

WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.



442
OSCILLOSCOPE
SERVICE

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

Serial Number _____

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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.


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OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

Terms In This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

Terms As Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

Symbols In This Manual



This symbol indicates where applicable cautionary or other information is to be found.

Symbols As Marked on Equipment



DANGER — High voltage.



Protective ground (earth) terminal.



ATTENTION — refer to manual.

Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

For detailed information on power cords and connectors, see Operating Instructions section.

Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only the fuse of correct type, voltage rating and current rating as specified in the parts list for your product.

Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers and panels properly installed.

SERVICE SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators Safety Summary.

Do Not Service Alone

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

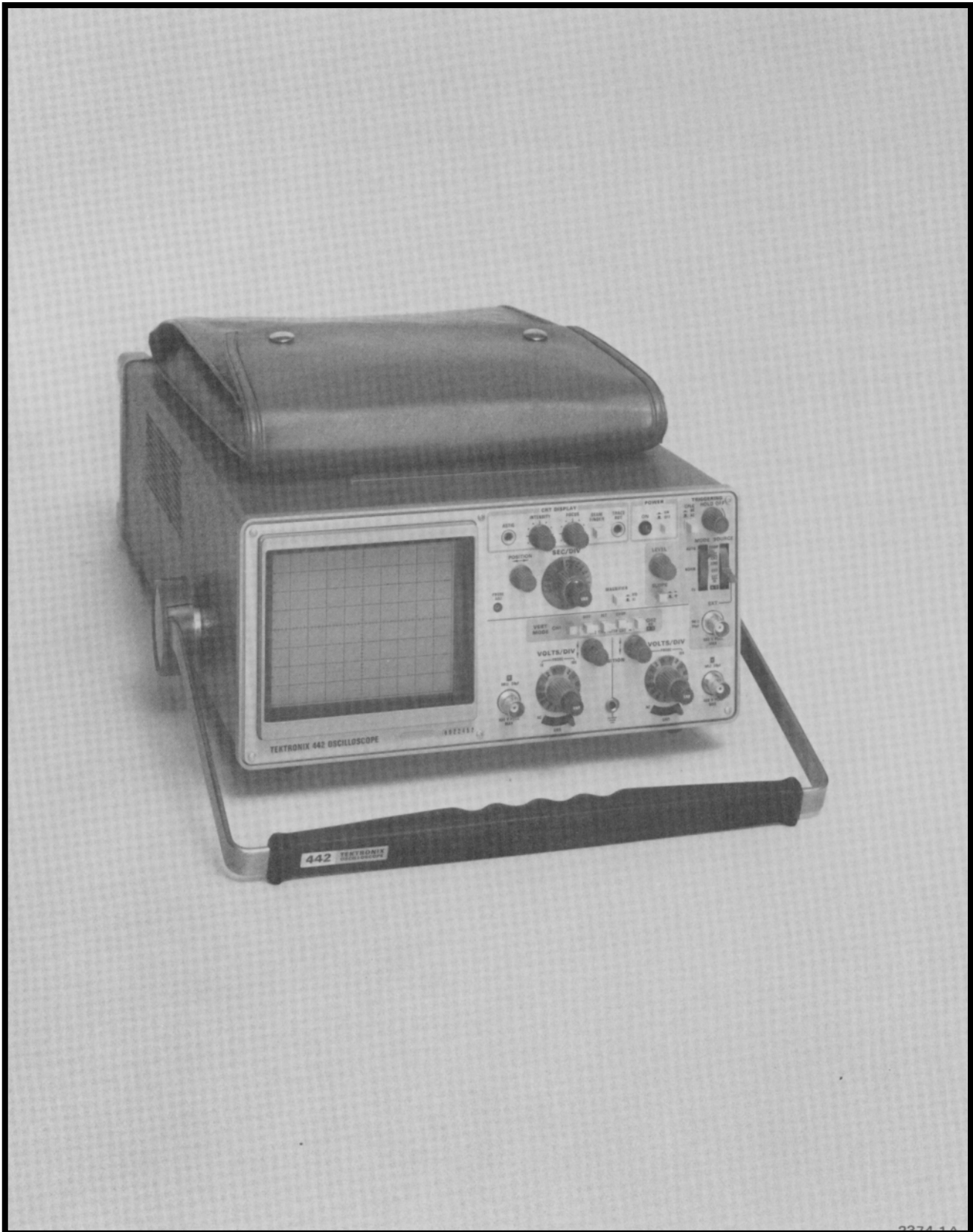
Use Care When Servicing With Power On

Dangerous voltages exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconnect power before removing protective panels, soldering, or replacing components.

Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.



442 Oscilloscope.

SPECIFICATION

This manual contains a specification, operating instructions, and service information pertaining to the TEKTRONIX 442 Oscilloscope. The 442 is a portable, 35 MHz, dual trace instrument with a choice of alternate or chop sweep presentation on a single time base. 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 and provides calibrated sweep rates from 0.5 s/div to 0.1 μ s/div. A X10 magnifier switch extends the fastest sweep rate to 10 ns/div.

The following instrument specification applies over an ambient temperature range of -15° to $+55^{\circ}$ C for instruments that have been calibrated at an ambient temperature between $+20^{\circ}$ C and $+30^{\circ}$ C unless otherwise indicated when the instrument has had a warmup period of about 20 minutes. The adjustment procedure in Section 4, when performed completely, allows the 442 to meet the electrical specification listed in Table 1-1.

Table 1-1
ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information
VERTICAL SYSTEM		
Deflection Factor		
Calibrated Range	2 mV to 10 V/div; 12 steps, in a 1-2-5 sequence.	
Accuracy		Gain adjusted with VOLTS/DIV switch set to 2 m.
$+20^{\circ}$ C to $+30^{\circ}$ C	Within 3%.	
-15° C to $+55^{\circ}$ C		Within 4%.
Uncalibrated (VAR) Range	Continuously variable between settings. Increases deflection factor by approximately 2.5:1.	Extends maximum deflection factor to at least 25 V/div.
Frequency Response		5-division reference signal centered vertically from a 25 Ω source with VOLTS/DIV VAR control in calibrated detent.
Bandwidth		
2 m to 1 V	Dc to at least 35 MHz.	
2 V, 5 V, & 10 V	Dc to at least 25 MHz.	
Chopped Mode Repetition Rate		Approximately 250 kHz.
Input Resistance		Approximately 1 M Ω .
Input Capacitance		Approximately 30 pF.
Maximum Input Voltage		400 V (dc + peak ac). 800 V p-p ac at 1 kHz or less.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
VERTICAL SYSTEM (cont)		
CMRR (DIFF Mode)	At least 10:1 at 1 MHz in 10 mV/div (1X window) position for common mode signals of 8 divisions or less with gain adjusted for best CMRR at 50 kHz.	
HORIZONTAL DEFLECTION SYSTEM		
Sweep Rate Calibrated Range	0.5 s to 0.1 μ s/div; 21 steps in a 1-2-5 sequence.	
Uncalibrated (VAR) Range	Continuously variable between calibrated settings. Decreases sweep rate by at least 2.5:1.	Extends slowest sweep rate to at least 1.25 sec/div.
Accuracy +20° C to +30° C Unmagnified Magnified -15° C to +55° C Unmagnified Magnified	Within 3%. Within 5%.	Sweep accuracy applies over the center 8 divisions. Exclude the first 50 ns of sweep for both magnified and unmagnified sweep rates as well as anything beyond the 100th magnified division. Within 4%. Within 6%.
X10 Magnifier	Extends fastest sweep rate to 10 ns/div.	10:1 (in X10 position— with button pressed in— the sweep rate is one tenth of that indicated for the SEC/DIV switch setting).
X-Y Operation X-Axis Deflection Accuracy +20° C to +30° C -15° C to +55° C	\pm 5% (MAGNIFIER in X1 only).	5-division reference signal. \pm 6% (MAGNIFIER in X1 only).
Sensitivity	Same as for Channel 1 and Channel 2 Calibrated Deflection Factor Range (MAGNIFIER in X1 only).	

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
VERTICAL SYSTEM (cont)		
X-Axis Bandwidth	Dc to at least 2 MHz.	5-division reference signal.
Input Resistance		Approximately 1 M Ω .
Input Capacitance		Approximately 30 pF.
Maximum Input Voltage		400 V (dc + peak ac). 800 V p-p ac at 1 kHz or less.
TRIGGERING SYSTEM		
Sensitivity		EXT/10 requirements are approximately ten times the values listed for EXT.
AC CPLG (AUTO & NORM)	0.5 div internal or 100 mV external from 60 Hz to 2 MHz, increasing to 1.5 div internal or 150 mV external at 35 MHz.	
DC CPLG (AUTO & NORM)	0.5 div internal or 100 mV external from dc to 2 MHz, increasing to 1.5 div internal or 150 mV external at 35 MHz.	
TV Sync		Composite sync 1 div internal or 100 mV external. Composite video approximately 2.3 div internal or 230 mV external.
External Trigger Input (EXT & EXT/10)		
Maximum Input Voltage		400 V (dc + peak ac). 800 V p-p ac (1 kHz or less).
Input Resistance		Approximately 1 M Ω .
Input Capacitance		Approximately 30 pF.
LEVEL Range		
EXT	-0.5 V to +0.5 V.	
EXT/10	-5 V to +5 V.	
PROBE ADJUST SIGNAL		
Output Voltage		Approximately 0.5 V.
Repetition Rate		Approximately 1 kHz.
Z-AXIS INPUT		
Sensitivity	5 volts causes noticeable modulation.	

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
Z-AXIS INPUT (cont)		
Usable Frequency Range	Dc to 5 MHz.	
Maximum Input Voltage		30 V (dc + peak ac). 30 V p-p ac at 1 kHz or less.
Input Impedance		Approximately 10 kΩ.
DISPLAY		
Display Area		8 X 10 cm.
Trace Rotation Range		Adequate to align trace with center horizontal graticule line.
Standard crt Phosphor		P31.
Nominal Anode Voltage		Approximately +10 kV.
POWER SOURCE		
Line Voltage Ranges, ac		120 V/240 V & HI/LO switches are accessible externally.
120 V Range	HI—110 to 132 V rms. LO—92 to 110 V rms.	
240 V Range	HI—220 to 250 V rms. LO—202 to 242 V rms.	
Line Frequency			48 to 62 Hz.
Power Consumption		36 watts (max); 0.35 amps (max) at 120 V, 60 Hz.

Table 1-2

ENVIRONMENTAL CHARACTERISTICS

Characteristics	Description
Temperature	
Operating	-15°C to +55°C.
Non-operating	-55°C to +75°C.
Altitude	
Operating	To 15,000 feet. Maximum operating temperature decreased 1°C/1000 feet above 5000 feet.
Non-operating	To 50,000 feet.

Table 1-2 (cont)

Characteristics	Description
Humidity Operating and Non-operating	5 cycles (120 hours) referenced to MIL-E-16400F.
Vibration (Operating)	15 min along each of 3 major axes at a total displacement of 0.025" p-p (4 g's at 55 Hz) with frequency varied from 10 Hz to 55 Hz to 10 Hz in one minute sweeps. Hold for three minutes at 55 Hz. All major resonances must be above 55 Hz.
Shock Operating and Non-operating	30 g's, 1/2 sine, 11 ms duration, 2 shocks per axis each direction for a total of 12 shocks.

Table 1-3
PHYSICAL CHARACTERISTICS

Characteristics	Description
Weight With Panel Cover, Accessories, and Accessories Pouch	22.5 pounds (10.1 kilograms).
Without Panel Cover, Accessories, and Accessory Pouch	18.0 pounds (8.1 kilograms).
Domestic Shipping Weight	28.5 pounds (12.95 kilograms).
Dimensions	Refer to Figure 1-1.

ACCESSORIES

NOTE

Refer to the Accessories tab page in the Replaceable Mechanical Parts list for further information about accessories listed here.

Standard Accessories

- 1 Operators Manual
- 1 Service Manual
- 2 10X Probes
- 1 Front Cover
- 1 Accessory Pouch

Optional Accessories

- Protective Waterproof Cover
- Clear Light Filter

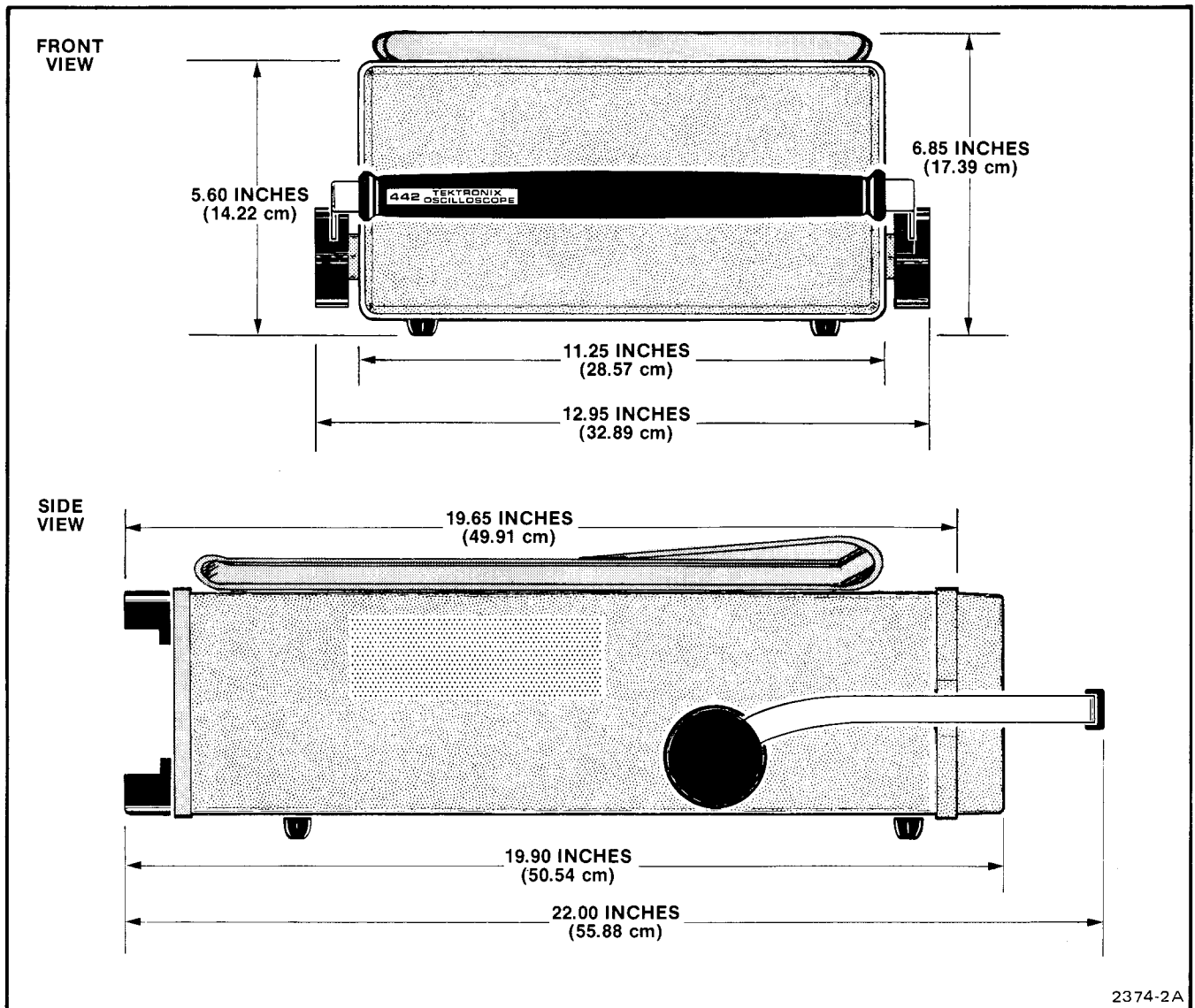


Figure 1-1. 442 Oscilloscope dimensions.

OPERATING INSTRUCTIONS

INTRODUCTION

The TEKTRONIX 442 Oscilloscope is a 35 MHz maximum bandwidth instrument with dual trace capability. A dual trace dc to 35 MHz vertical system provides calibrated deflection factors from 2 mV/div to 10 V/div. Triggering circuits provide stable triggering over the full vertical bandwidth. A horizontal deflection system provides calibrated sweep rates from 0.5 s/div to 0.1 μ s/div. A X10 magnifier circuit (push-button switch) extends maximum sweep to 10 ns/div. In X-Y mode of operation, vertical and horizontal deflection factors are the same as for the vertical amplifiers.

INSTALLATION

Unpacking

The 442 is shipped in its carton with the standard accessories listed on the Accessories tab page at the end of this manual. At installation time, save the shipping carton and packaging materials for repackaging. Refer to the end of this section for repackaging information.

Safety Considerations

CAUTION

This instrument may be damaged if operated with the Line Voltage Selector switch or the Regulating Range Selector switch set for the wrong applied line voltage or if the wrong line fuse is used.

Refer to the Safety Summary in the front of this manual for power source, grounding, and other safety considerations pertaining to use of the instrument. Before connecting the instrument to a power source, verify that the Line Voltage Selector switch and the Regulating Range Selector switch are both set for the line voltage being used, that the proper line fuse is installed, and that the line cord plug matches the power source to be used.

The 442 is designed to be used with a three-wire ac power system. If a three-to-two wire adapter is used to connect this instrument to a two-wire ac power system, be sure to connect the ground lead of the adapter to earth (ground). Failure to complete the ground system may allow the chassis of this instrument to be elevated above ground potential, thus posing a shock hazard.

Line Voltage Selection

WARNING

This instrument is designed for operation from a power source with its neutral at or near earth (ground) potential with a separate safety-earth conductor.

The power cord plug may require replacement with a type matching the power source. If necessary, change the line cord plug. Refer to Table 2-1 for power cord conductor identification and to Figure 2-1 for illustrations of commonly-used power plugs.

Table 2-1

POWER CORD CONDUCTOR IDENTIFICATION

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

The 442 operates from either 92 to 132 V or 202 to 250 V ac input at 48 to 62 Hz. A 120 or 240 V Line Voltage Selection switch and a HI/LO Regulating Range switch are located on the bottom of the instrument and are screw-driver actuated through openings in the cabinet.

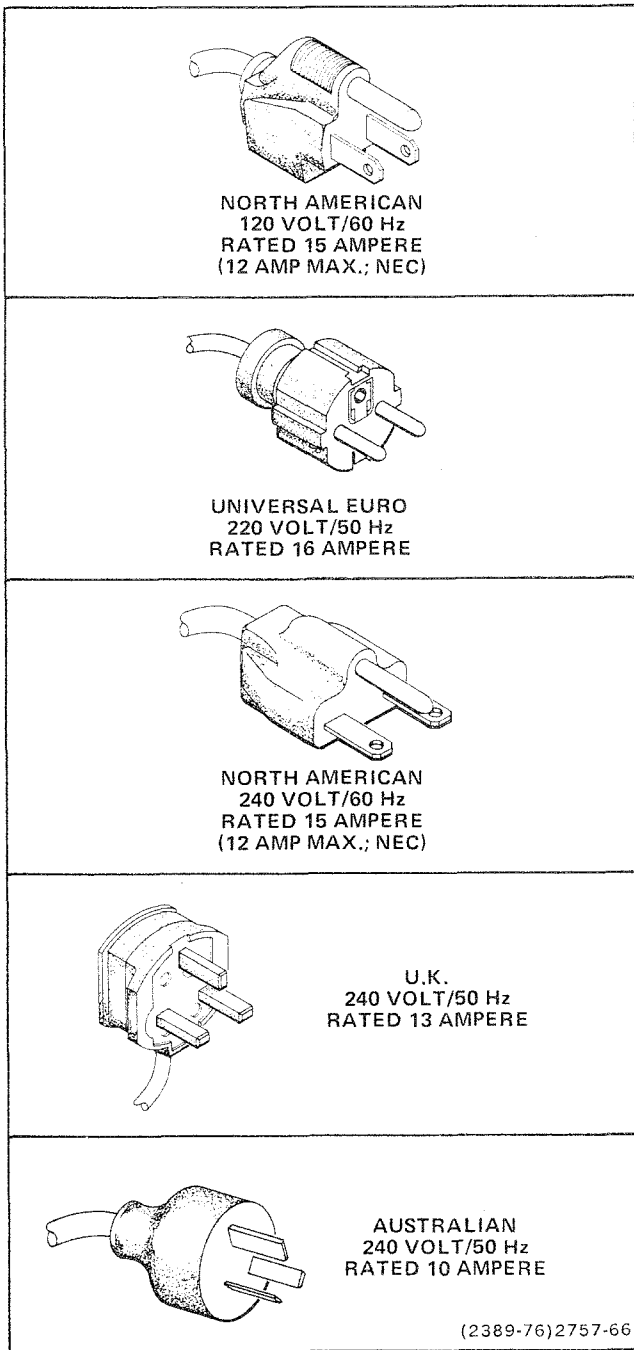


Figure 2-1. Commonly used power plugs.

Set the AC Line Voltage Selection switch to the nominal line voltage available (see Table 2-2). The fuse value must be changed when a different Line Voltage range is selected (see Table 2-3).

Set the HI/LO Regulating Range switch (see Figure 2-2) so the expected line-voltage fluctuations remain within the range selected (see Table 2-2).

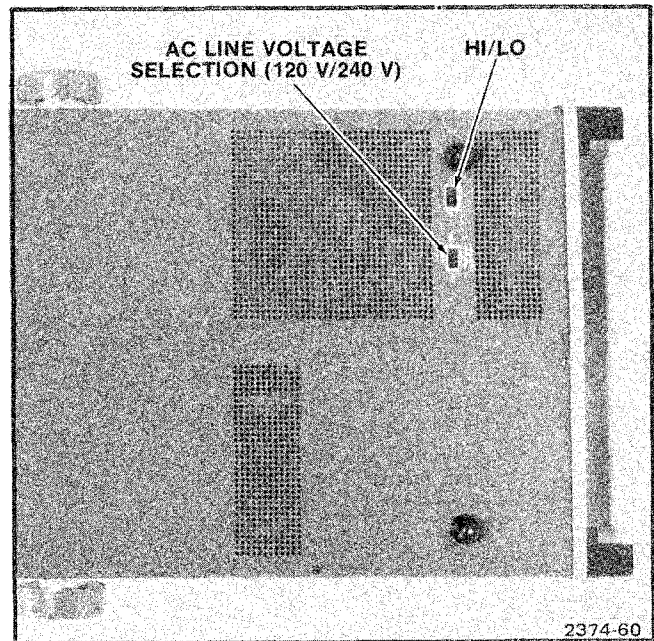


Figure 2-2. Power switch locations on bottom of the 442.

Table 2-2

AC REGULATING RANGES

HI/LO Switch Position	120 V/240 V Setting	
	120 V	240 V
HI	110 to 132 V rms	220 to 250 V rms
LO	92 to 110 V rms	202 to 240 V rms

Fuse Information

The 442 power input fuse is located in a fuse holder on the back panel of the 442. See Figure 2-3.

Table 2-3

POWER INPUT FUSE VALUES

Applied Voltage	F700 Value
120 V ac	0.75 A Fast Blow
240 V ac	0.30 A Slow Blow

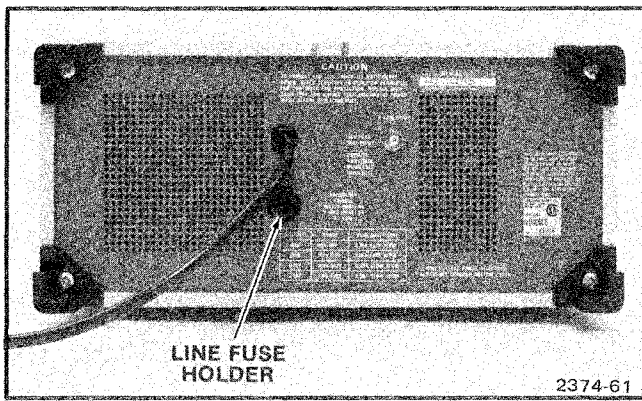


Figure 2-3. Power input fuse location on the 442 back panel.

CONTROLS, CONNECTORS, AND INDICATORS

Introduction

The following information will familiarize an operator with the location and operation of external controls, connectors, and indicators. These controls, connectors, and indicators are accessible from outside the instrument with its cabinet in place. Internal controls should not be adjusted except during instrument calibration and service. Calibration and service procedures must be referred to qualified personnel.

Crt Display and Power

(Front Panel. See Figure 2-4.)

① ASTIGmatism

Recessed screwdriver control used in conjunction with the FOCUS control to obtain a well-defined display. It does not require readjustment during normal operation of the 442.

② INTENSITY

Turn control clockwise to increase display brightness. Set for lowest visible display to prolong crt life.

③ FOCUS

Provides adjustment for optimum display definition when INTENSITY and sweep speed settings are changed significantly (also see ASTIG).

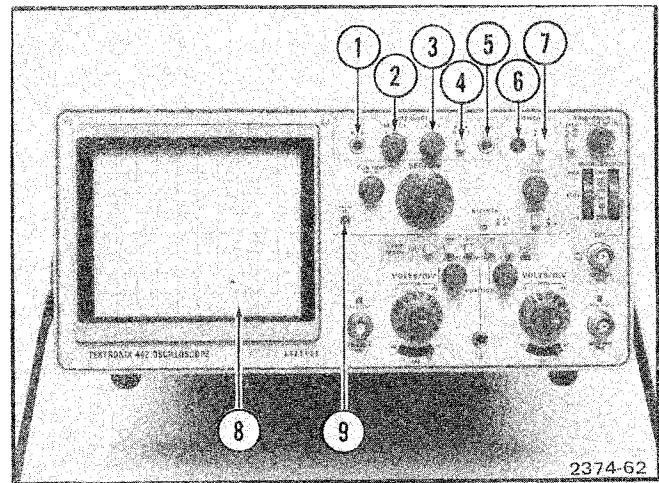


Figure 2-4. Crt Display and Power front panel controls and connectors.

④ BEAM FINDER

Spring-loaded push-button switch to locate off-screen displays. When the BEAM FINDER button is pressed in, the crt display is electrically compressed to within the graticule area, independent of position control settings or applied signals. To locate an off-screen display:

a. Set vertical POSITION and INTENSITY controls to midrange and rotate the horizontal POSITION control fully 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 INTENSITY until a dot or display appears.

If a dot or vertical line appears, the sweep is not triggered. Set trigger MODE switch to AUTO and obtain a display. Center the display with vertical and horizontal POSITION controls. Release BEAM FINDER push button and adjust trigger LEVEL control for a stable display.

After releasing BEAM FINDER, adjust INTENSITY, FOCUS, VOLTS/DIV switch, horizontal, and vertical POSITION controls for a viewable stable display.

⑤ TRACE ROTation

Recessed screwdriver adjustment aligns crt trace with horizontal graticule lines.

Operating Instructions—442 Service

- ⑥ **ON Indicator (LED)**
Lights when power is applied to the 442 and the POWER ON/OFF button is pressed in.
- ⑦ **ON/OFF Push Button Switch**
Turns instrument ON (in) and OFF (out).
- ⑧ **Internal Graticule**
Eliminates parallax. Risetime amplitude and measurement points are marked on the left edge of the graticule. VOLTS/DIV and SEC/DIV settings are calibrated to the graticule scale divisions.
- ⑨ **PROBE ADJust**
Pin connector supplies internally generated square wave of approximately 0.5 V at approximately 1 kHz for use in checking attenuation factors and compensation of probes.

Z AXIS INPUT

(Rear Panel. See Figure 2-5.)

- ⑩ **External Z AXIS INPUT Connector**
Bnc connector accepts signals from external sources for modulating intensity of crt display. Signals must be time-related to the display for stability. Positive signals decrease intensity. Input specification at connector is 30 V peak maximum input and 10,000 Ω input impedance.

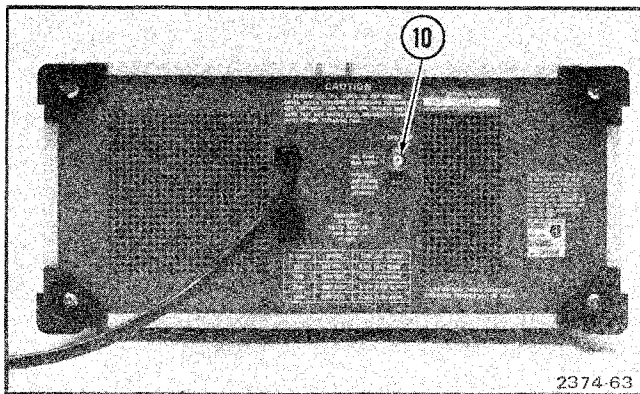


Figure 2-5. External Z AXIS INPUT connector on the back panel of the 442.

POWER INPUT SELECTOR SWITCHES and DC BALANCE CONTROLS

(Bottom of Cabinet. See Figure 2-6.)



Before operating or changing settings of Power Input Selector switches, verify that the 442 power cord is unplugged from the power source and that the correct value of fuse is installed for the available power input voltage (see Table 2-3, and Figures 2-3 and 2-6).

- ⑪ **120 V/240 V (Ac Power Input Selector Switch)**
Two-position, screwdriver actuated slide switch, which can be set to allow operation from an ac source of either 120 V or 240 V. Positions are marked on the cabinet.
- ⑫ **HI/LO (Regulating Range Selector Switch)**
Two-position, screwdriver actuated slide switch which can be set to allow operation from one of two ac ranges (see Table 2-2). Positions are marked on the cabinet.
- ⑬ **CH 1 DC BAL (Channel 1 Dc Balance Control)**
Screwdriver adjustment (through cabinet). When properly adjusted, prevents trace shift when switching between adjacent positions of channel 1 VOLTS/DIV switch.
- ⑭ **CH 2 DC BAL (Channel 2 Dc Balance Control)**
Screwdriver adjustment (through cabinet). When properly adjusted, prevents trace shift when switching between adjacent positions of channel 2 VOLTS/DIV switch.

Vertical

(Front Panel. See Figure 2-7.)

- ⑮ **CH 1 (X) (Channel 1 or X-axis Input)**
Activated when the VERT MODE CH 1 button is pressed in. Bnc connector for the application of external signals to the channel 1 vertical deflection system. For X-Y operation, this connector is the horizontal (X-axis) signal input (see Note).

NOTE

Channel 1 (X) is the horizontal (X-axis) signal input and Channel 2 (Y) is the vertical (Y-axis) signal input when the 442 is set for X-Y operation. The TRIGGERING SOURCE switch must be set to X-Y and the VERT MODE CH 2 button must be pressed in for X-Y operation. The horizontal POSITION control determines the X-axis signal display position and the channel 2 POSITION control determines the Y-axis signal display position when operating in the X-Y mode.

16 CH 2 (Y) (Channel 2 or Y-axis Input)

Activated when the VERT MODE CH 2 button is pressed in. Bnc connector for the application of external signals to the channel 2 vertical deflection system (see Note for X-Y operation).

17 VOLTS/DIV (Channel 1 and Channel 2)

Switches that select the vertical deflection factors in a 1-2-5 sequence. The item 18 VAR controls must be in the calibrated (detent) position to obtain the deflection factors indicated by the switch settings. The correct deflection factor when using a 1X probe or cable is read from the 1X (left) knob skirt window position, and the correct deflection factor when using a 10X probe is read from the 10X (right) knob skirt window position.

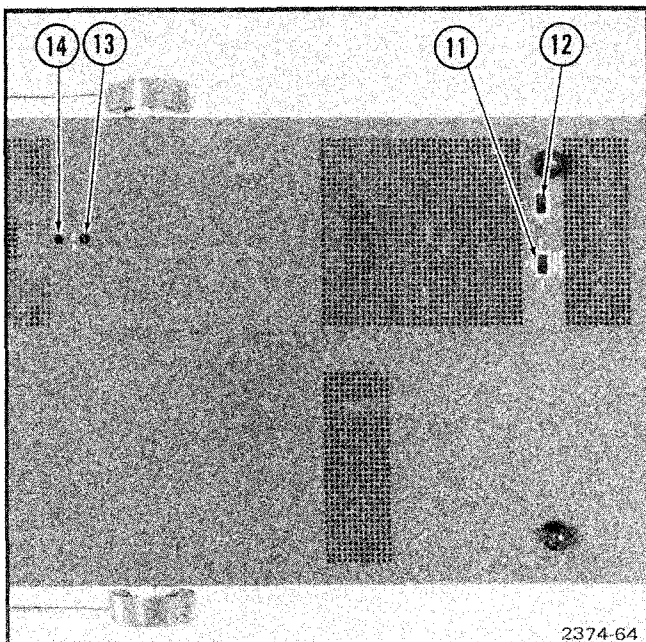


Figure 2-6. Controls and switches accessible through the bottom of the 442 cabinet.

18 VAR (Variable volts/division controls for Channel 1 and Channel 2)

When rotated out of the calibrated (fully clockwise detent) position, these controls provide continuously variable (uncalibrated) deflection factors between the calibrated positions of the VOLTS/DIV switches. Extends maximum deflection factors to 25 V/div with VOLTS/DIV switches set to 10 (volt) position and VAR rotated fully counterclockwise. VAR controls must be set to the detent position for calibrated deflection factors.

19 AC-GND-DC (Input coupling switches for Channel 1 and Channel 2)

Three-position lever switches that select the method of internally coupling the vertical input signals to the vertical amplifier input.

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 1 kHz.

GND: Grounds the input of the vertical amplifier to provide a ground reference display. Connects the applied 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 frequency components of the input signal are passed to the vertical amplifier.

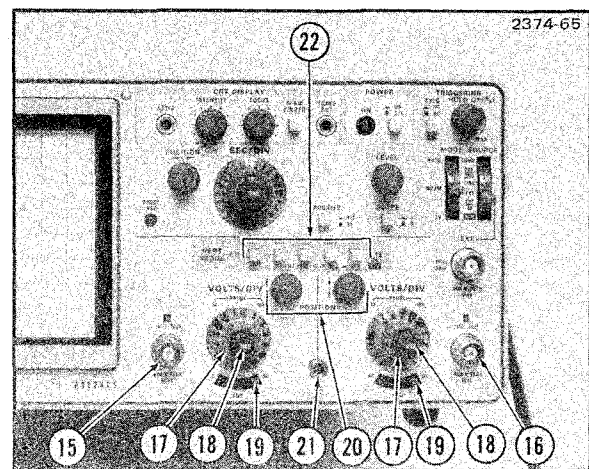


Figure 2-7. Vertical system controls.

20 POSITION (Vertical Position Controls for Channel 1 and Channel 2)

These controls determine the vertical position of the display for each channel. See preceding Note for X-Y positioning.

21 Ground Symbol (External Ground Jack)

Banana jack electrically and mechanically connected to front panel and internal chassis to allow grounding the 442 to an external ground.

22 VERT MODE (Vertical Display Mode Switches)

Five push-button switches that determine the vertical display signal source and operating mode. With TRIGGERING SOURCE switch set to CH1/CH2 the triggering signals are derived from the Channel 1 input signal except when CH 2 button alone or CH 2 button and one of DIFF, ALT, or CHOP buttons are latched-in simultaneously; then Channel 2 will be the triggering source.

CH 1: Displays only the signals applied to the Channel 1 input connector. Triggering signal is derived from the channel 1 signal when SOURCE is set to CH1/CH2.

DIFF: Provides a display of the algebraic difference between signals applied to the channel 1 and channel 2 inputs. Triggering signal is derived from the channel 1 signal unless CH 2 and DIFF are both latched in; then Channel 2 is the triggering signal source if SOURCE is set to CH1/CH2.

ALT: Display alternates between the Channel 1 and Channel 2 signals at the end of each sweep. If SOURCE is set to CH1/CH2 the channel 1 signal will provide the triggering signal unless CH 2 and ALT buttons are latched in; then Channel 2 will provide the triggering signal.

CHOP: Display switches from Channel 1 signal to Channel 2 signal at a rate of approximately 250 kHz. If SOURCE switch is set to CH1/CH2 the Channel 1 signal will provide the triggering signal unless CH 2 and CHOP buttons are both latched in; then Channel 2 will provide the triggering signal.

CH 2: Displays only the signals applied to the Channel 2 input connector. If SOURCE is set to CH1/CH2, Channel 2 will provide the triggering signal. For X-Y operation, the CH 2 button must be latched in and the SOURCE switch must be set to X-Y.

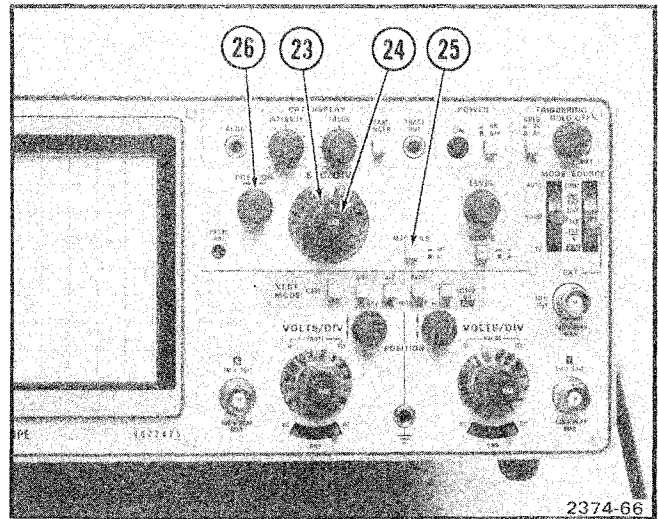


Figure 2-8. Horizontal system controls.

Horizontal

(Front Panel. See Figure 2-8.)

23 SEC/DIV

Switch selects calibrated sweep rates (when SEC/DIV VAR control is in fully clockwise detent position) from 0.5 second/division to 0.1 microsecond/division in a 1-2-5 sequence.

24 VAR

Control, concentric with SEC/DIV switch, provides continuously variable uncalibrated sweep rates to at least 2.5 times the calibrated setting (extends the slowest sweep rate to at least 1.25 seconds/division).

25 MAGNIFIER X10-X1

Push-button switch, when latched in to the X10 position, increases each sweep rate by a factor of 10. Extends the fastest sweep rate to 10 nanoseconds/division.

26 POSITION

Determines the horizontal position of the signal display in the graticule area.

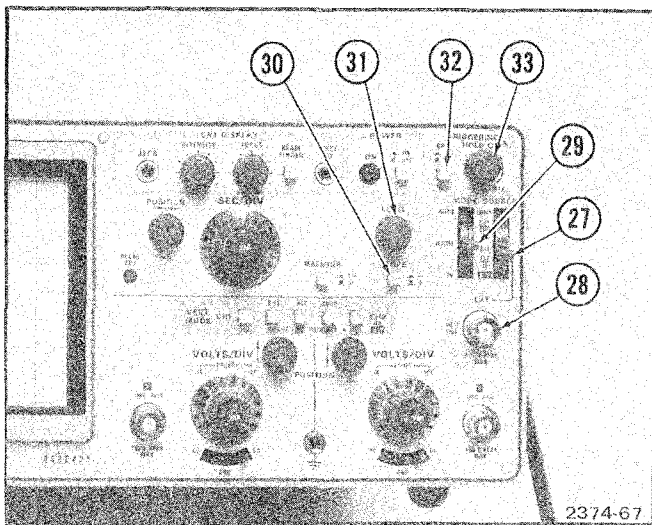


Figure 2-9. Triggering system controls.

Triggering

(Front Panel. See Figure 2-9.)

27 SOURCE

A six-position switch that, along with associated circuitry, determines the source of the signal that is supplied to the trigger input amplifier to initiate a sweep.

COMP: (Composite Triggering): In this position the trigger signal is derived from the signal(s) displayed on the crt. This source does not show the time relationship of Channel 1 and Channel 2 signals when ALTERNATE vertical mode is selected. COMP should not be used in conjunction with CHOP vertical mode because the sweep will be triggered from switching transients instead of the desired signal.

CH 1/CH 2: (Internal Triggering): In this source position, the trigger signal is a sample of the signal displayed on the crt—Channel 1 or Channel 2 when only one channel is selected by the vertical mode switch. When the CHOP, ALT, or DIFF vertical mode is selected, the trigger signal is derived from the signal applied to the Channel 1 input unless the CH 2 Vertical Mode button is latched in along with either the CHOP, ALT, or DIFF button; then the trigger signal is derived from channel 2.

LINE: In this position, the trigger signal is derived from a sample of the line voltage applied to the instrument.

EXT: (External Triggering): This position permits triggering from signals applied to the external trigger input connector (item 28).

EXT/10: Trigger signals applied to the external trigger input connector are attenuated by a factor of ten before being applied to the trigger circuitry.

X-Y: This position permits X-Y displays if the CH 2 VERT MODE button is latched in. During X-Y operation, X deflection is obtained from the signal applied to the channel 1 input connector, and Y deflection is obtained from the signal applied to the channel 2 input connector.

NOTE

X-Y deflection factors are determined by the channel 1 and channel 2 VOLTS/DIV switch settings when the MAGNIFIER switch is in the X1 (out) position. Read the 1X probe windows for direct input. In X-Y operation, the X (Channel 1 signal) position is determined by the horizontal POSITION control, and the Y (Channel 2 signal) position is determined by the Channel 2 vertical POSITION control. The X and Y deflection can also be attenuated (uncalibrated) by the Channel 1 and Channel 2 VOLTS/DIV VAR controls.

28 EXT

Bnc connector for connecting external signals to permit triggering the sweep from an external source when TRIGGERING SOURCE switch is set to EXT or EXT/10 positions.

29 MODE

A three-position switch for selecting the triggering mode.

AUTO: With proper signal amplitude and LEVEL control setting, a sweep will be triggered by input signals that have repetition rates above 20 Hz and are within the frequency range determined by the TRIGGERING CPLG (coupling) switch. In the absence of an adequate trigger signal, or when TRIGGERING controls are misadjusted, the sweep free-runs to provide a reference display (baseline).

NORM: In this mode, with proper signal amplitude and LEVEL control setting, a triggered sweep is initiated by input signals that are within the frequency range determined by the TRIGGERING CPLG (coupling) switch. In the absence of an adequate trigger signal, or when triggering controls are misadjusted, the sweep does not run and there is no display on the crt.

TV: This mode allows triggering on television signals. Triggering is at the TV field rate when SEC/DIV switch is set at .1 ms or slower. Triggering is at the TV line rate when SEC/DIV is set at 50 μ s or faster. Set SLOPE switch to + (out) for sync-positive input signals, and to - (in) for sync-negative input signals.

30 SLOPE

This push-button switch selects either the positive-going or negative-going slope of the trigger signal waveform.

+ (out): Allows triggering from the positive-going slope of the trigger signal.

- (in): Allows triggering from the negative-going slope of a trigger signal.

31 LEVEL

Control that selects the amplitude point on the trigger signal at which the sweep is triggered. Usually adjusted for the desired display after the trigger SOURCE and SLOPE settings have been selected.

32 CPLG (Coupling)

Push-button switch that allows a choice of capacitive or direct coupling to trigger input circuits.

AC: Push-button switch (out) provides circuitry to block the dc component of the triggering signal and allows triggering only on the ac portion. Signals below approximately 60 Hz are attenuated.

DC: Push-button switch (in) provides direct coupling so triggering signal frequency components from dc to above 35 MHz are seen at the trigger input circuit.

33 HOLD OFF

A control that permits varying the amount of hold-off time between sweeps. Provides stable triggering on low repetition-rate pulses or aperiodic signals. To obtain the best display, set or adjust all other triggering controls before adjusting the HOLD OFF control. For normal operation, set this control fully counterclockwise. Hold off increases to MAXimum as the control is rotated fully clockwise.

BASIC OSCILLOSCOPE OPERATION

The following procedures are intended to familiarize the operator with the basic operation of the 442 Oscilloscope.

PRELIMINARY

Signal Ground

The most reliable signal measurements are made when the 442 and the unit under test are connected together by a common reference (ground) lead in addition to the signal lead or probe. The probe ground strap may be used for this purpose, or a separate ground lead may be connected from the ground connector on the 442 front panel (item 21) to the ground reference on the unit under test.

Input Coupling Capacitor Precharging

In AC positions of the AC-GND-DC switches, voltage transients exceeding the 400 V maximum allowable input voltage can be generated if successive measurements are taken on two signals with different levels (even though both dc levels are within the maximum input voltage specification). For example, after measuring ripple on a +300 V dc supply, if the probe is then connected to a -250 V dc supply, the resultant transient amplitude is 550 V.

Use of the GND position of the AC-GND-DC switch before each voltage measurement can eliminate the above-mentioned problem. In the GND position, the vertical preamplifier input circuit is grounded and the applied input signal is connected to ground through the input coupling capacitor in series with a 1 M Ω resistor. This allows the input coupling capacitor to precharge to

the average dc level of the signal applied to the probe. The following procedure will prevent accidentally generated voltage transients from being applied to the preamplifier circuit and also reduce the amount of charging current drawn from the circuit under test.

1. Before connecting the probe tip to a signal source, set the AC-GND-DC switch to GND in order to establish a reference.
2. Touch the probe tip to the 442 front panel ground. Wait several seconds for the input coupling capacitor to discharge.
3. Connect the probe tip to the test signal source.
4. Wait several seconds for the coupling capacitor to charge.
5. Set the AC-GND-DC switch to AC. The display will remain on the screen so the ac component of the signal can be measured in the normal manner.

Operator's Adjustments and Checks

To verify basic accuracy of the 442, make the following checks and adjustments. See Calibration section of this Service manual for calibration information.

NOTE

When a 10X probe is used for making voltage measurements, the deflection factor must be read from the 10X window on the VOLTS/DIV knob skirt.

Probe Compensation

Improper probe compensation is a common source of operator error. Probe compensation should be rechecked when moving the probe from one oscilloscope to another or when transferring the probe from one vertical input channel to another on the same oscilloscope.

To compensate a 10X probe, connect its bnc connector to either the channel 1 or channel 2 input connector and touch the probe tip to the 442 front panel PROBE ADJ pin connector. Set the appropriate VOLTS/DIV switch for a displayed signal amplitude of 2 to 4 divisions. Set the SEC/DIV switch to .1 m, and adjust TRIGGERING controls for a triggered display. Adjust the probe compensation for a flat-top waveform (see Figure 2-10). Refer to the appropriate probe data sheet or manual for the specific method for compensating the probe in use.

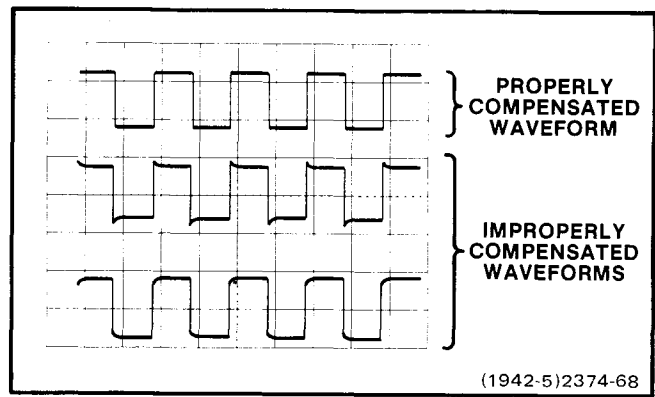


Figure 2-10. Probe compensation.

Vertical Gain Check

Obtain a display of the PROBE ADJ signal. Set the VOLTS/DIV switch to .1 (the VOLTS/DIV VAR control must be in the fully clockwise calibrated detent position). Check that the amplitude of the displayed signal is about 5 divisions.

Basic Timing Check

With the SEC/DIV VAR control in the fully clockwise calibrated detent position, obtain a normal sweep display of a signal with a known frequency. Using the previous setup for Vertical Gain Check, the PROBE ADJ signal should display approximately one complete square-wave cycle per graticule division with the SEC/DIV switch set to 1 m.

WARNING

To prevent possible cross grounding if the power input voltage is used as a signal source, do not attach the probe ground clip to either side of the line voltage source. The 442 chassis ground provides an adequate ground reference.

To use the power line frequency for a basic timing check, lay the 10X probe tip near the power cord and adjust the VOLTS/DIV switch for a vertical display amplitude of several divisions. Set the SEC/DIV switch to display one complete cycle over several horizontal graticule divisions. Duration = 1/frequency. If a 60 Hz power line frequency is being used, check that the duration of one complete cycle is 8.35 divisions with the SEC/DIV switch set to 2 m; and if the SEC/DIV switch is set to 10 m, six cycles of signal should be displayed within the graticule area (adjust LEVEL and other TRIGGERING controls as required to provide a stable triggered display of the signal being used).

Normal Sweep Operation

1. Preset the 442 controls as follows:

NOTE

See *Location and Operation of External Controls, Connectors, and Indicators* for detailed instructions concerning control operation. When using a 10X probe, use the 10X window on the VOLTS/DIV knob skirt. For direct input, use the 1X window.

VERT MODE	CH 1
VOLTS/DIV (both)	.1 (10X window)
VAR (all)	Calibrated (cw)
POSITION (all)	Midrange
SEC/DIV	1 m
MAGNIFIER	X1 (button out)
POWER	ON
INTENSITY	As desired
FOCUS	As desired
HOLDOFF	ccw
SLOPE	+OUT
LEVEL	ccw
SOURCE	CH 1/CH 2
CPLG	AC (out)
MODE	AUTO

2. Connect the PROBE ADJ signal (via the probe supplied with the 442) to the Channel 1 or X input connector.

3. Set the Channel 1 AC-GND-DC switch to select the desired method of coupling the input signal to the preamplifier circuit. With the PROBE ADJ output signal use DC. AC coupling will cause tilting of square waves below about 1 kHz (100 Hz with a 10X probe).

4. Adjust the Channel 1 VOLTS/DIV switch to obtain the desired display amplitude while adjusting the Channel 1 POSITION control to locate the display within the crt viewing area.

5. Adjust the LEVEL control for a stable display.

6. Adjust the SEC/DIV switch to obtain the desired display. Using the PROBE ADJ output signal, the display should appear as illustrated in Figure 2-11 (use a 10X probe with a VOLTS/DIV switch setting of .1 and a SEC/DIV switch setting of .5 m).

NOTE

Verify correct probe compensation (see beginning of Operator's Adjustments and Checks).

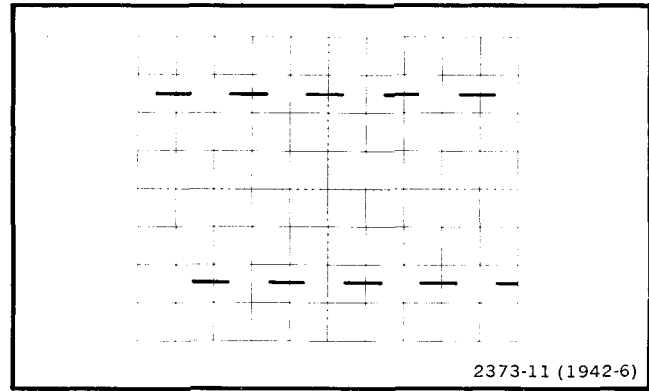


Figure 2-11. Display of 0.5 V PROBE ADJ output signal.

Applications

Peak-to-Peak Voltage Measurements

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

1. Connect a test signal to either Channel 1 or Channel 2 input connector.
2. Set VERT MODE switches to display the channel selected.
3. Set the VOLTS/DIV switch to display about 5 divisions of waveform amplitude.
4. Set the Triggering controls to obtain a stable triggered display. Set the SEC/DIV switch to a position that displays several cycles of the waveform.
5. Turn the vertical POSITION control so the lower portion of the waveform coincides with one of the graticule lines below the center horizontal line and the top of the waveform is in the viewing area. Use the horizontal POSITION control to move one of the upper peaks in alignment with the center vertical graticule line (see Figure 2-12).
6. Measure divisions of vertical deflection from peak-to-peak. Verify that the VOLTS/DIV VAR control is in the fully clockwise calibrated detent position.

NOTE

This procedure may also be used to measure between two points on the waveform rather than peak-to-peak.

7. Multiply the distance measured in step 6 by the VOLTS/DIV switch reading.

EXAMPLE: Assume a peak-to-peak vertical deflection of 4.6 divisions (see Figure 2-12) and a VOLTS/DIV switch setting of 5. Using the formula (read the appropriate VOLTS/DIV knob skirt window for the probe or cable in use):

$$\text{Volts Peak-to-Peak} = \text{Vertical deflection (divisions)} \times \text{VOLTS/DIV setting}$$

Substituting the given values:

$$\text{Volts Peak-to-Peak} = 4.6 \times 5 \text{ V}$$

The peak-to-peak voltage is 23 volts.

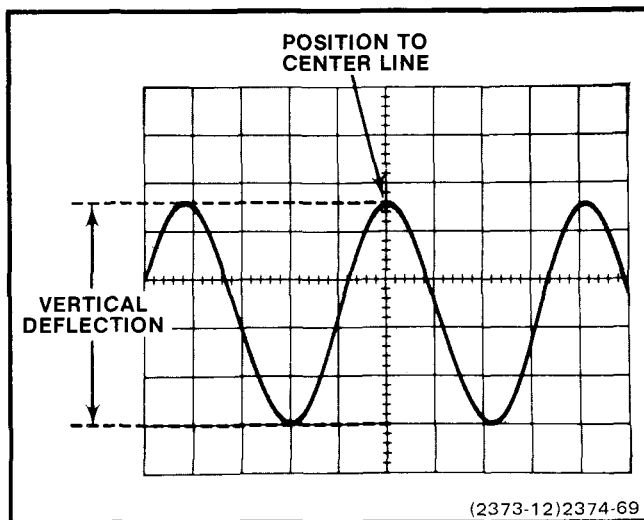


Figure 2-12. Measuring peak-to-peak voltage of a waveform.

Instantaneous Voltage Measurements—Dc

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

1. Connect the test signal to either the Channel 1 or Channel 2 input connector.
2. Set the VERT MODE switches to display the selected channel.
3. Set the VOLTS/DIV switch to display about 5 divisions of waveform.
4. Set the AC-GND-DC switch to GND.
5. Set the TRIGGERING MODE switch to AUTO.

6. Position the trace to the bottom line of the graticule or other reference line. If the voltage to be measured is negative with respect to ground, position the trace to the top line of the graticule. Do not change the vertical POSITION control setting after this reference line has been established.

NOTE

To measure a voltage level with respect to a voltage other than ground, make the following changes in step 6: Set the AC-GND-DC switch to DC and apply a reference voltage to the selected channel input connector. Then position the trace to the reference line.

7. Set the AC-GND-DC switch to DC. The ground reference line can be checked at any time by switching the AC-GND-DC switch to the GND position.

8. Set the Triggering controls to obtain a stable display. Set the SEC/DIV switch to a setting that displays several cycles of the signal.

9. Measure the distance in divisions between the reference line and the point on the waveform at which the dc level is to be measured. For example, in Figure 2-13 the measurement is made between the reference line and point A.

10. Establish the polarity of the signal. If the waveform is above the reference line, the voltage is positive; below the line, it is negative.

11. Multiply the distance measured in step 9 by the VOLTS/DIV switch reading of step 3.

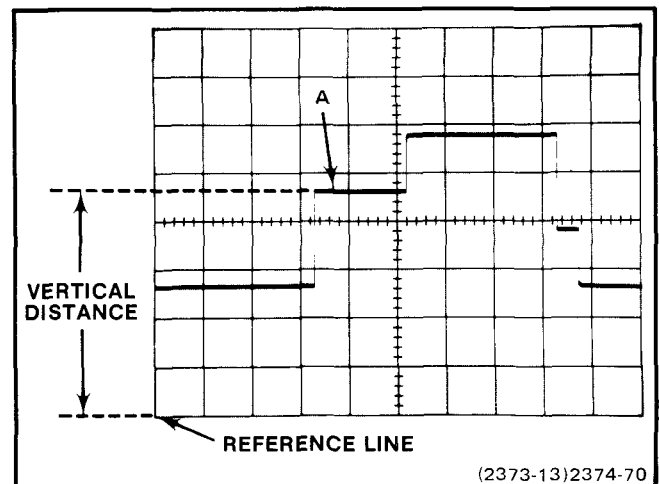


Figure 2-13. Measuring instantaneous dc voltage with respect to a reference voltage.

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EXAMPLE: Assume that the vertical distance measured is 4.6 divisions (see Figure 2-13), the waveform is above the reference line, and the VOLTS/DIV switch reads 2 (read the appropriate VOLTS/DIV window for the probe or cable being used).

Using the formula:

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

Substituting the given values:

$$\text{Instantaneous Voltage} = 4.6 \times +1 \times 2 \text{ V}$$

The instantaneous voltage is 9.2 volts.

DIFF Mode Operation

With the VERT MODE DIFF button pressed in, the displayed waveform is the difference between the signals applied to the Channel 1 and Channel 2 inputs (CH 1 — CH 2).

The following general precautions should be observed when using the DIFF mode:

1. Do not exceed the input voltage rating of the oscilloscope.
2. Do not apply signals that exceed the equivalent of about eight times the reading of the VOLTS/DIV switch settings, since high amplitude voltages may distort the display. For example, with a VOLTS/DIV switch setting of .5, the voltage applied to that channel should not exceed about four volts.

Comparison Measurements

In some applications it may be desirable to establish arbitrary units of measurement other than those indicated by the VOLTS/DIV switch or SEC/DIV switch. This is particularly useful when comparing unknown signals to a reference amplitude or repetition rate. One use for the comparison-measurement technique is to facilitate calibration of equipment (e.g., on an assembly-line test) where the desired amplitude or repetition rate does not produce an exact number of divisions of deflection. The adjustment will be easier and more accurate if arbitrary units of measurement are established so the correct adjustment is indicated by an exact number of divisions of deflection. Arbitrary sweep rates can be useful for com-

paring harmonic signals to a fundamental frequency, or for comparing the repetition rate of input and output pulses in a digital count-down circuit. The following procedure describes how to establish arbitrary units of measure for comparison measurements. Although the procedure for establishing vertical and horizontal arbitrary units of measurement is much the same, both processes are described in detail.

Vertical Deflection Factor. To establish an arbitrary vertical deflection factor based upon a specific reference amplitude, proceed as follows:

1. Connect a reference signal to the Channel 1 or Channel 2 input connector. Set the SEC/DIV switch to display several cycles of the signal.
2. Set the VERT MODE switches to display the selected channel, and set the VOLTS/DIV switch and VAR control for that channel to produce a display of an exact number of graticule divisions in amplitude. Do not change the VAR control setting after obtaining the desired deflection. This display can be used as a reference for amplitude comparison measurements.
3. To establish an arbitrary vertical deflection factor so the unknown amplitude of a signal can be measured accurately at any setting of the VOLTS/DIV switch, the amplitude of the reference signal must be known. If it is not known, it can be measured before the VAR control is set in step 2.
4. Divide the amplitude of the reference signal (volts) by the product of the vertical deflection established in step 2 (divisions) and the setting of the VOLTS/DIV switch. This is the vertical conversion factor.

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

5. To measure the amplitude of an unknown signal, disconnect the reference signal and connect the unknown signal to the selected channel input connector. Set the VOLTS/DIV switch to a setting that provides sufficient vertical deflection to make an accurate measurement. Do not readjust the VAR control.

6. Measure the vertical deflection in divisions, and calculate the amplitude of the unknown signal using the following formula:

$$\text{Signal Amplitude} = \frac{\text{VOLTS/DIV switch setting}}{\text{vertical conversion factor}} \times \text{vertical deflection (divisions)}$$

EXAMPLE: Assume a reference signal amplitude of 30 V, a VOLTS/DIV switch setting of 5, and the VAR control is adjusted to provide a vertical deflection of 4 divisions.

Substituting these values in the vertical conversion factor formula (step 4):

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

Then with a VOLTS/DIV switch setting of 1, the peak-to-peak amplitude of an unknown signal which produces a vertical deflection of 5 divisions can be determined by using the signal amplitude formula (step 6):

$$\text{Signal Amplitude} = 1 \text{ V} \times 1.5 \times 5 = 7.5 \text{ volts}$$

Sweep Rates. To establish an arbitrary horizontal sweep rate based upon a specific reference frequency, proceed as follows:

1. Set the VERT MODE switches to display the selected channel and connect a reference signal to the selected channel input connector. Set the VOLTS/DIV switch for 4 or 5 divisions of vertical deflection.

2. Set the SEC/DIV switch and VAR control so one cycle of signal covers an exact number of horizontal divisions. Do not change the VAR control setting after obtaining the desired deflection. This display can be used as a reference for frequency comparison measurements.

3. To establish an arbitrary sweep rate so the unknown period of a signal can be measured accurately at any setting of the SEC/DIV switch, the period of the reference signal must be known. If it is not known, it can be measured before the VAR control is set in step 2.

4. Divide the period of the reference signal (seconds) by the product of the horizontal deflection established in step 2 (divisions) and the setting of the SEC/DIV switch. This is the horizontal conversion factor:

$$\text{Horizontal Conversion Factor} = \frac{\text{reference signal period (seconds)}}{\text{horizontal deflection (divisions)} \times \text{SEC/DIV switch setting}}$$

5. To measure the period of a signal, disconnect the reference signal and connect the questioned signal to the selected channel input connector. Set the SEC/DIV switch to a setting that provides a sufficient horizontal display to make an accurate measurement (at least one full cycle). Do not readjust the VAR control.

6. Measure one full cycle of the horizontal display in divisions and calculate the period of the unknown signal using the following formula:

$$\text{Period} = \frac{\text{SEC/DIV switch setting}}{\text{horizontal conversion factor}} \times \text{horizontal display (divisions)}$$

EXAMPLE: Assume a reference signal frequency of 455 Hz (period 2.19 milliseconds), and a SEC/DIV switch setting of .2 m, with the VAR control adjusted to provide a horizontal deflection of eight divisions. Substituting these values in the horizontal conversion factor formula (step 4):

$$\text{Horizontal Conversion Factor} = \frac{2.19 \text{ milliseconds}}{.2 \times 8} = 1.37$$

Then, with a SEC/DIV switch setting of 50 μ the unknown period of a signal, which completes one cycle in 7 horizontal divisions, can be determined by using the period formula (step 6):

$$\text{Period} = 50 \mu\text{s} \times 1.37 \times 7 = 480 \mu\text{s}$$

This answer can be converted to frequency (repetition rate) by calculating the reciprocal of the period.

Time-Duration measurements

To measure time between two points on a waveform, use the following procedure:

1. Connect a signal to either the Channel 1 or the Channel 2 input connector.

2. Set the VERT MODE switches to display the selected channel.

3. Set the VOLTS/DIV switch to display about 5 divisions of waveform.

4. Set the Triggering controls to obtain a stable display.

5. For best accuracy use a SEC/DIV setting that gives the greatest number of on-screen divisions between time

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measurement points (see Figure 2-14). The MAGNIFIER may be set to X10 (button in) to expand the display when measuring portions of more complex waveforms. If this technique is employed, the final time duration figure in step 9 must be divided by ten.

6. Adjust the vertical POSITION control to move the display measurement points to the center horizontal graticule line.

7. Adjust the horizontal POSITION control to center the display within the center 8 graticule divisions.

8. Measure the horizontal distance between the time measurement points. Verify that the SEC/DIV VAR control is set in the calibrated detent (fully cw).

9. Multiply the distance measured in step 8 by the setting of the SEC/DIV switch.

EXAMPLE: Assume the distance between time measurement points is 5 divisions (see Figure 2-14) and the SEC/DIV switch is set at .1 m.

Using the formula:

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

Substitute given values:

$$\text{Time Duration} = 5 \times 0.1 \text{ m}$$

The time duration is 0.5 millisecond.

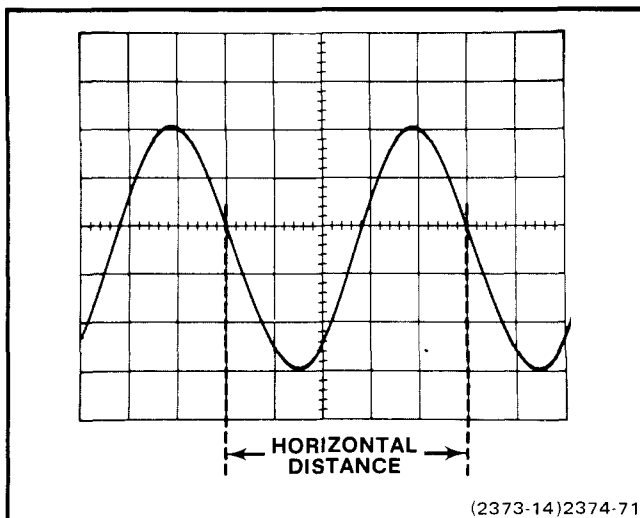


Figure 2-14. Measuring the time duration between points on a waveform.

Frequency Measurements

The time measurement technique can also be used to determine the frequency of a signal. The frequency of a periodically recurrent signal is the reciprocal of the time duration (period) of one cycle.

Use the following procedure:

1. Measure the time duration of one cycle of waveform as described in the previous application.

2. Calculate the reciprocal of the time duration to determine the frequency.

EXAMPLE: The frequency of the signal shown in Figure 2-14, which has a time duration of 0.5 millisecond, is calculated as follows:

$$\text{Frequency} = \frac{1}{\text{time duration}} = \frac{1}{0.5 \text{ ms}} = \frac{1}{0.5 \times 10^{-4}} = 2 \times 10^{-3} = 2 \text{ kHz}$$

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 amplitude (see percentage markings on the left edge of the graticule).

Use the following procedure to measure risetime:

1. Adjust the VOLTS/DIV switch and VAR control for a display amplitude of exactly 5 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 Figure 2-15).

3. Measure the horizontal distance (divisions) between the 10% and 90% points on the waveform (point A to point B, Figure 2-15).

Use the following formula to find risetime:

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

Examples:

The horizontal distance between the 10% and 90% point on the waveform is 5 divisions with a SEC/DIV switch setting of 1 μ s.

Substituting the given values:

$$\text{Risetime} = 5 \text{ divisions} \times 1 \mu\text{s/division}$$

$$\text{Risetime} = 5 \mu\text{s}$$

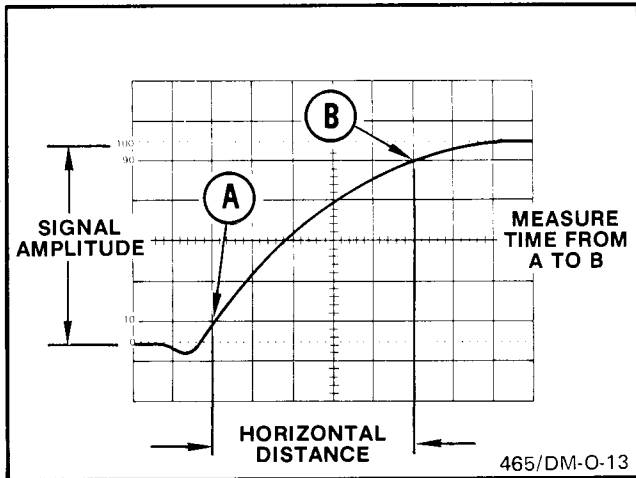


Figure 2-15. Measuring rise time.

Time-Difference Measurements

The calibrated sweep rate and dual-trace features of the 442 allow measurement of time difference between two separate events. To measure time difference, use the following procedure:

1. Set the Input Coupling switches (AC-GND-DC) to the AC or DC coupling positions depending on the type of coupling desired.

2. Set the VERT MODE switches to either CHOP or ALT. In general, the CHOP mode is more suitable for low-frequency signals while the ALT mode is more suitable for high-frequency signals.

3. Connect the reference signal to the Channel 1 input and the comparison signal to the Channel 2 input. The reference signal should precede the comparison signal in time. Connect the signals to the input connectors through coaxial cables that have equal delay time.

4. Set the VOLTS/DIV switches to produce 4 or 5 divisions of display amplitude.

5. Set the LEVEL control for a stable display.

6. If possible, set the SEC/DIV switch for a sweep rate which shows three or more divisions between the measurement points for the two waveforms.

7. Set the vertical POSITION controls to center each waveform (or points on the display between which the measurement is made) in relation to the center horizontal graticule line.

8. Set the horizontal POSITION control so the Channel 1 (reference) waveform crosses the center horizontal line at a vertical graticule line.

9. Measure the horizontal difference between the Channel 1 waveform measurement point and the Channel 2 waveform measurement point (see Figure 2-16).

10. Multiply the measured difference (horizontal divisions) by the SEC/DIV switch setting reading.

EXAMPLE: Assume the SEC/DIV switch is set to 50 μ , and the horizontal difference between measurement points on the two waveforms is 4.5 divisions (see Figure 2-16).

Using the formula:

$$\text{Time Difference} = \frac{\text{SEC/DIV}}{\text{setting}} \times \text{horizontal difference (divisions)}$$

Substituting the given values:

$$\text{Time Difference} = 50 \mu\text{s} \times 4.5$$

The time difference is 225 microseconds.

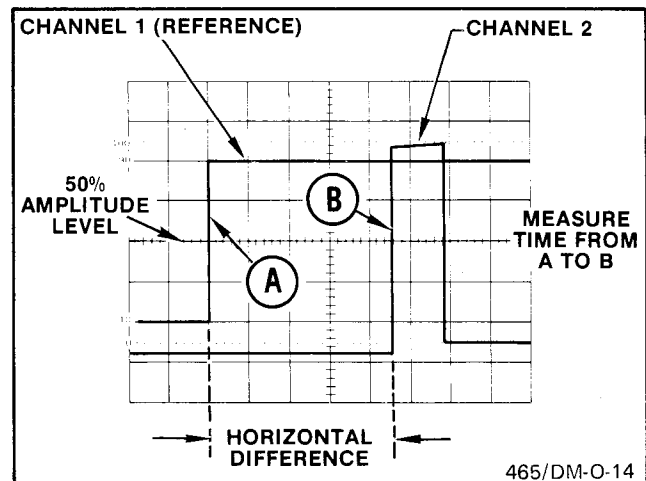


Figure 2-16. Measuring time difference between two pulses.

Multi-Trace Phase Difference Measurements

Phase comparison between two signals of the same frequency can be made using the dual-trace feature of the 442. This method of phase difference measurement can be used up to the frequency limit of the vertical system. To make a phase comparison measurement, use the following procedure:

1. Set the Input Coupling switches (AC-GND-DC) to the AC or DC position, depending on the type of coupling desired.

2. Set the VERT MODE switches to either CHOP or ALT. In general, the CHOP mode is more suitable for low-frequency signals while the ALT mode is more suitable for high-frequency signals.

3. Connect the reference signal to the Channel 1 input connector and the comparison signal to the Channel 2 input connector. The reference signal should precede the comparison signal in time. Use coaxial cables or probes that have equal time delay to connect signals to the input connectors.

4. Set the VOLTS/DIV switches and VAR controls so the displays are equal and about 5 divisions in amplitude.

5. Set the Triggering controls to obtain a stable display.

6. Set the SEC/DIV switch to a sweep rate which displays about one full cycle of each waveform over 10 graticule divisions.

7. Use the Channel 1 and Channel 2 POSITION controls to center the waveforms around the center horizontal graticule line.

8. Turn the SEC/DIV VAR control until one cycle of reference signal (Channel 1) occupies exactly 8 divisions between the second and tenth graticule lines (see Figure 2-17). Each division of graticule represents 45° of the cycle ($360^\circ \div 8 \text{ divisions} = 45^\circ/\text{division}$). The horizontal graticule calibration can be stated in terms of degrees as 45°/division.

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

10. Multiply the measured distance by 45°/division to obtain the exact amount of phase difference.

EXAMPLE: Assume a horizontal difference of 0.6 division with a horizontal graticule calibration of 45°/division as shown in Figure 2-17. Using the formula:

$$\text{Phase Difference} = \frac{\text{horizontal difference (divisions)}}{\text{horizontal graticule calibration (degrees/div)}}$$

Substituting the given values:

$$\text{Phase Difference} = 0.6 \times 45^\circ$$

The phase difference is 27°.

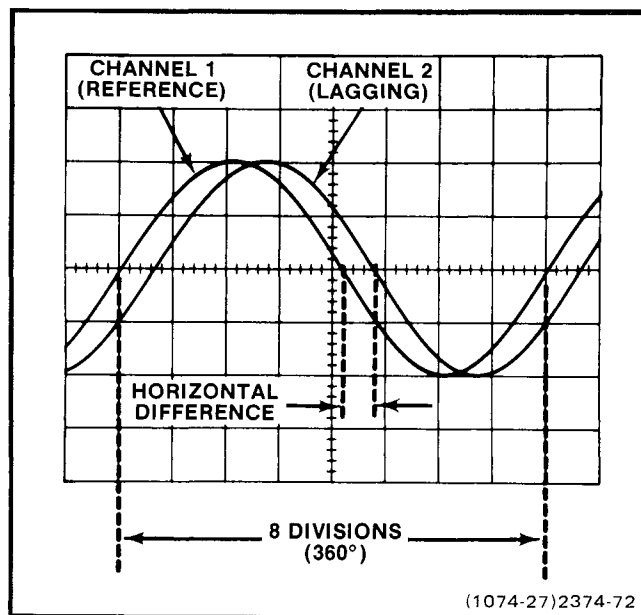


Figure 2-17. Measuring phase difference.

X-Y Phase Measurement

The X-Y phase measurement method can be used to measure the phase difference between two signals of the same frequency. This method provides an alternate method of measurement for signal frequencies up to 2 MHz. However, above this frequency the inherent phase difference between vertical and horizontal systems makes accurate phase measurement difficult. In this mode, one of the sinewave signals provides the horizontal deflection (X) while the other signal provides the vertical deflection (Y). The phase angle between the two signals can be determined from the lissajous pattern as follows:

1. Connect one of the sinewave signals to the Channel 1 or X connector; and the other signal to the Channel 2 or Y input connector.

2. Set the TRIGGERING SOURCE switch to X-Y and the VERT MODE switch to CH 2 or X-Y.

3. Position the display to the center of the crt graticule area and adjust the Channel 1 and Channel 2 VOLTS/DIV switches to produce a display amplitude of less than 6 divisions vertically (Y) and less than 10 divisions horizontally (X). The Channel 1 VOLTS/DIV switch controls the horizontal deflection (X) and the Channel 2 VOLTS/DIV switch controls the vertical deflection (Y).

4. Center the display around the center graticule lines. Measure the distance A and B as shown in Figure 2-18. Distance A is the horizontal measurement between two points where the trace crosses the center horizontal line. Distance B is the maximum horizontal width of display.

5. Divide A by B to obtain the sine of the phase angle (ϕ) between the two signals. The angle can then be obtained from a trigonometric table.

6. If the display appears as a diagonal straight line, the two signals are either in phase (tilted upper right to lower left) or 180° out of phase (tilted upper left to lower right). If the display is a circle, the signals are 90° out of phase.

EXAMPLE: To measure the phase of the display shown in Figure 2-18 where A is 5 divisions and B is 10 divisions, use the formula:

Substituting the given values:

$$\text{Sine } \phi = \frac{A}{B}$$

Substituting the given values:

$$\text{Sine } \phi = \frac{5}{10} = 0.5$$

From trigonometric tables:

$$\phi = 30^\circ$$

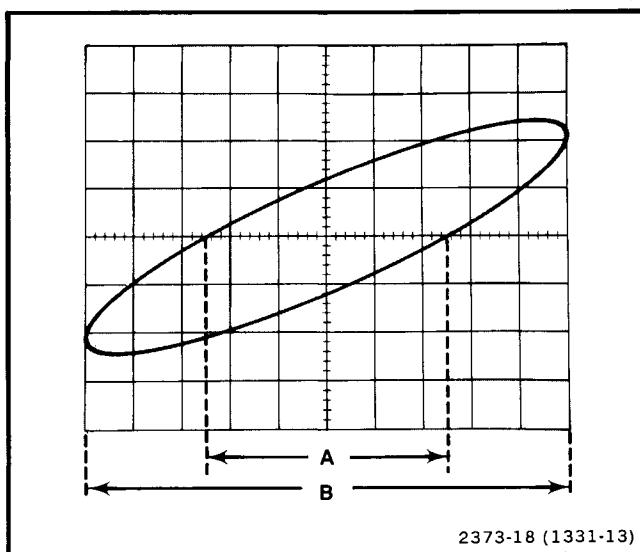


Figure 2-18. Phase difference measurement with an X-Y display.

Oscilloscope Light Filter and Graticule Illumination Photography Effects

The 442 Oscilloscope contains a factory installed colored (blue) plastic light filter in front of the crt faceplate to improve general purpose viewing contrast in ambient lighting conditions. This device also functions as an implosion shield.

The internal crt graticule lines in the 442 are not illuminated, and may not be visible on a photograph of the crt display when using ordinary photographic techniques. If the user wishes to produce oscilloscope photographs in which the graticule lines are visible along with the signal display, a special oscilloscope camera such as the TEKTRONIX C5C or C5C Option 3 is recommended. These cameras provide an external flash illumination for the crt graticule. Effectiveness of the external flash illumination is somewhat degraded when used with the blue crt light filter. A clear light filter is available as an optional accessory for the 442 (refer to the Accessories tab page at the back of this manual for part number and description of the clear filter) to be installed in place of the blue filter during oscilloscope photography.

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).

To order the optional clear light filter accessory, contact your local Tektronix Field Office.

To change light filters (implosion shields): Press down on the bottom of the black plastic light filter frame and tilt the top of the frame away from the crt face. Press the front of the existing filter to remove it from the frame and press the new filter into the frame. Reinstall the frame and filter on the oscilloscope by pressing the bottom of the frame down into the bezel channel; then tilt the top of the frame inward toward the crt face and the spring on the bottom of the frame will push the frame assembly up into the operating position.

Instrument Repackaging

Should reshipment become necessary, reuse the carton in which your instrument was shipped. If the original packaging is unfit for use or is not available, repackage the instrument as follows:

1. Obtain a carton of corrugated cardboard having inside dimensions of no less than six inches more than the instrument dimensions; this will allow for cushioning. Use a carton having a test strength of at least 275 pounds.

Operating Instructions—442 Service

2. Surround the instrument with polyethylene sheeting to protect the finish and prevent packing material from entering the instrument.

3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between carton and instrument, allowing three inches on all sides.

4. Seal carton with shipping tape or industrial stapler.

Required Reshipment Information

If the instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag containing the following information:

1. Owner's name and address, with the name of an individual at your firm who can be contacted.

2. Complete instrument serial number.

3. Description of the services required.

THEORY OF OPERATION

GENERAL

This section describes circuitry used in the 442 Oscilloscope. The description begins with a discussion of operation using the block diagram shown in Diagrams and Circuit Board Illustrations (Section 7).

Next, each circuit is described in detail.

Refer to the schematic diagrams (in Section 7) throughout the following discussions for specific electrical values and relationships.

BLOCK DIAGRAM DESCRIPTION

The following discussion is provided to aid in understanding the overall concept of the 442 Oscilloscope before individual circuits are discussed in detail.

VERTICAL INPUT

Signals to be displayed on the crt screen are applied to either (or both) Channel 1 (X) and Channel 2 (Y) input connectors. Input signals are amplified by Channel 1 or Channel 2 preamplifier circuits as appropriate. Each preamplifier circuit includes separate input coupling switches, attenuators, gain switching, variable attenuators, balance, and gain adjustments.

A Trigger Pickoff circuit in each vertical channel supplies a sample of the input signal to the Trigger Input Amplifier via the Trigger Switching circuit and the SOURCE switch.

When the SOURCE switch is in the X-Y position, triggering is disabled and Channel 1 signals are connected to the Horizontal Output Amplifier through the X Buffer Amplifier. Channel 2 signals are connected through regular Channel 2 vertical circuitry. Channel 1 provides X-Axis deflection and Channel 2 provides Y-Axis deflection.

VERTICAL SWITCHING

The Vertical Mode switches select the desired channel presentation and an appropriate trigger signal. The output of each Preamplifier is connected to the Delay Line Driver through a corresponding Input Buffer and a Diode Gate. The Diode Gates are controlled by the Vertical Switching circuit (as determined by the Vertical Mode switch) to select the channel(s) for display. An output from the Vertical Switching circuit is connected through the Chop Blanking Pulse Generator to the Z Axis Amplifier to blank switching transients in the CHOP mode. A sync pulse from the sweep, via the Alternate Sync Pulse Amplifier, switches the display between channels at the end of each sweep in ALTERNATE mode. A DIFFERENTIAL function allows a display of the difference between the two input signals using circuitry that inverts the Channel 2 signal and adds it algebraically to the Channel 1 signal.

VERTICAL AMPLIFIER

The vertical input signals go from the Delay Line Driver through the Delay Line to the Vertical Output Amplifier. The Delay Line provides approximately 140 ns delay in vertical signal transfer. This allows the sweep generator circuit time to initiate a sweep before the vertical signal reaches the crt vertical deflection plates. One section of the BEAM FINDER switch affects the Vertical Output Amplifier circuitry. When the BEAM FINDER button is pressed in, this section compresses the display vertically to within the graticule area (another section affects the Horizontal Amplifier circuitry and causes the display to compress horizontally when the button is pressed in). This aids in locating off-screen displays. The vertical output amplifier provides final amplification of the signal to drive the crt vertical deflection plates.

TRIGGER

The Trigger circuits produce timed logic signals to trigger the sweep. Trigger signals are selected by the SOURCE switch from four different sources: From the Composite Pick-off for COMP; from the Int Trigger Switching and the Int Trigger Buffer Amplifier for CH 1/CH 2; from the secondary of T700 (line voltage) for LINE; and from the EXT input connector for the EXT trigger

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function. The trigger SOURCE, EXT/10, uses the same signal as EXT but the signal is attenuated by a factor of ten for user convenience.

A selected trigger signal is amplified and inverted by the Trigger Input Amplifier. The trigger signal passes through a resistor network to the Trigger Level Comparator, which determines the voltage level (on the trigger waveform) at which triggering occurs. The SLOPE switch selects the slope or sync (TV) polarity. The Trigger Level Comparator also supplies a signal to the TV Sync Separator circuit.

Two Schmitt trigger circuits produce a logic trigger signal: one is for normal trigger signals and the other is for TV signals. The MODE switch selects which Schmitt trigger circuit will operate.

SWEEP AND HORIZONTAL AMPLIFIER

The Sweep circuit, when triggered by the Trigger circuit, produces a linear sawtooth output signal for the Horizontal Amplifier to produce a sweep. The slope of the sawtooth signal is controlled by the SEC/DIV switch, which determines the time period and frequency. When the sawtooth output reaches a predetermined level, the Holdoff circuit resets the Sweep circuit, blanks the crt (through the Z Axis Amplifier) and prevents subsequent triggers from initiating another sweep until sweep reset is completed. The HOLDOFF control can be adjusted for low frequency stability.

CRT CIRCUIT

The Z Axis Amplifier determines the crt intensity and blanking. It sums the current inputs from several sources: INTENSITY control; X-Y intensity limit; unblanking signals from the sweep circuit; chop blanking signals from the Vertical Switching circuit; and signals from the External Z AXIS INPUT connector, J419.

Output from the Z Axis circuit controls the trace intensity through the HV circuit. The HV circuit provides the voltages (greater than 100 V) necessary for operation of the crt.

PROBE ADJ

The Probe Adjust Generator provides a square-wave voltage output for checking and adjusting the compensation of voltage probes.

POWER SUPPLY

The Power Supply circuits provide low-voltage power necessary for operation of the instrument.

DETAILED CIRCUIT DESCRIPTION

The operation of circuits unique to this instrument is described in detail in this discussion. Circuits commonly used in the electronics industry are not described in detail.

The following circuit analysis gives names of individual stages, and describes how they are connected to form major circuits. The detailed circuit diagrams are shown in Section 7.

VERTICAL INPUT (Diagram 1)

Since the Channel 1 and Channel 2 input circuits are electrically nearly identical, only Channel 1 is discussed in detail. The 4100 series circuit numbers identify the Channel 1 components and 4200 series numbers identify the Channel 2 components.

Input Switching

Input Coupling Switch—AC-GND-DC. The vertical input signal is ac-coupled, dc-coupled, or grounded by S4100. With the coupling switch in the DC position, input signals are coupled directly to the VOLTS/DIV switch attenuator. With the coupling switch in the AC position, input signals pass through C4102 to the attenuator. With the coupling switch in the GND position, the input to the attenuator is grounded. This provides a ground reference without disconnecting the signal from the input connector. In the GND position, C4102 is charged to the average signal level through R4102 so that a trace remains on the crt when S4100 is changed to the AC position.

VOLTS/DIV Switch. The VOLTS/DIV switch selects the attenuator ratio and the preamplifier gain to determine the deflection factor. The basic deflection factor of the vertical deflection system is 2 mV/division. At this setting, no attenuators are switched into the system and the gain switch circuit sets the preamplifier gain to maximum. Precision attenuators are switched in and out of the attenuator and gain switching circuits to provide a complete range of deflection factors as indicated on the front panel.

Attenuators are frequency compensated voltage dividers that provide constant attenuation at all frequencies within the bandwidth of the 442. Input RC characteristics (approximately 1 M Ω times approximately

30 pF) are maintained for each setting of the VOLTS/DIV switch. The attenuator circuit consists of a 10X and a 100X attenuator. 1000X is obtained when the 10X and 100X attenuators are cascaded.

The gain switching circuit consists of R4143 through R4147 and three VOLTS/DIV switch contacts. Three preamplifier gains are selected: 1X (maximum), 2.5X reduction, and 5X reduction. Refer to Table 3-1 for the attenuator and gain switching sequence.

Table 3-1

ATTENUATOR AND GAIN SWITCHING SEQUENCE

VOLTS/DIV Setting	Attenuator (signal attenuation)	Gain Switch (preamp gain reduction)
2 m	1X	1X
5 m	1X	2.5X
10 m	1X	5X
20 m	10X	1X
50 m	10X	2.5X
.1	10X	5X
.2	100X	1X
.5	100X	2.5X
1	100X	5X
2	1000X	1X
5	1000X	2.5X
10	1000X	5X

Preamplifier

Input. Signals from the attenuator are connected to source follower Q4122 via C4122 and R4122. Resistor R4121 determines the 1 M Ω input resistance, and R4122 limits the current drive to the gate of Q4122A. Diode CR4122 protects the circuit from high negative-going input signals by limiting voltages at the gate of Q4122A to about -8 volts. Field effect transistor Q4122B provides a constant-current source for Q4122A.

Transistors Q4132 and Q4134 are emitter followers. The signal at the emitter of Q4132 follows the signal at the gate of Q4122A. Divider network R4143 through R4147 attenuates the signal from Q4132 which drives the base of Q4158. DC Bal R4130 adjusts for zero current in R4244, R4245, or R4246 providing minimum trace shift when switching between these resistors.

First Cascode Amplifier. The paraphase amplifier stage (Q4168, Q4158, and associated circuitry) converts the single-ended signal at the base of Q4158 to a push-pull

current signal. Capacitors C4158 and C4168 minimize the Miller effect through Q4158 and Q4168. Components C4154, C4156, R4156, R4166 and C4166 (connected between emitters of Q4158 and Q4168) compensate for high-frequency losses in the preamplifier. VAR control R4152 provides uncalibrated deflection factors between VOLTS/DIV switch settings by attenuating signals applied to the base of Q4158. Transistors Q4174, Q4184, and associated circuitry compose a common base amplifier stage.

Second Cascode Amplifier. Transistors Q4176-Q4186 and Q4344-Q4346 (on diagram 2) compose the second cascode amplifier. Capacitors C4177 and C4187 minimize the Miller effect through Q4176 and Q4186. POSITION control R4346 (on diagram 2) establishes the vertical position of the display on the crt.

A sample of the vertical voltage signal from the emitters of Q4176 and Q4186 is applied to Q4194 and Q4196 where it is converted to a current signal. This current signal is applied to the trigger input amplifier to provide a triggering signal (see diagram 4) via diode switching circuitry (see diagram 2). See circuit descriptions for diagrams 2 and 4 for further details.

Channel 2 operates the same as Channel 1 except for an inverting pair of transistors that invert the Channel 2 signal during DIFF mode operation.

An additional potentiometer R4265 (SN B010409 and above) or R4280 (serial numbers below B010409) is included in Channel 2 to provide an invert balance adjustment for Channel 2.

VERTICAL SWITCHING (Diagram 2)

Digital logic devices are used in the 442 to perform some functions. LO and HI designations are used in this description to indicate the states of the digital circuitry. HI indicates the more positive of two levels. Specific voltages, which constitute LO or HI logic states, may vary between individual devices.

Delay Line Driver

The delay line driver is a push-pull feedback amplifier stage composed of Q4386, Q4376, and associated circuitry. A sample of the output of Q4386 and Q4376 is fed back through R4383 and R4373 to the bases of Q4386 and Q4376. Due to this feedback, this stage forms an inverting operational amplifier with a virtual ground at the bases of Q4386 and Q4376. Any current into these virtual ground null points causes an output voltage that is proportional to the feedback resistance.

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Components C4396, R4396, C4397, C4395, R4397, C4398, and R4398 provide compensation (peaking) to correct for delay line losses.

Delay Line

Delay Line DL4380 provides approximately 140 ns delay for the vertical signals. This allows the sweep generator circuit to initiate a sweep before any vertical signal reaches the crt vertical deflection plates.

Vertical Switching

The Vertical Switching circuit determines when Channel 1 or Channel 2 is connected to the vertical output amplifier. In ALTERNATE or CHOPPED mode, both channels are displayed on a time shared basis.

Diode gates, consisting of four diodes each, act as switches that allow either of the vertical preamplifier signals to be coupled to the delay line driver. Diodes CR4346, CR4347, CR4348, and CR4349 control the Channel 1 output while CR4356, CR4357, CR4358, and CR4359 control the Channel 2 output. These diodes are controlled by flip-flop U4324A, which in turn is controlled by the Vertical Mode switch (five push-buttons), S4320.

When the Vertical Mode switch is set for CH 1 (CH 1 pushbutton in), pin 4 of U4324A is held LO. Since pin 1 is HI, this causes pin 5 to go HI. A HI at pin 5 (a voltage higher than at the bases of Q4386 and Q4376) reverse biases CR4347 and CR4348 and forward biases CR4346 and CR4349. This allows Channel 1 signals to pass to the delay line driver. When pin 5 is HI, pin 6 is LO causing the cathodes of CR4357 and CR4358 to connect to a voltage much lower than on the bases of Q4386 and Q4376. Diodes CR4357 and CR4348 are now forward biased and diodes CR4356 and CR4359 are reverse biased, preventing Channel 2 signals from passing through to the delay line driver.

In Channel 2 mode, the above conditions are reversed.

With Vertical Mode in DIFFERENTIAL, the inputs from both channels are added at the delay line driver. The DIFF push-button switch inverts Channel 2 by removing forward bias voltage from the bases of Q4354 and Q4356 and applying it to the bases of Q4350 and Q4352. The DIFF mode switch also sets pin 1 and 4 of U4324A low, causing pins 5 and 6 to go high, thus turning on both Channel 1 and Channel 2. Channel 1 and the inverted Channel 2 signal currents are then added at the input to the delay line driver.

In ALTERNATE or CHOPPED Vertical Mode, Channel 1 and Channel 2 are alternately connected to the delay line driver. The setting of the SEC/DIV switch should be considered when selection of ALT or CHOP mode is made. CHOP should be used with sweep speeds of 1 ms and slower and ALT should be used with sweep speeds of .5 ms and faster.

In the chopped mode, pin 2 of U4306A is ungrounded by the Vertical Mode push-button switching, allowing the multivibrator (U4306A and U4306D) to free run at about 250 kHz. The output at pin 8 of U4306C serves as a clock pulse for U4324A, which in turn switches the channel diode gates at the 250 kHz rate. The clock pulse is also fed to U4324B, which provides an output pulse to the Z-axis amplifier to blank out the transition between Channel 1 and Channel 2 traces. If pin 13 of U4324B goes LO, the output (pin 9) is set LO, causing pin 6 of U4306B to go HI. This causes pin 13 of U4324A to go HI after being delayed by C4315 charging through R4315. The clock pulse applied to pin 11 of U4324B causes pin 9 to go HI which, in turn (through the inverter and after some delay), sets pin 13 LO again. This causes pin 9 to go LO again. The positive-going voltage pulse (whose width is determined by R4315 and C4315) is converted to current by R4318 and sent to the Z-axis amplifier to blank out switching transients.

In the alternate mode, pin 2 of U4306A is grounded by the Vertical Mode push-button switching, preventing multivibrator operation and keeping pin 10 of U4306C HI. At the end of each sweep, the base of Q4302 receives a current pulse that drives it into saturation. The resulting negative-going pulse at the collector is fed through C4302 to pin 9 of U4306C, causing pin 8 to go HI. This, in turn, switches U4324A to pass either Channel 1 or Channel 2 to the delay line driver at the end of each sweep. Pin 12 of U4324B is grounded through the Vertical Mode switching and prevents any output at pin 9.

The Vertical Mode switching also selects appropriate triggering sources for Channel 1 and Channel 2. With the Vertical Mode switching set to CH 1, ALT, or CHOP, CR4335 is forward biased and signals from Channel 1 trigger pickoff go to the sweep circuit. In these modes, CR4331 is connected to +8 volts, thus reverse biasing CR4336 and preventing Channel 2 trigger signals from entering the trigger input amplifier. With the Vertical Mode switching set to CH 2, CR4336 becomes forward biased while CR4331 is reverse biased because CR4332 is now connected to +8 volts. Channel 2 triggering may be used with ALT, CHOP, or DIFF by pressing CH 2 and ALT, CHOP, or DIFF push-buttons simultaneously.

VERT OUTPUT AMPL, CRT, AND PROBE ADJ (Diagram 3)

Vertical Output Amplifier

The Vertical Output Amplifier circuit provides final amplification of the Channel 1 and Channel 2 signals to drive the crt vertical deflection plates.

Q112, Q122, Q134, Q136, Q144, and Q146 form a common-emitter shunt-feedback amplifier. Shunt-feedback transistors Q134, Q136, Q144, and Q146 are stacked. Resistors R118K, R118L, R118H, and R118J provide the feedback. The output voltage at the collectors of Q136 and Q146 is proportional to the collector current of Q112 and Q122 through feedback resistors R118K-R118L and R118H-R118J.

When BEAM FINDER button (section S410A) is pressed, R117 is placed in series with R118B and R118C, limiting Q112 and Q122 emitter current. This limits the maximum vertical deflection to within the crt graticule area. Another section of the BEAM FINDER switch limits the horizontal deflection.

Z-Axis Circuit

The Z Axis Amplifier controls the crt intensity level from several inputs; the INTENSITY control, unblanking signal from the sweep circuit, chop blanking signal from the vertical amplifier, and external signals from the Z AXIS INPUT connector (also intensity limit signal during X-Y operation). INTENSITY control R412 varies the trace intensity from off to maximum brightness, overriding all other inputs to the Z Axis Amplifier. The unblanking signal from the sweep circuit (through S2100) blanks the signal during retrace and holdoff. The chop blanking signal (with the vertical in the CHOP mode) blanks the crt during the channel switching interval to eliminate vertical chopping noise from appearing on the display. The Z AXIS INPUT connector, through J419, allows control of the trace intensity from an external source.

The current signals from the various inputs are connected to the emitter of Q416. The algebraic sum of the signals determines the collector conduction level. In case of overdrive from any input, Q416 cuts off and CR416 conducts the excess current to ground thereby preventing the output stage from saturating.

Transistors Q424, Q426, Q434, and associated circuitry form an inverting operational amplifier. Components R423 and C423 are the feedback elements. Any current into the input summing point (the base of Q424) results in an output voltage at the collectors of Q426 and Q434. This

output voltage controls the display intensity level by changing the dc voltage level at the junction of R462, C463, and C464.

Crt Circuit

High Voltage Oscillator. Transistor Q458 and associated circuitry make up the high-voltage oscillator that produces the drive for high-voltage transformer T460. When the instrument is turned on, current through Q454 provides forward bias for Q458. Transistor Q458 conducts and the collector current increases, which develops a voltage across the primary (Q458 collector) winding of T460. This produces a corresponding voltage increase in the feedback winding of T460 that is connected to the base of Q458 and Q458 conducts even harder. Eventually, the rate of collector current increase in Q458 becomes less than that required to maintain the voltage across the collector winding, and the output voltage drops. This turns off Q458 by way of the feedback voltage to the base. The voltage waveform at the collector of Q458 is a sine wave at the resonant frequency of T460. During the negative half cycle, Q458 remains off and the field collapses in the primary of T460. When the field is collapsed sufficiently, the base of Q458 becomes forward biased into conduction again and the cycle begins anew. The amplitude of sustained oscillation depends upon the average current delivered to the base of Q458 by the regulator circuitry. The frequency of oscillation is approximately 50 kHz. Components C458 and R458 decouple the unregulated +100 V supply line.

High Voltage Regulator. Transistors Q446-Q454 and associated circuitry control the output voltage of the High Voltage supply. Components R443 and C443 provide a slow start up for the high-voltage oscillator. When the instrument is turned on, the +100 V supply charges C443 through R443. The voltage increases until it is sufficient to forward bias CR443, holding the voltage at slightly above +8 volts. This forms the reference for the high-voltage regulator.

The resulting current in R444A (100 μ A) turns on Q446 and Q454, providing base current for Q458. This starts the high voltage oscillator, causing a negative voltage to develop at the crt cathode.

Resistors R444B, C, D, and R468 sample the cathode voltage. The high voltage increases until the cathode voltage is -2000 V. At this point the current in R444B is approximately the same as the current in R444A with Q446 barely conducting.

Any change in the level at the base of Q446 produces an error signal at the collector of Q446, which is amplified by Q454 and applied to the base of Q458 through the feedback winding of T460. Regulation occurs as follows:

Theory of Operation—442 Service

If the cathode voltage at the -2000 V point starts to go positive (less negative), this positive-going change is applied to the base of Q446. Q446 conducts harder, which in turn causes Q454 to conduct harder. This results in greater bias current to the base of Q458 through the feedback winding of T460. Now Q458 is biased closer to its conduction level so that it comes into conduction sooner to produce a larger induced voltage in the secondary of T460. This increased voltage appears as a more negative voltage at the crt cathode to correct the original positive-going change. By sampling the output from the crt cathode supply in this manner, the total output of the high-voltage supply is held relatively constant.

Components, R445 and C445, damp the response of the regulator against fast changes in the load such as when the crt is unblanked at the beginning of the sweep.

Resistors R446, R453, and R457, help prevent instabilities in the high-voltage oscillator.

High Voltage Rectifiers and Output. High-voltage transformer T460 has three output windings. One winding provides about 6.3 V for the crt filament. The crt filament is referenced to the cathode voltage (≈ -2 kV), preventing cathode-to-filament breakdown. A second winding provides high ac voltage to multiplier U460 to produce a 10 kV crt anode accelerating voltage. The same winding is tapped and rectified by CR465 to produce the dc voltage for the crt cathode. Components C465, R465, and C466 filter the dc voltage.

The third winding is used to control the crt intensity. Components CR463, C462, C463, C464, R462, and R463 rectify and filter the secondary voltage to provide approximately -2100 V which is applied to the crt grid. The entire winding is referenced to the output of the Z axis amplifier whose output voltage variations are used to control the crt intensity by varying the grid to cathode voltage. The dc path for the Z axis signal to the grid is through R462, CR463, R463, and the transformer winding. Resistor R462 isolates the transformer capacitance from the Z axis Amplifier. Capacitors C463 and C464 provide a path for fast changes in the Z axis output to the crt grid. Resistor R464 provides a discharge path for C462, C463, and C464. Glow lamps DS463 and DS465 prevent the grid-to-cathode voltage from rising high enough to cause breakdown within the crt during turn-on or when the cathode or grid is shorted to ground.

Crt Control Circuits. Crt display focus is controlled by FOCUS control R468. ASTIG adjustment R477, which is used in conjunction with the FOCUS control to provide a well-defined display, varies the voltage on the astigmatism grid. Geometry adjustment R473 varies the voltage on the horizontal deflection plate shields to control the overall geometry of the display.

Two adjustments control the trace alignment by varying the magnetic field around the crt. Y axis adjustment R474 controls the current through L470, which affects the crt beam after vertical deflection but before horizontal deflection. Therefore, it affects only the vertical (Y) components of the display. Trace Rotation (TRACE ROT) adjustment R472 controls the current through L472 and affects both vertical and horizontal rotation of the beam.

R475 and R476 provide the proper voltage for the vertical plate shield, and R478 and C478 decouple the first accelerator electrode from the $+32$ V supply.

Probe Adjust

The PROBE ADJust circuit provides a square-wave output of approximately 0.5 V peak-to-peak negative from ground at 1 kHz.

U24 is an operational amplifier that functions as a free-running multivibrator. The frequency determining elements are as follows:

When the output (pin 1 or 6 depending on serial number of the 442) of U24 is positive, voltage divider R22-R23 sets pin 3 at a positive voltage. Feedback through R24 charges C24 until the pin 2 level reaches the same positive voltage as pin 3. When pin 3 and pin 2 are at the same voltage, U24 output switches from positive to negative. The output of U24 is about 7.2 V either positive or negative. Then C24 starts charging negative. When pin 2 and pin 3 are at the same voltage again, U24 output switches positive, and the cycle repeats.

During the positive half cycle, CR26 is forward biased and CR27 is reverse biased, keeping the output at ground level. During the negative half cycle, CR26 is reverse biased and CR27 is forward biased, causing current to flow from ground through R27, CR27 and R26 to -8 V. This sets the output level to approximately -0.5 V.

TRIGGER (Diagram 4)

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 that constitute a LO and HI logic state may vary between individual devices.

Input and Switching

SOURCE Switch. SOURCE switch (S2010) selects trigger signals from COMP (composite), CH 1/CH 2 (internal), LINE, EXT, EXT/10, and X-Y sources.

COMP. The signal at P2000-1, from the collector of Q4388 (Vertical Switching diagram), is a portion of the output of the delay line driver. It is a current that represents the actual crt display (signal at the vertical output amplifier input). This composite current signal is switched on through CR2006 to the emitter of common base amplifier Q2020 when the SOURCE switch is in COMP. Follower Q2028 provides a voltage signal, and R2026 maintains the dc level for coupling at S2030. CR2002 and CR2005 are switched off in COMP to isolate the internal trigger signal from amplifier Q2020.

CH 1/CH 2. The internal trigger input for SOURCE switching is a current signal from CR4335 or CR4336 (Vertical Switching diagram), which is fed through CR2002 to the common base amplifier, Q2020. The current output at the Q2020 collector is fed to the base of follower Q2028 and appears as a voltage signal at its emitter. Coupling switch S2030 applies the voltage change to source followers Q2032A and B, which are common to all trigger signals (see description below in Trigger Input Amplifier description).

The Follower stage, a buffer amplifier consisting of Q2032A and B, provides a high impedance for all trigger inputs, and C2035 provides peaking for high frequency signals to ensure stable triggering. Q2038 is a common base amplifier that provides a current output for the Trigger Input Amplifier.

LINE. A sample of the line voltage, obtained from the power transformer, is switched directly to S2030 and to the follower stage at the collector of Q2032A.

EXT. Externally applied trigger signals pass through an attenuator circuit when switched by the SOURCE switch. Voltages are then converted to current signals, as with all trigger signals, and fed to the trigger input amplifier.

EXT/10. R2010, R2011, C2010, and C2011 provide an attenuator network to divide the EXT signal by a factor of 10.

X-Y. Current signals from the X input are fed to common base amplifier Q2050; then followed by Q2054 and converted to a voltage output for X gain adjustment. Q2058 acts as an emitter follower and R2060, R2062, R2061, and RT2061 convert this signal to a current for input to the horizontal amplifier (via CR2183, diagram 5). Y signals proceed through regular CH 2 circuits.

The SOURCE switch also connects +8 volts to R2182 to forward bias CR2183 providing a current to the horizontal

amplifier to center the crt display. +8 volts is also applied to CR2182 and R2185 to electrically place the sweep in the NORM mode and to disable the trigger circuit during X-Y operation.

MODE Switch. MODE switch S2150 selects three triggering modes: AUTO, NORM and TV.

AUTO. Allows the sweep to free-run in the absence of a triggering signal. See Sweep and Horizontal Amplifier description for details.

NORM. Connects +8 volts to R2223 in the sweep generator circuit. Allows the sweep to run only when a suitable triggering signal is present.

TV. The trigger signal is applied to the TV sync separator circuit (Q2164, Q2174, Q2176) and the normal trigger generator circuit is disabled. In this mode, the SLOPE switch is used to supply the sync separator with a signal of the proper polarity. For SEC/DIV settings of .1 m/div or slower, the sweep is triggered by vertical sync pulses, which occur at a field rate. For SEC/DIV settings of 50 μ and faster, the sweep is triggered by the TV horizontal line signals.

CPLG Switch. Coupling switch S2030 provides direct coupling of triggering signals from the output of the SOURCE switch to the input of the follower circuit in the DC position. In the AC position, capacitive coupling is provided via C2030.

Trigger Input Amplifier

The trigger input amplifier consists of Q2122, Q2124, Q2128, and associated circuitry. Resistors R2127 and R2128 set the amplifier input at -4 volts. The inverting configuration and feedback from the emitter of Q2128 form an inverting operational amplifier with a null point at the base of Q2122. Any current into the null point produces a voltage at the output proportional to the feedback resistor R2116.

Trigger Level Comparator

Differential amplifier Q2134-Q2136 functions as a comparator. LEVEL control R2138 selects the point on the waveform that starts a sweep. As the trigger signal at the base of Q2134 passes through the same voltage level as the base of Q2136 (set by LEVEL control), the signal at the emitter of Q2152 passes through the threshold (about 1 volt) of Schmitt trigger U2156A-U2156B producing a logic trigger signal. The trigger signals at the collectors of Q2134 and Q2136 are of opposite polarity. This allows the SLOPE switch S2140 to invert the signals applied to the TV

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trigger input amplifier Q2164 and the normal trigger input amplifier (Q2142, Q2144, and Q2152). When the SLOPE switch is in the +OUT position, the output at the collector of Q2142 is in phase with the trigger source signal. Transistors Q2142, Q2144, and Q2152 convert the current signal from the collectors of Q2134 or Q2136 to a voltage signal for triggering the Schmitt trigger.

TV Trigger Circuit

Active devices Q2164, Q2174, Q2176, U2156B, C, D, and associated circuitry comprise the TV trigger circuit. When the MODE switch is in TV, R2186 is disconnected from +8 volts which allows trigger signals from the collectors of Q2134 and Q2136 to pass through the TV trigger circuit. (In AUTO and NORM, the +8 volts applied to R2186 biases Q2164 to saturation.)

Transistor Q2164 is a high gain feedback amplifier. To achieve stable triggering on TV signals, the LEVEL control must be set at a point that will allow the sync pulses to appear within the dynamic range of the amplifier.

The sync separator circuit consists of Q2174 and associated circuitry. It processes sync-positive pulses when the SLOPE switch is in the +OUT position and sync-negative pulses in the -IN position. Transistor Q2174 produces large positive-going pulses from negative-going sync signals at the collector of Q2164.

In the TV field mode (SEC/DIV switch set for .1 ms or slower), Q2176 is saturated (since base is grounded), and the integrator (composed of C2174, C2176, R2174, and R2176) is switched into the circuit (effectively connected to +8 volts through saturated Q2176). The integrator filters out the horizontal sync pulses, leaving only the integrated vertical sync pulses, which trigger the TV Schmitt trigger U2156B and U2156C.

In the TV line mode (SEC/DIV switch set for 50 μ s or faster), Q2176 is turned off (base open), disconnecting C2174 and C2176 from +8 volts. Capacitors C2174 and C2176 no longer integrate the pulses, thus allowing both the horizontal and vertical sync pulses to pass through to the TV Schmitt trigger.

Schmitt Triggers

The Schmitt trigger for the NORM and AUTO triggering modes consists of U2156A, U2156B, and associated circuitry. Hysteresis of this trigger circuit is determined by R2152, R2153, and R2151.

The Schmitt trigger for the TV triggering mode is U2156B, U2156C, U2156D, and associated circuitry. Resistors R2154 and R2178 determine the sensitivity.

When the MODE switch S2150 is in AUTO or NORM, +8 volts is applied to R2156, which causes pin 1 of U2156A to go HI enabling Schmitt trigger U2156A-U2156B. At the same time, pins 12 and 13 of U2156D are also HI, disabling Schmitt trigger U2156C-U2156B. A Trigger signal from Q2152 triggers Schmitt trigger U2156A-U2156B to produce a logic trigger signal at pin 6 of U2156B.

When the MODE switch S2150 is in TV, the +8 volts is removed from R2156 and pin 1 of U2156A is LO, disabling Schmitt trigger U2156A-U2156B. Pins 12 and 13 of U2156D are LO, enabling Schmitt trigger U2156B-U2156C. The trigger signal from the TV sync separator triggers Schmitt trigger U2156B-U2156C to produce a logic trigger signal at pin 6 of U2156B.

SWEEP AND HORIZONTAL AMPLIFIER (Diagram 5)

Sweep Generator

The sweep is produced by a Miller Integrator circuit consisting of Q2242, Q2244, and Q2246. A sweep ramp is initiated at the collector of Q2246 when pin 3 of U2234A goes LO, and is terminated when pin 3 goes HI (see Timing diagram, Figure 3-1).

In the NORM triggering mode, pin 2 of U2212A is HI, allowing a positive-going trigger signal at pin 1 of U2212A to cause pin 3 of U2234A to go LO (via U2212D and U2234C). This reverse biases CR2233 and CR2234, and allows the timing capacitor (selected by SEC/DIV switch S2550) to charge, producing a sweep ramp at the collector of Q2246. When the sweep ramp reaches about 12 volts, Q2274 turns on. This causes pin 7 of U2224A to go LO, pin 8 of U2234C to go LO, and pin 3 of U2234A to go HI. When pin 3 of U2234A goes HI, CR2233 and CR2234 are forward biased, terminating the sweep. Pin 7 of U2224A remains LO for a length of time (hold-off time) determined by C2275, C2274, R2271, R2274, and HOLD OFF control R2272. Three hold-off times are selected by SEC/DIV switch S2550 and varied by R2272. After the selected hold-off time, U2224A pin 7 goes HI. This allows the next trigger signal to switch pin 3 of U2234A LO and again start the sweep.

In the AUTO triggering mode, when no trigger signal occurs at pin 11 of U2224B for about 50 ms, pin 10 of U2224B goes LO, causing the sweep to start after the hold-off time ends. This allows the sweep to free run and provide a reference display. When a trigger signal is present, pin 11 of U2224B goes HI, then LO (when trigger signal ends), and the time constant of C2226 and R2226 prevents pin 10 from going LO as long as the repetition rate of the trigger signal is higher than about 20 Hz.

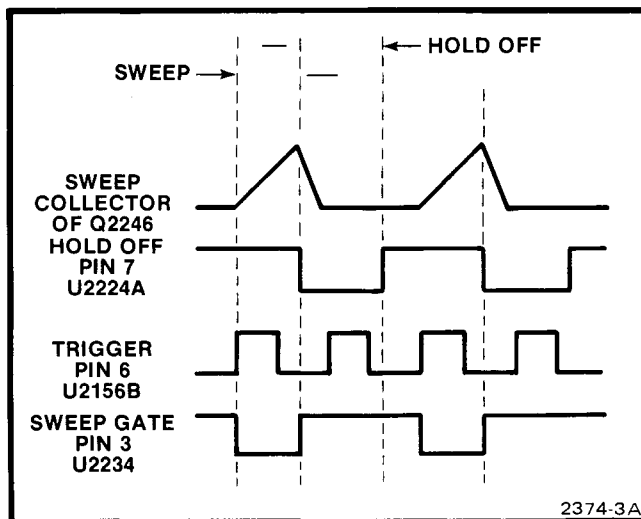


Figure 3-1. Sweep generator and sweep gate timing diagram.

When pin 3 of U2234A goes HI, the current set by R2236, R2235, and R2237 is sent to the Z Axis Amplifier Q416 (see diagram 3) to blank the crt during hold off.

Horizontal Amplifier

The horizontal amplifier converts the single-ended signal to a push-pull signal that drives the crt horizontal deflection plates. The input of the horizontal amplifier comes from either the sweep generator or the CH 1 vertical "X" pickoff. In the X-Y mode, the trace is shifted to the center of the screen by the current through R2182. In the AUTO and NORM modes, the input to the horizontal amplifier is a linear ramp from the sweep generator.

Transistors Q2314, Q2326, and associated circuitry form an operational amplifier with a switchable gain range of 10 to 1. Gain is set by feedback elements R2321 (X10 Mag Gain adjust), R2322, R2323, and the X1—X10 MAGNIFIER switch, S2312. Thermal resistor RT2310 ensures that there is no gain change with temperature change. The Horizontal POSITION control, R2316A and B, positions the crt display horizontally by varying the current into the base of Q2314. The cascode configuration of Q2314 and Q2326 preserves adequate high-frequency response.

When the BEAM FINDER switch, section S410B, is pressed, the collector of Q2326 is referenced to ground via CR2331 and CR2332 and the dynamic range of Q2326 is decreased. This limits the horizontal deflection to within the crt graticule area. Section S410A of the BEAM FINDER switch limits the vertical deflection to within the crt graticule area.

HORIZONTAL OUTPUT AMPLIFIER (Diagram 6)

Transistors Q2332, Q2334, Q2344, and associated circuitry form a paraphase amplifier. Transistor Q2332 is a low-impedance input for Q2334. Horiz Gain adjustment R2332 sets the gain of the paraphase amplifier. When the current through the collector of Q2334 increases, the current through the collector of Q2344 decreases and is 180° out of phase with the current at the collector of Q2334. The resulting signal to the crt deflection plates is a push-pull signal. Diode CR2334 prevents Q2334 from saturating when R2322 is in the X10 position.

Since Q2334 is a shunt feedback amplifier and Q2344 is a common base amplifier, any noise in the 100 volt power supply will appear as a part of the output. To prevent the noise from appearing on the crt screen, an operational amplifier, consisting of Q2354 and associated circuitry, supplies an inverted sample of the power supply noise to the output. Now, any noise in the 100 volt power supply appears common mode to the horizontal deflection plates, preventing horizontal deflection of the noise signal. Resistor R2354 provides feedback for the operational amplifier.

POWER SUPPLY (Diagram 7)

Primary Circuitry

AC power is applied to the primary of T700 through line fuse F700, POWER switch S700, Line Selector switch S701, and Range Selector switch S705.

The ON indicator, LED DS169, derives its power from the +8 V supply via R169 (located on the Interface board). Thus, the lack of illumination of DS169 does not necessarily indicate the absence of applied voltage to the T700 primary or secondary circuitry.

Switches S700 and S705 are screwdriver actuated slide switches, and are accessible through openings in the bottom of the instrument cabinet.

The Line Selection switch, S701, connects the split primary windings of T700 in parallel for 120 V operation, or in series for 240 V operation. When changing the nominal line voltage, the value of line fuse F700 must also be changed. Refer to the Replaceable Electrical Parts list for the correct fuse values.

The HI/LO Range Selector switch, S705, allows operation from either a 92 V to 110 V or 202 V to 242 V rms source in the LO position. In the HI position, the instru-

Theory of Operation—442 Service

ment may be operated from a 110 V to 132 V or 220 V to 250 V rms power input source, depending on the setting of the 120 V/240 V Line Selector switch, S701.

Secondary Circuitry

The Secondary circuits supply four regulated voltages and one unregulated voltage: -8 V, $+8$ V, $+32$ V, $+100$ V, and $+100$ V unregulated.

Operational amplifiers U742A ($+8$ V supply) and U742B (-8 V supply) have differential inputs that monitor output voltage variations and provide correction signals to the series-regulating transistors. For example, suppose the $+8$ volt supply drops. This negative change is coupled to the inverting input of U742A through sense resistor R756, causing pin 7 to go positive. Since the voltage across VR746 remains essentially constant, Q754 and Q756 follow this change and raise the output voltage back to $+8$ volts. In the $+100$ volt regulated supply, Q726 acts as the feedback amplifier with its base being the inverting input. The regulating action is the same as in the $+8$ and -8 volt supplies. Zener diode VR762 provides a 5 volt reference for the -8 volt supply, which in turn provides the reference for the $+8$ and $+100$ volt supplies. The series regulating elements in the $+100$ volt and $+8$ volt supplies are transistors Q734-Q736 and Q754-Q756. The series regulating element in the -8 volt supply is a modified Darlington configuration consisting of Q774 and Q776. Current limiting circuits provide short-circuit protection for each regulated supply. The following describes the $+8$ volt current-limiting circuit. The other current-limiting circuits operate similarly.

In the $+8$ volt supply, Q752 is normally biased off. Under normal conditions, the base of Q752 is set at about $+8$ V. As the supply current increases, the voltage drop across R754 increases. Since the Q756 emitter-base diode

voltage difference remains constant, the increasing voltage on Q756 emitter due to the R754 voltage drop causes a corresponding increase at the base of Q756. This voltage is applied to voltage divider R752 and R753, causing the base of Q752 to go more positive. When the supply current increases sufficiently beyond the normal operating current, Q752 turns on. The collector of Q752 moves in the negative direction, which begins turning off Q754-Q756 and creates a foldback condition (see Figure 3-2). Transistor Q756 continues to conduct some current when the supply is limited, dropping enough voltage across R754 to keep Q752 biased on.

The regulated $+32$ volt supply is derived from the $+100$ volt supply via Q812. Zener diode VR818 holds the base of Q812 at $+33$ volts, providing an output of approximately $+32$ volts at the emitter of Q812. CR816 prevents the Q812 emitter voltage from dropping below $+8$ volts if a short should occur on the $+32$ volt output line.

Divider network R741, R742, and R802 provides a sample of the line voltage for line triggering.

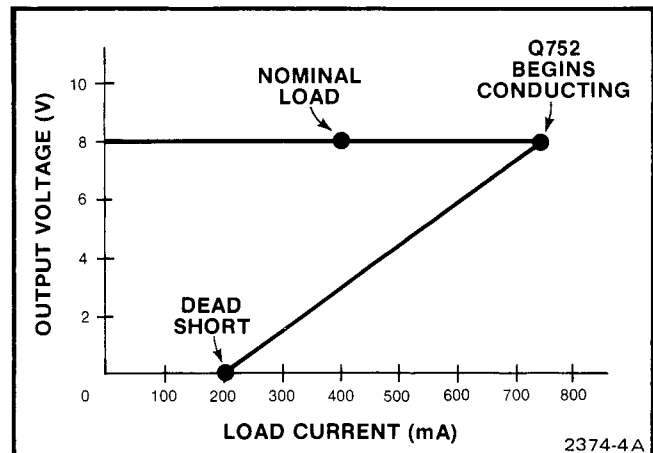


Figure 3-2. Foldback circuit action.

CALIBRATION PROCEDURE

GENERAL

Introduction

This section of the manual is in two parts: Performance Check and Adjustment Procedure. Each subsection has a different purpose and important information regarding their use is included at the beginning of both subsections.

Test Equipment Required

The test equipment listed in Table 4-1, or an equivalent piece of test equipment, is required if the complete Performance Check and Adjustment Procedure is to be

accomplished on the oscilloscope. A partial list of test equipment is provided in the Performance Check subsection to list the required test equipment to complete the Performance Check only.

In Table 4-1, the specifications given for the equipment are the minimum necessary to provide accurate results. Therefore, the equipment used must meet or exceed the listed specifications. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the appropriate instruction manual if more test equipment operating information is required.

Table 4-1

TEST EQUIPMENT REQUIRED

Description	Minimum Specification	Usage	Examples
1. Amplitude Calibrator	Amplitude accuracy, within 0.25%; signal amplitude, 10 mV to 10 V; output signal, 1 kHz square wave.	Vertical deflection accuracy checks, X-Axis deflection check, vertical gain adjustment.	a. TEKTRONIX PG 506 Calibration Generator. ^a
2. Digital Voltmeter	Range, 0 to 9 V; dc voltage accuracy within 0.3%; display, 4 1/2 digits.	Power supply adjustment.	a. TEKTRONIX DM 501A Digital Multimeter. ^a
3. Leveled Sine-wave Generator	Frequency, 50 kHz to above 35 MHz; output amplitude, variable from 0.5 to 5.5 V p-p; output impedance, 50 Ω ; reference frequency, 50 kHz; amplitude accuracy, constant within 3% of reference frequency as output frequency changes.	Bandwidth checks, Z-Axis check, Triggering adjustments, CMRR check.	a. TEKTRONIX SG 503 Leveled Sine wave Generator ^a (with included precision cable).
4. Square-wave Generator	Fast Rise output, 100 kHz with 2 ns or less risetime, and amplitude of at least 50 mV into a 50 Ω termination; High Amplitude output of 1 kHz with amplitude of at least 5 V into a 50 Ω termination, and at least 10 V unterminated.	Vertical high-frequency compensation and attenuator adjustment.	a. TEKTRONIX PG 506 Calibration Generator. ^a

Table 4-1 (cont)

Description	Minimum Specification	Usage	Examples
5. Time-mark Generator	Marker outputs, 0.1 μ s to 0.5 s; marker accuracy, within 0.1%; trigger output, 0.1 μ s to 0.5 s, time coincident with markers.	Timing checks and adjustments. Y-Axis alignment, Geometry adjustment.	a. TEKTRONIX TG 501 Time Mark Generator. ^a
6. Power Module	Compartments to accommodate the total number of TM 500 units in use for any portion of this Performance Check or Adjustment Procedure.	All checks and adjustments employing TM 500 equipment.	a. TEKTRONIX TM 501, TM 503, TM 504, TM 506, or TM 515 in any desired combination.
7. Television Signal Source	Composite Sync amplitude, at least 100 mV (or Composite Video amplitude, at least 230 mV).	TV Trigger check.	a. Any Television signal source with the specified output (such as a television receiver).
8. Adapter	Connectors, bnc female-to-bnc female.	Signal interconnection.	a. Tektronix Part No. 013-0028-00.
9. Adapter	Probe-tip-to-bnc.	Vertical attenuator compensation.	a. Tektronix Part No. 013-0084-02.
10. Alignment Tool	Low capacitance.	Variable capacitor adjustment, vertical attenuator and high-frequency compensation adjustments.	a. General Cement adjustment tool, GC 8722.
11. Attenuator	Ratio, 10X; impedance, 50 Ω ; connectors, bnc.	Signal attenuation.	a. Tektronix Part No. 011-0059-02.
12. Cable (3 required)	Impedance, 50 Ω ; length, 42 inches; connectors, bnc.	Signal interconnection.	a. Tektronix Part No. 012-0057-01.
13. Dual Input Coupler	Connectors, bnc female-to-two bnc male.	Signal interconnection.	a. Tektronix Part No. 067-0525-01.
14. Probe	Attenuation, 1X; connector, bnc.	TV Trigger check.	a. TEKTRONIX P6101 1X probe 010-6101-03.
15. Probe	Attenuation, 10X; connector, bnc; compensation range, to match the 442 vertical input characteristics.	Vertical attenuator compensation, TV trigger checks. Low-frequency triggering check.	a. TEKTRONIX P6108 10X probe 010-6108-03 (standard accessory for the 442).
16. Screwdriver	Bit, Phillips #1.	Interface board removal.	a. Xcelite, X108.
17. Screwdriver	Bit, Phillips #2.	Cabinet removal, Interface board removal.	a. Xcelite, X102.

Table 4-1 (cont)

Description	Minimum Specification	Usage	Examples
18. Screwdriver	Bit, 3/32"; shaft, 3".	Variable resistor adjust.	a. Xcelite, R3323.
19. Shield	Calibration fixture, vertical.	Vertical Amplifier adjustment.	a. Tektronix Part No. 067-0867-00.
20. Termination (two required)	Impedance, 50 Ω ; connectors, bnc.	Signal termination.	a. Tektronix Part No. 011-0049-01.
21. T Connector	Connectors, bnc.	Signal Interconnection.	a. Tektronix Part No. 103-0030-00.

^a Requires a TM 500 Series power module.

PERFORMANCE CHECK

INTRODUCTION

Purpose

The following procedure is intended to be used to determine the acceptability of newly purchased or recently recalibrated instruments. This procedure does not check every facet of the instrument's calibration; rather it is concerned primarily with those portions of the instrument that are essential to measurement accuracy and correct operation. Removing the instrument's dust cover is not necessary to perform this procedure. All checks are made from the front panel.

Limits and Tolerances

The limits and tolerances listed in this Performance Check are instrument specifications only if they are listed in the Performance Requirement column of the tables in Specification, Section 1.

Line Voltage Selection

Refer to the Preliminary Procedure preceding the Performance Check steps for instructions on setting the 442 for the available power input source voltage.

Test Equipment

All equipment is assumed to be calibrated and operating within the original specifications. The tolerances given in this performance check are for the oscilloscope under test and do not include test equipment error.

In this procedure, test equipment is named by the functional description (see Table 4-1 Description), rather than by specific front-panel nomenclature. The accessories listed are typical bench items.

The following abbreviated list includes the items in Table 4-1 that are required to perform a complete Performance Check. For equipment specifications, usage, and recommended types, refer to Table 4-1.

1. Amplitude Calibrator
2. Leveled Sine-wave Generator
3. Time-mark Generator
4. 42-inch, 50 Ω cable (2 required)
5. Dual-input Coupler
6. 50 Ω Termination (2 required)
7. Bnc T Connector
8. 10X Probe (442 Standard Accessory)
9. 1X Probe
10. Bnc female-to-female adapter
11. Television Signal Source

Test Equipment Alternatives

When equipment other than that recommended is used, control settings or test setup may need to be altered. If the exact item of equipment given as an example in the

Calibration Procedure—442 Service Performance Check

Test Equipment list is not available, first check the Minimum Specifications column carefully to see if any other equipment might suffice. Then check the Usage column to see the purpose of this item. If used for a check that is of little or no importance to your measurement requirements, the item and corresponding steps can be deleted.

Preparation

Connect the test equipment to an appropriate power input source. Turn on and allow a 20-minute warmup period before commencing the Performance Check.

Display

Performance Checks should be made with a stable, well-focused, low-intensity, vertically centered (unless otherwise stated) display. Unless otherwise instructed, set the Intensity, Astigmatism, Focus, Trigger, and Position controls as required.

PRELIMINARY PROCEDURE

Perform the following steps to place the 442 Oscilloscope into a basic operating mode before proceeding with the Performance Check steps.

WARNING

Make sure the 442 is unplugged from the power input source before changing the line voltage settings.

1. Use a small blade screwdriver to set the (120 V or 240 V) Line Voltage Selector and (HI or LO) Range Selector switches (both are accessible through openings in the bottom of the cabinet) to the correct settings for the power input voltage source that will be used during this procedure.

CAUTION

If the Line Voltage Selector (120 V/240 V) setting is changed, the line fuse (located in a fuse holder on the rear panel) must be of the value specified for the new Selector setting. Refer to the Operating Instructions section of this manual for complete operating voltage and fuse information.

Unless otherwise specified, the 442 is originally set for 120 V and HI line operation.

2. Connect the 442 power cord plug to the line voltage source and press the ON/OFF button on (in). The POWER ON LED should light.

NOTE

The 442 must have a warmup time of at least 20 minutes before starting the Performance Check Procedure, and must have been adjusted at an ambient temperature between +20° C and +30° C to ensure that checks in this procedure will meet specifications listed in Section 1.

3. Set the TRIGGERING MODE to AUTO, and SOURCE to CH 1/CH 2.

4. Set CPLG to AC (out) and leave it there throughout the Performance Check procedure unless instructed otherwise.

5. Set the following 442 controls as listed:

VERT MODE	CH 1
POSITION (CH 1 & CH 2)	Midrange
VOLTS/DIV (CH 1 & CH 2)	2m (1X)
VOLTS/DIV VAR (CH 1 & CH 2)	Detent (fully cw)
AC-GND-DC (CH 1)	GND
AC-GND-DC (CH 2)	DC
SEC/DIV	.1m
MAGNIFIER	X1 (out)
POSITION (horizontal)	Midrange
SLOPE	+ (out)
HOLD OFF	Fully ccw
LEVEL	Fully cw
INTENSITY	Midrange
FOCUS	Midrange

6. A baseline trace should be visible within the graticule area. Adjust the INTENSITY and FOCUS controls for a low-intensity, well-defined trace.

NOTE

The ASTIG control also affects trace definition, and if necessary, should be adjusted (after a signal has been applied) for best overall definition of a displayed signal (use a small bit screwdriver for this adjustment).

The baseline trace should be parallel with the horizontal graticule lines. If it is not, adjust TRACE ROT (Trace Rotation) with a small bit screwdriver until the trace is aligned.

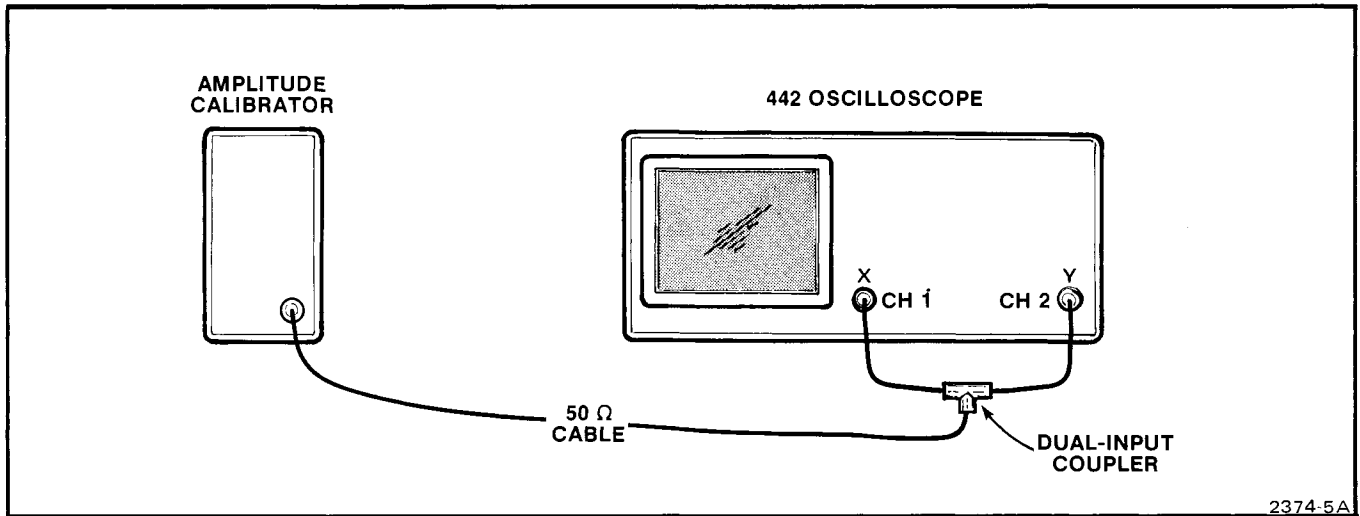


Figure 4-1. Vertical deflection accuracy test setup.

PROCEDURE

NOTE

The following procedure is arranged to be performed in its entirety, starting with Step 1 and proceeding in sequence to the end. This ensures the correct 442 and test equipment settings and connections for each step.

1. Channel 1 and Channel 2 Deflection Accuracy Check

a. Connect the test equipment as shown in Figure 4-1 and apply an unterminated 10 mV, 1 kHz Amplitude Calibrator signal to the CH 1 and CH 2 input connectors. Set the CH 1 AC-GND-DC switch to DC and the CH 2 AC-GND-DC switch to GND. In the remainder of this step, set the CH 1 and CH 2 POSITION control (as appropriate) to center the display within the graticule area.

b. CHECK—Channel 1 deflection accuracy for the settings listed in Table 4-2 within 3% (+20°C to +30°C). Adjust INTENSITY and all POSITION controls as required. For best results in Steps 1 and 2, leave the LEVEL control fully clockwise for a free-running display.

c. Set:

Amplitude Calibrator

Output 10 mV

442

AC-GND-DC (CH 1) GND
AC-GND-DC (CH 2) DC
VERT MODE CH 2
POSITION (CH 2) For centered display

d. CHECK—Channel 2 deflection accuracy for the settings listed in Table 4-2 within 3% (+20°C to +30°C). Set CH 2 POSITION as required.

Table 4-2

VERTICAL DEFLECTION ACCURACY

VOLTS/DIV Setting (1X Window)	Amplitude Calibrator Output	Vertical Deflection (Divisions)	±% Tolerance (Divisions)
2 m	10 mV	5	4.85 to 5.15
5 m	20 mV	4	3.88 to 4.12
10 m	50 mV	5	4.85 to 5.15
20 m	.1 V	5	4.85 to 5.15
.2	1 V	5	4.85 to 5.15
2	10 V	5	4.85 to 5.15

2. Channel 1 and Channel 2 VAR (Variable) VOLTS/DIV Range Check

a. Set the amplitude calibrator for a 0.1 volt output.

b. Set the Channel 1 and Channel 2 VOLTS/DIV switches to 20 m (1X window).

c. CHECK—Display amplitude reduces from 5 divisions to less than 2 divisions when the Channel 2 VAR control is rotated to its fully counterclockwise position.

Calibration Procedure—442 Service Performance Check

d. Set:

VERT MODE	CH 1
AC-GND-DC (Channel 1)	DC
AC-GND-DC (Channel 2)	GND

e. CHECK—Display amplitude reduces from 5 divisions to less than 2 divisions when the Channel 1 VAR control is rotated to its fully counterclockwise position.

f. Return both VAR controls to the fully clockwise (detent) position and disconnect the Dual Input Coupler from the test setup.

3. X-Axis Deflection Check

a. Connect the 0.1 volt Amplitude Calibrator signal cable to the Channel 1 (X) input connector and set the INTENSITY control for a barely visible 5-division amplitude display.

b. Set:

VERT MODE	CH 2 (X-Y)
SOURCE	X-Y
POSITION (Horizontal)	As required to view two dots
INTENSITY	Barely visible dots

c. CHECK—Distance between the two dots is 5 divisions $\pm 5\%$ (4.75 to 5.25 divisions).

d. Disconnect the Amplitude Calibrator signal cable from the Channel 1 input and set SOURCE to COMP.

4. CHOP, ALT, DIFF and Cmrr Function Checks

a. Set:

SOURCE	COMP
SEC/DIV	1 μ
VOLTS/DIV (CH 1 & CH 2)	10 m (1X)
AC-GND-DC (CH 1 & CH 2)	GND
VERT MODE	CHOP
INTENSITY	For visible display
POSITION (all)	As required

b. Set the POSITION controls to place the traces 4 divisions apart and centered within the graticule area.

c. Adjust the LEVEL control for a stable triggered display.

d. CHECK—Duration of one cycle is within approximately 3.33 μ s to 6 μ s (3.3 to 6 horizontal graticule divisions).

e. Set the LEVEL control fully clockwise.

f. CHECK—Both traces appear simultaneously at sweep speeds of .5 ms to .5 s (SEC/DIV settings of .5 m to .5).

g. Set VERT MODE to ALT.

h. CHECK—Both traces appear alternately at SEC/DIV settings of .1 μ through .5 m (traces are visible at the same time but may flicker due to the alternate sweeps).

i. Set:

AC-GND-DC (CH 1 & CH 2)	DC
VERT MODE	CH 1
VOLTS/DIV (CH 1 & CH 2)	10 m (1X)
POSITION (all)	As required
SEC/DIV	1 m

j. Connect a 50 kHz Leveled Sine-wave Generator signal through a 50 Ω precision cable, a 50 Ω termination, and a Dual Input Coupler to the Channel 1 and Channel 2 input connectors.

k. Set the generator amplitude to provide a 5-division display.

l. Set VERT MODE to DIFF and adjust Channel 1 and Channel 2 VOLTS/DIV VAR controls for a minimum amplitude display.

m. Set the generator output frequency to 1 MHz.

n. CHECK—Display amplitude is .5 division or less.

o. Return both VAR controls to the calibrated detent position (fully clockwise).

p. Disconnect the dual Input coupler from the test setup.

5. Channel 1 Bandwidth Check

a. Connect the test equipment to the Channel 1 input connector as shown in Figure 4-2.

b. Set:

SOURCE	CH 1/CH 2
VOLTS/DIV (CH 1 & CH 2)	5 m (1X)
SEC/DIV	.1 m
AC-GND-DC (CH 1 & CH 2)	DC
VERT MODE	CH 1

c. Set the Sine-wave Generator to 50 kHz (reference frequency) and set the generator output amplitude for a 5-division display.

d. Set the generator frequency to 35 MHz.

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

6. Channel 2 Bandwidth Check

a. Set:

VERT MODE	CH 2
-----------	------

b. Move the 50 Ω termination (Sine-wave Generator signal) from the Channel 1 input connector to the Channel 2 input connector.

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

d. Set the generator frequency to 35 MHz.

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

7. X-Axis Bandwidth Check

a. Set:

SOURCE	X-Y
VERT MODE	CH 2 (X-Y)
INTENSITY	For barely visible display
AC-GND-DC (CH 1)	AC
AC-GND-DC (CH 2)	GND

b. Move the 50 Ω termination (Sine-wave Generator signal) from the Channel 2 (Y) input connector to the Channel 1 (X) input connector.

c. Set the generator frequency to 50 kHz (reference frequency) and set the generator output amplitude for 5 divisions of horizontal deflection (about 25 mV), this will be a horizontal trace 5 divisions long. Set the horizontal POSITION control to center the trace within the graticule area.

d. Set the generator frequency to 2 MHz.

e. CHECK—Display is a horizontal trace at least 3.5 divisions long.

f. Disconnect the test equipment setup.

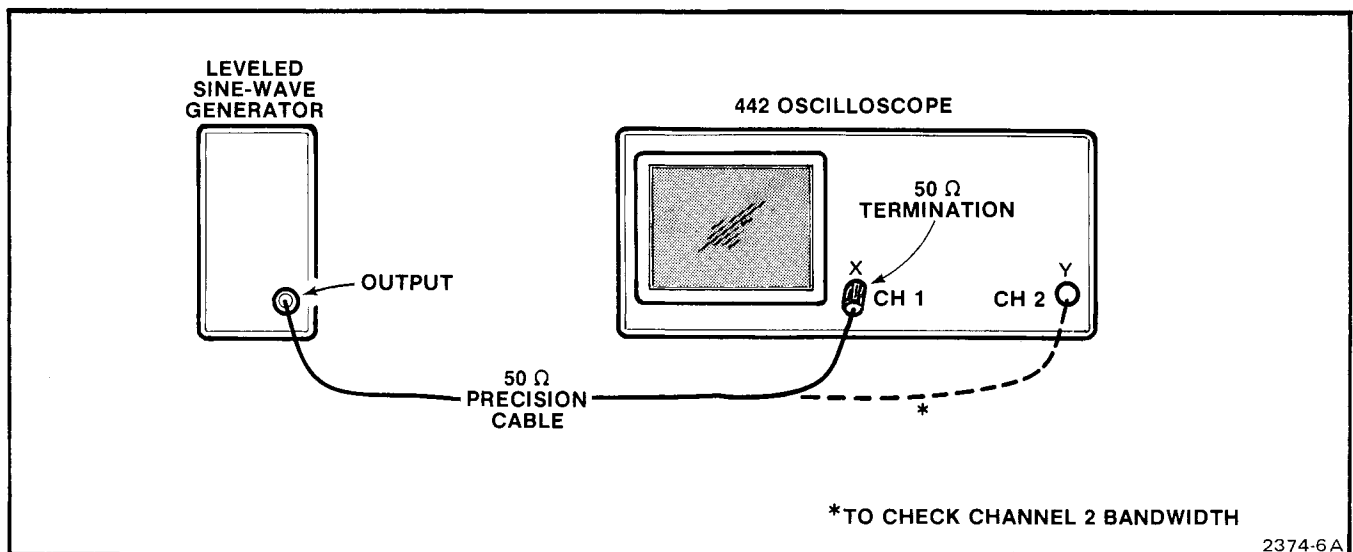


Figure 4-2. Bandwidth check test setup.

Calibration Procedure—442 Service Performance Check

NOTE

In the following Triggering check steps, adjust the LEVEL control, POSITION controls, and INTENSITY control for a visible, stable triggered display unless otherwise instructed.

8. Low Frequency Triggering

a. Set:

VERT MODE	CH 1
SOURCE	CH 1/CH 2
SEC/DIV	10 m
AC-GND-DC (CH 1)	DC
MODE	AUTO
INTENSITY	For visible trace

b. Connect the bnc connector end of the 10X probe to the Channel 1 input connector.

c. If the power input frequency is 60 Hz, lay the probe tip near the power cord or other convenient ac line voltage source (if the power input frequency is other than 60 Hz, substitute an appropriate 60 Hz low-frequency sine-wave generator signal in the remainder of this step).

d. Set the Channel 1 VOLTS/DIV switch and VOLTS/DIV VAR control to provide a 0.5-division display.

e. Set MODE to NORM, and adjust LEVEL for a triggered display.

f. CHECK—A stable display can be obtained with CPLG in both DC and AC positions and with SLOPE in both + (out) and – (in) positions.

9. Line Trigger

a. Set:

SOURCE	LINE
SLOPE	+ (out)

b. Verify that a 0.5-division display is still present (60 Hz signal).

c. CHECK—A stable display can be obtained with MODE set to both AUTO and NORM, and with SLOPE set to both + (out) and – (in).

d. Disconnect the probe from the test setup, and set the Channel 1 VOLTS/DIV VAR control to the calibrated detent (fully clockwise) position.

10. Internal Triggering 2 MHz Check

a. Connect the test equipment as shown in Figure 4-3.

b. Set:

AC-GND-DC (CH 1)	DC
VOLTS/DIV (CH 1)	.5 (1X)
SEC/DIV	.5 μ
SOURCE	CH 1/CH 2
MODE	AUTO
INTENSITY	For visible display

c. Set the sine-wave generator frequency to 2 MHz and adjust the generator output amplitude for a 1-division display. Set the Channel 1 VOLTS/DIV switch to 1 (1 volt per division, 1X window).

NOTE

Readjust the LEVEL control as required to maintain a stable triggered display in the remainder of Step 10 through Step 13.

d. CHECK—A stable display can be obtained for the .5-division signal with SLOPE in both + (out) and – (in) positions and with MODE in both AUTO and NORM settings.

e. CHECK—A stable display can be obtained with CPLG set to both DC and AC positions.

11. External Triggering 2 MHz Check

a. Set:

VOLTS/DIV (CH 1)	.1 (1X)
------------------	---------

b. Set the sine-wave generator output amplitude for a 1-division display (100 mV).

c. Set:

SOURCE	EXT
--------	-----

d. CHECK—A stable display can be obtained with SLOPE in both + (out) and – (in) positions, and with MODE in both AUTO and NORM settings.

e. CHECK—A stable display can be obtained with CPLG set to both DC and AC positions.

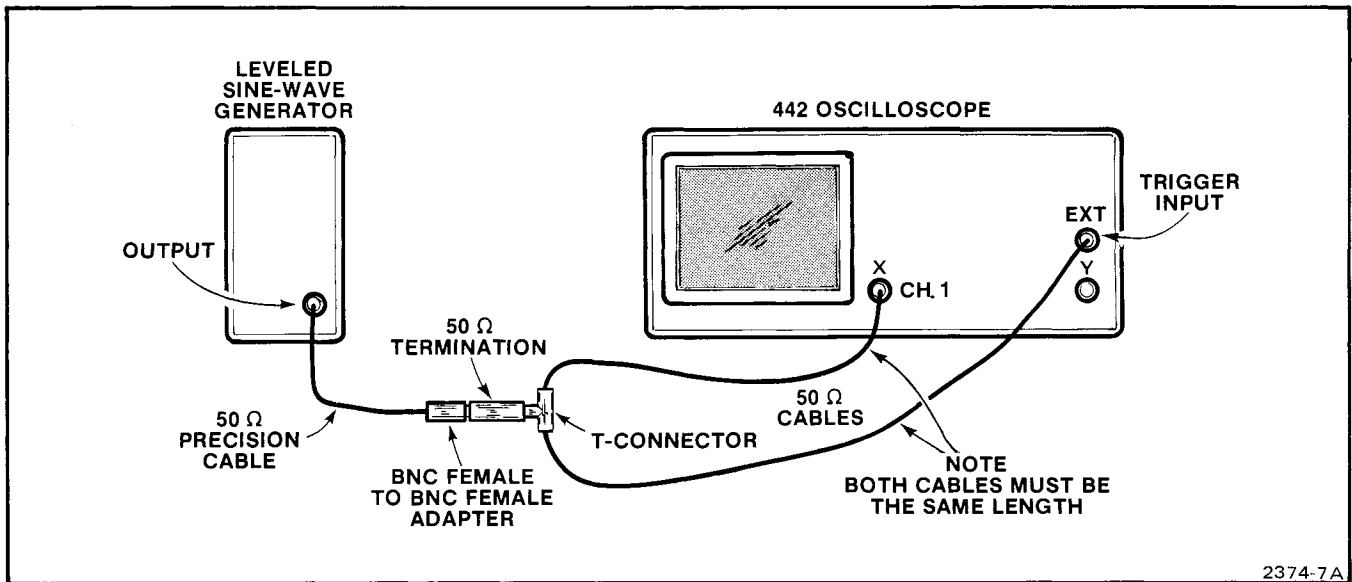


Figure 4-3. Triggering and Z-Axis input check test setup.

12. Internal Triggering 35 MHz Check

a. Set:

SOURCE	CH 1/CH 2
MODE	AUTO
MAGNIFIER	X10 (button in)

b. Set the sine-wave generator frequency to 35 MHz and output amplitude for a 1.5-division display.

c. CHECK—That a stable display can be obtained with SLOPE in both + (out) and – (in) positions, and with MODE in both AUTO and NORM settings.

d. CHECK—That a stable display can be obtained with CPLG set to both DC and AC positions.

13. External Triggering 35 MHz Check

a. Set:

SOURCE	EXT
--------	-----

b. CHECK—That a stable display can be obtained with SLOPE in both + (out) and – (in) positions, and with MODE in both AUTO and NORM settings.

c. CHECK—That a stable display can be obtained with CPLG set to DC and AC positions.

14. EXT and EXT/10 LEVEL Range Check

a. Set:

MAGNIFIER	X1 (button out)
SEC/DIV	20 μ
VOLTS/DIV (CH 1)	.5 (1X)
TRIGGERING MODE	AUTO
SOURCE	EXT
SLOPE	+ (out)
CPLG	AC

b. Remove the 50 Ω termination and connect the adapter directly to the T-Connector. Set the generator frequency to 50 kHz and output amplitude for a 4-division display (2 V p-p). Set the Horizontal POSITION control to move the display so the sweep start (left edge) can be observed.

c. CHECK—That rotating the LEVEL control will trigger the displayed signal at all points over a range with the leading edge at least one division below to at least one division above the center horizontal graticule line, and that the display is not triggered (free-runs) with the LEVEL control at either extreme of rotation.

d. Set SLOPE to – (button in).

e. Repeat part c.

f. Set CPLG to DC.

Calibration Procedure—442 Service Performance Check

g. Repeat parts c, d, and e.

h. Set SLOPE to + (button out).

i. Set the Channel 1 VOLTS/DIV switch to 5 (volts), SOURCE to EXT/10, and set the sine-wave generator amplitude for a 2-division display (10 V p-p).

j. Repeat parts c through h, except check that rotating the LEVEL control will trigger the displayed signal with the leading edge of the sine wave over a range from near the negative peak to near the positive peak. The generator output amplitude will not be sufficient to fully check the 5-volt Performance Requirement for EXT/10. If desired, a higher amplitude generator may be substituted and EXT/10 checked in the same manner as was done for EXT.

15. Z-Axis Input

a. Set:

VOLTS/DIV (CH 1) 1
 SEC/DIV 20 μ
 TRIGGERING MODE AUTO
 SOURCE CH 1/CH 2

b. Connect the test equipment as shown in Figure 4-3 (with 50 Ω termination) and set the sine-wave generator for a 5-division 50 kHz display.

c. Disconnect the 50 Ω cable from the EXT TRIGGERING input connector and connect it to the Z AXIS INPUT connector on the back panel of the 442.

d. CHECK—Intensity modulation of the trace is noticeable at normal intensity settings (adjust LEVEL and INTENSITY controls as required to obtain a stable, visible, modulated display).

e. Set the sine-wave generator for a 5-division 5 MHz display and set the SEC/DIV switch to .1 μ .

f. Repeat part d.

g. Disconnect the test setup.

16. Sweep Rate Accuracy

a. Connect the test equipment as shown in Figure 4-4.

b. Set:

SEC/DIV .1 μ
 SEC/DIV VAR Fully cw (detent)
 VOLTS/DIV (CH 1) .2 (1X)
 SOURCE CH 1/CH 2
 TRIGGERING MODE NORM
 MAGNIFIER X1 (out)
 INTENSITY For visible display
 POSITION (all) As required
 LEVEL As required

c. CHECK—Sweep rate accuracy according to Table 4-4. One time marker per division within 3% (within 0.24 division) over the center eight graticule divisions.

NOTE

Vertically position the display so the baseline is off screen at the bottom of the graticule area, and read the tips of the time markers at their intersection with the center horizontal graticule line.

Table 4-3

SWEEP RATE TIMING ACCURACY

SEC/DIV Setting	Time-Mark Generator Output	CRT Display (Markers/Division)
.1 μ	.1 μ s	1
.5 μ	.5 μ s	1
50 μ	.50 μ s	1
.1 m	.1 ms	1
.5 m	.5 ms	1
.2 (s)	.2 (sec)	1
.5 (s)	.5 (sec)	1

17. SEC/DIV VAR (Variable) Range

a. Set the time-mark generator to 1 m and the SEC/DIV switch to .2 m.

b. CHECK—Rotating the VAR control counterclockwise reduces the spacing between markers from 5 divisions to 2.5 divisions or less.

c. Return the SEC/DIV VAR control to the fully clockwise detent position.

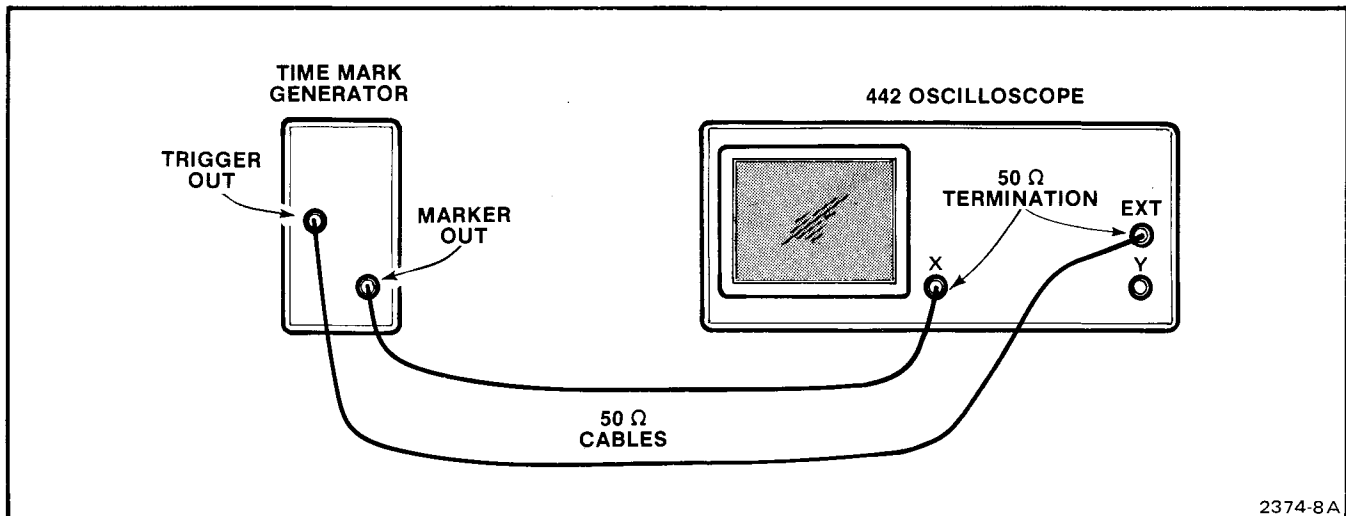


Figure 4-4. Timing accuracy check test setup.

18. Magnified Sweep Accuracy

a. Set:

MAGNIFIER	X10 (button in)
SEC/DIV	1 μ
SOURCE	EXT

b. Set the time-mark generator for a .1 μ s marker output.

c. CHECK—For one marker per each graticule division within 5% over the center eight graticule divisions. Exclude the first division (50 ns) of magnified sweep and all divisions beyond the 100th magnified division.

d. Disconnect the test setup.

19. TV Mode Check

NOTE

This step may be omitted if the 442 is not planned to be used for displaying television sync signals. A television receiver or any other convenient source of television sync signals may be used as the signal source for this check (see Table 4-1, item 7). This step lists appropriate signal amplitudes for checking both internal and external TV MODE Performance Requirements. To check internal triggering (SOURCE set to CH 1/CH 2 or COMP), set the VOLTS/DIV and VOLTS/DIV VAR to attenuate the TV signal to one division of composite sync or 2.3 divisions of composite video on the crt display.

WARNING

If a television receiver is used as the signal source, an isolation transformer must be installed between the receiver and its power input source if the receiver does not have a transformer operated power supply.

a. Set:

VERT MODE	CH 1
VOLTS/DIV (CH 1)	As required
VOLTS/DIV VAR (CH 1)	As required
SEC/DIV	.1 m
TRIGGERING MODE	TV
SOURCE	CH 1/CH 2
MAGNIFIER	X1 (out)

b. Attach a compensated 10X probe to the Channel 1 input connector. Connect the probe ground lead to the circuit ground on the television signal source and connect the probe tip to an appropriate composite sync or composite video test point.

c. Set Channel 1 VOLTS/DIV and VAR to display 1 division of composite sync signal (or 2.3 divisions of composite video signal).

d. CHECK—That a stable triggered display of the TV field signal can be obtained by adjusting the LEVEL and SLOPE control settings.

e. Set the SEC/DIV switch to 50 μ .

Calibration Procedure—442 Service Adjustment Procedure

f. CHECK—That a stable triggered display of the TV line signal can be obtained by adjusting the LEVEL and SLOPE control settings.

g. Connect a 1X probe to the EXT TRIGGERING input connector and connect the probe ground lead to the circuit ground on the TV signal source. Connect the probe tip to a 100 mV composite sync signal source or 230 mV composite video source (signal in phase with signal used in part b).

h. Set SOURCE to EXT.

i. CHECK—That the TV line displayed signal can be triggered by adjusting the LEVEL and SLOPE control settings.

j. Set the SEC/DIV switch to .1 m.

k. CHECK—That the TV field displayed signal can be triggered by adjusting the LEVEL and SLOPE control settings.

l. Disconnect the test setup.

ADJUSTMENT PROCEDURE

IMPORTANT—PLEASE READ BEFORE USING THIS PROCEDURE

INTRODUCTION

Purpose

The purpose of the Adjustment Procedure is to provide a calibration sequence for adjustments—not to provide a troubleshooting guide. Refer to the Maintenance section for troubleshooting information.

Limits and Tolerances

The limits and tolerances listed in this Adjustment Procedure are instrument specifications only if they are listed in the Performance Requirement column of the tables in Specification, Section 1.

Line Voltage Selection

Refer to the Preliminary Procedure preceding the Adjustment Procedure steps for instructions on setting the 442 for the available power input source voltage.

Internal Adjustments and Adjustment Interaction

Do not preset the internal controls or change the -8 volt supply adjustment setting as this will typically necessitate a complete recalibration of the instrument when only a partial recalibration might otherwise be

necessary. To avoid unnecessary recalibration, change internal control settings only when a Performance Characteristic is not met with the original setting. When it is necessary to change the setting of any internal control, also check any INTERACTION parts of that procedure step.

Partial Procedures

This procedure is structured in subsections to permit readjustment of individual sections of the instrument (except the power supply) when a complete recalibration is not required. For example: if only the Vertical section fails to meet Performance Requirements or has had repairs made and components replaced, it can be readjusted with little or no effect on other sections of the instrument. However, if the Power Supply section has undergone repairs or adjustment that changes the absolute values of any of the supply voltages, this may alter the calibration of other sections and it will usually be necessary to perform a complete Adjustment Procedure including all subsections.

When performing only a partial procedure, each subsection lists all the front panel control settings to prepare the instrument for step 1 in that subsection. Each succeeding step should then be performed in sequence to ensure that control setting changes will be correct for ensuing steps. Each subsection also lists the test equipment required for the steps in that subsection.

Test Equipment

All equipment is assumed to be calibrated and operating within the original specifications. The tolerances given in this procedure are for the oscilloscope under test and do not include test equipment error.

In this procedure, test equipment is named by the functional description (see Table 4-1, Description), rather than by specific front-panel nomenclature. The accessories listed are typical bench items.

Test Equipment Alternatives

When equipment other than that recommended is used, control settings or test setup may need to be altered. If the exact item of equipment given as an example in the Test Equipment list is not available, first check the Minimum Specifications column carefully to see if any other equipment might suffice. Then check the Usage column to see the purpose of this item. If used for a check that is of little or no importance to your measurement requirements, the item and corresponding steps can be deleted.

Special Calibration Fixtures

Special calibration fixtures are used only where they facilitate instrument adjustment. These fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Preparation

Connect the test equipment to an appropriate power input source. Turn it on and allow a 20-minute warmup period before commencing the Adjustment Procedure.

The 442 cabinet must be removed and the Interface board must be moved to the adjustment access position to allow adjustment of the internal controls. For accurate adjustment of the Vertical circuitry, a shield must be installed to simulate cabinet capacitance.

WARNING

Dangerous potentials exist at several points inside the 442. To prevent electrical shock, turn the 442 POWER switch off and disconnect the power cord plug from the power source before removing the cabinet or moving the Interface board to the adjustment access position. Do not touch exposed connections or components when the 442 is operated with the cabinet removed.

Remove the 442 cabinet according to the following steps (see Figure 4-5):

1. Attach the front cover on the 442 and position the 442 face down (supported by the cover) on a work bench or table (move the carrying handle away from the front of the 442).

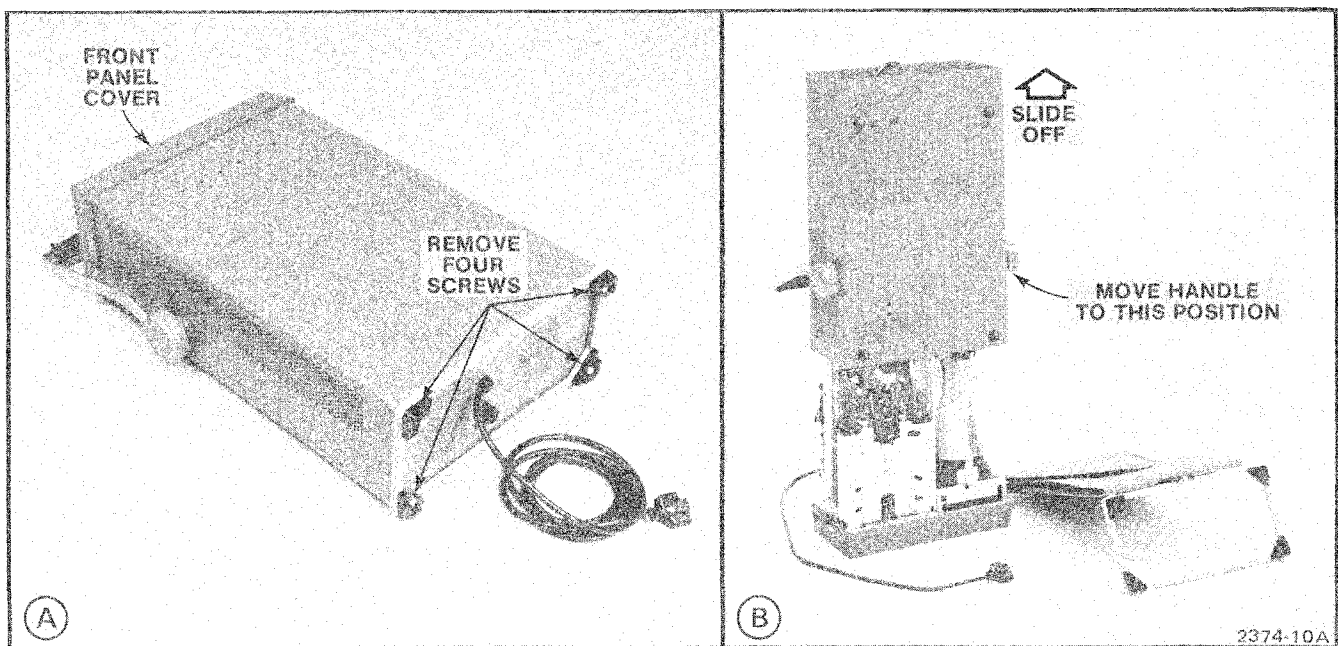


Figure 4-5. 442 cabinet removal.

Calibration Procedure—442 Service Adjustment Procedure

2. Unfasten the rear cabinet frame from the rear panel by removing the four Phillips-head rear foot securing screws. Loosen the screw that secures the accessory pouch to the rear cabinet frame and detach the accessory pouch.

3. Remove the rear cabinet frame and slide the cabinet up off the back of the 442.

4. At the completion of a partial or complete Adjustment Procedure, reassemble the 442 by reversing the order of the foregoing steps.

NOTE

The 442 may be calibrated in either of two basic positions: in a horizontal plane or in a vertical plane. If the vertical plane (front panel facing upward) is preferred, reinstall the rear cabinet frame and feet at this point to provide proper support for the 442. This procedure is written assuming the 442 will be positioned in its normal operating plane or rotated from that position as required for the individual steps.

Move the Interface board to the adjustment access position according to the following steps (see Figure 4-6):

1. Remove the FOCUS and INTENSITY knob-shaft assemblies by disconnecting them from the potentiometers and sliding them out through the front panel openings.

2. Use #1 and #2 Phillips-bit screwdrivers to remove the four Interface board mounting screws indicated in Figure 4-6A and slide the board edge out of the three plastic circuit board holders that support the edge of the board nearest the crt shield.

3. Slide the Interface board toward the rear of the 442 to clear the BEAM FINDER and ON/OFF push button/shaft assemblies from the front panel openings.

4. Place the Interface board in the adjustment access position (90° from the original normal operation position) by sliding the edge of the board into the second set of slots in the three plastic circuit board holders described in Step 2 (check that cables and wires from the board are clear of other components while the board is being changed from one position to the other and that no interconnecting plugs or pin connectors have loosened during the transition).

If the Vertical section is to be recalibrated, install a shield (see Table 4-1) over the foil side of the Interface board as follows:

1. Place the channel edge of the shield over the edge of the plastic insulation plate near P470, Q136, etc., and secure the opposite edge with the original Interface board mounting screws for the holes near J2 and J4.

To complete the preparation of the 442, reinstall the FOCUS and INTENSITY knob/shaft assemblies. To avoid damage to the potentiometers or the board, carefully note the orientation of the flatted portions of the shafts and do not apply excessive force while reinstalling the knob/shaft assemblies. After knob/shaft reinstallation, rotate both controls fully counterclockwise.

NOTE

To return the 442 to normal operating condition at the conclusion of a partial or complete Adjustment Procedure, reverse the order of the appropriate portions of the Preparation Steps.

Display

The Adjustment Procedure should be performed with a stable, well-focused, low-intensity, vertically centered (unless otherwise stated) display. Unless otherwise instructed, set the INTENSITY, ASTIGMATISM, FOCUS, TRIGGER, and POSITION controls as required.

PRELIMINARY PROCEDURE

Perform the following steps to place the 442 Oscilloscope into a basic operating mode before proceeding with the Adjustment Procedure steps.

WARNING

Make sure the 442 is unplugged from the power input source before changing the line voltage settings.

1. Use a small blade screwdriver to set the Line Voltage Selector (120 V or 240 V) and Range Selector (HI or LO) switches (both are accessible at the bottom of the instrument) to the correct settings for the power input voltage source that will be used during this procedure.

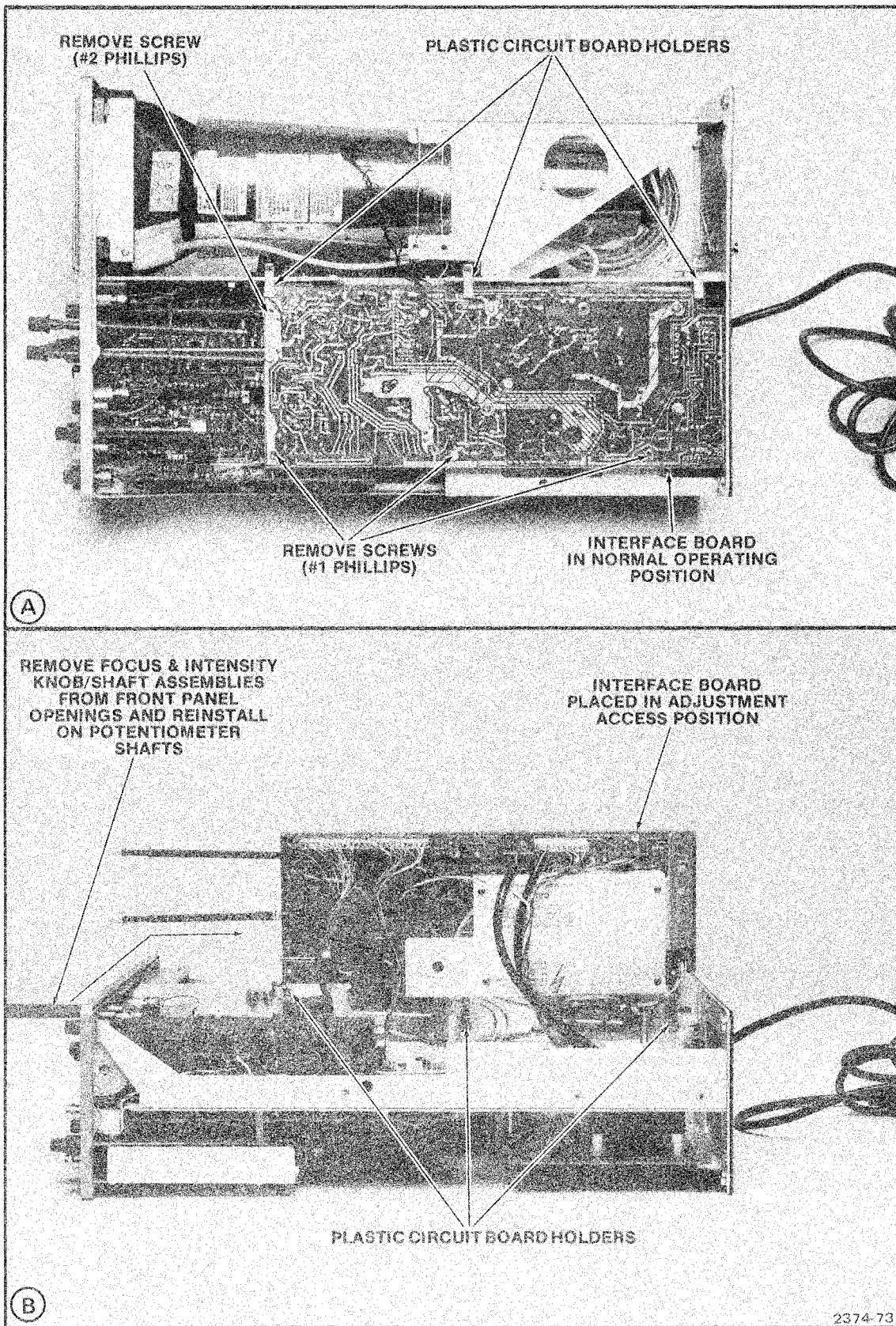


Figure 4-6. Moving Interface board to adjustment access position.

Calibration Procedure—442 Service Adjustment Procedure

CAUTION

If the Line Voltage Selector (120 V/240 V) setting is changed, the line fuse (located in a fuse holder on the rear panel) must be of the value specified for the new Selector setting. Refer to the Operating Instructions section of this manual for complete operating voltage and fuse information.

Unless otherwise specified, the 442 is originally set for 120 V and HI line operation.

2. Connect the 442 power cord plug to the line voltage source and press the ON/OFF button on (in). The POWER ON LED should light.

NOTE

The 442 must have a warmup time of at least 20 minutes before starting the Adjustment Procedure, and must be adjusted at an ambient temperature between 20° C and 30° C to ensure that checks in this procedure will meet specifications listed in Section 1.

3. Set the TRIGGERING MODE to AUTO, and SOURCE to CH 1/CH 2.

4. Set CPLG to AC (out) and leave it there throughout the procedure unless instructed otherwise.

5. Set the following 442 controls as listed:

VERT MODE	CH 1
POSITION (CH 1 & CH 2)	Midrange
VOLTS/DIV (CH 1 & CH 2)	2 m (1X)
VOLTS/DIV VAR (CH 1 & CH 2)	Detent (fully cw)
AC-GND-DC (CH 1)	GND
AC-GND-DC (CH 2)	DC
SEC/DIV	.1 m
MAGNIFIER	X1 (out)
POSITION (Horizontal)	Midrange
SLOPE	+ (out)
HOLD OFF	Fully ccw
LEVEL	Fully cw
INTENSITY	Midrange
FOCUS	Midrange

6. A baseline trace should be visible within the graticule area. Adjust the INTENSITY and FOCUS controls for a low-intensity, well-defined trace.

NOTE

The ASTIG control also affects trace definition, and if necessary, should be adjusted after a signal has been applied, for best overall definition of a displayed signal (use a small-bit screwdriver for this adjustment).

The baseline trace should be parallel with the horizontal graticule lines. If it is not, adjust TRACE ROT (Trace Rotation) with a small-bit screwdriver until the trace is aligned.

A. DISPLAY AND POWER SUPPLY

Equipment Required

Digital Voltmeter (Item 2)
Time-Mark Generator (Item 5)
50 Ω BNC Cable (Item 12)

50 Ω Termination (Item 20)
Screwdriver (Item 18)
Low-Capacitance Alignment Tool (Item 10)

PRELIMINARY CONTROL SETTINGS

Preset Front Panel controls as follows:

NOTE

Do not preset internal controls.

VERT MODE	CH 1
VOLTS/DIV (CH 1)	.1 (1X)
VOLTS/DIV VAR (CH 1 & CH 2)	Fully cw (detent)
AC-GND-DC (CH 1 & CH 2)	GND
POSITION (all)	Midrange
SEC/DIV	.1 m
SEC/DIV VAR	Fully cw (detent)
MAGNIFIER	X1 (out)
SOURCE	CH 1/CH 2
TRIGGERING MODE	AUTO
SLOPE	+ (out)
CPLG	AC (out)
LEVEL	Fully cw
HOLD OFF	Fully ccw
INTENSITY	For visible display

Set all other controls as desired. The 442 should display a baseline trace with the foregoing control settings. Set the INTENSITY, FOCUS, ASTIG, and POSITION controls as required to maintain a well-defined medium-intensity display within the graticule area.

PROCEDURE

1. -8 V Power Supply

NOTE

If the -8 V supply is found to be within the specified tolerance in Step 1, part a, skip part b and proceed to part c. If the -8 V adjustment is changed for any reason, the accuracy of all circuitry in the 442 will be affected and the entire Adjustment Procedure should be performed.

a. Set the digital voltmeter to a 20 V dc range and connect the LO lead to the junction of C742-C743 (ground). Connect the HI lead to the end of R775 illustrated in Figure 4-7 (-8 V point). If the meter reads between -7.96 V and -8.04 V proceed to part c. If the meter reading is outside these limits, proceed to part b.

b. ADJUST—R773 (-8 V Adj) for a reading of -8.00 V dc (see Figure 4-7).

c. Disconnect the digital voltmeter leads from the 442.

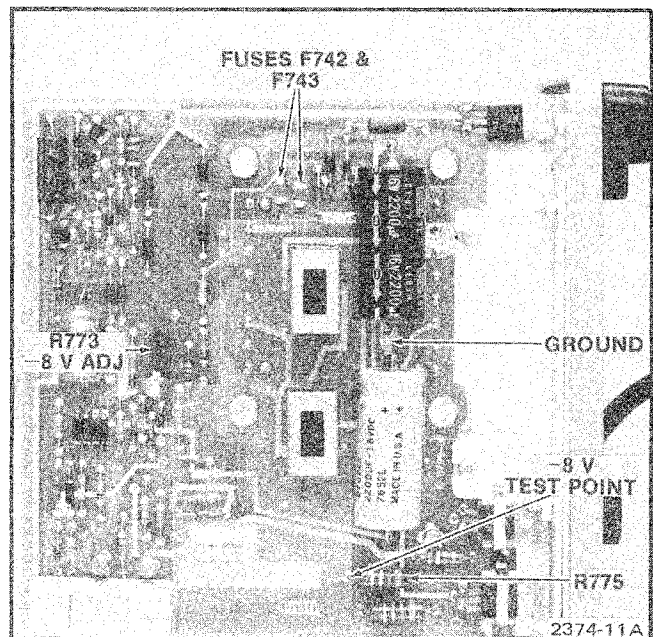


Figure 4-7. Low-voltage power supply adjustment location.

**Calibration Procedure—442 Service
Adjustment Procedure**

2. TRACE ROT (Trace Rotation)

- a. Set the Vertical POSITION control to move the trace to the center horizontal graticule line.

- b. ADJUST—The TRACE ROT control (located on the front panel) with a small-bit screwdriver to align the trace with the center horizontal graticule line.

3. Y-Axis Alignment

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

- b. Connect .1 ms markers from the time-mark generator through a 50 Ω cable and 50 Ω termination to the Channel 1 input connector.

- c. Set the channel 1 VOLTS/DIV, VAR, and POSITION controls to obtain a display of slightly more than 8 divisions of vertical deflection with the baseline about 1 division below the bottom of the graticule area and the tips of the time markers extending to the top graticule line.

- d. Set the SEC/DIV switch to display time markers spaced about 1 division apart. Set the Horizontal POSITION control to align the center time marker with the center vertical graticule line.

- e. ADJUST—R474 (Y-Axis Adjust, see Figure 4-8) to align the center time marker with the center vertical graticule line.

- f. INTERACTION—Set the Channel 1 AC-GND-DC switch to GND and set the Channel 1 POSITION control to move the baseline to the center horizontal graticule line. Check that the baseline trace aligns with the center horizontal graticule line. If not, repeat Steps 2 and 3 until optimum Trace Rotation and Y-Axis alignment is achieved.

4. Geometry

- a. Set the Channel 1 AC-GND-DC switch to DC and set the other controls to obtain a display as described in Step 3, parts c and d. Set the Horizontal POSITION control as required.

- b. ADJUST—R473 (Geom Adjust, see Figure 4-8) for best overall alignment of the time markers with the vertical graticule lines (minimum bowing of time markers).

- c. INTERACTION—Repeat all of Steps 3 and 4 to achieve optimum Geometry and Y-Axis Alignment adjustment.

- d. Disconnect the time-mark generator cable termination from the Channel 1 input connector and return the Channel 1 VOLTS/DIV VAR control to the fully clockwise calibrated detent position.

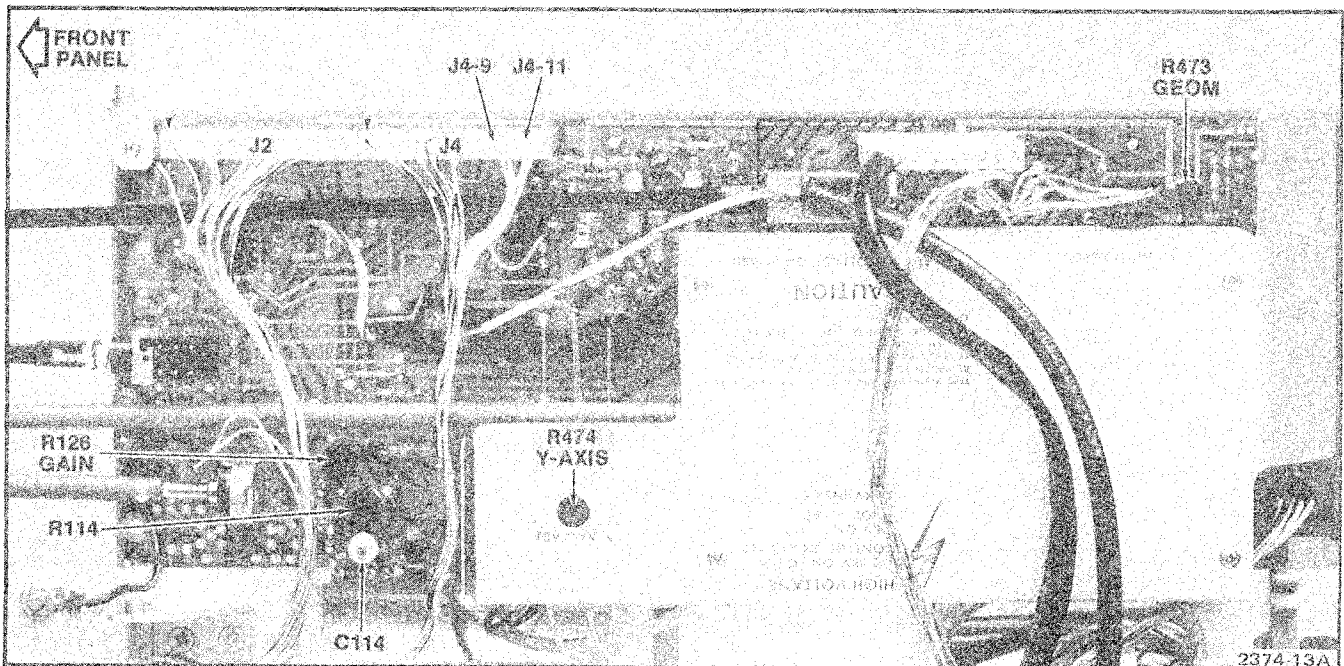


Figure 4-8. Interface board adjustment locations (board shown in access position).

B. VERTICAL AMPLIFIER

Equipment Required

Amplitude Calibrator (Item 1)	Screwdriver (Item 18)
Square-Wave Generator (Item 4)	10X Probe (Item 15)
50 Ω BNC Termination (Item 20)	10X Attenuator (Item 11)
50 Ω BNC Cable (Item 12)	Probe-tip-to-BNC Adapter (Item 9)
Low-Capacitance Alignment Tool (Item 10)	Dual Input Coupler (Optional) (Item 13)
	Shield (Item 19)

PRELIMINARY CONTROL SETTINGS

Preset Front Panel controls as follows:

NOTE

Do not preset internal controls.

VERT MODE	CH 1
VOLTS/DIV (CH 1 & CH 2)	10 m (1X)
VOLTS/DIV VAR (CH 1 & CH 2)	Fully cw (detent)
AC-GND-DC (CH 1 & CH 2)	GND
POSITION (all)	Midrange
SEC/DIV	.5 m
SEC/DIV VAR	Fully cw (detent)
MAGNIFIER	X1 (out)
SOURCE	CH 1/CH 2
TRIGGERING MODE	AUTO
SLOPE	+ (out)
CPLG	AC (out)
LEVEL	Midrange
HOLD OFF	Fully ccw
INTENSITY	For visible display

Set all other controls as desired. The 442 should display a baseline trace with the foregoing control settings. Set the INTENSITY, FOCUS, ASTIG, and POSITION controls as required to maintain a well-defined medium-intensity display within the graticule area.

NOTE

Verify that the Calibration Fixture Shield has been installed as described under Preparation in the Introduction portion of this Adjustment Procedure. If only a partial Adjustment procedure is to be performed, refer to Introduction and Preliminary Procedure at the beginning of this Adjustment Procedure to prepare the 442 for adjustment.

PROCEDURE

1. Vertical Preamplifier Balance

a. ADJUST—CH 1 DC BAL (R4130, see Figure 4-9) for minimum trace shift while switching Channel 1 VOLTS/DIV between 10 m and 20 m settings.

b. Set VERT MODE to CH 2.

c. ADJUST—CH 2 DC BAL (R4230, see Figure 4-9) for minimum trace shift while switching Channel 2 VOLTS/DIV between 10 m and 20 m settings.

2. Differential Balance (CH 2 Invert Balance)

a. Set both VOLTS/DIV switches to 10 m (1X window) and set VERT MODE to CH 1. Set Channel 1 POSITION control to align the trace with the center horizontal graticule line.

b. Set VERT MODE to CH 2 and set Channel 2 POSITION control to align the trace with the center horizontal graticule line.

c. Set VERT MODE to DIFF.

d. ADJUST—Either R4265 (SN B010409-up) or R4280 (SN B010100-B010408) for minimum trace shift while alternately pressing the DIFF and CH 2 Vertical Mode buttons (see Figure 4-9 for location of adjustments).

**Calibration Procedure—442 Service
Adjustment Procedure**

**3. Vertical Output Amplifier and Vertical
Preamplifier Gain**

NOTE

The vertical system gain should not require readjustment unless the crt or other vertical components have been replaced or adjustments have accidentally been altered.

a. Set:

VOLTS/DIV (CH 1 & CH 2)	2 m (1X)
AC-GND-DC (CH 1 & CH 2)	DC
VERT MODE	CH 1
SEC/DIV	.2 m
TRIGGERING MODE	AUTO
SOURCE	CH 1/CH 2
CPLG	AC
LEVEL	Fully cw

b. Preset R126, Gain (see Figure 4-8), R4151 (Channel 1 Gain), and R4251 (Channel 2 Gain, see Figure 4-9), all fully counterclockwise for minimum gain.

c. Set the Amplitude Calibrator for a 10 mV output signal and connect it through a 50 Ω cable to a dual-input coupler connected to the Channel 1 and Channel 2 input connectors.

d. ADJUST—R126 (Gain) for a centered vertical display amplitude of 4.8 divisions (set Channel 1 POSITION as necessary to maintain a vertically centered display).

e. ADJUST—R4151 (CH 1 Gain) for a 5-division centered vertical display amplitude (set Channel 1 POSITION as required).

f. Press VERT MODE CH 2 button in.

g. ADJUST—R4251 (CH 2 Gain) for a 5-division centered vertical display amplitude (set Channel 2 POSITION as required).

h. Disconnect the test equipment from the 442.

4. Channel 1 Attenuator Compensation

a. Set:

VOLTS/DIV (CH 1)	20 m (1X)
AC-GND-DC (CH 1)	DC
VERT MODE	CH 1
SEC/DIV	5 m
MAGNIFIER	X1 (button out)
POSITION (all)	As required
LEVEL	For a triggered display

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 1 input connector. Set the generator to 1 kHz and set the generator amplitude to provide a 5-division display.

c. ADJUST—C4114 (see Figure 4-9) for best square front corner (see Figure 4-10 for example).

d. Set Channel 1 VOLTS/DIV to .2 (1X) and set the generator output for a 5-division display.

e. ADJUST—C4105 (see Figure 4-9) for the best front corner on the square-wave display (see Figure 4-10 for example). Disconnect the test equipment from the 442.

f. Set Channel 1 VOLTS/DIV to 10 m (1X).

g. Connect a 10X probe to the CH 1 input connector. 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 high-amplitude output connector of the square-wave generator. Set the generator for a 5-division, 1 kHz display.

h. Compensate the probe for the best front corner on the displayed waveform.

i. Set the CH 1 VOLTS/DIV switch to 20 m (1X) and set the generator for a 5-division display.

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

k. Set CH 1 VOLTS/DIV to .2 (1X) and set the generator output for a 5-division display.

l. ADJUST—C4104 for the best flat top on the square wave.

m. Disconnect the test equipment from the 442.

5. CH 2 Attenuator Compensation

a. Set:

VOLTS/DIV (CH 2)	20 m (1X)
AC-GND-DC (CH 2)	DC
VERT MODE	CH 2
SEC/DIV	5 m
MAGNIFIER	X1 (button out)
POSITION (all)	As required

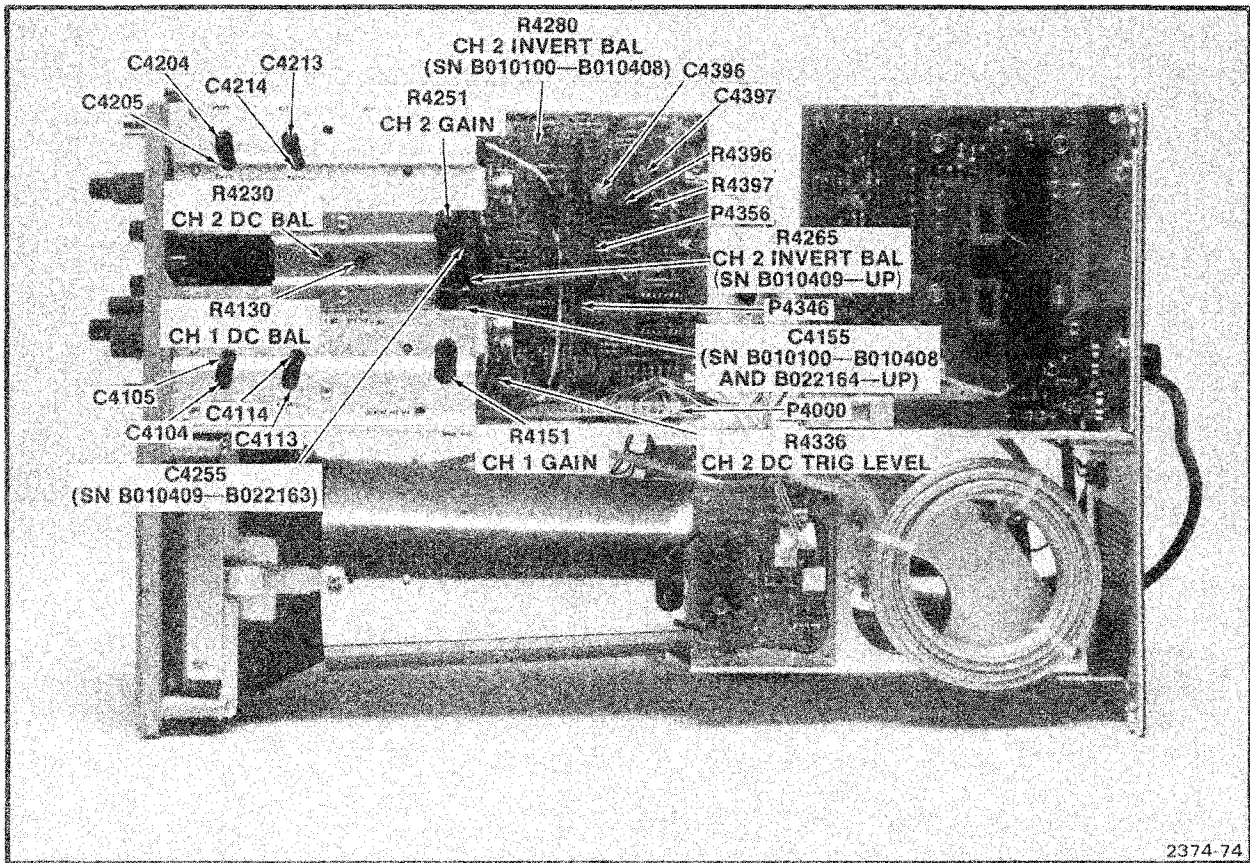


Figure 4-9. Vertical attenuator, preamplifier, delay line driver, and CH 2 dc trigger level adjustment locations.

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 the generator to 1 kHz and set the generator amplitude to provide a 5-division display.

c. ADJUST—C4214 (see Figure 4-9) for the best square front corner on the displayed waveform (see Figure 4-10 for example).

d. Set CH2 VOLTS/DIV to .2 (1X) and set the generator amplitude to provide a 5-division display.

e. ADJUST—C4205 (see Figure 4-9) for the best square front corner (see Figure 4-10 for example). Disconnect the test equipment from the 442.

f. Set CH 2 VOLTS/DIV to 10 m (1X).

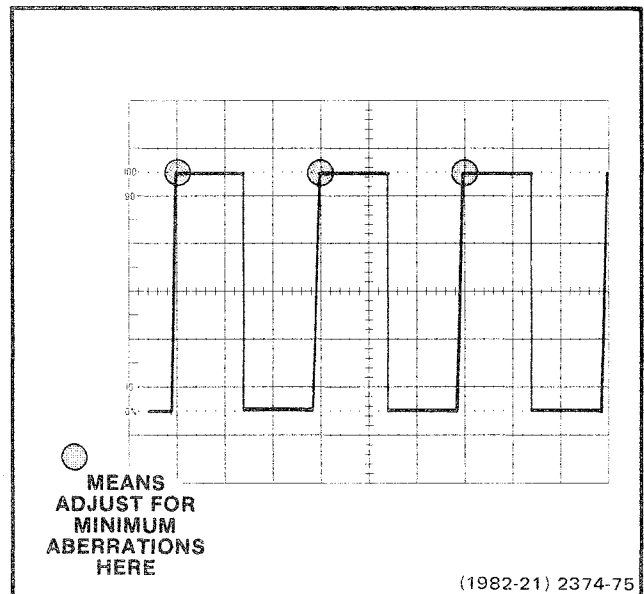


Figure 4-10. Display of correct (idealized) attenuator compensation.

Calibration Procedure—442 Service Adjustment Procedure

g. Connect a 10X probe to the CH 2 input connector. 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 high-amplitude output connector of the square-wave generator. Set the generator to provide a 5-division, 1 kHz display.

h. Compensate the probe for the best front corner on the displayed waveform.

i. Set CH 2 VOLTS/DIV to 20 m (1X) and set the generator for a 5-division display.

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

k. Set CH 2 VOLTS/DIV to .2 (1X), and set the generator amplitude to provide a 5-division display.

l. ADJUST—C4204 for the best flat top on the displayed square wave.

m. Disconnect the test equipment from the 442.

6. High Frequency Compensation

a. Set:

VOLTS/DIV (CH 1 & CH 2)	2 m (1X)
VERT MODE	CH 1
SEC/DIV	.5 m
INTENSITY	For a visible display
LEVEL	For a triggered display

b. Connect the square-wave generator fast-rise + transition output through a 50 Ω cable, a 10X attenuator, and a 50 Ω termination to the Channel 1 input connector.

c. Set the generator for a 100 kHz, 5-division display (set INTENSITY and POSITION controls for a visible centered display).

d. Set SEC/DIV to .5 μ , MAGNIFIER to X10 (button in) and adjust LEVEL and INTENSITY for a visible, stable, triggered, positive-going square-wave display. Set Horizontal POSITION control to view the leading edge of the square wave near the center of the graticule area.

e. ADJUST—R4397, C4397, C4396, R4396 (see Figure 4-9) and C114, R114 (see Figure 4-8), using a low-capacitance alignment tool, for best front corner of the waveform.

NOTE

For serial numbers B010409 through B022163, perform parts g, h, and i and ignore parts f and j.

For serial numbers below B010409 and above B022163 perform parts f, g, h, and j and ignore part i.

f. ADJUST—(For serial numbers below B010409 and above B022163) C4155 (see Figure 4-9) for best front corner of the waveform (use a low-capacitance alignment tool).

g. Set VERT MODE to CH 2.

h. Move the 50 Ω termination for the square-wave signal from the Channel 1 input connector to the Channel 2 input connector.

i. ADJUST—(For serial numbers B010409 through B022163) C4255 (see Figure 4-9) for best front corner of the waveform (use a low-capacitance alignment tool).

j. CHECK—(For serial numbers below B010409 and above B022163) for a square front corner on the Channel 2 waveform similar to the Channel 1 waveform obtained in part e.

k. INTERACTION—If either the Channel 2 waveform or the Channel 1 waveform is not satisfactory, repeat the adjustments and checks listed in parts e through i (as appropriate for the serial number of the instrument being adjusted) for best compromise of the waveforms for Channel 1 and Channel 2. For example, slightly readjust C4396, R4396, C4397, R4397, C114, and R114 along with C4255 (if present) for best Channel 2 display; then change signal and Mode to Channel 1 and check the display. Then, if necessary, readjust all listed components (including C4155, if present). Repeat as required to achieve best display front corner for both Channel 1 and Channel 2.

l. Disconnect the test equipment from the 442.

C. HORIZONTAL

Equipment Required

Time-Mark Generator (Item 5)	50 Ω BNC Termination (Item 20)
Amplitude Calibrator (Item 1)	Low-Capacitance Alignment Tool (Item 10)
50 Ω BNC Cable (Item 12)	

PRELIMINARY CONTROL SETTINGS

Preset the front panel controls as follows:

INTENSITY	Midrange
FOCUS	Midrange
VERT MODE	CH 1
VOLTS/DIV (CH 1)	.1 (1X)
VOLTS/DIV VAR (CH 1)	Fully cw (detent)
AC-GND-DC (CH 1)	DC
AC-GND-DC (CH 2)	GND
SEC/DIV	1 m
SEC/DIV VAR	Fully cw (detent)
MAGNIFIER	X1 (button out)
SOURCE	CH 1/CH 2
TRIGGERING MODE	AUTO
SLOPE	+ (button out)
CPLG	AC
HOLD OFF	Fully ccw
LEVEL	For triggered display
POSITION (all)	As required

If only a partial Adjustment Procedure is to be performed, refer to Introduction and Preliminary Procedure at the beginning of this Adjustment Procedure to prepare the 442 for adjustment.

The 442 should display a baseline trace with the foregoing control settings. Set the INTENSITY, FOCUS, ASTIG, and POSITION controls as required to maintain a well-defined medium-intensity display within the graticule area.

PROCEDURE

1. Horizontal Gain (X1 Gain)

a. Connect the time-mark generator signal through a 50 Ω bnc cable to a 50 Ω termination at the CH 1 input connector. Set the generator for 1 millisecond time markers.

b. If necessary, set the Channel 1 VOLTS/DIV and VAR controls to provide a display of slightly over 4 divisions in amplitude. Set the Channel 1 POSITION to place the

baseline trace just below the graticule area with the tips of the time markers at the center horizontal graticule line.

c. ADJUST—X1 Gain (R2332, see Figure 4-11) for one marker per division over the center 8 divisions (set the Horizontal POSITION control as required to align the time markers with the vertical graticule lines).

2. X10 Gain

a. Set:

MAGNIFIER X10 (button in)

b. Set the time-mark generator for .1 millisecond time markers.

c. ADJUST—X10 Gain (R2321, see Figure 4-12) for one marker per division over the center 8 graticule divisions (set POSITION and INTENSITY controls as required).

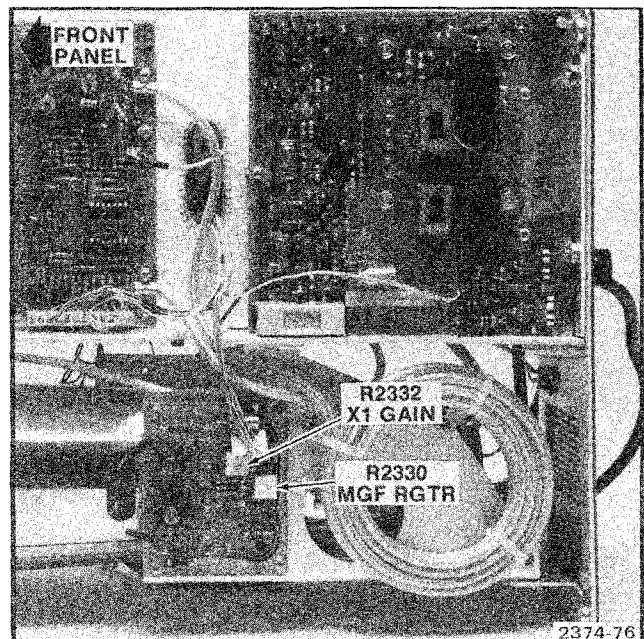


Figure 4-11. Horizontal adjustment locations on A14 Horizontal Output board.

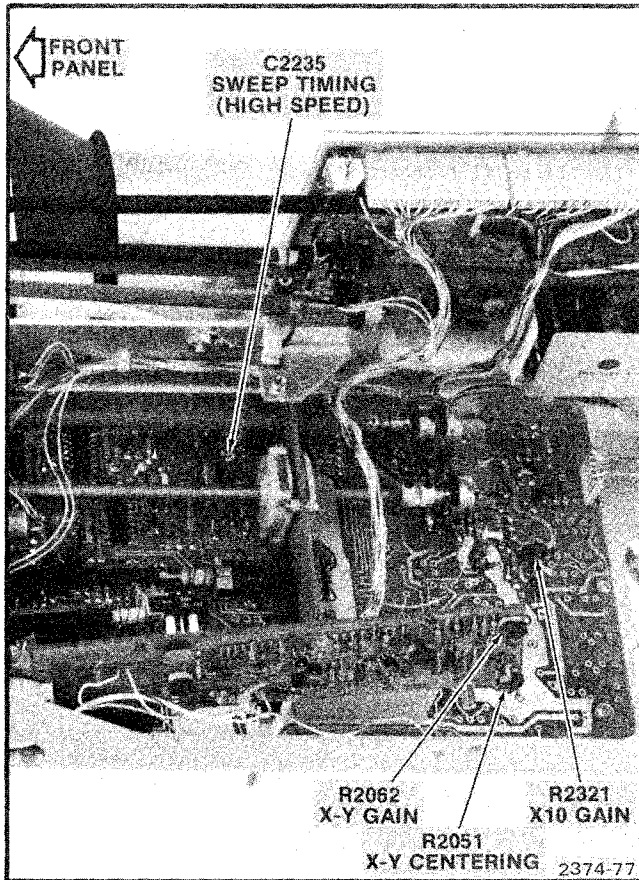


Figure 4-12. Horizontal adjustment locations on A12 Horizontal board and A11 Trigger Switch board.

3. Magnifier Registration

- a. Set the time-mark generator for 5 millisecond time markers.
- b. Set MAGNIFIER to X1 (button out).
- c. Set the Horizontal POSITION control to align the center time marker with the center vertical graticule line.
- d. Set MAGNIFIER to X10 (button in) and use the Horizontal POSITION control to move the closest time marker to the center vertical graticule line (set INTENSITY as required for visible time markers).
- e. Set MAGNIFIER to X1 (button out).
- f. ADJUST—Mgf Rgtr (R2330, see Figure 4-11) so the center time marker aligns with the center vertical graticule line.

- g. INTERACTION—Between X1 and X10 MAGNIFIER settings. Repeat adjustment of R2321 and R2330 and reset Horizontal POSITION control until there is no change in time marker position when switching MAGNIFIER from X1 to X10.

4. High Speed Sweep Timing

- a. Set:

MAGNIFIER	X1
-----------	----
- b. Set SEC/DIV to $.5 \mu$ and set the time-mark generator for .5 microsecond time markers. Set POSITION and INTENSITY controls as required.
- c. ADJUST—High Speed Sweep Timing (C2235, see Figure 4-12) for one time marker per graticule division over the center 8 graticule divisions (use a low-capacitance alignment tool).
- d. Disconnect the time-mark generator signal from the 442.

5. X-Axis Centering (X-Y Centering)

- a. Set:

SOURCE	CH 1/CH 2
CPLG	AC
SEC/DIV	.1 m
VERT MODE	CH 2
INTENSITY	For visible trace
- b. Set the Horizontal POSITION control so the sweep starts at the extreme left graticule line. Set SOURCE to X-Y and reduce INTENSITY setting so the displayed dot is visible but not excessively bright.
- c. ADJUST—X-Y Centering (R2051, see Figure 4-12) to position the dot to the center vertical graticule line.

6. X-Axis Gain (X-Y Gain)

- a. Set:

VOLTS/DIV (both)	10 m
AC-GND-DC (CH 1)	AC
AC-GND-DC (CH 2)	GND
- b. Connect a 1 kHz, 50 mV amplitude calibrator signal through a 50 Ω bnc cable to the Channel 1 input connector.

c. ADJUST—X-Y Gain (R2062, see Figure 4-12) for two dots spaced 5 divisions apart.

e. CHECK—For two dots spaced 5 divisions apart $\pm 5\%$ (4.75 to 5.25 divisions).

d. Set Channel 1 AC-GND-DC to DC.

f. Disconnect the amplitude calibrator signal from the 442.

D. TRIGGERING

Equipment Required

Sine-Wave Generator (Item 3)	Dual Input Coupler (Item 13)
50 Ω BNC Terminations (Item 20, two required)	Small Screwdriver (Item 18)
50 Ω BNC Cable (Item 12)	

PROCEDURE

1. Internal Trigger DC Level, Composite Trigger DC Level, and CH 2 DC Trigger Level

NOTE

Verify that Vertical Preamplifier Balance (see B. VERTICAL AMPLIFIER, Step 1) is correctly adjusted before commencing the following Triggering adjustments.

If only a partial procedure is to be performed, refer to Introduction and Preliminary Procedure at the beginning of this Adjustment Procedure to prepare the 442 for adjustment.

a. Set the 442 front panel controls as follows:

INTENSITY	For a visible display
FOCUS	For a well-defined trace
VOLTS/DIV (CH 1 & CH 2)	10 m (1X)
VOLTS/DIV VAR (CH 1 & CH 2)	Detent (fully cw)
AC-GND-DC (CH 1 & CH 2)	DC
VERT MODE	CH 1
SEC/DIV	10 μ
SEC/DIV VAR	Detent (fully cw)
MAGNIFIER	X1 (button out)
SOURCE	CH 1/CH 2
CPLG	AC (button out)
LEVEL	Midrange (triggered sweep)
TRIGGERING MODE	AUTO
SLOPE	+ (button out)
HOLD OFF	Fully ccw
POSITION (all)	As required

CALIBRATION PROCEDURE

GENERAL

Introduction

This section of the manual is in two parts: Performance Check and Adjustment Procedure. Each subsection has a different purpose and important information regarding their use is included at the beginning of both subsections.

Test Equipment Required

The test equipment listed in Table 4-1, or an equivalent piece of test equipment, is required if the complete Performance Check and Adjustment Procedure is to be

accomplished on the oscilloscope. A partial list of test equipment is provided in the Performance Check subsection to list the required test equipment to complete the Performance Check only.

In Table 4-1, the specifications given for the equipment are the minimum necessary to provide accurate results. Therefore, the equipment used must meet or exceed the listed specifications. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the appropriate instruction manual if more test equipment operating information is required.

Table 4-1

TEST EQUIPMENT REQUIRED

Description	Minimum Specification	Usage	Examples
1. Amplitude Calibrator	Amplitude accuracy, within 0.25%; signal amplitude, 10 mV to 10 V; output signal, 1 kHz square wave.	Vertical deflection accuracy checks, X-Axis deflection check, vertical gain adjustment.	a. TEKTRONIX PG 506 Calibration Generator. ^a
2. Digital Voltmeter	Range, 0 to 9 V; dc voltage accuracy within 0.3%; display, 4 1/2 digits.	Power supply adjustment.	a. TEKTRONIX DM 501A Digital Multimeter. ^a
3. Leveled Sine-wave Generator	Frequency, 50 kHz to above 35 MHz; output amplitude, variable from 0.5 to 5.5 V p-p; output impedance, 50 Ω ; reference frequency, 50 kHz; amplitude accuracy, constant within 3% of reference frequency as output frequency changes.	Bandwidth checks, Z-Axis check, Triggering adjustments, CMRR check.	a. TEKTRONIX SG 503 Leveled Sine wave Generator ^a (with included precision cable).
4. Square-wave Generator	Fast Rise output, 100 kHz with 2 ns or less risetime, and amplitude of at least 50 mV into a 50 Ω termination; High Amplitude output of 1 kHz with amplitude of at least 5 V into a 50 Ω termination, and at least 10 V unterminated.	Vertical high-frequency compensation and attenuator adjustment.	a. TEKTRONIX PG 506 Calibration Generator. ^a

MAINTENANCE

INTRODUCTION

This section of the manual contains information for preventive maintenance, troubleshooting, and corrective maintenance. Procedures for removal and replacement of the cabinet are presented at the beginning of this section. Should the instrument require reshipment to a Tektronix Service Center for repair, refer to the repackaging instructions at the end of Section 2. Refer to Table 5-3 at the end of this section for Maintenance Aids information.

Cabinet Removal

To remove the 442 cabinet, proceed as follows (see Figure 5-1):

1. Attach the front cover on the 442 and position the 442 face down (supported by the cover) on a work bench or table (move the carrying handle away from the front of the 442).
2. Unfasten the rear cabinet frame from the rear panel by removing the four Phillips-head rear foot securing screws. Loosen the screw that secures the accessory pouch to the rear cabinet frame and detach the accessory pouch.

3. Remove the rear cabinet frame and slide the cabinet up off the back of the 442.

4. To re-install the cabinet and accessory pouch, reverse the order of the foregoing steps.

Moving Interface Board to Access Position

The Interface board can be moved to the access position (to provide access to the component side of the Interface board or the Horizontal board) by performing the following steps (see Figure 5-2):

1. Remove the FOCUS and INTENSITY knob/shaft assemblies by disconnecting them from the potentiometers and sliding them out through the front panel openings.
2. Use #1 and #2 Phillips-bit screwdrivers to remove the four Interface board mounting screws indicated in Figure 5-2A and slide the board edge out of the three plastic circuit board holders that support the edge of the board nearest the crt shield.

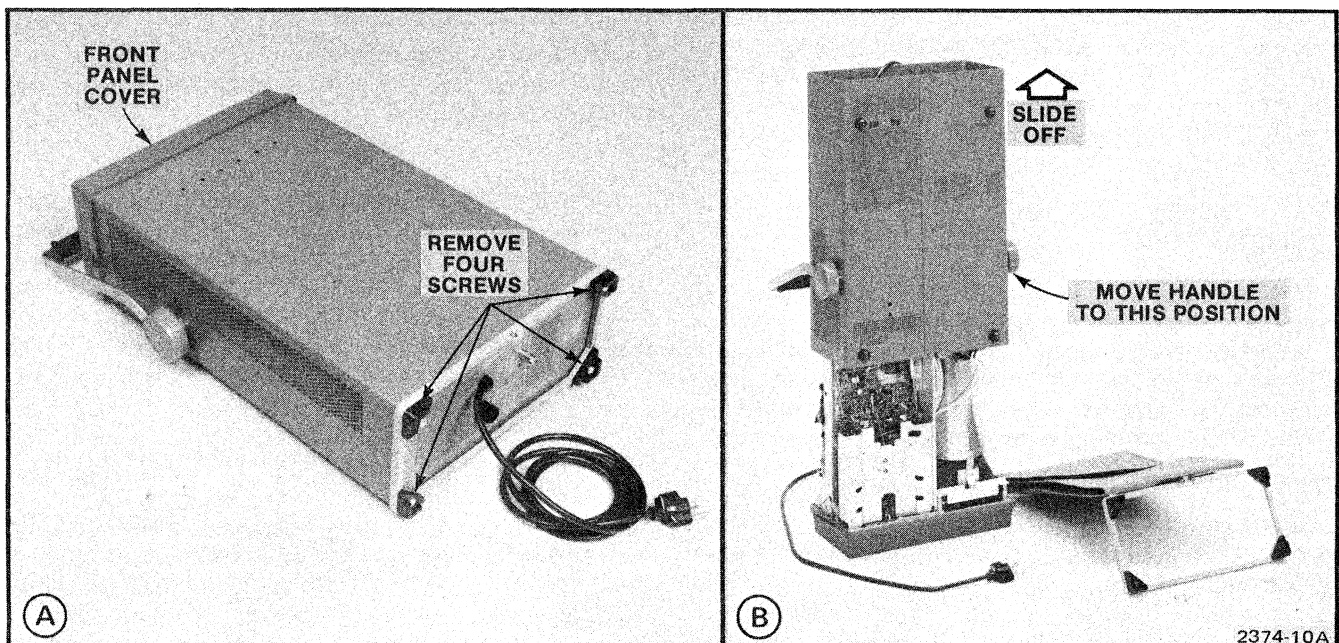


Figure 5-1. Cabinet removal.

Maintenance—442 Service

3. Slide the Interface board toward the rear of the 442 to clear the BEAM FINDER and ON/OFF push button/shaft assemblies from the front panel openings.

4. Place the Interface board in the access position (90° from the normal position) by sliding the edge of the board into the second set of slots in the three plastic circuit board holders described in Step 2 (check that cables and wires from the board are clear of other components while the board is being changed from one position to the other and that no interconnecting plugs or pin connectors have loosened during the transition).

5. To allow rotation of the FOCUS and INTENSITY controls while the Interface board is in the access position, reinstall the knob/shaft assemblies on the potentiometers. To avoid damage to the potentiometers or the board, carefully note the orientation of the flatted portions of the shafts and potentiometers and do not apply excessive force while reinstalling the knob/shaft assemblies. To avoid danger of burning the crt phosphor, rotate the INTENSITY knob fully counterclockwise during initial turn-on of the instrument.

6. To return the Interface board to the normal position, reverse the order of the foregoing steps.

PREVENTIVE MAINTENANCE

Introduction

Preventive maintenance consists primarily of cleaning and visual inspection. When performed on a regular basis, preventive maintenance can prevent instrument breakdown and ensure the reliability of this instrument. The severity of the environment to which the 442 is subjected will determine the frequency of maintenance. A convenient time to perform preventive maintenance is just prior to recalibration of the instrument.

Cleaning

The cabinet minimizes accumulation of dust inside the instrument. Operation without the cabinet in place necessitates more frequent cleaning. The front cover provides a measure of dust protection for the front panel and the crt face. The front cover should be installed when storing or transporting the instrument.

INTERIOR. Accumulation of dust and dirt should be removed as often as operating conditions require. Dirt can cause overheating and component breakdown. Dirt on components acts as an insulating blanket, preventing efficient heat dissipation. It also provides an electrical conduction path that can result in instrument failure, especially under high humidity conditions. The best way

to clean the interior is to blow off the accumulated dust with dry, low-pressure air (approximately 9 pounds per square inch). Remove any remaining dirt with a soft brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning circuit boards.

CAUTION

Avoid the use of chemical cleaning agents that might damage the plastics used in this instrument. Do not use chemicals that contain acetone, benzene, toluene, xylene, petroleum ether, white kerosene, carbon tetrachloride, methylene chloride, trichloroethane, trichlorotrifluoroethane (Freon 113, -tf, -ta, -te, -tmc) and trichlorethylene. Recommended cleaning agents are isopropyl alcohol, kelite (1 part kelite, 20 parts water), and a solution of 1% mild detergent and 99% water.

Most spray circuit coolants contain Freon 12 as a propellant. Because many Freons adversely affect switch contacts, check the contents and brand name before using a spray coolant. The following brand names are acceptable coolants: Artic Freeze, Quik-Freeze, and Can-O-Gas. Do not use Zero Mist brand of circuit coolant. The only recommended circuit coolants for the volts/division attenuators are dry ice (CO₂) or isopropyl alcohol.

SWITCH CONTACTS. Some of the switches in the 442 are circuit-board mounted, cam-actuated contacts. Care must be exercised to preserve the high-frequency characteristics of these switches. Switch maintenance is seldom necessary, but if it is required, observe the following precautions.

Clean the switch contacts only with isopropyl alcohol, especially in the area of the vertical attenuator boards. Carbon-based solvents will damage the boards used for the attenuators. Apply the isopropyl alcohol with a camel hair brush. Do not use cotton swabs, as they tend to snag on contacts, possibly causing damage, and the contacts may hold strands of cotton, causing intermittent electrical contact.

EXTERIOR. Loose dust accumulated on the outside of the oscilloscope can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt that remains can be removed with a soft cloth dampened in a mild solution of detergent and water. Abrasive cleaners should not be used.

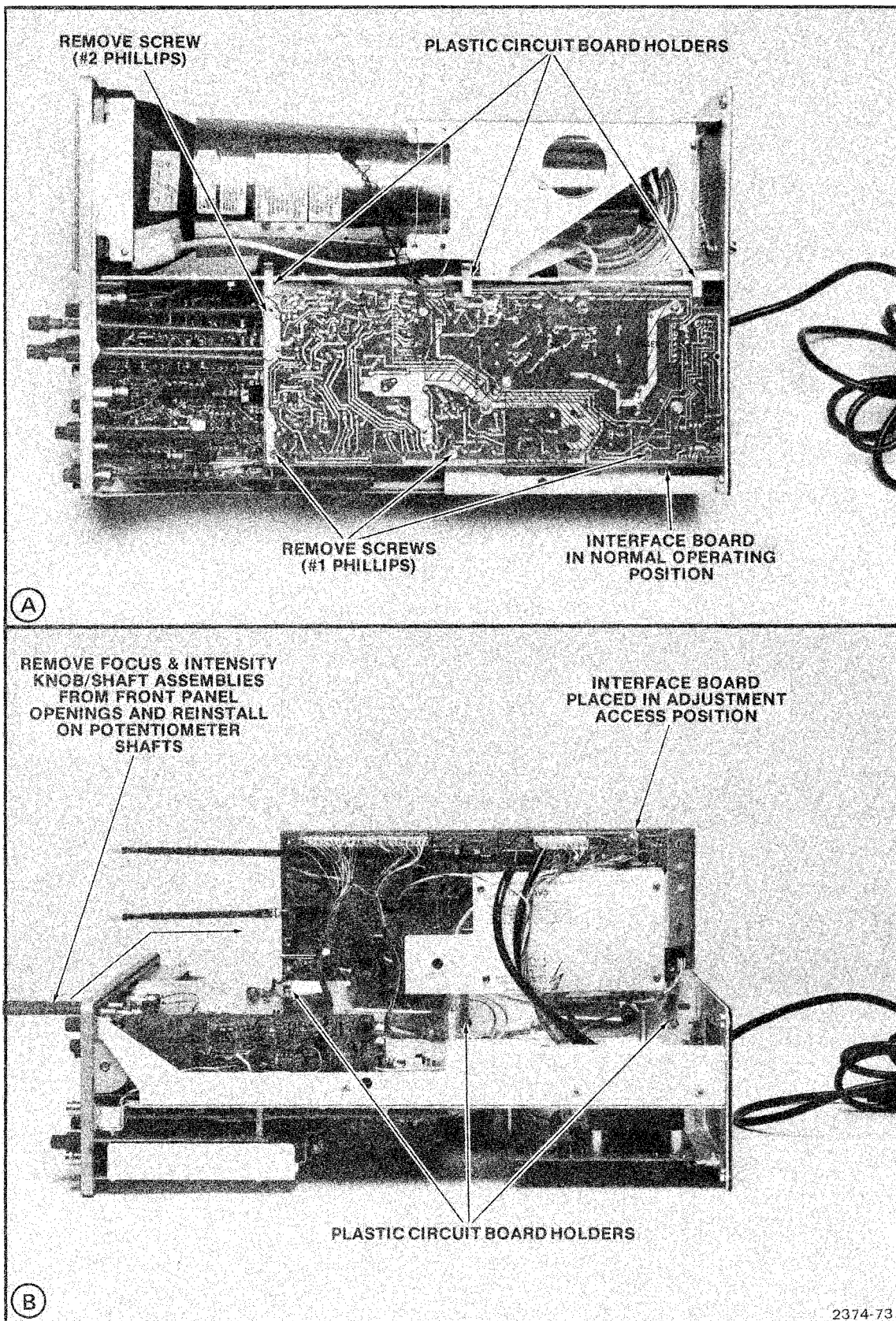


Figure 5-2. Moving Interface board to access position.

Maintenance—442 Service

CRT. A blue plastic light filter is installed on the 442 at the factory. Clean the light filter and the crt face with a soft lint-free cloth dampened with denatured alcohol or a mild detergent and water solution.

Visual Inspection

The instrument should be inspected occasionally for such defects as broken connections, improperly seated semiconductors, damaged or improperly installed circuit boards, and heat-damaged parts.

The corrective procedure for most visible defects is obvious; however, particular care must be taken if heat-damaged components are found. Overheating usually indicates other trouble in the instrument; therefore, it is important that the cause of overheating be corrected to prevent recurrence of the damage.

Lubrication

Most of the potentiometers used in the 442 are permanently sealed and generally do not require periodic lubrication. The switches used in the 442 (both cam- and lever-type) are installed with proper lubrication applied where necessary and will rarely require any additional lubrication. A regular periodic lubrication program for the 442 is not recommended.

Semiconductor Checks

Periodic checks of the transistors and other semiconductors in the oscilloscope are not recommended. The best check of semiconductor performance is actual operation in the instrument.

Readjustment

To ensure accurate measurements, check the adjustment of this instrument after each 1000 hours of operation or, if used infrequently, every six months. In addition, replacement of components may necessitate readjustment of the affected circuits. The adjustment procedure can also be helpful in localizing certain troubles in the instrument. In some cases, minor troubles may be revealed and/or corrected by readjustment. Complete adjustment instructions are given in the Calibration Procedure section.

TROUBLESHOOTING

Introduction

The following information is provided to facilitate troubleshooting. Information contained in other sections of this manual should be used along with the following information to aid in locating the defective component. An

understanding of the circuit operation is helpful in locating troubles, particularly where integrated circuits are used. See the Theory of Operation, Section 3, for this information.

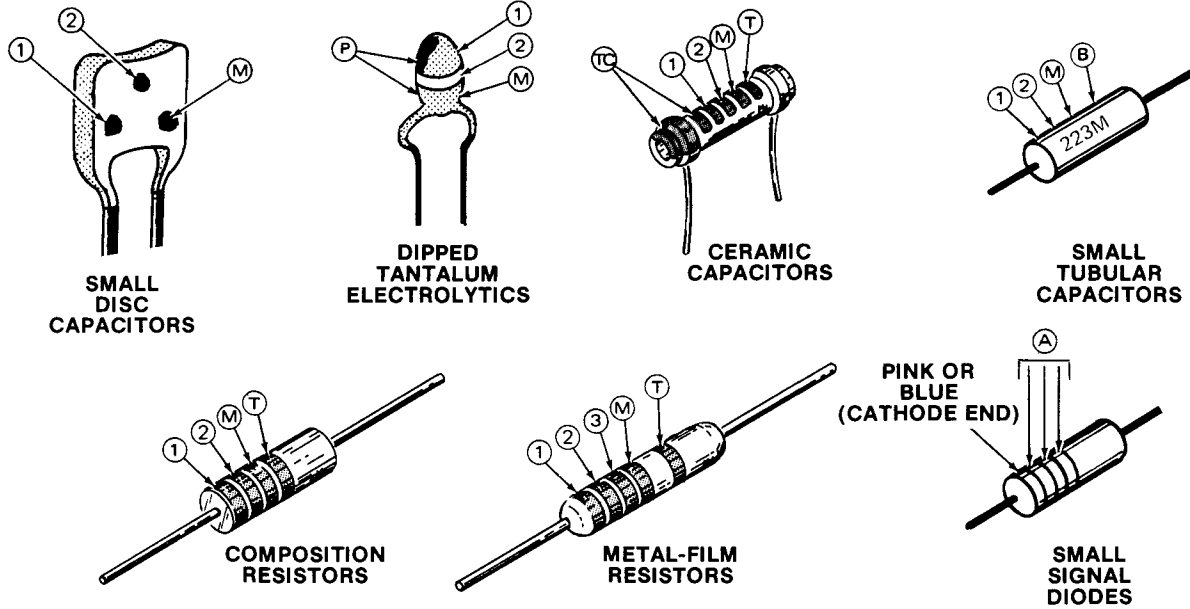
Troubleshooting Aids

DIAGRAMS. Complete circuit diagrams are given on foldout pages in the Diagrams section. The portions of the circuit mounted on circuit boards are enclosed within black lines. The component number and electrical value of each component in this instrument are shown on the diagrams. Important voltages and waveforms are also shown on the diagrams. The physical locations of the waveform test points are shown on the Circuit Board illustrations.

CIRCUIT BOARD ILLUSTRATIONS. In conjunction with each circuit diagram is a circuit board illustration. These can be found on the back of a pullout page preceding the circuit diagram to which it relates. Each circuit component shown on the circuit diagram is identified on the circuit board illustration by its component number.

ADJUSTMENT LOCATIONS ILLUSTRATIONS. To aid in locating test points and adjustable components, the Adjustment Locations illustrations (in the Adjustment Procedure portion of the Calibration Procedure) permit rapid location of test points and adjustable components because only these items are identified.

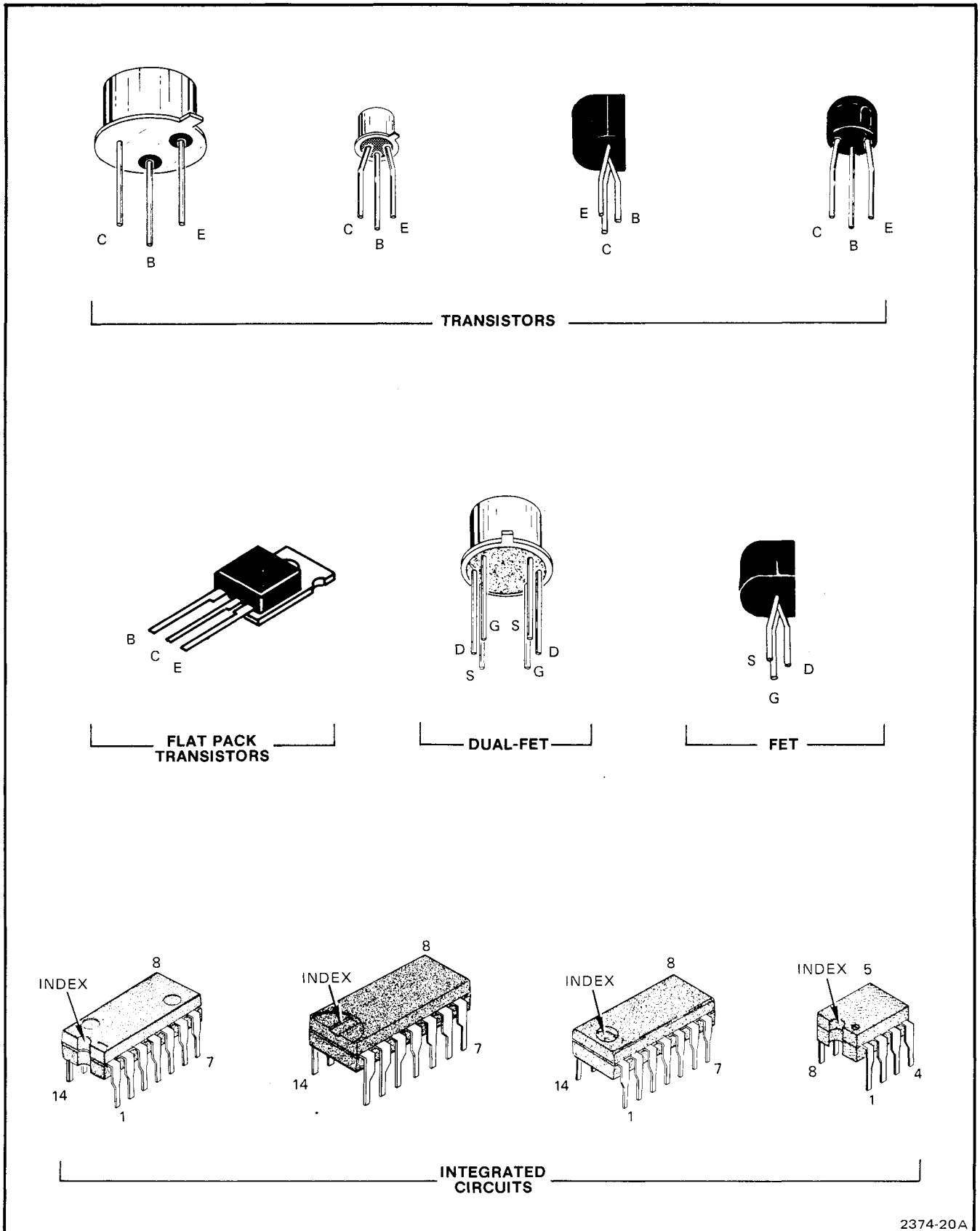
RESISTOR COLOR CODE. In addition to composition resistors, some metal-film resistors and some wire-wound resistors are used in the 442. The resistance values of wire-wound resistors are usually printed on the body of the component. The resistance values of composition resistors and metal-film resistors are color coded on the components with EIA color code (some metal-film resistors may have the value printed on the body). The color code is read starting with the stripe nearest the end of the resistor. Composition resistors have four stripes which consist of two significant figures, a multiplier, and a tolerance value (see Figure 5-3). Metal-film resistors have five stripes consisting of three significant figures, a multiplier, and a tolerance value. For values of individual resistors in thick-film resistor network assemblies, refer to the schematic diagram or the Replaceable Electrical Parts list.



- ① ② AND ③ – 1st, 2nd, and 3rd SIGNIFICANT FIGURES
- Ⓜ – MULTIPLIER
- Ⓟ – POLARITY AND VOLTAGE RATING
- Ⓟ – TOLERANCE; F=±1%, J=5%, K=10%, M=20%
- Ⓐ – COLORS IDENTIFY SIGNIFICANT DIGITS IN TEKTRONIX PART NUMBER (E.G., BROWN, GRAY, GREEN STRIPES INDICATE PART NUMBER 152-0185-00)
- Ⓣ – TOLERANCE
- ⓉⓈ – TEMPERATURE COEFFICIENT
- Ⓣ AND/OR ⓉⓈ COLOR CODE MAY NOT BE PRESENT ON SOME CAPACITORS

COLOR	SIGNIFICANT FIGURES	RESISTORS(Ω)		CAPACITORS(pF)			DIPPED TANTALUM VOLTAGE RATING
		MULTIPLIER	TOLERANCE	MULTIPLIER	TOLERANCE		
					over 10 pF	under 10 pF	
BLACK	0	1	----	1	±20%	±2pF	4 VDC
BROWN	1	10	±1%	10	±1%	±0.1 pF	6 VDC
RED	2	10 ² or 100	±2%	10 ² or 100	±2%	----	10 VDC
ORANGE	3	10 ³ or 1 K	±3%	10 ³ or 1000	±3%	----	15 VDC
YELLOW	4	10 ⁴ or 10 K	±4%	10 ⁴ or 10,000	+100%–9%	----	20 VDC
GREEN	5	10 ⁵ or 100 K	±1/2%	10 ⁵ or 100,000	±5%	±0.5 pF	25 VDC
BLUE	6	10 ⁶ or 1 M	±1/4%	10 ⁶ or 1,000,000	----	----	35 VDC
VIOLET	7	----	±1/10%	----	----	----	50 VDC
GRAY	8	----	----	10 ⁻² or 0.01	+80%–20%	±0.25 pF	----
WHITE	9	----	----	10 ⁻¹ or 0.1	±10%	±1 pF	3 VDC
GOLD	—	10 ⁻¹ or 0.1	±5%	----	----	----	----
SILVER	—	10 ⁻² or 0.01	±10%	----	----	----	----
NONE	—	----	±20%	----	±10%	±1 pF	----

Figure 5-3. Color codes.



2374-20A

Figure 5-4. Semiconductor lead configuration.

CAPACITOR MARKINGS. The capacitance values of common disc capacitors and electrolytics are marked on the component body. Some ceramic capacitors used in the 442 are color coded in picofarads, using a modified EIA code (see Figure 5-3).

The dipped tantalum capacitors used in the 442 are color coded in microfarads (see Figure 5-3). The color dot indicates the positive lead and voltage rating. Be careful to observe the polarity and voltage rating, as capacitors are easily destroyed by reverse or over voltage.

DIODE COLOR CODE. The cathode end of each glass-encased diode is indicated by a stripe, a series of stripes, or a dot. For most silicon or germanium diodes with a series of stripes, the color code identifies the three significant digits of the Tektronix Part Number using the resistor color-code system (e.g., a diode color-coded pink or blue-, brown - gray - green indicates Tektronix Part Number 152-0185-00). The cathode and anode ends of metal-encased diodes can be identified by the diode symbol marked on the body.

POWER CORD CONDUCTOR IDENTIFICATION. Refer to Section 2, Operating Instructions, for color code information pertaining to power cords available for the 442.

SEMICONDUCTOR LEAD IDENTIFICATION. Refer to Figure 5-4 for lead identification for semiconductors used in the 442.

MULTI-PIN CONNECTOR HOLDER ORIENTATION. Small multi-pin connector holders are indexed with two triangles to identify pin 1. One triangle is located on the holder, and the matching one is located on the etched circuit board near pin 1 of the mating connector (see Figure 5-5).

Some large multi-pin connector holders are indexed with the trade name at the pin 1 end and pin 1 may or may not be marked on the circuit board. In some applications, the jack or plug number may be marked on the board near the pin 1 end.

Troubleshooting Equipment

Refer to Table 5-3 at the end of this section for a list of suggested equipment to use for troubleshooting the 442.

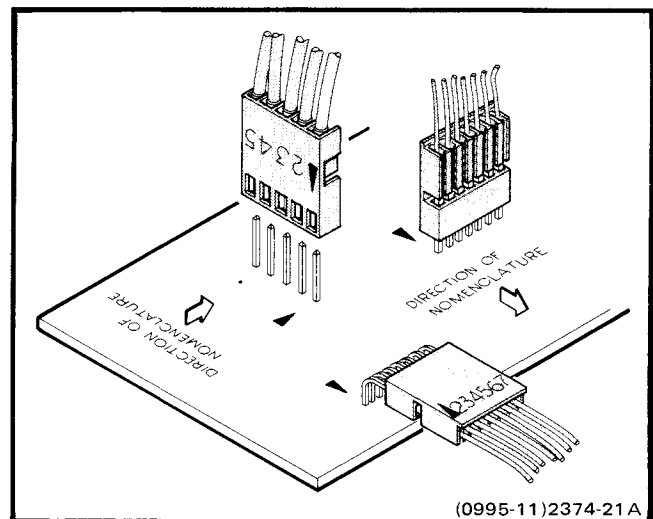


Figure 5-5. Multi-pin connector holder indexing.

Troubleshooting Techniques

This troubleshooting procedure is arranged in an order which checks the simple trouble possibilities before proceeding with extensive troubleshooting. The first few checks ensure proper connection, operation, and calibration. If the trouble is not located by these checks, the remaining steps will aid in locating the defective component. When the defective component is located, it should be replaced following the replacement procedure given under Corrective Maintenance.

1. CHECK CONTROL SETTINGS. Incorrect control settings can give a false indication of an instrument malfunction. If there is any question about the correct function or operation of any control, refer to the Operating Instructions section of this manual or the 442 Operators manual.

2. CHECK ASSOCIATED EQUIPMENT AND CONNECTIONS. Before proceeding with troubleshooting, check that the equipment used with this instrument is operating correctly. Check that the signal is properly connected and that the interconnecting cables are not defective. Also, check the power source (including the power cord and plug).

3. CHECK INSTRUMENT CALIBRATION. Check the calibration of this instrument, or the affected circuit if the trouble exists in one circuit. The apparent trouble may only be the result of misadjustment and may be corrected by proper adjustment. Complete adjustment instructions are given in the Calibration Procedure section of this manual.

4. VISUAL CHECK: Visually check the portion of the instrument in which the trouble is located. Many troubles can be located by visible indications such as unsoldered connections, broken wires, damaged circuit boards, damaged components, etc.

5. ISOLATE TROUBLE TO A CIRCUIT. To isolate trouble to a particular circuit, note the trouble symptom. The symptom often identifies the circuit in which 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 the power supplies, then check affected circuits by taking voltage and waveform readings. The power supplies are interdependent. All the low-voltage power supplies depend on the -8 volt supply for reference.

Table 5-1 lists outputs and tolerances of power supplies. Voltages are measured between power supply test points and ground. If a power supply voltage is within listed tolerance, assume the supply is operating correctly. A defective component elsewhere may appear as a power supply problem and may also affect operation of supporting circuitry.

Table 5-1

POWER SUPPLY TOLERANCE

Supply	Tolerance
-8 V	Set within 0.5%
+8 V	Within 3%
+100 V	Within 5%

Refer to the troubleshooting chart in the Diagrams section for help in isolating malfunctioning circuitry. However, not all problems are listed in the chart. Continue with this check list for cases not covered by the chart.

6. CHECK CIRCUIT BOARD INTERCONNECTIONS. After the trouble has been isolated to a particular circuit, check for loose or broken connections, improperly seated transistors, and heat-damaged components.

7. CHECK VOLTAGES AND WAVEFORMS. Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages are given on the diagrams. Waveforms are shown at the left of the circuit diagram.

NOTE

Voltages and waveforms given on the diagrams are not absolute and may vary slightly between instruments. Individual variations should be noted on the schematic diagrams for future reference. To obtain operating conditions similar to those used when the listed readings were taken, refer to the voltage and waveform setup procedures for each diagram. Note the recommended test signals, front panel control settings, and voltage and waveform conditions. The 442 control settings required to obtain the listed waveforms and voltages are located adjacent to the waveform illustrations.

8. CHECK INDIVIDUAL COMPONENTS. The following procedures describe methods of checking individual components. Components that are soldered in place are best checked by disconnecting one end. This isolates the measurement from the effects of surrounding circuitry.

WARNING

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

Semiconductors. A good check of transistor operation is actual performance under operating conditions. A transistor can be most effectively checked by substituting a new component for it (or one which has been checked previously). However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester. Static-type testers are not recommended, since they do not check operation under simulated operating conditions.

When troubleshooting transistors in the circuit with a voltmeter, measure the emitter-to-base and emitter-to-collector voltages to determine if the voltages are consistent with normal circuit voltage. Voltages across a transistor vary with the type of device and its circuit function. Some of these voltages are predictable. The emitter-to-base voltage of a conducting silicon transistor will normally be 0.6 to 0.8 volt. The emitter-to-collector voltage of saturated transistors is approximately 0.2 volt. Because these values are small, the best way to check them is by connecting the voltmeter across the junction and use a sensitive voltmeter setting. This method is preferable to comparing two voltages taken with respect to ground (both leads of the voltmeter must be isolated from ground, if this method is used). If values less than these are obtained, either the device is short-circuited or no current is flowing in the circuit. If values are in excess of the base-emitter voltages given, the junction is back-biased or the device is defective. Values in excess of those given for

emitter-collector voltages could indicate either a non-saturated device operating normally, or a defective (open-circuited) transistor. If the device is conducting, voltage will be developed across resistances in series with it; if it is open, no voltage will be developed across resistances in series with it unless current is being supplied by a parallel path.

When troubleshooting a field-effect transistor, the voltage across its elements can be checked in the same manner as for a transistor. However, it should be remembered that in the normal depletion mode of operation, the gate-to-source junction is reverse biased; in the enhanced mode, the junction is forward biased.

Integrated circuits (IC) can be checked with a voltmeter, test oscilloscope, or by direct substitution. A good understanding of circuit operation is essential to troubleshooting circuits using IC. Use care when checking voltages and waveforms around the IC so that adjacent leads are not shorted together. Typical semiconductor lead configurations are shown in Figure 5-4.

Diodes. A diode can be checked for an open or a short circuit by measuring the resistance between terminals with an ohmmeter set to the R X 1k scale. The diode resistance should be very high in one direction and very low when the meter leads are reversed. Do not check tunnel diodes or back diodes with an ohmmeter.



Do not use an ohmmeter scale that has a high internal current. High currents may damage the diode. Do not measure tunnel diodes with an ohmmeter; use a dynamic tester (such as a TEKTRONIX Type 576 Transistor-Curve Tracer). Checks on diodes can be performed in much the same manner as on transistor emitter-to-base junctions. Silicon diodes should have 0.6 to 0.8 volt across the junction when conducting. Higher readings indicate that they are either back biased or defective, depending on polarity.

To check other components—resistors, capacitors, and inductors—disconnect one end from the circuitry (see Soldering Techniques and Component Replacement in the Corrective Maintenance portion of this section. Especially note the material about machine inserted components.).

Resistors. Check resistors for discoloration. Then check them with an ohmmeter after disconnecting one end from the circuit. Refer to the Replaceable Electrical Parts list for tolerances of resistors used in this instrument.

Resistors normally do not need to be replaced unless the measured value varies widely from the specified value. The best check for thick film resistor networks is actual operation in the circuit.

Inductors. Check continuity of inductors with an ohmmeter to detect an open condition. (It may be necessary to disconnect one end of the inductor from the circuit to check continuity. Also, be aware that some inductors are wound on a resistive core and will present a resistive reading even when the inductive winding is open.) Shorted or partially shorted inductors can usually be detected by checking the waveform response when high-frequency signals are applied to 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 (set to the highest scale) after disconnecting one end from the circuit. Do not exceed the voltage rating of the capacitor (some ohmmeters use up to 30 volts as a source voltage). The resistance reading should be high after the 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 cam 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 cam 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.

9. REPAIR AND READJUST THE CIRCUIT. If any defective parts are located, follow the replacement procedures given under Corrective Maintenance in this section. Be sure to check the performance of any circuit that has been repaired or has had any components replaced. Readjustment of the affected circuit may be necessary. Refer to the Performance Check or Adjustment Procedure in the Calibration section of this manual.

Troubleshooting Hints

Power

SYMPTOM—No visible trace and no display when the BEAM FINDER button is pressed in (POWER ON LED is illuminated—if LED is not illuminated, check F700 and the +8 volt supply components).

a. Does a display or trace appear on the screen? If not, rotate the INTENSITY control clockwise while holding the BEAM FINDER button in until a trace appears or the control is fully clockwise. If a trace does not appear, suspect a malfunction in the power supplies (see Power Supply schematic diagram).

b. Check all low voltage power supplies, starting with the -8 volt supply (the -8 volt supply is the reference supply for the other low-voltage power supplies); then check the +8 volt and +100 volt supplies at their respective test points.

(1) If the -8 volt supply is low, check Q772, Q774, Q776, or U742. If the -8 volt supply reads zero, suspect a shorted load for the supply.

NOTE

If the -8 volt supply is not within specification, the other supplies will not meet their specifications.

(2) If the -8 volt supply is correct, but the +8 volt supply is low or zero, check Q752, Q754, Q756 and U742 (one section of U742 is used for the -8 volt supply and one section is used for the +8 volt supply).

c. Check the high voltage supplies (see Vertical Output, Crt, and Probe Adj schematic diagram).



Use a high voltage probe for measuring voltages in excess of 1000 volts dc.

(1) Check for -2 kilovolts at pin 1 of P465, or at pin 2 of the crt base socket.

(2) If the -2 kilovolt supply is low or zero, check for a 50 kHz sine wave (approximately 200 V, peak-to-peak) at pin 5 of T460 (primary winding of the high voltage transformer).

(3) If neither the -2 kV or a 50 kHz sine wave are present, check Q454, Q458, and Q446.



Do not short the secondary of the high-voltage transformer to ground as this could damage the transformer (T460).

Z-Axis

SYMPTOM—No intensity, or no control over intensity with BEAM FINDER button pressed in.

a. Does a trace appear on the screen? If not, and if the low and high voltage supplies are correct, the malfunction may be in the Z-axis circuit (see Vertical Output, Crt, and Probe Adj schematic diagram).

WARNING

The crt socket pins 2 and 3 in the following step have approximately 2 kilovolts applied to them.

(1) Check for approximately 60 volts swing between crt socket pins 2 and 3. If there is no voltage swing while rotating the INTENSITY control, the problem may be in the unblanking circuit.

(2) Check for a pulse at the emitter of Q416. The pulse amplitude should vary from 20 mV to 80 mV when the INTENSITY control is rotated from fully clockwise to fully counterclockwise.

(3) Check for a zero to 40 volt peak-to-peak unblanking pulse (varies with the setting of the INTENSITY control) at the collector of Q426.

(4) If there is no unblanking pulse present at any setting of the INTENSITY control, check Q426, Q424, Q416, and Q434.

Vertical

SYMPTOM 1—No trace on the crt screen, or vertical POSITION control does not center the display (see Vertical Switching or Vertical Output, Crt, and Probe Adj schematic diagrams).

a. If there is a trace on the screen but it can only be positioned about two divisions above or below the center horizontal graticule line, the vertical amplifier circuitry may be at fault.

b. Short plug pins P4-9 to P4-11 on the A8 Vertical board. If the trace still does not center vertically, the problem may be in the vertical output circuitry. Check Q112, Q122, Q134, Q144, Q136, and Q146.

c. If the trace is centered when P4-9 and P4-11 are shorted together, the trouble is ahead of P4.

d. Short the collector of Q4376 to the collector of Q4386. If the trace is centered, the trouble is ahead of Q4376 and Q4386 (the delay line drivers).

e. Check the voltage at the emitters of Q4344 and Q4346. Each should read approximately +5 volts with respect to ground. If the emitter voltages are correct, the trouble is either in Q4344, Q4346, or in the switching circuitry (shorted CR4356, CR4348, or open CR4346, for example).

SYMPTOM 2—With a 50 mV signal ac coupled to Channel 1 and Channel 1 VOLTS/DIV switch set to 10 m, the crt display does not position above the center horizontal graticule line.

a. If a trace does not appear on the screen, rotate the Channel 1 vertical POSITION control.

b. If a trace appears, but decreases in amplitude when it is positioned near the center horizontal graticule line, suspect a problem in the vertical output circuitry.

c. Short the collector of Q136 to the collector of Q146. If the trace is centered, next short the collector of Q112 to the collector of Q122. The trace should center. If not, suspect Q112, Q134, Q136 or associated circuitry.

Triggering

SYMPTOM 1—The trace free runs but will not trigger in AUTO or NORM MODE settings (see Trigger schematic diagram).

a. Set TRIGGERING MODE to AUTO. Rotate the LEVEL control fully clockwise and fully counterclockwise. Does the trace flicker? If not, the triggering signal is not reaching the sweep circuit.

b. Check the voltage at the junction of R2151-R2152-R2143. Does the voltage vary from -2 volts to +3 volts when the LEVEL control is rotated through its range? If it does, next check whether the U2156B output level varies when the LEVEL control is rotated.

c. Connect a signal to the Channel 1 input and check for a trigger pulse at the output of U2156B. If there is no pulse present, suspect U2156A, U2156B or associated circuitry.

SYMPTOM 2—Will not trigger when TRIGGERING MODE is set to AUTO (see Sweep and Horizontal Output schematic diagram).

a. Check for a trigger pulse at pin 6 of U2212B. If there is no pulse present, check for a HI at pin 4 of U2212B while rotating the LEVEL control. If pin 4 does not go HI, check for defective U2212B, U2224B or CR2227.

Sweep

SYMPTOM 1—No trace (sweep) on the crt screen (see Sweep and Horizontal Output schematic diagram).

a. Press the BEAM FINDER button in. If a trace or a dot appears at the right of the center vertical graticule line, check for a ramp signal approximately 12 volts in amplitude at the end of R2243 toward the center of the board.

b. If a ramp signal is not present, check for approximately 0.7 volt at the base of Q2274.

c. If the voltage at the base of Q2274 is high (approximately 8.0 volts), check Q2274, Q2242, Q2244, and Q2246 and associated circuitry.

SYMPTOM 2—No trace on the crt.

a. Repeat SYMPTOM 1, parts a and b.

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

Horizontal

SYMPTOM 1—No trace on crt screen (see Horizontal Output schematic diagram).

a. Check collectors of Q2334 and Q2344 for a ramp signal of approximately 40 volts amplitude (amplitude will vary with setting of Horizontal POSITION control). If ramp signals are correct, check for defective crt horizontal deflection plate leads or connectors.

Maintenance—442 Service

SYMPTOM 2—Trace is present on the crt screen, but the trace is too short.

a. Check collectors of Q2334 and Q2344 for a ramp signal of approximately 40 volts amplitude (amplitude will vary with setting of Horizontal POSITION control).

b. If there is no ramp signal at Q2334 or Q2344 collectors, check for a 12 volt ramp at the junction of R2243-R2311-C2246-R2245 (see Sweep and Horizontal Amplifier schematic diagram).

c. If a 12 volt ramp is present, check Q2332, Q2334, or Q2344 (see Horizontal Output schematic) and Q2314, Q2326 (see Sweep and Horizontal Amplifier schematic diagram).

CORRECTIVE MAINTENANCE

Introduction

Corrective maintenance consists of component replacement and instrument repair. Special techniques required to replace components in this instrument are given here.

Maintenance Precautions

To reduce the possibility of personal injury or instrument damage, observe the following precautions.

1. Disconnect the 442 from the power source before removing or installing components.
2. Use care not to interconnect instrument grounds, which may be at different potentials (cross grounding).
3. Do not use excessive heat when soldering. This can damage circuit boards and semiconductors.

Static-Sensitive Components



Static discharge can damage any semiconductor component in this instrument.

This instrument contains electrical components that are susceptible to damage from static discharge. See Relative Susceptibility table for various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following precautions to avoid damage.

1. Minimize handling of static-sensitive components.
2. Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.
3. Discharge the static voltage from your body by wearing a wrist strap while handling these components. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.
4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Keep the component leads shorted together whenever possible.
6. Pick up components by the body, never by the leads.
7. Do not slide the components over any surface.
8. Avoid handling components in areas that have a floor or work-surface covering capable of generating a static charge.
9. Use a soldering iron that is connected to earth ground.
10. Use only special antistatic suction type or wick type desoldering tools.

Table 5-2
RELATIVE SUSCEPTIBILITY TO
STATIC DISCHARGE DAMAGE

Semiconductor Classes	Relative Susceptibility Levels ^a
MOS or CMOS microcircuits or discretes, or linear microcircuits with MOS inputs (Most Sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETs	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (Least Sensitive)	9

^a Voltage equivalent for levels:

1 = 100 to 500 V 4 = 500 V 7 = 400 to 1000 V (est.)
 2 = 200 to 500 V 5 = 400 to 600 V 8 = 900 V
 3 = 250 V 6 = 600 to 800 V 9 = 1200 V
 (Voltage discharge from a 100 pF capacitor through a resistance of 100 ohms.)

Obtaining Replacement Parts

STANDARD PARTS. Most electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, you should be able to obtain many of the standard electronic components from a local commercial source in your area. Before you purchase or order a part from a source other than Tektronix, Inc., please check the Replaceable Electrical Parts list for the proper value, rating, tolerance and description.

NOTE

Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

SPECIAL PARTS. In addition to the standard electronic components, some special components are used in the 442. These components are manufactured or selected by Tektronix, Inc. to meet specific performance re-

quirements, or are manufactured for Tektronix, Inc. in accordance with our specifications (see Cross Index-Manufacturers Code Number to Manufacturer in the Replaceable Electrical Parts list for code numbers). Most of the mechanical parts used in this instrument have been manufactured by Tektronix, Inc. Order all special parts directly from your local Tektronix Field Office or representative.

ORDERING PARTS. When ordering replacement parts from Tektronix, Inc., it is imperative that all of the following information be included in order to ensure receiving the proper parts.

1. Instrument type (include modification or option numbers).
2. Instrument serial number.
3. A description of the part (if electrical, include the circuit number).
4. Tektronix part number.

Soldering Techniques

WARNING

To prevent electrical shock or damage to the 442, always disconnect it from the power source and allow approximately three minutes for the filter capacitors in the power supply to discharge before attempting to solder in the circuitry or replace components.

NOTE

Be sure you are familiar with soldering techniques and parts replacement procedures before replacing any electrical components in the 442.

Ordinary 60/40 solder and a 35- to 40-watt pencil-type soldering iron can be used to accomplish the majority of the soldering. If a higher wattage-rating soldering iron is used on the etched circuit boards, excessive heat can cause the etched circuit wiring to separate from the board base material.

If it becomes necessary to solder in the general area of any of the high-frequency contacts in the instrument, clean the contacts immediately upon completion of the soldering. Refer to the Switch Contacts paragraph in the Preventive Maintenance part of this section for recommended cleaners and procedures.

Maintenance—442 Service

Most components are located on one side of the board and are machine inserted with ends of leads bent over on the foil side of the board. It may be necessary to remove the board from the instrument to gain access to the foil side of the board for unsoldering leads from the foil. Circuit board removal and re-installation procedures are discussed later in this section. Attempts to unsolder, remove, and re-solder leads from the component side of the board may cause damage to the foil side of the board. Excess lead length protruding through the foil side of the board may cause shorting to other conductive parts. Clipping and re-soldering leads from the component side of the board may loosen the original solder bond on the foil side of the board, or damage the foil, unless adequate support and heat sinking is provided for the lead from the foil.

Fuse Replacement

The line voltage fuse, F700, is located in an externally accessible holder located on the back panel of the 442.

The high-voltage fuse, F722, is located on the A2 Power Supply board.

The unregulated + and -8 volt dc supplies are fused in two legs of the transformer secondary winding. These fuses (F742 and F743) are soldered to the A2 Power Supply board, and normally should not open unless the transformer secondary winding is physically shorted.

Refer to the Replaceable Electrical Parts list in this manual for all fuse values and descriptions.

Transistor and Integrated Circuit Replacement

Transistors and integrated circuits should not be replaced unless they are actually defective. If they are removed from their sockets during troubleshooting or routine maintenance, they should be returned to their original sockets. Unnecessary replacement or transposing of semiconductor devices may affect the calibration of the instrument. When it has been necessary to replace a semiconductor, the performance should be checked for that part of the instrument in which the replaced semiconductor is used.

Any replacement component should be of the original type or a direct replacement. Leads on the replacement component should be bent to fit the holes in the board and cut to the same length as the leads on the original component (refer to Figure 5-4 for Semiconductor Lead Identification).

WARNING

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

Some plastic case transistors have lead configurations that do not agree with those shown in Figure 5-4. If a replacement transistor is of a different manufacturer than the original, check that manufacturer's specifications for the correct basing. Most transistors in the 442 are soldered directly to the boards. Transistors with heat sinks or those mounted on the chassis require silicone grease to provide proper heat dissipation, and new silicone grease should be applied to all contact surfaces when these transistors are replaced. Most chassis mounted transistors in the 442 are secured with either metal clips or plastic screws (chassis-mounted power supply transistors are insulated from the chassis).

Reinstall the insulators and replace the silicone grease when replacing these transistors. The grease should be applied to both sides of the mica insulators and should be applied to the bottom side of the transistor, where it comes in contact with the insulator.

WARNING

Voltages are present on the exterior surface of the chassis-mounted power supply transistors if power is applied to the instrument and the POWER switch is on.

NOTE

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

Thick Film Resistor Replacement

To remove thick film resistor assemblies from the board, first remove all solder from the leads where they fasten to the board.

To install thick film resistor R118, match the index triangle on the board with the pin number 1 marking on the component body and insert the pins in the board holes; then re-solder the leads to the board. To install thick film resistor R445, match the pins on the component to the holes in the board, insert the pins in the holes and re-solder them to the board.

Interconnecting Cable and Pin Connector Replacement

Interconnecting cable assemblies are factory assembled with machine installed pin connectors (for individual leads or multi-lead assemblies mounted in plastic holders). Two types of multi-pin connectors are used in the 442, with different size holders.

If the larger multi-pin holder assemblies are damaged, the entire assembly should be replaced as a unit (refer to the Replaceable Mechanical Parts section for part numbers and ordering information).

The smaller multi-pin connector assemblies permit replacement of the individual wire/connector units in the holders, but the preferred method is to replace the entire assembly if a contact is damaged.

It is possible for the pin connectors to become dislodged from the smaller plastic holders. If this happens, refer to Figure 5-6 and the following steps for re-installation details:

NOTE

To provide correct indexing of the multi-pin connectors when they are re-connected to the matching pins on a circuit board, a triangular index mark is stamped on the circuit board. A matching index mark, the brand name, or the numeral 1 will be molded into the plastic housing of the connector to indicate pin 1. Be sure to match the index marks before re-installing the connectors. If the individual end-lead pin connectors are removed from the plastic holder, note the color of the insulation on the individual wires for reference when the connectors are re-installed in the holders.

1. Bend the slotted portion of the holder away from the wire leads as shown.

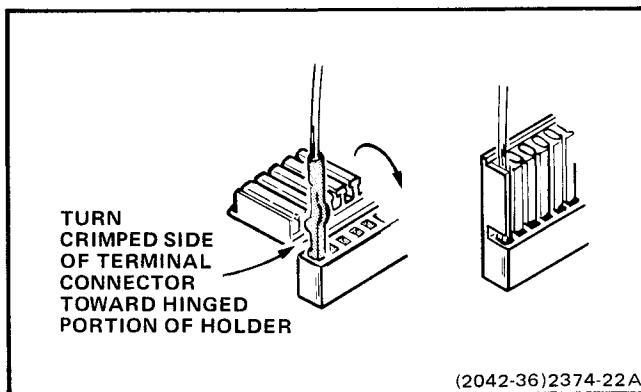


Figure 5-6. Pin connector re-installation in multi-pin holders.

2. Re-install the connector into the correct hole in the plug-in portion of the holder. Note color code on wire insulation to determine correct hole in the holder.

3. Bend the slotted portion of the holder back to its original position so connectors are captivated in the holder.

Readjustment After Repair

After any electrical component has been replaced, the adjustments for that particular circuit should be checked, as well as the adjustment of other closely related circuits. Since the power supply affects all circuits, adjustment of the entire instrument should be checked if work has been done in the power supply or if the transformer has been replaced.

Shaft/Knob Assembly Removal

The INTENSITY, Horizontal POSITION, LEVEL, and FOCUS shaft/knob assemblies are of a one-piece construction and can be removed or replaced as follows:

1. Grip the knob with one hand and the shaft with the other hand.
2. Pull on the knob while pushing on the shaft to free the recessed portion of the shaft from the panel retainer bushing (see Figure 5-7).

CAUTION

Some shaft/knobs may require considerable force to remove, and the bushing and shaft may separate abruptly. To avoid damage to the potentiometer and the circuit board, or personal injury, grip both pieces firmly during the shaft/knob removal. It may be helpful to grip the shaft with the tip of a pair of long-nose pliers and use a gentle rocking motion to separate the shaft/knob from the panel bushing and from the potentiometer shaft. Potentiometers with long mounting terminals can bend easily or damage the connections to the board, and therefore should be held firmly while the shaft/knob assembly is being disconnected from the potentiometer shaft.

Cam Switch Repair and Replacement

A cam switch is 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 that 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 that 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 (such as a cotton swab) that could snag the contact.*
- 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. While this may temporarily fix the problem, 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 it dry with low-pressure air. Isopropyl alcohol 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 Replaceable Mechanical Parts list for ordering information.

If a replacement contact strip assembly is not available, bend the contact for a temporary repair. If a contact must be bent, note its location and the symptom that required the bending, for reference if the contact fails again before a permanent repair can be made.

A6 and A7 Attenuator Removal

The following procedure is valid for removing the attenuator assembly for either channel. Place the instrument in the position shown in Figure 5-8 (temporarily reassemble the rear cabinet frame and four feet to the rear panel with the Phillips-head foot securing screws to support the 442).

NOTE

The attenuator assemblies may be removed before the A8 Vertical board is removed. However, the Vertical board may be removed without removing the attenuator assemblies from it (the VOLTS/DIV and VOLTS/DIV VAR knobs must be removed before either the attenuator assemblies or the Vertical board can be removed.

1. Remove the appropriate VOLTS/DIV and VAR knobs (use a 1/16" Allen wrench).
2. Use a Phillips screwdriver to remove the two screws that secure the small shield to the Channel 1 and Channel 2 attenuator shields. Set the small shield and screws aside.
3. Use a Phillips screwdriver to remove the two screws that secure the Channel 2 attenuator shield and the three screws that secure the Channel 1 shield (one screw head faces the crt shield).

4. Unsolder the two resistors and the wire from the VOLTS/DIV VAR potentiometer at the end of the attenuator chassis toward the back of the 442.

NOTE

For some serial numbers of the 442, the VOLTS/DIV VAR potentiometers may be mounted with their terminals connected directly to the Vertical board instead of with the bushing fastened to the attenuator chassis and electrical connections made to the Vertical board through resistors and wire leads. If terminals are connected directly to the Vertical board, use an Allen wrench to disconnect the coupling shaft from the VOLTS/DIV VAR potentiometer when removing the attenuator assembly.

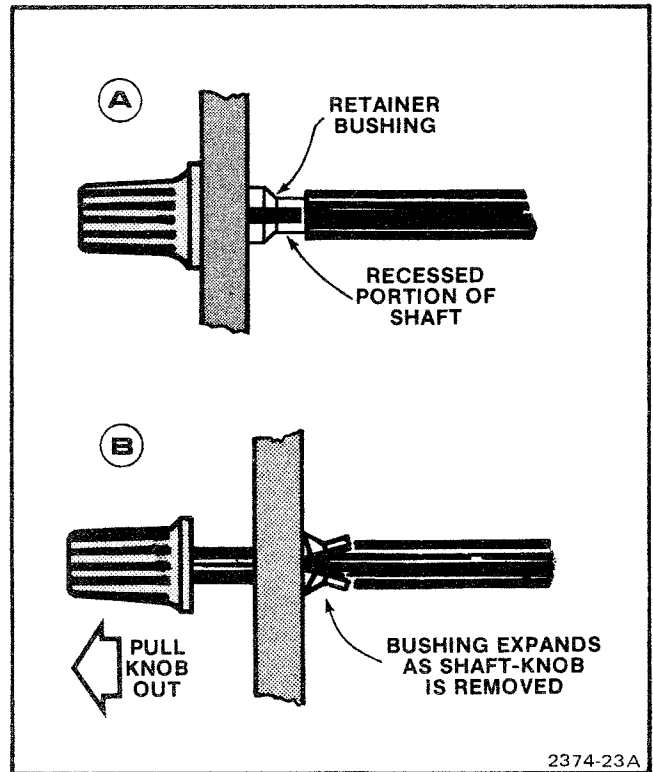


Figure 5-7. Shaft/knob assembly removal.

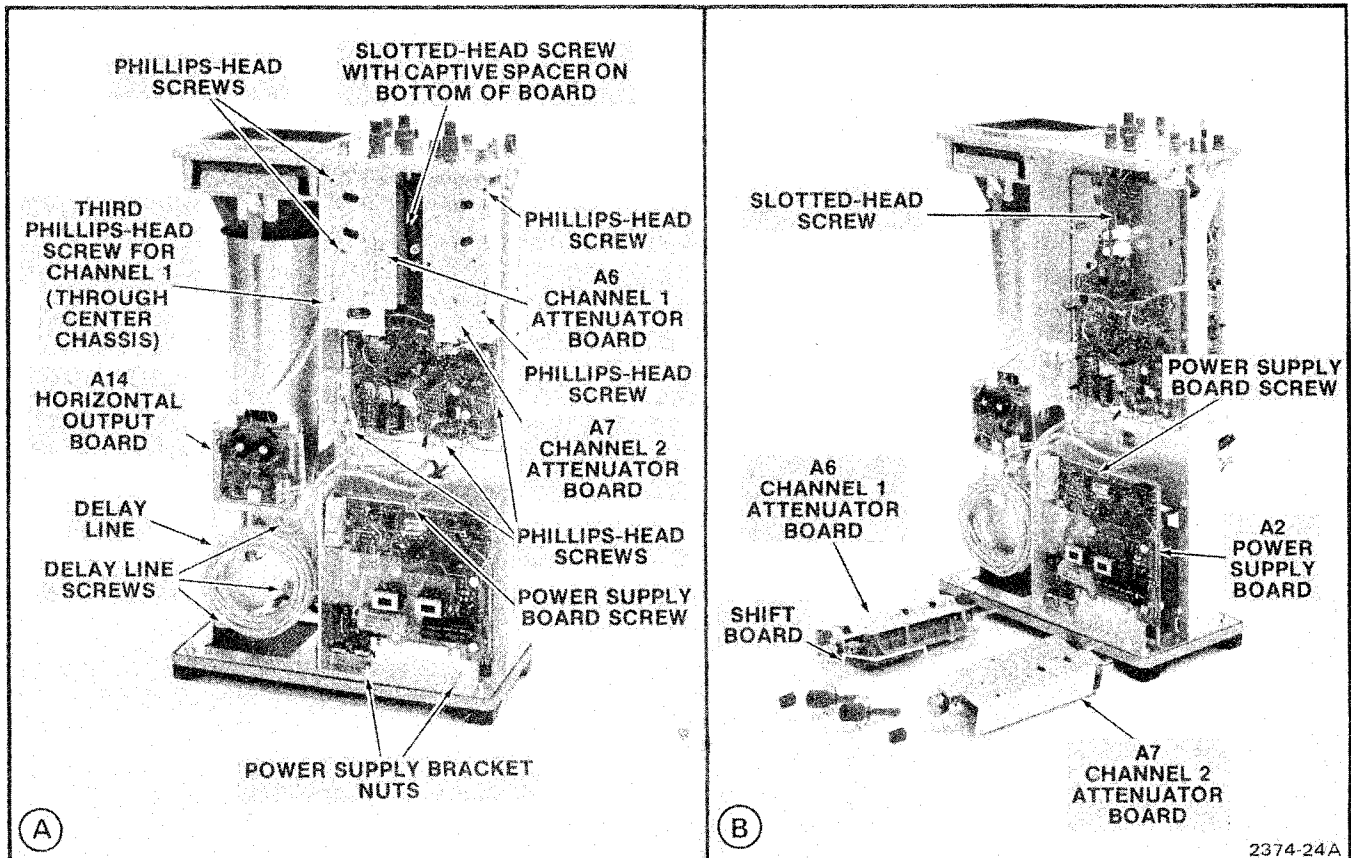


Figure 5-8. Attenuators, Attenuator Shift, Horizontal Output, and Power Supply assembly removal.

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5. Pull the attenuator assembly out away from the Vertical board to disengage the five pin connectors. Then carefully pull the attenuator assembly toward the back of the 442 so the input connector and the AC-GND-DC switch knob will clear the front panel openings while ensuring that the five inter-board connector pins do not get bent.

NOTE

The Channel 1 attenuator assembly employs an A5 Shift board to offset its connectors to the location where the connections are made to the Vertical board. After the Channel 1 attenuator assembly is removed from the Vertical board, the Shift board may be removed from the attenuator assembly by removing one Phillips-head screw (see Figure 5-8).

6. To re-install the attenuator assemblies and the Channel 1 Shift board, reassemble in reverse of the foregoing order. Exercise special care that all pin connectors are engaged without bending or breaking them.

Vertical POSITION Control Removal

To remove the vertical POSITION controls, first follow the foregoing procedure to remove at least one of the vertical attenuator assemblies to provide access to the POSITION controls. Then proceed as follows:

1. Remove the appropriate POSITION knob (use a 1/16" Allen wrench).
2. Remove the potentiometer securing nut (use a 5/16" hexagonal socket wrench).
3. Remove the potentiometer from the back of the front panel (note the lead or plug locations for reassembly reference) and unsolder the connecting leads or unplug the connector from the Vertical board.
4. To reinstall the POSITION control, reverse the order of the foregoing steps.

A8 Vertical Amplifier Board Removal

The attenuator assemblies may remain attached to the Vertical board while it is removed. If the attenuator assemblies are not removed first, they may be removed later by following the appropriate portions of the steps under A6 and A7 Attenuator Removal.

Remove the Vertical board as follows:

1. Use a 1/16" Allen wrench to remove all the VOLTS/DIV and VOLTS/DIV VAR knobs from their shafts.
2. Perform steps 2 and 3 under A6 and A7 Attenuator Removal.
3. Note locations for reassembly reference and disconnect all small and large connectors from the Vertical board.
4. Remove the four screws that secure the Vertical board to the 442 chassis. (Refer to Figure 5-8 for location of screws and board assemblies.)
5. The delay line leads may be left connected to the Vertical board and the delay line removed along with the board or the leads may be unsoldered from the board and the delay line left attached to the chassis. If the leads are to be unsoldered, note their positions for reassembly reference, unsolder the four leads, and remove the two screws to unfasten the delay line cable from the Vertical board (use a Phillips-head screwdriver; it may be necessary to partially raise the Vertical board away from the chassis and hold the nuts with a socket wrench or plier while unfastening these screws). If the delay line is to be left connected to the Vertical board, remove the three Phillips-head screws that secure the delay line assembly to the chassis.
6. Lift the Vertical board assembly toward the back and away from the 442 chassis. If the attenuator assemblies were left attached to the Vertical board, guide the input connectors, attenuator shafts, and AC-GND-DC switch knobs back out of the front panel openings. Make sure that all wires, cables, and connectors are free of the Vertical assembly as it is being removed.
7. If the attenuator assemblies and Shift board need to be removed and haven't already been removed, refer to A6 and A7 Attenuator Removal for instructions on completion of their removal from the Vertical board assembly.
8. To reinstall the Vertical assembly, reverse the order of the foregoing procedure.

A2 Power Supply Board Removal

Perform the following steps to remove the A2 Power Supply board (with the power transformer attached) from the 442:

1. Remove two nuts from the bolts that secure the power supply support bracket to the rear sub-panel. Remove the Phillips-head screw from the edge of the board toward the front of the 442 (see Figure 5-8 for location of these items).
2. Remove the two nuts that secure the power transformer to the support bracket that attaches to the chassis bracket. These nuts are accessible from the top of the 442 near the outside edge of the A1 Interface board (opposite side from the Power Supply board). See Figure 5-9.
3. Disconnect P7 (large multi-pin connector plug) from the Power Supply board, and lift the power supply assembly (including the power transformer) out of the 442.
4. To reinstall the power supply assembly, reverse the order of the foregoing procedure.

A14 Horizontal Output Board Removal

Remove the Horizontal Output board as follows:

1. Disconnect single-wire connectors P2334 and P2344 from the board pins and multi-pin connector P2332 from its board pins (see Figure 5-8).
2. Remove the four Phillips-head screws that secure the board to the rear crt bracket.
3. To reinstall the Horizontal Output board, reverse the order of the foregoing procedure.

Delay Line Removal

Remove the Delay Line as follows:

1. Remove the three Phillips-head screws that secure the Delay Line tie-down straps to the rear crt bracket (see Figure 5-8).
2. Remove the two screws that secure the delay line cable end clamps to the Vertical board (it may be necessary to partially or fully remove the Vertical board in order to hold the nuts while removing these two screws, see A8 Vertical Amplifier Board Removal).

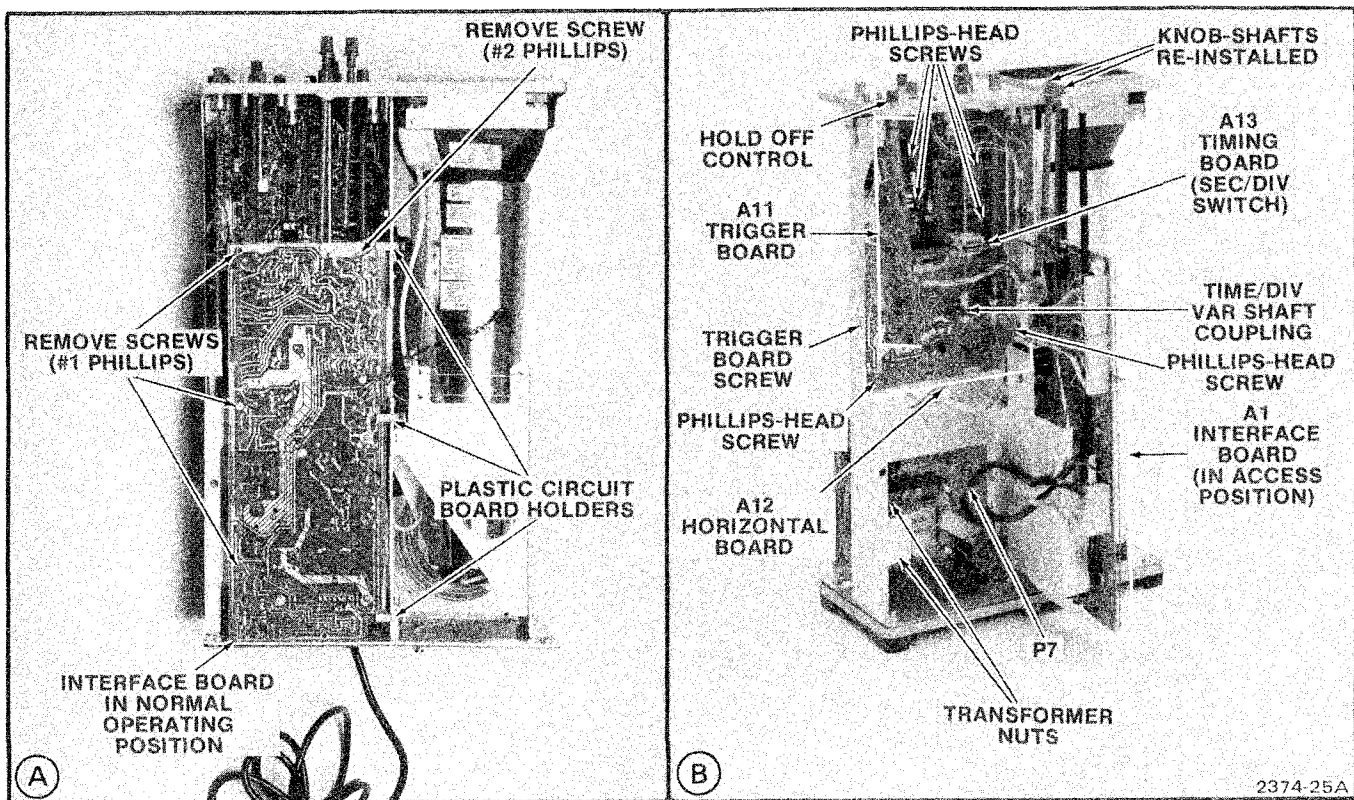


Figure 5-9. Interface, Trigger Switch, Horizontal, and Timing (SEC/DIV switch) assemblies removal.

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3. Note their locations for reassembly reference, and unsolder the four delay line leads from the A8 Vertical board.
4. To reinstall the Delay Line, reverse the order of the foregoing procedure.

If the Interface board is to be completely removed from the 442, proceed with the following steps:

5. Remove the two plastic shields that cover the foil side of the Interface board (two Phillips-head screws in each shield). Unsolder the leads from the fuse holder and power cord where they are soldered to the board near the ON/OFF switch, S700. Remove four screws from the High Voltage Caution shield and remove the shield.

WARNING

A1 Interface Board Removal

The Interface board assembly should be moved to the service and adjustment access position as the first step in preparing it for removal from the 442. Moving it to the access position also allows access for removal of the A12 Horizontal board. Remove the Interface board as follows:

1. Remove the FOCUS and INTENSITY shaft/knob assemblies by disconnecting them from the potentiometer shafts and sliding them out through the front panel openings.
2. Use #1 and #2 Phillips-bit screwdrivers to remove the four Interface board mounting screws indicated in Figure 5-9A and slide the board edge out of the three plastic circuit board holders that support the edge of the board nearest the crt shield.
3. Slide the Interface board toward the rear of the 442 to clear the BEAM FINDER and ON/OFF push button/shaft assemblies from the front panel openings.
4. Place the Interface board in the access position (90° from the original normal operation position) by sliding the edge of the board into the second set of slots in the three plastic circuit board holders described in Step 2 (see Figure 5-9B). Ensure that cables and wires connecting to the board are clear of other components while the board is being moved from one position to the other, and that no interconnecting plugs or pin connectors have loosened during the transition (important if the instrument is to be operated with the Interface board in the access position rather than removing the board completely from the 442). To operate the 442 with the Interface board in the access position, re-install the FOCUS and INTENSITY shaft/knob assemblies on the potentiometer shafts.

The crt anode and the output terminal of the high voltage multiplier (U460) may retain a 10,000 volt charge after the 442 is turned off. To avoid electrical shock, ground both the output terminal of U460 and the crt high-voltage anode lead to chassis ground.

6. Disconnect all large and small connectors from the Interface assembly (note locations for reassembly reference).
7. Using one hand (keep the other hand clear of the instrument), unplug the high-voltage anode lead from the output terminal of U460 and ground the terminal and the lead to chassis.
8. Slide the Interface board out of the three plastic circuit board holders.
9. To re-install the Interface board assembly, reverse the order of the foregoing steps.

A11 Trigger Switch Board Removal

To remove the Trigger board from the 442, first move the Interface board to the access position (see A1 Interface Board Removal), then proceed as follows:

1. Disconnect P2270 from the A12 Horizontal board (wires from the HOLD OFF control). Remove the HOLD OFF potentiometer from the front panel by loosening the knob set screw with a 1/16" Allen wrench, remove the knob, then remove the potentiometer securing nut with a 5/16" socket wrench.
2. Remove the Phillips-head screw that secures the Trigger board to the side chassis member (see Figure 5-9).

3. Unsolder or unplug all cables and wires that connect from the Trigger board to other assemblies (note locations for re-assembly reference).
4. Disconnect fixed connector P2100 on the Trigger board from J2100 on the Horizontal board by carefully lifting the Trigger board away from the Horizontal board; then lift the Trigger board toward the back of the 442 so the switch knobs clear the front panel openings.
5. To re-install the Trigger board and HOLD OFF control, reverse the order of the foregoing steps.

A12 Horizontal Board Removal

To remove the Horizontal board from the 442, first move the Interface board to the access position (see A1 Interface Board Removal). Then remove the Trigger Switch board from the 442 (see A11 Trigger Switch Board Removal). With that accomplished, proceed as follows:

1. Use a 1/16" Allen wrench to remove the SEC/DIV and SEC/DIV VAR knobs. Disconnect the LEVEL and Horizontal POSITION shaft/knob assemblies from the potentiometer shafts and remove the shaft/knob assemblies out through the front panel openings.
2. Disconnect all single and multi-pin connectors from either the Horizontal board or the board where the connector attaches (depending on which end has soldered connections). Note the location of these connections for re-assembly reference.
3. Remove the six Phillips-head screws that secure the Horizontal board to the 442 chassis (see Figure 5-9).
4. Guide the Horizontal board away from the front panel and chassis so the control buttons and shafts clear the front panel openings.
5. To re-install the Horizontal board, reverse the order of the foregoing steps.

A13 Timing Board (SEC/DIV Switch) Removal

The Timing board is plugged into two connectors on the A12 Horizontal board. To remove the Timing board, first move the Interface board to the access position (see A1 Interface Board Removal), then proceed as follows:

1. Disconnect the Horizontal POSITION shaft/knob assembly from the potentiometer shaft and pull the assembly far enough out through the front panel opening to clear the hole in the Timing board.
2. Use an Allen wrench to disconnect the SEC/DIV VAR shaft from the coupling that fastens it to the potentiometer and pull the SEC/DIV VAR knob to remove the shaft out from the SEC/DIV shaft.
3. Use a 1/16" Allen wrench to remove the SEC/DIV knob.
4. Lift the Timing board away from the Horizontal board and toward the back of the 442 so it disconnects from the two connectors and the SEC/DIV shaft clears the front panel opening.
5. To re-install the Timing board, reverse the order of the foregoing steps.

Cathode Ray Tube (crt) Removal

WARNING

Use care when handling a cathode ray tube. Protective clothing and safety glasses should be worn. Avoid striking the cathode ray tube on any object that could cause it to crack or implode. When storing a cathode ray tube, place it in a protective carton or set it face down on a smooth surface in a protective location with a soft mat under the faceplate to protect it from scratches.

To remove the crt, temporarily reassemble the rear cabinet frame and four feet to the rear panel with the Phillips-head foot securing screws. Position the 442 with the crt faceplate facing upward and the chassis supported by the rear feet. Rotate the instrument as required in the following steps and proceed as follows:

1. Move the Interface board to the access position (see A1 Interface Board Removal).
2. Disconnect the socket from the crt base.

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3. Remove the High Voltage Caution shield (four Phillips-head screws) from the Interface board.

WARNING

The crt anode and the output terminal of high-voltage multiplier U460 may retain a 10,000 volt charge after the instrument is turned off. To avoid electrical shock, ground both the output terminal of U460 and the crt high-voltage anode lead to chassis ground.

4. Ground the U460 high voltage multiplier output terminal and the crt anode lead to chassis ground. Disconnect the anode lead from the U460 output terminal. Dress the anode lead so it will clear all chassis parts and can be removed along with the crt and shield assembly in the following steps.

NOTE

In the following steps 5 through 8, make a note of all wire color codes, connection location and connector orientation, for re-assembly reference.

5. Disconnect the horizontal deflection plate pin connectors from the crt neck pins.
6. Disconnect both ends of the vertical deflection plate lead pin connectors (from the crt neck pins and from the Interface board at P138 and P148).
7. Disconnect P470 (four pins, two separate 2-pin plugs) from the Interface board.
8. Disconnect P2332 from the A14 Horizontal Output board (the A14 board will be removed from the instrument along with the crt and shield assembly in the following steps).
9. Remove the three screws that secure the delay line tie-down straps to the rear crt bracket (see Figure 5-8). Lay the delay line so it will clear the crt shield.
10. Remove the four screws that secure the rear crt bracket to the chassis near the crt base.
11. Support the crt shield assembly while removing the two screws that secure the crt front support plastic mounting bracket to the inside of the 442 front panel casting. These two screws are the ones closest to the bottom of the crt graticule. The two screws nearest the top of the crt graticule may be left in place.
12. Slide the plastic support bracket slightly in the direction of the bottom of the crt graticule to release the plastic support bracket from the lip on the metal clip (bracket) near the top of the crt graticule.
13. Slide the crt shield assembly toward the back of the 442; then tilt the neck support bracket toward the bottom of the 442 and tilt the crt faceplate end of the shield toward the top of the 442. Next, slide the entire crt and shield assembly away from the 442 chassis in the direction of the bottom of the instrument.
14. Carefully slide the crt and anode lead forward out of the shield. Note orientation of the anode lead (top right corner) and ground spring contact (bottom front) for re-assembly reference.
15. To re-install the crt in the shield assembly, carefully slide the crt and anode lead into the shield and guide the crt so the base passes freely through the trace rotation coil.
16. To re-install the crt and shield assembly in the 442, reverse the order of the foregoing steps.

CAUTION

Before using any test equipment to make measurements on static-sensitive components or assemblies, be certain that any voltage or current supplied by the test equipment does not exceed the limits of the component to be tested.

The following maintenance aids include items required for some maintenance procedures in this instrument. Equivalent products may be substituted for examples given providing characteristics are similar.

Table 5-3
MAINTENANCE AIDS

Equipment	Minimum Specification	Usage	Example
1. Semiconductor Tester	Dynamic type tester. Measures reverse breakdown voltages up to at least 400 V.	Test Semiconductors.	a. TEKTRONIX 576 Curve Tracer. b. TEKTRONIX 577 (D1 or D2) Curve Tracer with 177 Test Fixture
2. Test Oscilloscope with 10X voltage probe	Frequency response, dc to at least 15 MHz; deflection factor, 5 mV to 5 V/div; input impedance, 1M Ω , 30 pF; sweep rate, 0.5 s to 0.2 μ s/div.	Check operating waveforms. 10X probe required to reduce circuit loading when measuring waveforms or voltages.	TEKTRONIX T921 Oscilloscope with included 10X probe
3. Multimeter	Digital multimeter. Voltmeter input impedance, 10 M Ω ; range 0 to 150 volts; voltage accuracy, within 0.15%; display, 3 1/2 digits; Ohmmeter, 0 to 20 M Ω .	Check voltages below 1 kV and general troubleshooting. Use with a High Voltage probe for voltages above 1 kV.	TEKTRONIX DM 502A Digital Multimeter ^a
4. High Voltage probe	Dc voltage range, 1 kV to at least 3 kV; Accuracy, 1%; Impedance and connectors to match the digital multimeter.	Check voltages in crt circuit in excess of 1 kV. (not for 10 kV anode voltage measurement, which requires a non-loading voltmeter).	TEKTRONIX Part No. 010-0277-00
5. Variable Auto-transformer	Variable from 0 to 140 V at 1.2 A. With 3-wire power cord, plug, and receptacle.	Vary input line voltage when troubleshooting the power supply.	General Radio W8MT3VM or W10MT3W Metered Variac Autotransformer
6. Soldering Iron	15 watt	General soldering and unsoldering.	ANTEX PRECISION Model C
7. Screwdriver	Phillips #1 tip	General	Xcelite Model X108
8. Screwdriver	Phillips #2 tip	Assembly and disassembly	Xcelite Model X102
9. Screwdriver	Three-inch shaft; 3/32" flat bit	General	Xcelite R3323
10. Nutdriver	5/16"	Front panel control nuts	Xcelite #10
11. Open End Wrench	5/16"	Transformer nuts	
12. Allen Wrenches	1/16", 0.050", 5/32"	Assembly and disassembly	
13. Solder Wick		Unsoldering	Hex Wik #887-10

^a Requires a TM 500-Series power module.

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
000DN	FUSES UNLIMITED	9740 COZYCRAFT AVENUE	CHATSWORTH, CA 91311
00213	NYTRONICS, COMPONENTS GROUP, INC., SUBSIDIARY OF NYTRONICS, INC.	ORANGE STREET	DARLINGTON, SC 29532
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
02735	RCA CORPORATION, SOLID STATE DIVISION	ROUTE 202	SOMERVILLE, NY 08876
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
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
11237	CTS KEENE, INC.	3230 RIVERSIDE AVE.	PASO ROBLES, CA 93446
12697	CLAROSTAT MFG. CO., INC.	LOWER WASHINGTON STREET	DOVER, NH 03820
14193	CAL-R, INC.	1601 OLYMPIC BLVD.	SANTA MONICA, CA 90404
14433	ITT SEMICONDUCTORS	3301 ELECTRONICS WAY P O BOX 3049	WEST PALM BEACH, FL 33402
15454	RODAN INDUSTRIES, INC.	2905 BLUE STAR ST.	ANAHEIM, CA 92806
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
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
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
27264	MOLEX PRODUCTS CO.	5224 KATRINE AVE.	DOWNERS GROVE, IL 60515
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
50157	MIDWEST COMPONENTS INC.	P. O. BOX 787 1981 PORT CITY BLVD.	MUSKEGON, MI 49443
50437	RELIANCE STEEL PRODUCTS COMPANY	3700 WALNUT STREET	MCKEESPORT, PA 15132
51406	MURATA CORPORATION OF AMERICA	2 WESTCHESTER PLAZA	ELMSFORD, NY 10523
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	670-5349-00	B010100	B011417	CKT BOARD ASSY:INTERFACE	80009	670-5349-00
A1	670-5349-01	B011418		CKT BOARD ASSY:INTERFACE	80009	670-5349-01
A2	670-5251-00	B010100	B021816	CKT BOARD ASSY:POWER SUPPLY	80009	670-5251-00
A2	670-5251-02	B021817	B022729	CKT BOARD ASSY:POWER SUPPLY	80009	670-5251-02
A2	670-5251-04	B022730	B022914	CKT BOARD ASSY:POWER SUPPLY	80009	670-5251-04
A2	670-5251-05	B022915		CKT BOARD ASSY:POWER SUPPLY	80009	670-5251-05
A5	670-5249-00			CKT BOARD ASSY:ATTENUATOR SHIFT	80009	670-5249-00
A6	670-3972-04	B010100	B021448	CKT BOARD ASSY:ATTENUATOR CHANNEL 1	80009	670-3972-04
A6	670-3972-06	B021449		CKT BOARD ASSY:ATTENUATOR CHANNEL 1	80009	670-3972-06
A7	670-3973-04	B010100	B022090	CKT BOARD ASSY:ATTENUATOR CHANNEL 2	80009	670-3973-04
A7	670-3973-06	B022091		CKT BOARD ASSY:ATTENUATOR CHANNEL 2	80009	670-3973-06
A8	670-5247-00	B010100	B010815	CKT BOARD ASSY:VERTICAL	80009	670-5247-00
A8	670-5247-01	B010816	B022163	CKT BOARD ASSY:VERTICAL	80009	670-5247-01
A8	670-5247-02	B022164		CKT BOARD ASSY:VERTICAL	80009	670-5247-02
A11	670-5248-00	B010100	B022473	CKT BOARD ASSY:TRIGGER	80009	670-5248-00
A11	670-5248-01	B022744		CKT BOARD ASSY:TRIGGER	80009	670-5248-01
A12	670-5350-00	B010100	B010885	CKT BOARD ASSY:HORIZONTAL	80009	670-5350-00
A12	670-5350-01	B010886	B022572	CKT BOARD ASSY:HORIZONTAL	80009	670-5350-01
A12	670-5350-02	B022573		CKT BOARD ASSY:HORIZONTAL	80009	670-5350-02
A13	263-0051-00			SWITCH, ROTARY: PANCAKE, TIME/DIVISION	80009	263-0051-00
A14	670-5386-00			CKT BOARD ASSY:HORIZONTAL OUTPUT	80009	670-5386-00
C24	281-0773-00			CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C113	281-0505-00	XB010409		CAP., FXD, CER DI:12PF, +/-1.2PF, 500V	72982	301-012C0G0120K
C114	281-0207-00			CAP., VAR, PLSTC:2-18PF, 100V	80031	2807C00218MH02F0
C115	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8121N08325U0224M
C118	281-0619-00	XB011418		CAP., FXD, CER DI:1.2PF, +/-0.1PF, 200V	72982	374000C0K0129B
C119	281-0768-00			CAP., FXD, CER DI:470PF, 20%, 100V	72982	8035D9AADW5R471M
C124	281-0762-00	B010100	B010408X	CAP., FXD, CER DI:27PF, 20%, 100V	72982	8035D9AADCOG270M
C129	281-0768-00			CAP., FXD, CER DI:470PF, 20%, 100V	72982	8035D9AADW5R471M
C412	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C423	281-0661-00	B010100	B010408X	CAP., FXD, CER DI:0.8PF, +/-0.1PF, 500V	72982	301-000C0K0808B
C424	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
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
C445	281-0775-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C455	281-0773-00	B010100	B010159	CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C455	281-0772-00	B010160		CAP., FXD, CER DI:0.0047UF, 10%, 100V	72982	8005H9AADW5R472K
C458	290-0405-00			CAP., FXD, ELCTLT:10UF, +50-10%, 150V	56289	30D106F150DD4
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	283-0404-00			CAP., FXD, CER DI:0.01UF, 20%, 4KV	51406	DHR2825U103M1KV
C466	283-0404-00			CAP., FXD, CER DI:0.01UF, 20%, 4KV	51406	DHR2825U103M1KV
C467	283-0271-00	XB010160		CAP., FXD, CER DI:0.001UF, 20%, 4000V	56289	33C325
C476	281-0773-00			CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C477	281-0773-00			CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C478	281-0773-00			CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C722	290-0750-00			CAP., FXD, ELCTLT:100UF, +50-10%, 160V	56289	D76244
C723	281-0511-00	XB022915		CAP., FXD, CER DI:22PF, +/-2.2PF, 500V	72982	301-000C0G0220K
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

Replaceable Electrical Parts—442 Service

Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
C758	290-0107-00		CAP., FXD, ELCTLT: 25UF, +75-10%, 25V	56289	30D256G025DB9
C762	290-0301-00	XB010409	CAP., FXD, ELCTLT: 10UF, 10%, 20V	56289	150D106X9020B2
C763	281-0773-00		CAP., FXD, CER DI: 0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C764	281-0773-00	XB022730	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	290-0107-00		CAP., FXD, ELCTLT: 25UF, +75-10%, 25V	56289	30D256G025DB9
C802	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C817	281-0773-00		CAP., FXD, CER DI: 0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C2001	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2005	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2010	281-0534-00		CAP., FXD, CER DI: 3.3PF, +/-0.25PF, 500V	72982	301-000C0J0339C
C2011	281-0792-00		CAP., FXD, CER DI: 82PF, 10%, 100V	72982	8035D2AADCOG820K
C2013	281-0759-00		CAP., FXD, CER DI: 22PF, 10%, 100V	72982	8035D9AADC1G220K
C2014	281-0797-00		CAP., FXD, CER DI: 15PF, 10%, 100V	72982	8035D9AADCOG150K
C2019	281-0773-00		CAP., FXD, CER DI: 0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C2023	281-0814-00		CAP., FXD, CER DI: 100PF, 10%, 100V	04222	GC70-1-A101K
C2025	281-0814-00	XB010409	CAP., FXD, CER DI: 100PF, 10%, 100V	04222	GC70-1-A101K
C2030	283-0004-00		CAP., FXD, CER DI: 0.02UF, +80-20%, 150V	72982	855-558Z5V0203Z
C2033	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2034	290-0517-00		CAP., FXD, ELCTLT: 6.8UF, 20%, 35V	56289	196D685X0035KA1
C2035	281-0797-00		CAP., FXD, CER DI: 15PF, 10%, 100V	72982	8035D9AADCOG150K
C2063	281-0763-00		CAP., FXD, CER DI: 47PF, 10%, 100V	72982	8035D9AADC1G470K
C2090	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2091	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2092	290-0517-00		CAP., FXD, ELCTLT: 6.8UF, 20%, 35V	56289	196D685X0035KA1
C2123	290-0517-00		CAP., FXD, ELCTLT: 6.8UF, 20%, 35V	56289	196D685X0035KA1
C2124	281-0773-00		CAP., FXD, CER DI: 0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C2125	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2128	281-0773-00		CAP., FXD, CER DI: 0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C2144	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2149	290-0183-00		CAP., FXD, ELCTLT: 1UF, 10%, 35V	90201	TAE105K035P1A
C2156	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2162	290-0135-00		CAP., FXD, ELCTLT: 15UF, 20%, 20V	56289	150D156X0020B2
C2163	281-0763-00		CAP., FXD, CER DI: 47PF, 10%, 100V	72982	8035D9AADC1G470K
C2166	290-0183-00		CAP., FXD, ELCTLT: 1UF, 10%, 35V	90201	TAE105K035P1A
C2171	290-0183-00		CAP., FXD, ELCTLT: 1UF, 10%, 35V	90201	TAE105K035P1A
C2174	281-0773-00		CAP., FXD, CER DI: 0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C2175	283-0081-00		CAP., FXD, CER DI: 0.1UF, +80-20%, 25V	56289	36C600
C2176	281-0774-00		CAP., FXD, CER DI: 0.022UF, 20%, 100V	72982	8045A9ABDZ5U223M
C2181	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2212	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
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	281-0122-00		CAP., VAR, CER DI: 2.5-9PF, 100V	72982	518-000A2.5-9
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	281-0579-00	XB022573	CAP., FXD, CER DI: 21PF, 5%, 500V	72982	301-050C0G0210J
C2252	295-0179-00		CAP., SET, MTCHD: 0.01UF, 1.0UF, 1%	80009	295-0179-00
C2274	281-0772-00		CAP., FXD, CER DI: 0.0047UF, 10%, 100V	72982	8005H9AADW5R472K
C2275	290-0167-00	B010100 B011358	CAP., FXD, ELCTLT: 10UF, 20%, 15V	56289	150D106X0015B2
C2275	290-0415-00	B011359	CAP., FXD, ELCTLT: 5.6UF, 10%, 35V	56289	150D565X9035B2
C2276	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2278	281-0758-00		CAP., FXD, CER DI: 15PF, 20%, 100V	72982	314022COG0150M
C2317	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2322	281-0619-00		CAP., FXD, CER DI: 1.2PF, +/-0.1PF, 200V	72982	374000C0K0129B
C2325	281-0775-00		CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C2327	281-0775-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C2337	290-0480-00			CAP., FXD, ELCTLT: 0.5UF, +50-10%, 200V	80009	290-0480-00
C2398	283-0212-00			CAP., FXD, CER DI: 2UF, 20%, 50V	72982	8141N064Z5U205M
C2399	283-0212-00			CAP., FXD, CER DI: 2UF, 20%, 50V	72982	8141N064Z5U205M
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			CAP., VAR, CER DI: 0.5-3PF, 400V	80031	2502A0R503VP02F0
C4115	281-0610-00			CAP., FXD, CER DI: 2.2PF, +/-0.1PF, 500V	72982	374001C0J0229B
C4116	281-0759-00			CAP., FXD, CER DI: 22PF, 10%, 100V	72982	8035D9AADC1G220K
C4122	283-0002-00			CAP., FXD, CER DI: 0.01UF, +80-20%, 500V	72982	811-546E103Z
C4131	283-0198-00			CAP., FXD, CER DI: 0.22UF, 20%, 50V	72982	8121N083Z5U0224M
C4143	281-0763-00			CAP., FXD, CER DI: 47PF, 10%, 100V	72982	8035D9AADC1G470K
C4155	281-0204-00	B010100	B010408X	CAP., VAR, PLSTC: 2-22PF, 100V	80031	287C00222MJ02
C4155	281-0204-00	XB022164		CAP., VAR, PLSTC: 2-22PF, 100V	80031	287C00222MJ02
C4156	281-0546-00	B010100	B010408	CAP., FXD, CER DI: 330PF, 10%, 500V	04222	7001-1380
C4156	281-0543-00	B010409		CAP., FXD, CER DI: 270PF, 10%, 500V	72982	301055X5P271K
C4158	281-0788-00			CAP., FXD, CER DI: 470PF, 10%, 100V	72982	8005H9AADW5R471K
C4166	283-0119-00			CAP., FXD, CER DI: 2200PF, 5%, 200V	72982	855-535B222J
C4168	281-0788-00			CAP., FXD, CER DI: 470PF, 10%, 100V	72982	8005H9AADW5R471K
C4177	281-0788-00			CAP., FXD, CER DI: 470PF, 10%, 100V	72982	8005H9AADW5R471K
C4187	281-0788-00			CAP., FXD, CER DI: 470PF, 10%, 100V	72982	8005H9AADW5R471K
C4196	281-0762-00	B010100	B010119	CAP., FXD, CER DI: 27PF, 20%, 100V	72982	8035D9AADC0G270M
C4196	281-0763-00	B010120		CAP., FXD, CER DI: 47PF, 10%, 100V	72982	8035D9AADC1G470K
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			CAP., VAR, CER DI: 0.5-3PF, 400V	80031	2502A0R503VP02F0
C4215	281-0610-00			CAP., FXD, CER DI: 2.2PF, +/-0.1PF, 500V	72982	374001C0J0229B
C4216	281-0759-00			CAP., FXD, CER DI: 22PF, 10%, 100V	72982	8035D9AADC1G220K
C4222	283-0002-00			CAP., FXD, CER DI: 0.01UF, +80-20%, 500V	72982	811-546E103Z
C4231	283-0198-00			CAP., FXD, CER DI: 0.22UF, 20%, 50V	72982	8121N083Z5U0224M
C4243	281-0763-00	B010100	B010159	CAP., FXD, CER DI: 47PF, 10%, 100V	72982	8035D9AADC1G470K
C4243	281-0792-00	B010160		CAP., FXD, CER DI: 82PF, 10%, 100V	72982	8035D2AADC0G820K
C4255	281-0204-00	XB010409	B022163X	CAP., VAR, PLSTC: 2-22PF, 100V	80031	287C00222MJ02
C4256	281-0546-00	B010100	B010408	CAP., FXD, CER DI: 330PF, 10%, 500V	04222	7001-1380
C4256	281-0543-00	B010409		CAP., FXD, CER DI: 270PF, 10%, 500V	72982	301055X5P271K
C4258	281-0788-00			CAP., FXD, CER DI: 470PF, 10%, 100V	72982	8005H9AADW5R471K
C4266	283-0119-00			CAP., FXD, CER DI: 2200PF, 5%, 200V	72982	855-535B222J
C4268	281-0788-00			CAP., FXD, CER DI: 470PF, 10%, 100V	72982	8005H9AADW5R471K
C4277	281-0788-00			CAP., FXD, CER DI: 470PF, 10%, 100V	72982	8005H9AADW5R471K
C4287	281-0788-00			CAP., FXD, CER DI: 470PF, 10%, 100V	72982	8005H9AADW5R471K
C4296	281-0762-00	B010100	B010119	CAP., FXD, CER DI: 27PF, 20%, 100V	72982	8035D9AADC0G270M
C4296	281-0763-00	B010120		CAP., FXD, CER DI: 47PF, 10%, 100V	72982	8035D9AADC1G470K
C4302	281-0763-00			CAP., FXD, CER DI: 47PF, 10%, 100V	72982	8035D9AADC1G470K
C4306	281-0775-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M
C4307	281-0763-00			CAP., FXD, CER DI: 47PF, 10%, 100V	72982	8035D9AADC1G470K
C4308	281-0763-00			CAP., FXD, CER DI: 47PF, 10%, 100V	72982	8035D9AADC1G470K
C4312	281-0773-00			CAP., FXD, CER DI: 0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C4315	281-0770-00			CAP., FXD, CER DI: 0.001UF, 20%, 100V	72982	8035D9AADX5R102M
C4324	281-0775-00			CAP., FXD, CER DI: 0.1UF, 20%, 50V	72982	8005D9AABZ5U104M

Replaceable Electrical Parts—442 Service

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
C4331	281-0773-00			CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C4332	281-0773-00			CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C4334	281-0773-00			CAP., FXD, CER DI:0.01UF, 10%, 100V	72982	8005H9AADW5R103K
C4339	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8121N083Z5U0224M
C4355	281-0786-00			CAP., FXD, CER DI:150PF, 10%, 100V	72982	8035D2AADX5P151K
C4368	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C4375	281-0788-00	B010100	B010408X	CAP., FXD, CER DI:470PF, 10%, 100V	72982	8005H9AADW5R471K
C4378	281-0762-00			CAP., FXD, CER DI:27PF, 20%, 100V	72982	8035D9AADCOG270M
C4385	281-0788-00	B010100	B010408X	CAP., FXD, CER DI:470PF, 10%, 100V	72982	8005H9AADW5R471K
C4386	283-0111-00			CAP., FXD, CER DI:0.1UF, 20%, 50V	72982	8121-N088Z5U104M
C4388	281-0762-00			CAP., FXD, CER DI:27PF, 20%, 100V	72982	8035D9AADCOG270M
C4389	281-0811-00	XB010120		CAP., FXD, CER DI:10PF, 10%, 100V	72982	8035D2AADC1G100K
C4395	281-0511-00			CAP., FXD, CER DI:22PF, +/-2.2PF, 500V	72982	301-000COG0220K
C4396	281-0207-00			CAP., VAR, PLSTC:2-18PF, 100V	80031	2807C00218MH02F0
C4397	281-0207-00			CAP., VAR, PLSTC:2-18PF, 100V	80031	2807C00218MH02F0
C4398	281-0786-00			CAP., FXD, CER DI:150PF, 10%, 100V	72982	8035D2AADX5P151K
C4410	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	56289	273C5
C4411	290-0517-00			CAP., FXD, ELCTLT:6.8UF, 20%, 35V	56289	196D685X0035KA1
C4412	283-0198-00			CAP., FXD, CER DI:0.22UF, 20%, 50V	72982	8121N083Z5U0224M
C4413	290-0517-00			CAP., FXD, ELCTLT:6.8UF, 20%, 35V	56289	196D685X0035KA1
C4416	290-0517-00			CAP., FXD, ELCTLT:6.8UF, 20%, 35V	56289	196D685X0035KA1
C4417	283-0177-00			CAP., FXD, CER DI:1UF, +80-20%, 25V	56289	273C5
CR26	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR27	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR113	152-0269-00			SEMICON D DEVICE:SILICON, VAR VCAP., 4V, 33PF	80009	152-0269-00
CR123	152-0269-00			SEMICON D DEVICE:SILICON, VAR VCAP., 4V, 33PF	80009	152-0269-00
CR416	152-0075-00			SEMICON D DEVICE:GE, 25V, 40MA	14433	G866
CR418	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR437	152-0061-00			SEMICON D DEVICE:SILICON, 175V, 100MA	07263	FDH2161
CR443	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR463	152-0639-00			SEMICON D DEVICE:RECT, SI, 10KV, 10MA	80009	152-0639-00
CR465	152-0639-00			SEMICON D DEVICE:RECT, SI, 10KV, 10MA	80009	152-0639-00
CR466	152-0066-03	XB011194		SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR721	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR722	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR723	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR724	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR732	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR734	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR737	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR738	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR741	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR742	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR743	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR744	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR758	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR764	152-0141-02	B010100	B022729X	SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR765	152-0141-02	B010100	B022729X	SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR766	152-0141-02	B010100	B022729X	SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR767	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR778	152-0066-03			SEMICON D DEVICE:RECT, SI, 400V, 1A	80009	152-0066-03
CR816	152-0061-00			SEMICON D DEVICE:SILICON, 175V, 100MA	07263	FDH2161
CR2001	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR2002	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR2005	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR2006	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R
CR2024	152-0141-02			SEMICON D DEVICE:SILICON, 30V, 50NA	01295	1N4152R

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
CR2025	152-0141-02	XB010409		SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2032	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2036	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2063	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2181	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2182	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2183	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2186	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2227	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2233	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2234	152-0245-00			SEMICON D DEVICE: SILICON, 10NA AT 5V	80009	152-0245-00
CR2317	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2326	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2331	152-0075-00			SEMICON D DEVICE: GE, 25V, 40MA	14433	G866
CR2332	152-0075-00			SEMICON D DEVICE: GE, 25V, 40MA	14433	G866
CR2334	152-0574-00			SEMICON D DEVICE: SILICON, 120V, 0.15A	80009	152-0574-00
CR2342	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR2356	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4122	152-0246-00	B010100	B010408	SEMICON D DEVICE: SW, SI, 40V, 200MA	03508	DE140
CR4122	152-0324-00	B010409		SEMICON D DEVICE: SILICON, 35V, 100MA	03508	DE103
CR4222	152-0246-00	B010100	B010408	SEMICON D DEVICE: SW, SI, 40V, 200MA	03508	DE140
CR4222	152-0324-00	B010409		SEMICON D DEVICE: SILICON, 35V, 100MA	03508	DE103
CR4323	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4324	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4326	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4328	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4331	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4332	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4335	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4336	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4346	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4347	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4348	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4349	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4356	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4357	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4358	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
CR4359	152-0141-02			SEMICON D DEVICE: SILICON, 30V, 50NA	01295	1N4152R
DL4380	119-0954-00			DELAY LINE, ELEC: 120NS, 150 OHM	80009	119-0954-00
DS169	150-1017-00			LT EMITTING DIO: GREEN, 550NM, 55MA MAX	50437	LSM-16L-100
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)
F700	159-0042-00			FUSE, CARTRIDGE: 3AG, 0.75A, 250V, FAST-BLOW	71400	AGC 3/4
	-----			(FOR 90 TO 132V OPERATION)		
F700	159-0029-00			FUSE, CARTRIDGE: 3AG, 0.3A, 250V, SLOW-BLOW	71400	MDL3/10
	-----			(FOR 198 TO 240V OPERATION)		
F722	159-0051-00			FUSE, CARTRIDGE: 3AG, 0.062A, 250V, 20 SEC	71400	MDL1-16
F742	159-0059-00	B010100	B010379	FUSE, WIRE LEAD: 5A, FAST-BLOW	71400	GFA5
F742	159-0153-00	B010380		FUSE, WIRE LEAD: 1.5A, 125V, FAST BLOW	000DN	BUSSGFA 11/2
F743	159-0059-00	B010100	B010379	FUSE, WIRE LEAD: 5A, FAST-BLOW	71400	GFA5
F743	159-0153-00	B010380		FUSE, WIRE LEAD: 1.5A, 125V, FAST BLOW	000DN	BUSSGFA 11/2
J2	131-2116-00			CONN, RCPT, ELEC: FD-THRU, 12 MALE, GOLD PLATED	27264	09-70-1129
J4	131-2116-00			CONN, RCPT, ELEC: FD-THRU, 12 MALE, GOLD PLATED	27264	09-70-1129
J7	131-2115-00			CONN, RCPT, ELEC: FD-THRU, 10 MALE, TIN PLATED	27264	09-64-1129
J2100	131-1802-00			CONNECTOR, RCPT, :15 CONTACTS	05574	000201-4831

Replaceable Electrical Parts—442 Service

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
J2250	131-1801-00			CONNECTOR, RCPT, :9 CONTACTS	05574	000201-4832
J2260	131-1802-00			CONNECTOR, RCPT, :15 CONTACTS	05574	000201-4831
J4200	131-2116-00			CONN, RCPT, ELEC: FD-THRU, 12 MALE, GOLD PLATED	27264	09-70-1129
L470	108-0819-00			COIL, TUBE DEFLE: X-Y ALIGNMENT	80009	108-0819-00
L472	108-0818-00			COIL, TUBE DEFLE: TRACE ROTATION	80009	108-0818-00
Q112	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q122	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q134	151-0127-00			TRANSISTOR: SILICON, NPN	07263	S006075
Q136	151-0127-00			TRANSISTOR: SILICON, NPN	07263	S006075
Q144	151-0127-00			TRANSISTOR: SILICON, NPN	07263	S006075
Q146	151-0127-00			TRANSISTOR: SILICON, NPN	07263	S006075
Q416	151-0190-01			TRANSISTOR: SILICON, NPN	80009	151-0190-01
Q424	151-0190-01			TRANSISTOR: SILICON, NPN	80009	151-0190-01
Q426	151-0347-00			TRANSISTOR: SILICON, NPN	04713	SPS7951
Q434	151-0350-00			TRANSISTOR: SILICON, PNP	04713	SPS6700
Q446	151-0126-00			TRANSISTOR: SILICON, NPN	04713	2N2484
Q454	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q458	151-0423-00	B010100	B010159	TRANSISTOR: SILICON, NPN	01295	EP2970
Q458	151-0358-00	B010160	B011276	TRANSISTOR: SILICON, NPN, SEL FROM D44R4	80009	151-0358-00
Q458	151-0423-01	B011277		TRANSISTOR: SILICON, NPN, PRESTRESSED	80009	151-0423-01
Q722	151-0347-00			TRANSISTOR: SILICON, NPN	04713	SPS7951
Q726	151-0347-00			TRANSISTOR: SILICON, NPN	04713	SPS7951
Q734	151-0347-00			TRANSISTOR: SILICON, NPN	04713	SPS7951
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
Q812	151-0497-00			TRANSISTOR: SILICON, NPN	01295	TIP47
Q2020	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q2028	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q2032A, B	151-1042-00			SEMICON DVC SE: MATCHED PAIR FET	27014	SF50031
Q2038	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q2050	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q2054	151-0190-01			TRANSISTOR: SILICON, NPN	80009	151-0190-01
Q2058	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q2122	151-0224-02			TRANSISTOR: SILICON, NPN, PRESTRESSED	80009	151-0224-02
Q2124	151-0224-02			TRANSISTOR: SILICON, NPN, PRESTRESSED	80009	151-0224-02
Q2128	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q2134	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q2136	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q2142	151-0224-02			TRANSISTOR: SILICON, NPN, PRESTRESSED	80009	151-0224-02
Q2144	151-0224-02			TRANSISTOR: SILICON, NPN, PRESTRESSED	80009	151-0224-02
Q2152	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q2164	151-0190-01			TRANSISTOR: SILICON, NPN	80009	151-0190-01
Q2174	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q2176	151-0216-00			TRANSISTOR: SILICON, PNP	04713	SPS8803
Q2242	151-1042-00			SEMICON DVC SE: MATCHED PAIR FET	27014	SF50031
Q2244						
Q2246	151-0190-01			TRANSISTOR: SILICON, NPN	80009	151-0190-01
Q2274	151-0190-01			TRANSISTOR: SILICON, NPN	80009	151-0190-01
Q2312	151-1022-00			TRANSISTOR: SILICON, JFE, SEL FROM 2N4392	80009	151-1022-00
Q2314	151-0192-00			TRANSISTOR: SILICON, NPN, SEL FROM MPS6521	04713	SPS8801
Q2326	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
Q2332	151-0188-00			TRANSISTOR: SILICON, PNP	04713	SPS6868K
Q2334	151-0124-00			TRANSISTOR: SILICON, NPN, SEL FROM 2N3501	04713	SM8138
Q2344	151-0124-00			TRANSISTOR: SILICON, NPN, SEL FROM 2N3501	04713	SM8138
Q2354	151-0190-01			TRANSISTOR: SILICON, NPN	80009	151-0190-01
Q4122	151-1032-00			TRANSISTOR: SILICON, FET, DUAL	80009	151-1032-00
Q4132	151-0198-03			TRANSISTOR: SILICON, NPN, MATCHED	80009	151-0198-03
Q4134						
Q4158	151-0198-03			TRANSISTOR: SILICON, NPN, MATCHED	80009	151-0198-03
Q4168						
Q4174	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q4176	151-0427-00			TRANSISTOR: SILICON, NPN	80009	151-0427-00
Q4184	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q4186	151-0427-00			TRANSISTOR: SILICON, NPN	80009	151-0427-00
Q4194	151-0198-00			TRANSISTOR: SILICON, NPN, SEL FROM MPS918	80009	151-0198-00
Q4196	151-0198-00			TRANSISTOR: SILICON, NPN, SEL FROM MPS918	80009	151-0198-00
Q4222	151-1032-00			TRANSISTOR: SILICON, FET, DUAL	80009	151-1032-00
Q4232	151-0198-03			TRANSISTOR: SILICON, NPN, MATCHED	80009	151-0198-03
Q4234						
Q4258	151-0198-03			TRANSISTOR: SILICON, NPN, MATCHED	80009	151-0198-03
Q4268						
Q4274	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q4276	151-0427-00			TRANSISTOR: SILICON, NPN	80009	151-0427-00
Q4284	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q4286	151-0427-00			TRANSISTOR: SILICON, NPN	80009	151-0427-00
Q4294	151-0198-00			TRANSISTOR: SILICON, NPN, SEL FROM MPS918	80009	151-0198-00
Q4296	151-0198-00			TRANSISTOR: SILICON, NPN, SEL FROM MPS918	80009	151-0198-00
Q4302	151-0223-00			TRANSISTOR: SILICON, NPN	04713	SPS8026
Q4344	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q4346	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q4350	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q4352	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q4354	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q4356	151-0199-00			TRANSISTOR: SILICON, PNP	04713	SPS6866K
Q4376	151-0434-00			TRANSISTOR: SILICON, PNP	04713	SS7144
Q4386	151-0434-00			TRANSISTOR: SILICON, PNP	04713	SS7144
Q4388	151-0190-01	B010100	B010159	TRANSISTOR: SILICON, NPN	80009	151-0190-01
Q4388	151-0224-02	B010160		TRANSISTOR: SILICON, NPN, PRESTRESSED	80009	151-0224-02
R22	315-0134-00			RES., FXD, CMPSN: 130K OHM, 5%, 0.25W	01121	CB1345
R23	315-0434-00			RES., FXD, CMPSN: 430K OHM, 5%, 0.25W	01121	CB4345
R24	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R25	315-0222-00			RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R26	321-0235-00			RES., FXD, FILM: 2.74K OHM, 1%, 0.125W	91637	MFF1816G27400F
R27	321-0126-00			RES., FXD, FILM: 200 OHM, 1%, 0.125W	91637	MFF1816G200R0F
R112	321-0085-00			RES., FXD, FILM: 75 OHM, 1%, 0.125W	91637	MFF1816G75R00F
R113	321-0078-00			RES., FXD, FILM: 63.4 OHM, 1%, 0.125W	91637	MFF1816G63R40F
R114	311-1563-00			RES., VAR, NONWIR: 1K OHM, 20%, 0.50W	73138	91-85-0
R115	315-0153-00			RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R116	321-0163-00			RES., FXD, FILM: 487 OHM, 1%, 0.125W	91637	MFF1816G487R0F
R117	315-0272-00			RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W	01121	CB2725
R118	307-0494-00			RES, NTWK, FXD, FI: THICK FILM, VERT OUTPUT	80009	307-0494-00
R120	315-0563-00			RES., FXD, CMPSN: 56K OHM, 5%, 0.25W	01121	CB5635
R122	321-0085-00			RES., FXD, FILM: 75 OHM, 1%, 0.125W	91637	MFF1816G75R00F
R124	315-0560-00	B010100	B010408X	RES., FXD, CMPSN: 56 OHM, 5%, 0.25W	01121	CB5605
R126	311-1559-00			RES., VAR, NONWIR: 10K OHM, 20%, 0.50W	73138	91-81-0
R169	315-0201-00	B010100	B011417X	RES., FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015
R412	311-1786-00			RES., VAR, NONWIR: 2K OHM, 20%, 2W	12697	381-CM40946

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R413	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R414	315-0332-00			RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R416	315-0302-00			RES.,FXD,CMPSN:3K OHM,5%,0.25W	01121	CB3025
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	315-0222-00			RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
R433	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R434	315-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R435	315-0360-00			RES.,FXD,CMPSN:36 OHM,5%,0.25W	01121	CB3605
R437	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R443	315-0204-00			RES.,FXD,CMPSN:200K OHM,5%,0.25W	01121	CB2045
R444	307-0495-01			RES,NTWK,FXD,FI:NETWORK,HV,NON STORAGE	80009	307-0495-01
R445	315-0103-00	B010100	B010159	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R445	315-0202-00	B010160		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
R446	315-0103-00	B010100	B010159	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R446	315-0332-00	B010160		RES.,FXD,CMPSN:3.3K OHM,5%,0.25W	01121	CB3325
R447	315-0683-00			RES.,FXD,CMPSN:68K OHM,5%,0.25W	01121	CB6835
R453	315-0102-00	B010100	B010159	RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
R453	315-0151-00	B010160		RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R455	315-0512-00			RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
R457	315-0431-00			RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
R458	308-0218-00			RES.,FXD,WW:150 OHM,5%,3W	00213	1240S-150-5
R462	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
R463	315-0105-00	B010100	B011417	RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R463	315-0684-00	B011418		RES.,FXD,CMPSN:680K OHM,5%,0.25W	01121	CB6845
R464	315-0226-00	B010100	B010408X	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	307-0375-00	XB010409		RES.,FXD,FILM:100M OHM	80009	307-0375-00
R467	315-0205-00	XB010160		RES.,FXD,CMPSN:2M OHM,5%,0.25W	01121	CB2055
R468	311-1784-00			RES.,VAR,NONWIR:5M OHM,20%,1W	12697	381-CM40944
R472	311-0086-00			RES.,VAR,NONWIR:2.5K OHM,20%,0.50W	01121	W-7699
R473	311-1555-00			RES.,VAR,NONWIR:100K OHM,20%,0.5W	73138	91-77-0
R474	311-1562-00			RES.,VAR,NONWIR:2K OHM,20%,0.50W	73138	91-84-0
R475	315-0154-00			RES.,FXD,CMPSN:150K OHM,5%,0.25W	01121	CB1545
R476	315-0333-00			RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
R477	311-1200-00			RES.,VAR,NONWIR:100K OHM,20%,0.50W	01121	W-7861
R478	315-0471-00			RES.,FXD,CMPSN:470 OHM,5%,0.25W	01121	CB4715
R722	301-0473-00			RES.,FXD,CMPSN:47K OHM,5%,0.50W	01121	EB4735
R726	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
R732	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R733	321-0368-00			RES.,FXD,FILM:66.5K OHM,1%,0.125W	91637	MFF1816G66501F
R734	308-0574-00			RES.,FXD,WW:10 OHM,5%,2W	91637	RS2B162K10R00J
R736	321-0385-00			RES.,FXD,FILM:100K OHM,1%,0.125W	91637	MFF1816G10002F
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	321-0239-00			RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
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

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
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	321-0239-00	B010100	B010849	RES., FXD, FILM: 3.01K OHM, 1%, 0.125W	91637	MFF1816G30100F
R764	321-0285-00	B010850		RES., FXD, FILM: 9.09K OHM, 1%, 0.125W	91637	MFF1816G90900F
R765	321-0130-00	B010100	B010849	RES., FXD, FILM: 221 OHM, 1%, 0.125W	91637	MFF1816G221R0F
R765	321-0176-00	B010850		RES., FXD, FILM: 665 OHM, 1%, 0.125W	91637	MFF1816G665R0F
R766	301-0391-00	B010100	B010849	RES., FXD, CMPSN: 390 OHM, 5%, 0.50W	01121	EB3915
R766	301-0561-00	B010850		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	91-85-0
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
R802	315-0152-00			RES., FXD, CMPSN: 1.5K OHM, 5%, 0.25W	01121	CB1525
R811	315-0621-00	XB011418		RES., FXD, CMPSN: 620 OHM, 5%, 0.25W	01121	CB6215
R817	308-0298-00			RES., FXD, WW: 560 OHM, 5%, 3W	91637	CW2B-B560R0J
R818	315-0223-00			RES., FXD, CMPSN: 22K OHM, 5%, 0.25W	01121	CB2235
R2000	315-0150-00	XB010120		RES., FXD, CMPSN: 15 OHM, 5%, 0.25W	01121	CB1505
R2001	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R2005	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R2006	311-1564-00			RES., VAR, NONWIR: TRMR, 500 OHM, 0.5W	73138	91-86-0
R2007	321-0175-00			RES., FXD, FILM: 649 OHM, 1%, 0.125W	91637	MFF1816G649R0F
R2008	315-0360-00	XB010120		RES., FXD, CMPSN: 36 OHM, 5%, 0.25W	01121	CB3605
R2009	317-0150-00			RES., FXD, CMPSN: 15 OHM, 5%, 0.125W	01121	BB1505
R2010	322-0524-01			RES., FXD, FILM: 2.8M OHM, 0.5%, 0.25W	91637	HFF143G28003D
R2011	321-0389-00			RES., FXD, FILM: 110K OHM, 1%, 0.125W	91637	MFF1816G11002F
R2013	321-0481-00			RES., FXD, FILM: 1M OHM, 1%, 0.125W	24546	NA4D1004F
R2014	321-0481-00			RES., FXD, FILM: 1M OHM, 1%, 0.125W	24546	NA4D1004F
R2021	321-0150-00			RES., FXD, FILM: 357 OHM, 1%, 0.125W	91637	MFF1816G357R0F
R2022	321-0201-00			RES., FXD, FILM: 1.21K OHM, 1%, 0.125W	91637	MFF1816G12100F
R2023	321-0193-00			RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
R2024	321-0229-00			RES., FXD, FILM: 2.37K OHM, 1%, 0.125W	91637	MFF1816G23700F
R2025	315-0104-00	XB010409		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R2026	321-0220-00	B010100	B021648	RES., FXD, FILM: 1.91K OHM, 1%, 0.125W	91637	MFF1816G19100F
R2026	321-0213-00	B021649		RES., FXD, FILM: 1.62K OHM, 1%, 0.125W	91637	MFF1816G16200F
R2027	311-1563-00	B010100	B021648	RES., VAR, NONWIR: 1K OHM, 20%, 0.50W	73138	91-85-0
R2027	311-1749-00	B021649		RES., VAR, NONWIR: TRMR, 1.5K OHM, 0.75W	73138	91-97-0
R2028	315-0162-00			RES., FXD, CMPSN: 1.6K OHM, 5%, 0.25W	01121	CB1625
R2029	315-0104-00	XB010409		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R2030	321-0481-00			RES., FXD, FILM: 1M OHM, 1%, 0.125W	24546	NA4D1004F
R2032	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R2033	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R2034	315-0270-00			RES., FXD, CMPSN: 27 OHM, 5%, 0.25W	01121	CB2705
R2035	315-0202-00			RES., FXD, CMPSN: 2K OHM, 5%, 0.25W	01121	CB2025
R2036	315-0242-00			RES., FXD, CMPSN: 2.4K OHM, 5%, 0.25W	01121	CB2425
R2037	315-0301-00	B010100	B010119	RES., FXD, CMPSN: 300 OHM, 5%, 0.25W	01121	CB3015
R2037	315-0241-00	B010120		RES., FXD, CMPSN: 240 OHM, 5%, 0.25W	01121	CB2415
R2038	321-0234-00			RES., FXD, FILM: 2.67K OHM, 1%, 0.125W	91637	MFF1816G26700F
R2039	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R2048	321-0161-00			RES., FXD, FILM: 464 OHM, 1%, 0.125W	91637	MFF1816G464R0F
R2049	321-0226-00			RES., FXD, FILM: 2.21K OHM, 1%, 0.125W	91637	MFF1816G22100F
R2050	321-0193-00			RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
R2051	311-1566-00			RES., VAR, NONWIR: 200 OHM, 20%, 0.50W	73138	91-88-0
R2052	321-0162-00			RES., FXD, FILM: 475 OHM, 1%, 0.125W	91637	MFF1816G475R0F
R2053	321-0213-00			RES., FXD, FILM: 1.62K OHM, 1%, 0.125W	91637	MFF1816G16200F
R2055	321-0251-00			RES., FXD, FILM: 4.02K OHM, 1%, 0.125W	91637	MFF1816G40200F
R2057	315-0102-00			RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
R2060	321-0149-00		RES., FXD, FILM: 348 OHM, 1%, 0.125W	91637	MFF1816G348ROF
R2061	321-0068-00		RES., FXD, FILM: 49.9 OHM, 1%, 0.125W	91637	MFF1816G49R9OF
R2062	311-1565-00		RES., VAR, NONWIR: 250 OHM, 20%, 0.50W	73138	91-87-0
R2063	321-0251-00		RES., FXD, FILM: 4.02K OHM, 1%, 0.125W	91637	MFF1816G40200F
R2065	321-0214-00		RES., FXD, FILM: 1.65K OHM, 1%, 0.125W	91637	MFF1816G16500F
R2092	315-0270-00		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W	01121	CB2705
R2116	321-0641-00		RES., FXD, FILM: 1.8K OHM, 1%, 0.125W	91637	MFF1816G18000F
R2118	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R2120	-----		(SEE R2164 LISTING)		
R2121	321-0182-00		RES., FXD, FILM: 768 OHM, 1%, 0.125W	91637	MFF1816G768ROF
R2122	315-0270-00		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W	01121	CB2705
R2123	315-0270-00		RES., FXD, CMPSN: 27 OHM, 5%, 0.25W	01121	CB2705
R2124	321-0249-00		RES., FXD, FILM: 3.83K OHM, 1%, 0.125W	91637	MFF1816G38300F
R2125	321-0181-00		RES., FXD, FILM: 750 OHM, 1%, 0.125W	91637	MFF1816G750ROF
R2126	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R2127	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
R2128	321-0193-00		RES., FXD, FILM: 1K OHM, 1%, 0.125W	91637	MFF1816G10000F
R2131	315-0221-00		RES., FXD, CMPSN: 220 OHM, 5%, 0.25W	01121	CB2215
R2132	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R2133	323-0346-00		RES., FXD, FILM: 39.2K OHM, 1%, 0.50W	75042	CECT0-3922F
R2135	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R2136	315-0751-00		RES., FXD, CMPSN: 750 OHM, 5%, 0.25W	01121	CB7515
R2137	315-0622-00		RES., FXD, CMPSN: 6.2K OHM, 5%, 0.25W	01121	CB6225
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	321-0189-00		RES., FXD, FILM: 909 OHM, 1%, 0.125W	91637	MFF1816G909ROF
R2147	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R2151	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
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
R2154	315-0822-00		RES., FXD, CMPSN: 8.2K OHM, 5%, 0.25W	01121	CB8225
R2156	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
R2157	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R2158	315-0163-00		RES., FXD, CMPSN: 16K OHM, 5%, 0.25W	01121	CB1635
R2162	315-0221-00		RES., FXD, CMPSN: 220 OHM, 5%, 0.25W	01121	CB2215
R2163	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R2164	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R2166	315-0222-00		(R2164 IS MARKED R2120 ON SOME BOARDS) RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R2167	315-0203-00		RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R2171	315-0751-00		RES., FXD, CMPSN: 750 OHM, 5%, 0.25W	01121	CB7515
R2172	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R2174	315-0182-00		RES., FXD, CMPSN: 1.8K OHM, 5%, 0.25W	01121	CB1825
R2175	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R2176	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R2178	315-0222-00		RES., FXD, CMPSN: 2.2K OHM, 5%, 0.25W	01121	CB2225
R2182	321-0236-00		RES., FXD, FILM: 2.8K OHM, 1%, 0.125W	91637	MFF1816G28000F
R2185	315-0272-00		RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W	01121	CB2725
R2186	315-0272-00		RES., FXD, CMPSN: 2.7K OHM, 5%, 0.25W	01121	CB2725
R2188	315-0752-00		RES., FXD, CMPSN: 7.5K OHM, 5%, 0.25W	01121	CB7525
R2223	315-0911-00		RES., FXD, CMPSN: 910 OHM, 5%, 0.25W	01121	CB9115
R2224	315-0242-00		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	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025

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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	315-0512-00			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
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	321-0377-01			RES., FXD, FILM: 82.5K OHM, 0.5%, 0.125W	91637	MFF1816G82501D
R2255	321-0377-01			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	321-0281-01			RES., FXD, FILM: 8.25K OHM, 0.5%, 0.125W	91637	MFF1816G82500D
R2258	321-0281-01			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	321-0473-01			RES., FXD, FILM: 825K OHM, 0.5%, 0.125W	91637	MFF1816G82502D
R2264	321-0473-01			RES., FXD, FILM: 825K OHM, 0.5%, 0.125W	91637	MFF1816G82502D
R2268	321-0162-00			RES., FXD, FILM: 475 OHM, 1%, 0.125W	91637	MFF1816G475ROF
R2269	311-1965-00			RES., VAR, NONWIR: PANEL, 1K OHM, 10%, 0.5W	12697	CM41729
R2271	315-0434-00			RES., FXD, CMPSN: 430K OHM, 5%, 0.25W	01121	CB4345
R2272	311-0580-00			RES., VAR, NONWIR: 50K OHM, 20%, 0.50W	11237	300SF-41695
R2274	315-0512-00			RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R2276	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R2278	315-0512-00			RES., FXD, CMPSN: 5.1K OHM, 5%, 0.25W	01121	CB5125
R2310	321-0184-00			RES., FXD, FILM: 806 OHM, 1%, 0.125W	91637	MFF1816G806ROF
R2311	321-0268-00			RES., FXD, FILM: 6.04K OHM, 1%, 0.125W	91637	MFF1816G60400F
R2313	321-0279-00			RES., FXD, FILM: 7.87K OHM, 1%, 0.125W	91637	MFF1816G78700F
R2314	321-0320-00			RES., FXD, FILM: 21K OHM, 1%, 0.125W	91637	MFF1816G21001F
R2315	321-0297-00			RES., FXD, FILM: 12.1K OHM, 1%, 0.125W	91637	MFF1816G12101F
R2316A, B	311-1974-00			RES., VAR, NONWIR: PNL, 50K/20K OHM, 10%, 0.50W	12697	CM41730
R2317	315-0751-00			RES., FXD, CMPSN: 750 OHM, 5%, 0.25W	01121	CB7515
R2321	311-1814-00	B010100	B021477	RES., VAR, NONWIR: 2K OHM, 20%, 0.50W	73138	91-108-0
R2321	311-1918-00	B021478		RES., VAR, NONWIR: 2K OHM, 10%, 0.50W	73138	72-199-0
R2322	321-0290-00			RES., FXD, FILM: 10.2K OHM, 1%, 0.125W	91637	MFF1816G10201F
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
R2328	315-0101-00			RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
R2330	311-1230-00			RES., VAR, NONWIR: 20K OHM, 20%, 0.50W	32997	3386F-T04-203
R2331	315-0202-00			RES., FXD, CMPSN: 2K OHM, 5%, 0.25W	01121	CB2025
R2332	311-1226-00			RES., VAR, NONWIR: 2.5K OHM, 20%, 0.50W	32997	3386F-T04-252
R2333	315-0753-00			RES., FXD, CMPSN: 75K OHM, 5%, 0.25W	01121	CB7535
R2334	315-0752-00			RES., FXD, CMPSN: 7.5K OHM, 5%, 0.25W	01121	CB7525
R2335	315-0753-00			RES., FXD, CMPSN: 75K OHM, 5%, 0.25W	01121	CB7535
R2336	315-0152-00			RES., FXD, CMPSN: 1.5K OHM, 5%, 0.25W	01121	CB1525
R2337	308-0329-00			RES., FXD, WW: 4K OHM, 2%, 3W	91637	RS2B-B40000G
R2342	315-0152-00			RES., FXD, CMPSN: 1.5K OHM, 5%, 0.25W	01121	CB1525
R2344	308-0329-00			RES., FXD, WW: 4K OHM, 2%, 3W	91637	RS2B-B40000G
R2345	315-0331-00			RES., FXD, CMPSN: 330 OHM, 5%, 0.25W	01121	CB3315
R2347	315-0753-00			RES., FXD, CMPSN: 75K OHM, 5%, 0.25W	01121	CB7535
R2352	315-0104-00			RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
R2353	315-0622-00			RES., FXD, CMPSN: 6.2K OHM, 5%, 0.25W	01121	CB6225
R2354	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R2355	315-0202-00			RES., FXD, CMPSN: 2K OHM, 5%, 0.25W	01121	CB2025

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R2356	315-0182-00			RES., FXD, CMPSN: 1.8K OHM, 5%, 0.25W	01121	CB1825
R2357	315-0752-00			RES., FXD, CMPSN: 7.5K OHM, 5%, 0.25W	01121	CB7525
R2392	301-0240-00			RES., FXD, CMPSN: 24 OHM, 5%, 0.50W	01121	EB2405
R4101	317-0150-00			RES., FXD, CMPSN: 15 OHM, 5%, 0.125W	01121	BB1505
R4102	315-0105-00			RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
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	HFF1104G99002D
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
R4121	321-0481-00			RES., FXD, FILM: 1M OHM, 1%, 0.125W	24546	NA4D1004F
R4122	315-0474-00			RES., FXD, CMPSN: 470K OHM, 5%, 0.25W	01121	CB4745
R4124	321-0030-00			RES., FXD, FILM: 20 OHM, 1%, 0.125W	91637	MFF1816G20R00F
R4125	321-0030-00			RES., FXD, FILM: 20 OHM, 1%, 0.125W	91637	MFF1816G20R00F
R4127	315-0152-00			RES., FXD, CMPSN: 1.5K OHM, 5%, 0.25W	01121	CB1525
R4130	311-1559-00			RES., VAR, NONWIR: 10K OHM, 20%, 0.50W	73138	91-81-0
R4131	315-0153-00			RES., FXD, CMPSN: 15K OHM, 5%, 0.25W	01121	CB1535
R4133	315-0151-00			RES., FXD, CMPSN: 150 OHM, 5%, 0.25W	01121	CB1515
R4136	321-0077-00			RES., FXD, FILM: 61.9 OHM, 1%, 0.125W	91637	MFF1816G61R90F
R4137	315-0152-00			RES., FXD, CMPSN: 1.5K OHM, 5%, 0.25W	01121	CB1525
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
R4150	321-0041-00			RES., FXD, FILM: 26.1 OHM, 1%, 0.125W	91637	MFF1816G26R10F
R4151	311-1563-00			RES., VAR, NONWIR: 1K OHM, 20%, 0.50W	73138	91-85-0
R4152	311-1956-00			RES., VAR, NONWIR: PNL, 1K OHM, 10%, 0.50W	12697	CM41725
R4154	321-0078-00			RES., FXD, FILM: 63.4 OHM, 1%, 0.125W	91637	MFF1816G63R40F
R4155	315-0241-00	B010100	B010199	RES., FXD, CMPSN: 240 OHM, 5%, 0.25W	01121	CB2415
R4155	315-0101-00	B010200	B010408X	RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
R4155	315-0241-00	XB022164		RES., FXD, CMPSN: 240 OHM, 5%, 0.25W	01121	CB2415
R4156	315-0621-00	B010100	B010408	RES., FXD, CMPSN: 620 OHM, 5%, 0.25W	01121	CB6215
R4156	315-0681-00	B010409		RES., FXD, CMPSN: 680 OHM, 5%, 0.25W	01121	CB6815
R4157	321-0225-00			RES., FXD, FILM: 2.15K OHM, 1%, 0.125W	91637	MFF1816G21500F
R4158	315-0751-00			RES., FXD, CMPSN: 750 OHM, 5%, 0.25W	01121	CB7515
R4161	321-0154-00			RES., FXD, FILM: 392 OHM, 1%, 0.125W	91637	MFF1816G392R0F
R4162	321-0041-00			RES., FXD, FILM: 26.1 OHM, 1%, 0.125W	91637	MFF1816G26R10F
R4166	315-0682-00			RES., FXD, CMPSN: 6.8K OHM, 5%, 0.25W	01121	CB6825
R4167	321-0225-00			RES., FXD, FILM: 2.15K OHM, 1%, 0.125W	91637	MFF1816G21500F
R4168	315-0751-00			RES., FXD, CMPSN: 750 OHM, 5%, 0.25W	01121	CB7515
R4171	321-0185-00			RES., FXD, FILM: 825 OHM, 1%, 0.125W	91637	MFF1816G825R0F
R4172	321-0204-00			RES., FXD, FILM: 1.3K OHM, 1%, 0.125W	91637	MFF1816G13000F
R4173	321-0164-00			RES., FXD, FILM: 499 OHM, 1%, 0.125W	91637	MFF1816G499R0F
R4174	321-0080-00	B010100	B010408	RES., FXD, FILM: 66.5 OHM, 1%, 0.125W	91637	MFF1816G66R50F
R4174	321-0077-00	B010409		RES., FXD, FILM: 61.9 OHM, 1%, 0.125W	91637	MFF1816G61R90F
R4175	315-0201-00	B010100	B010408X	RES., FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015
R4176	321-0167-00			RES., FXD, FILM: 536 OHM, 1%, 0.125W	91637	MFF1816G536R0F
R4177	315-0821-00			RES., FXD, CMPSN: 820 OHM, 5%, 0.25W	01121	CB8215
R4178	315-0680-00	B010100	B010408	RES., FXD, CMPSN: 68 OHM, 5%, 0.25W	01121	CB6805
R4178	315-0220-00	B010409		RES., FXD, CMPSN: 22 OHM, 5%, 0.25W	01121	CB2205
R4179	321-0131-00			RES., FXD, FILM: 226 OHM, 1%, 0.125W	91637	MFF1816G226R0F
R4181	321-0185-00			RES., FXD, FILM: 825 OHM, 1%, 0.125W	91637	MFF1816G825R0F

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R4182	321-0165-00			RES.,FXD,FILM:511 OHM,1%,0.125W	91637	MFF1816G511ROF
R4183	321-0164-00			RES.,FXD,FILM:499 OHM,1%,0.125W	91637	MFF1816G499ROF
R4184	315-0271-00			RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R4186	321-0167-00			RES.,FXD,FILM:536 OHM,1%,0.125W	91637	MFF1816G536ROF
R4187	315-0821-00			RES.,FXD,CMPSN:820 OHM,5%,0.25W	01121	CB8215
R4188	315-0680-00	B010100	B010408	RES.,FXD,CMPSN:68 OHM,5%,0.25W	01121	CB6805
R4188	315-0220-00	B010409		RES.,FXD,CMPSN:22 OHM,5%,0.25W	01121	CB2205
R4189	321-0131-00			RES.,FXD,FILM:226 OHM,1%,0.125W	91637	MFF1816G226ROF
R4193	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4194	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4195	321-0117-00			RES.,FXD,FILM:162 OHM,1%,0.125W	91637	MFF1816G162ROF
R4196	315-0820-00			RES.,FXD,CMPSN:82 OHM,5%,0.25W	01121	CB8205
R4198	321-0177-00			RES.,FXD,FILM:681 OHM,1%,0.125W	91637	MFF1816G681ROF
R4199	321-0177-00			RES.,FXD,FILM:681 OHM,1%,0.125W	91637	MFF1816G681ROF
R4201	317-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.125W	01121	BB1505
R4202	315-0105-00			RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055
R4204	315-0241-00	B010100	B010159	RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R4204	315-0301-00	B010160	B010199	RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
R4204	315-0271-00	B010200		RES.,FXD,CMPSN:270 OHM,5%,0.25W	01121	CB2715
R4205	321-0790-01			RES.,FXD,FILM:990K OHM,0.5%,0.125W	91637	HFF1104G99002D
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
R4221	321-0481-00			RES.,FXD,FILM:1M OHM,1%,0.125W	24546	NA4D1004F
R4222	315-0474-00			RES.,FXD,CMPSN:470K OHM,5%,0.25W	01121	CB4745
R4224	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	MFF1816G20R00F
R4225	321-0030-00			RES.,FXD,FILM:20 OHM,1%,0.125W	91637	MFF1816G20R00F
R4227	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
R4230	311-1559-00			RES.,VAR, NONWIR:10K OHM,20%,0.50W	73138	91-81-0
R4231	315-0153-00			RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
R4233	315-0151-00			RES.,FXD,CMPSN:150 OHM,5%,0.25W	01121	CB1515
R4236	321-0077-00			RES.,FXD,FILM:61.9 OHM,1%,0.125W	91637	MFF1816G61R90F
R4237	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
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	MFF1816G150ROF
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
R4250	321-0041-00			RES.,FXD,FILM:26.1 OHM,1%,0.125W	91637	MFF1816G26R10F
R4251	311-1563-00			RES.,VAR, NONWIR:1K OHM,20%,0.50W	73138	91-85-0
R4252	311-1956-00			RES.,VAR, NONWIR:PNL,1K OHM,10%,0.50W	12697	CM41725
R4254	321-0078-00			RES.,FXD,FILM:63.4 OHM,1%,0.125W	91637	MFF1816G63R40F
R4255	315-0241-00	XB010409	B022163X	RES.,FXD,CMPSN:240 OHM,5%,0.25W	01121	CB2415
R4256	315-0621-00	B010100	B010408	RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R4256	315-0681-00	B010409		RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
R4257	321-0225-00			RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F
R4258	315-0751-00			RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
R4261	321-0154-00			RES.,FXD,FILM:392 OHM,1%,0.125W	91637	MFF1816G392ROF
R4262	321-0041-00			RES.,FXD,FILM:26.1 OHM,1%,0.125W	91637	MFF1816G26R10F
R4265	311-0634-00	XB010409	B022163	RES.,VAR, NONWIR:TRMR,500 OHM,0.5W	32997	3326H-G48-501
R4265	311-1563-00	B022164		RES.,VAR, NONWIR:1K OHM,20%,0.50W	73138	91-85-0
R4266	315-0682-00			RES.,FXD,CMPSN:6.8K OHM,5%,0.25W	01121	CB6825
R4267	321-0225-00	B010100	B010408	RES.,FXD,FILM:2.15K OHM,1%,0.125W	91637	MFF1816G21500F

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Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
R4267	321-0221-00	B010409		RES., FXD, FILM: 1.96K OHM, 1%, 0.125W	91637	MFF1816G19600F
R4268	315-0751-00			RES., FXD, CMPSN: 750 OHM, 5%, 0.25W	01121	CB7515
R4271	321-0185-00			RES., FXD, FILM: 825 OHM, 1%, 0.125W	91637	MFF1816G825ROF
R4272	321-0204-00			RES., FXD, FILM: 1.3K OHM, 1%, 0.125W	91637	MFF1816G13000F
R4273	321-0164-00			RES., FXD, FILM: 499 OHM, 1%, 0.125W	91637	MFF1816G499ROF
R4274	321-0080-00	B010100	B010408	RES., FXD, FILM: 66.5 OHM, 1%, 0.125W	91637	MFF1816G66R50F
R4274	321-0077-00	B010409		RES., FXD, FILM: 61.9 OHM, 1%, 0.125W	91637	MFF1816G61R90F
R4275	315-0201-00	B010100	B010408X	RES., FXD, CMPSN: 200 OHM, 5%, 0.25W	01121	CB2015
R4276	321-0173-00			RES., FXD, FILM: 619 OHM, 1%, 0.125W	91637	MFF1816G619ROF
R4277	315-0821-00			RES., FXD, CMPSN: 820 OHM, 5%, 0.25W	01121	CB8215
R4278	315-0680-00	B010100	B010408	RES., FXD, CMPSN: 68 OHM, 5%, 0.25W	01121	CB6805
R4278	315-0220-00	B010409		RES., FXD, CMPSN: 22 OHM, 5%, 0.25W	01121	CB2205
R4279	321-0133-00			RES., FXD, FILM: 237 OHM, 1%, 0.125W	91637	MFF1816G237ROF
R4280	311-1568-00	B010100	B010408X	RES., VAR, NONWIR: 50 OHM, 20%, 0.50W	73138	91-90-0
R4281	321-0185-00			RES., FXD, FILM: 825 OHM, 1%, 0.125W	91637	MFF1816G825ROF
R4282	321-0165-00			RES., FXD, FILM: 511 OHM, 1%, 0.125W	91637	MFF1816G511ROF
R4283	321-0164-00			RES., FXD, FILM: 499 OHM, 1%, 0.125W	91637	MFF1816G499ROF
R4284	315-0271-00			RES., FXD, CMPSN: 270 OHM, 5%, 0.25W	01121	CB2715
R4286	321-0173-00			RES., FXD, FILM: 619 OHM, 1%, 0.125W	91637	MFF1816G619ROF
R4287	315-0821-00			RES., FXD, CMPSN: 820 OHM, 5%, 0.25W	01121	CB8215
R4288	315-0680-00	B010100	B010408	RES., FXD, CMPSN: 68 OHM, 5%, 0.25W	01121	CB6805
R4288	315-0220-00	B010409		RES., FXD, CMPSN: 22 OHM, 5%, 0.25W	01121	CB2205
R4289	321-0129-00	B010100	B010408	RES., FXD, FILM: 215 OHM, 1%, 0.125W	91637	MFF1816G215ROF
R4289	321-0133-00	B010409		RES., FXD, FILM: 237 OHM, 1%, 0.125W	91637	MFF1816G237ROF
R4293	315-0101-00			RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
R4294	315-0101-00			RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
R4295	315-0161-00			RES., FXD, CMPSN: 160 OHM, 5%, 0.25W	01121	CB1615
R4296	315-0820-00			RES., FXD, CMPSN: 82 OHM, 5%, 0.25W	01121	CB8205
R4298	321-0185-00			RES., FXD, FILM: 825 OHM, 1%, 0.125W	91637	MFF1816G825ROF
R4299	321-0185-00			RES., FXD, FILM: 825 OHM, 1%, 0.125W	91637	MFF1816G825ROF
R4301	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R4302	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R4303	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R4304	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R4307	315-0203-00			RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R4308	315-0203-00			RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
R4312	315-0472-00			RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R4314	315-0472-00			RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R4315	315-0181-00			RES., FXD, CMPSN: 180 OHM, 5%, 0.25W	01121	CB1815
R4318	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R4321	315-0472-00			RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R4322	315-0472-00			RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
R4324	315-0202-00			RES., FXD, CMPSN: 2K OHM, 5%, 0.25W	01121	CB2025
R4325	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R4331	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R4332	315-0103-00			RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
R4334	321-0158-00			RES., FXD, FILM: 432 OHM, 1%, 0.125W	91637	MFF1816G432ROF
R4335	321-0262-00			RES., FXD, FILM: 5.23K OHM, 1%, 0.125W	91637	MFF1816G52300F
R4336	311-1559-00			RES., VAR, NONWIR: 10K OHM, 20%, 0.50W	73138	91-81-0
R4339	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R4340	321-0207-00			RES., FXD, FILM: 1.4K OHM, 1%, 0.125W	91637	MFF1816G14000F
R4341	315-0510-00			RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
R4344	321-0169-00			RES., FXD, FILM: 562 OHM, 1%, 0.125W	91637	MFF1816G562ROF
R4345	321-0139-00			RES., FXD, FILM: 274 OHM, 1%, 0.125W	91637	MFF1816G274ROF
R4346	311-0310-00			RES., VAR, NONWIR: 5K OHM, 20%, 0.50W	01121	W-7350A
R4347	321-0139-00			RES., FXD, FILM: 274 OHM, 1%, 0.125W	91637	MFF1816G274ROF
R4348	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
R4349	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R4350	321-0207-00			RES.,FXD,FILM:1.4K OHM,1%,0.125W	91637	MFF1816G14000F
R4351	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4352	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R4353	321-0193-00			RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
R4354	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
R4355	321-0139-00			RES.,FXD,FILM:274 OHM,1%,0.125W	91637	MFF1816G274ROF
R4356	311-0310-00			RES.,VAR, NONWIR:5K OHM,20%,0.50W	01121	W-7350A
R4357	321-0139-00			RES.,FXD,FILM:274 OHM,1%,0.125W	91637	MFF1816G274ROF
R4358	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R4359	315-0621-00			RES.,FXD,CMPSN:620 OHM,5%,0.25W	01121	CB6215
R4360	321-0226-00			RES.,FXD,FILM:2.21K OHM,1%,0.125W	91637	MFF1816G22100F
R4362	321-0226-00			RES.,FXD,FILM:2.21K OHM,1%,0.125W	91637	MFF1816G22100F
R4368	323-0131-00			RES.,FXD,FILM:226 OHM,1%,0.50W	75042	CECTO-2260F
R4373	321-0120-00			RES.,FXD,FILM:174 OHM,1%,0.125W	91637	MFF1816G174ROF
R4375	315-0430-00			RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
R4376	323-0162-00			RES.,FXD,FILM:475 OHM,1%,0.50W	75042	CECTO-4750F
R4377	321-0120-00			RES.,FXD,FILM:174 OHM,1%,0.125W	91637	MFF1816G174ROF
R4378	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R4383	321-0120-00			RES.,FXD,FILM:174 OHM,1%,0.125W	91637	MFF1816G174ROF
R4384	322-0133-00			RES.,FXD,FILM:237 OHM,1%,0.25W	75042	CEBTO-2370F
R4385	315-0430-00			RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
R4386	322-0133-00			RES.,FXD,FILM:237 OHM,1%,0.25W	75042	CEBTO-2370F
R4387	321-0120-00			RES.,FXD,FILM:174 OHM,1%,0.125W	91637	MFF1816G174ROF
R4388	315-0750-00			RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
R4389	321-0156-00			RES.,FXD,FILM:412 OHM,1%,0.125W	91637	MFF1816G412ROF
R4396	311-1563-00			RES.,VAR, NONWIR:1K OHM,20%,0.50W	73138	91-85-0
R4397	311-1561-00			RES.,VAR, NONWIR:2.5K OHM,20%,0.50W	73138	91-83-0
R4398	315-0103-00	B010100	B010408	RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
R4398	315-0203-00	B010409		RES.,FXD,CMPSN:20K OHM,5%,0.25W	01121	CB2035
R4411	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
R4412	315-0150-00			RES.,FXD,CMPSN:15 OHM,5%,0.25W	01121	CB1505
R4413	315-0270-00			RES.,FXD,CMPSN:27 OHM,5%,0.25W	01121	CB2705
R4415	315-0161-00			RES.,FXD,CMPSN:160 OHM,5%,0.25W	01121	CB1615
R4416	315-0470-00			RES.,FXD,CMPSN:47 OHM,5%,0.25W	01121	CB4705
RT120	307-0181-00			RES.,THERMAL:100K OHM,10%,4MW/DEG C	15454	1DE104-K-220EC
RT2061	307-0122-00			RES.,THERMAL:50 OHM,10%	50157	3D1515
RT2310	307-0477-00			RES.,THERMAL:1K OHM,10%,6MW/DEG C	14193	1013-10000K
RT4175	307-0127-00	B010100	B010408X	RES.,THERMAL:1K OHM,10%	50157	2D1596
RT4275	307-0127-00	B010100	B010408X	RES.,THERMAL:1K OHM,10%	50157	2D1596
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-7102D
S701	260-1776-01			SWITCH,SLIDE:DPDT,3A,125VAC	82389	11A1631
S705	260-1776-01			SWITCH,SLIDE:DPDT,3A,125VAC	82389	11A1631
S2010	263-0030-00			SW LEVER ASSY:	80009	263-0030-00
S2030	260-1211-00			SWITCH,PUSH:1A,28VDC	80009	260-1211-00
S2050	214-2289-02			LEVER,SWITCH:STYLE B,W/CONTACTS	80009	214-2289-02
S2140	260-1445-01			SWITCH,PUSH:1 STA,2 POLE,W/O MTG EARS	80009	260-1445-01
S2312	260-1445-01			SWITCH,PUSH:1 STA,2 POLE,W/O MTG EARS	80009	260-1445-01
S2550	-----			(PART OF A13 TIMING BOARD)		
S4100	-----			(PART OF A6 CH1 ATTENUATOR BOARD)		
S4110	-----			(PART OF A6 CH1 ATTENUATOR BOARD)		
S4200	-----			(PART OF A7 CH2 ATTENUATOR BOARD)		
S4210	-----			(PART OF A7 CH2 ATTENUATOR BOARD)		
S4320	260-1900-00			SWITCH,PUSH:5 BUTTON,2 POLE,PHENOLIC	80009	260-1900-00
T460	120-0996-00			XFMR,PWR,STU:HIGH VOLTAGE	80009	120-0996-00

Replaceable Electrical Parts—442 Service

Ckt No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
T700	120-0994-02			XFMR, PWR, STPDN:	80009	120-0994-02
U24	156-0067-11	B010100	B010119	MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	02735	CA741CG
U24	156-0067-12	B010120	B011417	MICROCIRCUIT, LI: OPERATIONAL AMPLIFIER	04713	MC1741CU
U24	156-0158-03	B011418		MICROCIRCUIT, LI: DUAL OPNL AMPL	80009	156-0158-03
U460	152-0637-02			SEMICON DVC, DI: HV MULTR	80009	152-0637-02
U742	156-0158-05	B010100	B010119	MICROCIRCUIT, LI: DUAL OPERATIONAL AMPLIFIER	80009	156-0158-05
U742	156-0158-00	B010120		MICROCIRCUIT, LI: DUAL OPERATIONAL AMPLIFIER	18324	MC1458V
U2156	156-0180-00			MICROCIRCUIT, DI: QUAD 2-INPUT NAND GATE	01295	SN74S00N
U2212	156-0180-00			MICROCIRCUIT, DI: QUAD 2-INPUT NAND GATE	01295	SN74S00N
U2224	156-0405-00			MICROCIRCUIT, DI: DUAL RETRIG MONOSTABLE MV	07263	9602 (PC OR DC)
U2234	156-0180-00			MICROCIRCUIT, DI: QUAD 2-INPUT NAND GATE	01295	SN74S00N
U4306	156-0113-00			MICROCIRCUIT, DI: QUAD 2-IMP NAND GATE	80009	156-0113-00
U4324	156-0388-00			MICROCIRCUIT, DI: DUAL D-TYPE FLIP-FLOP	80009	156-0388-00
V470	154-0729-00	B010100	B010786	ELECTRON TUBE: CRT, P31, INT SCALE	80009	154-0729-00
V470	154-0804-00	B010787		ELECTRON TUBE: CRT, P31	80009	154-0804-00
VR412	152-0280-00			SEMICON D DEVICE: ZENER, 0.4W, 6.2V, 5%	80009	152-0280-00
VR746	152-0306-00			SEMICON D DEVICE: ZENER, 0.4W, 9.1V, 5%	14433	1N960B
VR762	152-0195-00			SEMICON D DEVICE: ZENER, 0.4W, 5.1V, 5%	04713	SZ11755
VR764	152-0217-00	XB022730		SEMICON D DEVICE: ZENER, 0.4W, 8.2V, 5%	04713	SZG20
VR818	152-0241-00			SEMICON D DEVICE: ZENER, 0.4W, 33V, 5%	80009	152-0241-00
VR2392	152-0279-00			SEMICON D DEVICE: ZENER, 0.4W, 5.1V, 5%	80009	152-0279-00
VR4184	152-0195-00			SEMICON D DEVICE: ZENER, 0.4W, 5.1V, 5%	04713	SZ11755
VR4284	152-0195-00			SEMICON D DEVICE: ZENER, 0.4W, 5.1V, 5%	04713	SZ11755
VR4415	152-0195-00			SEMICON D DEVICE: ZENER, 0.4W, 5.1V, 5%	04713	SZ11755

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it is in the low state.

Abbreviations are based on ANSI Y1.1-1972.

Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

- Y14.15, 1966 Drafting Practices.
- Y14.2, 1973 Line Conventions and Lettering.
- Y10.5, 1968 Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

American National Standard Institute
1430 Broadway
New York, New York 10018

Component Values

Electrical components shown on the diagrams are in the following units unless noted otherwise:

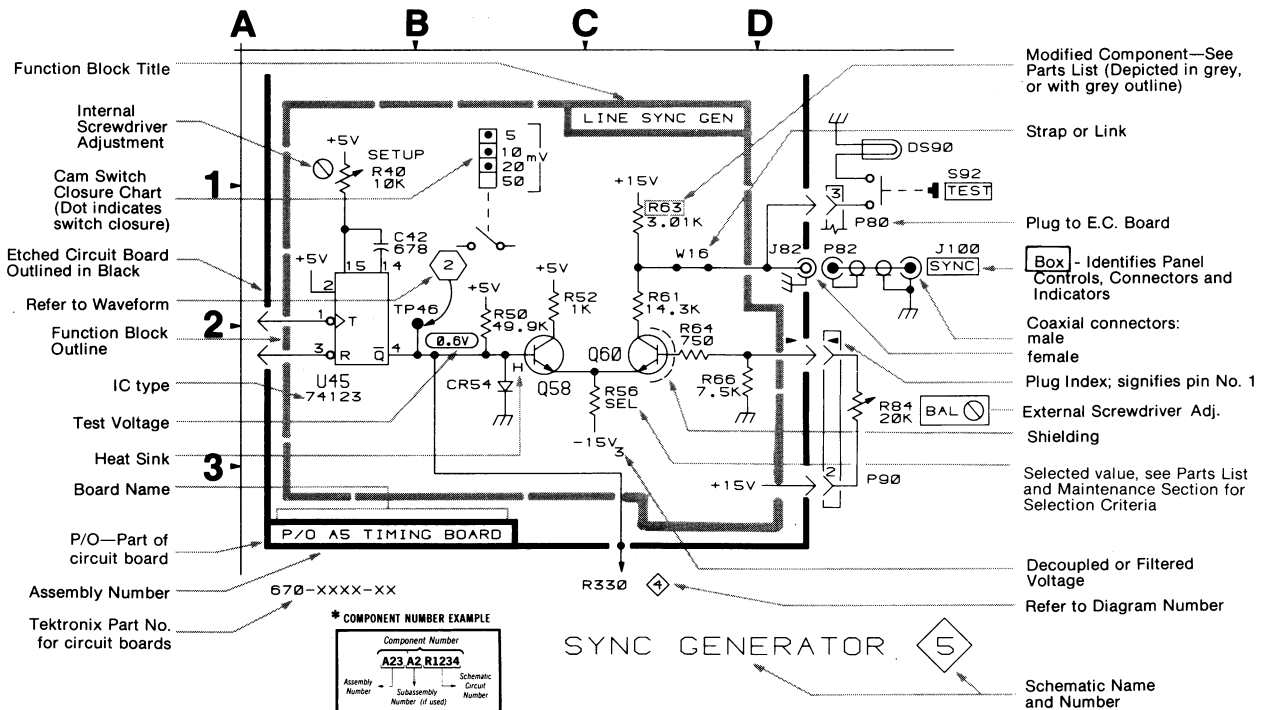
- Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).
- Resistors = Ohms (Ω).

————— The information and special symbols below may appear in this manual. —————

Assembly Numbers and Grid Coordinates

Each assembly in the instrument is assigned an assembly number (e.g., A20). The assembly number appears on the circuit board outline on the diagram, in the title for the circuit board component location illustration, and in the lookup table for the schematic diagram and corresponding component locator illustration. The Replaceable Electrical Parts list is arranged by assemblies in numerical sequence; the components are listed by component number *(see following illustration for constructing a component number).

The schematic diagram and circuit board component location illustration have grids. A lookup table with the grid coordinates is provided for ease of locating the component. Only the components illustrated on the facing diagram are listed in the lookup table. When more than one schematic diagram is used to illustrate the circuitry on a circuit board, the circuit board illustration may only appear opposite the first diagram on which it was illustrated; the lookup table will list the diagram number of other diagrams that the circuitry of the circuit board appears on.



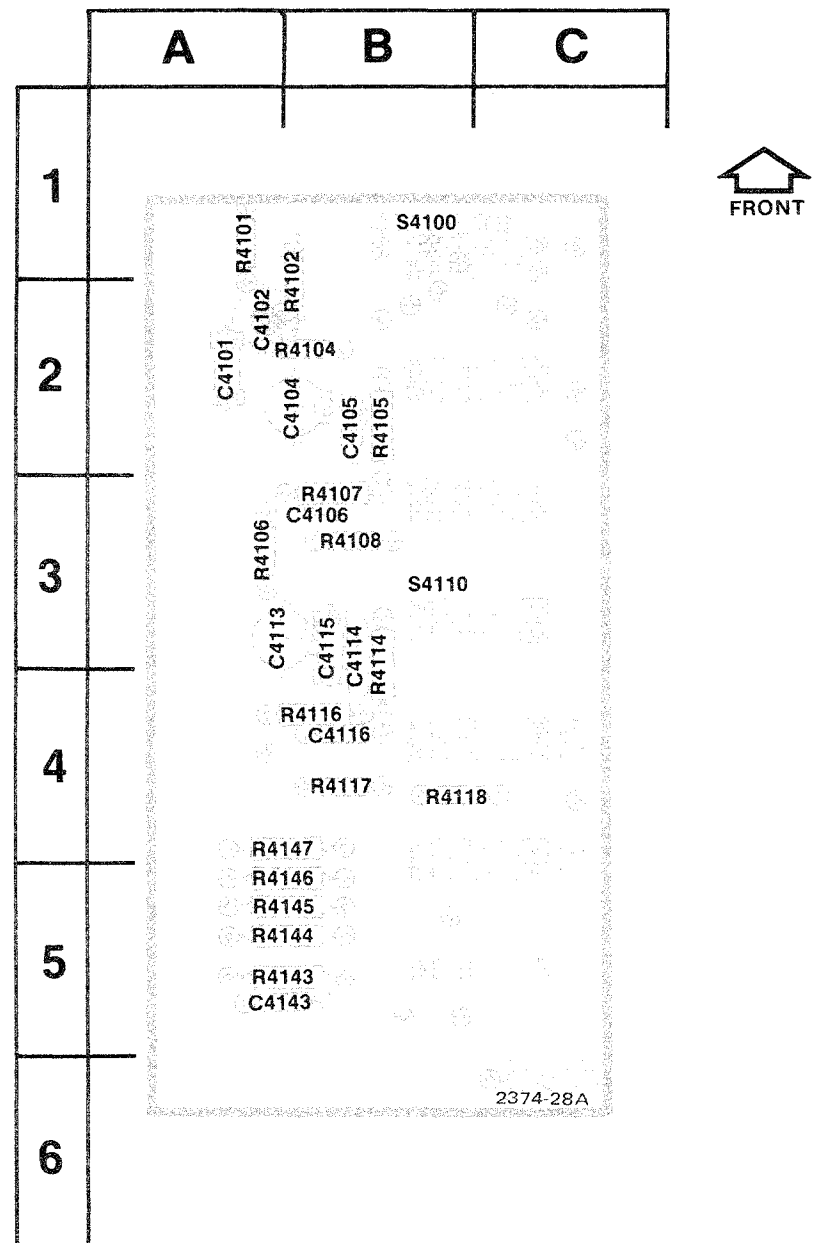


Figure 7-1. A6—CH 1 Attenuator circuit board component locations.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C4101	2A	R4104	2B	R4147	5A
C4102	2A	R4105	2B		
C4104	2B	R4106	3A	S4100	1B
C4105	2B	R4107	3B	S4110	3B
C4106	3B	R4108	3B		
C4113	3A	R4114	3B		
C4114	3B	R4116	4B		
C4115	3B	R4117	4B		
C4116	4B	R4118	4B		
C4143	5A	R4143	5A		
		R4144	5A		
		R4145	5A		
		R4146	5A		
R4101†	1A				
R4102	2B				

Static Sensitive Devices
See Maintenance Section
†One end connected off board.

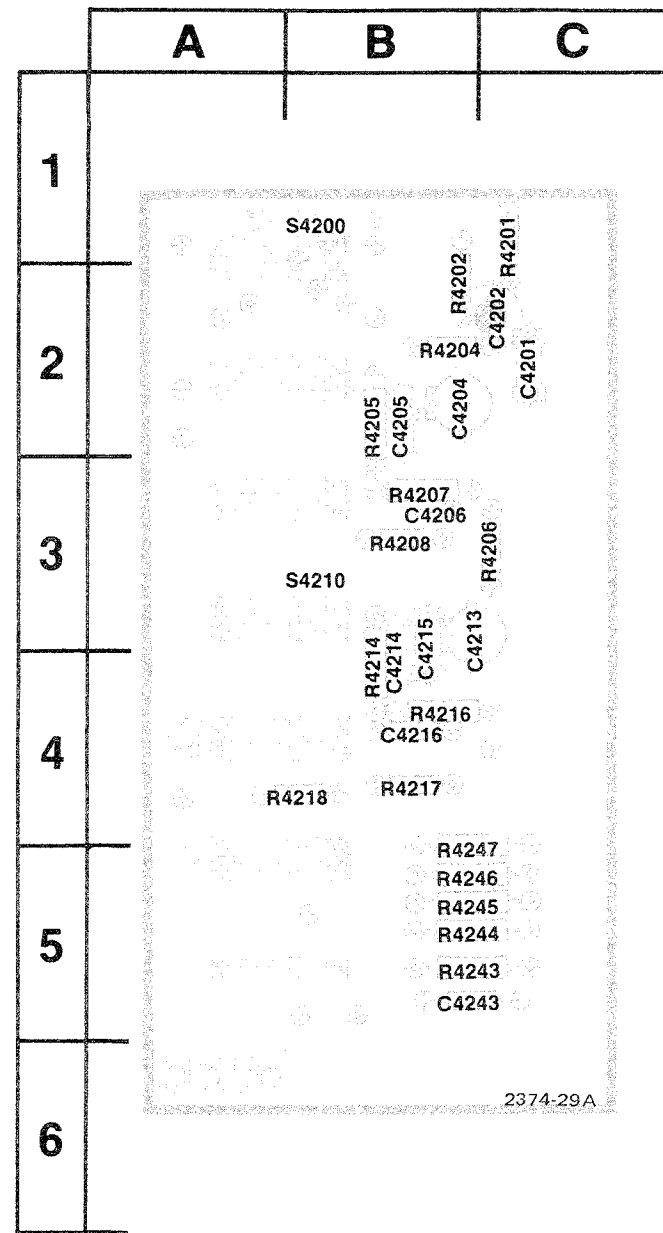


Figure 7-2. A7—CH 2 Attenuator circuit board component locations.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C4201	2C	R4204	2B	R4247	5B
C4202	2C	R4205	2B		
C4204	2B	R4206	3C	S4200	1B
C4205	2B	R4207	3B	S4210	3B
C4206	3B	R4208	3B		
C4213	3B	R4214	4B		
C4214	4B	R4216	4B		
C4215	3B	R4217	4B		
C4216	4B	R4218	4B		
C4243	5B	R4243	5B		
		R4244	5B		
		R4245	5B		
		R4246	5B		
R4201†	1C				
R4202	2B				

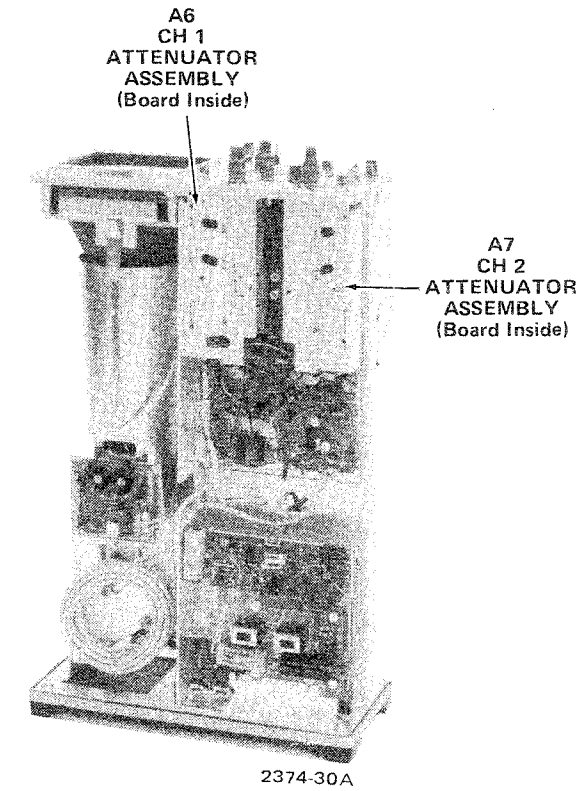


Figure 7-3. CH 1 & CH 2 Attenuator circuit board location.

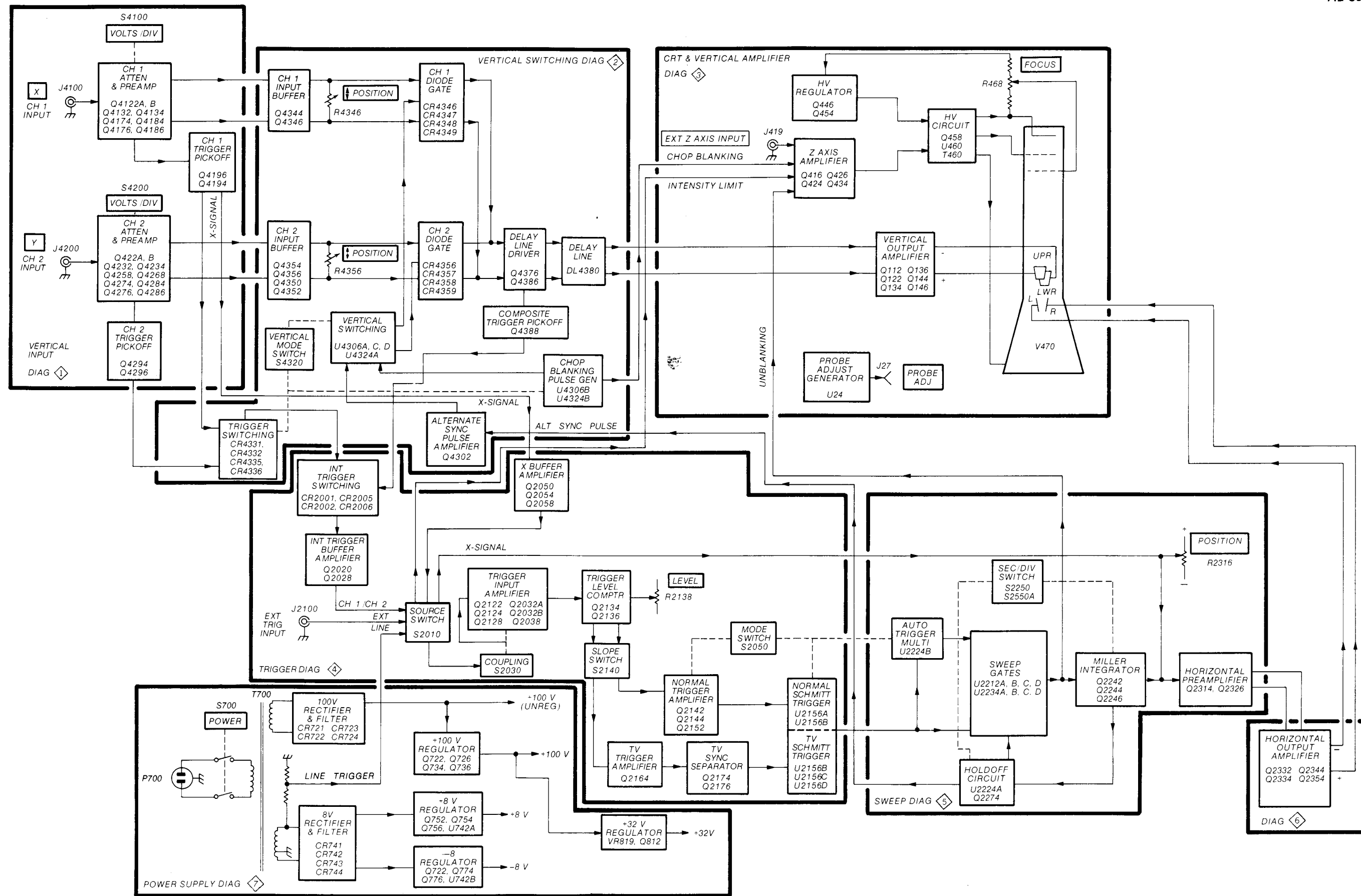


Figure 7-4. 442 Oscilloscope block diagram.

REV A JUN 1980

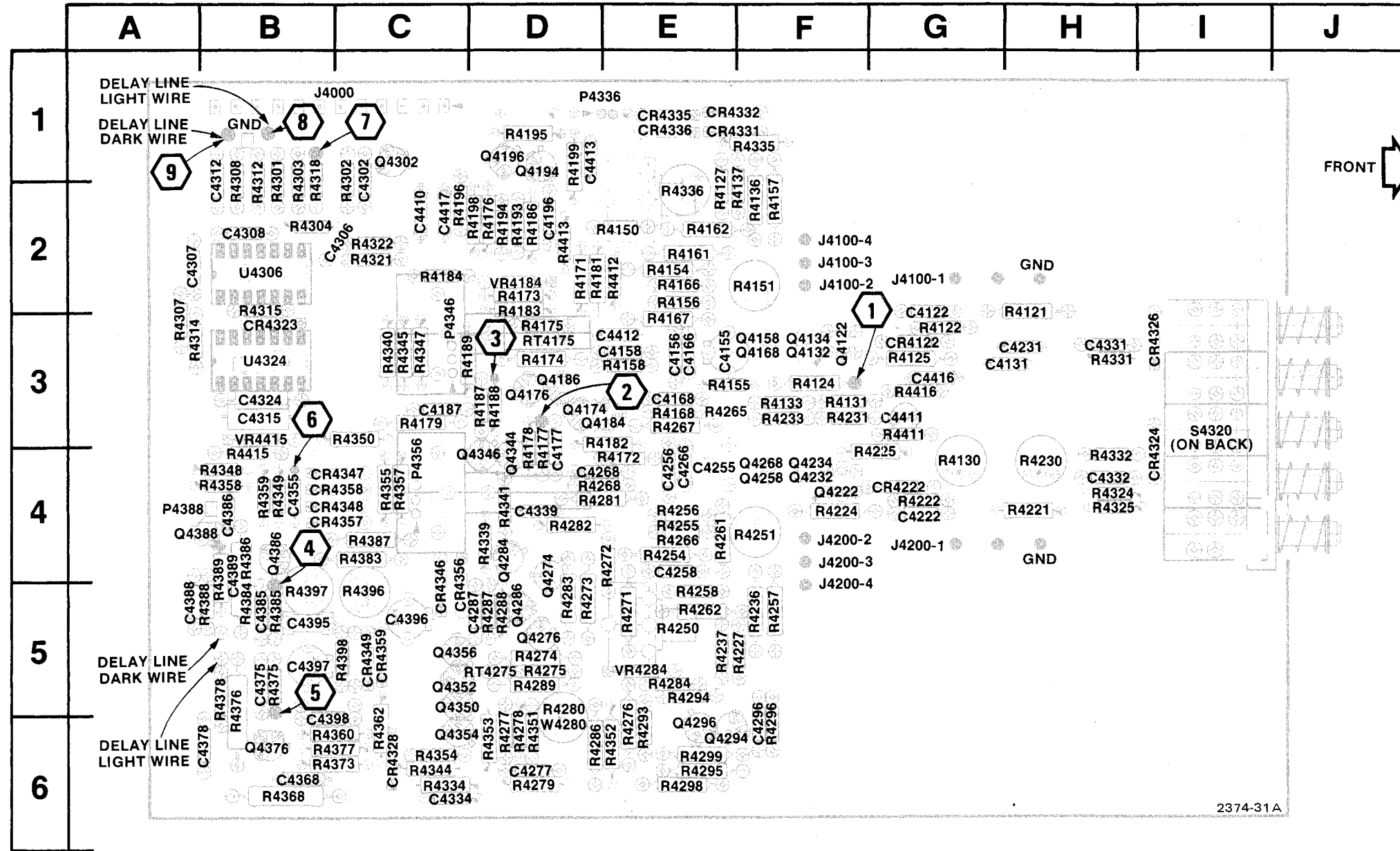


Figure 7-5. A8—Vertical circuit board component locations.

Static Sensitive Devices
See Maintenance Section

*See Parts List for serial number ranges.

†Located on back of board.

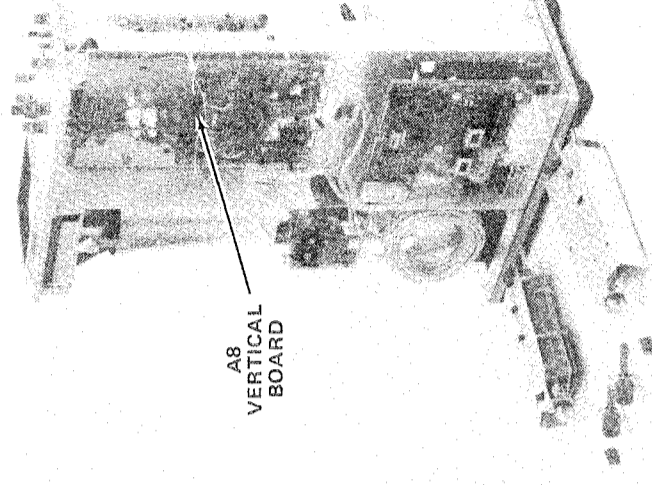
‡One end connected off board.

§Changed to board run for later serial number ranges.

**Incorrectly marked R4331 on some boards.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C4122	2G	J4100-3	2F	R4177	4C	R4318	1B
C4131	3H	J4100-4	2F	R4178	4C	R4321	2C
C4155*	3E	J4200-1	4G	R4179	3C	R4322	2C
C4156	3E	J4200-2	4F	R4181	2D	R4324	4H
C4158	3E	J4200-3	4F	R4182	3E	R4325	4H
C4166	3E	J4200-4	4F	R4183	2D	R4331	3H
C4168	3E			R4184	2C	R4332	4H
C4177	4C	P4336	1E	R4186	2D	R4334	6C
C4187	3C	P4346	3C	R4187	3D	R4335	1F
C4196	2D	P4356	4C	R4188	3D	R4336	2E
C4222	4G	P4388	4A	R4189	3D	R4339	4D
C4231	3H			R4193	2D	R4340	3C
C4255*	4E	Q4122	3F	R4194	2D	R4341	4D
C4256	4E	Q4132	3F	R4195	1D	R4344	6C
C4258	4E	Q4134	3F	R4196	2C	R4345	3C
C4266	4E	Q4158	3F	R4198	2D	R4346	2C
C4268	4D	Q4168	3F	R4199	1D	R4347	3C
C4277	6D	Q4174	3D	R4221	4H	R4348	4B
C4287	5D	Q4176	3D	R4222	4G	R4349	4B
C4296	6F	Q4184	3E	R4224	4F	R4350	3C
C4302	1C	Q4186	3E	R4225	4G	R4351	6D
C4306	2B	Q4194	1D	R4227	5F	R4352	6E
C4307	2A	Q4196	1D	R4230	4H	R4353	6D
C4308	2B	Q4222	4F	R4231	3F	R4354**	6C
C4312	1B	Q4232	4F	R4233	3F	R4355	4C
C4315	3B	Q4234	4F	R4236	5F	R4356	4C
C4324	3B	Q4258	4F	R4237	5E	R4357	4C
C4331	3H	Q4268	4F	R4250†	5E	R4358	4B
C4332	4H	Q4274	4D	R4251	4F	R4359	4B
C4334	6C	Q4276	5D	R4254	4E	R4360	6C
C4339	4D	Q4284	4D	R4255*	4E	R4362	6C
C4355	4B	Q4286	5D	R4256	4E	R4368	6B
C4368	6B	Q4294	6E	R4257	5F	R4373	6C
C4375*	5B	Q4296	6E	R4258	5E	R4375	5B
C4378	6B	Q4302	1C	R4261	4E	R4376	5B
C4385*	5B	Q4344	4D	R4262‡	5E	R4377	6C
C4386	4B	Q4346	4D	R4265‡	3E	R4378	5B
C4388	5A	Q4350	5C	R4266	4E	R4383	4C
C4389*	4B	Q4352	5C	R4267	3E	R4384	5B
C4395	5B	Q4354	6C	R4268	4D	R4385	5B
C4396	5C	Q4356	5C	R4271	5E	R4386	4B
C4397	5B	Q4376	6B	R4272	4E	R4387	4C
C4398	6B	Q4386	4B	R4273	5D	R4388	5B
C4410	2C	Q4388	4B	R4274	5D	R4389	4B
C4411	3G			R4275	5D	R4396	5C
C4412	3E	R4121	2H	R4276	6E	R4397	5B
C4413	1D	R4122	3G	R4277	6D	R4398	5C
C4416	3G	R4124	3F	R4278	6D	R4411	3G
C4417	2C	R4125	3G	R4279	6D	R4412	2E
		R4127	2E	R4280†	6D	R4413	2D
		R4130	4G	R4281	4D	R4415	4B
		R4131	3F	R4282	4D	R4416	3G
		R4133	3F	R4283	6D		
		R4136	2F	R4284	5E	RT4175*	3D
		R4137	2F	R4286	6D	RT4275*	5D
		R4150‡	2E	R4287	5D		
		R4151	2F	R4288	5D	S4320†	3I
		R4154	2E	R4289	6D		
		R4155*	3E	R4293	6E	U4306	2B
		R4156	2E	R4294	5E	U4324	3B
		R4157	2F	R4295	6E		
		R4158	3E	R4296	6F	VR4184	2D
		R4161	2E	R4298	6E	VR4284	5E
		R4162‡	2E	R4299	6E	VR4415	3B
		R4166	2E	R4301	1B		
		R4167	3E	R4302	1C	W4280§	6D
		R4168	3E	R4303	1B		
		R4171	2D	R4304	2B		
		R4172	4E	R4307	3A		
		R4173	2D	R4308	1B		
		R4174	3D	R4312	1B		
		R4175*	3D	R4314	3A		
		R4176	2E	R4315	2B		
J4000	1C						
J4100-1	2G						
J4100-2	2F						

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C4122	2G	J4100-3	2F	R4177	4C	R4318	1B
C4131	3H	J4100-4	2F	R4178	4C	R4321	2C
C4155*	3E	J4200-1	4G	R4179	3C	R4322	2C
C4156	3E	J4200-2	4F	R4181	2D	R4324	4H
C4158	3E	J4200-3	4F	R4182	3E	R4325	4H
C4166	3E	J4200-4	4F	R4183	2D	R4331	3H
C4168	3E			R4184	2C	R4332	4H
C4177	4C	P4336	1E	R4186	2D	R4334	6C
C4187	3C	P4346	3C	R4187	3D	R4335	1F
C4196	2D	P4356	4C	R4188	3D	R4336	2E
C4222	4G	P4388	4A	R4189	3D	R4339	4D
C4231	3H			R4193	2D	R4340	3C
C4255*	4E	Q4122	3F	R4194	2D	R4341	4D
C4256	4E	Q4132	3F	R4195	1D	R4344	6C
C4258	4E	Q4134	3F	R4196	2C	R4345	3C
C4266	4E	Q4158	3F	R4198	2D	R4346	2C
C4268	4E	Q4168	3F	R4199	1D	R4347	3C
C4277	6D	Q4174	3D	R4221	4H	R4348	4B
C4287	5D	Q4176	3D	R4222	4G	R4349	4B
C4296	6F	Q4184	3E	R4224	4F	R4350	3C
C4302	1C	Q4186	3E	R4225	4G	R4351	6D
C4306	2B	Q4194	1D	R4227	5F	R4352	6E
C4307	2A	Q4196	1D	R4230	4H	R4353	6D
C4308	2B	Q4222	4F	R4231	3F	R4354**	6C
C4312	1B	Q4232	4F	R4233	3F	R4355	4C
C4315	3B	Q4234	4F	R4236	5F	R4356	4C
C4324	3B	Q4258	4F	R4237	5E	R4357	4C
C4331	3H	Q4268	4F	R4250†	5E	R4358	4B
C4332	4H	Q4274	4D	R4251	4F	R4359	4B
C4334	6C	Q4276	5D	R4254	4E	R4360	6C
C4339	4D	Q4284	4D	R4255*	4E	R4362	6C
C4355	4B	Q4286	5D	R4256	4E	R4366	6B
C4368	6B	Q4294	6E	R4257	5F	R4373	6C
C4375*	5B	Q4296	6E	R4258	5E	R4375	5B
C4378	6B	Q4302	1C	R4261	4E	R4376	5B
C4385*	5B	Q4344	4D	R4262†	5E	R4377	6C
C4386	4B	Q4346	4D	R4265*	3E	R4378	5B
C4388	5A	Q4350	5C	R4266	4E	R4383	4C
C4389*	4B	Q4352	5C	R4267	3E	R4384	5B
C4395	5B	Q4354	6C	R4268	4D	R4385	5B
C4396	5C	Q4356	5C	R4271	5E	R4386	4B
C4397	5B	Q4376	6B	R4272	4E	R4387	4C
C4398	6B	Q4386	4B	R4273	5D	R4388	5B
C4410	2C	Q4388	4B	R4274	5D	R4389	4B
C4411	3G			R4275	5D	R4386	5C
C4412	3E	R4121	2H	R4276	6E	R4397	5C
C4413	1D	R4122	3G	R4277	6D	R4398	5C
C4416	3G	R4124	3F	R4278	6D	R4411	3G
C4417	2C	R4125	3G	R4279	6D	R4412	2E
		R4127	2E	R4280*	6D	R4413	2D
CR4122	3G	R4130	4G	R4281	4D	R4415	4B
CR4222	4G	R4131	3F	R4282	4D	R4416	3G
CR4323	3B	R4133	3F	R4283	6D		
CR4324	3I	R4136	2F	R4284	5E	RT4175*	3D
CR4326	4I	R4137	2F	R4286	6D	RT4275*	5D
CR4328	6C	R4150†	2E	R4287	5D	S4320†	3I
CR4331	1E	R4151	2F	R4288	5D		
CR4332	1E	R4154	2E	R4289	6D	U4306	2B
CR4335	1E	R4155*	3E	R4293	6E	U4324	3B
CR4336	1E	R4156	2E	R4294	5E		
CR4346	5C	R4157	2F	R4295	6E	VR4184	2D
CR4347	4C	R4158	3E	R4296	6F	VR4284	5E
CR4348	4C	R4161	2E	R4298	6E	VR4415	3B
CR4349	5C	R4162†	2E	R4299	6E		
CR4356	5C	R4166	2E	R4301	1B	W4280‡	6D
CR4357	4C	R4167	3E	R4302	1C		
CR4358	4C	R4168	3E	R4303	1B		
CR4359	5C	R4171	2D	R4304	2B		
		R4172	4E	R4307	3A		
J4000	1C	R4173	2D	R4308	1B		
J4100-1	2G	R4174	3D	R4312	1B		
J4100-2	2F	R4175*	3D	R4314	3A		
		R4176	2E	R4315	2B		



2374-32A

Figure 7-6. Vertical circuit board location.

Static Sensitive Devices
See Maintenance Section

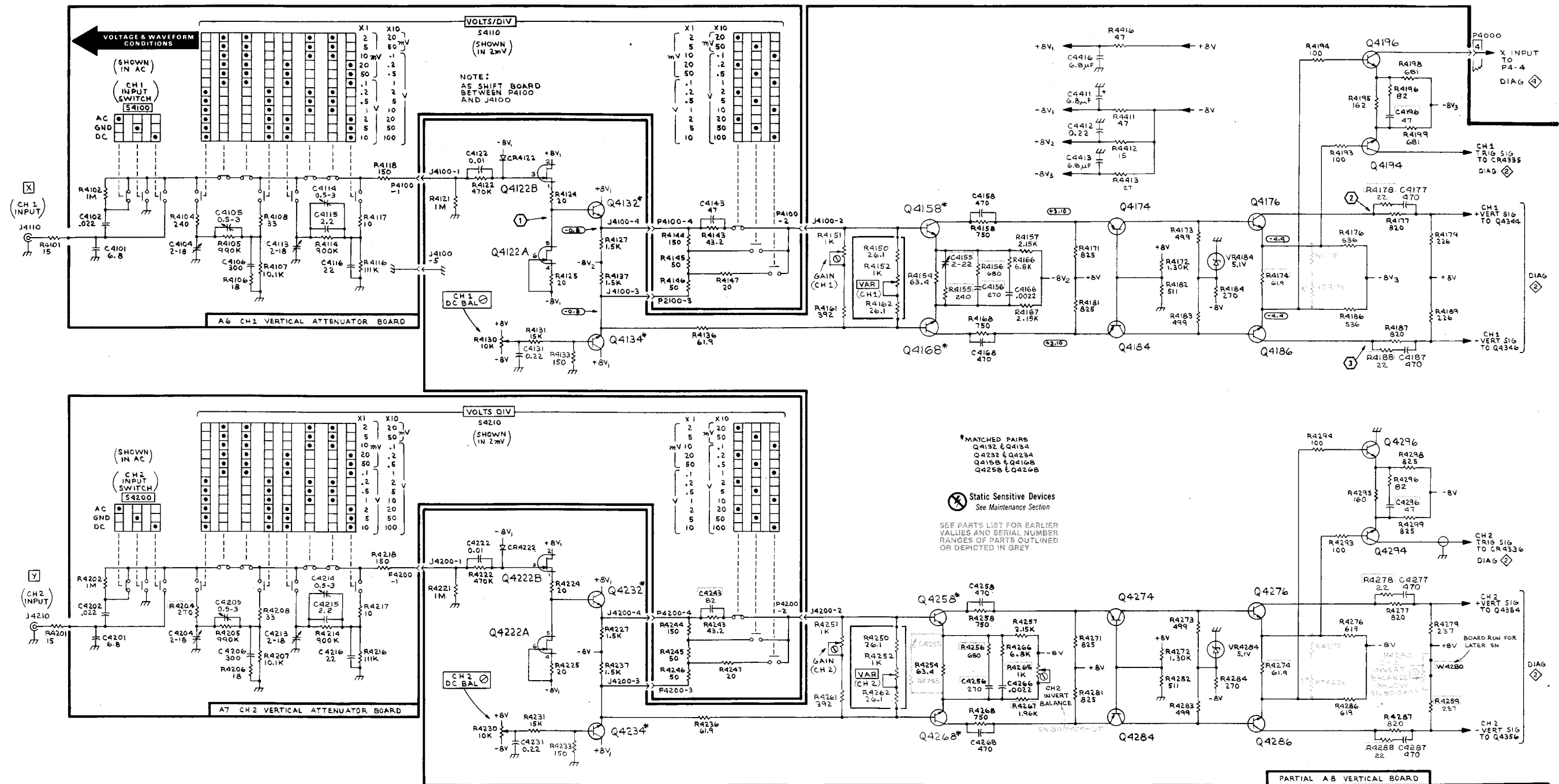
*See Parts List for serial number ranges.

†Located on back of board.

‡One end connected off board.

§Changed to board run for later serial number ranges.

**Incorrectly marked R4331 on some boards.



VOLTAGE AND WAVEFORM CONDITIONS

Voltage Conditions

Voltages shown on this schematic diagram were measured with a Tektronix DM 502A Digital Multimeter. Voltage measurements can vary as much as $\pm 20\%$. No signals were applied to the vertical inputs or the EXT-ernal trigger input.

Waveform Conditions

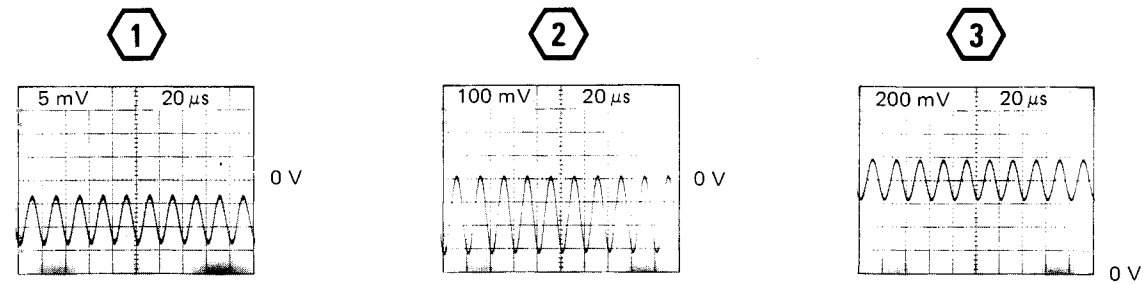
Waveforms below were taken from a Tektronix 475A Oscilloscope. Waveforms may vary as much as $\pm 20\%$.

A 50 kHz, 100 mV sine wave was applied to the Channel 1 input and a 50 kHz, 2 V square wave was applied to the Channel 2 input. A Tektronix SG 503 provided the sine wave and a Tektronix FG 502 provided the square wave.

442 controls were set as follows:

SOURCE	CH 1/CH 2
MODE	AUTO
SEC/DIV	10 μ s
VERT MODE	CH 1
Channel 1 VOLTS/DIV	50 mV
AC-GND-DC (both)	DC
VAR (both channels)	Detent, CCW
MAGNIFIER	X1 (out)
HOLDOFF	Fully CCW
Channel 2 VOLTS/DIV	1 V

Other controls were set as needed to obtain a stable display.



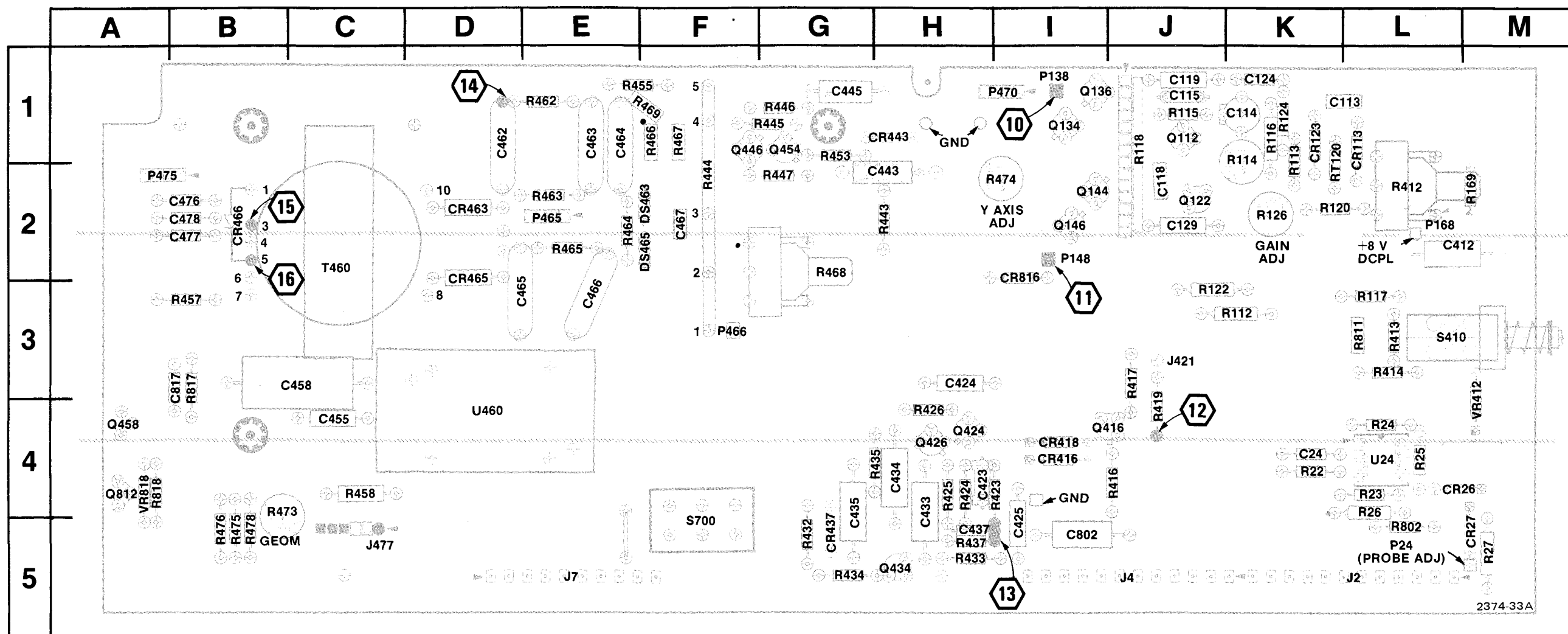
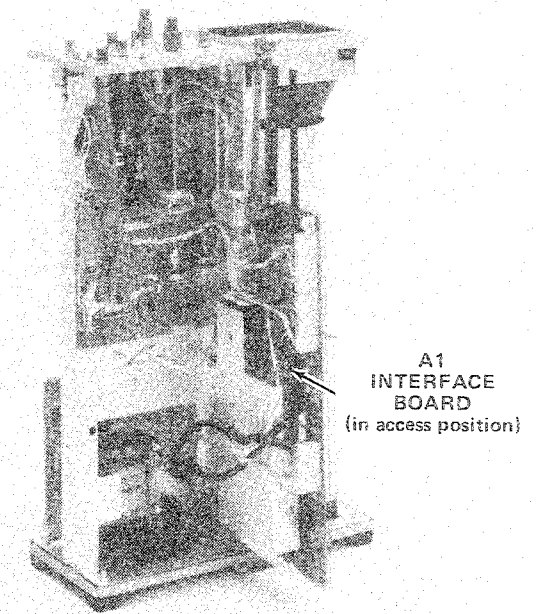


Figure 7-7. A1—Interface circuit board component locations.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C24	4K	C467*	2F	J7	5E	Q458†	4A	R417	3J
C113*	1K	C476	2B	J421	3J	Q812†	4A	R419	4J
C114	1K	C477	2B	J477	5C			R423	4I
C115	1J	C478	2B			R22	4K	R424	4H
C118*	2J	C802	5I	P24	5M	R23	4L	R425	4H
C119	1J	C817	3B	P138	1I	R24	4L	R426	4H
C124*	1K			P148	2I	R25	4L	R432	5G
C129	2J	CR26	4L	P168	2L	R26	4L	R433	5H
C412	2M	CR27	5M	P465	2E	R27	5M	R434	5G
C423*	4H	CR113	1K	P466	2F	R112	3K	R435	4G
C424	3H	CR123	1K	P470	1I	R113	1K	R437	5H
C425	5I	CR416	4I	P475	2A	R114	1K	R443	2H
C433	4H	CR418	4I			R115	1J	R444	2F
C434	4H	CR437	5G	Q112	1J	R116	1K	R445	1G
C435	4G	CR443	1H	Q122	2J	R117	3L	R446	1G
C437*	5H	CR463	2D	Q134	1I	R118	2J	R447	2G
C443	2H	CR465	2D	Q136	1I	R120	2K	R453	1G
C445	1G	CR466*	2B	Q144	2I	R122	3J	R455	1E
C455	4C	CR816	2I	Q146	2I	R124*	1K	R457	3B
C458	3C			Q416	4I	R126	2K	R458	4C
C462	1D	DS463	2F	Q424	4H	R169*	2M	R462	1E
C463	1E	DS465	2F	Q426	4H	R412	2L	R463	2E
C464	1E			Q434	5H	R413	3L	R464*	2E
C465	3D	J2	5L	Q446	1F	R414	3L	R465	2E
C466	3E	J4	5J	Q454	1G	R416	4I	R466*	1F
								R467*	1F
								R468	2G
								R469*	1E
								R473	5B
								R474	2I
								R475	5B
								R476	5B
								R478	5B
								R802	5L
								R811*	3L
								R817	3B
								R818	4A
								RT120	2K
								S410	3L
								S700	5F
								T460	2C
								U24	4L
								U460	4D
								VR412	4M
								VR818	4A

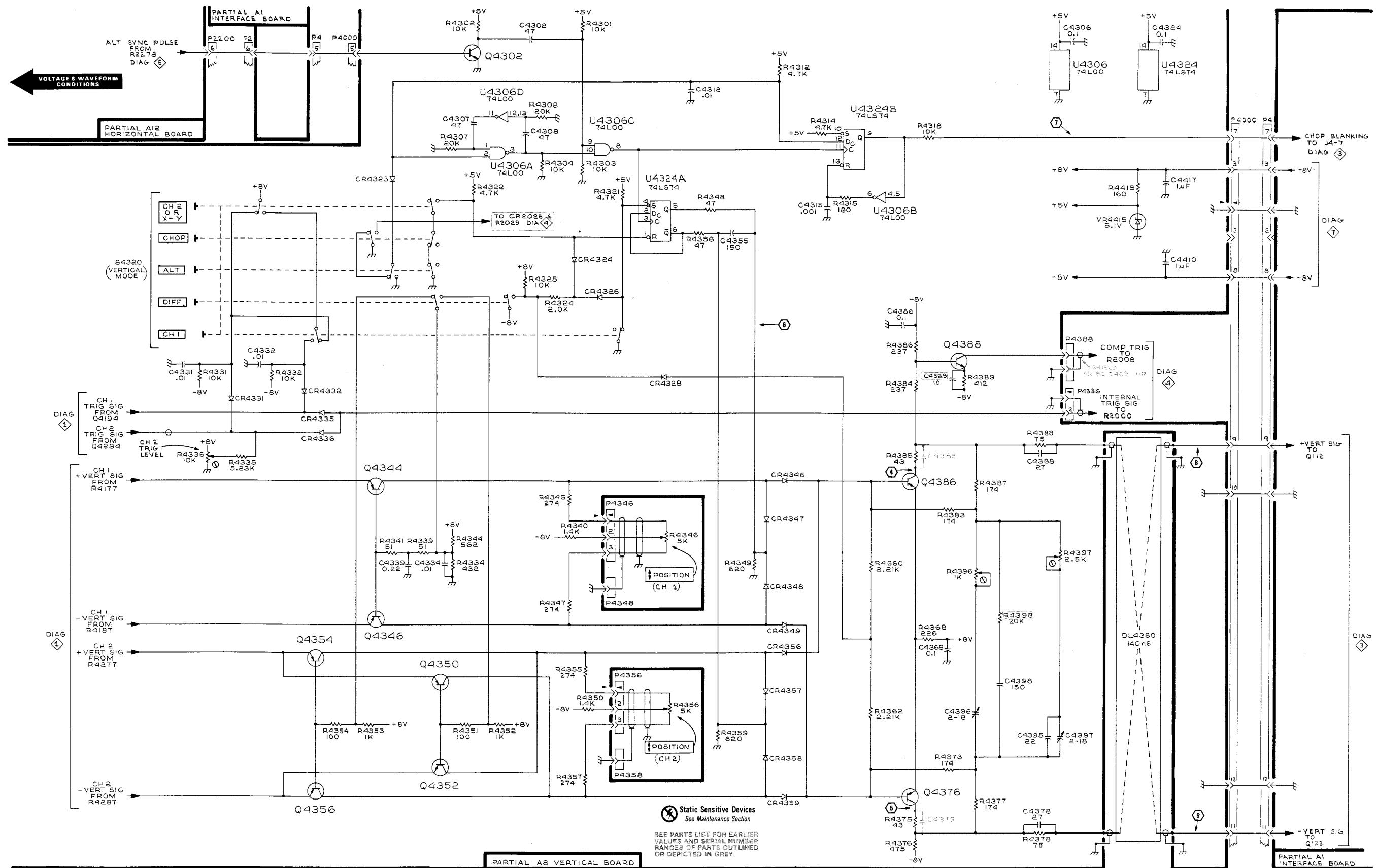
 Static Sensitive Devices
See Maintenance Section

*See Parts List for serial number ranges.
†Mounted on chassis.



2374-34A

Figure 7-8. Interface circuit board location.



VOLTAGE & WAVEFORM CONDITIONS

S4320 (VERTICAL MODE)
 CH 2 OR X-Y
 CHOP
 ALT
 DIFF
 CH 1

Static Sensitive Devices
 See Maintenance Section

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

PARTIAL A8 VERTICAL BOARD

PARTIAL A1 INTERFACE BOARD

VOLTAGE AND WAVEFORM CONDITIONS

Voltage Conditions

Voltages shown on this schematic diagram were measured with a Tektronix DM 502A Digital Multimeter. Voltage measurements can vary as much as $\pm 20\%$. No signals were applied to the vertical inputs or the EXT-ernal trigger input.

Waveform Conditions

Waveforms below were taken from a Tektronix 475A Oscilloscope. Waveforms may vary as much as $\pm 20\%$.

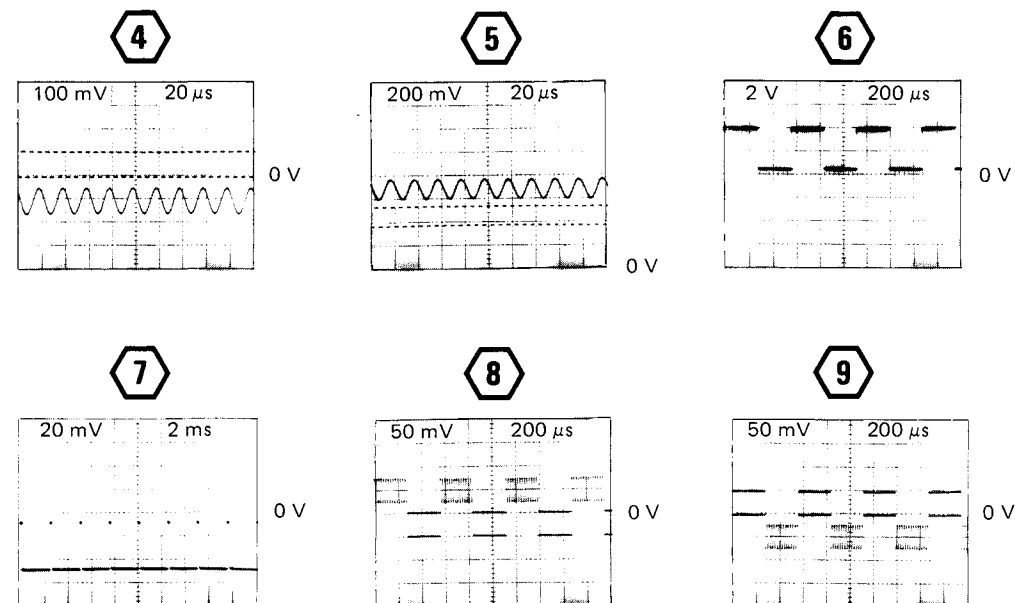
A 50 kHz, 100 mV sine wave was applied to the Channel 1 input and a 50 kHz, 2 V square wave was applied to the Channel 2 input. A Tektronix SG 503 provided the sine wave and a Tektronix FG 502 provided the square wave.

The 442 controls were set as follows:

SOURCE	CH 1/CH 2
MODE	AUTO
SEC/DIV	10 μ s
VERT MODE	ALT
Channel 1 VOLTS/DIV	50 mV
AC-GND-DC (both)	DC
VAR (both)	Detent
MAGNIFIER	X1
HOLDOFF	Fully CCW
Channel 2 VOLTS/DIV	1 V

Other controls were set as needed to obtain a stable display.

For waveform 7, the SEC/DIV switch was set to 0.2 ms.



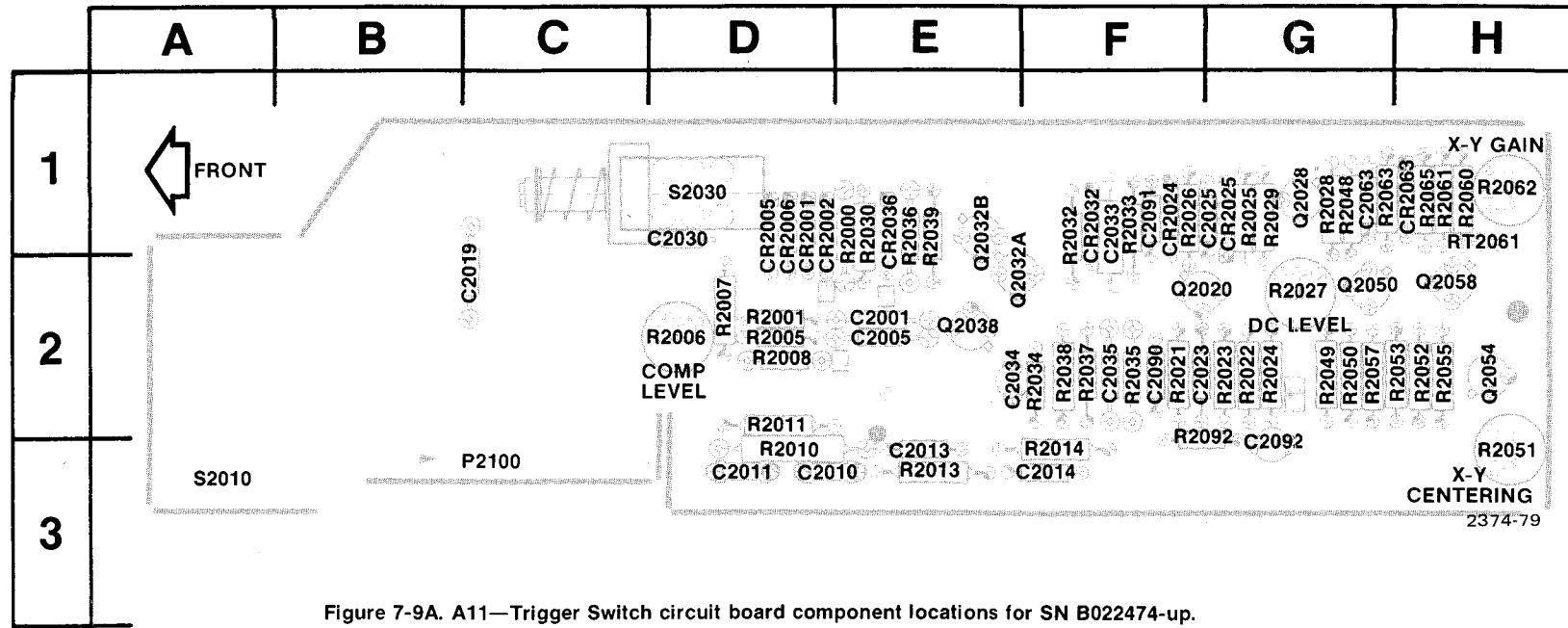


Figure 7-9A. A11—Trigger Switch circuit board component locations for SN B022474-up.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C2001	2E	CR2005	1D	R2006	2D	R2035	2F	RT2061	1H
C2005	2E	CR2006	1D	R2007	2D	R2036	1E		
C2010	3D	CR2024	1F	R2008†	2D	R2037	2F	S2010	3A
C2011	3D	CR2025	1G	R2010	3D	R2038	2F	S2030†	
C2013	3E	CR2032	1F	R2011	2D	R2039	1E	S2050†	
C2014	3F	CR2036	1E	R2013	3E	R2048	1G		
C2019	2C	CR2063	1H	R2014	3F	R2049	2G		
C2023	2F	P2100	3C	R2021	2F	R2050	2G		
C2025	1G	Q2020	2F	R2022	2G	R2051	3H		
C2030	1D	Q2028	1G	R2023	2G	R2052	2H		
C2033	1F	Q2032A	2E	R2024	2G	R2053	2H		
C2034	2E	Q2032B	1E	R2025	1G	R2055	2H		
C2035	2F	Q2038	2E	R2026	1F	R2057	2G		
C2063	1G	Q2050	2G	R2027	2G	R2060	1H		
C2090	2F	Q2054	2H	R2028	1G	R2061	1H		
C2091	1F	Q2058	2H	R2029	1G	R2062	1H		
C2092	3G			R2030	1E	R2063	1G		
CR2001	1D	R2000	1E	R2032	1F	R2065	1H		
CR2002	1D	R2001	2D	R2033	1F	R2092	3F		
		R2005	2D	R2034	2F				

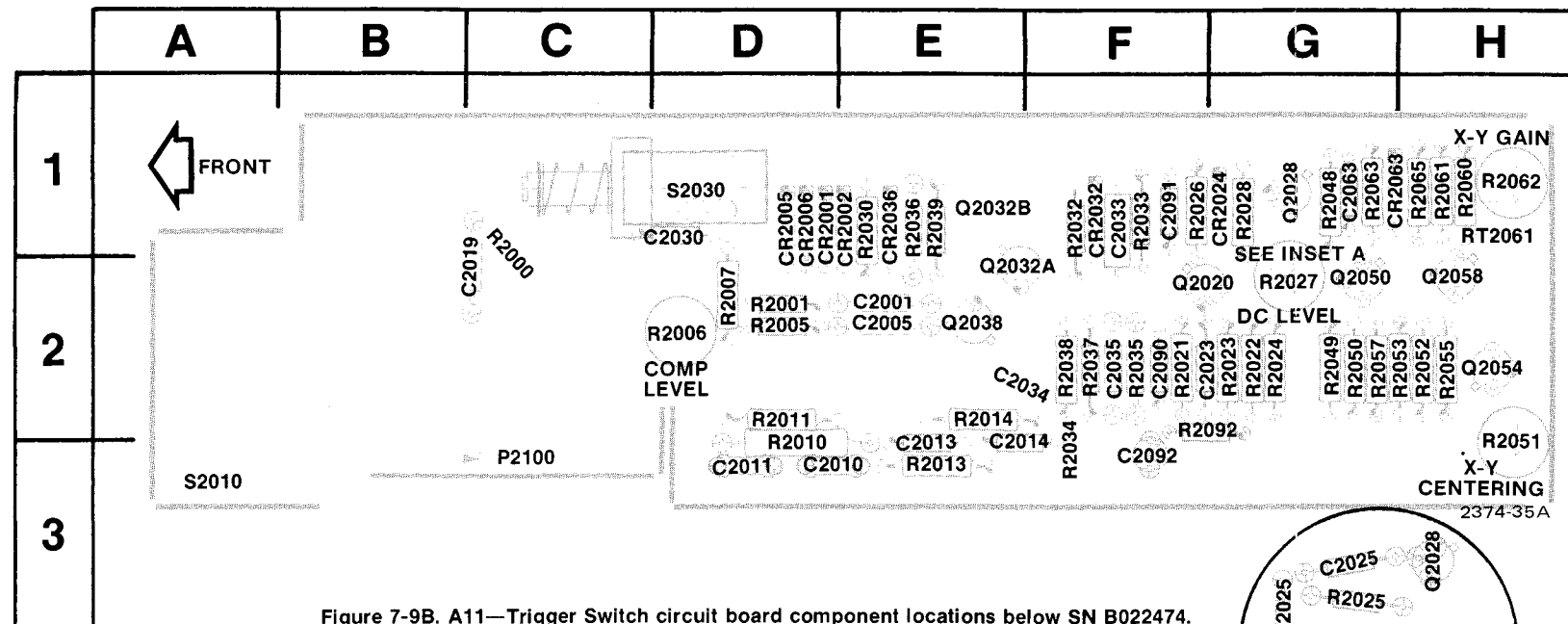
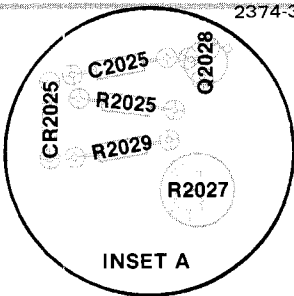


Figure 7-9B. A11—Trigger Switch circuit board component locations below SN B022474.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C2001	2E	CR2005	1D	R2006	2D	R2035	2F	RT2061	1H
C2005	2E	CR2006	1D	R2007	2D	R2036	1E		
C2010	3D	CR2024	1G	R2008*†		R2037	2F	S2010	3A
C2011	3D	CR2025* INSET		R2010	3D	R2038	2F	S2030†	
C2013	3E	CR2032	1F	R2011	2D	R2039	1E	S2050†	
C2014	3E	CR2036	1E	R2013	3E	R2048	1G		
C2019	2C	CR2063	1G	R2014	2E	R2049	2G		
C2023	2G	P2100	3C	R2021	2F	R2050	2G		
C2025* INSET		Q2020	2F	R2022	2G	R2051	3H		
C2030	1D	Q2028	1G	R2023	2G	R2052	2H		
C2033	1F	Q2032A	2E	R2024	2G	R2053	2H		
C2034	2E	Q2032B	1E	R2025* INSET		R2055	2H		
C2035	2F	Q2038	2E	R2026	1F	R2057	2G		
C2063	1G	Q2050	2G	R2027	2G	R2060	1H		
C2090	2F	Q2054	2H	R2028	1G	R2061	1H		
C2091	1F	Q2058	2H	R2029* INSET		R2062	1H		
C2092	3F			R2030	1E	R2063	1G		
CR2001	1D	R2000*	1C	R2032	1F	R2065	1H		
CR2002	1E	R2001	2D	R2033	1F	R2092	2F		
		R2005	2D	R2034	3F				

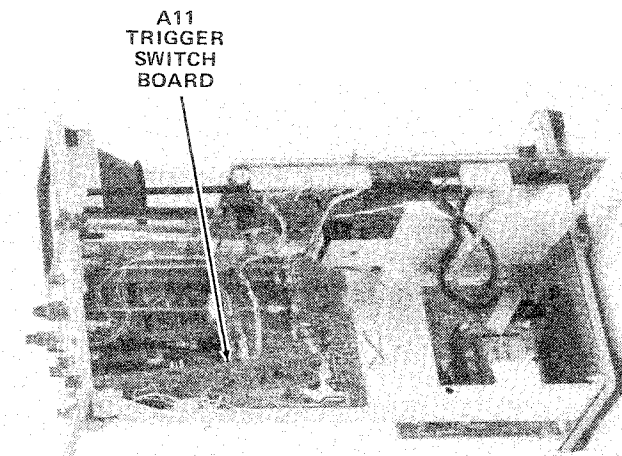


Static Sensitive Devices
See Maintenance Section

*See Parts List for serial number ranges.
†Located on back of board.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C2001	2E	CR2005	1D	R2006	2D	R2035	2F	RT2061	1H
C2005	2E	CR2006	1D	R2007	2D	R2036	1E		
C2010	3D	CR2024	1F	R2008†	2D	R2037	2F	S2010	3A
C2011	3D	CR2025	1G	R2010	3D	R2038	2F	S2030†	
C2013	3E	CR2032	1F	R2011	2D	R2039	1E	S2050†	
C2014	3F	CR2036	1E	R2013	3E	R2048	1G		
C2019	2C	CR2063	1H	R2014	3F	R2049	2G		
C2023	2F	P2100	3C	R2021	2F	R2050	2G		
C2025	1G	Q2020	2F	R2022	2G	R2051	3H		
C2030	1D	Q2028	1G	R2023	2G	R2052	2H		
C2033	1F	Q2032A	2E	R2024	2G	R2053	2H		
C2034	2E	Q2032B	1E	R2025	1G	R2055	2H		
C2035	2F	Q2038	2E	R2026	1F	R2057	2G		
C2063	1G	Q2038	2E	R2027	2G	R2060	1H		
C2090	2F	Q2050	2G	R2028	1G	R2061	1H		
C2091	1F	Q2054	2H	R2029	1G	R2062	1H		
C2092	3G	Q2058	2H	R2030	1E	R2063	1G		
				R2032	1F	R2065	1H		
CR2001	1D	R2000	1E	R2033	1F	R2092	3F		
CR2002	1D	R2001	2D	R2034	2F				
		R2005	2D						

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C2001	2E	CR2005	1D	R2006	2D	R2035	2F	RT2061	1H
C2005	2E	CR2006	1D	R2007	2D	R2036	1E		
C2010	3D	CR2024	1G	R2008†	2D	R2037	2F	S2010	3A
C2011	3D	CR2025* INSET		R2010	3D	R2038	2F	S2030†	
C2013	3E	CR2032	1F	R2011	2D	R2039	1E	S2050†	
C2014	3E	CR2036	1E	R2013	3E	R2048	1G		
C2019	2C	CR2063	1G	R2014	2E	R2049	2G		
C2023	2G	P2100	3C	R2021	2F	R2050	2G		
C2025* INSET		Q2020	2F	R2022	2G	R2051	3H		
C2030	1D	Q2028	1G	R2023	2G	R2052	2H		
C2033	1F	Q2032A	2E	R2024	2G	R2053	2H		
C2034	2E	Q2032B	1E	R2025* INSET		R2055	2H		
C2035	2F	Q2038	2E	R2026	1F	R2057	2G		
C2063	1G	Q2038	2E	R2027	2G	R2060	1H		
C2090	2F	Q2050	2G	R2028	1G	R2061	1H		
C2091	1F	Q2054	2H	R2029* INSET		R2062	1H		
C2092	3F	Q2058	2H	R2030	1E	R2063	1G		
				R2032	1F	R2065	1H		
CR2001	1D	R2000*	1C	R2033	1F	R2092	2F		
CR2002	1E	R2001	2D	R2034	3F				
		R2005	2D						



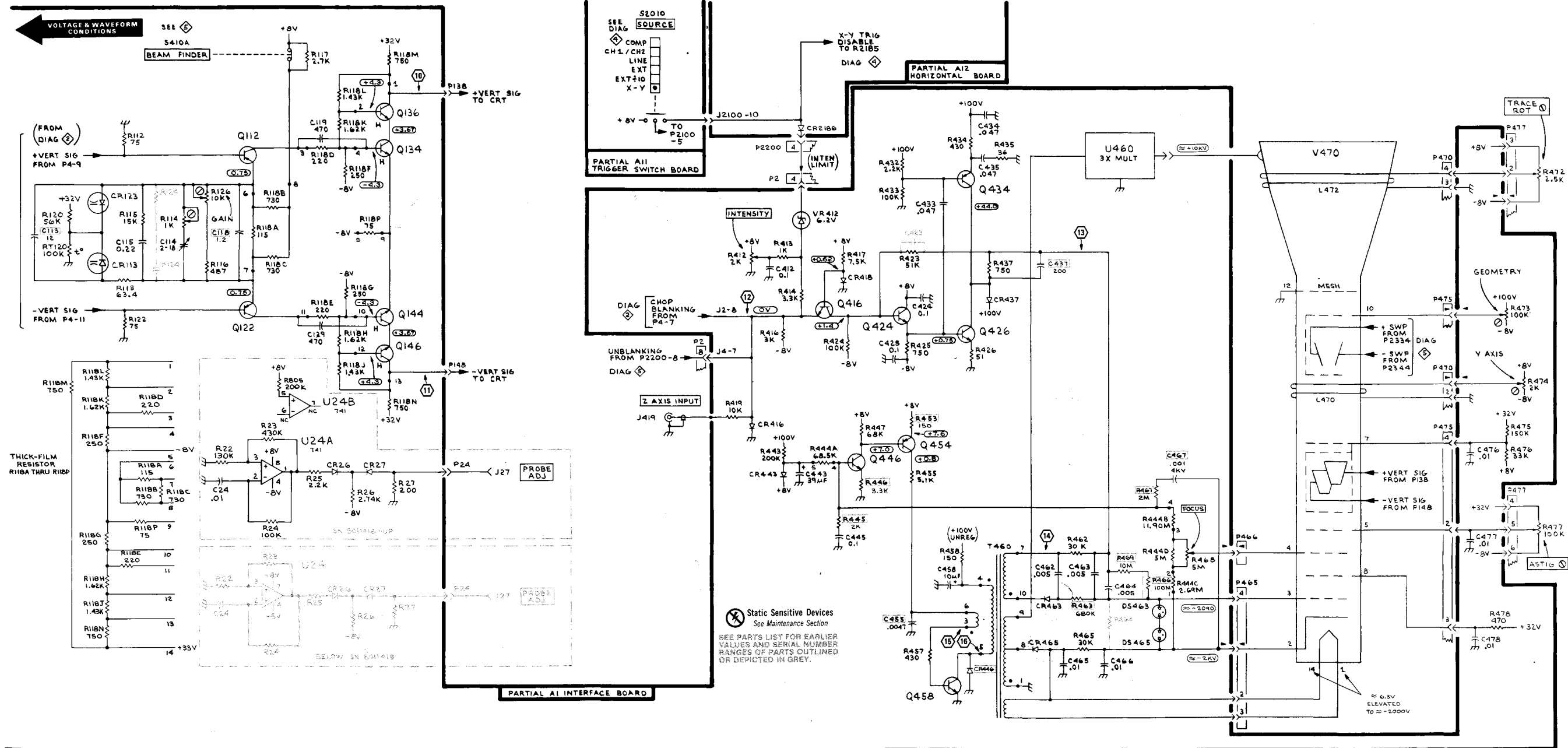
2374-36A

Figure 7-10. Trigger Switch circuit board location.

 Static Sensitive Devices
See Maintenance Section

*See Parts List for serial number ranges.

†Located on back of board.



VOLTAGE AND WAVEFORM CONDITIONS

Voltage Conditions

Voltages shown on this schematic diagram were measured with a Tektronix DM 502A Digital Multimeter. Voltage measurements can vary as much as $\pm 20\%$. No signals were applied to the vertical inputs or the External trigger input.

Waveform Conditions

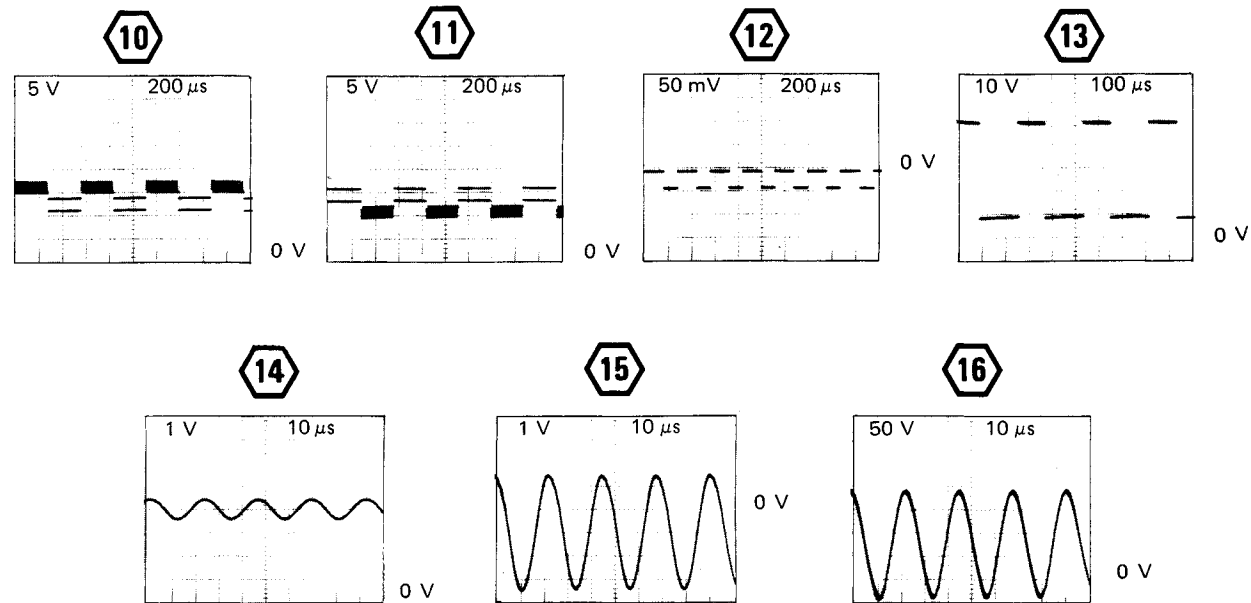
Waveforms below were taken from a Tektronix 475A Oscilloscope. The oscilloscope input coupling was set to dc. Waveforms may vary as much as $\pm 20\%$.

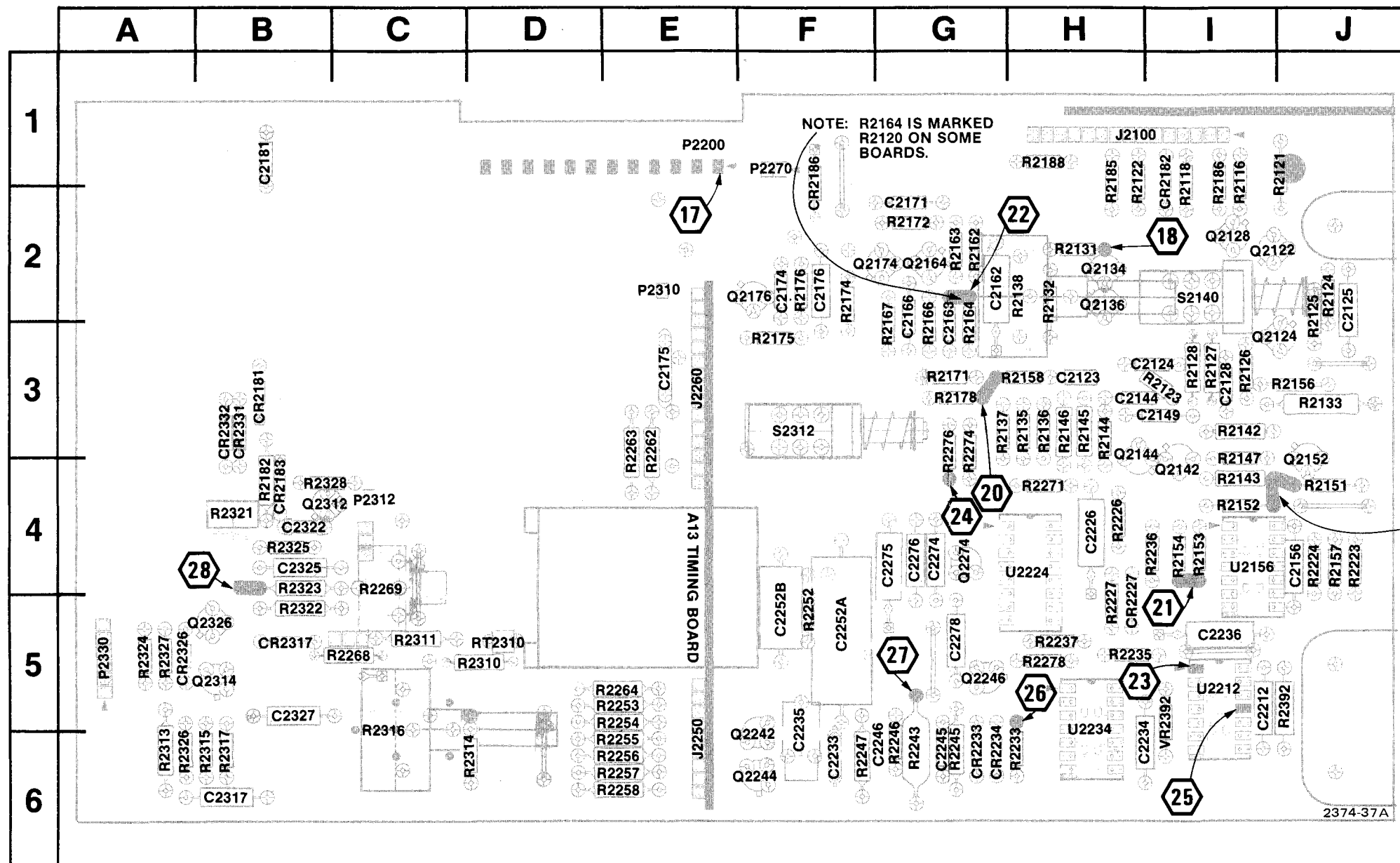
A 50 kHz, 100 mV sine wave was applied to the Channel 1 input and a 50 kHz, 2 V square wave was applied to the Channel 2 input. A Tektronix SG 503 provided the sine wave and a Tektronix FG 502 provided the square wave.

442 controls were set as follows:

SOURCE	CH 1/CH 2
MODE	AUTO
SEC/DIV	10 μ s
VERT MODE	CH 1
Channel 1 VOLTS/DIV	50 mV
AC-GND-DC (both)	DC
VAR (both)	Detent
MAGNIFIER	X1 (out)
HOLDOFF	Fully CCW
Channel 2 VOLTS/DIV	1 V

Other controls were set as needed to obtain a stable display.





CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C2123	3H	P2200	1D	R2151	4J	R2278	5H
C2124	3I	P2270	1F	R2152	4I	R2310	5D
C2125	2J	P2310	2E	R2153	4I	R2311	5C
C2128	3I	P2312	4C	R2154	4I	R2313	6A
C2144	3H	P2330	5A	R2156	3J	R2314	6D
C2149	3I			R2157	4J	R2315	6B
C2156	4J	Q2122	2I	R2158	3H	R2316	5C
C2162	2G	Q2124	3J	R2162	2G	R2317	6B
C2163	2G	Q2128	2I	R2163	2G	R2321	4B
C2166	2G	Q2134	2H	R2164	2G	R2322	5B
C2171	2G	Q2136	2H	R2166	2G	R2323	4B
C2174	2F	Q2142	3I	R2167	2G	R2324	5A
C2175	3E	Q2144	3H	R2171	3G	R2325	4B
C2176	2F	Q2152	4J	R2172	2G	R2326	6A
C2181	1B	Q2164	2G	R2174	2F	R2327	5A
C2212	5I	Q2174	2G	R2175	3F	R2328	4B
C2226	4H	Q2176	2F	R2176	2F	R2392	5J
C2233	6F	Q2242	6F	R2178	3G		
C2234	6I	Q2244	6F	R2182	4B	RT2310	5D
C2235	6F	Q2246	5G	R2185	1H		
C2236	5I	Q2274	4G	R2186	1I	S2140	2I
C2245	6G	Q2312	4B	R2188	1H	S2312	3F
C2246*	6G	Q2314	5B	R2223	4J		
C2252A	5F	Q2326	5B	R2224	4J	U2156	4I
C2252B	5F			R2226	4H	U2212	5I
C2274	4G	R2116	1I	R2227	5H	U2224	4H
C2275	4G	R2118	1I	R2233	6H	U2234	6H
C2276	4G	R2120+	2G	R2235	5H		
C2278	5G	R2121	1J	R2236	4I	VR2392	5I
C2317	6B	R2122	1H	R2237	5H		
C2322	4B	R2123	3I	R2243	6G		
C2325	4B	R2124	3J	R2245	6G		
C2327	5B	R2125	2J	R2246	6G		
		R2126	3I	R2247	6F		
		R2127	3I	R2252	5F		
		R2128	3I	R2253	5E		
		R2131	2H	R2254	5E		
		R2132	2H	R2255	6E		
		R2133	3J	R2256	6E		
		R2135	3H	R2257	6E		
		R2136	3H	R2258	6E		
		R2137	3G	R2262	3E		
		R2138	2H	R2263	3E		
		R2142	3I	R2264	5E		
		R2143	4I	R2268	5C		
		R2144	3H	R2269	4C		
		R2145	3H	R2271	4H		
		R2146	3H	R2274	3G		
		R2147	3I	R2276	3G		
J2100	1H						
J2250	6E						
J2260	3E						

Figure 7-11. A12—Horizontal circuit board component locations.

FRONT 

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C2123	3H	P2200	1D	R2151	4J	R2278	5H
C2124	3I	P2270	1F	R2152	4I	R2310	5D
C2125	2J	P2310	2E	R2153	4I	R2311	5C
C2128	3I	P2312	4C	R2154	4I	R2313	6A
C2144	3H	P2330	5A	R2156	3J	R2314	6D
C2149	3I			R2157	4J	R2315	6B
C2156	4J	Q2122	2I	R2158	3H	R2316	5C
C2162	2G	Q2124	3J	R2162	2G	R2317	6B
C2163	2G	Q2128	2I	R2163	2G	R2321	4B
C2166	2G	Q2134	2H	R2164	2G	R2322	5B
C2171	2G	Q2136	2H	R2166	2G	R2323	4B
C2174	2F	Q2142	3I	R2167	2G	R2324	5A
C2175	3E	Q2144	3H	R2171	3G	R2325	4B
C2176	2F	Q2152	4J	R2172	2G	R2326	6A
C2181	1B	Q2164	2G	R2174	2F	R2327	5A
C2212	5I	Q2174	2G	R2175	3F	R2328	4B
C2226	4H	Q2176	2F	R2176	2F	R2392	5J
C2233	6F	Q2242	6F	R2178	3G		
C2234	6I	Q2244	6F	R2182	4B	RT2310	5D
C2235	6F	Q2246	5G	R2185	1H		
C2236	5I	Q2274	4G	R2186	1I	S2140	2I
C2245	6G	Q2312	4B	R2188	1H	S2312	3F
C2246*	6G	Q2314	5B	R2223	4J		
C2252A	5F	Q2326	5B	R2224	4J	U2156	4I
C2252B	5F			R2226	4H	U2212	5I
C2274	4G	R2116	1I	R2227	5H	U2224	4H
C2275	4G	R2118	1I	R2233	6H	U2234	6H
C2276	4G	R2120†	2G	R2235	5H		
C2278	5G	R2121	1J	R2236	4I	VR2392	5I
C2317	6B	R2122	1H	R2237	5H		
C2322	4B	R2123	3I	R2243	6G		
C2325	4B	R2124	3J	R2245	6G		
C2327	5B	R2125	2J	R2246	6G		
		R2126	3I	R2247	6F		
CR2181	3B	R2127	3I	R2252	5F		
CR2182	1I	R2128	3I	R2253	5E		
CR2183	4B	R2131	2H	R2254	5E		
CR2186	1F	R2132	2H	R2255	6E		
CR2227	5H	R2133	3J	R2256	6E		
CR2233	6G	R2135	3H	R2257	6E		
CR2234	6G	R2136	3H	R2258	6E		
CR2317	5B	R2137	3G	R2262	3E		
CR2326	5A	R2138	2H	R2263	3E		
CR2331	3B	R2142	3I	R2264	5E		
CR2332	3B	R2143	4I	R2268	5C		
		R2144	3H	R2269	4C		
J2100	1H	R2145	3H	R2271	4H		
J2250	6E	R2146	3H	R2274	3G		
J2260	3E	R2147	3I	R2276	3G		

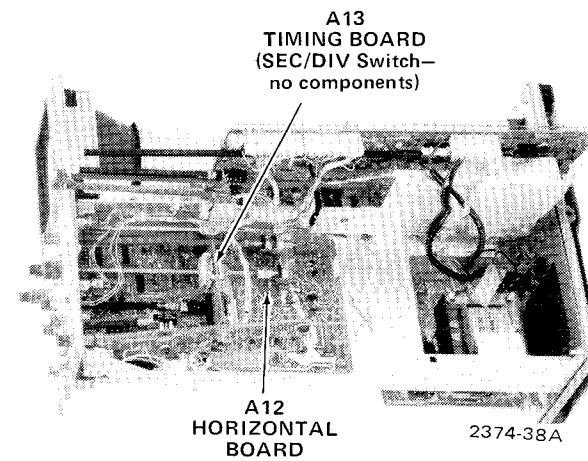
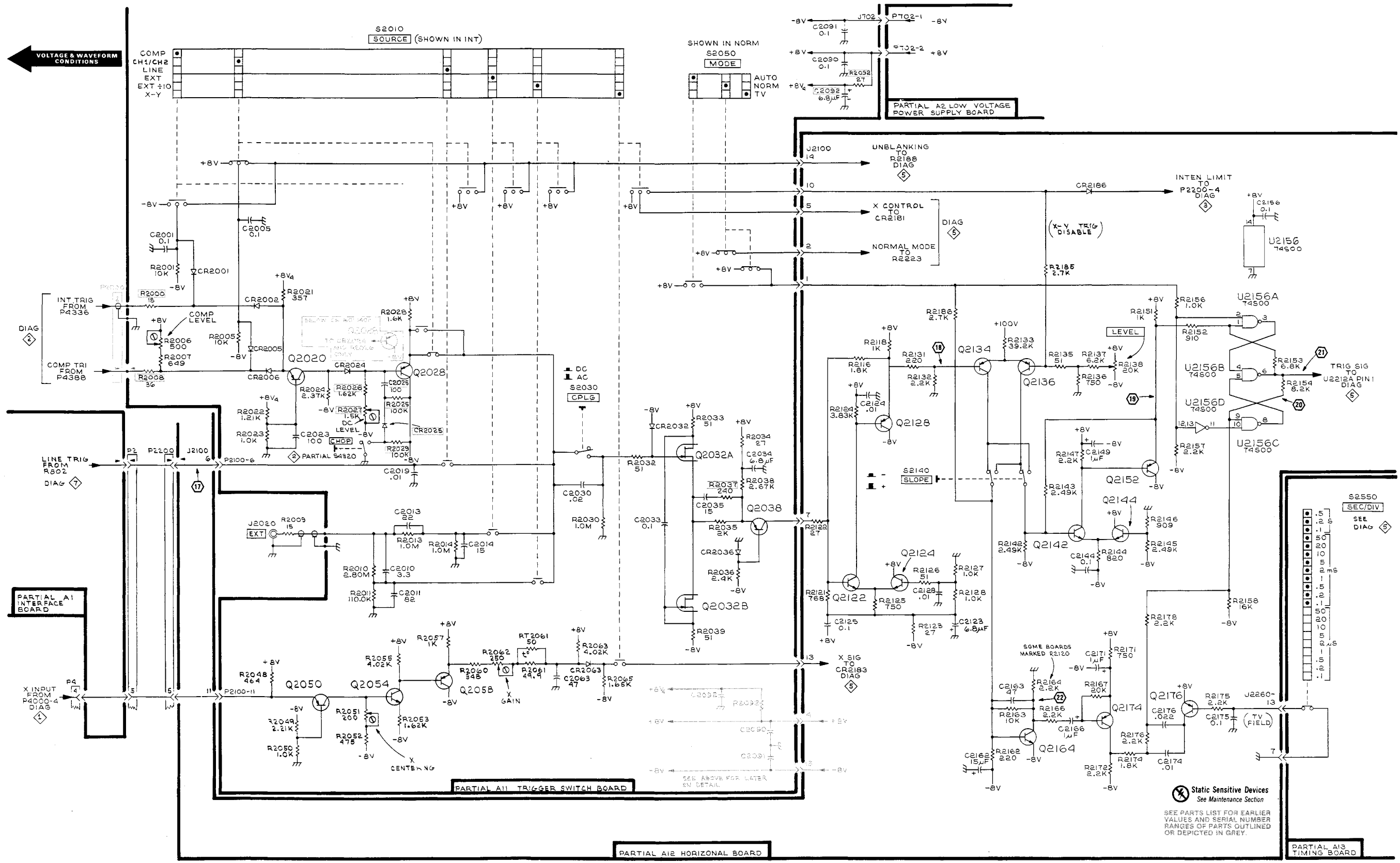


Figure 7-12. Horizontal circuit board location.

 Static Sensitive Devices
See Maintenance Section

*See Parts List for serial number ranges.
†Incorrect marking on some boards, see R2164.



VOLTAGE & WAVEFORM CONDITIONS

PARTIAL A1 INTERFACE BOARD

PARTIAL A11 TRIGGER SWITCH BOARD

PARTIAL A1E HORIZONTAL BOARD

PARTIAL A1S TIMING BOARD

Static Sensitive Devices
See Maintenance Section

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.

VOLTAGE AND WAVEFORM CONDITIONS

Voltage Conditions

Voltages shown on this schematic diagram were measured with a Tektronix DM 502A Digital Multimeter. Voltage measurements can vary as much as $\pm 20\%$. No signals were applied to the vertical inputs or the EXT-ernal trigger input.

Waveform Conditions

Waveforms below were taken from a Tektronix 475A Oscilloscope. Waveforms may vary as much as $\pm 20\%$.

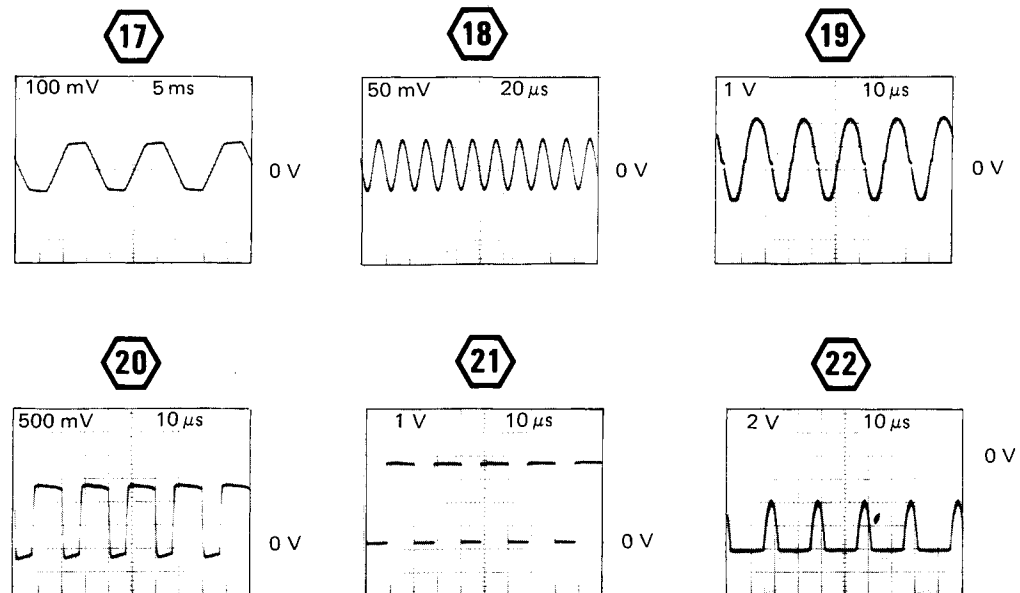
A 50 kHz, 100 mV sine wave was applied to the Channel 1 input and a 50 kHz, 2 V square wave was applied to the Channel 2 input. A Tektronix SG 503 provided the sine wave and a Tektronix FG 502 provided the square wave.

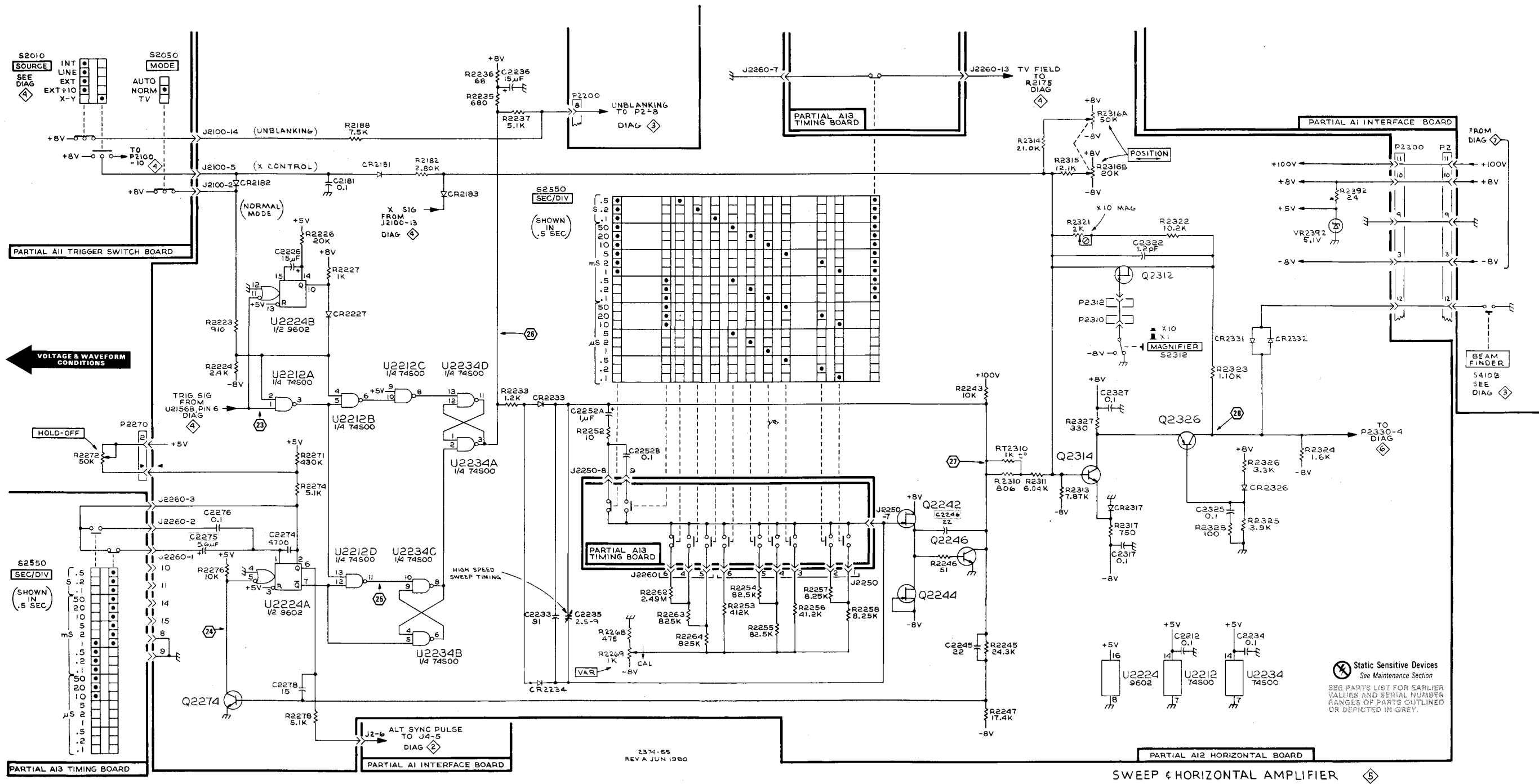
442 controls were set as follows:

SOURCE	CH 1/CH 2
MODE	AUTO
SEC/DIV	$10 \mu\text{s}$
VERT MODE	CH 1
Channel 1 VOLTS/DIV	50 mV
AC-GND-DC (both)	DC
VAR (both)	Detent
MAGNIFIER	X1
HOLDOFF	Fully CCW
Channel 2 VOLTS/DIV	1 V

Other controls were set as needed to obtain a stable display.

For waveform 20, 21, and 22, MODE switch was in TV.





Static Sensitive Devices
See Maintenance Section
SEE PARTS LIST FOR EARLIER
VALUES AND SERIAL NUMBER
RANGES OF PARTS OUTLINED
OR DEPICTED IN GREY.

VOLTAGE AND WAVEFORM CONDITIONS

Voltage Conditions

Voltages shown on this schematic diagram were measured with a Tektronix DM 502A Digital Multimeter. Voltage measurements can vary as much as $\pm 20\%$. No signals were applied to the vertical inputs or to EXT-ernal trigger input.

Waveform Conditions

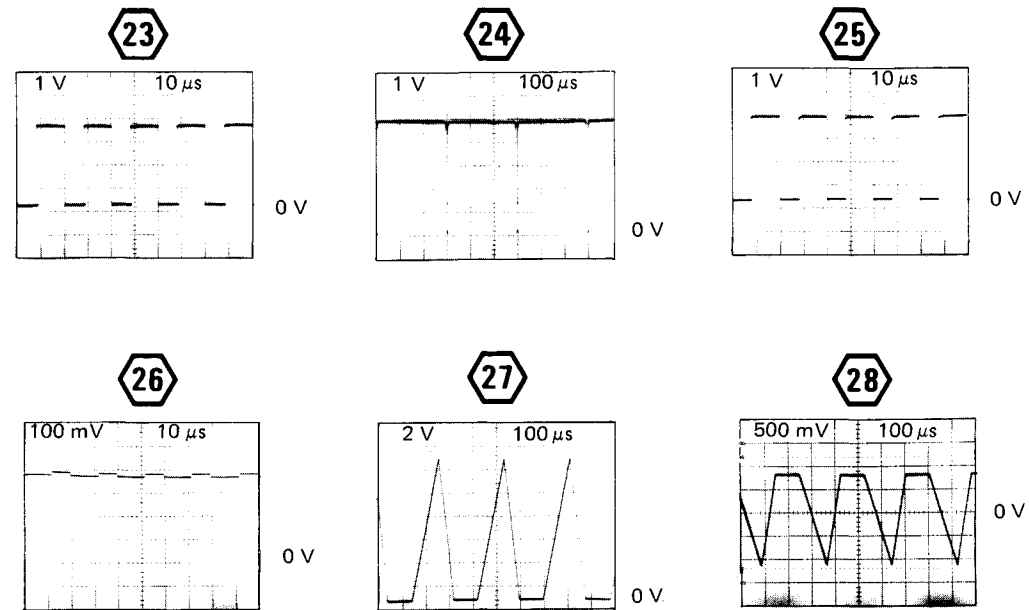
Waveforms below were taken from a Tektronix 475A Oscilloscope. Waveforms may vary as much as $\pm 20\%$.

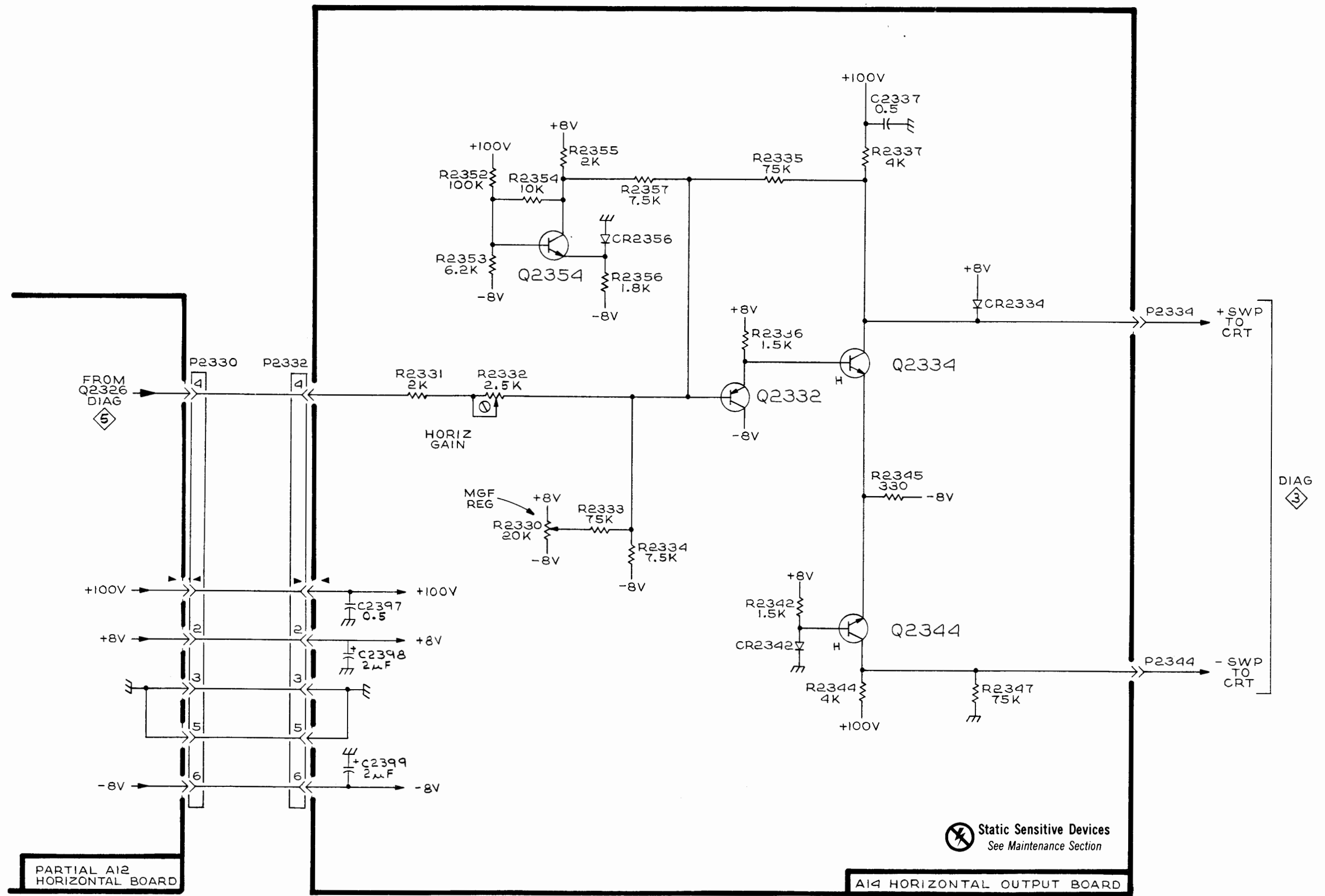
A 50 kHz, 100 mV sine wave was applied to the Channel 1 input and a 50 kHz, 2 V square wave was applied to the Channel 2 input. A Tektronix SG 503 provided the sine wave and a Tektronix FG 502 provided the square wave.

442 controls were set as follows:

SOURCE	CH 1/CH 2
MODE	AUTO
SEC/DIV	10 μ s
VERT MODE	CH 1
Channel 1 VOLTS/DIV	50 mV
AC-GND-DC	DC
VAR (both)	Detent
MAGNIFIER	X1 (out)
HOLD OFF	Fully CCW
Channel 2 VOLTS/DIV	1 V

Other controls were set as needed to obtain a stable display.





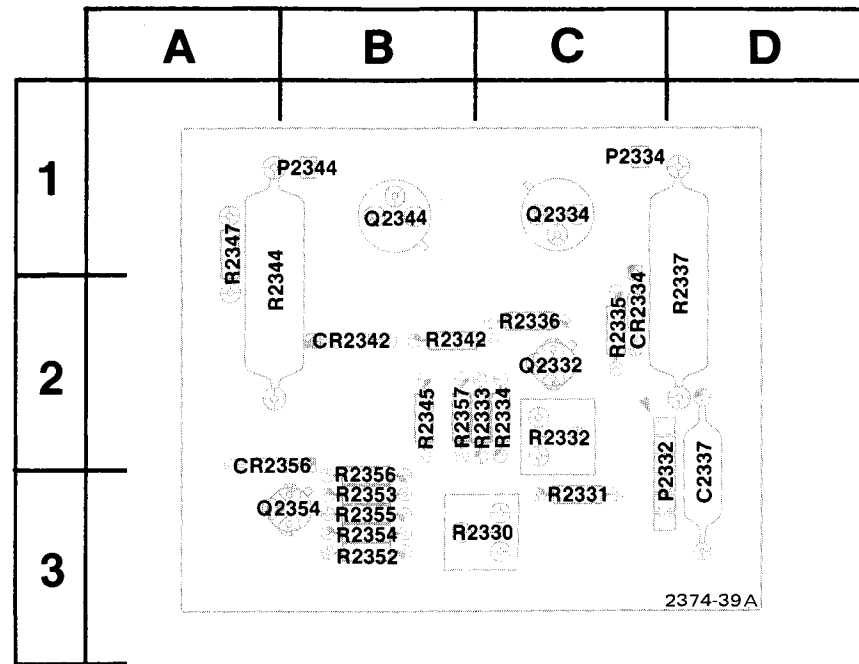


Figure 7-13. A14—Horizontal Output circuit board component locations.

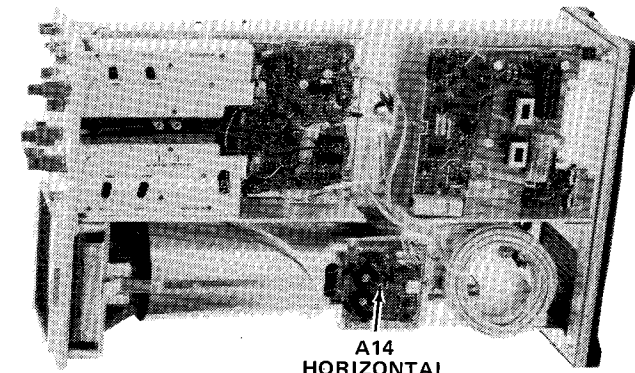


Figure 7-14. Horizontal Output circuit board locations.

CKT NO	GRID LOC	CKT NO	GRID LOC
C2337	3D	R2331	3C
C2398†		R2332	2C
C2399†		R2333	2C
		R2334	2C
CR2334	2C	R2335	2C
CR2342	2B	R2336	2C
CR2356	2A	R2337	2D
		R2342	2B
P2332	3C	R2344	2A
P2334	1C	R2345	2B
R2344	1B	R2347	1A
		R2352	3B
Q2332	2C	R2353	3B
Q2334	1C	R2354	3B
Q2344	1B	R2355	3B
Q2354	3B	R2356	3B
		R2357	2B
R2330	3C		

FIGURE 7-14

Static Sensitive Devices
See Maintenance Section
†Located on back of board.

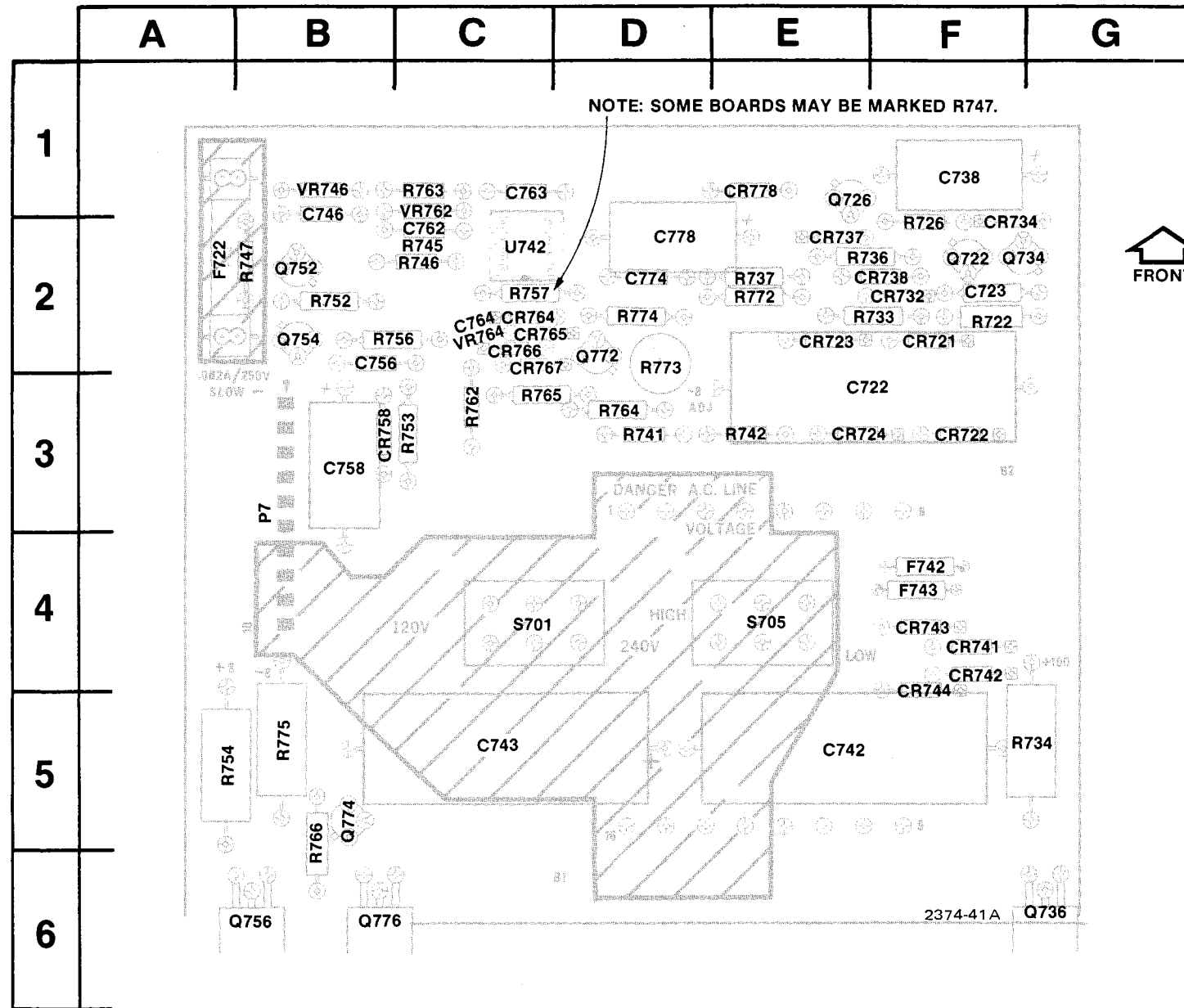


Figure 7-15. A2—Power Supply circuit board component locations.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C722†	3F	CR737	2E	Q726	1E	R746	2C	T700†	
C723*	2F	CR738	2F	Q734	2F	R747	2B	U742	2C
C738	1F	CR741	4F	Q736‡	6G	R752	2B		
C742	5E	CR742	4F	Q752	2B	R753	3C		
C743	5C	CR743	4F	Q754	2B	R754	5A	VR746	1B
C746	2B	CR744	5F	Q756‡	6B	R756	2B	VR762	1C
C756	2B	CR758	3B	Q772	2D	R757§	2C	VR764*	2C
C758	3B	CR764*	2C	Q774	5B	R762	3C		
C762*	2C	CR765*	2C	Q776‡	6B	R763	1C		
C763	1C	CR766*	2C			R764	3D		
C764*	2C	CR767	2C	R722	2F	R765	3C		
C774	2D	CR778	1E	R726	2F	R766	5B		
C778	2D			R732	2F	R772	2E		
		F722	2A	R733	2F	R773	2D		
CR721	2F	F742	4F	R734	5G	R774	2D		
CR722	3F	F743	4F	R736	2E	R775	5B		
CR723	2E			R737	2E				
CR724	3E	P7	3B	R741	3D	S701	4C		
CR732	2F			R742	3E	S705	4E		
CR734	2F	Q722	2F	R745	2C				

Static Sensitive Devices
See Maintenance Section

*See Parts List for serial number ranges.

†Located on back of board.

‡Located on chassis assembly.

§Some boards incorrectly marked R747.

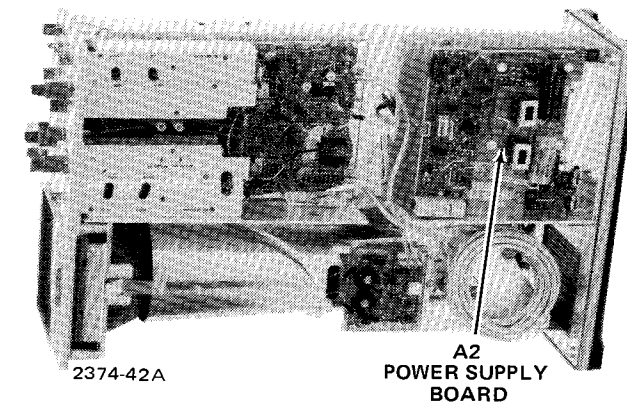
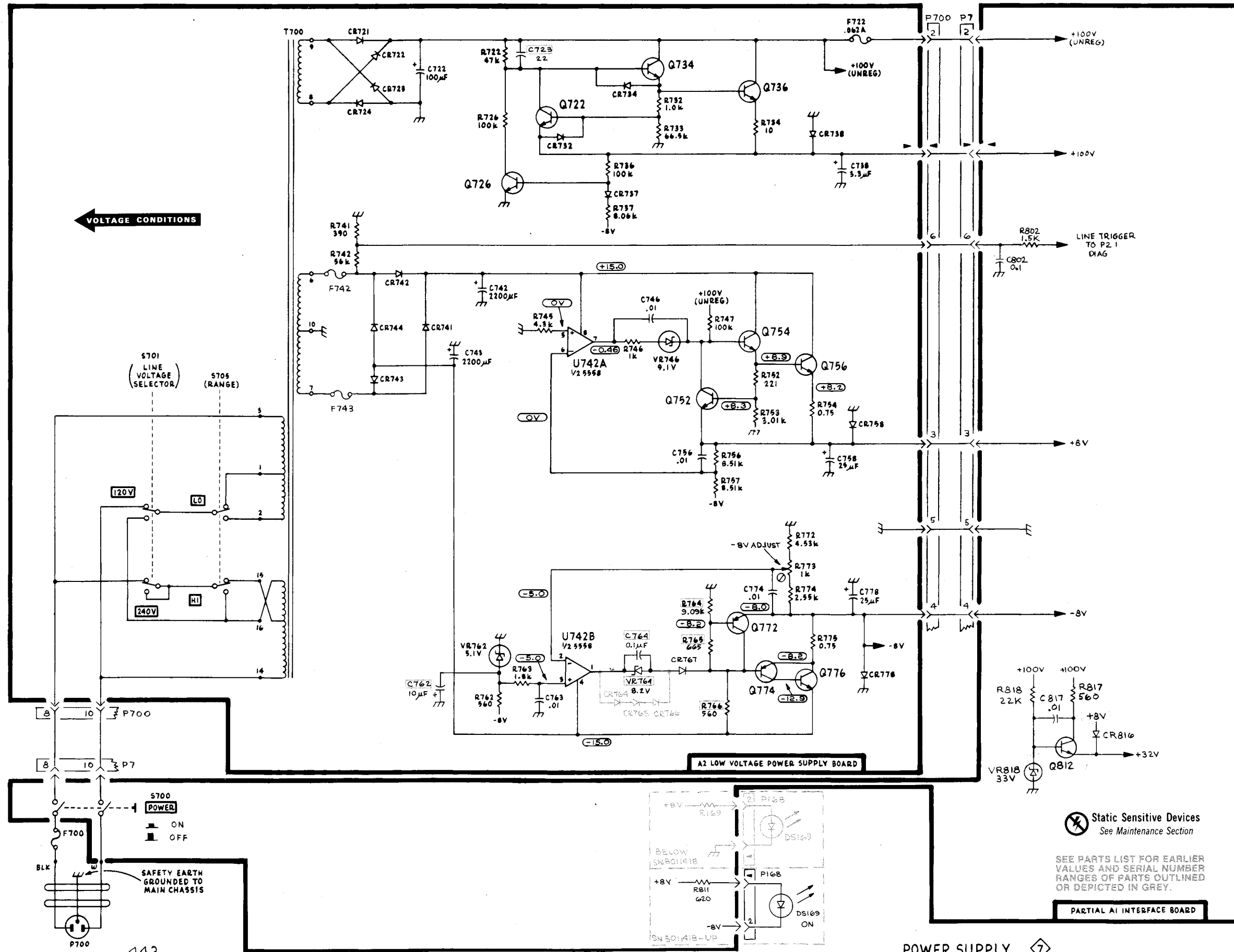


Figure 7-16. Power Supply circuit board location.

VOLTAGE CONDITIONS

Voltages shown on this schematic diagram were measured with a Tektronix DM 502A Digital Multimeter. Voltage measurements can vary as much as $\pm 20\%$. No signals were applied to the vertical input or to EXT-ernal trigger input.



VOLTAGE CONDITIONS ←

442

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⊗ Static Sensitive Devices
See Maintenance Section

SEE PARTS LIST FOR EARLIER
VALUES AND SERIAL NUMBER
RANGES OF PARTS OUTLINED
OR DEPICTED IN GREY.

PARTIAL A1 INTERFACE BOARD

POWER SUPPLY ◊

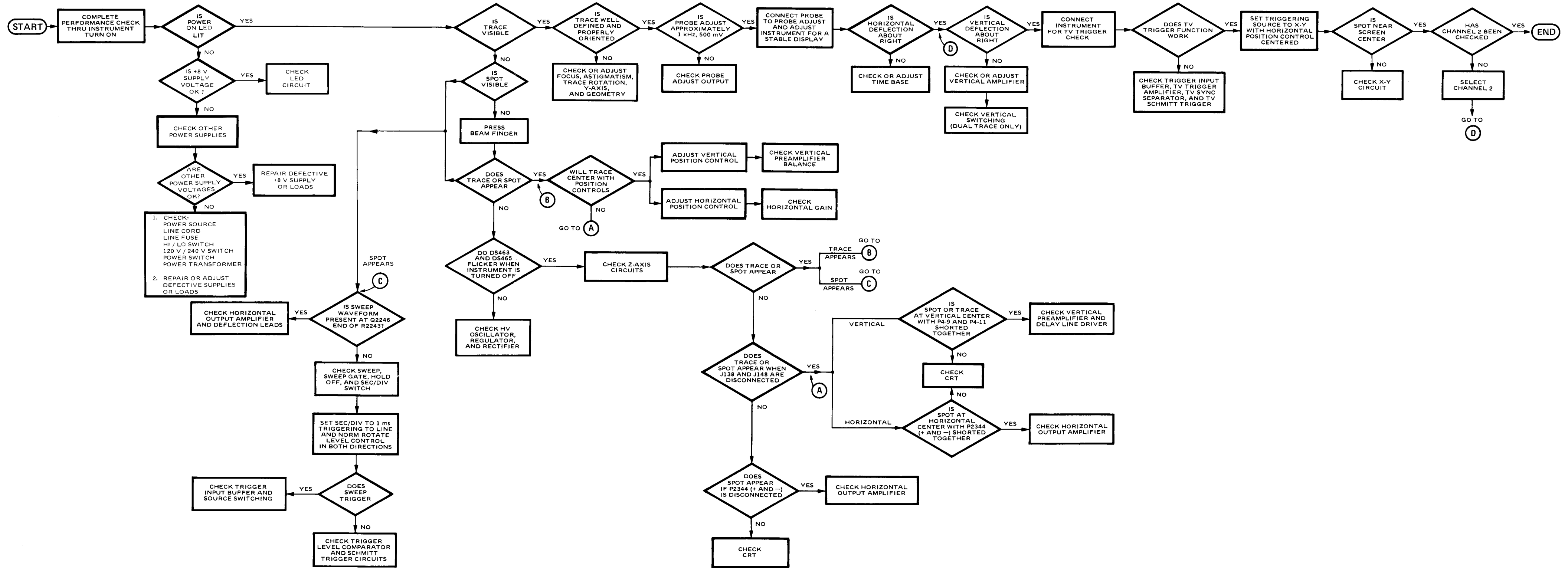


Figure 7-17. 442 Oscilloscope troubleshooting chart.

REPLACEABLE MECHANICAL 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

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```

1 2 3 4 5           Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
    ---*---
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
    ---*---
Parts of Detail Part
Attaching parts for Parts of Detail Part
    ---*---
  
```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol ---*--- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

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.

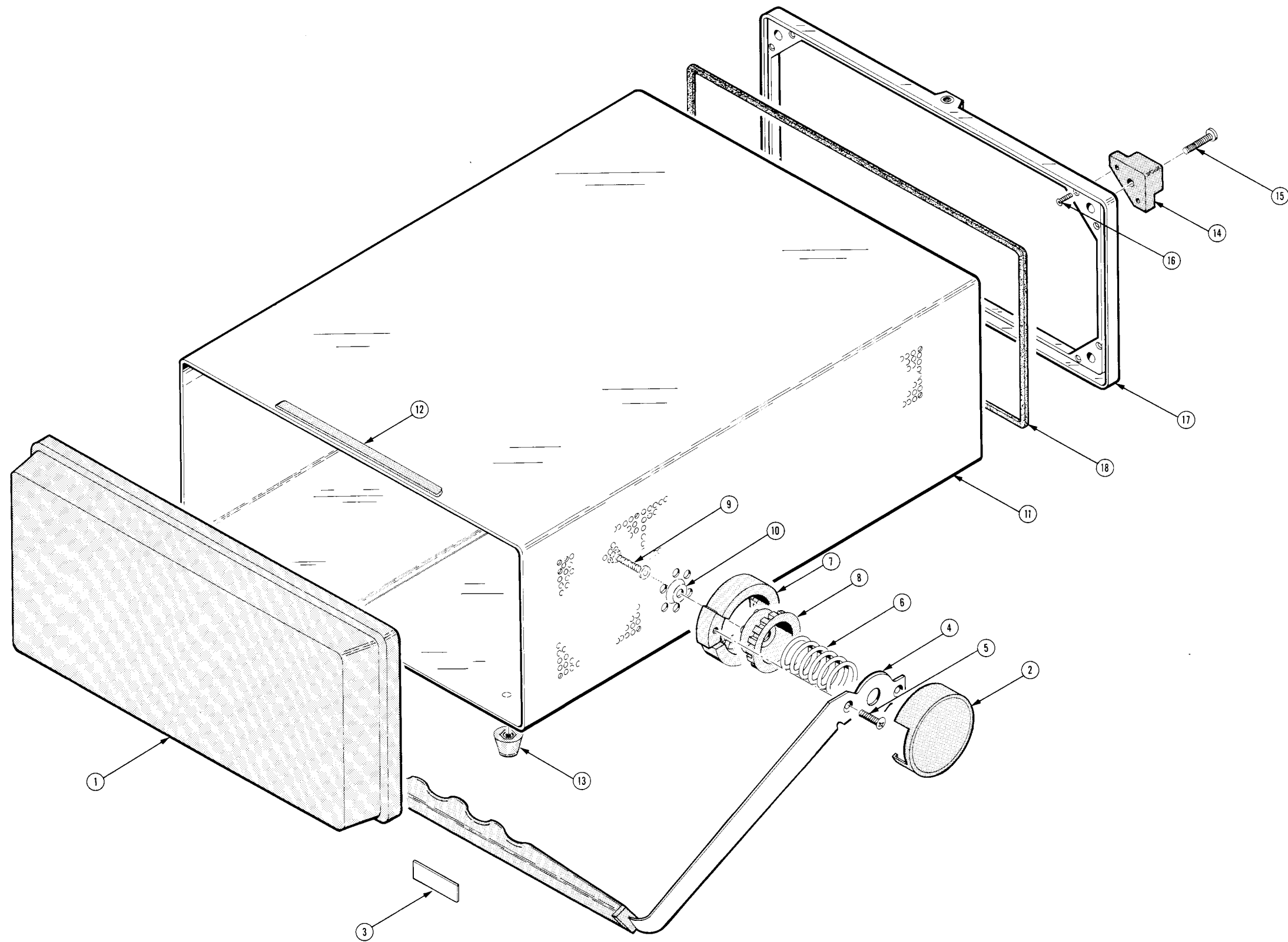
ABBREVIATIONS

"	INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
#	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMICOND	SEMICONDUCTOR
ADPTR	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGN	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVEING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLCPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDENT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
000AH	STANDARD PRESSED STEEL CO., UNBRAKO DIV.	8535 DICE ROAD	SANTA FE SPRINGS, CA 90670
000CY	NORTHWEST FASTENER SALES, INC.	7923 SW CIRRUS DRIVE	BEAVERTON, OREGON 97005
000EF	PLASTIC SUPPLIERS	12916 S. BROADWAY	LOS ANGELES, CA 90061
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
05574	VIKING INDUSTRIES, INC.	21001 NORDHOFF STREET	CHATSWORTH, CA 91311
06915	RICHCO PLASTIC CO.	5825 N. TRIPP AVE.	CHICAGO, IL 60646
07111	PNEUMO DYNAMICS CORPORATION	4800 PRUDENTIAL TOWER	BOSTON, MA 02199
08261	SPECTRA-STRIP CORP.	7100 LAMPSON AVE.	GARDEN GROVE, CA 92642
11897	PLASTIGLIDE MFG. CORPORATION	P O BOX 867, 1757 STANFORD ST.	SANTA MONICA, CA 90406
13103	THERMALLOY COMPANY, INC.	2021 W VALLEY VIEW LANE P O BOX 34829	DALLAS, TEXAS 75234
13511	AMPHENOL CARDRE DIV., BUNKER RAMO CORP.		LOS GATOS, CA 95030
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
23050	PRODUCT COMPONENTS CORP	30 LORRAINE AVE.	MT VERNON, NY 10553
26233	USM CORP NYLOC FASTENER DIV.	1501 W SEPULVEDA BLVD. P.O. BOX 3158	TORRANCE, CA 90510
26365	GRIES REPRODUCER CO., DIV. OF COATS AND CLARK, INC.	125 BEECHWOOD AVE.	NEW ROCHELLE, NY 10802
27264	MOLEX PRODUCTS CO.	5224 KATRINE AVE.	DOWNERS GROVE, IL 60515
28520	HEYMAN MFG. CO.	147 N. MICHIGAN AVE.	KENILWORTH, NJ 07033
28817	CAL-METEX CORP., SUBSIDIARY OF METEX CORP.	509 HINDRY AVE.	INGLEWOOD, CA 90301
55210	GETTIG ENG. AND MFG. COMPANY	PO BOX 85, OFF ROUTE 45	SPRING MILLS, PA 16875
59730	THOMAS AND BETTS COMPANY	36 BUTLER ST.	ELIZABETH, NJ 07207
70485	ATLANTIC INDIA RUBBER WORKS, INC.	571 W. POLK ST.	CHICAGO, IL 60607
71159	BRISTOL SOCKET SCREW, DIV. OF AMERICAN CHAIN AND CABLE CO., INC.	P O BOX 2244, 40 BRISTOL ST.	WATERBURY, CT 06720
71279	CAMBRIDGE THERMIONIC CORP.	445 CONCORD AVE.	CAMBRIDGE, MA 02138
71590	CENTRALAB ELECTRONICS, DIV. OF GLOBE-UNION, INC.	P O BOX 858	FORT DODGE, IA 50501
73743	FISCHER SPECIAL MFG. CO.	446 MORGAN ST.	CINCINNATI, OH 45206
74445	HOLO-KROME CO.	31 BROOK ST. WEST	HARTFORD, CT 06110
75915	LITTELFUSE, INC.	800 E. NORTHWEST HWY	DES PLAINES, IL 60016
78189	ILLINOIS TOOL WORKS, INC. SHAKEPROOF DIVISION	ST. CHARLES ROAD	ELGIN, IL 60120
79963	ZIERICK MFG. CO.	RADIO CIRCLE	MT. KISCO, NY 10549
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83330	SMITH, HERMAN H., INC.	812 SNEDIKER AVE.	BROOKLYN, NY 11207
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
86928	SEASTROM MFG. COMPANY, INC.	701 SONORA AVENUE	GLENDALE, CA 91201
88245	LITTON SYSTEMS, INC., USECO DIV.	13536 SATICOY ST.	VAN NUYS, CA 91409
98978	INTERNATIONAL ELECTRONIC RESEARCH CORP.	135 W. MAGNOLIA BLVD.	BURBANK, CA 91502
99742	PERMACEL DIV. OF JOHNSON AND JOHNSON	U. S. HIGHWAY 1	NEW BRUNSWICK, NJ 08901

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
1-1	200-1203-00			1						COVER,SCOPE:FRONT	80009	200-1203-00
	-----			-						(STANDARD ACCESSORY)		
-2	200-0602-00			2						COVER,HDL LATCH:2.12 DIA X 0.7,ACETAL	80009	200-0602-00
-3	334-3147-00			1						MARKER,IDENT:	80009	334-3147-00
-4	367-0195-00			1						HANDLE,CARRYING:	80009	367-0195-00
										(ATTACHING PARTS)		
-5	213-0227-00			4						SCR,TPG,THD FOR:6-32 X 0.50 DEG,FLH ST	83385	OBD
										- - - * - - -		
-6	214-0516-00			2						SPRING,HLCPS:0.959 DIA X 1.250 INCH LONG	80009	214-0516-00
-7	214-1987-00			2						INDEX,HDL RING:	80009	214-1987-00
-8	214-0515-02			2						HUB,HDL INDEX:1.42 DIA X 0.565 THK,AL CD	80009	214-0515-02
										(ATTACHING PARTS)		
-9	213-0139-01			2						SCREW,SLFLKG:10-24 X 0.375HEX HD. STL	26233	P38AS 1024 6C
-10	210-1182-00			2						WSHR,SPR TNSN:0.218 ID X 0.69 INCH OD	80009	210-1182-00
										- - - * - - -		
-11	390-0593-00	B010100	B021769	1						CAB.,WRAPAROUND:	80009	390-0593-00
	390-0593-01	B021770		1						CAB.,WRAPAROUND:	80009	390-0593-01
-12	352-0263-00			1						. HLDR,POUCH ASSY:	80009	352-0263-00
-13	348-0080-01			4						. FOOT,CABINET:BOTTOM	80009	348-0080-01
-14	348-0541-00			4						FOOT,REAR:BLACK,PLASTIC	80009	348-0541-00
										(ATTACHING PARTS)		
-15	212-0626-00			4						SCREW,MACHINE:10-24 X 0.875L,PNH,STL	000AH	OBD
-16	213-0012-00			8						SCREW,MACHINE:4-40 X 0.375 INCH,FLH STL	83385	OBD
										- - - * - - -		
-17	426-0720-01			1						FRAME SECT,CAB.:REAR	80009	426-0720-01
-18	348-0277-00			1						SHLD GSKT,ELEC:2.80 FEET LONG	28817	01-0504-1891



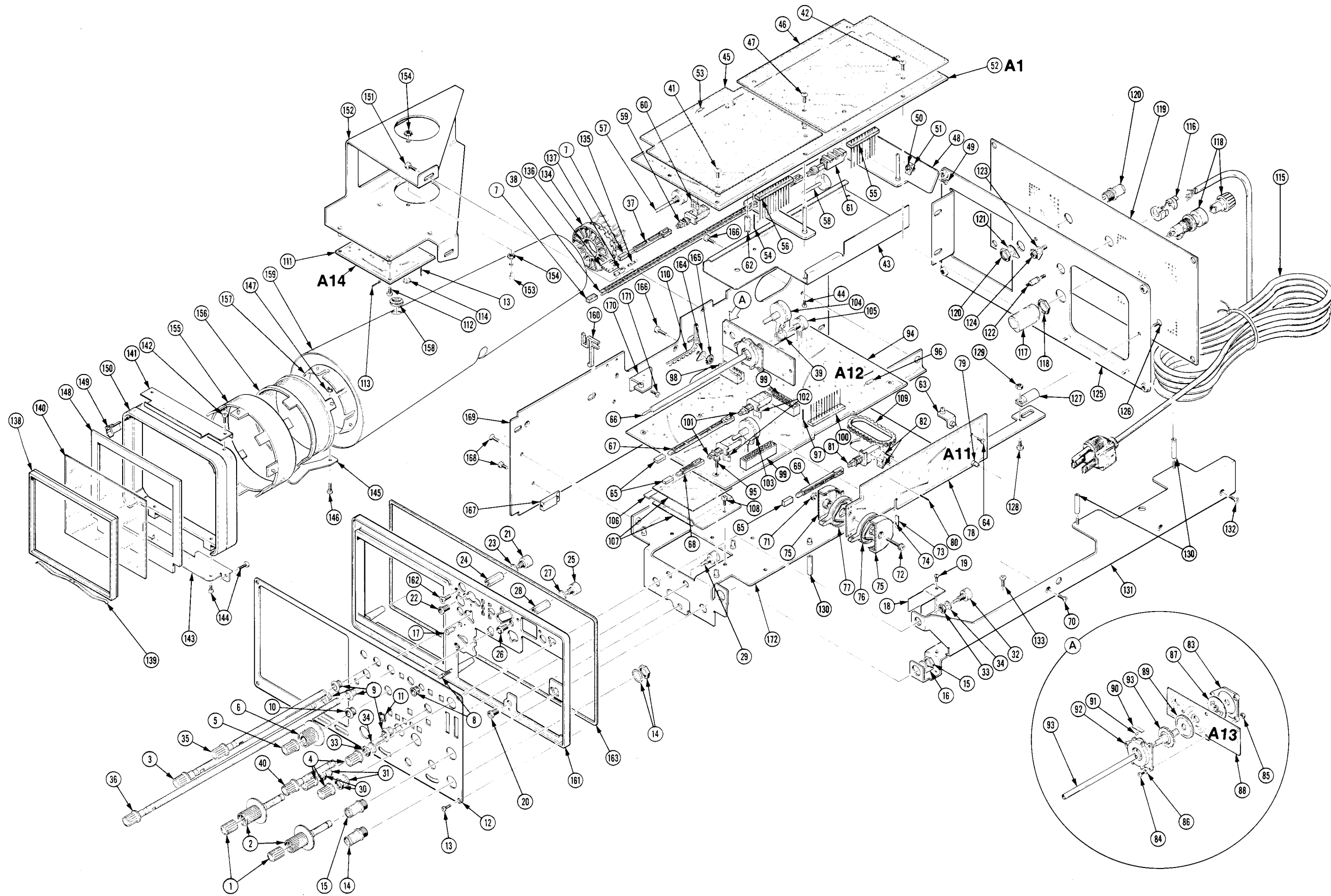


Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
2-1	366-1031-02			1		KNOB:RED,VAR,0.127ID X 0.392 OD	80009	366-1031-02
	213-0246-00			1		. SETSCREW:5-40 X 0.093 ITL BK OXD,HEX SKT	71159	0BD
-2	366-1746-00			2		KNOB:GY,VOLTS/DIV,0.588 OD,0.68 H	80009	366-1746-00
-3	384-1371-02	B010100	B023289	1		EXTENSION SHAFT:6.8" LONG,W/KNOB	80009	384-1371-02
	384-1371-07	B023290		1		EXTENSION SHAFT:6.5 L W/KNOB	80009	384-1371-07
-4	366-1660-00			3		KNOB:GRAY	80009	366-1660-00
	213-0153-00			1		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	0BD
-5	366-0493-01			1		KNOB:RED--VAR	80009	366-0493-01
	213-0246-00			1		. SETSCREW:5-40 X 0.093 ITL BK OXD,HEX SKT	71159	0BD
-6	366-1281-01			1		KNOB:GY,TIME/DIV,0.252 ID X 1.125OD	80009	366-1281-01
	213-0153-00			2		. SETSCREW:5-40 X 0.125,STL BK OXD,HEX	000CY	0BD
-7	366-1559-00			2		PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-8	-----			1		LAMP,LED:(SEE DS169 EPL)		
-9	358-0550-00			4		BUSHING,SHAFT:0.15 ID X 0.3INCH OD,PLSTC	80009	358-0550-00
-10	358-0216-00			1		BUSHING,PLASTIC:0.257 ID X 0.412 INCH OD	80009	358-0216-00
-11	426-1072-00			10		FRAME,PUSH BTN:PLASTIC	80009	426-1072-00
-12	333-2364-00			1		PANEL,FRONT:	80009	333-2364-00
						(ATTACHING PARTS)		
-13	211-0001-00	B010100	B010119	4		SCREW,MACHINE:2-56 X 0.25 INCH,PNH STL	83385	0BD
	211-0001-00	B010120		6		SCREW,MACHINE:2-56 X 0.25 INCH,PNH STL	83385	0BD
						- - - * - - - -		
-14	131-0955-00			1		CONNECTOR,RCPT,:CKT BD,28/56 CONTACT	13511	31-279
-15	131-0955-00			1		CONNECTOR,RCPT,:CKT BD,28/56 CONTACT	13511	31-279
-16	210-0255-00			1		TERMINAL,LUG:0.391" ID INT TOOTH	80009	210-0255-00
-17	136-0387-01			1		JACK,TIP:BLACK	71279	450-4252-01-0310
-18	337-2520-00			1		SHIELD,ELEC:CONNECTOR	80009	337-2520-00
						(ATTACHING PARTS)		
-19	211-0101-00			1		SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL	83385	0BD
						- - - * - - - -		
-20	136-0052-00			1		JACK,TIP:0.25-32 X 0.5,BL,BANANA	83330	21478
-21	-----			1		RES.,VAR,NONWIR:(SEE R477 EPL)		
						(ATTACHING PARTS)		
-22	358-0342-00			1		BSHG,MACH.THD:0.25 X 32 X 0.352 INCH LONG	80009	358-0342-00
-23	210-0046-00			2		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
-24	210-0471-00			1		NUT,SLEEVE:HEX.:0.312 X 0.594 INCH LONG	80009	210-0471-00
						- - - * - - - -		
-25	-----			1		RES.,VAR,NONWIR:(SEE R472 EPL)		
						(ATTACHING PARTS)		
-26	358-0342-00			1		BSHG,MACH.THD:0.25 X 32 X 0.352 INCH LONG	80009	358-0342-00
-27	210-0046-00			2		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
-28	210-0471-00			1		NUT,SLEEVE:HEX.:0.312 X 0.594 INCH LONG	80009	210-0471-00
						- - - * - - - -		
-29	-----			2		RES.,VAR,NONWIR:(SEE R4346 & R4356 EPL)		
						(ATTACHING PARTS)		
-30	210-0583-00			4		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-31	210-0046-00			4		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
						- - - * - - - -		
-32	-----			1		RES.,VAR,NONWIR:(SEE R2272 EPL)		
						(ATTACHING PARTS)		
-33	210-0583-00			2		NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-34	210-0046-00			2		WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
						- - - * - - - -		
-35	384-1371-01	B010100	B023289	1		EXTENSION SHAFT:5.2" LONG W/KNOB	80009	384-1371-01
	384-1371-06	B023290		1		EXTENSION SHAFT:5.0 L W/KNOB	80009	384-1371-06
-36	384-1371-03	B010100	B023289	1		EXTENSION SHAFT:10.7" LONG W/KNOB	80009	384-1371-03
	384-1371-08	B023290		1		EXTENSION SHAFT:10.35 L W/KNOB	80009	384-1371-08
-37	384-1370-00			1		EXTENSION SHAFT:4.68" L,MOLDED PLSTC	80009	384-1370-00
-38	384-1364-00			1		EXTENSION SHAFT:10.818" L,NYLON,BLK	80009	384-1364-00
-39	376-0051-00			1		CPLG,SHAFT,FLEX:FOR 0.125 INCH DIA SHAFTS	80009	376-0051-00
	213-0022-00			4		. SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	0BD
-40	384-1371-00	B010100	B023289	1		EXTENSION SHAFT:2.0" LONG,W/KNOB,PLASTIC	80009	384-1371-00
	384-1371-05	B023290		1		EXTENSION SHAFT:1.85 L W/KNOB	80009	384-1371-05

Replaceable Mechanical Parts—442 Service

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
2-	672-0689-00		1						CKT BOARD ASSY:INTERFACE (ATTACHING PARTS)	80009	672-0689-00
-41	211-0507-00		1						SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL	83385	OBD
-42	211-0025-00		2						SCREW,MACHINE:4-40 X 0.375 100 DEG,FLH STL - - - * - - -	83385	OBD
	342-0293-00		1						INSULATOR,SHLD:HV	80009	342-0293-00
-43	337-2484-00		1						SHIELD,ELEC:HIGH VOLTAGE (ATTACHING PARTS)	80009	337-2484-00
-44	211-0097-00		4						SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL - - - * - - -	83385	OBD
-45	337-2476-00		1						. INTERFACE ASSY INCLUDES: . SHIELD,ELEC:CIRCUIT CARD (ATTACHING PARTS)	80009	337-2476-00
	211-0025-00		5						. SCREW,MACHINE:4-40 X 0.375 100 DEG,FLH STL - - - * - - -	83385	OBD
-46	337-2483-00		1						. SHIELD,ELEC:CKT CARD,REAR (ATTACHING PARTS)	80009	337-2483-00
-47	211-0008-00		3						. SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL - - - * - - -	83385	OBD
-48	214-2635-00		1						. HEAT SINK,XSTR:(2)TO-220,ALUMINUM (ATTACHING PARTS)	80009	214-2635-00
-49	211-0213-00		2						. SCREW,MACHINE:4-40 X 0.312 INCH,PNH NYLON	23050	OBD
-50	210-0586-00		2						. NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL - - - * - - -	83385	211-041800-00
-51	342-0202-00		2						. INSULATOR,PLATE:TRANSISTOR	01295	10-21-023-106
-52	-----		1						. CKT BOARD ASSY:INTERFACE(SEE A1 EPL)		
-53	131-0566-00		1						. . BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
-54	131-0608-00		28						. . TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-55	131-2115-00		1						. . CONN,RCPT,ELEC:FD-THRU,10 MALE,TIN PLATED	27264	09-64-1129
-56	131-2116-00		2						. . CONN,RCPT,ELEC:FD-THRU,12 MALE,GOLD PLATED	27264	09-70-1129
-57	-----		1						. . RES.,VAR,NONWIR:(SEE R412 EPL)		
-58	-----		1						. . RES.,VAR,NONWIR:(SEE R468 EPL)		
-59	-----		-						. . SWITCH,PUSH:(SEE S410 EPL)		
-60	361-0608-00		2						. . SPACER,PUSH SW:PLASTIC	80009	361-0608-00
-61	-----		1						. . SWITCH,PUSH:(SEE S700 EPL)		
-62	214-0693-00		4						. . HEAT SINK, ELEC:0.25 ID X 0.75 INCH LONG	98978	TXD017-075
	198-3746-00		1						. . WIRE SET,ELEC:	80009	198-3746-00
-63	407-2083-00		1						BRACKET,ANGLE:CKT BOARD,ALUMINUM (ATTACHING PARTS)	80009	407-2083-00
-64	211-0244-00		1						SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL - - - * - - -	78189	OBD
-65	366-1559-00		3						PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-66	384-1422-00		1						EXTENSION SHAFT:8.06 L X 0.123 OD,PLASTIC	80009	384-1422-00
-67	384-1408-00		1						EXTENSION SHAFT:3.8 L,MOLDED PLASTIC	80009	384-1408-00
-68	384-1136-00		6						EXTENSION SHAFT:0.95 INCH LONG	80009	384-1136-00
-69	384-1292-00		1						EXTENSION SHAFT:2.417 INCH LONG,PLASTIC	80009	384-1292-00
	672-0775-00		1						CKT BOARD ASSY:HORIZONTAL MODULE	80009	672-0775-00
	672-0685-00		1						. CKT BOARD ASSY:TRIGGER SWITCH BD (ATTACHING PARTS)	80009	672-0685-00
-70	211-0101-00		1						. SCREW,MACHINE:4-40 X 0.25" 100 DEG,FLH STL - - - * - - -	83385	OBD
-71	210-0551-00		1						. . NUT,PLAIN,HEX.:4-40 X 0.25 INCH,STL	83385	OBD
-72	211-0240-00		1						. . SCR,ASSEM WSHR:4-40 X 0.688"PNH,STL	78189	OBD
	351-0448-01		1						. . GUIDE ,SWITCH:W/SPRING AND ROLLER	80009	351-0448-01
-73	214-1126-02		2						. . . SPRING,FLAT:RED COLORED	80009	214-1126-02
-74	214-1127-00		2						. . . ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-75	351-0448-00		2						. . . GUIDE,SW ACTR:LEVER	80009	351-0448-00
-76	263-0030-00		1						. . SW LEVER ASSY:	80009	263-0030-00
-77	214-2289-02		1						. . LEVER,SWITCH:STYLE B,W/CONTACTS	80009	214-2289-02
-78	-----		1						. . CKT BOARD ASSY:TRIGGER(SEE A11 EPL)		
-79	129-0259-00	B010100 B011358	1						. . . POST,ELEC-MECH:4-40 X 0.187 OD X 0.39" LG	80009	129-0259-00
	129-0756-00	B011359	1						. . . SPACER,POST:0.39 L,W/4-40THD THRU,BRS	80009	129-0756-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
2-80	131-0608-00		2	.	.	.	.	.	TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-81	-----		1	.	.	.	.	.	SWITCH,PUSH:(SEE S2030 EPL)		
-82	361-0690-00		2	.	.	.	.	.	SPACER,PB SW:375 INCH HIGH,PLSTC	80009	361-0690-00
	263-0051-00		1	.	.	.	.	.	SWITCH,ROTARY:PANCAKE,TIME/DIVISION	80009	263-0051-00
-83	401-0341-00		1	.	.	.	.	.	BEARING,RTRY SW:REAR,0.252 ID (ATTACHING PARTS)	80009	401-0341-00
-84	211-0185-00		3	.	.	.	.	.	SCREW,MACHINE:2-56 X 0.438",PNH,STL	07111	OBD
-85	210-0405-00		3	.	.	.	.	.	NUT,PLAIN,HEX.:2-56 X 0.188 INCH,BRS	73743	2X12157-402
-86	210-0053-00		3	.	.	.	.	.	WASHER,LOCK:INTL,0.092 ID X 0.175"OD,STL	83385	OBD
				-	-	-	-	-	* - - -		
-87	352-0423-04		1	.	.	.	.	.	HOLDER,CONTACT:ROTARY SWITCH	80009	352-0423-04
-88	-----		1	.	.	.	.	.	CIRCUIT BOARD:A SWEEP TIMING(SEE A13 EPL)		
-89	352-0423-02		1	.	.	.	.	.	HOLDER,CONTACT:4 CONTACT	80009	352-0423-02
-90	214-1126-00		2	.	.	.	.	.	SPRING,FLAT:GOLD COLORED	80009	214-1126-00
-91	214-1127-00		2	.	.	.	.	.	ROLLER,DETENT:0.125 DIA X 0.125 INCH L	80009	214-1127-00
-92	401-0340-00		1	.	.	.	.	.	BEARING,RTRY SW:FRONT,0.375 ID	80009	401-0340-00
-93	384-1367-06		1	.	.	.	.	.	SHAFT,ROTARY SW:W/DETENT,21 POSN,15 DEG	80009	384-1367-06
-94	-----		1	.	.	.	.	.	CKT BOARD ASSY:HORIZ(SEE A12 EPL) (ATTACHING PARTS)		
-95	211-0244-00		6	.	.	.	.	.	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	OBD
				-	-	-	-	-	* - - -		
			-	.	.	.	.	.	CKT BOARD INCLUDES:		
-96	131-0566-00		7	.	.	.	.	.	BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
-97	131-0608-00		10	.	.	.	.	.	TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-98	131-1801-00		1	.	.	.	.	.	CONNECTOR,RCPT,:9 CONTACTS	05574	000201-4832
-99	131-1802-00		2	.	.	.	.	.	CONNECTOR,RCPT,:15 CONTACTS	05574	000201-4831
-100	131-2116-00		1	.	.	.	.	.	CONN,RCPT,ELEC:FD-THRU,12 MALE,GOLD PLATED	27264	09-70-1129
-101	-----		2	.	.	.	.	.	SWITCH,PUSH:(SEE S2312 & S2140 EPL)		
-102	361-0542-00		4	.	.	.	.	.	SPACER,SWITCH:PLASTIC	71590	J-64281
-103	-----		1	.	.	.	.	.	RES.,VAR,NONWIR:(SEE R2138 EPL)		
-104	-----		1	.	.	.	.	.	RES.,VAR,NONWIR:(SEE R2316)		
-105	-----		1	.	.	.	.	.	RES.,VAR,NONWIR:(SEE R2269 EPL)		
-106	337-2500-00		1	.	.	.	.	.	SHIELD,ELEC:CIRCUIT CARD	80009	337-2500-00
-107	255-0427-00		2	.	.	.	.	.	PLASTIC FILM: (ATTACHING PARTS)	000EF	OBD
-108	211-0008-00		2	.	.	.	.	.	SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
				-	-	-	-	-	* - - -		
-109	255-0334-00		1	.	.	.	.	.	PLASTIC CHANNEL:12.75 X 0.175X 0.155,NYL	11897	122-37-2500
-110	255-0619-00		FT	.	.	.	.	.	PLASTIC CHANNEL:0.206 W X 0.22 H,NYLON	06915	SNGS-3
-111	-----		1	.	.	.	.	.	CKT BOARD ASSY:HOR OUTPUT(SEE A14 EPL) (ATTACHING PARTS)		
-112	211-0244-00		4	.	.	.	.	.	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	OBD
				-	-	-	-	-	* - - -		
			-	.	.	.	.	.	CKT BOARD ASSY INCLUDES:		
-113	131-0608-00		6	.	.	.	.	.	TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-114	386-1130-00		2	.	.	.	.	.	INSULATOR DISC:TRANSISTOR,NYLON	13103	7717-15N
-115	161-0049-00		1	.	.	.	.	.	CABLE ASSY,PWR,:80 INCH LONG,W/MALE CONN	80009	161-0049-00
-116	358-0323-00	B010100 B010119	1	.	.	.	.	.	BSHG,STRAIN RLF:90 DEG,0.515 DIA HOLE	28520	SR15-1
	358-0161-00	B010120	1	.	.	.	.	.	BSHG,STRAIN RLF:FOR 0.50 INCH HOLE,PLASTIC	28520	SR5P4
-117	200-0237-03		1	.	.	.	.	.	COVER,FUSE HLDR:	80009	200-0237-03
-118	352-0362-01		1	.	.	.	.	.	FUSEHOLDER:W/HARDWARE	75915	345002
-119	333-2359-00		1	.	.	.	.	.	PANEL,REAR:	80009	333-2359-00
-120	131-0955-00		1	.	.	.	.	.	CONNECTOR,RCPT,:CKT BD,28/56 CONTACT	13511	31-279
-121	210-0255-00		1	.	.	.	.	.	TERMINAL,LUG:0.391" ID INT TOOTH	80009	210-0255-00
	210-0201-00	XB010409	1	.	.	.	.	.	TERMINAL,LUG:SE #4	86928	A373-157-2
-122	131-0775-00		1	.	.	.	.	.	CONTACT,ELEC:HEX,0.25 INCH W/6-32 1 END	88245	1601-A
-123	210-0205-00		1	.	.	.	.	.	TERMINAL,LUG:SE #8 (ATTACHING PARTS)	86928	5442-7
				-	-	-	-	-	* - - -		
-124	210-0457-00		1	.	.	.	.	.	NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
	334-3379-00	XB010409	1	.	.	.	.	.	MARKER,IDENT:MARKED GROUND SYMBOL	80009	334-3379-00

Replaceable Mechanical Parts—442 Service

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
2-125	386-3811-00		1	SUBPANEL, REAR: (ATTACHING PARTS)					80009	386-3811-00	
-126	212-0040-00		3	SCREW, MACHINE: 8-32 X 0.375 100 DEG, FLH STL					83385	OBD	
	210-0458-00		2	NUT, PL, ASSEM WA: 8-32 X 0.344 INCH, STL					78189	511-081800-00	
	211-0507-00		2	SCREW, MACHINE: 6-32 X 0.312 INCH, PNH STL					83385	OBD	
				- - - * - - -							
-127	220-0595-00		4	NUT, BLOCK: 8-32 INCH THREADS (ATTACHING PARTS)					26365	OBD	
-128	211-0538-00		4	SCREW, MACHINE: 6-32 X 0.312" 100 DEG, FLH STL					83385	OBD	
-129	210-0407-00		4	NUT, PLAIN, HEX.: 6-32 X 0.25 INCH, BRS					73743	3038-0228-402	
				- - - * - - -							
-130	129-0674-00	B010100 B010119	3	SPACER, POST: 0.814, 4-40 BOTH ENDS, BRASS					80009	129-0674-00	
	129-0674-00	B010120	2	SPACER, POST: 0.814, 4-40 BOTH ENDS, BRASS					80009	129-0674-00	
	129-0202-00	XB010120	1	INSULATOR, STDF: 0.801 L, W/4-40 X 0.25					80009	129-0202-00	
-131	407-2062-00		1	BRACKET, CHASSIS: CKT CARD, ALUMINUM (ATTACHING PARTS)					80009	407-2062-00	
-132	211-0538-00		2	SCREW, MACHINE: 6-32 X 0.312" 100 DEG, FLH STL					83385	OBD	
-133	211-0008-00		3	SCREW, MACHINE: 4-40 X 0.25 INCH, PNH STL					83385	OBD	
				- - - * - - -							
-134	136-0689-00		1	SKT, PL-IN ELEK:					80009	136-0689-00	
-135	131-0707-00		9	. CONNECTOR, TERM.: 22-26 AWG, BRS & CU BE GOLD					22526	47439	
-136	352-0162-00		1	. HLDR, TERM CONN: 4 WIRE BLACK					80009	352-0162-00	
	352-0162-01		1	. CONN BODY, PL, EL: 4 WIRE BROWN					80009	352-0162-01	
-137	352-0171-02		1	. CONN BODY, PL, EL: 1 WIRE RED					80009	352-0171-02	
-138	426-0721-02		1	FRAME, LT FILTER:					80009	426-0721-02	
-139	214-1517-00		1	. SPRING, RTNG:					80009	214-1517-00	
-140	378-0678-01		1	FILTER, LT, CRT: BLUE, 4.319 X 3.531 X 0.06					80009	378-0678-01	
-141	407-2031-00		1	BRACKET, CRT: TOP, STEEL (ATTACHING PARTS)					80009	407-2031-00	
-142	211-0007-00		2	SCREW, MACHINE: 4-40 X 0.188 INCH, PNH STL					83385	OBD	
				- - - * - - -							
-143	407-2028-00		1	BRACKET, CRT: BOTTOM, STEEL (ATTACHING PARTS)					80009	407-2028-00	
-144	211-0507-00		4	SCREW, MACHINE: 6-32 X 0.312 INCH, PNH STL					83385	OBD	
				- - - * - - -							
-145	214-2300-00		1	CONTACT, ELEC: GROUNDING, BRS (ATTACHING PARTS)					80009	214-2300-00	
-146	211-0008-00		1	SCREW, MACHINE: 4-40 X 0.25 INCH, PNH STL					83385	OBD	
-147	210-0586-00		1	NUT, PL, ASSEM WA: 4-40 X 0.25, STL CD PL					83385	211-041800-00	
				- - - * - - -							
-148	348-0536-00		1	GASKET, CRT: PLASTIC					80009	348-0536-00	
-149	386-3812-00		4	SUPPORT, CRT: FRONT					80009	386-3812-00	
-150	407-2030-00		1	BRACKET, CRT MTG: POLYCARBONATE					80009	407-2030-00	
	626-0457-00		1	CRT SHIELD ASSY: (ATTACHING PARTS)					80009	626-0457-00	
-151	211-0007-00		2	SCREW, MACHINE: 4-40 X 0.188 INCH, PNH STL					83385	OBD	
				- - - * - - -							
-152	407-2029-00		1	. BRACKET, CRT: REAR, ALUMINUM (ATTACHING PARTS)					80009	407-2029-00	
-153	211-0097-00		2	. SCREW, MACHINE: 4-40 X 0.312 INCH, PNH STL					83385	OBD	
-154	210-0586-00	B010100 B010408	4	. NUT, PL, ASSEM WA: 4-40 X 0.25, STL CD PL					83385	211-041800-00	
				- - - * - - -							
	210-0586-00	B010409	3	. NUT, PL, ASSEM WA: 4-40 X 0.25, STL CD PL					83385	211-041800-00	
	220-0471-02	XB010409	3	. NUT, SHOULDERED: 4-40 X 0.375 HEX X 0.12 THK					80009	220-0471-02	
-155	-----		1	. COIL, TUBE DEFL: (SEE L472 EPL)							
-156	-----		1	. COIL, TUBE DEFL: (SEE L470 EPL)							
-157	386-3305-00		1	. SUPPORT, CRT: REAR					80009	386-3305-00	
	386-4044-00	XB010409	1	. SPRT, CRT LEAD:					80009	386-4044-00	
-158	348-0004-00		1	. GROMMET, RUBBER: 0.281 ID X 0.563 INCH OD					70485	763	
	348-0031-00	XB010409	4	. GROMMET, PLASTIC: 0.156 INCH DIA					80009	348-0031-00	
-159	337-2223-00	B010100 B010889	1	. SHIELD, ELEC: CRT					80009	337-2223-00	
	337-2223-02	B010890	1	. SHIELD, CRT:					80009	337-2223-02	

Fig. & Index No.	Tektronix Part No.	Serial/Model No.		Qty	1 2 3 4 5	Name & Description	Mfr	
		Eff	Dscont				Code	Mfr Part Number
2-160	352-0497-00			3		HOLDER,CKT CD:	80009	352-0497-00
	210-0273-00	XB010160		1		TERMINAL,LUG:0.781 INCH LONG (ATTACHING PARTS)	79963	547
	212-0070-00	XB010160	B010199	1		SCREW,MACHINE:8-32 X 0.312"100 DEG,FLH STL	83385	OBD
	211-0038-00		B010200	1		SCREW,MACHINE:4-40 X 0.312,FLH,100 DEG	83385	OBD
	210-0458-00	XB010160	B010199	1		NUT,PL,ASSEM WA:8-32 X 0.344 INCH,STL	78189	511-081800-00
	210-0586-00		B010200	1		NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL - - - * - - -	83385	211-041800-00
-161	386-1854-03			1		SUBPANEL,FRONT: (ATTACHING PARTS)	80009	386-1854-03
-162	212-0040-00			2		SCREW,MACHINE:8-32 X 0.375 100 DEG,FLH STL - - - * - - -	83385	OBD
-163	348-0276-00			1		SHLD GSKT,ELEC:0.026 OD NPRNW/WIRE NET CO	28817	01-0404-3719
-164	210-0205-00			1		TERMINAL,LUG:SE #8 (ATTACHING PARTS)	86928	5442-7
-165	210-0457-00			1		NUT,PL,ASSEM WA:6-32 X 0.312 INCH,STL	83385	OBD
-166	212-0004-00			1		SCREW,MACHINE:8-32 X 0.312 INCH,PNH STL - - - * - - -	83385	OBD
-167	220-0811-00			1		NUT BLOCK:(3)8-32 (1)4-40,1.375 L (ATTACHING PARTS)	80009	220-0811-00
-168	211-0040-00			2		SCREW,MACHINE:4-40 X 0.25",BDGH PLSTC - - - * - - -	26365	OBD
-169	441-1397-00			1		CHASSIS,SCOPE:MAIN	80009	441-1397-00
-170	407-2084-00			1		BRACKET,ANGLE:CKT BOARD,ALUMINUM (ATTACHING PARTS)	80009	407-2084-00
-171	211-0538-00			2		SCREW,MACHINE:6-32 X 0.312"100 DEG,FLH STL - - - * - - -	83385	OBD
-172	441-1398-00			1		CHASSIS,SCOPE:CIRCUIT BOARD	80009	441-1398-00
	198-4154-00			1		WIRE SET,ELEC:	80009	198-4154-00
	131-2084-00			2		. TERM,QUICK DISC:26 AWG,COPPERNICKEL	00779	5250-207-2
	352-0171-00			2		. HLDR,TERM CONN:1 WIRE BLACK	80009	352-0171-00

Replaceable Mechanical Parts—442 Service

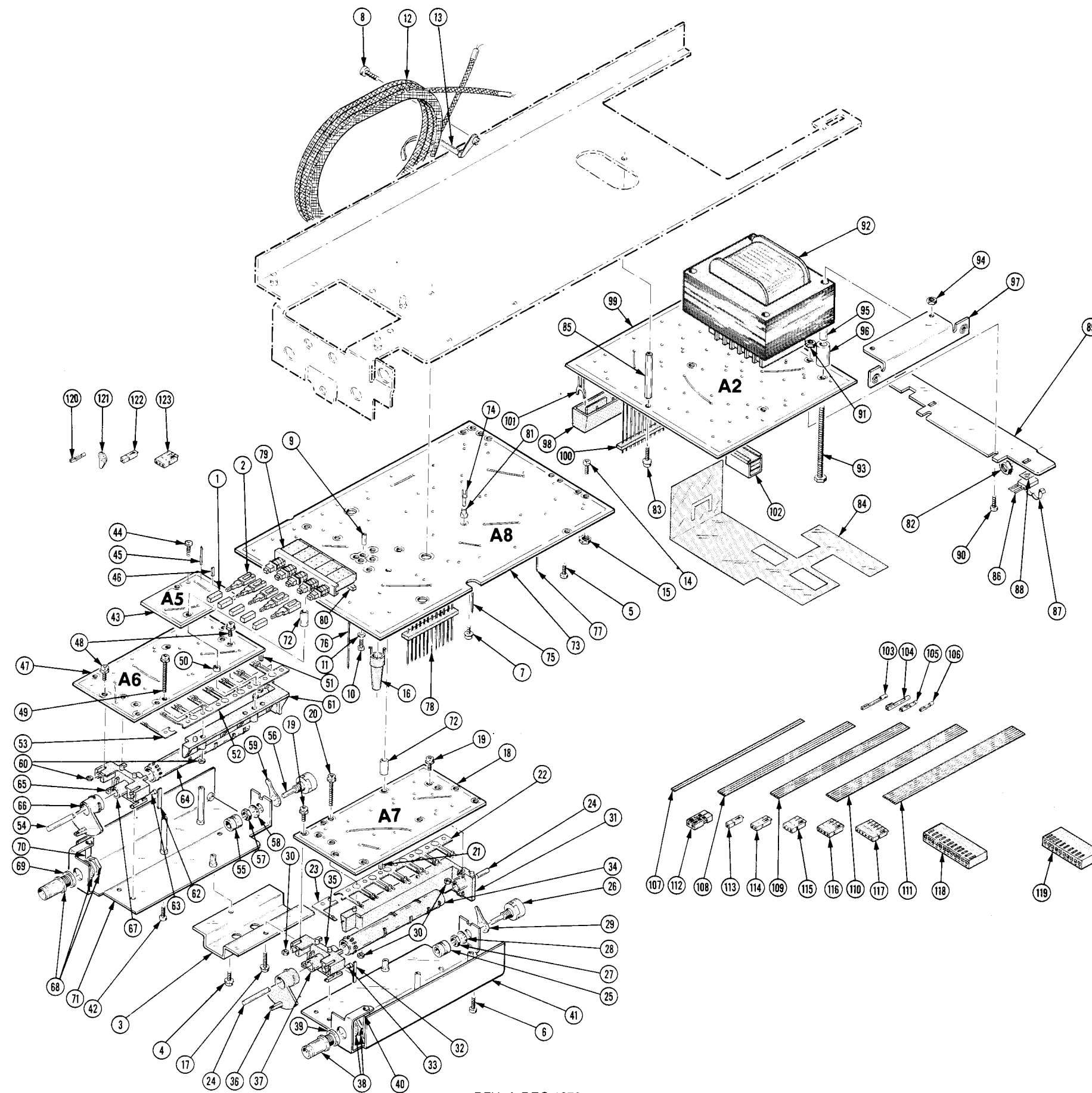
Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
3-1	366-1559-00		5		PUSH BUTTON:SIL GY,0.18 SQ X 0.43	80009	366-1559-00
-2	384-1136-00		5		EXTENSION SHAFT:0.95 INCH LONG	80009	384-1136-00
-3	337-2499-00		1		SHIELD,ELEC:CIRCUIT BOARD (ATTACHING PARTS)	80009	337-2499-00
-4	211-0097-00		1		SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL - - - * - - -	83385	OBD
	672-0674-00		1		CKT BOARD ASSY:VERTICAL (ATTACHING PARTS)	80009	672-0674-00
-5	211-0244-00		2		SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	OBD
-6	211-0021-00		3		SCREW,MACHINE:4-40 X 1.25 INCH,PNH STL	83385	OBD
-7	211-0008-00		1		SCREW,MACHINE:4-40 X 0.25 INCH,PNH STL	83385	OBD
-8	211-0507-00		3		SCREW,MACHINE:6-32 X 0.312 INCH,PNH STL - - - * - - -	83385	OBD
-9	129-0690-00		1		. CKT BOARD ASSY INCLUDES: . SPACER,POST:0.21 L,4-40 THRU THD,BRASS (ATTACHING PARTS)	80009	129-0690-00
-10	211-0205-00		1		. SCREW MACHINE:RDH SST	80009	211-0205-00
-11	210-0054-00		1		. WASHER,LOCK:SPLIT,0.118 ID X 0.212"OD STL - - - * - - -	83385	OBD
-12	-----		1		. DELAY LINE,ELEC:(SEE DL4380 EPL)		
-13	346-0121-00		3		. STRAP,ELEC COMP:TIE DOWN,5.0 LONG (ATTACHING PARTS FOR DELAY LINE)	59730	3Y-34M
-14	211-0244-00		2		. SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	OBD
-15	210-0586-00		2		. NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL - - - * - - -	83385	211-041800-00
-16	351-0456-00		2		. GUIDE,RES ADJ:PLASTIC	80009	351-0456-00
	672-0677-00		1		. CKT BOARD ASSY:ATTENUATOR,CHAN 2,W/CAM SW (ATTACHING PARTS)	80009	672-0677-00
-17	211-0166-00		1		. SCREW,MACHINE:4-40 X 1.750,PNH,STL,CD PL	83385	OBD
	210-0586-00		1		. NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL - - - * - - -	83385	211-041800-00
-18	-----		-		. . . ATTENUATOR INCLUDES: . . . ATTENUATOR,CHANNEL 2:(SEE A7 EPL) (ATTACHING PARTS)		
-19	211-0244-00		4		. . SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	OBD
-20	211-0246-00		1		. . SCR,ASSEM WSHR:4-40 X 0.625 INCH,PNH,STL - - - * - - -	78189	OBD
-21	136-0263-04		5		. . . . CKT BOARD INCLUDES: SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
-22	131-1779-02		1		. . . CONT ASSY,ELEC:CAM SW,13 CONTACT,RIGHT,CH2	80009	131-1779-02
-23	131-1779-04		1		. . . CONT ASSY,ELEC:CAM SW,1 CONTACT,RIGHT,CH2	80009	131-1779-04
-24	384-1393-00		1		. . . EXTENSION SHAFT:0.123 DIA X 6.3" L,PLSTC	80009	384-1393-00
-25	376-0051-00		1		. . . CPLG,SHAFT,FLEX:FOR 0.125 INCH DIA SHAFTS	80009	376-0051-00
	213-0022-00		4		. . . SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	OBD
-26	-----		1		. . . RES.,VAR,NONWIR:(SEE R4252 EPL) (ATTACHING PARTS)		
-27	210-0583-00		1		. . . NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-28	210-0046-00		1		. . . WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
-29	210-0223-00		1		. . . TERMINAL,LUG:0.25 INCH DIA,SE - - - * - - -	86928	A313-136
-30	210-0406-00		4		. . . NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-31	343-0565-00		1		. . . RTNR BAR,CONT:ATTENUATOR,RIGHT CH2	80009	343-0565-00
-32	214-1126-01		4		. . . SPRING,FLAT:GREEN COLORED	80009	214-1126-01
-33	214-1752-00		4		. . . ROLLER,DETENT:GREEN	80009	214-1752-00
-34	105-0679-00		1		. . . ACTUATOR,CAM SW:ATTENUATOR	80009	105-0679-00
-35	401-0338-00		1		. . . BEARING,CAM SW:FRONT	80009	401-0338-00
-36	-----		1		. . . ACTUATOR,CAM SW:(SEE S4200 EPL)		
-37	376-0174-00		1		. . . CPLG,SHAFT,RGD:0.19 ID X 0.325 OD X 0.2" H	80009	376-0174-00
-38	131-0955-00		1		. . . CONNECTOR,RCPT,:CKT BD,28/56 CONTACT	13511	31-279
-39	210-1000-00		1		. . . WASHER,FLAT:0.384 ID X 0.50" OD,AL	80009	210-1000-00
-40	361-0873-00		1		. . . SPACER,SLEEVE:1.03 L X 0.125 ID,ALUMINUM	80009	361-0873-00
-41	337-2473-00		1		. . . SHIELD,ELEC:ATTENUATOR,RIGHT	80009	337-2473-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
3-	672-0676-00			1	.	.	.	.	.	CKT BOARD ASSY:ATTENUATOR CHAN 1 (ATTACHING PARTS)	80009	672-0676-00
-42	211-0131-00			1	.	.	.	.	.	SCREW,MACHINE:4-40 X 1.875 INCH,PNH	83385	OBD
	210-0586-00			1	.	.	.	.	.	NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	83385	211-041800-00
	-----			-	.	.	.	.	.	ATTENUATOR ASSY INCLUDES:		
-43	-----			1	.	.	.	.	.	CKT BOARD ASSY:ATTENUATOR SHIFT(SEE A5 EPL) (ATTACHING PARTS)		
-44	211-0017-00			1	.	.	.	.	.	SCREW,MACHINE:4-40 X 0.375 INCH,PNH STL	83385	OBD
	-----			-	.	.	.	.	.	CKT BOARD ASSY INCLUDES:		
-45	131-0589-00			5	.	.	.	.	.	TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-46	136-0263-04			5	.	.	.	.	.	SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
-47	-----			1	.	.	.	.	.	CKT BOARD ASSY:ATTEN CHANNEL' 1(SEE A6 EPL) (ATTACHING PARTS)		
-48	211-0244-00			4	.	.	.	.	.	SCR,ASSEM WSHR:4-40 X 0.312 INCH,PNH STL	78189	OBD
-49	211-0246-00			1	.	.	.	.	.	SCR,ASSEM WSHR:4-40 X 0.625 INCH,PNH,STL	78189	OBD
-50	361-0735-00			1	.	.	.	.	.	SPACER,CKT BD:0.25"OD X 0.093" H,PLSTC	80009	361-0735-00
	-----			-	.	.	.	.	.	CKT BOARD ASSY INCLUDES:		
-51	136-0263-04			5	.	.	.	.	.	SOCKET,PIN TERM:FOR 0.025 INCH SQUARE PIN	22526	75377-001
-52	131-1779-01			1	.	.	.	.	.	CONT ASSY,ELEC:CAM SW,13 CONTACT,LEFT,CH1	80009	131-1779-01
-53	131-1779-03			1	.	.	.	.	.	CONT ASSY,ELEC:CAM SW,1 CONTACT,LEFT,CH1	80009	131-1779-03
-54	384-1393-00			1	.	.	.	.	.	EXTENSION SHAFT:0.123 DIA X 6.3" L,PLSTC	80009	384-1393-00
-55	376-0051-00			1	.	.	.	.	.	CPLG,SHAFT,FLEX:FOR 0.125 INCH DIA SHAFTS	80009	376-0051-00
	213-0022-00			4	.	.	.	.	.	SETSCREW:4-40 X 0.188 INCH,HEX SOC STL	74445	OBD
-56	-----			1	.	.	.	.	.	RES.,VAR,NONWIR:(SEE R4152 EPL) (ATTACHING PARTS)		
-57	210-0583-00			1	.	.	.	.	.	NUT,PLAIN,HEX.:0.25-32 X 0.312 INCH,BRS	73743	2X20317-402
-58	210-0046-00			1	.	.	.	.	.	WASHER,LOCK:0.261 ID,INTL,0.018 THK,BRS	78189	1214-05-00-0541C
-59	210-0223-00			1	.	.	.	.	.	TERMINAL,LUG:0.25 INCH DIA,SE	86928	A313-136
	-----			-	.	.	.	.	.	CKT BOARD ASSY INCLUDES:		
-60	210-0406-00			4	.	.	.	.	.	NUT,PLAIN,HEX.:4-40 X 0.188 INCH,BRS	73743	2X12161-402
-61	343-0564-00			1	.	.	.	.	.	RTNR BAR,CONT:ATTENUATOR,LEFT CH1	80009	343-0564-00
-62	214-1126-01			4	.	.	.	.	.	SPRING,FLAT:GREEN COLORED	80009	214-1126-01
-63	214-1752-00			4	.	.	.	.	.	ROLLER,DETENT	80009	214-1752-00
-64	105-0679-00			1	.	.	.	.	.	ACTUATOR,CAM SW:ATTENUATOR	80009	105-0679-00
-65	401-0338-00			1	.	.	.	.	.	BEARING,CAM SW:FRONT	80009	401-0338-00
-66	-----			1	.	.	.	.	.	DRUM,CAM SWITCH:(SEE S4100 EPL)		
-67	376-0174-00			1	.	.	.	.	.	CPLG,SHAFT,RGD:0.19 ID X 0.325 OD X 0.2" H	80009	376-0174-00
-68	131-0955-00			1	.	.	.	.	.	CONNECTOR,RCPT,:CKT BD,28/56 CONTACT	13511	31-279
-69	210-1000-00			1	.	.	.	.	.	WASHER,FLAT:0.384 ID X 0.50" OD,AL	80009	210-1000-00
-70	361-0873-00			1	.	.	.	.	.	SPACER,SLEEVE:1.03 L X 0.125 ID,ALUMINUM	80009	361-0873-00
-71	337-2474-00			1	.	.	.	.	.	SHIELD,ELEC:ATTENUATOR,LEFT	80009	337-2474-00
-72	361-0886-00			2	.	.	.	.	.	SPACER,SLEEVE:0.613 L X 0.132 ID,BRASS	80009	361-0886-00
-73	-----			1	.	.	.	.	.	CKT BOARD ASSY:VERTICAL(SEE A8 EPL)		
-74	131-0433-00			2	.	.	.	.	.	TERMINAL,FEEDTH:0.057 ID X 0.42" LONG,BRS	88245	421572-9
-75	131-0589-00			5	.	.	.	.	.	TERM,PIN:0.46 L X 0.025 SQ.PH BRZ GL	22526	47350
-76	131-0592-00			5	.	.	.	.	.	CONTACT,ELEC:0.885 INCH LONG	22526	47353
-77	131-0608-00	B010100	B010119	11	.	.	.	.	.	TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
	131-0608-00	B010120	B010194	12	.	.	.	.	.	TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
	131-0608-00	B010195		13	.	.	.	.	.	TERMINAL,PIN:0.365 L X 0.025 PH BRZ GOLD	22526	47357
-78	131-2116-00			1	.	.	.	.	.	CONN,RCPT,ELEC:FD-THRU,12 MALE,GOLD PLATED	27264	09-70-1129
	131-0566-00	XB010409		1	.	.	.	.	.	BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	55210	L-2007-1
-79	-----			1	.	.	.	.	.	SWITCH,PUSH:(SEE S4320 EPL)		
-80	361-0542-00	B010100	B010119	4	.	.	.	.	.	SPACER,SWITCH:PLASTIC	71590	J-64281
	361-0542-00	B010120		10	.	.	.	.	.	SPACER,SWITCH:PLASTIC	71590	J-64281
-81	358-0136-00			2	.	.	.	.	.	INSULATOR,BSHG:	88245	420971
	198-4034-00	XB010409		1	.	.	.	.	.	WIRE SET,ELEC:	80009	198-4034-00
	210-0201-00	XB010409		1	.	.	.	.	.	TERMINAL,LUG:SE #4	86928	A373-157-2
	198-3802-00	B010100	B010786	2	.	.	.	.	.	WIRE SET,ELEC:	80009	198-3802-00
	198-3802-01	B010787		1	.	.	.	.	.	WIRE SET,ELEC:	80009	198-3802-01
	198-4153-00			1	.	.	.	.	.	WIRE SET,ELEC:	80009	198-4153-00

Replaceable Mechanical Parts—442 Service

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
3-	131-0707-00		2	.	CONNECTOR, TERM.: 22-26 AWG, BRS& CU BE GOLD	22526	47439
	352-0169-00		1	.	HLDR, TERM CONN: 2 WIRE BLACK	80009	352-0169-00
	200-2439-00	XB022407	2	.	COVER, XSTR: TEMP STABILIZER	80009	200-2439-00
	672-0675-00		1	.	CKT BOARD ASSY: POWER SUPPLY (SEE A2 EPL) (ATTACHING PARTS)		
	211-0538-00		2	.	SCREW, MACHINE: 6-32 X 0.312" 100 DEG, FLH STL	83385	OBD
-82	210-0457-00		2	.	NUT, PL, ASSEM WA: 6-32 X 0.312 INCH, STL	83385	OBD
-83	211-0244-00		1	.	SCR, ASSEM WSHR: 4-40 X 0.312 INCH, PNH STL - - - * - - -	78189	OBD
-84	337-2302-00		1	.	SHIELD, ELEC: LV POWER CARD	80009	337-2302-00
-85	129-0678-00		1	.	SPACER, POST: 1.318 L, 4-40 BOTH ENDS, BRASS - . POWER SUPPLY ASSY INCLUDES:	80009	129-0678-00
-86	-----		3	.	TRANSISTOR: (SEE Q736, Q756, Q776 EPL)		
-87	344-0236-01		2	.	CLIP, SPR TNSN: TRANSISTOR MOUNTING	80009	344-0236-01
	253-0202-00		FT	.	INSUL TAPE, ELEC: POLYIMIDE	99742	221
-88	342-0202-00		3	.	INSULATOR, PLATE: TRANSISTOR	01295	10-21-023-106
-89	214-2622-00		1	.	HEAT SINK, XSTR: (3) TO-220, ALUMINUM (ATTACHING PARTS)	80009	214-2622-00
-90	211-0008-00		2	.	SCREW, MACHINE: 4-40 X 0.25 INCH, PNH STL	83385	OBD
-91	210-0586-00		2	.	NUT, PL, ASSEM WA: 4-40 X 0.25, STL CD PL - - - * - - -	83385	211-041800-00
-92	-----		1	.	XFMR, PWR, STPDN: (SEE T700 EPL) (ATTACHING PARTS)		
-93	212-0515-00		4	.	SCREW, MACHINE: 10-32 X 2.250" HEX. HD STL	83385	OBD
-94	220-0572-00		4	.	NUT, PLAIN, HEX.: 10-32 X 0.25 INCH, PL BRS	73743	OBD
-95	166-0457-00		4	.	INSUL SLVG, ELEC: 0.19 ID X 1.875" LONG MYLAR - - - * - - -	80009	166-0457-00
-96	361-0877-00	B010100 B011276	4	.	SPACER, SLEEVE: 0.625 L X 0.31 ID, ALUMINUM	80009	361-0877-00
	361-0877-01	B011277	4	.	SPACER, SLEEVE: 0.65 L X 0.31 ID, ALUMINUM	80009	361-0877-01
-97	407-2035-00		1	.	BRACKET, XFMR: CKT BOARD, ALUMINUM	80009	407-2035-00
-98	352-0425-00		1	.	FUSEHOLDER: PLASTIC	80009	352-0425-00
	337-2692-00	XB022448	1	.	SHIELD, ELEC: CKT BD, FIBER	80009	337-2692-00
-99	-----		1	.	CKT BOARD ASSY: POWER SUPPLY (SEE A2 EPL)		
-100	131-1750-00	B010100 B022729	1	.	TERM., FEED THRU: 10 PIN INSULATED	27264	09-64-1103
	131-1750-01	B022730	1	.	TERM. FEEDTHRU: 8 PIN INSULATED	80009	131-1750-01
	131-0608-00	XB010787	2	.	TERMINAL, PIN: 0.365 L X 0.025 PH BRZ GOLD	22526	47357
-101	344-0154-00		2	.	CLIP, ELECTRICAL: FUSE, CKT BD MT	80009	344-0154-00
-102	-----		1	.	SW, SLIDE: DPDT, 3A, 125VAC (SEE S701, 705 EPL)		
	198-4152-00		1	.	WIRE SET, ELEC:	80009	198-4152-00
	198-3704-00		1	.	WIRE SET, ELEC:	80009	198-3704-00
-103	131-0707-00		5	.	CONNECTOR, TERM.: 22-26 AWG, BRS& CU BE GOLD	22526	47439
-104	131-1790-00		4	.	CONTACT, ELEC: 18-24 AWG, FEMALE, BRASS	27264	08-56-0105
-105	131-1810-00		2	.	CONTACT, ELEC: FEMALE, FOR 0.025 SQ PIN	00779	87124-1
-106	131-2084-00		1	.	TERM, QUICK DISC: 26 AWG, COPPERNICKEL	00779	5250-207-2
-107	175-0825-00		FT	.	WIRE, ELECTRICAL: 2 WIRE RIBBON	80009	175-0825-00
-108	175-0827-00		FT	.	CABLE, SP, ELEC: 4, 26 AWG, STRD, PVC JKT, RBN	08261	SS04267(1061)OC
-109	175-0860-00		FT	.	WIRE, ELECTRICAL: 5 WIRE RIBBON	08261	SS-0522-1910610C
-110	175-0829-00		FT	.	WIRE, ELECTRICAL: 6 WIRE RIBBON	08261	SS-0626-710610C
-111	175-0858-00		FT	.	WIRE, ELECTRICAL: 7 WIRE RIBBON	08261	SS-0722-1910610C
-112	204-0675-00		2	.	CONN BODY, PLUG: 1 LKG CLIP POZ, 0.025 SQ PIN	00779	87175-2
-113	352-0171-00		1	.	HLDR, TERM CONN: 1 WIRE BLACK	80009	352-0171-00
	352-0171-01		1	.	CONN BODY, PL, EL: 1 WIRE BROWN	80009	352-0171-01
-114	352-0169-00		1	.	HLDR, TERM CONN: 2 WIRE BLACK	80009	352-0169-00
	352-0169-01		1	.	HLDR TERM CONN: 2 WIRE, BROWN	80009	352-0169-01
-115	352-0161-02		2	.	CONN BODY, PL, EL: 3 WIRE RED	80009	352-0161-02
-116	352-0162-00		1	.	HLDR, TERM CONN: 4 WIRE BLACK	80009	352-0162-00
-117	352-0164-00		1	.	CONN BODY, PL, EL: 6 WIRE BLACK	80009	352-0164-00
-118	352-0461-00		4	.	HLDR, TERM. CONN: 12 FEMALE, NYLON	27264	09-50-7121
-119	352-0462-00		2	.	HLDR, TERM. CONN: 10 FEMALE, NYLON	27264	09-50-7101
	198-3803-00		1	.	WIRE SET, ELEC:	80009	198-3803-00
-120	131-0707-00		8	.	CONNECTOR, TERM.: 22-26 AWG, BRS& CU BE GOLD	22526	47439
-121	210-0255-00		1	.	TERMINAL, LUG: 0.391" ID INT TOOTH	80009	210-0255-00
-122	352-0161-00		2	.	HLDR, TERM CONN: 3 WIRE BLACK	80009	352-0161-00
-123	352-0171-00		2	.	HLDR, TERM CONN: 1 WIRE BLACK	80009	352-0171-00
	352-0169-00	XB010915	1	.	HLDR, TERM CONN: 2 WIRE BLACK	80009	352-0169-00
	131-1918-00	XB010915	1	.	CONTACT, ELEC: 22-26 AWG WIRE, CRIMP ON, BRS	27264	08-56-0107
	179-2581-00		1	.	WIRING HARNESS, :MAIN	80009	179-2581-00

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
	010-6108-03			2						PROBE,VOLTAGE:10X,1 METER,W/O GND & RDOUT	80009	010-6108-03
	016-0165-00			1						POUCH,ACCESSORY:W/HARDWARE	80009	016-0165-00
	200-1203-00			1						COVER,FRONT:	80009	200-1203-00
	-----			-						(SEE MECHANICAL PARTS LIST FIG 1-1)		
	070-2373-00			1						MANUAL,TECH:OPERATORS	80009	070-2373-00
	070-2374-01			1						MANUAL,TECH:SERVICE	80009	070-2374-01
OPTIONAL ACCESSORIES												
	016-0554-00			1						COVER,PROT:	80009	016-0554-00
	378-0677-01			1						FILTER,LT,CRT:CLEAR	80009	378-0677-01
	-----			-						(FOR PHOTOGRAPHY USED ONLY)		



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MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

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

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107 108	PG 501 - Risetime less than 3.5 ns into 50 Ω. PG 501 - 5 V output pulse; 3.5 ns Risetime	107 - Risetime less than 3.0 ns into 50 Ω. 108 - 10 V output pulse 1 ns Risetime
PG 502 replaces 107 108 111	PG 502 - 5 V output PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay	108 - 10 V output 111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay
PG 508 replaces 114 115 2101	Performance of replacement equipment is the same or better than equipment being replaced.	
PG 506 replaces 106 067-0502-01	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V. PG 506 - Does not have chopped feature.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V. 0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B 191 067-0532-01	SG 503 - Amplitude range 5 mV to 5.5 V p-p. SG 503 - Frequency range 250 kHz to 250 MHz.	190B - Amplitude range 40 mV to 10 V p-p. 0532-01 - Frequency range 65 MHz to 500 MHz.
SG 504 replaces 067-0532-01 067-0650-00	SG 504 - Frequency range 245 MHz to 1050 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
TG 501 replaces 180, 180A 181 184 2901	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time. TG 501 - Trigger output-slaved to market output from 5 sec through 100 ns. One time-mark can be generated at a time. TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously. 181 - Multiple time-marks 184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μs. 2901 - Separate trigger pulses, from 5 sec to 0.1 μs. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in instruments require TM 500-Series Power Module.

Date: 7-18-80 Change Reference: M37963

Product: 442 SERVICE EFF SN B023856-UP Manual Part No.: 070-2374-01

DESCRIPTION

REPLACEABLE ELECTRICAL PARTS AND SCHEMATIC CHANGES

CHANGE TO:

A8	670-5247-03	CKT BOARD ASSY:VERTICAL
R4174	321-0081-00	RES.,FXD,FILM:68.1 OHM,1%,0.125W
R4274	321-0081-00	RES.,FXD,FILM:68.1 OHM,1%,0.125W

R4174 and R4274 are located on the A8 VERTICAL board and are shown on VERTICAL INPUT diagram 1.

DESCRIPTION

SECTION 5 Last page

TEXT CHANGES

ADD: Selectable Components

Selecting R463 (values between 680K Ω and 2 M Ω) and R469 (values between 1 M Ω and 10 M Ω).

WARNING

High voltages are present in the area of R463 and R469. Before touching or soldering or unsoldering components in this circuit, disconnect instrument ac input power and use an insulated tool or wire to discharge the junction of R463-C463 to chassis ground.

R463 is selected to eliminate any intensity modulation that is visible when operating in CHOP mode at slow sweep speeds (SEC/DIV at 2m or slower). R469 is selected (after intensity modulation has been eliminated) so that during X-Y operation when INTENSITY is set fully counterclockwise the displayed dot will extinguish within 15 minutes after instrument turn-on.

Correct values are selected during manufacture of the instrument and should not require changing unless there has been a major repair such as a cathode ray tube replacement. To check operation and select values of either resistor, perform the following steps:

1. With no signal applied, turn the instrument on, select CHOP vertical operation, AUTO triggering, and set SEC/DIV to 2m. Set INTENSITY for a barely visible display.
2. CHECK--For no intensity modulation on the chopped waveform. If intensity modulation is present proceed to Step 5.
3. If no intensity modulation is noted, set INTENSITY fully counterclockwise and set TRIGGERING SOURCE to X-Y.
4. CHECK--That displayed dot extinguishes within 15 minutes of instrument turn-on.
5. If checks in either steps 2 or 4 are unsatisfactory, install a 10 megohm value for R469 and a 680 kilohm value for R463. Set controls per Step 3 and increase the value of R463 in steps (to the next higher nominal value) until the dot just

DESCRIPTION

appears, then repeat steps 1 and 2. If intensity modulation is now eliminated, permanently install the new value of R463. If intensity modulation is noted, install the next higher nominal value for R463, repeat steps 1 and 2, and if intensity modulation is now OK, permanently install the latest R463 value.

6. If the Step 2 check is OK, repeat steps 3 and 4. If Step 4 check is also OK the selection process is completed. If the Step 4 check is unsatisfactory, proceed to Step 7.

7. To select R469, reduce its value (to the next lower nominal value) in steps while repeating Steps 3 and 4 until satisfactory results are obtained. Repeat Steps 1 through 7 as necessary.

REPLACEABLE ELECTRICAL PARTS & SCHEMATIC CHANGES

CHANGE TO:

R463 SELECTED (NOMINAL VALUE 910KΩ)

R469 SELECTED (NOMINAL VALUE 10MΩ)

R463 and R469 are located on the A1 INTERFACE board and are shown on VERTICAL OUTPUT, CRT & PROBE ADJ diagram 3.

Date: 10-16-80 Change Reference: M41860

Product: 442 EFF SN B024470 Manual Part No.: 070-2374-01

DESCRIPTION

CHANGE TO: REPLACEABLE ELECTRICAL PARTS AND SCHEMATIC CHANGES

A12	670-5350-03	CKT BOARD ASSY:HORIZONTAL
C2322	281-0611-00	CAP.,FXD,CER DI:2.7PF,+/-0.25PF,500V
R2310	321-0160-00	RES.,FXD,FILM:453 OHM,1%,0.125W
R2317	315-0511-00	RES.,FXD,CMPSN:510 OHM,5%,0.25W

REMOVE:

RT2310	307-0477-00	RES.,THERMAL:1K OHM,10%,6MW/DEG C
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The above parts are located on the HORIZONTAL circuit board assembly and are shown on diagram 5 SWEEP & HORIZONTAL AMPLIFIER.