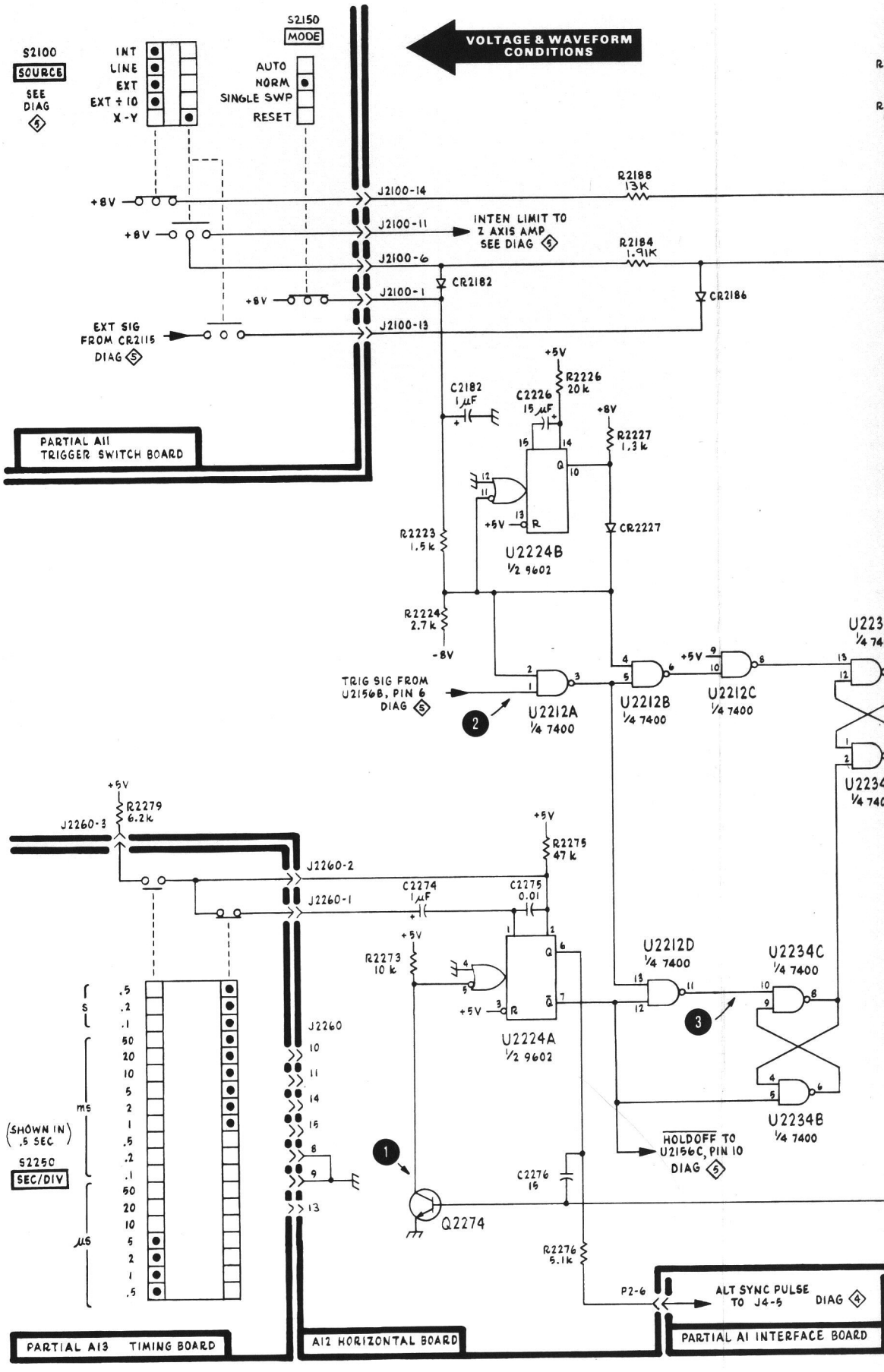

VOLTAGE & WAVEFORM CONDITIONS
S2100
SOURCE
(SHOWN IN INT)
INT
LINE
EXT
EXT ÷ 10
X-Y
+8V
(EXT TRIG)
J2110
X
C2112
47
R2112
649K
-8V
CR2116
R2113
51
R2116
51
C2116
0.1
Q2114
R2110
2.61K
R2111
1.1K
CR2115
R2114
365K
C2114
82
Q2116
R2118
2.61K
CR2118
R2115
1.21K
INT TRIG
FROM J4-2
DIAG 4
P2-2
P2100-10
LINE TRIG
FROM R802
DIAG 2
P2-1
P2100-7
1
A11 TRIGGER BOARD

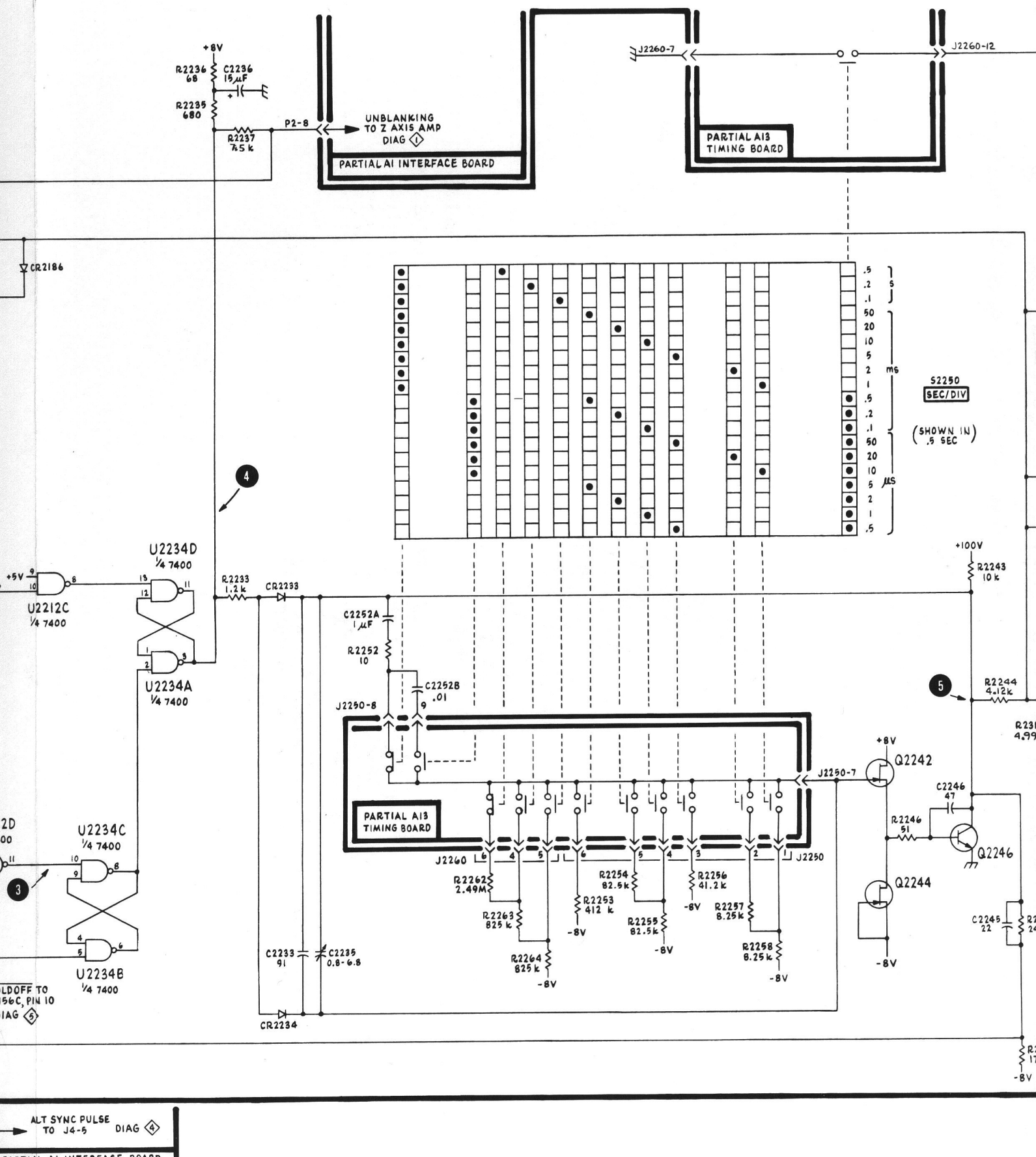


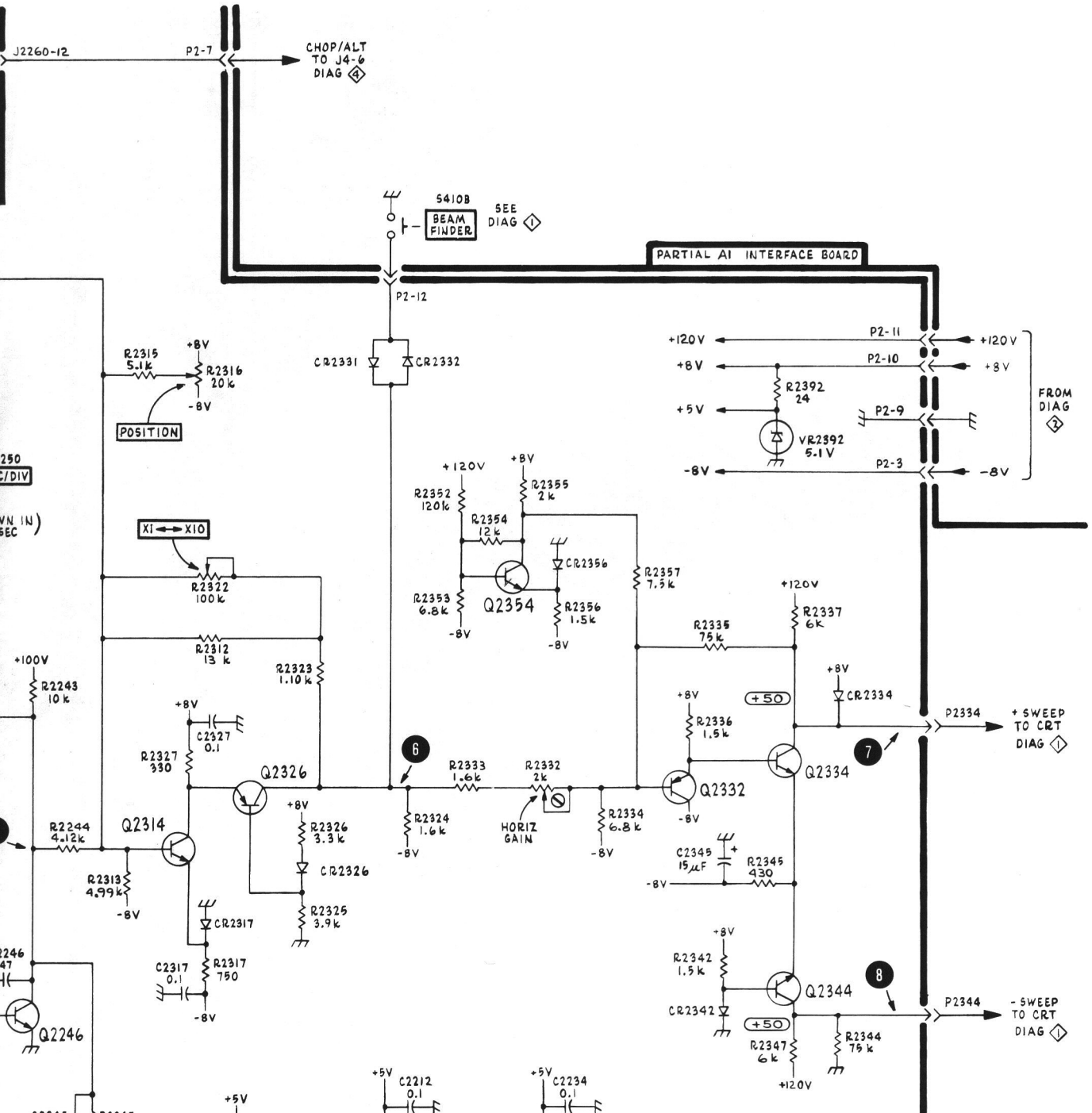
PARTIAL A12 HORIZONTAL BOARD


CR2135
P2-4
INTEN LIMIT TO Z AXIS AMP DIAG 1
P2-5
CR2185
ENHANCE CONTROL TO P9-10
PARTIAL A1 INTERFACE BOARD
R2134 5.1K
R2165 100K
+100V
R2133 39K
LEVEL
R2137 100
R2135 30K
+8V
R2138 20K
-8V
Q2136
R2136 750
C2136 0.1
+5V
C2156 0.1
U2156 7400
U2156A 1/4 7400
+8V
R2147 2.2K
C2147 0.1
R2152 910
R2143 2.49K
U2126C 1/5 3086
R2146 4.42K
R2153 6.8K
TRIG SIG TO U2212A PIN1 DIAG 6
R2142 2.49K
R2144 820
R2145 2.49K
U2126D 1/5 3086
C2144 1μF
U2156D 1/4 7400
U2156B 1/4 7400
R2168 47K
R2167 3.6K
U2126E 1/5 3086
120Ω
TRIGGER ARMED INDICATOR
C2162 .01
R2163 10K
R2164 10K
C2165 1μF
U2156C 1/4 7400
HOLDOFF FROM U2224A PIN7 DIAG 6
SEE PARTS LIST FOR SEMICONDUCTOR TYPES.
L.I.C.
P7 P7

TRIGGER 5


VOLTAGE & WAVEFORM CONDITIONS
S2100
SOURCE
SEE DIAG 5
INT
LINE
EXT
EXT ÷ 10
X-Y
S2150
MODE
AUTO
NORM
SINGLE SWP
RESET
+8V
J2100-14
R2188 13K
J2100-11
INTEN LIMIT TO Z AXIS AMP SEE DIAG 5
J2100-6
R2184 1.91K
J2100-1
CR2182
CR2186
EXT SIG FROM CR2115 DIAG 5
J2100-13
PARTIAL A11 TRIGGER SWITCH BOARD
+5V
R2226 20k
C2182 1 µF
C2226 15 µF
R2227 1.3k
R2223 1.5k
U2224B 1/2 9602
CR2227
R2224 2.7k
-8V
TRIG SIG FROM U2156B, PIN 6 DIAG 5
U2212A 1/4 7400
U2212B 1/4 7400
U2212C 1/4 7400
U223
1/4 74
U2234
1/4 740
J2260-3
R2279 6.2k
J2260-2
J2260-1
R2275 47 k
C2274 1 µF
C2275 0.01
R2273 10 k
U2224A 1/2 9602
U2212D 1/4 7400
U2234C 1/4 7400
U2234B 1/4 7400
HOLDOFF TO U2156C, PIN 10 DIAG 5
J2260
S
ms
µs
.5
.2
.1
50
20
10
5
2
1
.5
(SHOWN IN .5 SEC)
S2250
SEC/DIV
Q2274
C2276 15
R2276 5.1k
P2-6
ALT SYNC PULSE TO J4-5 DIAG 4
PARTIAL A13 TIMING BOARD
A12 HORIZONTAL BOARD
PARTIAL A1 INTERFACE BOARD


+8V
R2236 68
C2236 15 µF
R2235 680
R2237 7.5 k
P2-8
UNBLANKING TO Z AXIS AMP DIAG 1
PARTIAL A1 INTERFACE BOARD
J2260-7
J2260-12
PARTIAL A13 TIMING BOARD
CR2186
.5
.2
.1
50
20
10
5
2
1
.5
.2
.1
50
20
10
5
2
1
.5
ms
µs
S2250 SEC/DIV
(SHOWN IN .5 SEC
4
U2234D 1/4 7400
+5V
U2212C 1/4 7400
U2234A 1/4 7400
R2233 1.2 k
CR2233
C2252A 1 µF
R2252 10
C2252B .01
J2250-8
+100V
R2243 10 k
5
R2244 4.12k
R23 4.99
+8V
Q2242
J2250-7
C2246 47
R2246 51
Q2246
Q2244
U2234C 1/4 7400
3
J2260
J2250
R2262 2.49M
R2263 825 k
R2264 825 k
R2253 412 k
R2254 82.5k
R2255 82.5k
R2256 41.2 k
R2257 8.25k
R2258 8.25k
-8V
C2233 91
C2235 0.8-6.8
CR2234
C2245 22
U2234B 1/4 7400
LDOFF TO 56C, PIN 10
IAG 5
ALT SYNC PULSE TO J4-5 DIAG 4
PARTIAL A1 INTERFACE BOARD



SWEEP & HORIZONTAL AMPLIFIER 6